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ELECTRONICS and BEYOND

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Ideas into profit
Electronic themes
Projects to make
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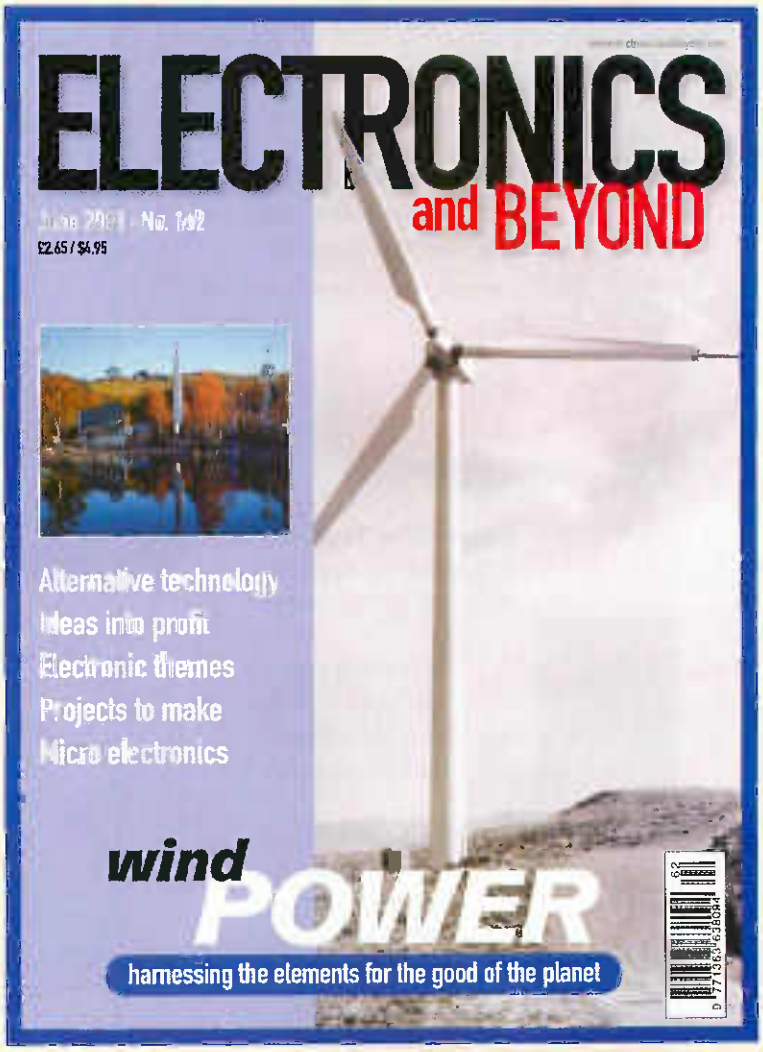

If you want diverse, reliable and up-to-date information on all aspects of electronics and its impact on the environment, new technology and the current business climate, globally, look no further than the new look Electronics and Beyond. Electronics and Beyond offers you hands on experience in radio, robotics, microcontrollers and other practical projects, plus the opportunity to revisit projects utilizing the latest technology.

Turn to page 74 for details of how to subscribe.

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The Past, Present and Future of Electronics

The Electronics and Beyond Team

Jonathan Aldred BSc(Hons) - News Editor

I was born in Wirral, Merseyside where I lived up until 7 years ago when I moved to Talybont, near Aberystwyth. I studied Geography at Aberystwyth University, but my interests cover a wide range of subjects and I am currently learning how to program in C.

My other hobbies include reading, short story writing, science fiction programmes, computer games and keeping up to date with technological trends and current events.

You can contact me at jaldred@kanda.com.

Anna Penar - Media Sales Manager

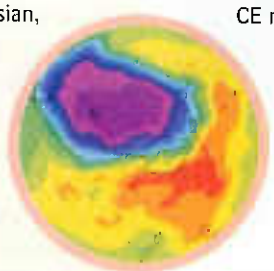
I was born in a mountain area in Lower Silesia in Poland in February 1975. I studied Law in three countries: Poland, Germany and United Kingdom.

I have two law degrees and study at the moment a part-time MBA at the University of Wales (Aberystwyth).

I often worked for international organisations like Red Cross in Poland, Konvoi 96 in Germany, but have work experience in administration (magistrate court and Internal and Foreign Ministry in Poland) and business as well (DEBET consulting and accounting company in Wroclaw, Kanda Systems).

One of my passions are foreign languages (Polish, Russian, German, English, Spanish and Italian), Contact: apenar@kanda.com.

Natasha Nagaoka - Publishing Manager



I was born in Aberystwyth, brought up on a welsh hill farm and then studied Politics at Leicester, then a year in Bilbao, Spain as a TEFL Teacher .

I did an MBA and moved to Tokyo, where I worked for two diverse Japanese companies, studied on a Scholarship scheme at Keio University.

I relocated to the UK after 9 years in Tokyo, and joined Kanda in October 2000 as Marketing Manager, and am now in charge of Electronics and Beyond.

I enjoy horse-riding, oriental arts and learning new skills, I speak fluent Japanese and some Spanish.

I can be contacted on 01970 621030 , via Fax on 01970 621040 , email to nnagaoka@electronicsandbeyond.com and welcome any feedback on the contents of the magazine.

Paula Matthews - Subscriptions Manager

I was born in Sutton Coalfield not so long ago, I have a BTEC in Business and Finance and Business & Finance.

I worked as a special constable for 4 years in Aberystwyth and then joined Kanda Systems in 1997 as a receptionist and later on as an accounts assistant and customer service co-ordinator.

In my spare time, I enjoy films, reading and dining out and try to do some sport in between.

As Your Subscriptions manager, I handle all day to day queries on Electronics and Beyond, update all customer information and you can ring the Electronics and Beyond Hotline on 01970 621039 which is open between 9 and 5.30pm on weekdays for assistance.

I look forward to talking to you and helping you with any questions you have as a subscriber to Electronics and Beyond.

Summer is coming...

The fresh face of Electronics and Beyond is here for early Summer. As the sun starts to shine brighter each day we hope in the same way that by adding colour and content we can brighten up the image of your magazine which has over 20 years of history in the Electronics world. We believe you will like the new colour coded themes running through the pages and that you will be able to pick up new ideas and opportunities in the new look format.

In the green section, let us introduce you to CAT, not the animal species as such, but the Centre for Alternative Technology where you have the opportunity to learn more about wind turbines and their ability to conserve energy.

Enter the time warp as we take you back in time to issue 109 and the challenge is to rework an old project with state of the art components.

If you need help setting up internationally recognized standards for your business then flick through the ISO introduction or find out what CE marking really means in blue.

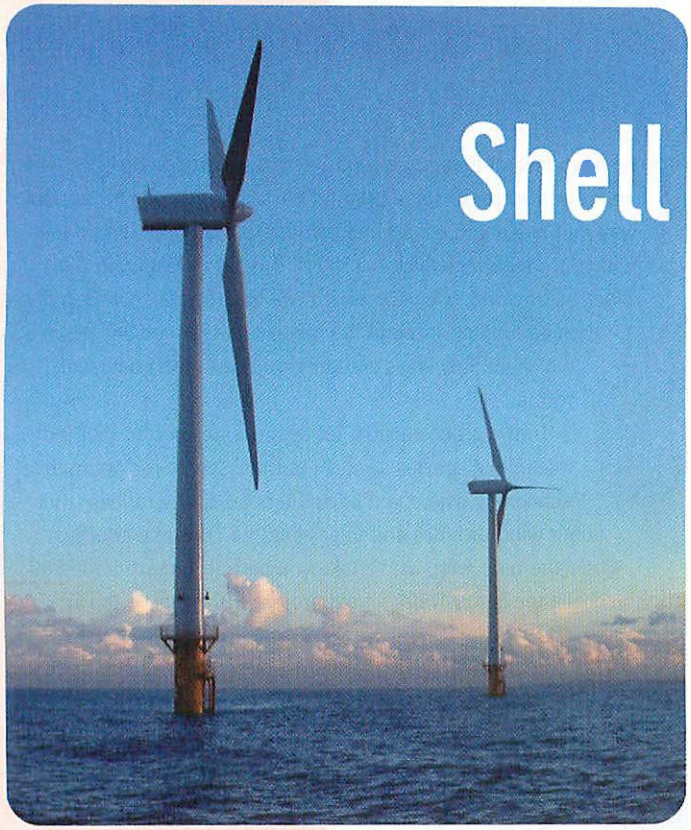
Look out for Robots of the configurable kind as they come to life in red.

For those of you interested in micro electronics, watch out for the colour purple which introduces you to the myriad of micro controllers from many of the world's leading silicon manufacturers.

We have listened to your feedback over the last six months and have worked to make the design and content interesting and lively whilst keeping it user-friendly. As Uri moves to Microsoft, many old favourites arrive back such as the classified section where you can exchange valuable bits and pieces plus you have the chance to voice your opinions on the Letters page or you may wish to be creative and want to try your hand at picture taking or write a story for the magazine. Maybe you would instead just like to pick a good book from the shelf in the Bookshop and go off to read it under a tree in the shade.

Our aim throughout is to provide something of interest for everyone involved in the world of electronics and you can tell us directly if we are succeeding by taking the time to fill out the readership questionnaire .

Remember you have the option to send, fax or email any suggestions or comments to me and also please do visit your Electronics and Beyond website and if you want to link up then let me know as the web ring for www.electronicsandbeyond.com grows and spreads each day. At the left you can see the team behind the new look magazine- literally the who's who of Electronics and Beyond . This team looks forward to taking you on a journey back to the past, into the present and forward into the future of Electronics.



Shell welcomes offshore wind opportunity

Shell Renewables Ltd, has welcomed the announcement by the Crown Estate that it has been chosen to explore the potential of developing an offshore wind farm in the Irish Sea near Blackpool.

Shell has been awarded a ten-square-kilometre-block, which has been earmarked for possible development as a wind farm with up to 30 turbines generating at least 60 megawatts of electricity - enough for 40,000 households or more than half the households in Blackpool. The project, if it goes ahead, will reduce global annual carbon dioxide emissions by at least 135,000 tonnes, sulphur dioxide by 1,570 tonnes and nitrogen oxide by 473 tonnes.

'We are very pleased to be selected for this site. The UK offshore wind has the potential to contribute appreciably to the country's future energy needs and we wish to play a significant role in developing this exciting new industry,' said David Jones, Executive Vice President of Shell Renewables' Wind Energy business. 'We believe that with Shell's wealth of experience in working offshore, we can become a leading innovator developing this technology to its full potential and continue to meet our commitment to sustainable development.' The proposed site lies next to two others, awarded by the Crown Estate to Celt Power and Elsam A/S respectively, and the three companies have agreed to work together on site investigation and development.

Extensive site evaluation, including onsite wind measurement, environmental studies and discussions with the local community will now take place. Final consent will have to be obtained from the Department of Trade and Industry after full consultation. Construction is estimated to start in 2004. The UK is one of the windiest countries in Europe and has enough offshore wind practically available to supply one third of total electricity demand, according to the Department of Trade and Industry. Shell has identified the UK as one of its priority areas in its newly developing wind energy business and is part of a consortium that constructed a four-megawatt-capacity offshore wind project near Blyth in Northumberland last year.

Globally, Shell Renewables is committed to becoming a leader and innovator for offshore wind, developing and operating wind energy projects largely in Europe and North America.

Shell Renewables was established by the Royal Dutch/Shell Group to develop commercial opportunities in solar, biomass and wind energy. Renewable energy sources are expected to meet an increasing percentage of the world's energy demand and Shell Renewables plans to be a significant player in this sustainable energy market.

NEWS bytes

Elnec win the Golden AMPER 2001...

At the 9th International Trade Fair of Electrotechnics and Electronics in the Czech Republic, Elnec won the AMPER 2001 award. This international fair is held every April and this year, Elnec won with their universal programmer, LabProg+.

The MD of Elnec, Vladimir Doval said 'We are proud to receive this prize, it is a big success for our company'.

Easby Electronics

Easby Electronics extends its offering of suppression products with a new range of X1 Class suppression capacitors from Acrotronics. The capacitors have built-in self-healing properties designed for equipment that is permanently connected to the mains supply. The R49 extends the wide choice of suppression products available from Easby, which include film and ceramic capacitors, transient voltage diodes, inductors and a wide range of mains plug and PCB/chassis mounted filters.

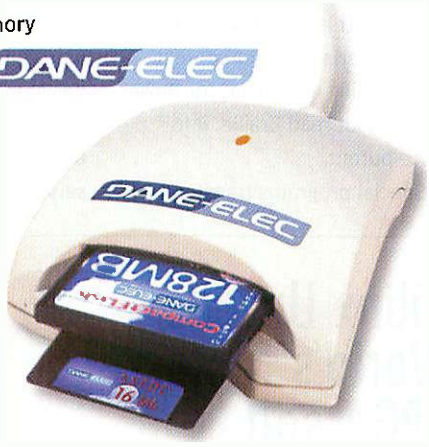
Contact Easby Electronics on 01748 850555 or via email to sales@easby.co.uk

Smartcard Media -Biggest yet

The biggest SmartMedia Card to date has been launched. SmartMedia is the latest in data storage, and features an embedded NAND-type flash memory chip that allows users to store a library of images and sounds.

This removable card is ideal for storing data within equipment such as digital cameras, PDA's, voice recorders and other mobile electronic devices. This development will enable digital still cameras and portable information equipment to become smaller in size. It also saves time when transferring images from portable devices to PC's

Dane-Elec's CompactFlash Adapter is a clever gadget that enables a small, CompactFlash card to physically resemble a standard ATA Flash memory card. The CompactFlash card from a digital camera is inserted into the CompactFlash Adapter that in turn is placed into the standard PC card or PCMCIA slot located on most PC's and laptops. The user has the ability to download images from a digital camera to a computer quickly and easily.and then transfer and receive data from a PC or MAC



Dane-Elec's PhotoMate card reader enables users of digital cameras, MP3players, PDA's and portable devices to transfer data to and from a PC or Mac. Just by inserting the CompactFlash card into the reader, data can be downloaded providing an effective way of moving files, images and data. PhotoMate readers do not require additional software, and are available for use with USB ports, providing a true plug and play experience on both PC and Mac.

For more information on Dane-Elec visit www.dane-elec.com

UEA to become an 'Electronic Campus' with Foundry Networks

The University of East Anglia has invested in Foundry's Gigabit Ethernet solutions for its main campus in Norwich. This will allow for a new web-based interactive learning system, advanced teaching and research methods can then be used, creating an 'electronic campus' for the 15,000 staff and students.

FOUNDRY NETWORKS

'This reinforces UEA's commitment to electronic development in education' said Dr David Baker, Pro-Vice-Chancellor for Human Resources and Academic Infrastructure.

The new network will support video conferencing and offer students increased access to online materials. Financing for the network upgrade was obtained from the Higher Education Funding Council for England and will enable the University to pioneer new Internet-based teaching methods.

Providing Internet Access for the Blind

Blind or visually impaired individuals are largely excluded from being able to enjoy the variety of information available on the WorldWide Web-from online newspapers and travel services to personal contacts and chat rooms.

But now, help is on the way: Cityweb Plus, an online service for the blind and visually impaired, allows users to interactively determine what they read or listen to on the Internet. C-LAB-Siemens' and the University of Paderborn's

NEWS bytes

ARM news

ARM Holdings plc announces 52% growth in revenues and 39% increase in pre-tax profit. Robin Saxby, Chairman and Chief Executive Officer said of the first quarter's results, 'As an intellectual property licensing business, we have not been directly exposed to the inventory corrections seen by many technology companies in the last few months and have experienced a strong quarter, with 20 licenses signed'

STMicroelectronics licences ARM microprocessor cores

STMicroelectronics has licensed the ARM7TM, ARM9TM and ARM10TM families for use in its system-on-chip (SoC) devices. STMicroelectronics is integrating the ARM Microprocessor cores onto its technology roadmap for wireless, wireline and printer businesses, and will use ARM cores to provide complex SoC solutions to customers in the areas of automotive and digital radio.

ARM Supports partners and developers community with launch of ARM Devzone website

The ARM DevZone site will host an online community in a collaborative environment, providing development advice, open communication forums and advanced access to new ARM technology. The ARM DevZone will

NEWS bytes

also provide support for the growing Linux community. 'We see the ARM DevZone as a 'one-stop developer shop' providing a valuable resource to our development community that will help them achieve faster time-to-market for their products' said Rod Crawford, Director, Third-Party Software Products, ARM.

For more information visit www.arm.com

Xicor Announces Fibre Optic Module

Xicor Inc. in California (Nasdaq/NMS: XICO) has announced the availability of a 1Gb/s fiber optic module reference design. This reference design is a complete fibre optic module system targeted at Fibre Channel and storage area network applications. The reference platform contains Honeywell HFE4380-321 Vertical Cavity Surface Emitting Laser (VCSEL) diodes, Micrel SY88922 & SY88905 driver IC's to control PECL compatible data

The reference design is available free at www.xicor.com.

The module design provides solutions to some of the key design challenges facing fibre optic module designers today, these being, temperature compensation, control of the 'knee' or threshold effect, and accurate monitoring of average optical power output.

'This reference design is a tool for designers tackling fibre optic modules for LAN applications,' stated Mike Levis, vice president of marketing at Xicor. 'It clearly articulates the key

innovation workshop developed Cityweb Plus with the Internet provider Cityweb Network. It is based on software that converts Internet content into a Braille display or, for those who cannot read Braille, into voice output.

Special programs transform the computer data from the Web into tactile or audible information. If photographs are part of the content, the software uses the available captions as a description.

The information provided is based on the Cityweb online service, which offers local and international news from all editions of the WAZ newspaper group. The easy to use service is also suitable for business purposes and for use by older people who are not that familiar with information technology. Further information is available at www.c-lab.de/textbrowser.

Xilinx Unveils World's Fastest FPGA soft processor.

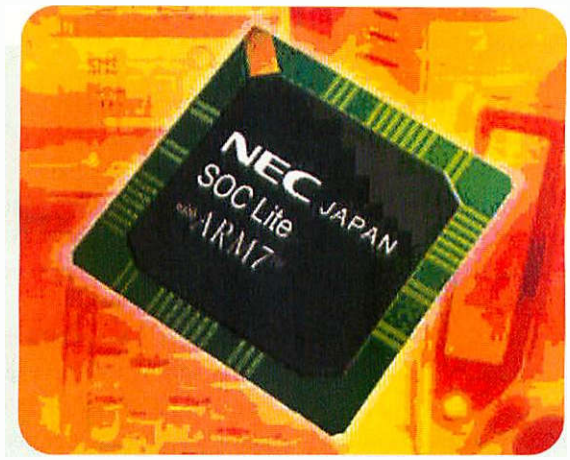
Xilinx Incorporated has unveiled the MicroBlaze processor, the world's fastest 32-bit soft processor core developed by an FPGA (Field Programmable Gate Array) vendor. Running at 125MHz, the MicroBlaze delivers a true 32-bit instruction and data bus critical for building complex systems for the networking, telecommunication, data communication, embedded and consumer markets. The processor features a Harvard-style architecture with separate 32-bit instruction and data busses running at full speed to execute programs or access data out of on-chip or external memory.

The core of the processor is a standard RISC-based engine with a 32 register by 32 bit Lut RAM-based (fast) Register File, with separate instructions for data and memory access. It supports both on-chip BlockRam and/or external memory. All peripherals including the memory controller, UART and the interrupt controller run off of the OPB bus. Additional processor performance is achieved by utilising Virtex-II architecture features like the embedded mulitplier ALU.

According to Wim Roelandts, Xilinx's president and CEO, 'The MicroBlaze processor offers performance previously seen only in ASICs. By running at twice the speed and using half the logic of competing FPGA vendors' best efforts, MicroBlaze demonstrates its clear architectural advantage and also the power of the Xilinx Virtex-II FPGA fabric'.

The MicroBlaze processor has been deployed through a beta program to leading suppliers of networking and telecommunications equipment manufacturers and will be in production in late summer of 2001. As part of this Beta program, Xilinx has already delivered CoreConnect enabled peripherals including an Arbiter and UART. Under development are 10/100 Ethernet MAC, SPI and ATM Utopia level-2 interfaces as well as a standard set of peripherals, including timer/counters, UART, interrupt controller, GPIO, and external flash and SRAM memory interfaces.

A leading innovator of complete programmable logic solutions, including advanced integrated circuits, software design tools, and predefined system functions delivered as cores, Xilinx invented the Field Programmable Gate Array and fulfils more than half of the world demand for these devices today. For more information, go to the Xilinx web site at www.xilinx.com.



Latest System on Chip device from Sunrise uses ARM core

Sunrise Electronics, the UK's distributor of NEC semiconductor products announced an exciting new development known as System-on-Chip Lite. The device is based on the ARM7TDMI 32-bit RISC microprocessor core. The ARM core-based subsystem frees the user from the task of developing a complete RISC computer system. Intended applications are factory automation, industrial bus systems, card readers, business phones, terminals and home communication.

Contact: www.sunrise.co.uk/arm_core.htm

Eurobytes

The introduction of the Euro will require most if not all processes/systems that handle monetary amounts to be upgraded or even replaced. Most organizations use psychologically attractive pricing such as £9.99 or £49.99 etc, but what will happen when these amounts do not convert into a similarly attractive Euro price?

The options are to raise or lower prices or repackage to an acceptable price level. Conversion to the Euro will need to be more than getting the symbol on the invoices right. There is an inherent risk of data pollution and how does one keep two currencies separate to facilitate easy banking and reconciliation of balance sheets?

Do you have an opinion? Please send your thoughts to the Editor at Electronics and Beyond.

For more information on the Euro available in the 5 main European languages, visit www.5-ibm.com

Text messaging - the ultimate flirting tool

Text messaging may be the ultimate street language for today's teenagers, but many are using this new way of communicating as a way to combat nerves when embarking on new relationships according to a recent survey conducted by Orange. Over 30% of 16-18yr olds are sending an average of over 20 messages a week and many respondents are relying on texting to avoid those tricky face to face conversations.

Chatting-up girls seems to be the thing for boys, with over 52% using their mobiles to get a date compared to only 19% of girls! But when it comes down to gossiping, the girls take the top slot-47% use texting to swap news on their mates and their love-lives as opposed to only 3% of boys!

That's where the differences between the genders stop and the similarities start. 72% of teens (72% girls v 71% boys) agreed that they get a buzz from receiving text messages and 54% (54% girls v 56% boys) are disappointed if they don't receive at least one message every day!

Style is everything for teens and texting is no exception, especially with the use of symbols. 93% of girls and 86% of boys knew what CUL8R (see you later?) stood for whereas 40% of boys and only 18% of girls knew how to text 'Be seeing you' (BCNU) properly!

Overall though, the teens knowledge of texting symbols is below par: Only 22% of teens knew KHUF (Know how you feel) .I & (tongue-tied) caused the most problems-only 10% knew it. . Only 16% of boys & 18% of girls knew the symbol for in love (*_*)

However, getting news or info via text messaging is deemed too boring for this age group as none of the respondents admitted to receiving the latest news information to their mobiles!

Denise Lewis, Group Director of Corporate Affairs stated 'Text messaging provides yet another way to share our thoughts with others. Where shyness used to prevent some from communicating their feelings, text messaging has fully opened the gates; the buzz of receiving text messages goes on the anytime, anywhere scenario. Orange text messaging is the ideal way to keep in touch!

For more information on Orange, visit www.orange.com.

NEWS bytes

challenges, and provides real world solutions that our customers can use as a starting point in their next design.'

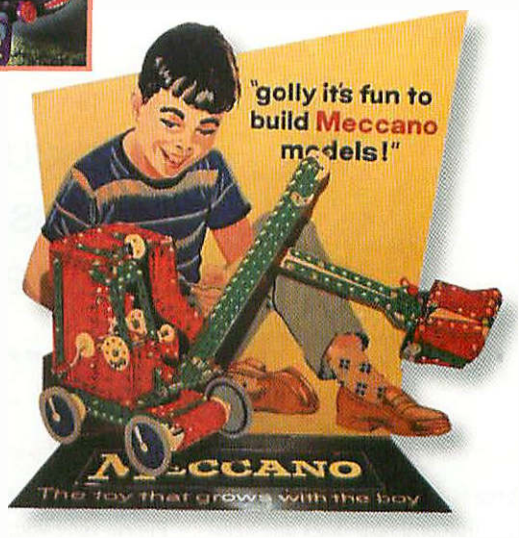
Xicor designs, develops, and markets a wide variety of programmable mixed-signal integrated circuits and nonvolatile memory products used in networking, computing, communication and industrial applications. The Company's products include digitally controlled potentiometers and system management IC's that allow system designers to digitally control analog functions in signal processing, microprocessor monitoring and power management.

Xicor can be found at www.xicor.com.

Samsung finds new route to displays market through PanelX

The flat panel display industry's Business-to-Business(B2B) portal and trading site PanelX, has added Samsung Electro-Mechanics to its extensive portfolio of leading display brand names. PanelX enables industry professionals to view and order Samsung products online, and as PanelX has a truly global presence so there are no hidden costs in the form of duties, customs or long shipping times.

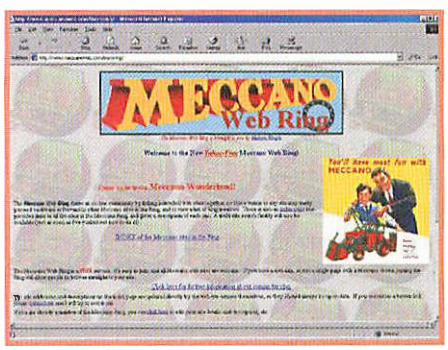
For more information on Samsung contact: www.sem.samsung.com. On PanelX visit:www.panelx.com.



MECCANO Celebrates Centenary

IT IS 100 YEARS AGO THIS YEAR THAT FRANK HORNBY (WHO IS ALSO REMEMBERED FOR HORNBY MODEL RAILWAYS) PATENTED HIS METAL CONSTRUCTION TOY THEN KNOWN AS 'MECHANICS MADE EASY'.

It was not the first constructional toy, but it does seem to have been the first metal one that incorporated all the important elements that make such a system work (namely regular spaced holes which take bolt fixings and axles). The product wasn't an instant hit – it was, at first, crudely made and a set cost 7/6d, which was very expensive back then. However, through a combination of good marketing and sheer persistence it slowly began to take off. By 1907 it had gained its new name – MECCANO, as well as several imitators. Over the years, gears and other specialised part were introduced and quality was also improved. British production ceased during WW2 but resumed in 1945. After a brief period of prosperity in the 1950s, their fortunes began to wane. After a series of takeovers, production at the famous Liverpool Binns Road factory closed in 1979. Production continued at a Meccano subsidiary plant in France, where it continues to this day.



Meccano on the web

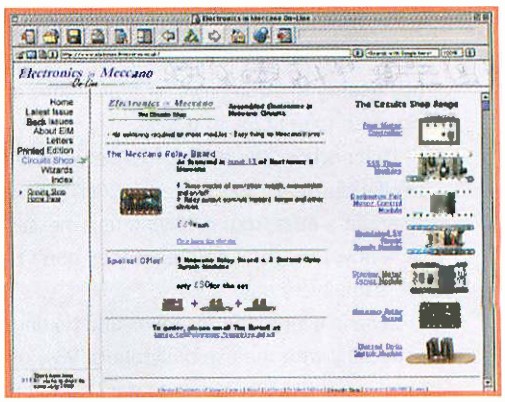
At the time of writing, the English version of the official Meccano site is under construction, but there is a French version available via a language selection screen on www.meccano.com. In addition there are loads of websites out there operated by dedicated enthusiasts.

www.meccanoman.co.uk is operated by Meccano specialist Dave Taylor, who runs a mail order service and has a wealth of Meccano information on his website. Meccano fans can find out, via this website, about Meccano club meetings and centenary events.

The Meccanoman site forms part of an in integrated on-line community known as the Meccano Web Ring, further details of which are available at www.meccanoweb.com/meccring. The Meccano web Ring links together numerous Meccano-orientated websites in such a way that the user can easily move back and forth through different sites, call up an index of sites at any time, and even call one up at random. All this is achieved merely by clicking on a special interface at the bottom of each page.

Electronics In Meccano

One of the best sites on the Meccano Web Ring is that of Electronics In Meccano Online www.eleinmec.freeserve.co.uk, the electronic version of a four-page magazine published quarterly by Tim Surtell which aims to help Meccano modellers put electronic circuits to good use in their models. To quote the site itself, 'The circuits described in the articles range from simple wiring, such as reversing switches for motors, through to more complex circuits for controlling lamps and motors'. All articles contain circuit diagrams and shopping lists for the components involved. The site also includes a circuit shop where you can buy ready assembled items, and a selection of component wizards which can calculate the components that you need for any given circuit, and will even give you pictures of the components themselves.



Why Standards MATTER

A REPORT BY THE INTERNATIONAL STANDARDS ORGANISATION -ISO

What if standards did not exist?

If there were no standards, we would soon notice. Standards make an enormous contribution to most aspects of our lives – although very often, that contribution is invisible. It is when there is an absence of standards that their importance is brought home. For example, as purchasers or users of products, we soon notice when they turn out to be of poor quality, do not fit, are incompatible with equipment we already have, are unreliable or dangerous. When products meet our expectations, we tend to take this for granted. We are usually unaware of the role played by standards in raising levels of quality, safety, reliability, efficiency and interchangeability – as well as in providing such benefits at an economical cost.

ISO (International Organisation for Standardisation) is the world's largest developer of standards. Although ISO's principal activity is the development of technical standards, ISO standards also have important economic and social repercussions. ISO standards make a positive difference, not just to engineers and manufacturers for whom they solve basic problems in production and distribution, but to society as a whole.

The International Standards which ISO develops are very useful. They are useful to industrial and business organisations of all types, to governments and other regulatory bodies, to trade officials, to conformity assessment professionals, to suppliers and customers of products and services in both public and private sectors, and, ultimately, to people in general in their roles as consumers and end users.

ISO standards contribute to making the development, manufacturing and supply of products and services more efficient, safer and cleaner. They make trade between countries easier and fairer. They provide governments with a technical base for health, safety and environmental legislation. They aid in transferring technology to developing countries. They safeguard members of the general public, as well as making their lives simpler.

When things go well – for example, when systems, machinery and devices work well and safely – then often it is because they conform to standards. And the organisation responsible for many thousands of the standards, which benefit society worldwide, is ISO.

Who ISO is

ISO is a network of the national standards institutes of some 140 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that co-ordinates the system.

ISO is a non-governmental organisation: its members are not, as is the case in the United Nations system, delegations of national governments. Nevertheless, ISO occupies a special position between the public and private sectors. This is because, on the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

Therefore, ISO is able to act as a bridging organisation in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users.

What ISO's name means

Because 'International Organisation for Standardisation' would have different abbreviations in different languages ('IOS' in English, 'OIN' in French for Organisation internationale de normalisation), it was decided at the outset to use a word derived from the Greek isos, meaning 'equal'. Therefore, whatever the country, whatever the language, the short form of the organisation's name is always ISO.

How it all started

International standardisation began in the electrotechnical field: the International Electrotechnical Commission (IEC) was established in 1906. Pioneering work in other fields was carried out by the International Federation of the National Standardising Associations (ISA), which was set up in 1926. The emphasis within ISA was laid heavily on mechanical engineering. ISA's activities came to an end in 1942.

In 1946, delegates from 25 countries met in London and decided to create a new international organisation, of which the object would be 'to facilitate the international co-ordination and unification of industrial standards'. The new organisation, ISO, officially began operations on 23 February 1947.

What 'international standardisation' means

When the large majority of products or services in a particular business or industry sector conform to International Standards, a state of industry-wide standardisation can be said to exist. This is achieved through consensus agreements between national delegations representing all the economic stakeholders concerned – suppliers, users and, often, governments and other interest

groups, such as consumers. They agree on specifications and criteria to be applied consistently in the classification of materials, in the manufacture and supply of products, in testing and analysis, in terminology and in the provision of services. In this way, International Standards provide a reference framework, or a common technological language, between suppliers and their customers – which facilitates trade and the transfer of technology.

How ISO standards benefit society

For businesses, the widespread adoption of International Standards means that suppliers can base the development of their products and services on specifications that have wide acceptance in their sectors. This, in turn, means that businesses using International Standards are increasingly free to compete on many more markets around the world.

For customers, the worldwide compatibility of technology which is achieved when products and services are based on International Standards brings them an increasingly wide choice of offers, and they also benefit from the effects of competition among suppliers.

For governments, International Standards provide the technological and scientific baselines underpinning health, safety and environmental legislation.

For trade officials negotiating the emergence of regional and global markets, International Standards create 'a level playing field' for all competitors on those markets. The existence of divergent national or regional standards can create technical barriers to trade, even when there is political agreement to do away with restrictive import quotas and the like. International Standards are the technical means by which political trade agreements can be put into practice.

For developing countries, International Standards that represent an international consensus on the state of the art constitute an important source of technological know-how. By defining the characteristics that products and services will be expected to meet on export markets, International Standards give developing countries a basis for making the right decisions when investing their scarce resources and thus avoid squandering them.

For consumers, conformance of products and services to International Standards provides assurance about their quality, safety and reliability.

For everyone, International Standards can contribute to the quality of life in general by ensuring that the transport, machinery and tools we use are safe.

For the planet we inhabit, International Standards on air, water and soil quality, and on emissions of gases and radiation, can contribute to efforts to preserve the environment.

The hallmarks of the ISO brand: Equal footing

Every participating ISO member institution has the right to take part in the development of any standard which it judges to be important to its country's economy. No matter what the size or strength of that economy, each participating member in ISO has one vote. ISO's activities are thus carried out in a democratic framework where each country is on an equal footing to influence the direction of ISO's work at the strategic level, as well as the technical content of its individual standards.

Voluntary

ISO standards are voluntary. As a non-governmental organisation, ISO has no legal authority to enforce their implementation. A certain percentage of ISO standards – mainly those concerned with health, safety or the environment – have been adopted in some countries as part of their regulatory framework, or are referred to in legislation for which they serve as the technical basis. Such adoptions are sovereign decisions by the regulatory authorities or governments of the countries concerned; ISO itself does not regulate or legislate. However, although ISO standards are voluntary, they may become a market requirement, as has happened in the case of ISO 9000 quality management systems, or ISO freight container dimensions.

Market-driven

ISO develops only those standards for which there is a market requirement. The work is carried out by experts on loan from the industrial, technical and business sectors which have asked for the standards, and which subsequently put them to use. These experts may be joined by others with relevant knowledge, such as representatives of government agencies, consumer organisations, academia and testing laboratories.

Consensus

Although ISO standards are voluntary, the fact that they are developed in response to market demand, and are based on consensus among the interested parties, ensures widespread applicability of the standards. Consensus, like technology, evolves and ISO takes account both of evolving technology and of evolving interests by requiring a review of its standards at least every five years to decide whether they should be maintained, updated or withdrawn. In this way, ISO standards retain their position as the state of the art, as agreed by an international cross-section of experts in the field.

Worldwide

ISO standards are technical agreements that provide the framework for compatible technology worldwide. Developing technical consensus on this international scale is a major operation. In all, there are more than 2 850 ISO technical groups (technical committees, subcommittees, working groups etc.) in which some 30 000 experts participate annually to develop ISO standards.

ISO and world trade

ISO – together with IEC (International Electrotechnical Commission) and ITU (International Telecommunication Union) – is building a strategic partnership with the World Trade Organisation (WTO) with the common goal of promoting a free and fair

global trading system. The political agreements reached within the framework of the WTO require underpinning by technical agreements. ISO, IEC and ITU, as the three principal organisations in international standardisation, have the complementary scopes, the framework, the expertise and the experience to provide this technical support for the growth of the global market.

The WTO's Agreement on Technical Barriers to Trade (TBT) includes the Code of Good Practice for the Preparation, Adoption and Application of Standards. The TBT Agreement recognises the important contribution that International Standards and conformity assessment systems can make to improving efficiency of production and facilitating international trade. Therefore, where International Standards exist or their completion is imminent, the Code states that standardising bodies should use them as a basis for standards they develop. The Code requires that standardising bodies that have accepted its terms notify this fact to the ISO/IEC Information Centre located at the ISO Central Secretariat. Standardising bodies having accepted the Code must publish their work programmes and also notify the existence of their work programmes to the ISO/IEC Information Centre. On behalf of the WTO, ISO periodically publishes a directory of standardising bodies that have accepted the WTO TBT Standards Code.

What ISO does for developing countries

ISO standards represent a reservoir of technology. Developing countries in particular, with their scarce resources, stand to gain from this wealth of knowledge. For them, ISO standards are an important means both of acquiring technological know-how that is backed by international consensus as the state of the art, and of raising their capability to export and compete on global markets. In addition to this general benefit of ISO standards, ISO has a specific programme for developing countries which consists of training seminars, sponsorships/fellowships and publications. ISO also has a policy committee on developing country matters, DEVCO, with a membership of nearly 100 standards institutes from both industrialised and developing countries.

How to recognise an ISO standard

An ISO standard can be anything from a four-page document to one several hundred pages' long and, in the future, will increasingly be available in electronic form. It carries the ISO logo and the designation, 'International Standard'. In most cases, it is published in A4 format – which is itself one of the ISO standard paper sizes.

The big, wide world of ISO standards

Between 1947 and 2000, ISO published more than 13 000 International Standards. ISO's work programme ranges from standards for traditional activities, such as agriculture and construction, through mechanical engineering, to medical devices, to the newest information technology developments, such as the digital coding of audio-visual signals for multimedia applications.

Standardisation of screw threads helps to keep chairs, children's bicycles and aircraft together and solves the repair and maintenance problems caused by a lack of standardisation that were once a major headache for manufacturers and product users. Standards establishing an international consensus on terminology make technology transfer easier and can represent an important stage in the advancement of new technologies.

Without the standardised dimensions of freight containers, international trade would be slower and more expensive. Without the standardisation of telephone and banking cards, life would be more complicated. A lack of standardisation may even affect the quality of life itself: for the disabled, for example, when they are barred access to consumer products, public transport and buildings because the dimensions of wheel-chairs and entrances are not standardised.

Standardised symbols provide danger warnings and information across linguistic frontiers. Consensus on grades of various materials gives a common reference for suppliers and clients in business dealings.

Agreement on a sufficient number of variations of a product to meet most current applications allows economies of scale with cost benefits for both producers and consumers. An example is the standardisation of paper sizes.

Standardisation of performance or safety requirements of diverse equipment makes sure that users' needs are met while allowing individual manufacturers the freedom to design their own solution on how to meet those needs.

Standardised protocols allow computers from different vendors to 'talk' to each other. Standardised documents speed up the transit of goods, or identify sensitive or dangerous cargoes that may be handled by people speaking different languages. Standardisation of connections and interfaces of all types ensures the compatibility of equipment of diverse origins and the interoperability of different technologies.

Agreement on test methods allows meaningful comparisons of products, or plays an important part in controlling pollution – whether by noise, vibration or emissions. Safety standards for machinery protect people at work, at play, at sea... and at the dentist's.

Without the international agreement contained in ISO standards on quantities and units, shopping and trade would be haphazard, science would be – unscientific – and technological development would be handicapped.

Tens of thousands of businesses in more than 150 countries are implementing ISO 9000 which provides a framework for quality management throughout the processes of producing and delivering products and services for the customer.

ISO 14000 environmental management systems are helping organisations of all types to improve their environmental performance at the same time as making a positive impact on business results.

What makes ISO 9000 and ISO 14000 so special

The ISO 9000 and ISO 14000 families are among ISO's most widely known and successful standards ever. ISO 9000 has become an international reference for quality requirements in business to business dealings, and ISO 14000 looks set to achieve at least as much, if not more, in helping organisations to meet their environmental challenges.

The vast majority of ISO standards are highly specific to a particular product, material, or process. However, the standards that have earned the ISO 9000 and ISO 14000 families a worldwide reputation are known as 'generic management system standards'. 'Generic' means that the same standards can be applied to any organisation, large or small, whatever its product – including whether its 'product' is actually a service – in any sector of activity, and whether it is a business enterprise, a public administration, or a government department. 'Management system' refers to what the organisation does to manage its processes, or activities. 'Generic' also signifies that no matter what the organisation is or does, if it wants to establish a quality management system or an environmental management system, then such a system has a number of essential features which are spelled out in the relevant standards of the ISO 9000 or ISO

14000 families.

ISO 9000 is concerned with 'quality management'. This means what the organisation does to ensure that its products conform to the customer's requirements and continually to improve its performance in this regard. ISO 14000 is primarily concerned with 'environmental management'. This means what the organisation does to minimise harmful effects on the environment caused by its activities, and continually to improve its environmental performance.

What makes conformity assessment so important

At its simplest, 'conformity assessment' means checking that products, materials, services, systems or people measure up to the specifications of a relevant standard. Today, many products require testing for conformance with specifications or compliance with safety or other regulations before they can be put on many markets. Even simpler products may require supporting technical documentation that includes test data. With so much trade taking place across borders, conformity assessment has become an important component of the world economy. Over the years, ISO has developed many of the standards against which products are assessed for conformity, as well as the standardised test methods that allow the meaningful comparison of test results so necessary for international trade. ISO itself does not carry out conformity assessment. However, in partnership with IEC (International Electrotechnical Commission), ISO develops ISO/IEC guides and standards to be used by organisations which carry out conformity assessment activities. The voluntary criteria contained in these guides and standards represent an international consensus on what constitutes best practice. Their use contributes to the consistency and coherence of conformity assessment worldwide and so facilitates trade across borders.

Where to find information on standards

ISO's entire portfolio of standards is listed in the ISO Catalogue that can be accessed on the organisation's Web site, ISO Online (www.iso.ch). The site also provides access to the World Standards Services Network (WSSN) which is a network of publicly accessible Web servers of standards organisations around the world. It contains links to international, regional and national standardisation bodies, and also to other international and regional organisations which develop standards in their specialised subject area, in addition to their principal activity.

In fact, there are several hundred thousand standards and technical regulations in the world containing special requirements for a particular country or region. Finding information about these, or about related conformity assessment activities, can be a heavy task. ISONET, the ISO Information Network, can ease the problem. This is a worldwide network of national standards information centres which have co-operatively developed a system to provide rapid access to information about standards, technical regulations, and testing and conformity assessment activities in operation around the world. The World Trade Organisation's Agreement on Technical Barriers to Trade (WTO/TBT) calls upon its signatory countries to establish a national enquiry point to answer questions on these same areas in relation to that country. In many countries, the ISONET and WTO enquiry points are one and the same.

Who can join ISO

Membership of ISO is open to national standards institutes or similar organisations most representative of standardisation in their country (one member in each country). Full members, known as 'member bodies', each have one vote, whatever the size or strength of the economy of the country concerned. In addition, ISO also has two categories of membership for countries with fewer resources. They pay reduced membership fees. Although such members do not have a vote, they can remain up-to-date on standardisation developments. 'Correspondent members' are usually organisations in countries, which do not yet have a fully developed national standards activity. Correspondent members do not take an active part in the technical work, but are entitled to be kept fully informed about the work of interest to them. 'Subscriber members' are institutes from countries with very small economies that nevertheless wish to maintain contact with international standardisation.

Although individuals or enterprises are not eligible for membership, both have a range of opportunities for taking part in ISO's work, or in contributing to the development of standards through the ISO member in their country. Individuals may be selected by member institutes to serve on national delegations participating in ISO technical committees, or may provide their input during the process of developing a national consensus for presentation by the delegation. International organisations and associations, both non-governmental and representing industry sectors, can apply for liaison status to a technical committee. They do not vote, but can participate in the debates and the development of consensus.

How the ISO system is managed

All strategic decisions are referred to the ISO members, who meet for an annual General Assembly. The proposals put to the members are developed by the ISO Council, drawn from the membership as a whole, which resembles the board of directors of a business organisation. ISO Council meets three times a year and its membership is rotated to ensure that it is representative of ISO's membership. Operations are managed by a Secretary-General, which is a permanent appointment. The Secretary-General reports to a President who is a prominent figure in standardisation or in business, elected for two years. The Secretary-General is based at ISO Central Secretariat in Geneva, Switzerland, with a compact staff which provides administrative and technical support to the ISO members, co-ordinates the decentralised standards' development programme, and publishes the output.

How the ISO system is financed

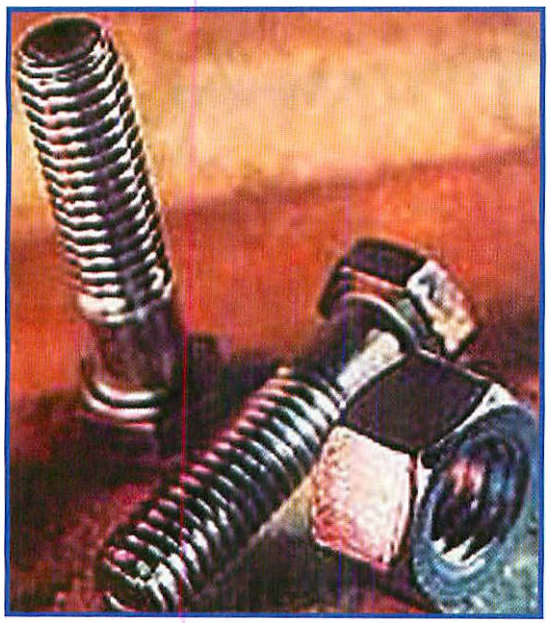
ISO's national members pay subscriptions that meet the operational cost of ISO's Central Secretariat. The subscription paid by each member is in proportion to the country's Gross National Product and trade figures. Another source of revenue is the sale of standards. However, the operations of ISO Central Secretariat represent only about one fifth of the cost of the system's operation. The main costs are borne by the member bodies which manage the specific standards' development projects and the business organisations which loan experts to participate in the technical work. These organisations are, in effect, subsidising the technical work by paying the travel costs of the experts and allowing them time to work on their ISO assignments.

How ISO decides what standards to develop

Working through the ISO system, it is the sectors, which need the standards that are at the origin of their development. What happens is that the need for a standard is felt by an industry or business sector which communicates the requirement to one of ISO's national members. The latter then proposes the new work item to ISO as a

whole. If accepted, the work item is assigned to an existing technical committee. Proposals may also be made to set up technical committees to cover new scopes of technological activity. In order to use resources most efficiently, ISO only launches the development of new standards for which there is clearly a market requirement.

The focus of the technical committees is necessarily specialised and specific. In addition, ISO has four general policy development committees with a more horizontal approach. Their job is to provide strategic guidance for the standards'



development work on cross-sectoral aspects. They are: CASCO (conformity assessment); COPOLCO (consumer policy); DEVCO (developing country matters); INFCO (information systems and services). These committees' help to ensure that the specific technical work is aligned with broader market and stakeholder group interests.

Who develops ISO standards

ISO standards are developed by technical committees comprising experts on loan from the industrial, technical and business sectors, which have asked for the standards and which subsequently, put them to use. These experts may be joined by others with relevant knowledge, such as representatives of government agencies, testing laboratories, consumer associations, environmentalists, and so on. The experts participate as national delegations, chosen by the ISO national member institute for the country concerned. These delegations are required to represent not just the views of the organisations in which their participating experts work, but of other stakeholders too. According to *ISO rules*, the member institute is expected to take account of the views of the range of parties interested in the standard under development and to present a consolidated, national consensus position to the technical committee.

How ISO standards are developed

The national delegations of experts of a technical committee meet to discuss, debate and argue until they reach consensus on a draft agreement. This is then circulated as a Draft International Standard (DIS) to ISO's membership as a whole for comment and balloting. Many members have public review procedures for making draft standards known and available to interested parties and to the general public. The ISO members then take account of any feedback they receive in formulating their position on the draft standard. If the voting is in favour, the document, with eventual modifications, is circulated to the ISO members as a Final Draft International Standard (FDIS). If that vote is positive, the document is then published as an International Standard.

Every working day of the year, an average of 13 ISO meetings are taking place somewhere in the world. In between meetings, the experts continue the standards' development work by correspondence. Increasingly, their contacts are made by electronic means and some ISO technical bodies have already gone over entirely to electronic working, which speeds up the development of standards and reduces travel costs.

When speed is of the essence

ISO standards are developed according to strict rules to ensure that they are transparent and fair. The reverse side of the coin is that it can take time to develop consensus among the interested parties and for the resulting agreement to go through the public review process in the ISO member countries. For some users of standards, particularly those working in fast-changing technology sectors, it may be more important to agree on a technical specification and publish it quickly, before going through the various checks and balances needed to win the status of a full International Standard. Therefore, to meet such needs, ISO has developed a new range of 'deliverables', or different categories of specifications, allowing publication at an intermediate stage of development before full consensus: Publicly Available Specification (PAS), Technical Specification (TS), Technical Report (TR), Industry Technical Agreement (ITA).

ISO's international partners

ISO collaborates with its partners in international standardisation, the IEC (International Electrotechnical Commission), whose scope of activities complements ISO's. In turn, ISO and the IEC cooperate on a joint basis with the ITU (International Telecommunication Union). Like ISO, the IEC is a non-governmental body, while the ITU is part of the United Nations Organisation and its members are governments. The three organisations have a strong collaboration on standardisation in the fields of information technology and telecommunications.

ISO's regional partners

Many of ISO's members also belong to regional standardisation organisations. This makes it easier for ISO to build bridges with regional standardisation activities throughout the world. ISO has recognised regional standards organisations representing Africa, the Arab countries, the area covered by the Commonwealth of Independent States, Europe, Latin America, the Pacific area, and the south-east Asian nations. This recognition is based on a commitment by the regional bodies to adopt ISO standards — whenever possible without change — as the national standards of their members and to initiate the development of divergent standards only if no appropriate ISO standards are available for direct adoption.

Specialist liaisons

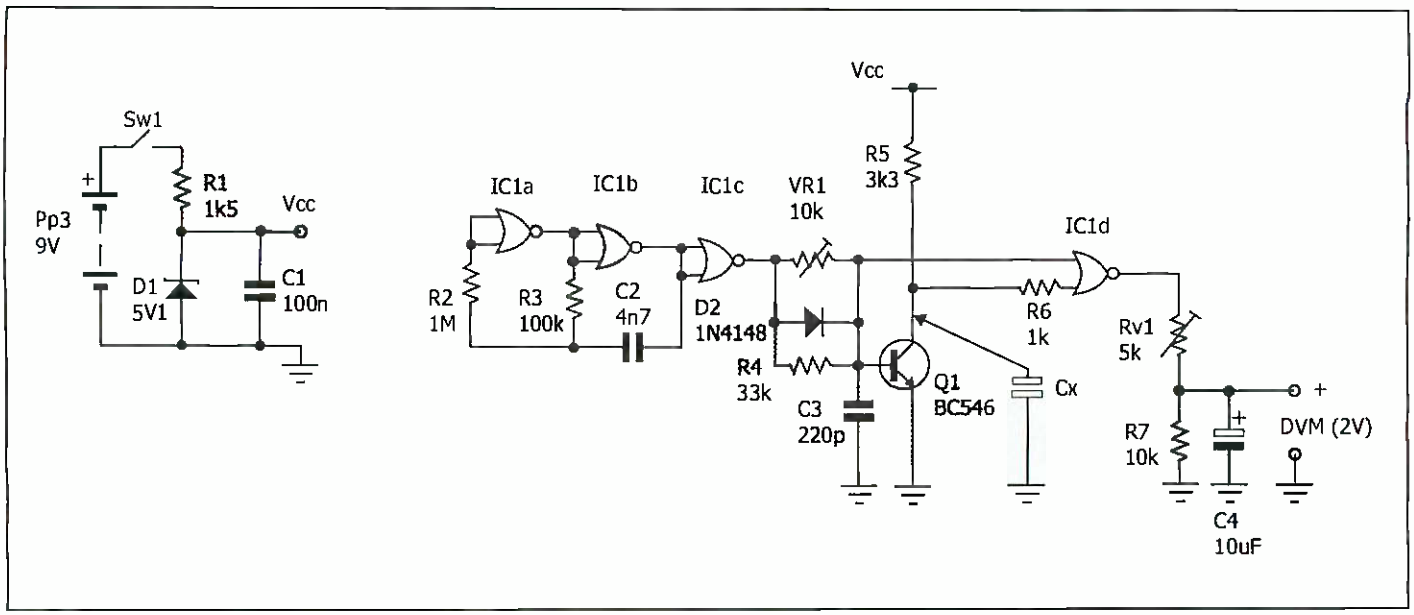
ISO also liases with some 550 international and regional organisations interested in aspects of ISO's standardisation work. These include the 28 or so international standards developing bodies outside the ISO/IEC system. Each of these bodies works in a specific area, usually with a United Nations mandate; an example is the World Health Organisation. ISO and the IEC together produce about 85% of all International Standards, and these other specialised bodies account for the rest.

Special products

In addition to International Standards and the 'new deliverables', ISO develops guideline documents, manuals for developing countries, standards compendia – as paper products and CD-ROM's – handbooks and a whole range of standards-related publications. ISO also publishes two magazines: the monthly ISO Bulletin which presents an overview of ISO's activities, and the bimonthly ISO 9000 + ISO 14000 News.

Simple One Chip CAPACITANCE METER

by John Edwards



THIS CIRCUIT IS FOR A VERY SIMPLE CAPACITANCE METER. CALIBRATION IS PROVIDED TO TRIM OUT THE STRAY CAPACITANCE SO THAT IT CAN MEASURE SMALL VALUES.

As drawn, it is for a single fixed example range of 20nF full scale, but it is easily adaptable over a wide range, and to cover multiple ranges. Details of construction are not shown.

The way it works is to use the unknown capacitor Cx to set the width of a pulse. By generating this pulse at a fixed frequency, an output is generated in which it has a duty cycle proportional to the value of Cx. This signal is then filtered and metered. The meter is calibrated to give full scale when the duty cycle is at its maximum. In this circuit, the maximum duty cycle will be 50 (that is, the pulse will be high for half of the cycle)

A PP3 is used for power, as it is easy to connect to. Measurement begins with SW1 closing, which turns the power on; a press-button switch might be best here. Vcc is set at 5.1V by R1 and zener D1, and is supplied to the 74HC02 quad NOR chip. This chip needs a decoupling capacitor C1 mounting close to it across the power pins. Three NOR gates U1a and U1b form a commonly used oscillator, with R3 and C2 as the main timing elements and U1c as an output buffer. The squarewave output 'Osc' of this oscillator drives the transistor Q1 on and off. When Osc is high, it discharges Cx with Q1, whilst forcing U1d output low via D2. When Osc goes low, the transistor is turned off, and Cx starts to charge via R5. After a slight delay set by VR1 and C3, U1d output will go high. This short delay in releasing U1d compensates for the turn-on delay of Q1, and for stray capacitance on the Cx terminals, and due to D2 it is only applied to the falling edge of Osc. When Cx voltage on rises through the logic threshold of U1d, the output of this gate will go low again, so producing a variable duty-cycle signal. The maximum duty cycle is 50 , which when averaged will give Vcc/2, This is just over 2.5V. For the circuit values given this will be when Cx is about 23nF, so VR2 and R7 form a potential divider to give a maximum output across R7 of 2.3V. Then a DVM on a 2V range can be used across R7 to measure up to 20nF with 10pF resolution. Note that polarised capacitors should be connected with the positive end towards R5.

Reducing C2 in value increases the pulse rate, and thereby reduces the value range for Cx which gives the equivalent of 2V out on the DVM. For example, changing it to 470pF will give a 2.0nF full-scale equivalent reading, increasing it to 47n will produce an effective 200nF full-scale. Alternatively, R5 can be altered. Increase it to reduce full-scale. Reducing it is not advised, as this increases the current drawn from the PP3. The circuit values give a pulse rate of around 9.25kHz, and a time period of 108us. Full scale occurs when R5 times Cx is 0.7 times this, which is 76.4us, so with R5 at 3.3k, the maximum for Cx would be around 23nF.

Send in your circuit ideas to Electronicsand Beyond and we will publish your ideas. Mark all circuits for the attention of the editor and send via email to editor@electronicsandbeyond.com or to:
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The aim of the this survey is to ensure we are providing you with an opportunity to tell us what you think of the magazine and also helps us keep your records up-to-date on our database.

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Alternative Technology

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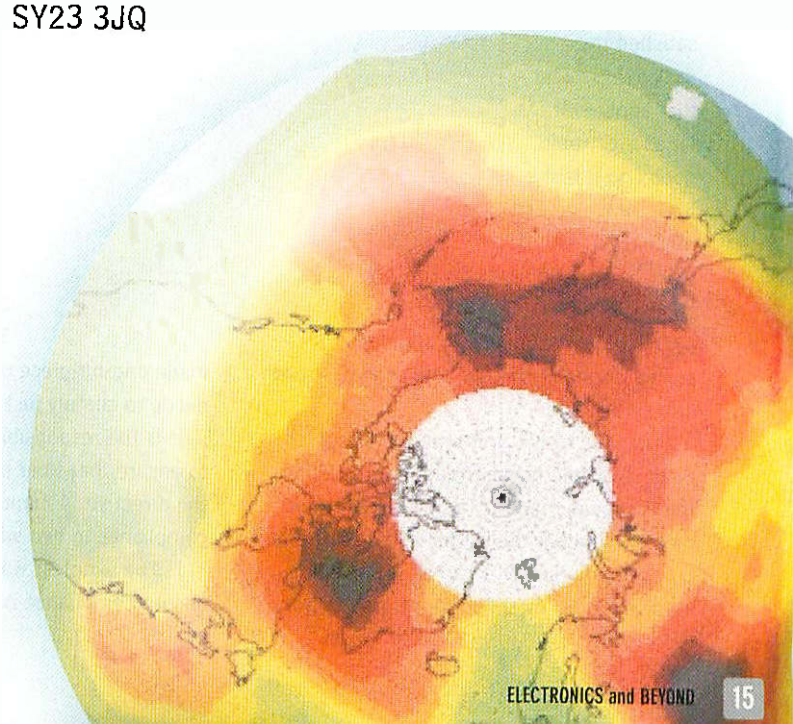
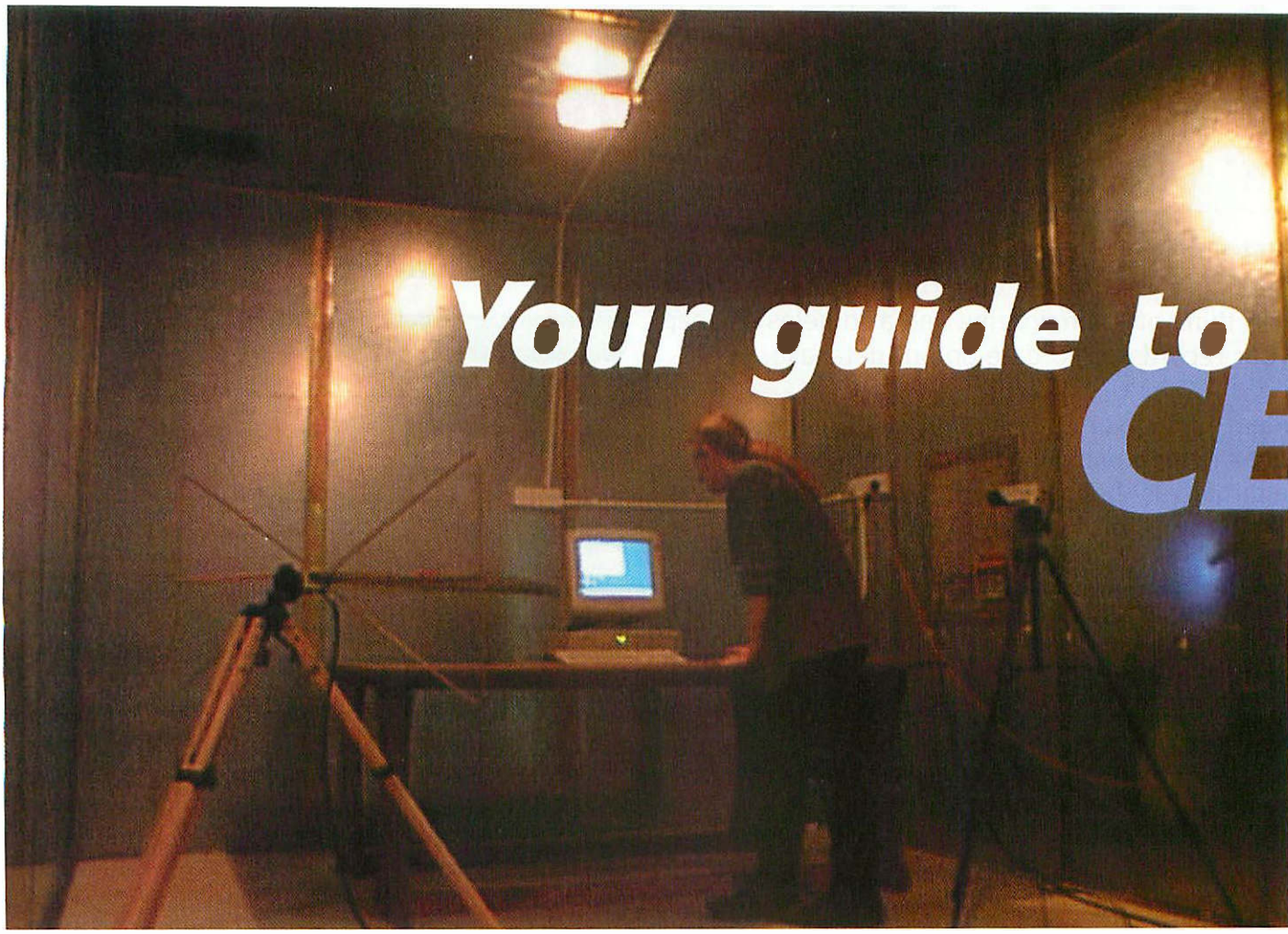




Your guide to CE

WHAT MAKES AN ELECTRONIC OR ELECTRICAL PRODUCT SAFE FOR USE IN EUROPE? GARETH BRADLEY REPORTS ON WHAT IT TAKES TO BRING PRODUCTS UP TO THE STANDARD OF BEARING THE CE MARK. PART 1

If a product has the CE marking on it, it guarantees the free passage of those goods throughout the member states of the European community. The term CE itself comes from the French phrase Conformité Europeene that means literally European Conformity. A CE mark on a product means that the product has satisfied the directives (tests) that apply to it. As far as electronic goods go it is the EMC Directive. EMC meaning electromagnetic compatibility.

This directive applies to all goods placed on the EU market and products taken into service.

It applies to the first time a product is made available for distribution or used in the European market. The product can be manufactured in the EU for release into the European market or it can be produced outside the EU intended for release into the European market. In either case the product needs to comply with the directive.

For equipment that is taken into service, it means that a manufacturer who imports or manufactures a product for his or her own use which is not commercially available. This could be a custom made one-off piece of equipment, but it still needs to comply just the same.

It is the responsibility of the manufacturer to ensure that their products comply with the directive. A manufacturer can ensure compliance in two ways.

1. The simplest way a manufacturer can ensure compliance is through self-certification. This can be done through sending the product to be tested to an EMC test house or by in-house testing if the manufacturer has such a facility and tested to the relevant standards for the product in question. Due to the potentially high cost of having such a facility many small to medium enterprises cannot afford the outlay for such a test facility and so they tend to send to a test house.

2. The alternative is to produce what is called a technical construction file. This file needs to be kept at hand for inspection by the bodies responsible for policing the directive. The technical construction file should contain design procedures aimed at reducing potential electromagnetic interference. It should also include any test results that are carried out by a competent body. A competent body is a test house that has been accredited by the United Kingdom Accreditation Service (UKAS). This method

of compliance came into force in January 1996 and should be used if there is no way of testing by the first method.

Once compliance has been shown then a declaration of conformity can be issued. This must contain a description of the product and reference to route of conformity and tests carried out. It's a signature to bind the manufacturer. Once this has been done then the CE mark can be placed on the product, placed in the operating instructions, on the guarantee certificate or on the packaging.

MARKING

by Gareth Bradley

The enforcement of the EMC Directive is down to the enforcement authorities. They have powers to procure test purchases, powers for search, seizure of apparatus or documentation. They can issue prohibition and suspension notices. It is up to each member state of the EU to enforce the Directive.

In the United Kingdom the enforcement authorities are the weights and measures authorities but in practice the trading standards enforce the regulations. In Northern Ireland it is the Department of Economic Development.

There are bodies for enforcement for specific apparatus.

The CAA is responsible for wireless telegraphy apparatus and the Director General of Electricity supply for electricity meters.

The directive requires that each member state takes appropriate steps to ensure that only goods that are compliant are either taken into service or placed on the EU market, therefore, there are measures like fines and penalties in place for breaches of the directive.

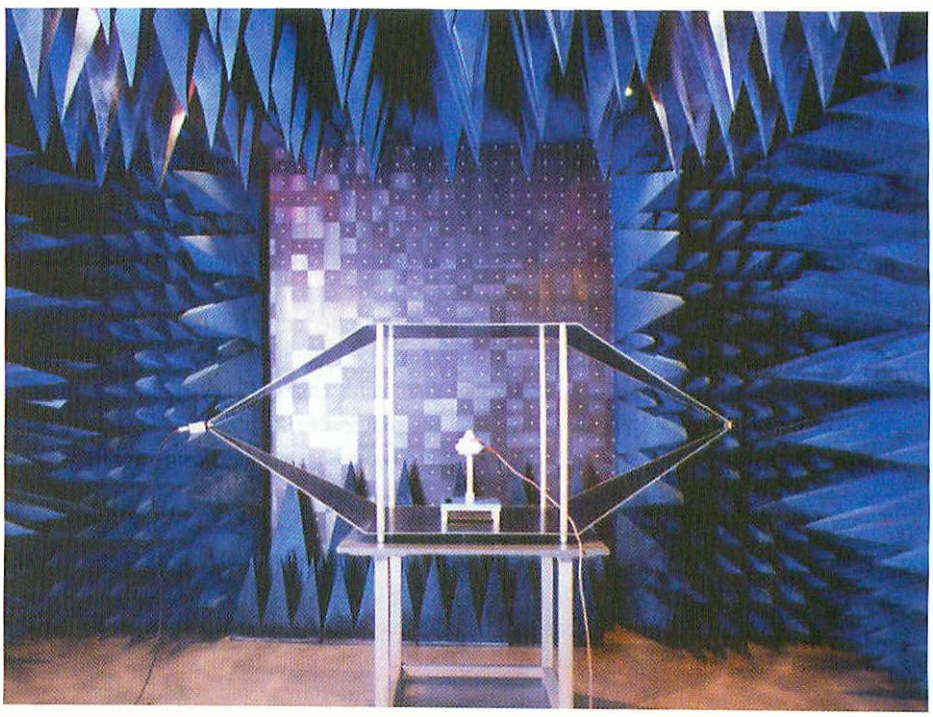
Breaches fall into these catagories.

1. Knowingly supplying or taking into service relevant apparatus breaching the directive.
2. Contravention of a prohibition or suspension notice.
3. Provision of false or misleading information in the required documentation.
4. Knowingly affixing the CE marking or an inscription that may be confused with the CE marking, to non-compliant apparatus and or issuing a false declaration of conformity.
5. Failure to assist an enforcement officer (obstruction).
6. Anyone pretending to be an enforcement officer.
7. Failure to retain full documentation.

The penalties for these offences are.

For offences 2,3 and 6 they carry, on conviction, an imprisonment for up to 3 months and/or a fine up to a level 5 fine of £5000.

For offences 1,4,5 and 7 they carry a fine up to level 5, a fine of £5000.



Where someone is convicted of offences 1 or 4 then the court may decide to order that remedial action be made by the person committing the offence in order for the equipment to become compliant. This has to be done within a specific time period as decided by the court. This time period can be extended by the order of the court.

An enforcement authority can under the regulation call for the forfeiture of any equipment found to be in breach of the directive, a forfeit of some or all of the equipment in question. The courts will only grant a forfeiture order if it is satisfied that the equipment does not satisfy the protection requirements of the directive. Forfeited equipment will either be destroyed, disposed of for reconditioning or disposed of for scrap as directed by the court.

There is the defence of due diligence. If a manufacturer can show that he has taken all necessary steps to obtain compliance and can show that he could not do any more then this is defence of due diligence and they may not be convicted.

It is left to each member state of the EU to police the directive. The level to which this is done can vary from country to country in the EU. The trading standards are responsible for policing the directive in the United Kingdom and the cost of this has to be taken out of the trading standards existing budget. It is therefore not heavily enforced. They are however obliged to investigate if they receive a complaint about a product that does not comply or is suspected not to comply. Some countries within the EU enforce the directive a lot more vigorously than in the United Kingdom. Germany, for example, brings quite a lot of cases to court every year.

As most manufacturers do not have necessary expertise and test facilities to produce the required documentation to support any claim that the manufacturer makes against any of his products. The responsibility to show compliance still falls on the manufacturer and they will most definitely incur costs in doing so.

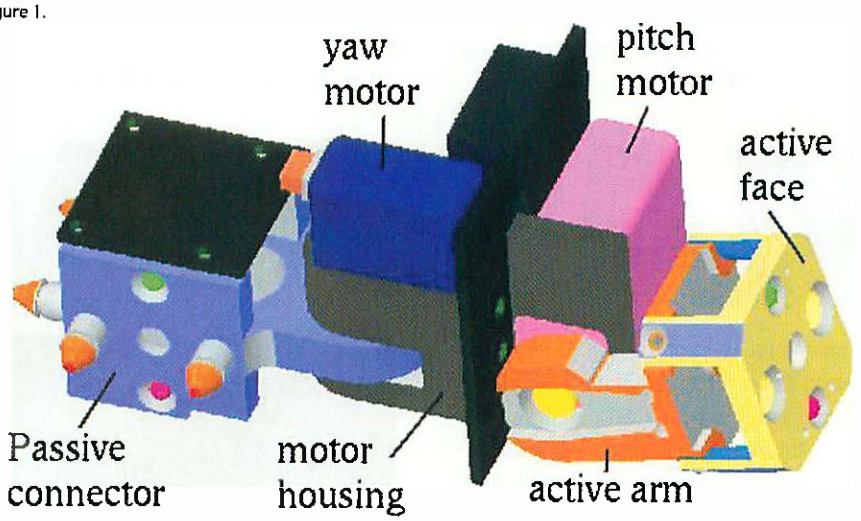
Next Month: find out the difference between pre-compliance and compliance...

Configurable ROBOTS

by Reg Miles

AT THE UNIVERSITY OF SOUTHERN CALIFORNIA'S INFORMATION SCIENCES INSTITUTE, RESEARCHERS ARE BUSY PRODUCING SMALL ROBOTS THAT CAN ASSEMBLE THEMSELVES INTO LARGER UNITS TO PERFORM TASKS THAT WOULD BE IMPOSSIBLE FOR THEM TO DO ALONE.

Figure 1.



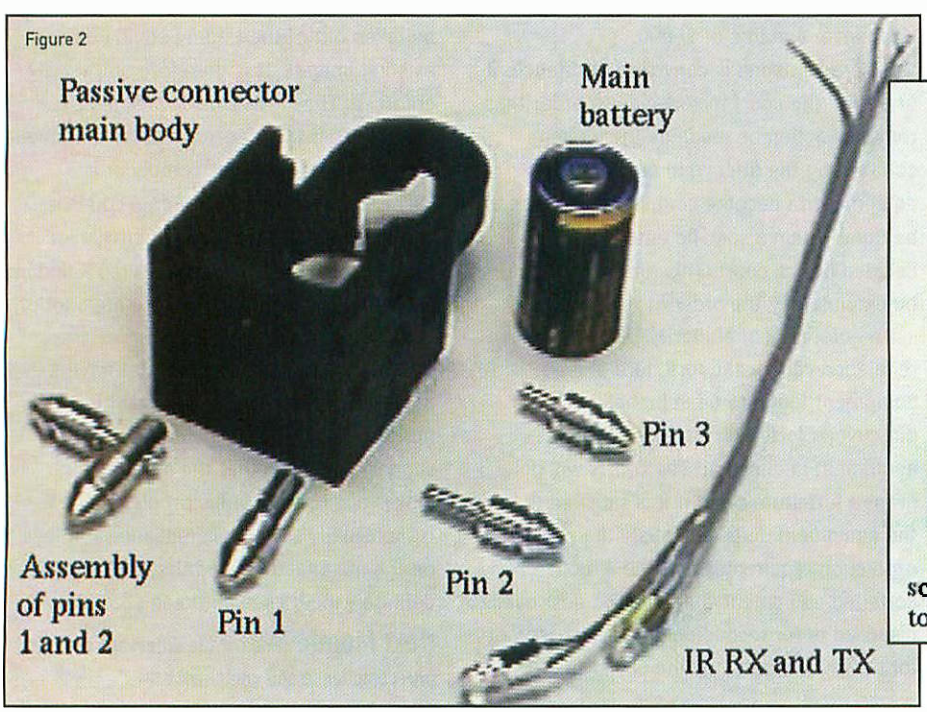
As the press release puts it: 'Soon they may even be creeping through crevices in earthquake debris or braving flames at a fire scene. Once inside, they might assemble into devices that can carry cameras, water or medicine to people trapped in the rubble. Or they could even jack up rocks and clear an escape path. Other possible tasks include surveillance work or scouting on battlefields.' The research is supported by DARPA, the central R&D organisation of the US Department of Defense.

Each configurable robot, or CONRO, measures just 10cm in length, and consists of a few small electric motors, a computer chip and an 'active end' that can move back and forth, and up and down. Special plugs on this active end fit into receptacles on the front of other devices. The onboard computer chip directs the robot's activities. Each unit's chip can also communicate with the processors in other CONRO units to send and receive instructions using infrared transmitters.

Researchers Andres Castano and Wei-Min Shen are currently creating software for the CONRO system, using two separate approaches. Castano, who designed the units and actually built many of them, pursues a 'holistic pattern' in which a single program totally guides assembled robots through their activities. While Shen pursues an alternative strategy using software modules called 'hormones', by analogy with biological chemical messengers, with each hormone designed to elicit a certain behaviour, and action by consolidated CONRO units being accomplished by orchestrating hormones in different orders and permutations.

The CONRO team recently succeeded in getting a snake of six modules to find and link to its own tail, forming a ring capable of standing on its side and rolling forward. In another eight-unit configuration the CONRO units form an insect-like creature that walks on six legs, moving three at a time.

Figure 2



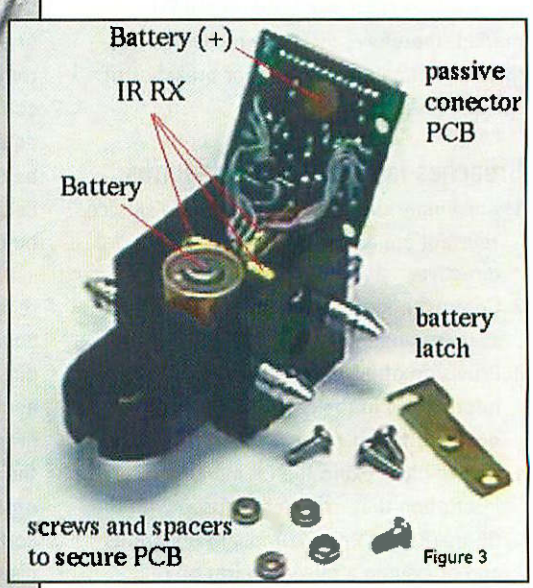


Figure 3

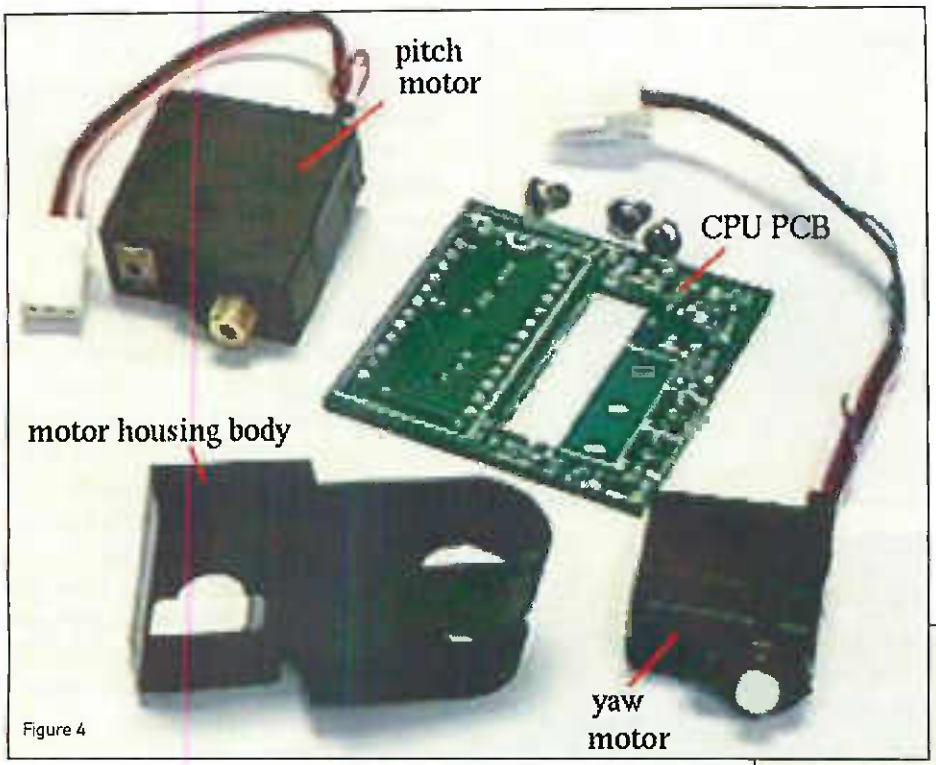


Figure 4

Team leader Peter Will notes that the creation of truly 'metamorphosing' robots will require many improvements, including better chips that run on less power. The software demands are daunting, too, apparently. 'The robots must recognise the conditions that dictate a change in form, must determine the proper new form to assume, and be able to do so quickly and efficiently under confused, real world conditions. These are major challenges. Nevertheless, the rewards for successful implementation of this technology make a vigorous effort worthwhile, and we are cheered by the successes we have so far achieved.'

The module has three main parts (see Figure 1): a passive connector that has pins to allow the module to connect to other modules, a motor housing that supports the servos of the module, and an active connector that contains the connection and disconnection mechanism that allows other modules to attach to it. The active connector has two subparts: an active arm that is connected directly to the pitch motor and an active face that actually holds the connection/disconnection mechanism.

The main part of the passive connector, its body, is a 25mm cube with a tail that is used to attach the passive connector to the yaw motor (see Figure 2). The body is made from delrin. On three faces of the cube are installed an infrared pair and 2 aluminium pins. Due to space constraints, the three pins are different. Pins 1 and 2 actually intersect inside the cube and thus, pin 1 has a hole that pin 2 screws into, as shown in the figure.

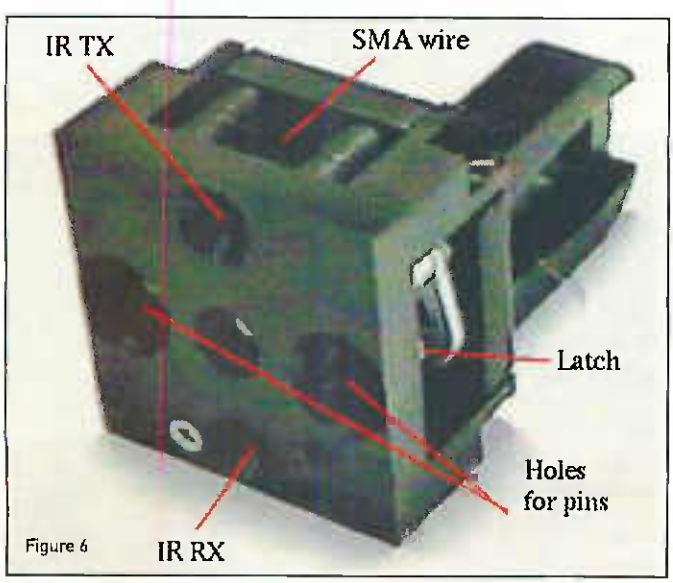


Figure 6

The body of the active connector also serves as the main battery holder. Figure 3 shows the battery installed inside the body of the passive connector. The pins and the infrared pairs have also been installed. The cables of the infrareds are soldered directly to a PCB that lies on top of the passive connector and the bottom of the PCB has a pad that contacts the cathode of the battery; with the battery latch providing the contact for the anode.

Although each module is self contained, the economics dictate that all tests are performed using an external power supply and cables: the reason being that each module uses two S6 batteries and they last for 35-40 minutes; a hexapod configuration requires nine modules so it costs over $100 to power it, so an experiment that lasts five hours costs around $800.

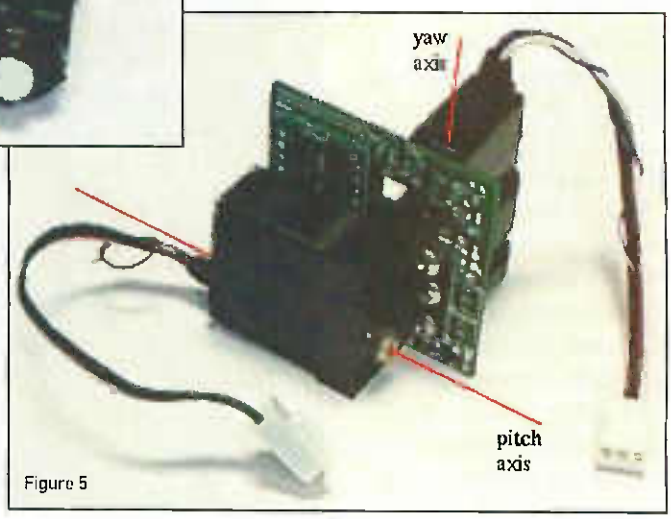


Figure 5

Figure 4 shows the motor housing and the pitch and yaw motors that provide the locomotion. The CPU PCB has not been populated. Figure 5 shows the motor housing assembled, with indications of the pitch and yaw axes. The shaft of the yaw motor connects to the passive connector, while the shaft of the pitch servo connects to the active connector.

This is being constantly improved, and so not much detail has been provided. However, the version shown in Figure 6 is already

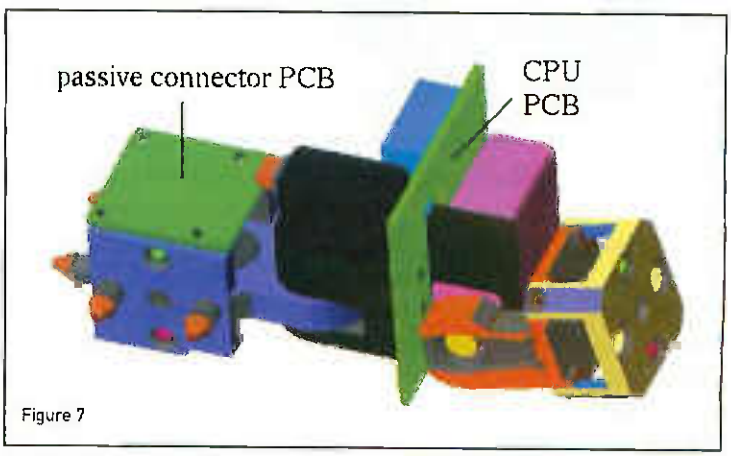


Figure 7

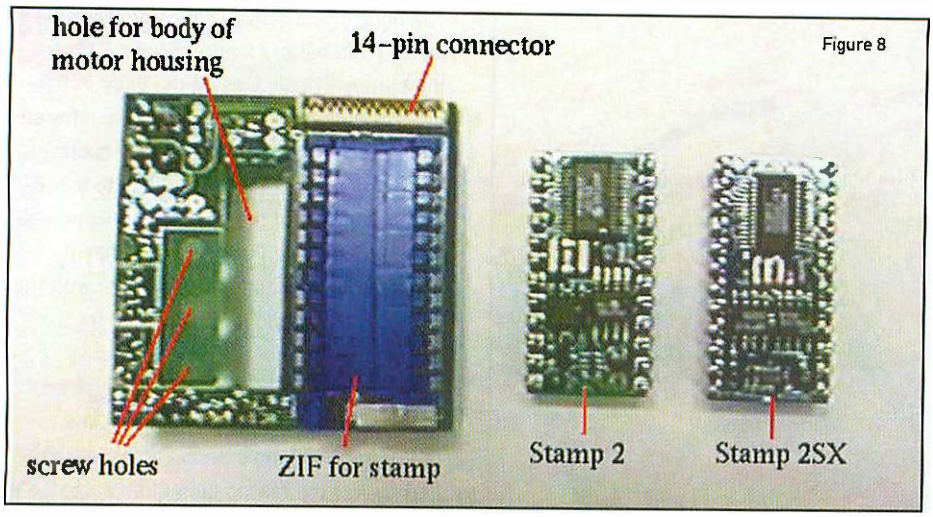


Figure 8

functional, albeit not completely reliable, apparently. The active connector has four holes in its face: two of these are for the infrared receiver and transmitter; the other two are receptacles to take the pins of other modules. When the pins of another module are inserted into the active face, the latch engages grooves on the pins and secures them. Releasing the pins is achieved by the contraction of a wire pulling the latch back. Figure 7 shows the electronic components of the module. Apart from the infrared receiver and transmitter, all the components are on two PCBs - one on top of the passive connector, the other on the motor housing between the two servos. The PCB located on top of the passive connector controls the infrared receiver and transmitter of the passive connector. The second board, which contains the CPU, comes in two versions - left and right - to conform to modules that have their pitch motor on either the left or right side. Figure 8 shows the front side of the right version of the CPU PCB. The stamps were selected as processors for several reasons: being based on PIC microprocessors they are available everywhere and they have an on-board EEPROM; additionally they offer a good compromise between computational power (frequency of the PIC and memory) and power consumption. Two, largely interchangeable, versions of the stamp are used: stamp 2 consumes only 8mA at 5V running at 20MHz; stamp 2SX runs at 50MHz but consumes 60mA at 5V. The task at hand determines which stamp to use. And the zero insertion force (ZIF) socket allows it to be easily removed for either replacement or reprogramming.

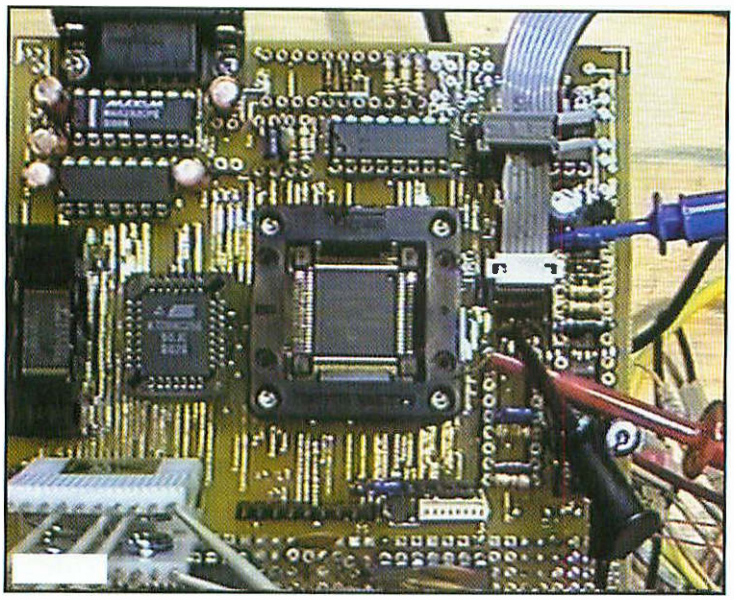
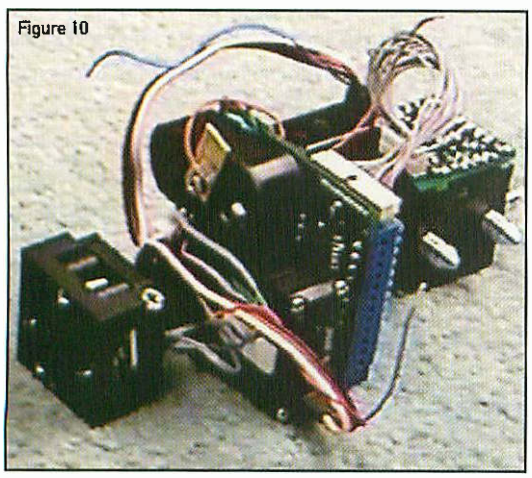


Figure 10



However, a 68HC12-based board has been designed to replace the stamp-based boards (see Figure 9). Originally designed by Marcos Ferretti; it was finished, debugged, implemented and tested by Arvind Seshadri who has continued with its development.

The back of the right version of the CPU PBC has four main components: a super-capacitor that prevents the CPU from resetting when the voltage drops due to motor motions, two 3 pin connectors to control the two servos, a multiplexer to increase the number of input lines of the stamp and an 8-bit ADC to read analogue signals from the motors and the IR receivers.

The resulting CONRO module is shown in Figure 10 and a combination device in Figure 11. Figure 12 is an artists impression of what the researchers hope to be able to achieve. But there are still major challenges ahead, including packaging, power and cooling, as well as the issue of programming and program control.

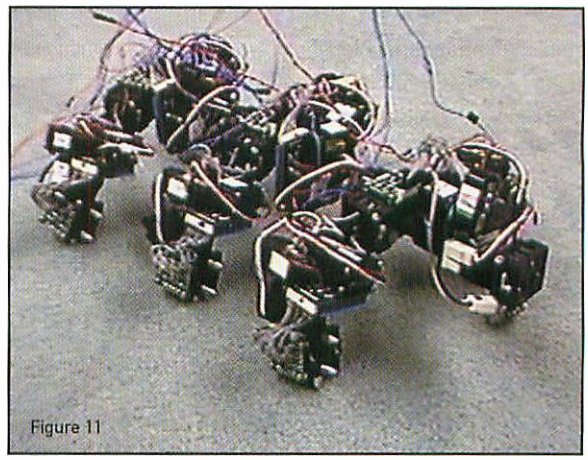


Figure 11

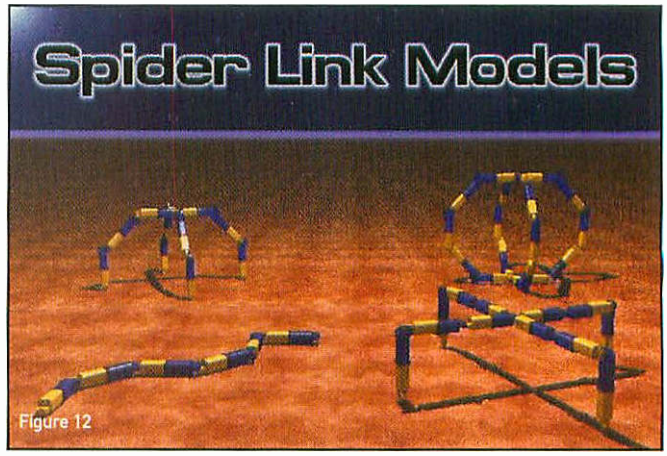


Figure 12

For more information contact: uscnews@usc.edu

All pictures: USC Information Sciences Institute.

Robot Kits

5 Axis Arm Kit £165.00
- Preassembled electronics
- Easy to assemble mechanics
- BASIC controllable, uses Mini SSC

3 Axis Arm Kit £130.00
- Preassembled electronics
- Simplified design
- BASIC controllable, uses Mini SSC

Mobile 5 Axis Arm £210.00
- Jumpstart your advanced experiments
- Make a remote piloted arm
- Includes the Mini Servo Controller

Mobile 3 Axis Arm £175.00
- Jumpstart your advanced experiments
- Make a remote piloted arm
- Includes the Mini Servo Controller

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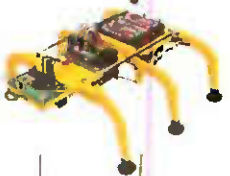
- Jumpstart your advanced experiments
- Make a remote piloted arm
- Includes the Mini Servo Controller

Hexapod 2 Kit £320.00
- Large 300mm x 300mm walker
- 90mm ground clearance
- Walks with a variety of gaits

Hexapod 2 / Big Grip Kit £375.00
- Includes wide gripper
- Large 300mm x 300mm walker
- Walks with a variety of gaits

Quadrapod Walker £250.00
- Large 180mm x 300mm walker
- 90mm ground clearance
- Includes the First Step/Next Step Micro



Hexapod Walker Kit £130.00
- Simple 3 servo walking robot
- Add IRPD for autonomous operation
- Includes the First Step/Next Step Micro

Remote Piloted Hexapod £180.00
- Robot walks under remote control
- Includes pan/tilt for CCD camera
- Includes the First Step/Next Step Micro

Carpet Rover 1 Kit £89.00
- First Step equipped
- Add IRPD for autonomous operation
- 150mm x 150mm footprint

Carpet Rover 2 Kit £95.00
- Next Step equipped
- Add IRPD for autonomous operation
- 150mm x 150mm footprint

Electronics

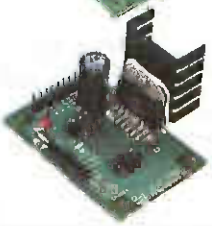
First Step Micro Kit £35.00
- Robotics Microcontroller (Stamp 1)
- Easy to assemble circuit board
- Programmable in Parallax Basic

Next Step Micro Kit £35.00
- Robotics Microcontroller (Stamp 2)
- Easy to assemble circuit board
- 2 LEDs and push buttons

Mini Servo Controller £40.00
- Preassembled electronics
- Control up to 8 servos per SSC
- Tiny footprint suitable for robotics

IR Proximity Detector Kit £26.00
- No contact obstacle detection
- First/Next Step compatible
- Adjustable range

Line Tracker Kit £18.00
- Reliable line tracking made easy
- First/Next Step compatible
- Sumo robot edge detector



Dual H-Bridge Kit £26.00
- Speed and direction is controllable
- First/Next Step compatible
- 2 amps per channel at 12 volts

Living with WIND

WELCOME TO ELECTRONICS & BEYOND'S GREEN PAGES. IN COLLABORATION WITH THE CENTRE FOR ALTERNATIVE TECHNOLOGY, THE MAGAZINE PRESENTS THE FIRST IN A SERIES OF FEATURES ON ALTERNATIVE TECHNOLOGY THEORY AND PRACTICE.

LIVING WITH WIND

...AN EXTRACT FROM HUGH PIGGOTT'S BESTSELLING TITLE IT'S A BREEZE: A GUIDE TO CHOOSING WINDPOWER. FUTURE EDITIONS WILL FEATURE INTRODUCTIONS TO SOLAR AND HYDROPOWER.

The Centre for Alternative Technology (CAT) is based in Machynlleth in mid-Wales and has been at the forefront of the alternative technology movement since its inception in 1975. Originally intended to be a statement in environmentally friendly living by a group of like-minded individuals looking to practice what they preached, CAT has grown into an internationally renowned centre for research into renewable energy systems, organic horticulture, alternative building methods and waste and water treatment systems. The centre offers consultancy in all its main areas of interest, runs a visitor's centre open to school and university groups and the general public, runs educational and leisure courses, has developed a travelling exhibition and collaborates with two universities on higher degrees. CAT also has its own list of publications to support the services offered by its free information service. The extract featured here is taken from one such title...

Living with wind – Its a breeze! A guide to choosing windpower by Hugh Piggott

Although we can all buy green electricity from the national grid, there are some situations where a stand-alone windpower system can't be beaten: yachts, caravans, remote off- the-grid holiday homes – all can benefit from stand-alone green electricity. Choosing the right system, however, needs some careful thought and planning.

When it comes to small scale windpower production Hugh Piggott is, as Positive News described him, 'a true guru of the art.' Having run a remote renewable energy system from his island home in Scoraig, Scotland, for the past twenty-five years, he was the perfect choice for technical consultant to BBC TV's Castaway 2000. Hugh has now updated his starter guide to choosing a windpower system – It's a Breeze! In this extract below he tells you how to assess your energy needs as the first step to choosing the right wind system.

Assessing your needs

In order to assess your needs you need to understand the exact meanings of the two words, 'energy' and 'power'. Energy is what you pay for in your electricity bill. It is measured in units. The technical term for a unit of electricity is one 'kilowatt-hour' (kWh; equivalent to a one bar electric fire running for one hour). Power is the rate of delivery of energy. It is measured in watts. One kilowatt (kW) is 1,000 watts.

A load which uses 1kW of power will use 1kWh of energy in one hour. In two hours it will use 2kWh. So it is equally important to know both the power requirements of a load and the hours for which it will run. Then you can calculate the energy it will use.

Assuming that there is battery storage in the windpower system, it is not necessary to match the power output of the wind turbine to the power required by the load. Both of these power levels will vary in a complicated way, depending on wind conditions and user activity. Successful system design depends on matching energy supply over a period of time to the energy requirements of the user.

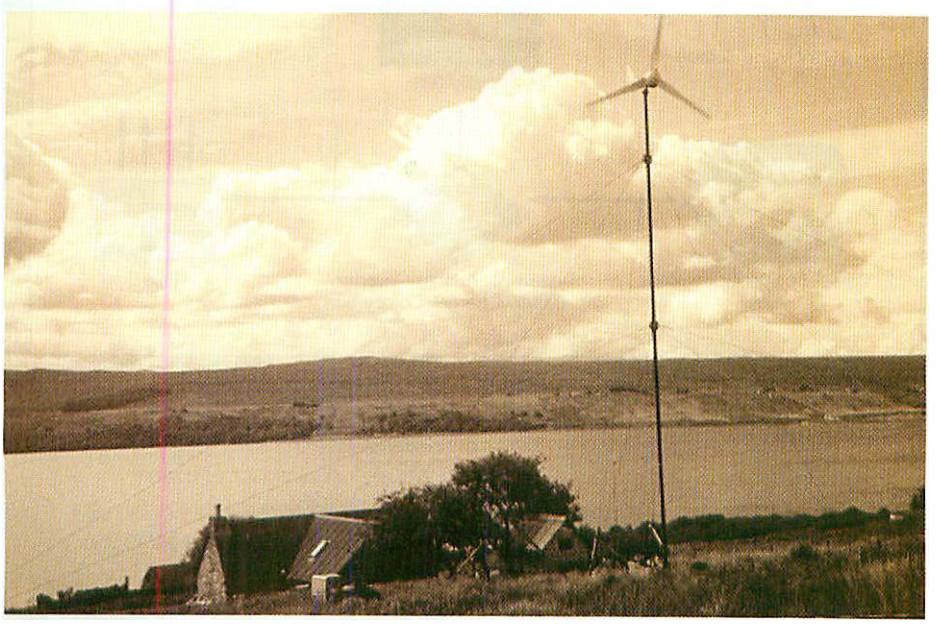
Here we shall discuss methods of estimating the energy requirements of some typical loads. The loads can be listed along with their power consumption and likely hours of use, so that energy consumption can be calculated for each load. This can be an interesting exercise, especially for the purpose of comparing the energy costs of different loads, but the answers will always be approximate. Given an approximate idea of the energy we shall need, we can match this up to an even more approximate estimate of the energy we expect to get from the wind turbine on our chosen site. This will help us to choose the best wind turbine for the job. An allowance should always be made for losses in the cable, battery and inverter (say 30% overall loss).

Often the resulting choice will be too expensive, and then it will be necessary to look hard at the list of loads. Much electrical energy can be saved by using other energy sources for the hungry items. Cooking, heating and even refrigeration can often be done by gas. Sometimes it is possible to use windpower in windy weather and then revert to fossil fuels in calms. For example, caravan fridges are often designed to run on gas or electricity, but it is important to realise that this kind use much more electricity (when electrically powered) than those which cannot be run on gas at all.

The first step is to choose a time period over which to study our energy demand. This should be a day or a week, as longer periods are not realistic in terms of battery storage. Next we make up a table with 4 columns. (See case study example).

Load Name	Power (watts)	Hours per week	Energy kWh/week
5 compact fluorescent lamps @ 20 watts each	100	40	4
TV (20" colour)	100	40	4
Vacuum cleaner	800	1	0.8
Washing machine	2,000	1	2.0
		Total	10.8
		+ 30% to cover losses	3.24
		TOTAL	14.04

Battery voltage: 24V
Capacity: 416 amp-hours, giving about 10 kWh
In this case the presence of the diesel engine generator makes battery capacity less critically important.
The battery would last about 4 days (80%=8 kWh).



- In column 1 put the name of the load.
- In column 2 put the power rating. This will be in watts or kW.
- In column 3 put an estimate of the average hours per week it will be in use.
- In column 4 multiply the entries from columns 2 and 3, to give energy demand in kWh.

If the entry in column 2 was watts rather than kW, then we need to divide by 1,000.

Some loads have two very different modes of operation. For example, a fax machine may use 50 watts when printing out (i.e. for a minute or two), but during its standby mode it only uses about 10 watts.

Often the hardest part to answer is column 3 – the hours. If the load is a fridge, for example, then it will turn itself on and off,

depending on the temperature and the number of times the door is opened. The only accurate way to measure the energy consumption of some loads is to use an electricity meter.

By totalling the figures in column 4, you can estimate your total energy needs over one week. This helps you to choose the right size of wind turbine. You will need to do this for both the summer and winter months.

You can also use this information to help with choice of battery capacity. There are two basic specifications for a battery: voltage and capacity in amp-hours. Multiplying volts by amp-hours gives the battery capacity in watt-hours. Divide this by 1,000 to obtain the kWh capacity of the battery. Compare this figure with the energy needs in kWh/week, and you can see how many days reserve the battery offers. A battery capacity sized to last between three days and a week is desirable.

The table of loads also helps with choosing a suitable inverter (a device for converting power from a battery for use by 240 volt a.c. loads – i.e. standard domestic equipment). Here we look at power requirements rather than energy. Loads which run from the battery require no inverter, and there is almost no limit to the amount of power which the battery can deliver at any given instant. Loads which run from the inverter need to be looked at in terms of the maximum load which they will put on the inverter if used simultaneously. The inverter should be chosen to meet this load.

So, now your interest in living with wind has been kick-started, CAT is offering a number of books, products and courses to Electronics & Beyond readers.

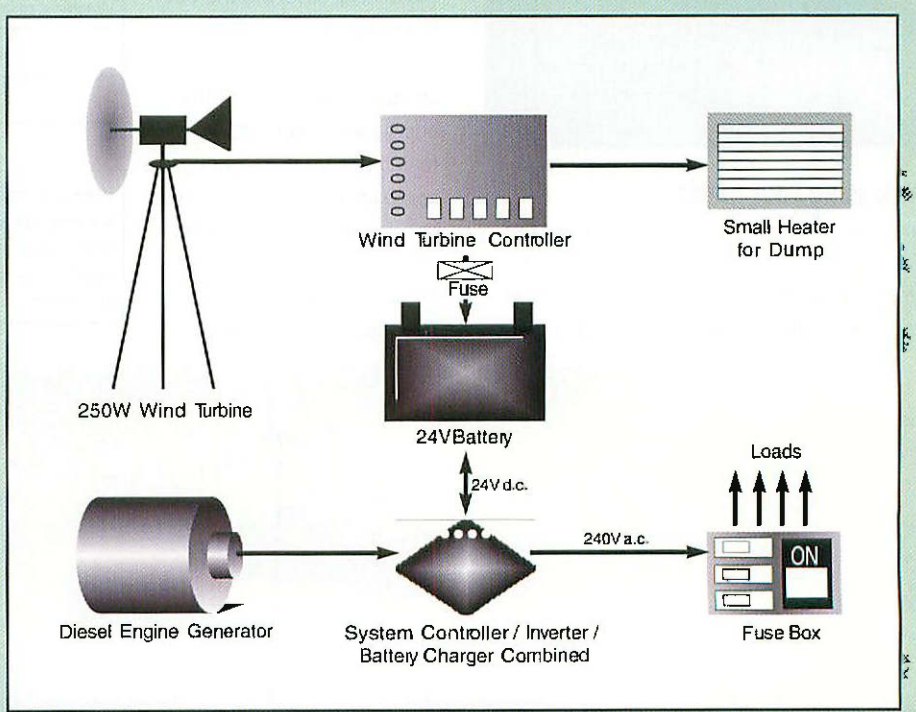
For further details and to order contact CAT Mail Order Department, CAT, Machynlleth, Powys, SY20 9AZ, Tel. 01654 705959 or visit the website at www.cat.org.uk and quote the reference E&8001.

Publications

It's A Breeze: *A guide to choosing windpower, Hugh Piggott, 36pp.* Offer price £5.40 (£5.99 rrp)

For anyone who wants to generate electricity from a wind turbine this extremely clear and non-technical book cuts straight through the jargon. Assess your needs, decide which system is best for you and find out where to place your turbine.

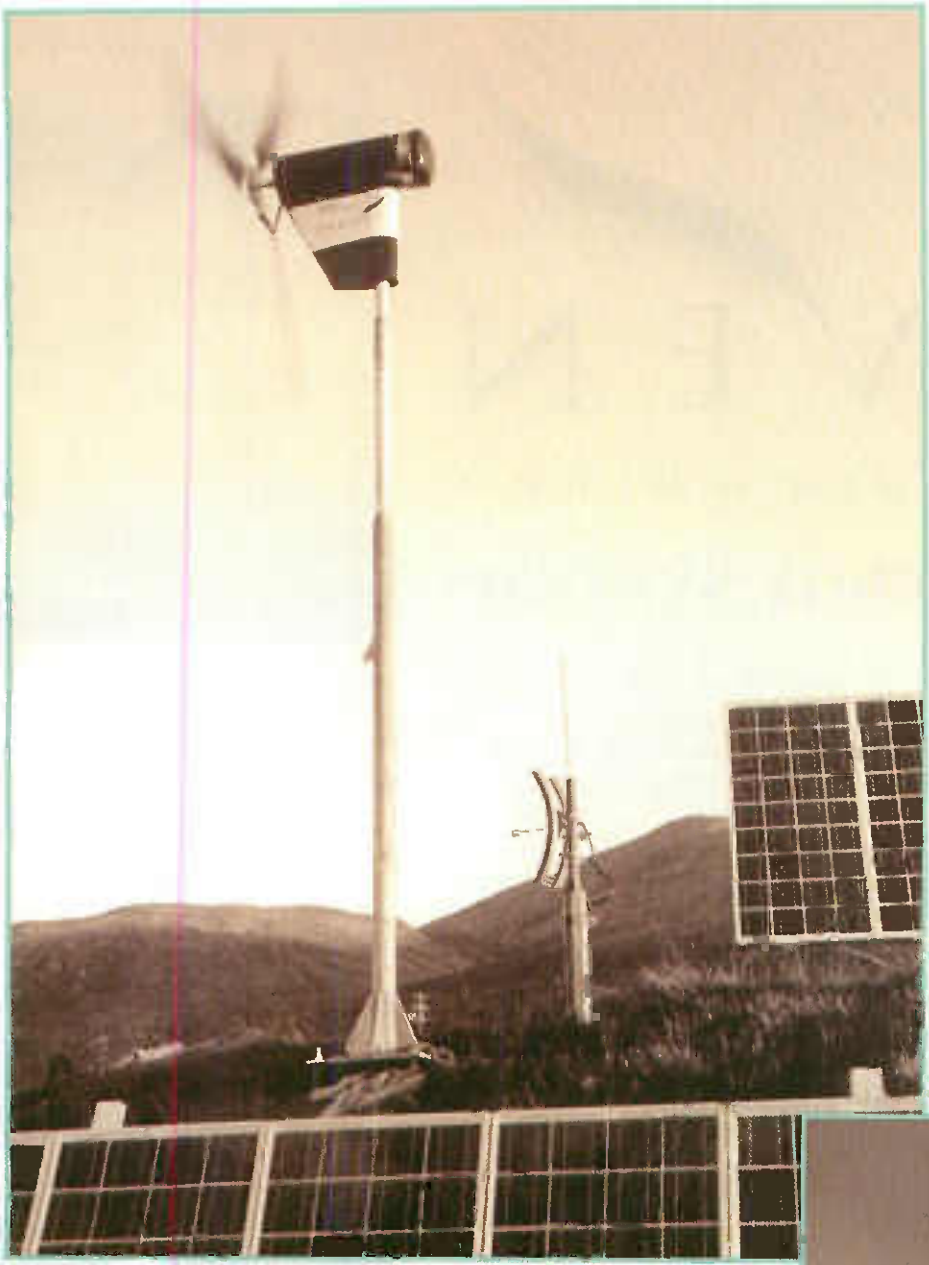
Case Study: *a holiday cottage*



This is a fairly minimal system, containing the basic ingredients for generation (wind turbine), storage (battery), and control (shunt regulator and fuse box). The wind turbine produces energy at the required voltage, but only when the wind blows. This energy is fed to the battery, which accumulates it until it is required by the loads. In the event that the battery is 'full', surplus energy is diverted into heating by the shunt regulator. This prevents damage to the battery and the loads, which would otherwise occur due to the system voltage rising too high. The fuse box is also used for protection, in this case against the consequences of a short circuit in the wiring, which could otherwise cause cables to overheat, starting a fire. No controls are necessary to prevent the battery being run down, since the owners will be monitoring the situation by watching the voltmeter.

How we assessed our case study's needs In the holiday cottage we need to keep energy use to a minimum, since it would be very expensive to provide the amount used by a typical household on the mains (about 20 kWh per head per week). With a little attention to energy conservation this can be cut right down.

- No electric heaters are provided, as there is good insulation and an efficient wood fired heating system.
- Compact fluorescent lights are used in place of normal 'incandescent' light bulbs. These lamps cost more to buy, but only use a fraction of the power to give the same light level.



Windpower Workshop,
Hugh Piggott. 160pp.
Offer price £9.00 (£10.00 rrp)
It is extremely satisfying to make your own power from a natural resource. Hugh Piggott, one of Britain's leading experts on the subject, explains very clearly how to design a home wind system and live with it, how to liase with suppliers and how to design and build your own wind generator from scrap and recycled parts.
Darrieus Wind Generator,
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Offer price £4.50 (rrp £5.00)
Savonius Type 12V DC - 200W. Offer price £2.70 (rrp £3.00) Savonius Type 12V DC - 5W. Offer price £2.70 (rrp £3.00) These DIY booklets are excellent value for those with some basic skills who are interested in constructing vertical axis wind generators.

Products

Wind Speed Indicator. Offer price £8.05 (rrp £8.95). A direct reading wind gauge which measures wind speed in the range of 5-50mph or 8-80 kph. With a scale to read metres per second and a compass to measure wind direction. Complete with instructions and suggested activities.

CAT Wind Kit. Offer price £17.95 (RRP £19.95) A practical model for demonstrating the potential of wind power, to generate electricity or do mechanical work - not suitable for very young children.

Courses

For further details and to book contact Joan Randle, Tel. 01654 705981 or email courses@cat.org.uk (fees include full board, tuition and materials). Please quote the reference E&B001.

Introduction to renewable energy systems
September 24-27. 2001
Fees: High waged: £230
Waged: £170
Non-waged/student: £120
This course will look at the potential for generating your own electricity from wind, water and solar power and also at the possibilities for reducing energy consumption.

Windpower
November 12-16, 2001
(Part 1: Nov 12-14. Part 2: Nov 14-16)
Fees: Ports 1 & 2 High waged: £350
Waged: £275
Non-waged/student: £175.
Fees: Part 1 or 2 only: High waged: £230
Waged: £170
Non-waged/student: £120.
Part 1 covers all the basic requirements for choosing and installing a wind energy system, and is suitable for those thinking of buying or building their own system, as well as for those with a general interest in the subject. Part 2 consists of detailed workshops on the design of wind machines.

For £16.00 per year you can join the Alternative Technology Association, CAT's member organisation, which entitles you to quarterly copies of the journal, Clean Slate, a 10% discount on all CAT Publications and other members' benefits. Contact ATA on 01654 705988, quoting the reference E&B001.

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WORLD FRIENDLY ENERGY

RENEWABLE ENERGY SYSTEMS

- Telecoms power supply
- Domestic/holiday homes
- Farms & water pumping
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Air Your Views

Colourful Language

I enjoyed the piece on Understanding Colour immensely, and found it highly informative. I use various graphics packages at work to edit and manipulate scans and digital photographs for inclusion in my company's monthly franchise magazine, and I prefer to use a HSB palette interface because I find the RGB and CMY colour cubes awkward and visually difficult to use. The article went in-depth into something I work with often but had not really thought about on that level before.

R.S. Coogan, Dundee.

I found Mike Bedford's Understanding Colour article extremely interesting. But it made me wonder why we can't see UV or IR and what our perception of colour would be like if we were able to see them. If blind people were to get artificial eyes one day and were suddenly able to see into these wavelengths, how would they visualise them? If their brains were still developing, perhaps what ordinary people perceive to be the spectrum would broaden out for them so that IR was represented as red, and UV as violet. If so, would red be represented as yellow and blue as green?

Petra Morgan, Gwent.

Perhaps someone out there could answer this. Ed

Annoyed@@Internet

Op-Amp Cookbook is just the kind of thing I buy EAB for. I'm looking forward to the other two parts. One thing about the magazine that I don't like, however, is the Internet-related material. I'm not interested in web-sites, I just want the electronics. Perhaps some people would say I am behind the times, but I have never used the Internet and do not see any reason to start now.

John Copeland, Kilkenny.

Uri Geller – For

People always knock Uri Geller without ever even considering the possibility that his psychic abilities might be genuine. People have such closed minds when it comes to things they do not understand. Thank you for challenging people's narrow perceptions by including his items within your magazine for so long.

Hillary Marsh.

I am sad to hear that Uri's Extended Reality will no longer appear in Electronics And Beyond. You don't have to believe in his 'powers', which I certainly don't, in order to find the column funny. I have found myself rolling about on the floor sometimes – the man is funnier than Dickens.

Linton Rapid, Birkenhead.

...And Against

I was delighted to read that Uri Geller will no longer be contributing to the magazine and that more simple projects will be included. Uri Geller's continued ramblings had convinced me that I should cancel my subscription at the next opportunity, I will of course continue my subscription now.

Keith Rhodes.

I have never read the column and in my mind it was a complete waste of space in an otherwise great magazine. I am all for inclusion of a few lighter items, but they've got to be entertaining or otherwise why have them? Its not even as if Uri Geller has anything to do with electronics.

Jamie Friedman, Kent.

'Robots' On The Web

A couple of weeks ago, whilst on the tube, I overheard someone talking about Web Robots. What is a Web Robot and how come a friend of mine who is into robotics has never heard of it?

Yoshida Tashiro, London.

A Web Robot is not actually a robot at all. It is a program that automatically trawls the hypertext structure of the Internet by retrieving a document and then recursively retrieving all documents that are referenced. 'Web Robot' is not actually a very common term – most people refer to them as 'Web Crawlers' or 'Spiders'. Some people believe Web Robots are bad for the web because when programmed badly they can overload networks and servers. But the majority nowadays are well designed, do not cause problems and can provide valuable information for people who want to put their time to better use elsewhere.

Revealing Interests

I enjoyed 'Revealing The Secrets In Art' by Douglas Clarkson in the April issue. More like that, please. I thought I'd write in with a couple of interesting links. One of these is the Sheffield Galleries and Museums Trust www.sheffieldgalleries.org.uk, which contains information on two of my favourite art galleries – the Mappin and the Graves, as well as a list of exhibitions and events going on in the area. Another good site is www.thebritishmuseum.ac.uk. Which is extremely useful if, like me, you are planning to visit the British Museum in the future. I will be going in a couple of weeks for my third time. Excursions Into Excel has been extremely useful to me, as I use Excel a lot. Perhaps you could do Excursions Into Access soon as well. Keep up the good work, but for God's sake get rid of Uri Geller – he seems to be everywhere nowadays.

Derek Hartnell, Sheffield.

If you have any views or queries, then send them in to:

Air Your Views,
Electronics And Beyond,
17/18 Glanyrafon Enterprise Park,
Aberystwyth, Ceredigion. SY23 3JQ.

Alternatively, you can fax them to 01970 621 040, or e-mail them to jaldred@kanda.com.

VCDinosaurs?

Regarding Keith Brindley's comments on DVDs and VCDs in the March issue, VCDs might be popular in Asia but here they are doomed to go the way of the dinosaurs, and are doing so already. They do have advantages over videocassettes, yes, but as soon as affordable DVD-writers come on the market, there will be no advantage in putting video onto the Video CD format at all. Keith Brindley may think it's a shame that the format is not popular over here, but I think the majority of people would agree with me when I say 'rightly so, and the sooner it dies off, the better'.

Lewis L. Palmer.

Commuting With EAB

I commute between Oxford and Birmingham regularly and always take a new magazine for each journey so that I can read it on the way there and, if it is interesting enough, on the way back. Recently I picked up Electronics And Beyond, as I had been very interested in electronics and making circuits from projects in my youth. The car immobiliser project in the April issue was just the excuse I needed for taking up my old hobby again. I will be getting the magazine on a regular basis from now on.

Robert Chapel, Oxford.

Introducing AVRs

Basic concepts – Numbering Systems

THIS ARTICLE IS INCLUDED TO MAKE SURE THAT ALL OUR READERS ARE FAMILIAR WITH THE BASIC BUILDING BLOCKS OF MICROELECTRONICS, ESPECIALLY NUMBERING SYSTEMS AND TERMINOLOGY.

If you are already familiar with these concepts, then please bear with us.

We are all familiar with the decimal numbering system because we use it every day, but do we understand how it operates? The decimal system is number system to the base 10. There are ten digits 0 to 9, so the base of a numbering system is the number it never reaches, in this case 10. In the decimal system there is no digit 10, when we reach 9, we revert back to zero and put a one in front of it for the next series. Similarly, when we reach ninety nine, we place another zero in front of it to give 100. It is the relative position of the numbers that is important.

Powers

We have names for each of these columns - ones, tens, hundreds, thousands etc. but it is more accurate to talk of a series of powers to the base ten. A power of a number is when a number is multiplied by itself e.g. $10^2 = 10 \times 10 = 100$, $10^3 = 10 \times 10 \times 10 = 1000$. What about 10^1? This is 10 i.e. the number itself ($4^1 = 4$, $26^1 = 26$ etc). 100 trickier but any number to the power zero is equal to one, so $100 = 1$, $40 = 1$ etc.

So our one's column is 10^0, tens are 10^1, hundreds are 10^2, thousands are 10^3 and so on.

	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Example	1000000's	100000's	10000's	1000's	100's	10's	1's
34,782	0	0	3	4	7	5	2
3,656,904	3	6	5	6	9	0	4
9,000,601	9	0	0	0	6	0	1

Table 1

Each column represents an increasing power of 10 from right to left, and we could extend this to as many powers of ten as we wanted.

Bases

A number series to the base 10 i.e. decimal, uses ten digits (0 to 9) and a series of columns representing position each of which is another power of 10. Could we have a number system using a different number base? We are actually familiar with these other numbering system, for example base 60 on a clock. This is 0 to 59 seconds (60^0, then we revert to zero and place a one in front (60^1 = minutes). Other examples include the old penny – base 12 with 0 to 11 as digits, imperial weighing systems – base 16 (ounces) and base 14 (pounds).

Numbering systems with different bases are familiar concepts to us but we do not realise that we use them everyday. Having established that we are happy with different numbering systems, we can go on to talk about numbering systems that are useful in digital systems and microcontrollers. As microcontrollers use electrical levels with only two states, high and low, then the only two digits that can be used are 0 and 1. So we need a number system that only has two digits which is obviously base two as the base is one more than the number of digits. Base two is commonly known as binary. Binary numbers appear as a long series of 0 and 1's that microcontrollers recognise very easily but human beings do not. So it would be useful to be able to group 0's and 1's together by using a higher base that is a multiple of two and the commonly used one is base 16. This is known as Hexadecimal. In the next sections, we will go into detail about Binary and Hexadecimal numbering systems.

Binary

There are only two binary digits, 0 and 1, as 2 is never reached – remember that the base is the number that is never reached. We therefore start with 0 followed by 1, and then revert back to 0 with a 1 placed before it, so decimal 2 becomes 10 in binary.

Decimal	Binary 2^1	Binary 2^0
0	0	0
1	0	1
2	1	0

Table 2

This system is exactly the same as the decimal system described earlier, except we only have two digits (0 and 1) instead of ten digits (0 to 9). In the decimal table, each column represents and increasing power of ten. Similarly, with binary numbers each column represents an increasing power of two but with only two possible digits – 0 and 1.

	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	128s	64s	32s	16s	8s	4s	2s	1s
7d	0	0	0	0	0	1	1	1
22d	0	0	0	1	0	1	1	0
255d	1	1	1	1	1	1	1	1

Table 3

Each column represents a power of two, so the

- first column is 1's $20 = 1$
- second column is 2's $21 = 2$
- third column is 4s $22 = 4$
- fourth column is 8s $23 = 2 \times 2 \times 2 = 8$
- fifth column is 16s $24 = 2 \times 2 \times 2 \times 2 = 16$

and so on.

In the examples given
00000111 = 7 decimal from
(1 x 4) + (1 x 2) + (1 x 1)
00010110 = 22 decimal from
(1 x 16) + (1 x 4) + (1 x 2)
11111111 = 255 decimal from
(1 x 128) + (1 x 64) + (1 x 32) etc.

Converting decimal to binary

Apart from using a scientific calculator, how do we convert a decimal number into binary? The process is to divide the decimal number by each power of two starting with the highest and place a 0 or 1 in the correct power of two column until we get to the lowest power of two (20 or 1s).

For example, let's convert 105 decimal into binary referring to the table above.

Step 1: The highest power of two we are using is 27 = 128.
105 / 128 = 0, so we put a 0 in this column, giving 0xxxxxxx b

Step 2: The next column is 26 = 64
105 / 64 = 1, remainder 41. So we put a 1 in the 64s (26) column
= 01xxxxxx b

Step 3: The next column is 25 = 32
41 / 32 = 1, remainder 9, so a 1 goes in 32s column giving 011xxxxx b

Step 4: The next column is 24 = 16
9 / 16 = 1, so 0 goes into 16s column, giving 0110xxxxb

Step 5: The next column is 23 = 8
9 / 8 = 1, remainder 1, so 1 goes into 8s column giving 01101xxxb

Step 6: The next column is 22 = 4
1/ 4 = 0, remainder 1, so 0 goes into 4s column giving 011010xxb

Step 7: The next column is 21 = 2
1/ 2 = 0, remainder 1, so 0 goes into 2s column giving 0110100xb

Step 8: The next column is 20 = 1
1/ 1 = 1, remainder 0, so 0 goes into 1s column giving 01101001b

In summary 105d becomes 01101001b from :

105 / 128 (2^7 = 0	Carry 105	= 0xxxxxxxb
105 / 64 (2^6 = 1	Carry 41	= 01xxxxxxb
41 / 32 (2^5 = 1	Carry 9	= 011xxxxxb
9 / 16 (2^4 = 0	Carry 9	= 0110xxxxb
9 / 8 (2^3 = 1	Carry 1	= 01101xxxb
1 / 4 (2^2 = 0	Carry 1	= 011010xxb
1 / 2 (2^1 = 0	Carry 1	= 0110100xb
1/1 (2^0 = 1	Carry 0	= 01101001b

Table 4

This example only uses eight powers of two (up to 27) but the series can be expanded indefinitely, but the division gets a bit tricky!

Converting binary to decimal

Converting binary to decimal is actually easier, because it uses multiplication rather than division which most of us find much simpler. We take each binary digit in turn and multiply it by the corresponding power of two and add the results together.

For example, we can see what 10101010b means in decimal by going through this procedure.

2^7 128	2^6 64	2^5 32	2^4 16	2^3 8	2^2 4	2^1 2	2^0 1
1	0	1	0	1	0	1	0

Table 5

This gives

Binary	Decimal	Total
1 x 128	128	128
0 x 64	0	128
1 x 32	32	160
0 x 16	0	160
1 x 8	8	168
0 x 4	0	168
1 x 2	2	170
0 x 1	0	170

Table 6

So 10101010b is 170 in decimal.

Exercises

Convert the following decimal numbers to binary...

11d 29d 251d 43d 196d

Convert the following binary numbers to decimal..

10011011b
01110110b
00100101b
01000011b
11100111b

Hexadecimal numbers

Eight digit binary numbers can be confusing, but 16 or 32 digit ones are very difficult for us to read e.g: 00010110001110001111000010000011100b, so it would be ideal to use a numbering system that still represents values that can be converted easily into binary but are simpler for us to read. So, we need to choose a base that is a multiple of two for simple conversion into binary and in the past base 8 was often used. This is known as Octal, but it has generally been superseded by base 16 which is known as Hexadecimal or hex for short. Hexa is simply Latin (or maybe Greek) for six and decimal means ten.

From our previous study of numbering systems we know that we need 16 digits including 0, and each column will be another power of 16 as we move to the right. Other numbering systems we have looked at just borrow digits from the decimal system to be digits in the new system e.g. 0 and 1 in binary. If the base is greater than ten, they use combinations of decimal digits e.g. 59 seconds and the carry becomes another name, in this case minutes so the combination is clear e.g. 1min 59 sec or 1:59. If we just wrote it as 159, is this 1 x 601 + 59 x 600 = 119 seconds or is it 1 x 602 + 5 x 601 + 9 x 600 = 3600 + 300 + 9 = 3909 seconds?

To avoid this confusion, we need to create some new symbols to represent the extra digits. We could invent some new strange shapes, because after all 0, 1, 2, 9 are just symbols but instead we borrow letters, so the new digits we need are the letters A to F. Therefore, we have 16 digits in the hexadecimal system which are...

0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

So, in hex we count from 0 to F, then revert to 0 and place a 1 in the next column which represents the next power of 16.

16^4	16^3	16^2	16^1	16^0
65536	4096	256	16	1

Table 7

As you can se, the numbers involved increase rapidly, so we will look at smaller numbers to start with to avoid heavy addition.

How would you interpret the number 15h (hex)

At first glance it looks like 15 decimal but from the table above we can see that it is actually 1 x 161 + 5 x 160 = 16 + 5 = 21d.

How about 22h?
This is (2 x 16) + (2 x 1) = 34d

111h?
This is (1 x 256) + (1 x16) + (1 x 1) = 273d

Now a nasty one! What is 2Ah in decimal? The two is quite easy and is 2 x 16 = 32. The 'A' is the tenth digit in the hexadecimal sequence so represents 10 x 160 = 10 x 1 = 10. So 2Ah is 32 + 10 = 42d.

Try 3Fh, 1Dh and AAh for yourself.

Hexadecimal and Binary

We are using hex instead of binary so how do the two number sets compare? We know that 16 is 24 so one hex digit is equal to four binary digits as we can see from the following table.

Decimal	Binary	Hexidecimal
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Table 8

From this table, a binary nibble (4 binary digits) is one hexadecimal digit, so 8 binary digits (a byte) is two hexadecimal digits and 16 binary digits (a word) is 4 hexadecimal digits.

To convert from binary to hexadecimal, just break the binary number into groups of four and convert them into the equivalent hex digit

Examples...

1100 1000b = C8h, 1111 0011b = F3h

To convert from hexadecimal into binary, remember that four binary digits are equal to 1 hex digit. Four binary bits have the following values.

2^3	2^2	2^1	2^0
8	4	2	1

Table 9

So: 1111 = 8 + 4 + 2 + 1 = Fh (15d)
1010 = 8 + 0 + 2 + 0 = Ah (10d)

11101011 = 1110 1011 as two nibbles.
1110 = 8+4+2 = Eh and 1011 = 8+2+1 = Bh, therefore the answer is EBh.

This concludes this basic introduction to numbering systems, and it just remains to mention a few commonly used programming conventions.

- Binary – ends in b or starts with % e.g. 11110101b or %11110101
- Hexadecimal - ends in h or starts with 0x e.g. C9h or 0xC9
- Decimal - ends with d e.g. 15d

Most assembly language or C programmers use hexadecimal as it is easy to write and fits with the 8-bit binary numbers used by microcontrollers. If you use decimal, it is very easy to make mistakes when programming.

Basic concepts – Binary arithmetic

As well as carrying out logical operations, we can also manipulate binary numbers (bytes) with arithmetic. An understanding of these operations also helps with assemble language programming.

Addition

Addition of binary numbers is carried out in exactly the same way as addition of decimal numbers. For example, 2 + 3 = 5. Let's see if 00000010 (2d) + 00000011 (3d) = 00000101 (5d).

We carry out this addition in exactly the same way as we would with ordinary decimal numbers, starting with the right most column (least significant bit). Remember that we are working in binary so 1 + 1 = 10.

Step 1

```
   0000001   0
+  0000001   1
-------------------
             1   no carry
```

Step 2

```
   000000    1   0
+  000000    1   1
-------------------
            10   1   carry
```

Step 3

```
   00000     0   10
+  00000     0   11
+            1       carry
-------------------
             1   01  no carry
```

Step 4

```
   0000      0   010
+  0000      0   011
-------------------
   0000      0   101 no carry
```

The rest of the addition is 0 + 0 = 0, so we will not step through in detail. So the answer becomes...

```
   00000010
+  00000011
-----------
   00000101
```

Note that 00000101 is five decimal and so we see that adding 0000010 and 00000011 is exactly the same as adding 2 and 3. All binary additions can be carried out in the same way. What happens if we add 11111111b and 00000001b? The answer is the byte value becomes 0 and we get a carry out...

```
   11111111
+  00000001
-----------
   00000000
```

All microcontrollers have a store where this carry bit is stored so that it can be used in later operations. This is often called the Carry FLAG.

Subtraction

We can subtract binary numbers in the same way that we subtract decimal numbers using a borrow from the next column to the left if one is needed.

```
e.g.  43
      27
```

This sum requires a borrow from the 10's column in order to subtract 7 from 3. Binary subtraction works in the same way.

```
e.g.  10
      01
```

To subtract 1 fro 0 in the first column we must borrow from the second column. The main difference between binary and decimal subtraction is that in binary subtraction once you have done one borrow, you have to keep borrowing as we only have two possible values.

```
e.g.  1000
    - 0001
```

To do this sum we have to keep borrowing from each column until we find a one at the top in column four:

```
  $100^10$      $10^10^10$     $1^10^10^10$
  $00^101$      $0^10^101$     $^10^10^101$
-------------------------------------------
     1            11          0 1 1 1
```

If we need to borrow from the ninth bit in order to complete the sum, then this borrow would be stored in the carry flag of the microcontroller for us in subsequent operations. However, microcontrollers do not do subtraction in this way. Instead they use a method called 2's complement addition. The process of 2's complement addition is described next.

2's complement addition

The first step is to take the number to be subtracted (in for example 5 –2, we take 2) and invert or complement it. As we have seen before, this can be done by XOR with 11111111. The resulting number is known as the 1's complement.

In order to obtain the final answer, we need to add 1 to the 1's complement to give the 2's complement.

This new number is then ADDED to the

number from which we were subtracting, in our example 5.

For example:

5 -2	00000101	- 00000010		
Obtain 1's complement of 2	00000010	XOR	11111111	= 11111101
Obtain the 2's complement	11111101	+	00000001	= 11111110
Add 2's complement to 5	11111110	+	00000101	= 100000011

In this case, the carry is discarded, giving the answer of 00000011b = 3 decimal.

Multiplication

The main interest with multiplication in microcontrollers is multiplication by two. To see how a microcontroller achieves this, we need to look at an example such as 4 x 2

4 = 00000100
4 x 2 = 8 = 00001000

We can see that the result of multiplying by two is that the byte has shifted one place to the left. Let us look at a more complicated number and see if the same pattern holds true, for example 77 x 2 :

77 = 01110111
77 x 2 = 154 = 10011001

Once again, the byte has shifted one place to the left and a zero has appeared in the least significant bit. This rule holds true for any multiplication by two. Therefore, to multiply a binary number by 2, shift the bits one place to the left, discard the most significant bit and put 0 in least significant bit. In microcontroller programming, this operation is called Shift Left.

If we wanted to multiply by four, we would shift left twice, by eight we would shift left three times and so on. What about multiplication by an odd number? A microcontroller would shift left the correct number of bits and then add the odd number. For example, to multiply by 5 x 9 would be

5	00000101
Shift Left 3 times	00101000
Add 5	00000101
Total	00101101 = 45

Division

Division by two is again the most important. Let us look at an example such as 12 / 2.

12 = 00001100
12 / 2 = 6 = 00000110

We can see that the bit pattern has moved to the right, with the least significant bit disappearing and 0 appearing in the most significant bit. This is the opposite of multiplication by two as we would expect. This is known as Shift Right.

This forms the main arithmetic instructions that we need to concern ourselves with with looking at assembly language programming.

Basic Concepts – logic functions

This section introduces you to the concepts of logic, logical operators and arithmetic functions, which are essential tools for digital microelectronics and microcontroller programming.

Boolean Logic

The basic building blocks of logic in microcontrollers and microelectronics is the concept of TRUE and FALSE so that the result of any logic operation is either true or false. These are often equated to 1 and 0 respectively. Boolean logic describes four operations that give results that are true or false. There are four basic operators : AND, OR, XOR and NOT.

AND function

Let's imagine we want to make some black coffee. To do this we need some coffee powder and some hot water. That is, if we have coffee powder (coffee = TRUE) AND we have hot water (hot water = TRUE), then black coffee is TRUE. We can show this as a table where TRUE is the same as 1...

Coffee Powder	AND	Hot Water	=Black Coffee
TRUE	AND	TRUE	=TRUE
1	AND	1	=1

Table 10

What about when we have run out of coffee powder, so we can't get our cup of coffee?

Coffee Powder	AND	Hot Water	=Black Coffee
TRUE	AND	FALSE	=FALSE
1	AND	0	=0

Table 11

The same situation occurs if we did have coffee powder but didn't have any hot water...

Coffee Powder	AND	Hot Water	=Black Coffee
FALSE	AND	TRUE	=FALSE
0	AND	1	=0

Table 12

So we can use 1 and 0 to describe TRUE and FALSE and derive a rule from the tables above. You should be able to see that the rule for the AND function is: if both bits are 1, then the answer is 1 but if either or both of the bits is 0, then the result is 0. This can be shown in a Truth Table which maps the result of every possible input combination and shows the output...

0	AND	0	=0
0	AND	1	=0
1	AND	0	=0
1	AND	1	=0

Table 13

The AND function can have as many inputs as you like but only has 1 output so if any input is 0 the output is 0.

OR Function

Let's now imagine that we already have coffee powder in our mug, and we have a choice of using either hot water or hot milk. In either case, we will still get our coffee...

Hot Water	OR	Hot Milk	=Coffee
TRUE	OR	TRUE	=TRUE
1	OR	1	=1

Table 14

If we don't have milk, we can still get coffee...

Hot Water	OR	Hot Milk	=Coffee
TRUE	OR	FALSE	=TRUE
1	OR	0	=1

Table 15

If we don't have any water...

Hot Water	OR	Hot Milk	=Coffee
FALSE	OR	TRUE	=TRUE
0	OR	1	=1

Table 16

If we have both, we can still get coffee. Therefore the only situation where we cannot get a mug of coffee is when we have neither milk or water.

Hot Water	OR	Hot Milk	=Coffee
FALSE	OR	FALSE	=FALSE
0	OR	0	=0

Table 17

From these results you should see that the simple rule for an OR function is : If any input is 1, then the output is 1. Again, this can be shown as a truth table...

0	OR	0	=0
0	OR	1	=1
1	OR	0	=1
1	OR	1	=1

Table 18

Again there is no limit to the amount of inputs but there is only 1 output.

XOR function

Let's assume that that we have the hot water and we can add this to a tea bag or coffee powder. If we use the OR function shown above, we could have a problem or a really disgusting drink in any case. Looking at the four possible OR function possibilities...

Tea Bag		Coffee	Drink
0	OR	0	=0
1	OR	0	=1
0	OR	1	=1
1	OR	1	=1

Table 19

Ok, except we can get one drink which is tea and coffee mixed, not an ideal result. The OR function allows this outcome, so what we need is another function which prevents this outcome. This is called Exclusive OR or XOR. Its outcomes are the same as OR function, except that it will give FALSE if both inputs are TRUE..

0	XOR	0	=0
0	XOR	1	=1
1	XOR	0	=1
1	XOR	1	=0

Table 20

So, we see that the simple rule or the XOR function is: If the inputs are different, the output is 1. If the inputs are the same, the output is 0. Note that unlike AND and OR, XOR only works with two inputs.

NOT Function

This is slightly different as it applies to only one input. It inverts the input so that the output is the opposite of the input..

NOT TRUE = FALSE or NOT 1 = 0
NOT FALSE = TRUE or NOT 0 = 1

Using NOT functions with other functions

NOT can be used with other functions such as OR, AND and XOR to give effectively a new set of functions :

1 AND 1 = NOT 1 = 0
1 AND 0 = NOT 0 = 1

The two functions together are called NAND function and its truth table is...

0	0	1
0	1	1
1	0	1
1	1	0

Table 21

The simple rule for NAND function is – Any 0 in, gives 1 out.

In the same way, OR and NOT together give NOR functions which is –

0	0	1
0	1	0
1	0	0
1	1	0

Table 22

And the simple rule is any 1 in gives 0 out.

Finally, XOR and NOT is called XNOR (which is easier to pronounce than NXOR). The truth table is –

0	0	1
0	1	0
1	0	0
1	1	1

Table 23

And the simple rule is - Inputs the same gives 1 out.

Using combinations of different gates means that we can achieve any logic result we require. Logic is a powerful tool and this is just a very basic introduction to get you started.

Uses for these functions

The main use of these functions in programming is to MASK values in bytes to give a specific result. It is called masking because we use one value – the mask – to change the appearance (value) of another byte.

Setting bits

If we want to make sure that a particular bit in a byte is set to a 1 how do we do it? From the truth tables given above, we can see that the OR function will give a 1 out if any input is a 1. So to set a bit in a byte we need to make sure that we OR the byte with a mask byte that has the same bit set to a one. For example, we want to set bit 0 – right hand bit...

Original value	01010110
Mask	00000001
New value	01010111

We put 0 in all other positions in the byte so that the value will stay the same – if the original value is 0 and we OR with 0, what do we get? From our truth table, we will get 0. If the original value was 1 and we OR with 0, what do we get? Any 1 in, gives 1 out so we will get 1.

So to set one or more than one bit in a byte we OR with a mask byte with 1 in any position we want to set and 0 in the others.

Examples

1 Set bit 7 and 5

Original value	10000000
OR	
Mask	10100000
New Value	10100000

Clearing bits

The opposite operation is also very useful, so how do we ensure that a bit is cleared to 0? Have a look back at the different truth tables and you will see that the AND function looks like a good bet as any 0 in will give 0 out.

So to clear a bit, we need to AND it with 0. How do we ensure that we do not affect the other bits in the byte and they will retain their original values? If we make the other values 0, then the results will all be 0...

Original value	11111111
AND	
Mask	00000000
New Value	00000000
	because any 0 in gives 0 out.

What about making them all 1's?

Original Value	11111111
AND	
Mask	11111110
New Value	11111110

This works, so to clear a bit in a byte put a 0 in that position and a 1 in all other locations.

Example: To clear bit 4 and 3, the mask value will be 11100111

Complementing a byte

Complementing a byte so that all the 1's become 0 and all the 0's become 1 is also useful. How can we do this? Looking at the truth table for XOR function can you see that using an XOR with 11111111 will change every bit?

01010101
XOR
11111111

result 10101010 because the rule for XOR is inputs the same gives 0 out and inputs different gives 1 out.

This is a basic introduction to Boolean functions, AND, OR, XOR and NOT which should help with understanding some of the microcontroller projects in this section.

Basic Concepts – Microcontrollers

A lot of people get confused between microcontrollers and microprocessors.

A processor is a calculating machine and an abacus is a simple processor. But we generally mean an electronic machine that can do arithmetic and logic operations and store the result. The early mainframes that filled whole rooms are effectively processors. A microprocessor is just that, a processor made smaller by the use of Integrated Circuits (IC or commonly chip). Your PC is essentially a microprocessor with devices attached to give input and output – keyboard, mouse, monitor, disk drives etc. – and support circuitry that stores information, provides power and links to the attached devices. The whole PC is a microprocessor system.

Microprocessors

A microprocessor provides the computing power and in essence it consists of an Arithmetic and Logic Unit (ALU) with some associated storage registers that hold the numbers, the results and necessary information such as the carry flag. Another essential component is an instruction decoder called a Microcode. A microprocessor is not very useful on its own and it must have a whole range of support ICs around it.

These include ICs to provide program and data storage (see memory devices), buffers and latches to provide links to the outside world, timers, counters and sometimes a real time clocks. The system must also have a method of internal timing called the clock so that events can happen in the correct sequence. It must also have a number of linking wires called buses that allow information and control signals to be passed around the system.

In order to do anything useful, a microprocessor must be given a series of instructions to perform. This is called a program or code which must be stored somewhere – the program memory. The microprocessor system also requires a memory to store data.

Microcontrollers

A microcontroller is simply a microprocessor with some of these external components included in the same package (IC), so it does not need so much external circuitry. A typical microcontroller will have the same features as a microprocessor – ALU, storage and control registers and microcode – plus RAM to store data and built in buffers and latches (ports). It will also include internal buses for program and data movement and control and timing signals. It is how many lines there are in the data bus that determines the number of bits that the microcontroller uses. An 8-bit microcontroller has 8 data lines in parallel so that a byte can be transferred and stored at once. A 16-bit microcontroller obviously has 16 and so on.

Depending on the particular microcontroller it may have all sorts of other peripherals included in the package. These include communications ports – SPI, UART, RS232, USB, CAN and others, ADC and DAC, watchdog timers and pulse width modulators.

Each different family of microcontrollers has a different instruction set. Each instruction set has an assembly language associated with it. Once you have learnt to program and use one type of microcontroller, it is relatively easy to change to another family. The other way is to use a common language like C, and use a different compiler to convert the C code into the correct instructions.

Memory devices

Any IC that is used to store information is called a memory IC, and different names are given to different types.

RAM – Random Access Memory stores data when the power is on but the data is lost when it is switched off

ROM – Read Only Memory will store data after the power is off but can only be programmed once – also known as One Time Programmable (OTP)

EPROM – Erasable Programmable Read Only Memory is the same as ROM but UV light can be used to erase it for re-programming.

EEPROM – Electrically Erasable Read Only Memory has the same features but it can be erased by electrical signals so it can be erased in system if required.

FLASH RAM – very similar to EEPROM but faster and allows more writes. Commonly used now for microcontrollers that can be re-programmed again and again, especially through the use of IN System Programming (ISP).

Timing

Another important basic of microcontrollers is timing. In order for events to happen at the correct time, the various parts of the device must act synchronously. For example, to move data from the memory to the ALU, the memory must be set to read, the data bus must be clear of other signals and the ALU must be ready to accept the data. Therefore, we need a timing pulse that synchronises events.

This is nearly always supplied from an external circuit that supplies square wave pulses to a particular pin on the microcontroller. This clock circuit can be a crystal, RC oscillator or ceramic resonator depending on the circuit function and accuracy required – UARTs need more accurate clock signals so a crystal is preferred.

Microcontrollers are advertised with different speeds of operation e.g. 4 MHz, 24 MHz. This is the maximum clock input frequency and using a faster clock will often cause problems, but a slower clock can be used. This is not the whole story as some microcontrollers immediately divide this input clock so that their true speed of operation is much slower. For example, the PIC divides the clock by 4 and the 8051 divides by 12. ●

Diary Dates

1–2 June. SECC Glasgow.
Small Office/Home Office Show
01244 881 777

5 June. King's Hall , Belfast.
IT Showcase Live.
01425 477 565

5–6 June. Olympia, London.
ITF 2001 International Trade Forum 2001
020 7973 6401

5–7 June. NEC Birmingham.
ET: Environmental Technology
www.et-expo.co.uk
Eurochem
www.eurochem.co.uk
020 8910 7910 (for both events)

5–7 June. Earl's Court, London.
Internet World UK
www.internetworld.co.uk
Service Management Europe
www.servicemanagement.co.uk
Enterprise Customer Management
www.ecmshow.co.uk
Customer Contact Centres
www.customercontactcentres.com
e-Fulfilment
www.efulfilmentshow.com

5–7 June. NEC Birmingham.
Retail Solutions and Retail Interiors.
020 7520 1500

5–7 June. NEC Birmingham.
Library & Information Show.
01844 342 894

5–8 June. NEC Birmingham.
Screenprint 2001
0208 340 3291

6–7 June. Business Design Centre, London.
E-Learning Conference & Exhibition.
020 8394 5100

12–13 June. Olympia, London.
E-Recruitment Conference & Exhibition.
01937 579 871

15–16 June. G-MEX, Manchester.
Small Office/Home Office Show.
01244 881 777

15–16 June. London.
Engineering Recruitment Show.
020 7973 6401

26 June. Doncaster Exhibition Centre.
Computer Fair.
01706 299 902

26–28 June. NEC Birmingham.
Training Solutions and IT Training Show 2001.
020 7973 6401

27 June–1 July. Earl's Court, London.
BBC Tomorrow's World Live Event
020 8307 2300 (Organiser),
0870 122 0099 (Tickets)

4–5 July 2001. Olympia, London.
Linux Expo 2001
01483 469 060
www.itevents.co.uk

9–11 July. Manchester International Convention Centre.
The Radio Academy Festival.
020 7255 2010
www.radioacademy.org

11–13 July. ICC Birmingham.
Future Cities Conference.
E-mail piazza@bmp.org.uk
www.futurecitiesconference.com

24 July. Doncaster Exhibition Centre.
Computer Fair.
01706 299 902

30 July–2 August. ICC Birmingham.
Royal Society of Chemistry Annual Conference & Exhibition.
01892 518 877

WHAT'S ON in June & July

Exhibitions

5 – 7 June. NEC Birmingham.
ET: Environmental Technology
www.et-expo.co.uk
Eurochem
www.eurochem.co.uk
020 8910 7910 (for both events)

Environmental Technology 2001 is of interest to every organisation involved in the environmental industry. It will have exhibits, workshops, seminars, debates and a high profile conference themed on resource efficiency. Whatever the size of your company or local authority, ET 2001 can provide solutions on such issues as environment, water, waste, recycling, impending environmental legislation and land remediation services. ET in 2001 will be co-located with Eurochem – a process engineering event with over 400 exhibiting companies covering the full spectrum of process plant and services. If your business is processing in the chemical, pharmaceutical, food and drink, oil and gas, water, metal manufacturing, petrochemical or associated industries, Eurochem will definitely be of interest.

5 – 7 June.
Earl's Court, London.
Internet World UK
www.internetworld.co.uk
Service Management Europe
www.servicemanagement.co.uk
Enterprise Customer Management
www.ecmshow.co.uk
Customer Contact Centres
www.customercontactcentres.com
e-Fulfilment
www.efulfilmentshow.com

Visitors to Earl's Court on the 5th to the 7th of June are spoilt for choice, with no less than 5 top e-business exhibitions all going on at once. Details vary between the exhibitions so contact Penton Media Ltd on 020 8232 1600 for further information, or click onto the above sites for further details of all the above co-located events.

27 June – 1 July.
Earl's Court, London.
BBC Tomorrow's World Live Event
020 8307 2300 (Organiser)
0870 122 0099 (Tickets)

The BBC Tomorrow's World Live Event 2001 is being billed as the nation's largest technology theme park, showcasing the very latest state-of-the-art innovations – the kind of technology that will influence everyday life in the 21st century. Visitors will be able to explore a series of themed worlds featuring innovations from industries including construction, transport, telecommunications, sport, health, music and television. They will be able to experiment with new technology and interact with the people and organisations that make it happen.

Worlds will include Planet Internet, Mobile World, Future of London, The Intelligent Home, Future Transport, Inventing Tomorrow, Future Health, Cyberworld, Live Lab, Future of Formula 1, Science of Sport, and Music World. Further details can be found at <www.twle.co.uk>.

4 – 5 July 2001. Olympia, London.
Linux Expo 2001
01483 469 060
www.itevents.co.uk

Linux EXPO 2001

The market for Linux products and services continues to grow as an increasing number of organisations adopt the open source operating system for their IT infrastructure. The UK Linux Expo, now in its third year, brings together the major vendors who supply Linux tools, support, applications and servers with the users and decision-makers responsible for implementing Linux based systems.

If you are evaluating the importance and impact of Linux technology on your IT infrastructure, you can meet over 80

international players who are leading the Linux revolution. From development tools, e-commerce, security and Internet tools to Linux based training and support;

Linux Expo 2001 is expected to attract more than 10,000 senior IT professionals, and with seminar, conference and debating opportunities, and over 80 major international players to talk to, this is an opportunity to discuss your Linux issues directly with the industry leaders.

11 – 13 July. ICC Birmingham. Future Cities Conference.

E-mail piazza@bmp.org.uk
www.futurecitiesconference.com

The two-day Future Cities Conference marks the 10th anniversary of Birmingham's International Convention Centre, which was opened by the Queen in April 1991 and has been an integral part of the acclaimed transformation of central Birmingham in recent years.

The conference will bring together experts from every area of urban renewal – from planners, architects and surveyors to local authorities, investors and academics. Policy makers from the UK, Europe and North America will debate issues in 5 main areas: Restructuring the City's Economy, Reshaping the City, People and Communities, Urban Governance, and the Interaction of Cities and Regions. Speakers already confirmed include Professor Michael Parkinson, director of the European Institute of Urban Affairs at Liverpool John Moores University; Professor Brian Robson, of the University of Manchester; and Professor David Hulchanski, of the University of Toronto, Canada.

Delegates will have the opportunity to see first hand how public and private partnerships have already transformed the face of Birmingham, and continue to do so through major schemes like the redevelopment of the Bull Ring, with more than £2 billion of investment completed, underway or currently planned.

Please send details of events and exhibitions to jaldred@kanda.com.

Courses

Of particular interest to readers of Electronics and Beyond are four courses being run by the Centre For Professional Advancement www.cfpa.com in June and July – the first two in The Hague, the second two in Amsterdam. All four courses have qualified as Eurotraining 'Quality Labelled Courses' (see www.eurotraining.net) and will be conducted in the English language.

Microelectronics Packaging

(Technologies and trends for the ULSI and Multichip Era)

Electronics is the fastest growing global industry, fuelled by the need for communication, information, information processing and control systems. Modern microelectronics are required to continue to deliver more for less: more complexity in less space, and more reliability at lower cost. Moreover, future applications environments are likely to be more hostile as electronics increases its penetration globally. Innovations in electronics packaging materials and technologies continue to meet these requirements and enable greater product miniaturisation while increasing manufacturability, testability and robustness. Modern solutions combine chip scale and chip size packages and bare dice into multi-chip high-density packaging solutions for systems. The inexorable drive toward lower costs is achieved by solutions in cost-effective packaging, namely the achievement of performance and reliability at modest cost. Hence, the field of microelectronics packaging is a dynamic one with evolutionary and revolutionary developments of technologies, techniques and materials, which are addressed in this course.

Encapsulation of Electronic Devices and Components

(Properties, Techniques, Equipment and Testing)

This course will provide a working knowledge of the protection of electronic and electrical devices by encapsulation. Material properties, techniques, equipment, testing and removal of encapsulants will be discussed in both fundamental and practical terms. The latest developments will be examined in addition to present day practices. A special session will cover the technology involved in the packaging of micromodules, with emphasis on the interaction of material, encapsulation techniques, and circuit. Upon registering, participants are urged to submit items or descriptions of areas of special interest or particular problems, so that the course material may be adjusted to meet specific interests.

Encapsulation Removal and Other Diagnostic Techniques

Electromagnetic Compatibility Engineering

These courses are intended for both electronic and mechanical designers, reliability and standards engineers, technical managers, systems engineers, test and instrumentation engineers, technicians, and others concerned with electromagnetic interference and regulatory compliance. The course should be of particular interest to those involved with information technology, computing, communications, industrial, electronic, and home entertainment systems, as well as other electronic equipment. The program is intended for product developers who assess conformity during the design cycle, quality assurance personnel, those responsible for interpreting and distributing mandatory EMC standards. It is also for product managers who work with marketing to determine countries to introduce products, and others who deal with in-house or outside test house measurements for product compliance, and the necessity to make changes to products based on these test results.

EMC Design and EMI Mitigation

This course will cover the practical emission and immunity aspects of electronic system designs to achieve global regulatory compliance. Cost-effective approaches to EMC design and retrofit techniques are emphasised and illustrated with actual applications to analogue and digital circuit design to system integration problems. The commercial and industrial aspects of EMC are stressed with additional emphasis on product immunity. The importance of the systems approach to EMI early in the design stage to meet government regulations also will be covered. The interference situations and their solutions are explained using basic physical concepts with complex mathematics kept to a minimum. The course will include a PWB design and EMI evaluation discussion that will allow you to apply the knowledge gained in the course.

For further details of all four courses, and the texts and personnel involved, visit www.cfpa.com. The site also has details on tuition fees and how to book.

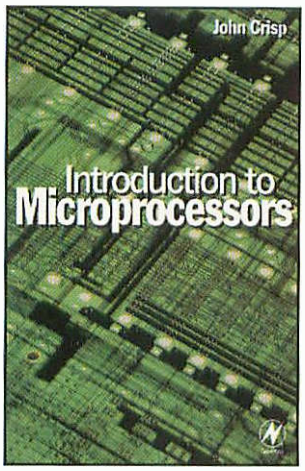
Bookshop

BASIC Stamp: An Introduction to Microcontrollers (Second Edition)

Intended for a readership of engineers, students and hobbyists, BASIC Stamp introduces microcontroller theory using the Parallax BASIC Stamp I, II, and IIsx. The BASIC Stamp microcontroller is based on Microchip's PIC hardware with some modifications and is very approachable for beginn ers. Once the basic theory is established, BASIC Stamp walks the reader through applications suitable for designers as well as the home hobbyist. These applications can be used as is or as a basis for further modifications to suit specific design needs. BASIC Stamp thoroughly explains the hardware base of the BASIC Stamp microcontroller including internal architecture, the peripheral functions, as well as providing the technical data sheets for each kind of chip. The authors also explain the BASIC Stamp development systems including DOS and Windows-based tools in tremendous detail. As an added feature, BASIC Stamp includes full instructions for using PBASIC programming and formatting.

The Authors: Dr. Claus Kühnel (author of AVR RISC Microcontroller Handbook) & Dr. Klaus Zahnert. Dr. Klaus Zahnert is a retired measurement systems designer, and an active electronics hobbyist. He writes books and articles for the German electronics market.

Pages: 400pp
Price: £19.99



Introduction to Microprocessors

Providing a thoroughly readable introduction to microprocessors, that is suitable for a wide range of introductory courses in further and higher education (including BTEC National and HNC/D, GNVQ, and City & Guilds 2710), this book assumes no previous knowledge of the subject, nor a technical or mathematical background. Designed for students, technicians, engineers and hobbyists, it covers the full range of modern microprocessors. All technical terms are carefully introduced and subjects which have proved difficult, for example 2's complement, are clearly explained.

It has a strong practical bias that will appeal to practitioners and trainees, but is also clear and comprehensive with not too much maths. It has an excellent overview of the popular programming languages, and you'll also get a good idea of current device developments. It is a friendly and accessible book that even has the occasional cartoon thrown in to illustrate a point.

The Author: John Crisp is an experienced lecturer in microprocessors, fibre-optics, mathematics and electronics. He has written several training manuals for use on the courses that he teaches.

Pages: 240pp
Price: £16.99

AVR RISC Microcontroller Handbook

The AVR RISC Microcontroller Handbook is a comprehensive guide to designing with Atmel's new controller family, which is designed to offer high speed and low power consumption at a lower cost. The main text is divided into three sections: hardware, which covers all internal peripherals; software, which covers programming and the instruction set; and tools, explained using Atmel's Assembler and Simulator (which is available on the Web) as well as IAR's C compiler. The book is of interest to embedded systems designers and students, as well as hobbyists.

The Author: Dr. Claus Kühnel is the Engineering Manager for Multanova AG, in Switzerland. He is a member of the IEEE, and has a strong background in microcontroller design. Dr. Kühnel has written books and articles for the German and Swiss electronics markets.

Pages: 256pp
Price: £30.00

Closed Circuit Television

Closed Circuit Television (CCTV) surveillance is one of the fastest growing areas in the security industry. This book is an essential guide for all security professionals and CCTV installers. However, unlike most existing books on CCTV, Closed Circuit Television is not just a discussion of security issues, but a thorough guide to the technical side – installation, maintenance, video recording, cameras and monitors, etc. This book is a valuable text for professional security system designers and installers, and it also provides the underpinning knowledge required for the level 3 NVQs from SITO / City & Guilds. The concise, accessible text makes it an ideal coursebook, and this accessibility also makes it ideal for hard-pressed practitioners.

The Author: Joe Cieszynski is a well known technical writer – author of a series on CCTV in Television magazine, and a contributor to the SITO distance learning materials on CCTV. He has extensive experience in the industry and teaches at Manchester College of Arts and Technology.

Pages: 232pp
Price: £19.00

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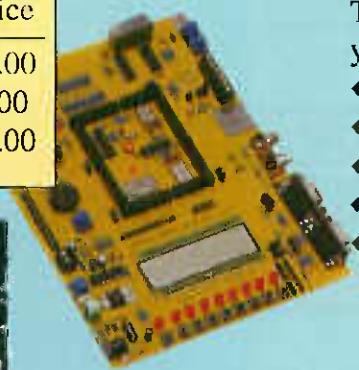

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The ChipMaster 6000 is a PC based Universal Programmer that connects through any standard Parallel Port. The 6000 features a 48-pin universal pin driver and expandable TTL pin driver. With its on-board processor and FPGA the 6000 has the power and flexibility to handle many of todays and tomorrows complicated DIP package silicon PLD's, Microprocessors, and High Density FLASH without the need for programming adapters.

The 6000's on-board intelligence reduces system overhead to a minimum giving way to maximum programming speeds. Perform an entire programming pass from Blank Check to Verification on an 8Mb device in less than 60sec. (Depends slightly on the processing power of your PC) Faster and more accurate than comperable programmers, the 6000 is a highly productive solution for programming todays high density, multi-megabit memory devices. The 6000 is designed for mass-production or laboratory applications, supporting nearly 3000 devices including PAL, PEEL, MACH, EPROM's, FLASH memories and a multitude of microprocessors.

Protect your pocket book by preventing accidental, expensive, time consuming chip damage by enabling the 6000's pin contact and insertion tests on a device before a programming operation. 6000 can detect poor pin contact or devices inserted upside-down or in the wrong position.

Part#	Description	£Price
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PRG-CM5-000	ChipMaster 5000	458.00
COP8ISP	COP8 ISP	90.00

COP8 ISP

The COP8 ISP is our new in system programmer for COP8 devices. Based on our popular ISP range, this compact programmer programs significantly faster than many other COP8 programmers on the market. High Speed Parallel or serial operation. Offers simple operation with powerful utilities for configuring device specific features.

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The 5000 is a low-cost, compact, software expandable Universal Programmer. Based on its bigger sisters design, the 5000 has the same functions as the 6000, but does not support as many devices and is a third smaller in size leaving more room on your work bench.

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- Supports 2.8 and 3.3v devices
- Programs an 8Mb device in less than a minute
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In System Programmers

AVR ISP Super

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Super High-Speed USB, In-System programmer for AVR Devices. Connecting to your PC via the USB port not only allows you to keep your serial and parallel ports free, but you also benefit from USB flexibility and speed.

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- AT90S/LS2333
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- ATmega161/161L
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Part#	Description	£Price
AVRUSB	AVR ISP Super	104.00

ISP Solutions

High Speed Parallel or serial operation. All kits offer simple operation with powerful utilities for configuring device specific features. DLL's available for embedding directly into your applications. ISP solutions for Nationals COP-8 Processors, Atmel AVR and ST Flash.

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Call for more ISP solutions

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KF0040	Keyfob Service Pack	279.00	N/A
KF0030	Keyfob Multipack(5)	209.00	N/A
KF0020	Individual Keyfobs	69.00	39.00

8051 Development Environment

The Workshop provides a complete development environment for Serial Programmable 51 devices. Includes comprehensive integrated software and development hardware for debugging and programming the 51 series devices. It incorporates Switches, Lights, RS232 Provision and Sound via an on board mini speaker.

Part#	Description	£Price
AVM0028	8051 Workshop	39.00

Gang Programmers

GangStar-Pro

Turbo Gang Programmer

The GangStar is a one of a kind PC based parallel port GANG programmer with 8 fully isolated 48-pin ZIF sockets. Each of the GangStars' sockets are designed with dedicated FPGA's for independent control. This independent design gives the GangStar its' semi-concurrent programming capabilities. For example you can program four devices while removing/inserting devices in the remaining four sockets. And with the modular design of the GangStar, in the event one, two socket module ever fails you still have three modules to continue your programming while the other is returned for repair or replacement.

The GangStar has been dubbed the Turbo Gang Programmer for a reason; use the GangStar to program eight, 8-mb parts in under one minute. Programming times may vary slightly from PC to PC depending on the PC's processing capabilities (programming time based on a 486dx 66 system).

Part#	Description	£Price
PRG-GSP-000	GangStar-Pro	1969.00

LC Series Mini Gang Programmers

Low cost, light weight and portable, multiple variations of these desk-top programmers allow you to program up to 4, 8Mb devices at one time! Talk to the programmer via "X-link" software, use it's features to edit your file, configure devices even print out labels. Husky-LC is limited to PC operation, through "X-link" or "dumb terminal" program of choice, while Shooter-LC is capable of performing all program/copy operations independent of a host.

Part#	Description	£Price
PRG-HLC-D11	Husky 1Meg/1Dip	311.00
PRG-HLC-D44	Husky 4Meg/4Dip	419.00
PRG-HLC-D48	Husky 4Meg/8Dip	519.00
PRG-SLC-D11	Shooter 1Meg/1Dip	419.00
PRG-SLC-D44	Shooter 4Meg/4Dip	519.00
PRG-SLC-D48	Shooter 4Meg/8Dip	625.00

ChipMaster 7000 E/EPROM Gang

A software expandable universal device programming workstation supports a wide variety of PLD's, in addition to the capability of testing digital IC's. This state of the art programmer offers you the most advanced programming facilities with a user friendly interface, for DOS, Win9x and Win NT. The design of the 7000 makes it possible to swap the standard single 48-pin ZIF module with the available gang module. With the gang module you can program up to 8, 32-pin DIP devices in the same amount of time it takes to program one device.

Part#	Description	£Price
PRG-CM7-000	ChipMaster 7000	669.00
OPT-CM7-8G	8 Gang Module	419.00
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Go Small, Go Portable

The Shooter III Field Service Pack consists of the compact lightweight Shooter III Copier/Programmer and the PalmErase EPROM eraser plus a handy, Shoulder / Hip-pack to tote them around in.

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- Program from file or copy from master
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Part#	Description	£Price
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OPT-SH3-FSP	OPT-SH3-FSP	325.00

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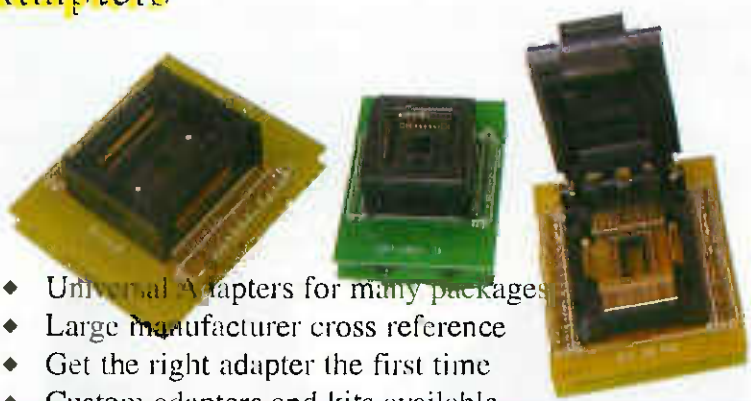

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Field Programmable GATE ARRAYS

What are they?

by Peter Mason

IN THE WORLD OF DIGITAL ELECTRONICS THERE IS PROBABLY NO OTHER DEVICE WITH SUCH AN AURA OF MYSTIQUE.

This fear of the unknown has led many engineers to avoid these devices. It is Kanda's intention to put these fears to rest.

Firstly then, what is an FPGA? An FPGA is best thought of as a complete circuit in one chip, with cells (Logic gates), connected together by direct connections and buses (wires), with I/O pads (connectors) to the outside world. These are all programmable (i.e. are defined by the user) to make just about any digital circuit the user could require.

FPGA devices all have a number of features in common. All FPGA's contain blocks of logic function (also referred to as cells), one or more ways for these cells to connect to each other, and finally a set of I/O pads that communicates the signals in and out of the FPGA. The areas where FPGA's differ are; functionality of its core cell, cell connection and structure of their I/O pads. Various architectures also offer features such as on board SRAM, mixed voltage operation, global clock and reset structures.

FPGA's can be operationally configured in two ways, Antifuse and SRAM. Antifuse device's are permanently blown with a configuration, and are therefore, ready to use once the power is switched on. However, the downside is that this technology is one time programmable. This device will need to be thrown away if you make any errors. SRAM based FPGA's store their configuration data in the SRAM and this needs to be reconfigured everytime you turn the power on. Consequently, the configuration data must be stored in an external non-volatile memory, which can be of the reprogrammable variety. Atmel have designed a series of EEPROM memory devices to support this faculty. Atmel's AT40K devices have a built in interface to allow direct connection to the serial EEPROM (Atmel's AT17CXXX have been developed with this in mind).

Fundamental in the design of the FPGAs are Computer Aided Design (CAD) tools. FPGA's have several methods of design entry such as the traditional schematic capture, diagrammatic state machine entry and Hardware Description Language (HDL) or the industry standard HDL, VHDL.

Once the CAD phase is completed, there is a need to implement the design functionality within the FPGA. The FPGA uses place and route tools to output a bitstream for programming the serial EEPROM configuration; this in turn implements the design in hardware. These same tools allow timing analysis of the design to ensure it meets design parameters.

FPGA's are becoming increasingly more popular with engineers. This maybe due to the FPGA's ability to integrate system level functionality into one device, thus offers the system designer the ability to re-think his approach to his solution. As technology advances, there is .a need for applications to possess more processing power; several options are then presented. Firstly, Use a faster processing core. However, this often has the disadvantages of higher cost matched with higher power consumption. (CMOS logic power consumption is directly proportional to operating frequency).

Secondly, the addition of another processor to the system. This again suffers the same setbacks as the first option, excess cost and excess power consumption. Also the PCB needs to be increased dramatically to accommodate the extra device.

Thirdly, there is the option of moving to a new processor family. Again you will incur increased expenditure as you have to purchase new software and hardware tools. There is also the time spent learning new procedures to take into account.

Finally, a custom gate array device could be considered, but this is only practical for large volume and/or high cost applications, for which an FPGA may be a stepping stone. The last option is to use an FPGA to implement function.

So, by using an FPGA, what solution are we offered that we haven't seen in the above. Well firstly, the high performance design can be achieved with lower power consumption than using additional or higher performance processors. Lower power means several things:

Firstly, and most obviously, the lower the power in a battery powered system, the longer the battery life.

Secondly, using an FPGA provides direct access to libraries of design cores, both user defined, and from intellectual property vendors. This gives a faster time to market, and hence lower development costs compared to the other solutions. This all results in lower product costs, which results in a leverage for the finished product in it's designated market.

Finally and most importantly, FPGA devices can be significantly cheaper than dedicated microprocessors, so production costs can be easily reduced. In addition, if the product volume becomes large, the option of moving to a custom gate array is significantly more simple and cheaper than taking a microprocessor core and using this in an ASIC.

Kanda, already renown for designing and running engineering websites are soon to launch www.FPGA-Forum.com. The main features of this site will be chat, FAQ's and application notes. Keep checking www.kanda.com for release information.

Note: If you would like to find out more about FPGAs or would like to purchase an FPGA starter kit, please contact Pete Mason at Kanda Systems, Unit 17-18, Glanyrafon Enteprise Park, Aberystwyth, Ceredigion, SY23 3JQ, UK. Tel 44+ (0)1970 621030 or email Pmason@kanda.com.

21st Century OZONE FUTURES

by Douglas Clarkson

THERE IS A GENERAL AWARENESS OF THE RISKS RELATING TO LEVELS OF ULTRAVIOLET RADIATION - PRIMARILY THROUGH THE RISK OF SKIN CANCER THROUGH EXCESSIVE SOLAR EXPOSURE.

While these risks are real enough, there is much less awareness of the many other processes which may be adversely affected by increasing levels of ultraviolet radiation due to depletion of the ozone layer. Agriculture may suffer loss of production and levels of plankton in the oceans may be adversely affected.

This has made scientific research into ozone depletion that potentially allows more energetic wavelengths of ultra violet to reach ground level a highly relevant environmental science. This comes, also, at a time when changes in atmospheric condition due to global warming may be introducing changes that will in turn introduce uncertainty into models of ozone recovery in the stratosphere. It is useful at this stage, however, to provide a brief overview of solar ultra violet radiation.

Solar Spectra

Objects when they are heated give off light. This spectrum is more formally described as 'black body' radiation. While normal tungsten filament lamps will have equivalent spectra corresponding to a black body temperature of around 3000°C (being limited to the melting point of tungsten of 3410°C), the characteristic temperature of the sun's outer radiating layers is around 6000°C. This enhances the spectral content of shorter wavelength and increases the relative content of ultra violet radiation.

Without the protective qualities of the earth's atmosphere, however, life on earth would be much sparser. The lifetime of most living cells exposed to such direct solar radiation could be counted in mere seconds. Atmospheric ozone acts primarily to absorb shorter wavelengths of ultra violet radiation and determines the shortest wavelength of ultra violet radiation reaching ground level - which is typically no shorter than about 290nm.

For the purposes of definition Table 1 outlines the various definitions of ultra violet radiation.

In order to designate standard extents of atmospheric path, defined elements of 'air mass' relate to standard levels of ozone

UV Band	wavelength range
UVC	100-280
UVB	280-315
UVA	315-400

Table 1: CIE (Commission International de l'Eclairage) defined wavelength bands of ultraviolet radiation.

absorption. Figure 1 indicates details of NASA/ASTM standard solar irradiance for ultra violet radiation in the range of 200 to 400nm, where data is presented for solar and air mass 1 and air mass 2. Air mass 1 relates to a standard degree of atmospheric absorption. This reveals the significant effect of the level of relative air mass on the surface irradiance of ultra violet radiation. This data, however, assumes an intrinsic level of ozone concentration within the corresponding air mass column.

Superimposed on top of this variation of ultra violet level due to ozone depletion, there are aspects of variation due to time of day, season of the year and relative latitude. In particular, for a given location on the earth, the daily variation of the sun's rays through the atmosphere provides a cyclic variation of air mass, with a minimum value around solar noon that corresponds to

Photo 1: Appearance of polar stratospheric clouds (PSCs) which form from cold aerosol particles and which when activated by sunlight can cause rapid ozone depletion. (Courtesy NASA).

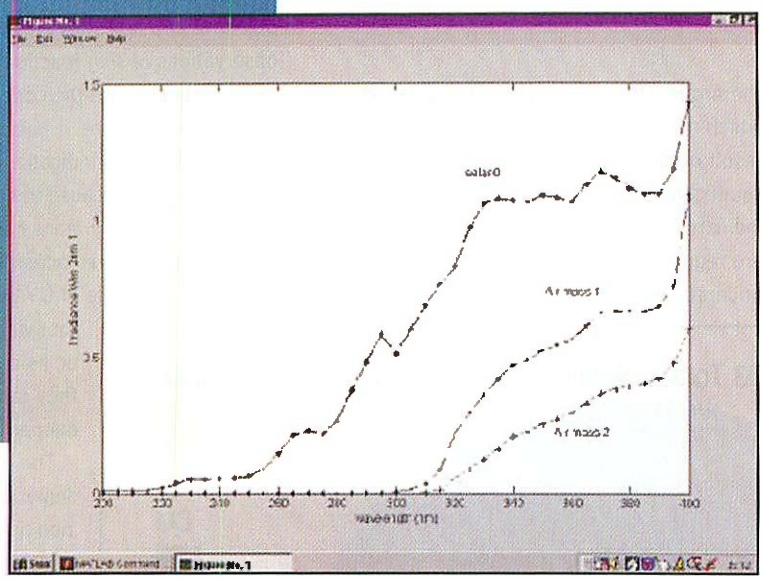


Figure 1: Details of NASA/ASTM standard solar irradiance for ultra violet radiation in the range 200 to 400nm for solar, air mass 1 and air mass 2 atmospheric loading.

maximum levels of UV radiation. The degree of cloud cover and surface reflectivity can also significantly affect the nature of levels. Also, circulation in the stratosphere can cause significant day to day variations in the 'ozone column'.

Role of Ozone

The world is surrounded by a layer of ozone, split between the troposphere which extends from ground level to about 10 km and the stratosphere which extends from 10km to about 30km above the earth's surface. The ozone molecule is formed when three atoms of oxygen combine to form a stable species due to chemical excitation initiated by ultraviolet radiation. Thus ozone which protects against ultra violet radiation is itself generated by the presence of such radiation. As much as 90% of ozone lies at heights of 10 to 50 kilometres above the Earth's surface.

Levels of ozone in the atmosphere are described in so called Dobson units (DU) where one Dobson Unit is defined as the height in milli-centimetres that pure gaseous ozone would occupy if compressed to standard conditions of one atmosphere pressure and 0 degrees centigrade. A typical level of atmospheric ozone is around 300 Dobson units, which is equivalent to a layer of ozone 3mm thick at standard temperature and pressure. Ozone therefore has a very significant effect on the biosphere while being present at trace levels.

One Dobson unit of ozone can be expressed as 0.01 mm of the gas at standard temperature and pressure. Thus a typical value of 300 DU is equivalent to 3mm of ozone at standard temperature and pressure.

Chemical species which may attack ozone while in the lower troposphere tend to be washed out within its zone of active weather - while such species which reach the stratosphere tend to persist for much longer and consequently present a much greater threat to the environment. When a chlorine atom reacts with a methane molecule, for example, it forms a hydrochloride molecule which slowly migrates down to the troposphere and hence to ground level through active weather systems.

It is estimated that the atmosphere contains around 9000 million tonnes of ozone and with the CFC loading of the atmosphere having peaked at around 30 million tonnes. Approximately one in sixty CFC and halon molecules reach the stratosphere where they can take place in ozone depletion.

While ozone is itself produced by the action of sunlight on oxygen species and this effect is greater around the equator, there tends to be a circulation of air to higher latitudes which itself depletes levels near the equator. Thus there tends to be higher average levels at higher latitudes and with lower values towards the equator. Around the equator the effects of direct path through the atmosphere of the sun and a reduced ozone concentration tend to give enhanced intensities of UV radiation.

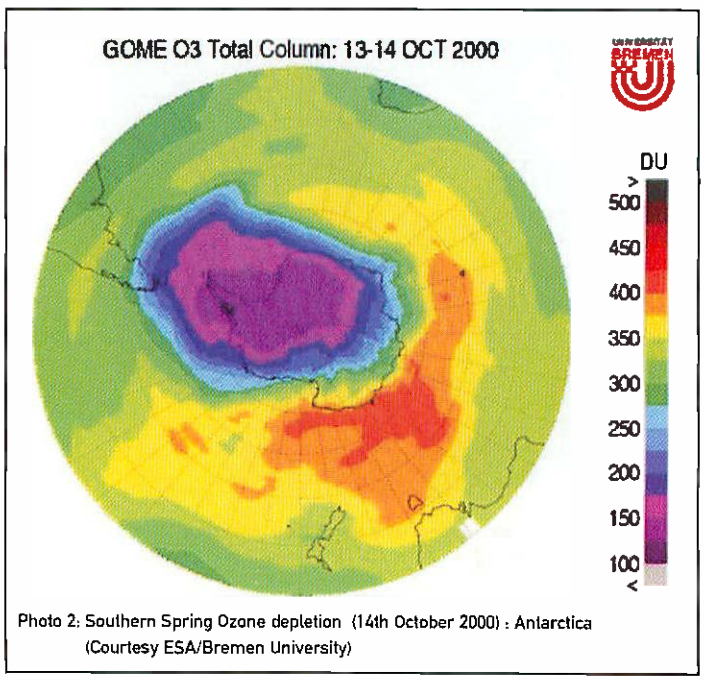


Photo 2: Southern Spring Ozone depletion (14th October 2000) : Antarctica (Courtesy ESA/Bremen University)

Ozone Watch

It was in 1985 that the British Antarctic Survey initially discovered the depletion of ozone in the Antarctic. Review of satellite data indicates that in the period between 1979 and 1995 in latitudes 35 degrees N to 55 degrees N average ozone levels have decreased by more than 12% over 16 years. Global reporting of ozone depletion is undertaken by the World Meteorological Organisation (WMO).

During 1996, as a result probably of particularly cold winters, record low levels of ozone were detected over Europe. The chemistry of the stratosphere is being discovered to be highly complex - in particular over the relative efficiency with which chlorofluorocarbons (CFCs), halons, carbon tetrachloride and methylchloroform as the main man-made ozone depleting chemicals remain active. A key aspect of the relative activity of these species is their interaction with ultra fine frozen aerosol droplets that consist of a mixture of water and sulphuric acid. At

temperatures of around -80°C, clouds can form from these aerosols. With the return of the sun during Arctic and Antarctic springs this causes rapid depletion of ozone levels.

In the formation of such polar stratospheric clouds (PSCs), chemical reactions occur which transform inert molecules such as ClONO2 and HCl to active forms such as ClO. The activated chlorine destroys ozone in the presence of sunlight. Photo 1 at the beginning of this article indicates the typical appearance of such PSCs. While temperature is a key factor for the formation of such clouds, the extent of air circulation is also important for determining how much ozone will be depleted as such clouds are illuminated by the sun.

Air circulation can by natural processes transport these droplets from the lower atmosphere. Also, volcanic eruptions - such as that of Mount Pinatubo in 1991, can inject large amounts of such aerosol into the stratosphere. This event triggered significantly enhanced ozone destruction during 1992 and 1993 though subsequently aerosol levels have returned to normal.

While the ozone levels may be about to stabilise in the next few years and hopefully undergo a long-term recovery, any major volcanic eruption on an extent considerably greater than Mount Pinatubo would have dire consequences for ozone depletion. This risk will remain in place for as long as there is a significant burden of ozone depleting chemicals in the stratosphere.

A key aspect of the investigation of ozone depletion relates to circulation of air within the stratosphere. Within the Antarctic, air circulation is more limited, and areas of ozone depletion in the spring tend to last longer than for corresponding processes in the Arctic. Thus patterns of air circulation, which may themselves be changing as a result of global climatic change, also have a significant effect on ozone levels. This indicates that a range of research approaches are required to obtaining a fuller understanding of ozone depletion.

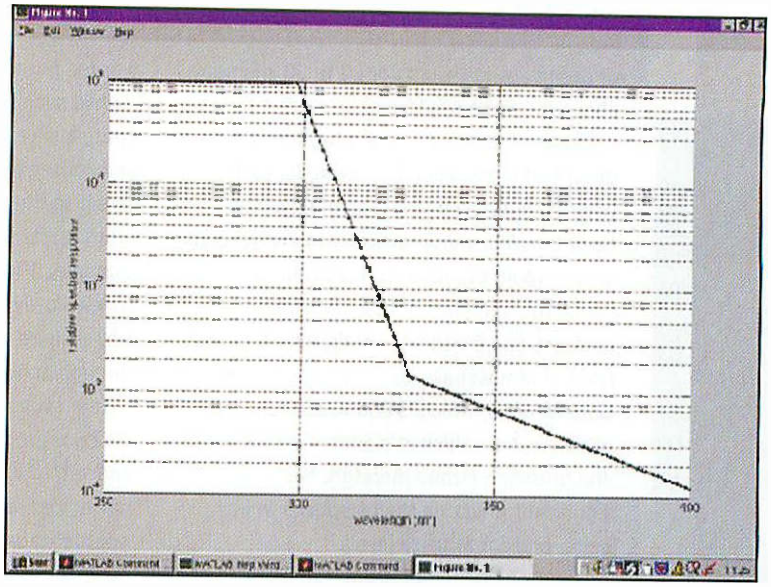


Figure 2: CIE Erythemal action spectrum for °skin exposure.

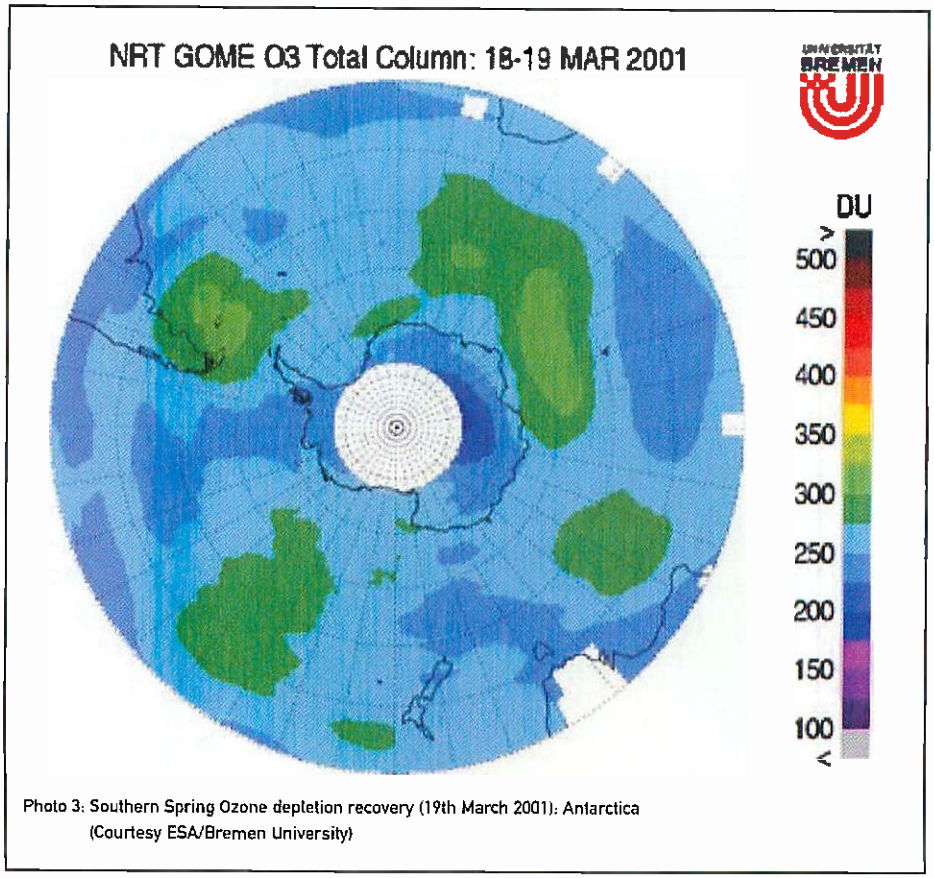


Photo 3: Southern Spring Ozone depletion recovery (19th March 2001): Antarctica (Courtesy ESA/Bremen University)

Action Spectra

The CIE action spectrum is a defined means of weighting ultra violet skin exposure with wavelength and is indicated in Figure 2. This is a means of assessing the erythemal(skin reddening) response to the skin of ultra violet radiation. The key attribute of this spectral response is the fact that it is highly wavelength dependent - with a variation of a factor of around 1000 in going from 300nm to 320nm. This has also made it difficult to measure personal exposure effectively using a detector with suitable wavelength response.

Based on this definition of relative spectral effectiveness, the MED or minimal erythemal skin dose has been defined as 200J/m2 (Joules per square metre) with the weighting of the CIE response applied. The CIE weighting curve is relatively easy to determine since it is based on objective and relatively short-term observations of skin reaction. While there is the intention to use the concept of the MED to quantify exposure, it does not necessarily map directly as an indication of risk of skin cancer - simply because the action spectrum for skin cancer in humans has not been determined. There is increasing suspicion, however, of the role of UVA wavelengths in that while they may not be as energetic as UVB, they can penetrate deeper into tissue.

The effect of ozone depletion is very much 'non linear' across the wavelength range of UV radiation because the effect of UV on biological systems is itself non-linear. Typically effects at shorter wavelength where intensities are lower are compensated for by the fact that such shorter wavelengths are much more significant for biological effects.

It has been estimated that for modest changes a 1% decrease in ozone will result in a 1.1% increase in UV erythemal response - an indication of the so-called Radiation Amplification Factor.

UV Index

The UV index has been widely adopted as an indication of relative solar UV hazard. A level of radiation of one UV index value is stated to be equivalent to a level of 25 mW/m2 (milliWatts per square metre). At this level, a

dose of 200 Joules per square metre would be collected in 133 minutes. Table 2 indicates a range of maximum exposure times in relation of a maximum exposure of one MED value.

Solar UV Index	Max time in sun (minutes)
1	133.3
2	66.6
3	44.4
4	33.3
5	26.6
6	22.2
7	19.0
8	16.7
9	14.8
10	13.3
11	12.1
12	11.11

Table 2: Variation of 'safe' exposure time as a function of UV index.

When the UV Index is presented in weather forecasts, this in fact refers to the peak solar radiation levels under clear sky conditions. The UV index as such presents information essentially about maximum possible short-term skin UV exposure - exposure likely to result in skin erythemal responses. There is also an implied minimisation of long term exposure for effects of skin cancer. There is now an emphasis in avoidance of UV solar radiation by avoiding exposure around solar noon and wearing more by way of skin protection than in calculating how long it is 'safe' to stay in the sun or applying sun tan lotion.

Montreal Protocols

The Montreal Protocol on Ozone Depleting Substances (1987) provided a framework for phasing out production of ozone depleting chemicals and further revisions being held in London in 1990 and Copenhagen in 1992. The most recent meeting of the interested parties was in Vienna in 1995 when stricter controls on the consumption of HCFCs and methyl bromide.

Some positive indications of the Montreal protocol were observed in 1996 when a reduction of ozone depleting chemicals was observed in the lower atmosphere. At best, however, current expectations are that the ozone will not really begin to recover for at least another ten years.

One complication in this model is that of global warming, which could alter the relative size of the troposphere/stratosphere and changes the levels of relative interaction between them. Also, changing patterns of cloud cover can also significantly affect ultra violet dose levels.

European Ozone Watch

European Science has established a broadly based research programme into monitoring the composition of the upper atmosphere. A programme of atmospheric measurements based on extensive balloon flight investigations is on-going while the highly successful GOME instrument on board ERS-2 launched by the European Space Agency in 1995 has provided extensive sets of new data. The results of such research shows that ozone is still globally declining - in spite of the impact of the Montreal Protocol. Also, a 50% ozone loss over the Arctic in the lower atmosphere has been observed during short periods in the spring of 2000. Also, during the year 2000, the extent of the ozone hole over the Antarctic was seen to grow to record size with centres of population beginning to be influenced in South America.

The usefulness of the GOME instrument has been to allow measurement of a range of trace stratospheric gases. A key aspect of this has been to detect chlorine activation within the atmosphere and has at last allowed a direct link to be made between localised ozone depletion and regions of chlorine activation.

Enhanced atmospheric measurement capability will be provided with the launch of ESA's ENVISAT in June of 2001. Further systems for atmospheric measurement are planned for EUMETSAT MetOp 1, 2 and 3 platforms for launch in period 2005-2020. Such systems should enhance measurement facilities in the future by keeping a careful watch on the condition of the chemistry of the stratosphere.

The ERS-2 satellite, however, which has been operating for over six years, is increasingly prone to reliability problems such as failure of gyroscopes which is having an impact on system 'up' time. While GOME-1 continues to work well, it is some two years beyond its guaranteed operating period. Also ERS-2 is now at the end of its official guaranteed lifetime. The data it continues to provide, however, is a key element in current ozone monitoring programmes.

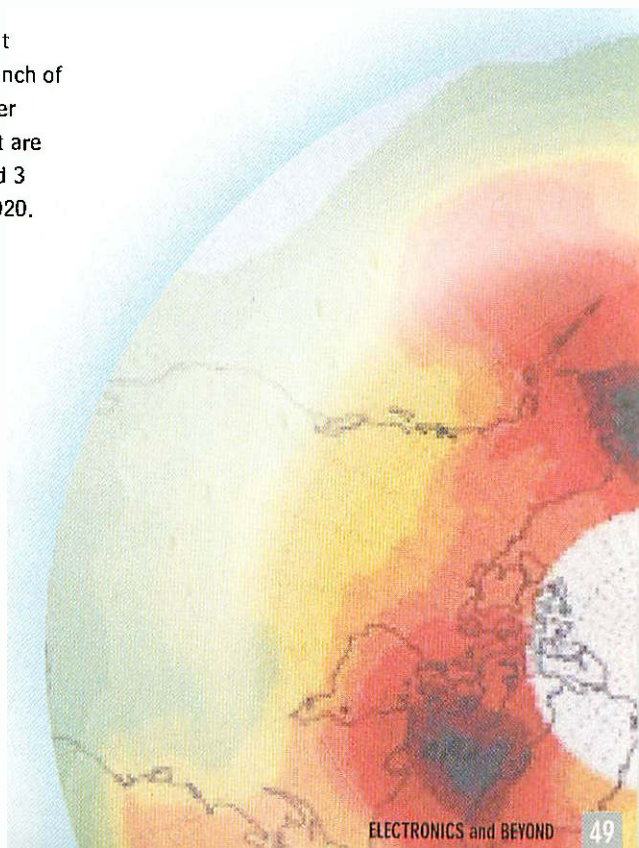
The GOME Spectrometer

The GOME instrument performs an analysis of radiation in wavelength range 240nm to 790nm and undertakes this using four independent linear Reticon silicon diode arrays each with 1024 spectral elements as outlined in Table 3.

Channel	wavelength range (nm)	integration time (sec)	spectral resolution (nm)
1A	237-283	12	0.2
1B	283-316	1.5	0.2
2	311-405	1.5	0.17
3	405-611	1.5	0.29
4	595-793	1.5	0.33

Table 3: Channel characteristics of GOME instrument.

The approach of splitting light into a series of separate diode arrays using dispersing prism and holographic diffraction gratings allows for increased wavelength resolution. This in turn permits more detailed analysis of trace gas content in the atmosphere.
In channel 1A, an increased integration time is utilised due to the low level of signal present. The advantage of the use of diode arrays lies in the fact that data from the individual array elements is available 'in parallel' so that data capture is relatively rapid. While GOME is used primarily on light scattered from the



earth's atmosphere, once a day (or every fourteenth orbit) the solar irradiance is captured.

A key aspect of the use of such instrumentation is calibration of the detection circuits. This is carried out at monthly intervals during which over the period of an entire orbit a calibration lamp with a known output spectrum is switched on. A key part of optimisation of GOME data has been the comparison of GOME ozone data with ground based measurement teams. ERS-2 data is received by ground stations in Canada (Prince Albert and Gatineau),Sweden (Kiruna), Canary Islands (Maspalomas).

GOME NRT

The so-called GOME NRT (Near Real Time) data service is designed to communicate data from GOME within a day of reception of satellite data. This is to provide on-going scientific support for stratospheric and tropospheric field measurement campaigns and also to provide data to the public regarding ozone depletion. In the previous system, data was collected on computer tape and mailed to DLR, the German Aerospace Centre where processing of data was undertaken and with ozone data only becoming available some weeks later.

Data is now readily available on the internet through the NRT service provide by the University of Bremen which processes data principally from the Kiruna ground station in Sweden. Images are available in JPEG or Postscript formats and relate principally to single day or two day average data of north or south hemisphere. Also thumbnail images can be observed for a selected month. This can rapidly reveal, for example, the widespread ozone depletions in the arctic and Antarctic springs. This facility is therefore a very good example of the internet proving excellent public access to data relating to key environmental concerns.

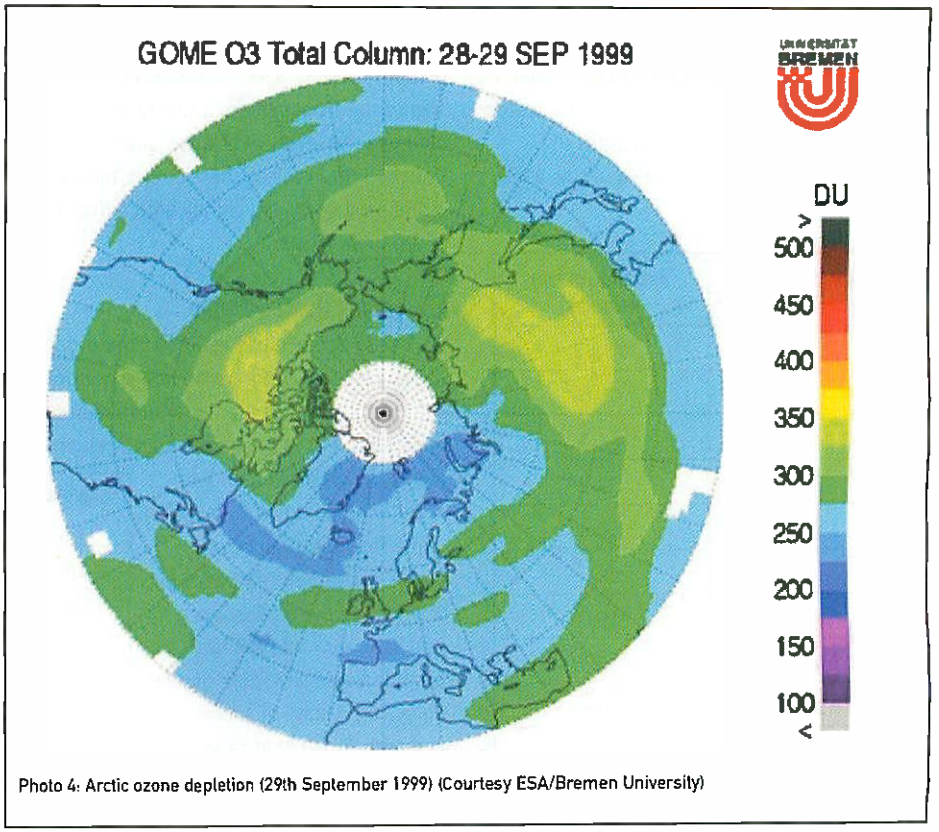


Photo 4: Arctic ozone depletion (29th September 1999) (Courtesy ESA/Bremen University)

Photo 2 indicates the typical ozone depletion of the southern spring of October 2000 and with photo 3 indicating the image of partial ozone recovery in the following March. In the northern hemisphere there appears to be a stabilising of ozone during the winter months as indicated in photo 4 of ozone column of 27 th February 1999. Photo 5 indicates that by September of that year ozone has reached minimum levels. It appears from inspecting the pattern of ozone distribution in Europe that recently the mediterranean seems prone to ozone thinning from June to September.

European Co-operation

While 'big science' in the form of ERS-2 plays a key role in providing extensive sets of data on stratospheric ozone, more basic scientific experiments on atmospheric science which include balloon and rocket flights play a key role in developing models of atmospheric circulation and ozone content. Indeed, there is active co-operation to sample specific atmospheric regions using such methods and to have the findings compared with ERS0-2 GOME findings. The ozone concentration data provided by GOME is highly complex and requires extensive processing using detailed models to produce 'calibrated' outputs of real levels of ozone. The refinement of models of stratospheric ozone plays a key part in optimising the accuracy of GOME measurements.

An initial programme of research within this European context included EASOE (European Arctic Stratospheric Ozone Experiment) which ran from November 1991 to March 1992 and involved over 60 research groups. Three aircraft flew 100 missions to determine concentrations of trace gases and 1000 balloon launches were made from 20 stations.

This was followed from November 1991 to March 1992 by SESAME (Second European Stratospheric Arctic and Mid latitude Experiment. A total of five aircraft were available for trace gas measurement and a total of 2000 balloon launches were undertaken from 26 stations. During SESAME direct evidence was obtained of ozone loss - with losses of around 50% being observed at altitudes of 18 kilometres.

Heightened interest in the ozone layer prompted the Third European Stratospheric Experiment on Ozone (THESEO) which ran from winter 1997/98 to December 2000. A civilian version of the infamous Lockheed U-2 spy plane has been active in northern Europe as part of the THESEO initiative sponsored by the European Commission. Photo 6 indicates this aircraft at Kiruna Airport in Northern

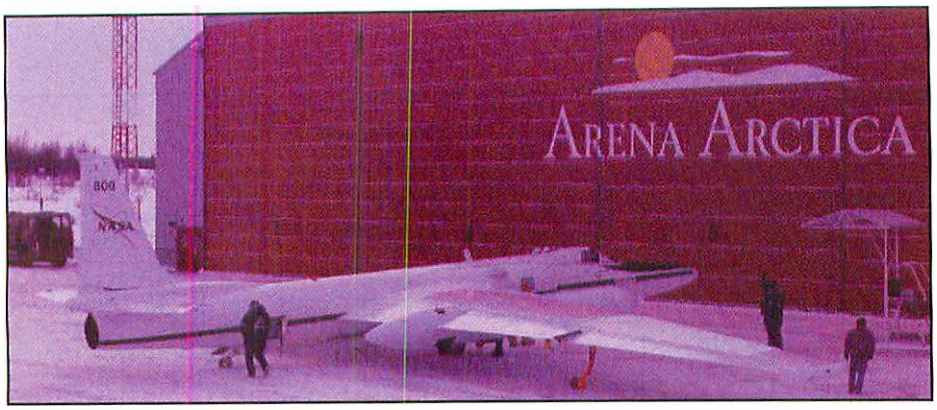


Photo 6: Civilian ER-2 spy plane used in sampling of stratospheric gases from base at Kiruna Airport. (Courtesy NASA).

Sweden. Extensive flights have been undertaken over Russian airspace to collect data on trace gases, including ozone, in the stratosphere.

While satellite data provides data covering almost the entire planet, deviations between ground based observations and corresponding satellite data remain. This is probably due to aspects of local cloud distribution and effects of air pollution. Thus while ground observations detect a 40% difference between locations of comparable latitude between southern hemisphere and northern hemisphere, satellite observations yield only a 10 to 15% difference. This accounts in part for the diversity of approaches within the current programmes of European research.

While the steps already taken to stabilise and eventually reduce the CFC and halon burden of the stratosphere, may give some element of comfort, the increasing intensity of ozone monitoring being undertaken by scientists, especially in northern Europe, is evidence of mounting concern over increasingly severe ozone losses over the Antarctic and the Arctic.

Ozone depletion over the Antarctic has been observed as high as 60% while the maximum levels over the Arctic are around 40%. Typically, ozone depletion is not as likely over the Arctic since temperatures lower than -78 C required for creation of polar stratospheric clouds are less likely to occur.

Ecological Issues

It is considered that the greatest risks of ozone depletion arise with regard to ecological issues. Limited research undertaken into the effects of increased levels of UV on fauna and flora indicates generally variable effects with some species benefiting and others responding adversely. In particular, plankton in oceanic ecosystems accounts for half of the carbon bound up in biological assimilation and increased levels of UV may change the mix of plankton species in the oceans.

While limited short term investigations can be undertaken in laboratory conditions, the long term effects, however, on complex interdependent ecosystems, are generally much more difficult to determine and so there is considerable uncertainty in prediction of such effects.

It is very much apparent that current research in ozone depletion is becoming more and more linked to continued investigation of climate change where the factors now being considered relate to how patterns of atmospheric circulation and temperature stratification which could be influenced by climate change will interact with the large CFC and halon burden in the stratosphere. The trend to identify these significant issues as separate certainly seems to be absent within the scientific community, though among public perception at present they are seen as separate issues.

Scientists are at present, however, seeking to obtain as much data as possible to confirm their suspicions that climatic change is making a tricky ozone depletion problem much worse. The fact that severe ozone depletion can occur over the Arctic and Antarctic where population levels are very

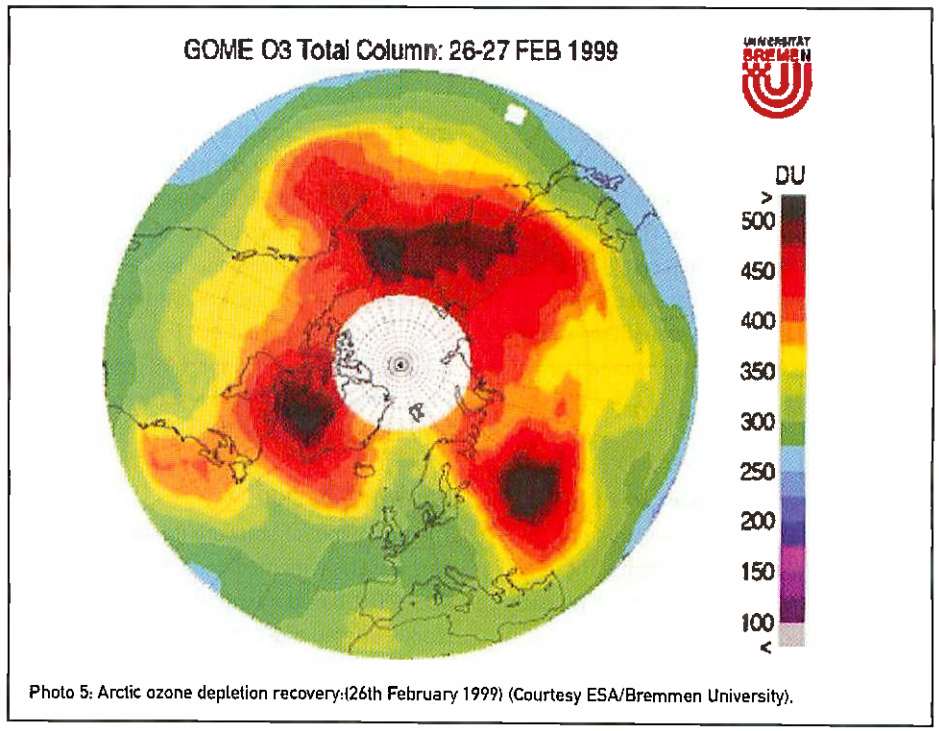


Photo 5: Arctic ozone depletion recovery:(26th February 1999) (Courtesy ESA/Bremmen University).

And So the Future

While extensive ozone loss since the 1990's is a repeatable observation in the Antarctic, the occurrence of ozone depletion in the Arctic is more variable and linked to temperature profiles within the stratosphere. During the 1998/1999 winter, for example, losses at 19 km were around less than 10% while in the following year corresponding losses exceeded 65%. Such high losses have confirmed the need for researchers to be vigilant in respect of future variations in the ozone levels.

Levels of ozone depleting chemicals have been observed to fall in the atmosphere since the beginning of the 1990's though this has not been observed to be associated with a long-term recovery of the ozone layer.

low has tended to reduce the profile of the impact of such episodes. There is every likelihood, however, that as such areas of ozone depletion extend even wider, they will attract more attention among the public. As mentioned previously, there is always the chance that volcanic activity over the next 50 years can react with the CFC/halon burden in the stratosphere to cause additional severe depletion of the ozone.

Web Contacts

www.iup.physik.uni-bremen.de/gomenrt2001
www.nilu.no/projects/sammoa
www.who.int/inf-fs/en/fact133.html
ftp://code916.gsfc.nasa.gov/pub/solve/images
www.grid.org/UNEP1998/UNEP98p9.html

ANALOG DEVICES' ADSP21XX FAMILY OF DSPS DO NOT OFFER ASYNCHRONOUS SERIAL DATA TRANSFER FACILITY. WE NEEDED SERIAL DATA TRANSFER (RS-232 FORMAT) FOR THIS DSP TO COMMUNICATE WITH AN 8052 CONTROLLER.

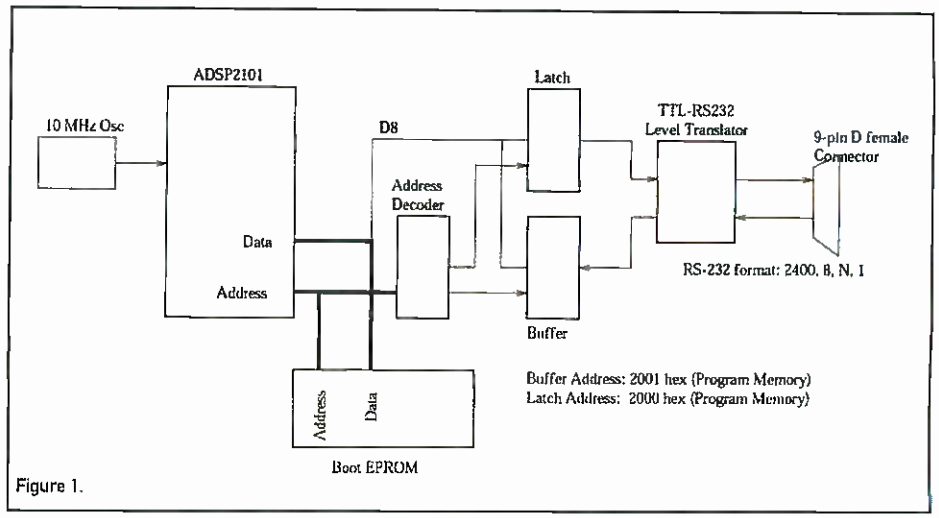


Figure 1.

Soft UART for the ADSP21xx DSP Family

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This brief describes the hardware that was utilized to implement the RS-232 serial data communication between the DSP and an external device. The serial data format employed was: 2400 bps, 8 bits, 1 stop bit, no parity. Also described in this document is the DSP software driver and the test procedure employed to validate the system.

Introduction

Complex instrument systems are often implemented as an interconnection of distributed intelligent subsystems. These subsystems need to communicate with each other. Various communications protocols exist, depending upon the application and the need. The choice of the communication protocol is dictated by the data transmission speed requirement among other things. For infrequent, slow data transfers, serial data communication of one form or the other is often utilized. Various popular serial data transfer protocols are: I2C, SPI, RS-232, RS-485 etc. I2C and SPI are synchronous data transfer protocols while the RS-232 and RS-485 are asynchronous. Most embedded controllers such as the 8051, 68xx and others offer RS-232 serial data transfer protocol as a standard on chip feature. I2C and SPI on the other hand are relatively new entrants and are yet to find popular support across all platforms, besides, they are typically used for communication across short distances.

We needed a serial data transfer protocol between an ADSP2101 based CCD Controller and an 8052 equipped shutter/temperature/motor and telemetry controller. Since we also needed to use this 8052 equipped shutter/temperature/motor and telemetry controller as a stand-alone device in other applications, we chose RS-232 format as the 8052 readily supported this format. However, ADSP2101 does not support RS-232 and so we needed to implement a software driven RS-232 port on the ADSP2101.

Hardware Design

The prototype for software driven RS-232 port was implemented on an existing ADSP2101 based waveform generator as it readily offered most of the required circuitry.

Figure 1 shows the block diagram of the circuit to implement the software driven RS-232 port. Figure 2 shows the circuit schematic for the ADSP-2101 based software UART. This circuit which is part of larger system, operates on a 10.000 MHz clock. Pull up resistors RSPIX in figure 2 is used to pull various DSP signals to +5V.

A buffer 74HCT244 (U6A) was installed to read the serial input data. Pin 8 of this IC was connected to receive the serial input and pin 12 (corresponding output of the buffer) was connected to data bus pin D8.

A Latch 74HCT273 (U5) was installed. Output pin 19 was used for the serial data output. This output was driven by the data bus output D8. The Latch (U5) and the Buffer (U6A) were mapped in the program memory space of the ADSP-2101 DSP.

Decoder ICs 74F138 (U7 and U8) were installed for address decoding. Output 0 (SEL0, Pin 15) of U7 was used to latch data into the 74HCT273 (U5) latch. Output 1 of decoder U8 (RD1, pin 14) was used to enable the input buffer 74HCT244 (U6A).

The addresses of the latch and the buffer are:

Device	Address
Buffer IC (U6A)	2001 hex in Program Memory
Latch IC(U5)	2000 hex in Program Memory

The DSP has been programmed to transmit and receive serial RS-232 data at 2400 bits/s, 8 data bits, no parity and 1 stop bit. This data rate was chosen because, with a 10.000 MHz crystal, an 8052 can only be programmed to work at 2400 bps with less than 1 percent error. All other standard baud rates have significant errors (more than 5) when generated using a 10.000 MHz clock on the 8052. The constraint on the 8052 in this particular system was to operate from the shared 10.000 MHz clock generated from the ADSP-2101 circuit. However, it is quite easy to generate any other bit rate on the ADSP-2101 using the given example software driver.

The RS232 to TTL level translator circuit shown in figure 2 is a standard circuit provided in manufacturer's data sheets. I used ADM232L which is a drop in replacement for the MAX232 (which is shown in the figure 2). Powered with +5V supply, the marking voltage output of the translator

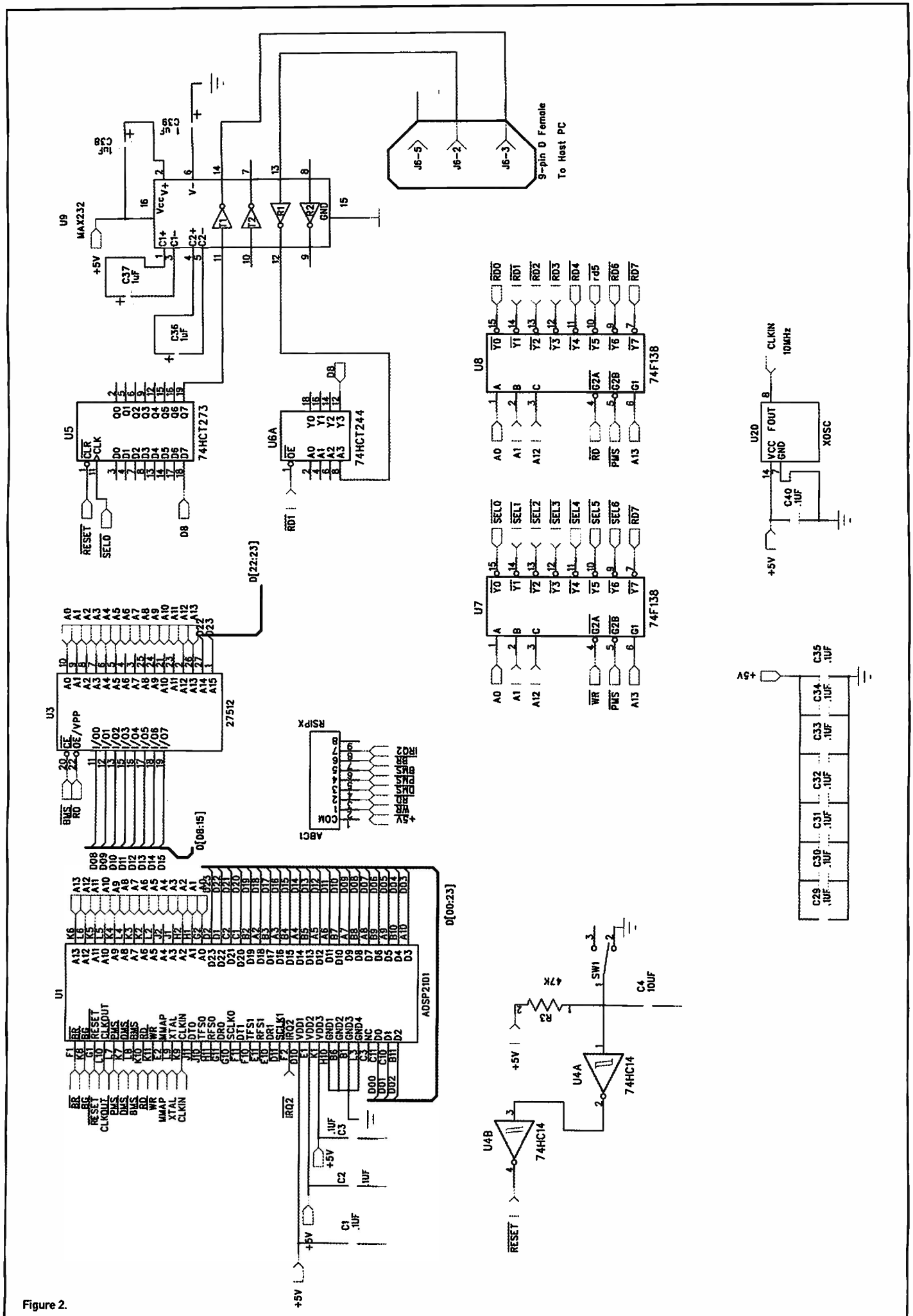

U1
ADSP2101
U3
27512
U4A
74HC14
U4B
74HC14
U5
74HCT273
U6A
74HCT244
U7
74F138
U8
74F138
U9
MAX232
U2D
XOSC
J6-5
J6-2
J6-3
9-pin D Female
To Host PC
D[00:23]
D[08:15]
D[22:23]
RESET
SEL0
RD1
D8
CLKIN
10MHz
+5V

Figure 2.

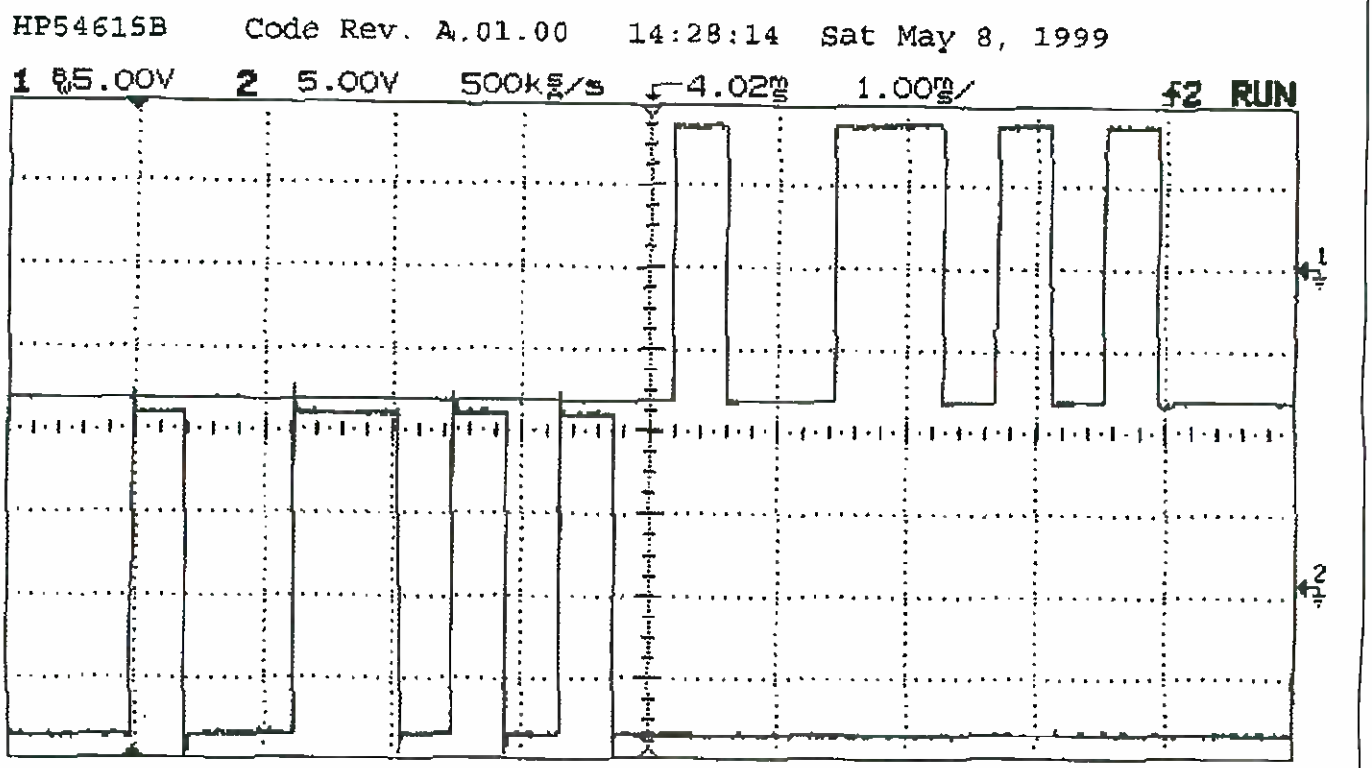


Figure 3.

is -8.28 V. The most +ve voltage output of the translator is +8.4 V measured on the HP digital scope.

Software Driver

The DSP software driver to support transmission and reception of serial RS-232 data was written in ADSP21xx assembler. A minimal no frills driver has 2 routines: send_byte and get_byte. As the names of the routines imply, send_byte, when invoked transmits a byte from a DSP internal data memory location (named data_tx) at 2400 bps. Similarly, get_byte, when invoked receives a serial byte and puts it in an internal DSP data memory location (named data_rx).

A simple program to receive a byte of serial data and echo back to the host is written for the purpose of test and validation. The program is as follows:

```
loop_here:    call get_byte;
ay0=dm(data_rx);
dm(data_tx)=ay0;
call send_byte;
jump loop_here;
```

This software driver uses the DSP timer to generate the bit rate for the serial data. In our case, the bit time corresponding to 2400 bps is 416 us. The timer is actually programmed to generate time ticks at 104 us intervals so as to be able to sample the data stream four times in a bit period.

The RS-232 serial data is composed of a start bit for 1 bit time, 8 data bits (lsb first and msb last), each for 1 bit time and 1 stop bit (for our configuration of 2400, 8, N, 1).

The software driver also uses many of the internal DSP registers as well as the alternate register set.

To integrate this driver into another program, care must be taken to maintain the integrity of the various registers across subroutine calls.

System Test and Validation

This hardware and software scheme was tested by connecting the DSP circuit to a PC serial port. On the PC a terminal emulation program VTERM was used to send and receive serial data, sourced from either a disk file or the keyboard. The VTERM program set the PC serial port to transmit and receive data at the required format and rate (i.e. 2400, 8, N, 1). The DSP was programmed with the test program mentioned above, to echo any data received on it's receive input pin onto it's transmit output pin.

A sample RS-232 transmission of ASCII character 'S' was captured on a digital scope is shown in figure 3.

A comprehensive test of data transmission and reception was performed by sending and receiving an entire disk file. the disk file was received without any error. For this test, VTERM (a terminal emulation program) was set to transmit the file contents on a 'paced by echo' basis. That is to say that characters were transmitted after the previous one was received by the PC. Similar tests can be performed using the Hyperterm communication program on Windows OS.

Conclusion

A software driven UART is implemented to perform at 2400,8,N,1. Suitable hardware and driver software is shown. This can now be integrated into any system. It is important to realize the implications of implementing a UART in software. It cannot be expected to offer the same functionality or performance of a hardware UART. Sufficient gaps between transmissions must be allowed to account for bit rate mismatch between the transmitter and receiver and that the software UART has to execute a program to transmit or receive data, unlike a hardware UART. Also the software UART in this case is implemented so as to work in a half duplex mode.

References

The Art of Electronics. Horowitz and Hill, Cambridge Univ. Press. 2nd Edition.
ADSP-2100 Family User's Manual. Analog Devices
Designer's Reference Manual, Analog Devices, 1996.

Driver Code

```
.MODULE/RAM/ABS=0
dsp_proto;
{Port addresses of the UART Transmit
and Receive Port}
.PORT       tx_port;
.PORT   rx_port;

{To isolate the TxD and RxD bits from
the Transmit and Receive ports. Both
bits are on Data Bus bit D8 which
translates to least significant bit on an
internal 16 bit register}

.const tx_bit = 0x01;
.const rx_bit = 0x01;

{the sample time is .25 the actual
required bit time. so for a 2400 bps, the
bit time is 416 us. so the 104 us}

.const sam_time = 104;
.const TSCALE = 0x3ffb;
.const TCOUNT = 0x3ffc;
.const TPERIOD = 0x3ffd;

.VAR/DM/RAM/SEG=INT_DM
data_value;
.VAR/DM/RAM/SEG=INT_DM data_rx;
.VAR/DM/RAM/SEG=INT_DM data_tx;

{————Interrupt vector table————}

      JUMP start; NOP; NOP; NOP;
{reset vector}
      RTI; NOP; NOP; NOP;
{IRQ2}
      RTI; NOP; NOP; NOP;
{SPORT0 transmit}
      RTI; NOP; NOP; NOP;
{SPORT0 receive}
      RTI; NOP; NOP; NOP;
{SPORT1 transmit}
      RTI; NOP; NOP; NOP;
{SPORT1 receive}
      RTI; NOP; NOP; NOP;
{timer}



start:          i6=^tx_port;
          m6=0;
          l6=0;
          i5=^rx_port;
          m5=0;
          l5=0;
          ax0=0x01;
          pm(i6, m6)=ax0;
          ax0=0;
          dm(data_value)=ax0;
more:          call init_timer;
loop_here:     call get_byte;
          ay0=dm(data_rx);
          dm(data_tx)=ay0;
          call send_byte;
          jump loop_here;
get_byte:      i6=^rx_port;
          m6=0;
          l6=0;

{get falling edge for the start bit}
check_high:    ax0=pm(i6,m6);
          ay0=rx_bit;
          ar=ax0 and ay0;
          if eq jump check_high;
fall_edge:     ax0=pm(i6,m6);
          ay0=rx_bit;
          ar=ax0 and ay0;
          if ne jump fall_edge;

{now wait for 2 times sam_time to get to
the middle of the start bit}
          call sam2time;
{make sure that your bit is still low}
          ax0=pm(i6,m6);
          ay0=rx_bit;
          ar=ax0 and ay0;
          if ne jump check_high;
          cntr=8;
          ay0=0;
DO shift_in until ce;
          call sam4time;
          ax0=pm(i6,m6);
          ay1=rx_bit;
          ar=ax0 and ay1;
          si=ar;
          sr=lshift si by 8 (LO);
          ay1=0x0100;
          ar = sr0 and ay1;
          ay1=ar;
          ax0=ay0;
          ar=ax0 or ay1;
          si=ar;
          sr=lshift si by -1 (LO);
          ay0=sr0;
shift_in:      nop;
          ax0=ay0;
          ay1=0x00ff;
          ar=ax0 and ay1;
          dm(data_rx)=ar;
          call sam4time;
          call sam2time;
          rts;

send_byte:     i6=^tx_port;
          m6=0;
          l6=0;
          ax0=0;
          pm(i6, m6)=ax0;
          call sam4time;
          cntr=8;
DO send_out until CE;
          ax0=dm(data_tx);
          ay0=0x01;
          ar=ax0 and ay0;
          pm(i6, m6)=ar;
          si=ax0;
          sr=lshift SI by -1 (LO);
          ax0=sr0;
          dm(data_tx)=ax0;
          call sam4time;
send_out:      nop;
          ax0=0x01;
          pm(i6, m6)=ax0;
          call sam4time;
          rts;

sam2time:      ena SEC_REG;

          cntr=2;
do get2 until CE;
          ax0=sam_time;
          dm(TCOUNT)=ax0;
chk_zero00:    ax0=dm(TCOUNT);
          ay0=0xffff;
          ar=ax0 and ay0;
          if ne jump chk_zero00;
get2:          nop;
          dis sec_reg;
          rts;

sam4time:      ena SEC_REG;

          cntr=4;
do get4 until CE;
          ax0=sam_time;
          dm(TCOUNT)=ax0;
chk_zero01:    ax0=dm(TCOUNT);
          ay0=0xffff;
          ar=ax0 and ay0;
          if ne jump chk_zero01;
get4:          nop;
          dis sec_reg;
          rts;
{2400 baud means 416 us bit time}

init_timer: ax0=9;
          dm(TSCALE)=ax0;
          ax0=sam_time;
          dm(TPERIOD)=ax0;
          dm(TCOUNT)=ax0;
          ena timer;
          rts;
START1:             jump start;
.ENDMOD;
```

IN THE COMING MONTHS WE WILL BE FEATURING CLASSIC PROJECTS FROM PAST ISSUES OF ELECTRONICS AND BEYOND. THIS MONTH WE START WITH PART 1 OF...

On Guard LOOP ALARM

by Mark Price

This alarm system (first featured in Electronics and Beyond January 1997 No. 109) was originally designed to protect the contents of a garden shed, although it would also be ideal for other outside buildings. In addition, it would offer a good basic security system for small residential areas, such as flats and bedsits. It may be installed without drilling or attaching to the building, which could be an advantage in rented accommodation.

The unit features two separate protection arrangements. The entry/exit is protected using standard normally open and/or normally closed sensors such as magnetic switches and pressure mats. Entry and exit delays are independently adjustable, from 5 to 30 seconds, during which time, a warning sounder operates and a status LED flashes.

Valuable items are protected by a wire loop system similar to that used in shops, etc. This uses a two-core cable which is threaded through the items to be protected, and the alarm will be triggered immediately if either core becomes open-circuit or if the two cores are shorted together. Suggestions are given later for making the system even more tamper-resistant.

The loop system can be used independently from the entry/ exit system. This would be useful if a shed or garage needs to be left open when working in the garden, while still providing protection for valuable bicycles and power tools.

The unit is battery powered, and will give at least six months of continuous operation from a PP9 battery. The alarm sounding period is limited to about sixteen minutes, to conserve battery life and reduce annoyance, but the status LED remains on after this period to indicate that the alarm has been triggered. An optional relay output can be connected to an extra sounder or household alarm system.

Project Spec

Number of zones	2 (Entry/Exit and Loop Cable)
Maximum Loop Length	Unlimited
Exit Time	5 to 30 seconds (set by internal preset)
Entry Time	5 to 30 seconds (set by internal preset)
Alarm Time	16 minutes (typical)
Entry/Exit Warning	Pulsed Buzzer and Flashing Status LED
Alarm Sounder	Piezo Siren (110dB @ 1m)
Supply Voltage	9V nominal (PP9 Battery)
Low Battery Indicator	Status LED extinguished below 6·5V
Supply Current (Armed)	1mA (typical)
Battery Life	6 months (typical)
Remote Output	Optional changeover relay
PCB Size	172 x 75mm
Overall Size	177 x 120 3 83mm
Weight	500g

Block Diagram

Referring to the Block Diagram shown in Figure 1, the Loop Input and Entry/Exit Input are both followed by Latches to hold the alarm state even if the input reverts to normal. The Entry/Exit Latch can be disabled by setting the keyswitch to the Loop Only position.

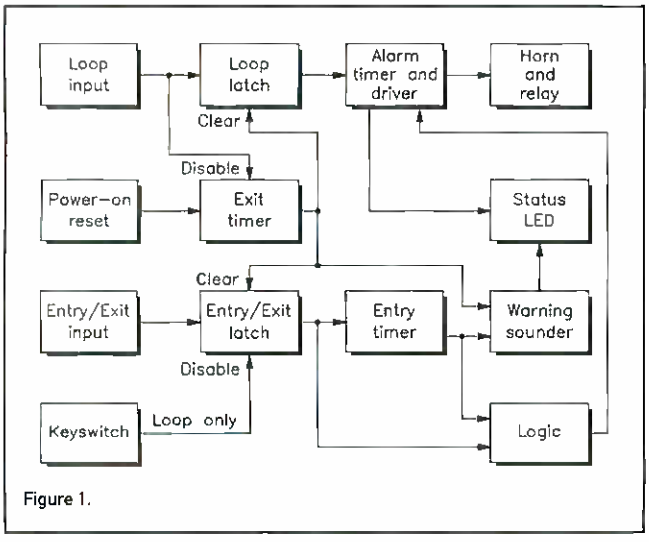


Figure 1.

The Loop Latch operates the Alarm Timer and Driver immediately. The Entry/Exit Latch triggers the Entry Timer which drives the Warning Sounder. If the unit is not switched off by the end of the Entry Timer period, the Alarm Timer and Driver are operated.

When the unit is switched on, the Power-On Reset circuit triggers the Exit Timer. During this period, the two Latches are cleared and the Warning Sounder operates. If the Loop is not connected correctly, the Exit Timer will not operate.

The Status LED flashes while the Warning Sounder is operating, and is lit steadily when the Alarm is or has been sounding.

Circuit Operation

The circuit diagram (see Figures 2 and 3) contains a number of inter-connected sections. To simplify the diagram, the various sections are shown separately, with interconnections indicated by labelled arrows.

The loop input and latch are shown in Figure 2A. The far end of the loop is terminated by a 100kΩ resistor (R5) which, when the loop is connected, forms a potential

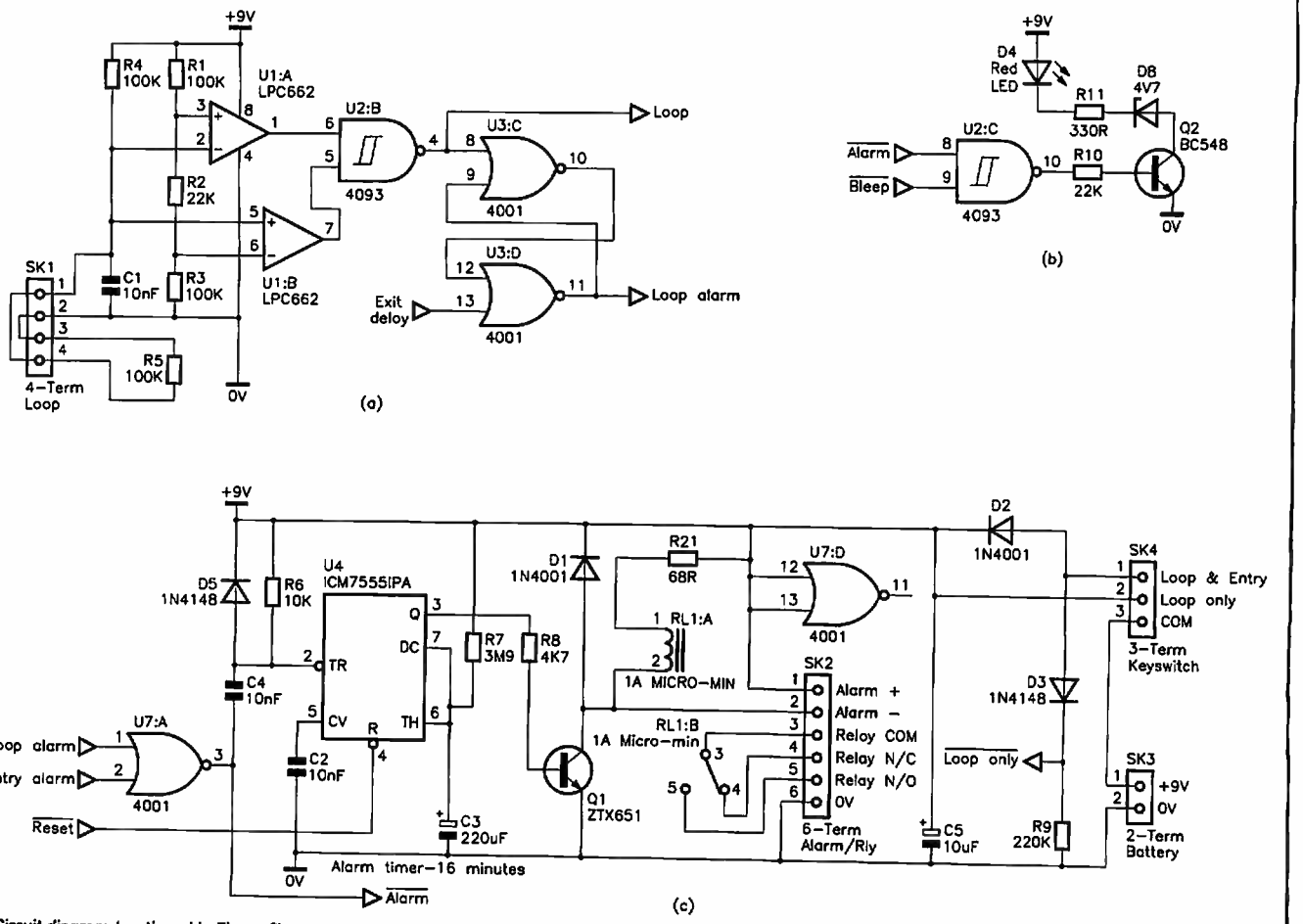


Figure 2. Circuit diagram (continued in Figure 3).

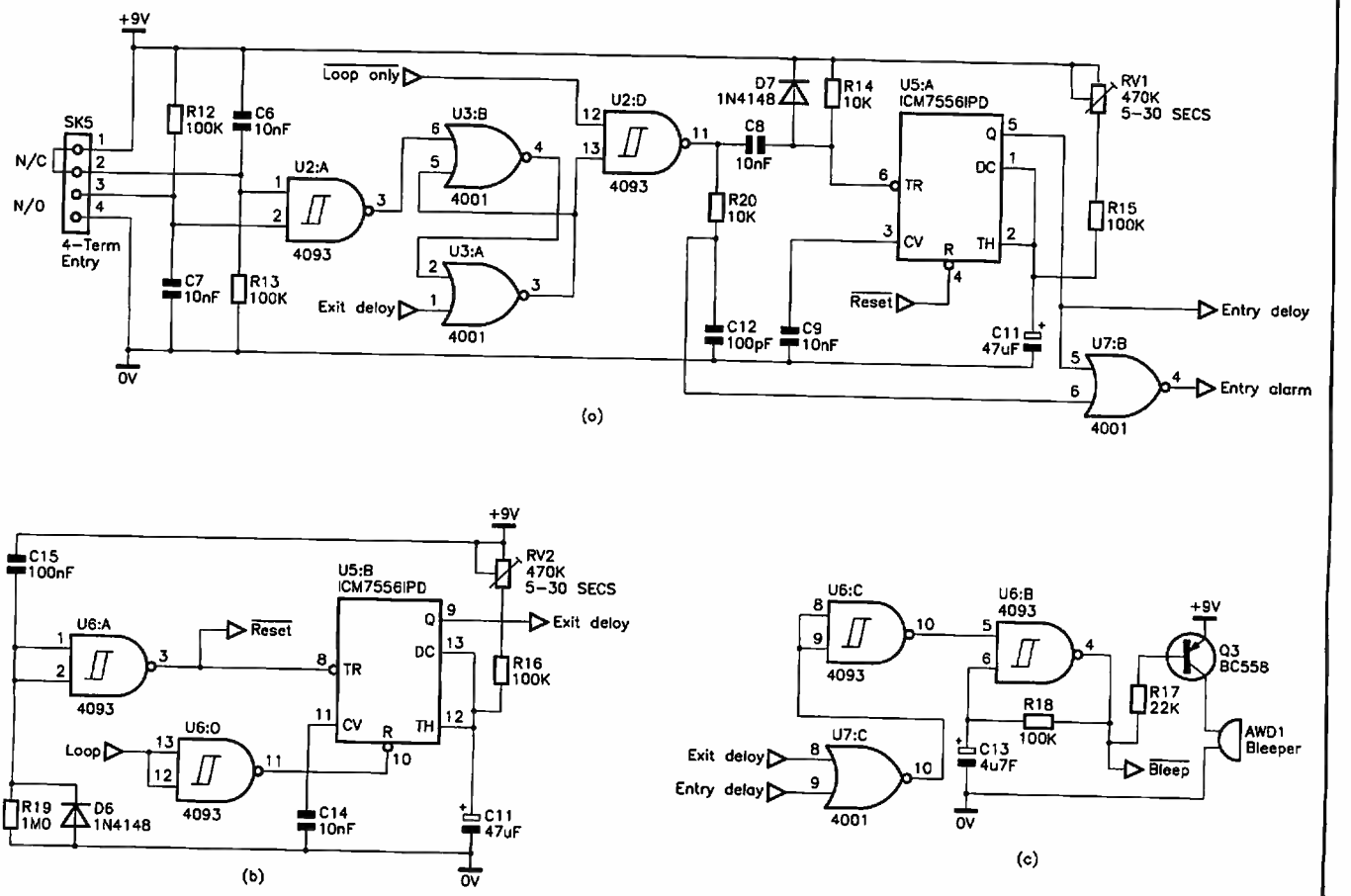


Figure 3. Circuit diagram (continued from Figure 2).

divider with R4 to give a voltage equal to half the power supply voltage on pins 2 and 6 of U1 (4·5V with a 9V battery). C1 removes any noise that may be picked up along the loop wire.

U1:A and U1:B (LPC662 dual op-amp) form a window comparator. R1, R2 and R3 set the top and bottom ends of the acceptance range. With a 9V battery, the voltage on pin 3 of U1:A is about 5V and that on pin 6 of U1:B is about 4V. If the voltage from the loop potential divider should become outside this range, the appropriate output of U1 will go low, giving a high level on pin 4 of U2:B. The LPC662 op-amp has the lowest current consumption in the range of devices offered by Maplin that will operate down to 6V.

U3:C and U3:D form an S-R (Set-Reset) Latch. This is cleared by the Exit Delay timer when the unit is switched on. If the output of U2:B should go high, even momentarily, the latch will change state, triggering the alarm.

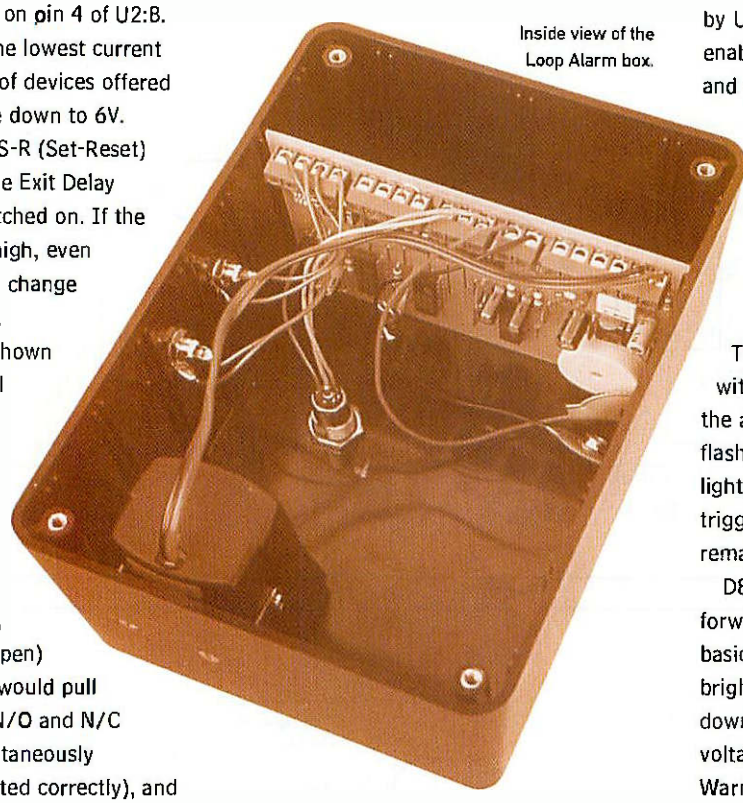
The Entry/Exit input is shown in Figure 3A. In the normal state, pin 1 of U2:A is held high by the N/C (Normally Closed) sensors, and pin 2 is held high by R12. If a sensor on the N/C circuit should operate, pin 1 will be taken low by R13, while if a N/O (Normally Open) sensor were to operate, it would pull pin 2 low. Note that both N/O and N/C sensors may be used simultaneously (providing they are connected correctly), and either will trigger the alarm. C6 and C7 remove any noise which may be picked up along these connections. U3:A and U3:B form a latch which operates in the same manner as that used for the Loop input.

The active-low Loop Only signal on pin 12 of U2:D comes from the keyswitch. When the line is low, it prevents the signal from the latch from reaching the Entry Timer.

U5:A is the Entry Timer, which is triggered by the negative going output of U2:D. RV1 sets the entry delay period from 5 to 30 seconds. The output on pin 5 of U5:A is high during the entry delay period. U7:B gates the signals from U2:D and U5:A to give an output that is high when the Entry Latch has operated and the Entry Timer has timed out. R20 and C12 provide a very short delay to compensate for the propagation delay of U5:A.

The Alarm Timer and output are shown in Figure 2B. When either the Entry Alarm or Loop Alarm line goes high, the output of U7:A goes low, triggering the Alarm Timer (U4). The values of R7 and C3 give a calculated time period of 16 minutes, although in practice, this may be a minute or two longer due to the minute leakage current in C3. Even in this case, the alarm period will be less than 20 minutes, which is now a legal requirement.

During the alarm period, Q1 is turned on, driving the alarm sounder connected to terminals 1 and 2 of SK2 and the optional relay (RL1:A). D1 protects the transistor from the back-emf produced by the relay when it is switched off. The relay contacts are brought out to terminals on SK2, together with the circuits 0V rail, for connection to a remote sounder or alarm system if required. If this option is not used, RL1 and R21 should be omitted to conserve battery life.



Inside view of the Loop Alarm box.

Gate U7:D is unused, so both inputs are connected to the 9V rail and the output is left unconnected.

The battery (9V PP9 type) connects to SK3 and the keyswitch to SK4. When the switch is set so that terminals 1 and 3 of SK4 are linked, power is connected to the circuit via D2 and the active low Loop Only line is taken high via D3. When the switch links terminals 2 and 3, power is connected directly to the circuit and the active low Loop Only line is low.

The Power-On Reset circuit and Exit Timer are shown in Figure 3B. When the unit is switched on C15 will be discharged, holding the inputs of U6:A high. C15 will charge via R19 within half a second. The output of U6:A will, therefore, be low for a brief period when the unit is switched on, giving a suitable signal to trigger the Exit Timer (U5:B), and reset the entry and alarm timers. The device used for U6 has Schmitt trigger inputs to give reliable operation with an input signal that does not conform to digital levels.

U6:D inverts the signal from the Loop input, so that the Exit Timer (U5:B) is held reset and, therefore, disabled, if the loop is not connected. RV2 sets the Exit period from 5 to 30 seconds (approximately).

The Warning Sounder is shown in Figure 3C. During the Exit and Entry periods, the output of U7:C will be low. This is inverted by U6:C, giving a high level to U6:B. This enables the oscillator formed by U6:B, R18 and C13, which operates at a frequency of about 2Hz. This drives a self-contained audible sounder (AWD1) via Q3, so that the sounder beeps twice every second. For this type of oscillator to operate, an IC with a Schmitt trigger input is specified.

The Status LED is shown in Figure 2B. The output of U2:C goes high in sympathy with the warning sounder, and also when the alarm has operated. Thus, the LED flashes during the Exit and Entry periods, and lights steadily when alarm is (or has been) triggered. In the normal operating state, it remains off to conserve battery life.

D8 (4V7 Zener) in conjunction with the forward voltage drop of D4 (red LED) act as a basic low battery indicator. The LED brightness will reduce as the battery runs down, and it will not illuminate if the battery voltage is below about 6·5V, although the Warning Sounder will continue to operate. The remainder of the circuit will operate with a battery voltage as low as 6·0V, but prompt battery replacement is recommended when the LED fails to light or becomes very dim.

The circuit consumes under 1mA in the armed state. Most of this is due to U1, U4 and U5. The unit will give typically six months continuous operation from a high capacity 9V battery such as a PP9. A large battery is also more able to operate the alarm sounder.

Part 2 Next Month

If you have any ideas or suggestions for historical projects please drop us a line.

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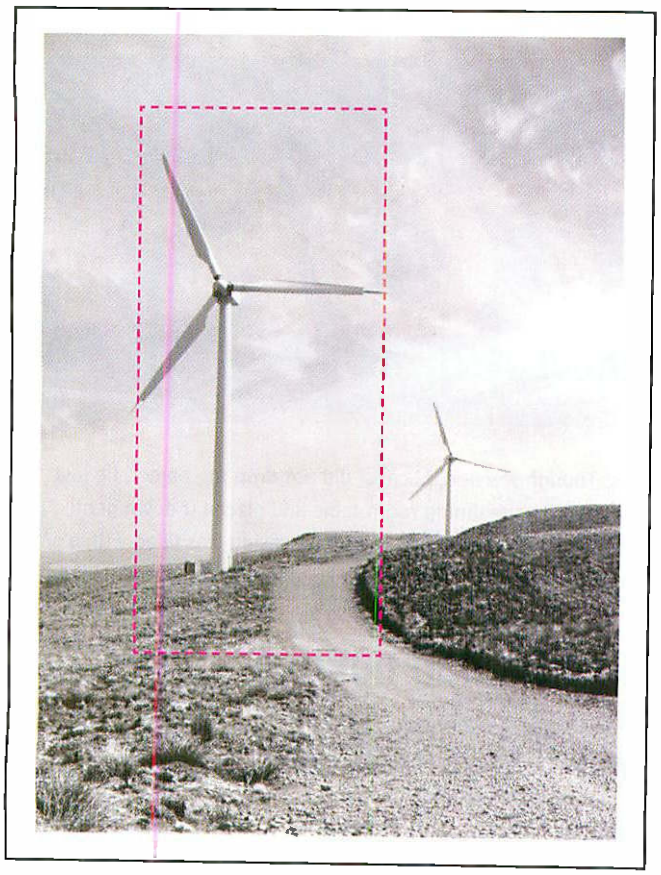

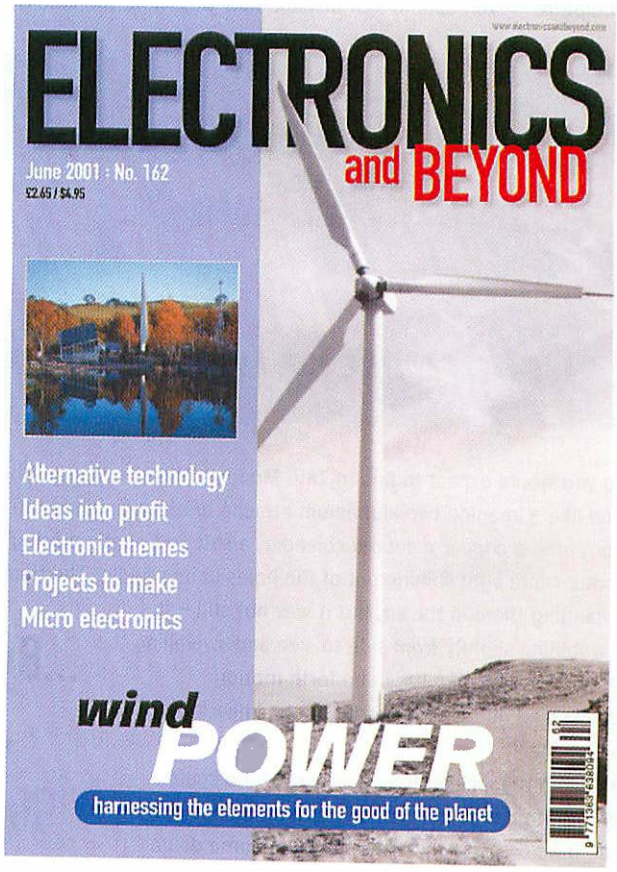

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The FACTORY

A short story by Jonathan Bethell Aldred.

Having a spacecraft touch down in your garden is not something you expect to happen. But if it did, you would probably expect someone or something to come out of it. You might also expect it to be a little bit bigger than the strange object Michael Taylor saw descend and land on his patio late one Saturday night in January 2001.

Michael had been drinking down at his local with some mates, had come home to an empty house and had been frying up some leftovers in the kitchen when he suddenly noticed his security light come on. His first reaction was that it was probably a cat, not a would-be thief – but he thought he had better make sure, and so he walked through into the dining room so as to get a better look.

By the time he had opened up the curtains, whatever it was that had triggered the security light had come right up to and was practically touching the patio door. It was not a cat, or indeed any other kind of animal. In fact, it looked very much like some kind of metallic modern art sculpture – even upon closer inspection it was more the kind of thing you would expect to find in Tate Modern. This is what the object looked like – imagine two aluminium attaché briefcases joined top and bottom onto a copper-coloured colander, a soft and gently pulsing hypnotic white light shining out of the holes in its middle. The thing was hanging there in the air, but it was not still – it was wobbling slightly from side to side and swivelling gently in an oscillating back and forth motion. Michael could not see the string, but he knew there must be one.

He undid the lock on the patio door so he could step out into the garden but by the time he had slid the door across, the unusual object had come down and was resting on the patio decking. He looked for the string again, but they must have yanked it off and pulled it away. Where were they? On the roof? He called up to anyone who might be there, but there was no reply. He looked around – was it someone with a pole? Who was doing it? Someone from the pub? Well, it had to be – who else would try and play such a stupid trick on him. He had to admit, though, that it was a good trick. Mind you, if it was supposed to be a flying saucer they could have gone to a little bit more effort.

'Yeah, thanks,' he shouted out into the bushes. 'I could do with more modern art around the place'. But no one answered back. He couldn't even hear anyone laughing at him, and that made him feel uncomfortable – the whole point of playing a practical joke was that you were supposed to show yourself afterwards, wasn't it? Otherwise what was the point? Well, he wasn't going to stand there any more, and he certainly wasn't going to look up at the roof again. He picked up the miniature spacecraft and took it with him indoors. He would, as it happened, find out what it was in the morning.

• • •

The next day was a Saturday. Michael came down just before noon and spotted the strange metallic object from the night before. He had another look at it, picked it up, turned it round, and had to admit that in the light of day, even with a mild hangover, it was in fact very cleverly crafted. The top and bottom parts of it – the parts he had initially thought were briefcases – were covered with strange rune-like symbols. The pulsing white light that seeped out of the holes in its middle section was extremely bright – or at least that is what his eyes told him, but they also told him that the light was at the same time extremely dull, almost as if seen on a television with the brightness turned down. And the crude welding that he had expected to find holding the thing together was not there – all three segments seemed to blend into one another without any indication of having once been distinct component pieces. He was starting to think that some factory somewhere was missing a vital piece of high-tech equipment.

And then, without warning, the top section unfolded into two halves. Though startled, Michael did not drop the object, he just walked over to the dining room table and placed it down gently, just in case anything else went off. The upper casing was lined with a smooth material layer that looked a little like gold, but tinted red. Lying on top of it was a dark grey metallic ring – the kind of thing you might envisage with a ball and chain attached, but instead a sharp spike of the same dark grey metal was embedded halfway within, pointing in towards the centre of the ring. It could be radioactive, part of his brain warned him – what if this was part of some expensive machine? It could be hazardous material. But his curiosity was too great – he reached out and put his hand around it to pick it up. And that's when things really started getting strange.

...By the time he had opened up the curtains, whatever it was that had triggered the security light had come right up to and was practically touching the patio door...

The spiked ring was far heavier than it should have been. The object, or machine, or whatever it was had been incredibly light – almost as if it had been constructed out of cardboard. The thing that had been inside it he could barely even lift in his hand. It didn't make any sense at all. Swearing to himself under his breath he weighed the thing up in both hands, put it down upon the table, lifted up its container, and then picked up and placed the spiked ring back inside again. He could feel the weight disappear. This was no practical joke – this was practically getting into the realms of the paranormal!

Wondering what the thing was, where it had come from, and why the hell he had ended up with it, he put the object and its gravity-

defying cargo back down onto the table. An image of what he had later written off as an ill-conceived attempt to fool him into thinking that he'd seen a spaceship, came back to him and he felt a shudder go up and down his spine. He could remember it hanging suspended, hovering even, in front of his patio windows and suddenly he was not so sure of anything. He backed away.

Several minutes passed whilst he wondered what to do with it. He could bury it, of course. Sell his story to the newspapers... But his curiosity was too great for him to just leave the thing alone. After a while, he walked back over and picked up the ring with the spike in it once again. But instead of holding it in his palm, he made the unwitting mistake of getting hold of it by putting his hand through the inside.

Then, without any kind of warning, the spike thrust itself suddenly inwards and right through the top of his hand. It passed cleanly through and its point emerged from his palm only to connect with the opposite inner face of the ring and continue to go through until half an inch of the point was clearly visible sticking out the other side. As if this wasn't distressing enough, Michael then watched in horror as the whole apparatus shrank and, like water being drawn into a sponge, absorbed itself into his skin. He fell back, scattering a couple of chairs on his way down onto the floor.

• • •

A week later, Felicity, Michael's girlfriend came up for the weekend from Liverpool Hope University, where she was doing a teacher training course. She rang him every day – every other day sometimes, as she thought it did their relationship good for him not to take her calls for granted – but this last week he had been a little distant. He had claimed to be off work with the flu, and at times his voice did seem quite heavy, but she was worried that it was just some kind of excuse – something was wrong, she could tell, and she hoped to God that it wasn't anything serious.

She got off the train and looked around for Michael. He was not there. It was not, however, unusual for him to forget the time especially when he was down the Reckless Horse with the usual crew. He was, however, supposed to be sick so perhaps he had stayed at home. Well, he could have had the courtesy to ring her and tell her so. She would have to get some money out so that she could pay for the taxi fare.

When she got to the house, Felicity noticed that the door was ever so slightly open. She stepped in, closed it, and walked through into the living room. The sofa had been moved to the side, and in its place was a pile of half metre square blocks of dull grey metal. 'Oh my God!' she exclaimed. She walked back into the hall and called up the stairs. 'Michael?'

'I'm here'.

Felicity turned around. 'Oh my God...' she repeated, but this time it was more of a choked whisper. 'What the... What happened to you?'

If they had met in unfamiliar surroundings, she would probably not have recognised him at all.

'Yeah, I, er... I know. I look like I've swallowed a mountain'.

'But how? I mean... A fortnight ago, you...'

'It's complicated'.

He led her by the arm into the dining room. 'And it's got more than a little,' he said, pointing at the very small spacecraft, which was hovering once again in the corner of the room, 'to do with that'.

• • •

Michael told her about the strange experience with the spiked ring and what had happened afterwards. He told her how the immense pain he had felt in his hand had slowly spread throughout his entire body, and then suddenly disappeared. He told her how he had not for one second, whilst all this had been going on, taken his eyes away from his left hand, which bore not a trace that the spiked ring had ever even been there, let alone skewered him and drawn itself into his body. And he had just started to explain to her how he had looked down at his own body in terror as it began to swell up, his clothes changing size as he did to accommodate him, when he suddenly stopped in mid-sentence and started to go pale.

'What's the matter?' she asked – it was the first time she had spoken since the hallway, and she was beginning to think all the extra weight must have affected his mind.

'It's happening,' he said, nervously.

'What is?'

'I haven't got round to telling you yet. I should hide. I should go in the other room, but if you don't see me then you won't believe. It's a horrible sight. Really – I've seen it so many times now, and it never gets any less... Oh no, I can feel it happening! Look, please just prepare yourself for something–'

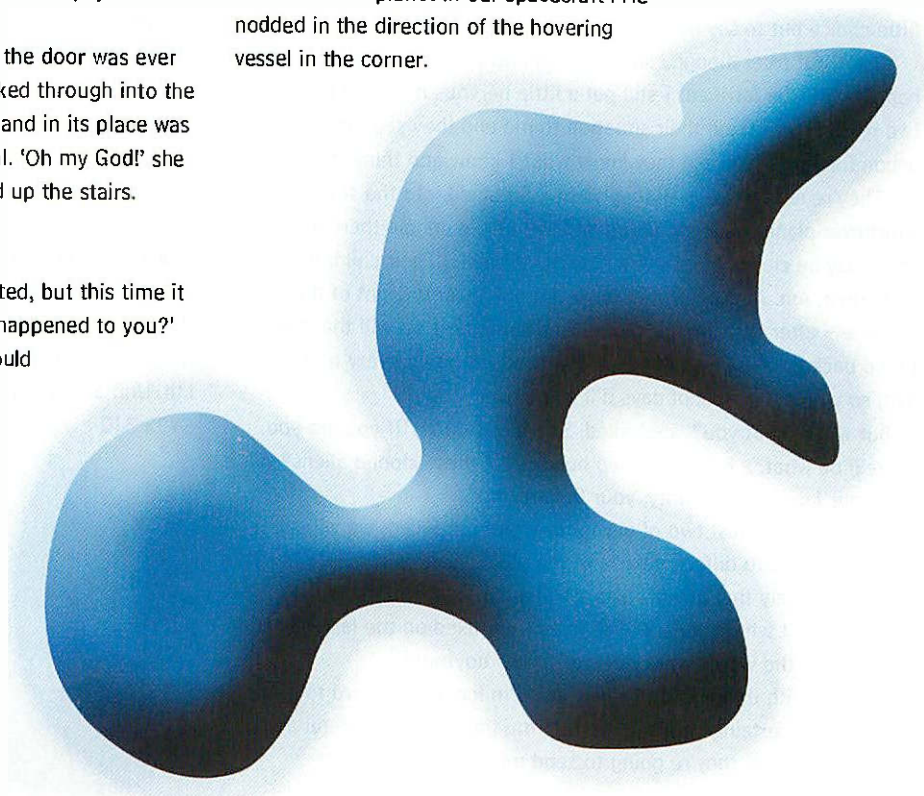
Felicity screamed as before her eyes her boyfriend's body twisted and distorted in ways you could never imagine, not even in your nightmares. It was like watching three blobs of solder run together and join into one, only in reverse and in full colour with clothes and living flesh. Standing in front of her now were three Michaels. They were all how she remembered him.

'Like one of those weight-watchers commercials, eh?' the middle Michael said nervously. 'Just watch the weight drop off'.

'Shall we stay or leave?' asked the Michael on the right. 'We can explain for you if you like'.

'It might be easier,' said the other one. The Michael in the middle nodded.

'We are clones,' Left Michael explained to Felicity, who was looking extremely shocked but was still conscious, albeit trying to slowly shuffle her chair away backwards. 'Exact cellular copies of your boyfriend, created by the nanobots injected into him by the device carried to this planet in our spacecraft'. He nodded in the direction of the hovering vessel in the corner.



'Our own planet was dying,' continued the Michael on the right. 'Genetic pollution – the unintentional legacy of the only other intelligent species on our planet – had spread throughout the ecosystem, infecting every single organism, including us. The creators of the pollution died out completely and we would soon have followed. Our only hope of survival was to encode our memories and personalities into data crystals and embed them into nanotechnology injection devices that would be carried via highly advanced spacecraft to every other inhabited planet in this area of the galaxy. These craft would then seek out the dominant species and present them with injection devices in the knowledge that sooner or later they would hold them in such a way as to trigger the mechanism'.

'The nanobots that Michael carries within him are extremely advanced and capable of taking inorganic matter – those blocks you saw in the living room – and converting them into flesh and bone,' said Michael Left. 'Even the clothes we are wearing have been replicated in this way. It looks barbaric and inhuman, we know,' he added. 'Whilst retaining our own personalities, we posses his memories and patterns of thought now, and had we thought like human beings when we designed the spacecraft we would not have chosen to inject other intelligent and self-aware beings against their will. But we were a different species from a planet where values were very different to yours. We are lucky your boyfriend sympathises with our predicament. There are many thousands of other spacecraft that have been sent out to inhabited planets with dominant lifeforms all over this part of the galaxy, over a hundred to other areas of this planet alone. They may not all be so understanding'.

'Understanding?' Felicity got to her feet and stared angrily at the Michael who had just been speaking. 'You use him as some kind of factory production line, without giving him any choice in the matter and you think it's all right because he says he understands? He has little choice but to say he understands!'

'That's not true, though,' said the real Michael. 'When it first happened I was terrified. I still get a little nervous now, but the first two replicas explained their situation to me and they seemed to feel uncomfortable – you see they know what I know and think the way I do. They're not hostile – all they want is to blend into the society of whichever planet they end up on and live as the people there live. They may be clones but they're human, not alien. Their children will be human, too. And as for me, there are only twenty eight of them left to clone – after that the nanobots will disintegrate, so will the ship and I'll go back to being myself again. I'm producing two every hour and a half, so within a couple of days it'll all be over'.

'But what about you?' she asked. She then added, 'If you are you. There'll be what, a hundred? Two hundred of these cloned aliens? All with your face, your identity, your fingerprints'.

'As soon as the last two of our number are produced, we will split up and relocate to different parts of the globe,' said Michael Right. 'It is highly unlikely that any problems will arise'.

'That wasn't what I meant'. Her eyes were fixed on the last speaking Michael, but the words were directed at her boyfriend.

'I'm fine with it,' he said, 'I really am. I'm looking forward to getting my life back, certainly, but they've told me that they're grateful and, wherever they go, they're going to send me back a little bit of whatever they earn for five years, so I won't have gone through all of this for nothing,' he turned and glanced at both of the Michaels in turn, 'present company excepted, of course'.

'And that will, of course, be on top of the money we'll be paying back to replace what we took out of his bank account in order to pay for the materials'.

'Look', said Felicity, getting up to leave. She could barely disguise the tremor in her voice. 'You have to understand what this is like for me. I mean, I've seen it with my own eyes and I'm still finding it hard to believe. It's just all too weird and I need to get away. You... You do understand that, don't you? It doesn't mean I don't care'.

'It's a lot to take in, isn't it'.

'Well, yes!' She paused and then sighed heavily. 'I'll phone you...'

'Yeah. I'll be here. Or in work – when all this stops, I mean'.

'I... Look, can we have a moment to ourselves here?'

The other two Michaels nodded and walked out of the room.

'Just you and me, eh?' said Michael.

'I... I'm still not alone with you though, am I'.

'In a sense, I suppose, but...'

Felicity sighed again, half in anger, half frustration. She turned and headed for the door. 'I have to go'.

'I love you,' said Michael.

Felicity stopped, a pained expression on her face, but she didn't look back. 'Yeah,' she said. There was a pause. 'Me too. I'll... I'll call you'.

And with that she left the room and then the house. Michael was left all alone in the dining room. The other two Michaels walked back in again.

'He'll be lucky, the one of us who gets to stay and live his life here with her,' said one of the Michaels who had returned.

'Yes,' said the Michael that the other two had split from. 'Most of my good memories involve this area, this house and her'.

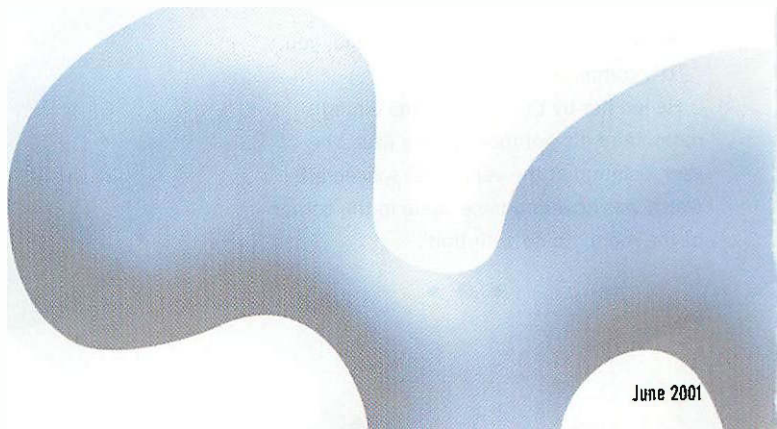
'As it is for all of us,' said the third.

Without further communication, they all went through to the living room.

...Michael told her about the strange experience with the spiked ring and what had happened afterwards. He told her how the immense pain he had felt in his hand had slowly spread throughout his entire body...

What did you think of this?

Any comments or even better stories can be sent for the attention of the Editor on Fax No. 01970 621040 or via email to nnagaoka@electronicsandbeyond.com or by post to: Kanda Systems Ltd, Unit 17/18 Glanyrafon Industrial Estate, Aberystwyth, Ceredigion SY23 3JQ



OP-AMP cookbook

RAY MARSTON LOOKS AT PRACTICAL OP-AMP INSTRUMENTATION AND TEST-GEAR CIRCUITS IN THE FINAL EPISODE OF THIS 4-PART SURVEY OF OP-AMP PRINCIPLES AND APPLICATIONS.

PART 4

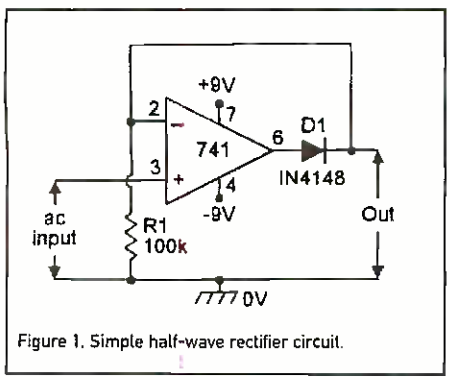


Figure 1. Simple half-wave rectifier circuit.

The opening episode of this 4-part 'op-amp' series described the basic operating principles of conventional voltage-differencing op-amps (typified by the 741 type) and showed some basic circuit configurations in which they can be used. This month's concluding episode looks at practical ways of using such op-amps in various instrumentation and test-gear applications, including those of precision rectifiers, ac/dc converters, electronic analogue meter drivers, and variable voltage-reference and DC power supply circuits.

When reading this episode, note that most practical circuits are shown designed around a standard 741, 3140 or LF351-type op-amp and operated from dual 9V supplies, but that these circuits will usually work (without modification) with most voltage-differencing op-amps, and from any DC supply within that op-amp's operating range. Also note that all 741-based circuits have a very limited frequency response, which can be greatly improved by using an alternative 'wide-band' op-amp type.

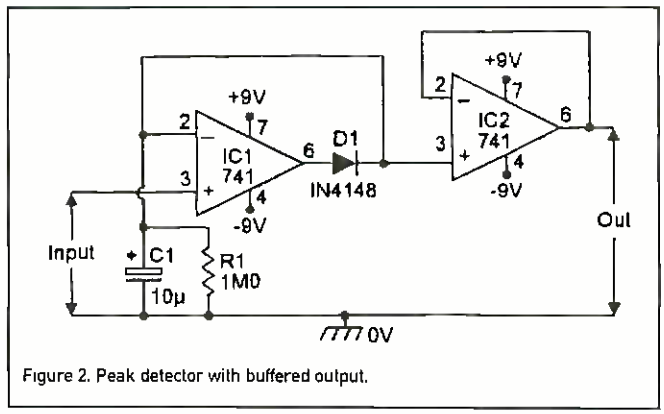


Figure 2. Peak detector with buffered output.

Electronic Rectifier Circuits

Simple diodes are poor rectifiers of low-level ac signals, and do not start to conduct until the applied voltage exceeds a certain 'knee' value; silicon diodes have knee values of about 600mV, and thus give negligible rectification of signal voltages below this value. This weakness can be overcome by wiring the diode into the feedback loop of an op-amp, in such a way that the effective knee voltage is reduced by a factor equal to the op-amp's open-loop voltage gain; the combination then acts as a near-perfect rectifier that can respond to signal inputs as low as a fraction of a millivolt. Figure 1 shows a simple half-wave rectifier of this type.

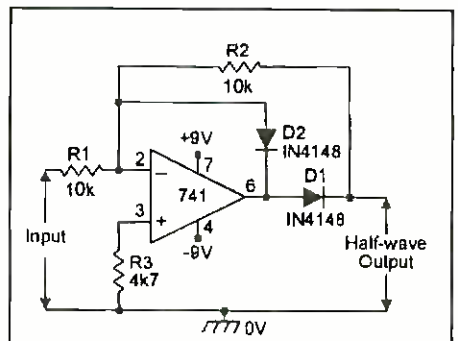


Figure 3. Precision half-wave rectifier.

The Figure 1 circuit is wired as a non-inverting amplifier, with feedback applied via silicon diode D1, and with the circuit output taken from across load resistor R1. When positive input signals are applied to the circuit the op-amp output also goes positive; an input of only a few microvolts is enough to drive the op-amp output to the 600mV 'knee' voltage of D1, at which point D1 becomes forward biased; negative feedback through D1 then forces the inverting input (and thus the circuit's output) to accurately follow all positive input signals greater than a few microvolts. The circuit thus acts as a voltage follower to positive input signals.

When the input signal is negative, the op-amp output swings negative and reverse biases D1. Under this condition the reverse leakage resistance of D1 (typically hundreds of Megohms) acts as a potential divider with R1 and determines the negative voltage gain of the circuit; typically, with the component values shown, the negative gain is roughly -

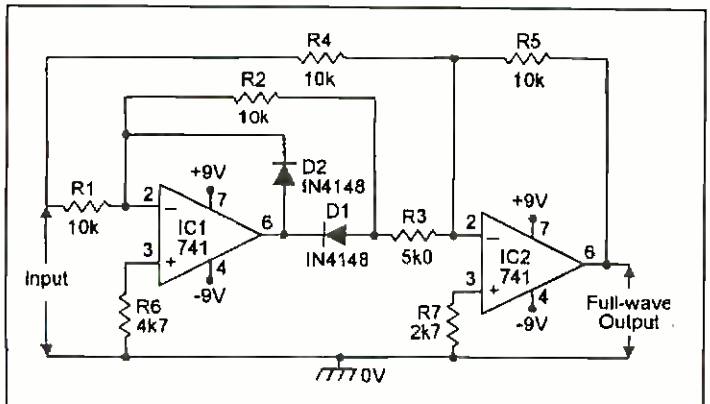


Figure 4. Precision full-wave rectifier.

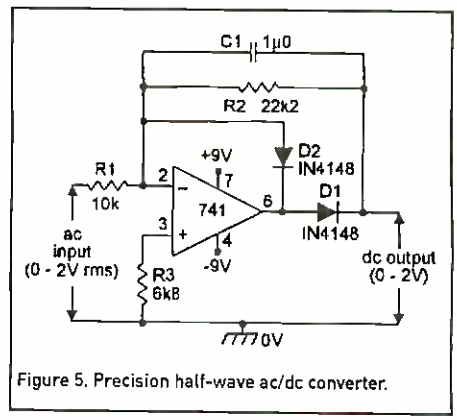


Figure 5. Precision half-wave ac/dc converter.

60dB. The circuit thus 'follows' positive input signals but rejects negative ones, and hence acts like a near-perfect signal rectifier.

Figure 2 shows how the above circuit can be modified to act as a peak voltage detector by wiring C1 in parallel with R1. This capacitor charges rapidly, via D1, to the peak positive value of an input signal, but discharges slowly via R1 when the signal falls below the peak value. IC2 is used as a voltage-following buffer stage, to ensure that R1 is not shunted by external loading effects.

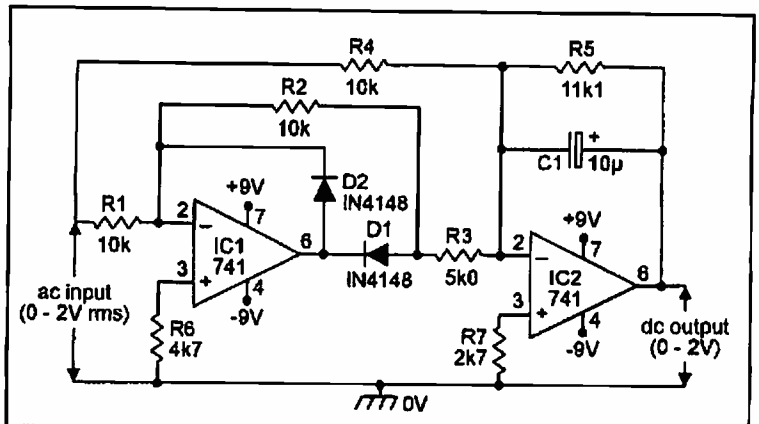


Figure 6. Precision full-wave ac/dc converter.

its knee value its resistance is large and the circuit gives high gain, but when D1 is operating above the knee value its resistance is very low and the circuit gain equals R2/R1. The circuit thus acts as an inverting precision rectifier to negative input signals.

When the input signal goes positive the op-amp output swings negative, but the negative swing is limited to -600mV via D2, and the output at the D1-R2

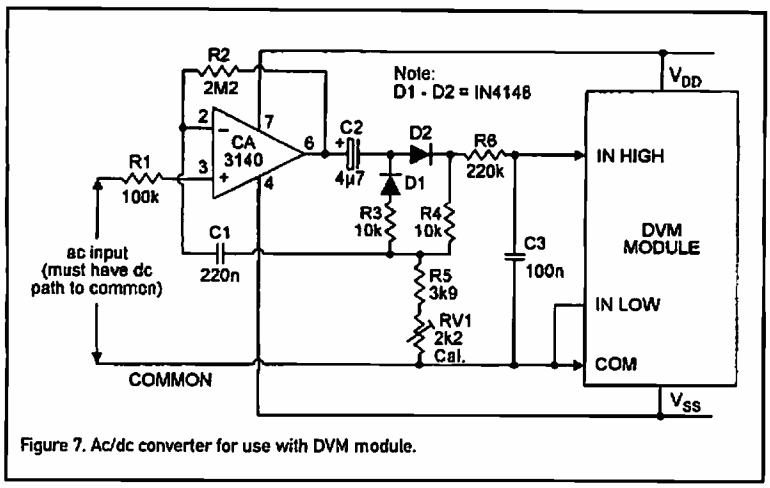


Figure 7. Ac/dc converter for use with DVM module.

negative-output version of the above circuit can be combined with an inverting 'adder' to make a precision full-wave rectifier. Here, IC2 inverts and gives x2 gain (via R3-R5) to the half-wave rectified signal of IC1, and inverts and gives unity gain (via R4-R5) to the original input signal (E_{in}). Thus, when negative input signals are applied, the output of IC1 is zero, so the output of IC2 equals $+E_{in}$. When positive input signals are applied, IC1 gives a negative output, so IC2 generates an output of $+2E_{in}$ via IC1 and $-E_{in}$ via the original input signal, thus giving an actual output of $+E_{in}$. The output of this circuit is thus positive, and always has a value equal to the absolute value of the input signal.

AC/DC Converter Circuits

The Figure 3 and 4 circuits can be made to function as precision ac/dc converters by first providing them with voltage-gain values suitable for form-factor correction, and by then integrating their outputs to give the ac/dc conversion, as shown in Figures 5 and 6 respectively. Note that these circuits are intended for use with sinewave input signals only.

In the half-wave ac/dc converter of Figure 5 the circuit gives a voltage gain of x2.22 via R2/R1, to give form-factor correction, and integration is accomplished via C1-R2. Note that this circuit has a high output impedance, and the output must be buffered if it is to be fed to low-impedance loads.

In the full-wave ac/dc converter of Figure 6, the circuit has a voltage gain of x1.11 to give form-factor correction, and integration is accomplished via C1-R5. This circuit has a low-impedance output.

Note that the basic Figure 1 and 2 circuits each have a very high input impedance. In most practical applications, the input signal should be ac-coupled and pin-3 of the op-amp should be tied to the common rail via a 100k resistor.

Precision Rectifier Circuits

The Figure 1 rectifier circuit has a rather limited frequency response, and may produce a slight negative output signal if D1 has poor reverse resistance characteristics. Figure 3 shows an alternative type of half-wave rectifier circuit, which has a greatly improved rectifier performance at the expense of a greatly reduced input impedance.

In Figure 3 the op-amp is wired as an inverting amplifier with a 10k (= R1) input impedance. When the input signal is negative the op-amp output swings positive, forward biasing D1 and developing an output across R2. Under this condition the voltage gain equals $(R2+R_D)/R1$, where RD is the active resistance of this diode. Thus, when D1 is operating below

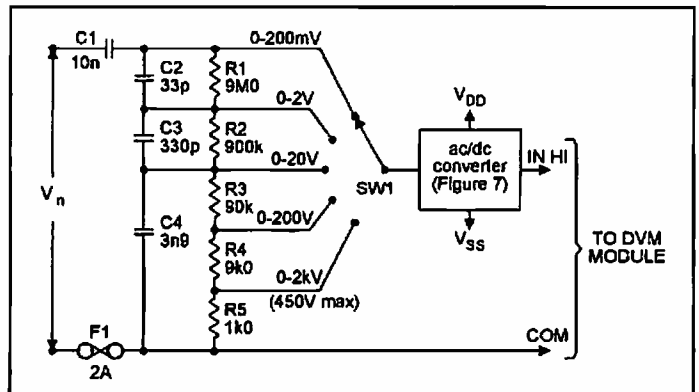


Figure 8. 5-range ac volt-meter converter for use with DVM modules.

junction does not significantly shift from zero under this condition. This circuit thus produces a positive-going half-wave rectified output. The basic circuit can be made to give a negative-going half-wave rectified output by simply reversing the polarities of the two diodes.

Figure 4 shows how a

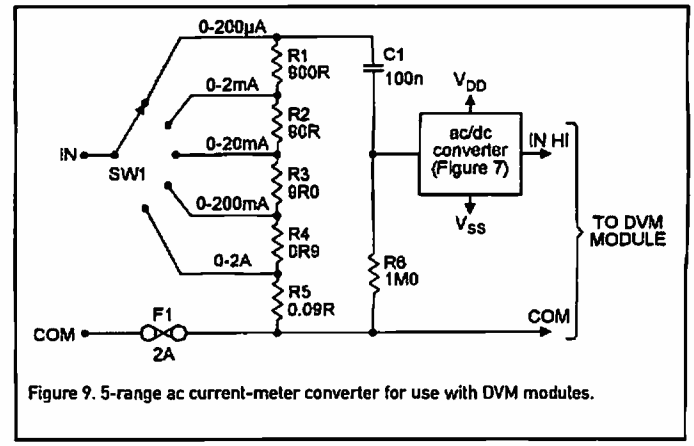
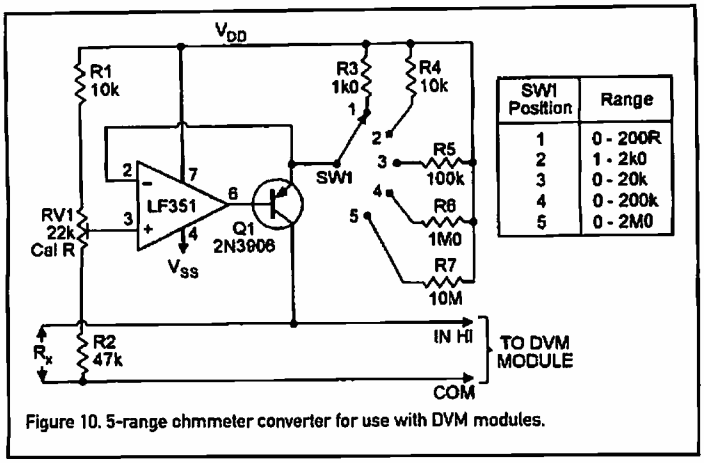


Figure 9. 5-range ac current-meter converter for use with DVM modules.



SW1 Position	Range
1	0 - 200R
2	1 - 2k0
3	0 - 20k
4	0 - 200k
5	0 - 2M0

Figure 10. 5-range ohmmeter converter for use with DVM modules.

DVM Converter Circuits

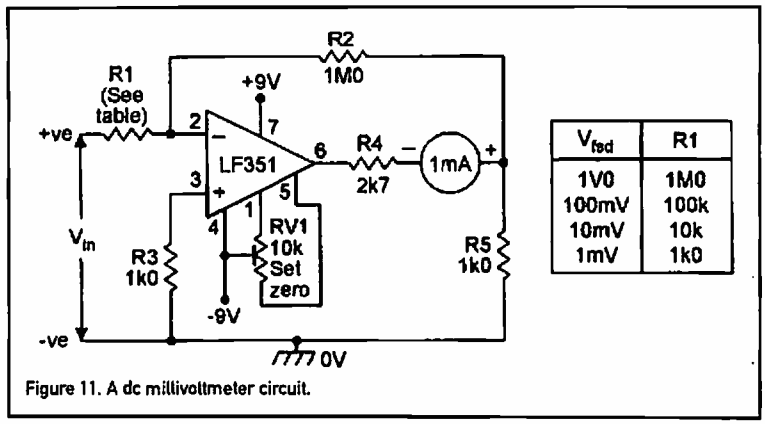
Precision 3_-digit Digital Voltmeter (DVM) modules are readily available at modest cost, and can easily be used as the basis of individually built multi-range and multi-function meters. These modules are usually powered via a 9V battery, and have a basic full-scale measurement sensitivity of 200mV dc and a near-infinite input resistance. They can be made to act as multi-range dc voltmeters by simply feeding the test voltage to the module via a suitable 'multiplier' (resistive attenuator) network, or as multi-range dc current meters by feeding the test current to the module via a switched current shunt.

A DVM module can be used to measure ac voltages by connecting a suitable ac/dc converter to its input terminals, as shown in Figure 7. This particular converter has a near-infinite input impedance. The op-amp is used in the non-inverting mode, with dc feedback applied via R2 and ac feedback applied via C1-C2 and the diode-resistor network. The converter gain is variable over a limited range (to give form-factor correction) via RV1, and the circuit's rectified output is integrated via R6-C3, to give dc conversion. The COMMON terminal of the DVM module is internally biased at about 2.8 volts below the V_{DD} (positive supply terminal) voltage, and the CA3140 op-amp uses the V_{DD}, COMMON, and V_{SS} terminals of the module as its supply rail points.

Figure 8 shows a simple frequency-compensated attenuator network used in conjunction with the above ac/dc converter to convert a standard DVM module into a 5-range ac voltmeter, and Figure 9 shows how a switched shunt network can be used to convert the module into a 5-range ac current meter.

Figure 10 shows a circuit that can be used to convert a DVM module into a 5-range ohmmeter. This circuit actually functions as a multi-range constant-current generator, in which the constant current feeds (from Q1 collector) into R_x, and the resulting R_x volt drop (which is directly proportional to the R_x value) is read by the DVM module.

Here, Q1 and the op-amp are wired as a compound voltage follower, in which Q1 emitter precisely follows the voltage set on RV1 slider. In practice, this voltage is set at exactly 1V0 below V_{DD}, and the emitter and collector (R_x) currents of Q1 thus equal 1V0 divided by the R3 to R7 range-resistor value, e.g., 1mA with R3 in circuit, etc. The actual DVM module reads full scale when the R_x voltage equals 200mV, and this reading is obtained when R_x has a value one-fifth of that of the range resistor, e.g., 200R on Range 1, or 2M0 on Range 5, etc.



V_{fsd}	R1
1V0	1M0
100mV	100k
10mV	10k
1mV	1k0

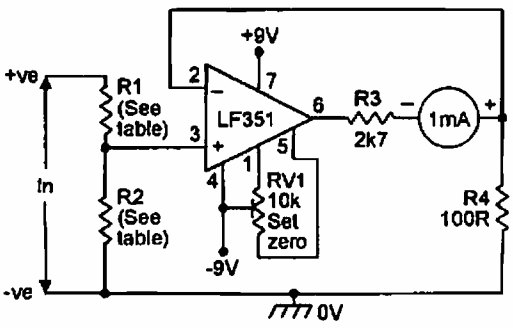
Figure 11. A dc millivoltmeter circuit.

Analogue Meter Circuits

An op-amp can easily be used to convert a standard moving coil meter into a sensitive analogue voltage, current, or resistance meter, as shown in the practical circuits of Figures 11 to 16. All six circuits operate from dual 9V supplies and are designed around the LF351 JFET op-amp, which has a very high input impedance and good drift characteristics. All circuits have an offset nulling facility, to enable the meter readings to be set to precisely zero with zero input, and are designed to operate with a moving coil meter with a basic sensitivity of 1mA fsd.

If desired, these circuits can be used in conjunction with the 1mA dc range of an existing multi-meter, in which case these circuits function as 'range converters'. Note that each circuit has a 2k7 resistor wired in series with the output of its op-amp, to limit the available output current to a couple of milliamps and thus provide the meter with automatic overload protection.

Figure 11 shows a simple way of converting the 1mA meter into a fixed-range



Voltmeter fsd	R1	R2
1000V	10M	1k0
100V	10M	10k
10V	10M	100k
1V	900k	100k
100mV	-	100k
Current meter		
1A	-	0R1
100mA	-	1R0
10mA	-	10R
1mA	-	100R
100µA	-	1k0
10µA	-	10k
1µA	-	100k

Figure 12. A dc voltage or current meter.

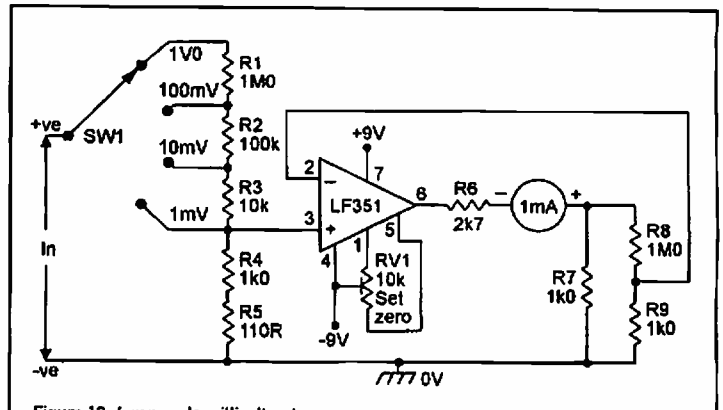


Figure 13. 4-range dc millivoltmeter.

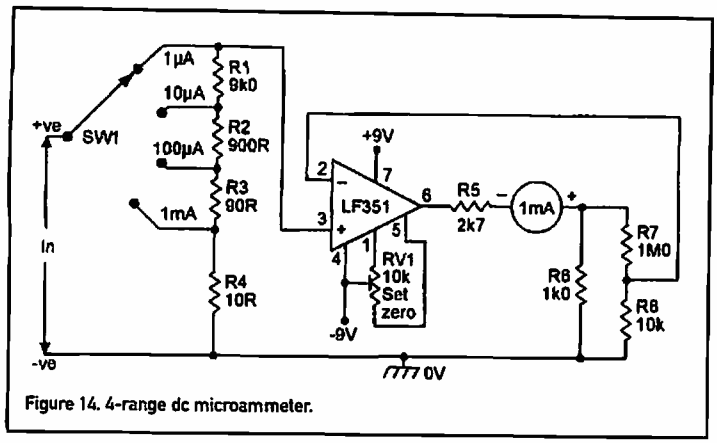


Figure 14. 4-range dc microammeter.

dc millivolt meter with a full-scale sensitivity of 1mV, 10mV, 100mV or 1V0. The circuit has an input sensitivity of 1M0/volt, and the table shows the appropriate R1 value for different fsd sensitivities. To set the circuit up initially, short its input terminals together and adjust RV1 to give zero deflection on the meter. The circuit is then ready for use.

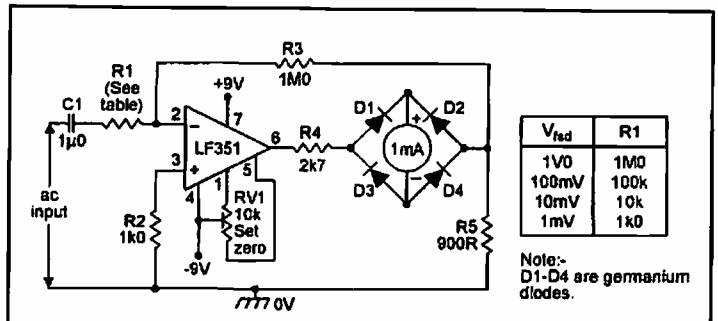
Figure 12 shows a circuit that can be used to convert a 1mA meter into either a fixed-range dc voltmeter with any full-scale sensitivity in the range 100mV to 1000V, or a fixed-range dc current meter with a full-scale sensitivity in the range 1mA to 1A. The table shows alternative R1 and R2 values for different ranges.

Figure 13 shows how the above circuit can be modified to make a 4-range dc millivolt meter with fsd ranges of 1mV, 10mV, 100mV and 1V0, and Figure 14 shows how it can be modified to make a 4-range dc microammeter with fsd ranges of 1mA, 10mA, 100mA and 1mA. The range resistors used in these circuits should have precisions of 2% or better.

Figure 15 shows the circuit of a simple but very useful 4-range ac millivoltmeter. The input impedance of the circuit is equal to R1, and varies from 1k0 in the 1mV fsd mode to 1M0 in the 1V fsd mode. The circuit gives a useful performance at frequencies up to about 100kHz when used in the 1mV to 100mV fsd modes. In the 1V fsd mode the frequency response extends up to a few tens of kHz. This good frequency response is ensured by the LF351 op-amp, which has very good bandwidth characteristics.

Finally, Figure 16 shows the circuit of a 5-range linear-scale ohmmeter, which has full-scale sensitivities ranging from 1k0 to 10M. Range resistors R5 to R9 determine the measurement accuracy. Q1-ZD1 and the associated components simply apply a fixed 1V0 (nominal) to the 'common' side of the range-resistor network, and the gain of the op-amp circuit is determined by the ratios of the selected range-resistor and Rx and equals unity when these components have equal values: the meter reads full-scale under this condition, since it is calibrated to indicate full-scale when 1V0 (nominal) appears across the R_x terminals.

To initially set up the Figure 16 circuit, set SW1 to the 10k position and short the R_x terminals together. Then adjust the RV1 'set zero' control to give zero deflection on the meter. Next, remove the short, connect an accurate 10k resistor in the R_x position, and adjust RV2 to give precisely full-scale deflection on the meter. The circuit is then ready for use, and should need no further adjustment for several months.



V_{fsd}	R1
1V0	1M0
100mV	100k
10mV	10k
1mV	1k0

Figure 15. 4-range ac millivoltmeter.

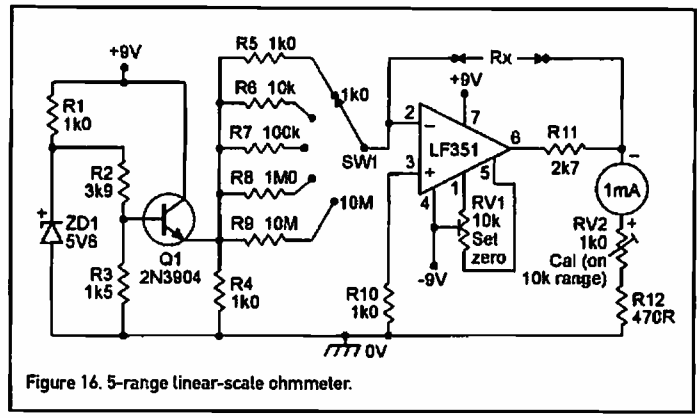


Figure 16. 5-range linear-scale ohmmeter.

Voltage Reference Circuits

An op-amp can be used as a fixed or variable voltage reference by wiring it as a voltage follower and applying a suitable reference to its input. An op-amp has a very high input impedance when used in the 'follower' mode and thus draws near-zero current from the input reference, but has a very low output impedance and can supply several milliamps of current to an external load. Variations in output loading cause little change in the output voltage value.

Figure 17 shows a practical positive voltage reference with an output fully variable from +0.2V to +12V via RV1. Zener diode ZD1 generates a stable 12V, which is applied to the non-inverting input of the op-amp via RV1. A CA3140 op-amp is used here because its input and output can track signals to within 200mV of the negative supply rail voltage. The complete circuit is powered from an unregulated single-ended 18V supply.

Figure 18 shows a negative voltage reference that gives an output fully variable from -0.5V to -12V via RV1. An LF351 op-amp is used in this design, because its input and output can track signals to within about 0.5V of the positive supply rail value. Note that the op-amps used in these two regulator circuits are wide-band devices, and R2 is used to enhance their circuit stability.

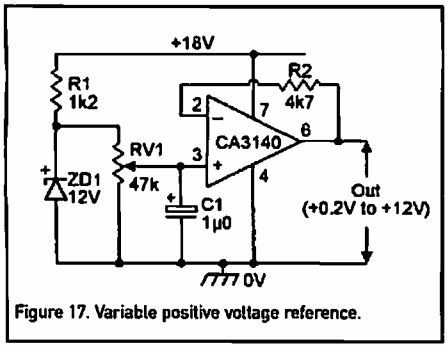


Figure 17. Variable positive voltage reference.

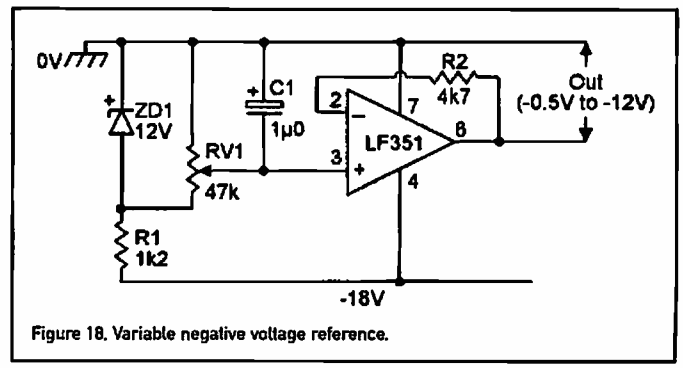


Figure 18. Variable negative voltage reference.

Voltage Regulator Circuits

The basic circuits of Figures 17 and 18 can be

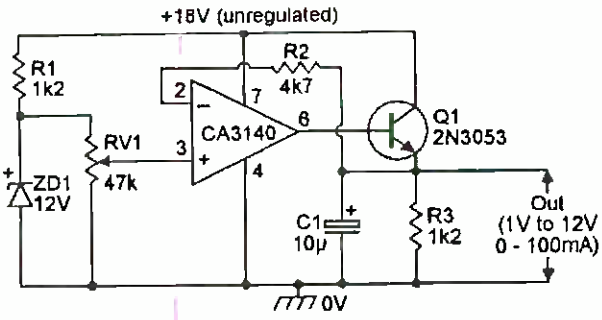


Figure 19. Simple variable-voltage regulated power supply.

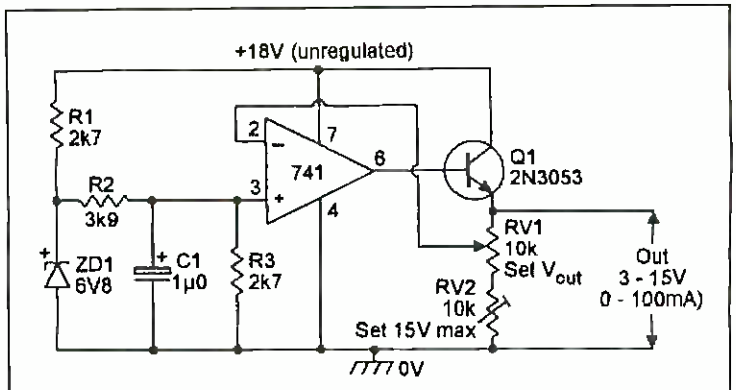


Figure 20. 3V to 15V, 0 to 100 mA stabilized PSU

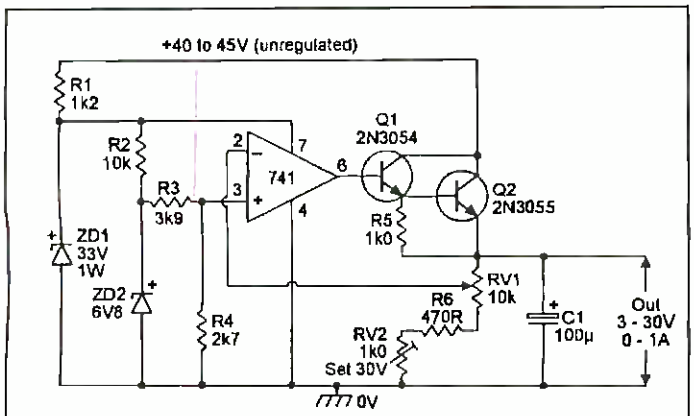


Figure 21. 3V to 30V, 0 to 1 amp stabilized PSU.

made to act as high-current regulated voltage (power) supply circuits by wiring current-boosting transistor networks into their outputs. Figure 19 shows how the Figure 17 circuit can be modified to act as a 1V to 12V variable power supply with an output current capability (limited by Q1's power rating) of about 100mA. Note that the base-emitter junction of Q1 is included in the circuit's negative feedback loop, to minimise offset effects. The circuit can be made to give an output that is variable all the way down to zero volts by connecting pin-4 of the op-amp to a supply that is at least 2V negative.

Figure 20 shows an alternative type of power supply circuit, in which the output is variable from 3V to 15V at currents up to 100mA. In this case a fixed 3V reference is applied to the non-inverting input terminal of the 741 op-amp via ZD1 and the R2-C1-R3 network, and the op-amp plus Q1 are wired as a non-inverting amplifier with gain variable via RV1. When RV1 slider is set to the upper position, the circuit gives unity gain and gives an output of 3V; when RV1 slider is set to the lower position the circuit gives a gain of x5 and thus gives an output of 15V. The gain is fully variable between these two values. RV2 enables the maximum output voltage to be pre-set to precisely 15V.

Figure 21 shows how the above circuit can be modified to act as a 3V to 30V, 0 to 1A stabilized power supply unit (PSU). Here, the available output current is boosted by the Darlington-connected Q1-Q2 pair of transistors, the circuit gain is fully variable from unity to x10 via RV1, and the stability of the 3V reference input to the op-amp is enhanced by the ZD1 pre-regulator network.

Figure 22 shows how the above circuit can be further modified to incorporate automatic overload protection. Here, R6 senses the magnitude of the output current and when this exceeds 1A the resulting volt drop starts to bias Q3 on, thereby shunting the base-drive current of Q1 and automatically limiting the circuits output current.

Finally, Figure 23 shows the circuit of a simple centre-tapped 0 to 30V PSU that can provide maximum output currents of about 50mA. The PSU has three output terminals, and can provide either 0 to +15V between the common and +ve terminals and 0 to -15V between the common and -ve terminals, or 0 to 30V between the -ve and +ve terminals. The circuit operates as follows:

ZD1 and R2-RV1 provide a regulated 0 to 5V potential to the input of IC1. IC1 and Q1 are wired as a x3 non-inverting amplifier, and thus generate a fully variable 0 to 15V on the +ve terminal of the PSU. This voltage is also applied to the input of the IC2-Q2 circuit, which is wired as a unity-gain inverting amplifier and thus generates an output voltage of identical magnitude but opposite polarity on the -ve terminal of the PSU. The output current capability of each terminal is limited to about 50mA by the power ratings of Q1 and Q2, but can easily be increased by replacing these components with Darlington (Super-Alpha) power transistors of appropriate polarity.

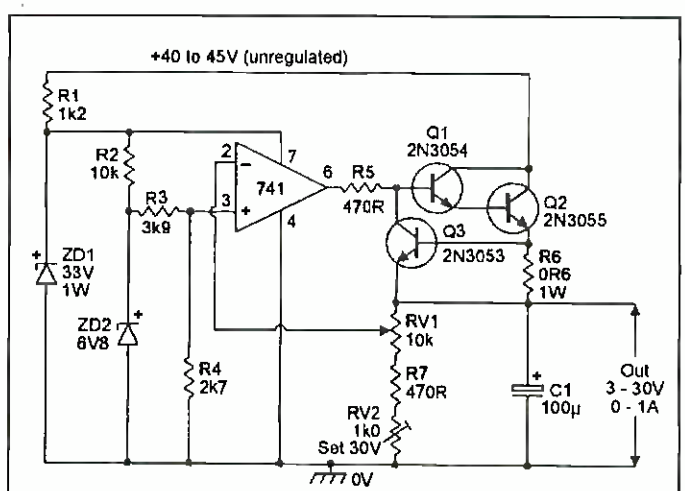


Figure 22. 3V to 30V stabilized PSU with overload protection.

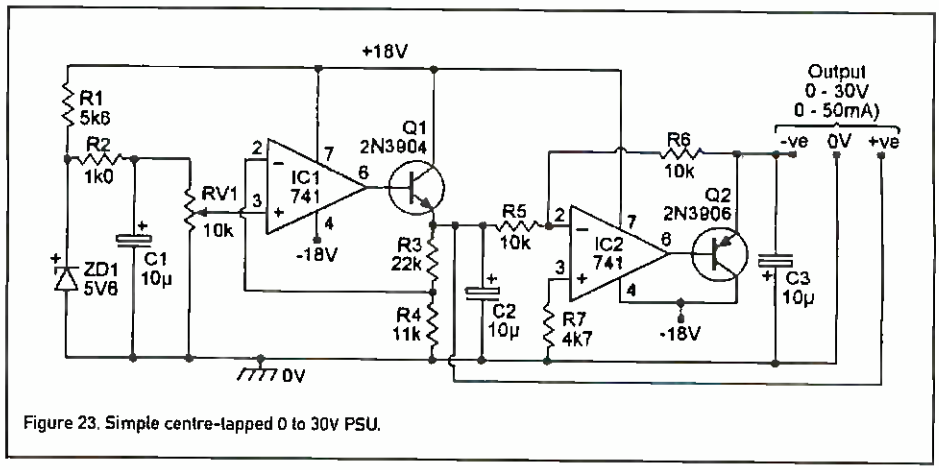


Figure 23. Simple centre-tapped 0 to 30V PSU.

WAP

After the panic over flash availability and the rush to swamp the market with cheap WAP mobile phones the telecommunications industry is finding it hard to sell the sets that it made and is now having to lay off workers to recoup the cost. It has also caused the stock markets around the world to worry about anything that can be considered a technology share.

The impact has been dramatic to say the least. The original vision was that the WAP revolution would keep the very high growth that the mobile telecoms companies have enjoyed, moving in the right direction for the foreseeable future but instead the consumer seems to be quite happy with what they have got now.

The WAP technology itself has a long way to go before it can be considered a breakthrough. It is slow, expensive and a hark back to the days of the old Viewdata formats of the late 70's early 80's. Most download speeds would make a tortoise giggle. So maybe the industry should be using this slump as an opportunity to do something about this.

For the latest information about WAP then visit www.wap.net this site is also a very useful resource for WAP developers and enthusiasts to learn about the intricacies of the WML (Wireless

Oi! John. Want a new motor?

The Internet is the ideal source of information on cars, and — in particular — one of the best places to look when you're considering buying one. Obviously, you can always start by looking at each car manufacturers Web site. Toyota's Web site is a good example. Much of the basic information you need — specifications, prices, equipment, local dealers and so on — will be there, at little more than the click of a few buttons. Many manufacturers even have on-line ordering systems on their Web sites (check Vauxhall's offering, at: http://buypower.vauxhall.co.uk for one of the best examples available, giving significant discounts over dealer-bought cars), which mean that you can carry out all the purchasing business at your computer, then simply pick-up the car at your local dealer when it arrives.

But there are many other places to go for information too. After all, manufacturers won't necessarily be unbiased in their opinions about their own car models. Many people when looking to buy a car, might take a look at the various magazines available on the news-stands. However, even here you don't need to leave your computer screen. It's usual for magazines to have Web sites associated with them, and car magazines are no exception. Often, exactly the same data available within the pages of magazines can be located on the Web site. What Car? Online, say (at: www.whatcar.co.uk), provides an excellent method of locating car information.

But often, it's the third-party Web sites that can be the most useful — providing both an unbiased source of car information, and the means whereby cars can be bought. There are many examples, including New Car Net, at: www.new-car-net.co.uk; Autohit, at: www.autohit.co.uk; CarSurfer, at: www.carsurfer.co.uk, and Autobytel, at: www.autobytel.co.uk. There are many others, and it may pay you to search around to get the best bargain.

However, the Internet is nothing if not international in the way it works, and there's nothing to stop you locating, buying, and importing a car from another country. Indeed, the financial benefits gained from doing so can be exceptional. It's long been known that car dealers in the UK take a bigger cut of the profits to be made than those on the Continent, so it should come as no surprise that it's easy on the Internet to bypass UK dealers and go straight to the European dealers.

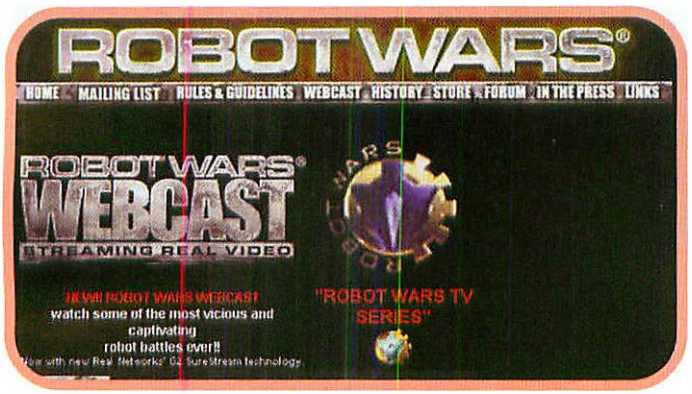
You can opt to go directly to the continental dealers and do all the work yourself, however, many Websites can be found from UK dealers who specialise in importing cars for customers. Of course, they charge an amount to do so, but despite this, the overall savings over UK dealer price can still be considerable. A few sites which might help in your quest for a car are Showroom 4 Cars, at: www.showroom4cars.com, Carbusters, at: www.carbusters.com, OneSwoop, at: www.oneswoop.com, Hodgsons Import Brokers, at: http://hodgsons.net, and — if you're interested in importing a marque car, Import Marques, at: www.importmarques.com. Many other Web sites exist to, and it's really just a job of searching for them.

Some Web sites exist merely to give information about how to set about buying or importing cars. The Motorist, at: www.themotorist.co.uk is one such site. Car Importing from Europe, at: www.carimporting.co.uk is a site that's been constructed to look at the aspects of importing your own car. Even if you choose not to import a car totally on your own, this is an excellent source on information about the importing process, with many links to other organisations that can help you.

Of course, it's not only new cars that people want to buy. If you're looking for a pre-owned car, try Virtual Showroom, at: www.virtual-showroom.co.uk.

Mark-up Language). It also contains reviews of the latest mobile phones and a discussion forum for you to thrash out those unique ideas that you may have.

There is also a number of WAP browser emulators around. These are available from most of the mobile manufacturers to download and try out. The Ericsson version being a very good example, because it has a WML development application that allows you to load the compiled WML files into an emulated WAP phone to try it out.
http://mobileinternet.ericsson.com



Robotics

The TV series Robotwars www.robotwars.com has meant a big interest in robots over the last few months, many people have become interested in the development of killer robots that can mangle and destroy other robots -a sort of gladiators for the new millennium.

All the robots used in Robotwars are remote controlled, so they still need that human element to make them do their work. There are a number of rather good sites available for the robot enthusiasts.

Electronics for beginners

If you've started out into the wide world of electronics and need to know what all that stuff such as ohm's law means, then maybe you need some help from a tutorial site. There are a wide number of beginner's sites out there on the web, but tracking them down can be a bit of a problem.

A good site to start with would be www.iguanalabs.com/maintut.htm the Iguana labs page has numerous tutorials on different aspects of electronics. The pages are divided into beginner, intermediate and advanced. The beginners site ranges from the basics to pointers on the use of a multimeter, advanced subjects include the Serial port programming and LCD instruction sets.

Another equally useful site would be http://ourworld.compuserve.com/homepages/q_knott Electronics for beginners and intermediate electronics. The sites' topics in the beginners section ranges from Theory and block diagrams to Digital electronics. The intermediate section has a wide range of tutorials from Diodes to sequential logic. This site is also available for 10uk pounds and a useful addition to any budding electronics student's library.

Embedded Linux

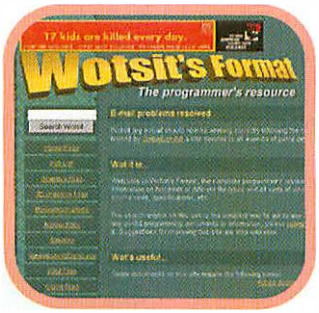
Linux is now becoming the OS choice of a number of engineers these days, but few realise the potential that linux has for embedded systems. The ready availability of the complete kernal sourcecode makes it a possible choice for embedded applications. The Linux devices site www.linuxdevices.com contains news, articles, polls, forums, jobs links and a list of available products that all use embedded Linux for their main kernal. Its all worth taking a look as this may be the defacto standard has Microsoft moves further towards its .NET goals.

Linux used to be the realm for techies and nurds but more and more it is being used as the main alternative to the Windows OS on the PC. A very good implementation of the Linux OS is Mandrake. It is has a very easy installer that eliminates the need for endless fiddling to get hardware that is considered standard on Windows to work. It configures your settings for you and even managed to find my obscure Modem when I installed it. Its available for a very large download at:
www.linux-mandrake.com/en/

this site has additional drivers and applications for when you have got your Mandrake installation to work, and lots of information and support to help you get it working if you haven't.

Developer resources

If like me you are usually a little under the weather in the bank account department, then maybe you need a site that lists all those freebie tools that are available on the web in one easily accessible place. Here is the site for you. It is www.freebyte.com/programming and is packed with links to free programming tools; they include links to sites that provide free source too.



Another useful site of interest would be the Wotsit's Format www.wotsit.org a site full of file formats listed from A to Z. If you can't find the file format you want here you can submit a request and they will try to find out the information for you.

Electronics Projects

Hobbyists have been around for a long time in electronics, most of the early computers pioneers started out in this way, there are a lot of very good hobbyist web sites around giving practical advice, some have large lists of the projects that their author has been involved in other have tutorials. The Bob Blick's Assorted Electronics Projects site www.bobblick.com/bob/projects is an example of this, he has listed projects with descriptions and help on how they were achieved and is a useful resource for the budding electronics fanatic.

Other sites available are Mark's Electronics Projects www.mastincrosbie.com/mark/electronics.html this site provides useful links, tutorials and projects.

Electronic Trains

www.electronictrains.com -the Site dedicated to the electronic trains enthusiast .

Electronic Trains provide a conversion service and can convert three-rail O-gauge trains to command control through replacing the e-unit with an electronic module.

For more information contact david@electronictrains.com

This site is linked to the Toy Train Operating Society

The Toy Train Operating Society was founded in the US in 1966 and now operates through 22 divisions in the US and Canada. On this site you can find out how to buy, sell and trade toy trains plus details on how to collect, operate and take part in local events. The society organizes informative seminars, slide shows and presentations. The link is at www.ttos.org.

The Main Link is www.railserve.com where you can find a wealth of information on how to make successful layouts, build your own model railway, follow the general rules of railroading and adhere to the standards and procedures which are universal for all enthusiasts.

Click through on the title Model Railroads:Layout and Design Information. Then go the link for Superior Northern Lines directly through http://sioux-lookout.lakehead.ca/~iwhite/sharing.html

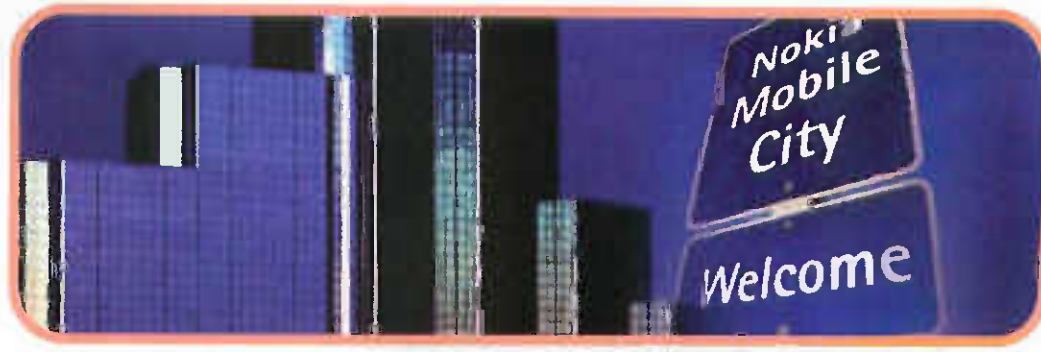
Browser Trolleys have directional headlights and interior lights that can be remotely controlled.

Here you will find a homemade layout featuring lots of circuit diagrams in the Electronics section on control system, throttles, signal driver for AC Block in use, signal generator for detectors, signal driver #2 for power detection and track connections and staging yard.

Nokia Mobile City

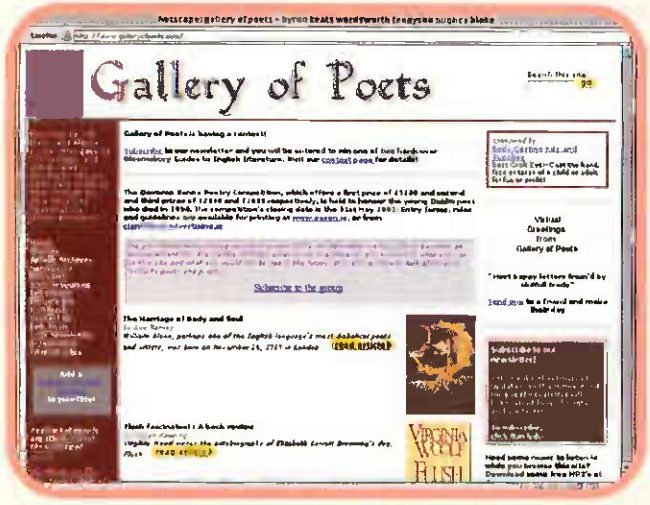
The home for companies working together for the mobile future.

Stroll down Application Avenue and stop off at System Street, the WAP Plaza, Communicator Square, Accessory Avenue and the mobile Internet Street. You can shop in Brand Boulevard and join club Nokia where you can get the latest Harry Potter book from Amazon.com. You can find out what WAP really means so visit www.nokia.com



Site SURVEY

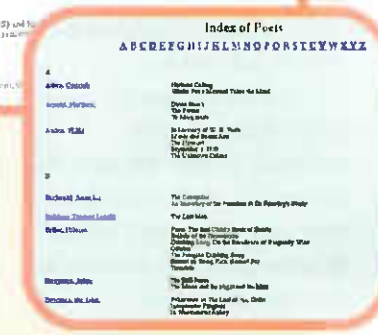
Destinations of the Month



Spring has sprung, the grass has risen and all that, and we're into poetry this month. No better place to start looking for British poets than the Gallery of Poets, at: www.galleryofpoets.com.

If you're looking for information about a specific American poet or his or her works, try American Poets.org, at: www.americanpoets.org.

If you know the first line of a poem, but can't trace the poet or the rest of the poem, it can be very frustrating. Try the Index of First Lines of British poets to 1920, at: www.peart.com/bartleby/mbp/indexline.html.



If you are looking for a few lines to charm your loved one, Love Poetry First Lines, at: www.acedate.com/uk/poetry.html may provide something to help.

If you want to locate a specific poet, and some works, try the Index of Poets, at: www.newtrix.com/poems/poetindex.htm.

Finally, one of the greatest British poets, Philip Larkin, is celebrated by the Web site of the Philip Larkin Society, at: www.philiplarkin.com. It's worth a trip there if you're interested in Larkin's work, and to see what the society is up to.

Introducing ARM...

It designs microprocessor cores and then licenses the designs (its Intellectual Property or IP) to semiconductor manufacturers who produce the chips that are found in the digital devices of today and tomorrow.

ARM IS ONE OF THE MOST INFLUENTIAL COMPANIES IN THE SEMICONDUCTOR MARKET BUT IT DOES NOT MAKE CHIPS.

ARM – The Architecture for the Digital World

ARM Holdings plc '(LSE:ARM); (Nasdaq:ARMHY)', ranked by Dataquest as the number one IP supplier in the world, has emerged as a pre-eminent force in the semiconductor revolution. When ARM pioneered the concept of openly licensable IP for the development of 32-bit RISC microprocessor-based SoCs in the early 1990s, it changed the dynamics of the semiconductor industry forever. By licensing, rather than manufacturing and selling its chip technology, the Company established a new business model that has redefined the way microprocessors are designed, produced and sold. More importantly, ARM has shaped a new era of next-generation electronics: ARM Powered® microprocessors are pervasive in the electronic products we use, driving key functions in a variety of applications in diverse markets, including automotive, consumer entertainment, imaging, industrial control, mass storage, networking, secure, and wireless.

ARM licenses its IP to a network of partners, which includes some of the world's leading semiconductor and systems companies. These partners utilise ARM's low-cost, power-efficient core designs to create and manufacture microprocessors, peripherals and SoC solutions. As the foundation of the company's Global Technology Network, these partners have played a pivotal role in the widespread adoption of the ARM® architecture as a de-facto standard

The History of ARM

ARM was established in November 1990 as Advanced RISC Machines Ltd., a U.K.-based joint venture between Apple Computer, Acorn Computer Group and VLSI Technology. Apple and VLSI both provided funding, while Acorn supplied the technology and ARM's 12 founding engineers. Acorn, developer of the world's first commercial single-chip RISC (Reduced Instruction Set Computing) processor, and Apple, intent on advancing the use of RISC technology in its own systems, chartered ARM with creating a new microprocessor standard. ARM immediately differentiated itself in the market by creating the first low-cost RISC architecture – a design ideally suited to desktop computing. Conversely, competing architectures, which were more commonly focused on maximising performance, were first used in high-end workstations.

With the introduction of its first embedded RISC core, the ARM6™, in 1991, ARM signed VLSI as its initial licensee. One year later, Sharp and GEC Plessey entered into licensing agreements, with Texas Instruments and Cirrus Logic following suit in 1993. Over the years, ARM has significantly expanded both its IP portfolio and its licensee base. After the 1993 addition of Nippon Investment and Finance (NIF) as a shareholder, the company began establishing a global presence, opening new offices in Asia, the U.S. and Europe.

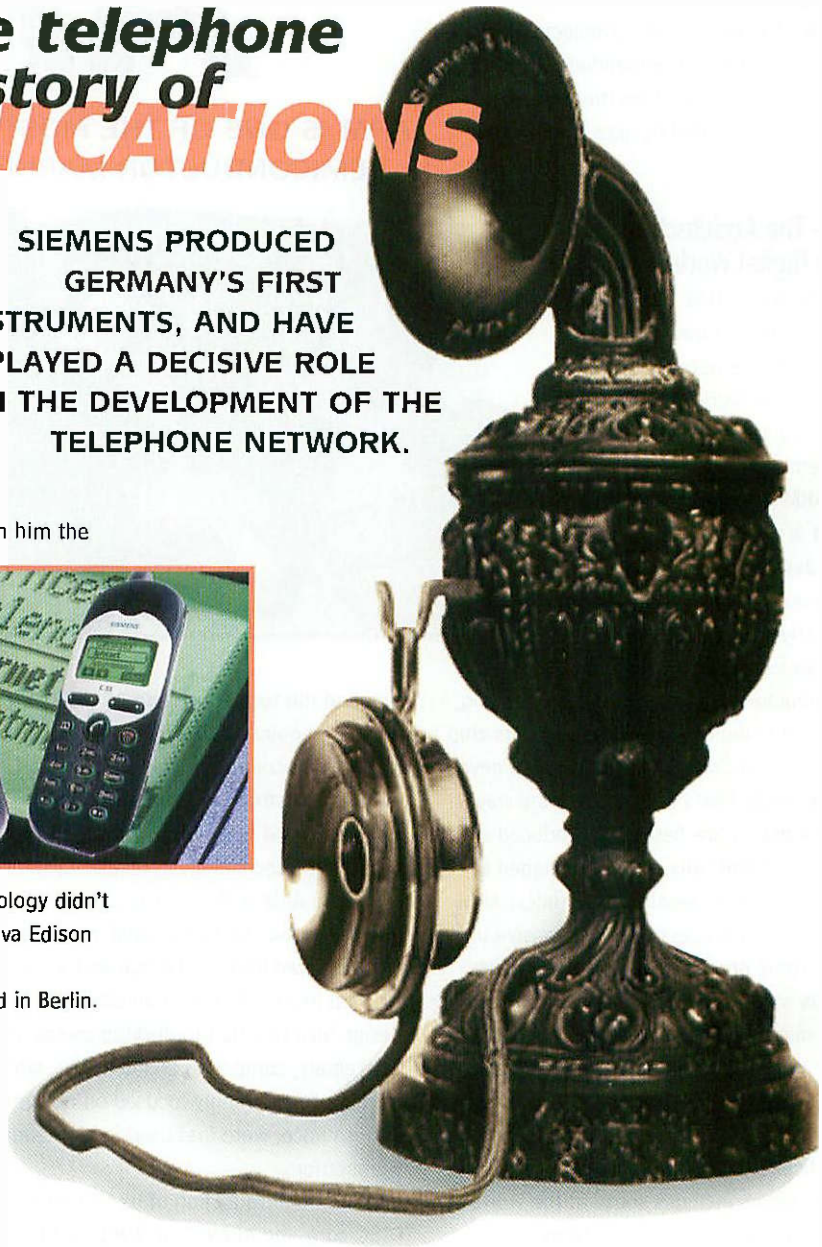
System-on-chip (SoC) Offerings

ARM's microprocessors, peripherals and SoC designs deliver an unrivaled combination of advanced logic, high-speed functionality, low-power consumption and affordability. ARM's IP cores include the ARM7™ Thumb_, ARM9™ Thumb, ARM9E-S™ Thumb, ARM10™ Thumb and StrongARM® processor families, which provide software-compatible architectures ranging from 60 to 1200+ million instructions per second (MIPS).

To accelerate the acceptance of its IP offerings, ARM also supplies software and development systems and provides comprehensive consulting, support, maintenance and training services. The Company's IP Solutions ports operating systems to the ARM architecture and works with specialist third-party application software vendors to deliver software solutions optimised for the ARM architecture. Development Systems provides designers with a fully-integrated environment combining software tools, EDA simulation models, hardware/software co-design support.

125 years of the telephone ...a story of COMMUNICATIONS

SIEMENS PRODUCED GERMANY'S FIRST INSTRUMENTS, AND HAVE PLAYED A DECISIVE ROLE IN THE DEVELOPMENT OF THE TELEPHONE NETWORK.



'The horse doesn't eat salad'

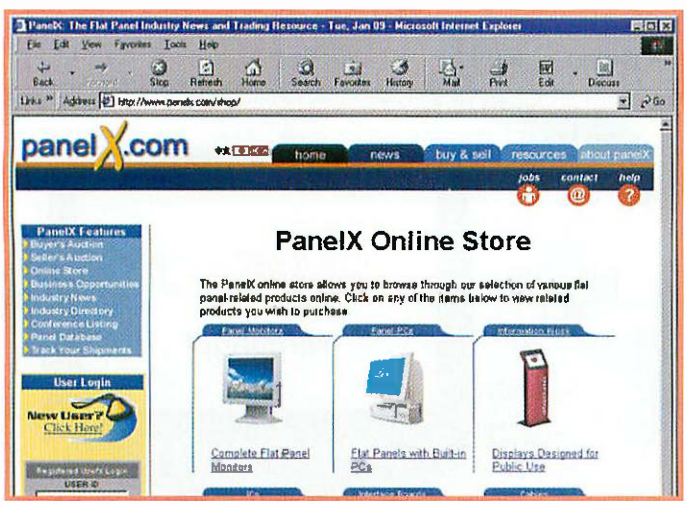
These were the words the inventor of the telephone, Philipp Reis, is supposed to have said during the world's first telephone call. The German physics teacher presented the first electric telephone in 1863. He was ahead of his time, however, and the revolutionary invention did not earn him the renown that was his due.

The age of the telephone was therefore not ushered in until Alexander Graham Bell applied for a patent on his 'electrical speech machine' on February 14 1876. His device consisted of two identical trumpet-shaped transceivers that were connected to each other via a battery. The new technology didn't achieve a real breakthrough, however until Thomas Alva Edison invented the carbon microphone.

A year later, a two-kilometre telephone line was laid in Berlin. Siemens did not only produce the first telephones in Germany; it also developed the network and the requisite switching technology.

In addition, the company played a crucial role in introducing ISDN –the Integrated Services Digital Network and today is one of the world's leading pioneers in the field of UMTS technology.

For more information www.siemens.com



Samsung finds new route to displays market via PanelX.

The flat panel display industry's Business-to-Business (B2B) portal and trading site, PanelX, has added Samsung Electro-Mechanics to its extensive portfolio of leading display brand names. A distribution agreement between the companies provides the electronic display industry with a new and convenient method of evaluating and purchasing high performance display solutions via the Internet, including Samsung's LCOS Projection Engine.

Enabling industry professionals to view and order Samsung products online, the agreement delivers significant benefits to display and video projector manufacturers. As PanelX has a global presence, there are generally no hidden costs in the forms of duties, customs or long shipping times, since all products are shipped from warehouses close to the end user. PanelX will offer 24/7 access for ordering, shipping, tracking, account status and supply and demand forecasting.

LCOS Projection Engine, included in the agreement, is an advanced core electro-optical component for next generation imaging on computer monitors. Consisting of a polarising spectrograph and polariser, together with an ultra-slim separator and synthesiser, the LCOS Projection Engine is designed for SXGA monitors as a text-oriented, micro pause image, high-resolution system. The system is also designed to prevent electromagnetic waves and static electricity while providing a high-quality image.

'We are delighted at this commitment to the development of a long-term relationship between our two companies,' commented C.K. Leung, PanelX Sales Director, Asia. 'The combination of Samsung's superb product range and our extensive distribution capability is a very powerful one, and we are confident that our results will reflect this synergy. With the addition of Samsung's high performance products to our web site we are now able to offer our members a greater selection than ever before'.

From a Samsung perspective, the agreement is equally promising. 'The development of our distribution channel through PanelX is significant for us,' said Seungwoo La, Sales and Marketing, Samsung Electro-Mechanics. 'The company is a highly specialised distributor of electronic display equipment and we are confident that PanelX will make a real contribution to Samsung's world-wide sales effort'.

www.panelx.com www.sem.samsung.com

Siemens IC35 – The Unifier

In this mobile age there is a growing demand for easy-to-use devices that deliver information and communication as well as mobile phone functions. The Siemens IC35 Unifier (£179) doesn't just handle messaging – it has a WAP browser as well, allowing data and information sites to be called up at any time, anywhere. In combination with a cellular phone, the new Unifier constitutes the perfect solution to modern information and communication needs, and it slips into all but the smallest of pockets as well.

Despite its small size, the Unifier has a keypad that is easy to use, and the PC key arrangement means that text can be entered rapidly. The large display makes for a clear overview presentation of all the information, and the intelligent menu system helps you swiftly find your way through the individual information pages.

With programmes such as Text Editor, Pocket Calculator, or Euro Converter, you can have everything at your fingertips which otherwise you could only have at your workstation. With an appointment calendar, address book, and task list, the Unifier has everything you need for your personal day-to-day organisation. And all these entries can be quickly and easily synchronised with the PC via the SyncStation using Microsoft Outlook and Lotus Organiser. For entertainment, there are even some games available, and additional programmes can be loaded via the Internet.

The Telephone Manager lets you call up the telephone book in your mobile, work with it and add to it. And it's also possible to dial a telephone number from the address databank directly via your mobile. Thanks to the direct access to the address databank of the Unifier, you can rapidly call up the mail address or telephone number you want, and the message which has been written can be sent off immediately via the mobile phone, as soon as the connection has been set up.

The integrated WAP browser (which supports WAP Standard 1.1, the established standard preferred by most network operators) gives you rapid access to the mass of information available on the Internet even when you're on the move. Thanks to its two MultiMedia Card slots, the Unifier can be extended in an extremely versatile way. As well as the memory extension capacity, with the MultiMedia Card additional programmes can also be installed. The Unifier works perfectly with Siemens mobiles. With the standardised IrDA interface or via a serial cable, it will work almost as well, according to Siemens, with mobiles from other manufacturers.

For more information go to www.siemens.co.uk.

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electronics classified

TOS interface?

Does anyone know where I can get interface schematics for the TOS interface? A TOS interface is an optical interface used in audio applications, for example Mini Disk. It is also known as S-PDIF. **M. Joshi.** Please contact me through the Forum on www.electronicsandbeyond.com.

The Public Electronics Circuit Archive

www.publicelectronics.cjb.net is a place where people can submit circuits for others to view, modify and construct. There is also a forum to place links and ideas etc. Please take a look and submit your circuit designs, no matter how simple or complex. Please add a little about what it is and how it works too! Everything is free-gratis, so everyone benefits!!

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Alternatively, why not go to the Forum section of the Electronics And Beyond web site www.electronicsandbeyond.com, where you can post your views, pose questions that other visitors to the site might be able to answer, or publicise your own clubs and web-sites. The most interesting submissions will be reproduced in the magazine, for other readers to see.

Institute of Inventors

The Institute of Inventors is a voluntary, non-profit inventors' club, run by professional engineer inventors, with help for all private inventors – evaluation of new ideas, gadgets and inventions, prototype drawings and development, patent specification, drawings and applications, licensing of intellectual property to maximise inventors' chances of earning money on inventions with merit. The institute also undertakes commissions for customised inventions as required by industry and governments to enhance the quality of life on this planet for maximising the miracle of man's inventiveness. 19-21-23 Fosse Way, Ealing, London. W13 0BZ. United Kingdom.
Tel: +44 (0)20 8998 3540, +44 (0)20 8998 6372. Internet: http://members.aol.com/mikinvent/index.html.
e-mail: mikinvent@aol.com.

ROUGOL.

The RISC OS User Group of London is a leading force in the world of RISC OS. We have regular meetings, with provision for refreshments, and excellent presentation facilities. The group has over 120 members, and is the fastest growing RISC OS user group in the world. We hold meetings on a wide range of topics, in a variety of locations, and at different times, catering for all. We generally intend holding meetings every six or seven weeks. Everyone on our mailing list will be kept informed of these and other ROUGOL initiatives. Go to http://rougol.jellybaby.net/ to see our home page.

Model Railway Events In Scotland June 2001

Glenrothes Model Railway Exhibition – Rothes Halls, Glenrothes, Saturday 2nd June 10am till 6pm, Sunday 3rd June 10am till 5pm. Strathclyde 'O' *Model Railway Construction Group* – Glasgow, Pollokshaws Burgh Hall, Saturday 9th June 10am till 5pm, Sunday 10th June 10:30am till 5pm (Adult £3.00, Child £1.50, Family £6.50). *Perth Model Railway Club* – City Hall, Perth, Saturday 23rd June 10am till 5pm, Sunday 24th June 10am till 4:30pm (Approximately 12 layouts representing most scales and gauges and trade support, buffet service and raffle. £2 adult, £1 child, £5 family).

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Excursions into EXCEL

by Mike Bedford

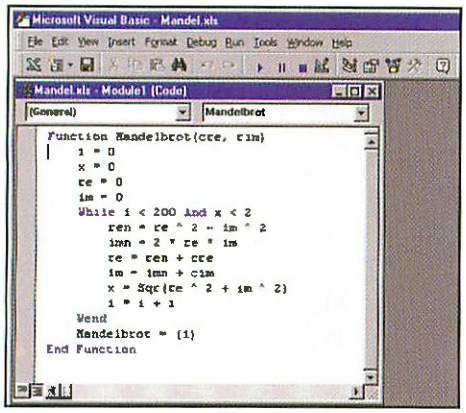


Figure 1.

PART 8

LAST MONTH I PRESENTED A WORKBOOK WHICH PLOTTED THE BIFURCATION DIAGRAM WHICH WILL BE FAMILIAR TO ANYONE WHO HAS EVER DABBLED IN CHAOS THEORY.

However, it was tricky to present the data in such a way that it could be plotted and I ended up using a macro to re-order the data prior to plotting. As with all the workbooks in this series, the one for the bifurcation was placed on the Electronics & Beyond Website and those readers who downloaded it would have been able to use it as intended. However, unless you've previously written macros, part of the operation of that workbook would have been something of a mystery to you. I did, though, promise to take a look at macros in more detail later in the series and this, in fact, is our topic here.

The example I've chosen should be reasonably familiar – the generation of that amazingly complicated fractal called the Mandelbrot Set. First of all, though, the mathematical background. Start with the origin on the complex plain, square it and add a complex constant c. If the modulus of the resulting point (that is its radial distance from the origin) is more than two then c is not in the Mandelbrot Set. If the modulus is less than 2, carry out the transformation again – i.e. square the complex number and add the complex constant c. Once again, if the modulus of the resulting point is more than 2 from the origin, c is not in the Mandelbrot Set. With some values of c, however many times you do this, the result will never get far from the origin – these are the points in the Mandelbrot Set. For other starting points the modulus soon becomes very large indeed. Of course, it's not possible to carry out the transformation an infinite number of times, so some sort of limit has to be placed on the number of times we perform the transformation. 200 is typical although if you use a larger number, then you'll get a more accurate result but it will take longer to compute the answer. So, to get a picture of the Mandelbrot Set, carry out the above process for a large number of constants c on the complex plain, plotting a mark for those points which are in the Mandelbrot Set. In fact, the process we've just seen would produce a monochrome image since points which are in the Mandelbrot Set would end up black and those which are not would be white. A more interesting result can be achieved by producing a contour plot in which the colour depends on how many iterations were required before the modulus exceeded the magic figure of 2.

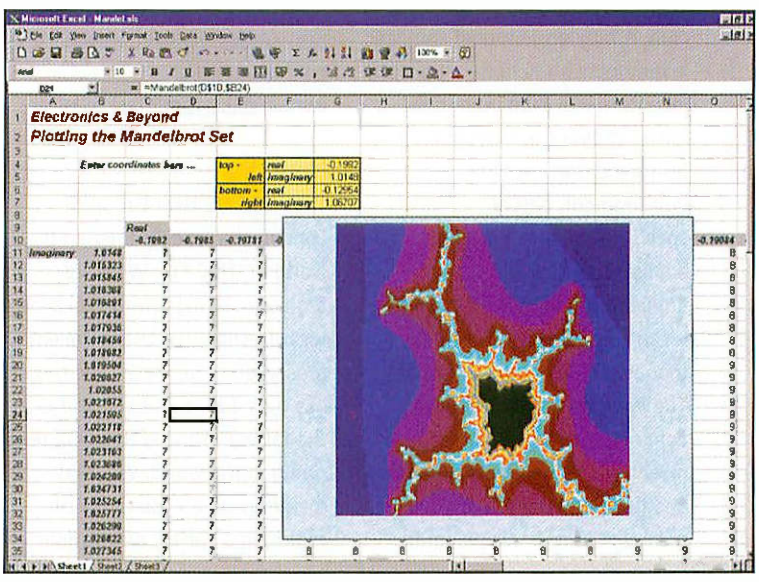


Figure 2.

Since complex numbers are represented on the complex plane with the real component on the x-axis and the imaginary component on the y-axis, this is the obvious way to represent it in our workbook. So, we set up a 2D array with 101 x 101 elements – clearly more elements would have given us a better picture but the speed wouldn't have been acceptable. We need to be able to plot any portion of the complex plane since only this way can the user zoom in on any portion of the Mandelbrot Set and so investigate its amazing fractal properties. So, we provide cells at the top of the worksheet into which the user can enter the real and imaginary components of the top-left and bottom-right hand corners of the area to plot. From this information, it's trivially simple to calculate the row and column headings (i.e. the real and imaginary components) of our array. Now, if we had a Mandelbrot function, all we need in each cell of the array is something like =Mandelbrot(C$10,$B11), bearing in mind, of course, that we need to use a combination of relative row / absolute column and absolute row / relative column references as we've seen before in similar applications. The snag, of course, is that Excel doesn't include a Mandelbrot function so we have to write our own as a Visual Basic macro.

To create the macro, select Tools > Macro > Macros. Enter the name Mandelbrot into the Macro Name box of the Macro window which is displayed and click on Create. You'll now be launched into the Visual Basic Editor and you'll find that the start and end of your macro are already in place. All you now need to do, therefore, is enter the specific code for the Mandelbrot macro between the lines Sub Mandelbrot() and the End Sub and you also need to enter the names of the arguments which will be passed to the macro inside the brackets on the first line. The screen shot shows the macro which I wrote. Let's see

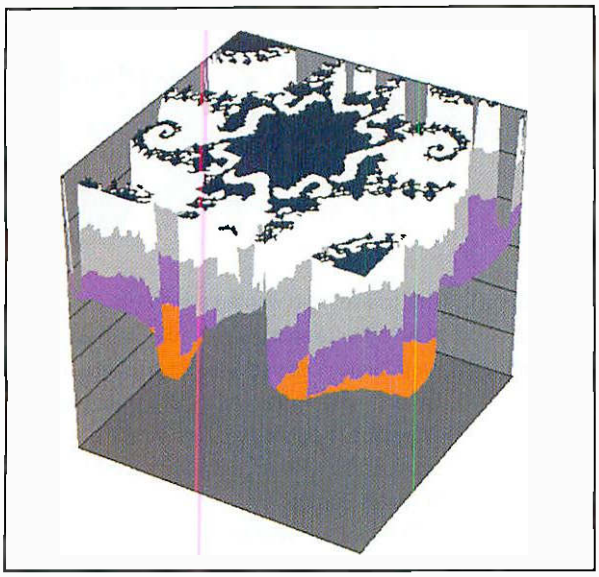


Figure 3.

how it works. The arguments passed to the macro are cre and cim, the real and imaginary parts, respectively, of the complex constant c, and the first few lines of code just set up a few initial values. Specifically we initialise i, the increment counter and x the modulus of the latest point evaluated to zero, and we also initialise re and im, the real and imaginary components of the latest point evaluated to zero since we always start at the origin. Now we have a loop which is executed for as long as the increment counter is less than 200 and the modulus of the latest point evaluated is less than 2. And inside that loop we do three things: we evaluate the latest point by squaring the previous point and adding the constant c, we determine the modulus of that latest point, x, and we increment the loop counter i. If you bear in mind that the real part of the square of a complex number is real2 – imaginary2, and the imaginary part is 2 real imaginary, and if you also bear in mind that the modulus is evaluated by Pythagoras – i.e. modulus is the square root of (real2 + imaginary2) – everything should make perfect sense.

So we have a 2D array of values, each of which calls up the macro Mandelbrot. We also have that Mandelbrot macro so, at this point, that array will be filled with numbers. These number will be either a value between 1 and 199 indicating the number of iterations required to give a modulus greater than 2, or 200, indicating that it still hadn't exceeded 2 after 200 iterations. And it's now a fairly simple task to create a contour plot as shown in the main screen shot. Actually, this doesn't use the default settings and you may have to play around for a while to get a pleasing colour palette. In fact, you'll find that you'll need different colour palettes for different portions of the Mandelbrot set to cope with the fact that some areas might include all values from 1 to 200, whereas others may have all the action in the range, say, 150 to 200. As an interesting alternative, you could plot this as a 3D surface instead of a contour plot to see the Mandelbrot Landscape, an example is shown here.

A final comment on this workbook is that it can take many seconds to recalculate. And since you don't want to have to wait a minute or so every time you enter something into a cell, you should turn off automatic recalculation in Tools > Options > Calculations, now, whenever you do want it to update, just press F9. If you download this workbook from our Website, be aware that it won't update automatically. Note also that, when you load it, Excel will warn you that the workbook contains macros and will ask you if you want them to be disabled. This is a security precaution since it's through macros that viruses are included in Excel workbooks. Obviously this workbook won't work if you do disable macros but rest assured, we have fully virus-scanned it.

Technology Watch

with Martin Pipe

THERE'S BEEN A CERTAIN AMOUNT OF INTEREST IN DIGITAL RADIO, NOW THAT MORE AFFORDABLE DAB (DIGITAL AUDIO BROADCASTING) PRODUCTS HAVE BEGUN TO APPEAR IN THE MARKETPLACE.

It's taken a long time, seeing that the BBC begun DAB broadcasts back in 1995. We examined two of these products – the VideoLogic DRX-601 and Psion WaveFinder, both of which sell for £300 – in a recent Technology Watch. One can be forgiven for believing that digital radio is a rich man's toy. Far from it, if the pioneering WorldSpace project is anything to go by. WorldSpace, a commercial corporation headquartered in Washington, will employ three geostationary satellites to deliver digital radio to a sizeable proportion of the planet's population (its potential reach, says WorldSpace, is 5 billion people). Two of these satellites, AfriStar and AmeriStar, are already in operation and disseminating radio programmes to a wide audience. This undoubtedly ambitious project was the brainchild of one man - Noah Samara, who founded WorldSpace back in 1990. In 1992, this ex-lawyer was able to obtain scarce radio spectrum at an international conference. This was the 'reward' for getting developing countries to back the US-funded Globalstar and Iridium satellite-phone systems

Launch of the AfriStar Satellite

WorldSpace's remit is to provide those living in developing countries with a wide choice of news, entertainment and educational radio programmes. Broadcasters with a presence on the system include the BBC World Service, CNN, World Radio Network, Radio Exterior de Espana, Radio France International, All India Radio and the African Learning Channel. An independent US-based non-profit organisation created in 1997, the WorldSpace Foundation, provides educational and informational programming to developing regions. Services currently provided through the WorldSpace Foundation are Canal Educative Francophone (education and information in French) and the Africa Learning Channel (social development, educational and cultural programming in English).

WorldSpace also offers a data service via some of its transponders – subscribers can download electronic versions of newspapers. Just the ticket if telephone connections for modems are unreliable – or non-existent. The WorldSpace radios – which are mass-produced by Hitachi, JVC, Panasonic and Sanyo - are affordable. Indeed, the Hitachi model, which also includes a four-band analogue tuner, sells for less than £100 in the UK. WorldSpace is working with Freeplay on a 'wind-up' version of its radio, which could prove popular in remote villages that don't have mains electricity supplies.

In the UK, WorldSpace listeners can receive transmissions from the west beam (Beam 1) of AfriStar, which was designed to serve western and northern Africa. Each of these beams has a coverage of approximately 14 million square kilometres. WorldSpace didn't originally intend to cover the UK or Europe, but AfriStar's west beam proved to have a bigger footprint than expected. This prompted WorldSpace to sell receivers in this country, primarily to long-distance broadcasting enthusiasts who wanted a more reliable alternative to short-wave radio. Indeed, WorldSpace has had a major presence at the larger amateur radio rallies in recent years. WorldSpace claims that receivers are successfully receiving AfriStar's west beam in northern Europe.

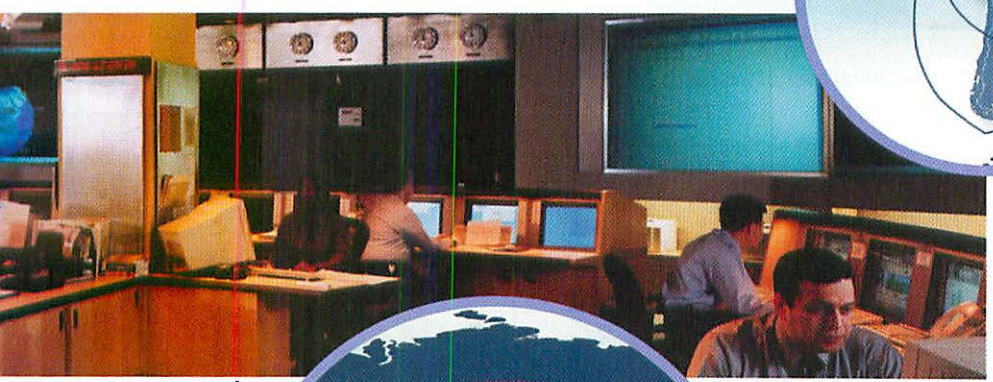
The AfriStar satellite, which is located at an orbital position of 21.5°E, has two other beams. Beam 2, which caters for southern and eastern Africa, also carries as far as western India. The third beam covers southern Africa. What of the two other satellites? AmeriStar – due for launch soon – will cover the entire South American continent, the Carribean and much of Central America (including most of Mexico). Ironically enough, the USA isn't covered! The States will have its own digital radio service soon, though. The three beams of AsiaStar, which can be found at 105°E, will serve nearly all Asia, including China, India, Indonesia, Malaysia, Philippines, Singapore, Thailand, and many ASEAN islands. The choice of programming relayed via each satellite transponder reflects the languages and interests of those living within its footprint. Each beam is capable of delivering over 40 channels.

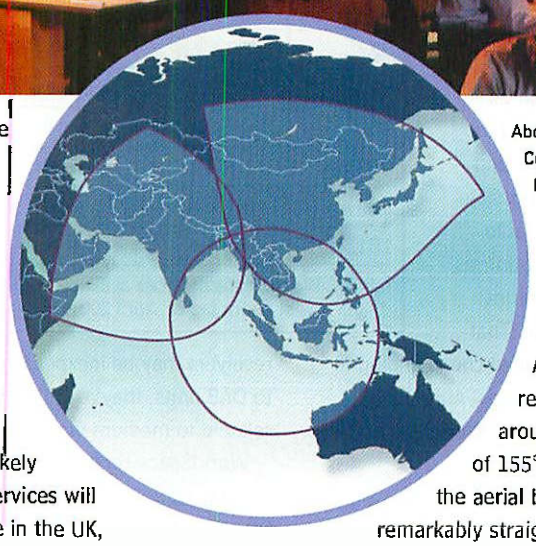
World Space HQ. Washington DC

If you were to point your motorised satellite dish towards 21.5°E, you wouldn't be able to see or hear anything. This is because WorldSpace's satellites operate on the L-band, frequencies ranging between 1452MHz and 1492MHz. Satellite TV broadcasting, on the other hand, employs the much-higher Ku band (approximately 10GHz to13GHz). To maximise the available spectrum, the signals

are polarised. Circular polarisation is used, mainly for ease of aerial alignment. Radio programme providers uplink their services at frequencies ranging between 7025MHz and 7075MHz. There are several earth stations and control facilities around the world. AfriStar's two uplink stations, for example, are in London and Johannesburg. Each main ('broadcaster') channel can incorporate several additional 'service channels'.. WorldSpace radios will tell you if these service channels are available, and give you some way of selecting them. Broadcasts are compressed using a variant of the popular MP3 system, and radio stations can choose data rates that vary from 16 kbps (AM broadcast quality, mono) to 128kbps (comparable to CD-quality stereo). Interestingly, one of WorldSpace's partners is MP3 inventor Fraunhofer Institut Integrierte Schalttungen.

WorldSpace plans to make money through the leasing of satellite space to broadcasters. There will also be subscription services, such as the delivery of data to computers. All receivers have a proprietary 9-pin serial data port, which interfaces to a PC via an interface 'black box'. The maximum data rate that can supported is 128kbps – theoretically, compressed video streams (Real G2, for example) could be passed to, decoded by and displayed by computers. Satellite TV from a system originally designed only for radio is quite a concept! It is unlikely that these data services will be made available in the UK, where cheap and reliable Internet access is taken for granted. Premium radio services, supported by the radios via a PIN-entry system, are another possibility. Most of the radio stations on offer will be free, though. Some are in stereo, while others are in mono.

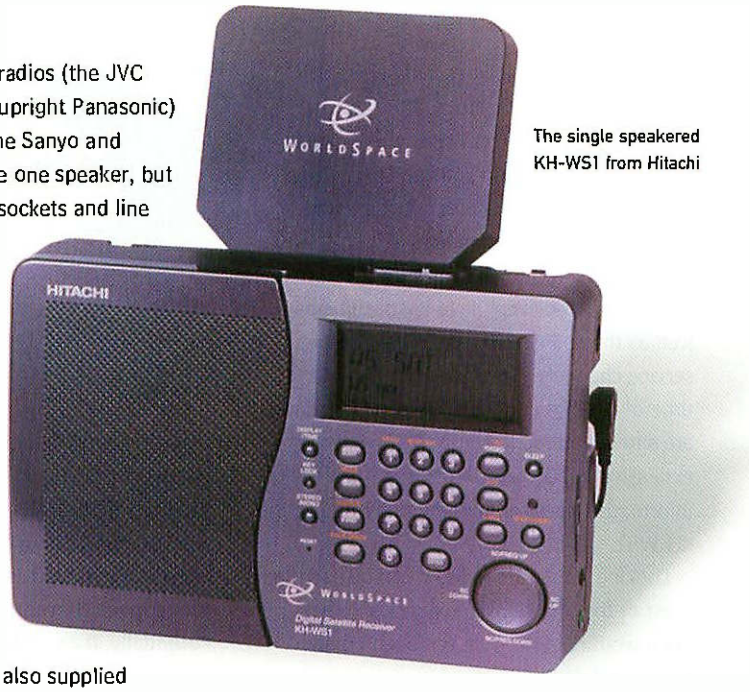




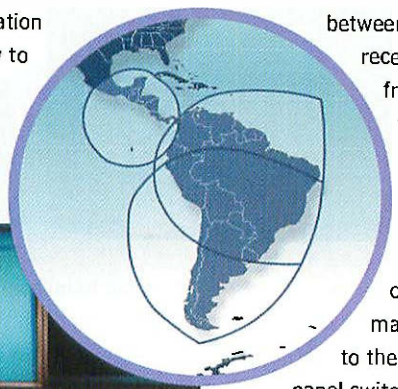
Above: Regional Operations Centre
Left: AsiaStar's footprint

Two of the WorldSpace radios (the JVC 'ghetto-blaster' and the upright Panasonic) have stereo speakers. The Sanyo and Hitachi models only have one speaker, but have stereo headphone sockets and line outputs for amplifiers and recorders. In addition, the Sanyo model has a digital audio output for Minidisc recorders.

The radios come with a waterproofed flat-plate active aerial that clips into position. The aerial plugs into an 'F' socket via a short trailing lead. However, the radios are also supplied with an coaxial extension cable that allows the aerial to be positioned outside (and thus have a direct line-of-sight view of the satellite) when indoor reception is required. The aerials incorporate a bracketed frame with a hinge that facilitates elevation adjustment. It's thus easy to place the aerial on a flat horizontal surface and point it towards the satellite. At the South-East test location, AfriStar reception requires an elevation of around 27° and an azimuth of 155°.. We found aligning the aerial by trial-and-error to be remarkably straightforward, and locked onto the satellite within seconds. Our Hitachi WorldSpace receiver (the KH-WS1) had a signal strength meter, although this proved to be less than useful.



The single speakered KH-WS1 from Hitachi

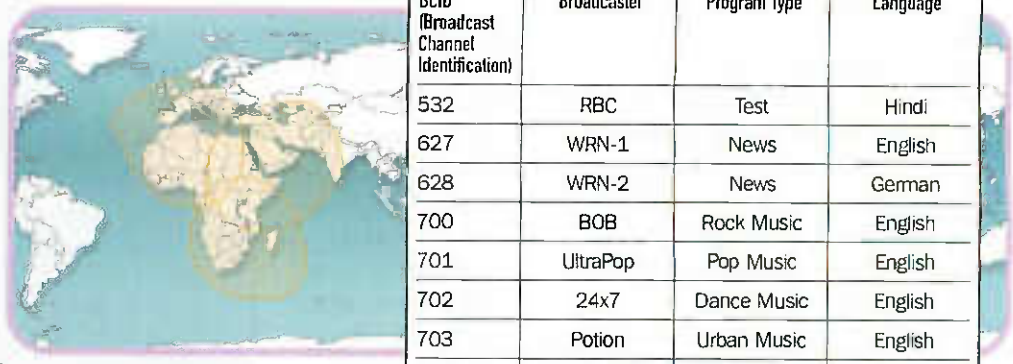


Right: AmeriStar's footprint

The KH-WS1 also includes a frequency-synthesised analogue radio tuner. You get stereo FM, MW and two SW bands – one covering 2.3MHz to 7.3MHz, the other 9.5MHz to 26.1MHz). The set is equipped with a telescopic rod and internal ferrite rod aerials for these. Switching between satellite and analogue radio reception involves pressing a front panel button. There are a total of 40 user-definable tuning presets – five each for the shortwave bands, ten MW, ten FM and ten WorldSpace. The KH-WS1 can be operated from the mains (110V or 220V, according to the position of a recessed rear-panel switch) or from 4 'D' cells. Hitachi claims that up to 30 hours of operation can be squeezed from a set of alkaline cells. In terms of performance, we found that the WorldSpace channels did suffer from obvious audio artifacting – even the higher-bitrate stereo ones. The overall effect isn't dissimilar to a low-bitrate MP3 (imagine a 56kbps stereo one with a 44.1KHz sampling rate). But then again, there's no fading – and that's where the system really scores over short-wave (stereo is merely an added bonus!). The SW and MW sections were usable, but the FM tuner proved to be rather insensitive. Gaps in SW coverage preclude reception of certain BBC World Service transmissions, which seems a little odd.

Although the FM section lacks RDS, WorldSpace offers a similar feature. Radios have 'programme type' (PTY) display. You can bring up a list of channels that broadcast programmes of a specific type (there are 15 of these, ranging from news to jazz), and select stations from there. Another useful feature of the receiver is is 'language awareness'. Bearing in mind the fact that

many different languages could be spoken within one of the satellite footprints, one could argue that it's mandatory! Press the 'language' button, and you can specify the language of your choice. A list of stations broadcasting in that language is then displayed for you to choose from. All WorldSpace receivers have this facility, as well as the ability to handle reception of service channels (which were rare at the time of writing) and data. The user interfaces are similar, although some of the more expensive radios have larger and more informative displays than the one fitted to the KH-WS1.



Looking inside the radio, it can be seen that most of the WorldSpace functionality has been whittled down to a screened L-band tuner module and two main ICs. These chips, which are manufactured by Micronas, were developed specifically for WorldSpace and are common to all four current receivers. We could not get any information on them; when we spoke to Micronas we were told that a WorldSpace non-disclosure agreement would have to be signed before the datasheets could be released to us. One of the chips, a DRD3515A, is concerned with demodulating the signal and retrieving the MPEG datastream. The second chip, a MAS3506D, is an MPEG audio decoder. Within the Hitachi receiver, the WorldSpace receiver section is built onto a separate PCB – a I2C interface chip allows the subsystem to talk to the system control microprocessor. Because the same chipset is used for all receivers, one can presuppose that a S/PDIF digital audio output could be added to all receivers (the Sanyo has one already). However, the lack of a datasheet doesn't make the job easier – instead, you'll have to prod around with a 'scope. The relatively-poor audio quality we experienced probably makes the task pointless, though.

The Panasonic RE-WS10

One cannot fault the WorldSpace concept, though. Potentially, it could bring basic education to millions of people. Note that although WorldSpace may be seen as just another source of radio programmes here in the UK, it may be the only source in some far-off lands. From a Western perspective though, some of the programmes were absolutely fascinating – amongst other things, we chanced on Chinese lessons (broadcast in English!), Moroccan news and African pop music. It's possible that local low-powered radio stations in developing countries may retransmit programmes received via WorldSpace. That way, villagers will only need cheap analogue radios. Although WorldSpace receivers may be inexpensive when compared to DAB units, they're still very expensive relative to medium-wave 'pocket radio' sets.

BCID (Broadcast Channel Identification)	Broadcaster	Program Type	Language
532	RBC	Test	Hindi
627	WRN-1	News	English
628	WRN-2	News	German
700	BOB	Rock Music	English
701	UltraPop	Pop Music	English
702	24x7	Dance Music	English
703	Potion	Urban Music	English
704	Up Country	Country Music	English
705	RIFF	Jazz	English
706	RITMD!	Other	English
707	Maestro	Classical Music	English
708	EARZ	Children	English
709	LETTERS	Word Ent.	English
750	ALC	Education	English
800	Egypt-1	Information	Arabic
801	Egypt-2	News	English
802	Egypt-3	Information	French
804	Voyager	Pop Music	English
806	East FM	Music	English/Hindi
807	KBC	Information	Swahili
809	Golfe FM	News	French
810	Radio Sud	Full Service	French
812	WALF FM	Full Service	French
814	CNNI	News	English
817	Medi-1	Other	French
818	Bloomberg-En	News	English
819	Bloomberg-Fr	News	French
820	Bloomberg-Sp	News	Spanish
821	Bloomberg-It	News	Italian
822	Tamil	Pop Music	Tamil
823	Radio One	Pop Music	English
824	Capital Radio	Pop Music	English/Turkish
827	LA 7	News	French
829	REE	Full Service	Spanish
900	KAYA	Music	English
903	RFI-1	News	French
904	BBC-AfW	News	English
1515	Marine T	Weather	English

Table 1. WorldSpace services available in UK via AfriStar's west beam (as of April 2001)

WorldSpace receivers can be bought on-line at www.worldspace.com, or from Waters and Stanton (01702 206835).

the JVC FR-DS100

Any ideas or comments?

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