ELECTRONICS WORLD

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Avoid modern comms security chasm

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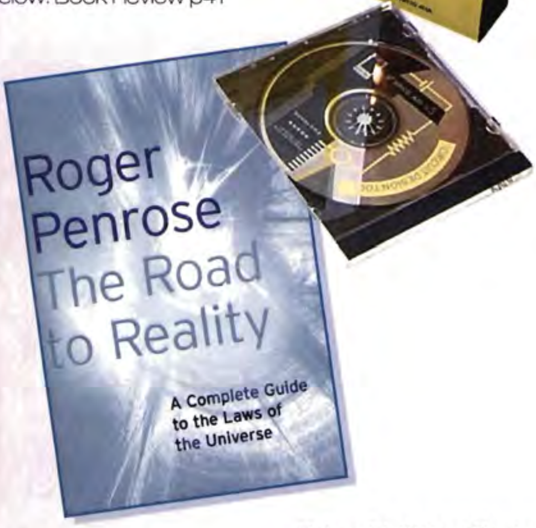

Below: EMC Test Centre p56

This month's front cover was supplied to Electronics World by Potentia Semiconductor

Never stop playing

In response to many of you who called for a features list to contribute toward with content, I am pleased to list the following subjects that we will cover for the rest of the year in Electronics World magazine.

- April – *Spectrum Analysers*
- May – *Relays*
- June – *USB Interface Design*
- July – *Low-Noise Circuit Design*
- August – *High-Speed Discrete Design*
- September – *Analogue IC Design*
- October – *RF and Microwave Design*
- November – *Interconnect Technologies*
- December – *Emerging Technologies and Techniques*

Please feel free to send us your features, circuit ideas and other material that relates to these subjects, but also feel free to send us material on any other electronics-related subject that has not been covered in the features list above. The world of components and design never stops evolving. We are continually witnessing the shrinking of electronics that many DIY enthusiasts have a problem with – modern chips tend to be small, very difficult to manually assemble into a circuit and hard to acquire in small quantities at a sensible price. For the keen DIY circuit developer, the fun of the 'chase' in completing an efficient, perfectly functioning circuit built from scratch has been replaced by bemusement at the development boards that can be programmed to meet the craziest of needs. Not only they can be programmed but Internet-connected or LAN/WAN/PAN (etc) networked. As one Electronics World reader said, "such a board can be programmed to be a wine cellar burglar trap that can be controlled across the world as an active web page".

To have fun and learn with electronics today is more likely to mean having a PC and a data link to a small, semi-intelligent, development card than owning a soldering iron. Many firms the likes of Microchip provide low-cost devices and even free development software.

But is the nature of having fun with electronics, physics or any other sciences as we know them going to change? With greater device integration, smaller component sizes and just software, software, software, the older ways of picking up a soldering iron and tinkering away are slowly disappearing.

Another Electronics World reader recently wrote: "The constant need of industry to go for ever more integration and product specialisation has led to a drop in home-designed, home-made electronics ideas."

Even though some aspects of home-made electronics are disappearing, there is still plenty of fun to be had – even if that means software programming. Curiosity, empiricisms and pure playfulness are such an integral part of human nature that whatever shape electronics takes on, we will find a way to continue inventing.

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Pervasive, networked computing will dawn in Europe first

A consortium of European scientists is setting out to create a network of "invisible computers" that are the billions of electronic devices we use every day.

RUNES (Reconfigurable Ubiquitous Networked Embedded Systems) is a research project funded by the European Community's Sixth Framework Programme. Its goal is to harness the processing power of microprocessors in PCs and embedded systems to create new applications in healthcare, transport, manufacturing and disaster recovery among others, but also giving Europe a competitive edge.

"Every European home contains multiple embedded systems and most people carry several around with them, from phones and watches to portable computers and music devices. By joining up existing devices, we are enabling the era of wearable computers, smart homes and a whole new generation of health monitoring," said EU project officer Franck Boissiere.

The project aims to create a standardised, adaptable, computing architecture that can organise itself to suit its environment and meet the different demands placed upon it. "We are in the middle of the revolution but people don't yet know it's happening. Invisible, or pervasive, computing is already all around us. It's the pervasive – networked – computing that is about to happen," said Steven Hailes, RUNES technical director and computer science lecturer at University College London.

RUNES is expected to enable factories to rapidly reconfigure control and information systems to improve performance, or completely alter production processes to meet changing demands. In retail, it will enable shelves to report their own inventory to warehouses. A network of sensors could monitor a patient and automatically provide alerts if their condition changes or call the emergency services, and so on.

"The challenge now is to connect it altogether and find standard ways to get different types of devices working across different networks to perform different functions in an 'always on' way. That is what RUNES is setting out to do," added Hailes.

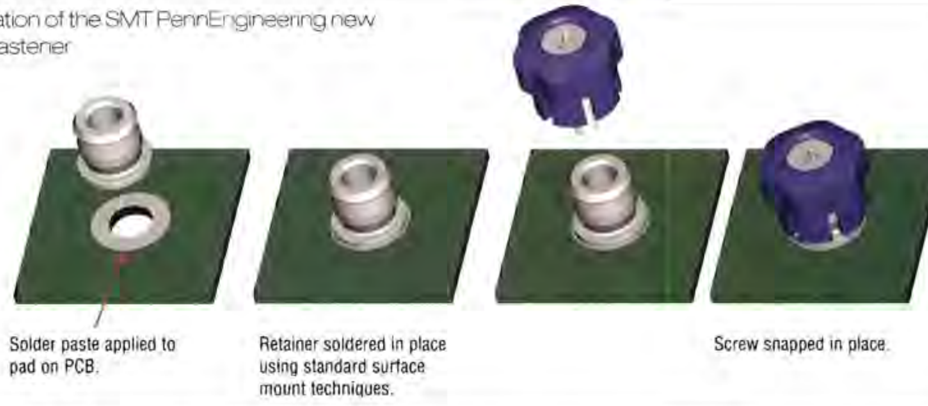
RUNES will adopt the existing connectivity technologies such as Bluetooth, the Internet, fibre optic networks and others to connect all of these devices.

There are 22 industrial and academic partners in the project, from six European countries, Australia and the US. Among them are Ericsson and the Swedish Institute of Computer Science.

A new fastener technology holds on tight to PCBs

PennEngineering Fastening Technologies has developed a system that uses surface mount technology (SMT) to add fasteners to printed circuit boards (PCBs). Dubbed ReelFast, the system adheres various types of fasteners directly onto the solder pad on the surface of the PCB, using the same soldering process as the board's electronic components.

Installation of the SMT PennEngineering new PCB fastener



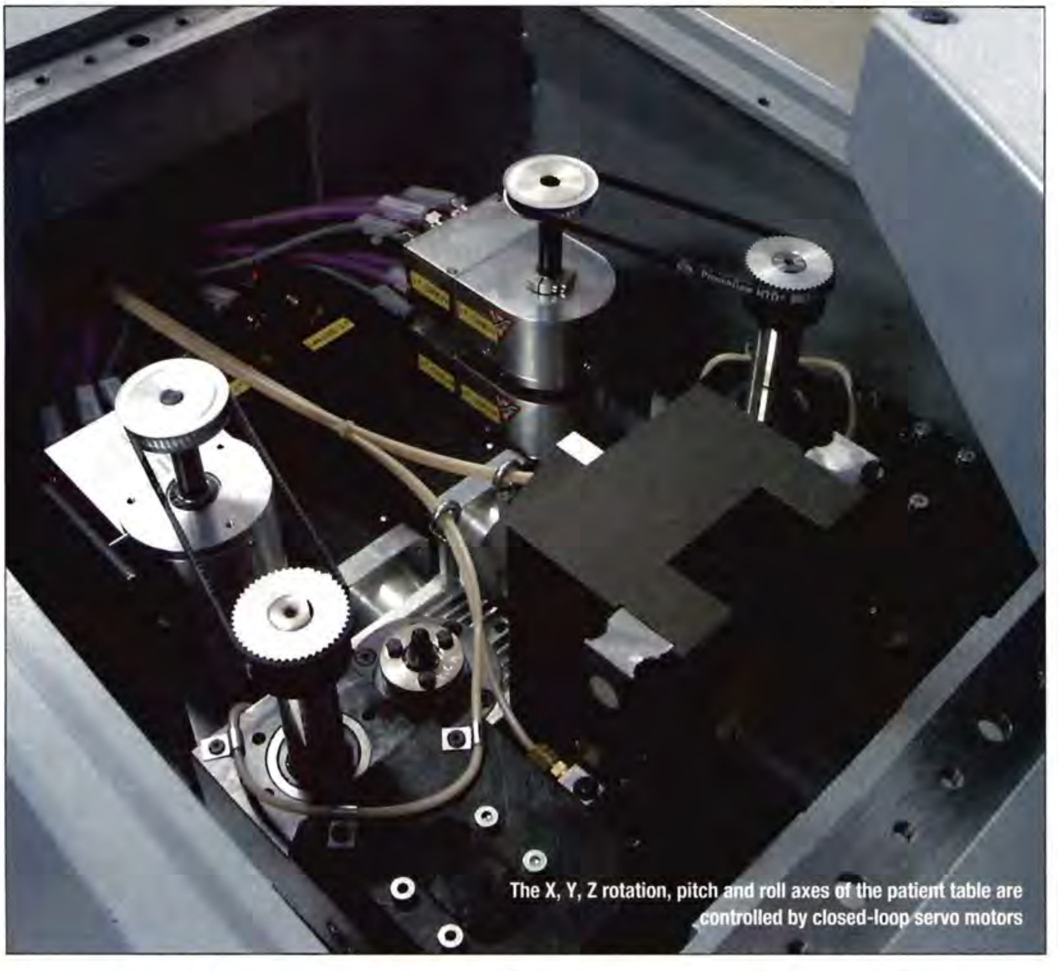
The ReelFast SMT fasteners minimise damage to PCBs as they are placed during component population and not after, as is the case with the broaching fasteners, which can subject the PCB to a significant amount of stress when it is most expensive. They also eliminate secondary fastener installations, reducing costs.

However, as the panel fastener consists of a metal retainer and a plastic cap-and-screw that is snapped into place by hand, it may prove labour intensive. "The alternative – broaching fasteners – are even more labour intensive," said Mark O'Relly, business development director at Arconix, a UK-based division of PennEngineering. "This year, Penn Engineering will bring out a right-angle SMT fastener that will not require any labour. All of these fasteners are for different usages, however. Some are panel fasteners for access, the right-angled fasteners will be used as spacers and so on."

Although surface mount, these fasteners exhibit good performance characteristics compared to broaching fasteners. For example, a ReelFast retaining nut, installed into a 6.35mm hole, has an average pull-off strength of at least 375N and average torque-out strength of 3.7N/m.

The fasteners come in tape-and-reel packages suitable for use with existing pick-and-place robots.

Health machine uses Linux



The X, Y, Z rotation, pitch and roll axes of the patient table are controlled by closed-loop servo motors

A new high-integrity motion control system used in proton beam irradiation therapy for treating tumour patients is one of the first such machines to be based on the Linux operating system (OS). IPG of Switzerland designed the novel eight-axis control system for the machine, based on components from Baldor and the Mint-language motion commands, specially ported to run under Linux for this project.

IPG wanted to use Linux to guarantee maintainability and long life for the system, which is enabled by the Linux's open access source code. However, this also meant writing a new Linux driver for Baldor's Mint-compatible 'C' library. "The Mint language's sophisticated motion functions helped to simplify this complex project. It allowed us to concentrate our efforts on developing the application-specific algorithms that underpin the positioning movements, and on the overall control system," said Alexander Ferro, IPG's Head of Automation Engineering.

The proton beam machine consists of a large steel cylinder weighing 100 tonnes, housing a gantry with very large magnets that guide the accelerated proton beam. The patient is driven into the cylinder and positioned in the path of the beam to within a half millimetre, by means of a table with control of X, Y, Z rotation, pitch and roll axes based on closed-loop servo motors. The table itself weighs 4.5 tonnes, to provide the stiffness required for accurate and repeatable positioning of the long load. At the heart of the control system is a PC, fitted with Baldor's PCI bus based multi-axis motion controller, NextMove-PCI. Control is provided by a Linux-based application written in 'C'.

The system, which treats tumour patients a lot better than X-ray due to the lesser collateral damage it does, is currently being commissioned for commercial operation at Europe's first proton beam therapy facility – the Rinecker Proton Therapy Centre in Munich.

The semiconductor industry is entering another slump, with 2005 expected to be a down year with revenue declining 5.7% to $199bn, states research organisation In-Stat. The downturn comes on the heels of 2004 annual revenue growth of 27% at $211bn, a new record. However, it is not expected to be severe as the economy is in good stead and growing at 4.3%.

According to In-Stat, the semiconductor industry's growth will resume in 2006 and continue through 2008, before the industry suffers another downturn in 2009.

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A four-year £2.2m EU-funded study carried out in Germany has concluded that radiation from active mobile phone handsets affects the living organisms' DNA. Researchers led by Franz Adlkofer found that cells mutated in a way that could not be stopped and which could lead to cancer, particularly in the elderly. The mutation is caused by highly reactive groups of atoms and molecules released by microwave signals.

They also found that the effects of microwave radiation are worse when the body is exposed to five-minute bursts of mobile phone use rather than longer sessions.

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The analogue professional mobile radio market is experiencing a revival despite the greater uptake of digital technologies, says IMS Research. European sales of analogue radios in 2004 were up 20.1% on the year before.

The European analogue infrastructure sales also increased around 37.4% in comparison to the first half of 2003.

Senior analyst, John Devlin, said: "It would appear that there is an increasing demand for analogue networks for the first time in recent years [and] this is not just related to Europe. However, it should be noted that this growth in analogue is not at the expense of digital but represents the success of new markets being opened up by the analogue suppliers."

MEMS key to Europe

The future for the European semiconductor industry lies in the production of MEMS (Micro-Electro Mechanical Systems). So says Ian Hyslop, the new chairman of SEMI (Semiconductor Equipment and Material International), a global association representing this industry.

However, in order for Europe to turn MEMS into a roaring success, it has to address a few issues first, including redesigning the toolset and the manufacturing process itself, he added.

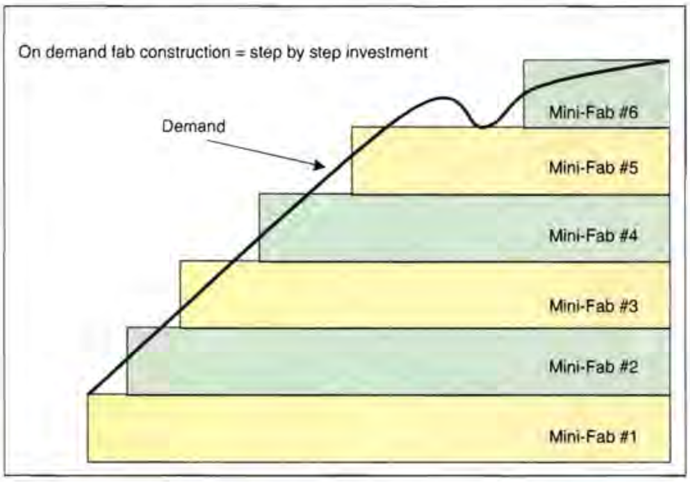
"The opportunities for Europe lie in MEMS. Although not currently [a] significant [business], it will grow. However, it has to be one batch of one wafer to be economical."

"At the moment you can't do that because it's based on an old CMOS toolset, but that is expensive. However, other businesses, as in the metal industry for example, can do this. They have batches of one; they do small-scale manufacturing," he said. "We will need to redesign the toolset to be successful in MEMS."

Highly Agile Line Concept Advancement (HALCA) is a new Japanese semiconductor fabrication concept that is currently being evaluated by European representatives. It is seen as one way forward to achieving economical, small-scale manufacturing.

Minifab concept may open doors to more business in the UK

The Japanese semiconductor industry is investigating a new, 'minifab' concept for producing semiconductors. The Joint Equipment and Materials Initiative (JEMI) team said that this approach, or Highly Agile Line Concept Advancement (HALCA), could be a way to integrate multiple technologies, such as chemical mechanical polishing, ion implant and others to produce high-quality new products at low volumes and relatively low cost.



Minifab is defined as a facility with throughput of around 2,500 wafers per month (8-inch equivalent), as opposed to a 'megafab' that fabricates over 25,000 wafers per month. The concept could cater for volumes of below 50,000 chips for various product lines, including mobile phones and DVD players. It allows for a gradual investment that can be expandable and flexible enough for small-scale manufacturing. This should give small and medium sized enterprises (SMEs) the chance to enter markets normally dominated by large companies that are able to finance significant capital investment programmes over long periods.

A group from the UK industry visited HALCA last June to assess its potential impact on the UK semiconductor business, which is not large scale but speciliased and niche, such as small-scale manufacturing of Micro-Electro Mechanical Systems (MEMS), biological silicon devices, optoelectronics, microdisplays and others. The 'lab on a chip' concept is starting to open opportunities for collaboration with chip manufacturers. Such micro-fluidic chips will need to be of low-cost materials, disposable and high quality. Thus, the team feels that the agile minifabs concept is an opportunity for the UK to explore this market.

In addition, there is also a need for small, flexible, self-contained units for processing materials like gold, wafer treatment and 3D structure formation in organic compounds, without the risk of contaminating other processes.

Kyocera introduces 200W solar module

Japanese firm Kyocera has launched a solar module with an output capability of 200W, the largest among the mass production-type solar modules. The company believes that its product will fit large-scale solar electric-generating systems of 100kW or greater, which are increasingly being installed in public and industrial applications.

The SPG200T-02 model has a conversion efficiency of 14.18%, and the rectangular cell used, with an average efficiency of 15.9%, is based on multicrystal silicon.

The module is 1425mm x 990mm x 36mm in size and weights 18.5kg.

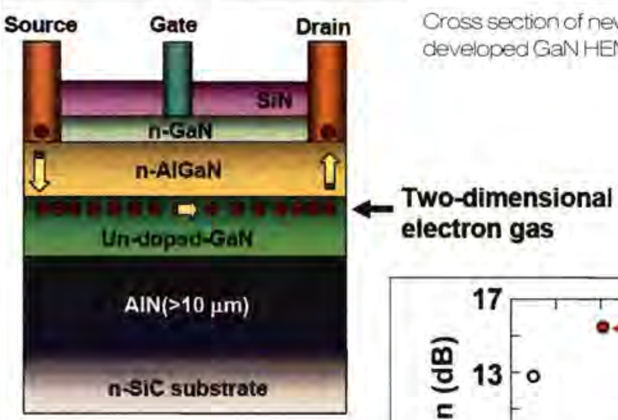
The Japanese government last year set a target to achieve 4.82m kW of national energy capacity through solar power generation by 2010, growing to 83m kW by 2030. This is likely to boost interest and use of solar cells in Japan, including in residential applications.

Fujitsu develops low-cost Gallium-Nitride HEMT

Fujitsu Laboratories has developed a process that enables low-cost production of gallium-nitride (GaN) High Electron Mobility Transistors (HEMT).

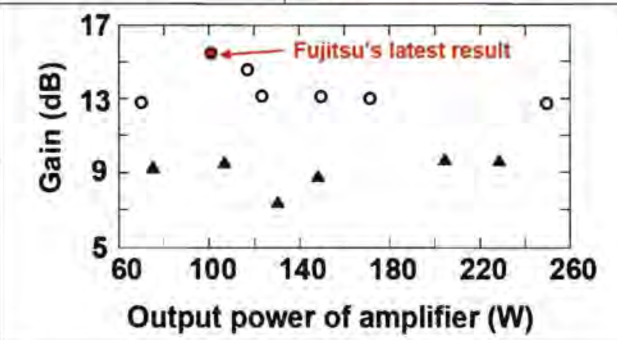
HEMT amplifiers are used in mobile base-stations, making them more energy-efficient. GaN is the basic material used as it enables the amplifiers to be driven at high voltages, with good output performance and efficiency. In addition, a semi-insulating silicon carbide (SiC) substrate is applied as base to reliably deliver high operating efficiency. But, this is an expensive material, so Fujitsu used lower cost conductive-SiC substrates, already available in blue LEDs.

Although lower in cost, this material brought its own set of problems including parasitic capacitance between the electrodes and substrate that leads to lower gain, and increased leakage current.



Cross section of newly developed GaN HEMT

Fujitsu overcame these by forming an aluminium nitride (AlN) epitaxial layer of above 10μm on the conductive n-type SiC substrate, followed by depositing an epitaxial layer of GaN HEMT developed on top of that substrate. The firm discovered that the parasitic capacitance is lower when the AlN thickness goes above 10μm, which in turn, yields high gain. In addition, by using AlN, which features a wider band gap than GaN, and by optimising GaN growth conditions on AlN, Fujitsu succeeded in suppressing the leakage current.



Comparison of gain/output results of GaN-HEMT
Red dot: Fujitsu's latest result. Plain dots: past results by Fujitsu.
Black triangles: Past results by other organisations

The characteristics achieved, including maximum output of 101W, maximum power-added efficiency of 50% and gain of 15.5dB, are sufficient for practical application of GaN HEMT amplifiers. In addition, the technology reduces GaN HEMT production costs to less than one-third that of conventional levels, thereby contributing to the realisation of lower-cost GaN HEMT-based amplifiers.

Direct digital feedback amplifier heralds a new era

A direct digital feedback technology from Zetex Semiconductors, launched at the Consumer Electronics Show (CES) 2005 in the US last month, promises to set a new standard in digital amplifier sound quality.

Named Class Z, this proprietary technology was demonstrated using a digital amplifier, operating from an unregulated supply that achieves a THD+N figure of less than 0.005% and a damping factor greater than 250. The firm says that the sound quality produced by the switching amplifier challenges that of the very best linear amplifiers.

Zetex used a fast, direct digital feedback architecture that handles the limitations of FET output bridges at high powers, is tolerant to high levels of PSU noise and accommodates non-linearities in output filters. In addition, tradeoffs between distortion and dissipation in the output stage have been removed. The technology also accurately senses and immediately acts on audio signal data. This allows for fault protection, system diagnostics, amplifier self-test and speaker load detection facilities to be readily implemented into digital amplifier systems.

Zetex's amplifier architecture is scaleable and it can be applied to a broad range of amplifier power levels. It promises to dramatically simplify system design and reduce cost. The company now plans to integrate it into a new range of digital amplifier products during 2005 that target the high quality power amplifier and AV receiver sectors.

Medical device manufacturers are planning to spend more on electronic components during 2005, says latest research conducted by the organisers of the Medical Device Technology Exhibition & Conference (MDT). However, some 61% of the medical and in-vitro diagnostics makers said they would like more innovation in electronic components. This will help them develop new products for current and new markets and improve the quality/performance of their existing ranges. Over 81% of medical device manufacturers are looking for new electronics suppliers.

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A flat, flexible wiring system for automotive interior applications is expected on the market soon thanks to a recently signed collaboration between 3M and I&T Innovation Technology. The system will combine I&T's wiring solutions with 3M's technical capability to offer automotive manufacturers a weight, space and cost-saving alternative to the traditional round wire cables. The current trend toward more electronics in vehicle interiors requires an increasing amount of signal wiring in vehicles.

Ω

The Chartered Institute of Patent Agents (CIPA), a professional body representing patent attorneys in the UK, calls for changes in the Scottish legal system. It has proposed to the working group for research into the Scotland legal services market that interested parties are allowed to make an application for rights of audience and rights to conduct litigation in the Scottish courts, and that a court similar to the Patents County Court in Scotland should be established or the Patents County Court's jurisdiction extended to Scotland. The changes are expected to level the legal 'playing field' between Scotland and England and Wales.

Engis lapping machine aids accoustic wave research in Trent

Researchers at Nottingham Trent University have purchased an Engis polishing and lapping machine to assist their work into the use of acoustic wave devices in sensors.

Engis technology installed at Nottingham Trent

The current three-year research project, led by Dr Michael Newton, investigates surface acoustic wave device designs using thinned wafers. It has been established that if the wafer is sufficiently thin, the metal inter-digital transducers (IDT) can be fabricated on its reverse surface from the one used for sensing. It is in the creation of these very thin wafers that the Engis lapping and polishing equipment is being used.

"Surface acoustic wave devices are used extensively in radio frequency electronics such as mobile phones, but they have additional properties, one of which is mass sensitivity, making them potentially useful in sensor applications," said Dr Newton.

The three materials currently being used for the wafers are quartz, lithium niobate and lithium tantalate. The wafers themselves are polished from a starting thickness of approximately 0.5mm to a finished thickness of between 100-150µm. In this particular application, extreme flatness is not important because the sensing devices have an area of only 1cm^2.

One of the aspects of the Engis machine that was most attractive to the research group was its very small footprint.

MMW frequencies – more than just skin-deep?

Cranfield University has embarked on a study to determine the effects of everyday millimetric waveband (MMW) frequencies on the human skin.

"This research study is important because MMW frequencies are increasingly being used in a large number of applications in radar as well as defence and civilian communications, such as 3G mobile phones, radio antennas, car cruise control, collision avoidance radar systems and even airport security check-points," said Dr Clive Alabaster of the Radar Systems Group at Cranfield University, who is also leading this study.

"To date, only predictive studies have attempted to describe human skin at these very high frequencies. This research study is for the first time collecting hard data in order to assess the potential risks associated with this technology."

When exposed to high frequencies, the skin bears the brunt of radiation exposure. As a result, it absorbs MMW frequencies and is heated on the surface. Using the safety benchmark set by the National Radiological Protection Board (NRPB) of 10mW/cm2, Dr Alabaster calculated the temperature rise of skin exposed to this level of MMW radiation over a 30 second period. "The initial results on a single skin sample showed that this exposure would cause the surface of the skin to heat by only 0.2°C. The body will hardly notice this increase in temperature and so we can conclude that current legislation will avoid any burning hazard," added Dr Alabaster.

Do MMW frequencies have an effect on the human skin?

The same techniques are now being applied in the investigation of damage sustained by composite materials and structures. "These range from novel bridge materials through to helicopter rotor blades and even the materials of today's modern sports cars," said Dr Alabaster.

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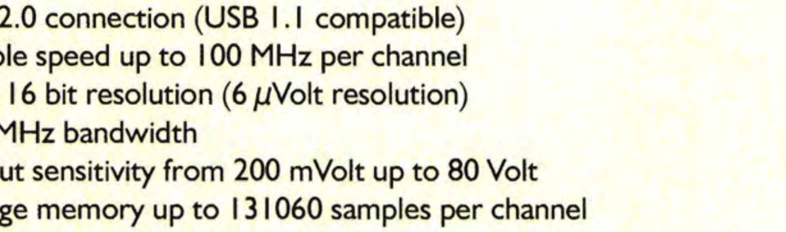

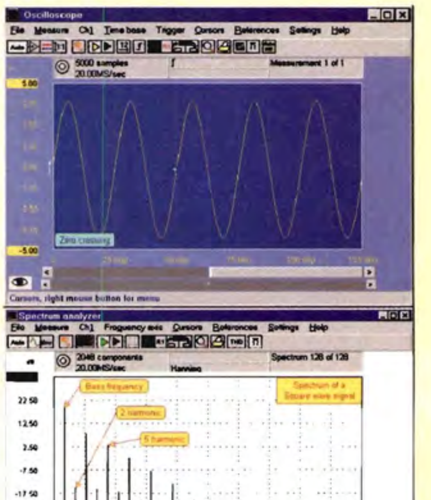

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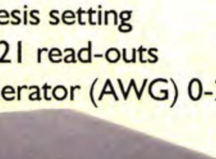

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Never forget innovation

The challenges of 3G and new communications technologies can only be met with innovative thinking, says Christian Kermarrec

As 3G cellular networks and services roll out, everyone in the industry should be mindful of the role of innovation. I am concerned that this huge industry, which serves over a billion customers worldwide, ships over one million mobile phones every day, spends over $35bn annually on semiconductors and has spent countless billions more on licensing spectrum, will abandon the formula that brought us here. A formula that valued innovation and the risk-taking that often goes with innovation. I hope that when faced with the new service and content opportunities enabled by 3G, we will all reject the incremental approaches. We must all realise that 3G is a vast shift requiring profoundly new approaches.

With 3G, the industry shifts from a communications industry to a consumer industry. The handset shifts from 'phone' to 'multimedia device'. The competitive landscape shifts from regional competitors to global competitors. Operators no longer rely on simply communications technology. They rely on convergence technology, where communications, computing and consumer electronics will either collide or coalesce. These shifts are driving the need for multimode devices that can roam from 2G to 3G networks and multiband devices that work everywhere from Boston to Beijing. Content is moving beyond voice to music, high-definition images and video, digital TV, multimedia messaging services and more. The underlying technology changes in response to these market trends, as speeds shift from low bit-rates to broadband, tasks shift from voice processing to multimedia applications and the engineering effort shifts from inflexible hardwired systems to infinitely flexible software-centric systems.

Innovative technology simultaneously yields lower cost, more flexibility and faster time-to-market. All of which profoundly impact capital and operating expenses for operators. Examples of ADI innovations include high IF sampling technology that enabled the SDR (software-defined radio) vision, RF power detection technology that is now ubiquitous in base stations, because it drastically reduces power consumption and size, and Othello, the first commercially available direct conversion radio for handsets.

However, 3G embodies many more challenges. Supporting different variations of 3G, providing new services and delivering a variety of new content types, implies considerable flexibility in the systems the industry deploys. So, we face some opposing forces. We must figure out how to deliver more services to an ever-segmenting consumer market, while improving spectrum efficiency, limiting new site acquisition, accelerating time-to-market and, ultimately, accelerating time-to-profits. Incremental enhancements to existing base stations and handsets won't introduce the flexibility the industry needs.

It's obvious that the 3G base stations must be adaptable and upgradeable. The advent of [the software upgrade] HSDPA (high speed downlink packet access) illustrates the need. This downlink capability was added to the 3G standard recently and is now a required feature in many networks. The change has sent many base station suppliers and operators scrambling to add HSDPA hardware. But several base station manufacturers developed their 3G systems as software-programmable platforms. With a 100% software baseband, these basestations can add HSDPA easily by changing only the software.

The advantages of an all-software 3G digital baseband extend from the infrastructure manufacturers all the way through to the operators. For base station manufacturers, the same hardware platform can be adapted with software to any of the 3G standards in use in different regions of the world. This platform can be easily upgraded as these standards evolve and as features are added. Similarly, operators gain the ability to continuously upgrade services.

> *"Operators no longer rely on simply communications – they rely on convergence tecchnology, where communications, computing and consumer electronics will either collide or coalesce"*

Successful 3G handsets also demand innovative thinking. Simply evolving the existing chip technology in handsets to incrementally add processing performance is not enough. The 3G industry relies on maintaining – and extending – the progress made by the 2G handsets. We need to bring the features of 3G at the cost, size and power levels of 2G. That's a significantly more difficult task...not an incrementally more difficult one.

Christian Kermarrec is vice president of RF and wireless systems at Analog Devices (ADI).

Programmable

Gene Frantz, a technical advisor at Texas Instruments, gives a view for the future of systems on a chip

By Nick Flaherty

Programmability – both in software and in hardware – is vital for the future of devices as the industry heads down to 32nm technologies, according to one of the leading thinkers at digital signal processors (DSPs) and analogue components supplier Texas Instruments (TI). That will start to create significant shifts in the way chips are designed.

"By 2010 we will be at 32nm starting volume," said Gene Frantz, a senior fellow at TI. He is head of TI's Technical Advisory Board that provides long-term guidance on emerging technical trends which may impact TI's business and products.

The march of Moore's Law, with the density of transistors doubling every 18 months (Table 1), brings some huge problems. By 2010 it will be possible to put hundreds of millions of transistors on a system-on-a-chip (SoC). Many of these will be used for increasing the amount of memory, but many will also be used to boost the performance of programmable engines, either with more functions in the programmable core, more cores operating in parallel as Intel is now doing, or using dedicated acceleration engines to support the programmable cores.

The cost of designing such a chip – the non-recurring engineering (NRE) cost - is already in the tens of millions of dollars at 90nm, and that will only increase as the industry moves through 65nm, 45nm and 32nm. Companies like TI and Altera already spend over $100m on designing and making their families of devices, and this means the cost has to be spread over a wide range of application areas.

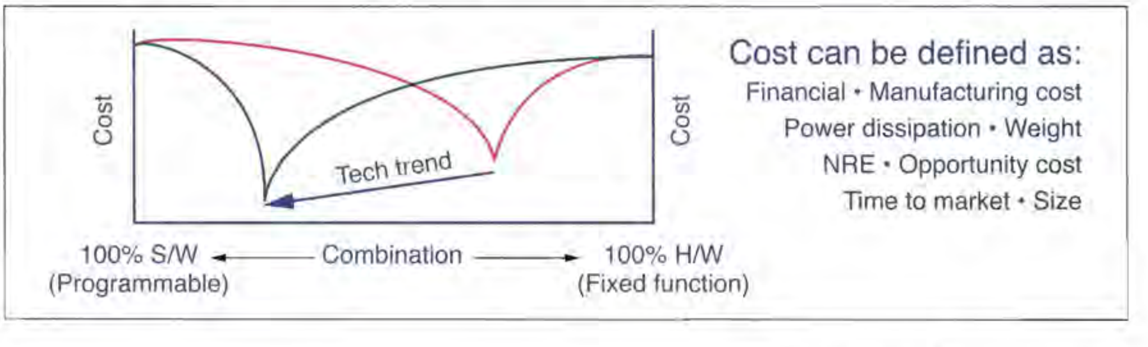
This in itself drives the use of programmability, but more important is the number of transistors and the power that they will consume. As the clock speed increases, the power increases linearly. But as the density increases, the power increases by a square factor. So by increasing the clock speed in a programmable device, rather than the area in a fixed function device, gives power benefits. "Just the physics [alone] tells us it will tend to programmable," said Frantz.

These issues are key when thinking on the future design of SoC. "We, as vendors, think SoC is moving from a noun to a verb – it's a method for creating ICs that includes common processes for analogue, digital and RF, and the firmware and middleware for those chips. It's now a decision whether we bring the analogue up to the same level as the digital. To some extent, that is already happening."

> *"We, as vendors, think SoC is moving from noun to a verb."*
> Gene Frantz, senior fellow, TI

That in itself is a huge change. Currently, analogue and RF processes lag behind digital. For example, Analog Devices (ADI) has just developed a leading edge analogue CMOS process on 0.35mm, three process nodes behind today's 90nm digital CMOS. But putting these on the same chip saves large amounts of power by avoiding the need to go off-chip through the amplifiers, pins and circuit tracks, as well as saving cost in the end system.

Similarly, TI has already developed a digital RF process that is being used for a Bluetooth SoC for short range wireless links that combines the baseband processing with a 2.4GHz front-end. For wireless LAN applications, TI has combined a programmable baseband and MACs for the



Critical elements to consider for designing chips

is the future

802.11a, b and g standards with 2.4GHz and 5GHz RF front-ends on a chip.

But, programmability means also having to provide the software to make the systems operate and an increasing amount of resources are dedicated to providing firmware and software for SoCs, says Frantz. That includes the encoders and decoders.

The current roadmap for devices at TI confirms this trend of programmable systems approaching the costs of the fixed function devices. Jean Marc Charpentier, DSP business development manager at TI, says the time is coming for programmable solutions in areas that have traditionally been dominated by fixed-function devices, particularly set-top boxes for digital television. "This year customers are starting to ship boxes based on our programmable [TMS320] DM64 [digital media processor] in volume," he said. "The idea is that by adding programmability, operators and manufacturers can add more features that add value for them in the food chain," he said. "Look at what we have done in the mobile phone – that's a programmable device, with an ARM processor alongside a DSP, and that's in volume at consumer price points. Expect us to do a similar thing for the set-top box." He also points to modems, where programmable DSPs completely replaced fixed-function devices.

Typical device capabilities

	1980	1990	2000	2010
Die size mm	50	50	50	5
Technology (uM)	3	0.8	.01	0.032
MIPS	5	40	5,000	50K
MHz	20	80	1,000	10,000
RAM (bytes)	256	2K	323K	1M
Price	$150	$15	$5	$0.15
Power (mW/MIPS)	250	12.5	0.1	0.001
Transistors	50K	500K	5M	50M
Wafer size	3"	6"	12"	12"

Two decades of integration

"We have three strands – the cost reduction through process, making the architecture more efficient so that we do more with the same cycles, and integrating new peripherals for high definition TV and high-speed memories, and we are doing all three in parallel," said Charpentier.

The TMS320DM64x family has VelociTI.2 extensions to TI's VelociTI Advanced Very Long Instruction Word (VLIW) TMS320C64 core. Effectively, it has accelerator blocks optimised for digital TV. The family is moving onto 90nm now and then 65nm in 2005, he says.

That move to 90nm means TI has now dropped the price of its C6410 fixed point DSP to under $20, with the floating point C6413 at under $30. This compares to $500 when the devices were first launched in 2002. These are targeting packet-switched telecom, media gateways and other cost-sensitive, high performance applications. The C6410, priced at $17.95 in volume at 400MHz, gives 89MMACs (Million Multiply – ACcumulate operations per second) per dollar, while the C6413, priced at $28.95 in volume, offers 69MMACS per dollar at 500MHz.

Any SoC is a mix of software and hardware (Figure 1). As the mix changes, the balance falls in cost as more use is made of programmability. This changes even more when hardware configurability is included.

Being able to re-use blocks of transistors for different hardware functions cuts the number of transistors in total, reducing the cost, but also reducing the total draining power as a lower number of transistors are working.

But there are problems facing the move to programmable SoCs that Frantz highlights. The main one is soft errors, where the small geometries and small number of electrons being used in the transistors mean they are vulnerable to strikes by particles from incident radiation. This is particularly important in maintaining the coherency of memory blocks. "How do we solve that as we go to the technology node? One way is error correction but I don't think that's the right answer," said Frantz.

Then, there are inherent problems with the existing Instruction Set Architectures that can slow down the chips and prevent them from making full use of the clock speed or of parallel cores, and this will have to be tackled by innovative architectures.

So, the view from TI is that there will still be a few custom chips designed in 2010, but the vast majority will have to be programmable systems on a chip, complete with the firmware and even some of the application software. This is driven both by the physics of the power consumption and by the cost of developing the chips – having a programmable system is the only way they will be able to afford to stay in business.

Simplifying power system design

David Cooper, applications manager at Canadian firm Potentia Semiconductor, explains how to create a fully operational, robust power system when designing with multiple power rails in a single design

On-card power systems are rapidly increasing in complexity. Leading edge ICs are demanding lower and lower voltages and multiple voltage rails that must be applied in the correct sequence. At the same time, the current they consume continues to increase, making the power designer's task increasingly difficult.

Very low voltages at high currents cannot be distributed efficiently from a single, central power supply. Instead, distributed power systems using point-of-load (POL) power converters have become the norm. A relatively high voltage is distributed through the backplane or motherboard and each of the cards in the system includes DC-DC converters to reduce the backplane voltage to the low voltages needed by the ICs. In this way power efficiency can be high. The downside, however, is that each card designer now has the task of designing a power system for that card.

For equipment using 12V or 5V backplane voltages, the continual increases in power levels and resulting high backplane currents are difficult to manage. Most large systems therefore distribute a higher voltage to reduce current and improve power efficiency. The telecom standard of 48V has been adopted in a wide range of applications such as compute servers, industrial products and military systems, often with duplicated 48V feeds to provide redundancy for high-availability applications.

One important consequence of using a higher backplane voltage is that each card must provide isolation between the primary side (the 48V input) and the secondary side, both for safety and to avoid unwanted ground current paths.

On-card power systems

Most on-card power systems are based on an architecture that uses modular DC-DC converters as building blocks. Very high performance DC-DC converter modules are available from a wide range of suppliers, both as isolated bricks and as non-isolated POLs. **Figure 1** shows a typical 48V power system using a single brick to generate a 12V intermediate bus that feeds a number of POL converters. Using these modules dramatically simplifies the task of designing a high performance power system.

There is, however, a lot more to the power system than the DC-DC converters themselves. A power management function is necessary to tie the building blocks together into a fully operational, robust power system.

Some of the main aspects that must be addressed by the power management function include the following:

➢ Each DC-DC converter behaves independently and the power management function must coordinate sequencing and tracking relationships between rails during startup and shutdown.

➢ All outputs must be monitored to correctly shut down all rails in the event of a fault on any rail.

➢ Output voltage adjustment must be provided where necessary, for trimming and margin testing,

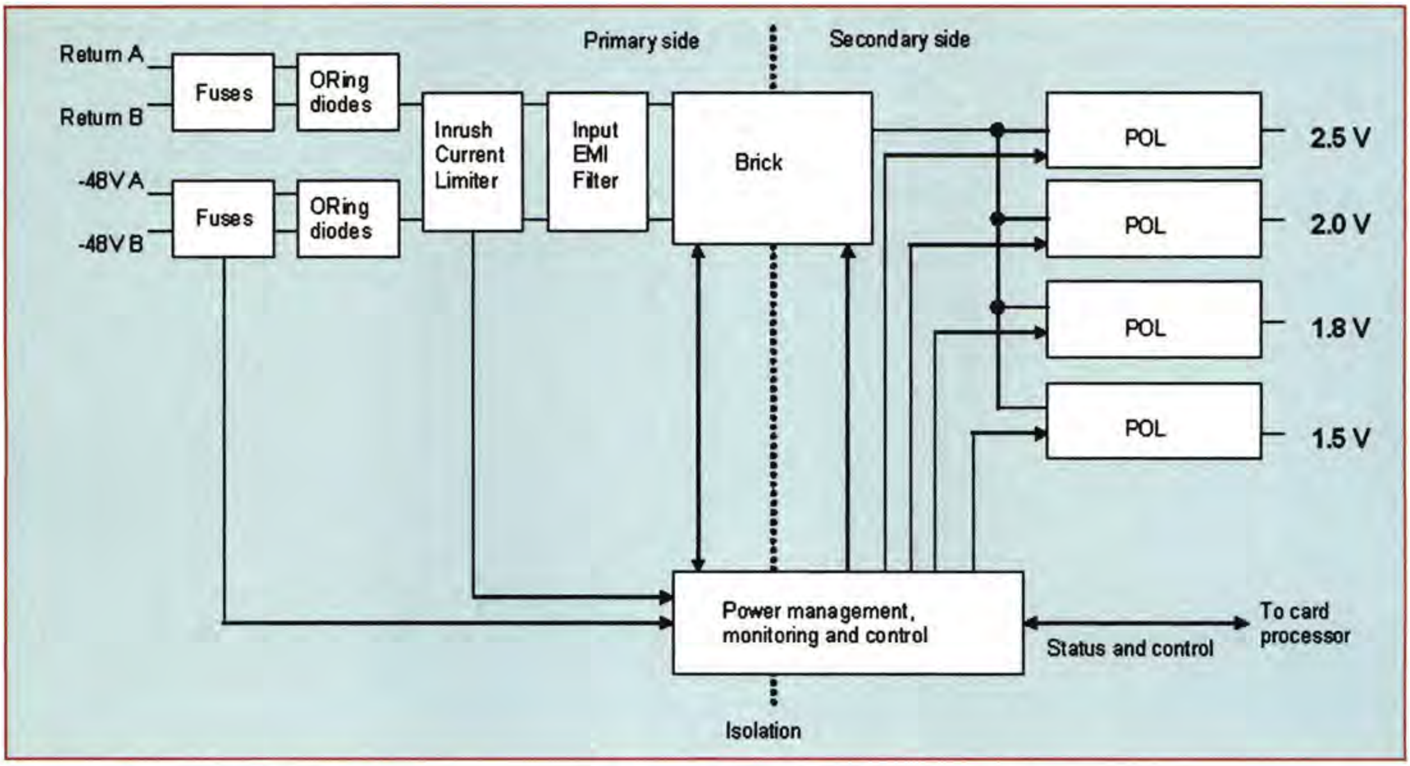


Figure 1: Card power system

preferably under software control.

➢ And for high-performance applications there are additional considerations:

➢ System software should be able to read out the power system parameters remotely, particularly in redundant systems.

➢ Primary side monitoring can significantly improve system performance by detecting latent faults before they cause system outages.

In a high performance power system with many output rails, design of the power management function becomes a complex task. This article describes how this task can be simplified by using a dedicated power management IC chipset from Potentia Semiconductor. The PS-1006 manages the primary side power functions, while the PS-2406 manages the secondary side. An isolated data-link from primary to secondary sides allows real-time monitoring of primary side parameters from the secondary side, such as input voltage, input current and input fuse status.

Secondary side power management

A number of different secondary-side controllers are available, offering different combinations of features. For this design example, the Potentia PS-2406 is used to provide full management of four POL DC-DC converters. Management functions of the PS-2406 include startup and shutdown sequencing control, output voltage monitoring, overvoltage (OV) and undervoltage (UV) protection, and voltage margin control. Four GPIO pins allow additional flexibility and a scratchpad for user data is also supported.

The PS-2406 has an industry-standard I^2C interface for communication with the card microcontroller. It also provides an isolated communication interface to a primary side controller (referred to as the PI-Link interface) using a proprietary protocol.

When used with the PS-1006 primary side controller, the PS-2406 also provides an additional shutdown function to protect against catastrophic faults in a secondary side POL converter. If a POL converter has an unrecoverable OV fault, the PS-2406 transmits a primary shutdown signal and the intermediate bus brick is immediately turned off by the PS-1006.

Note: an unrecoverable secondary side fault can occur in any power system using non-isolated POL DC-DC converters. This is because most POLs use a buck topology in which the output voltage is controlled by varying the duty cycle of an upper and lower switching FET. If the upper FET fails short-circuit, the output voltage becomes equal to the input and cannot be controlled except by removing the input voltage.

Primary side power management

In the primary side of the power system shown in Figure 1, fuses are needed at the power input pins to meet safety requirements. Diodes are used to provide an OR function between the redundant power feeds. The inrush current limiter prevents current surges during hot swap of the card and

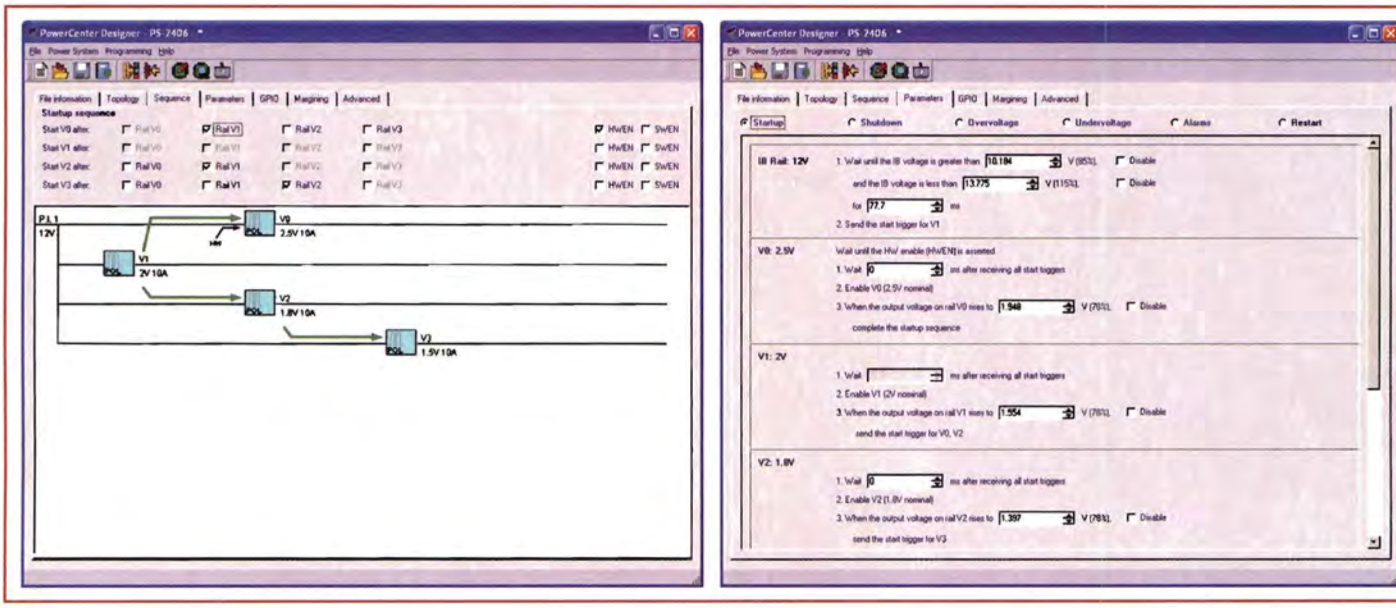


Figure 2: Configuration software

can also function as an electronic circuit breaker to provide over-current protection. Primary side monitoring functions include measurement of input voltage and input current, detection of overvoltage, undervoltage or overcurrent conditions, card seating detection, fuse failure detection and inrush limiter status. As indicated in Figure 1, the monitoring and control function must also provide isolation, to allow reporting of primary side status information through the secondary side interface.

Secondary side design

By using the PS-2406 secondary side digital controller, very little additional circuitry is required. Figure 3 shows how the PS-2406 connects to the

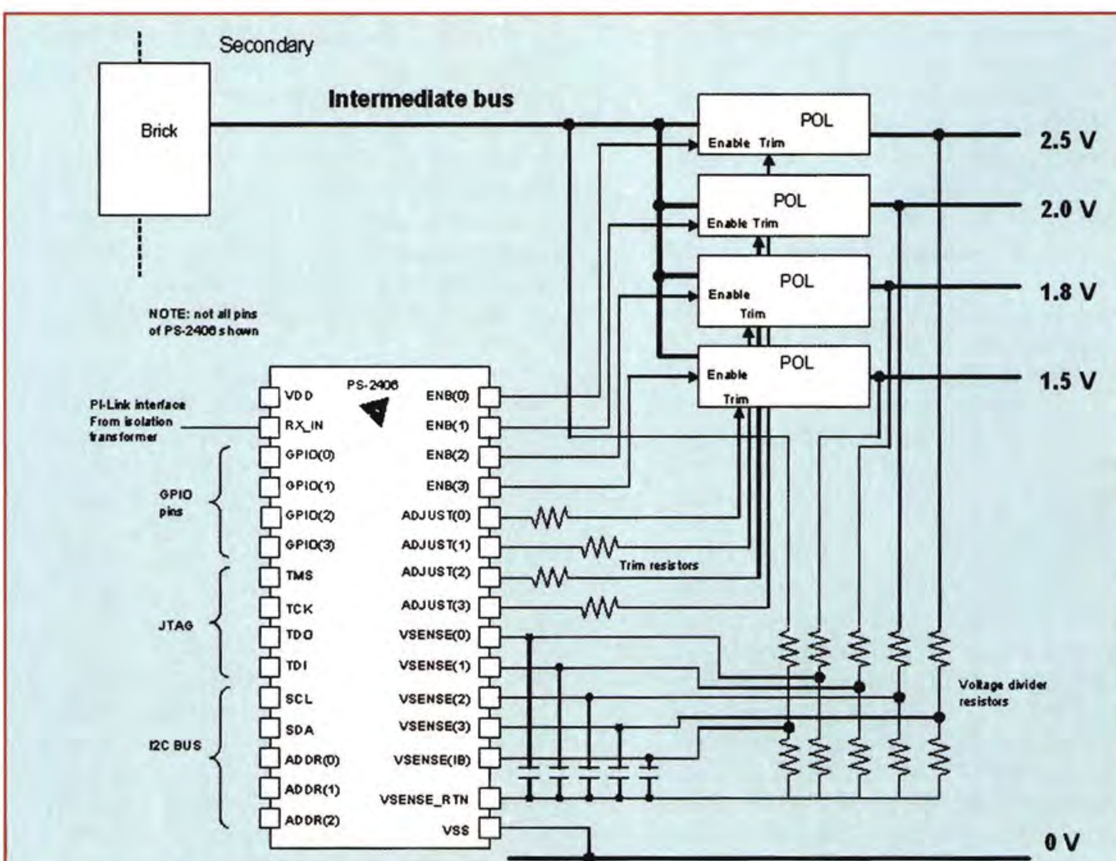


Figure 3: Secondary side POL control

POL converters to provide secondary side power management.

All power system design parameters such as sequencing, interlock voltage thresholds, OV and UV protection, time delays and GPIO pin functions are set by internal memory registers in the device. These parameters are established through configuration software that provides an intuitive graphical interface. **Figure 2** shows sample screens of the configuration software for the PS-2406, known as PowerCenter Designer. Once all design parameters have been selected, they are simply downloaded into the PS-2406 memory using a programming cable. To further simplify the design, all parameters are initially set as default values in PowerCenter Designer. These defaults are suitable for many applications and are easily altered.

PowerCenter Designer also generates output files suitable for production programming, which can be done via JTAG or I^{2}C after board assembly. Alternatively, the PS-2406 can be pre-programmed before assembly, if required.

In addition, the PS-2406 controls startup and shutdown sequencing, using voltage interlocking to guarantee the correct sequence under all conditions. The required power configuration and startup sequence is entered graphically as shown in Figure 2. All interlock thresholds and time delays are programmable through PowerCenter Designer to suit the application.

Output voltage monitoring

The PS-2406 measures the intermediate bus and each output voltage using an internal 10-bit analogue-to-digital converter (ADC), with voltage divider resistors as shown in **Figure 3**. Suitable resistor values are recommended by PowerCenter Designer, according to the output rail voltage, to give approximately 1V at the sense input pin. For example, the suggested divider resistors for the 2.5V rail are 20kΩ and 35.2kΩ. If an output OV or UV condition is detected, a controlled shutdown is initiated. Output OV and UV parameters are programmable through PowerCenter Designer.

Output voltage margin control

The PS-2406 controls the output voltage of each POL converter by driving the trim pin from an internal digital-to-analogue converter (DAC), via a trim resistor. The DAC voltage setting can be stored internally, or can be set in real time through the I^{2}C interface.

Primary side design

The PS-1006 is designed to operate in conjunction with the PS-2406 to extend the power management function to include the primary side. Because of the high voltages and isolation requirements, the PS-1006 uses mainly analogue inputs and operating parameters are set by external resistor values.

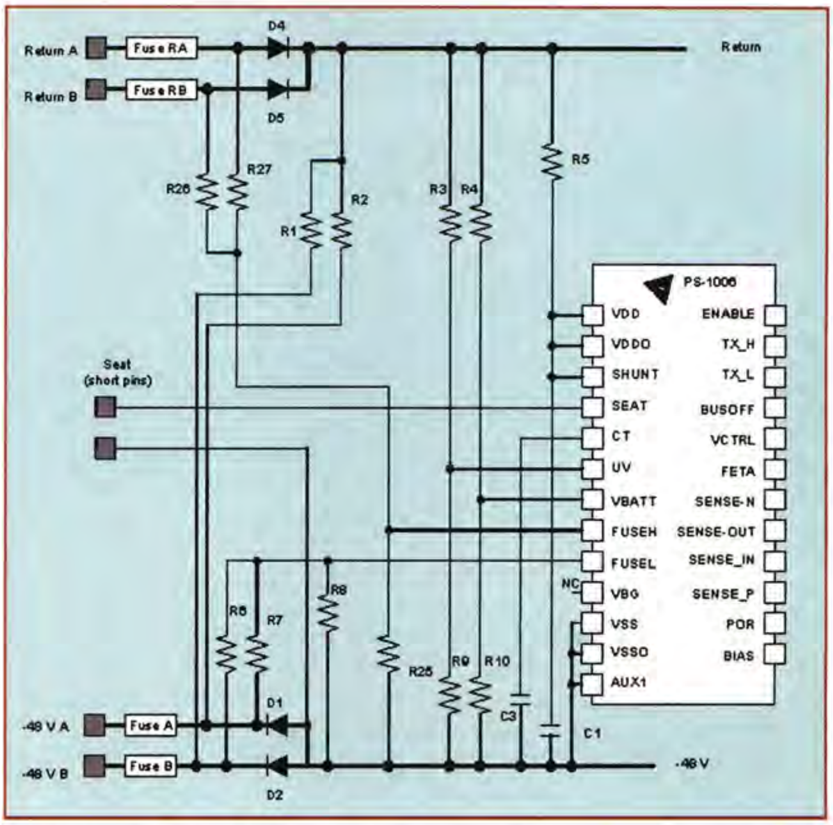


Figure 4: Primary side voltage and fuse monitor

Figure 4 shows how the PS-1006 is connected to measure input voltage, detect primary side OV and UV conditions and monitor the input fuses. **Figure 5** shows how the PS-1006 connects to the intermediate bus brick and how it controls inrush current. It also shows the communication link to the secondary side controller, in this example the Potentia PS-2406.

The PS-1006 controls the intermediate bus brick via its enable pin. When the input voltage is below the UV shutdown threshold the enable pin is turned off. When the input voltage rises above the UV recovery threshold the enable pin is turned on. Hysteresis is included to ensure definitive on-off control.

Inrush current limiting

The PS-1006 provides inrush current limiting for hot-swap applications, to control the surge current into the input capacitors at the moment of plug-in. The inrush limit MOSFET (Q1 in Figure 5) is slowly turned on by the PS-1006, via the transistor Q2. When the input current rises to the current limit point set by R18, R12 and R15, the drive to Q2 is reduced to prevent the input current exceeding the limit value. A time-out and retry capability is included to limit power dissipation in the MOSFET under overload conditions.

Input voltage monitoring

The PS-1006 measures input voltage using an internal 10-bit ADC at the VBATT pin, through the voltage divider R4 and R10. The voltage at the VBATT pin is compared to an internal 2.38V reference to provide overvoltage detection.

R4 and R10 are chosen to give 2.38V at VBATT at the desired OV threshold. For example, if R10 = 9.42kΩ and R4 = 301kΩ, the OV threshold is 2.38 x 310.42/9.42 = 78.42V.

Don't forget that the voltage at the card input will be approximately 1.5V higher because of the drop in the ORing diodes and the input fuses.

Input undervoltage shutdown and recovery

Voltage divider resistors R3 and R9 connect to the UV pin of the PS-1006. The voltage at the UV pin is compared to an internal 1.25V reference to provide undervoltage (UV) detection. An internal 10μA current source is switched in when UV is detected, to provide hysteresis. If a UV condition is detected, the intermediate bus brick is shut down via an optocoupler. The optocoupler is necessary because the brick is on the other side of the EMI filter and there can be a significant voltage drop across the filter under transient conditions. The UV pin is also compared to a slightly higher internal reference of 1.31V. This comparator is used to detect a brownout condition, as a warning that the input voltage is low before the brick shutdown occurs.

R3 and R9 are chosen to give 1.25V at the UV pin at the desired UV shutdown threshold. For example, if R9=10.5kΩ and R3=301kΩ, the UV shutdown threshold is 1.25 x 311.5/10.5 = 37.08V. Also the value of R3 is chosen to give the required hysteresis between UV shutdown and recovery. Since the hysteresis current is 10μA, the value of 301kΩ results in a hysteresis of 3V and the power system will restart at an input voltage of 40.08V. Again, remember that the voltage at the card input will be approximately 1.5V higher because of the drop in the two ORing diodes and the input fuses.

Input fuse monitoring

The PS-1006 has two pins for monitoring the input fuses. Pin FUSEH monitors the high-side fuses (in the battery return input) via resistor network R25, R26 and R27. The voltage at pin FUSEH is compared against the voltage at pin VBATT and if it is lower than 57% of VBATT a fuse failure is detected. Pin FUSEL monitors the low-side fuses

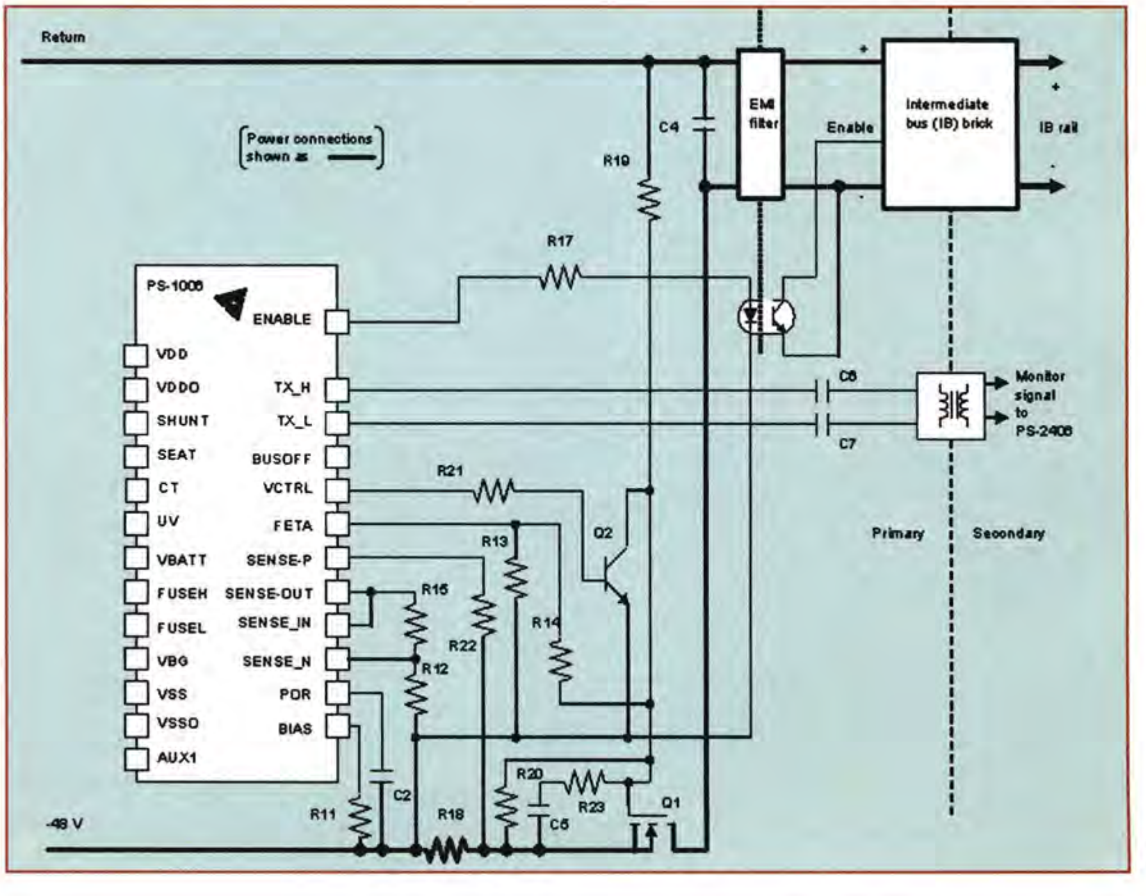


Figure 5:
Inrush limiter, brick control and communication

Table 1: Recommended fuse monitor resistors

Resistor	Recommended value
R1	100kΩ
R2	100kΩ
R6	301kΩ
R7	301kΩ
R8	9.09kΩ
R25	3.32kΩ
R26	301kΩ
R27	301kΩ

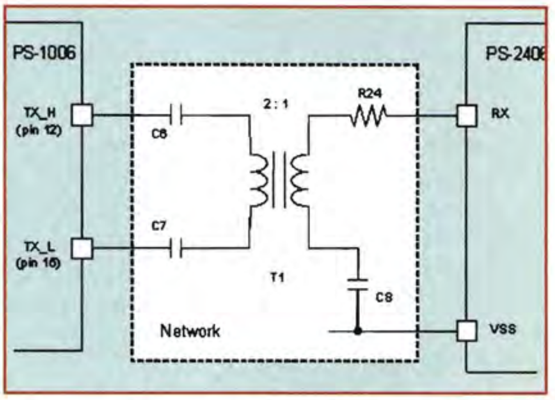


Figure 6: Communication link components

(in the -48V feeds) via resistor network R1, R2, R6, R7 and R8. The voltage at pin FUSEL is compared against the voltage at pin VBATT and if it is higher than 57% of VBATT a fuse failure is detected.

Resistor values must be chosen to guarantee that the circuit correctly detects a fuse failure even when the voltage at the two feeds is not equal. Using the resistor values recommended in **Table 1**, the circuit will correctly detect fuse failures even if one feed is at 36V and the other feed is at 75V, an extreme worst case condition.

Input current monitoring

Primary current is measured by current sense resistor R18 (refer to Figure 5), using a current sense amplifier in the PS-1006. R12 and R15 set the gain of the amplifier and should be chosen so that the output of the current sense amplifier is approximately 2V at full load current. For example, for a 200W card the maximum card current is 5A at 40V. If a value of 20mΩ is used for R18, the current sense voltage is 100mV at 5A. In this case, choose R15 = 47.5kΩ and R12 = 2.49kΩ to give an amplifier gain of x20. The voltage at the SENSE_IN pin is compared to an internal 2.38V reference to provide overcurrent (OC) detection. With the component values discussed in the example above, overcurrent is detected at 5.95A.

The PS-1006 can provide an electronic circuit breaker function, if required. If it detects an OC

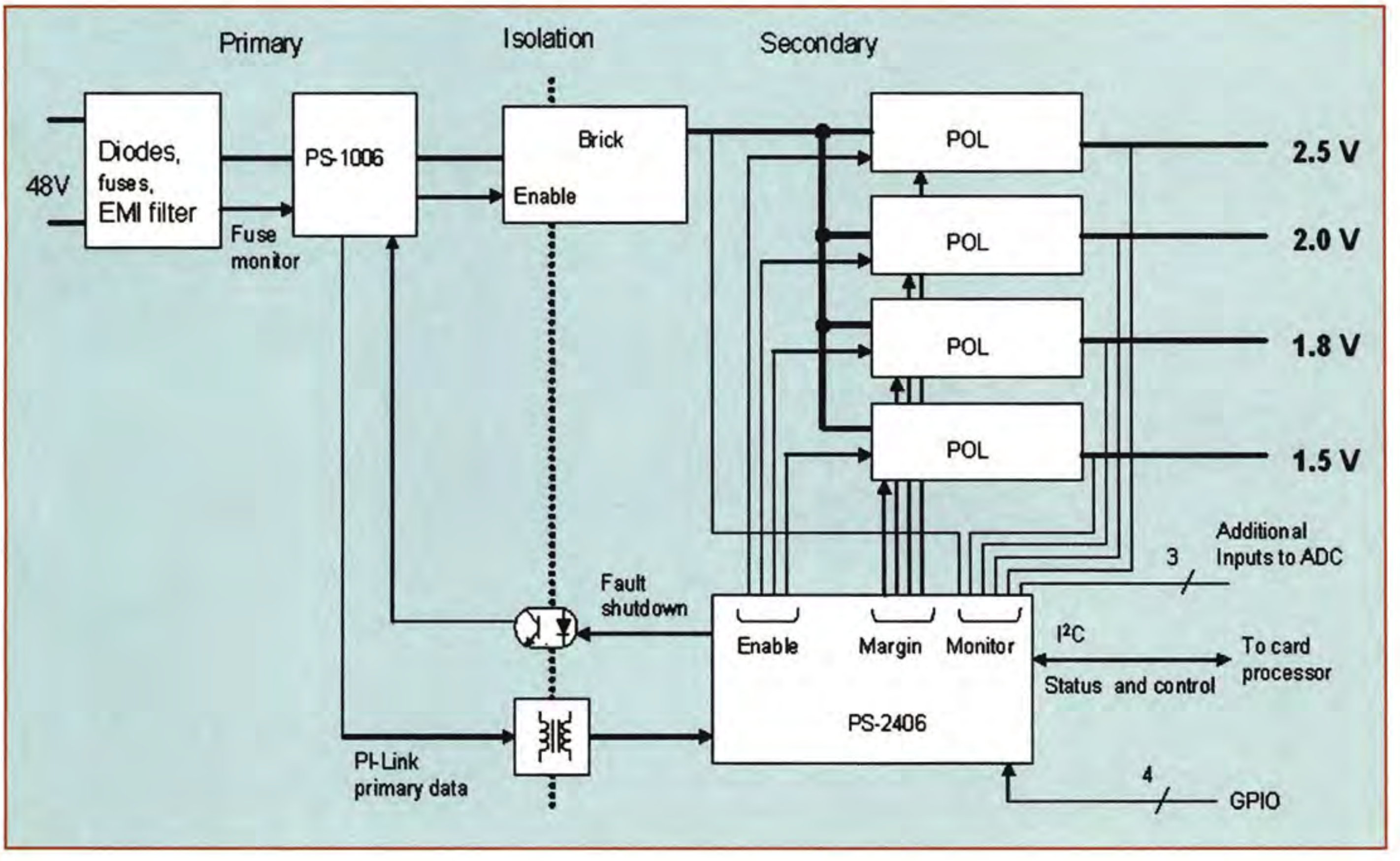


Figure 7: Primary and secondary power management

condition, it turns off the MOSFET used for inrush current limiting. A time delay is included to prevent nuisance tripping.

Communication link to secondary

The isolated communication link uses a small transformer together with three capacitors and one resistor, as shown in **Figure 6**. The recommended transformer is type ESMIT 4153A from Sumida, or equivalent. This transformer has a 2:1 winding ratio and must be connected as shown in Figure 6.

Capacitors C5 and C6 (100nF) provide isolation to fully meet safety requirements of IEC60950. Capacitor C8 (1µF) provides DC blocking and resistor R24 (1kΩ) acts as a high frequency filter in conjunction with the input pad input capacitance of the PS-2406.

The transformer itself meets the isolation requirements (creepage and clearance) for basic insulation according to IEC60950, for input voltages up to 60V nominal (75V DC maximum, 100V transient). To ensure that the complete card meets these requirements, the intermediate bus brick and any optocouplers used for isolation must meet the same requirements. The PCB must maintain adequate spacing between primary and secondary. This is best achieved by using an isolation barrier in the PCB that is free of copper on all layers. The isolation barrier should be a minimum of 0.062 inches, or preferably 0.1 inches.

The main information transmitted over the PI-Link interface includes the following:

ADC voltage measurements (real-time): Input voltage (10-bit value) ■ Input current (8-bit value)

Status information bits: Fuse fault ■ Input overvoltage ■ Input brownout ■ Input overcurrent.

All this information is available through the secondary side I^2C interface on the PS-2406.

Summary

Figure 7 shows the same power system as Figure 1, but with all power management functions provided by the PS-1006 and PS-2406. Both primary and secondary power system parameters and control functions are accessible through the single I^2C interface.

Using the approach described in this article, card power system design is considerably simplified and the necessary power management functions are easily implemented. Comprehensive power system monitoring allows system designers to offer higher availability performance, including the ability to detect latent faults before they cause system outages.

Datasheets and applications information for the PS-1006 and PS-2406 are available from Potentia Semiconductor, at www.potentiasemi.com.

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Security chasm

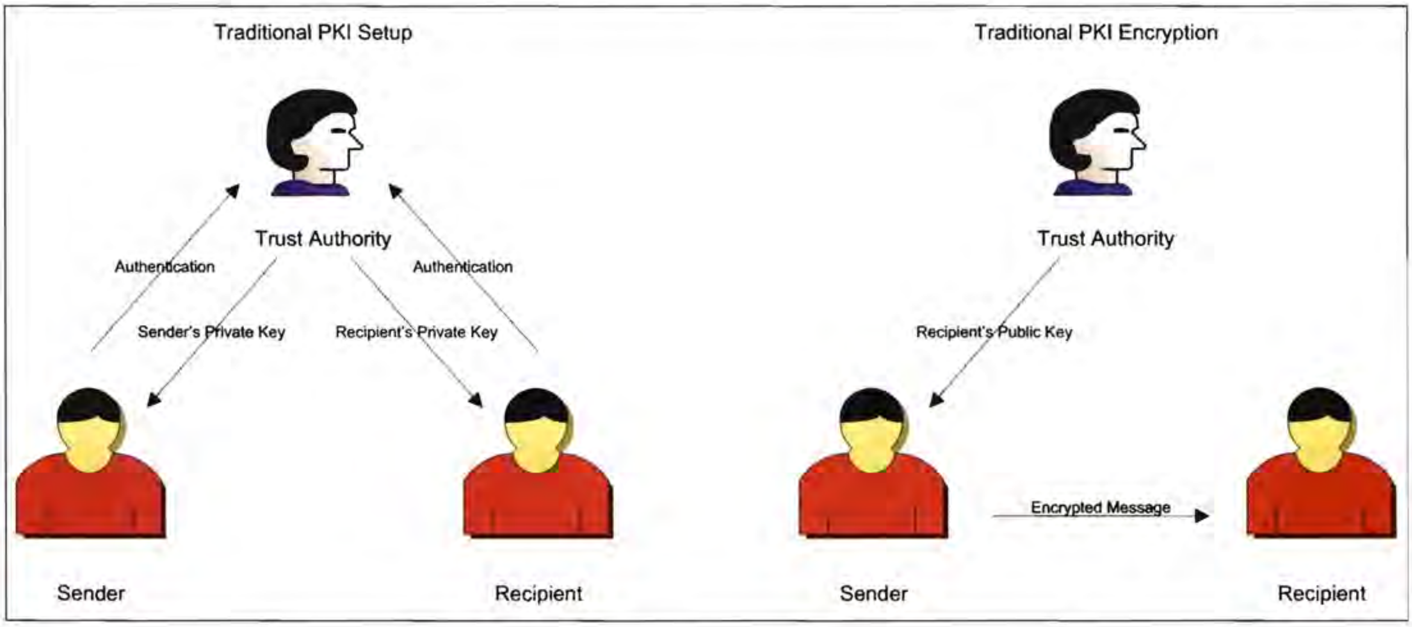
Mark Chimley, senior developer at encryption specialist Argelcom, discloses the secrets behind the encryption code of securing emails

Most of us are aware that cryptography is used to protect the sensitive data that pervades our daily lives: bank transactions, mobile phone conversations and purchases over the Internet. All of these are protected using appropriately secure and unobtrusive encryption systems. There is, however, one widely applied communications medium that is invariably used with no encryption whatsoever – electronic mail.

So why has email seemingly slipped through the security net? One important reason is that an email message comprises a single, one-way transaction. The email message can easily be encrypted with a strong symmetric algorithm, such as AES (Advanced Encryption Standard) for example, but the uni-directional nature of email leaves the problem of exchanging the symmetric key. In contrast, Internet shopping over a secure Web page, for example, involves multiple 'handshaking' transactions between client and server computers. For an SSL-secured Web page, key exchange (or 'key agreement') is achieved using Public-Key Cryptography (PKC) during the handshaking stage and results in a mutual session key to encrypt the secure content with.

There are solutions to the email security problem, but until recently these have all relied on some form of Public-Key Infrastructure (PKI). If sender@somewhere.com wishes to send an encrypted message

Figure1: Public-Key Infrastructure (PKI) setup and encryption



to recipient@overhere.org, the recipient must first generate a public/private key-pair using agreed system parameters. The recipient's public key must then be sent to the sender so that they can encrypt the email with it (or, more accurately, encrypt the encrypted email's symmetric key). This achieves the desired encryption but the sender has no way of knowing that the recipient's public key really belongs to them. All such systems therefore require the recipient to authenticate themselves (usually through a trusted third-party), adding to the complexity of the system (**Figure 1**).

There is now an alternative to the PKI model. Identity-Based Encryption (IBE) allows the sender of a message (email or any other data) to encrypt it using no information about the recipient other than their identity. The identity can be an email address, a passport number, or any other piece of information unique to the recipient. For email encryption, the natural choice of identity is a recipient's email address and this is all that the sender needs. At the time of sending, the recipient does not even need to know that IBE exists, let alone set up keys; only when they wish to decrypt the message must they obtain (or have previously obtained) the private key for their email address.

Authentication is a crucial part of an IBE system. It is necessary for a user to prove to the Trust Authority (TA) managing the system that they own their identity. The central role of the TA also means that key-escrow (the ability of a central authority to obtain the keys of its users) is inherent in an IBE system. Whilst libertarians may baulk at this feature, key-escrow is becoming increasingly important as governments attempt to legislate the use of cryptography (**Figure 2**).

IBE history

Adi Shamir first proposed the idea of identity-based encryption in 1984. IBE requires some public and private system parameters and some method of obtaining a private key for an identity so that a message encrypted using the identity, can only be decrypted using the corresponding private key. No practical system was published until 2000 when Sakai, Ogishi and Kasahara presented a paper on *Identity-based Non-Interactive Key Sharing* (ID-NIKS) at Chuo University, Japan.

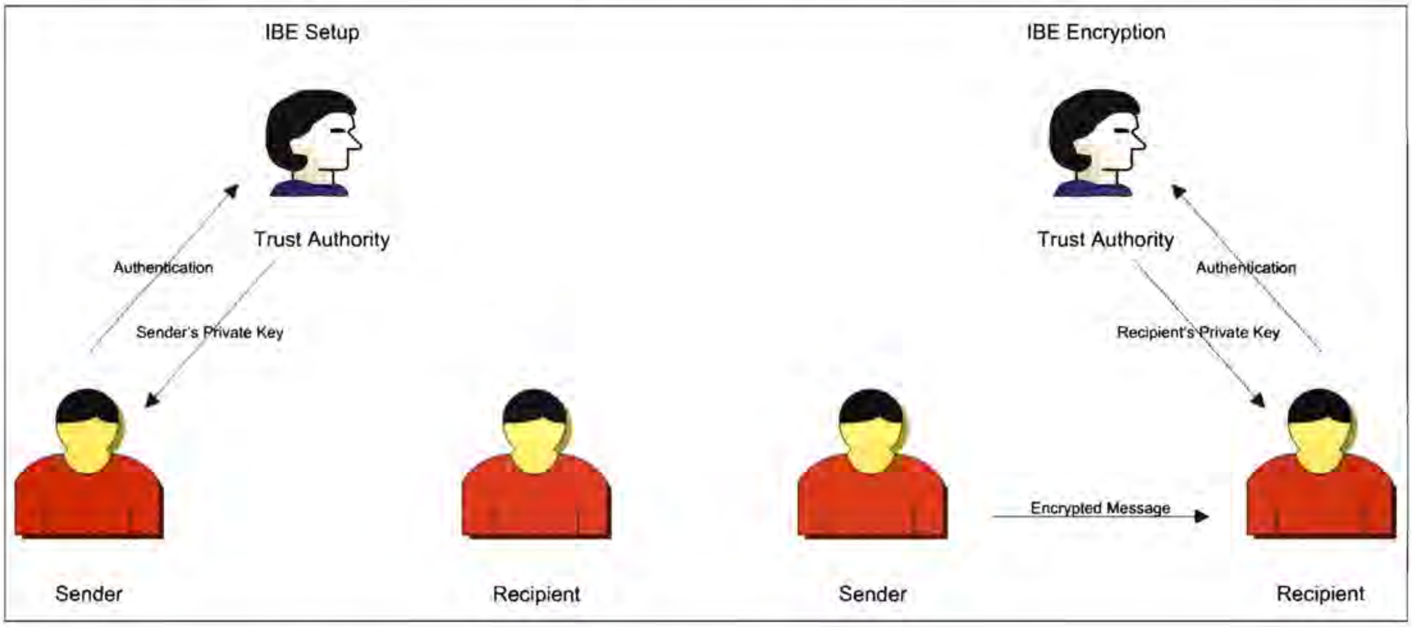
The following year, Clifford Cocks of CESG published details of an IBE scheme , based on Quadratic Residuosity (QR) – a branch of abstract algebra concerning numbers that are perfect squares in an integral ring. Dan Boneh and Matt Franklin published details of an elliptic curve based scheme using pairings in a similar manner to the ID-NIKS proposal. The QR method suffers from the need to compute a quadratic residue for each bit of the key, leading to a relatively high computational overhead. Consequently, the IBE systems in use today are variations on the Elliptic Curve (EC)-based schemes described in the Sakai-Ogishi-Kasahara and Boneh-Franklin papers.

Internal workings

The underlying mathematics of IBE is fairly complex and rarely seen outside mathematical papers. Here, however, is a description of the mathematical workings of a general EC-IBE system in more accessible terms.

Intuitively, a 'curve' is a connected set of points in two dimensions (think of a contour line on a map). A more precise definition is that of a set of points

Figure 2: Identity-Based Encryption (IBE) setup and process



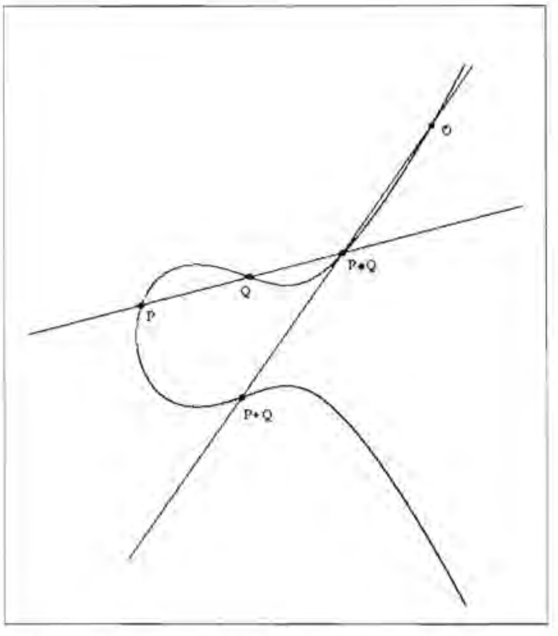


Figure 3: A visual description of the mathematical workings of a general EC-IBE system

satisfying an equation in two variables, such as $x^2+2xy^2+4=0$. The 'degree' of the (polynomial) term on the left-hand side is the highest (combined) power of its component terms. So, in this example, the polynomial x^2+2xy^2+4 has degree 3, given by the term xy^2. Curves of degree 3 are known as 'cubic' curves. If you imagine the line of a general curve drawn on a piece of paper, it is possible for the line to cross itself (e.g. the figure '8'). Any curve that does this is not 'smooth' at the crossing point. (Crossing points are also known as 'singularities' but this word has been avoided to prevent confusion with a later term.) A simple definition of an elliptic curve is that it is a curve of degree 3 without any crossing points, i.e. it is a 'smooth cubic curve' (**Figure 3**).

When thinking of a curve on a sheet of paper with an x-axis and y-axis, the set of points through which the curve passes lie within the real numbers – all whole numbers, fractions and decimals. Within the set of real numbers you can add, subtract, multiply and divide and still get a real number; not something you can do with integers. This is because the real numbers are an example of a 'field'. EC-IBE requires its elliptic curves to be defined over 'finite fields'. Operations between elements of a finite field are similar to the way a 12-hour clock operates: when you add three hours to 11 o'clock, you get 2 o'clock. Crucially, however, it is not possible to divide all of the numbers in a 12-hour clock (there is no multiplicative inverse of 9, for instance) but in a finite field every non-zero element has a multiplicative inverse.

A finite field, by definition, contains a finite number of elements and this number is known as the 'order' of the field. There is a unique finite field for every power of a prime number (e.g. 3, 23^2, 97^{13}) and the order of these fields is the corresponding prime power. If an elliptic curve is defined over a finite field, instead of the real numbers, it has only a finite number of points (each with coordinates in the finite field) and this number is known as the 'order' of the curve.

To be suitable for use in IBE, elliptic curves must satisfy a set of conditions. In particular, the order of the curve must be divisible by a large prime number and another value, known as the 'security parameter' of the curve (a relationship between the order of the curve and the order of its underlying field) must be small but greater than 1. This condition usually results in 'supersingular' curves being chosen, for these all have sufficiently small security parameters. The restriction ensures that there is a suitable mapping, known as a 'pairing', between pairs of points on the curve and elements within another (larger) finite field. Just think geometrically of two points on the elliptic curve shown being related to a particular number.

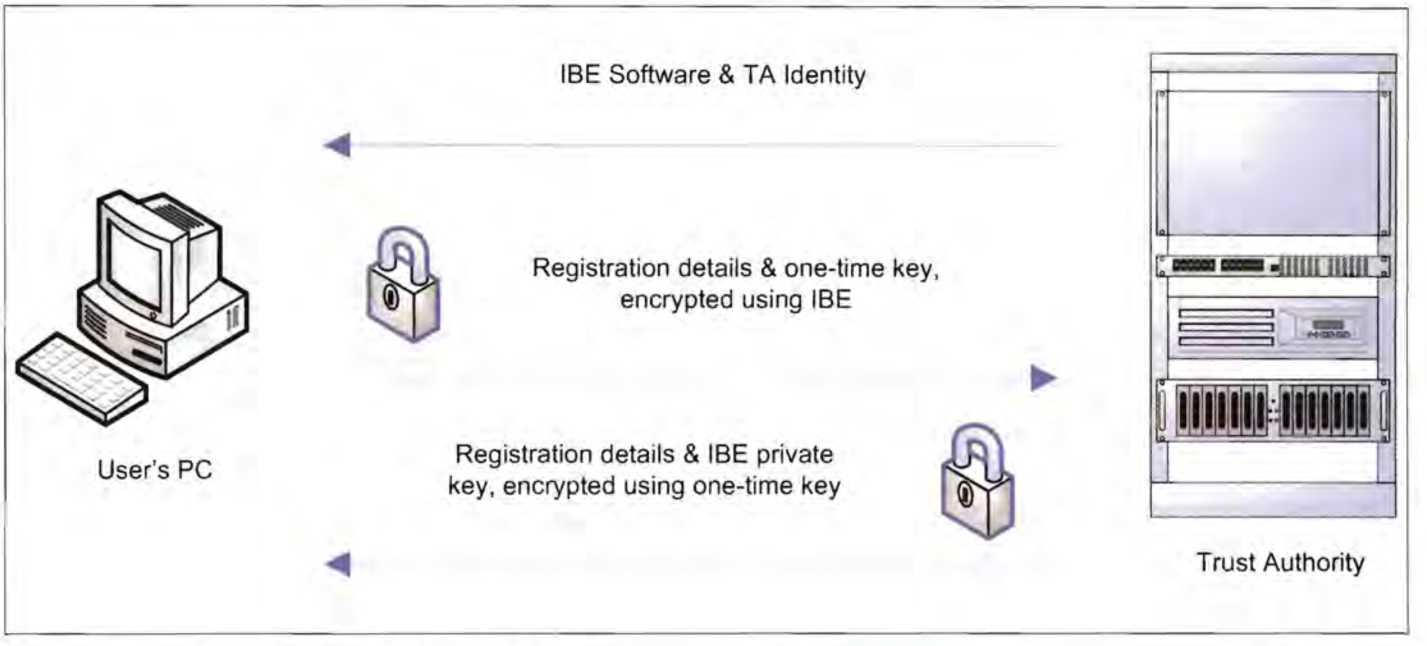
Both ID-NIKS and Boneh-Franklin's example IBE schemes used a modified version of a relationship called the 'Weil pairing', but most systems now use a modified 'Tate pairing' since it is more efficient. Now here's the important bit, which unfortunately requires a bit of mathematical symbolism: Having established all the right conditions, our pairing, denoted t, has the crucial property of being 'bilinear' which means that $t(\lambda P, \mu Q) = t(P,Q)^{\lambda\mu}$. Here P and Q are points on the curve and λ and μ are elements of the finite field. The results of the pairings, $t(\lambda P, \mu Q)$ and $t(P,Q)^{\lambda\mu}$ are elements of the larger finite field.

In IBE, as with many other systems, the encryption of plain-text is actually performed using a 'standard' symmetric algorithm such as AES. The IBE-specific part of the system is the method used to send the encryption key to the recipient: Let G be a chosen point on our elliptic curve. The curve's EC-pair is (d,Q) where $Q=dG$ and d is a secret and held by the TA. Here, all upper case letters are points on the curve and lower case letters are elements in our field. An identity (ID)-pair for an identity I is (S,I) where $S=dI$. S is generated by the TA and given to the holder of the identity I.

A sender encrypts a plain-text message using a key derived using the pairing $f=t(I,Q)^r$ where I is the recipient's identity, Q is the public system parameter, and r is a random value. The sender sends the encrypted message together with the value $U=rG$. The recipient with identity I can form f from U and S using the properties of the pairing:

$$t(S,U) = t(dI,rG) = t(I,dG)^r = t(I,Q)^r = f$$

and can then decrypt the message. In practice, IBE systems involve more steps than this (to



provide authentication and enhance security) but the principle is the same.

An IBE solution for email

IBE's cryptographic properties mean it is particularly suited to securing electronic mail. It requires no pre-requisite information or configuration on behalf of the receiver. The sender requires only the destination email address and so the one-way transmission of email is not a problem. Also, despite the complexity of the underlying mathematics, at the application level, an IBE system is simple to use and set up. IBE also makes it very easy for an organisation to send a secure message to multiple recipients. With a PKI system, the organisation (e.g. a government or bank) would have to obtain the public key for each recipient first, but with IBE the message can just be encrypted using the recipients' identities.

One of the first companies to develop a complete IBE email solution is Argelcom Ltd. Argelcom's IBE software suite comprises a set of IBE tools that perform the core IBE operations, together with plug-ins for common email clients.

The IBE suite can be downloaded from the Internet (**Figure 4**) and is signed to ensure its integrity. When installed on a client PC, the software contacts the host TA to perform a one-time registration of the user, allowing the IBE suite to securely receive secret keys for the user's identity. The registration process itself utilises IBE to securely transmit registration details to the server using the server's identity. Transmissions from the server to the client are then encrypted using a one-time registration key.

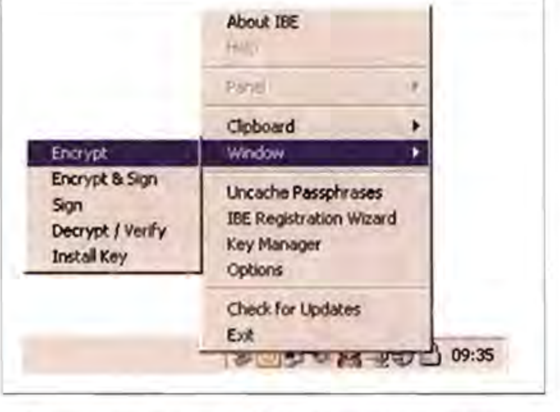


Figure 4 (above): Downloading of the IBE tools of the Internet is made simple

Figure 5 (left): The universal operation is provided by a Windows service with a system-tray icon

Once registered, the IBE tools can be used on their own, to encrypt email using any Windows-based email client or can be integrated with specific clients via plug-in software modules. The universal operation is provided by a Windows service with a system-tray icon (**Figure 5**).

Encrypted messages are Base-64 encoded so that they can be sent as ordinary email text. Tags identify the cipher-text and a URL is included in the message so that users who have not yet downloaded the tools know where to get the software. Once they have installed the software, recipients can decrypt the message in the email client's window using the system-tray icon's 'Decrypt' option.

When an email client's plug-in is installed, the IBE operations are even simpler, amounting to a single click of a toolbar button. The plug-in can also be configured so that all messages are encrypted and signed by default – a useful feature for a corporate installation.

Sign-off

Email security is not simply a matter of protecting a message's contents from a third party; it is often important to ensure the integrity and authentication of a communication. IBE can provide these assurances too by adding a digital signature to the message. In order to digitally sign a message, a user must have obtained the private key for their identity. Any recipient is then able to verify that the sender holds the secret key for the identity, as they must have authenticated themselves to the TA. The universal IBE tools and the email client plug-ins all provide signing and verification operations in addition to encryption and decryption.

Important reading:

The following mathematical papers record crucial events in the development of the IBE.

1. A paper "Crypt Schemes based on Weil Pairing" was subsequently submitted to Asia Crypt 2000.
2. "An Identity Based Encryption Scheme Based on Quadratic Residues", Proceedings of the 8th IMA International Conference Cirencester, 2001.
3. "Identity based encryption from the Weil pairing", SIAM J of Computing, Vol. 32, No. 3.

Have you ideas for a kernel?

IBE is a new technology and whilst it is ideally suited to securing email messages, it is likely to prove useful in other areas too. At the heart of Argelcom's IBE Tools is a general-purpose IBE kernel. The Argelcom team, which includes Professor Nigel Smart – a renowned expert in elliptic-curve cryptography, would be very interested to hear from anyone with ideas for alternative uses of the kernel. See the company's website: **http://www.argelcom.com/** for details or to contact them by email **info@argelcom.com**

LF-to-RF relative gain and phase measurement system

By Emil Vladkov

Very often in design practice there's the need to measure the gain and phase response of a circuit/device under test, comparing output to input. Sometimes, it is necessary to measure the phase relation of two different signals with the same frequency. But, the trickiest of all the measurement problems associated with modern high-speed circuitry and communications is maybe the measurement of return loss parameters of a transmission system – how much of the energy is reflected back due to an improper termination. The purpose of this project is to evaluate the features of a new and very exciting integrated circuit from Analog Devices – the AD8302, which is a gain and phase detector capable of operation in the range LF-2.7GHz. It should give answers to some of the above-mentioned problems or provide a useful help in constructing more complex and sophisticated systems to measure return loss in antenna feed systems for example.

AD8302 theory of operation

The AD8302 consists of two separate measurement systems – one for the gain/loss ratio of two signals, and one for the phase difference between these signals. The internal structure of the gain and phase detector is depicted in **Figure 1**.

The first subsystem comprises a pair of closely matched 7 stage 60dB demodulating logarithmic amplifiers. The relative gain subsystem takes the difference between the outputs of these logarithmic amplifiers and so a value is available at the VMAG-pin, which is proportional to the magnitude ratio of the two input signals at ports INPA and INPB.

In normal measurement applications, a feedback around the output stage is closed and the VMAG output is connected to the MSET input. In control applications, this feedback is broken and MSET can be used to program a threshold voltage. In the last case, the feedback is closed around the system to be driven by the VMAG-output with the INPA and INPB inputs connected to the two points of the external system with the desired threshold magnitude ratio to be obtained by this kind of controller.

The controller application of the AD8302 is not implemented in the proposed design, which is a pure measurement device, so this short explanation of the IC's additional feature should be enough for understanding its internal working.

The phase difference subsystem is a simple phase detector, consisting of a multiplier, driven by the fully limited input signals appearing at the outputs of the logarithmic amplifiers. As the logarithmic amplifiers produce a clipped/limited version of the input signals for weak and strong input signals (this is a main feature of the logarithmic amplifier with more and more amplifying stages switched on in the signal path as the signal gets weaker), the phase comparators, and so the phase measurements, do not depend on the signal level. Exactly as in the case of the gain measurement module the phase difference output VPHS and the phase threshold input PSET are normally connected for measurement tasks. In phase controller applications, this feedback loop around the output is broken and is closed again around the system under control.

The two outputs providing relative gain and phase information VMAG and VPHS swing between 0 and 1.8V. This range can be modified with the help of the stable on-board reference 1.8V available at VREF.

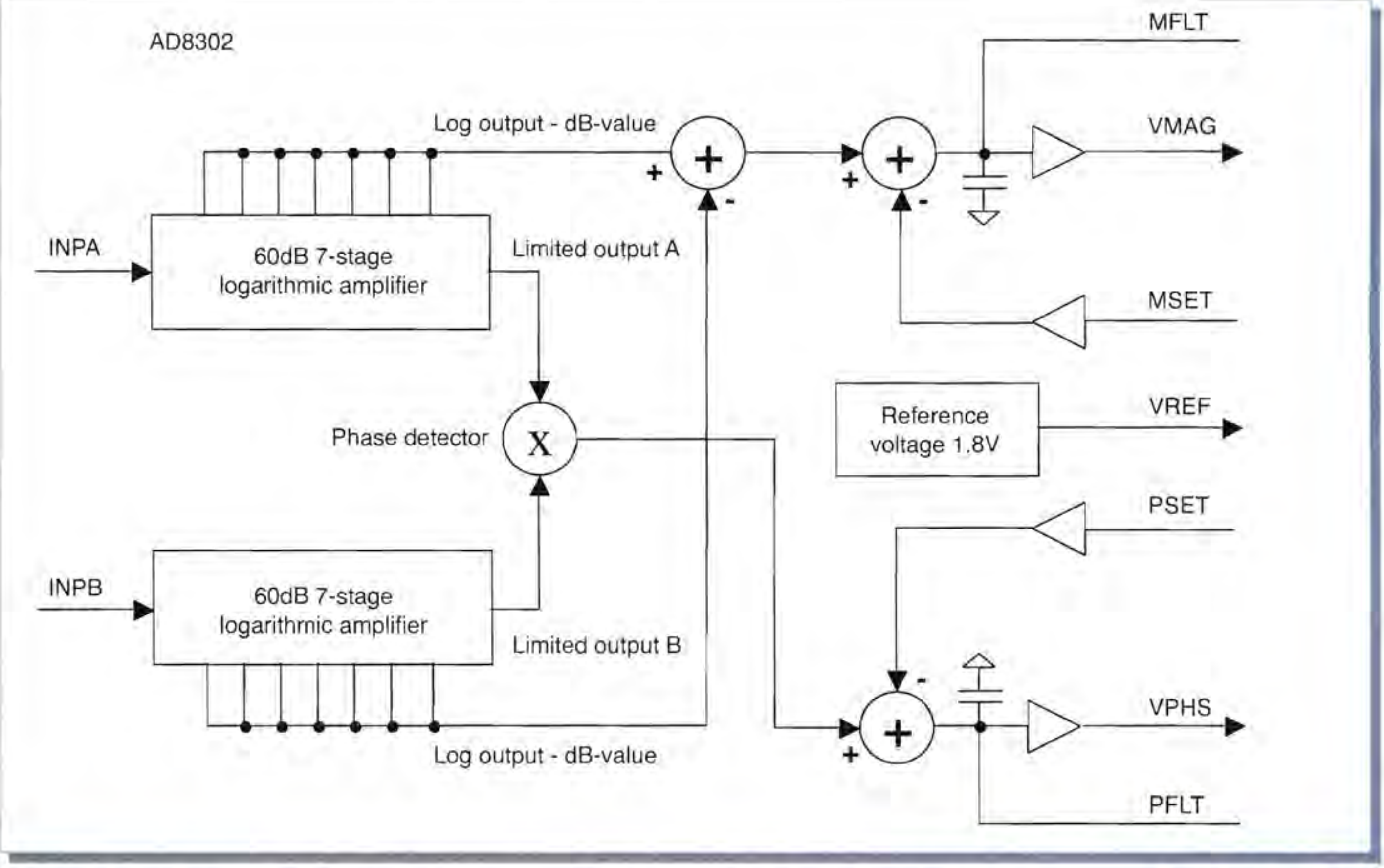


Figure 1: AD8302 gain and phase detector internal structure

The input signals are usually AC-coupled to the inputs INPA and INPB and should be in the range from -60dBm to 0dBm for a 50Ω system. Optimal performance can be achieved with this device for inputs in the order of -30dBm, so, in the proposed design, attenuators at the inputs are used to weaken strong signals to the optimal power value. The output of the phase detector and the relative gain output can be additionally low-pass filtered through external capacitors, connected to the PFLT and MFLT pins of the IC. This low-pass filtering aids in implementing lower speed ADCs to capture a stable value of the measured phase/gain to be displayed on a slow updating LCD display, for example. Some filtering is provided with internal capacitors, depicted on Figure1.

The outputs for the magnitude ratio and the phase can be expressed:

$$(1) \quad V_{MAG} = V_{SLP} \log(V_{INA}/V_{INB}) + V_{CP}$$

$$(2) \quad V_{PHS} = V_{\Phi}(|\Phi(V_{INA}) - \Phi(V_{INB})| - 90^{\circ}) + V_{CP}$$

VSLP is the so-called slope voltage for the magnitude ratio, which is 30mV/dB for AD8302. V_{Φ} is the phase slope voltage, which is 10mV/deg. These values are used by the firmware routines residing in the device MCU (MCU) to compute valid results in dB and degrees from the analogue voltages, obtained from the gain and phase detector. V_{CP} is the center point voltage, which is used to shift the transfer characteristics for the gain and the phase. For both types of measurements the center point voltage is 900mV.

The magnitude ratio output is centered at 900mV (half full scale) for 0dB gain and the phase difference output is centered at 900mV for 90° between inputs. It should be noted that the transfer function for the phase difference is ambiguous, so equal voltage outputs for the phase are obtained for the -180° to 0° range and for the 0° to 180° range. This is a specific feature of the type of phase detector used, which responds to the relative position of the zero crossings between the input channels, but, in the most cases, it should not lead to any difficulties in real measurement tasks.

Both transfer functions for the AD8302 are presented in **Figure 2**. The real transfer function for the phase differs somewhat from the representation in Figure 2 at both extremes: 0° and 180°. This is especially true for higher frequencies, as in the latter case the rise and fall times of the waveforms at the inputs of the phase comparator are finite and this creates dead zones of phase angles, which can not be measured. According to the manufacturer's datasheet, for 100MHz input signals this phase error

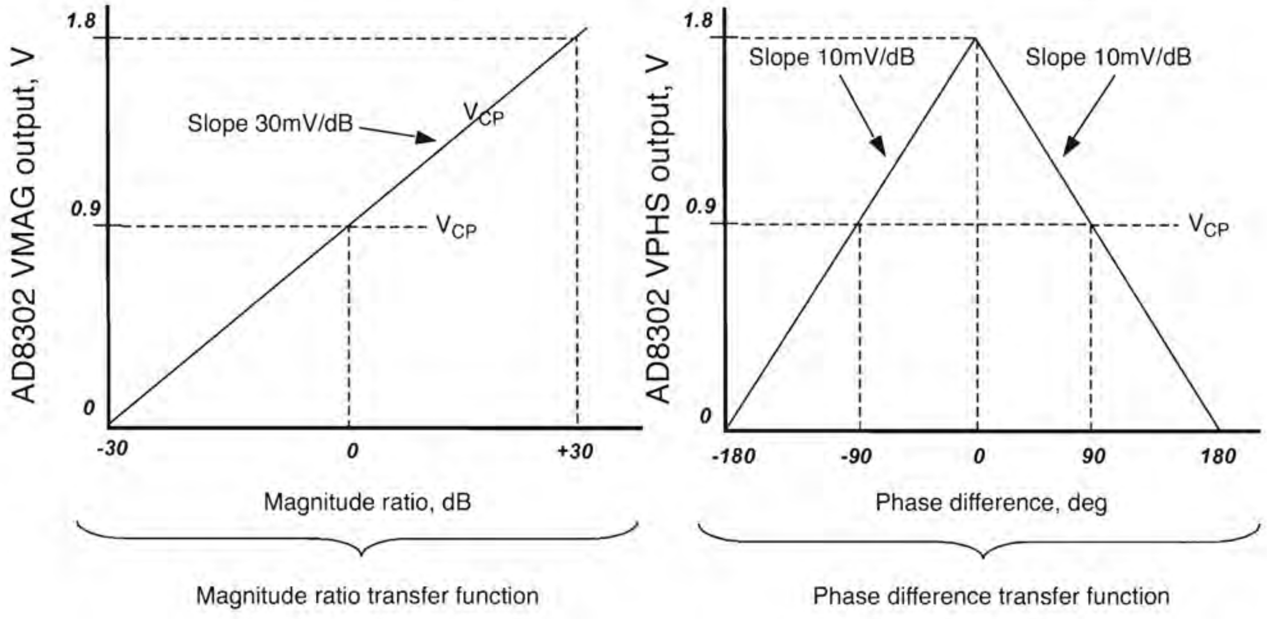


Figure 2: AD8302 gain and phase transfer functions

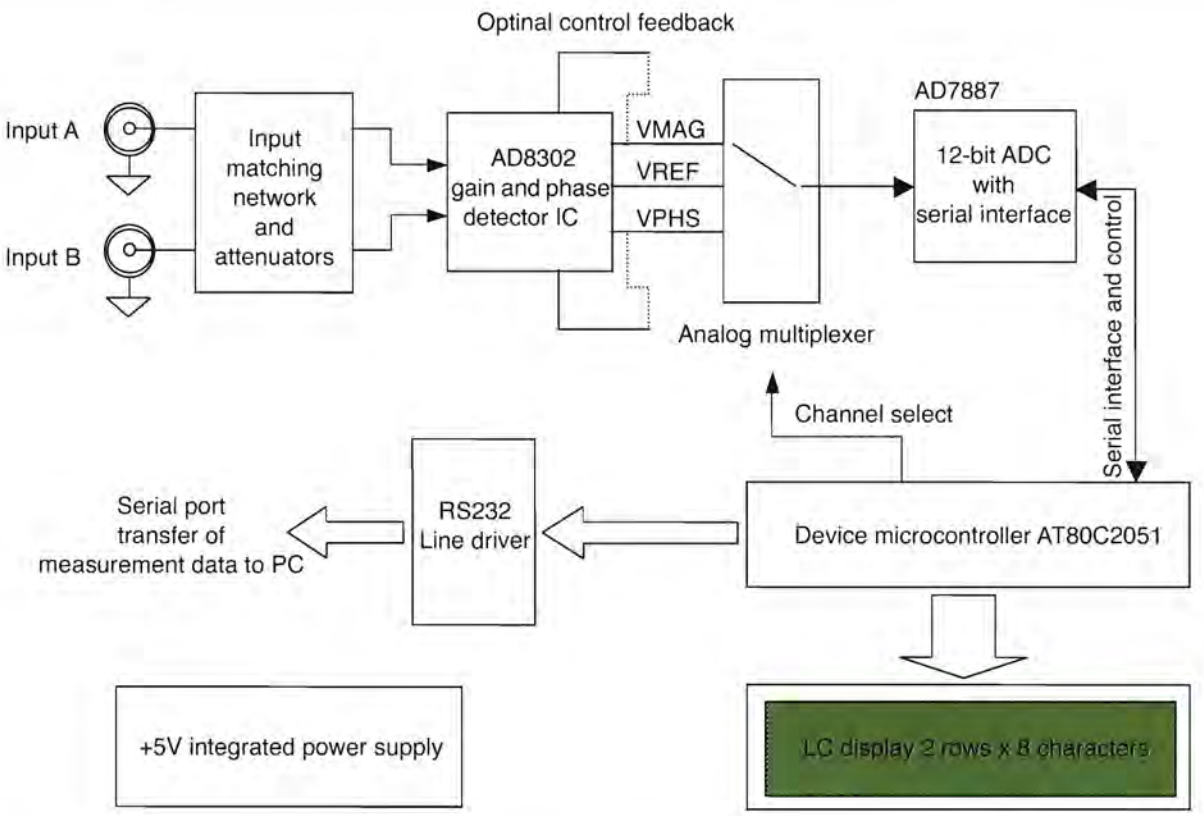


Figure 3: Functional structure of the gain and phase measurement system

at the extremes can reach nearly 8° (and more at higher frequencies). This explains some inaccuracies in the phase response at 180° observed when the prototype was measured.

Another peculiarity of the AD8302 IC is that if the magnitude difference between inputs A and B is greater than 20dB, cross-modulation between the phase and gain ratio measurement subcircuits can occur, which becomes an issue at frequencies above 900MHz.

System architecture

Block diagram of the prototype is presented in **Figure 3**. The two signals to be compared in phase and magnitude are applied on input A and input B. As the system is intended to be used within communication systems with 50Ω interfaces, the input matching network is necessary, which has two main goals: matching the impedance close to the coaxial line impedance, so no reflections and standing wave situations occur; and providing input attenuation, so that strong signals are brought to optimal for the AD8302 IC (-30dBm) power levels. Such attenuated and conditioned signals are fed to the magnitude and phase comparator AD8302. Three of the output signals of this integrated circuit are supplied to the following data acquisition unit – the magnitude ratio analogue output VMAG, the phase difference analogue output VPHS and the reference voltage VREF. As discussed earlier, the AD8302 IC has optional inputs for external feedback loops so that it can be used in controller applications. Although these are not used in the actual design, they are provided as testpoints and for optional device extensions.

The ADC used (AD7887) is actually a two analogue inputs device (it has an onboard multiplexer). Unfortunately the second analogue input AIN1 is shared with the external voltage reference input and the onboard reference of the ADC is not suitable for the full dynamic range application (1.8V). So the AIN1 can not be used as input as the VREF of 1.8V is applied there. This transforms the ADC into a simple one-input converter, which has to capture analogue signals. This makes the use of an analogue multiplexer mandatory, so that the three analogue signals can be applied and converted sequentially by the ADC.

The device MCU AT89C2051, which also captures the data representing samples from the analogue signals corresponding to magnitude ratios and phase differences, selects the channel currently converted by the ADC. The interface to the AD7887 is serial.

The firmware residing in the MCU's internal flash memory is responsible for the test. If the voltage is not in the specified range, then some part of the circuitry may not function correctly. The AT89C2051 MCU has two other important tasks: it sends the measurement data through a serial asynchronous interface to a host PC for further processing (in a spreadsheet application) and it initialises a liquid crystal display where the data is presented for immediate viewing. The alphanumerical standard display is perfectly suited for the presentation of the two values of the relative magnitude and the phase difference. The whole unit is powered by means of an integrated +5V power supply, so only an external unregulated power supply in the range 9-15V DC is necessary to complete the project.

Circuit schematics

The complete circuit schematics diagram of the project is presented in **Figure 4**. The two inputs INA and INB are fed into the J2 and J3 BNC connectors. If high frequency signals are to be measured (the maximum frequency processed by the AD8302 can reach 2.7GHz), then the BNC-type connectors should be replaced with SMA-types. The circuitry around the two 20dB directional couplers and associated matching components Z_L, R21, R22 and R_S is external to the device and illustrates a possible application of the VRC8302 in vector reflection coefficient measurement system.

The resistors R15 to R20 form the attenuators, which should bring the two incident signals into the -30dBm range. With the values shown, these modules provide 1dB and 20dB attenuation, which is perfect if one of the input signals (the reflected one) is 19dB lower in power than the other (the incident signal). For signals expected to be in the same magnitude range, it is advisable to use two identical 20dB attenuators on both channels. The two attenuators are calculated for 50Ω input and output impedances. The R1 and R2 components are the input matching impedances and the input signals are AC coupled to the AD8302 through C1, C4, C5 and C6 capacitors. The gain and phase detector AD8302 is represented in Figure 4 as U1. The power supply to the IC is additionally filtered by means of the components R4, C3 and C7. The relative complicated way of interfacing the input signals to U1 (which involves not only the INPA and INPB inputs but also OFSA and OFSB pins) can be explained with the need for offset compensation and, especially, with setting the offset compensation filter corner frequency.

The VMAG, VPHS and VREF-outputs of U1 are applied to the inputs of the U3 analogue multiplexer (HEF4051). The R7 and R8 feedback resistors are included in the design to provide some kind of versatility in implementing different configurations

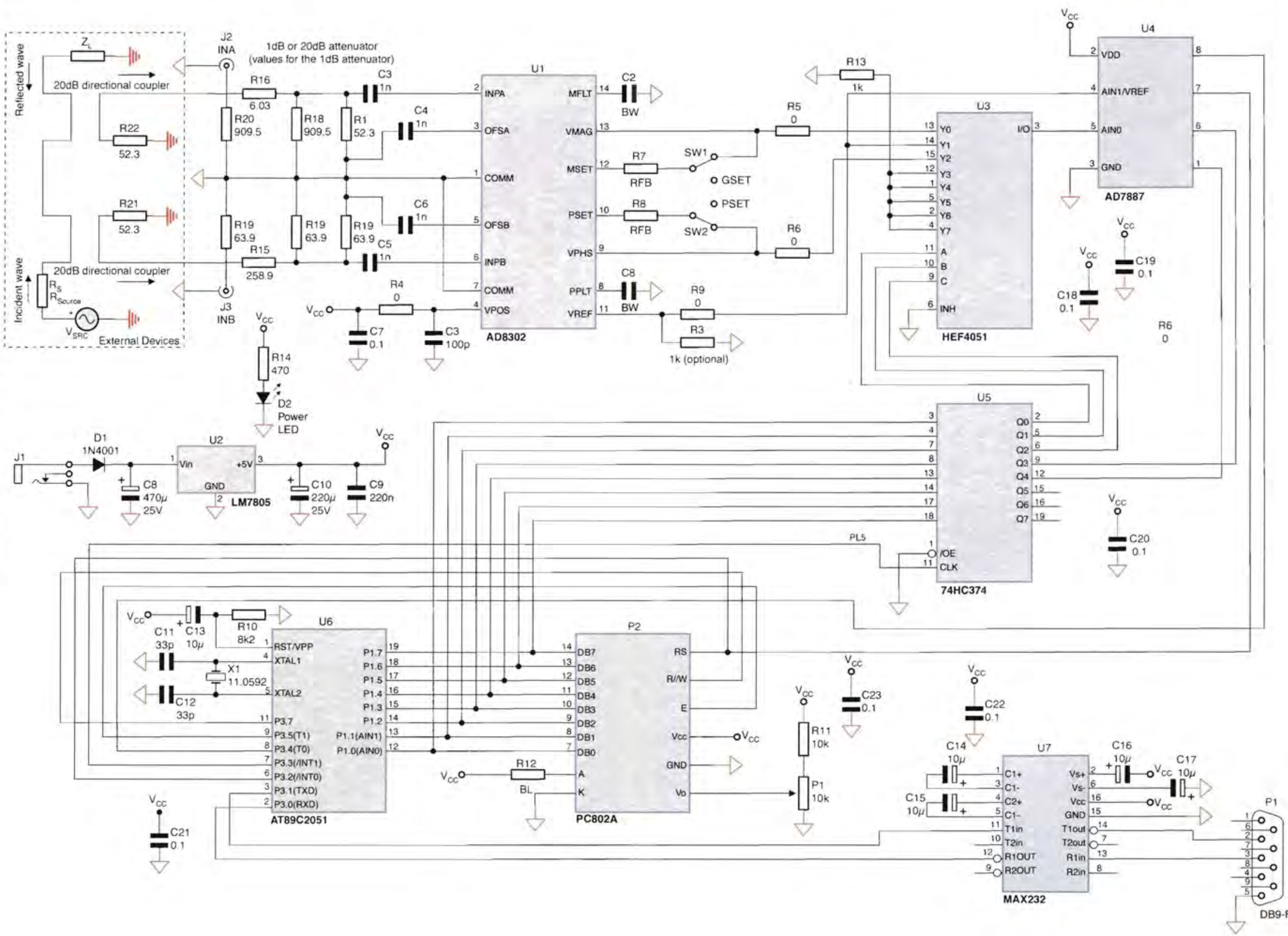


Figure 4: Schematic diagram of the gain and phase measurement system, VRC8302

(for example closing the output feedback around a phase or amplitude controller by the use of SW1 and SW2 and the GSET and PSET testpoints). The R5, R6 and R9 resistors are actually short circuits, but non-zero values can be used to isolate somewhat the outputs of the detector and the inputs of the multiplexer. The unused inputs of the U3 multiplexer (Y3 to Y7) are tied to ground through the R13 resistor. The outputs of U1 are bandwidth limited by the C2 and C8 components – their values depend on the way and speed measurement data is collected and manipulated – I have chosen 100nF values in the design, presuming a slow LCD update rate.

ADC's U4 is the AD7887 12-bit serial output device. Its reference voltage is provided by the VREF-output of the gain and phase detector at 1.8V. So the full 12-bit range of the ADC is utilised when measuring the outputs of U1. The output of the multiplexer is connected to the input of the ADC supplying sequentially the gain and phase output voltage for conversion. The protocol for the serial communication between the ADC and MCU is accomplished in software from the firmware routines. The serial communication needs a clock line (SCLK) and data output line (DOUT), which are connected directly to the P3.4 and P3.3 lines of the MCU.

Things get more complicated as the ADC has several modes of operation (one or two channel mode for example) and these should be programmed into the ADC prior to the first conversion. The modes of operation are determined by the content of a Control Register, which should be initialised in software – in the project mode 2 is used – the ADC is fully powered up, the power-down is disabled and the device is fast accessible (there is no 5ms start-up time between conversions). Configuration data is loaded into the device through the DIN-pin but, unfortunately, the pins/output ports of the MCU used are not enough to ensure all interface requirements of the design. A solution to this problem is to use the latch U5 (74HC374), which is loaded from the P1-port of the MCU with the P3.5 acting as a clock/latching signal. The U5-latch functions as interface demultiplexer and extends the output lines of the MCU. Not only is DIN driven by the pre-loaded Q3 output of the latch, but also is the Chip Select signal of the ADC (CS\) – driven by the Q4-output. The channel select inputs of the analogue multiplexer U3 – A, B and C – are driven by the outputs of the extending latch (Q0, Q1, Q2) too.

If the U1 AD8302 device is the heart of the project, the U6 (the AT89C2051 MCU) is the brain. It is clocked by the X1 quartz crystal with the associated C11 and C12 components. Reset is provided by R10-C13 and the asynchronous serial port signals are output at the P3.0, P3.1 lines. These are connected to the RS232 driver U7 surrounded by the corresponding components C14-C17. The RS232 port of the unit is the P1 connector. Through port P1, the MCU drives the U5 latch and directs the input data port (DB7-DB0) of the LC display module, P2. P3.3, P3.2 and P3.7 provide the control signals for the LCD (Register Select, Read/Write and Enable). The contrast of the LCD is set through R11-P1 divider. Optional provision for backlit LCD units is covered too as the R12 current limiting resistor is included in the design.

The integrated power supply consists of the voltage regulator U2 (LM7805) with the associated filtering components C8, C9 and C10. D1 serves the protection in case a reverse supply voltage is applied accidentally to the unit at the J1 power supply plug. R14 and D2 provide a visual indication when the unit is powered. Power supply filtering next to the components is accomplished with the C18-C23 capacitors.

And this constitutes the whole design from the schematics point of view – simple but effective.

Experimental set-up for device evaluation

After building a device, especially one intended for measurement purposes, it is important to verify it is working correctly as expected. This means that the gain ratio and phase difference measurement system has to be characterised throughout its whole measurement range. The two experimental set ups are presented in **Figure 5** and **Figure 6**. Measuring the phase response (with Figure 5 set-up) proved to be a real challenge, as there was necessary to find two signals with exactly the same frequencies and to shift one of them in phase relative to the other in small steps for the results to be representative. I decided to use the Direct Digital Synthesis (DDS – AD9851) evaluation system, which allows the user to precisely synthesise sinusoidal signals from a 20MHz clock in the range 0-60MHz with 0.03Hz resolution. A very beneficial feature of the DDS system for my intention is its ability to modulate/shift the phase of the synthesised output (relative to the reference clock signal, if the two frequencies are equal). Actually, this feature is intended for several PSK (Phase Shift Keying) applications known from the telecom world.

The phase step is 11.25 degree – more than adequate for our task. The two signals – the reference 20MHz clock and the synthesised signal (again with exactly 20MHz frequency) are fed to the INA and INB inputs of the system under test. As the clock signal has a weak driver capability, a buffer (or a simple attenuator) is placed in the path of this signal, so that the 50Ω input impedance of the phase-measurement system does not load the

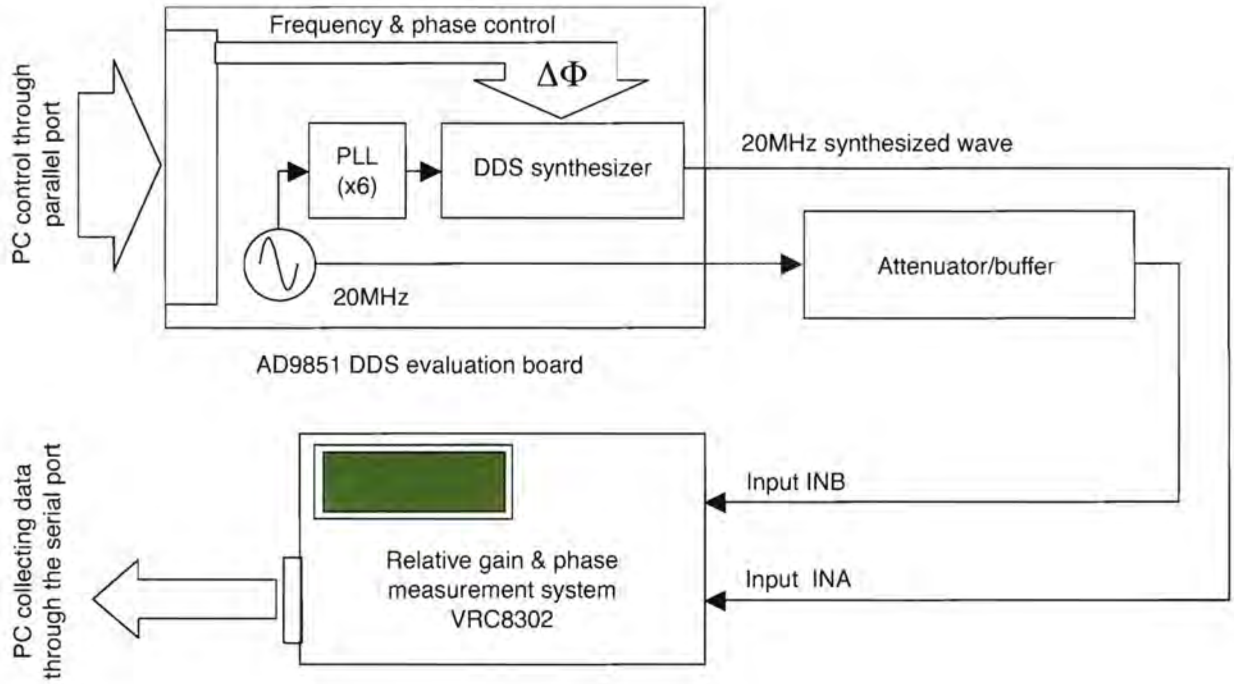


Figure 5: Phase response measurement set-up using a DDS synthesiser and its local oscillator

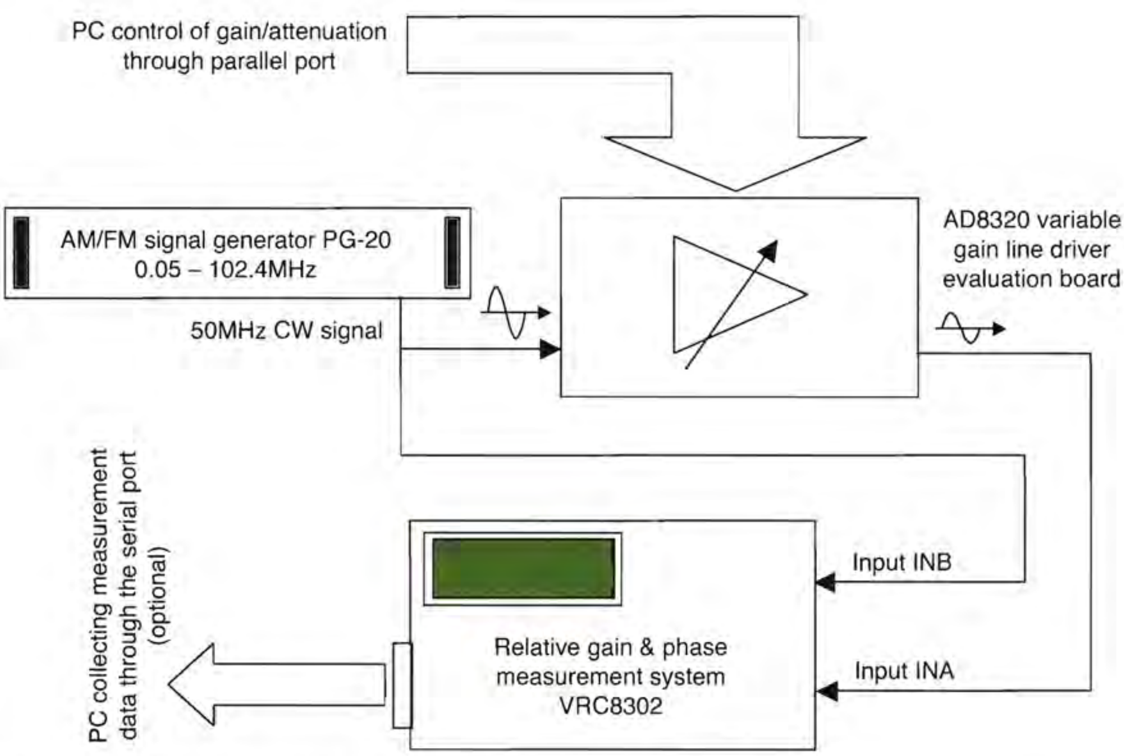


Figure 6: Magnitude ratio measurement set-up implementing a programmable attenuator/amplifier

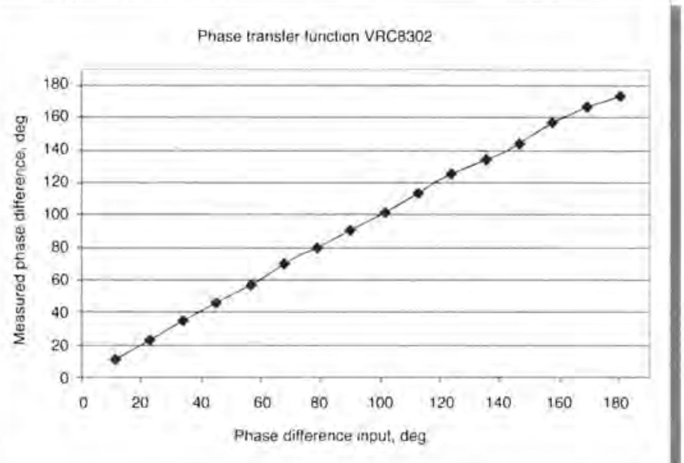


Figure 7: Measurement results for the phase difference with the set-up from Figure 5

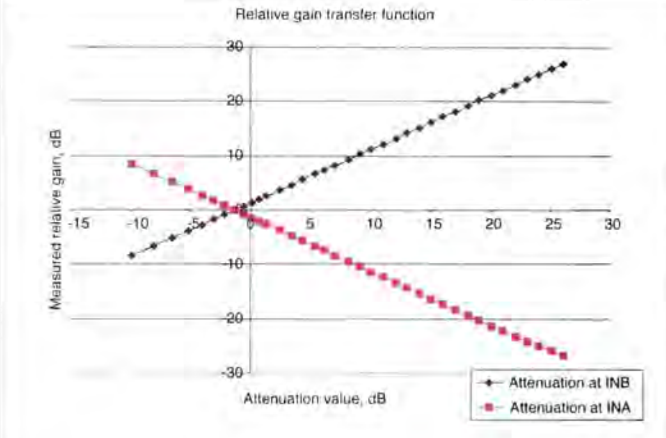


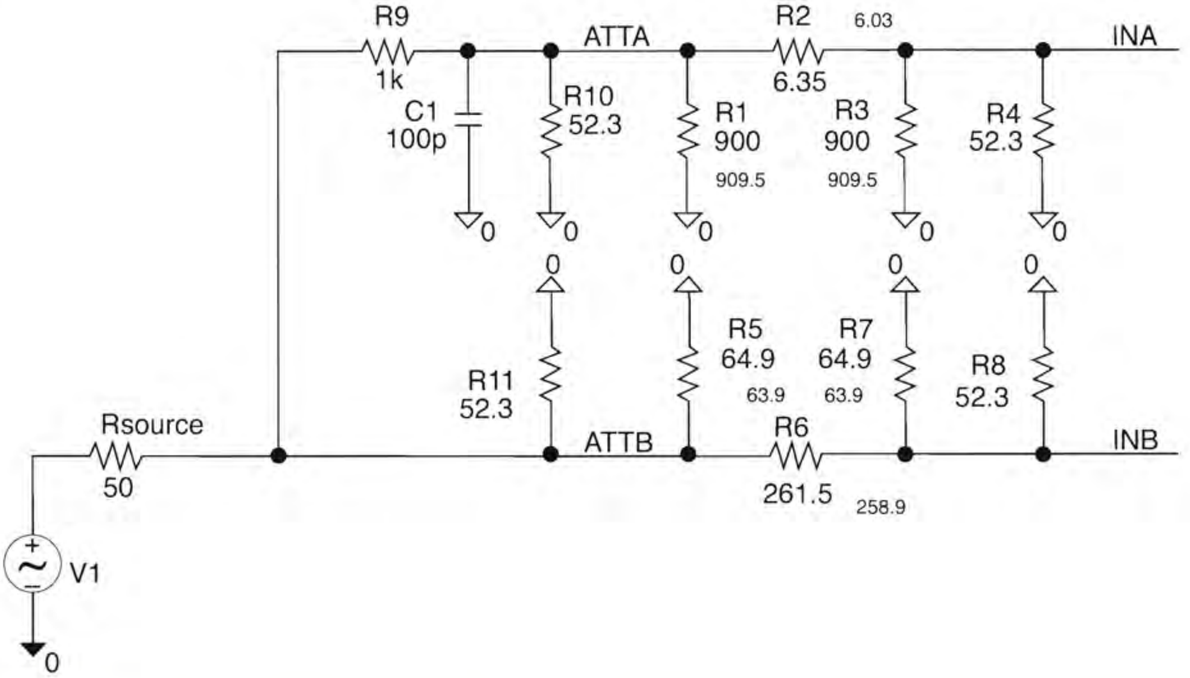
Figure 8: Measurement results for the magnitude ratio with the set-up from Figure 6

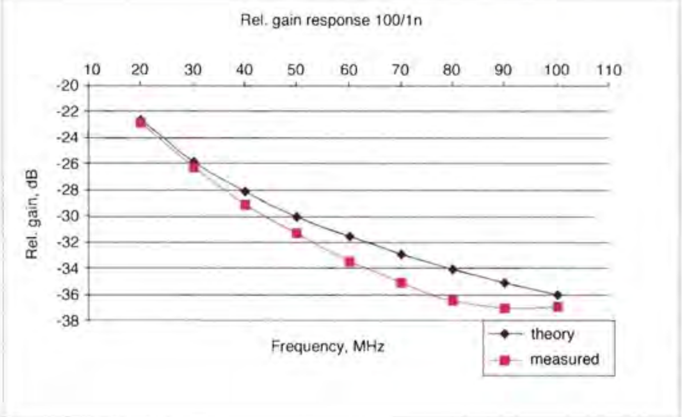
clock. The phase control of the DDS is accomplished through a dedicated GUI interface running on a PC via the parallel port. Measurement results are evaluated from the display readings and the data sent to the PC via the serial port connection; they are presented in the graph in **Figure 7**. The phase difference transfer function is close to a straight line with small deviations at the 180° end.

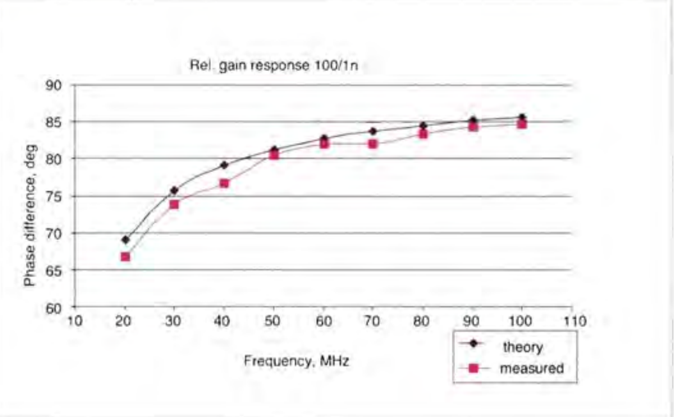
The device under test evaluation regarding the magnitude ratio behaviour is performed with the set-up depicted in Figure 6. Here one of the two signals at 50MHz CW to be compared in magnitude is attenuated/amplified by means of a programmable amplifier/attenuator. I have used the AD8320 variable gain line driver evaluation board for this purpose. The attenuation/gain value is programmed under software control with a dedicated GUI interface through the parallel port of the host PC. As the AD8320 is usually implemented in cable modem systems to adjust the level of the return channel depending on the distance to the headend, the attenuator/amplifier board is designed for 75Ω line impedances. The input interfaces of the VRC8302 system are 50Ω types, exactly as the output of the AM/FM signal generator us in the measurement set-up. The line impedances mismatch do not influence the results to a great extent, but they (and the input/output networks of the attenuator board in general) explain why the two transfer functions presented in the results graph in **Figure 8** do not cross at the origin of the x- and y-axes. The shift to the left equals exactly the additional attenuation due to the input and output line matching networks of the attenuator. The two transfer functions presented in Figure 8 illustrate the two cases of applying the attenuation/amplification in the signal path to channels INA and INB. This set-up allows us to determine the response of the VRC8302 system throughout its full measurement range (nearly), which includes both cases of attenuation and gain of one of the signals relative to the other. It can be seen from the results that the transfer functions are straight lines, which conforms excellently to the expected values and behavior.

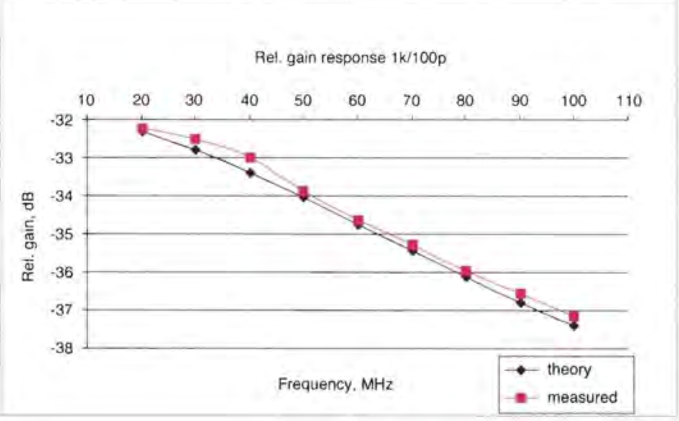
The most difficult case in thinking out a measurement set up is the one, which involves the simultaneous change of magnitude ratio and phase difference between two signals. A possible implementation will be a simple low-pass filter, which alters the amplitude and the phase of an input signal. The VRC8302 can be used to evaluate the differences between input and output of the filter. Of course, such a simple circuit has the drawback of impossible matching of the signal source to the R-C group, which results in increased values for the return loss and, eventually, measurement errors. I have tried two such line-ups: one with a 1dB/20dB attenuators and one with 20dB/20dB attenuators. The schematics of the two set-ups are presented in the diagrams in **Figure 9**. These schematic diagrams are used as input for the Spice simulation and so the theoretical curves are obtained. It can be seen not only the RC filter response is simulated but also the whole ensemble of input matching networks, attenuators and signal source impedances. The theoretical curves are compared against the experimental results (taken as display readouts) to draw the plots, represented under the respective schematics. Actually, these are the amplitude and phase responses of the circuit. Different combinations of resistor/capacitor values have been evaluated: 100Ω/1nF, 1kΩ/100pF for the 1dB/20dB attenuators and 47Ω/82pF, 100Ω/360pF for the 20dB/20dB attenuators. The experimental curves (squares) show good coincidence with the theoretical curves (diamonds). The deviations at

Figure 9a: Experimental results with a simple 1st order filter set-up with attenuators 1dB/20dB









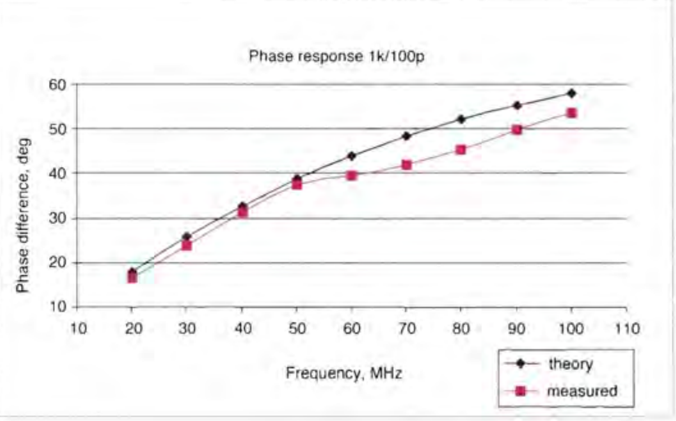
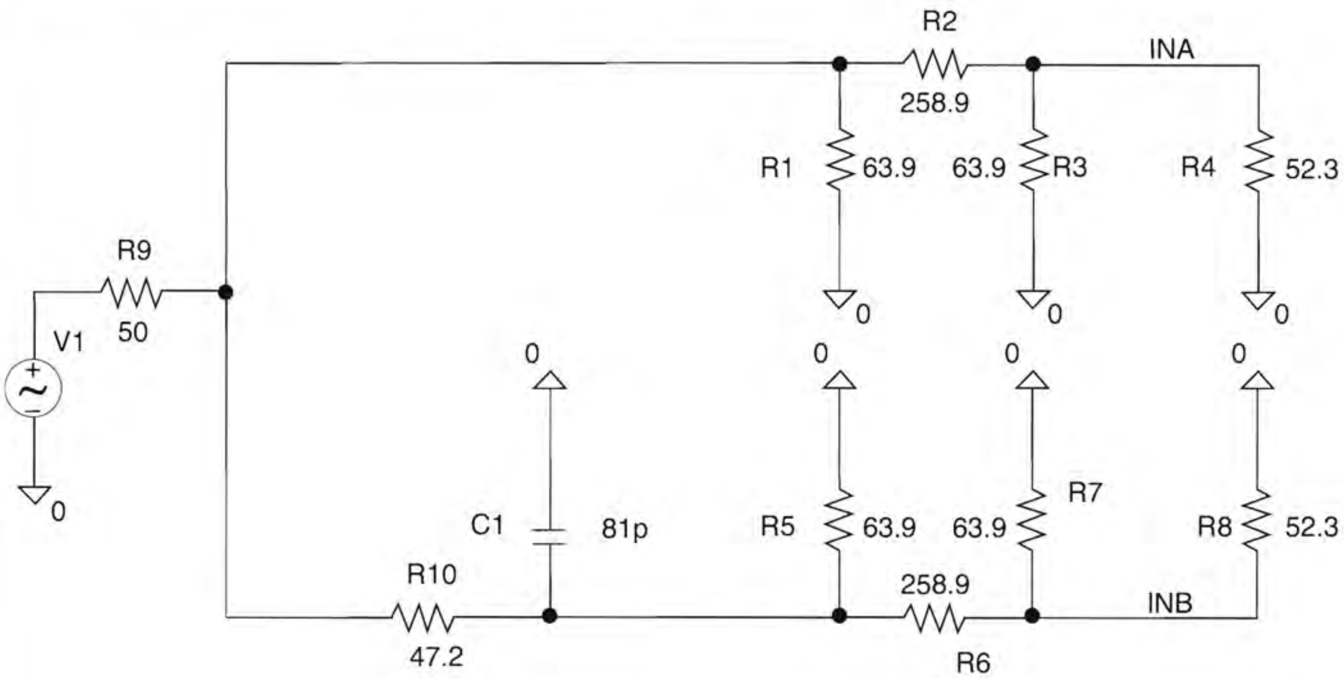
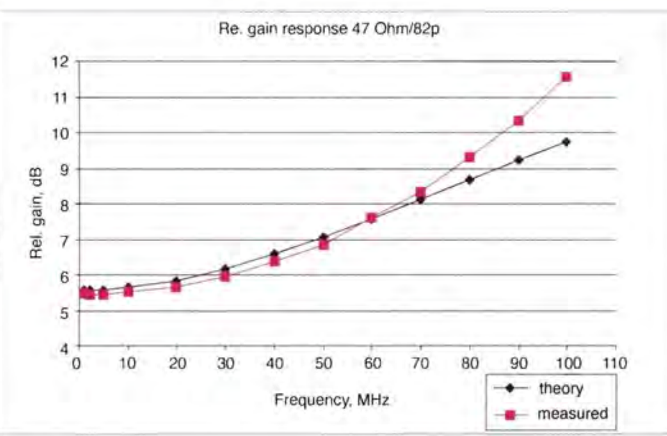
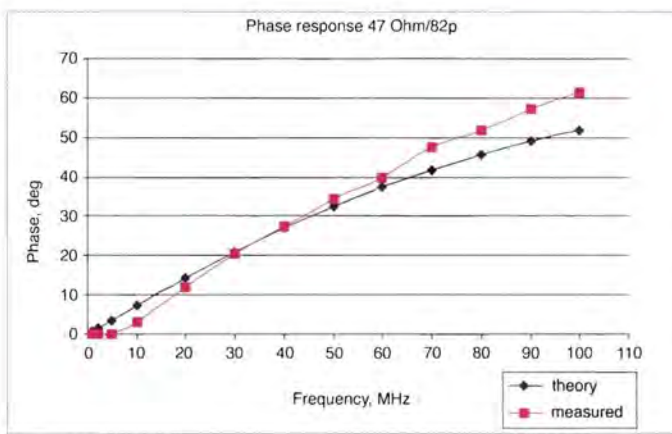
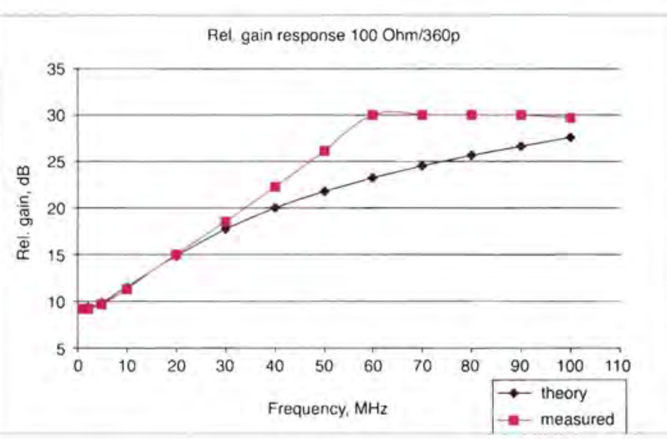


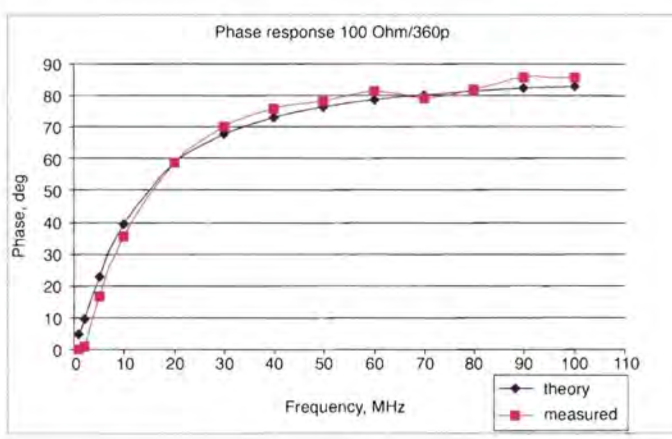
Figure 9b: Experimental results with a simple 1st order filter set-up with attenuators 20dB/20dB











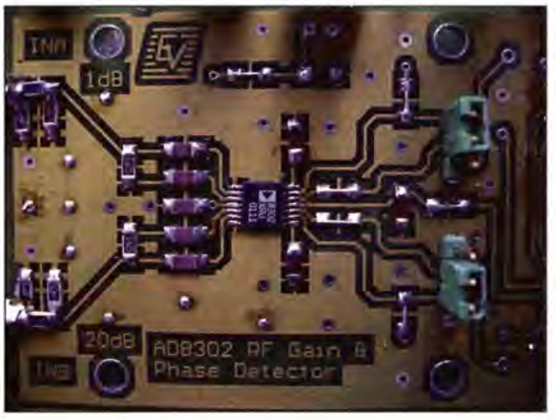


Figure 10a: The gain and phase detector IC AD8302

Figure 10b: VRC8302 prototype measurement system

Figure 10c: VRC8302 powered up

Figure 10d: VRC8302 powered up

higher frequencies can be explained with the component tolerances and impedance mismatch problems.

Possible applications

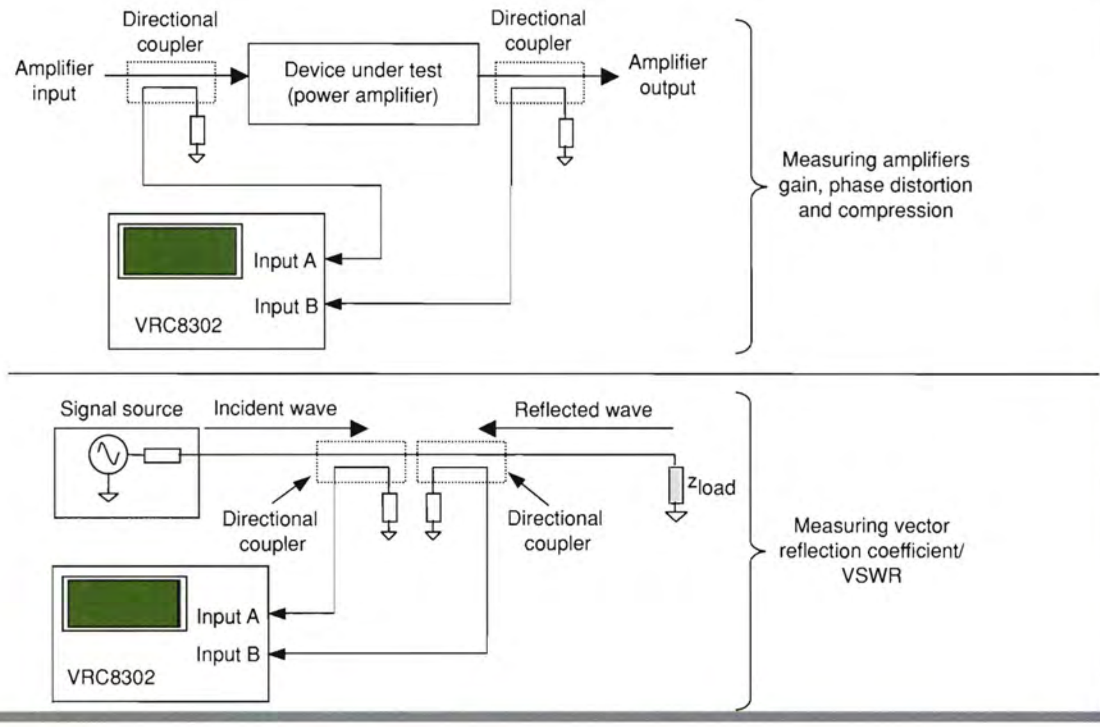
I intended to use the VRC8302 as a vector reflection coefficient (VRC) measurement system. Later, I realised that what I have build was much more universal and only the original name remained. The system has two inputs, A and B, what will be connected to them depends on the application, only the connectors may need a change depending on the frequency range of interest. **Figure 11** gives examples of the two most common tasks, where the VRC8302 can be helpful.

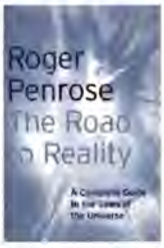
The first one is measuring the gain and phase between input and output of an unknown Device Under Test (DUT) – it may be a power amplifier to be used in 2G, 2.5G and 3G mobile communication systems. The new mobile systems replacing the "plain old" GSM have very stringent requirements on linearity of the power amplifiers in the base station. If the input signal is clipped (because the input is too strong and the amplifier enters the nonlinear region of its transfer function) this will lead to AM-to-AM distortion, gain-to-phase distortion and nonlinearity, in general. Unfortunately, the new systems (such as EDGE – Enhanced Data rate for GSM Evolution – for example) have abandoned the good and foolproof concept of constant envelope signals (Minimum Gaussian Shift Keying) so the output power cannot be predicted and brought into a safe dynamic range. Feedbacks have to be deployed to prevent distortion and compression of the signal and to improve the efficiency of the linear power amplifiers (which is low in class A and class AB operation). To apply the feedback you need a measurement of the gain and the phase relation between input and output – and this is exactly what the VRC8302 does. Part of the signal at input/output is split from the main path to the VRC8302 with directional couplers (usually 20dB devices). The two signals at inputs A and B have to be brought to a "safe" optimal power value of -30dBm as discussed earlier. This is done with the onboard attenuators. The attenuation values must be optimised and the difference between them should be equal the gain of the DUT.

The second case depicted in Figure 11 describes a set-up for measuring the vector reflection coefficient of a transmission line. As the sink impedance of a line does not exactly match the source and line impedances, part of the energy is reflected back from the load towards source. According to the amount of the mismatch and its direction, the reflected signal has different amplitude and phase, which can be evaluated against the original incident wave. Here again, the VRC8302 can be helpful comparing signals from incident and reflected wave – the magnitude ratio corresponds in this case to the well-known quantity Return Loss (RL). The Voltage Standing Wave Ratio (VSWR) of a transmission line under test can be easily estimated with the help of the RL-value – the last issue is of primary importance in high-speed design and communication systems. The two directional couplers serve here the same purpose as in the previous example. They bring the signals to the optimal -30dBm value and their attenuation ratio can be calculated estimating the incident power value and the expected return losses.

These are only two possible ways to put the project into practice. They are surely more possible set ups for evaluating communication systems parameters and performance.

Figure 11:
Applications of the VRC8302 gain and phase measurement system





The Road to Reality

By Roger Penrose

Jonathan Cape

Copies of this book sold quickly when it was put on sale recently in Oxford, which is not surprising, considering the impact *'The Emperor's New Mind'* made when it was released in 1989.

One of Roger's main concerns in *'The Emperor's New Mind'* was to quell some of the hype being put about by strong supporters of artificial intelligence, but he also took the opportunity of introducing his belief in *'Objective Reduction'*, a process that must occur in quantum dynamics for which various interpretations have been postulated:

a) Copenhagen (Bohr);
b) Many worlds (parallel universes), (Everett III);
c) Environmental decoherence;
d) Consistent histories (Gell-Mann/Hartle);
e) Pilot wave (deBroglie, Bohm/Hiley).

The main objective of *'The Road to Reality'*, as far as I can ascertain, is to refute (a), (b), (c) and (d) and, to this end, he's had to introduce a lot of mathematics (Chapters 1 to 16, nearly 400 pages of it), much of which is mind-numbing.

Penrose believes that (e) is the "clearest ontology... although it does not address the measurement paradox", which is why he proposes in *'Objective Reduction'*, occurring in twister space projective null (PN) (Chapters 32 and 33), a formulation that has many advantages. For example, a light ray in Minkowski space M maps to a point in PN, so we can use this to explain the Catt anomaly; charge propagation 'in' two parallel conductors maps to a two-point metric (width) in PN – there is no length. It's only a suggestion – my suggestion, but some *Electronics World* (EW) readers might like to 'play around' with it.

Chapters 17 to 33 deal with much of the physics involved, quantum and relativistic, which *EW* readers are familiar with, for example, 'Zitterbewegung', the zig-zag picture of the electron, which was discussed in *Electronics World's* September 2004 issue on pages 50-51; and 'leakage', discussed in *Electronics World's* December 2004 issue on pages 50-51); p628 et seq and p905 in *'The Road to Reality'*, respectively. Magnetic field 'lines' and conduction holes in semiconductors, which readers have asked about, are similarly dealt with – but there's a lot more.

This tome is a sine qua non for serious scholars of science – "green fuse to drive the red blood" (Dylan).

Tony Callegari

TOP 10 TIPS

VINTAGE ELECTRONICS REPAIR

▸▸ Don't ever be tempted to "plug in and see", always use a 40W bulb as a lamp limiter or run the system up on a Variac; having first replaced the mains input filter cap with a class X type and renewed the audio coupling cap. It is also useful to have left the set in a warm dry place for a week or so before working on it to fully dry out wound components. Impatience at this stage can result in the loss of a part that will be difficult to replace.

▸▸ Varnish sealed nuts and bolts can be released with the heat from a soldering iron.

▸▸ Valves with a damaged external screening coating can be restored by wrapping in kitchen foil and binding tightly with copper wire at the glass/base interface. This wire should then be soldered to the top of the screen pin on the valve base. On older valves it is worthwhile re-flowing the solder on the valve pins, as this often reduces noise and crackles. A small spot of contact lubricant on the pins themselves will also help.

▸▸ Top caps that have become detached can be re-fixed by using a metal loaded (PCB repair) epoxy to connect a new wire to the stub where it passes through the glass. (The glass can be carefully ground back with a Dremel to expose more wire if necessary). After curing the cap itself can be secured with epoxy, not superglue as epoxy has more "give" and is not likely to fail at valve envelope temperatures.

▸▸ Valves that have lost their markings can often be "read" by putting them in the freezer for 30 minutes. On removal, when viewed in a strong light it is then possible to make out the type number in the condensation.

▸▸ Old varnished sleeving can often become sticky and partially conductive. It can be replaced by modern, woven glass fibre sleeving that has been sprayed with a suitable car colour.

▸▸ Old electrolytic capacitors will often reform satisfactorily, but may have poor performance at higher frequencies, leading to instability in the set. Fitting a 0.1μF cap across the electrolytic cures this problem.

▸▸ Many of the older sets used AC/DC techniques and had a potentially live chassis. It is essential to make sure they are connected correctly with the chassis at low potential. There can still be problems in modern houses with RCD's tripping due to neutral/earth currents when test equipment is connected. This can be overcome by use of an isolation transformer. The "old" and not recommended method was to isolate the test equipment earth of the signal generator or scope with a switch fitted to the mains lead.

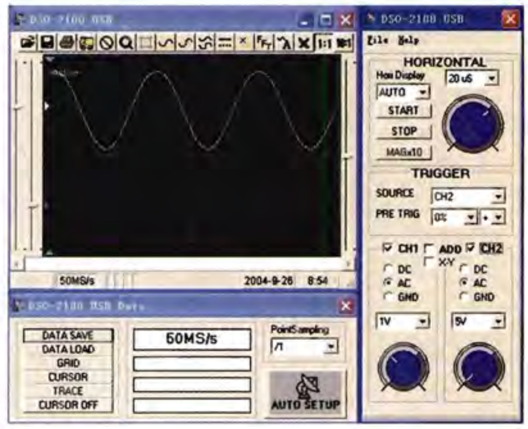
▸▸ When carrying analogue meters to different jobs always set them to the highest DC current range. This places a low value damping resistor across the meter movement and prevents it swinging wildly about, with possible damage. Always start on the highest range and work down when making measurements.

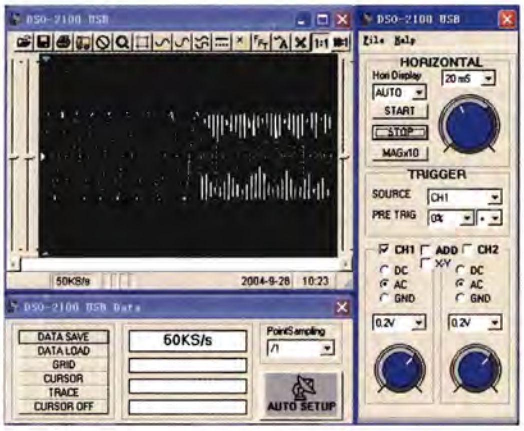
▸▸ When your set is finally completed and working well give it a three- to five-hour "soak" test with a low value mains fuse fitted (say 1A) and monitor frequently as there are bound to be faults and component breakdowns you have missed.

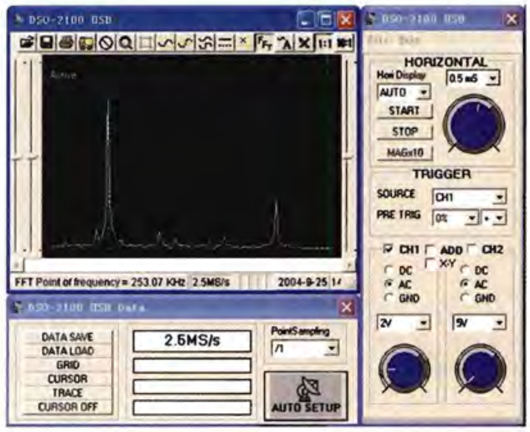
Ed Dinning from Newcastle, UK, sent in this month's Top Ten Tips.

If you'd like to send us your top five or top ten tips on any subject you like, please write to the Editor at **EWadmin@highburybiz.com**


DSO-2100 USB







Uncertainty, uncertainty

By Mike Brookes

Some €2m has been spent recently by the European Union on the 'Reflex Project' to determine whether or not there are dangerous effects to health caused by long term exposure to radiation. The Reflex project, which looked at subjects as diverse as power line emissions and mobile phones, examined both high and low frequency radiation. It stated that, "electromagnetic radiation of low and high frequencies is able to generate a genotoxic effect on certain but not all types of cells, and is also able to change the function of certain genes, activating and de-activating them".

This is not the usual studied effect, such as of heating that causes physical damage, but a much more sinister problem relating to cell function, at levels of radiation not usually considered hazardous. The results of the Reflex Project study are not conclusive; there were differences in types of experimental equipment used for the project and of the results obtained. However, the implication that there is potential for demonstrable health effects is not helpful to developers of radio systems in the current climate of litigation.

> *"This is not the usual studied effect, such as of heating that causes physical damage, but a much more sinister problem"*

Fifteen years ago, the nearest exposure most people got to radiation, other than excess sunshine, was to the broadcast devices – one wonders about the effect to members of the public living within close proximity to megawatt transmitters like Crystal Palace. But, with the advent of mobile phones and the increasing deployment of short range devices (SRD), the situation has changed radically.

The SRD industry has reacted. After a slow start, it revolutionised its product manufacturing and unit pricing to the extent where wide scale domestic installations at affordable prices will lead to wireless – or radiation based pieces of equipment becoming as ubiquitous as the mobile phone – over a wide range of operating frequencies.

Unit prices have fallen so much that the Holy Grail of true home automation is now achievable, which will lead to increasing levels of exposure to electromagnetic radiation throughout the spectrum from 100kHz to 2.4GHz.

In the car, there are even more wireless devices covering duties like engine management, telematics, interactive information, radar monitoring etc.

Individually, most of these devices have extremely low radiation levels, typically 1-10mW or 1/200 the level of a mobile phone handset, but cumulatively, and over a vast spectrum range, will they expose the SRD industry to increased litigation?

The industry would be wise to pre-empt the consequences; which may otherwise prove catastrophic.

The LPRA (Low Power Radio Association) is a European trade body that represents manufacturers and users of short range devices (SRDs).

It is active in the production of SRD Radio standards and regulations.

Mike Brookes is LPRA's chairman.

Printer port based, low-cost, multi-channel monitoring system

Monitoring a number of analogue signals is an important task in industrial process controls and R&D experimental setups. Most of the PC-based monitoring systems used for such purposes are based on either general purpose or tailor-made data acquisition cards. However, these cards are often costly and are plug-in type, requiring opening of the PC for their configuration and maintainance.

To avoid this, in most of the situations, one can build a simple and inexpensive PC-based, multi-channel, analogue monitoring system by using generally available components and printer port of a PC as shown in **Figure1**.

The printer port based monitoring system can measure up to eight analogue signals. One of many possible applications for such a system is in an ion beam implanter (for which the present design was originally developed), where analogue signals (like ion beam current in the nA to mA range, high voltage and vacuum level that is DC or low frequency AC with an amplitude of 0V to 5V) are monitored.

As seen in the figure, the system is made of an 8:1 analogue multiplexer (IC1, DG508), a 12-bit serial ADC (IC2, MAX187) and optical coupling networks (IC3-IC8, 6N136).

The ADC is an 8-pin device that is self-contained and has useful features like on-board reference, built-in S/H, low power consumption (10µA) and low conversion times (8-10µs).

The signal conditioning circuits are required for interfacing between the multiplexer and the systems whose outputs are the monitoring signals. The basic functions of signal conditioners (like signal amplification, signal/noise filtering and impedance transformation) are designed so that all the channel signals applied to the ADC through the multiplexer match its full-scale range of 0V to 4.096V.

The optical coupling networks provide electrical isolation so that the PC is protected from any possible high voltages that may come from the systems being monitored. The PC monitors these analogue signals through its printer port. In this design, $D_0...D_2$ output lines of the data port (@0x378 address of the printer port) are used as address input to the multiplexer through IC3...IC5, while $D_3...D_4$ lines are used as SCLK and /CS inputs to the ADC. The digital representation of the analogue signal, or the serial digital output data of the ADC, is read through /error input of STATUS port @0x379 address.

Development

Development of monitoring software for this system can be done in any of the higher level languages like C, BASIC, PASCAL. However, for easy and quick development and in tune with ever increased usage of graphical programming like LabVIEW in industries, a LabVIEW-based monitoring Virtual Instrument (VI) Program – 8Chmon – was used. In this program, the 8-channel analogue signal monitoring is carried out as follows. Initially a data of 0x00 is set on $D_0...D_2$ lines of the data port to apply the analogue signal at channel 0 of the multiplexer to the ADC, while the signals /CS and SCLK are set at logic 1 and logic 0, respectively.

After a delay of 1ms, this program calls another sub VI, 8chMAX187.VI, which controls the complete process of analogue to digital conversion and acquisition of the digital data. It first initiates analogue to digital conversion by pulling /CS low. Then, the PC continuously polls D_{out} of the ADC at /error input for detecting the end of conversion indicated by a low to high transition.

On detecting the end of conversion, the PC acquires the 12-bit serial digital data stored in the ADC, from MSB to LSB by serially clocking the SCLK input with 13 pulses and reading the D_{out} at every falling edge of the SCLK. The 12-bit serial data acquired is then related to the analogue input signal as per the following relationship, see the formula below.

The program displays the measured value on the channel 0 analogue meter in the front panel. Then it selects channel 1 by sending 0x01 and the process is repeated. Likewise, all the 8 channels are sequentially acquired and monitored.

Flexibility

This design is so flexible (and uses only few of I/O lines on the printer port) that the number of input channel can be easily increased to 16. It can be done by using an additional 8-channel multiplexer and one more data line of the printer port. By simple modifications in the software, the sampling rate can be easily varied. Since the data acquisition module is external to the PC, testing and trouble shooting is fast and easy, without any requirement for inner access of the PC.

This module can be used in a variety applications like PC-based, multi-channel virtual oscilloscope, monitoring of home automation signals etc. One can build the total system by spending less than $10, which makes it a really cost-effective solution.

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Materials Science Division,
Indira Gandhi Centre for
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India

$$\text{Measured Value (Volts)} = \frac{\text{(Decimal value of the 12 bit serial binary data)} * 4.096}{409}$$

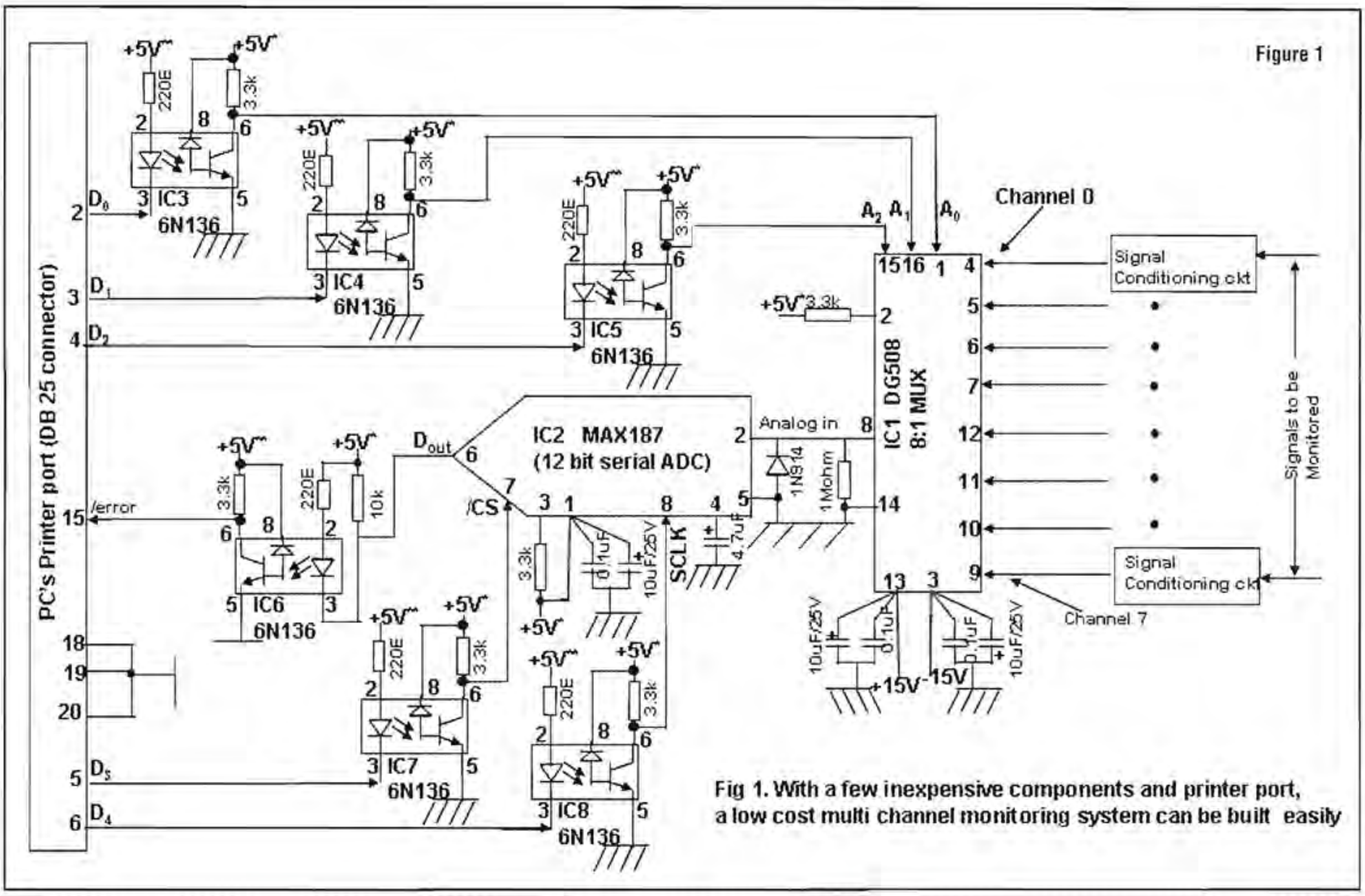
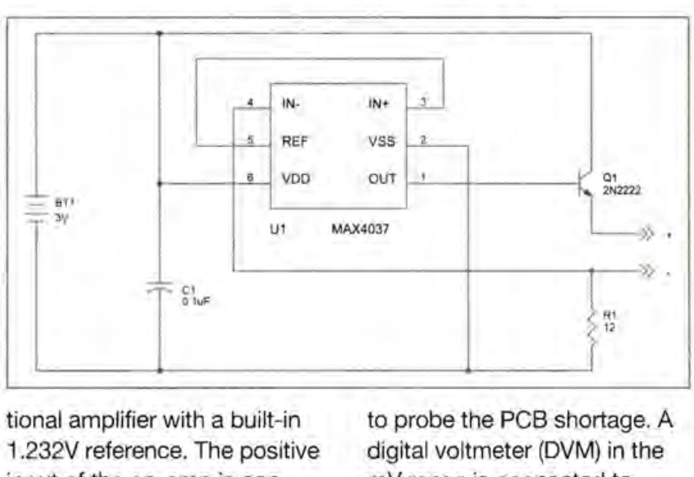


Fig 1. With a few inexpensive components and printer port, a low cost multi channel monitoring system can be built easily

Simple, portable milliohmmeter

It is not an easy task to find the exact location of a PCB trace shortage. A regular ohmmeter may not work simply because the measured resistance is too low. One way to solve the problem is to apply a fairly large current to the traces and use a milliohmmeter to measure the voltage across the traces. The shorting point will have the lowest measured voltage. Since the components have been installed on the board, the applied current source has to limit its open circuitry voltage in order to avoid damaging the parts.

The circuitry uses an extra low power op-amp to form a constant current source. MAX4037 is a single operational amplifier with a built-in 1.232V reference. The positive input of the op-amp is connected to the reference directly. The negative input is through a 12Ω resistor to ground. Output of the op-amp drives an NPN transistor to increase the driving current. Terminals '+' and '-' are used to probe the PCB shortage. A digital voltmeter (DVM) in the mV range is connected to these two terminals to get the milliohm reading.



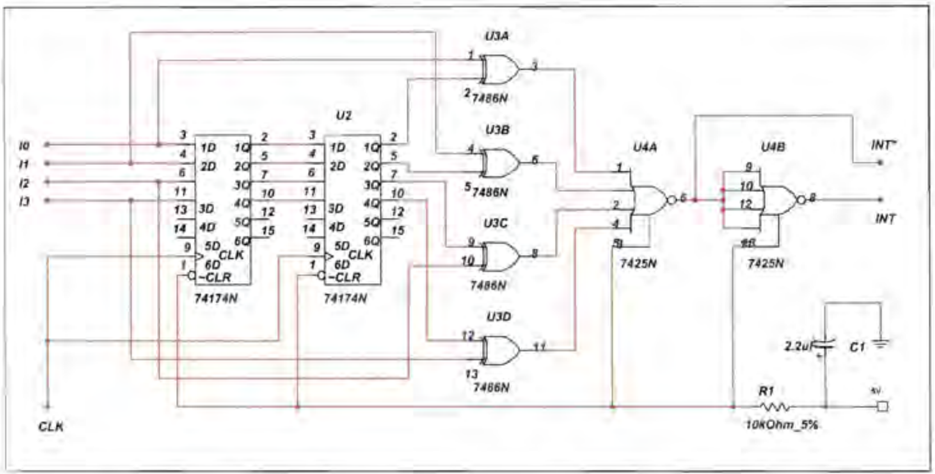
Assume the terminals '+' and '-' are shorted, Q1 provides a constant current because the voltage at R1 should be equal to the reference voltage. Since R1 is 12Ω, the current is about 100mA. As long as the op-amp is within linear operation range, a small resistance between terminal '+' and '-' will not change this constant current. In other words, the current goes through terminal '+' and '-' is always 100mA. Thus, 1mV DVM reading equals 0.01Ω. If 10mA constant current is desired, R1 needs to be 120Ω. The DVM reading will be 1mV=0.1Ω.

The circuit uses less 2µA current during stand-by. If two AAA batteries are used as power source, the battery will last a very long time, such that no power switch is required.

Yongping Xia
Torrance, USA

Interrupt multiplexer for microcontrollers

Frequently, microcontrollers in embedded systems are required to monitor several digital inputs but are equipped with only one external interrupt line. The circuit shown here can handle any number of inputs and will generate a single interrupt if one or more of the lines being monitored change their states. As given here, the circuit has been implemented with four 74 series TTL ICs. If power consumption is important then equivalent CMOS components could be substituted. This circuit could also be implemented in a programmable logic device in order to save space.



The circuit works by latching the current state of the monitored lines into a D type latch and then latching it again into a second D type latch. This historical state is then compared to the existing state on the lines by a set of exclusive OR gates and their outputs are summed by a NOR gate. The other NOR gate of the package has been used as an inverter to generate another polarity for the interrupt signal, just in case the microcontroller uses a positive going interrupt scheme. Double buffering of the input lines ensures that interrupts are not missed if the input lines toggle quickly. The interrupt pulses are between one and two clock time period long. The clock is the external system clock. Certain pins on the IC packages are wired to logic high through a 10kW resistor. The 2.2mF capacitor should be a tantalum type and serves to bypass power supply glitches from accidentally resetting the D latches.

Please note that power supply connections to the IC packages have been omitted for clarity of the schematic diagram.

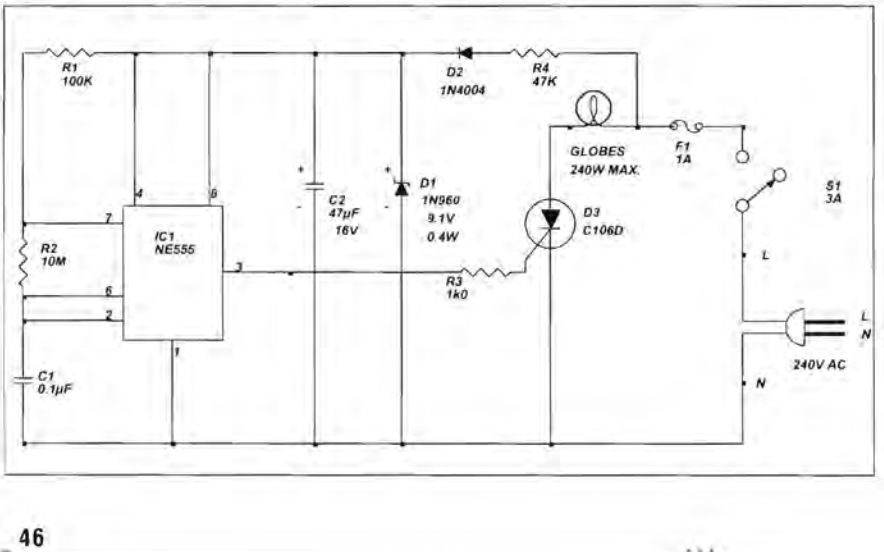
Dr Faiz Rahman
Department of Electronic and Electrical Engineering,
University of Glasgow,
UK

Mains powered globes flasher

The common Christmas and New Year flashing lights come with one thermal flasher globe, which switches the chain of globes on and off giving a flashing effect. As the thermal flasher globe is a semi-mechanical device, it tends to fail quite often and, usually, at the moment when you need it most. When the thermal flasher globe fails, the lights are either left completely 'on' (not flashing) or 'off'.

The rescue shown here is a solid state device that runs off the incoming 240V AC power without a mains transformer. Hence, it is highly reliable and consumes negligible power and can be built to fit into a compact box.

For safety reasons, a fuse F1 is used. IC1 is a NE555 timer. The timer is configured as an astable multivibrator. Its sequence (duty cycle) is derived from the values of R1, R2 and C1. The high R and small C are chosen as opposed to low R and high C is to effect miniaturisation, reliability and stability.



The power source for IC1 is fed from the AC mains via resistor R4 and rectifier diode D2. Zener diode D1 is used to maintain a stable 9V DC while capacitor C2 smoothes out the low level 50Hz ripple.

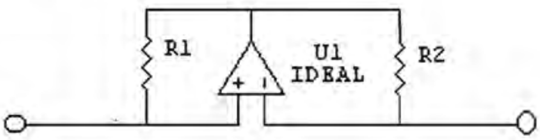
The output of IC1 triggers a sensitive gate SCR diode D3 via resistor R3.

The circuit will work only on resistive loads, and operates on half-wave of the 50Hz AC frequency. As a result, the globes are lit half their brightness. This is a simple way to reduce energy usage.

Michael Ong Yong Kin
City Beach,
Australia

Synthetic floating negative inductor using only two op-amps

Figure 1



Inverter

Figure 2

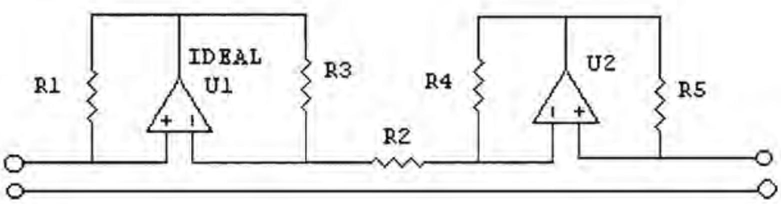


Figure 3

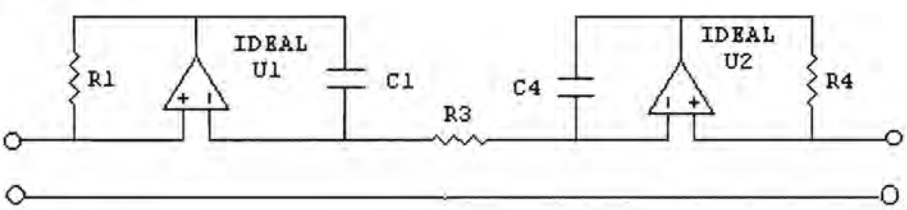
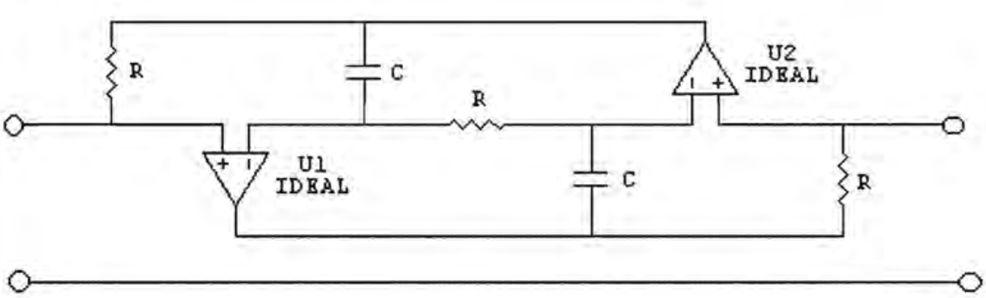


Figure 4



The end circuit represents a floating negative inductor using only two op-amps. It obviates use of GIC (General Impedance Converter) that requires more than four op-amps for the same purpose. It requires two matched capacitors and three matched resistors.

Figure 1: The given circuit represents a normal NIC (Negative Impedance Converter) design when R1=R2.

Figure 2: The NIC can be used to build a floating negative resistor, here when R1=R3 and R4=R5 the equivalent floating impedance is given by Z=-R2.

Figure 3: Replacing the inner resistances R3 and R4 with capacitor of capacitance C1=C4=C, and keeping R1=R4=R3=R gives us a transfer function for a negative floating inductor.

Stabilising the above circuit without changing its transfer function gives us **Figure 4.**

Saumitra Raj Mehrotra
New Delhi,
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Send new circuit ideas to:

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or email to:
ewcircuit@highburybiz.com

Flowing energy

Congratulations on the bright new design of Electronics World.

On the subject of Ian Hickman's article on the "Catt Anomaly", I think it better to praise positive contributions than to get bogged down in politics, as readers of EW will usually want to escape from politics.

Hickman explains how conductors physically charge up when connected to battery terminals. Connect a wire to the positive terminal and the electrons are attracted towards the battery, leaving an imbalance since then there are more protons than electrons per unit length of wire (so it becomes positive). Connecting a wire to the negative terminal of a battery adds extra electrons into the wire, so it gains a net negative charge.

It is clear that when you connect a pair of wires to a battery, they form a capacitor, charging up by energy flowing along them at the speed of light for the dielectric between the wires (plastic or vacuum). Maxwell postulated displacement current as flowing across the gap between a pair of capacitor plates, whereas Walton and Catt in Wireless World showed that for charge to spread along the capacitor plates at light speed it must travel at 90 degree to displacement current. A transmission line therefore behaves as a capacitor, as does a radio system.

Energy must flow across the gap between the capacitor plates while the capacitor charges up, in order for energy to be available throughout the circuit during this process. Maxwell did not know of the Walton-Catt argument, so in his "theory" of radio waves, varying electric fields cause varying magnetic fields in a cycle allowing propagation. However, the charging and discharging of a capacitor transmits energy through the vacuum between capacitor plates like radio. Catt points out that when energy is moving along a capacitor plate, it has a magnetic field. Hence, really understanding radio requires Catt's work. Sadly, Catt rejects such physical application.

Maxwell's empirical formula for displacement current (current equals permittivity of dielectric multiplied rate of change of electric field between plates) correctly models what we measure, but it does not explain what is going on. An stationary electron spins at light speed, and a net flow of energy occurs along electric field lines at light speed as a capacitor charges or discharges. In addition, energy must flow along field lines to deliver momentum and force. Modern physics speculations on force mechanisms do not disprove the facts observed in experiments, no matter how much is published about the accuracy of QED in calculating the electron's magnetism.

The Walton-Catt model explains why light speed energy remains in a charged capacitor: the charge energy reciprocates up and down each plate at light speed. Contrary to some of Catt's statements, energy also travels between the plates while the capacitor is either charging or discharging. D. Di Mario first suggested the black hole electron in EW (Feb 93 p114).

Electromagnetic energy such as a gamma ray is a varying electromagnetic field, half positive and half negative. Pair production is an absorption process that occurs when a gamma ray from cobalt-60 passes near a lead nucleus, giving rise to an electron and positron (positive electron). The conservation of momentum implies that the light speed of the energy is maintained in the spins of each particle, which is trapped by gravity into a loop (black hole). Ludvik Kostro first pointed out in EW (March 88 p238) that 15 years after special relativity, Einstein at Leyden University finally brought back a continuous ether (space-time continuum) to explain gravity for general relativity.

Nigel Cook
Colchester
UK

To test we must

I fully agree with Phil Dennis (Letters, December 2004, p54) about the need for objective testing of subjective claims about the audibility of distortion. The Boston Audio Society has recently conducted ABX tests (the practical implementation of the double blind test) of SACD quality versus CD quality.

For further information on the ABX test, see www.bostonaudiosociety.org.

Dennis says that, "frequency response infers the transient response". This is only true for minimum phase systems. In general, a correct statement would be "knowledge of frequency response and phase response implies (not infers) transient response and vice versa".

David Hadaway
New Hampshire
USA

Operation beyond spec?

With regard to the query by K. Tourle over the Linear Phase Shifter on page 20 in Electronics World, September 2004 issue.

Mr Tourle is attempting to operate this circuit beyond the specification on page 20, which clearly states that the lowest operating frequency is 10Hz. By attempting to operate at 1Hz, generating the 900 vector, on page 21, is impossible, because the balance potentiometer cannot equal the reactance of the lowest range capacitor, a lower range would be required and fitting another range capacitor of 47μF, is not a practical solution, because non-electrolytic capacitors are of enormous size and they have a poor power-factor, i.e. they leak.

A more suitable modification is to use the 10 50000Ω and label this 1-10Hz balance. Also label the new switch 1-10Hz range.

(See 'Circuit requirements' on page 21, and 'Measuring an unknown waveform', on page 22.)

The results he has experienced at 10Hz suggest that adjusting the frequency balance is again in error. I wish to point out that accuracy in the setting of the frequency balance potentiometer is absolutely essential to achieve a 900 vector.

I have discovered that even at 10Hz, my modern cheap multi-meter cannot cope. The digital voltmeter (DVM) originally used must have had a much greater range. To overcome this, rectify and smooth the BAL output and set the DVM to read DC VOLTS.

I have included a rectifier/filter circuit that can operate at the lower frequencies.

Due to the long time constant used, patience is required while adjusting the balance potentiometer. Alternatively, an oscilloscope with vertical sensitivity set to the maximum, which allows the setting of the shift control to view the tip of the waveform, can be used to adjust the balance control for equality of waveform size, for each position of the balance switch.

Mr Tourle also talks of percentage settings of the Output Pot. I find this confusing, because the arrangement gives a dial that reads directly in degrees i.e. 0 to 90.

One final comment that I feel could be useful is, with an oscilloscope, check all four quadrant vectors for high frequency oscillation.

If oscillation is the case, then introduce a 220Ω resistor, directly to the output of each quadrant amplifier i.e. directly to the amplifier out pin as shown at IC3a. This is an advisable change, even if oscillation is not observed, because connecting cables or other apparatus to the outputs, can cause spurious oscillations without you knowing.

I trust these comments allow Mr Tourle some success.

Robert Watt
Edinburg, UK

'Cube' is nowhere near a 'Conundrum'

Einstein said: "Things should be made as simple as possible, but not simpler". 'The cube' should never have been advertised as a 'complicated' problem.

To solve the cube problem you don't need any network theory or Kirchoff's Laws, all you need is one simple principle. "If there is never any potential difference between two points in a circuit, then no current ever flows, so those points can be connected or disconnected without any effect."

For Example:

Figure 1: If R1 = R and R3 = R4, link can be cut without effect.

So going to that cube: what is R between A and B? See **Figure 2**.

By symmetry, the two links can be cut because there is no potential difference across them. The circuit now reduces to two identical circuits in parallel. See **Figure 3**.

So, just work on one of the two. See **Figure4**.

There's no potential difference between Q and R or S and T, so cut links. The cube reduces to six S or resistors in parallel.

$1/R=1/5+1/5+1/5+1/5+1/5+1/5 = 5/6$ therefore $R=5/6$

The question proposed by Ian Cuthbert in September 2004 is also too easy. Along the edge of the cube it is as in **Figure 5**. And the, that is equal to **Figure 6**.You then have two 14/5 R in parallel = 14/10 R. In parallel with R, which is equal to:

$(Rx14/10\ R) / (R + 14/10\ R) = (14/10\ R2) / (24/10\ R) = 14/24\ R = 7/12\ R$ Same result as in Ian's answer.

Figure 1

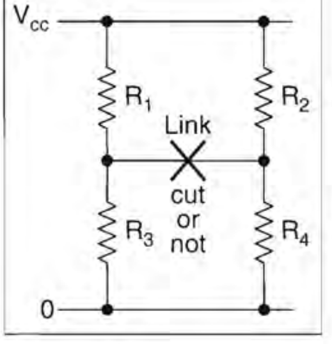


Figure 2

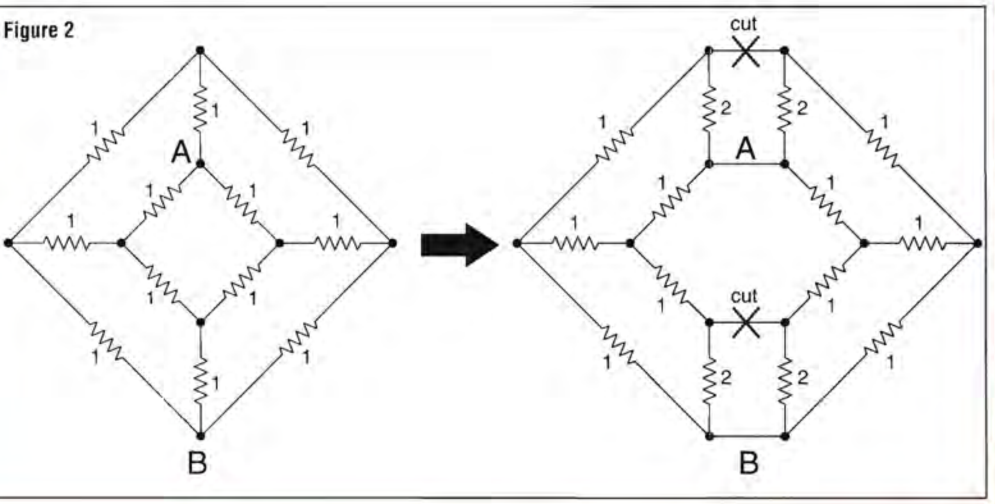


Figure 3

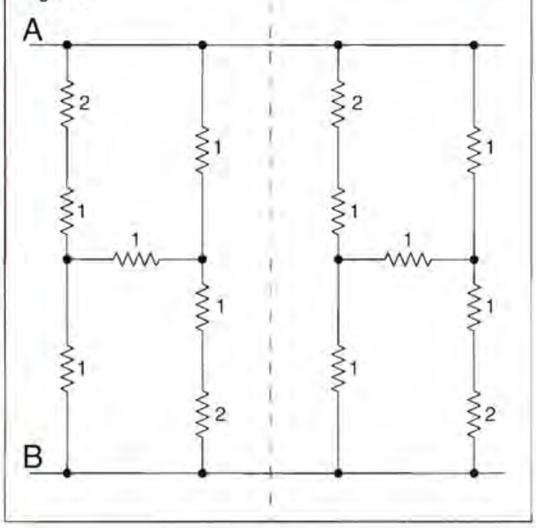


Figure 4

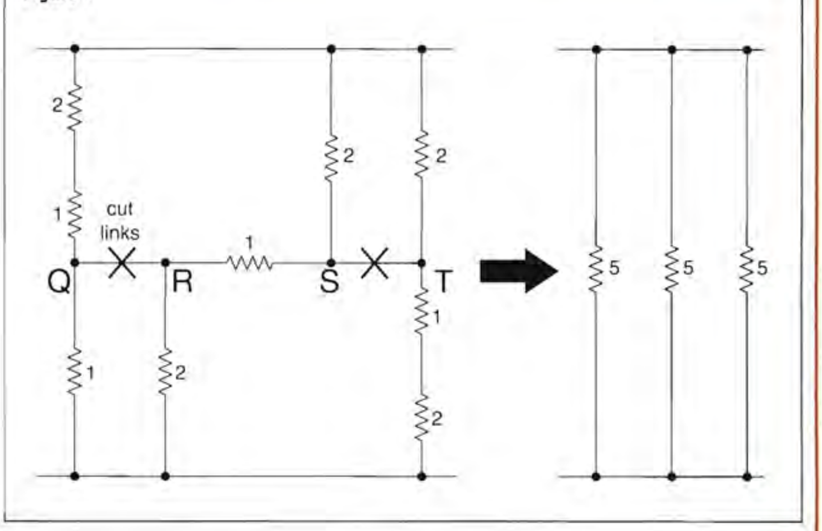


Figure 5

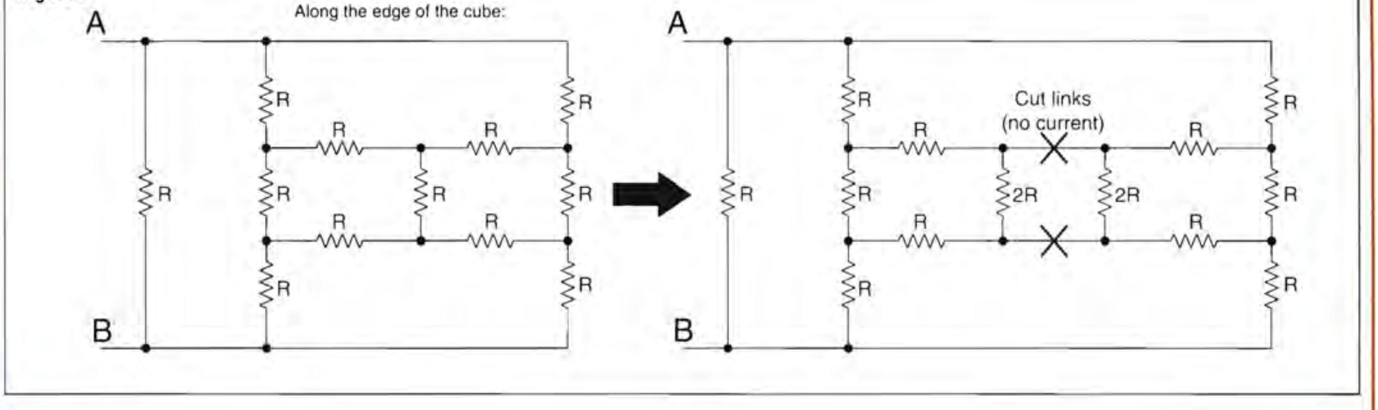
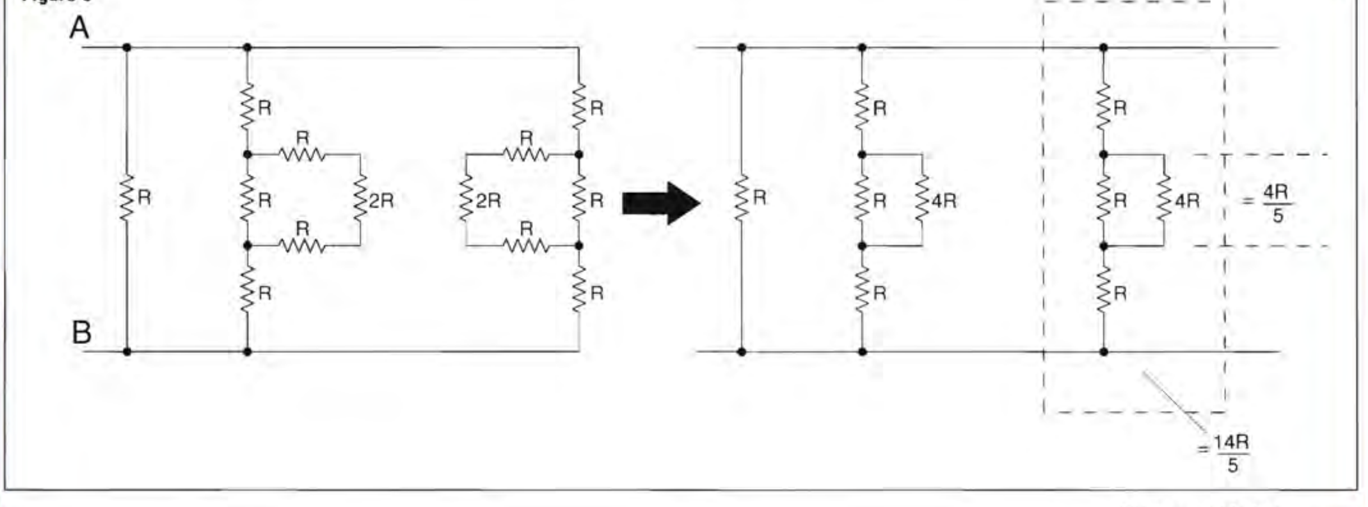


Figure 6



Dr Hugo Holden
Queensland
Australia

B2Spice version goes up a notch

Version 5 of the B2Spice package is now available from RD Research.

After a development of two years, the company has made extensive enhancements to the software's simulation capabilities, which now include a "scenario editor" that will allow users to sweep any parameter for any component. In addition, the user interface has been redesigned for easier and quicker design. There's a new parts browser, which allows users to navigate through a pop-up menu tree structure with great ease.

Amongst v5's feature rich enhancements is a "live circuit" feature that will allow users to modify components while a simulation is running and see the effects immediately. Parameter sweeping of any circuit/program/model/device parameter is available for every test, as is Monte Carlo analysis. A parts bin to store most frequently used parts is provided along with interactive "live" components such as switches, buttons, LEDs and others.

A new "circuit wizard" feature will auto-generate many circuit designs either as a new circuit or as a sub-circuit part that can plug into an existing circuit.

"We are so confident that B2 Spice version 5 will impress users that we are offering it on a full 30 day evaluation basis," said Paul Williamson, managing director of RD Research.

www.spice-software.com

Small coax cables get own debur tool

Times Microwave Systems has recently introduced the DBT-02 (3190-1706) debur tool for use with the smaller range of LMR low loss coaxial cables. The new tool chamfers the centre conductor to facilitate attachment of the centre pin contact of both EZ no-solder as well as solder-type connectors. The tool can be used with all LMR-195, 200 (50Ω only), 240, 300 cables and connectors as well as LMR-400-75.

The tool is made from case-hardened carbon steel for long service life. The DBT-02 (3190-1706) debur tool is available from stock.

www.timesmicrowave.com

High accuracy pressure sensor

Sensor and switches company Polaron Components has just announced the availability of its P10000 series high accuracy pressure sensor based on a highly stable piezoresistive silicon chip technology.

The sensor series can achieve accuracy of better than +/- 0.25% full-scale pressure over a wide temperature range.

The device is suitable for an extensive range of test applications where stability of reading, premium accuracy and high dynamic response are required. It is available in pressure ranges from 1 to 700 bar, with 5V, 10V or 4-20mA outputs.

www.polaron.co.uk/components

FPGA board with USB 2.0 interface

Orange Tree Technologies announced ZestSC1, a desktop FPGA development board with high speed USB 2.0 host computer interface. It is intended for FPGA development work, training and education, and applications such as data acquisition, control, DSP and image processing.

The interface runs at 480Mbits/s and achieves a sustained bandwidth of over 40MB/s using the streaming interface of the dedicated on-board USB hardware engine. The FPGA is configured from the host computer over USB and it can be changed on the fly.

The FPGA used is Xilinx's Spartan-3 consisting of a million system gates, including 24 hardware multipliers and 432kbits of RAM. There's also 8MB of synchronous SRAM on the board.

There are 49 pins of user I/O that connect directly to the FPGA, providing both single-ended (LVTTL and LVCMOS) and differential (LVDS) interfaces for data acquisition and control. The header has 5V, 3V3 and ground pins to power a daughter card plugged into it for applications such as video in/out and ADC/DAC. ZestSC1 could, for example, be used as a bridge between USB and a parallel interface such as PCI or GPIB.

www.orangetreetech.com

MPEG-4 aacPlus v2 for Equator BSP-15 processors

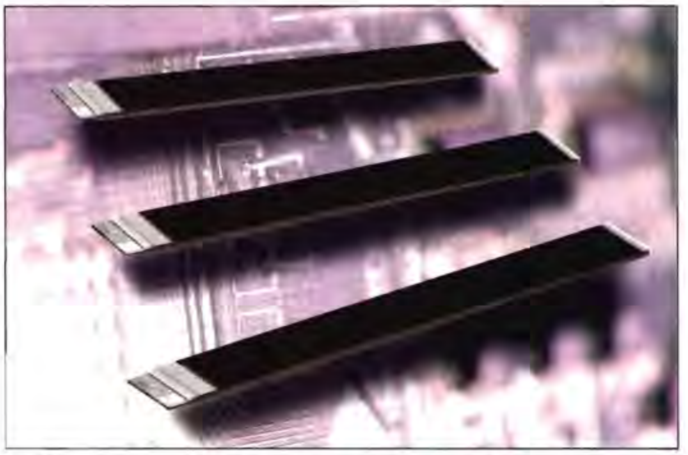
Equator Technologies announced the availability of Coding Technologies MPEG-4 aacPlus v2 codec on Equator's BSP-15 processor. Device makers and ODMs using BSP-15 and Equator reference platforms, like the Babelfish Hardware Platform, can immediately take advantage of aacPlus v2 for digital media adaptors, set-top boxes and personal video recorders.

The addition of aacPlus to the BSP-15 platform allows device makers to access important standards like DVB and DVD. DVB is a key standard globally for digital television broadcasting. Within DVB, aacPlus is a core MPEG format and is the required audio format for DVB over IP (used in DSL TV).

Also, aacPlus is an enabling factor for BSP-15 digital media adapter products to play back content from the growing number of mobile download and Internet streaming services from vendors like America Online and Musiwave, including content distributed in the new DVD compressed audio format.

"Our BSP-15 processor and manufacturing ready reference platforms are the fast path to create high quality digital media adaptors, set-top boxes and PVRs," said John O'Donnell, vice president and CTO of Equator Technologies.

www.codingtechnologies.com
www.equator.com



Piezo bimorph offers improved performance

Morgan Electro Ceramics has developed a new piezo bimorph (bender) for manufacturers in the electronics industry. The bimorph uses a carbon fibre instead of the traditional metal inner layer. This allows it to provide greater deflection and increased force, hence improving performance and reliability by 20-30%. A safety electrode has also been fitted that guarantees operation in severe applications where the piezo plates are stretched to the limits of breaking.

A piezo bimorph consists of two active piezo plates separated by an inactive inner layer. By electrically driving one of the two piezo-plates to expand, the whole component bends providing an active component that can be used in a variety of applications. Unlike electrical coils that are still used in most of these applications, the bimorphs do not create an electric field and therefore ensure a distortion-free environment.

The bimorph is available in a range of sizes, such as length of between 15mm and 45mm and width of between 2mm and15mm.

www.morganelectroceramics.com

Ultra low-power hi-def graphics processor

New DeltaChromeT S8 ULP from S3 Graphics delivers a full hi-def DirectX 9.0 capability with no need for a fan or heatsink. This is an ultra low-power graphics processor for silent desktop PC systems, and gaming and entertainment devices. Operating at under 2.5W core power while running 3D applications, DeltaChrome S8 ULP uses less than 50% of the average power consumption of popular graphics card GPUs and is defining a new class of ultra low power graphics.

The device is based on an 8 Pixel Shader pipeline. Its HDTV component video output has a resolution from 480i to 1080p.
System builders can integrate advanced DirectX 9.0 graphics and enhanced media playback in small custom chassis and specialised applications not possible until now. Systems requiring always on, full time operation will benefit from the lower total system power usage, completely silent operation and higher reliability due to the absence of any mechanical cooling for the graphics processor.

www.s3graphics.com

Remote coverage 2GHz digital microwave system

New Zealand based firm 4RF Communications has introduced a new 2GHz variant of its Aprisa XE digital microwave radio transmission system. The new radio allows network operators to expand high-quality communications coverage and capacity to remote and rural enterprises and consumers.

The system makes optimum use of the licensed 2GHz (1.9-2.7GHz) point-to-point frequency band, enabling the extension of services further than is achievable with current analogue or higher-frequency digital alternatives. It offers robust, spectrum-efficient transmission over distances of above 100km in a single link, in difficult terrain and other areas where wired infrastructure is not viable.

Typical applications include medium-capacity linking for mobile and broadband backhaul, ADSL and Ethernet extension, PSTN trunking, broadband wireless access, private mobile radio and remote monitoring and control applications for utility networks.

The new Aprisa 2GHz variant supports all the current bandwidths ranging from 250kHz to 3.5MHz and capacities up to 17Mbps (8E1).

"Spectrum is a finite resource: with Aprisa 2GHz system customers can make the best use of it," said Grant Dow, 4RF Communications CEO.

www.4rf.com

16kbit SPI targets telematics applications

Ramtron announced its 16kbit Serial Peripheral Interface (SPI) non-volatile RAM – the FM25L16 – that operates at 3V and runs at up to 20MHz. It is offered in a lead-free DFN (dual flat no-lead) package with dimensions of 3x6.4x0.75mm. The FM25L16 is designed to fit into compact telematics and car infotainment systems with limited available board space. It is footprint-compatible with conventional 8-pin TSSOP packages, but it is also available in a lead-free 8-pin SOIC package.

The FM25L16 reads and writes continuously at bus speeds of up to 20MHz with no write delays. Similar EEPROM devices require long millisecond write delays and write-polling software, and have endurance limited to less than one million write cycles.

Samples of the FM25L16 are available immediately and pricing starts at $1.13 in quantities of 10,000.

www.ramtron.com

UK EMS company applies 'blended' production

Walters Microsystems has manufacturing facilities in the UK and China

Walters Microsystems, a UK-based Contract Electronics Manufacturer (CEM) based in High Wycombe, UK, is setting up a 'blended' manufacturing model that will help customers save costs but meet high volume demands.

The firm has four high capacity SMT lines in the UK, with a temporary manufacturing facility in Shanghai. A typical split of manufacturing could be 80:20 where 80% would be produced in China to take advantage of the low labour costs.

"Many companies are outsourcing product to China and other Far East regions to save on costs. However, this usually requires very high production run orders and reduces the flexibility that customers typically require. Our approach is to combine both onshore and offshore manufacturing, investing both in new production lines here in the UK and in China," said Clive Matthews, sales director.

Walters Microsystems plans a purpose-built production plant in Nantong, which will mirror the UK facility, by the year-end.

www.waltersgroup.co.uk

High current latching relays

Specialist distributor Switchtec has two high current latching relays available now that are able to replace contactors in applications where panel space is limited. The compact units are ideal for use in soft starters, electricity metering and many other contactor applications where it is desirable to save space whilst maintaining current ratings. Aimed at panel builders and OEMs, the KG K100 and K200 are rated at 100A and 200A respectively at a voltage of 480Vac. Featuring a patented linear drive unit, the relays feature a short current path for overall lower resistance and reduced heat build up. A 3mm contact gap offers improved isolation in applications where safety is required as standard.

As latching relays, the units only require a short duration pulse voltage – 50ms minimum – to change state, and therefore consume far less energy than an equivalent contactor that requires a permanently applied voltage to maintain the 'on' state.

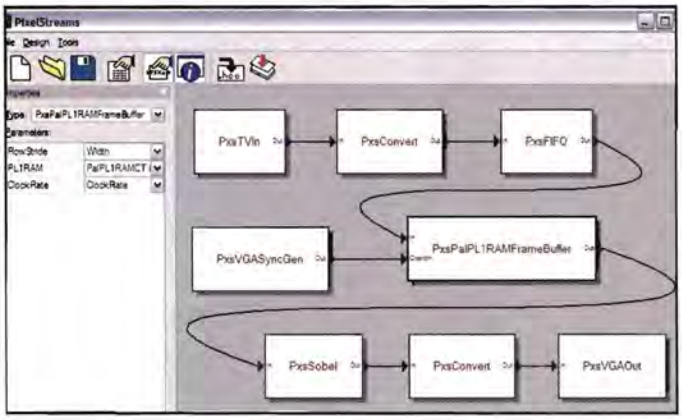
The KG100 has a SPST contact arrangement and an operating time of 20mS, the K200 has DPST contacts with an operating time of 30mS. All units are available with operating coils of 12, 24, and 48V, however the K100 is also available with a 6V coil. The relays can operate in a temperature range of -40°C to +70°C. The relay has a 60A motor load rating from UL that requires a minimum of 50 switching cycles at 600A.

www.switchtec.co.uk

Interactive tool for streaming video

Celoxica added algorithm IP and a block-based graphical design entry platform to its expanding portfolio of electronic system level (ESL) design tools.
The PixelStreams development environment provides a library of powerful video data manipulation functions with an easy-to-use interactive graphical editor.

PixelStreams provides a broad range of macro calls that allow the user to gather, manipulate and output streams of video pixel data. These C-based models deliver enhanced parameterisation capabilities and high-level interface abstraction. In addition, PixelStreams includes an IP reuse graphical editor as an entry tool for imaging algorithms to provide ease-of-use and design productivity in a familiar block-based methodology.



From this block diagram entry, developers can quickly design, analyse and implement hardware prototypes for complex video imaging systems using the Celoxica DK Design Suite for C-based synthesis.

Video and image processing algorithms are rapidly being used in applications such as machine vision in industrial control systems, sensor fusion in automotive systems, pattern recognition in biometrics and security systems, as well as the more established electronics markets for consumer, defence and office automation.

www.celoxica.com

Low cost alarm protects portable assets

Small, high value assets such as computers and projectors are notoriously vulnerable to theft and, more often than not, are no longer adequately covered by insurance. Now, HotAV from High Wycombe, has come up with a low cost, but highly effective, alarm that attaches to virtually any piece of equipment and protects.

The D-Tex alarm, which has a retail price of £140, is fixed to the piece of equipment with the strongest adhesive available, which bonds it permanently to the casing of the device. The D-Tex alarm has an electronic key with a unique code from 4 billion combinations that activates the alarm. If the device is unplugged from the mains without de-activating the alarm, a motion sensor sets off a 120dB alarm, which sounds until the device is plugged into the mains again or de-activated with the coded key.

Dave Savage, HotAV's MD says that, D-Tex is extremely effective in deterring opportunist thieves that try to walk off with portable electronic devices that they slip under their coat or into a bag. "The noise that the alarm makes, stops them in their tracks," he said.

Call 0845 130 6161
www.hotav.uk.com

New EMC test facility

UK-based test and certification company TRL Compliance has opened a new 18x14x6m EMC test facility in Malvern, the UK. This is a large size chamber, which could easily accommodate large military, agricultural and industrial vehicles and equipment.

The Malvern site features a reinforced flooring to handle loads up to 80 tonnes. The site roadways have been constructed for heavy machinery and secured for confidentiality.

Here, TRL can carry out a wide range of compliance tests, including electromagnetic fields in excess of 200V/m 10kHz to 18GHz simulating very hostile environments. Other tests include DEF STAN 59-41, MIL STD 461 and RTCA/DO160C/D. TRL is UKAS accredited. Its service includes turnkey solutions and technical authors providing clear concise test plans, procedures and reports.

www.trlcompliance.co.uk

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Edited by George Brown

This book collects together some of the best articles from around the world on the subject of antennas. It will appeal to radio amateurs in general, whether they be antenna enthusiasts or not. It is a follow-up to the successful The International Antenna Collection, compiled by the same editor.

2003

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Peter Dodd

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2000 • 208 pages • PB

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Johan van der Tang, Dieter Kasperkovitz & Arthur van Roermund

This text covers the analysis and design of all high-frequency oscillators required to realize integrated transceivers for wireless and wired applications. This includes the design of oscillator types as single-phase LC oscillators, I/Q LC oscillators, multi-phase LC oscillators, and ring oscillators in various IC technologies such as bipolar, BiCMOS, CMOS, and SOI (silicon on insulator). Starting from an in depth review of basic oscillator theory, the authors discuss key oscillator specifications, numerous oscillator circuit topologies, and introduce the concepts of design figures of merit (FOMs) and benchmark FOMs.

2003 • 343 pages • HB

£78.00 Code 1-4020-7564-2

BEGINNERS HANDBOOK OF AMATEUR RADIO
Clay Laster

This text provides the reader with the necessary electronics background to begin "hamming" and to help with preparations for the FCC novice or "no-code" technician class license examinations. It covers the basics of wave propagation, power supplies and electronic circuits.

4th edition • 2000 • 550 pages • PB

£25.99 Code 0-0713-6187-1

AN ANALOG ELECTRONICS COMPANION
Scott Hamilton

Engineers and scientists frequently find themselves having to get involved in electronic circuit design even though this may not be their specialty. This book is specifically designed for these situations, and has two major advantages for the inexperienced designer: it assumes little prior knowledge of electronics and it takes a modular approach, so you can find just what you need without working through a whole chapter. A major bonus and learning aid is the inclusion of a CD with the student edition of the PSpice simulation software, together with models of most of the circuits described in the book.

April 2003 • 668 pages & CD • HB

£75.00 Code 0-5217-9838-8

ANTENNA TOPICS
Pat Hawker

If you are interested in antennas this book is a goldmine of information and ideas on the subject. Pat Hawker has been writing his "Technical Topics" column in Radcom since 1958 and in this time has produced much excellent work in this time. This book is a chronological collection of cuttings of Pat's words over the years. Hundreds of areas and subjects are covered and many a good idea is included. Carefully indexed this book is not only a great reference work but also a history of over forty years of antenna design. At 384 pages this book is excellent value and asset to any amateur interested in antennas.

2002 • 384 pages • PB

£18.99 Code 1-8723-0989-5

VHF/UHF ANTENNAS
Ian Poole

This great new book from the popular author Ian Poole investigates the exciting area of VHF and UHF antennas. The VHF and UHF bands provide an exciting opportunity for those wishing to experiment, whilst the antenna sizes at these frequencies mean that they do not occupy great amounts of space.

2002 • 128 pages

£13.99 Code 1-8723-0976-3

RSGB RADIO AMATEUR CALL BOOK
Radio Society of Britain

For the First Time you can get up to date UK call information on a CD with World Call data. Taking over from the **Pegasus Flying Horse CD** is the **RSGB Radio Amateur Call Book**. Using the very latest UK, Europe and US call data, makes this the most up-to-date and very best World Call CD available. Requiring no hard disk installation this CD has an easy to use and effective interface. The "RSGB Radio Amateur Call Book" is compatible with existing logging software and all operating systems from DOS to Windows XP.

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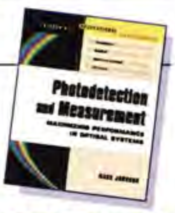
PHOTODETECTION AND MEASUREMENT
Mark Johnson



Using basic theory, fully-worked calculation, cicuit snippets and rules-of-thumb, this book conveys the know-how of good opto-electronic design, from low-noise receivers to synchronous detection. "TRY IT" topics provide light-hearted demonstrations of key points. The grad student starting in photonics and the engineer optimising an opto-electronic product will benefit particularly!

2003 • 298 pages • HB

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Steve C. Cripps

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BASIC ENGINEERING CIRCUIT ANALYSIS
J. Irwin

Presentation of first and second-order transient circuits has been streamlined, derivations have been eliminated and MATLAB solutions have been added. In addition, practical examples have been added throughout.

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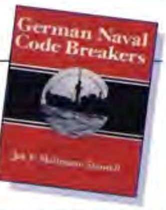

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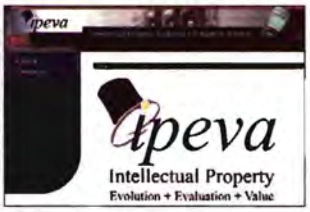

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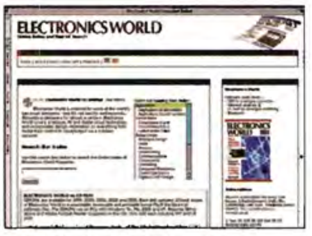

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