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ELECTRONICS WORLD

THE ESSENTIAL ELECTRONIC ENGINEERING MAGAZINE

FOCUS
THE CHIPLET APPROACH

LFSR
GENERATING COMPLEX CODES

TEST AND MEASUREMENT

SPECIAL REPORT

TECHNOLOGY
FIRST 45NM TEST CHIPS READY

UKDL
THE FAR EAST ADVANCES IN LED TECHNOLOGY

TIPS 'N' TRICKS
WIN A MICROCHIP PICDEM 4 DEMO BOARD

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YOUR CHANCE TO PARTICIPATE IN ELECTRONICS WORLD'S WEB CREATION

Dear Readers,

Electronics World has changed shape yet again – as you have already noticed by its new format and design. We have done this to keep Electronics World modern, in keeping with current times.

We are also developing a comprehensive website, which will allow readers to get to their copy of the magazine faster, search old material, read the latest technology developments and design techniques, but also communicate with each other through forums, blogs and specific virtual communities.

And this is exactly the point where I want to invite you all to participate. Since *Electronics World* readers have always been very interactive, communicating their needs, wishes, praises and, indeed, complaints to us, I thought that this would be the perfect opportunity for you to tell us what you think are the key elements of a website that will cater for your needs exactly.

Indeed we do have many ideas ourselves that we can implement straight away, but to make this website your first port of call on the Internet, it will need your input.

To start with, we would like to hear your ideas of what you'd like to see on the new website – what do you think will help you at your work, with your projects or you'd simply like to see more of.

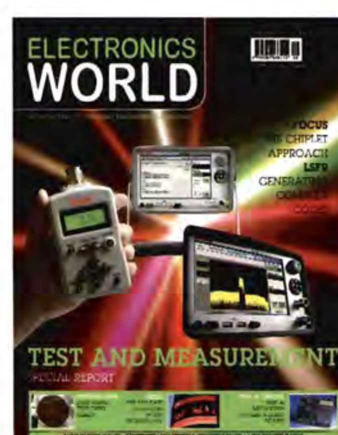
We are thinking of creating some five or six main categories of topics that we could split the content in, and where you will find your specific virtual community or space to read about your chosen subjects. These could be application specific, discipline specific or technology specific. Following that, we will keep you updated by emails (this is optional, of course) whenever new content arrives in that virtual space.

WE WOULD LIKE TO CREATE SOME FIVE OR SIX MAIN CATEGORIES OF TOPICS THAT WE COULD SPLIT THE CONTENT IN

Let us know what you'd like these categories to be, but also every other idea that you'd like to see on the new *Electronics World* website.

So, go on, put your thinking caps on and email those ideas to me at: **svetlana.josifovska@stjohnpatrick.com**

From your editor,
Svetlana Josifovska



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IMEC announces fully reconfigurable software defined radio transceiver

A wideband software defined radio transceiver from IMEC, called Scaldio, uses a CMOS 130nm IC to cover all standards over the 174MHz to 6GHz frequency range. It is widely programmable for operation with all current and future cellular WLAN, WPAN, broadcast and positioning standards.

The current state of the art multi-mode terminals have a limited flexibility of two or three standard modes and also suffer from increased power consumption and materials cost owing to the lack of re-use of building blocks. IMEC's unique transceiver architecture enables its multi-mode receiver to operate with a power consumption and a CMOS chip area that are comparable to the best current single mode radio transceivers, thus enabling it to satisfy the needs of the next generation of volume mobile devices.

The front-end of the transceiver includes a fully reconfigurable direct conversion receiver, transmitter and two synthesisers. Direct conversion is used to permit reconfiguration from 174MHz to 6GHz. The performance of each block can be digitally adjusted for a wide range of specifications by using a novel form of analogue network on a chip. Specific requirements for different standards can thus be obtained, including RF carrier frequency, channel bandwidth, noise figure, linearity, filter characteristics, etc.

If desired, the power consumption of the front-end can be significantly reduced by exploiting real time power-performance trade off, if this satisfies the conditions of the environment.

New mixed-signal control, calibration and compensation techniques are used to relax the specifications in the analogue domain and hence reduce the cost of the analogue circuit design.

The Scaldio software defined radio transceiver from IMEC

Fujitsu Chip Validates Toric's Jitter Suppression Technology

Fujitsu Microelectronics Europe and Toric Limited, a London-based technology licensing company, have announced the results of their collaboration to verify embedded jitter-suppressing macros based on Toric's patented AJC (Anti-Jitter Cell) technology. Fujitsu's test chip, implemented in 90nm technology, demonstrates jitter suppression of 6:1 at 500MHz.

AJC provides the foundation for Toric's first product, 'PhaseFilter' a low-power, on-chip circuit for the suppression of jitter in clock signals. The design uses only generic building blocks and so can readily be implemented in a wide range of semiconductor technologies. On a typical advanced mixed-signal CMOS process, with an operating frequency in excess of 1GHz, macros with a 2:1 tracking range and -150dBc/Hz plateau noise (far from carrier) are achievable.

PhaseFilter can enhance the performance of ICs in a wide range of applications including RF (LO) synthesis, serial communications, low-power PLLs and digital audio. Direct benefits include reduced system power and silicon area. Equally important is the potential for lower bill of materials and shorter development cycles, both of which enable significant reduction in total solution cost compared with conventional jitter suppression techniques.

TAIWANESE LED INDUSTRY ASSOCIATION FORMED

The Taiwan Optoelectronic Semiconductor Industry Association (TOSIA) was formed in Taipei this spring by the Industrial Technology Research Institute and 14 Taiwan LED makers and chipmakers. It aims to strengthen Taiwan's LED industry by increasing cooperation and exchanges amongst companies and researchers involved in the optoelectronics and semiconductor industries by upgrading the R&D of new technologies. It will push for the establishment of standards in the optoelectronics and semiconductor industries, sponsor conferences that are conducive to enhancing the industry's development, promote technological cooperation on an international basis and help the Taiwan administration enact relevant policies to help the industry's progress.

A senior technology adviser to the Ministry of Economic Affairs said the ministry will continue to help propel the development of lighting and optoelectronic display products and applications. The aim is to eventually make Taiwan a leader in this sector.

PROGRAMME TO EVALUATE RADIATION EFFECTS ON MILITARY COMPONENTS

A study to be undertaken by QinetiQ in the UK will assess the potential vulnerabilities of advanced components within military equipment to naturally occurring radiation. The results of this study, funded by a £1.9m 5-year contract from the UK Ministry of Defence (MOD), will enable the MOD to manage the likely impact of exposure to naturally occurring radiation earlier in the equipment design and development cycle, thus avoiding subsequent resulting time and cost problems.

It is becoming increasingly understood that naturally occurring radiation can cause reliability issues for the advanced components used in various systems operating at high altitudes, such as aircraft, unmanned systems and missiles. Even at sea level the natural radiation can potentially cause problems for ground based equipment, possibly causing component failure and hence system level problems.

Commercially sourced components, such as high-density memories, gate arrays, processors and microelectro-mechanical systems (MEMS) are increasingly being used in military equipment, but unlike many components designed specifically for military use, they are seldom hardened against exposure to radiation. Hence, it is important to understand how such equipment will behave in various environments in order to evaluate its reliability and to design out problems early in the equipment development.

Results of the study will enable the MOD to accurately predict the reliability of electronic equipment at altitudes from 100,000 feet down to sea-level. It will include the effects of solar particle events on military systems due to sudden activity on the surface of the Sun, which can raise radiation levels by up to 1000 times their normal values. The potential effect of the ever-present background radiation, which peaks at 60,000 feet, will also be assessed.

The military use of advanced electronics developed commercially is a reality, but component failure in a fast jet is potentially far more serious than in a home PC. Components need to be sufficiently robust to perform the challenging tasks demanded of them and this study will be an important contribution towards ensuring future equipment programmes are not compromised.

Synthetic diamond to be used in electronic device fabrication

Novel devices based on synthetic diamond films formed by Chemical Vapour Deposition (CVD) are to be produced for customised detector applications. The detectors will initially be aimed at the four main markets: high energy physics, including work for the Large Hadron Collider at CERN and the large UK 'Diamond' light source; the detection of deep UV photons, including photolithography applications and cleaning in semiconductor manufacture; monitoring in the nuclear industry for alpha, beta and gamma radiation detection; and dosimetry detectors for use in medical radiotherapy.

"Diamond has long been recognised as a semiconductor material that can detect many types of radiation from UV and X rays to particle detection," said Kevin Oliver, Technical Director of Diamond Detectors Ltd, a spin-out company set up by Element Six at Ascot, UK. "The ability to make diamond material of the size, quality and consistency required for advanced detection applications opens up significant new potential markets for novel detectors in a wide range of industries. It also enables us to overcome the inherent problems associated with the selection of appropriate natural diamonds in existing detector applications."

The parent company, Element 6, is also collaborating with the Institute of Photonics of the University of Strathclyde in a Micromachined Diamond Device Initiative (MIDDI), the aim of which is to develop a kit of manufacturing technologies for high power and high frequency devices based on single crystal synthetic diamond. Electronic devices based on diamond, such as MESFETs, have a wide range of potential applications in communications and power switching.

It is expected that recent breakthroughs in CVD processing for diamond synthesis will enable the really remarkable properties of synthetic diamond as an engineering material to be more fully exploited in a wide range of future products, instead of being used mainly as an abrasive material.

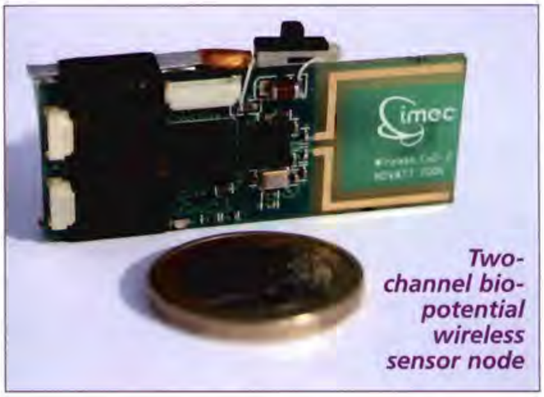
IN BRIEF

● A recent study by the tracking firm comScore has found that some 122 million Europeans use the Internet each day. The Netherlands has the highest net penetration, with 83% of the country online, followed by Sweden and Norway with 70%.
Although the average European accesses the Internet every 16.5 day, the UK had the most active online population, spending more than 34.4 hours online each month and a peak of more than 21.8 million people online in any given day.
At the other end of the scale however are Spain with a 39% of the population online, followed by Italy with 36% and Russia with only 11%.

● European IT workers are not being held responsible for delivering projects late, states a new study which was conducted by HP and the Economist Intelligence Unit (EIU). The study, for which some 1125 professionals were contacted worldwide, suggests that 51% of European IT professionals do not feel their jobs are at risk for delivering a project late, compared to 33% in Asia and 22% in the Americas.
Sweden was the most likely country for a project to be delivered on time in Europe with 44%, whilst Spain and Russia the least likely, with only 4% chance of a project being delivered on time. The UK came sixth with 11%.
The three most common causes for delay were outsourcing, changing priorities half way through a project and poor co-ordination between managers.

● A particle physicist is aiming to popularise physics by offering his first novel, a crime thriller set in a physics institute, for free as a downloadable e-book on the Internet. According to the author Dr Nick Evans of the University of Southampton's School of Physics and Astronomy, the aim for the book entitled '*The Newtonian Legacy*' is to communicate science knowledge and an insight into physics with "relatively little pain". "I don't think the science is hard to follow because the basic theories behind physics are elegantly simple. But the book is challenging and readers will have to think a little," he added.
The inspiration for the thriller came from the new physics likely to emerge when the world's largest particle accelerator and collider – the Large Hadron Collider – is switched on at the end of 2007. The book can be found at **www.hep.phys.soton.ac.uk/~evans/NL**

Body sensors transmit data wirelessly to a central monitor



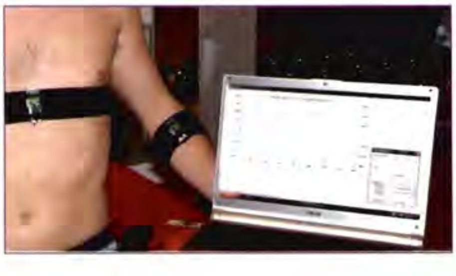
Two-channel bio-potential wireless sensor node

Dual channel and eight channel sensor systems can monitor various vital body signs and transmit the resulting data wirelessly to a central monitor. Developed by IMEC (Inter-University Microelectronics Centre, Leuven, Belgium) and its sister company, IMEC Nederland, the small size and low power consumption of both systems permit non-invasive and ambulatory monitoring of vital body parameters.

The eight channel wireless EEG system is integrated into a 1.35cm cube by using IMEC's 3D system-in-a package technology. It can be used with a portable electrocardiogram (ECG) to monitor the activity of the heart, with an electromyogram (EMG) to monitor muscle contraction, with an electroencephalogram (EEG) to monitor brain waves and with an electroculogram (EOG) to monitor eye movement.

The small size and autonomy of the systems improves the patient's quality of life and autonomy, while opening new applications for sports, entertainment, comfort monitoring and other health and lifestyle products and services.

ECG and EMG monitoring using IMEC's two-channel bio-potential wireless sensor node



Both systems use IMEC's proprietary extremely low power bio-potential readout ASICs to extract the data produced in the measurements, while consuming only 60μW for a single channel and 300μW for the eight channel version. The high common mode rejection ratio of over 120dB is required to cope with the common mode interference in the μV signals.

The two channel system integrates two of the single channel bio-potentials, enabling the simultaneous monitoring of two signals with a commercial microprocessor and a 2.4GHz radio link. It includes a loop antenna adapted to the human body that offers a range of up to 10m. Applications include monitoring of sleep, activity and muscle fatigue and rehabilitation monitoring.

The eight channel wireless EEG system requires only 6.6mW of power, 70% of which is for the radio at a 512Hz sampling rate, providing 60 hours of autonomous operation from a 150mA-hr Li-ion battery.

IMEC intends to further research the integration of its ultra low power, ultra wide band radio to further improve the system autonomy. It aims at complete energy autonomy by integrating energy scavengers, such as thermal scavengers that use body heat to generate the required power.

IN BRIEF

● Freescale Semiconductor unveiled one of the world's highest-power LDMOS RF transistors at the recent MTT-S International Microwave Symposium. The MRF6VP11KH delivers pulsed RF output power of 1kW at 130MHz and features the highest drain efficiency and power gain of any device in its class. It operates at 50V, offers distinct advantages over bipolar and MOSFET devices and provides the power required for equipment such as Magnetic Resonance Imaging (MRI) systems, CO2 lasers, plasma generators and other systems.
The high gain drastically reduces the number of parts required by up to 70% versus traditional designs.
Designed for operation from 10-150MHz, the transistor is based on Freescale's sixth-generation, very high-voltage (VHV6) laterally diffused metal oxide semiconductor (LDMOS) technology.

● Mobile phone maker Nokia is planning a new feature for its handsets called Visual Radio. The existing FM signal from a radio station will be enabled to carry enhancements such as information, pictures and interactive content for competitions, votes and rating. The visual channel content is run from a computer at the radio station and sends out different kinds of information to the handset depending on what is being played.
Initially, Nokia will offer the Visual Radio capability in two of its handsets – the 3230 and 7710. It is estimated that there will be some 100 million Visual Radio enabled mobile phones in circulation by the end of 2006.

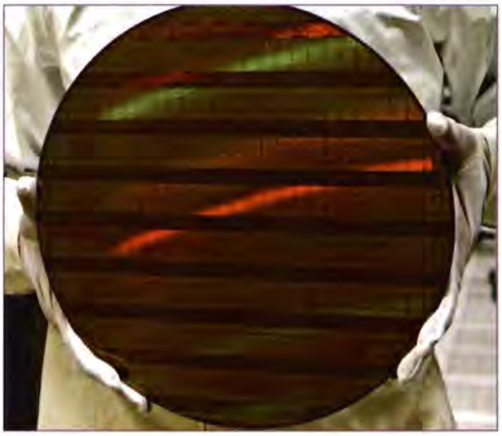
● The Technology Programme led by the UK Department of Trade and Industry (DTI) is supporting a new initiative to develop high temperature electronics packaging solutions for down-well and aero engine applications. Installing electronic power and control systems in high temperature environments will help improve the accuracy of critical measurements and reduce the cost of cabling from remote and hostile locations. This requirement has posed a challenge to the traditional limit of 125ºC for high temperature exposure of electronics systems. In order to address this, the UPTEMP project has been formed with support from a £192,000 grant from the Technology Programme.

Intel unveils details of 45nm processor chip

Intel has revealed some details of its Penryn microprocessor core to be produced later this year using 45nm design technologies. These CPUs will incorporate integrated memory controllers and graphics engines, together with micro-architecture advances. They will achieve up to 45% faster operation with higher clock frequencies of over 3GHz, yet without increasing power consumption and thermal targets. The front side bus will operate at 1.6GHz instead of the current 1.333GHz. The high-k gate insulators will use hafnium, which an Intel director called the biggest change in chips since the 1960s.

Following the Penryn will be the Nehalem devices planned for production next year with hyperthreading, which is a simultaneous multithreading feature that supports up to 16 or more threads and eight or more cores with scalable cache sizes. Intel used hyperthreading in its Pentium 4 processors in 2002, but it has been largely unused since multicore chips were introduced. The Nehalem chips will also include an optional integrated memory controller and an integrated graphics core.

Intel revealed that it has a number of further 45nm products in various stages of development using high-k components, with some types expected to be in production by next year. The 25% reduction in the die size achieved by using 45nm features will help boost margins and yields, which are so important in this price competitive market, as AMD plans to produce 45nm chips next year.



Intel's 300mm wafer with 45nm shuttle test chips

NANO-LED SHINES BRIGHTER

Scientists from the Cranfield Microsystems and Nanotechnology Centre in the UK have invented a brighter and more efficient light emitting diode (LED) than what's currently available. The device, called nano-LED, uses particles of a semiconductor material that are only 3.5 nanometers in size.

The academics initially developed the technology for use in smart dashboards for cars but soon realised its advantages for future manufacturers. These include the ability to produce multi-coloured devices using only one process, which wasn't previously possible; the ability to produce the device in an ambient environment without a need for complicated clean rooms or dry atmospheres; and being able to produce pixels that range in size from a few tenths of a millimetre to many centimeters.

It may also be possible to use such a device to produce pure white light, something that is proving particularly difficult with the technologies currently on offer.

The new technology – which has huge potential for improving the efficiency of many applications from gigantic advertising displays to mobile phones, PC monitors and televisions – has now been granted a patent.

"The patent represents the culmination of a lot of hard work, and we are now actively seeking partners to work with us to further refine the technology and maximise its potential," said Dr Steve Dunn of the Microsystems and Nanotechnology Centre.

Effective Communication During Crisis

During a crisis, time is of the essence. To deal with any crisis effectively, a company needs to be prepared to move quickly so as to minimise damage to its reputation as well as the impact on its employees. Vital part of any crisis planning is ensuring that channels of communication are open and available, even if the unexpected should happen. As with any emergency, preparation is key in order to minimise damage whilst providing support. The following are key factors for preparing:

01. Communications plan – the communications plan should underpin the main crisis plan and enable its successful execution. The plan should offer an in-depth understanding of the communication channels available during a crisis and the correct procedures of how to use them. It is important for the plan to contain relevant contact details of who to contact and the process to follow to maximise the speed within which the crisis is dealt with.

02. Accessibility – the plan needs to be easy to follow and accessible by all members of the company. Employees need to be aware of where the plan is kept and have access to their own copy in both soft and hard copy.

03. Buy in – companies need to ensure that employees are bought into and agree to the plan. Company-wide meetings to discuss the plan and how an employee should communicate during the crisis are critical.

04. Testing – A plan should not undergo its first test during a crisis. No matter how carefully crafted it is, the plan will probably reveal discrepancies during practice. It is vital that companies test their technology systems and carry out a yearly practice.

05. Technology – companies should ensure that there is the ability to communicate effectively when the usual channel such as mobile networks and the local telephone exchange goes down. This contingency will help companies maintain control of the situation by ensuring that people can talk to each other immediately and execute the crisis plan.

Technology is available to help when communication channels go down, it should be used to transmit information to the population concerned on the procedures to follow and the extent of the incident, to organise conferences and meetings for those involved and to circulate details on the knock-on effects of the incident. Freephone lines can be set up providing information for relevant people.

06. Updating the plan – organisations change on a daily basis, keeping the plan up-to-date is crucial for companies. Employee records and details should be easily accessible and updated by companies.

07. Execution – It is essential to prepare for a crisis, but when it does happen, plans can go out of the window. Companies should adhere to the following points to make sure that it stays effective and at the forefront of everyone's mind:

08. Sticking to the plan – It is important for companies to adhere to the plan and follow the guidelines set rather than panicking and second-guessing what to do. Employees need to remain calm and collected during a crisis. The plan has been set up to advice employees on what to do during the crisis.

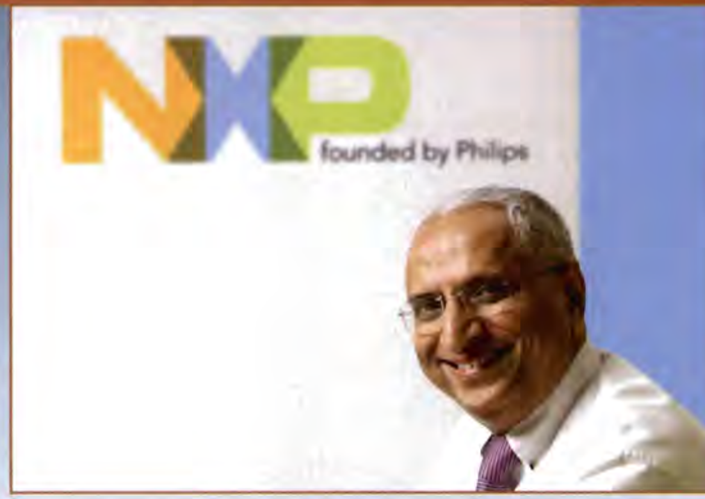
09. Employees – They are a company's most valuable asset and it is the company's responsibility to protect them. Companies should make sure that all employees are kept safe, and are able to contact their loved ones during a crisis. Technology is available to help companies keep track of where their employees are, arrange meetings to inform them about what is going on and what to do as well as help employees relaying messages. For example, automated SMS alerts or voice messaging can be used as a more mobile channel for employees to reassure their families that they are safe.

10. Inform relevant parties – companies need to ensure that they are able to control their external communications and reduce negative perceptions and media stories. Companies need to ensure that they remain in contact with customers, media, authorities, shareholders and suppliers. This can be done by having clear communication channels in place to protect the reputation of a company.

This month's tips were supplied by Emma Paton, Account Manager at Premiere Global Services.

If you want to send us your top five or ten tips on any engineering and design subject, please write to the Editor: **svetlana.josifovska@stjohnpatrick.com**

THE 450mm ERA



AJIT MANOCHA, CHIEF MANUFACTURING OFFICER AT THE NEWLY CREATED NXP SEMICONDUCTORS LOOKS INTO WHO WILL BE ABLE TO AFFORD THE 450NM FABS

The market dynamics and manufacturing paradigm that will drive the 300mm fab era are evident enough for credible forecasting. The 450mm era, on the other hand, presents a less predictable forecasting environment.

There are some basic calculations, however, that may at least elucidate the risks and challenges involved in the transition from 300mm to 450mm fabs. The first is the drastic decrease in the number of fabs. Today, there are about 200 to 250 200mm fabs in the world. By the end of this decade, there will be between 50 and 60 300mm fabs.

Based on the extrapolation of the revenue from a 300mm fab, each 450mm fab that goes online would be likely to generate $15bn per year in annual revenue if it is run at or near capacity.

This raises the question of how the additional $100bn in semiconductor revenue between 2010 and 2013 will be satisfied in terms of production capacity. If it is completely provided by 450mm fabs, only six additional fabs would be required.

In addition, the same basic economics that are determining the 300mm fab landscape are likely to be true at 450mm: first, an enormous capital expense that even fewer companies could afford by themselves; and, second, the goal of having the 450mm megafab full or nearly full in order to make it profitable.

There are other troubling aspects in the transition to 450mm: the number of high-volume products that require 250 million transistors may be too limited to provide favourable economics for 450mm fabs.

The availability of production tools is another issue. The transition from 200mm to 300mm was disastrous for the tools industry, which lost several companies in the process and has only recently recovered. With the prospect of just a few customers and an enormous investment, the tool makers will most likely postpone the 450 mm development in favour of developing the next generation of 300mm tools.

Faced with these realities, all but the very largest IDMs are unlikely to be able to afford a new fab. The number might be as low as one, or perhaps the top two. Microprocessors and memory devices are the only obvious products that are produced in volumes sufficient to keep a 450mm fab busy.

Medium-sized IDMs presumably would have to resort to the joint venture option or go fabless. But the joint venture option is limited: by the number of partners that could be involved and still make sharing the fab's output workable for both the member companies for the fab's profitability.

The foundry landscape is just as intimidating for the same reasons. Not many foundries can afford the investment or be optimistic about having the fab run at nearly full capacity. With these complexities in mind, Figure 1 illustrates one likely semiconductor production landscape in 2015.

Given this analysis, the most likely scenario for the introduction of 450mm production is that it will be delayed well past the time most forecasters project. ■

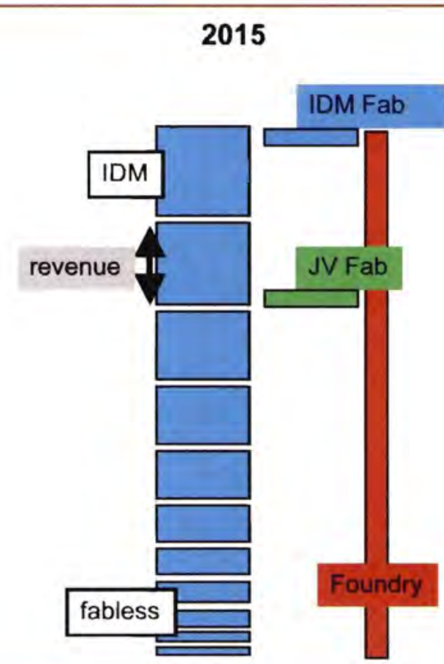


Figure 1: The 450mm era will bring foundry domination to IC manufacturing.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model DCA55
RED GREEN BLUE
Base Emit Coll
PEAK
electronic design ltd
semiconductor component analyser
automatic lead identification
scroll - off
on - test
warning, avoid charge/voltages

THE CHIPLET APPROACH TO NEW CAPABILITIES

By Keith Gurnett & Tom Adams

How would you re-invent the Multi-Chip Module? Multi-Chip Module (MCMs) are very useful, because they interconnect otherwise incompatible chip species, such as silicon and gallium nitride. But their basic design is decades old and, except for the normal shrinkage in the sizes of the various die, they haven't changed much. In many applications, it would be handy if someone could miniaturise the MCM itself.

Great amounts to the next incarnation of MCMs are now being developed at Queen's University in Belfast, Northern Ireland, where Dr Vincent Fusco has achieved a breakthrough by very careful characterisation of a method of etching ordinary silicon wafers. Dr Fusco and his colleague and Professor Harold Gamble of the Northern Ireland Semiconductor Research Centre have focused on the etching of pits of very precise dimensions into the surface of 4-inch silicon wafers. A given pit might need to measure 1mm x 1mm x 100 microns or, more precisely, a few microns larger than this in each of the three dimensions. The tolerances, however, are very small: the depth of the pit may acceptably be 99 microns or 100 microns, not, for example, 108 microns.

Dr Fusco needs to achieve this degree of precision because the next step after etching is to drop a gallium arsenide chip measuring 1mm x 1mm x 100 microns into the pit. The silicon wafer is, in this case, simply the substrate for the gallium arsenide chip – much as a printed circuit board is the substrate for a conventional MCM.

The tiny gallium arsenide chips (also known as chiplets) that Dr Fusco drops into the pits are made commercial and the silicon wafers that he uses are off-the-shelf high-resistivity wafers, four inches in diameter and 500 microns thick. The high-resistivity wafer enables Dr Fusco to minimise crosstalk and other coupling effects between the system and the substrate.

The goal of his research efforts is to develop an MCM-like assembly that can be put together easily and with conventional tools in a fab environment. Characterising the etch process so completely that it could be controlled to within a few microns was very difficult, Dr Fusco explains, but once characterisation was completed he has been able to achieve a very high repeatability in etching pits to precise dimensions.

THE GOAL OF HIS RESEARCH EFFORTS IS TO DEVELOP AN MCM-LIKE ASSEMBLY THAT CAN BE PUT TOGETHER EASILY AND WITH CONVENTIONAL TOOLS IN A FAB ENVIRONMENT

One advantage of using the chiplet approach in product, of course, would be much lower cost. A wafer could be sawn into hundreds of chips each of which would contain multiple chiplets. Each of the chiplet-bearing chips could then be surface-mounted like any other chip, but very likely at a much lower cost.

The second major advantage is the chance to pack different species of chiplets into the same bit of silicon. Dr Fusco has already inserted both gallium arsenide and silicon chiplets into this wafers and could easily add chips of other species, such as indium phosphide. One obvious beneficiary of chiplet technology would be mobile phones, which must currently incorporate separate silicon and gallium arsenide chips. A mobile phone having Internet capability needs browser software incorporated into the control circuitry and this software needs to handle multiple types of Internet code. In addition, some method of enlarging the viewing field, such as rollout display techniques, would require more sophisticated drivers.

It is too early to estimate how many chiplets might be inserted into pits on a given silicon chip, but the number would probably not be large, Dr Fusco thinks. A silicon chip measuring 1cm x 1cm has 100 times the area of the 1mm x 1mm gallium arsenide chiplets that Dr Fusco uses, so it is not hard to envision a 1cm silicon chip holding eight to ten gallium arsenide chips and a handful of silicon chips, which usually measure 2mm x 3mm.

Once a chiplet is inserted into its prepared pit, two additional essential steps need to be carried out: stabilising the chiplet and interconnecting it with other chiplets. To stabilise the chiplet, Dr Fusco starts before insertion and etches a circular hole from the back of the wafer into the bottom of the pit. This hole is about half the diameter of the pit. After the chiplet has been inserted (and temporarily stabilised with tape), the hole is copper-plated, starting from the metallised bottom surface of the chiplet. When plating is completed, the result is a copper plug that holds the chiplet in place and serves as a very efficient heat sink.

At this point, the chiplet fits within the pit with a small gap. The top surface of the chiplet is positioned vertically within a micron or two of the top surface of the surrounding wafer. What remains is to interconnect the chiplet with other chiplets.

Figure 1: *Cross-section cut through a wafer where the chiplet has been inserted into its pit, but the via below has not yet been plated with copper. Note the slight spaces around the edges of the chiplet*

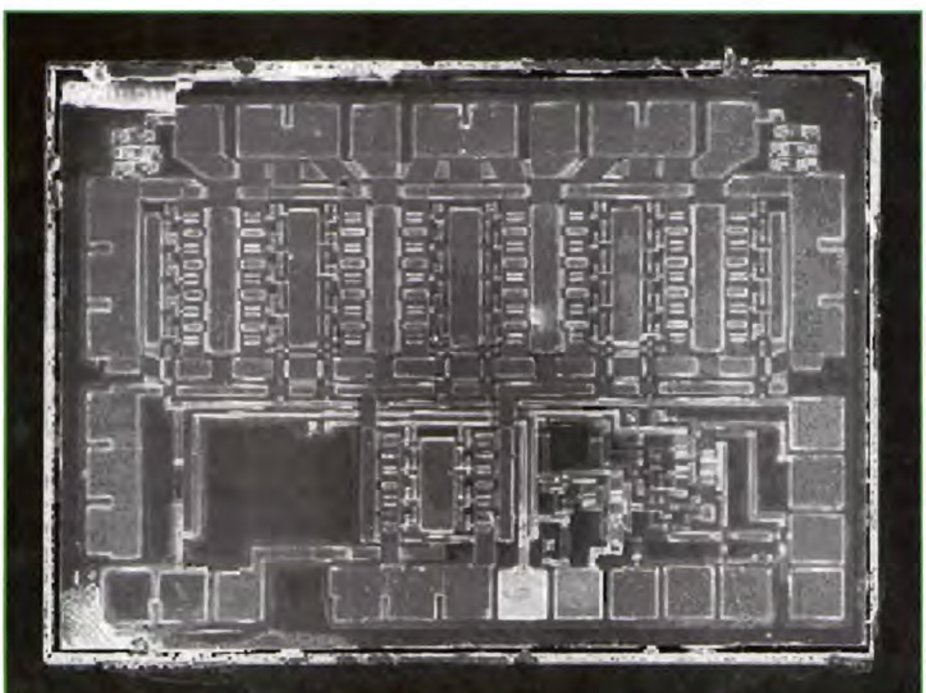

Figure 2: *Top view of a chiplet inserted into its pit, before the application of the metallization layer*

Dr Fusco could have spun a fluid resist onto the wafer to create a surface coating and then drilled (probably with a laser) vias down to the leads on the chiplets. The vias could then have been plated and interconnected. But this method would have added numerous processing steps and probably increased costs. Alternately, he could have used readily available wire-bonding equipment to interconnect the chiplets, a method that has been used by other researchers investigating this concept. He rejected this approach because the thermosonic bonding process involved might damage the chiplets.

What Dr Fusco chose was a sequence of standard photolithographic procedures that put down a layer of metallisation to interconnect the chiplets. Cheap and reliable, this method has the advantage that the metallisation layer will accommodate small variations in height between a chiplet and the silicon, and will also easily bridge a gap between the chiplet and the silicon. Dr Fusco points out that photolithography was a natural choice because it is also used to create bridge-like structures in MEMS devices.

In a broader sense, what Dr Fusco is attempting to accomplish is the creation of those key production processes that will make it possible to achieve very high reliability in the assembly of chiplets. The ability to insert chiplets of two, three or even more species into pits on a single silicon die has profound consequences for miniaturisation.

It would also enable the introduction of components requiring totally different capabilities. Existing well-understood processes could be used to engineer diodes and switching elements in chiplet form. These diodes and switching elements would serve as protection devices and, thus, permit high-voltage operation of the system. Such protection is especially needed for mobile phones that are beginning to use more than one core processors.

Some applications might also benefit from a design where only a portion of a silicon die is used for chiplets, while the rest of the die has conventional silicon patterning. This is a logical way to incorporate gallium arsenide or indium phosphide with silicon. Such a mixed design might turn out to be a reliable and inexpensive way to produce some system-on-a-chip functions. ■

REALLY "LOW POWER" RADIO

by Myk Dormer

The term 'low power radio' is understood to refer to ISM band wireless links operating at 500mW or less. The purpose of this article is to examine their use in low power applications, where restrictions imposed by battery life (or other power availability issues) require extremely current-frugal design techniques.

Such applications include battery powered remote monitoring (automated gas meter reading, for example), fire and intruder alarm sensors, long range tagging/RFID applications, emergency lighting/alarms/ signals, pager applications and others.

In the simplest case the application just requires a low power transmitter which is very infrequently activated (a temperature monitoring system might only need to take a reading every ten minutes; an agricultural soil condition monitor might only report once per day, while some wireless alarms only transmit when activated or when indicating low battery).

> "WHILE VERY LOW POWER DESIGN TECHNIQUES CONSTITUTE A HUGE SUBJECT, THERE ARE A FEW USEFUL POINTERS"

In more complicated applications the receiver power consumption is key, in tasks where it must constantly monitor for a command transmission which either initiates an operation (emergency lights, pagers) or triggers ('polls') a transmit-back burst of stored data (RFID tags, remotely read meters).

For all these types of applications the dominant design aim is to keep power consumption to an absolute minimum. While very low power design techniques constitute a huge subject, here are a few useful pointers:

- Keep everything you aren't using turned completely off. Be prepared to switch the power supply to sensors, radio modules and other peripherals. (In 'standby' mode some of these devices can still draw tens of µA). If the main processor is too power hungry to operate constantly, then design a low current 'master timer' to periodically cycle it 'on'. (A single unijunction transistor operating as a relaxation oscillator can draw less than 1µA at a 1Hz rate.)
- Design around the slowest digital clocks you can. CMOS logic power consumption is directly in proportion to the switching speed. Modern microcontrollers intended for low power tasks frequently can be operated from 32kHz watch crystals and often have lower power 'sleep' or 'wait' modes, from which timer interrupts can periodically wake them.
- Activate the radio module as infrequently as possible. It will probably be the largest single power consumer in the design (a UHF receiver can consume 20mA at 3V, compared to below 100µA for a modern microprocessor). Keep transmit bursts short (within accepted data rate versus performance trade-offs) and where response time allows it, cycle the receiver on and off (see Note 2).
- Minimise standing (quiescent) currents: Use low quiescent current LDO regulators (78LCxx types draw only 1µA).
- Switch with Mosfets (zero gate current), not bipolar devices.
- Keep pull-up and bias resistors as large as possible.
- If indicator lights are needed, use low current LEDs and flash them, slowly.
- Be aware of wasted charge in large capacitors (a 100µF capacitor at 5V contains 500µC. Charging this up once per second is equivalent to an extra 0.5mA current drain). Where possible, switch 'down-stream' of such high value decouplers.
- Keep within maximum (peak) current drain – and temperature ratings – of the batteries used. Outside these limits the performance of the cells can be significantly impaired (especially in the case of high energy density lithium cells).

Note 1:

Power consumption of typical ISM band radios:

Very low current VHF single channel Rx module	1mA @ 3V (Radiometrix RX1L)
Typical VHF single channel receiver module	7mA @ 3V
Typical UHF single channel receiver module	12mA @ 3V
UHF multichannel receiver	20mA @ 3V
1mW VHF transmitter	9mA @ 2.2V
10mW UHF single channel transmitter	18mA @ 3V
10mW UHF multichannel transmitter	34mA @ 3V
Class 1 Bluetooth device	22-35mA @ 3V3
Simple WiFi module	210-340mA @ 3V3

- Use moderate data rates, to reduce coding and decoding processing effort (and hence CPU clock speeds). There is no point in reducing the burst length to under 2mS by using an inconveniently high data rate, if the transmitter and receiver used require 20mS of preamble to key-up and settle.
- Most importantly of all, design for low power from the very beginning. It is impossible to create a low power development of a design that is already based around bloated high-level code, running on power hungry processors, or which is committed to using current hungry radio devices. Do it right, from the start.

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Note 2:

Cyclic receiver operation (or "battery economy cycling") is a technique used to minimise receiver power consumption, originally applied to pagers. Simply, a transmit operation consists of the same sub-burst of data repeated over and over. The entire operation must be longer than the period between two receiver 'on' times, and the duration of the receiver 'on' time needs to be over twice the length of a sub-burst (to ensure that, even if a receiver wakes in the middle of a sub-burst, it is then on for long enough to decode the next one).
The period between receiver 'on' can be as long as is desired (with commensurate power reductions), provided it is realised that the worst case response time of the system is equal to this period.

Example:

A fire alarm system uses radio-activated, battery-powered emergency lights. The system requires a response time of 5 seconds or less between alarm and 'lights on'. A 50 bit burst is used, at 1kbit/s and the receiver needs 25mS to stabilise at power-on. (So a sub-burst needs 50mS for data, plus 25mS settling 'preamble' = 75mS, and receiver 'on time' must be 2 x sub-burst duration = 150mS).
For 5 second maximum response time, a receive cycle of (5-0.15) = 4.85 seconds is usable. So receiver off/on ratio is 4.7 : 0.15, or about 31:1.
In this system, a 10mA receiver will have an effective current consumption of about 320μA (if the lights run from 18 amp-hour D cells and this radio current is the dominant power drain, then we can expect a 'lights off' battery life of about six years).

EVALUATING ETHERNET AS A SYSTEM-LEVEL INTERCONNECT

It is doubtful that the originators of Ethernet could have envisaged how widespread and prevalent the technology they were inventing would become. Available in a wide variety of "flavours" defined by advanced services implemented as higher layer protocols, Ethernet has become the common language of the Internet, evolving into a ubiquitous as well as indispensable wide and local area computer interconnect.

Ethernet continues to cast its net out to an ever-widening range of applications, working its way deeper into the system fabric by extending its reach down into the backplane and chassis-level communications infrastructure. Today, Ethernet is clearly the incumbent technology in these applications as developers strive to step away from proprietary implementations that tie them down to a particular vendor, with other interconnect standards such RapidIO technology quickly gaining market share.

By moving to established industry standards, engineers are able to capitalise upon the accelerated innovation, higher functionality and lower cost that come as a result of open competition. Migrating to established communications standards in the backplane and chassis in particular, also promises to improve performance and reduce cost by consolidating interconnect stages across the system fabric, beginning by collapsing the data and control plans onto a single interconnect. High performance networking and communications applications are also tightly connected through data pipelines that cross between the different system domains, from IC to board to chassis to LAN and finally out to the wide area network. Each crossover has its own interconnect protocol to manage the transfer of data through the different stages of the data pipeline. Since each interconnect adds complexity, latency and cost, reducing the number of interconnect stages by consolidating several layers using a single standard reduces protocol inefficiencies leading to increased throughput and overall system performance.

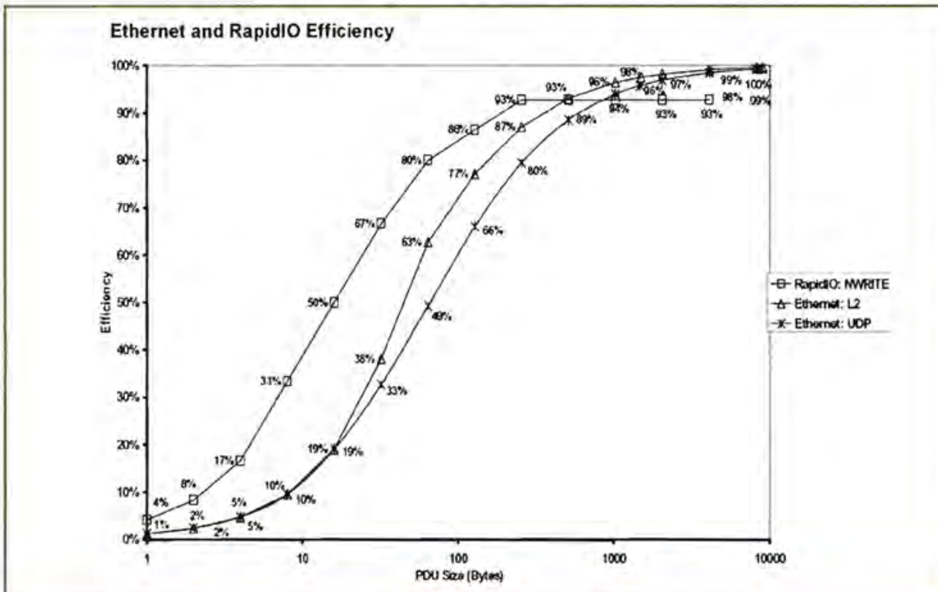

***Figure 1:** Ethernet achieves its best efficiency with a maximum payload, although this comes at the cost of increased latency jitter. By balancing large payload jitter against small payload inefficiency, an alternative interconnect standard like RapidIO technology achieves better overall efficiency across the payload sizes most common to embedded backplane applications*

Ethernet is an extremely flexible standard, which is one of the reasons it has been adopted so completely. This flexibility is perhaps its greatest strength but in this, also one of its most important weaknesses. As data rates continue to rise, this flexibility introduces inefficiency that, especially in 1Gbps and 10Gbps applications, can seriously limit the applications in which Ethernet can cost-effectively consolidate interconnect layers of the system fabric.

THE ORIGINS OF ETHERNET

Ethernet's beginnings can be traced to the labs at Xerox. In later years, Digital Equipment Corporation (DEC), Intel and Xerox released the "DIX" or Ethernet I standard followed by Ethernet II. Independently, the IEEE organisation created the 802.3 specification that also came to be called Ethernet. The IEEE eventually recognised the value of these standards coexisting together and it modified the DIX header format in the 802.3 standard to support both standards over the same network.

These early forms of Ethernet assumed a network topology based upon point-to-point connections between desktop computers and Ethernet switches and routers deployed in a star configuration. Because the original intention was to connect computer workstations, these early designers also assumed that each endpoint would have a powerful processor available that could participate in protocol processing.

Back in the 70s with the limited hardware capabilities available at the time, this was a sound business decision, balancing the trade-off between hardware and software in favour of software. This choice enabled manufacturers to keep hardware simple and inexpensive while maximising flexibility

IN THE LAST ISSUE WE STARTED A SHORT SERIES ON ETHERNET AND RAPIDIO INTERCONNECT TECHNOLOGIES: TYPES, TECHNICAL COMPARISONS AND OVERVIEW, PRACTICALITIES AND DESIGN CONSIDERATIONS. IN THIS SECOND ARTICLE GREG SHIPPEN, SYSTEM ARCHITECT FOR THE FREESCALE SEMICONDUCTOR DIGITAL SYSTEMS DIVISION, AND A MEMBER OF THE RAPIDIO TRADE ASSOCIATION'S TECHNICAL WORKING GROUP AND STEERING COMMITTEE FOCUSES ON ETHERNET

and extensibility of the protocol across many applications. As a result, Ethernet was designed to have a relatively large protocol stack, especially when higher-layer services such as TCP/IP and RMDA are introduced.

In the new millennia, however, the balance between hardware and software has shifted significantly. Advances in silicon manufacturing technology have enabled Ethernet PHY data rates to increase from 10Mbps up to 10Gbps, but the degree of innovation in software processors has not kept a similar pace. Given Ethernet's extensive protocol stack, formidable protocol processing bottlenecks quickly overwhelm host processors in 1Gbps and 10Gbps embedded applications. Currently developers have two approaches available to them to address protocol processing bottlenecks in high-speed applications: custom stacks and TCP/IP Offload Engines (TOEs).

In order to preserve its flexibility over the years, many of Ethernet's advanced features, such as RDMA, are implemented as optional layer 3+ protocols. These extra layers come at the cost of increasing header size, added protocol complexity and latency, and reducing overall throughput efficiency, all of which further aggravate protocol processing bottlenecks. Custom stacks enable developers to optimise protocol processing through stacks specialised for a particular application.

Unfortunately, the cost of supporting custom stacks across multiple vendors or even multiple generations of the same vendor hardware quickly becomes prohibitive. The ready availability of robust off-the-shelf TCP/IP stacks with proven reliability is the primary reason many developers willingly take the performance hit of utilising UDP or TCP/IP rather than communicating directly through the more efficient lower layers.

The second alternative available to developers is to offload TCP/IP processing to a specialised hardware engine. However, given the many flavours available based on the flexible choice of features within Ethernet, no single, unified specification is uniformly implemented, resulting in a diversity of actual implementations and increased Ethernet stack complexity. As a consequence, even off-the-shelf TCP/IP offload engines are effectively proprietary implementations, each with its own unique partitioning of processing between hardware and software and vendor-specific Ethernet stack that ties down developers. Clearly there is little advantage to be gained from using an established standard if it must be implemented in such a constraining, proprietary fashion.

OVERCOMING INEFFICIENCIES

Even with hardware protocol processing such as TCP/IP offload, Ethernet's simple header and flexible architecture make it quite inefficient for many high-speed embedded applications. For example, basic Ethernet offers only best-effort transport. In order to meet the guaranteed packet delivery and minimum quality of service (QoS) requirements of backplane applications, developers must introduce higher-layer protocols which add extra header fields that increase parsing complexity and latency.

Also, since Ethernet must support millions of endpoints in the LAN, its MAC address is substantially bigger than it needs to be for backplane and chassis applications, and the introduction of TCP/IP alone adds 40 bytes of overhead to every packet. Additionally, Ethernet's mandate to maintain backward compatibility, while ensuring its long-term viability, has led to undesirable header legacies such as maintaining preamble and IFG fields required for the original half-duplex shared coax PHY but for which more recently defined PHYs have no need.

One of the most important ways to reduce interconnect complexity and cost is to consolidate the data plane and control plane onto a single fabric. Because of the differing nature of the packets they transport – data plane traffic must support some degree of QoS with minimum bandwidth guarantees while control plane traffic must have guaranteed delivery with low latency – such a fabric must be fairly advanced in its capabilities.

Ethernet supports a payload size from 64 to 1500 bytes (up to over 9000 with jumbo packets). Because of its fixed overhead, efficiency is best with a maximum payload, not at the typically much smaller size of control plane transactions. Such large payloads also come at the cost of increased latency jitter, which can increase system-level costs when transporting jitter sensitive data such as voice.

Additionally, a data/control fabric must be significantly over-provisioned in order to eliminate control packet loss and thus limit associated latency and jitter. Assuming 25-35% usage for many applications, sustainable effective throughput for Layer 2 traffic takes a substantial hit, dropping to ~ 250Mbps for 1GE and 2.5Gbps for 10GE, depending on average packet size. Even with over-provisioning, end-to-end latency can still run in milliseconds since traffic must traverse multiple layers of software protocol stacks.

Ethernet's single transaction type also limits efficiency. Backplane applications, for example, typically move tremendous amounts of latency-sensitive data. For these applications, Remote DMA (DMA) is becoming an increasingly important higher-layer Ethernet protocol that enables direct placement of data into destination buffers, thus minimising the number of times data must be copied as well as number of associated processing interrupts required. These efficiencies, however, come only at the cost of increasing overall protocol stack complexity.

While TCP/IP and RDMA serve to harden Ethernet, making it robust enough to use in embedded applications, in comparison to protocols such as RapidIO technology that have been designed specifically to serve as a backplane transport, Ethernet is extremely inefficient (see **Figure 1**). RapidIO technology, for example, was designed to minimise latency, limit software impact and simplify switches while achieving effective data rates from 667Mbps to 30Gbps for embedded in-the-box and chassis control plane applications. Its high efficiency is made possible through hardware-based protocol processing as well as inherent support for read/write operations, messaging, data streaming, QoS, data plane extensions and protocol encapsulation, to name a few of its capabilities.

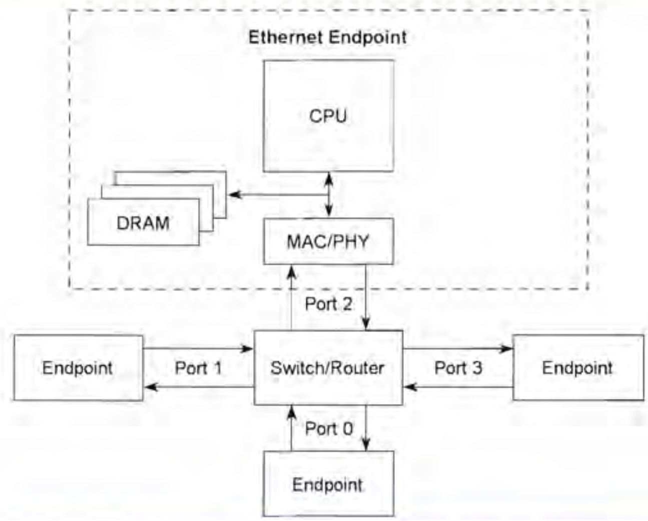

***Figure 2:** Ethernet was originally designed to connect a large number of powerful computing endpoints in LAN-type configurations. Given its best-effort approach, simple header, addressing for millions of endpoints and single transaction type, the further Ethernet extends down into the system fabric the further its capabilities are stretched to the point where its performance, throughput and reliability begin to appreciably degrade*

QUALITY OF SERVICE

QoS is critical for many backplane applications. While TCP/IP enables Ethernet to support millions of individual streams and differentiate traffic by port number and protocol fields, no commonly used Class of Service (CoS) field exists. Additionally, Ethernet's best-effort service commonly manages congestion by dropping packets, leading to latency jitter as a result of the use of higher-layer protocols to guarantee packet delivery.

Further degrading Ethernet QoS is the fact that system fabric flow control mechanisms belong to upper-layer protocols such as TCP. This prevents proactive congestion management since by the time TCP flow controls are invoked, latency jitter has already occurred and packets have been dropped. Without short-term, link-level flow control, endpoint receive buffers must be larger to avoid overruns.

Further exacerbating latency is how error detection and recovery occurs at the system rather than link level. Time-outs, therefore, exist only at Layer 3 and above, resulting in much longer time-outs and significantly increased latency jitter. Because there are no hardware-based recovery standards such as retries or time-outs, packets will have been dropped for a significant period of time before failure is detected, severely impacting the reliability of control plane transactions.

Clearly, for high-speed embedded applications, Ethernet is limited in its ability to serve as reliable and efficient system interconnect. Ethernet was designed and optimised to connect a large number of powerful computing endpoints. With its flexible yet inefficient header and best-effort approach, the further Ethernet extends down into the system fabric, the more its capabilities are stretched to the point where performance, throughput and reliability degrade excessively (see **Figure 2**). Even Ethernet's most compelling advantage – low cost through widespread deployment and high volumes – doesn't apply to most high-speed embedded applications because of the need for specialised implementations of Ethernet supported by only a limited vendor ecosystem. The majority of Ethernet's volume is in the LAN and the reality is that these cost economies and capabilities simply don't always carry forward as Ethernet attempts to serve as a system-level fabric.

Developers designing efficient high-speed embedded backplanes and chassis need to look beyond Ethernet to other technologies such as RapidIO for example, which while originally conceived as a front-side bus for high-speed embedded processors was specifically designed from the ground up to function as a system-level interconnect. By considering these more appropriate alternatives, developers can successfully consolidate the multiple interconnect stages, reducing the number of protocols making up a system fabric and leading to increased simplicity, throughput, functionality and reliability. Certainly Ethernet will continue to dominate the LAN but without doubt it will be another protocol that serves as the system-level fabric that carries embedded developers into the future. ■

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MULTIMEDIA CONVERGENCE

K. FAWZI IBRAHIM, A SENIOR LECTURER AT THE COLLEGE OF NORTH WEST LONDON AND DIRECTOR OF KFI TRAINING AND CONSULTANCY, HERE PRESENTS A SERIES OF ARTICLES BASED ON THE FORTHCOMING 4TH EDITION OF NEWNES GUIDE TO TELEVISION AND VIDEO TECHNOLOGY. IN THE SECOND ARTICLE SEEN HERE, HE DESCRIBES WHAT HAPPENS TO THE DIGITAL 'BIT' IN THE CONVERGED WORLD OF MULTIMEDIA

In the digital world, a "bit" is a "bit" whether it represents audio, video, data or software. Consequently, in principle, there should be no need for separate networks for broadcasting and telecommunications.

Of course, the reality is slightly more complex. In practice, there are some fundamental distinctions between broadcasting and telecommunications. Broadcasting essentially delivers one-way, one-to-many services, whereas telecoms operators provide two-way, one-to-one services. Nevertheless, the boundaries between broadcasting and telecoms have become increasingly blurred since the early 1980s; some analogue TV services have been used to deliver limited "telecoms-like" services, such as delivery of encrypted teletext services for individuals or closed groups of users for example.

The introduction of digital radio and TV networks opens up new opportunities for data services, particularly for delivery to portable or handheld devices. Demand for short 30-second video clips (e.g. a football goal) on mobile phones is increasing. Large-scale on-demand video services via UMTS (Universal Mobile Telecommunication System) proved to be uneconomic. Instead, attention has turned to the benefits of one-to-many services: rather than sending individual video streams to each consumer, it would be much more efficient to transmit the same material simultaneously to all those interested. Of course, this "new idea" is actually "broadcasting"!

The over-used concept of convergence can apply to incorporating Internet services onto a broadcasting platform, known as Digital Multimedia Broadcasting (DMB), or conversely, incorporating broadcasting services onto the Internet platform, known as on-line convergence, or a mixture of the two.

DMB

Arising from the hype surrounding the Internet, there has been increasing interest in offering multimedia services to mobile phones. First, there was the big bang of selling frequencies for UMTS all over Europe, but it turned out that UMTS will not offer the huge bandwidth that modern streaming Internet applications such as TV require. This means that, apart from point-to-point applications, there is an increasing requirement for point-to-multipoint, wireless Internet access technologies. Hence, the terrestrial broadcast systems come into focus, as a means of streaming multimedia content to mobile, portable and handheld receivers.

There are two different technical solutions that could meet these requirements:

- DVB-H (H for handheld), the latest terrestrial standard from DVB;
- DAB (Digital Audio Broadcasting), adapted for multimedia delivery;
- A third solution, ISDB-T from Japan is not to be deployed in Europe.

Although the fact that all three components – audio, video and data – are presented in digital form makes it possible for them to share the same transmission medium, it is not sufficient for practical convergence. What makes the whole enterprise a practical possibility is their adherence to a standard network communication model, the Open System Interconnect (OSI) model [see panel].

DVB-H

The terrestrial version of the DVB system (DVB-T) was developed in the mid-90s. It was primarily intended for portable and stationary reception using roof-top antennas. The design of the system was strongly influenced by the cost of the receiver.

To make the receivers cheaper, time interleaving – which would have benefited mobile reception – was not implemented; instead, the same error correction as the satellite system, DVB-S, was used.

DVB-T can effectively be used for mobile and portable reception provided the multi-antenna diversity receiver is available to enable high-speed mobile reception of DVB-T. However, such fast varying channels are error prone. The situation is worsened by the fact that antennas built into handheld devices have limited dimensions and cannot be continuously pointed at the transmitter if the handheld terminal is in motion. This

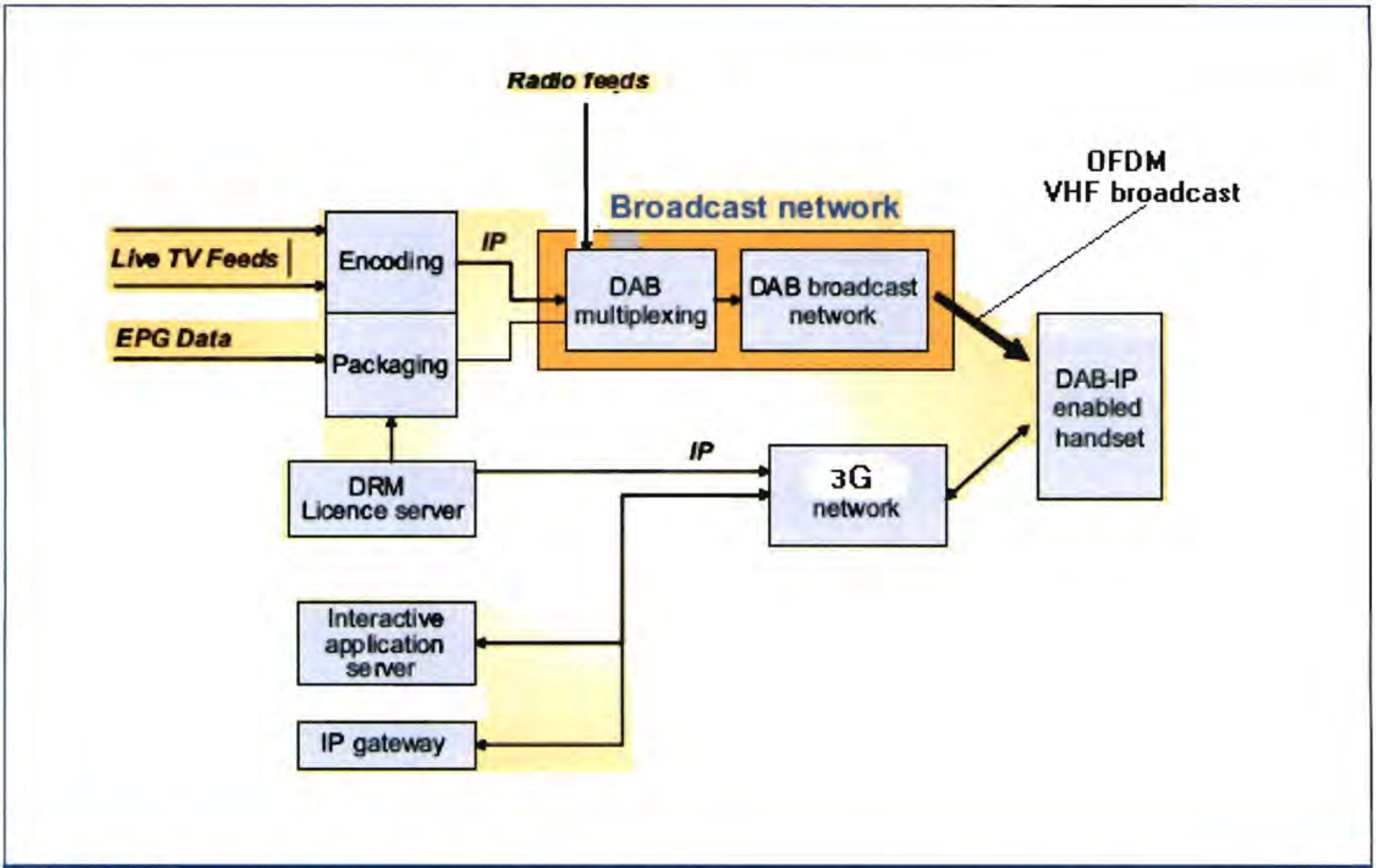

Figure 1: *DAB TV system architecture*

is just one of the problems of using DVB-T. The stumbling block for the use of straight forward DVB-T for mobile devices is however, the very practical problem of battery life. Power consumption of DVB-T front ends is too high to support handheld receivers that are expected to last from one to several days on a single battery charge.

To make DVB-T suitable for mobile multimedia services, a dedicated standard for handhelds, based on DVB-T, was necessary. It is called DVB-H (DVB-Handhelds). The aim is to provide an efficient way of carrying multimedia services over digital terrestrial broadcasting networks to handheld terminals.

DVB-H specifications were drawn up with the following objectives:

- To power off some part of the reception chain to increase the battery useful lifetime;
- Easy access to services and seamless transition from one service to another;
- Sufficient flexibility/scalability to allow reception of services at various speeds, while optimising transmitter coverage;
- To mitigate against the effects of high levels of man-made noise such as car ignitions interference;
- To provide a generic way to serve handheld terminals in various transmission bands and channel bandwidths in various part of the world;
- To receive multimedia services using a single antenna in the portable, mobile and indoor environments;
- To maintain maximum compatibility with existing DVB-T networks and systems.

These requirements were drawn up after much debate and with an eye on the emerging convergence devices providing video services and other broadcast data services to 3G handheld devices.

DVB-H SYSTEM PROPERTIES

The main properties of DVB-H are: time-slicing, IP interfacing, enhanced signalling and in-depth interleaving. In order to save power, a power-saving algorithm based on time division has been introduced. The technique, called time slicing, results in a large battery power-saving. In order to provide a common platform with Internet services, and for reliable transmission in poor signal reception conditions, IP interfacing with an enhanced error-protection scheme was developed. This scheme is called MPE-FEC (Multi-Protocol Encapsulation – Forward Error Correction). It employs powerful channel coding on top of the channel coding included in the DVB-T specification and offers a degree of time interleaving. Furthermore, the DVB-H standard features an extra network mode, the 4K mode, offering additional flexibility in designing Single-Frequency Networks

(SFNs) which still are well suited for mobile reception, and also provides an enhanced signalling channel for improving access to the various services. Convergence with Internet services is accomplished by IP (Internet Protocol) encapsulation of Internet services prior to the transport multiplexing stage.

DVB-H is fully compatible with DVB-T. It can be used in 6MHz, 7MHz and 8MHz channel environments. However, a 5MHz option is also specified for use in non-broadcast environments. A key initial requirement, and an amazing feature of DVB-H, is that it can co-exist with DVB-T in the same multiplex. Thus, an operator can choose to have two DVB-T services and one DVB-H service in the same overall DVB-T multiplex.

TIME-SLICING

A special problem for DVB-H terminals is the limited battery capacity caused by the relatively high power consumption of a DVB-T front end, typically in the region of 600–1000mW. Before any one of the multiplexed elementary streams of the selected programmes can be accessed, the whole data stream has to be decoded first. A large part of the power consumed by the front end is therefore unnecessary. The power saving made possible by DVB-H is derived from the fact that essentially only those parts of the transport stream which carry the data of the service currently selected have to be processed.

In order to do this, the data stream needs to be reorganised in a suitable way for that purpose. With DVB-H, several services are multiplexed using pure time-division. The data of one particular service is therefore not transmitted continuously but in compact periodical bursts with interruptions in between. At the transmitting end, several services with different bit rates are multiplexed and a continuous, uninterrupted transport stream at a constant bit rate is maintained.

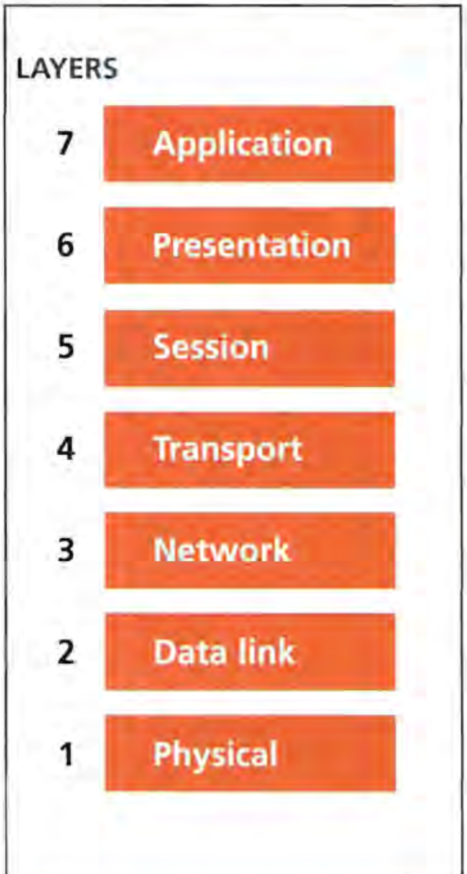

Figure 2: *The OSI process*

To indicate to the receiver when to expect the next burst, the time to the beginning of the next burst is indicated within the burst. Between the bursts, data of the elementary stream is not transmitted, allowing other elementary streams to be transmitted using the remaining bandwidth. Time-slicing enables a receiver to stay active only a fraction of the time, while receiving bursts of a requested service.

Bursts entering the receiver have to be buffered and read out of the buffer at the service bit rate. Practically, the duration of one burst is in the range of several hundred milliseconds, whereas the power-save time may amount to several seconds. Depending on the ratio of on-time/power-save time, the resulting power saving may be more than 90%.

Time slicing offers another benefit for the terminal architecture. The comparatively long power-save periods may be used to search for channels in neighbouring network cells offering the same service but that offers better reception. This is important as the handheld receiver movement may take him from one network cell to another. In this way a channel handover can be performed at the border between two cells which remains imperceptible for the user.

DAB TV

DAB easily lends itself to portable and handheld receivers as it was designed with mobile reception and single frequency networks in mind. It was not surprising therefore that it became a favourite in the delivery of digital multimedia broadcasting. Unlike DVB which had to be modified to incorporate the requirements for portable and handheld reception, DAB from its inception was designed for mobile reception with one antenna. With DAB, data is sent in bursts that are part of a frame, which lasts 24ms followed by a null frame using time interleaving, to overcome the problem of fading. Another advantage of DAB is the use of UEP (Unequal Error Protection) technique in which bits are protected according to their importance in the decoding process. This is very important for mobile and portable reception where hostile reception conditions cannot be avoided.

The DAB system is capable of carrying IP packets (datagrams) using IP/UDP connectionless protocol. As these packets travel unidirectionally from a service provider to many users simultaneously, it is not necessary to establish a connection between the transmitter and the user prior to the transmission of data.

A DAB-TV system, also known as DAB-

IP is illustrated in **Figure 1**. Live TV is encoded and encapsulated into an IP frame to be multiplexed with the normal digital radio broadcasts. The resulting transport stream is then fed into the DAB broadcast network and transmitted as a Mode 1 OFDM VHF signal. The IP interface provides an independent platform which supports a wide range of services and applications.

TV encoding employs Enhanced Packet Mode (WorldDMB, formally known as the World DAB Forum standard) which enables video and other services such as an Electronic Program Guide (EPG) that are more sensitive to errors than the native audio services, to be carried.

At the receiving end, the handset decoder extracts the required TV channel from the multiplex, decodes it and feeds it into the small screen display. The handset also receives and decodes the normal interactive services through the third generation (3G) platform.

As can be seen, DAB-TV shares multiplex capacity with DAB digital audio services. This enables operators to use spare capacity on DAB networks to start offering mobile TV without waiting for a new spectrum to become available. This is the main reason for DAB-TV gaining ground over its rival DVB-H system.

ON-LINE CONVERGENCE

On-line convergence involves sending video broadcast services on traditional twisted-pair telephone lines. There is nothing new about video streaming, sending video clips down the line to be downloaded on a PC. However, sending live TV broadcasts down the line, usually known as IPTV, is of a qualitatively different scale. These services are often called Broadband TV, ADSL TV, DSL TV or IPTV. First let's look at the telephone system and at the technique known as ADSL.

In the UK alone there are over 30 million twisted-pair phone lines in operation between BT exchanges and individual subscribers' premises. Originally the telephone lines were designed to carry simple command (dialling) pulses and frequency-restricted (300–3500Hz) baseband voice signals. The remaining bandwidth of a copper wire was left unused. With the introduction of electronic exchanges, touch-tone dialling and routing functions became possible.

The next step was to use a full digital system where the copper wires from each subscriber terminated in an interface or 'line card' containing ADCs and DACs. This made a wide band of frequencies available to be divided into 4kHz 'telephone channels'. The sampling rate of 8kHz and 8-bit quantisation retained the traditional analogue bandwidth resulting in a 64kbps per telephone channel. First, time-division multiplexing was used in what is known as ISDN (Integrated Services Digital Network) and by combining a number of 64kbps channels, high bit rates were reached. One of the problems of ISDN is that the bit rate is limited and a new cabling from the subscriber to the exchange was needed. ADSL (Asymmetrical Digital Subscriber Line) solved that problem by using frequency-division techniques and dynamic control of the bit rate.

IPTV

Internet Protocol Television (IPTV), also known as Broadband Television (BTV) involves accessing multimedia content via a broadband connection and viewing it on a normal TV. IPTV is not the same as Internet TV which accesses TV via a PC. IPTV is sometimes called ADSL TV or DSL TV.

The Internet Protocol as mentioned above is a packet delivery system operating at the Network Layer 3 of the OSI model in which the data load (payload) is encapsulated into a packet with an IP header containing various information and control bits including the destination and source addresses. Since IP networks are bi-directional, IPTV can deliver not only live television but also interactive and on-demand TV. Telecom operators who have been traditionally interested in providing communication services between clients find their role is being expanded to provide what is known as Triple Play: communication services (including Voice over IP, or VoIP); a high-speed Internet connection and IP-based television and video-on-demand services.

At the receiving end, playback requires only an Internet connection and an Internet enabled device such as a personal computer, iPod, set-top box connected to a TV receiver or even a 3G cell/mobile phone to watch the IPTV broadcasts. Apple's iPhone uses mobile phone GSM (Global System for Mobile Communications) quad-band (900MHz, 1800MHz for Europe and 850 and 1900MHz for the Americas) to provide images and television shows and films, Internet, email and text messages as well as mobile phone facility. ■

OPEN SYSTEM INTERCONNECT (OSI)

The model describes how information or data makes its way from an application by a user such as a spreadsheet or a video clip, through a network medium such a pair of wires, a radio or a satellite link to another user located on a remote network.

RF MEASUREMENT BASICS FOR THE DC TEST ENGINEER

TEST ENGINEERS WHO NOW HAVE THE ADDED RESPONSIBILITY FOR CHARACTERISING WIRELESS PRODUCTS NEED TO UNDERSTAND THE BASICS OF MAKING RF MEASUREMENTS. THIS OFTEN REQUIRES ENGINEERS WHO'VE SPENT THEIR CAREERS DESIGNING LOW FREQUENCY APPLICATIONS TO REFRESH THEIR MEMORIES OF THE RF THEORY THEY LEARNED IN SCHOOL, THEN BONE UP ON NEW RF TECHNOLOGIES AND TEST INSTRUMENTATION. BY ROBERT GREEN, SENIOR MARKET DEVELOPMENT MANAGER AT KEITHLEY INSTRUMENTS

The number of wireless communication products based on radio frequency (RF) technology is growing at an astonishing rate. For example, the number of mobile phones manufactured each year is approaching one billion units. In addition to the growing popularity of other consumer products like wireless-Internet-accessible PDAs, WiFi-enabled laptops and Bluetooth headsets, there is rapid growth in the production of RF devices like RFID tags for inventory control and supply chain management (and many other applications), wireless medical devices and ZigBee sensors.

To ensure the products their organisations design and manufacture are tested thoroughly and efficiently, test engineers need to understand the basics of RF technology – what to test for and which instruments are best suited for a particular application. Test engineers who have historically worked with low frequency applications (products operating at frequencies of less than 1MHz) need to re-acquaint themselves with the RF technology they learned but have not used for a long time.

TALKING THE TALK: LEARNING THE CORRECT RF TERMINOLOGY

RF engineers talk about power, not voltage

RF signal strength can vary dramatically. As the signal propagates through space, the power per unit area decreases proportionally to the distance squared, so changes in power are measured in decibels (dB).

Using decibels for power measurements greatly simplifies calculations. Unlike DC calculations that involve multiplication or division (such as I x R = V), power gains or losses are calculated by adding or subtracting in dB. The formal definition of dB is:

$$dB = 10 \log (Pout/Pin)$$

A dB value is a relative quantity; in other words, it's only meaningful in relation to some reference value. A related unit is dBm, which is the absolute power measured relative to 1mW. **Figure 1** lists dBm values and their corresponding values in Watts. The power transmission range of a mobile phone is shown as reference, as well as how low a signal that a sensitive receiver can detect.

Figure 2 shows an equation defining the theoretical noise floor for RF signals at room temperature. The signal level that reaches the receiver can be quite low for a number of reasons, including attenuation due to the signal's propagation through air, atmospheric electromagnetic interference and interference from other RF signals. It is not unusual for a receiver to be capable of detecting signal levels less than 0.1pW, which is equivalent to less than 1µV of signal level.

Impedance mismatches lead to power losses

In circuits operating at low frequencies, the goal is to transfer voltages through circuits with minimal voltage drop. The most effective circuits have high input impedance and low output impedance.

dBm	Watts	
–140	0.01 fW	Receiver Sensitivity Range
–130	0.1 fW	
–100	100 fW	
–70	100 pW	
–60	1 nW	Cellular Phone Transmitter Range
–50	10 nW	
–40	100 nW	
–30	1 µW	
–20	10 µW	
–10	100 µW	
0	1mW	
+10	10mW	
+20	100mW	
+30	1 W	
+40	10 W	
+50	100 W	

Figure 1: *dBm values and their corresponding values in Watts*

The Noise Floor The smallest signal that can be resolved

$$\text{Noise Power (Noise Floor)} = -174dBm + 10\log_{10}\left(\frac{Bandwidth}{1Hz}\right)$$

$$P \propto kTB$$

- Noise Power in 200kHz bandwidth = –121dBm
- Noise Power in 1.23MHz bandwidth = –113dBm

Figure 2: *The equation that defines the theoretical noise floor for RF signals at room temperature*

With RF applications, where the cable might be as long as one-quarter of a wavelength, signals must be treated as waves. Any time a wave hits an impedance mismatch, some of the wave is reflected.

The goal with RF signals is to transfer all the power to the load without loss. Any reflection of power means that some of the power is not getting to the load, so mismatch is a critical parameter. Any difference in impedance between circuit elements and the transmission line causes reflections and loss of power.

In RF applications, transmission lines are generally coaxial cables external to circuit boards and microstrips within circuit boards. These components have characteristic impedance. The expression for the characteristic impedance of a transmission line depends on the geometry of the conductors, the properties of the conductors and the insulator holding or separating the conductors.

For RF applications, the characteristic impedance of the transmission lines and the input and output impedances of components are designed to be 50 or 75Ω. A 50Ω impedance is used to optimise power transfer in a system because that value is close to 30Ω, the maximum power handling capacity for coaxial transmission lines, while 75Ω systems are designed to minimise attenuation (i.e. reduction in signal level per unit distance), such as in cable television systems. Most RF wireless transmission systems are optimised for power transfer and are 50Ω characteristic impedance systems.

To minimise reflections, RF cables and components for test and measurement systems for wireless devices are designed for 50Ω. Conversely, the optimal power transfer takes place when impedances are matched.

A wave passing from one characteristic impedance to a different characteristic impedance causes reflection and transmission. If the impedances are the same, there is no reflection. In cases where there is a reflected wave due to an impedance difference, there will be waves travelling in both directions on the transmission line.

At some point where the waves are in phase, a maximum voltage (Vmax) will occur; the point where the waves are 180 degrees out of phase, the minimum voltage (Vmin) will occur. The ratio of Vmax to Vmin is the voltage standing wave ratio or VSWR. This is one indication of how close the impedance of a connector or a cable is to 50Ω. **Figure 3** lists the formulas for determining the other measures of mismatch from 50Ω or from some other characteristic impedance. The reflection coefficient (ρ) is a direct indication of the percentage of the signal that is reflected at a discontinuity or a change in impedance (cable-to-instrument connector or antenna-to-low noise amplifier, as examples).

The return loss is a measure of the attenuation to a reflected signal. A high return loss is desirable. **Figure 4** shows the relationship between the three values for the ideal case, a perfect match (no reflection), the ideal open circuit or short circuit (100% reflection) and for three values in between these extremes. Test instrumentation typically has input or

Reflection Coefficient

$$\rho = \frac{V_{reflected}}{V_{incident}} = \frac{Z - Z_0}{Z + Z_0}\ ;\ Z_0 = Z_{\substack{transmission\ line \\ Characteristic\ impedance}}$$

Voltage Standing Wave Ratio

$$VSWR = \frac{V_{max}}{V_{min}} = \frac{V_{incident} + V_{reflected}}{V_{incident} - V_{reflected}} = \frac{1+\rho}{1-\rho}$$

$$\rho = \frac{VSWR - 1}{VSWR + 1}$$

Return Loss

$$\text{Return Loss} = 10Log_{10}\frac{P_{incident}}{P_{reflected}} = 20Log_{10}\frac{1}{\rho}$$

$$= 20Log_{10}\left(\frac{VSWR+1}{VSWR-1}\right)$$

Figure 3: *Formulae determining the other measures of mismatch from 50Ω or from some other characteristic impedance*

ρ	VSWR	Return Loss	Reflected Power	
0	1.0:1	∞ dB	0.0%	No reflection $Z_L = Z_0$
0.047	1.10:1	26.4 dB	0.2%	
0.099	1.22:1	20.1 dB	1.0%	
0.224	1.58:1	13.0 dB	5.0%	
1	∞	0 dB	100%	Full reflection Z_L = open,short

Figure 4: *The relationship between the three values for the ideal case, a perfect match (no reflection), the ideal open circuit or short circuit (100% reflection) and for three values in between these extremes*

output VSWRs in the 1.2:1 to 1.6:1 range.

Get up to speed on RF connectors, cables and components

The frequency response of cables with BNC connectors typically begins to degrade at frequencies greater than 500MHz. In the RF world, cables are often equipped with N-connectors and SMA connectors. N-connectors are commonly used on test instrumentation, because they are rugged, can handle high power and perform well up to about 18GHz. The SMA-connector is much smaller than the N-connector and is rated for lower power than the N-connector, but it can be used well beyond 18GHz.

All RF cables are coaxial. Coaxial RF cables can be inflexible (rigid), flexible for a limited number of bends (semi-rigid), or flexible. Care of the cable is much more important for RF cables than for low frequency cables. Excessive bending of the cable and sharp, 90° bends can cause damage to the cable, severely degrading performance.

At low frequencies, a good connection means that the conductors are in contact with each other (simply continuity). At RF frequencies, the importance of mismatch means that a good connection not only has the conductors in contact but also that the connectors are properly torqued together. Manufacturers recommend about 90 Newton-centimeters of torque to ensure good contact and minimal resistance (insertion loss in RF terms) between the connectors.

Maintaining the 50Ω line throughout a test system

Avoiding parallel connections or multiple signal paths in RF circuits is not as simple as in low frequency circuits. Maintaining a matched circuit path to minimise discontinuities and signal reflections is critical. RF switches are precision-machined and designed to maintain 50Ω impedance through the switch.

To effect a parallel path in RF, devices known as splitters or dividers separate an input signal path into two or more output paths, each with 50Ω impedance. Combiners perform the opposite function by converting multiple input paths into a single output path. These are just of a few of the specialised components needed for RF test systems. If you are new to RF test, be prepared for sticker shock because RF components cost much more than their equivalent DC components.

What kinds of RF instrumentation do your tests demand?

There's a growing array of RF test instruments that are commercially available, including signal sources, power meters, spectrum analysers and network analysers.

POWER METERS

Power is the most frequently measured RF parameter. The easiest way to measure power is with a power meter, which employs a broadband detector and reports absolute power, usually expressed in Watts, dBm, or possibly, dB microvolts. In most power meters, the broadband detector (or sensor) is an RF Schottky diode or diode network that performs an RF-to-DC conversion.

Power meters provide the best accuracy of any RF instrument for measuring power. High-end power meters (which often require an external power sensor) can measure with 0.1dB accuracy or better. Power meters can operate down to near -70dBm (100pW). Sensors range from high power models to high frequency (40GHz) models; high bandwidth models are available for peak power measurement.

Power meters may have either one or two channels, but each channel requires a separate sensor. Meters with two channels allow measuring both input and output power on a device, circuit, or system, which is useful for computing a gain or loss.

Some power meters can take up to 200 to 1,500 power readings/sec. Some can measure peak power characteristics of many types of signals, including modulated signals and pulsed RF signals used in communications and other applications. Two-channel meters can also make accurate relative power measurements. Power meters can be packaged into small enclosures designed for portability, making them suitable for use in the field.

A power meter's main drawback is its limited amplitude measurement range, which represents a trade-off for the wide frequency range it covers. In addition, a power meter will provide an accurate measurement of a signal's power but will give no information on the frequency composition of the signal.

SPECTRUM AND VECTOR ANALYSERS

A spectrum or vector signal analyser measures RF signals in the frequency domain using narrowband detection techniques. The primary output display is a spectrum of power vs frequency (both absolute and relative power). The output can also be a demodulated signal.

Spectrum analysers and vector signal analysers lack the high accuracy of power meters; however, the narrowband detection techniques they employ allow them to make measurements at levels as low as -150dBm. RF analysers typically have accuracies of ±0.5dB or better.

Spectrum and vector signal analysers can measure signal frequencies ranging from kilohertz to 40GHz and beyond. However, the wider the analyser's frequency range, the higher its cost. The most common analysers can measure frequencies up to 3GHz. New communication standards, which operate in the 5.8GHz region, require analysers with 6GHz bandwidths and higher.

Vector signal analysers are spectrum analysers with added signal processing capabilities, which not only measure a signal's amplitude but also can decompose the signal into its in-phase and quadrature components. Vector signal analysers can demodulate modulated signals, such as those generated by mobile phones, wireless LAN devices and devices operating on other emerging standards. Vector signal analysers can display constellation diagrams and code domain plots, and compute measures of modulation quality such as error vector magnitude.

Traditional spectrum analysers are known as swept-tuned devices because a local oscillator is swept across a frequency span so that a narrowband filter can acquire the power content at the individual frequencies within the frequency span. Vector signal analysers also sweep over a portion of the spectrum, but they capture wide frequency segments of data. This allows vector signal analysers to capture a spectrum much faster than spectrum analysers can.

One key measure of a vector signal analyser's performance is its measurement bandwidth. The new high-bandwidth communication standards, such as WLAN and WiMax, generate 20MHz bandwidth signals. To acquire and analyse these signals, the analyser must have a bandwidth wide enough to acquire the whole signal. If you are testing high bandwidth, digitally modulated signals, be sure to specify an analyser that has the measurement bandwidth to capture the signal adequately.

A spectrum analyser will verify that a transmitter is generating the appropriate power spectrum. If design engineering has requested testing of distortion components such as harmonics or spurious signals, then a spectrum or vector signal analyser is needed. Similarly, if a device's noise power is of concern, an RF analyser is required. Other tests that require a spectrum analyser or vector signal analyser include testing for intermodulation distortion, third order intercept, the 1dB gain compression on a power amplifier or power transistor, and a device's frequency response.

Testing a transmitter or amplifier that must process digitally modulated signals requires a vector signal analyser to demodulate the signal. The vector signal analyser can measure how much modulation distortion a device is creating. The demodulation process is a complex, computation-intensive process. Therefore, vector signal analysers that can perform the demodulation and measurement computations quickly can reduce test times significantly, which can help cut testing costs.

RF SIGNAL SOURCE

All RF signal sources generate continuous wave (CW) RF sine wave signals. Some signal generators can also modulate an RF signal (i.e. AM signals or a pulsed RF signal), while vector signal generators use IQ modulators to generate digitally modulated signals.

Types of sources can be further distinguished as fixed CW sinusoidal wave outputs, sweepers that sweep over a range of frequencies, analogue signal generators, and vector signal generators that add analogue and digital modulation capabilities, respectively.

An RF source is needed whenever test requirements call for a stimulus signal. Key specifications for RF sources include the frequency and amplitude ranges, amplitude accuracy and modulation quality (for sources that generate modulated signals). Frequency tuning speeds and amplitude settling times are also critical for minimising test time.

Vector signal generators are high performance sources that often incorporate arbitrary waveform generators for digital signal generation. The arbitrary waveform generator enables the vector signal generator to produce any kind of digitally modulated signal. Many waveforms can be generated internally. In some cases, a waveform can be created externally and downloaded to the instrument. If the test specifications require a component, device, or system to be tested with the modulation that the device-under-test (DUT) will process in its end use, a vector signal generator is often needed.

RF sourcing is needed if test specifications call for receiver sensitivity tests, bit error rate tests, adjacent channel rejection, two-tone intermodulation rejection, or two-tone intermodulation distortion. The two-tone intermodulation tests and the adjacent channel rejection test require two sources. The receiver sensitivity test and/or the bit error rate test require a single RF source.

If the DUT is used in the mobile phone industry, it will most likely require a test

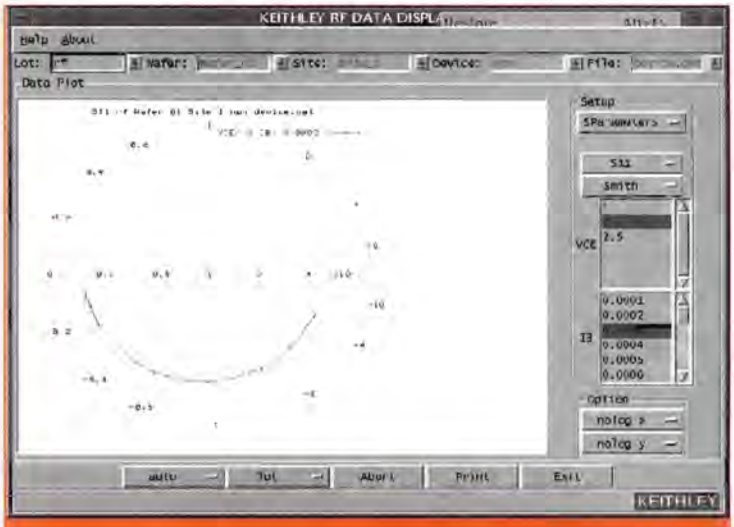

Figure 5: Smith chart

with the type of modulated signal required by the mobile phone standard. A mobile phone power amplifier will require testing with a modulated source, such as a vector signal generator. To ensure a specific vector signal generator will provide the fastest possible test times, evaluate the speed at which it can switch between different modulated signals.

NETWORK ANALYSERS

Network analysers combine an internal RF source and either a broadband or narrowband detector to test RF devices. The output displays the device characteristics in either x-y rectangular coordinates, polar display, or a Smith chart (**Figure 5**).

Essentially, a network analyser measures the S-parameters of a device. A vector network analyser can provide both magnitude and phase information and can determine transmission losses and gains of these devices over a wide frequency range with good accuracy. It can also measure return loss (reflection coefficient), impedance match and, when used in conjunction with a vector network analyser, phase measurements and group delay together.

Network analysers are used mostly for analysing components such as filters and amplifiers. It's important to be aware that these instruments work with continuous wave unmodulated signals and that period calibration is extremely important. Network analysers are expensive because they combine sourcing and measurement in a single instrument that offers a wide frequency range.

POWER AMPLIFIER TESTING

Power amplifier (PA) testing is one common application that requires four major RF test instruments.

A source can provide the input signal and either a power meter or a spectrum analyser can measure output power. If accuracy is critical, such as in a maximum power measurement, then a power meter is needed for the output measurement.

A power amplifier's input match is a key parameter of interest for a designer developing an RF transmitter. It is important to amplify all the power supplied to the PA and avoid losing a substantial amount due to reflection. For this reason, PA manufacturers will specify and measure return loss (or S11) of a PA, which a network analyser can measure. Alternatively, if only the scalar magnitude is required, then a source and a spectrum analyser or power meter can be combined with a coupler to measure the magnitude of the reflected power. The only drawback is that the setup is more complicated than the use of a network analyser because additional passive RF components are required. The power meter will provide the more accurate power measurement for the return loss scalar measurement.

The ability of a PA to deliver power to a load that has an input impedance that's not matched to the output impedance (typically 50Ω) is a key measure of the amplifier's ability to perform under real-world conditions, where loads such as antennas may not have exactly 50Ω characteristic input impedance. In such cases, a non-50Ω resistive load is switched to the output of the PA. The load can force the PA to output into a VSWR of up to 20:1 (a 50Ω load would result in a VSWR near 1:1, the ideal perfect match VSWR). The PA must be able to function properly and deliver some power to the load in the presence of a large amount of reflected power.

Some output measurements require spectrum analysis. RF PAs used in broadcast or mobile phone applications require that excess power not be generated in frequency channels adjacent to the channel at which the PA is operating. Adjacent channel power, intermodulation distortion and harmonic distortion are measures of the power that a PA generates outside the intended transmission channel. For these measurements, dynamic range, the ability to measure a small signal in the presence of a large signal such as a carrier signal, is an important spectrum analyser specification.

For example, if a PA has a specification that its adjacent channel power (for a certain type of modulation scheme or for a specific mobile phone standard) is 60dBc (decibels below the carrier), then the dynamic range of the spectrum analyser (under the required test conditions) must be at least 6dB greater than the minimum allowed power level for the harmonic, the adjacent channel power level, or the intermodulation product.

The adjacent channel power measurement must be performed with a modulated signal, which means the source's adjacent channel performance must also be considered. The source's adjacent channel power output must be at least 6dB less than the maximum allowable adjacent channel power that the power amplifier can generate.

For harmonic measurements, the analyser must have a frequency range three times greater than the maximum operating frequency (3dB bandwidth frequency) of the PA to adequately capture the power in the third harmonic of the maximum operating frequency. Again, dynamic range and noise floor of the spectrum analyser must be at least 6dB better than the DUT to make a good measurement on the third harmonic component and have a reasonable signal-to-noise ratio for an accurate and repeatable measurement. The harmonic measurements indicate the amount of distortion the PA creates. Excessive distortion can negatively affect modulation performance.

Intermodulation distortion determines how much distortion the PA generates when signals at different frequencies or components of a signal at different frequencies are at the PA's input. Two separate sources are required to generate the test signals. One dual-output source would have insufficient isolation between the two outputs, which would cause the source to create its own intermodulation distortion, leading to higher and incorrect amplifier distortion measurements.

Modulation quality measurements are also often made on PAs designed for the mobile phone market and other market segments such as WLAN applications, where complex modulation schemes are used. This often involves measuring the error vector magnitude.

MULTIPLE SOURCES NEEDED

This overview of key RF concepts and RF test instrumentation attempts to give some overall guidance on what types of test instrumentation are needed to meet test requirements. In many test applications, multiple sources and instruments will be needed. ■


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FACING THE CHALLENGES

MURRAY COLEMAN, BUSINESS DEVELOPMENT MANAGER OF IP PRODUCTS AT COMMUNICATIONS TEST EQUIPMENT MANUFACTURER ANRITSU, LOOKS AT THE CHALLENGES AHEAD FOR ROLLING OUT THE NEW GENERATION OF TELECOMS NETWORKS BASED ENTIRELY ON IP

All over the telecoms industry, networks are moving to using the Internet Protocol (IP). The growth of the Internet and packet-based IP technology has driven economies of scale and new types of network architecture and protocols that reduce costs ensure quality of service and provide scalability. This is attracting all types of network providers, from the traditional telephone provider adding video streaming to data and voice services, through the cable operator adding voice to data and video, to the mobile phone operator routing all three over wireless links and needing cost-effective bandwidth back into the fixed network.

But the real cost savings come when the network is entirely Internet Protocol (IP), rather than a mix of different legacy technologies such as ATM, frame relay, SDH and even old PDH networks. Because IP packets can run on any physical link, most of today's data, video and voice-over-IP (VoIP) traffic is still carried over these older networks, creating significant problems with running, expanding and testing the network.

BENEFITS OF ALL-IP NETWORKS

The benefits of an all-IP network are, in theory, huge. Unlike traditional telecoms traffic, IP packets do not need to be translated when they are switched from, for instance an optical to an electrical network; nor do they need to be re-packaged when moving from one type of carrier to another, a process that introduces an error-handling overhead. This means that an IP network can be faster and more resilient. By providing higher bandwidth that operates more reliably, all-IP networks promise the ultimate justification for a technology investment: better performance for less cost.

Not only this, the equipment and services supporting all-IP networks are essentially the same, even though they can serve many different markets and applications. This creates tremendous potential economies of scale, further reducing the cost of investment.

The enterprise market, in particular, pulls huge volumes of equipment from the switch and router vendors. There is also a large and evolving ecosystem of software applications, both at the customer end and throughout the network. As software is an increasingly important part of any network, this allows the operators' software engineers to focus on the areas where they make a real difference, providing more differentiation to the network offering, rather than having to develop new software for each new network technology that comes along.

Again, when the carrier and the enterprise are both on IP, they can enjoy seamless links between their networks, allowing corporate users higher performance across wider areas. For instance, the move to IP networks allows the addition of new capabilities such as Network-Attached Storage (NAS) and

Figure 1: Anritsu's MD1230

OF ALL IP NETWORKS

Storage-Attached Networks (SANs), where arrays of hard disk drives can be added easily to the network to prevent storage acting as a bottleneck.

Finally, the architecture of an IP network makes it resilient. Since packets take different routes around the network and are reconstructed at the end point, traffic can be distributed more evenly around the network. And if there is a failure at one point, packets will still get to the destination by other means.

THE DIFFICULTIES OF IMPLEMENTING AN ALL-IP NETWORK

These benefits of an all-IP network are all available in theory and some have been derived in practice. But carrying all types of traffic on an all-IP network as described is far from straightforward, whether in the existing IPv4 or the newer IPv6 networks.

Perhaps the biggest challenge that traditional telecoms network operators face in adopting an all-IP network is that IP was not designed for streaming technologies such as voice and data. Quality of Service (QoS) algorithms are applied on top of the original IP protocols to give certain packets – typically, those carrying voice or video – priority over data that does not have to arrive within a specific time. Latency, and particularly latency variation, also needs to be tackled – especially in voice links, to prevent the echo and delays that currently plague VoIP systems.

Multicast, primarily IGMP (Internet Group Management Protocol), was not originally designed to be a video delivery protocol, so there are several issues when it is used to control IPTV applications. First, many network devices do not have the required performance (i.e. forwarding rates) and will need replacing or upgrading. Second, the protocol itself includes an inherent join and leave delay when changing multicast groups, and for a TV service this will mean that there is a lag when changing programmes. So 'channel-zapping', which most – if not all – viewers do on broadcast TV, will not be possible. User control will probably be driven through indexes and menus even more than is currently the case with satellite TV.

Figure 2: *Anritsu's MP1590*

There are also different integrity priorities for different types of traffic. For instance, to drop one packet in a video stream might not be too important, but in a low-bandwidth voice call it is critical, because a much greater proportion of the data is lost. With high definition video this is even more important, as dropped packets affect perceived picture quality and data rates are 10 times higher, providing 10 times more load on the network and 10 times more opportunities to drop packets.

Not only this, but IP is also inherently a 'best effort' technology: in other words, if a packet does not get through, a new one is sent to replace it. Not only does this cause a delay, it also generates two additional packets: one to notify the loss and one replacement. This overhead can swamp the network's bandwidth if it is not carefully managed. Running the network under too much stress is just not a viable option.

There is a second big category of problem for the network operator seeking to implement an all-IP network. Some old network equipment is not suitable for handling millions of packets a second. While routers can be regularly upgraded over the network, they eventually hit the limit of the performance of their hardware and can cause bottlenecks in the system. Because the IP packets tend to route through the most direct path, this can put a problem router in the critical path and slow down the entire network.

Test equipment can help the operator manage this problem. By emulating a router in the network and simulating its performance with different types of packets, the operator can, at any single point in time, discover how to engineer traffic to optimise data flows.

But networks are constantly evolving, with IP running across many other network technologies such as SDH and ATM. Test routines and test equipment set-ups have to accommodate this variety. In addition, there is a limit to how far an operator can scale up SDH or ATM traffic to handle ever-greater loads.

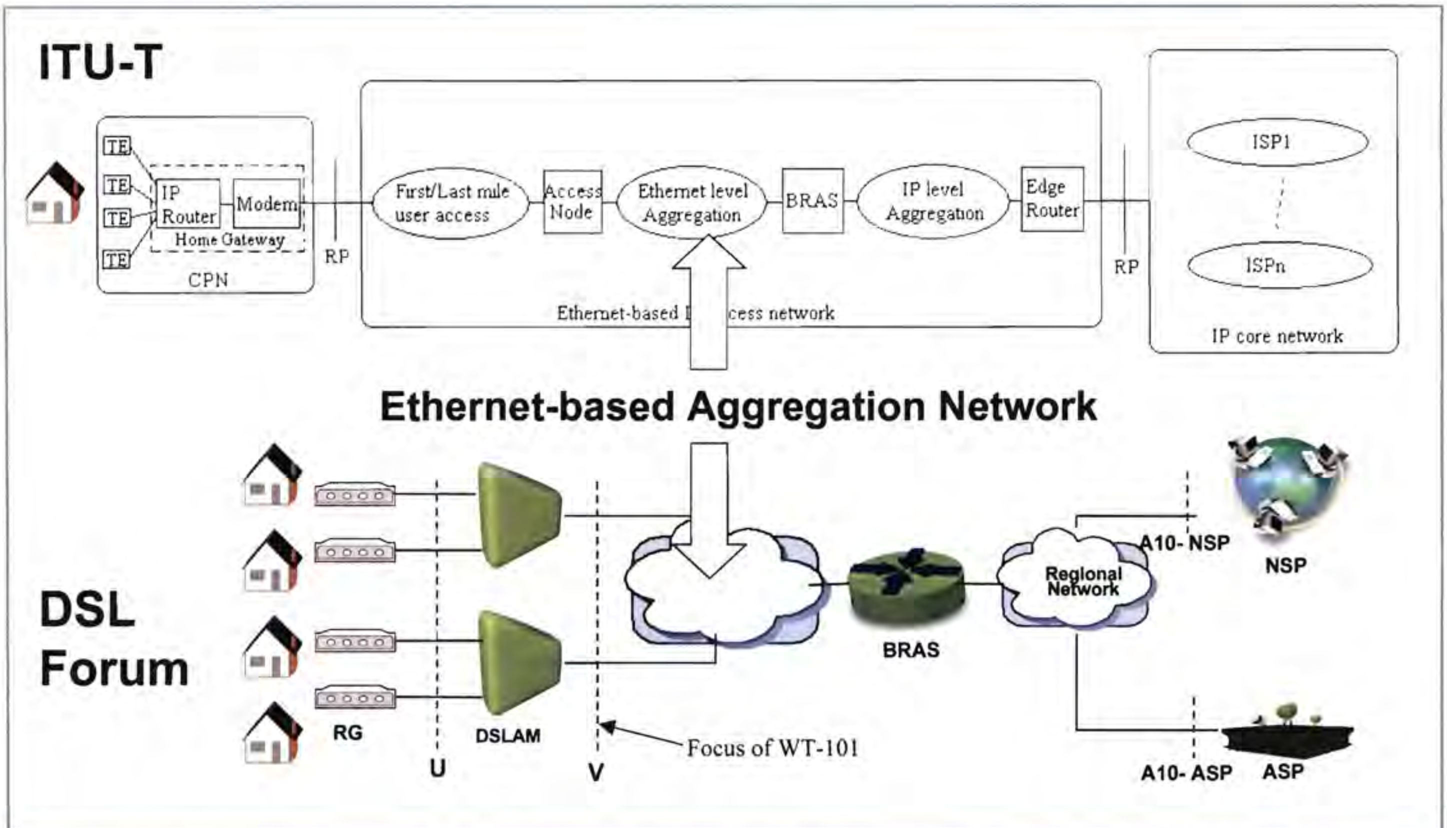


Figure 3: The network architecture for effective delivery of voice, data and video is extremely complex – migrating every element of this structure to IP is far from a trivial task

Unfortunately, operators do not benefit from a robust standards environment to guide investment decisions and to deliver economies of scale. While the International Telecommunications Union defines clear standards for telecoms networks, there are many different organisations – some standards-based and others private – providing specifications for IP technologies. These include the Internet Engineering Task Force (IETF), 3GPP (the 3rd Generation Partnership Project) governing the mobile telephony arena, and the Metro Ethernet Forum.

The specifications from these organisations can be interpreted in many different ways. Further, there is a vacuum where standards for network equipment and test equipment should be, for instance in the area of content security, which is important for operators seeking to derive revenue from the delivery of high-value data streams such as video.

DELIVERING QUALITY OF SERVICE OVER IP

An all-IP network poses very particular challenges when it comes to the quality of user experience. In short, dropped packets are experienced by the user as dropped calls, poor quality voice and video, and slow services.

The key problem is measurement. When packets can travel through any number of different routes, how can you measure network latency and guarantee that the network is supporting the QoS priorities throughout?

The reason this is such a challenge is because of the way in which test equipment is set up to sample network traffic. Operators typically sample network traffic at 1s intervals. This approach to network monitoring has worked well for many years on existing network technologies.

With a native IP network, however, network traffic can fluctuate dramatically depending on the type of packets being carried and in ways that are not detectable by the analysis of 1s samples. For example, when sampled at 1s, a network might show an average of a 4-5Mbit/s data rate. Sampled at 20ms, the same network might show an average of a 20-30Mbit/s data rate. At 1ms, the same network could be showing bursts of traffic that peak at 100Mbit/s.

These bursts of traffic hit network latency, as packets get buffered at the routers and create bottlenecks that slow down the entire network.

YESTERDAY'S EQUIPMENT FOR TOMORROW'S TRAFFIC

One of the challenges of the all-IP network comes as a result of its very flexibility. The global IP infrastructure expands all the time, with new equipment being added regularly to boost capacity. But there is older equipment scattered around the network and this can cause bottlenecks. And because the packets can take many different routes, the network operator does not necessarily have control over the path the packets take and, therefore, over which equipment is used.

While much of the equipment is regularly upgraded with new software and protocols, some of the older routers cannot handle the new protocols and the increasing bandwidth requirements of video.

This is also driven by the business models of the operators. During the dotcom boom of the late 1990s, operators that installed large amounts of equipment and waited for the services to grow to fill the capacity went bust. Now operators are offering services – and installing equipment – piecemeal to support the services as they grow, leading to a mix of equipment throughout the network.

As we shall see, this gives rise to a requirement on the network operator to do effective 'traffic shaping' – using sophisticated monitoring and management tools to route traffic effectively and optimise bandwidth utilisation.

INCREASING BANDWIDTH AT THE PLAYER LAYER

The bandwidth issue is inherent in the fabric of the network. As more and more data is carried, different network operators are taking different approaches to meeting the ever higher demands for bandwidth and this has dramatic challenges for testing and monitoring the network. Ideally, Gigabit Ethernet would form the backbone of the access network, but these links have to be aggregated into faster pipes. Currently these infrastructure pipes are running on 10Gbit/s links, but the demand for video has been driving the upgrade of these links to 40Gbit/s over the past 18 months.

Operators such as NTT in Japan are testing 40Gbit/s networks and there are now proposals for 100Gbit/s Ethernet. But these have to interface to other systems, such as 160Gbit/s SDH test labs in Germany, which can carry four 40Gbit/s channels but could only carry one 100G Ethernet channel without complex conversion equipment.

And there are still issues in the access network, as the old E1 links running on PDH are still very popular and are carrying IP traffic. These have to be aggregated together and then converted into native IP traffic, which can be complex and time consuming and can cause latency issues.

IMPACT OF PROTOCOLS ON BANDWIDTH

The protocols running on the network have as much impact on the quality of the user experience as the physical network. Using Point-To-Point protocols (PPP) in a router can provide a dedicated link to a user but dedicate large amounts of bandwidth that might otherwise be used, making it an expensive and inefficient approach.

Newer protocols such as MultiProtocol Label Switching (MPLS) move many of the packet-handling algorithms from the Layer 3 down to Layer 2. Thus, MPLS enables simple traffic engineering on IP networks and provides the ability to transport Layer 3 Virtual Private Network (VPN) channels with overlapping address spaces.

Generalised MPLS (GMPLS) extends the protocol for optical networks, but users then face the issue of the move to the switched Optical Transport Network (OTN). This uses the G.709 protocol as a digital wrapper around the packets, with forward error correction to provide a 6dB coding gain. It gives enough headroom for the optical network to switch the packets directly without having to de-multiplex the packets to switch them and then re-multiplexing. This saves tremendous amounts of time and gives a huge boost to the latency of the services.

SECURITY: PROTECTING REVENUE

Having everything as an IP packet allows new architectures to be used, particularly in storage. Arrays of SAN and NAS disks from the enterprise world can be added at any point in the network, avoiding the creation of bottlenecks for accessing content, which gives the operator more flexibility and lower costs.

There are other issues to be considered with distributed storage, such as caching popular content in drives close to the users. Also, copying large amounts of content takes bandwidth. But this is the lowest priority application, and can be handled in the background.

But with this comes a huge challenge in making the packets secure. The provisioning of the services to make sure that the streams, particularly video, go only to the people who have paid for them, is vital for operators to see a return on their investment. Specifications such as IPsec operate at the network Layer 3 to encrypt packets (rather than the higher layer SSL security seen in websites), but

IMPLEMENTING TEST IN THE ALL-IP ENVIRONMENT

Anritsu provides two families of test, monitoring and emulation solutions. The MD1230 is aimed at IP datacoms, providing traffic simulation and protocol emulation. This means a router can be plugged into the test equipment which emulates the network elements and creates simulated traffic flows. For example, it can feed 26,000 varying VPN circuits into a router to check that it is operating effectively under different traffic loads.
The MP1590 family adds support for optical SDH and OTN networks, which are increasingly important as the performance and bandwidth of networks increases. This product helps the user tackle the mix of networks in the core.

need more performance in the network equipment. Emulation and monitoring equipment has to also handle the IPsec protocols to give a realistic model of the network and evaluate its true performance.

HOW WOULD STANDARDS HELP?

All this highlights the need for standards throughout the IP network. While the lack of strict standards drives innovation in equipment design, spurs the creation of new features and drives down costs, at the same time it creates significant challenges. For instance, network equipment providers have to demonstrate interoperability between their equipment through 'plug fests', and operators spend millions of dollars every year on test labs to ensure that the equipment works together.

These challenges are even more important for testing and monitoring the network, as the test equipment has to handle a wide range of equipment from many different providers and emulate the effects of that equipment on the many different types of packets in network traffic at the full wire rate.

Unfortunately, the specifications from the IETF are not sufficient at the performance levels needed in the optical network. It is vital to sample down to 1ms to find out what is happening in the network so that it can be controlled. Longer sampling rates run the risk of missing latency issues, and there is currently no guarantee that the latency in the test equipment is actually the latency that is measured in the network. This needs standards from a test house such as the UK's National Physical Laboratory to determine the specifications of test equipment such as OTDRs meet the requirements of network testing.

There are also different implementations of alarms and error handing in different equipment, and the test and monitoring equipment has to be aware of these, otherwise problems are ignored until they become all too obvious – and by then it is too late.

POTENTIAL

The move to a native IP network has the potential to provide operators with tremendous advantages, but there are significant challenges to overcome. Tackling the latency, bandwidth and security issues needs an extensive test and monitoring capability that can show what is really happening in large, real world networks so that traffic can be shaped and managed to provide the best quality of experience to the user.

More standards are needed for this, both in the network and in the test equipment, to make things easier. In the meantime, networks continue to evolve as combinations of IP, SDH and legacy technologies. This creates even more of a challenge for test equipment. An all-IP network is the Chelsea of the Premiership; most networks are still playing in the lower divisions. ■

ARMED TO THE TEETH – TOOLS OF THE TRADE

A CRAFTSMAN IS ONLY AS GOOD AS HIS TOOLS, SAYS **SCOTT BLACK,** EXTECH INSTRUMENTS PRODUCT SPECIALIST, WHO IN THIS ARTICLE OUTLINES THE MOST IMPORTANT T&M EQUIPMENT TO HAVE TO HAND

In the fight against downtime and non-compliance, plant maintenance professionals face an ever increasing array of responsibilities. First and foremost, they need to keep many varying types of equipment running and at peak performance rate at that. If a system is running at less than 100% optimum performance, then people are wasting time and, as the saying goes, "Time is money".

If a piece of machinery is running at less than 100% of manufacturer specifications, then it will probably wear down prematurely. That too wastes money and drains resources. The equipment has to be running safely so as to minimise the risk of injury on the job. Injuries result in lost productivity and cost a lot of money. The equipment needs to be running efficiently so as to not waste energy. Wasted energy is wasted money and is harming the environment.

Now here's the kicker... As if being held accountable for all the aforementioned is not enough, the plant maintenance professional has to do it all while minimising the disruption of others. If the line has to be brought down, it has to be planned well in advance so contingencies can be put in place to keep the workforce productive. Repairing devices as they break down is no longer an acceptable business practice. Maintenance has become preventive and scheduled maintenance. More than ever, plant maintenance professionals must rely on their test equipment to assist them in getting the job done quickly, safely and with minimum disruption.

A craftsman is only as good as his tools. When the costs of down-time are measured in the tens of thousands of dollars, it certainly makes financial sense for the plant maintenance professional to be ready for any contingency by being armed to the teeth.

THE LINE UP

Proximity Voltage Detectors

This is a basic safety tool used to simply detect whether or not voltage is present. Before performing any electrical work, establishing whether a circuit is live is a basic practice. The "Test Before Touch" principal is taught to future electricians on day one of their training.

The typical voltage detector will flash and emit an audible warning if voltage is present. Proximity voltage detectors do have limitations. They detect AC voltage only. They will not indicate voltage inside grounded enclosures, shielded cables and cables that are wet internally. They may also be incapable of indicating the presence of voltage if a cable is partially buried or if the operator is isolated from ground. Manufacturers have added features such as a current detector or a flashlight to make the detector a more versatile tool.

The Wiggy

The venerable solenoid type tester, known as a "Wiggy", is a staple in every electrician's tool box. The Wiggy is the perfect tool for day to day 'go/no-go' line voltage testing. The operation of the meter is very simple since there are no switches to inadvertently set incorrectly. And since the presence of power creates a perceptible vibration and an audible alert, there is no need to read a gauge or scale. Solenoid voltmeters are extremely rugged and are not very susceptible to damage.

An electrician using a True RMS 3-Phase Clamp-on Power Analyser to measure, compute and display 3-phase power on balance or unbalanced loads

Clamp-On Ground Resistance Meter

Whether called "earth" or "ground", a critical element of any power system is grounding. A failed ground becomes a safety hazard and since it no longer provides a reference, testing becomes all but impossible. Any preventive maintenance schedule should include a periodic ground check. The clamp-on ground resistance testing technique gives the user the ability to measure the resistance of ground conductors without having to disconnect parallel ground rods. Furthermore, this method also eliminates the need to drive auxiliary ground stakes, something that is difficult to do inside buildings. This type of measurement also offers the advantage of including the bonding to ground and the overall ground connection resistances. The clamp-on ground resistance meter is a must in the tool box of the plant maintenance professional.

Multimeter and Clamp Meter

Electric conductors are insulated with protective sheathing not only to prevent electric shock but also to prevent current loss upstream of the intended point of use. If electric components are not provided with the proper amount of voltage and current they will operate inefficiently and fail prematurely. As insulation fails, the amount of current loss increases. Common causes of insulation failure include excessive heat or cold, moisture, dirt, corrosive gases, oils and vibration.

Insulation testers, or megohmmeters, are an extremely cost-effective way to avert downtime associated with failure of motors, transformers, generators, cables, wires and other insulated conductors as a result of bad or deteriorating insulation.

Whether it is a new equipment installation or an older, operating system, insulation testing provides the baseline data for comparison to future testing results. Environmental conditions such as temperature and humidity, which can be a challenge to control, contribute to the deterioration of insulation. As a result, insulation test readings are relatively meaningless without some value or specification to compare them to.

Keeping a record of test results over time can identify trends that are indicative of insulation breakdown. There are several manufacturers of affordable and accurate insulation testers. They should also be considered a must for preventative maintenance tool box.

An electrician using a handheld T&M device

Phase Rotation Detector

A required tool anywhere, three phase power is used to feed power to motors and drives. The rotation tester is used to determine phase rotation direction and to identify the correct connections before wiring in a new motor.

Thermal Imaging Cameras

The use of thermal imaging cameras as preventative maintenance and inspection tools has grown rapidly in the past five years. This technology is no longer limited to use by the military and security services. Applicable industries now include but are not limited to facilities maintenance, fire fighting, water damage restoration, mold assessment and carpet cleaning and restoration.

The thermography technology is based on the fact that all objects emit infrared radiation and the amount of radiation is related to the object's temperature. As temperature increases, the amount of radiation emitted increases. Thermal imaging cameras allow the operator to see variations in temperature. Warmer objects stand out well compared to their cooler background or surroundings.

The use of thermography as part of a preventative maintenance and repair program is a proven way to identify potential areas of equipment failure and costly downtime. Thermal imagers can be used to inspect electrical panels for loose and corroded connections, scan motor control centers, pumps, compressors and transformers for hot spots; this all adds up to the ability to identify faulty wiring, poor insulation or electrical imbalance.

Thermal imagers not only identify problem areas, they also have the ability to provide a permanent record with the thermal image and digital photograph. This information can be made a part of the preventative maintenance process by comparing images and photographs for temperature changes over time. The number of thermal imaging camera suppliers seems to increase each year bringing down the prices to reasonable levels. They should be seriously considered as an addition to the maintenance engineer's tool box.

Three Phase Power Meter

The three phase power meter is a "must have" for any person who maintains or troubleshoots three phase power. Three-phase power quality meters help prevent and troubleshoot problems in power distribution systems. A powerful predictive maintenance tool, the three phase power meter will help detect and prevent power quality issues before they can cause downtime and lost production time. The three phase power meter also assists in load studies and verifies system capacity prior to the addition of new loads. Of equal importance, the power meter facilitates energy assessments. If your company is investing in energy saving devices, the three phase power analyser is the tool that will give you the before and after picture you'll need to support or disapprove the investment.

Handheld Oscilloscopes

With the ever increasing use of computer-based systems in plant automation, the handheld oscilloscope has become a must-have for the maintenance professional. Events happen so quickly that they are impossible to see without the ability of a scope to trigger on an event. Once the waveform is captured, a multi-input (multi-channel) scope will let you easily compare waveforms. These channels can be displayed separately, simultaneously, simultaneously with one inverted, added, or subtracted. The latest digital storage oscilloscopes now offer advanced features that have traditionally been available only in more expensive models. Bandwidth options of up to 200MHz are now available, providing the ability to work in a broad range of applications. Displays are getting larger, thereby increasing the waveform viewing area. Also, manufacturers are now including advanced menu driven measurement features to make the job easier.

Infrared Thermometers

Infrared thermometers have been referred to as the poor man's thermal imaging camera. They too can be used in a preventative maintenance program to identify hot spots in electrical systems and components by measuring surface temperature. The thermometers use a lens to focus the infrared radiation emitted from the target surface onto a detector. The detector converts the radiated energy to an electrical signal which can be displayed as a temperature. This technology allows for temperature measurements from a distance without contacting the surface being measured.

There are several other beneficial features offered by infrared thermometers: Measurement of high temperatures (>1300°C) are easily achieved; it is a very fast process which saves time when many measurements must be taken. Moving targets and hazardous or physically inaccessible areas can also be measured. They are also an extremely affordable tool. In the last few years the costs of infrared thermometers has dropped dramatically. Accurate thermometers that measure up to 1000°F are readily available for £75 or less making them an absolute must for any tool box.

Far left: *Continuity Tester*
Left: *An autoranging digital megohmmeter in use*

NEW LFSR BASED CIRCUIT FOR GENERATING COMPLEX CODE SEQUENCES

G. MOHIUDDIN BHAT AND **FAROZE AHMAD**, BHAT AND FAROZE AHMAD FROM THE SCIENCE INSTRUMENTATION CENTRE AT THE UNIVERSITY OF KASHMIR IN INDIA IN THIS ARTICLE PRESENT A SIMPLE TECHNIQUE FOR GENERATING COMPLEX CODE SEQUENCES, SUITABLE FOR CRYPTOGRAPHIC APPLICATIONS, USING SMALLER LENGTH-LFSRs

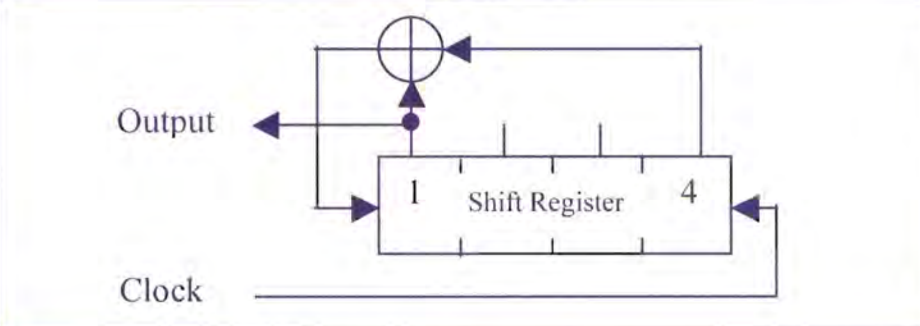


Figure 1: *Conventional m-sequence generator*

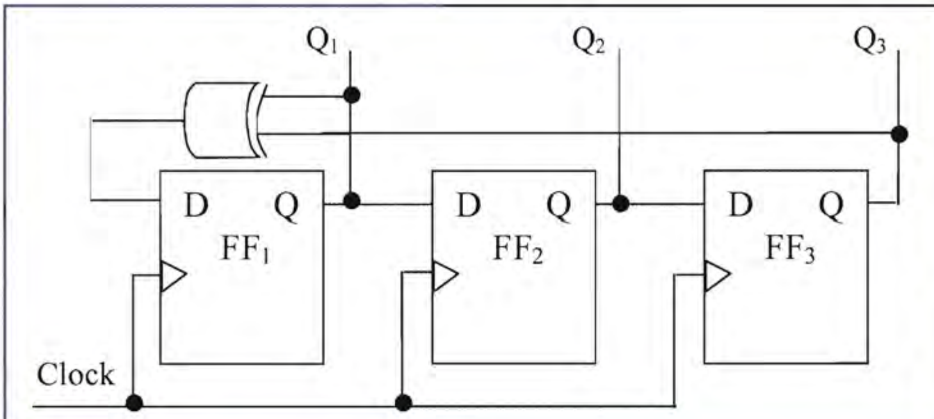


Figure 2: *Stage conventional m-sequence generator*

Code sequences generated using Linear Feedback Shift Registers (LFSRs) are useful for stream enciphering/deciphering. However, they involve lengthy LFSRs and, generally, the codes generated are not sufficiently complex to avoid eavesdropping.

In this article a very simple technique is presented for generating lengthy and complex code sequences, suitable for cryptographic applications, using smaller length-LFSRs.

SECURE COMMUNICATION

Nowadays secure communication is not only a need of military systems but it has penetrated the commercial market as well. However, the level of security needed for certain commercial applications may not be as high as that demanded by military and other applications. Thus, several simple and low-cost systems for secure and reliable communication, using spread-spectrum modulation methods and cryptographic techniques, suitable for commercial applications in non-military sector have been reported in literature. The funding agencies appreciate this demand and are actively promoting research and development in low-cost secure message communication.

A random or noise-like code is necessary for both cryptographic as well as spread-spectrum techniques at the transmitter as well as at the authorised receiver. However, because of the practical constraints and the necessity for perfect replica of the random code (with perfect synchronism) at the receiver, pseudo-random or pseudo-noise (PN) sequences are used by the transmitting and the receiving parties to enable secure message communication. The term "pseudorandom" or "pseudo-noise" is used specially to mean random in appearance but reproducible by deterministic means. It appears to an unauthorised listener to be a truly random signal.

A PN sequence is represented as a sequence of 1s and 0s with certain properties, and are generally categorised into two classes: (1) Periodic sequences and (2) Aperiodic sequences. The class of sequences used in spread-spectrum communication is usually periodic.

There are many types of periodic sequences. Among the popular ones are:

(i) Maximal-Length Linear Shift Register Sequences (m-sequences);

(ii) Quadratic Residue Sequences (q-r sequences);
(iii) Hall Sequences; and
(iv) Twin Primes.

Among all these sequences, the most commonly used ones are the m-sequences. These sequences have been widely used in military applications and other single-user spread-spectrum systems; although in some personal communication CDMA systems, some other PN sequences such as Kasami-sequences, Walsh sequences or Gold sequences are desirable because of the cross-correlation demands.

Maximal sequences are easily generated by Linear Feedback Shift Registers (LFSRs) with a relatively smaller number of stages as shown in **Figure 1**.

An LFSR consists of a shift register and a feedback network (or a parity generator) consisting of only modulo-2 adders (XOR gates). The output of the feedback network is applied to the input of the shift register. The feedback network provides output logic 0 when an even number of inputs are logic 0 and generates logic 1 when an odd number of inputs are in the logic 1 state. The number of flip-flops and the selection of flip-flop outputs connected to the feedback network determine the length and the characteristics of the generated PN sequence. Further, all the flip flops of the shift register are driven by the same clock. Besides hardware complexity, these sequences perform better while attaining the code synchronisation (between the transmitter and receiver).

The length (N) of an m-sequence is given by: $N = 2^m - 1$ (1)
where m is the number of stages in the shift register (also known as register length).
For $m = 1, 2, 3, \ldots$
we have $N = 7, 15, 31, \ldots$ respectively

Figure 2 illustrates the operation of m-sequences with three stages i.e. $m = 3$. Representing the states of the three flip-flops by Q^1, Q^2 and Q^3, we see that the feedback sum is equal to the modulo-2 sum of Q^1 and Q^3. The output of each flip-flop is connected to the input of the next flip-flop. At each pulse of the clock, the state of each flip-flop is shifted to the next one down the line.

Stream ciphers based on LFSRs give good data security, provided that the length of the

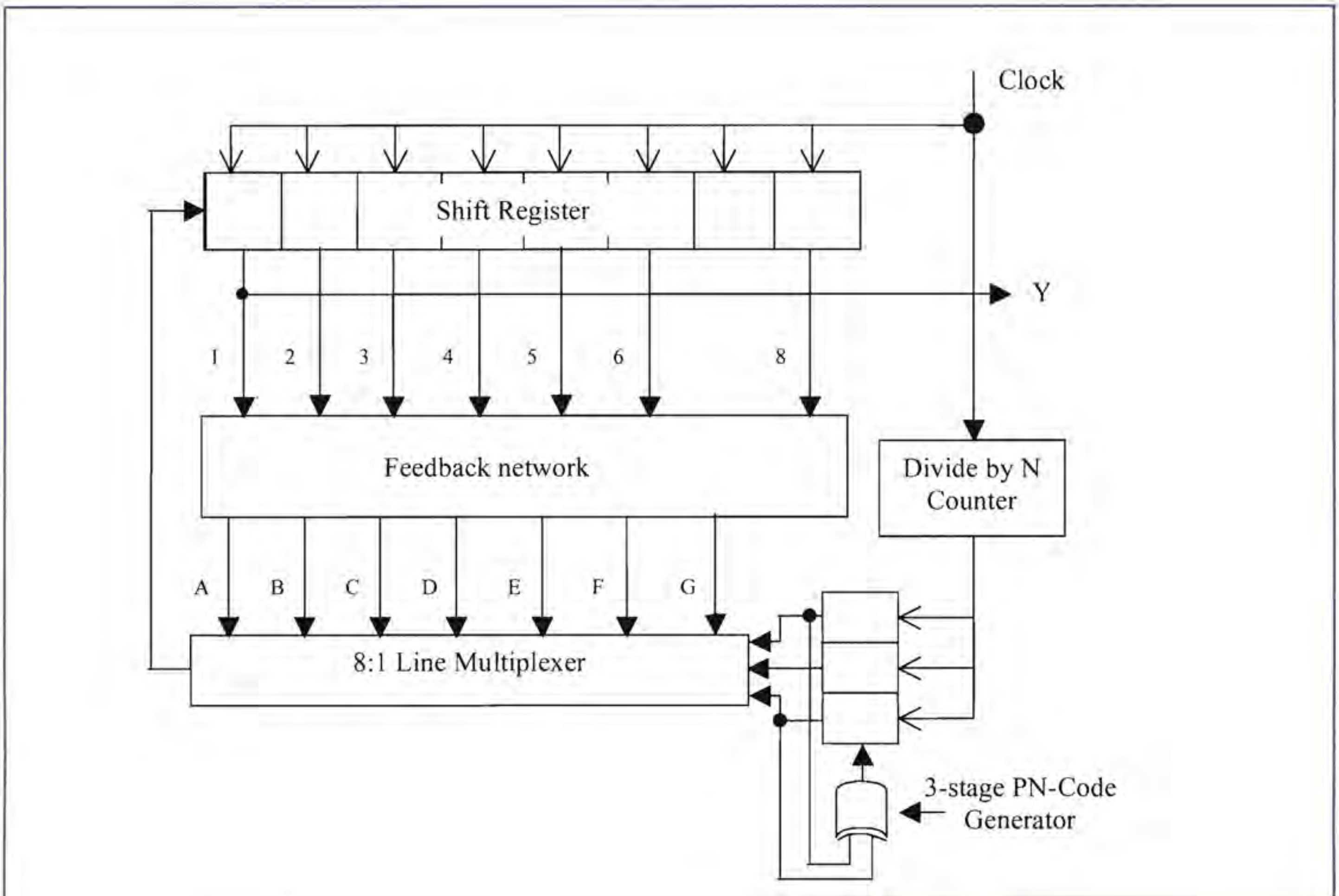


Figure 3: *Proposed m-sequence generator*

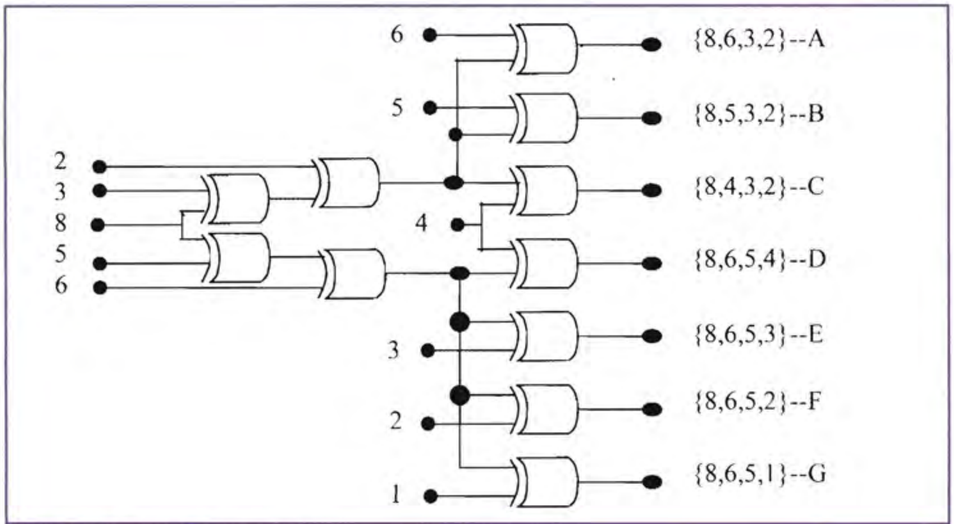


Figure 4: *Feedback network*

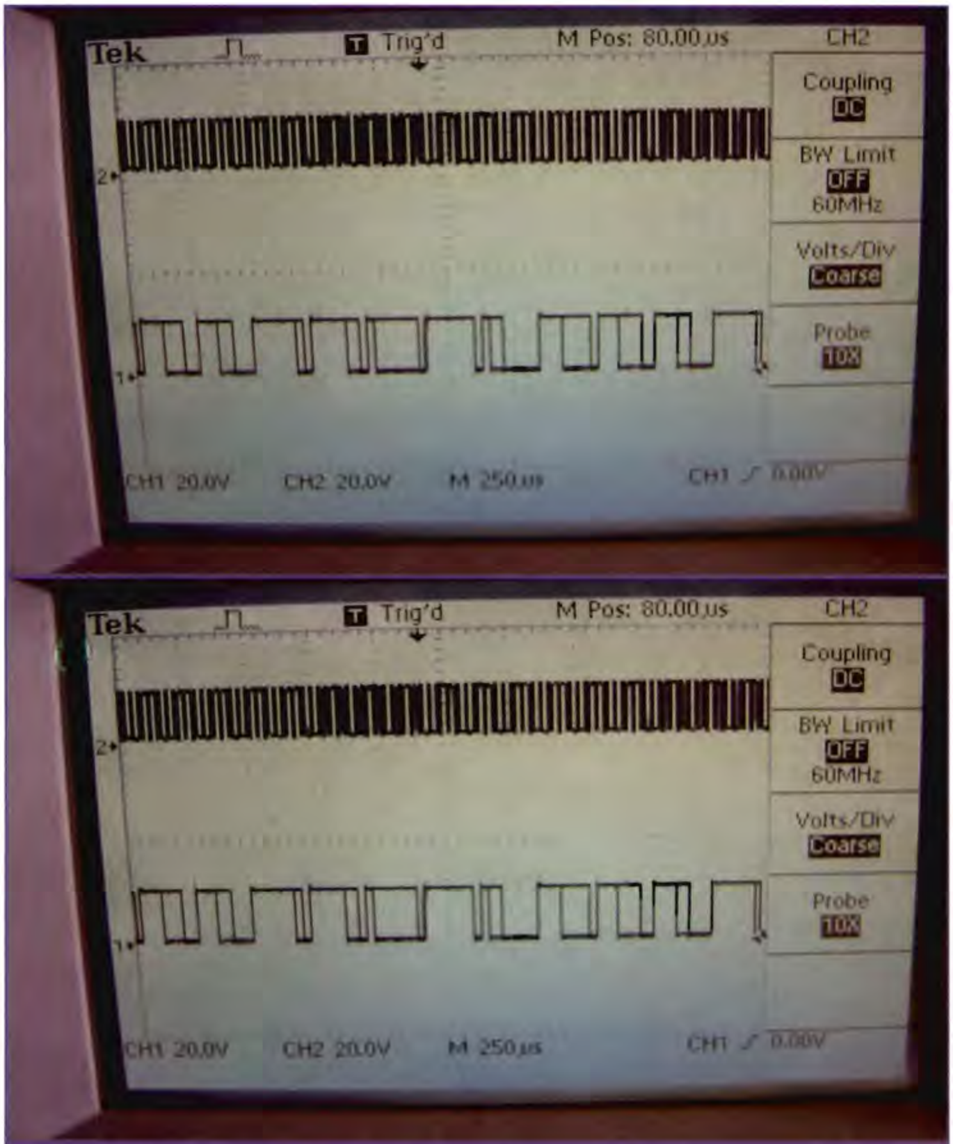


Figure 5: *Waveforms generated by the circuit shown in Figure 3*
(a) *At stage 1 of the shift register (Upper: clock signal, Lower: PN-code signal)*
(b) *At two different stages of the shift register (Upper: At first stage, Lower: At second stage).*

shift register is large. Although their software implementation is inefficient, these prove to be easy and simple for hardware implementation. Hence, these circuits are quite attractive for the development of low-cost secure communication systems. Various schemes are reported for stream ciphers using LFSRs with their own advantages and disadvantages. In all such cases, generation of a PN-sequence, synchronised with the plain text, is important. The generated PN-sequence (used as the KEY) is XORed with the plain text to produce cipher text at the transmitter. At the receiver, the same PN-sequence or Key is XORed with the cipher text to reproduce the original plain text.

Maximal-sequence codes, generated by using LFSRs, are not adequately secure for smaller lengths of LFSRs. If an n-bit shift register with certain feedback tapings is used to generate an m-sequence code of length (2^n-1) bits, it can be shown that the feedback tapings can be found if 2^n bits of the code word are known. The eavesdropping in such situations becomes easy. Several novel techniques have been developed by researchers around the world to improve the security of PN-sequences, with few patents issued by US Patent Office.

However, in most of these techniques, the feedback schemes of LFSRs are fixed and therefore can again be, sometimes, easy for a cryptanalyst or jammer to discover. In this article we present a more secure m-sequence generator wherein the feedback tapings are kept on changing in a pseudo-random manner, which makes the generated codes quite complex. Simplicity of the circuit along with the complexity of the generated codes makes the circuit attractive for low cost, secure message, communication applications.

CIRCUIT DESCRIPTION

Figure 3 shows the proposed circuit. It uses an 8-bit LFSR which can generate 16 different sets of 255-bit code sequences, depending on 16 valid sets of feedback tapings as: {8,4,3,2}, {8,6,5,4}, {8,6,5,3}, {8,5,3,2}, {8,6,5,2}, {8,6,3,2}, {8,5,3,1}, {8,7,4,3}, {8,6,5,1}, {8,7,3,2}, {8,7,6,1}, {8,7,2,1}, {8,7,6,5,2,1}, {8,7,6,3,2,1}, {8,6,4,3,2,1} or {8,7,6,5,3,2}.

Any one of these sets of feedback tapings can be used at a time so that a particular combination of the outputs of the LFSR is connected back to its input, through a modulo-2 adder. Thus, any one of the above sets of feedback connections can be selected at a time to generate the corresponding code-sequence, in part or in full, depending on the time for which the selected feedback remains connected.

If these feedback connections are changed synchronously in a random manner, the output sequence (Y in Figure 3) also changes correspondingly. This can be implemented as shown in Figure 3. For simplicity of demonstration of the scheme, only seven sets of feedback connections viz. {8,4,3,2}, {8,6,5,4}, {8,6,5,3}, {8,5,3,2}, {8,6,5,2}, {8,6,3,2} and {8,6,5,1} are chosen here. These sets of feedback connections are obtained by XORing various outputs of the LFSR as shown in **Figure 4**. One set of these connections can be selected at a time, with the help of an 8-to-1 line multiplexer (MUX) controlled by a 3-bit word generated by another PN-sequence, as shown in Figure 3.

Since 000 is to be avoided as the control word of the MUX (as may be the case in the PN-sequence, generating the required control word), only seven inputs of the MUX (one at a time) will be chosen depending upon the control word. As such, feedback tapings are changed randomly, selected one at a time out of the set of seven different sets. Hence, depending on the value of N (the divide-by factor in the circuit), the initial state of the code generator and the initial state of the MUX, a complex code sequence can be generated and obtained at the output Y, in Figure 3.

EXPERIMENTAL RESULTS

The proposed circuit has been assembled using IC74151 as a multiplexer, IC 7486 as X-OR gates for implementing feedback networks, IC74LS76 (J-K flip flop) in combination with IC7400 (NAND gate) as shift registers and divide-by-N counters.

The input clock signal required by the circuits was taken from the function generator. The proposed circuit has been tested experimentally with the PN-code signals obtained from different stages of the feedback shift registers as shown in **Figure 5**. It can be shown that a complex code sequences are generated by the proposed circuit as per theoretical expectations.

CONCLUSION

A modified scheme for PN-sequence generation employing an LFSR with randomly changing feedback connections has been presented which seems to be very interesting for stream ciphering/deciphering. The divide-by-count, N, decides the length of a particular PN-sequence at the output of the LFSR, corresponding to a particular selected set of feedback tapings. The results of experimental investigation are also presented in this article.

The maximum value of N in this case is 255. A 4-bit PN-sequence (instead of 3-bit PN-sequence) can also be used for providing the control word for the MUX, which will enhance the complexity and, hence, the security of the code words generated. In such a case, a 16-to-1 line MUX will be used with all the 16 possible sets of feedback combinations at its input. ■

The first year in force

Gary Nevison is chairman of the AFDEC RoHS team, board director at Electronics Yorkshire and head of product market strategy at Farnell InOne. As such he is our industry expert who will try and answer any questions that you might have relating to the issues of RoHS, WEEE and REACH. Your questions will be published together with Gary's answers in the following issues of Electronics World.

Q

Who is enforcing the RoHS directive?

A

RoHS is being enforced by an increasing number of EU RoHS organisations. The UK's enforcement body is the National Weights and Measure Laboratory (NWML). They started work a year in advance of most others, so were ready on day one, whereas the enforcement bodies of other EU member states only started work more recently.

Q

How is RoHS being enforced?

A

Two approaches to enforcement are being used: audit of documentation and selective analysis of equipment "put on the market" on or after July 1st 2006. In addition, the Customs authorities of some member states are also checking imports.

Q

To what extent is the industry complying?

A

There are conflicting reports on this. On the one hand figures show that 95% of products sold in the EU are 95% compliant, which means that the RoHS directive has already met its main aim. On the other, the experience of NWML in the UK shows that currently over 90% of products are not fully compliant, even though most have just one or two components that contain a RoHS substance.

Q

What are the most common causes of non-compliance?

A

Re-work of lead-free soldered products is a particularly common problem. Another is the use of obsolete components that have tin or lead termination coatings and screws with hexavalent chromium passivation coatings.

Where a non-compliant product is identified, the approach taken by NWML is to work with the producer towards full compliance. Many producers have already been contacted for documentation to show that all reasonable steps have been taken to ensure compliance. Some have been slow to respond but no one has yet been prosecuted. According to NWML, 15% of those contacted claimed, incorrectly in the opinion of the authorities, that their products are out of scope of RoHS and another 15% had inadequate documentation.

Q

Is the scope of RoHS consistent across the EU?

A

As RoHS is a single market directive, the scope is supposed to be the same in all member states, but unfortunately there are variations. Holland for example regards car radios sold in a shop to users as being in scope, contrary to the EC's published guidance. Equipment such as electric heaters and air conditioning that is bolted to walls is regarded as being in scope by some states but outside scope in others. The status of large industrial machines is also unclear, regarded by some as large-scale stationary industrial tools (out of scope) and by others simply as tools and, so, in scope.

Many other questions still remain unanswered. For example, scope is still being discussed by the European Commission and the Technical Adaptation Committee, with the status of "fixed installations", cables and luminaires remaining unclear.

Q

What's the situation with exemptions?

A

The question of exemptions is a major problem. There are now 29 exemptions in place, from over 100 reviewed with a further 23 currently under evaluation. The exemption request procedure is very lengthy, some having taken several years from the date of application to be granted, which is a difficult problem for manufacturers.
Many manufacturers cannot yet produce compliant products because they believe that there are no alternatives to specific applications that they use and they are waiting for a final decision on an exemption request. Some have stopped making products, with consequential loss of profits, whereas others are continuing and hoping that the authorities will allow this while the exemption request is under review.

NWML suggests that manufacturers in this position should not stop production. NWML would closely follow the exemption request process and take action only when clear that the request is not going to be accepted. Other enforcement bodies may not be so helpful.

One of the agreed exemptions is "Decabromodiphenyl ether in polymeric applications". Although it seems to be reasonable to grant an exemption for the use of this substance, which has no known harmful effects on health or the environment, it is causing great controversy. Denmark and the European Parliament are taking the Commission to the European Court over this issue as they say that there are alternatives. This is true, but for certain types of polymer all of these are either harmful substances or have not been as extensively tested as Decabromodiphenyl ether and so potentially, they could be more hazardous.

To make this issue even more complicated, it is unclear whether this exemption is intended to cover commercial grades of Decabromodiphenyl ether or only a high purity material that was not available in commercial quantities until very recently.

The Commission is continuing to receive requests for exemptions, as there is no time limit for these.

Please email your questions to:
svetlana.josifovska@stjohnpatrick.com
marking them as RoHS or WEEE

A VIEW FROM **THE FAR EAST**

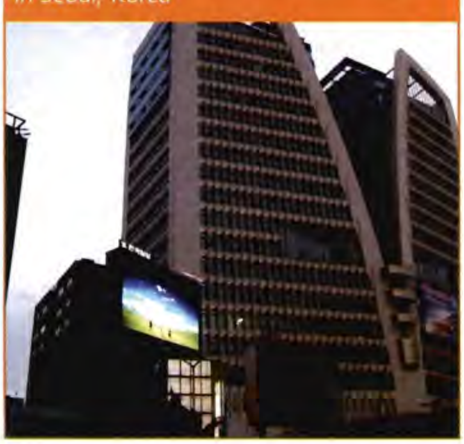
By Chris Williams, UKDL

I am writing this article sat in my hotel room in Taiwan, overlooking the centre of Taipei. Hustle and bustle all around, but here on the 12th floor overlooking a park, all is restful and relaxing – except for all the paperwork I have to catch up on!

I am here in Taiwan seeing companies on behalf of UK Plc after a short trip to Korea, where I was invited to deliver a talk at the Korean International Seminar on LEDs, Displays and Lighting 2007. It was a great opportunity to hear the latest research and production plans from some of the largest electronics companies on the planet, plus it gave me the chance to walk around the LED exhibition and see how this technology has advanced over recent years.

The exhibition revealed some fascinating developments in LED technology and its application in LED displays and lighting products.

Figure 1 & 2: *Building displays in daylight in Seoul, Korea*



Firstly, I have to comment on the explosion of the use of LED video walls around the city centre of Seoul. They are everywhere – there is simply no escape from the continual bombardment of advertising. Good job it was all in Korean, or I might have been tempted to spend my money on a thousand different things as soon as I walked a hundred yards from the hotel. Clearly many of the fixed advertising billboards and the old neon tube advertising have been supplanted by these LED signs.

The daytime views of the LED signs show that they retain good visibility in direct sunlight and they have the ability to be formed in to curved housings, allowing them to meet architectural demands for shaped surfaces.

Figure 3 & 4: *Multiple LEDs are mounted, with their packaged control electronics, as sub-assemblies on a tape assembly. Multiple tape assemblies are then joined together and a car image on one of these assemblies*

Having seen the LED screens in action, I was then fascinated to walk around the ISDL exhibition to look at them in closer detail. One development was quite stunning – I am accustomed to conventional assemblies, with LEDs mounted onto printed circuit boards to create "tiles" of LEDs which are then clustered together to make a larger assembly. What I had not seen before was the new technique of mounting LEDs onto flexible tape and then mounting these tapes vertically to create the columns of an LED video display.

This assembly is shown in **Figure 3**, where multiple RBG white LEDs are mounted, with their packaged control electronics, as sub-assemblies on the tape assembly. Multiple tape assemblies are then mounted adjacent to each other and, when driven, the picture is formed.

The image quality is poor when looking at the display close up, but is quite acceptable when seen from a distance.

Two things are very noticeable here: Firstly, the aperture ratio of each LED pixel is quite small. The aperture ratio for a display of this type is the ratio of the light emitting area compared to the total physical area that is defined as each pixel.

Now, your guess is as good as mine, but I would estimate from the picture that the aperture ratio for these LED tapes is about 15%. This is very low for a display, but it works and shows that new approaches to implementation can certainly reduce costs.

This new approach also cleverly addresses the other main problem of LED video walls – heat management. By having the LEDs mounted in free space on tapes, fresh air (or forced air if the tapes are box-mounted) can easily circulate around the LED tapes to move the heat away from the devices themselves. Simple, yet very effective.

There were also many different LED lighting products on show. What caught my eye was the integration of LEDs into tubes to act as multi-colour lighting columns as shown in **Figures 5** and **6** (variants of the

TAIWAN AND KOREA ARE CERTAINLY THE POWERHOUSE OF HIGH TECHNOLOGY MANU-FACTURING AND NO-ONE WHO VISITS HERE CAN FAIL TO BE IMPRESSED BY THE PROGRESS THAT THESE COUNTRIES HAVE MADE

old Lava lamp?) and the use of multiple LEDs to make lighting tiles designed to replace banks of fluorescent tubes.

Where there may be problems in their widespread consumer adoption is in the absolute brightness they can achieve and the long-term reliability of the systems.

Figure 7 shows different colour temperatures of white light in the standard tiles.

This clearly shows that different tiles have been set to different colour temperatures by using different LED types.

There is an interesting conundrum – the design and components you need for good quality and excellent lifetime costs money, but the objective of the lighting manufacturers I spoke to, without exception, is to get the cheapest price possible.

Research done in the UK by Cambridge University has shown that the lifetime of white LEDs can be extended to more than 100,000 hours by changing the encapsulating material from epoxy to a silicone based material. I discussed this with "household name" manufacturers and yet nobody was interested because it would cost money.

So, when I see lighting panels on show that are "new", I can be confident that all the LEDs are working to specification; but after 100s of hours, who knows. Cambridge research showed LEDs would fail and, therefore, perhaps we would see many individual LEDs failing, leaving the light output from the panel looking decidedly blotchy. Not good!

Figure 5 & 6: *LED tubes and lighting tiles*

In similar manner, the cheapest way to get white light is to use a dichroic approach: blue LED + yellow phosphor overlay = white light. If either component ages disproportionately compared with adjacent devices, the perceived colour temperature of the white will change and the colour will become blotchy white. Again, not good!

The only way to control the colour temperature is to control the emissions from the devices themselves, i.e. to use RGB chips and have colour and luminance monitoring circuitry to try and maintain a balanced luminance output and a balanced colour temperature over the reasonable operating lifetime of the device. This circuitry certainly costs money and I wonder just how many of the Korean, Taiwanese and Chinese manufacturers whose products I saw will bother to even consider this design requirement.

Figure 7: *Different colour temperatures of white light in the standard tiles*

This has been a fascinating trip, and I have made many new contacts and friends who I shall be working with over the next months and years.

Taiwan and Korea are certainly the powerhouse of high technology manufacturing and no-one who visits here can fail to be impressed by the progress that these countries have made. However, their technology is focused on conventional semiconductors, displays on glass, and low-cost very high volume manufacturing of other components and devices.

That leaves plenty of opportunity for the rest of us who are looking at new production methods – printing on paper and plastic, organic semiconductors, printed sensors, batteries and PV cells – the next platform for manufacturing electronic devices will be shared with companies on all continents and will not be dominated by our friends here in the Far East.

With best regards from Taiwan,
Chris Williams

Chris Williams is Network Director at UK Displays & Lighting KTN (Knowledge Transfer Network)

PIC DIGITAL POWER SUPPLY

Email your circuit ideas to:
svetlana.josifovska@stjohnpatrick.com

A linear power supply has a heat dissipation problem on the output transistor.

For example in a 0 to 15V variable power supply, there is 10V drop on the output transistor for a given 5V 1A output. It generates heat of 10W.

A switching power supply does not have the heat dissipation problem but it does have a noise problem.

You can combine both to get all the advantages.

Here, I propose the PIC digital power supply, which has three parts:

1. Digital control by PIC with keys and an LCD display;
2. Variable switching regulator control;
3. Variable linear regulator control.

DIGITAL CONTROL BY PIC WITH KEYS AN LCD DISPLAY

PIC program is written in C, and the software tools use MPLAB IDE v7.10 (2K free). However, there is a problem with this version. In order to use "Bank1" on writing C in this chip PIC16F690, I downloaded the unzipped "cglpic" file and placed it in C:\Program Files\HI-TECH Software\PICC-Lite\9.50\din.

For the LCD display format, do not use the "String.h" header file.

For a Char = 255, break it down to 2 5 5, then
2 Add 30 = 32 Ascll code.
5 Add 30 = 35 Ascll code.
5 Add 30 = 35 Ascll code.

Send one by one ASCII code to a 4-bit mode LCD. Disconnect the JP1 jumper when USB PICKIT 2 is connected to PIC 16F690 and Install JP1 jumper when USB PICKIT 2 is disconnected to PIC 16F690.

For further reading and details, I recommend the reference book called *"The book of 123 PIC MCU experiments from the Evil Genius"* published by McGraw Hill, written by Myke Predko.

For the DAC parts, the ideas came from *Electronics World* magazine, November 2004 issue (Ian Benton).

So, initially I wrote the C program. However, I don't believe it's prefect and that it might not have a bug. Please direct your questions to the editor and I will try my best to answer them.

I include all the source file and code, schematic and diagram.

VARIABLE SWITCHING REGULATOR CONTROL

The switching step-down regulator circuit consists of an LT1076, to maintain a constant output voltage. The FB pins need 2.5V. The feedback resistor network R1, R3 and U4-D form a feedback voltage circuit and the switching output voltage is controlled by the U4-A voltage output.

C1 and C2 should use Lo-SER type capacitors.

VARIABLE LINEAR REGULATOR CONTROL

The linear regulator consists of Q1, Q2, and Q3. The feedback resistor network R19, R20 and U4-C form a feedback voltage circuit and the linear output voltage is controlled by the U4-A voltage output.

U4-A and resistors like R5, R6, (R35+R7), R8, (R36+R9) form a DAC.

Q4, Q5 and U4-B from the current sense and range circuit.

For testing the switching and linear regulators, simply remove the PIC chip from the PCB socket. Just by connecting a variable potential resistor between 5V to 0V, you can get a variable potential voltage between 0 to 5V. Connect this point to TP1 – the power supply output voltage will vary with this potentiometer.

Set the power supply output to 6V by adjusting the potential meter and measure the voltage at the Q2 emitter and Q2 collector. The difference should be around 1 to 2V.

There are two range of current measurements: 1 to 1000uA range and 1 to 1000mA range.

Connect 5V to TP2, set the current measurement to mA; connect 0V to TP2, set the current measurement to uA.

Please refer to 'PIC digital power supply calibration procedure' below to do the calibration before use.

Fung Tak Sang
Singapore

PIC DIGITAL POWER SUPPLY CALIBRATION PROCEDURE

1. Connect a digital volt meter across the output of the PIC digital power supply.

********************* select voltage output ***************************

2. Press Enter key once.
3. Press up key or down key until LCD First line display " SeL V" –select voltage output
4. Press Enter key once.
5. LCD second line display "XX.X " -(Default is 25.5)
6. Press up key until LCD second line display "XX.0".
7. Press Enter key once.
8. Press up key until LCD second line display "X2.0".
9. Press Enter key once.
10. Press up key until LCD second line display "2.0".
11. Press Enter key once.

*************** select current output **Auto range in input less then 100 ********

12. Press Enter key once.
13. Press up key or down key until LCD First line display " SeL A" –
14. Press Enter key once.
15. LCD second line display "XX.X " -(Default is 25.5)
16. Press up key until LCD second line display "X5.5".
17. Press Enter key once.
18. Press up key until LCD second line display "X5.5".
19. Press Enter key once.
20. Press up key until LCD second line display "5.5".
21. Press Enter key once.

********************** Pass word 55 ********************************

22. Press Enter key once.
23. Press up key or down key until LCD First line display " Password"
24. Press Enter key once.
25. LCD second line display "XX.X " -(Default is 25.5)
26. Press up key until LCD second line display "XX.5".
27. Press Enter key once.
28. Press up key until LCD second line display "X5.5".
29. Press Enter key once.
30. Press up key until LCD second line display " 5.5".
31. Press Enter key once.

*********************Pass word 56 ******************************

32. Press Enter key once.
33. Press up key or down key until LCD First line display " Password"
34. Press Enter key once.
35. LCD second line display " 5.5 "
36. Press up key until LCD second line display "5.6".
37. Press Enter key once.
38. Press up key until LCD second line display "5.6".
39. Press Enter key once.
40. Press up key until LCD second line display "5.6".
41. Press Enter key once.
42. The digital power supply should be in default reading (ideal calibration slope)

*********************Obtain two cal point from power supply***********

43. Look at the DVM. Write down the reading example 1.25V
44. Look at the LCD first line display, Write down the reading, example=2.0V
45. Press Enter key once.
46. Press up key or down key until LCD First line display " SeL V"
47. Press Enter key once.
48. LCD second line display "2.0 "
49. Press up key until LCD second line display "2.0".
50. Press Enter key once.
51. Press up key until LCD second line display "6.0".
52. Press Enter key once.
53. Press up key until LCD second line display "6.0".
54. Press Enter key once.
55. Look at the DVM. Write down the reading example 3.68V
56. Look at the LCD first line display, Write down the reading, example=6.1V

*********************Store two cal point to power supply**************

57. Press Enter key once.
58. Press up key or down key until LCD First line display "Cal V1"
59. Press Enter key once.
60. LCD second line display "XX.X "
61. Press up key until LCD second line display "X X.2".
62. Press Enter key once.
63. Press up key until LCD second line display "X 1.2".
64. Press Enter key once.
65. Press up key until LCD second line display "1.2".
66. Press Enter key once.

*********************Store two cal point to power supply**************

67. Press Enter key once.
68. Press up key or down key until LCD First line display "Cal V2"
69. Press Enter key once.
70. LCD second line display "XX.X "
71. Press up key until LCD second line display "X X.6".
72. Press Enter key once.
73. Press up key until LCD second line display "X 3.6".
74. Press Enter key once.
75. Press up key until LCD second line display "3.6".
76. Press Enter key once.

********************Pass word 57 **************************
77.Press Enter key once.
78.Press up key or down key until LCD First line display "Password"
79.Press Enter key once.
80.LCD second line display "5.6 "
81.Press up key until LCD second line display "5.7".
82.Press Enter key once.
83.Press up key until LCD second line display "5.7".
84.Press Enter key once.
85.Press up key until LCD second line display "5.7".
86.Press Enter key once.
87.The digital power supply of the DAC should be calibrated.

******************** Pass word 58 *************************
88.Press Enter key once.
89.Press up key or down key until LCD First line display " Password"
90.Press Enter key once.
91.LCD second line display "5.7 "
92.Press up key until LCD second line display "5.8".
93.Press Enter key once.
94.Press up key until LCD second line display "5.8".
95.Press Enter key once.
96.Press up key until LCD second line display "5.8".
97.Press Enter key once.

******************** CalibrationADC ************************
98.Press Enter key once.
99.Press up key or down key until LCD First line display " Cal V1"
100. Press Enter key once.
101. LCD second line display "XX.X "
102. Press up key until LCD second line display "X X.0".
103. Press Enter key once.
104. Press up key until LCD second line display "X 2.0".
105. Press Enter key once.
106. Press up key until LCD second line display "2.0".
107. Press Enter key once.

********************Store two cal point to power supply*********
108. Press Enter key once.
109. Press up key or down key until LCD First line display "Cal V2"
110. Press Enter key once.
111. LCD second line display "XX.X "
112. Press up key until LCD second line display "X X.0".
113. Press Enter key once.
114. Press up key until LCD second line display "X 6.0".
115. Press Enter key once.
116. Press up key until LCD second line display "6.0".
117. Press Enter key once.

********************Pass word 59 **************************
118. Press Enter key once.
119. Press up key or down key until LCD First line display "Password"
120. Press Enter key once.
121. LCD second line display "5.8 "
122. Press up key until LCD second line display "5.9".
123. Press Enter key once.
124. Press up key until LCD second line display "5.9".
125. Press Enter key once.
126. Press up key until LCD second line display "5.9".
127. Press Enter key once.
128. The digital power supply of the DAC should be calibrated.

********************Pass word 60 **************************
129. Press Enter key once.
130. Press up key or down key until LCD First line display " Password"
131. Press Enter key once.
132. LCD second line display "5.9 "
133. Press up key until LCD second line display "5.0".
134. Press Enter key once.
135. Press up key until LCD second line display "6.0".
136. Press Enter key once.
137. Press up key until LCD second line display "6.0".
138. Press Enter key once.

************ Set up for measuring output current =100mA ****************
139. Connect a resistor and current meter.
140. Adjust the voltage output so the external current meter read 100mA
141. Look at the LCD first line display, Write down the reading, example=101 mA

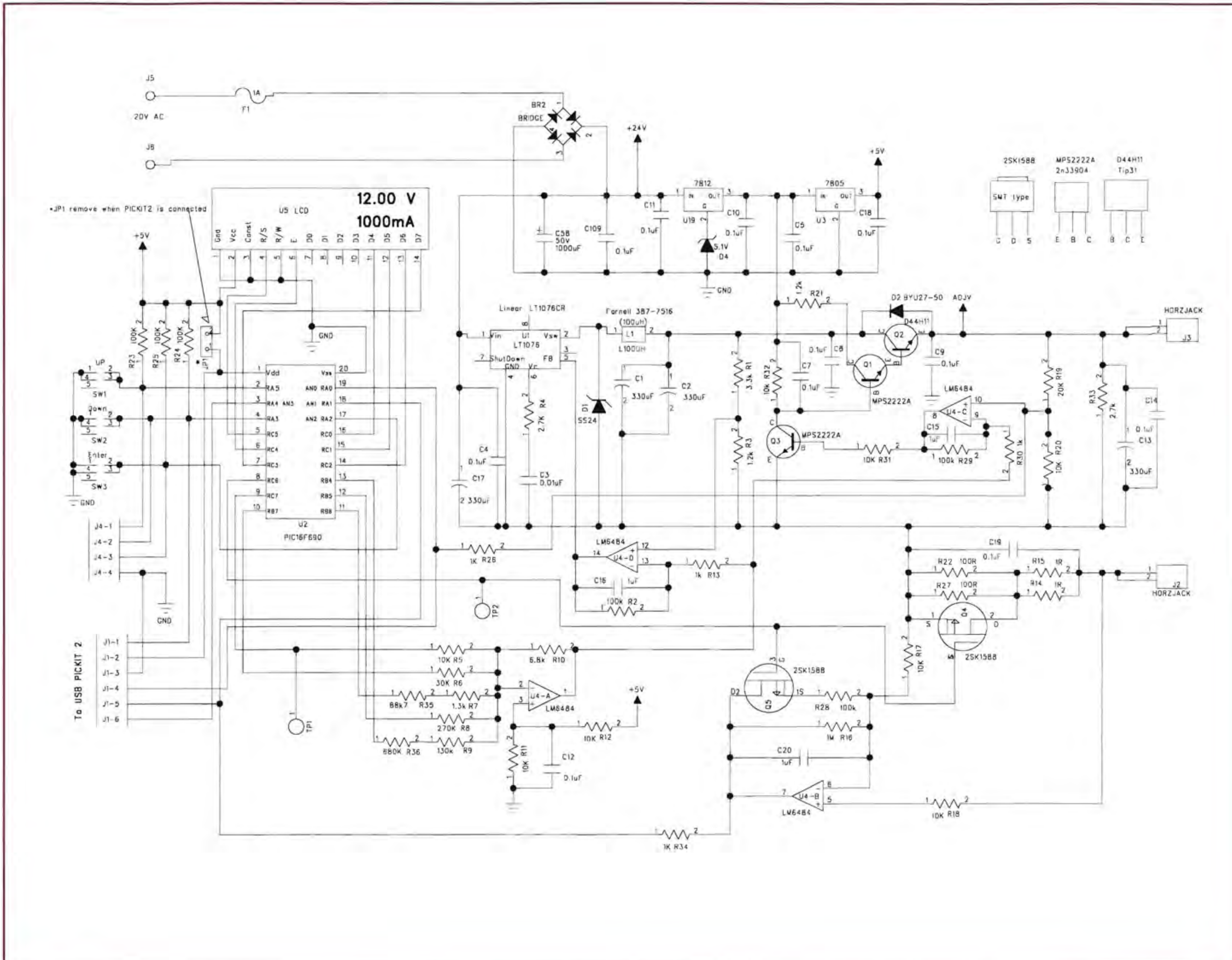
********************Store two mA cal point to power supply***************
142. Press Enter key once.
143. Press up key or down key until LCD First line display "Cal V1"
144. Press Enter key once.
145. LCD second line display "XX.X "
146. Press up key until LCD second line display "X X.0".
147. Press Enter key once.
148. Press up key until LCD second line display "X 0.0".
149. Press Enter key once.
150. Press up key until LCD second line display "0.0".
151. Press Enter key once.

****

152. Press Enter key once.
153. Press up key or down key until LCD First line display "Cal V2"
154. Press Enter key once.
155. LCD second line display "XX.X "
156. Press up key until LCD second line display "X X.0".
157. Press Enter key once.
158. Press up key until LCD second line display "X 0.0".
159. Press Enter key once.
160. Press up key until LCD second line display "1 0.1".
161. Press Enter key once.

********************Pass word 00 ********************************
162. Press Enter key once.
163. Press up key or down key until LCD First line display "Password"
164. Press Enter key once.
165. LCD second line display "6.0 "
166. Press up key until LCD second line display "6.0".
167. Press Enter key once.
168. Press up key until LCD second line display "0.0".
169. Press Enter key once.
170. Press up key until LCD second line display "0.0".
171. Press Enter key once.

********************Pass word 11 ********************************
172. Press Enter key once.
173. Press up key or down key until LCD First line display "Password"
174. Press Enter key once.
175. LCD second line display "0.0 "
176. Press up key until LCD second line display "0.1".
177. Press Enter key once.
178. Press up key until LCD second line display "0.1".
179. Press Enter key once.
180. Press up key until LCD second line display "1.1".
181. Press Enter key once.
182. The power supply up key will make the output= Cal V1 setting
183. The power supply down key will make the output=Cal V2 setting


J5
20V AC
F1 1A
J6
BR2 BRIDGE
+24V
+5V
7812
U19
7805
U3
C38 50v 1000uF
C109 0.1uF
C11 0.1uF
C10 0.1uF
C5 0.1uF
C18 0.1uF
D4 5.1V
GND
2SK1588
SMT type
G D S
MPS2222A
2n33904
E B C
D44H11
Tip31
B C E
U5 LCD
12.00 V
1000mA
•JP1 remove when PICKIT2 is connected
Gnd Vcc Const R/S R/W E D0 D1 D2 D3 D4 D5 D6 D7
JP1
R23 100K
R25 100K
R24 100K
UP
SW1
Down
SW2
Enter
SW3
GND
U2
PIC16F690
Vdd Vss RA5 RA4 AN3 RA3 RC5 RC4 RC3 RC6 RC7 RB7 AN0 RA0 AN1 RA1 AN2 RA2 RC0 RC1 RC2 RB4 RB5 RB6
J4-1
J4-2
J4-3
J4-4
To USB PICKIT 2
J1-1
J1-2
J1-3
J1-4
J1-5
J1-6
Linear LT1076CR
U1
LT1076
Vin Vsw ShutDown FB GND Vc
Farnell 387-7516
(100uH)
L1
L100UH
C1 330uF
C2 330uF
D1
SS24
R4 2.7K
C3 0.01uF
C4 0.1uF
C17 330uF
R21 1.2k
D2 BYU27-50
ADJV
D44H11
Q2
Q1
MPS2222A
Q3
MPS2222A
C7 0.1uF
C8 0.1uF
C9 0.1uF
R1 3.3k
R32 10k
R3 1.2k
LM6484
U4-C
C15 1uF
10K R31
100k R29
R30 1k
R19 20K
R20 10K
R33 2.7k
C14 0.1uF
C13 330uF
HORZJACK
J3
1K R26
LM6484
U4-D
1k R13
C16 1uF
100k R2
TP2
C19 0.1uF
R22 100R
R27 100R
R15 1R
R14 1R
J2
HORZJACK
Q4
2SK1588
R17 10K
10K R5
6.8k R10
30K R6
88k7 R35
1.3k R7
U4-A
LM6484
270K R8
880K R36
130k R9
+5V
10K R12
R11 10K
C12 0.1uF
TP1
Q5
2SK1588
R28 100k
1M R16
C20 1uF
U4-B
LM6484
10K R18
1K R34

TIPS 'N' TRICKS INTRODUCTION

The following Tips 'n' Tricks address the challenges with a collection of power supply building blocks, digital level translation blocks and even analogue translation blocks. Throughout them, multiple options are presented for each of the transitions, spanning the range from all-in-one interface devices, to low-cost discrete solutions. In short, all the blocks a designer is likely to need for handling the 3.3V challenge, whether the driving force is complexity, cost or size.

Method	V_{REG}	I_Q	Eff.	Size	Cost	Transient Response
Zener Shun Reg.	10% Typ	5 mA	60%	Sm	Low	Poor
Series Linear Reg.	0.4% Typ	1 µA to 100 µA	60%	Sm	Med	Excellent
Switching Buck Reg.	0.4% Typ	30 µA to 2 mA	93%	Med to Lg	High	Good

Table 1: *Power supply comparisons*

Note: The Tips 'n' Tricks presented here assume a 3.3V supply. However, the techniques work equally well for other supply voltages with the appropriate modifications.

POWER SUPPLIES

One of the first 3.3V challenges is generating the 3.3V supply voltage. Given that we are discussing interfacing 5V systems to 3.3V systems, we can assume that we have a stable 5VDC supply. This section will present voltage regulator solutions designed for the 5V to 3.3V transition. A design with only modest current requirements may use a simple linear regulator. Higher current needs may dictate a switching regulator solution. Cost sensitive applications may need the simplicity of a discrete diode regulator. Examples from each of these areas are included here, with the necessary support information to adapt to a wide variety of end applications.

TIP 1: POWERING 3.3V SYSTEMS FROM 5V, USING AN LDO REGULATOR

The dropout voltage of standard three-terminal linear regulators is typically 2.0-3.0V. This precludes them from being used to convert 5V to 3.3V reliably. Low Dropout (LDO) regulators, with a dropout voltage in the few hundred millivolt range, are perfectly suited for this type of application. **Figure 1** contains a block diagram of a basic LDO system with appropriate current elements labelled. From this figure it can be seen that an LDO consists of four main elements:

1. Pass transistor
2. Bandgap reference
3. Operational amplifier
4. Feedback resistor divider

When selecting an LDO, it is important to know what distinguishes one LDO from another. Device quiescent current, package size and type are important device parameters. Evaluating for each parameter for the specific application yields an optimal design.

An LDOs quiescent current, IQ, is the device ground current, IGND, while the device is operating at no load. IGND is the current used by the LDO to perform the regulating operation. The efficiency of an LDO can be approximated as the output voltage divided by the input voltage when IOUT >> IQ. However, at light loads, the IQ must be taken into account when calculating the efficiency. An LDO with lower IQ will have higher light load efficiency. This increase in light load efficiency has a negative effect on the LDO performance. Higher quiescent current LDOs are able to respond quicker to sudden line and load transitions.

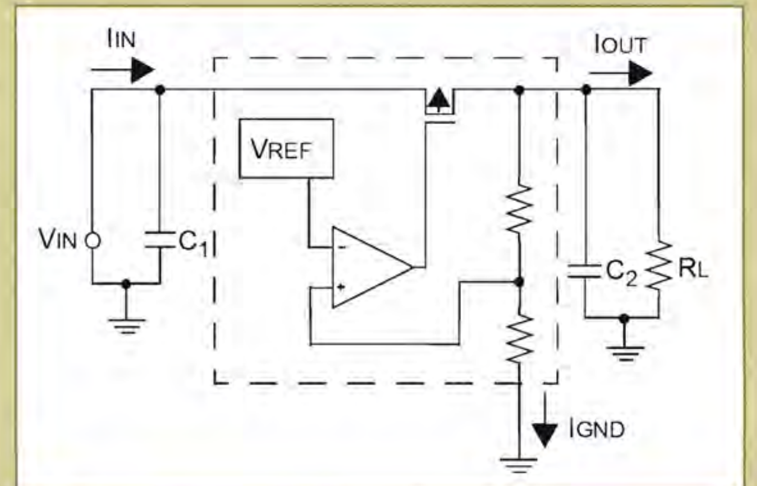


Figure 1: *LDO voltage regulator*

TIP 2: LOW-COST ALTERNATIVE POWER SYSTEM USING A ZENER DIODE

This tip details a low-cost regulator alternative using a Zener diode

A simple, low-cost 3.3V regulator can be made out of a Zener diode and a resistor as shown in **Figure 2**. In many applications, this circuit can be a cost-effective alternative to using an LDO regulator. However, this regulator is more load-sensitive than an LDO regulator. Additionally, it is less energy efficient, as power is always being dissipated in R1 and D1.

R1 limits the current to D1 and the PICmicro MCU so that VDD stays within the allowable range. Because the reverse voltage across a Zener diode varies as the current through it changes, the value of R1 needs to be considered carefully.

R1 must be sized so that at maximum load, typically when the PICmicro MCU is running and is driving its outputs high, the voltage drop across R1 is low enough so that the PICmicro MCU has enough voltage to operate. Also, R1 must be sized so that at minimum load, typically when the PICmicro MCU is in reset, that VDD does not exceed either the Zener diode's power rating or the maximum VDD for the PICmicro MCU.

TIP 3: LOWER COST ALTERNATIVE POWER SYSTEM USING THREE RECTIFIER DIODES

Figure 3 details a lower cost regulator alternative using 3 rectifier diodes

We can also use the forward drop of a series of normal switching diodes to drop the voltage going into the PICmicro MCU. This can be even more cost-effective than the Zener diode regulator. The current draw from this design is typically less than a circuit using a Zener.

The number of diodes needed varies based on the forward voltage of the diode selected. The voltage drop across diodes D1-D3 is a function of the current through the diodes. R1 is present to keep the voltage at the PICmicro MCUs VDD pin from exceeding the PICmicro MCU's maximum VDD at minimum loads (typically when the PICmicro MCU is in reset or sleeping).

Depending on the other circuitry connected to VDD, this resistor may have its value increased or possibly even eliminated entirely. Diodes D1-D3 must be selected so that at maximum load, typically when the PICmicro is running and is driving its outputs high, the voltage drop across D1-D3 is low enough to meet the PICmicro MCUs minimum VDD requirements.

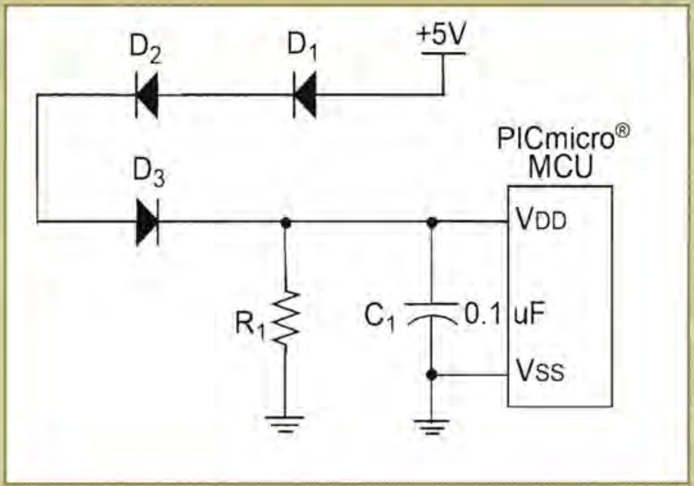


***Figure 3:** Diode supply*

TIP 4: POWERING 3.3V SYSTEMS FROM 5V, USING SWITCHING REGULATORS

A buck switching regulator, shown in **Figure 4**, is an inductor-based converter used to step down an input voltage source to a lower magnitude output voltage. The regulation of the output is achieved by controlling the ON time of MOSFET Q1. Since the MOSFET is either in a lower or high resistive state (ON or OFF respectively), a high source voltage can be converted to a lower output voltage very efficiently.

The relationship between the input and output voltage can be established by balancing the volt-time of the inductor during both states of Q1.

$$(V_s - V_o) * t_{on} = V_o * (T - t_{on})$$

Where: $T \equiv t_{on} / \text{Duty\_Cycle}$

It therefore follows that for MOSFET Q1:

$$\text{Duty\_Cycle}_{Q1} = V_o / V_s$$

When choosing an inductor value, a good starting point is to select a value to produce a maximum peak-to-peak ripple current in the inductor equal to ten percent of the maximum load current.

$V = L * (di/dt)$

$L = (V_S - V_o) * (t_{on}/I_o * 0.10)$

When choosing an output capacitor value, a good starting point is to set the LC filter characteristic impedance equal to the load resistance. This produces an acceptable voltage overshoot when operating at full load and having the load abruptly removed.

$Z_o \equiv \sqrt{L/C}$

$C = L/R^2 = (I_0^2 * L)/V_0^2$

When choosing a diode for D1, choose a device with a sufficient current rating to handle the inductor current during the discharge part of the pulse cycle (IL).

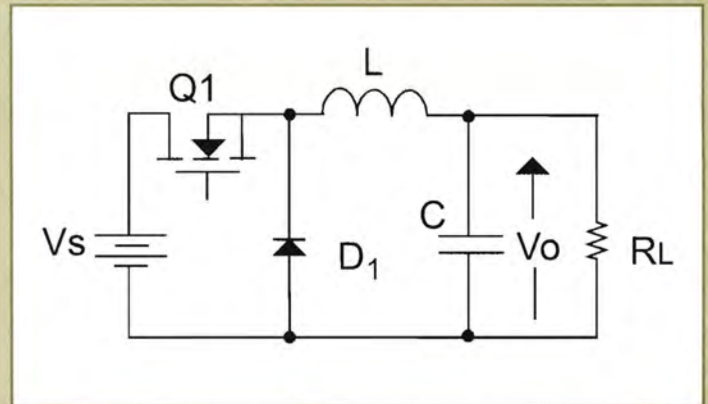


Figure 4: *Buck regulator*

TIP: RMS-DC CONVERTER ENABLES PRECISION AMPLITUDE STABLE LOW-DISTORTION SINE WAVE OSCILLATOR

By Cheng-Wei Pei from Linear Technology

Many applications require a frequency and/or amplitude-stable sine wave as a reference for calibration or measurement. Low harmonic distortion is also required for meaningful results in applications such as LVDT signal conditioning, ADC testing and, of course, harmonic distortion testing. Many sine wave generation techniques simply cannot achieve the low harmonic distortion and amplitude stability required of a precision sine wave reference. The technique shown here generates a sine wave with less than 0.003% distortion and 0.1% amplitude stability.

Figure 1 shows a simple oscillator circuit consisting of a Wein bridge oscillator core and an amplitude stabilisation loop. Linear Technology's LT1632 high-speed low-distortion amplifier and its positive feedback RC network generate the oscillations. The amplitude – and amplitude stability – of the sine wave is controlled via a negative feedback loop comprising an LTC1968 RMS-to-DC oscillator, an LTC2054 buffer and an LT1632 error amplifier.

The oscillation occurs at a frequency of $1/(2\pi RC)$, where R and C are the positive feedback components of the amplifier. The attenuation of the negative feedback network is approximately 3, to match the attenuation encountered in the positive feedback network. The 2N4338 JFET acts as a variable resistor whose resistance changes according it is the gate-source voltage bias. Changing the bias of the JFET adjusts the gain of the oscillator and, thus, the amplitude of the resulting sine wave signal. The turn-on and amplitude settling time of this circuit are dominated by the settling time of the LTC1968, which is typically around one millisecond with a 0.01µF averaging capacitor.

The LTC1968 precisely measures the RMS amplitude of the LT1632's output sine wave and gives a DC output that corresponds to the RMS level of the sine wave. The resistive attenuator at its input allows the LTC1968 to remain within its low-error region of $\leq 1V_{OUT(DC)}$ for up to $3V_{RMS}$ output sine waves. The LTC2054 buffers the output of the LTC1968 for minimal error due to output loading, and the LT1632 error amplifier compares the RMS level of the sine wave with VRMS, the desired RMS amplitude.

The error amp controls the gate-source voltage bias of the JFET to modulate the amplitude accordingly. The 10k-11.5k resistive attenuator at the gate of the JFET compensates for the channel modulation effects of the JFET, which otherwise would cause severe harmonic distortion in the circuit. As shown, the output amplitude of the sine wave is

$V_{OUT(RMS)} = 3 \times V_{RMS}$; with $0V \leq V_{RMS} \leq 1V$

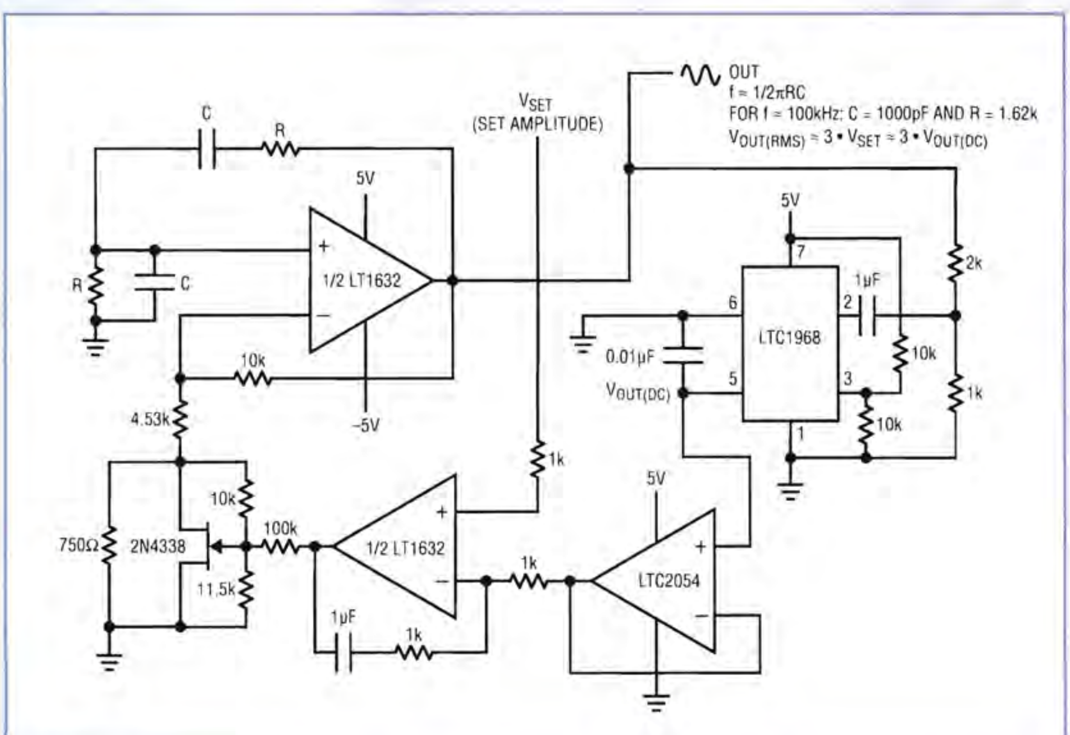


Figure 1: Schematic of the sine wave oscillator, consisting of a low-distortion LT1632-based Wein bridge oscillator core and an LTC1968-controlled amplitude stabilisation loop. The output of the LTC1968 equals the RMS level of the sine wave divided by 3

As measured with a Hewlett-Packard 3589A Spectrum Analyser, the harmonic distortion of this circuit with a 100kHz, $1V_{RMS}$ sine wave output is: –92dBc (0.0025%). The amplitude stability is better than –60dBc (0.1%). With a 2VRMS output, the circuit yields only slightly degraded performance, at –80dBc (0.01%) harmonic distortion and –55dBc (0.18%) amplitude stability.

The LTC1968 can measure the amplitude of sine waves up to 500kHz in frequency with less than 1% absolute error (independent of the amplitude stability of the circuit). Producing higher frequency sine waves using this circuit is possible, up to the 15MHz bandwidth of the LTC1968.

PRACTICAL ELECTRONICS HANDBOOK - 6TH EDITION

IAN SINCLAIR • JOHN DUNTON

NEWNES

This is the first book that I have reviewed and I approached it with some concern because there already existed glowing reviews, and I had doubts that I would be able to contribute anything extra to them. Having read the book I now ask the question "Did the earlier reviewers actually read the book, or did they simply scan the index?"

Unfortunately, this is one book that I would be unable to recommend. Although it contains a mass of useful information, there are gaps in the information, glaring errors and inconsistencies. A book of this nature should present information clearly and unambiguously, it should not present a challenge to the user to determine if the information presented can be trusted.

What follows is a synopsis of my review, although it is in reality a very truncated synopsis of a proof reading (which should have been completed by the originators prior to issue). Should anyone be interested (especially if you have already purchased the book) I am making my review notes available via the editor of *Electronics World*.

A look through Edition 3 of the '*Practical Handbook of Electronics*', which I borrowed from the IET Library, reveals a book with largely clear explanations, well constructed drawings and the obligatory bibliography to enable the reader to pursue further research.

It is difficult not to compare the third edition, which appears to have been assembled by a team of professionals (author, illustrator, typesetter, proof reader etc) with the sixth edition which appears to have been assembled on a word processor – which corrects spelling mistakes but, of course, cannot distinguish the correct word from the incorrect one – and several graphics packages. I would have expected all of my comments and the anomalies that I have found in the sixth edition to have been found by the proof reader. The third edition may be out of date in much of its content, but it is far superior in style and accuracy.

Although the sixth edition includes plenty about the microprocessor and similar ICs, such as programmable logic integrated op-amp, audio, radio etc, it leaves out other equally practical devices like the IGBT (Insulated Gate Bipolar Transistor) which has been around for a fair few years. Equally, the information on the triac and associated diac are skimpy to say the least, and the lack of a section on the USB is unfortunate.

The illustrations leave a lot to be desired. There is no consistency in use of symbols or accuracy. Illustrations that would be better presented in portrait are shown in landscape and, in one case, an illustration is shown with the drawing in landscape, but the text in portrait and with the input at the top and output at the bottom – very confusing.

Nit picking this may be, but the lack of consistency and the high number of errors make it difficult to accept the truly worthwhile information that this book may contain. Further, in my case, these have effectively side tracked me away from carrying out a proper review of this book.

Chapter 4 – Chemical Cells and Batteries, offers the potential of an insight into the multitude of cells and batteries available. Although the historical details are fascinating they are not in keeping with a practical handbook. Also, I found it difficult to follow the use of the new convention of describing the component chemicals. Manganese dioxide and its formula MnO2 I can readily understand, but manganese (II) oxide confused me, it turns out that it is MnO (manganese oxide). Manganese dioxide (MnO2), as found at **www.webelements.com/webelements/compounds/text/Mn/Mn1O2-1313139.html** turns out to be 'Manganese (IV) oxide'. It begs the question as to whether the practitioner of electronics needs also to be a chemistry graduate. It also puts in doubt the illustration of the Leclanche wet cell which indicates that 'manganese (II) oxide' (which translates as manganese oxide) is used round the carbon anode, whereas the description on page 90 states that the carbon rod is surrounded by a paste of 'manganese dioxide' (e.g. manganese (IV) oxide).

The illustrations of the various cells identify the connections as 'positive' and 'negative', whilst the text talks of the 'anode'. We all know that the anode is the positive terminal, don't we? But for clarity sake, if the text talks of the anode then it should be indicated on

THE MORE I LOOK THROUGH THE BOOK, THE MORE ANOMALIES I FIND. THERE IS INDEED A GREAT DEAL OF USEFUL INFORMATION, BUT THE AUTHORS HAVE FAILED TO KEEP THE BOOK UP TO DATE WITH THE ACCELERATION OF DEVELOPMENTS IN THEIR CHOSEN SUBJECT, AND INSUFFICIENT EFFORT HAS BEEN GIVEN TO CHECKING THE DETAIL.

the illustrations. Further, it would help if the descriptions of the various electrolytes and other elements correlated with the illustrations.

One little snippet that caught my eye was the claim (page 89) that "The insulation provided by hydrogen gas is used as the dielectric for electrolytic capacitors..." This is not so; page 35, first paragraph correctly describes the formation of aluminium oxide as the insulator (and hence dielectric).

Again under transformers it is implied that mains power transformers require an air gap to function correctly. This is the first time I have been made aware of this and it must be challenged.

Although some bibliographical references are made, the majority of references are to websites, and whilst the majority of these lead to active sites (one will lead you the Grace Community Church website), there are some mistakes that make it frustrating since, by their very nature, URLs are extremely unforgiving of errors. But, on the whole, this system appears to work quite well, especially for the manufacturers' websites.

The book declines to address the USB, but does have interesting details on the RS232 and Centronics printer (parallel) ports. There is what is claimed to be an 'exemplar' Qbasic program for linking an ADC to a PC. My laptop uses only USB, so I am biased, but my understanding is that whilst current build desktop computers may still have serial (RS232) and parallel (Centronics) ports as well as USB, these are being gradually phased out.

The more I look through the book, the more anomalies I find. There is indeed a great deal of useful information, but the authors have failed to keep the book up to date with the acceleration of developments in their chosen subject, and insufficient effort has been given to checking the detail.

The paperback version of Edition 6 is available from Amazon (UK) for £17.99 and if you feel so inclined, the paperback version of Edition 5 is still available for £18.99.

John Mayo

Omni-Directional WiFi Antennas With 9dBi Gain

CTi Ltd has launched a new series of omni-directional WiFi antennae which provide a range of gain levels up to 9dBi, greatly improving over most standard antennas fitted to indoor wireless access points, routers and bridges.

The new CTI-RA series WiFi antennas enable users to increase the signal strengths of SOHO (small office/home office) wireless equipment significantly; simply by replacing the supplied antenna, they can extend the equipment's operating range appreciably.

Suitable for use with any 802.11 standard 2.4GHz wireless systems, CTI-RA antennas are available with a choice of 3dBi, 5dBi, 7dBi or 9dBi gain levels to facilitate optimum application matching, and with three types of connector: SMA Male RS, TNC Male and N Male. All six antennas employ co-linear elements to maximise RF efficiency and minimise length, contained within a robust, semi-flexible rubber housing.

The base of each antenna features a swivel joint that enables it to be used for vertically or horizontally polarised signals, and the connector is fitted with high quality gold-plated pins for signal integrity. CTI-RA antennas have a nominal 50 Ohm output impedance and an output VSWR (Voltage Standing Wave Ratio) of less than 2:1 across the band.

www.cti-int.com

New Distributor Deal at Surtech

Surtech Distribution, the Andover-based specialist distributor of enclosures, thermal management products, power supplies and related electro-mechanical components, has struck a deal with German-based Eplax – formerly Vero Electronics – to import and distribute the company's range of pluggable power supplies into the UK electronics market.

Eplax previously maintained a UK sales office to provide sales and technical support for the standard product families, which include the PK, VP, EC and GK ranges of 3U and 6U pluggable supplies offering single and multiple outputs with a wide choice of current ratings. Stock holding will be increased substantially so that service levels can be enhanced with many popular products available ex-stock and others on short lead times.

The strengthening of the company's product portfolio with increased emphasis on PSUs is a natural progression in providing increased value-added capability to support its strong position as a leading supplier of configured enclosures and subracks, notably the Vero 19" IMRAK 1400, IMserv, KM6 subracks, modules and front panels, Diplomat and other desktop instrument cases. Veroboard prototyping products, extender cards, terminal pins are another major offering for the development engineer.

www.surtechdist.co.uk

Software Development Solution for Automotive Microcontrollers

Green Hills Software has announced the immediate availability of ECU software development suite targeting Freescale's MPC5510 microcontroller family, which is built on the Power Architecture technology.

Components of the toolkit include royalty-free RTOSs, optimising C/C++ compilers for Power Architecture, MULTI Integrated Development Environment (IDE) with multicore debugger, virtual prototyping platform, TimeMachine tool suite and high-speed Nexus hardware probes.

Green Hills Software tuned its solution specifically for the MPC5510 family's dual-core architecture. For example, it offers tuned support for the Variable Length Encoding (VLE) instruction set, an extension to the e200 core that is designed to dramatically reduce application memory footprint.

The Optimising C/C++ compilers, advanced debugger and the MULTI IDE are available now for MPC5510-based application development. TimeMachine is also available now for the integrated instruction set simulator. Support for Green Hills RTOSs, SuperTrace probe and Green Hills probe are expected soon.

The MPC5510 family of 32-bit microcontrollers are Freescale's MCUs designed to address the next wave of central body and gateway applications within the vehicle.

www.ghs.com

Waterproof Ethernet Connectors for IDC and PC Mounting

Bulgin's IP68 Waterproof Ethernet Buccaneer family has been extended with two new panel mount versions. Using the RJ45 standard these connectors are now available for PCB mounting and IDC termination.

The PX0839/PC is designed for direct PCB mounting. The connector is rear-of panel mounting, which in addition to providing an anchor point for the PCB, also allows assembly and, if necessary, testing before fitting to the panel. The connector is intended for volume applications where speed of construction without costly cabling is essential.

The PX0839/IDC is also rear-of-panel mounting but with IDC terminations.

The insulation displacement termination is a standard method of connecting individual wires using a simple assembly tool. Designed for 'field termination' it is a quick, reliable, proven technology for data terminations.

These new versions mate with all existing Ethernet Buccaneer flex connectors (PX0834, 836, 837 and 838) maintaining the Cat5e system performance and IP68 sealing integrity.

www.bulgin.co.uk

European Distribution Agreement

AMS Technologies has expanded its product range to include the measurement sensors from the French manufacturer Bergoz Instrumentation.

Founded in 1981, Bergoz Instrumentation develops and manufacturers Rogowski Coils for measuring the current in cables or in particle accelerators. The measurement process is without physical contact. The measurement parameters include DC currents, pulse currents, RMS and RF currents and can also cover the position of the current in Beams.

The current converters can be used in air, oil or high vacuums, depending on the application.

Bergoz Instrumentations' range of current converters is suitable for use for currents up to 20kA and for frequencies from 0.5Hz up to 500MHz. These products have an accuracy of 0.5% and are used mainly in research facilities, industrial laboratories and OEM equipment. The current converters are available in different sizes and can be delivered with a factory certified calibration certificate.

All the products from Bergoz Instrumentation are available throughout Europe from AMS Technologies AG.

www.ams.de

Luminary Micro Announces Stellaris Evaluation Kits

Luminary Micro announced the immediate availability of two Stellaris Evaluation Kits with a 30-day evaluation license for CodeSourcery's Sourcery G++ software development environment.

Designed for the new class of Stellaris integrated communication MCUs, these compact and versatile evaluation kits take advantage of the capabilities of the new Stellaris microcontrollers with more memory, more GPIOs, enhanced power management and the addition of integrated 10/100 Ethernet MAC and PHY communications and integrated CAN communications. Both kits include a 30-day evaluation version of the Sourcery G++ toolchain, which offers an integrated development environment, the GNU Toolchain and hardware debug support for Stellaris MCUs, including the 27 new MCUs with real-time networking capabilities.

In partnership with ARM, CodeSourcery develops improvements to the GNU Toolchain for ARM processors and provides regular, validated releases of the GNU Toolchain. CodeSourcery's current release of Sourcery G++ and includes full support for the ARM Cortex-M3 microcontroller core and the entire Stellaris family.

The EKC-LM3S6965 features fully integrated 10/100 Ethernet capability and includes two examples of an embedded web-server application. The quickstart application that runs out-of-the-box includes an embedded web server utilising the open source lwIP Ethernet stack. The kit also contains a web server demonstration application with FreeRTOS.org RTOS and the open source uIP Ethernet stack.

www.luminarymicro.com

Environmental Packaging Issues on Top for IPS

Wrexham-based supplier of protective packaging in materials such as advanced foams, corrugated boards and composites, Interactive Packaging Solutions (IPS) has made available its heat-treated plyboard clip cases.

Supplied in a variety of sizes and incorporating a palletised design for easy transportation, the clip cases provide a re-usable, flexible and cost-effective packaging solution which also addresses key environmental issues. This includes the use of steel clips which hold the lightweight outer case panels in place. These can be unclipped to enable the entire case to be re-used. This contrasts with heavy traditional shipping cases, which are usually broken up to access the contents. The result is an unnecessary consumption of materials and a 'once-only' packaging approach.

The use of laminated panels, which are heat-treated to kill pests typically found in untreated raw-wood packaging. These pests – including the Asian long-horn beetle and Pine Wood Nematode – have spread across the world through wooden packaging materials, which has prompted many countries to introduce regulations to ban their use.

www.ips-uk.co.uk

New Digital SPI Bus Pressure Sensors

Sensortechnics's new digital RCE series offers precision absolute, gage or differential pressure measurement from ±10mbar to 5 bar. These devices generate a calibrated and temperature compensated digital output signal with high resolution and very fast response times.

The sensors comply with the SPI bus protocol and can be easily interfaced to microcontrollers without the need for additional electronic components. Custom specific outputs, I2C bus, analogue or switching outputs can also be provided on request.

The RCE series utilises the latest ASIC technologies for high precision digital signal conditioning and achieves high total accuracies of up to ±1.0 %FSS (Full Scale Span).

The sensors feature highly stable micromachined silicon elements packaged with two pressure ports for easy manifold or tubing connection and mounting holes for convenient PCB assembly.

The digital RCE series offers OEM customers precision pressure measurement for a wide range of applications. Typical examples include medical instrumentation, barometry, HVAC and pneumatic controls.

www.sensortechnics.com/rce

To reserve your website space phone Matthew Dawe 020 7933 8980 or email matthew.dawe@stjohnpatrick.com

Alpha Wire

www.xtraguard.com

Leading supplier of advance solutions and service in wire, cabling and tubing, Alpha Wire International, has announced the launch of a new website dedicated solely to its range of hazard-matched cables, XTRA•GUARD® that provide extreme performance for extreme environments. The new website www.xtraguard.com represents an industry first for a website dedicated solely to a single brand of cable. The site offers an intuitive selection aid to help engineers correctly specify cable for their application's extreme environment.

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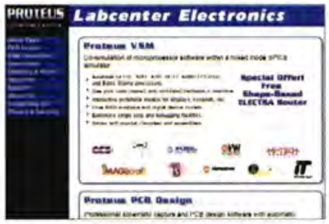

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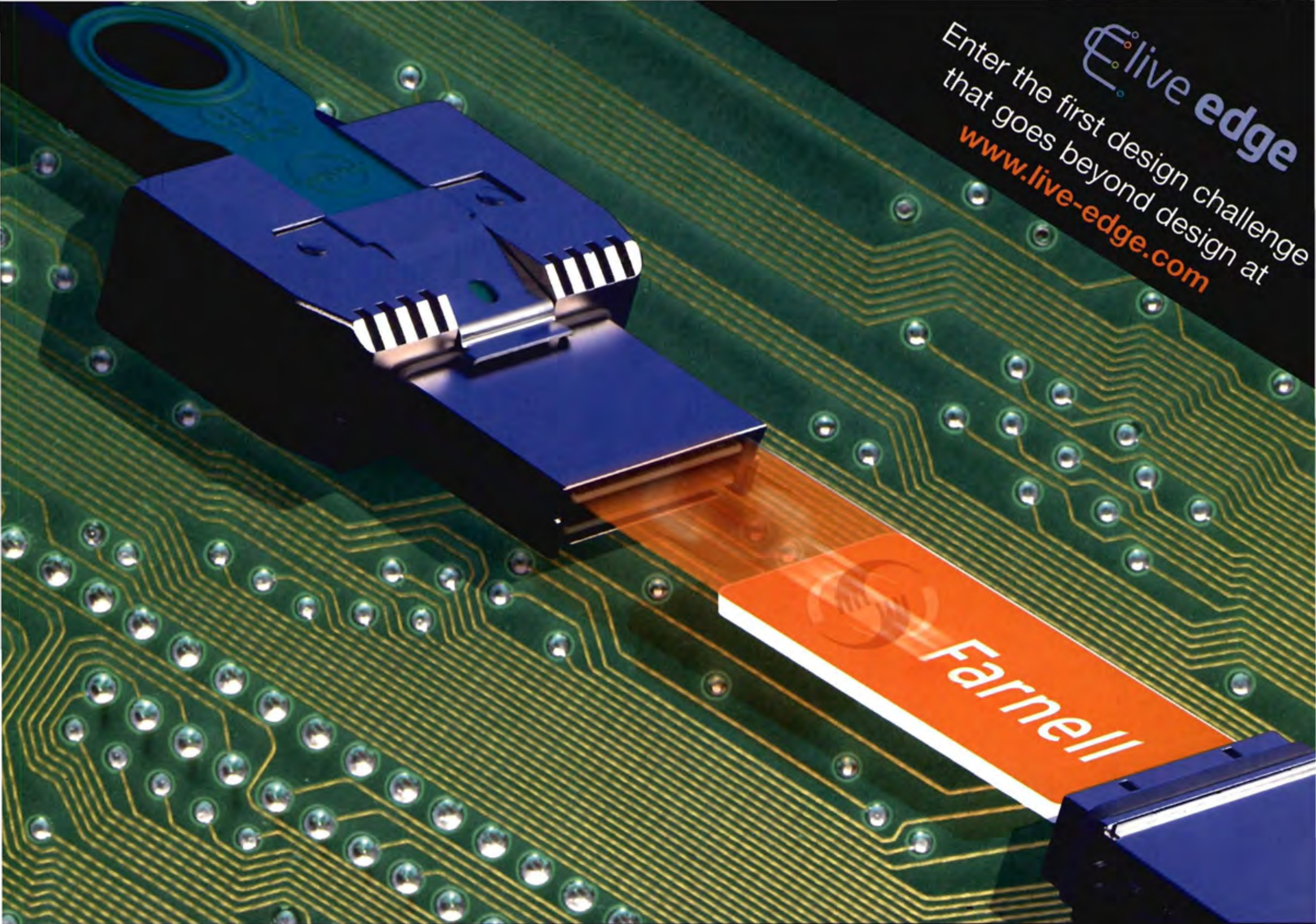
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