ELECTRONICS and Beyond

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REVIEW Newnes Pocketfinder

THE MAPLIN MAGAZINE

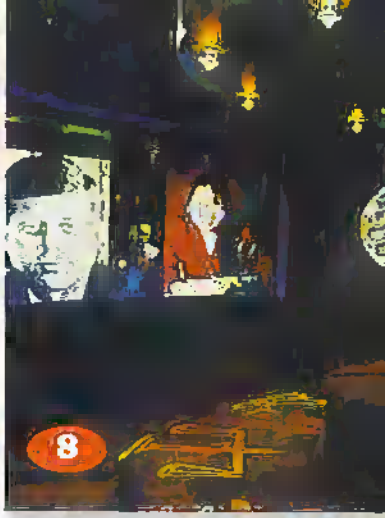
ELECTRONICS and Beyond

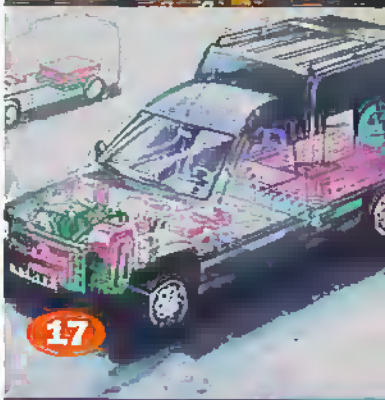
October 1998 Vol. 17 No. 130

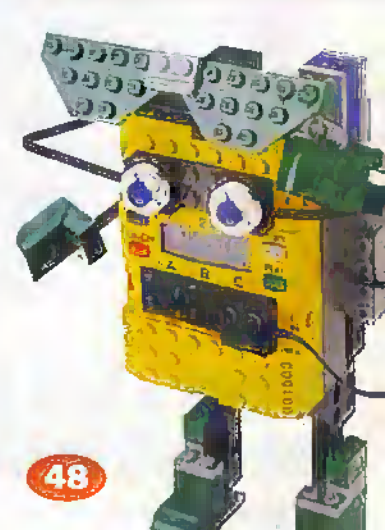
Projects

Features

Regulars







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Published by Maplin Electronics plc., P.O. Box 777, Rayleigh, Essex, SS6 8LU.
Tel: (01702) 554155.
Fax: (01702) 554001.
Lithographic Reproduction by Planographic Studios, 18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UZ.
Printed by Millennium Web Offset plc., Penryn, Cornwall, TR10 9EP

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Tel: 0181 869 8410

UK Newstrade Distribution
Maplin Electronics PLC.

ELECTRONICS and Beyond

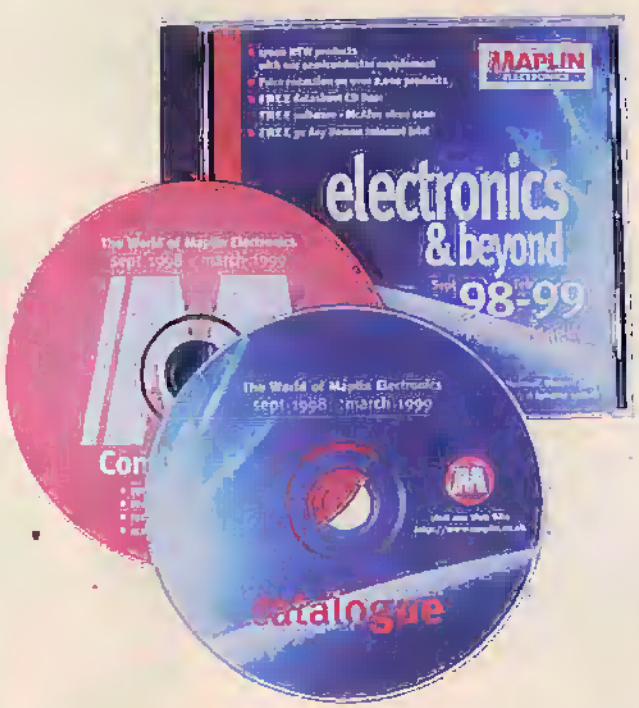
This month we take the controversial step of venturing into paranormal investigations with a project from David Aldous. For many years David has been very interested in psycho-kinetic phenomena – the ability to move objects remotely without touch. In this first installment he gives an absorbing introduction and recollection of his research and studies, and also the basis of this project. Next month sees more constructional details. We hope you find his article and project both interesting and stimulating.

The Lego Company, the people that make plastic bricks has introduced a new concept called Mindstorms. This offers youngsters and teenagers (and adults!) an extremely innovative and intuitive introduction to programming, computers and robot construction. We were very impressed with the attention to detail and thought that had gone into this concept. Open these pages to find out more.

For the hi-fi enthusiast, Mike Bedford suggests some systems that are amongst the best available, but could give your wallet nightmares! Plus, we have a look at RadioScape a small company in London who will be using software and hardware to bring digital radio to your PC at a very affordable price.

CD-ROM

As promised we have included the latest Maplin Catalogue on CD-ROM which we believe you will find much easier to install and use. Next month we will be including a second Maplin CD which is filled with technical specifications etc. and free software.



Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Palm's Pilots Depart 3Com

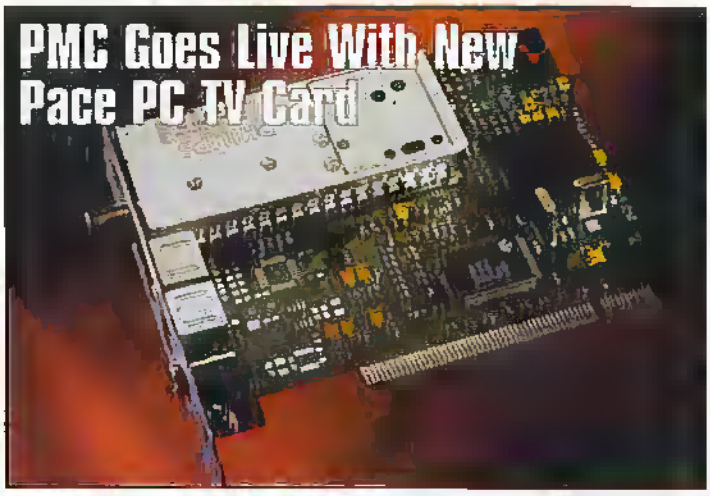
Palm Computing president Donna Dubinsky and chief technology officer Jeff Hawkins are departing from 3Com to develop their own devices based on the operating system used in the PalmPilot. In contrast to the PalmPilot, their new product will be aimed at the consumer rather than the business market.

For further details, check: <www.3com.com>.

Contact: 3Com, Tel: (01189) 228200.

NEWS BYTES

PMC Goes Live With New Pace PC TV Card



PMC Consumer Electronics is launching the Pace PC TV Card, a new device which brings live terrestrial, cable or satellite TV to your PC. It also provides access to Teletext, the free 24 hours a day information and entertainment service, bringing you up-to-the-minute news, stock market reports, sport, weather, travel and television listings directly to your PC. The product will go on sale at £89.00 and will be available from the end of August.

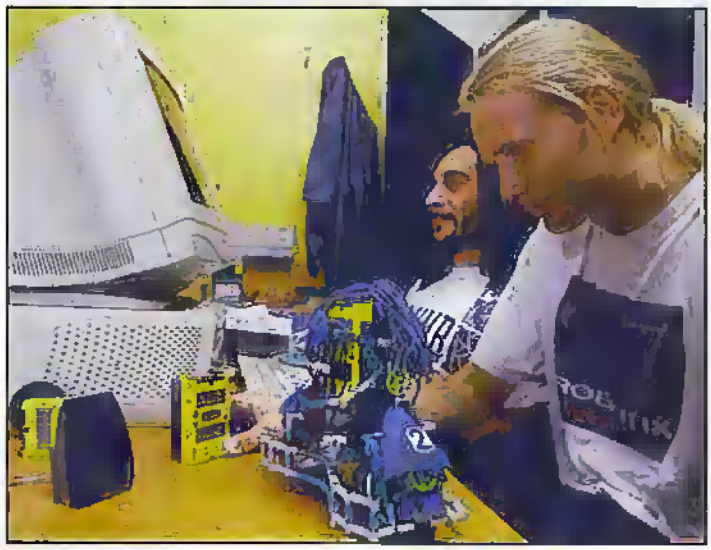
For further details, check: <www.pacecom.co.uk>.
Contact: Pace, Tel: (0990) 561001.

Soccer Playing Robots Demonstrate Robotic LEGO

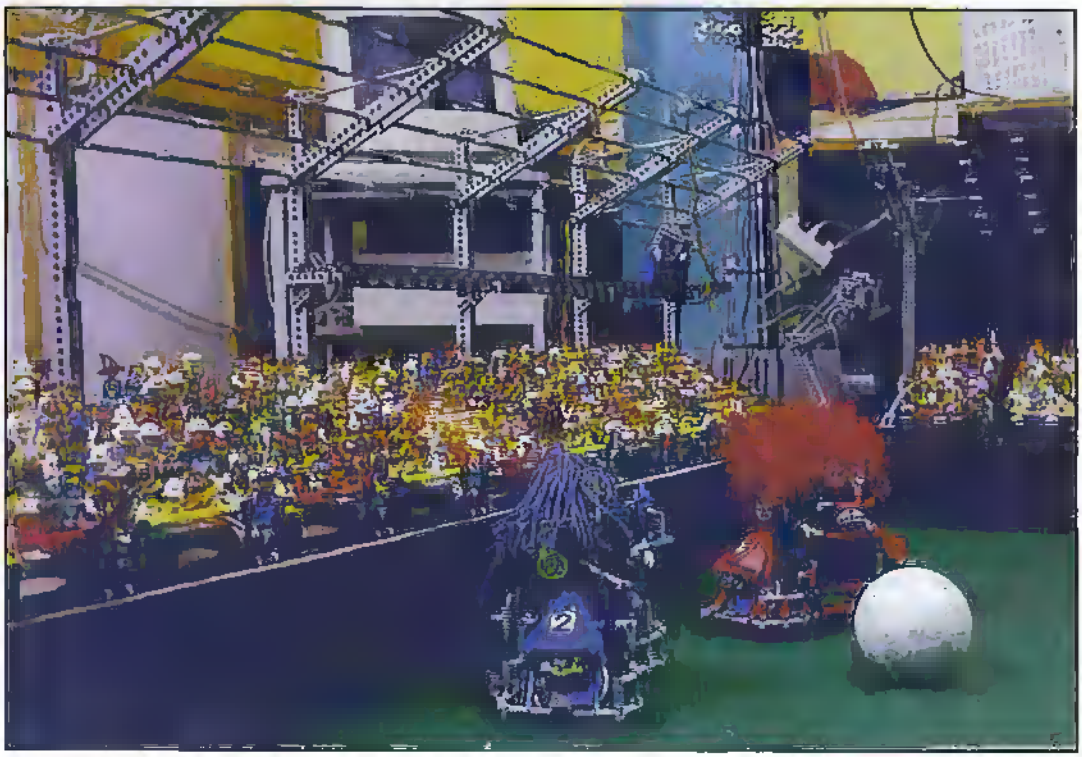
LEGO demonstrated how a new 'intelligent' LEGO brick can be used to create robots that play football, as part of the Robot World Cup Soccer Games and Conferences 1998 at the beginning of July. With a programmable microprocessor-based 'brain', light and touch sensors and LEGO motors and gears, robots built entirely of LEGO pieces behave.

The LEGO robots are part of a revolutionary LEGO product category called LEGO MINDSTORMS and in one example are just like football players. They dribble a ball around obstacles, make smart play choices and shoot to score a goal.

LEGO *MINDSTORMS*, meant for children 11 and older, will be launched for commercial sale in September/October 1998. The technology behind the concept was developed in co-operation with the Massachusetts Institute of Technology (MIT) in the USA, to put into creative hands of children cybernetics concepts that have until now been reserved for the university laboratory or events like the RoboCup.



For further details, check: <www.lego.com>.
Contact: Lego, Tel: (01978) 290 900.



Satellite Deal Completes BBC Digital Wide Screen Picture

The final part of the BBC's plan to make its wide screen digital services available to all licence fee payers was confirmed this month with an agreement for distribution via the Astra satellite and the Sky Digital satellite service.

The announcement ensures that the BBC's licence fee funded television services will be available on all digital television distribution systems – cable, satellite or terrestrial. The BBC has already announced its plans to give viewers access to the new services on the Digital Terrestrial Television network to be launched later in the year. Services will also be available on cable systems as they go digital.

For further details, check: <www.bbc.co.uk>.
Contact: BBC, Tel: (0181) 743 8000.

Microsoft To Pay $5million For Brand Name

Microsoft has agreed to pay a bankrupt software company $5 million for use of the 'Internet Explorer' name. SyNet previously owned the trademark on the name Microsoft was using for its popular Web browser.

For further details, check: <www.microsoft.com>.
Contact: Microsoft, Tel: (0345) 002000.

ICL's Recycling Service Slashes the Cost of PCs

ICL is set is to offer a unique recycling service in which unwanted PCs and notebooks are fully reconditioned and sold through dealers including Maplin to UK consumers who can buy them at a fraction of the cost of a new machine. The service – branded STAR (Second Time Around) – is aimed at the growing small business, home office and home user market which does not necessarily require high specification machines.

The new service will offer quality reconditioned desktop PCs and notebooks from big names including AST, Compaq, Fujitsu, Hewlett-Packard and IBM. The PCs, which are acquired from large companies, will be wiped clean of data, refurbished, resprayed, relicensed, have a new keyboard and new mouse fitted, repackaged, and come complete with Microsoft Windows software loaded and a 90-day warranty.

Key to the STAR service will be a standard price list which dealers will not be able to undercut. Prices start at £199 inclusive of VAT for a 486 (below 50MHz), rising to £348 inclusive of VAT for a high end Pentium (above 100MHz). ICL will ensure that all STAR dealers are vetted and provide telephone support, installation and have the ability to provide extended warranty services.

For further details, check: <www.icl.co.uk>.
Contact: ICL, Tel: (01925) 435041.

NEWS BYTES

Dropout Regulator Extends Battery Life

National Semiconductor has launched a micro-power low-dropout (LDO) regulator that reduces high-frequency noise and increases battery efficiency in cellular phones and other portable equipment by taking advantage of the low ESR (equivalent series resistance) of ceramic output capacitors. The LP2985 is designed to assure stable operation across the entire range of operating temperature and output current when used with small, low-cost ceramic output capacitors having ESR as low as 5mΩ.

For further details, check: <www.national.com>.

Contact: National Semiconductor, Tel: (01475) 633733

Compaq Fingerprint System

Compaq is launching a Fingerprint Identification Technology. The system, which is about the size of a paperback book and plugs into the office computer, will allows an employee to hold his or her finger to a camera for matching with a stored print map of the authenticated fingerprint in order to convince the computer to allow access.

For further details, check: <www.compaq.com>.

Contact: Compaq, Tel: (0990) 134456.

Tiny Turbines To Power Laptops

Scientists at the Massachusetts Institute of Technology (MIT) gas-turbine lab predict that sometime around 2000 engines the size of shirt buttons will begin replacing the batteries now powering handheld computers, cell phones and camcorders. Scientists claim a turbine-driven power pack could be made about 25% smaller than today's lithium batteries and last twice as long between re-fuelings. The MIT model resembles a miniature jet engine and runs on butane.

For further details, check: <www.mit.edu>.

Contact: Massachusetts Institute of Technology, Tel: + 1 (617) 253 2700.

Compaq Takes Pole in Storage Systems Market

Following its acquisition of Digital, Compaq has taken the lead as the world's largest vendor of multi-user storage systems based on the two companies' combined 1997 revenue, which totals more than $4.9 billion, according to IDC. Compaq's storage leadership, which has grown steadily from fifth place in 1995, cuts across all markets, including Windows NT, Unix, and NetWare.

For further details, check: <www.compaq.com>.

Contact: Compaq, Tel: (0990) 134456.

Light Set to Replace Electricity in Computers

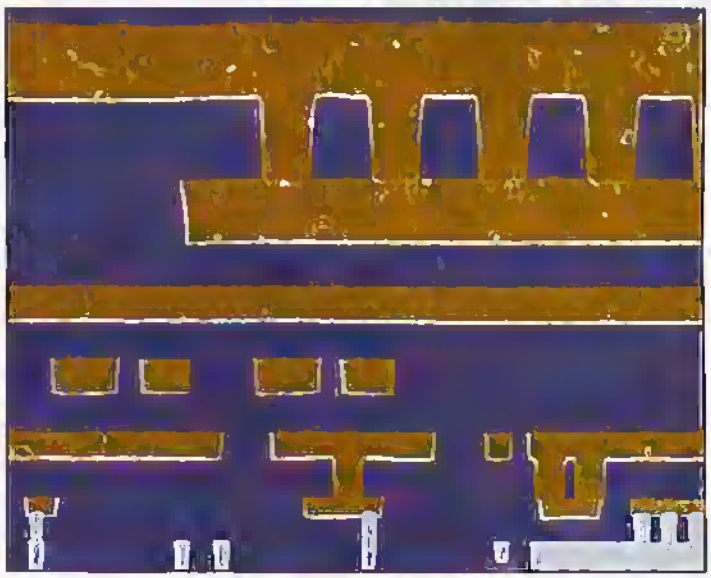
Using chaos theory, a team of scientists from Yale University, Lucent Technologies' Bell Labs, and the Max Planck Institute of Physics in Germany have demonstrated novel semiconductor micro-lasers with more than 1,000 times the power of conventional, disk-shaped micro-lasers. The lasers are only 0.05mm in diameter, or roughly the width of a human hair.

The discovery brings scientists a step closer to developing faster computers that use light instead of electrons in some components to shuttle information. In addition to their possible use in faster computers, the new micro-lasers also could increase the speed of voice, video, Internet and other data transmission via existing fibre-optic networks, or could become the basis for entirely new architectures for local-area optical networks.

For further details, check: <ee.yale.edu>.

Contact: Yale University, Tel: +1 203 432 4300.

Novellus Signs Up To IBM Copper Agreement



Novellus Systems has signed a licensing agreement with IBM pertaining to certain critical technologies needed to manufacture advanced integrated circuits (ICs) with copper interconnect structures. The agreement is an outgrowth of a two-year joint development program between the two companies aimed at creating electroplating equipment needed for volume production of higher speed copper-based devices. Novellus has shipped copper plating systems to IBM to support its ramp of sub-0.25 micron copper manufacturing.

For further details, check: <www.ibm.com>.

Contact: IBM, Tel: (0990) 426426.

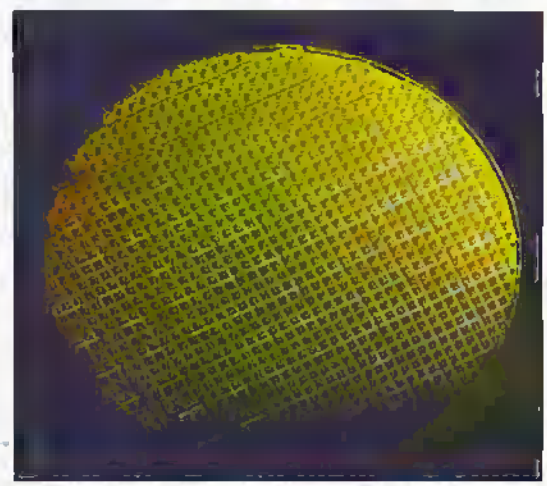
IBM Packaging Puts System-On-A-Chip Within Reach

IBM has announced new semiconductor packaging products that can help electronics manufacturers integrate more components onto a single microchip. The drive to single-chip systems is a growing trend in the electronics industry as manufacturers strive to squeeze more performance and function into ever-smaller devices.

The three new offerings, ultra fine pitch wire bond plastic ball grid arrays (PBGAs), glass ceramic chip carriers, and multi-chip modules on laminate (MCM-L), represent significant advances in packaging materials and design. These packages provide high performance connectivity between the chip and the rest of the system, relieving bottlenecks that can occur as more circuitry is built into each chip.

For further details, check: <www.ibm.com>.

Contact: IBM, Tel: (0990) 426426.



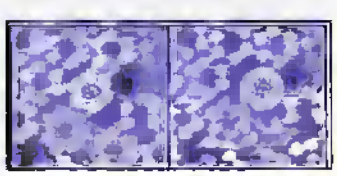
IBM Discovers Molecular Wheels

IBM scientists and a team of international collaborators have reported the discovery of 'molecular wheels': propeller-shaped molecules that rotate rapidly in a bearing-like structure formed by surrounding molecules. The scientists believe this unexpected phenomenon shows great promise for the development of molecular mechanical devices and further demonstrates the validity of using single molecules to perform the various functions required in such devices.

In a paper published in Science, IBM's Zurich Research Laboratory, together with colleagues at the French National Centre for Scientific Research (CNRS) in Toulouse, and the Riso National Laboratory in Roskilde, Denmark, report their design of the propeller-shaped molecules which can switch between two states – rotating and immobilised, and the high-speed molecular rotation which they observed by using a scanning tunnelling microscope (STM).

For further details, check: <www.ibm.com>.

Contact: IBM, Tel: (0990) 426426.



Digital Photos Without PC From FOTOcopy

FOTOcopy is the latest peripheral for use with digital cameras. Developed by Colorgraph, it allows images to be displayed on a TV screen and to be output on a colour printer, dispensing with the need for a computer.

There is no need for image database software, as FOTOcopy has it own image handling capabilities – including a slideshow, index pages and image rotation. FOTOcopy gives instant photo proofing capability.

Two versions are available, the Smart Card and PCMCIA/Flash Card, at £240 each. FOTOcopy works by decoding the digital images, optionally displaying them on a TV screen and printing them on a colour printer.

For further details, check: <www.colorgraph co.uk>.

Contact: Colorgraph, Tel: (01189) 819435.

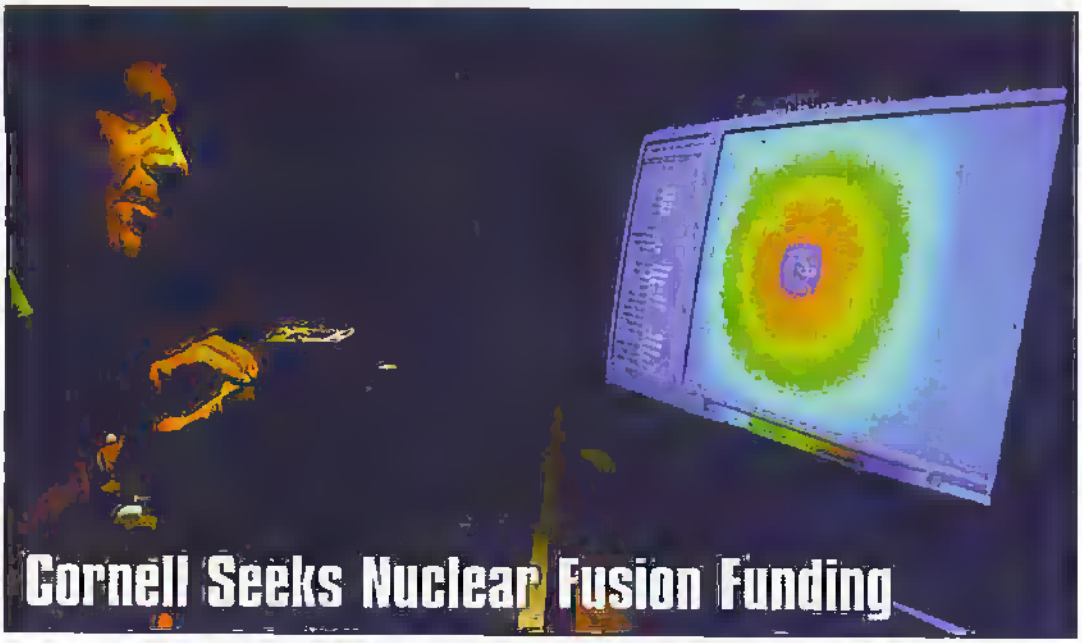
Silicon Graphics Inaugurates Virtual Reality Initiative

Silicon Graphics is set to form the Silicon Graphics Virtual Reality Initiative, to promote the adoption of virtual reality (VR) technology. The Initiative will include an international VR Experts Group, which will address critical technical and theoretical issues; a VR partner-funding program through which Silicon Graphics' virtual reality hardware, software and research partners will be provided with technical and marketing support; educational programs and resources; and Silicon Graphics RealityCenter solutions.

Silicon Graphics claim that barriers to VR adoption include availability of off-the-shelf software, awareness of business benefits at the executive level and lack of standards of interaction. The lack of-interaction standards means that every application currently uses a different method to navigate through the virtual environment. Standardised, robust interface technologies, along with more off-the-shelf applications, are critical to future growth.

For further details, check: <www.sgi.com>.

Contact: Silicon Graphics, (0118) 925 7697.



Cornell Seeks Nuclear Fusion Funding

In the basement of a Cornell University engineering building, a large aluminium cylinder envelops micro-explosions that one day, given sufficient US government, could contribute to developing the world's major hope for efficient electricity generation.

That hope is called nuclear fusion, the energy source of the sun and other stars in which hydrogen nuclei combine, or fuse, to produce huge amounts of energy. Cornell's contribution to this is a research method that, literally, hangs by hair-thin wires.

Researchers at Sandia and Cornell are developing a fusion system that uses X-rays instead of a laser beam and is called simply Z. It is far less costly than a comparable laser facility, says Hammer, perhaps only 20% of the cost. The Z machine, 90 feet in diameter, is designed to generate an extremely high power X-ray pulse which would create temperatures in the millions of degrees in the hydrogen fusion fuel.

The direct generation of X-rays offers the promise of energy efficiency when compared with the huge power demands of a laser device. The laser inertial confinement system has very briefly produced fusion reactions, but this output was infinitesimal compared with the amount of energy required to power the laser.

The Sandia Z machine accumulates energy over a period of two minutes, and then, in a burst of current lasting a tenth of a microsecond, bombards its target, made up of 240 or more wisp-thin wires of tungsten or other metal strung together in a circular array.

The wires explode, creating a hot ionised gas called a plasma. The intense magnetic field created by the current compresses, or 'pinches', the plasma, generating X-rays. In a fusion reactor this powerful X-ray source could be directed at the hydrogen fuel. The Z machine is the world's most powerful producer of X-rays.

For further details, check: <www.cornell.edu>.

Contact: Cornell University, +1 607 255 3651.

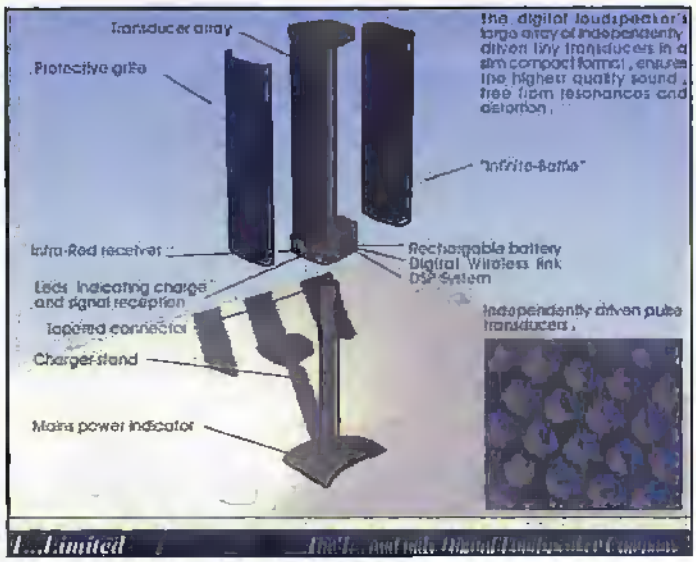
Digital Loudspeaker Due Within Two Years

A Cambridge-based research and development company has announced a drive to attract industrial investors/partners in a bid to take its digital loudspeaker (DLS) technology out of the labs and into commercial production.

The 1... Limited DLS is based on a fundamentally new design approach. Based on a flat panel matrix of novel piezo-electric long-throw transducers, the speakers are driven via digital, rather than conventional analogue signals. In this way 1... Limited can control the direction and audio levels emitted from the DLS more accurately than with any other existing audio technology – delivering significantly advanced sound quality.

1... Limited's DLS can be connected direct to digital audio signals such as CD, digital TV, DAB and DVD without the need for a power amplifier or other audio equipment. And because the speakers are digital, they can be driven using a wireless or infra-red link from the music source, with no loss of sound quality. Improvements in efficiency will enable them to be powered by small re-chargeable batteries, making them truly portable.

Having developed the DLS to an initial prototype stage, 1... Limited is set to build on existing academic partnerships and forge new relationships with companies with proven expertise in areas such as piezo-electrics and electro-magnetics in a bid to commercialise its core technology.



For further details, check: <www.cambnet.co.uk/cnl>.

Contact: 1_ Limited, Tel: (01223) 575398.

Intel Celebrates 30 Years of Innovation

Thirty years ago, Robert Noyce and Gordon Moore started something innovative and unique – Intel Corporation. Today, Intel is the world's largest computer chip maker.

At its founding on July 18, 1968, Intel's primary purpose was to build a cheaper, better alternative to magnetic core memory based on semiconductor technology. Success came in the form of the 1103, the first merchant market dynamic random access memory (DRAM).

The 1103, introduced in 1970, became the world's largest-selling semiconductor device by the end of the following year. Meanwhile, behind the scenes, a Japanese calculator company had approached Intel to design a set of 12 custom logic chips for a high-performance calculator line.

Intel engineers offered a counter-proposal – a single-chip, general-purpose logic device – and the microprocessor was born. In 1971, Intel introduced the world's first microprocessor, the 4004.

For further details, check: <www.intel.com>.

Contact: Intel, Tel: (01793) 403000.

BT to Form Europe's Largest Network

BT and its European partners have announced an initiative to form the largest pan-European communications network, meeting the explosive demand for high-speed data services.

The network, based on leading-edge SDH and dense wave division multiplexing (DWDM) technologies, will consist of 32,000kms of fibre-and have Europe's greatest reach with points-of-presence (POPs) in more than 200 cities.

In the first phase, BT, Albacom, BT Belgium, Cegetel, Sunrise, Telfort and VIAG Interkom will connect their networks in the UK, Italy, Belgium, France, Switzerland, the Netherlands and Germany.

The new pan-European network will enable the partners and Concert to provide and manage resilient, high-bandwidth ATM and Internet Protocol (IP) services across Europe via a single network.

The new links comprise 7,000km of fibre and 14 POPs connecting seven national networks. Through the deployment of Nortel (Northern Telecom) SDH and DWDM technology, the network will be optimised to deliver 160Gbit/s of capacity per fibre pair with the ability to increase transmission to 320Gbit/s in the future.

For further details, check: <www.bt.com>.

Contact: BT, Tel: (01743) 647445.

World's Highest Pixel Count CCD

Toshiba have introduced the world's highest pixel count CCD area sensor – 1,660,000 – primarily aimed at the digital still camera market. The TCD5603D surpasses other similar products with higher levels of resolution and enhanced image quality. The new CCD will enter mass production this August, and samples are now available at approximately £140.

Digital still camera sales have boomed in the last few years and reached annual sales of 2,700,000 units in 1997 with Toshiba's forecasting global sales for this year of 5,000,000. The demand reflects their versatility of digitally-recorded images as they can be easily and quickly viewed on LCDs integrated into cameras, or on TVs or computer screens. Once in a computer, images can be printed, e-mailed, used in desktop publishing or posted on the internet, and manipulated for special effects with a vast array of software.

While early models offered only VGA-level resolution, recent 'mega-pixel' cameras complement high-quality colour ink-jet printers and large, high-resolution monitors, and offer pictures fast approaching the quality levels of conventional film cameras.

TCD5603D is a 1/2-inch CCD area image sensor. Each individual pixel has an RGB primary filter, organised in a cross-striped array so that pixels with a green filter are always diagonally adjacent to one another. Four-field interlace scanning combines data from four pixels in forming individual fields, at a maximum of 8.8 frames a second. The image aspect ratio is 3:2, but the huge pixel count supports viewing on 16:9 wide-screen TVs, and 3:1 panoramic views.

For further information:
Toshiba Corporation
Corporate Communications Office
Telephone: +81-3-3457-2105
Fax: +81-3-3456-4776
e-mail: press@toshiba.co.jp
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Electronics Principles 5.0

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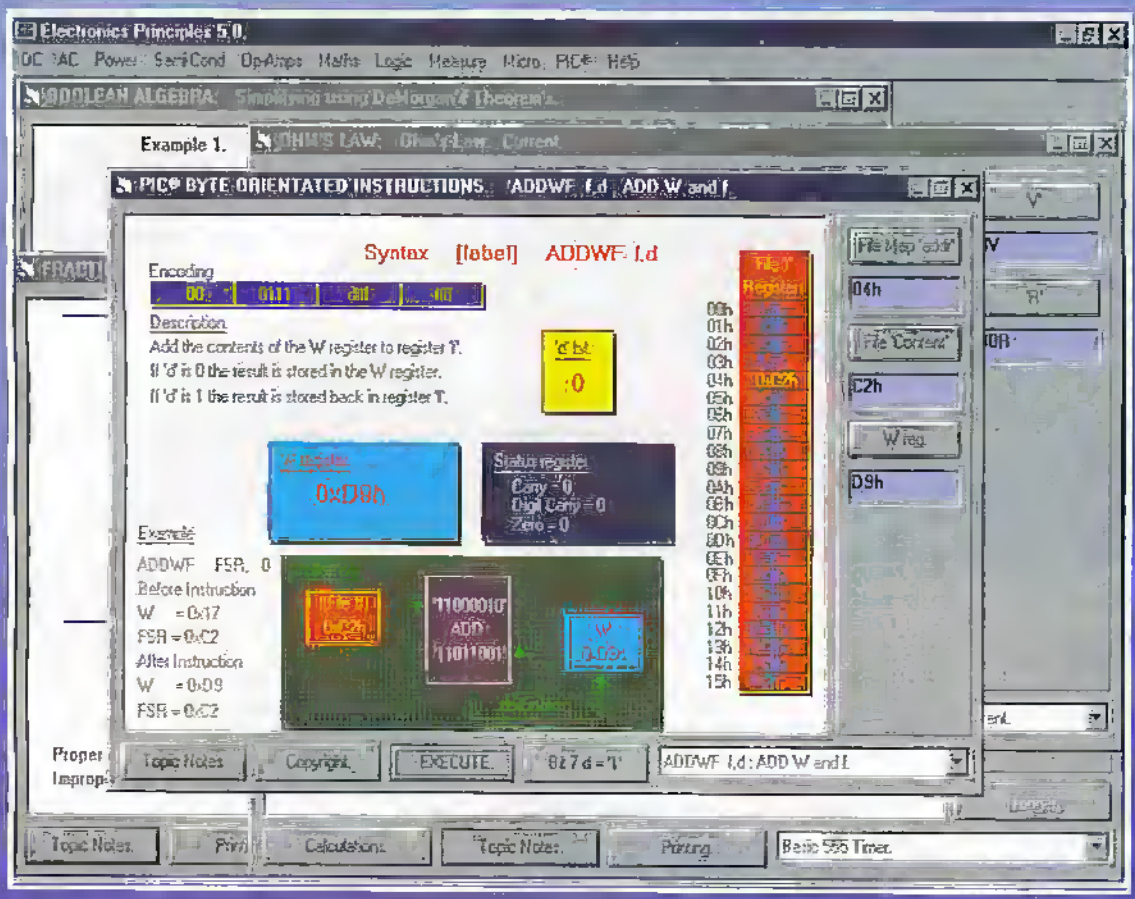

EP5.0 is a significant upgrade of our popular electronics software with even more analogue, digital and microprocessor electronics PLUS over a hundred new engineering maths topics to further your understanding of formulae and calculations. Approved by Microchip, the PIC16F84 microcontroller hardware and instruction set has been introduced and brought to life through colourful interactive graphics where you can study the architecture of this device by changing the data values to simulate all of the registers and the complete instruction set, including direct/indirect addressing, program/data memory and input/output port configuration. In addition the analogue to digital functions of the PIC16C71 device. If you would like to learn more about the principles of these popular microcontrollers then it could not be made easier.

Electronics Principles software is currently used in hundreds of UK and overseas schools and colleges to support City & Guilds, GCSE, A-Level, BTEC and university foundation courses

Telephone for a list of the 560 topics included.

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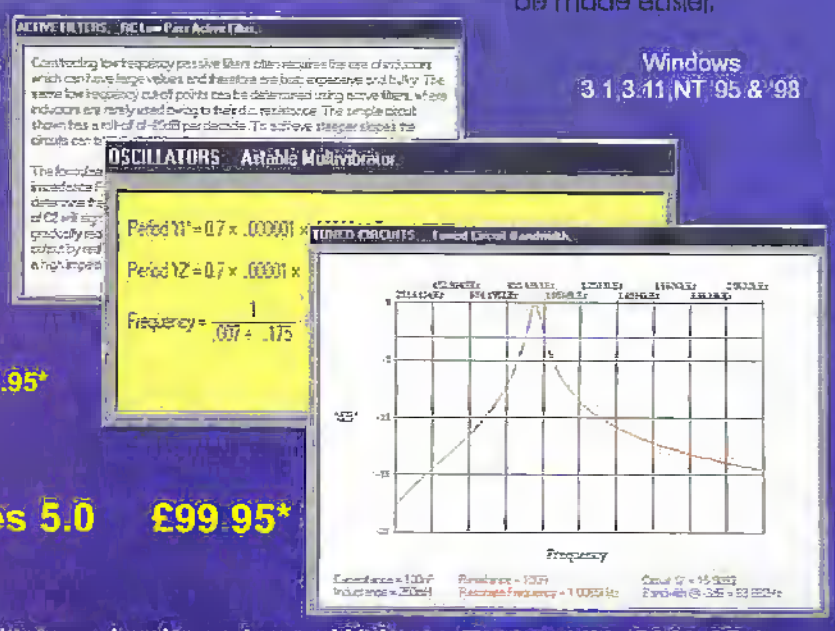

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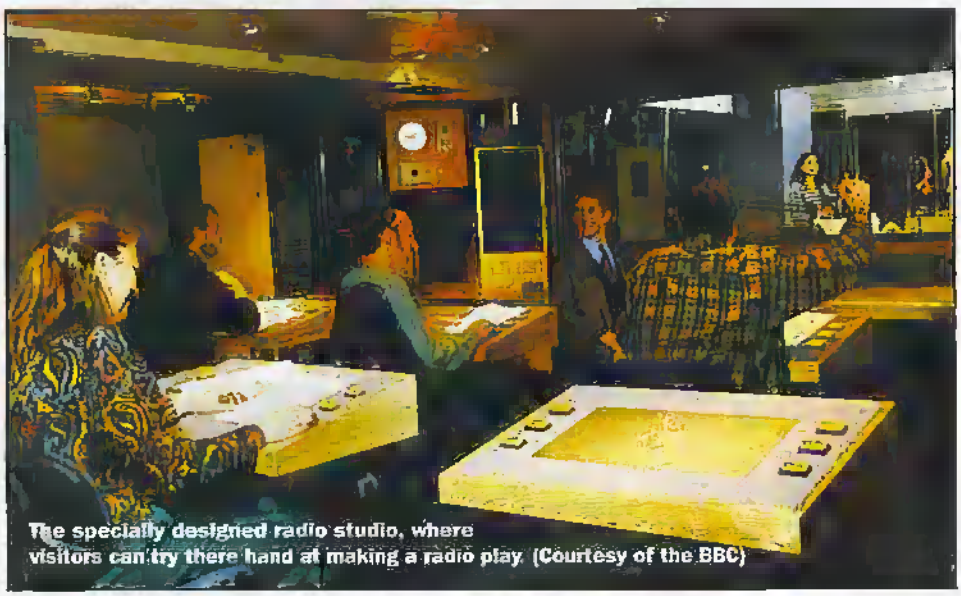
Sound! Lights! Music! -IT'S A BBC EXPERIENCE!

Alan Simpson has a look round the visitor centre at Broadcasting House.



The specially designed radio studio, where visitors can try there hand at making a radio play. (Courtesy of the BBC)

One of London's best kept secrets – at least until now – is the BBC Experience Visitor Centre tucked beneath Broadcasting House in Portland Place, London. The interactive experience can be viewed as an extended commercial for the BBC or a visionary look behind the Broadcasting scenes. For the BBC, it's a celebration of the Corporation's 75 year history – and what a history it is. Anyone with a modicum of interest in broadcasting, radio and television or electronic (and I guess that covers most if not all readers) will find much to fascinate. Reminders of the Broadcasting greats displayed in the foyer greet visitors, although as could be expected, TV personalities, outstrip those of radio stars. Mingling together are TV hot shots Terry Wogan, Sue Lawley, Jimmy Young (together of course with his Royal Highness The Prince of Wales) plus radio beacons, The Goon Show, Hancock's Half Hour, Richard Murdoch and Kenneth Horne.

As part of the BBC's 75th anniversary celebrations, BBC Experience was formally opened by Her Majesty the Queen, who also inaugurated a new lighting scheme, which sees the building in the spotlight for the first time in nearly 60 years. BBC Experience offers a look at the Corporation past, present and future and expects to attract 200,000 visitors a year. The centre combines audio visual shows and interactive displays with broadcasting classics and important memorabilia. On view for the first time is the Marconi Collection, including some of the earliest radio equipment and other artefacts on loan from GEC-Marconi.

Visitors can try a range of broadcasting skills for themselves including sports commentaries, directing 'EastEnders', presenting a weather forecast and sound mixing. There is even an opportunity to take part in the production of a radio play, or be one of Sue Lawley's castaways on 'Desert Island Discs'. "We have opened the doors to the broadcasting organisation that is the envy of the world" says General Manager Mike McDonald. We aim to provide visitors with a unique, value-for-money and highly entertaining attraction in the best traditions of the BBC. There really is something for everyone.

A vivid reminder of the BBC's central role in the nation's cultural and social history, BBC Experience also looks to the future and the advent of the multi-channel, digital and interactive age with a range of exciting exhibits. There are opportunities for the next generation with specially designed materials for school groups, linked to the National Curriculum. Exhibition Director Michael Barton says: "BBC Experience showcases the history and heritage of the BBC, the range of programmes past and present, its associated products and activities and its future role in the digital age". BBC Director of Corporate Affairs, Colin Browne adds: "It is only right that an organisation held in high regard and affection, should open its doors to the public, who as licence payers', fund it. BBC Experience will allow visitors from both home and abroad to get a special insight into the most famous name in British broadcasting and enjoy a high quality, entertaining attraction".

BBC Experience – The Background

Broadcasting House was the world's first building which was purpose-made for broadcasting. It is home to BBC Radio 1, 2, 3, 4 and 5 Live and is the heart of the BBC. Broadcasting House is a landmark building in the centre of London's West End, close to Oxford Circus and is Grade II listed. It represents the history and heritage of the British Broadcasting Corporation. Broadcasting House officially became the BBC's headquarters on May 1, 1932, although the first broadcast took place on March 12, 1932 – Henry Hall and the BBC's Dance Orchestra. The new prestigious building replaced studios at Savoy Hill, off the Strand, which had been the BBC's home since May 1, 1923. Early broadcasts were made from November 14, 1922 from Marconi House in the Strand. The BBC inaugurated its experimental television service from Broadcasting House on August 22, 1932, using a studio in the new premises and using apparatus developed by John Logie Baird.

The unusual shape of the site and the need for the most up-to-date studios determined the design of the building, which embodies the fashionable art deco style of the time. Designed by the architect G. Val Myer there were many unusual features inside and outside the building, notably sculptures of Prospero and Ariel by the distinguished artist Eric Gill. It was one of the first buildings in London to be of steel frame construction. Broadcasting House was bombed during World War II and the building was badly damaged. Parts of the building have been re-designed and re-equipped over the years, but some areas, such as the Foyer, the Council Chamber and The Radio Theatre (formerly The Concert Hall) have retained many of their original features. In 1992 Broadcasting House was opened to the public for BH 92, an audio-visual show and exhibition marking 70 years of radio. The public response was so positive – 52,000 visitors in eight weeks – that it inspired a permanent visitor centre. Building preparation begin in October 1996 and the exhibition was built from July 1997.

BBC Experience spans three floors and takes up an area of approximately 20,000sq.ft. The area BBC Experience occupies had housed a range of production facilities and offices over the years and, more recently, storage, catering and conference facilities. All of these have been found alternative accommodation. The project has cost £5.5 million to develop. The admission charge for the exhibition is designed to recover costs and it is expected that BBC Experience will pay for itself by its seventh year of trading.

BBC Experience – Guide To The Exhibition

Visitors assemble in the foyer of the Marconi Collection before starting the tour. A highlight of the exhibits in this area is a major display on the work of Guglielmo Marconi, the pioneer of wireless (radio) development. His company was one of the principal founders of the British Broadcasting Company formed on October 18, 1922, which became the British Broadcasting Corporation on the granting of a Royal Charter on January 1, 1927. This is the first time the Marconi collection has been on public view and has been lent to the BBC by GEC-Marconi. Among the rare artefacts are Marconi's earliest radio equipment, diaries, telegrams from The Titanic, a selection of historic photographs and the microphone used by Dame Nellie Melba for a song recital in June 1920 – Britain's first advertised public broadcast programme. A guide will welcome groups to BBC Experience as doors automatically open to the first of the exhibition areas.

World of Sound – Prospero's Observatory. (Courtesy of the BBC)

A Day In The Life Of Broadcasting House

The first half of this spectacular audio-visual show features a fully-automated seven-screen presentation. Another day dawns as a large model of Broadcasting House comes alive with light and sound. The network radio presenters greet their early morning audiences and large screens begin to show the rich variety of a day in the life of the BBC and the range of output including music, news, drama, comedy, sport ... The guide takes over and describes what is happening in Broadcasting House right now. Visitors experience how news is gathered and prepared and see the process via cameras in Radio 5 Live's newsroom and studios. Highlights here include watching a live reading of road traffic reports plus the inevitable video of Steve Wright the famed DJ.

The Interactive Radio Studio

D-I-Y Action – visitors have their first opportunity to try their hand at broadcasting activities. Budding actors and technicians can make a three minute radio play in a specially designed studio and hear the results of their creativity played back. A choice of action-packed scripts, together with music and sound effects, will be available and fans of 'The Archers', for example, can take part in a scene using the voices of characters Joe Grundy and Lynda Snell.

This is where the 'fun' starts. The Drama Studio is fully equipped with banks of desks, housing pre-recorded sound effects. Groups are cast into sound technican and actors. The spooky scripts provides well sign-posted opportunities for the sound technician teams equipped with two coconuts for galloping horses, wind machines, gravels and door bells. However synchronisation tends to go somewhat beserk as the director speeds up the production. It is debatable whether the acting at the time of the visit would win any Oscars but at least performing fees would be minimal. Highly impressive however, was the instant playback of the performance.

Heritage And History – World Of Sound

The next section is a dramatic 'surround sound', multi-media presentation of the BBC's history, drawing on the rich resources of its vast sound archives. Prospero, the magician from Shakespear's 'The Tempest' – voiced by the distinguished classical actor Paul Scofield – together with his spirit Ariel, summon up the past in a spell-binding sound, light and image show, beginning with the voice of Marconi himself and the birth of radio. Outstanding moments from early programmes from Savoy Hill and Broadcasting House, including the arrest of Dr. Crippen, the first live sports commentary, 'Children's House', the General Strike of 1926, royal broadcasts and actuality recordings from World War II, all bring vivid reminders of the BBC's role in the nation's history and culture. Visitors are then invited by Prospero to move from his library into his observatory for a second multi-media spectacular evoking major events and programming from the Coronation of Queen Elizabeth II to the present day, with images and recordings recalling, for example, the launch of the new radio networks after World War II, 'The Goon Show', 'The Archers', 'The Promenade Concerts', the Beatles and world events such as the assassination of President Kennedy and 'The Eagle Has Landed' moon landing – great info-entertainments.

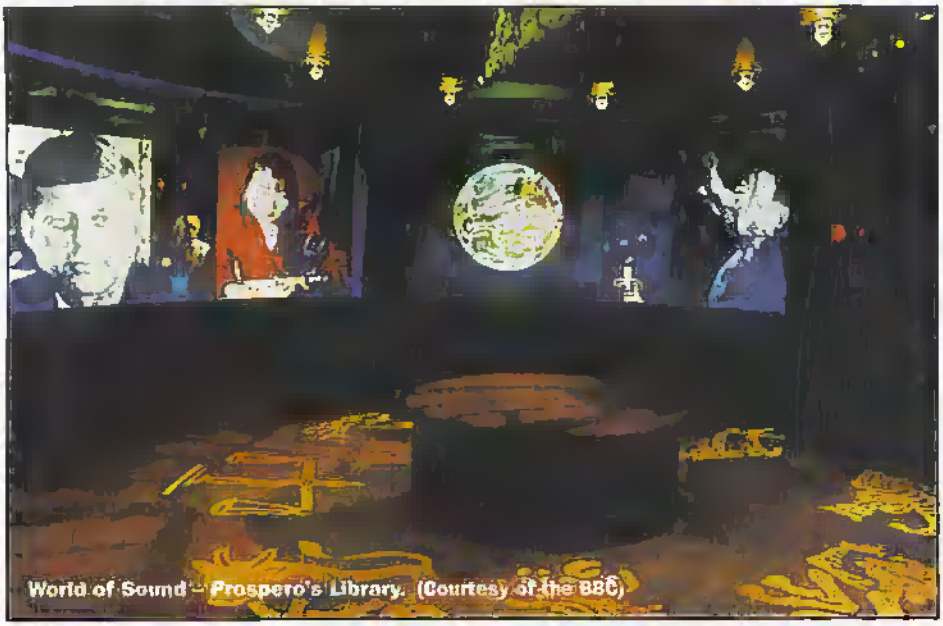
The Radio Experience

One of the highlights in this section – is a semi-animatronic figure of Tony Hancock in the 'Hancock's Radio', based on the famous 'Radio Ham' sketch from 1961. In the 1998 version Hancock roams the dial – this time picking up a range of classic comedies from 'The Goons' and 'Round the Horne' to 'I'm Sorry I'll Read That Again' and 'The News Huddlines'. The clips have been cleverly edited, linking them with recordings of Hancock himself.

Since the first broadcast in 1942, Desert Island Disks has clicked up over 2,500 castaways. An interactive display allows visitors to select a piece of music, get the required sound balance and play the tune on an ancient record player – thoughtfully washed up on the Island. Other interactive delights from the section include an un-issued rendition of 'Two Litde Boys' sung by Rolf Harris in Japanese, the oldest surviving record in the world from 1888 and the only known recording of AA Milne reading an extract from his all time classic 'Winnie the Pooh'. To bring the show into todays world, there are PC based quizzes, CD-ROMs, CD, The Radio 1 internet web site plus graphic displays showing the diversity of the BBC's national, regional and radio services.

The Television Experience

Visitors next enter the world of television in a studio environment with many hands-on features. Children will recognise the new studio set from Children's BBC Presentation, where they can operate the puppets Badger and Mousey in front of a television camera. They can also operate CD-ROMs or see extracts from some of their favourite programmes including 'The Animals of Farthingwood', 'Live and Kicking', 'Noddy' and 'Blue Peter'. An imaginative invention –



World of Sound – Prospero's Library. (Courtesy of the BBC)

the walking suitcase – is on display. Fans of 'EastEnders' can try their hand at directing recently recorded scenes. An Outside Broadcasts display reveals the technical magic of the latest in miniature cameras, including an impressive demonstration where a camera is placed inside a moving locomotive on a miniature railway, and a helicopter simulator which allows visitors to operate a TV camera by remote control. Would-be weather presenters and sports commentators can experience the real thing by recording their own attempts – and seeing the results played back.

The last space on this floor is devoted to broadcasting in the next 10 to 15 years. There is an enticing glimpse into the technological wonders of the forthcoming multi-channel, interactive, digital age of television and the BBC's role at the leading edge of research. The BBC-1 programme 'Tomorrow's World' demonstrates how the BBC is harnessing new technology to deliver its services into the home in new and improved ways, in an 18-screen presentation together with the latest in new technology, a slimeline plasma widescreen.

As can perhaps be expected the 'Full Monty' of the BBC's role as a patron of the arts over the last 70 years is celebrated in an imaginative show, set within a theatre, in which visitors are invited to watch 'The Living Arts'. Here specially commissioned music and drama illustrate the BBC's commitment, not only to new music and writing, but to all the other arts, from new groups on Radio 1 to operate relays from around the world; from 'The Proms' to Radio 1's sponsorship of festivals and to the unlikely areas, on radio, of both dance and film.

Plans are well advanced to take live feeds from the TV news services, which have now been relocated to West London. Then it will be possible to watch 'Breaking News' as it happens. There is no doubt that the BBC Experience has pleased visitors. A BBC exit poll recording 82% of happy visitors, with 87% saying that the length of the tour (about 1 ½ hours) was about right. Although The Experience may be aimed at the fully paid-up members of Women Institute Groups rather than those who have just had breakfast at Threshers, and more country casuals than anorak wearers, for those looking to 'chill-out' the event has much to offer.

A Total Learning Experience

Teachers looking for a change from a visit to the Science Museum or Royal Academy need look no longer as The Experience offers groups from the education world fascinating, interactive and memorable visit. Even if developments on the digital broadcasting field are in low key, National Curriculum studies are incorporated and there are special education rooms available. No event is staged without a shop and their is no exception. The BBC Shop sells the full range of BBC publications, audio tapes and audio-visual production plus visitors souvenirs. For relaxing and refreshments there is the BBC Cafe. The Experience does not stop here however, as you can watch flat-screen TV's showing BBC programmes as you eat, but sitting at tables rather than typically sofas at home.

Certainly when it comes to recording establishment events, such as Royal Marriages, State Openings, Tennis Championships, Auntie Beeb has few equals. If you are seeking Lara Croft or Melinda Messenger images, this is not the place. Here Sue Lawley and Anna Ford reign supreme but for this visitor," been there, done it, loved it".

Opening times:

Monday	1.00 pm – 4.30 pm
Tuesday – Friday	9.30 am – 4.30 pm
Saturday/Sunday	9.30 am – 5.30 pm
Admission charges: adult –	£6.50
child –	£4.50
concession –	£5.50

Pre-bookings tel: 0870 60 30 304
Address: Broadcasting House, Portland Place, London W1.

Competition

We have no less than six double tickets to be won by Electronics and Beyond readers. The first all correct entries drawn on the 5th October will receive a double ticket.

1. Spot the odd one out:
a. News Night ☐
b. Coronation Street ☐
c. EastEnders ☐
d. Tomorrow's World ☐

2. Where is Broadcasting House
a. Central London ☐
b. The BT Tower ☐
c. Cape Carnival ☐
d. Canary Wharf ☐

3. What does BBC stand for
a. Born Before Computers ☐
b. Brixton Borough Council ☐
c. Brain, Beauty and Charm ☐
d. British Broadcasting Corporation ☐

4. The BBC is noted for:
a. Topless darts ☐
b. Operating a mobile phone service ☐
c. Manufacturing bath soap ☐
d. Top Of The Pops ☐

Send your entries to:
The Editor, Electronics & Beyond,
PO Box 777, Rayleigh, Essex, SS6 8LU.

Name _____

Address _____

_____

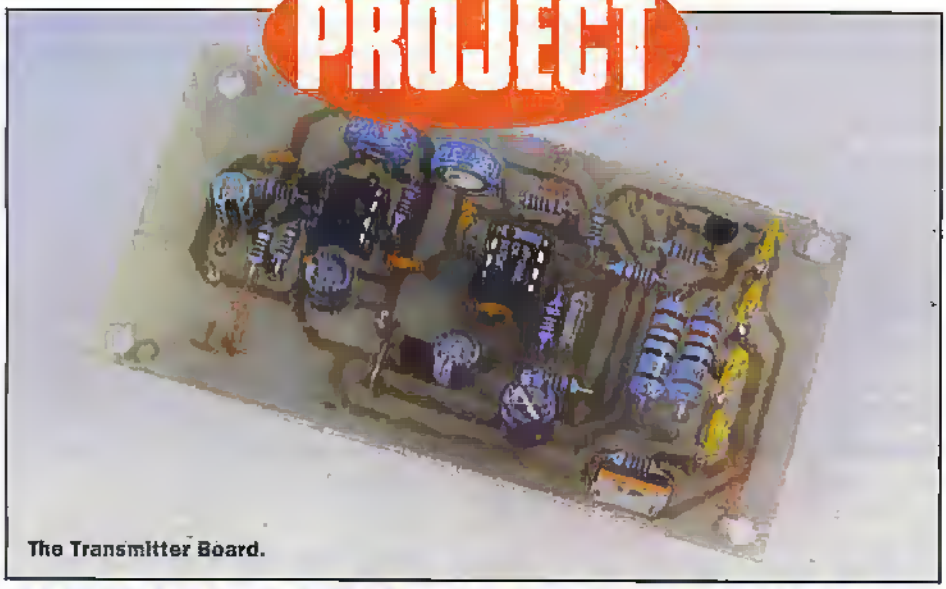
_____

Post Code _____

All employees of Maplin Electronics are excluded form entering, multiple entries will be disqualified. You may photocopy this coupon.

A semi-animatronic figure of the legendary comic actor Tony Hancock. (Courtesy of the BBC)

PROJECT



The Transmitter Board.

INFRARED LINK

Gavin Cheeseman looks at the design and construction of a low-cost infrared link.

General Overview

The circuits described in this article are intended to provide a basic open ended building block which can be used to transmit analogue or digital information over a short range infrared link. The system allows the transmission of audio frequency signals or low speed data which can be used for remote control or monitoring purposes.

A Phase Locked Loop (PLL) system is used for versatility as this provides a valid logic output when an input of the appropriate frequency is detected, and also provides a simple method of demodulating an FM (Frequency Modulated) signal. In addition, because the PLL is tuned to detect a specific frequency, the system provides some degree of immunity to unwanted out of band signals such as those produced by domestic mains lighting.

FEATURES

- Uses Phase Locked Loop system
- Provides Infrared link for Audio or Low Speed Data
- Switched output when valid transmission received
- 9V – 12V Operation

APPLICATIONS

- Wireless Audio Link
- Remote Control
- Short Range Telemetry

Introduction

Situations regularly arise where it is necessary to transmit information over a short range but quite often it is impractical to use a directly wired connection. This may be due to problems with accessibility or because one end of the link cannot be in a fixed position. In this situation a wireless link is called for. There are several ways to achieve this including radio frequency transmission, ultrasonics and infrared; in this article we look at some applications using the latter. Infrared systems are relatively cheap and simple to implement and if set up correctly are capable of providing a good level of performance over a short range. Also, infrared transmissions are generally line of sight and are heavily attenuated by walls and other solid objects. Therefore, it is generally fairly easy to maintain system security where this is required. In addition, the bandwidth available from infrared systems is wider than that often provided by simple RF links.

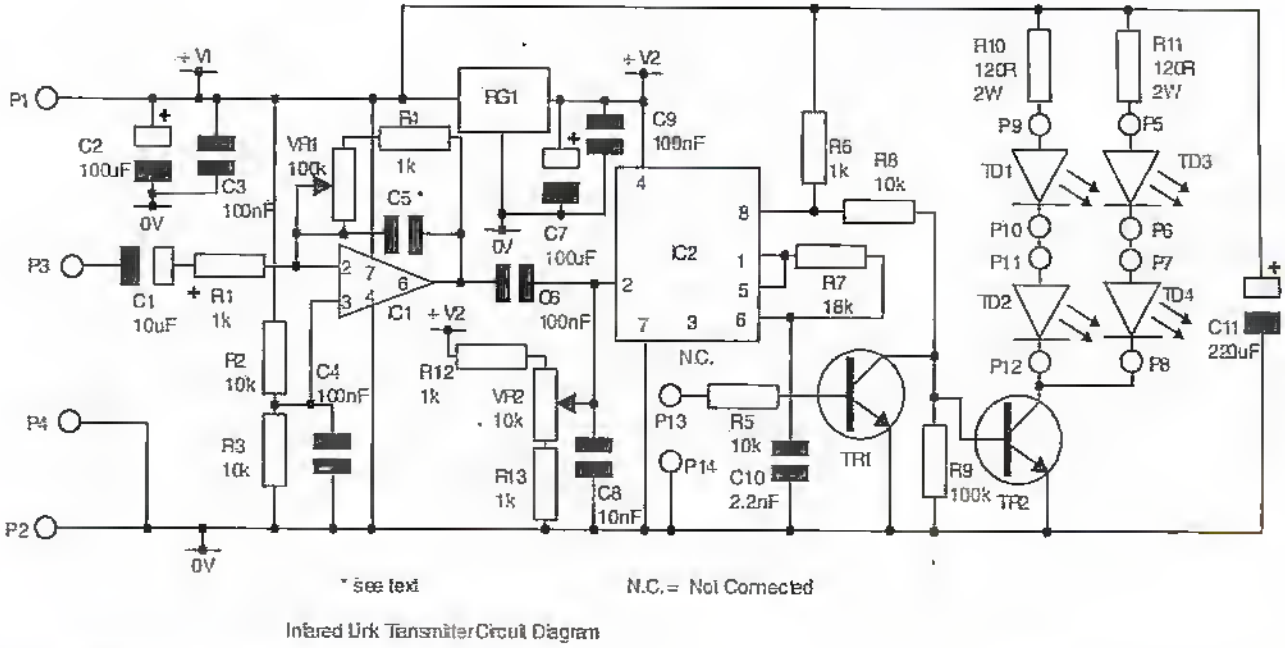


Figure 1. Transmitter Circuit Diagram.

Transmitter Circuit Description

Both the transmitter and receiver circuits have been designed to provide versatility allowing for a range of different applications. Figure 1 shows the circuit diagram of the transmitter.

The power supply connections are on P1 (+V) and P2 (0V). To ensure that the power supply rails remain free from unwanted noise and help to maintain stable operation, several capacitors are used for de-coupling purposes. Capacitor C2 acts as bulk de-coupling, whereas C3, C7, C9, and C11 are positioned close to specific parts of the circuit to providing local filtering.

Audio frequency signals may be applied between P3 (AF input) and P4 (0V) and these are buffered and amplified by operational amplifier IC1. R2 and R3 together with C4 provide a reference voltage for the op-amp. The input signal is coupled via capacitor C1 which blocks DC. The gain of this stage is determined by resistors R1 and R4 together with pre-set resistor VR1. Capacitor C5 provides a high frequency roll-off, reducing unwanted high frequencies. It is not necessary to fit this component for all applications. The inclusion of VR1 in the circuit allows the gain of the stage to be easily adjusted so that a variety of input levels can be accommodated. The output of IC1 is on pin 6 and this is fed to IC2 via coupling capacitor C6.

IC2 is the popular LM567 phase locked loop device but in this application it is used as a simple voltage controlled oscillator producing a carrier in the kHz range. Preset resistor VR2 allows the input bias of the oscillator to be adjusted. Audio frequencies from the output of IC1 effectively modulate the carrier frequency produced on pin 8 of IC2. The nominal carrier frequency is determined by R7 and C10. R6 acts as a pull up resistor for the output at IC2 pin 8. To prevent large variations in carrier frequency due to changes in the supply voltage, IC2 is powered from a 5V regulator (RG1).

To allow the switching of higher current loads than would be possible directly, the output of IC2 is used to switch transistor TR2 and this, in turn, drives infrared diodes TD1 – TD4. Resistor R8 limits the current to the base of TR2 and R9 ensures that the transistor switches off fully. The current through the infrared diodes is limited by R10 and R11.

Transistor TR1 inhibits the input to the base of TR2 if P13 is connected to +V. This provides a simple method of gating the circuits infrared output and is useful in control and data transmission applications.

Receiver Circuit Description

The circuit diagram of the infrared receiver is shown in Figure 2. As with the transmitter, the power supply is connected between P1 (+V) and P2 (0V). Capacitor C1 provides de-coupling close to the supply input. In addition, there is also local de-coupling at critical points in the circuit. Low frequency smoothing is provided by C10 and C16, while higher frequency noise is filtered by C3, C7, C11 and C17. Supply filtering is particularly important in a circuit of this type, because of the high gain amplification stages employed.

RD1 is biased by R1. The voltage at P3 varies with the level of incident infrared energy. This variation is typically in the region of a few mV and requires considerable amplification to produce a usable signal level. The required gain is provided by operational amplifiers IC1 and IC2. Capacitor C2 couples the signal from RD1 to the input of IC1. Resistors R2 and R3 bias the input of the op-amp at approximately half the supply. The maximum gain of IC1 is determined by R4 and R5. C4 provides a low frequency roll-off characteristic whereas C5 reduces the gain of the stage at high frequencies. The amplified signal appearing at IC1 pin 6 is fed to the input of IC2 which provides further amplification. The component arrangement at IC2 is similar to that of IC1 but with the addition of signal diodes D1 and D2. These limit the gain of the amplifier at high signal levels and help to prevent the input of IC3 from being overloaded. The output of IC2 is coupled to IC3 by C9.

IC3 and associated components form the basis of a phase locked loop. As with the transmitter, this has its own regulated 5V supply provided by RG1, to help to maintain oscillator stability. This performs different functions depending on the application of the circuit. When the frequency of the input signal at IC3 pin 3 approximates that of the PLL's internal oscillator, the oscillator locks to the frequency of the incoming signal. In the locked condition, IC3 pin 8 switches from a logic high condition to a logic low condition and remains in this state as long as the input frequency is within the lock range of the device. This can be extremely useful for control applications (more of this later). As long as the input frequency remains within the lock range of the PLL, the frequency of the internal oscillator tracks that of the incoming signal. A rather useful consequence of this is that the filtered voltage at IC3 pin 2 is proportional to the incoming frequency. Therefore if the received signal is frequency modulated an approximation of the modulating waveform is produced at pin IC3 pin 2.

In our circuit, the output at pin 2 is AC coupled to operational amplifier IC4 via C15. Resistors R11 and R12 together with de-coupling capacitor C18 provide a half supply reference for IC4. The maximum gain of the stage is determined by R10, R13 and VR2. The signal at IC3 pin 2 normally contains unwanted high frequencies. C19 rolls off the high frequency response of the amplifier reducing this effect. The amplified audio frequency signal is output at IC4 pin 6. R16 limits the output level. This resistor has been included to limit the output level and allow correct operation if headphones are directly connected to P10 for monitoring purposes. An further attenuated AF output is available at P8.

The frequency of the phase locked loop's internal oscillator is determined by R9, VR1 and C14. VR1 has been included to allow

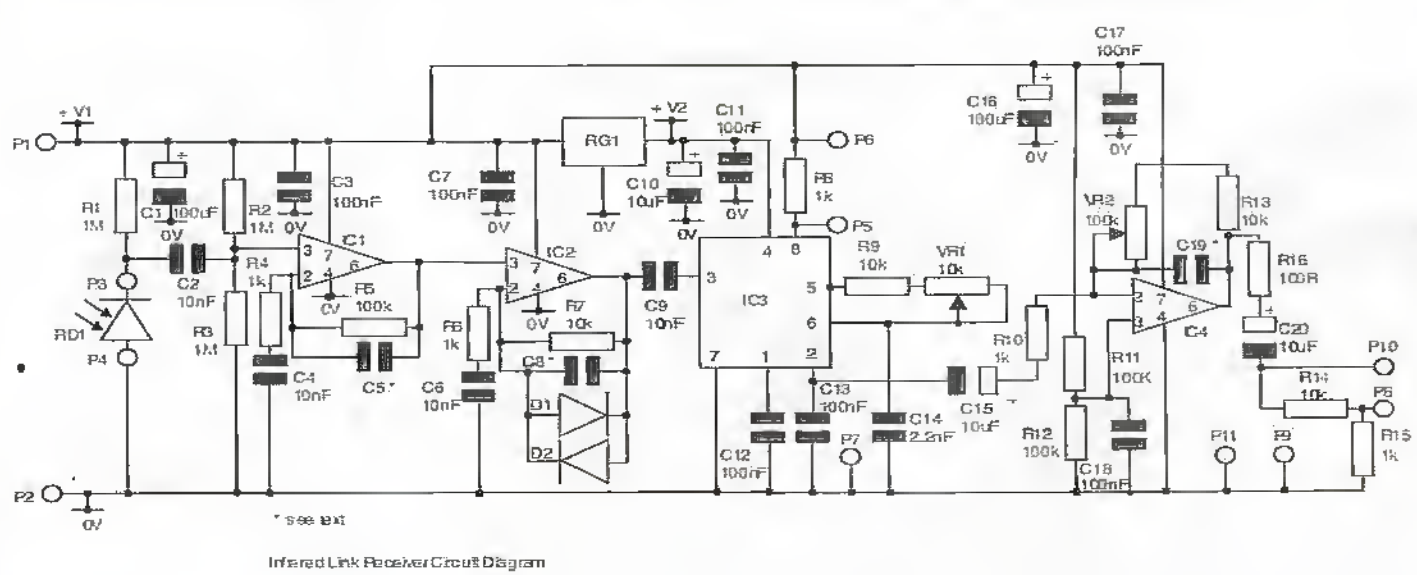


Figure 2. Receiver Circuit Diagram.

IC3 to be adjusted such that it will lock to the incoming signal.

Throughout the receiver circuit, the values of coupling and DC blocking capacitors have been chosen to attenuate low frequency signals. This has a beneficial effect in that it reduces to response of the receiver to the effect of ambient artificial lighting.

Building the Circuits

The circuits may be built on standard single sided copper clad board. Fibreglass board is recommended. PCB layouts and component overlays are shown in Figure 3 and Figure 4. Insert and solder the components onto the PCB referring to the relevant component overlay. Start by fitting the low profile components such as resistors and diodes. It is recommended that DIL sockets are used for the ICs to prevent damage during soldering and to allow for easy replacement in the event of failure. Take care to ensure that polarised components are fitted observing the correct polarity. This is important as incorrectly connected components can become irreparably damaged and may even explode. The ICs should be fitted such that the notch at one end of the device corresponds with the notch on the PCB overlay. Don't forget to straighten the IC pins before insertion into the socket. Similarly, the diodes are fitted such that the position of the band at one end of the diode (marking the cathode) corresponds with that on the PCB overlay. Regulator RG1 should be fitted to correspond with its outline. The polarity of electrolytic capacitors is normally indicated by a minus (-) symbol on one side of the device. These should be fitted such that the lead closest to the minus symbol on the component is positioned furthest from the '+' symbol on the PCB.

Capacitor C5 on the transmitter unit and C5 on the receiver do not need to be fitted for most applications. A position for these components has been provided on the PCB to allow suitable value capacitors to be inserted, where it is necessary to reduce the gain of the circuit at high frequencies. Similarly the value of C19 on the receiver will depend on the audio frequency range being transmitted. In this type of circuit, there is always a compromise between bandwidth and the level of unwanted noise on the signal. A typical value for C19 is 1nF (ceramic).

The PCB pins are inserted using a soldering iron. Insert the pin into the appropriate hole in the PCB from the track side. Heat the head of the pin with the soldering iron and gently press the pin into position. Do not apply excessive pressure with the iron, as this can be hazardous. If the pin is hot enough, very little pressure should be required to complete this operation. If necessary the pins can be straightened after insertion.

Both the infrared emitter diodes and the photo transistor are mounted on pins as shown in Figure 5. This allows the height to be easily adjusted and minimises the stress on the associated PCB tracks. It should also be possible to mount the devices on a short length of screened lead but long lengths may affect the correct operation of the circuit.

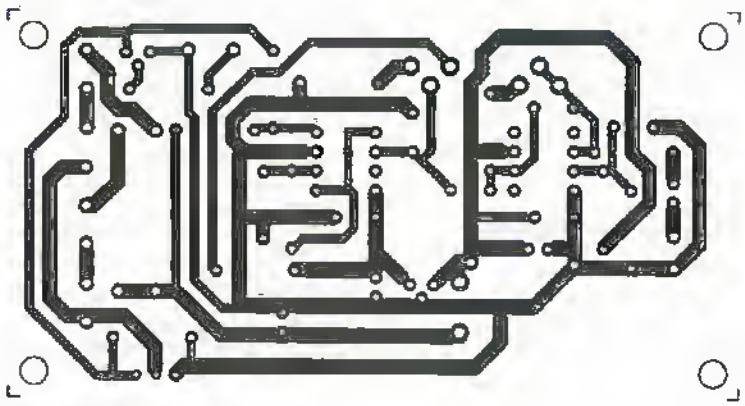


Figure 3a. Transmitter PCB Layout.

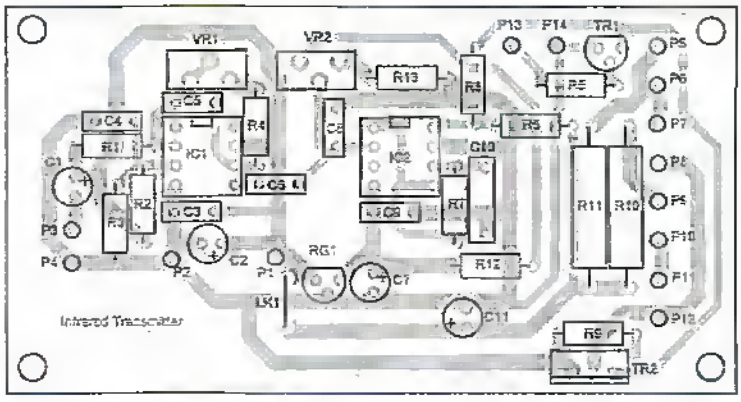


Figure 3b. Transmitter Component Overlay.

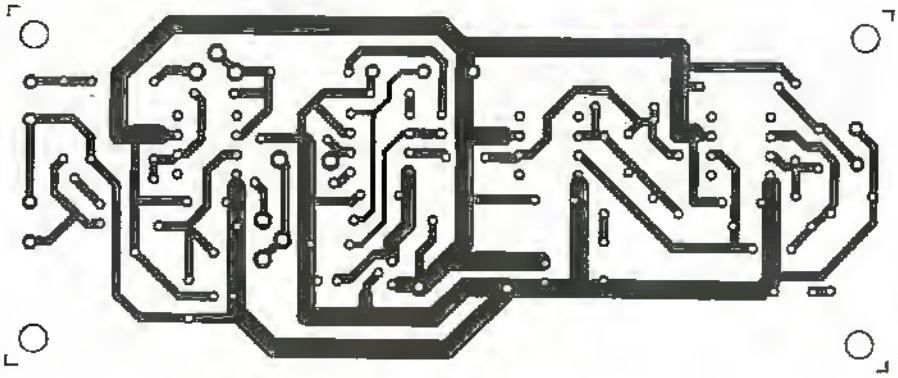


Figure 4a. Receiver PCB Layout.

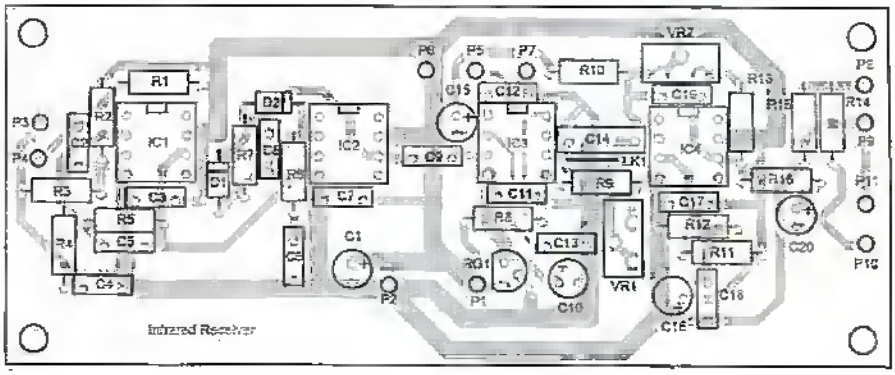


Figure 4b. Receiver Component Overlay.

When you have finished constructing the circuits, take some time to check your work before applying power, to make sure that there are no errors. In particular double check the component values and polarities. Look over your soldering to make sure that there are no unwanted dry joints or solder short circuits.

Testing the Completed PCB's

It is probably simplest to test the transmitter and receiver circuits together. The wiring diagrams are shown in Figures 6 to 8. Connect the transmitter unit to a suitable 12V power supply. Terminal P1 is connected to +V and P2 is connected to 0V. For both the receiver and transmitter, it is recommended that the power supply is suitably fused as shown in the wiring diagrams as this provides some protection in the event of a fault.

When first applying power to the circuit, it is a good idea to measure the current consumption. If possible connect a multimeter set to read current in series with the +V supply to the circuit. Switch on the power to the circuit and check that the supply current does not exceed 300mA. If the current reading is excessive. Switch off and double check your work. If an oscilloscope or frequency counter is available, check the output on IC2 pin 8. This should be a square wave with a frequency in approximately the 20kHz to 40kHz range. If you do not have suitable test equipment it will be necessary to test the operation of the transmitter using the receiver.

If all appears to be well, apply power to the receiver circuit. This time the current consumption should be well below 100mA. In order to test the various functions you will need some method of monitoring the various outputs. The switched output at P5 can be checked using the LED arrangement shown in Figure 8 or using a multimeter. To check the AF output on P8 and P10 you will need some method of monitoring audio frequencies. An oscilloscope with a high impedance input is ideal but if you don't have one you can get away with a pair of high impedance headphones or a crystal earpiece. You will also need an audio signal to feed into the transmitter. This can be from a signal generator, a microphone or a similar source of audio not exceeding line level.

Initially it will be necessary to align the operating frequency of the receiver phase locked loop to correspond with that of the transmitter. Set up the transmitter and receiver such that the transmitter diodes are pointing at the receiver phototransistor. Initially, space the units at a distance of about 50cm. If the spacing is too close there may be a tendency to overload the receiver input so avoid very close coupling. Adjust VR1 on the receiver until the output at P5 switches to a low condition illuminating the LED if connected. If all is well, momentarily connect P13 on the transmitter PCB to terminal P1 on the same unit. This should inhibit the output of the transmitter resulting in terminal P5 on the receiver returning to a high condition (LED extinguished). Remove the connection to

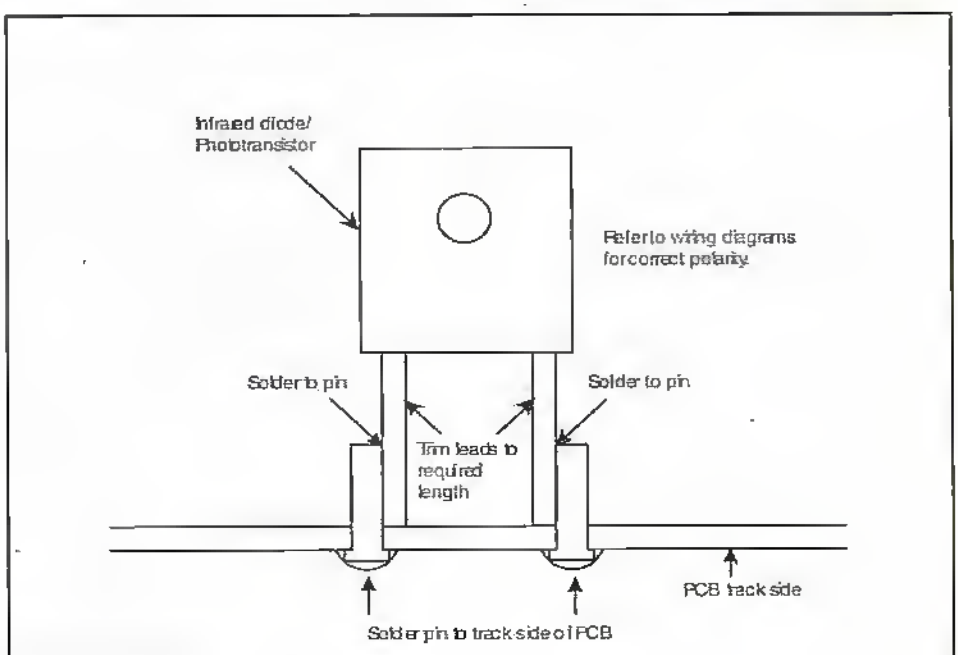


Figure 5. Mounting the infrared emitter diodes and phototransisor.

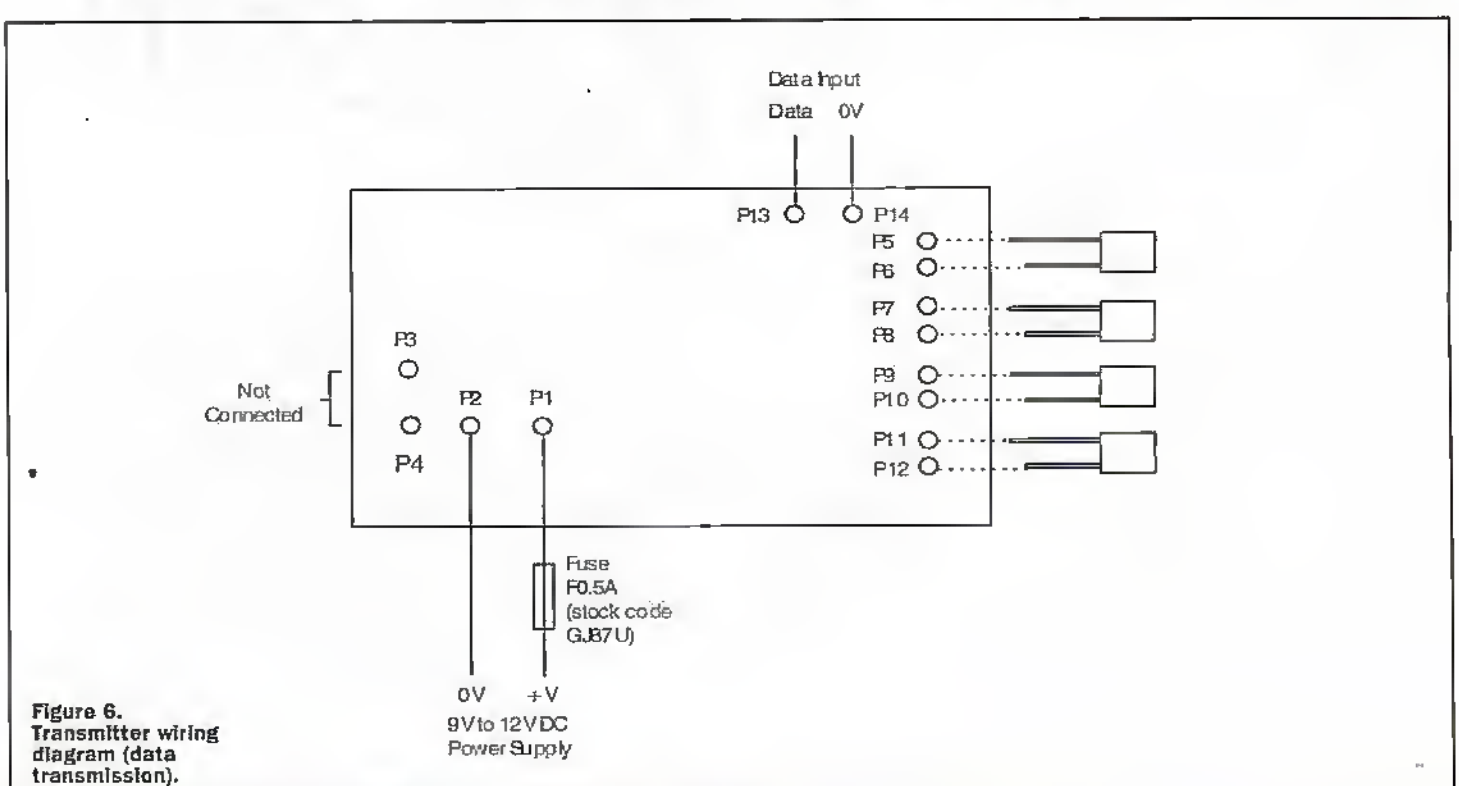


Figure 6. Transmitter wiring diagram (data transmission).

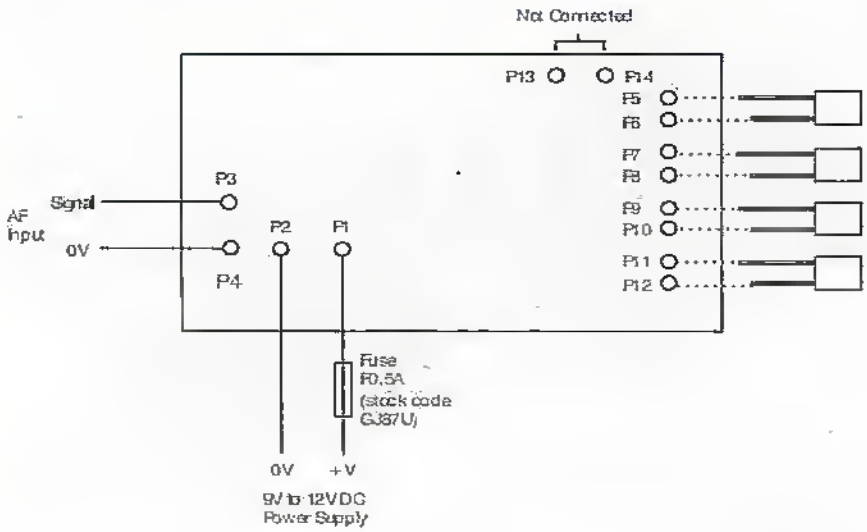


Figure 7. Transmitter wiring diagram (AF transmission).

P13 and P5 should switch to a low state.

Apply an audio frequency signal to the AF input of the receiver circuit (P3). If you are using a signal generator set it to a frequency of approximately 1kHz . Alternatively you can use a music or other source but in either case the maximum output level should not exceed 775mV rms. Before connection set the output level of the signal source to minimum.

At the receiver end connect an oscilloscope or crystal earpiece between P10 (signal) and P11 (0V). Slowly increase the level of the signal source until an output is detected at the receiver. Initially this may be considerably distorted. Adjust preset resistor VR2 on the transmitter to achieve minimum distortion at the receiver output. If you find it is a problem obtaining an undistorted output, check that you are not overloading the input. It will be necessary to adjust VR1 on the transmitter to the most appropriate setting for the input level you are using in order to prevent clipping at the input stage. On the receiver, VR2 is normally set for the highest output level achievable without distortion. It may be necessary to reduce this setting if you are driving further amplifiers from the receiver. It should be noted that the audio produced is not hi-fi quality and is of limited bandwidth. However, it is acceptable for many applications.

Increase the distance between the transmitter and receiver units until the PLL looses lock resulting in the output at receiver P5 switching high (LED extinguished). Try to retune the receiver by adjusting VR1 repeating the process until maximum operating range is obtained. If you are using the link to transmit audio frequencies adjust VR1 on the receiver to provide minimum distortion at the output.

The actual range obtainable is dependant on several factors but is typically a few metres. This can be considerably increased with the use of lenses.

Take care not to touch resistors R10 and R11 on the transmitter as these reach a relatively high temperature.

Using the Infrared Link

The link has been designed in the form of general purpose modules and can be used in a wide range of applications requiring short range communications over a distance of a few metres. The system can be used in connection with point to point data transmission, security, remote control and wireless headphone links.

When positioning the units, it should be remembered that there must be a clear line of sight path between the transmitter and receiver. As infrared energy is basically a longer wavelength form of light, it can be reflected from walls and mirrors. This can be useful if you need to transmit the signal round a corner in a room or corridor. It should also be remembered that some materials that are transparent to visible light can produce considerable attenuation of infrared energy.

The circuit is designed so as to reduce the effect of ambient infrared emissions from mains operated lighting etc. However, bright lights may affect the operation of the receiver. If this becomes a problem, try to re-sight the receiver if possible. Avoid mounting the unit where the photo transistor will be exposed to direct sunlight as this tends to result in saturation and poor performance.

It is also possible that the receiver will respond to other infrared devices that are in use around the home. An example of this is the remote control units used operate televisions, video recorders and similar appliances. These usually operate at a specific carrier frequency, often around 38kHz. The operating frequency of the infrared link has be chosen to avoid this frequency. If you find that the receiver is affected by a remote control device it is possible to change operating frequency of the link to overcome this. The frequency of the PLL oscillator on the receiver can be tuned over a sufficiently wide range using VR1. Usually, it is only necessary to make a small change to the value of R7 and/or C10 on the transmitter board in order to shift the frequency enough to cure the problem.

Saving on Components

For some purposes, not all of the components may be required. For example, if you are using the system for remote control using the output at receiver terminal P5, then R1 – R4, VR1, VR2, C1, C4 – C6 and IC1 can be omitted from the transmitter circuit. Similarly IC4, R10 – R16, VR2, C15 and C18 – C20 can be left out of the receiver circuit. Also, the component values used are not optimised for any specific application and some readers may wish to experiment with the circuit arrangement and values. The PCB's should provide a good basis for this type of experimentation.

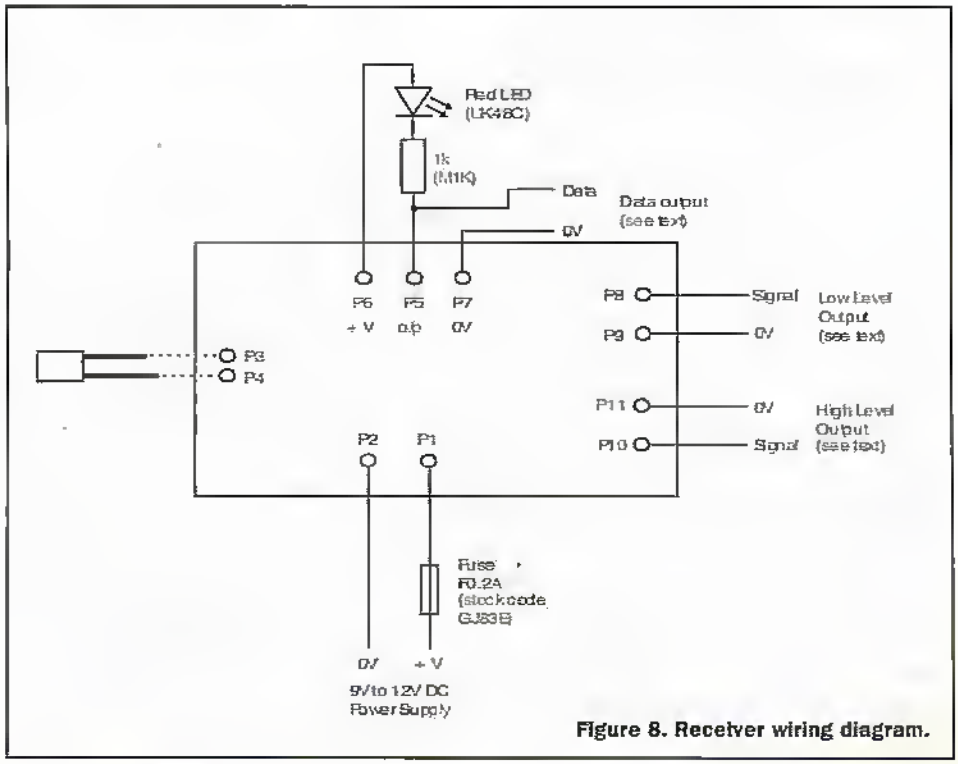


Figure 8. Receiver wiring diagram.

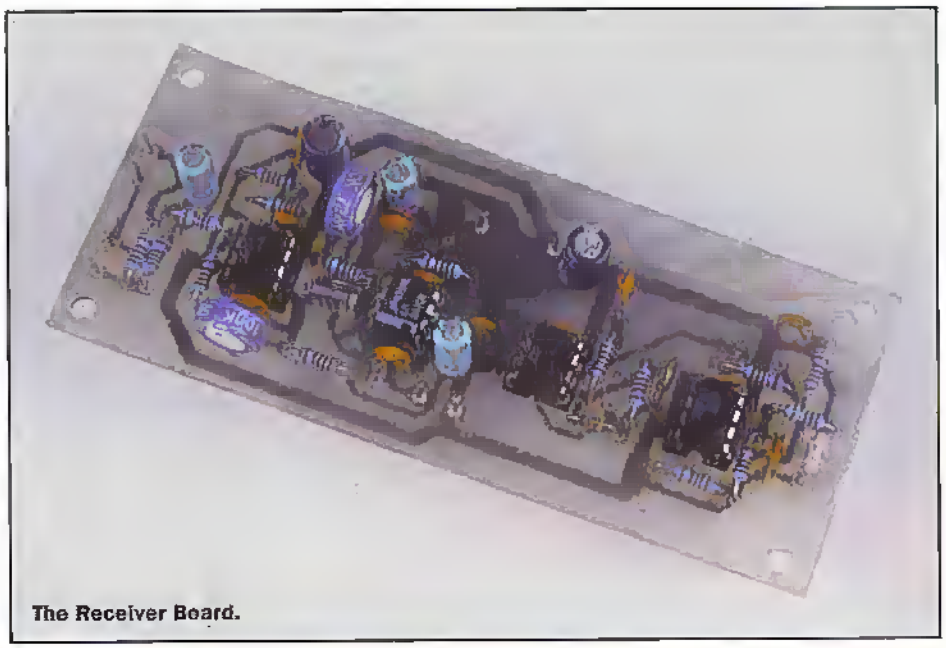
Housing the Units

How you house the system will be very much dependant on the application. Both the transmitter and receiver units can be mounted in a box using standard M3 nuts, bolts and washers. The transmitter diodes and receiver photodiode can be mounted behind a small hole in the case or alternatively behind a suitable plastic infrared filter.

When choosing a case for the transmitter, bear in mind that parts of the circuit operate at an elevated temperature if the circuit is operating for more than a few seconds. Allow for ventilation if possible and avoid mounting the PCB where the heat generated may affect plastics etc.

Next month...

Next month, we will look at some applications for the system and how these may be implemented in practice.



The Receiver Board.

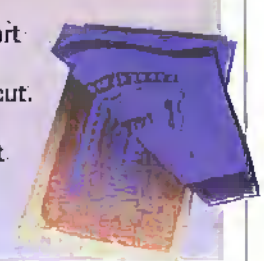
Producing The PCBs

The PCB can be produced using the standard UV exposure method. If you do not have the necessary equipment to produce a board in this way another method is to use the 'Press-n-Peel' system (Maplin stock code AB15R). This is a type of iron-on film that is relatively simple to use and is capable of producing good results.

First it is necessary to copy the PCB layout onto the film using a standard photocopier. The track layout should appear as if you are looking through the PCB from the component side. After the copying process the film is trimmed to an appropriate size and placed face down on an appropriate sized piece of copper clad board. As with most PCB manufacturing processes, it is recommended that the copper face of the board is carefully cleaned before applying the film, so as to remove unwanted oxide and grease. A domestic iron may then be applied to the surface of the film to transfer the artwork onto the copper. It is important to apply the heat evenly and to ensure that the artwork has been fully transferred to the copper before removing the film. The board retains the heat for some time after the iron is applied; so ensure that you allow enough time for cooling before the film is removed. Although the transfer is usually relatively good, there are sometimes areas where the etch resist is missing. In practice, this is not normally a problem the missing areas can be carefully filled in using an etch resist pen. At this stage the PCB can be etched. Details of suitable etchants are given in the literature supplied with the product. Once etching is complete, the remaining solder resist is removed using the appropriate solvent and the PCB may then be drilled in the usual way.

If you do not have the equipment to photo-etch PCB's and you want a low cost alternative, the 'Press-n-Peel' system is well worth considering.

Link LK1 can be fashioned from a short length of wire or a component lead off-cut. Bend the wire to the correct size so that it fits neatly into position on the PCB.



TRANSMITTER PARTS LIST

COST £14.30 APPROX.

RESISTORS			
R1, 4, 6, 12, 13	Min Res 1k	5	M1K
R2, 3, 5, 8	Min Res 10k	4	M10K
R7	Min Res 18k	1	M18K
R9	Min Res 100k	1	M100K
R10, 11	120R 2 Watt	2	D120R
VR1	Vrt Encl Preset 100k	1	UH19V
VR2	Vrt Encl Preset 10k	1	UH16S
CAPACITORS			
C1	Genelect 10µF 63V	1	AT77J
C2, 7	Genelect 100µF 16V	2	AT40T
C3, 4, 6, 9	Minidisc 100nF 16V	4	YR75S
C5	see text		
C8	Disc 10nF 50V	1	BX00A
C10	Poly Layer 2.2nF	1	WW24B
C11	Genelect 220µF 16V	1	AT41U
SEMICONDUCTORS			
TR1	BC548	1	QB73Q
TR2	TIP122	1	WQ73Q
IC1	LF351N	1	WQ30H
IC2	LM567CN	1	QH69A
RG1	78L05ACZ	1	QL26D
TD1-4	Side Looking IR TX	4	CH10L
MISCELLANEOUS			
	8 Pin DIL Socket	2	BL17T
	Pin 2145	14 pins	FL24B

INFRARED RECEIVER PARTS LIST

COST £10.30 APPROX.

RESISTORS			
R1, 2, 3	Min Res 1M	3	M1M
R4, 6, 8, 10, 15	Min Res 1k	5	M1K
R5, 11, 12	Min Res 100k	3	M100K
R7, 9, 13, 14	Min Res 10k	4	M10K
R16	Min Res 100R	1	M100R
CAPACITORS			
C1, 16	Genelect 100µF 16V	2	AT40T
C2, 4, 6, 9	Disc 10nF 50V	4	BX00A
C3, 7, 11, 12, 13, 17, 18	Minidisc 100nF 16V	7	YR75S
C5, 8, 19	see text		
C10, 15, 20	Genelect 10µF 63V	3	AT77J
C14	Poly Layer 2.2nF	1	WW24B
SEMICONDUCTORS			
IC1, 2, 4	LF351N	3	WQ30H
IC3	LM567CN	1	QH69A
RG1	78L05ACZ	1	QL26D
RD1	Side Looking IR RX	1	CH11M
D1, 2	1N4148	2	QL80B
MISCELLANEOUS			
	8-Pin DIL Socket	4	BL17T
	Pin 2145	11 pins	FL24B

Hybrid & ELECTRIC VEHICLES

PART 2

John Mosely continues his look at these environmentally friendly vehicles.

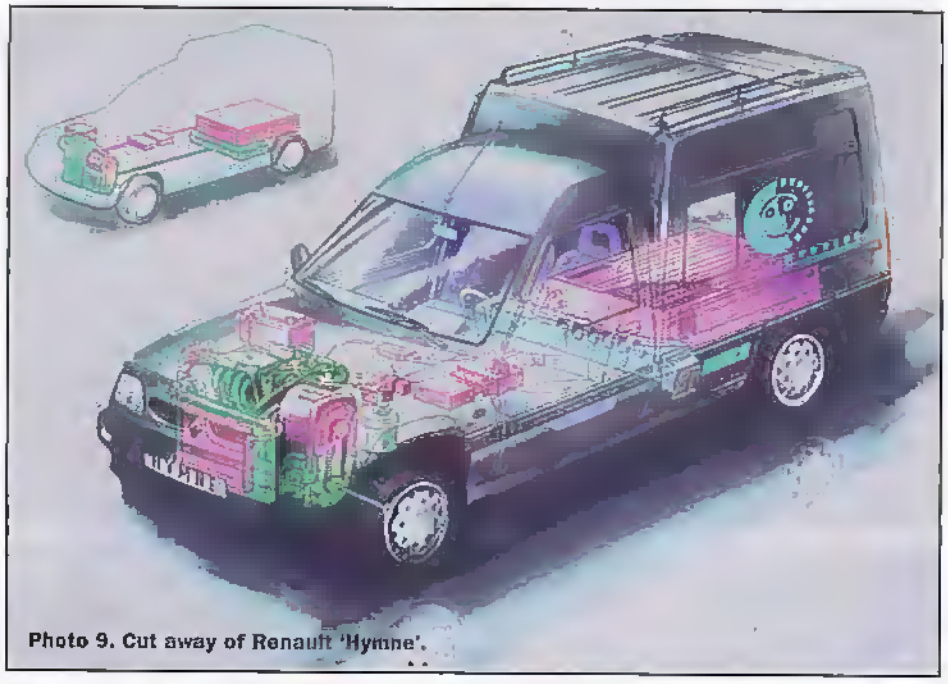


Photo 9. Cut away of Renault 'Hymne'.

Renault Hymne

The Japanese are not the only car manufacturers producing electric driven vehicles. Renault has been working for some years on electric and hybrid cars. The Hymne (HYbride a Moteur Normal Electrique – hybrid with electric motor) is based on the light commercial Renault Express. The difference with this model is that the driver can select either pure electric or hybrid mode, and is designed to cover 100 to 120km per day, a third of it in urban traffic, with at least a dozen stops and restarts. It is equipped with a 15kW electric motor and a 1200cc, 43kW petrol engine.

In hybrid mode, a 'supervisor' computer continually adjusts the mode of propulsion – electric, internal combustion or mixed – according to speed, acceleration, and the level of battery charge. The object is to balance the power output between the petrol engine and the electric motor so as to minimise fuel consumption and emissions. The result is a car that consumes only 3.7l of petrol and less than 1kWh per 100km. Up to 60kph, the car is a pure electric vehicle, but above this speed the petrol engine progressively takes over and ensures a range of up to 600km. The electric motor provides additional power for maximum acceleration, or to achieve the highest speeds. Although it weighs 1,500kg, it can achieve 160kph.

In pure electric mode the range is 35km and a top speed of 125kph, with all the typical comfort and characteristics of electric vehicles – smooth ride, extremely quiet and no pollution. The 235kg NiCd battery pack is recharged by an external 16A power supply or by the petrol engine driving a generator.

The Renault VERT

In this next generation hybrid vehicle, Renault have combined batteries with a 'turbo-generator' to power the twin back-to-back mounted ac synchronous electric motors in a front-wheel drive Espace. The result is a vehicle that has been classified as an ULEV (ultra low emission vehicle).

The 'turbo-generator' is a compact designing featuring a turbine that drives a conventional generator to charge the batteries and drive the electric motors. The generator is directly coupled to the turbine and has an extremely high output, since the turbine rotates at nearly 90,000rpm! A turbine offers the following advantages:-

- high power with simple, compact design.
- continuous combustion which greatly reduces polluting emissions without the need for a catalytic converter.
- high output.
- can use various fuels, both liquid and gas without the need for modification
- fewer moving parts.

The turbine develops 38kW and has a state-of-the art heat exchanger and combustion chamber with lean premix, pre-vaporisation. The turbine shaft drives a compressor which supplies air compressed by a factor of four to the inlet manifold. After the fuel, normally diesel, has been burnt in a self-sustaining (after initial combustion by a pilot flame) semi-open chamber at constant pressure, the burnt gas escapes at a very high velocity and at a temperature of 1025°C, to drive the turbine. A 'rotating' heat exchanger consisting of a ceramic matrix rotating at between 10 to 20rpm, which alternatively passes through the exhaust gas and the intake flow of compressed air. The aim is to increase, as much as possible, the air temperature before it enters the combustion chamber.

In town, the batteries provide all the power to the electric motors up to 63kW, more than adequate for driving in traffic. On motorways, the turbo-generators 38kW of power allows a cruising speed of 130kph. For extra power, the driver simply accelerates harder, and power from the batteries are added bringing the total power

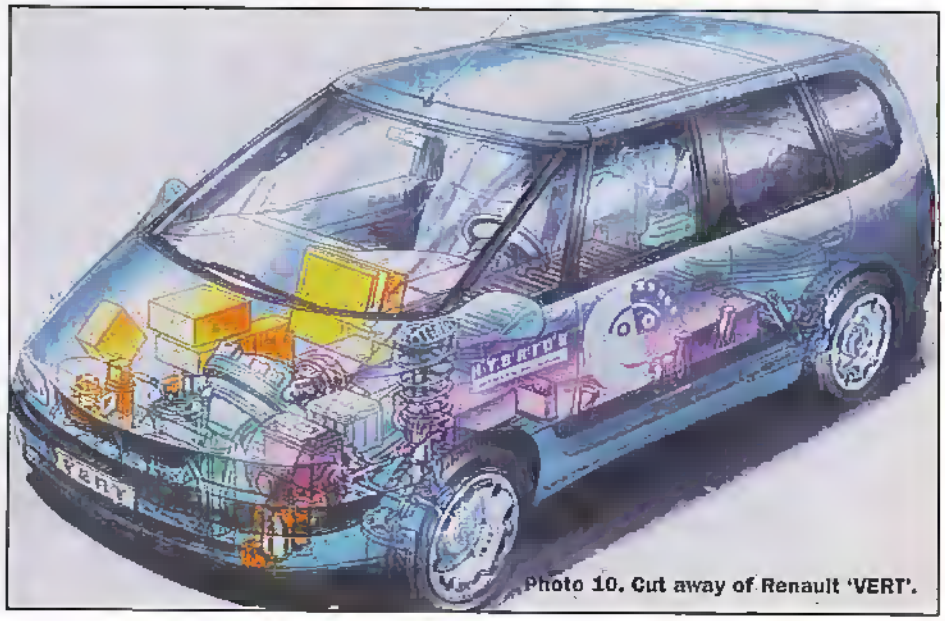


Photo 10. Cut away of Renault 'VERT'.

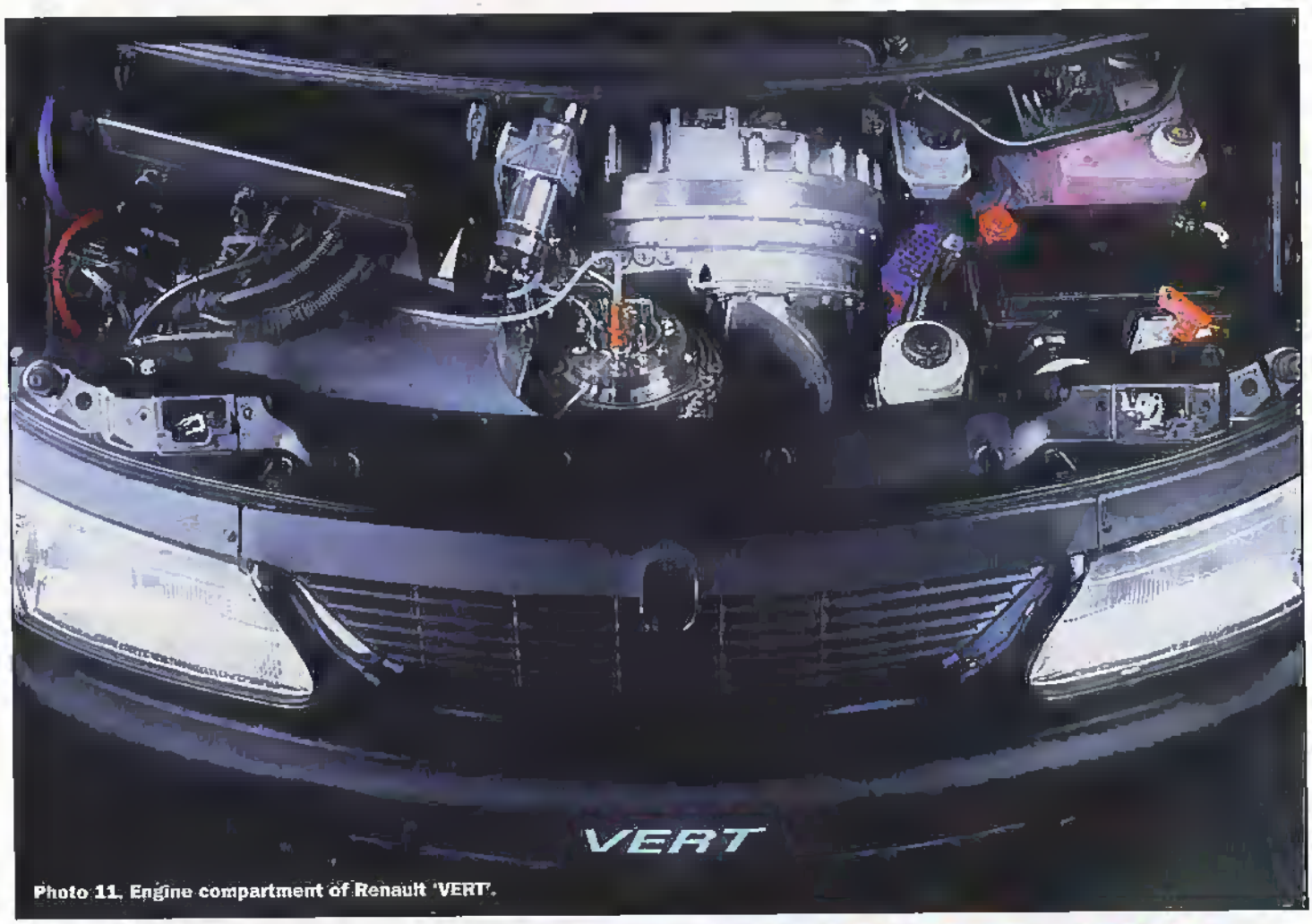


Photo 11. Engine compartment of Renault 'VERT'.

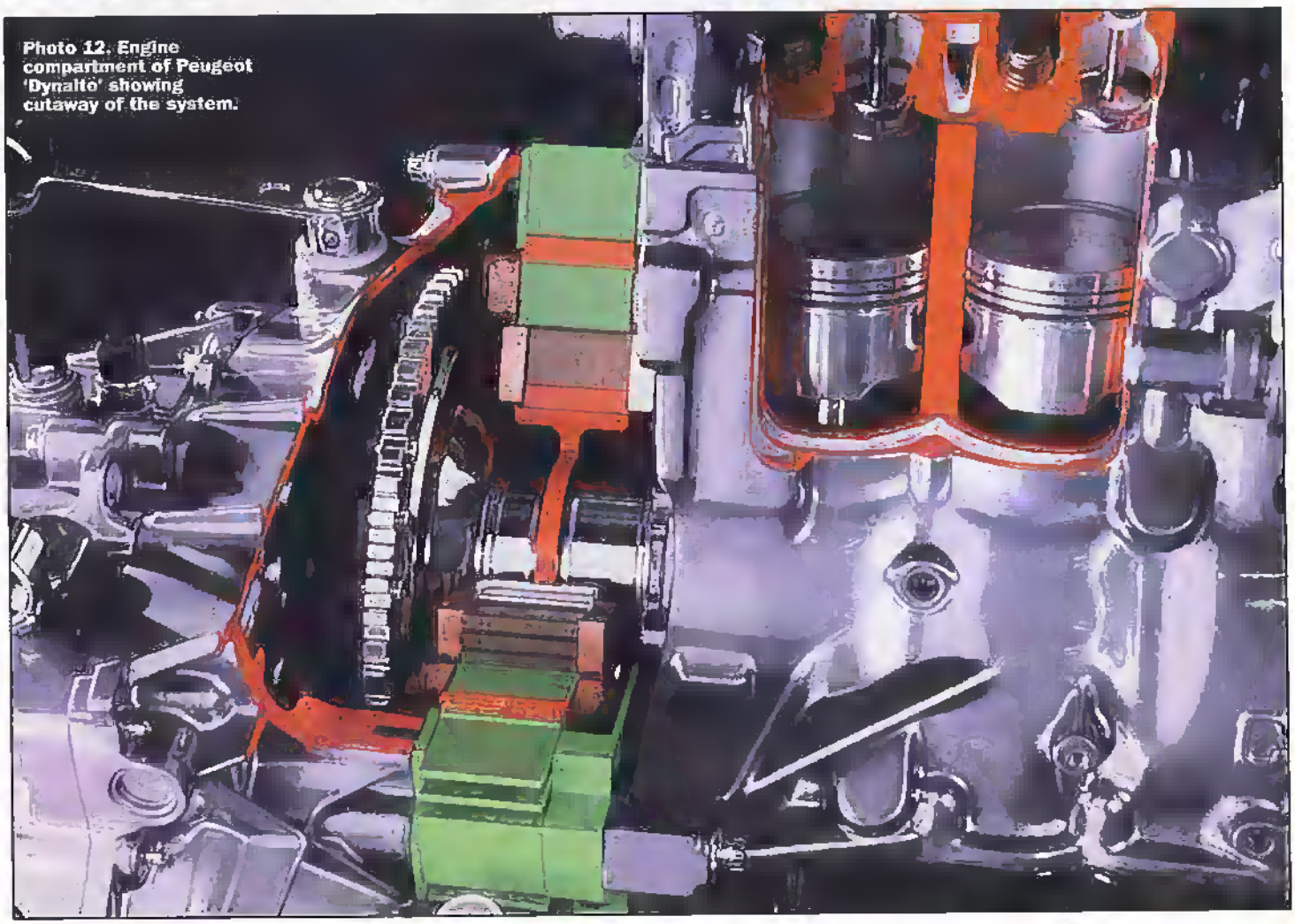


Photo 12. Engine compartment of Peugeot 'Dynalto' showing cutaway of the system.

Photo 13: Peugeot 'Xsara Dynalto'

to 90kW. Top speed now rises to 165kph, and acceleration from 80 to 120kph takes less than 20 seconds – without any gear change.

Renault hope to start volume production of a hybrid vehicle at a realistic price between the years 2003 and 2005.

Citroën Xsara Dynalto

Although perhaps not a true hybrid system, the 'Dynalto' from Citroën is an interesting concept as it combines the function of the flywheel, alternator and starter into one unit. The unit is only 6.8cm wide and is positioned between the engine and gearbox, replacing the flywheel. An electronic management system controls its action and provides a system that offers several advantages.

When the car is stopped for more than two seconds the engine is shut down, and restarted by simply selecting a lower gear and pressing the accelerator. Normally the engine will restart in 1/10th of a second which is a lot less than conventional starters. They can take up to three seconds. When running, electric energy generated is stored by the Dynalto system and is available at any time when sudden acceleration is required. This booster power is rated at 5kW (8bhp), and, additionally, can be of use at low speeds to avoid stalling when performing difficult manoeuvres.

By nature, the rotational speed of an internal combustion engine is never completely uniform. The torque of the Dynalto system helps stabilise the angular velocity of the engine, and generally counteract the torsional vibrations of the powertrain, thus making the engine's power curve more linear. The result is a car that runs a lot smoother in all situations including sudden acceleration or braking, which incidentally includes regenerative braking.

The engine used in the Xsara Dynalto is a 65kW (90bhp) 1560cc petrol engine, with a fuel consumption that is claimed to be up to 20% less than that of an equivalent model without the Dynalto system.

One nice touch is that the car has two 220V power outlets for running small mains electrical appliances!

Fuel Cell Electric Vehicle

The world's first practical fuel cell was mounted on the American Gemini V spacecraft in 1965. It produced electricity for the craft using the reaction between oxygen and hydrogen, and as a by-product created drinking water for the crew.

The fuel cell electric vehicle (FCEV) uses an unlimited supply of a combustible fuel – oxygen – and an oxidising agent – air. Figure 8 shows a typical layout. The Renault 'Fever' (Fuel cell Electric Vehicle Extended Range) carries the hydrogen in liquid form in a cryogenic tank at -253°C! The Fever is based on a Laguna estate (see Figure 9) and at present is a demonstrator designed and produced to evaluate this type of propulsion system. The electro-chemical reaction generates 30kW of electric power at a nominal 90V dc, which is then converted to 250V to power the synchronous electric motor. The by-product of this reaction is water. Again batteries are used to store charge from the generator and from regenerative braking. Range is 500km, with a top speed of 120kph.

Toyota use methanol to produce hydrogen in their FCEV, which is based on a RAV4 off-road vehicle. A methanol reformer (see Figure 10) is used to produce the hydrogen. Methanol and water are mixed and heated to vaporisation then catalysed in the reformer to produce H_2 and CO_2. Although CO_2 is a by-product, the level produced is less than half of conventional petrol engines.

Heat + Catalyst

$CHO_3OH + H_2O \rightarrow 3H_2 + CO_2$

(Methanol)(Water) → (Hydrogen)(Carbon Dioxide)

As methanol is a liquid fuel, it presents a practical solution to the hydrogen supply problem. It is presently made from natural gas but in large volumes it could be produced from biomass, so helping to reduce dependence on fossil fuel.

Basically, the fuel ionises hydrogen, extracts the free electrons as electricity, and then applies that current to produce water – a by-product of the process, which in the case of the Toyota FCEV is passed back for use in the methanol reformer.

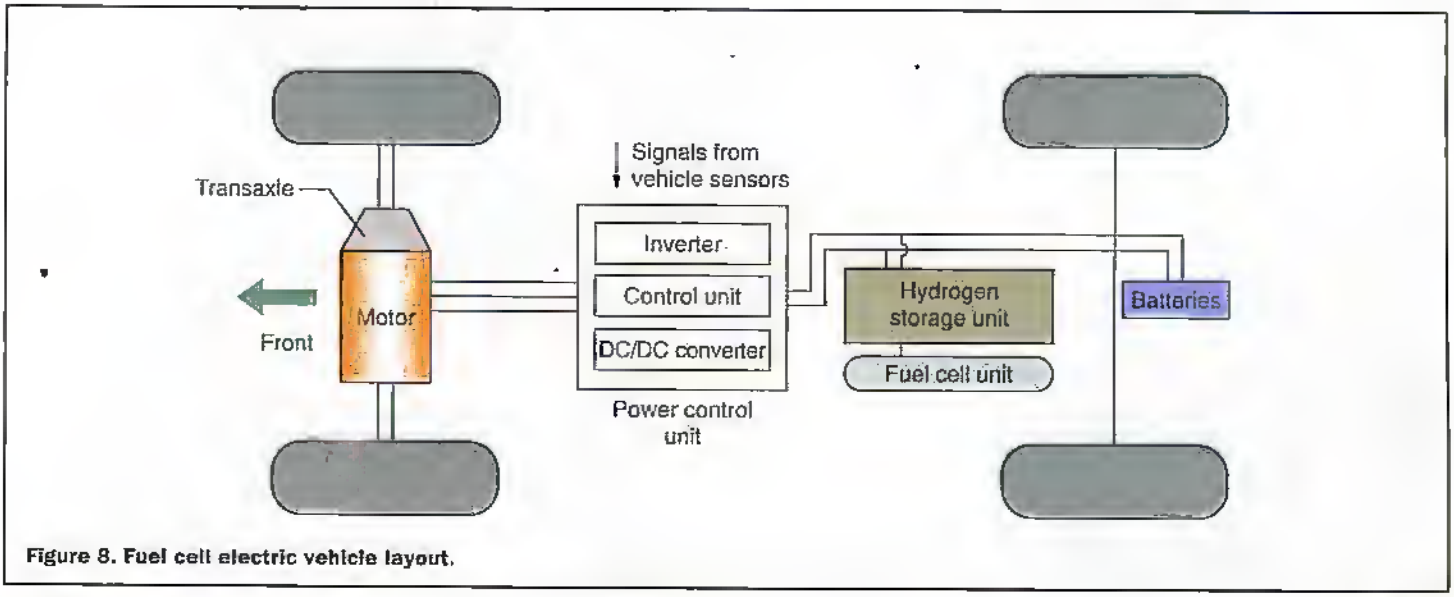


Figure 8. Fuel cell electric vehicle layout.

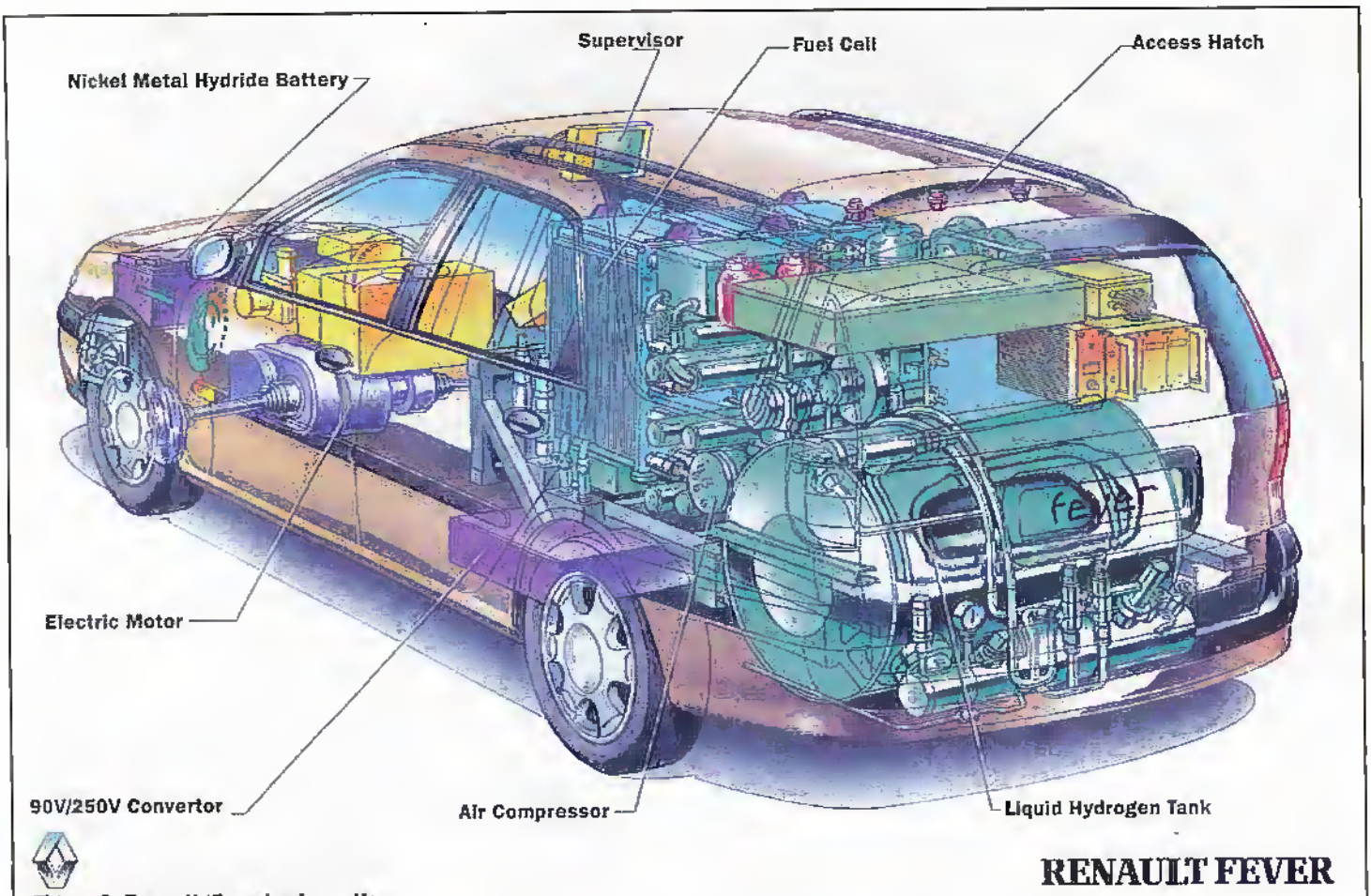


Figure 9. Renault 'Fever' schematic.

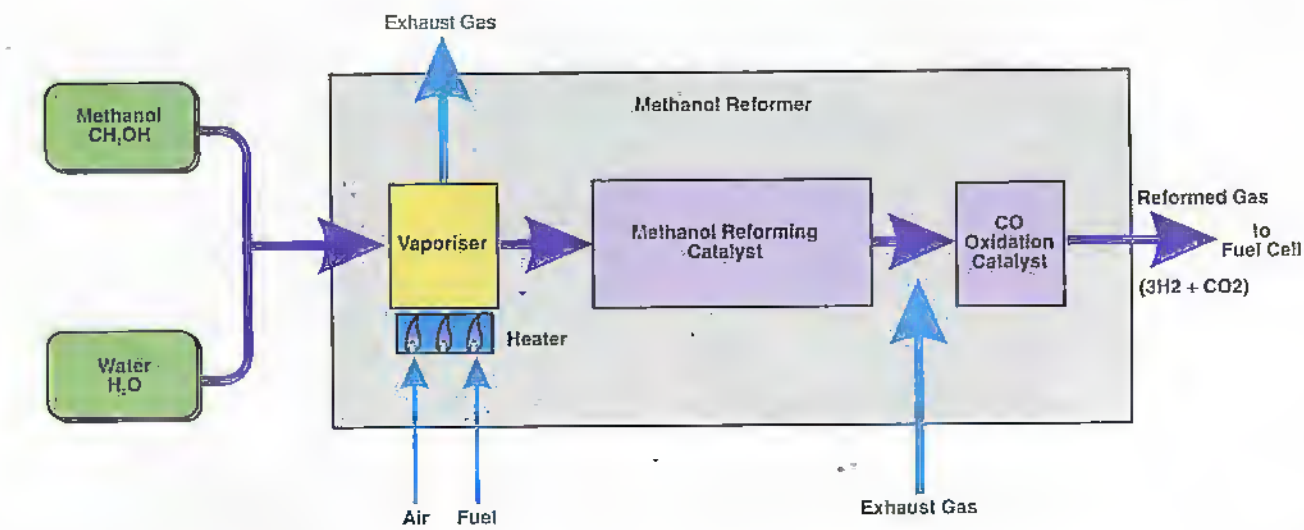


Figure 10. Honda hydrogen reformer.

Each cell consists of an electrolyte membrane sandwiched between negative and positive electrodes of woven carbon fibre with particles of platinum catalyst adhering to them. Hydrogen is fed to the negative electrodes, and oxygen to the positive electrode. The platinum catalyst ionises the hydrogen and the ions migrate through the membrane towards the positive electrodes. The negative electrons released by ionisation are also attracted to the positive electrodes, but cannot pass through the membrane. Instead they travel through an external circuit as electrical current (see Figures 11 and 12). One fuel cell can produce only about 0.7V of electricity, so many fuel cells are stacked together, separated by sheets of carbon to create a fuel cell unit. Toyota use 400 cells to produce a 300V power source.

Since the amount of electrical current is determined by the amount of hydrogen per minute that can be pushed through the electrolyte and combined with oxygen, it is important to optimise both the position and shape of the two supply channels. The internal resistance is less than chemical batteries, so power output can readily be increase by supplying more oxygen and hydrogen. Furthermore, wet electrolyte membranes speed reactions, so the air is humidified before it is fed to the fuel cells, and efficiency is improved by operating the cells at the higher end of the 40°C to 80°C operating temperature range. Toyota have incorporated these features in their design and produced a fuel cell that is capable of powering a 45kW motor, fitted in the drivetrain which is similar to all the Toyota range of electric powered vehicles.

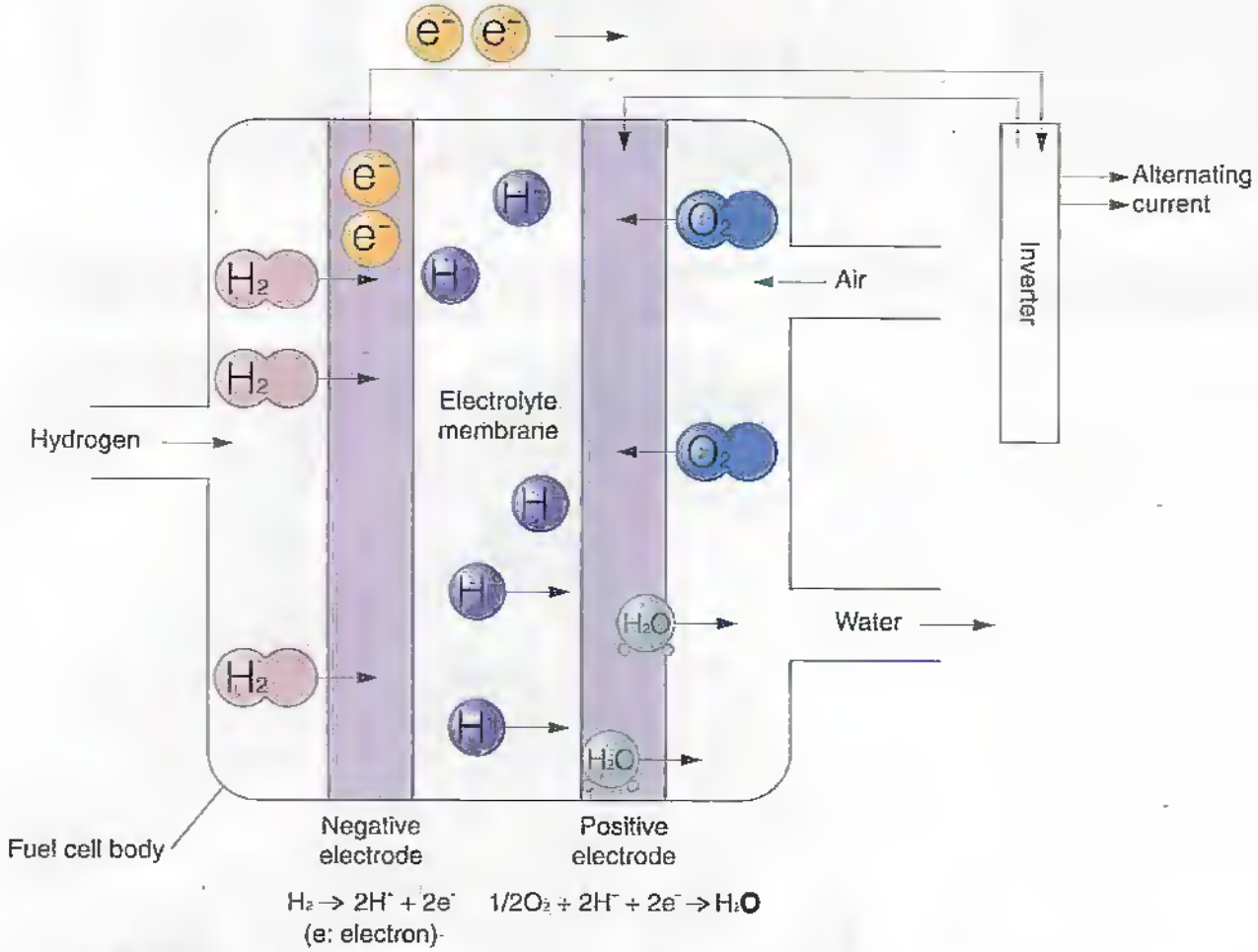


Figure 11. Fuel cell chemical action.

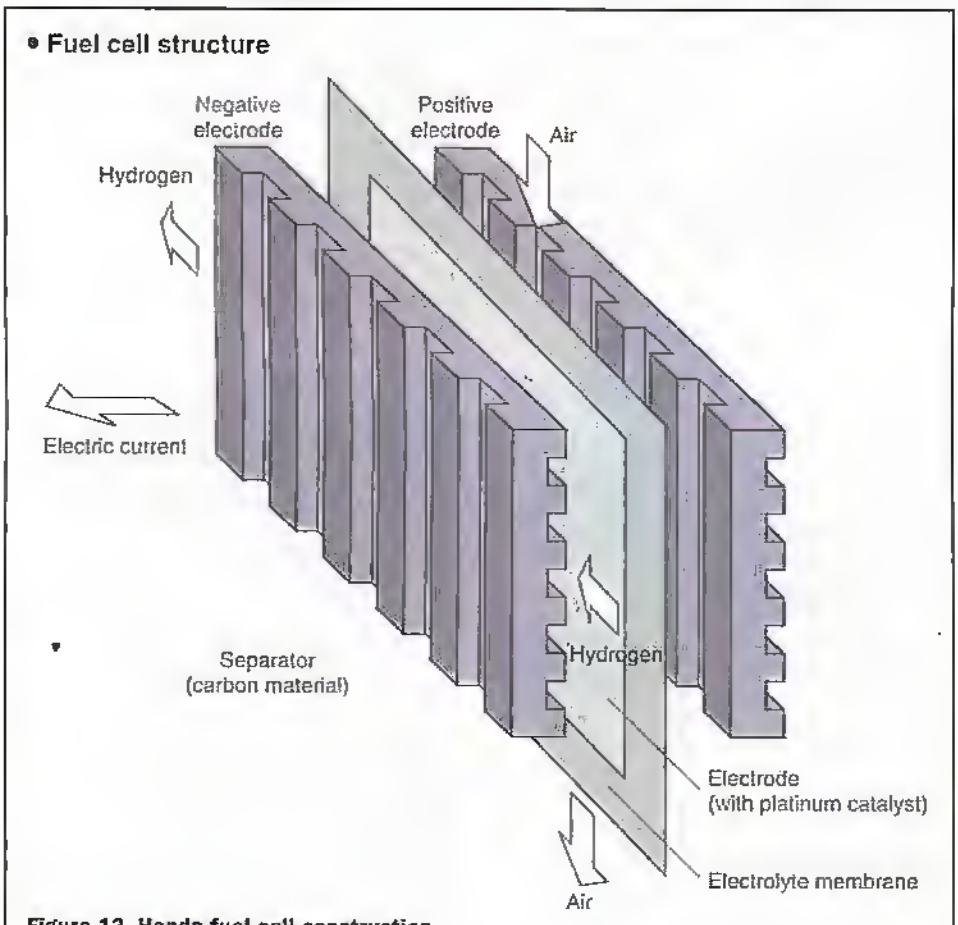


Figure 12. Honda fuel cell construction.

The Future

Toyota has not just limited their hybrid electric development to cars, they have also used their 1500cc hybrid system in a small 20-seater urban bus with a range of over 400km. The eventual aim of all this development – along with other major companies and the Japanese government – is to achieve a smoother, more comfortable transport system.

Research and development in the next-generation intelligent transport system (ITS) is progressing at a rapid rate. ITS represents the integration of the traffic infrastructure with today's advanced electronics, information and communications technologies. The idea is to bring together these technologies to create a smooth interface between roads, vehicles and people, and go along way towards reducing traffic congestion, improving safety and producing a cleaner environment.

Points of Contact

Honda (UK), 4 Power Road, Chiswick, London, W4 5YT. Tel: 0181 747 1400

Toyota (GB) Ltd, The Quadrangle, Redhill, Surrey, RH1111 1PX Tel: 01737 76858

Renault, 34, quai du Point du Jour – 92109 Boulogne Billancourt Cedex – France

Citroen, 62, bd Victor Hugo, 92200 Neuilly-sur-Seine, France.

French Technology Press Bureau, 21-24 Grosvenor Place, London SW1X 7TB. Tel: 0171 235 5330.

NOW, WHERE AM I?

A review of two GPS products by Keith Brindley

The Global Positioning by Satellite (GPS) system is technically quite smart. It is a worldwide system, in which 24 low-orbit satellites continually track over the earth's surface, transmitting signals in a continuous stream of data. At any point on the earth's surface therefore, there are always a number of these satellites in line-of-sight. Thus, a satellite transmission receiver at any point can pickup signals from several satellites simultaneously. Depending on satellite position, and not taking into account high buildings, trees, or other obstructions around the reception point, there can be upto seven or eight satellites 'visible', and never fewer than three.

Data transmitted from each satellite contains information relating to its position and orbit, as well as all other satellites, whether it's functioning correctly, and the precise time. For this reason, a suitable receiver on the ground can use the data from all satellites it receives from to calculate its own exact position. It's a bit like the old school physics experiment where someone fires a gun at one side of the school playing field and another measures the time difference between seeing the smoke the gun emits and hearing the gun retort to calculate the speed of sound. In the GPS system, it's radio waves (the speed of which we know) not sound that's used, and the differential information is used to locate the receiver not calculate speed, but the principle is more-or-less the same.

The US government developed the GPS system as a means of tracking and locating missiles and objects, and for this purpose it's accurate to within 1m anywhere on the earth. However, aware that this could be used militarily by others, the satellite signals are scrambled to reduce accuracy somewhat for commercial systems. Nevertheless, the system is always within 100 metres so you could find your way to the top of a mountain you're walking up, but you couldn't drop a missile directly on the Houses of Parliament.

Recently, commercial GPS receivers have been introduced which allow anyone to take advantage of the GPS system. They're not particularly expensive, starting at under £100 for basic models, although some full-featured models are well over £1000. Many of them are battery-powered and pocket-sized, so are ideal companions for walkers, cyclists, and motorists. The system though is still in its infancy so current GPS receivers tend to be quite technical, and users need to be able to map read pretty accurately. Things will change over the coming years though.

We've picked a couple of GPS receivers to road test: the Garmin GPS III and the Magellan GPS ColorTRAK. These are both portable devices, intended for quite serious use. The Garmin GPS III is available from Maplin (order code LS21X, £399.99), either by mail-order, or through our nationwide chain of stores.

The Magellan ColorTRAK is the first portable GPS receiver to feature a colour screen. While this isn't a massive improvement over others with more basic LCD screens, it does help to differentiate features as you view them. It's a rather chunky receiver, but comes with a useful pouch that can be strapped to a belt and boasts the longest battery life of any portable GPS receiver — up to 30 hours.

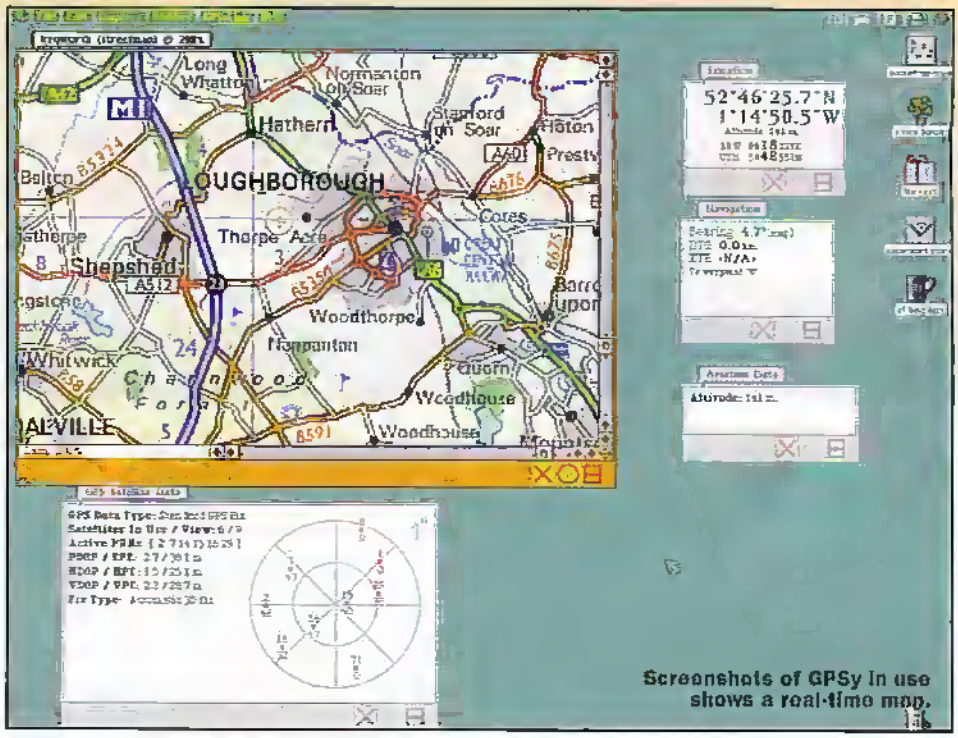
The Garmin GPS III is quite unusual in a portable GPS receiver in that it is supplied with on-board worldwide maps. This means that, from first power on, you can locate yourself anywhere in the world. As you move, the map adjusts to keep your position central. This would be a wonderful feature except that the map detail is quite limited. Major roads and towns are shown, but there's no detail below this. As such, it's a good tool to have on your dashboard while driving, as its sit-up-and-beg shape supports this usage, though not particularly effective while walking. Also, battery power is quite poor, only eight hours.

So what does anyone do with a GPS receiver, apart from locating position? Well, GPS receivers are ideal tools for people who take map-reading and outdoor pursuits seriously. Yes, at their very least, they can tell you where your position is on a map. Also, they can be used to record specific points of interest, termed waypoints. As you move along, a GPS receiver records your multiple positions in an automatic log, called a track that does not require you to mark waypoints as you progress. These give a record of where you have been, and you can monitor this real-time as you move, or afterwards back home. Conversely, you can with the aid of a map plan

a route beforehand, adding waypoints even before you leave home. In effect, GPS receivers are locational power tools for travellers — modern day equivalents of the compass and the sextant.

As useful as GPS receivers are alone, there is something else we can do with them. Most GPS receivers have a data port, through which the received data from the GPS satellites is pumped out, according to a standard developed by the US National Maritime Electronics Association (NEMA) called NMEA-0183. Electrically this is similar to RS-232, which means that most computers can be connected to most receivers and, together with the proper software, can use the received GPS satellite signals for further purposes. Typically, this is to interface with on-screen maps, so that positional information is displayed in a more friendly way than a GPS receiver does on its own. Effectively users can monitor their position on an accurate detailed map as they move. Another use, however, is to upload and download track, route and waypoint details between GPS receiver and computer. So, after an outing all details can be downloaded to the computer, to view the outing on the on-screen map. Or, a complete outing can be planned beforehand on computer, then uploaded to the GPS receiver. Needless to say, a GPS receiver's functionality can be greatly extended in combination with a computer.

A software package that allows this sort of functionality is shown. It is a Macintosh format product called GPSy. Similar products are available for whatever your computing platform. GPSy is quite a powerful product



Screenshots of GPSy in use shows a real-time map.

in that it allows users to import maps (scanned from OS maps, say, or from Internet-based map servers) to whatever scale or accuracy you want. From there, it's a simple matter of linking directly to a GPS receiver. Most common receivers, including the two used in this review, are usable. The screenshot of GPSy in use shows a real-time map being used from the UK Streetmap map server (at http://www.streetmap.co.uk) to locate position. From here, position on the map as you move is displayed in real-time, shown by the cross-hair cursor on screen, or you can download/upload receiver details from and to the computer. It's the perfect companion to give a more high-tech front end to an already high-tech GPS receiver.

Magellan http://www.magellangps.com
Garmin: http://www.garmin.com
GPSy: http://www.gpsy.com

Radioactivity
A CENTURY OF CONTROVERSY
PART 5

In this final part Greg Grant looks at the nuclear power factor

A nuclear reactor is a device which supplies a continuous flow of heat energy derived from nuclear fission. It operates on the principle that some radioactive atomic nuclei, when bombarded by neutrons, generate even more neutrons. This process becomes self-sustaining, provided the speed of the bombarding particles is sufficiently controlled.

The reactor's 'fuel' is uranium 235, uranium 238 or plutonium 239, the speed of the bombarding particles being controlled by what is termed a Moderator. Finally, a heat exchanger system utilises the reactor's output to drive the turbines of an electric power plant. This basic assembly is illustrated in Figure 1.

The first self-sustaining reaction was triggered at around 3.45pm on December 2nd, 1942, from an " . . exponential graphite-uranium pile," [1] located in a disused squash court, under the football stadium of the University of Chicago. The uranium atoms had been split by 'moderated' neutrons, which liberated the energy.

The word pile was used initially for a very good reason: it described exactly how the 'fuel' was assembled. To begin with, a base layer of uranium had a layer of carbon placed on top of it. The carbon – in turn – was capped by another layer of uranium . . which was subsequently topped by a second layer of carbon, and so on, forming the 'pile,' or stack, of Figure 2.

The term remained in vogue for some years until, through increasing experience and further development within the industry, they were constructed in a more precise and efficient way. As a result, they came to be termed nuclear reactors.

The Chicago assembly produced the plutonium used in the nuclear weapon dropped on the city of Nagasaki. The destructive power of this – and the earlier – weapon gave the embryo industry, as we have seen, the worst possible press that almost any new enterprise has had to endure before or since.

Yet by 1990, There were more than 400 nuclear power reactors in operation in some 26 countries.

Moreover, a further 100 were under construction. Therefore about 400,000 Megawatts (MW) of the world's electricity is nuclear-generated. By the dawn of the new millennium matters will be different again.

It is estimated that one-third of all electric power generated world-wide will, by 2002, come from nuclear plants. Given the dangers inherent in radioactivity generally, how safe are such plants presently? More to the point, will this safety factor be improved upon in the future?

The first thing to note concerning the nuclear power industry is that it was initiated and developed in two of the most technologically experienced nations in the world: the United States of America and Great Britain. Since the beginning, the industry has been well aware of the safety procedures and statutory enactments that have been in place in both countries for a very long time, in some industries for almost two hundred years.

Yet despite such precautions in the railway industry, in technological manufacture, in heavy construction and in commercial airline operations worldwide, human error can – and has in the past – resulted in death and injury on a scale far greater than that of any nuclear accident thus far.

What many people are unaware of or – in the case of the viciously anti-technological eco-lobby – choose to ignore, is that in the nuclear industry safety is paramount. Nor has the press helped. Any form of disaster ". . . sells newspapers and makes news, and the nearer the disaster is to home the better. The media must bear some of the responsibility for the somewhat irrational attitude of the public to nuclear energy." [2] Nevertheless the first nuclear accident was caused by a cocky complacency, typical of many industries even today.

The First Nuclear Accident

On the 21st of May 1946 Louis Slotin, the Canadian who assembled the core of the first atomic bomb, was preparing to take up an Assistant Professorship at the University of Chicago. Before leaving his post at Los Alamos nuclear facility, he had one important duty to perform. This was to show his successor, Alan Graves, how to bring two critical hemispheres of plutonium *almost* together, so that a very slow and controlled chain reaction would result.

The two hemispheres were kept apart by a pair of metal spacers, located on the lower hemisphere. Slotin removed these shims and replaced them with a screwdriver blade, held in his right hand. The screwdriver however slipped and the two hemispheres connected. Immediately, a blue glow filled the room and the neutron monitor went berserk. This was followed by a heat flash.

Slotin almost immediately knocked the two hemispheres apart with his bare hands, terminating the chain reaction, before

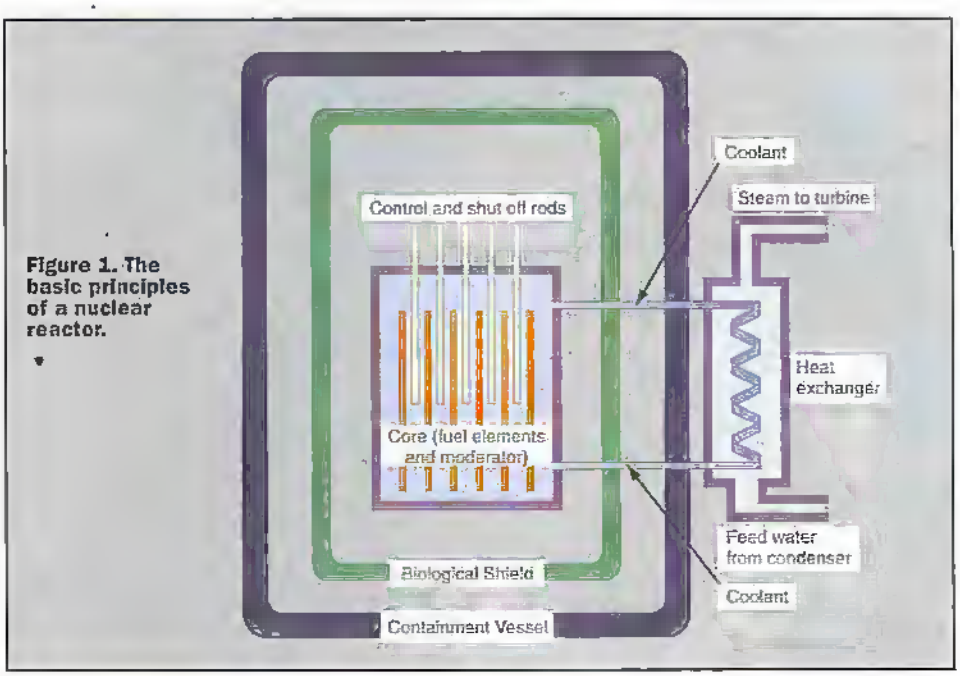


Figure 1. The basic principles of a nuclear reactor.

Figure 2. The world's first nuclear 'pile' at the University of Chicago, 1942.

calling for an ambulance. After five days in hospital, his hands swelled considerably and, despite daily transfusions, his white blood cell count continued to fall drastically. Four days later he was dead. He had received a radiation dose of some 900rem.

Alvin Graves had taken about 200rem, initially resulting in sickness, which subsided after about eight hours. Five days after being admitted to hospital, his temperature reached 103°F and he received two blood transfusions. He was allowed home after 10 days and subsequently made a complete recovery. This was the first nuclear accident, brought about by a mixture of complacency and the ignoring of safety procedures and devices.

By 1957 most people thought of a nuclear pile as the 'engine' of an atomic weapon. A nuclear power station therefore had to be a controlled bomb of some kind, encased in a very solid container, one much tougher than that encasing a weapon. Therefore if there was any danger from these new generating stations, it would surely amount to a giant explosion of some kind, although such a scenario was highly unlikely, given the safety procedures and precautions. No one thought of the leakage of radioactive material into the atmosphere. Not that is until a second accident occurred in 1957.

The Windscale Affair

In 1956 the British production engineer Christopher Hinton opened Calder Hall "... the first large-scale nuclear power station in the world which supplied public electricity." [3] The main British nuclear power effort was concentrated at what is now termed Windscale and it was here, on the 8th October 1957, that the first major British nuclear accident took place: in Windscale Pile No. 1.

During a procedure known as Wigner Release, there was a failure of one – or perhaps more – of the fuel cans, which simply oxidised. The monitoring instrumentation did not indicate this failure until the afternoon of the 10th. A visual inspection revealed glowing fuel elements and flames also.

Every possible technique – from blowing it out with carbon dioxide to shutting off the air – had no effect. The decision was taken finally to use water, which was first applied at 8.55am on the 11th of October. By 3pm the following day the water had done the trick: the pile was cold. Naturally there was a price to pay. Almost 40,000 curies of radioactive material such as strontium 90, iodine 132, tellurium 132 and caesium 137 was being freighted away on the wind and deposited over the surrounding area.

The Aftermath

The reactor operators and other workers were wearing respirators and protective clothing and their periods of exposure were controlled. Consequently the maximum thyroid dose received was 9.5rem, the average dose about 0.4 rem.

Nor were the people living in the irradiated area severely endangered, according to measurements of the radiation dosage. It was found that the population living in the region of maximum deposition had received a dose of around 50millirem. This compared favourably with the natural 110millirem dose per annum from ground-leaked radon gas, cosmic rays and radium from building materials.

However in equipment terms, Windscale was a costly business. Two reactors were written off, it being considered that modifying Pile No. 2 to the required safety standards would be financially prohibitive. Both reactors were completely sealed.

Moreover, some two million litres of milk were poured down the local drains as a precaution in regard to childrens' health, although it was still acceptable for use in cheese-making for example.

On balance, this was something of a 'model' nuclear accident, if there is such a thing. This view appeared to be a reasonably accurate one too for 25 years after the event, further measurements were taken in the area. In 1982 the National Radiological Protection Board (NRPB) – having had a great deal more experience of the effects of low-level radiation than formerly – thought that the nation's population had received an extra dose of radiation equivalent to about half the dose it would normally receive in a year from natural sources.

The Three Mile Island 'Disaster'

Who, wherever they live, work or play, has not heard of Three Mile Island? Located in the middle of the Susquehanna River, downstream from the city of Middletown, Pennsylvania, the island was the location of an accident whose effect on the nuclear industry's public image, and on American energy policy in general, was little short of devastating.

At 4am on March 28th 1979, the Three Mile Island power station sustained a fault in its cooling system, caused by a combination of temporarily ineffective valves and human error. This meant that the fission core of the reactor – which was normally submerged in water – became exposed to the atmosphere. The highly radioactive fuel rods making up the core began to melt, releasing radioactive gases as a result. Although the amounts of radioactive material released were very small, the incident caused considerable – and unnecessary – anxiety.

In reality, the emergency was over by 8pm, when the staff stabilised the reactor and the correct cooling had been restored and was functioning properly. However confusion, not to say panic took over "... as officials contradicted each other." [4] By March 30th, the State Governor was advising pregnant mothers and children living close to the facility to leave, and many took this advice.

The Aftermath

The major reason Three Mile Island became a world event rather than a little local difficulty was the uncertainty among the staff as to what exactly was happening, and why. Consequently the politicians were badly advised and so dispensed faulty, if well-intentioned, advice such as evacuation. The industry itself was deeply shocked by the event and experienced the cancellation or postponement of a number of orders for nuclear power installations as a result.

However on the credit side the event brought nuclear safety to public attention as few other events had done. Throughout the world, nuclear reactors and their peripheral installations had their procedures and safety records looked at anew to determine how they would have coped in a similar situation.

For the American nuclear authorities, one result was the realisation that continuous training for nuclear operators was not – as had formerly been thought – an expensive option, but an operational imperative. Moreover, *all* nuclear industry employees had to know their roles in an emergency situation and carry them out speedily and effectively.

The nuclear industry in general – and in America particularly – returned to generating electricity once more, having put in place active measures to limit the public relations damage. One illustration of this in Britain is the current advertising campaign the industry is running encouraging the public, and schools particularly, to visit such nuclear centres as Sellafield and see how the industry operates.

Nine years after Three Mile Island the industry was stunned by the sort of event it had fervently hoped would never happen.

The Big One

On Monday 28th April 1986, Swedish nuclear workers at Forsmark nuclear generating station noticed high readings on their radiation detectors. Assuming that this indicated a malfunction in their own equipment, they shut the reactor down and evacuated the station. By the afternoon Swedish scientists had detected fallout in the atmosphere, indicating that a reactor had indeed developed a problem, but it was certainly not the Forsmark facility.

This in fact would prove to be the 'Big One', an event that would turn a modest-size city near the junction of the Pripyat and Ushk rivers in the Ukraine, into a household name worldwide: Chernobyl.

In Western Europe, other countries too shortly became aware of radioactive fallout. On the 29th April, a scientific attaché from the Soviet embassy in Bonn, suddenly turned up at the offices of Atomforum. This non-governmental agency of what was then West Germany's nuclear power industry, was asked if it could advise the attaché's government on how to extinguish a graphite fire in a nuclear reactor.

Atomforum replied that a number of standard fire-fighting substances could do the job effectively such as foam, water and sand. However, to choose a really effective material, they would have to know the nature and circumstances of the problem. The Germans also advised the Russians to contact the British, who had experienced a graphite fire at Windscale, almost thirty years earlier.

The Americans too offered assistance. This comprised a comprehensive investigative package, including technical experts, health physicists and a specially equipped helicopter, the details of which was cabled to America's embassy in Moscow for onward transmission to the Soviet government. The Russians however declined these offers, requesting only the aid of Dr. Robert Gale, an eminent American bone-marrow transplant surgeon.

This set the pattern for the events that followed. The Soviets, even when they appeared to be a little less intransigent than formerly, in fact gave little away. They blamed the staff at Chernobyl for both the accident and the subsequent confusion. Moscow – according to the leader of the Soviet accident investigation team – knew nothing about what had happened until the evening of Sunday April 27th.

At this time the readings on Swedish monitoring equipment, 1,000 km from the disaster, were suggesting that if the region was taking this sort of irradiation, it was time to seriously consider lead as an alternative clothing material! In fact, the chemical explosion had actually occurred in the wee small hours of Saturday April 26th resulting, apparently, in a fire spreading to one of the four reactors.

The Aftermath

Chernobyl was the world's worst nuclear accident, or rather the worst recorded, even if only by default. By June 5th the death toll had – officially – risen to 26 and meltdown had only been avoided by completely enclosing the damaged reactor in concrete. Its fallout, for example, equalled the total fallout from all the nuclear test explosions that had taken place since the end of World War Two!

Naturally heads rolled, among which were those of the Deputy Minister of Power and Electrification, a First Deputy Director of Medium Machine Building and the Deputy Director of the research institute which had designed Chernobyl's reactors. The Soviet Politburo announced the creation of a new government department, the Ministry of Atomic Power Engineering, which was intended to raise standards of management and take responsibility for nuclear engineering development.

Naturally, there was no mention whatsoever of matters that are taken for granted in the West, such as an opening up of information on nuclear power stations, freedom to report on the industry in general, not to mention accurate casualty figures. All of which of course raises questions such as 'was this the first nuclear accident the Soviets had experienced?' If this was so, it would go some way to explain their drastic handling of it.

In fact, this was not the first nuclear accident in Russia. There have been a considerable number of such accidents across the industrialised world in the half century or so since the industry began including at least one in the old Soviet Union. The above incidents aside, Table 1 lists those that were reported and the one that was not. Short of reading the table, neither the writer nor the publisher are offering a prize for successfully guessing where the unreported one occurred!

The way ahead, as seen by a number of large engineering concerns such as Mitsubishi in Japan and Westinghouse in America, is to make future nuclear generating plants 'inherently safe.' This would be achieved by building smaller, high-temperature reactors, the cores of which would be manufactured from ceramics. Such materials would make them virtually 'meltdown free.'

That said, there are a number of factors which must be resolved. Firstly, a considerable improvement in performance and reliability will be required from the new stations, coupled with a drop in both running and maintenance costs. Finally, an acceptable solution has to be found for the difficulties of de-commissioning old nuclear power plants and the siting – and monitoring – of nuclear waste dumps.

This latter problem was highlighted in July last year when an explosion occurred at the Hanford Nuclear Reservation in Washington State, America's largest and oldest nuclear waste dump. Here, once more, human failure brought about a catalogue of errors that everyone had thought had been done away with after the Three Mile Island confusion. Not so however; not so.

The nuclear industry, as Table 1 shows, still has some one third of its failures caused by human error of one kind or another. That points to one thing: inadequate training and awareness in the safety field. Until this is addressed, the industry will always have a hard time from the environmental lobby and the public will continue to harbour doubts over an industry that, thus far, has a safety record as enviable as that of the world's airlines.

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1. *Bronowski, Jacob (1973): The Ascent of Man. BBC., London. Page 347.*
2. *McGaw, James (1987): How Safe? Three Mile Island, Chernobyl and Beyond. Stoddart Publishing Co. Ltd., Toronto. Page 151.*
3. *Armytage, W.H.G. (1976): Social History of Engineering. Faber & Faber, London. Page 313.*
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Picture Credits

Article 1: Fig. 1: Engineering Science & Education Journal. June, 1996.

Article 2: Fig. 1: The Versatile Satellite. Richard W. Porter. OUP. 1977. Page 157.

Article 3: Fig. 1: How Things Work. Ed. C. Van Amerongen. Heron Books, London. 1967. Page 457.

Article 4: Figs. 1, 2 & 3: Radiation Doses: Maps & Magnitudes. Published by NRPB in their 'At A Glance' series.

Article 5: Fig. 1: How Safe? Page 139.
Fig 2: Ascent of Man. Jacob Bronowski. BBC, London. 1973. Page 346.

DATE	PLACE	ACCIDENT	CAUSE
December, 1952.	* Chalk River facility, Canada.	Four control rods were lifted out of the reactor.	Human error.
November, 1955.	* Idaho Falls, USA.	Whilst testing this reactor, the staff lost control.	Human error.
Winter, 1957-1958.	Kyshtym, Chelyabinsk, USSR.	Believed to have been a weapons plant accident.	Authorities have never admitted this took place.
May 23rd, 1958.	* Chalk River, Canada.	Radioactive material released into atmosphere.	Faulty fuel rod over-heating.
July 24th, 1959.	* Santa Susana,California.	12 Fuel rods melted.	Cooling system blockage.
October 5th, 1966.	* South East Michigan, USA.	Part of reactor core melted.	Faulty Component.
January 21st, 1969.	* Lucens, Switzerland.	Reactor core damaged.	A pressure tube burst.
June 5th, 1970.	* Morris, Illinois, USA.	Reactor out of control.	Faulty meter reading.
June 5th,1970.	* Monticello, Minnesota, USA	Radioactive waste spillage, 50,000 gallons.	Waste storage facility overflowed.
March 22nd, 1975.	* Decatur, Alabama, USA.	Reactor core overheated.	Human error.
June, 1977.	* Hinckley Point, Somerset, UK.	Reactor fault.	Major cooling pipe fracture.
September, 1977.	* Hunterston, Ayrshire, UK.	Seawater fed into reactor's core.	Human error.
March 28th, 1978.	* Rancho Seco, California, USA.	Control computer swamped by false signals.	Human error.
February 11th, 1981.	* Sequoyah, Tennessee, USA.	Radioactive coolant leak.	Coolant leak.
January 25th, 1982.	* Ginna Point, Rochester, New York, USA.	Radioactive water spillage into containment area.	Steam generator tube ruptured.
February 25th, 1983.	* Salem, New Jersey, USA.	Reactor core water levels dropped.	Automatic shutdown system failed – twice!
November 21st, 1985.	* San Onofre, California, USA.	Electrical power loss, resulting in a coolant loss.	Equipment failure.
December 26th, 1985.	* Rancho Seco, California, USA.	Reactor cooled rapidly.	Loss of control room dc power.
August, 1986.	* Hope Creek, New Jersey, USA.	Pressure equaliser had been installed backwards!	Human error. Management failure.

* Indicates those incidents that were reported and discussed – often at great length – in the national and international press.

Table 1. A chapter of accidents.

Removable MEDIA

PART 2

In a recent issue, Martin Pipe examined some of the removable media options available to personal computer users. In this article, he follows up with a look at some of the hardware available.

Removable storage has become big business recently, and there is a fair number of alternatives to choose from. It's not hard to understand why; the standard floppy disk fitted to PCs and Macs has an unformatted capacity of 2Mb, which is inadequate by todays standards. Modern programs and files may span several disks - indeed, the full install of Microsoft Office 97 is spread out over more than thirty. Hardly surprisingly, most vendors prefer to supply their wares on CD-ROM. Similar problems are encountered if the PC user wants to send a large collection of files - or a single large file - to a friend or colleague. Then there's the issue of backup - copying the most-used data and/or programs onto a removable medium so that it can be restored to the computer in the event of a hard disk crash, fire or virus infection. The sheer number of floppy disks involved in backing up a modern hard disk makes this approach somewhat impractical. New products, such as digital cameras, lend themselves very well to removable media otherwise your hard disk will clog up very quickly!

Alternatives

Previously, we discussed more capacious alternatives to the floppy disk. These included second hard disk drives in a removable enclosure (fast - and practical, now that hard disks are so cheap), tape-type systems (slow and largely proprietary recording/compression formats, but high capacity and low media costs), CD Recordable/Rewritable (quite fast, cheap media and largely compatible with CD-ROM) and proprietary disk media (variable media cost/speed, only readable by specific hardware). In this issue, well be taking a closer look at several proprietary disk systems - from Avatar, Iomega and Mitsubishi/Nexus - and a tape drive from Iomega. Next month, well look at more hardware from Panasonic, Syquest, Danmere and Hewlett-Packard. Across this range, all three common personal computer interface standards - SCSI, parallel-port, PCMCIA and IDE - are catered for . One device, the Iomega Zip Plus, caters for both parallel-port and SCSI interfaces within the same unit. Handy if you have got both PC and Mac, or a notebook and desktop hardware.

Zip system can be used vertically or horizontally.

Iomega Zip/Zip Plus

Originally introduced in 1995, the 100Mb-capacity (formatted) Zip system has built up a loyal customer base with around 10 million drives now in use. Many personal computer vendors, including Apple, are now building Zip hardware into their machines. The Zip is essentially a super-floppy medium, based around a thin flexible disk coated with a metal particle recording medium on both sides. This is contained within a rigid plastic enclosure, which has roughly the same dimensions as a fat floppy disk. A spring-loaded protective shutter allows the head assembly to enter during use. The high capacity owes a lot to a quartet of servo Z-tracks, which are embedded on the disk surface during manufacture. These are used to accurately position the read/write heads. Similar embedded servo technology is an important factor of other systems - notably CD-Recordable and the competing LS-120 SuperDisk. Other features of the Zip design specification include soft disk ejection, an average seek time of 29ms, LBA (logical block addressing), RLL (run length-limited) media recording and Reed-Solomon error-correction.

The hardware is available in several forms. Firstly, there are internal drives designed for integration into a PC. These variants are available in SCSI and IDE forms. Next, we have the external stand-alone Zip drives, both of which are built into a somewhat flimsy blue case. One of these has a parallel port, the other a (faster) 8-bit SCSI-2 interface. Round the back of the external drives are a pair of 25-way D connectors. On the SCSI variant, these permit daisy chaining. The parallel port model, the two sockets allow the printer to remain connected to the system. The SCSI models also have switches for SCSI ID (5 or 6), and termination (this should be activated if the Zip drive is to be the last in the chain).

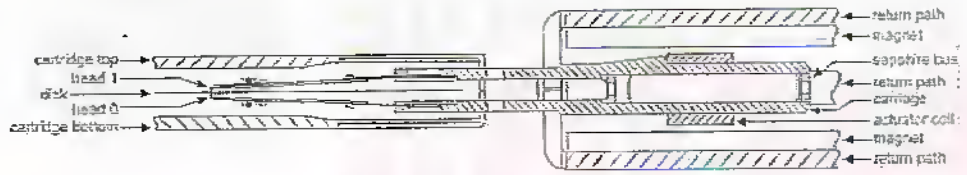
A throughput of 1.4Mb/sec is quoted for the SCSI model, and 500Kb/sec for the parallel-port model. The most recent - and most expensive - model, the Zip Plus, has a slightly-better performance - and both SCSI and parallel interfaces. This drive automatically detects the connected interface, and configures itself appropriately.

Zip disk.

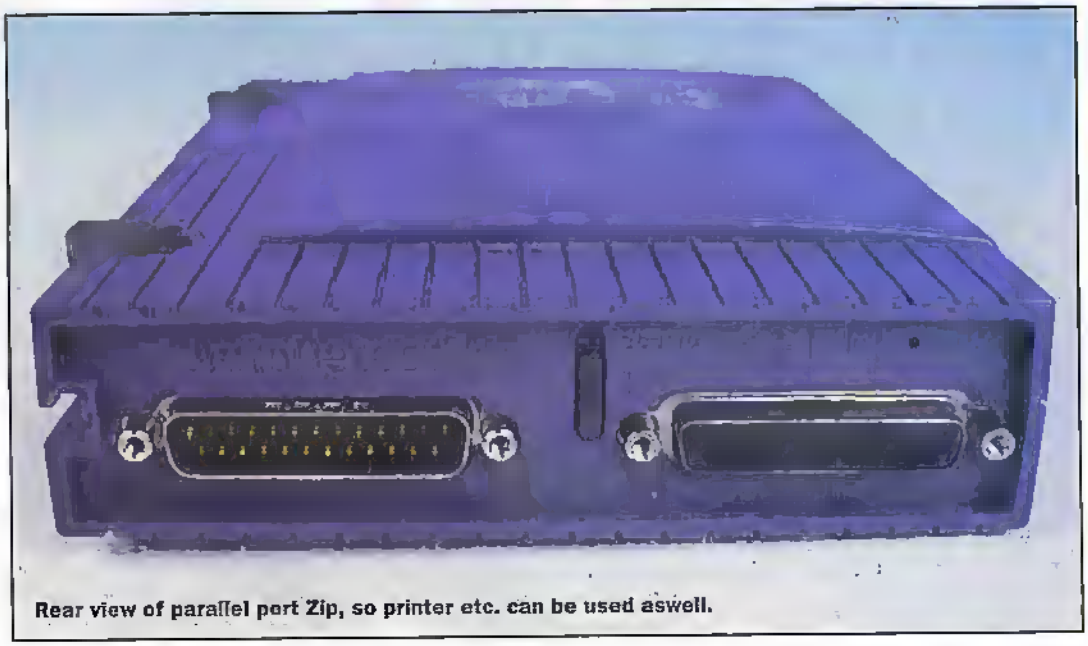
In SCSI mode, the Zip Plus terminates the bus automatically where appropriate. Zip device drivers are available for PC (DOS/Win3.x/95/NT 3.51 and 4.0) and Mac. Other software caters for password-protection of disks, media cataloguing and hard drive back-up. Each drive is supplied with cables, a PSU, a floppy installer program and a Zip disk that contains the rest of the Iomega software.

Because the Zip has been around for some time, a picture of long-term reliability has been built up. A minority of users - including one Maplin member of staff - have reported what has been graphically nicknamed the click of death. Apparently the heads become misaligned - leading to erratic performance. In the worst case, the media is damaged to the sound of a regular clicking noise - hence the nickname. Iomega claim that the problem only affected a certain (early) batch of drives, and is prepared to replace the drive and any damaged media free of charge if they're returned. I have found that the click of death is experienced even on a good drive - but only if you try to read Zip disks written by misaligned hardware. Nevertheless, the popularity of Zip is a good thing, and the media costs are reasonable - typically £10 to £12 per disk on the street.

Something worth mentioning is that multiple packs of Zip disks are supplied with Iomega RecordIt - an excellent audio recording/playback that employs real-time MPEG-1 Layer 2 compression. The Zip Plus, meanwhile, is supplied with RecordIt as standard. We looked at this software in the CD-Recordable audio series earlier this year. By the end of the year, Iomega will have introduced Clik, a removable media system that stores 40Mb on each tiny disk. This system, which will be aimed at users of digital cameras, PDAs and notebook PCs, appears to be a smaller version of the Zip - and hence uses the same technology.



Cross sectional view of Zip actuator and cartridge.



Rear view of parallel port Zip, so printer etc. can be used aswell.

The software bundle includes: drivers, Iomega Tools (1-Step Backup/Restore, Copy Machine-disk copying, FindIt - cataloguing and file browsing and Guest 95. This allows another machine to read disk without permanently installing Iomega Tools. Mac users are served by Dantz DiskFit Direct backup program and Leader Technologies FileMatch desktop/notebook file synchroniser). ZipPlus purchasers also get following programs in both Mac and Windows guises: Adobe PhotoDeluxe (image retouching), DataViz Web Buddy (off-line web browser), Iomega RecordIt (MP2 audio recorder/player), PictureWorks NetCard (e-mail postcards) and Digital Arts and Sciences ImageAXS (image manager).

Contact Iomega, (0800) 973194. Web: `http://www.iomega.com`

Iomega Jaz

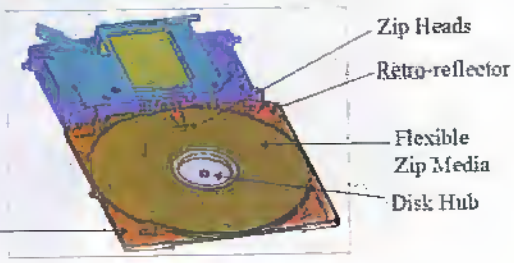
Jaz was launched shortly after the Zip, and has become quite popular with the creative industries (publishing, animation, graphics and Web design for example) as a replacement for the Syquest 5.25in. removable hard-disk cartridge. While the largest such Syquest disk will store 200Mb (the 88MB cartridge is, however, the most popular), each Jaz disk will accommodate a gigabyte. At nearly £100 the disks are quite expensive - they are even dearer than the small-capacity Syquest cartridges - but the cost per megabyte is far superior. In addition, the Jaz cartridges employ 3.5in. media and are hence smaller - an important issue as far as storage, transport and speed are concerned.

The media itself is very similar to that of a hard disk. There are two rigid aluminium platters, both of which are coated on both sides with a high-energy thin-film sputtered-metal magnetic coating and protective overcoat. Disks are pre-formatted at the factory with servo positioning information, sector and track identifications. Another similarity to hard disks is that any media errors are flagged during factory pre-formatting, so that they are skipped in use by the thin-film heads. Like Zip - and some other media - pre-written servo tracks are embedded on each recording surface. Other Jaz features include RLL recording, LBA,

Performance - Zip

SCSI, Windows 95:	0.62Mb/sec (write), 0.79Mb/sec (read)
SCSI, DOS:	0.67Mb/sec (write); 0.85Mb/sec (read)
Drive cost (RRP, inc. VAT):	£129 (external parallel-port), £129 (external SCSI), £129 (internal SCSI), £139 (internal, IDE), £170 (Zip Plus external)
Media cost (RRP, inc. VAT):	£15 - refer to article for street prices
Media cost per megabyte:	15p

Cut-away Zip disk inside an ATAPI internal Zip drive



Zip disk internals.

Jaz system.

Reed-Solomon error correction, software disk ejection, an average seek time of 11ms and a 256Kb cache.

The hardware, which can be bought in external and internal forms, is available only with a synchronous Fast SCSI-2 interface. This will support the Jaz transfer rates, which are claimed to go as high 6.62Mb/sec (sustained). The external unit, tested here, has a pair of high-density 50-way connectors (for SCSI daisychaining) on the back of the drive. The SCSI device ID (0 to 7) can be selected by means of a pair of recessed buttons, and the SCSI termination enabled, disabled or automatically-configured. As with Zip, device drivers are available for DOS, Windows 3.x/95/NT3.51/4.0 and MacOS. The other software is identical to that supplied with the Zip - operations catered for include back-up, disk copying and cataloguing. The hardware supplied includes a SCSI-2 cable, 50-way to DB25 adaptor and a power supply unit. No reliability problems with Jaz have been reported since its 1995 introduction. Note that, at the time of writing, a new (and more expensive) backwards-compatible 2Gb version of the Jaz had just become available.


Jaz drive with SCSI connections.

Software bundle is similar to the Zip drive (see previous page). Contact: Iomega, (0800) 973194. Web: `http://www.iomega.com`

Iomega Ditto Max

Until the comparatively recent introduction of removable disk systems, tape drives were the only practical way of clearing up less-used files or backing up your hard disk. Today, it remains the most cost-effective - a tape cartridge with the capacity of a modern hard disk typically sells for less than £10. The main drawback concerns speed - backing up the entire contents of a hard disk (a full backup) or reformatting the tape may take several hours thanks to speeds measured in megabytes per minute! If data compression is switched on to maximise the capacity of the tape, backup times can be even longer - largely because the compression tends to be software-based and is hence influenced heavily by the processing power of the host PC. Some more expensive drives - notably DAT types - do employ a standardised form of hardware compression, which not only takes the load off the PC but eliminates one more cause of potential incompatibility.

Fortunately, subsequent backups - which only involve changes made since the last full backup - can be much quicker. Because tape is a serial-access medium, restoring one or more particular files can take some time because the drive has to spool the tape to the appropriate position(s). To ease backup to tape, most drives are supplied with software that allows you to select files for backup or restore - you cannot simply copy files from one drive to another, because the tape drive is not treated as a disk and hence does not have a logical drive letter. That said, this Iomega drive is supplied with special software that allows the first 125Mb section of the tape to be treated like a hard disk - albeit a very sluggish one, with seek times in the order of seconds and low data transfer rates. Nevertheless, FlashFile - as the system is known - is handy in situations where a particular file or small-ish collection of files needs to be backed up frequently. If you are working constantly on a particular project, FlashFile can be very useful.

Drive	Maplin Order Code
Zip Plus	LS84F
Jaz Internal	CD01B
Jaz External	CD02C
Ditto Max Internal	LS85G
Ditto Max External	LS86T
Ditto Max Pro Internal	LS87U
Ditto Max Pro External	LS88V

Please phone for latest prices.

Zip Plus is supplied with Recordit - an excellent audio recording/playback programme.

Performance - Jaz	
Windows 95:	1.25Mb/sec (write); 4.3Mb/sec (write)
DOS:	1.32Mb/sec (write); 5.22Mb/sec (read)
Drive cost (RRP, inc. VAT):	£289 (internal), £369 (external)
Media cost (RRP, inc. VAT):	£119
Media cost per megabyte:	11.1p per megabyte (assuming DOS formatted capacity of 1070.28Mb)

Jaz disk showing the record surface.

Unfortunately, FlashFile is a proprietary system - the tapes can only be read by Iomega tape drives and Iomega software. This criticism can be applied to tape on a more general basis - the way in which the tape is treated and files are compressed tends to vary from one piece of backup software to another. Having the same hardware and tape is no guarantee that you'll be able to read a particular tape - in nearly every case, you will need the same software that was used to create the archive. If that software was written for an older operating system, there is a fair chance it will not run under what your PC is running now. This can lead to obvious complications! If you're sending files on tape to a third party, you need to ensure that the recipient has access to the right tape drive/software and hence will be able to read it. If you plan to send data to other people on a frequent basis and are unsure of their hardware provision, you are best advised to invest in CD-Recordable. CD-R media can be read by any CD-ROM drive.

The Ditto Max is designed to be interfaced to a personal computer via its parallel port - as a result, it isn't suitable for use with Apple Macs (which don't have one!). Backup software and drivers are supplied for DOS and Windows 3.x/95. NT (3.51/4.0) drivers are available, but only as an option. The drive will offer up to 7Gb of capacity on special tapes, which are longer than most cartridges so that more tape can be accommodated. That capacity is available only if compression is used, and then only if the files aren't that compressed anyway (text files, bitmap images and so on). Without compression - i.e. native - each Ditto Max-specific cartridge will store 3.5Gb. If you to maximise tape capacity, you will need a fast machine because the Ditto Max compression system is software-based. Iomega recommends a 150MHz (or faster) Pentium-based PC under such circumstances.

Fortunately, you have to rely on the Ditto Max cartridges - which are somewhat expensive. In addition to the 30.7Gb variant, we have cheaper types with capacities of 3 and 5Gb. The devices Omnitray tape drawer will also accept standard-sized tapes, and indeed Ditto 2Gb and QIC-3020 'Easy (Travan TR-3) tapes are on the compatibility list. Unfortunately, these two can only be read from - and not written to! Handy, I suppose, if you want to read from older backups - or somebody elses' tapes, if you have the same backup software. That, however, is as far as it goes; other popular quarter inch cartridge (QIC) tape formats, such as Travan TR1, QIC-40 and QIC-80 should not be used at all. Iomega claims that such tapes could damage the head assembly on the Ditto Max. The same applies to cleaning cartridges - you can only use a special Ditto Max one sold by Iomega itself.

The Ditto Max works in a fashion similar to that of other QIC system. Inside the drive is a capstan and rubber wheel directly driven by a stepper motor. During operation, this rubber wheel engages with another one built into the tape cartridge, with the tape sandwiched between them. The driven wheel rotates, and drives the tape past at one of three constant linear speeds - 34, 68 or 85 inches per second, depending on the transfer rate and whether the drive is in seach mode. There are sixty tracks on the tape, which are written to or read by a thin-film head assembly. The tracks are selected by moving the heads up or down the tape vertically, by means of a worm gear coupled to a second stepper motor. Reference bursts on the tape are used to align the heads accurately to the tracks. The drive writes data to the tape using a technique known as modified frequency modulation (MFM) - this is also the recording system found in many hard disk drives. Recording takes place at 22 or 44 thousand flux reversals per linear inch, depending on the linear tape speed. On the back of the drive are a pair of DB25 connectors; courtesy of a pass-through feature, your printer can remain connected simultaneously.

You cannot, obviously, back up data and print at the same time. A PC connecting cable is supplied, as is a power supply unit and the simple-to-use software. Ditto Max did live up to its claims. Its certainly quite fast by tape standards, although rather slow when compared to some of the disk-based systems examined elsewhere. The FlashFile feature was undoubtedly useful - interestingly, *My Computer/ Properties* reckons that the 125Mb partition is, in fact 136Mb. Note that the FlashFile partition needs to be set up on the tape and formatted before use. There is an annoying wait when a tape is first inserted - the tape can be heard shuttling back and forth for well over a minute as the reference zero track is hunted down - during this time the FlashFile icon in the taskbar just winks at you. Note that Iomega also sells a slightly-uprated version of this product, known as the Ditto Max Pro. This will store 10Gb per tape if compression is employed, or 5Gb without.

Contact:

Iomega, (0800) 973194.

Web: `http://www.iomega.com`

Ditto tape system.

Performance - Ditto Max	
Windows 95, FlashFile:	0.09Mb/s (write), 0.09Mb/s (read)
Windows 95, regular backup:	Backup/verify 42.5Mb file 16 min 18 secs, average transfer rate 6.4Mb/min. Restore 42.5Mb file 7min 8 secs.
Average transfer rate:	6.6Mb/min
Drive cost (RRP, inc VAT):	£199
Media cost:	£30 (3.5Gb uncompressed/7Gb max. compressed)
Media cost per megabyte:	0.83p (assuming compression not used)
Software bundle:	Ditto Tools (drivers and backup software for DOS and Windows 3.x/95). NT Tools available as option.

Avatar Shark

This system, introduced comparatively recently, is effectively a removable hard disk system. As such, it shares many conceptual similarities to the Iomega Jaz. The disk, which is built into an enclosure with a protective shutter, consists of a single 2.5 inch-diameter aluminium platter coated on both sides by the magnetic media. Each disk will store up to 250Mb, against the 1Gb of the Jaz. The small platter size does, however, lead to performance benefits - average seek time, for example, is quoted as less than 12ms. Note that write protection is facilitated by means of a movable tab, rather than Iomegas somewhat more elegant software solution.

The Shark has been designed primarily for notebook computers. To this end, the interface takes the form of a PCMCIA card. Only Windows 95 is catered for - to the best of my knowledge, there are no versions for Windows NT, DOS or earlier versions of Windows. Nor do PCMCIA-equipped Apple Macintosh PowerBooks appear to be catered for. A parallel port interface is available as an option - data can thus easily be transferred between desktop and notebook by attaching the Shark via the relevant cable. The PCMCIA card, which employs a 16-bit interface, is faster than the parallel connection - manufacturer-quoted typical figures are 2Mb/sec for the former, against 1.25Mb/sec for the latter.

The Shark hardware is, as one would expect from a product designed for portable computers, compact and low in weight. As with the Zip and Jaz, the media is inserted into a slot at the front of the drive. Disk eject is software controlled, but there is also a rear-mounted eject button. Data transfer apart, the PCMCIA connection also supplies power to the Shark; the notebook PCs battery thus also powers the drive. Another power cable, which attaches to the notebooks external Mini-DIN (PS/2) keyboard socket (from which a 5V rail is available) is provided for occasions where the PCMCIA hardware is unable to provide sufficient current - presumably, the typical PCMCIA socket has its own voltage regulators. Power consumption is quoted as 3.3W (at 5V), but although this isn't much it will still impact battery life. Avatar recommend that the notebook should be powered by its mains adaptor whenever possible - we would not disagree with this!

Note that a mains power supply for the Shark is sold separately as an accessory - there is a dedicated socket on the back of the drive. The drive can be connected or disconnected without having to reboot the computer. Its good to see that Avatar has included some software on its media - which, incidentally, is referred to as a Hard Diskette. You get, amongst other things, a trial version of Microsofts Monster Truck Madness game. Of more practical benefit are backup, off-line Web browsing and virus scanning utilities. The parallel port add-on package consists of a driver, a cable/interface unit (with printer pass-through) and a pair of power cables that allow the Shark to be powered from a PS/2 or standard DIN A keyboard socket (note that a trailing socket allows the keyboard to remain connected). The interface caters for standard parallel ports - ECP or EPP compatibility is not essential.

We did have some problems with Shark when attempting to connect it to a notebook via PCMCIA - Avatars claim that the system installs in less than 3 minutes was not justified in our experience. Although the software installed fine, the Shark was not recognised at boot-up - an extra drive letter should be added. Strangely, removing and then re-inserting the Shark PCMCIA card while the PC was running got things moving - the drive icon then appeared in My Computer and we were able to access the data on it.

The Shark should be fast, considering that its based on hard disk technology. Our results were not that impressive - perhaps this has something to do with the notebook that was partnered with the drive. A 486DX33 with 8Mb of RAM doesn't exactly run Windows 95 particularly quickly or smoothly. That said, the elderly notebook in question did at least have a PCMCIA slot. Use the parallel port interface, and the data rate is roughly halved; as a result, files take about twice as long to copy from the Shark to the hard disk and vice versa.

Software bundle: Windows 95 drivers; Microsoft Monster Truck Madness (game); McAfee WebScan (virus protection); McAfee PCCrypto (encryption); DocuMagix HotPagePlus (off-line browsing); NovaDisk Lite (backup); Blaze Barking Cards (animated Internet postcards), Adobe Acrobat Reader

Contact: Nexus Peripherals, (01491) 413663.
Web: `http://www.nexusp.com` or `http://www.goavatar.com`
Next month, we'll look at disk-based systems from Panasonic, Syquest and the LS-120/SuperDisk, plus tape-backup hardware from Hewlett Packard and Danmere.

Performance - Shark	
Windows 95, PCMCIA interface:	0.78Mb/sec (read), 0.86Mb/sec (write). Note that others with more advanced machines than the test model (486DX33/8Mb) have reported faster throughputs.
Drive cost (RRP, inc. VAT):	£176.19
Media cost (RRP, inc. VAT):	£32.89
Media cost per megabyte:	13.2p

Shark system plugged into a laptop.

RESEARCH NEWS

New Photonic Bandgap Structures For Optical Fibre Communications

Dr Chris Lavers looks at the possibility of optical computers.

There has recently been rapid progress in the fabrication of optical Photonic Band Gap (PBG) structures driven by the very real and exciting possibility of developing the first generation of all optical computer, and for switching light emission within active electro-optic devices such as LEDs and lasers. PBG structures are devices that have an extremely fine periodic structure with a pitch of the order of the wavelength of radiation used. Such PBG structures can route, reflect and filter specific narrowband wavelengths of light. For many years, researchers in optical communications have been striving to make compact optical circuits based on these structures for applications such as demultiplexing adjacent wavelength channels in communications. Although these PBG devices have been demonstrated in the infra red, researchers at the University of Southampton, UK have just designed and demonstrated the existence of an optical band gap device in the visible region of the spectrum. By incorporating a PBG within an optical waveguide, the efficiency and usefulness of a device may be improved significantly. Martin Charlton of the Department of Electrical and Computer Science at Southampton University says, "To our knowledge, this was the first ever demonstration of a visible photonic band gap confined in a waveguide structure."

Construction

PBG's are etched into a planar waveguide, and consist of a triangular array of air holes or microscopic 'pores' etched through the cladding and core of a silicon nitride waveguide. The cross section through an isolated 'bridge' waveguide structure is shown supporting a guided mode with close packed pores (Figure 1). The waveguide core is completely undercut forming an air cavity below the 'lattice' region. This device has a major design advantage that there are now identical mediums on each sides of the PBG lattice. Not surprisingly, bridge waveguide structures are extremely fragile and may collapse if too large. Charlton and fellow workers have successfully created bridge devices having over 20 lattice periods and an air filling fraction of 60%. The porous honeycomb of silicon dioxide which provides the support for the waveguide core in Figure 1 is shown and in close up in Figure 2, some of the silicon dioxide cladding layer has been removed to reveal a section of the silicon nitride waveguide core. The pore diameters are 135nm in the silicon nitride waveguide core and 250nm in the lower silicon dioxide buffer layer. The quality of the pores is extremely well defined, with extremely straight pore walls.

The waveguide consists of thermally grown 1.8μm thick silicon dioxide substrates (refractive index, n=1.46), and a 250nm thick silicon nitride waveguiding layer (n=2.02) deposited by Low Pressure Chemical Vapour Deposition (LPCVD) and a thin (75nm-180nm) silicon dioxide cladding layer, also LPCVD deposited. Wafers were then patterned by directly written electron beam lithography and plasma etched to create wells extending down to the core/buffer interface. The wafers were finally cleaved into individual devices. Pores could be fabricated between 50-120nm using standard processes, but considerable expertise was required in the lithography and plasma etching processes to expand the pores outside of this range. Mark Charlton and his team at Southampton are now able to fabricate good quality pores with diameters in the range 50-200nm at a pitch of 260nm through waveguide structures over 500nm thick.

In a conventional waveguide, light is confined within a high refractive index region surrounded by a lower refractive index dielectric cladding (both usually glass materials) by the process of total internal reflection. To permit transmission across a PBG device at wavelengths outside the bandgap, it is necessary to ensure that the effective refractive index of the core is greater than that of the cladding and any buffer layers which separates the silicon substrate from the nitride core.

The silicon nitride waveguide completely blocks TE polarised red and yellow light whilst transmitting other colours, such as green. In Figure 3 we can see some surprising diffraction effects, (i) with incident red light (632.8nm) being spectacularly split by a 60 lattice periods structure into six equal intensity output beams, acting as a redundancy switch. Three beams are transmitted across the device, two beams are reflected backwards, and a third is reflected back along the input beam path. The effect is due to zero order 2-dimensional diffraction from lattice symmetry planes. (ii) In the second case with yellow wavelength radiation (594nm) the transmitted beam is abruptly blocked, and (iii) in the green wavelength state (545nm) transmission through the photonic bandgap is clearly visible.

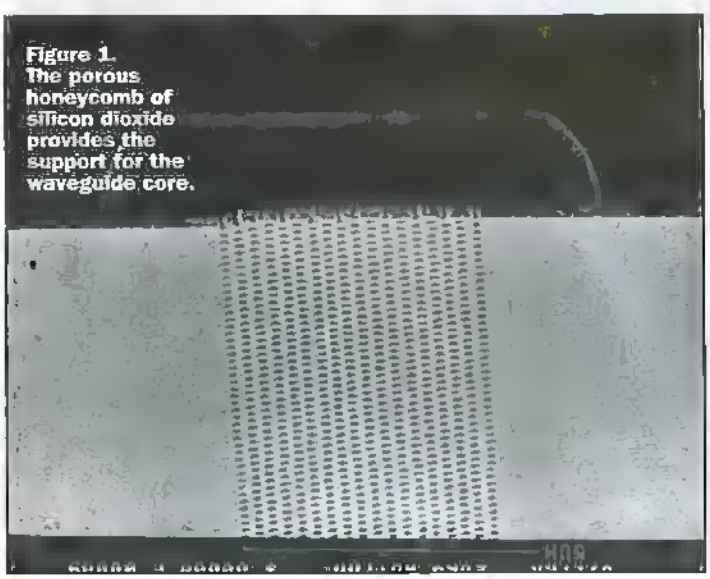


Figure 1. The porous honeycomb of silicon dioxide provides the support for the waveguide core.

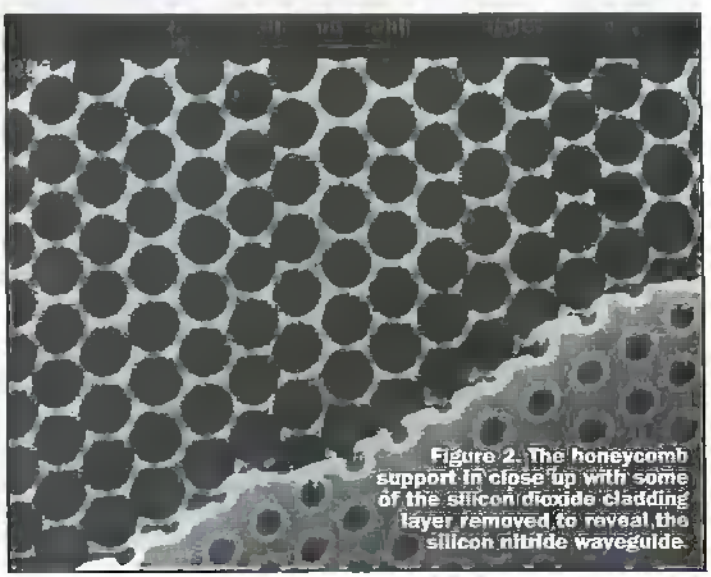


Figure 2. The honeycomb support in close up with some of the silicon dioxide cladding layer removed to reveal the silicon nitride waveguide.

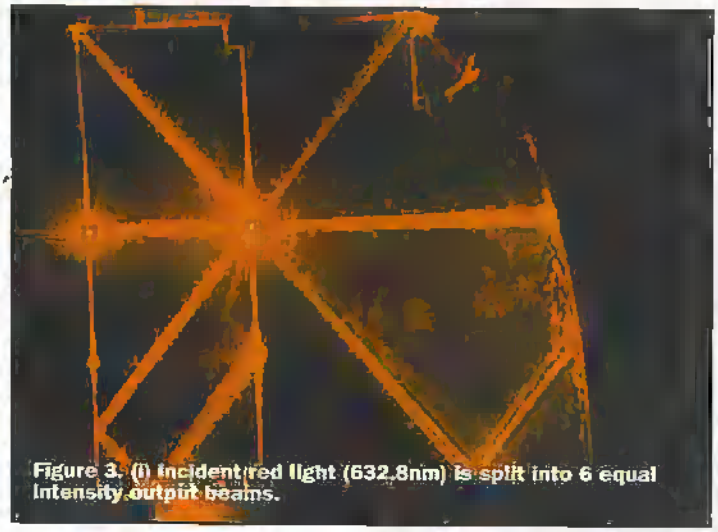


Figure 3. (i) incident red light (632.8nm) is split into 6 equal intensity output beams.

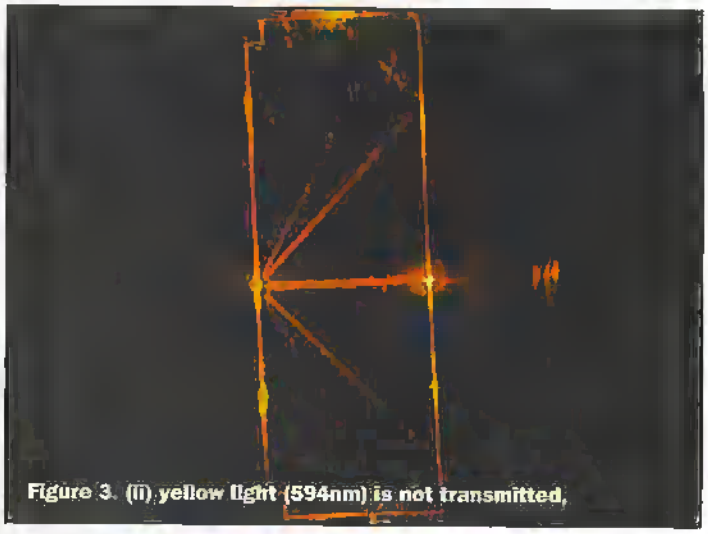


Figure 3. (ii) yellow light (594nm) is not transmitted.

Application

Charlton constructed a device consisting of 2730 rows of air pores (radius 200nm) with a 40% air filling fraction, arranged on a triangular lattice (pitch 300nm), in a strip across a single mode silicon nitride waveguide (core thickness 250nm). He demonstrated a useful PBG polarisation dependence in the visible. In Figure 4 we view the device directly from above. Red light from a Helium-Neon laser operating at 632.8nm is end-fire coupled into the device perpendicular to the PBG strip (left to right in the picture). The red path is revealed due to micro-scattering effects in the waveguide from defects at the core/cladding interface and impurities. It is clear that TM polarised light (with the magnetic field in the plane of the surface) on the left of the diagram is strongly transmitted as a single beam, but TE polarised light (with the magnetic field perpendicular to the surface) on the right is completely blocked by the device. TE polarised light is either scattered vertically out of the waveguide, or reflected back along the incident beam path. Some debate about the likely loss mechanism exists, but the latter is most plausible as there is little visible increase in scattering. Replacing the fixed wavelength with a tuneable dye laser, single strong beam transmission extends down to 575nm, strengthening the conclusion that scattering is not responsible.

The Southampton group have demonstrated the successful fabrication of extremely unusual PBG waveguide designs. Useful applications for PBG structures are now emerging fast, and it is clear that many will require a planar waveguide geometry compatible with present Very Low Scale Integration (VLSI) technology. Eventually, the monolithic integration of optical waveguide devices, with detector and preamplification circuitry, may lead to hybrid opto-electronic circuits. Although these results are in the visible region of the spectrum, Martin Charlton's nano-fabrication processes and material systems are suitable for operation in the infra-red, covering all the major optical communications windows and proposed optical computing applications.

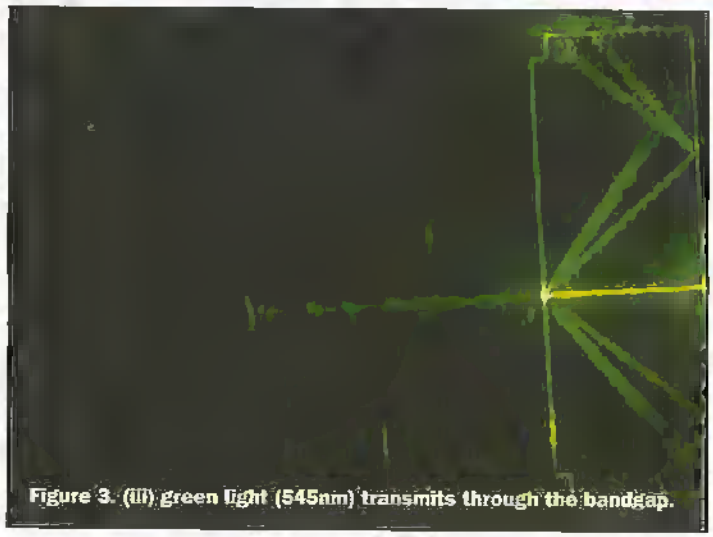


Figure 3. (iii) green light (545nm) transmits through the bandgap.

Natural occurring

The natural world often has the last word on what man may design. It has been found recently that PBG surfaces exist in nature, such as in the surface structure of a butterfly wing, which generates beautiful iridescent patterns to the keen observer. Similar structures have also been found in single-celled algae and in certain mineral classes. Light scattering from biological surfaces behaves in a similar way to the light within a waveguide containing a PBG structure. Electron microscopy studies have shown that for natural bandgaps to exist in the visible requires a hole to hole periodicity of about 0.2 to 0.3 microns which is current state-of-the-art man-made technology, usually only generated by writing with an electron beam!

Pictures courtesy of Martin Charlton Dept of Electronics and Computer Science, University of Southampton.

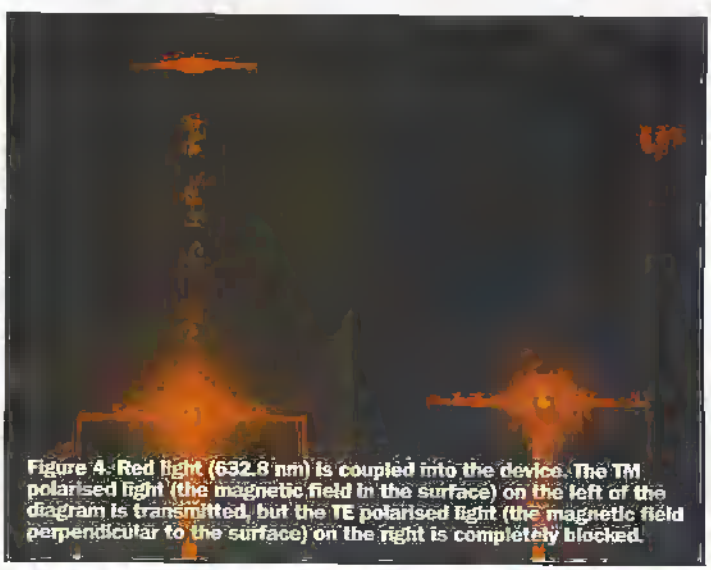


Figure 4. Red light (632.8 nm) is coupled into the device. The TM polarised light (the magnetic field in the surface) on the left of the diagram is transmitted, but the TE polarised light (the magnetic field perpendicular to the surface) on the right is completely blocked.

Forthcoming Electronics and Electronics Related Conferences

The 4th Sensor and Transducer Conference will be held at the National Exhibition Centre, Birmingham, UK on February 17th-18th, 1999 alongside the mtec'99 exhibition, the UK's leading event dedicated wholly to sensors, measurement and instrumentation. Topics will include: Gas Sensors and Analysers, Vibrational and Displacement Sensors, Advances in Sensor Signal Processing, Silicon Sensors, and Microfabrication Techniques. Further information may be found by Faxing: 01822 841300 or Telephone: 01822 840434.

Following the success of meetings in Amsterdam and Hamburg, the CLEO/Europe EQEC'98 conference will be held in Glasgow between 14th-18th September 1998. The combined conferences will bring together scientists and engineers from both academia and industry. The Conference on Lasers and Electro-Optics (CLEO) and the European Quantum Electronics Conference (EQEC) provides a joint forum for discussing recent advances in a wide spectrum of electronics topics for applications in engineering, industry, science and medicine. Further details may be found at http://www.iop.org/IOP/Confs/CLEO.

RadioScape DAB RECEIVER

Dr Gavin Ferris (Radioscape Ltd.)

RadioScape is a UK company, dedicated to the production of software systems for digital broadcasting. Over the last twelve months, RadioScape has developed the revolutionary Softceiver™ engine, which allows Digital Audio Broadcasting (DAB) signals to be demodulated and decoded on Windows-based PCs. By replacing most of the dedicated hardware requirements of a DAB receiver, RadioScape solution makes possible the volume production of low-cost plug-in cards for digital radio on the PC platform.

History

RadioScape Ltd. was founded at the end of 1996 by Peter Florence and Dr. Gavin Ferris to develop wireless data products and services, both men have extensive experience of management and software development and have known each other for many years whilst working in the UK and USA. At RadioScape, Dr. Ferris pioneered the concept of the PC-software DAB receiver. He is the architect of RadioScape Softceiver™ engine.

Business Focus

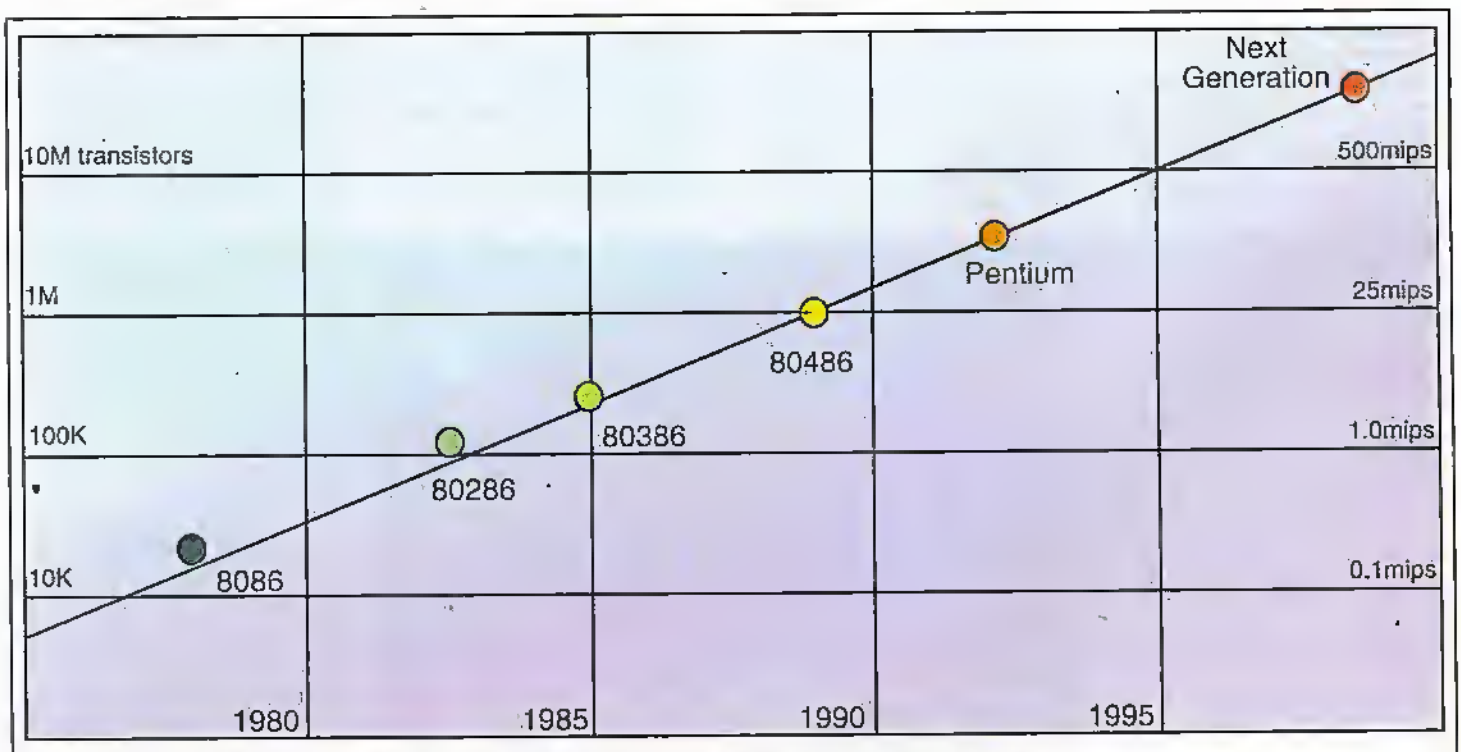
RadioScape core expertise is the production of software for digital broadcasting, and in particular the development of code for the Eureka 147 Digital Audio Broadcasting (DAB) system. RadioScape believes that DAB ability to deliver data, in addition to high-quality audio, wirelessly at up to 10 times the rate of ISDN, is very significant, and has plans for a staged series of products that will exploit the opportunity of DAB audio and data services on the PC platform.

Products

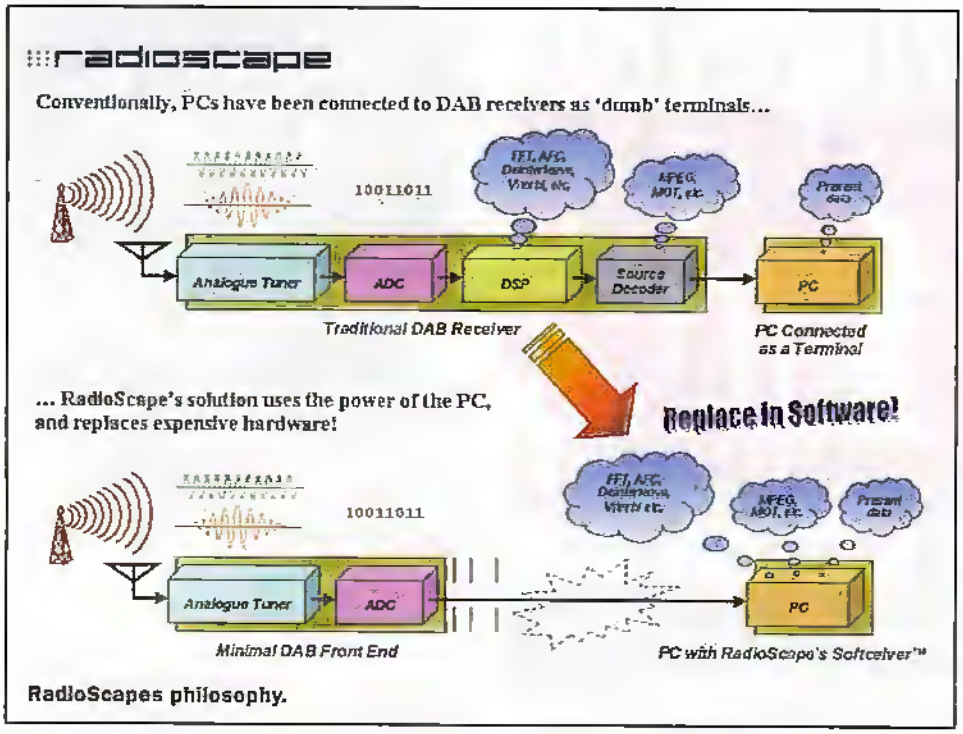
RadioScape's core product, the DAB Softceiver™, is a full, real time PC software implementation of all the DAB demodulation and decoding functions normally implemented on a dedicated DSP in a receiver. The system consists of a PCI card and software for the PC, running under Windows 95, 98 or NT. The PCI card includes an on-board DAB tuner covering VHF band III and L-band. The software includes an interactive, real-time GUI for control of the receiver and display of graphical metrics. With this breakthrough, RadioScape is able to offer a low cost route to DAB reception on the PC, requiring only an analogue tuner and ADC on the plug-in card, with all the signal processing 'intelligence' for DQPSK, Viterbi etc. being done in software on the Wintel side. RadioScape is currently in licensing discussions with manufacturers. A test receiver being the first product to be released will offer:

- full DAB compliance (ETS 300 401), including MOT, TII, and dynamic multiplex reconfiguration.
- VHF band III and L-band operation, modes I-IV.
- interactive, real-time GUI.
- software API (C++ and scripting), with access to all levels of the signal demodulation chain – allows engineers to write *custom metrics*.
- extensive library of DAB metrics supplied.
- full error logging (CRC, BER, etc.).
- alarm monitoring with relays on PCI card.
- mobile data gathering mode for automated signal coverage testing.
- support for all audio modes with output through the PCs audio card.
- whole-multiplexed demodulation on suitable PCs with the ability to store and retrieve data/metrics to disk.
- rack mount, desktop and mobile form factors.

With a conventional, hardware based receiver, you are limited to a small number of signal analysis metrics, which are usually computed at the source level (CRC checks etc.). By contrast, RadioScape's software-based test receiver is an open, extensive platform. A large library of analysis metrics is supplied, covering low-level DSP as well as high level monitoring, plus the user can add their own metrics to the receiver using RadioScape's C++ or scripting APIs. This allows the user's software to receive real time data feeds from any point in the DAB signal processing chain, and provides maximum flexibility.



Moores' Law - for every 18 months, the processing power for a given amount of money doubles.



RadioScapes philosophy.

On modern PCs, the Softceiver can decode a full 192kbps stereo audio subchannel at protection level 3 (including the MPEG I layer II audio render), keep track of the FIC and maintain synchronisation, all in around 10-15% core CPU usage. This allows it to run comfortably as a background task, so the user can enjoy high quality radio and/or data services delivered to his or her desktop while word processing, surfing the Web, or performing other tasks. (Of course, the process-intensive part of our software is all done in highly optimised MMX assembler).

The use of general purpose hardware to perform demanding DSP tasks (such as DAB demodulation) requires lots of processing

radioscape

RadioScape Software.

power. For DAB, both the FFT and Viterbi decode are serious MIP consumers. Fortunately, Moore's Law is on the side of the software solution – for every 18 months the processing power for a given amount of money doubles. It was only comparatively recently that PCs became powerful enough to decode DAB in real time (a 133MHz MMX Pentium is needed to run the Rasdioscape software).

There is a 'car radio' style UI (see above), and the ability to feed a Web browser, for data carousel display.

Further Information

You can find our more info website
http://www.radioscape.com

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Microcontroller DEVELOPMENT USING THE STAMP

ARCHITECTURE FUNDAMENTALS

PART 3

Application Development

Over the last two months we have taken a detailed look at the BASIC STAMP microcontroller architecture. These single chip computer devices can be programmed using a dialect of BASIC. Here Stephen Waddington previews a series of applications based on the BS1 and provides an insight into microprocessor development.

I feel like a patient in a self-help therapy group. Since I discovered the STAMP family of microcontrollers my life has changed. Stop laughing, it's true. If you had spent more that ten years trying to get to grips with programming PIC, Motorola or Hitachi microprocessors, the STAMP is a revelation.

The STAMP devices are literally self-contained computers. The STAMP comes in two flavours; BASIC STAMP 1 (BS1) and its more sophisticated counterpart the BASIC STAMP 2 (BS2). Each device includes a 5V voltage regulator, microprocessor, crystal clock, brownout control circuitry, serial EEPROM, and a PBASIC interpreter.

Development Environment

STAMP devices can be programmed using a dialect of BASIC, called Parallax BASIC (PBASIC). And as they are EEPROM based they can be programmed and re-programmed as many times are you like. Even better is the fact that the development environment and the devices themselves are relatively inexpensive. It's possible to get started with a prototyping board, development software and STAMP device for under £100 – see Buyers Guide at the end of this article.

STAMP microcontrollers have fully programmable I/O pins that can be used to directly interface to TTL-level devices, such as buttons, LEDs, loudspeakers, and potentiometers. And with just a few extra components, these I/O pins can be connected to typically non-TTL devices, such as solenoids, relays, RS-232 networks, and other high current/voltage devices.

Last Month

Last month we looked at how to use the BASIC STAMP 1 for digital input and output. We also examined some more unusual forms of I/O, namely the use of switches and the STAMPs de-bounce features, pulse width modulation (PWM), serial communication, audio output and pseudo-A/D conversion enabling the use of potentiometers in control applications.

Throughout this series we have focussed on the BS1. Making the transition to the BS2 is a straightforward task. Aside from the increased performance capability of the BS2, there are only a few register addresses and BASIC instructions that are different between the two devices.

Application Development

In this feature we are going to take a look at the hardware and software aspects of a series of application circuit examples incorporating the BS1. This should provide you with a reasonable idea of how STAMP solutions can be develop and should also provide an insight into developing software.

All of the application examples detailed here are discussed in greater depth in the BASIC STAMP Manual which can be downloaded from the Parrallax Web site – please refer to the list of resources at the end of this feature for further information. The BASIC STAMP Manual provides comprehensive hardware and software information for both the BS1 and BS2 as well as more than twenty application examples for each device.

Debug

But before we dive into application examples, I want to cover a command in detail that I omitted last month. The DEBUG command can be used at any point within a PBASIC programme. A series of sample command uses are shown below:

```
DEBUG b2   Print "b2 = " + value of b2
DEBUG $b2  Print value of b2
```

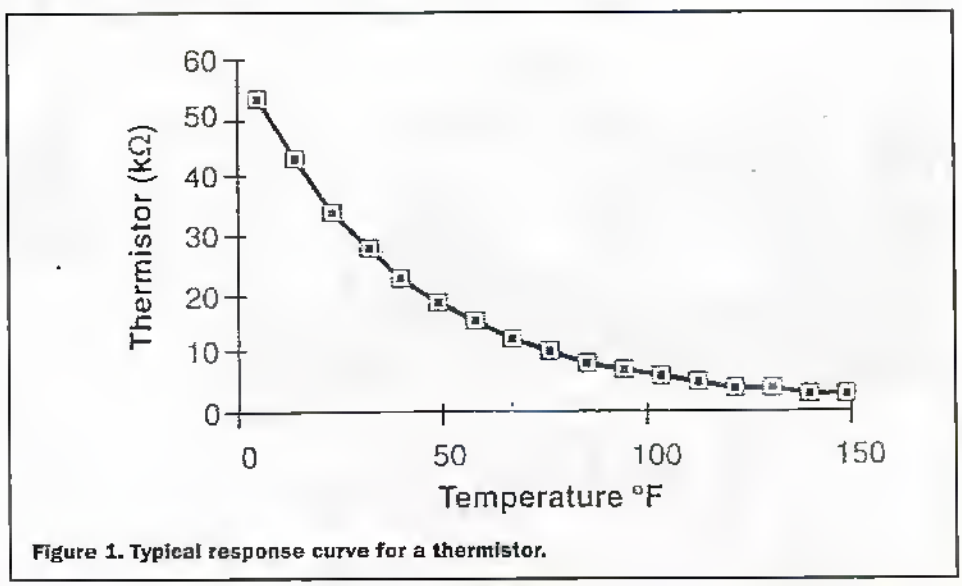


Figure 1. Typical response curve for a thermistor.

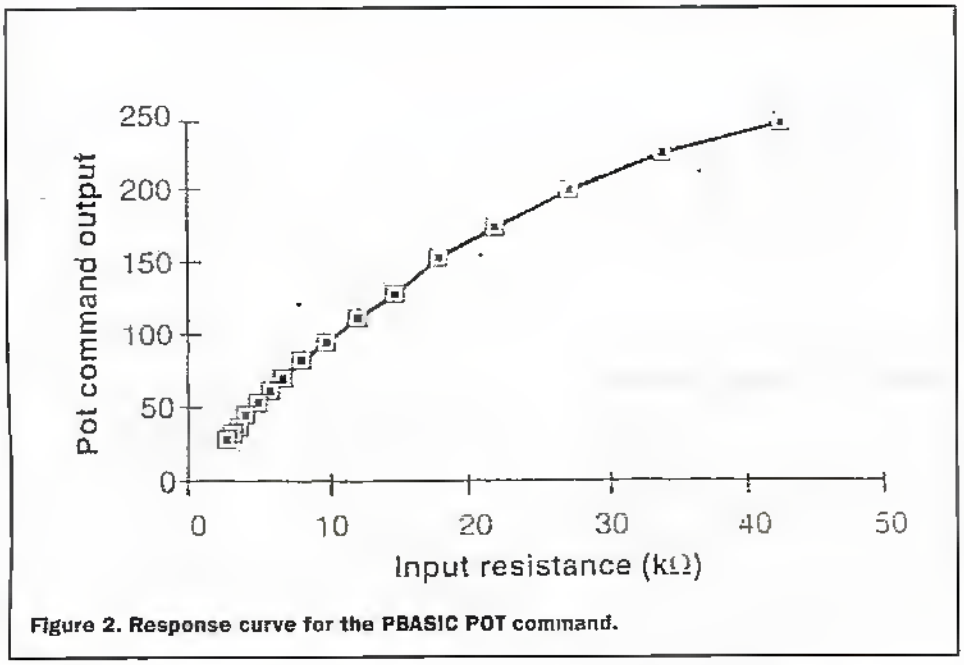


Figure 2. Response curve for the PBASIC POT command.

```
DEBUG "reading is ",b2
Print "reading is " and value of b2

DEBUG #%b2 Print value of b2 in binary
DEBUG #$b2 Display the ASCII character
corresponding to the value in b2

DEBUG "inputs ", b2, b3, cr
Print "inputs", value of b2, value of
b3 and carriage return
```

The DEBUG command allows the programmer to determine information about variables within the programme at any point during a programme cycle. The data relating to a specified variable is displayed in a window of the connected PC. Debug only works after a 'run'<ALT>-<R> download has finished and the host PC must be connected to the STAMP device.

The ability to watch a programme as it executes invaluable for STAMP software development and is one of the major benefits that STAMP devices have over using standard PICs.

STAMP Senses

We examined just about every form of input and output last month. But there are more. Using the POT command its possible to measure the value of a linear resistance. This means the STAMP can be used to determine light, movement, temperature and sound levels. The last two measurements are more of a challenge. This is because audio or temperature transducers do no alter their resistance linearly with sound. Some clever mathematics is required.

Maplin offers a whole series of inexpensive and relatively precise thermistors. The device's resistance decreases as the temperature increases, but this response is not linear. Data sheets provided with the thermistor package detail the resistance at various temperatures in degrees Celsius (°C) and Fahrenheit (°F). The left hand graph of Figure 1 shows the general shape of a typical thermistor response curve in terms of the more familiar Fahrenheit scale (°F).

The POT command, while it responds in a basic linear fashion, has a curve of its own, as shown in Figure 2. Though not as pronounced as the thermistor curve, it must be figured into our temperature calculations in order for the results to be usable.

One possibility for correcting the combined curves of the thermistor and the POT command would be to create a lookup table in the STAMP's EEPROM. The table would have to be quite large to cover a reasonable temperature range at a 1° precision. An alternative would be to create a smaller table at 10° precision, and figure where a particular reading might lie within its 10° range. This is interpolation, and it can work quite well, although it would still use quite a bit of the STAMP's limited EEPROM space, though.

Alternative Approach

Another approach, the one used here, is to use a power-series polynomial equation to model the relationship between the potentiometer reading and temperature. This is easier than it sounds, and can be applied to many non-linear relationships.

The first step is to create a table of a dozen or so inputs and outputs. The inputs are resistance measurements and outputs are temperatures in Fahrenheit. Resistance values in this case are numbers returned by the POT function. To equate POT values with temperatures, connect a 50kΩ potentiometer and a 0.01µF capacitor to the STAMP. Obtain a scale factor by using the POT configuration routine described last month and in the BASIC STAMP Manual.

Next, watch the POT value change as the potentiometer is adjusted. To do this disconnect the potentiometer from the STAMP and hook it up to an ohmmeter. After setting the potentiometer to 33.89kΩ (corresponding to a thermistor at 23°F or -5°C), reconnected it to the STAMP and log the resulting reading. Do this for each of the calibration values on the back of the thermistor package, up to 149°F (65°C). You'll find a hair dryer, a blow torch and a freezer will be invaluable to help you complete this exercise.

The equation that can approximate our non-linear temperature curve is:

$$\text{Temperature} = C0 + C1 \times (\text{Pot Val}) + C2 \times (\text{Pot Val})^2 + C3 \times (\text{Pot Val})^3$$

Where C0, C1, C2, and C3 are coefficients supplied by analytical software, and each Cn x (Pot Val)^n is called a term.

The equation above has three terms, so it is called a third-order equation. Each additional term increases the range over which the equation's results are accurate. You can increase or decrease the number of terms as necessary, but each additional coefficient requires that Pot Val be raised to a higher power. This can make programming messy, so it pays to limit the number of terms to the fewest that will do the job.

The software that determines the coefficients is called GAUSFIT.EXE and is available from the Parallax Web site—see resource list at the end of this article for further information. To use it, create a plain text file called GF.DAT. In this file, which should be saved to the same subdirectory as GAUSFIT, list the inputs and outputs in the form in, out <return>. If there are values that require particular precision, they may be listed more than once.

To run the program, type GAUSFIT n where n is the number of terms desired. The program will compute coefficients and present you with a table showing how the computed data fits your samples. The fit will be good in the middle, and poorer at the edges. If the edges are unacceptable, you can increase the number of terms. If they are okay, try re-running the program with fewer terms. We were able to get away with just two terms by allowing accuracy to suffer outside a range of 50°F to 90°F.

The coefficients that GAUSFIT produces are not directly useful in a BASIC STAMP program. Plug the values into a spreadsheet and compute temperatures from pot values and then started playing with the coefficients. The problem that remains is how to use these values in a STAMP program. The following coefficients worked almost as well as the originals: C0 = 162, C1 =–1.12, and C2 = 0.0024.

The STAMP deals in only positive integers from 0 to 65,535. The trick is to express the numbers to the right of the decimal point as fractions. For example, the decimal number 0.75 can be expressed as 3/4. So to multiply a number by 0.75 with the BASIC STAMP, first multiply the number by 3, then divide the result by 4. For less familiar decimal values, it may take some trial and error to find suitable fractions. But for example, the 0.12 portion of C1 is equal to 255/2125, and that C2 (0.0024) = 3/1250.

But just substituting the fractions for the decimal portions of the formula still won't work. The problem is that portions of terms, such as 3 x Pot Val2/1250, can exceed the 65,535 limit. If Pot Val were 244, then (3 x 244)2 would equal 178,608; too high. The solution is to factor the coefficients and rearrange them into smaller problems that can be solved within the limit. For example (using PV to stand for Pot Val):

$$PV \times PV \times 3/1{,}250 =$$
$$PV \times PV \times 3/(5\times5\times5\times5\times2) =$$
$$PV/25 \times PV \times 3/50$$

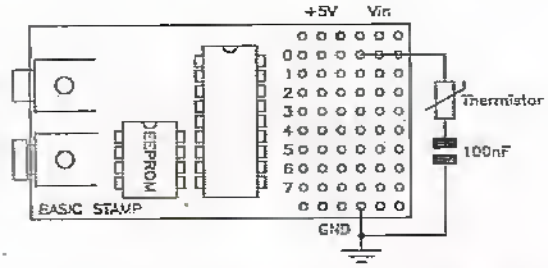


Figure 3. Circuit diagram for the electronic thermistor using the BS1.

The program in the listing is an example of just such factoring and rearrangement. Remember to watch out for the lower limit as well. Try to keep intermediate results as high as possible within the STAMP's integer limits. This will reduce the effect of truncation errors (where any value to the right of the decimal point is lost).

The finished program, which reports the temperature to the PC screen via the debug command, is deceptively simple. An informal check of its output found that it tracks within 1°F of a mercury/glass bulb thermometer in the range of 60°F to 90°F. Additional range could be obtained at the expense of a third-order equation; however, current performance is more than adequate for use in a household thermostat or other non-critical application. Cost and complexity are far less than that of a linear sensor, precision voltage reference, and analogue-to-digital converter.

If you adapt this application for your own use, component tolerances will probably produce different results. However, you can calibrate the program very easily. Connect the thermistor and a stable, close-tolerance 100nF capacitor to the STAMP as shown in Figure 3. Run the program and note the value that appears in the debug window. Compare it to a known accurate thermometer located close to the thermistor. If the thermometer says 75 and the STAMP 78, reduce the value of C0 by 3. If the thermometer says 80 and the STAMP 75, increase the value of C0 by 5. This works because the relationship between the thermistor resistance and the temperature is the same, only the value of the capacitor is different. Adjusting C0 corrects this offset.

```
Symbol co0     = 162
Symbol co1top  = 255
Symbol co1btm  = 2125
Symbol co2bt1  = 25
Symbol co2top  = 3
Symbol co2btm  = 50

'Program loop
Check_temp:
pot 0,46,w0 '46 is the scale factor.

'Remember that STAMP maths is computed
left to
'right with no parentheses and no
precedence of
'operators.

let w1 = w0*w0/co2bt1*co2top/co2btm
let w0 = w0*co1top/co1btm+w0
let w0 = co0+w1-w0

debug w0

pause 1000 'Wait 1 second for next

goto Check_temp 'temperature reading
```

Robotic Applications

One of the most common uses for the STAMP devices is robotics. Here the devices are used to measure inputs and generate the pulse sequences required to control servos.

Figure 4 shows a typical servo. The three wires are +5V, ground, and signal. The output shaft accepts a variety of prefabricated disks and levers. It is driven by a geared-down motor and rotates through 90°C to 180°C. Most servos can rotate 90°C in less than a half second. Torque, a measure of the servo's ability to overcome mechanical resistance ranges from 20 to more than 100 inch-ounces.

To make a servo move, connect it to a 5V power supply capable of delivering an amp or more of peak current, and supply a positioning signal. The signal is generally a 5V positive-going pulse between 1 and 2ms long, repeated about 50 times per second. The width of the pulse determines the position of the servo. Since servos' travel can vary, there isn't a definite correspondence between a given pulse width and a particular servo angle, but most servos will move to the centre of their travel when receiving 1.5ms pulses.

Servos are closed-loop devices. This means that they are constantly comparing their commanded position (proportional to the pulse width) to their actual position (proportional to the resistance of a potentiometer mechanically linked to the shaft). If there is more than a small difference between the two, the servo's electronics will turn on the motor to eliminate the error. In addition to moving in response to changing input signals, this active error correction means that servos will resist mechanical forces that try to move them away from a commanded position. When the servo is not powered or not receiving positioning pulses, you can easily turn the output shaft by hand. When the servo is powered and receiving signals, it won't budge from its position.

Driving servos with the BASIC STAMP is straightforward. The instruction pulsout pin, time generates a pulse in 10ms units, so the following code fragment would command a servo to its centred position and hold it there:

```
servo:

pulsout 0,150
pause 20
goto servo
```

The 20ms pause ensures that the program sends the pulse at the standard 50Hz rate required by Servos.

Let's look at a more sophisticated servo control circuit. Figure 5, combined with the code below, uses two switches connected on pins 4 and 5 of a BS1 to control the direction a servomotor will turn. If neither switch is press the servo defaults to its centred position.

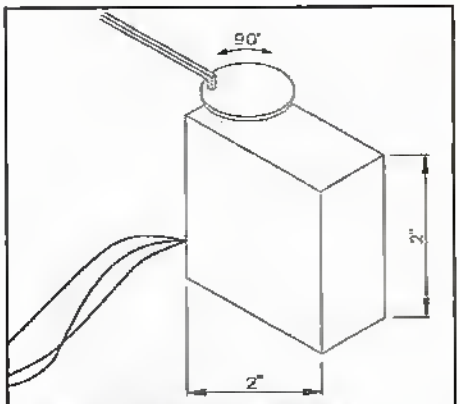


Figure 4. Typical servo showing rotational horn and three input leads.

```
dirs = %00001111

loop:
pulsout 0,150
pause 20

loop1
if pin 4 =1 then left
if pin 5 =1 then right

goto loop

left:
pulsout 0,75
pause 20
goto loop1

right:
pulsout 0,225:
pause 20
goto loop1
```

For information on controlling other types of motor, particularly stepper motors, check the BASIC STAMP 1 manual. Stepper motors lend themselves to STAMP control because of their reliance on digital signals to generate step patterns.

Serial Communication

When I spoke to Edward Buckley at Milford Instruments at the beginning of July, he told me that he was putting the final touches to a radio communication kit for the STAMP. This would provide a direct connection to the BS1 enabling serial data to be communicated back and forth. If you have a requirement to transmit data without cables between two points, the new wireless kit from Milford Instruments would be ideal. But there is another option. Why not build and infra red link?

With a few inexpensive parts from Maplin, you can communicate at 1,200 baud over distances greater than 10 feet indoors using infra-red. The circuit here can be modified for greater range by the use of a higher performance LED.

As the name implies, infra-red remote controls transmit data over a beam of infra-red light. To avoid interference from other household sources of infrared, primarily incandescent lights, the beam is modulated with a 40kHz carrier. Legend has it that 40kHz was selected because the previous

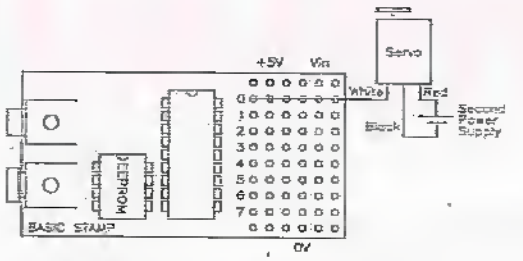


Figure 5. Diagram of STAMP servo driver.

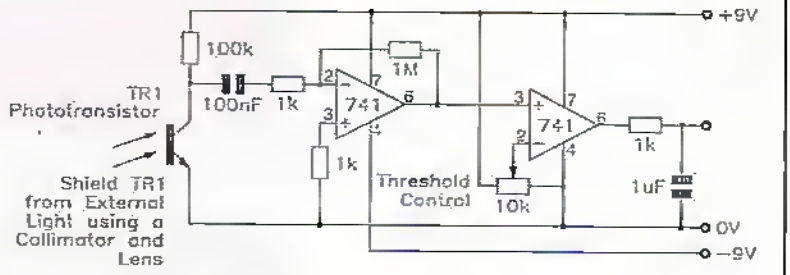


Figure 7. Infra-red serial data receiver using the STAMP.

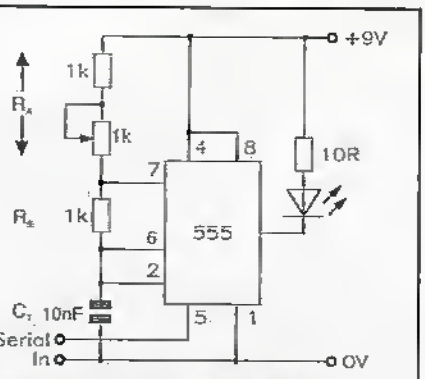


Figure 6. Infra-red serial data transmitter using the STAMP.

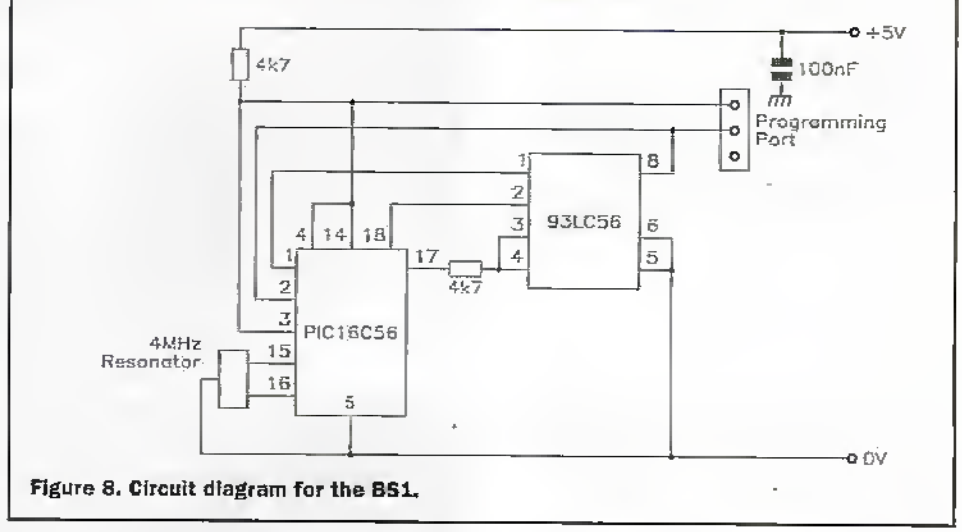


Figure 8. Circuit diagram for the BS1.

generation of ultrasonic remotes worked at this frequency. Adapting their circuits was just a matter of swapping an LED for the ultrasonic speaker.

The popularity of infra-red remotes has inspired several component manufacturers to introduce ready-made infra-red receiver modules. They contain the necessary infra-red detector, amplifier, filter, demodulator, and output stages required to convert a 40kHz infra-red signal into 5V logic levels. An alternative is to build a small discrete circuit from raw components as shown in Figure 6 to handle all the necessary filtering and demodulation. Figure 6 shows a infra-red transmitter, while Figure 7 shows its counterpart receiver.

For the transmitting end, all that is required is a switchable source of 40kHz modulation to drive an infra-red LED. That's the purpose of the timer circuit in the schematic. Putting a 'one' on the 555s reset pin turns the 40kHz modulation on; a 'zero' turns it off. You may have to fiddle with the values of R_A, R_B, and C_T. The formula is Frequency = $1.44/((R_A+2\ R_B)\ C_T)$.

With R_B at 1kΩ, the potentiometer in the R_A leg of the circuit should be set to about 600Ω for 40kHz operation. However, capacitor tolerances being what they are, you may have to adjust this potentiometer for optimum operation.

To transmit from a STAMP, connect one of the I/O pins directly to pin 4 of the 555 timer. If you use pin 0, your program should contain code something like this:

```
low 0 'turn off pin 0's output latch.

Output 0 'change pin 0 to output.
... 'other instructions

serout 0,ni200,("x") 'send the letter "x"
```

To receive with a PC, you'll need to verify that the PC is capable of receiving 5V RS-232. If you have successfully sent RS-232 from your STAMP to the PC, then it's compatible.

To transmit from a PC, you'll need to add a diode and resistor ahead of the 555 timer as shown in the schematic. These protect the timer from the negative voltage swings of the PC's real RS-232 output.

If you want more range or easier alignment between transmitter and receiver, consider using more or better LEDs. Some manufacturers' data sheets offer instructions for using peak current, duty cycle, thermal characteristics, and other factors to calculate optimum LED power right up to the edge of burnout. However, in casual tests around the work-shop, we found that a regular LED driven as shown could reliably communicate with a receiver more than 10 feet away. A simple reflector or lens arrangement might be as beneficial as an exotic LED for improving on this performance.

STAMP Tips

Believe it or not, owning a BS1 is not a pre-requisite to programming and building circuits based around the microcontroller. It's possible to cheat. Figure 8 shows the discrete circuit diagram of a STAMP microcontroller. All of the components that make up the device are standard parts. Given a piece a breadboard and little patience its possible to build the microcontroller from discrete parts.

And if you like short-cuts and tips here's another that enables the PIC16C58 to be programmed using PBASIC. Using a Parallax programmer its possible to insert a PIC16C58 into the programmer, in the place BS1. Then when instead of hitting <ALT>-<R> to run the code from the STAMP.exe file, hit <ALT>-<I>. The programmer menu then appears and after hitting <space> the BS1 code and interpreter code is downloaded to the PIC16C58.

I discovered these two nuggets of information after joining the Parallax STAMP mailing list. Details of how to sign-up are provided in the resource list at the end of the article. Being able to share ideas with people online is a superb way to learn. It's also an ideal place to discover the answers to questions if you get stuck with a piece of code.

Resources

The Web is packed with information relating to the STAMP environment. Visitors to the Parallax Web site at www.parallaxinc.com can download data sheets, instruction manuals and project examples.

Milford Instruments in Leeds is the UK distributor of STAMP products. You can reach the company by telephone on (01977) 683665, or write to Milford Instruments, Milford House, 120 High Street, South Milford, Leeds LS25 5AQ. Alternatively check out the Milford Instruments' Web site at **www.milinst.demon.co.uk.**

You can learn from other users that are developing on the STAMP environment, join the e-mail mailing list run by Parallax. To join this list simply send e-mail to majordomo@parallaxinc.com. and type 'subscribe STAMPs' in the body of the message. If you prefer, you can subscribe using the online subscription form on the Parallax Web site at **www.parallaxinc.com.**

Buyers Guide

Description	Code	Cost
BASIC STAMP 1 (BS1) Development Kit	NW23A	£98.70
BASIC STAMP 2 (BS2) Development Kit	NW25C	£122.20
BASIC STAMP 1 (BS1) Microcontroller	NW32K	£32.90
BASIC STAMP 1 (BS2) Microcontroller	NW33L	£51.70

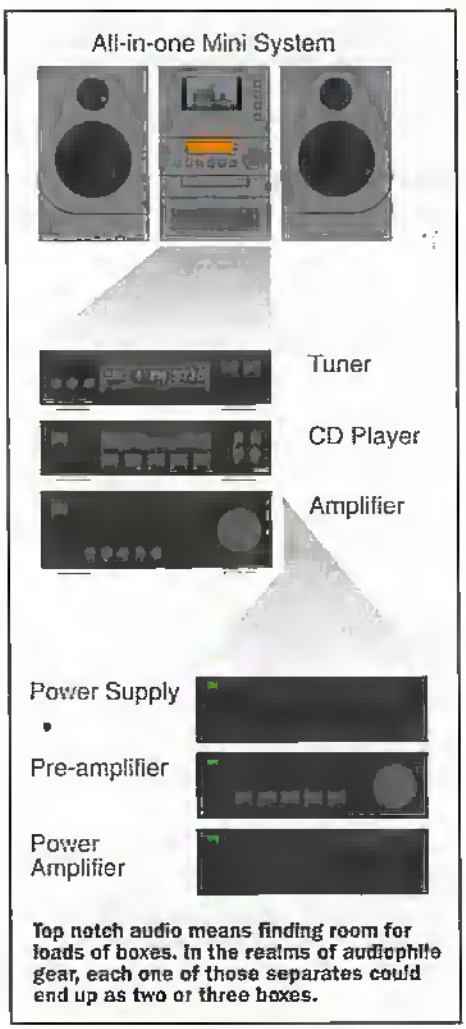
AUDIOPHILE HI-FI

PART 1

In part 1 Mike Bedford explains the meaning of audiophile hi-fi.

Courtesy of Radfords of Bristol.

This article is about hi fi and at the outset, let's make it quite clear that I'm not talking about those all-in-one midi, mini or micro systems which are frequently referred to as 'hi fis'. These are common or garden audio systems, they're not what I call hi fi equipment. Well, we're only two sentences into the article and already, I can imagine that many readers' hackles are rising at the suggestion that their audio systems don't produce true high fidelity music. OK, I do have to admit to taking something of a delight in making statements like this, but there's also a great deal of truth in what I've just suggested. Let's think about what the phrase 'hi fi' actually meant when it was first coined some decades ago. The meaning of the phrase was 'better than average sound quality'. So, if you weren't too critical about the music you stuck with a gramophone, a music centre or whatever, but if you aspired to a better quality of music, you splashed out on hi fi equipment. Well, things have changed – standard run-of-the-mill audio equipment is now far better than it was in the 60s and 70s. However, does that mean we can refer to it as hi fi? Not if the original meaning of the phrase is still valid. After all, the type of equipment which the majority of people listen is, by definition, average. So common sense tells us that it can't also be better than average as it would need to be to qualify for the 'hi fi' tag. So packaged mini systems might be infinitely better than 70s music centres but hi fi equipment is something quite different, as is the quality of the sound it produces.



Top notch audio means finding room for loads of boxes. In the realms of audiophile gear, each one of those separates could end up as two or three boxes.

In this article, we're going to be looking at true hi fi and by this I mean systems built up from separate components rather than bought as a single unit. And whereas most separates systems are better than most packaged systems, even this level of performance isn't the subject of this article. Our subject here is the absolute top-end of the hi fi market, a niche which is often referred to as audiophile hi fi.

Separates Systems

But before we get into the realm of audiophile equipment, let's spend a while thinking about why hi fi is synonymous with separates. Surely just putting the amplifier in a separate box from the CD player and putting the tuner in yet another box can't improve the quality of the sound which comes out of the speakers. Well actually, I suppose it can – screening will be much improved, for example – but there are much more fundamental reasons than this.

A major factor which causes people to go for separates rather than an integrated system is that of choice. Generally if you want the absolute best, you need to go to a specialist. Certainly many of the Japanese and Korean corporations make a passable job at manufacturing anything and everything from washing machines to audio gear to cars to oil tankers but, in the main, they don't produce absolutely top-notch gear. So if you want the best in audio equipment, you'd be better off going to a company which specialises in hi fi equipment. However, at the top-end, even hi fi equipment is a rather broad classification and many people believe that a company can't be the best at absolutely everything. Speakers, for example, require quite different design skills from CD players or amplifiers. So to get the very best you need to be able to mix and match, to go to a different company for your amplifier, your CD player, your turntable, your tuner and your speakers.

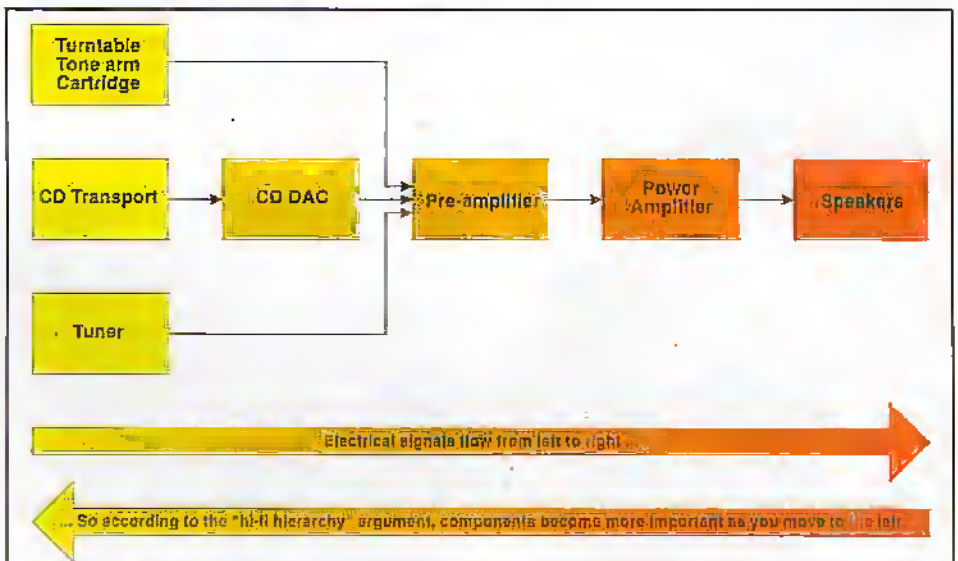
Whether it's a valid argument that no one company can excel in all parts of a hi fi system is open to debate. But even if single

companies can do everything well, choice is still a factor which favours separates. It's common for hi fi manufacturers to offer a range of amplifiers, a range of CD players and so forth, with a model to suit most pockets. So, if you're serious about listening to CDs but have only a passing interest in listening to the radio, you could choose a really good CD player but just an average tuner. With all-in-one systems this isn't possible – all the components tend to be matched in terms of quality and it's not hard to see why. Let's assume that a company has three different amplifiers, three different CD players, three different tuners, and three different sets of speakers. If they're selling these as separates, that's 12 different products to stock. If, on the other hand, they sell all-in-one systems and want to make every combination available, that comes to a massive 81 different systems to stock. A far more likely decision would be to put the bottom end components into one system, the mid-range components into another and the top-end parts into a third. That's just three products to stock but much reduced choice for the consumer.

Another major reason for picking separates is upgrade considerations. Let's assume that you have an integrated system and you decide that you'd like to upgrade the amplifier. Many of these integrated systems – even though they're designed to look like separates – are actually housed in a single box. So removing the amplifier in order to replace it with a better amplifier just isn't an option – not without resorting to a hacksaw, that is. OK, not all integrated systems are housed in single boxes, some come in separate boxes just like true hi fi separates, even though you buy them as a job lot. There's still a problem in upgrading, however, albeit one which is now commercial rather than physical. Just as you'll have bought everything together, so anyone you might consider selling components to would probably only be interested in buying the whole lot. Without a doubt, even if you did manage to sell a single component, the price you'd get would be derisory. So one way or another, upgrading individual parts just isn't viable with all-in-one systems.

Which is the Most Important Component?

One question which has exercised the minds of hi fi enthusiasts to a significant extent is which of the component parts of a separates-based system is the most important. And whereas this applies to ordinary hi fi systems, not just the ultra top-end systems which are the subject of this article, we'll be building on the principles. Of course, the question doesn't relate to components which aren't used simultaneously – this would be a pointless question. Whether a CD player, turntable or tuner is the most important depends on whether you prefer listening to CDs, vinyl records or radio programmes. What the question does relate to, of course, is those components which are in use at the same time. So, for example, in listening to a CD, which is the most important – the CD player, the amplifier or the speakers?



Which is the most important component in a separates based hi fi system. The hierarchy argument suggests that the sources are the most important.

NAIM 52 pre-amplifier...

In the early days of hi fi separates, most enthusiasts would have suggested that the speakers were the most important component, followed by the amplifier with the sources – the turntable and tuner – being the least important. What the justification for this view was is rather hard to say. I guess the only plausible explanation is that if you go for an expensive amplifier or speakers, this will affect the sound quality of everything you listen to whereas an expensive tuner would only benefit radio reception and an expensive turntable would only make a difference if you were listening to records.

Today, the tables have been turned and the consensus of opinion is that the sources are the most important, followed by the amplification, followed by the speakers. And the justification for this is summed up in the phrase "garbage in; garbage out". In other words, no degree of sophistication in the amplifier or speakers can improve the quality of the signal generated by the CD player or tuner. So, hi fi enthusiasts talk about a hi fi hierarchy. If you draw a diagram of your hi fi system with signals passing from left to right, the components become increasingly important as you move from right to left. This isn't just some sort of academic exercise – it affects your purchasing and upgrading policy. So, conventional wisdom says that you spend the most on your sources, the next most on amplification and the least on the speakers. Similarly, if you're looking to upgrade your system, you first of all consider upgrading the sources with the amplifier and speakers being further down the list.

To a point this makes sense, although I can't help but feel that the hierarchy argument needs moderating somewhat. For example, a system consisting of a £1,000 CD player, a £200 amplifier and £50 speakers probably wouldn't perform as you might hope even though it does favour the source, followed by the amplifier and with the speakers well down the list. The reason that this system would be disappointing, of course, is that the amplifier and speakers just wouldn't be able to do justice to the quality of signal produced by the CD player. So, I'd be inclined to suggest that a system should be balanced. If you have a system which clearly isn't balanced, a sensible upgrade option would be to replace the weakest link in the chain irrespective of whether it's a source, an amplifier or the speakers. Only if you're sure that your system is well balanced would you use the hi fi hierarchy to identify the next area for improvement.

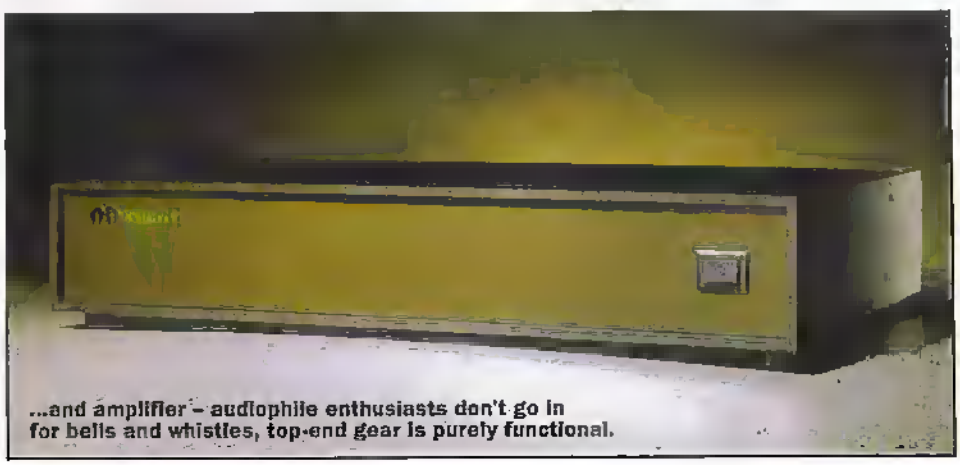
In this section, I've referred to just three types of hi fi component, the source (which can take various forms), the amplifier and the speakers. This is a conventional (i.e. ordinary) separates system. As we start to look at super hi fi, we'll see that many of these components themselves split into smaller separates. For example, in the realm of audiophile equipment, instead of a CD player you might have a CD transport and a DAC, and instead of an integrated amplifier you might have a pre-amplifier and a power amplifier. But although the number of boxes might increase, the hierarchy argument still applies. So, for example, the signal passes from the source to the pre-amplifier to the power amplifier and so we might conclude that the pre-amplifier is more important than the power amplifier.

OK, with that bit of preamble out of the way, let's now look at each of the major components of a standard hi fi system and see how things differ when we move into the realm of audiophile hi fi. But beware – the road to the ultimate hi fi experience is a very slippery slope. Many people have taken their first faltering steps on this road only to find themselves much further down than they'd expected and with a very sick looking bank account in only a few years time. This doesn't mean that it has to cost you an arm and a leg to progress beyond ordinary hi fi. By choosing sound quality rather than bells and whistles and by deciding to major on just one source – CD, for example – rather than having mediocre results from CD, vinyl, tape and tuner, a really good sounding system may not cost you a lot more than an ordinary system. But whether you'll then have the will power to resist continual upgrades, well that's another matter entirely. You have been warned.

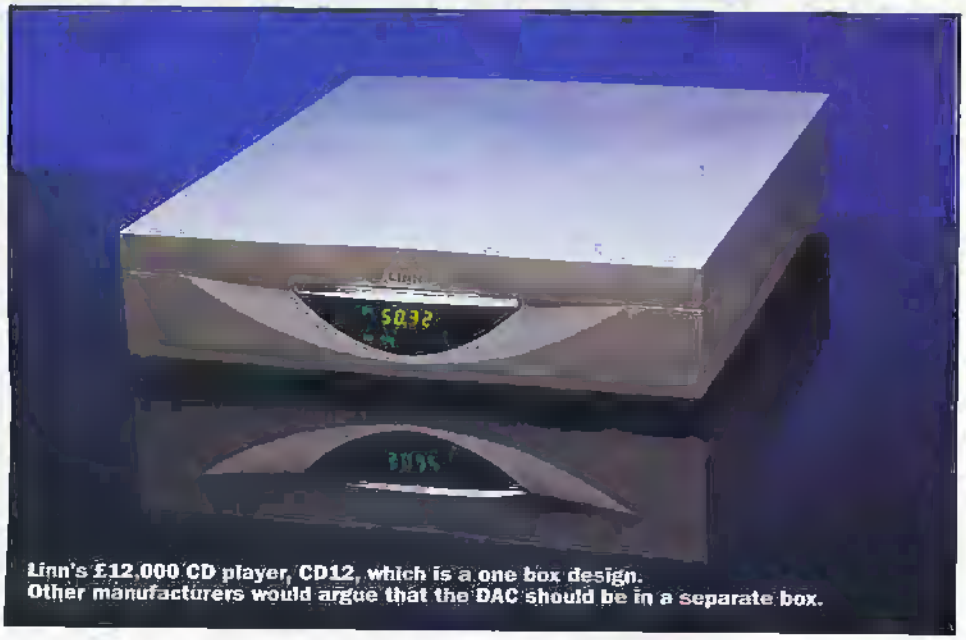
The CD Player

I've already made reference to the fact that, within the world of audiophile hi fi equipment, the CD player is normally replaced by a couple of separate boxes, namely the CD transport and the DAC or digital to analogue converter. So the CD transport spins the disk and extracts the digital data which is passed, as a stream of binary data, to the DAC. The DAC then converts this to a low-level audio signal which is passed to the amplifier. Interestingly, the justification for splitting a CD player in this way is much less clear than is the case, for example, for splitting a midi system into source, amplifier and speakers. Most people choose to buy a CD transport and DAC of a similar quality and normally from the same manufacturer so the issue of choice isn't quite as relevant here. This doesn't mean that you can't match a transport from one company with a DAC from another. Standardisation is starting to take off in this area and some people do, indeed, choose these two components from different manufacturers.

But if choice isn't a major consideration in buying a separate CD transport and DAC, then upgrading often is. For example, let's assume that you already have a separates system with an integrated CD player and that you're looking for a way to improve the standard of reproduction. On the assumption that your system is reasonably balanced, then the hi fi hierarchy argument would suggest that you should look, first of all, at your source, that is your CD player. Certainly you could replace the integrated CD player with separate transport and DAC but with many CD players, there is a less costly first step. Rather than totally replace the CD player, some manufacturers allow you simply to get an external DAC and continue to use your old unit as the transport. Then at a later stage, when your finances have recovered, you can get a separate CD transport to replace the original CD player. There are also technical reasons for designing a CD player in two boxes, albeit reasons which are, perhaps, now being eroded. For some years, Linn's flagship CD player was a two-box solution., the Karik / Numerik combination which costs £1,850 + £1,500. So it's interesting that their new top of the range CD player, the £12,000 CD12, is housed in a single box. I asked Linn's Bill Miller for his views on the pros and cons of the two approaches. If you look inside the Numerik DAC I was told, it's fairly well stuffed with electronics. Of course a low-end DAC needn't be this bulky, the DAC on a PC's CD-Rom drive, for example, is little more than a single chip. But in the case of the Numerik circuitry, you'd never be able to cram that amount of circuitry into the same box as the Karik. And the second reason is that DACs are very sensitive to the sort of electrical noise kicked out by the servo systems and the digital circuitry in the



...and amplifier – audiophile enthusiasts don't go in for bells and whistles, top-end gear is purely functional.



Linn's £12,000 CD player, CD12, which is a one box design. Other manufacturers would argue that the DAC should be in a separate box.

transport. The best solution, therefore, is to keep them well apart. On the reverse side of the coin, however, to transmit the digital data to the DAC it has to be converted into a serial format with an embedded clock. Failure to accurately extract the clock will result in timing inaccuracies and ultimately, garbled music. In the case of a single box CD player, the data can be routed in parallel and with the clock as a separate signal. So what, you may wonder, has changed to allow the CD12 to be designed as a single box and hence alleviate the problems associated with the serial link? Well first of all, greater integration has allowed the DAC to be made smaller and secondly a better understanding of CD transport circuitry has allowed noise levels to be kept to acceptable levels.

Interestingly, not all audiophile manufacturers – even those with a two-box solution – offer a separate CD transport and DAC. Naim Audio, for example, put the transport and DAC in the same box, even on their top of the range model and, in common with many Naim products, put the mains power supply in a separate box. With the CD player, there's a single power supply which has to be used and the complete package costs £2,200. With other products such as pre-amplifiers, however, Naim offer a range of power supplies ranging in price from £350 to over £2,000 – we'll look at the affect of mains power supplies on performance a bit later. Of course, if I were to be cynical, I could suggest another reason for putting a CD player into two boxes – the audiophile community expects it and it means that, as a manufacturer, you can put a much bigger price tag on the units. Since I'm not a cynic, however, I won't suggest that.

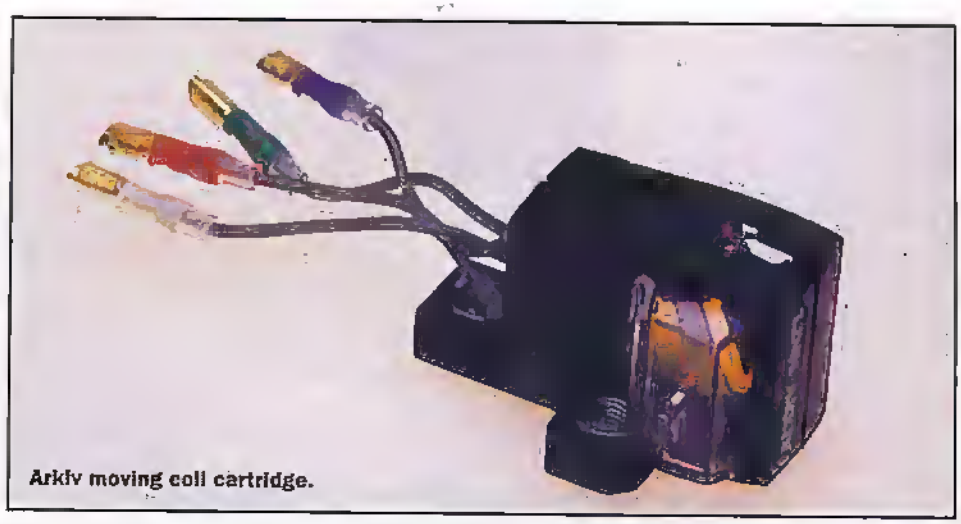
Finally on the subject of top-end CD reproduction, we can't fail to mention the DVD – the digital versatile disk, formerly called the digital video disk. As you're probably aware, the DVD is already established as a computer peripheral in the guise of DVD-ROM, a super-high capacity version of CD-ROM. And it's also starting to appear as a consumer product – specifically: you can now buy movies on DVD and DVD video players. And intriguingly, the sound track on DVD movies is of a higher quality than the CD's 16-bit words and 44.1kHz sampling rate. So why isn't it also being put forward as a higher quality audio standard than CD? Actually it is, although the standards wars are still raging and if an audio-only DVD format ever does appear, it will be quite some way behind DVD-ROM and DVD video. What we can say, however, is that all the proposed standards include a variety of sampling options which record companies can choose from. Ordinary CD quality will be one option for cramming a very large amount of music onto the disk at a mediocre quality. But at the top end, up to 24-bit resolution and a sampling rate of 96kHz is being proposed. Plus, on the hardware side – DVD video players will be able to play DVD audio disks but for the hi fi purist, audio-only players will probably be available as will separate transports and DACs.

Vinyl Reproduction

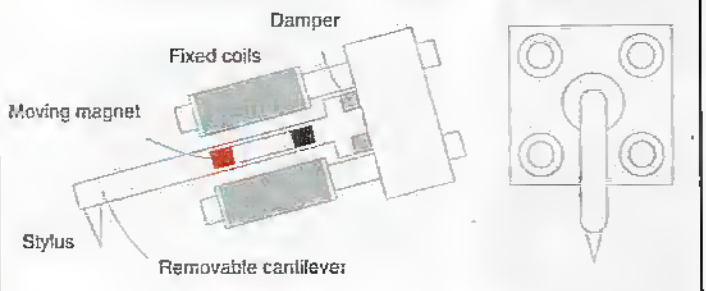
If you're a confirmed CD addict, you probably didn't expect to see mention of scratchy old vinyl records in an article in a high tech magazine on the ultimate in hi fi reproduction. But the fact is, a not insignificant number of audiophile fans retain a vinyl playing capability. For some, the turntable simply provides a means of continuing to enjoy valuable old recordings which will probably never be released on CD. But for others there's a much more fundamental reason for sticking with vinyl. Large numbers of hi fi enthusiasts are yet to be convinced that CDs can equal vinyl records for their inherent musicality. And this isn't just a lunatic minority. The hi fi magazines are starting, once again, to take an interest in turntables, cartridges and the like, vinyl manufacturing plant in Japan is being brought back on line after having been mothballed for years and – of particular relevance to this article – the technology of vinyl reproduction is still being improved.

First a bit of terminology. The phrase record deck is rarely used today. Instead, hi fi enthusiasts tend to talk about the turntable but, strictly speaking, the turntable is only one of a number of components you need to extract the musical information from a vinyl record. The other essential elements are the tone arm and the cartridge and as with most top-end separates, it's often possible to mix and match these three components, even from different manufacturers. And then there are optional extra components such as external power supplies and off-board phono stages.

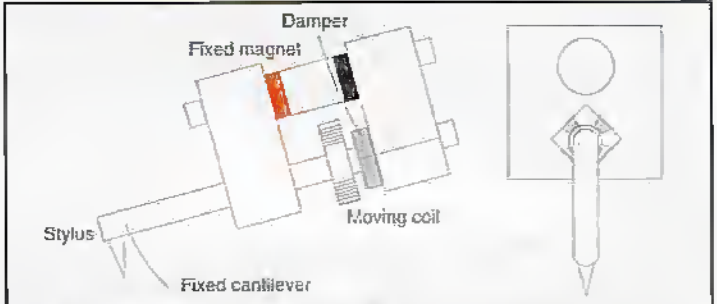
Although the design of the turntable and the tone arm are highly specialised, the skills involved are primarily mechanical so we'll skip over these to the first electronic element – the cartridge. However, let me just present a few facts which hint at the enormity of the task of making a top-end turntable or tone arm. The most a stylus will ever move when playing a record is 0.2mm – this is in the really loud passages. The quietest passages are 90dB down on that, and if you do the sums, you'll find that to extract all the information from a record, the cartridge needs to be able to respond to a movement no more than a few wavelengths of light. If the turntable or tone arm wobbles or vibrates by more than this, you'll either loose vital information or you'll add something that shouldn't actually be there. And what this means, of course, is that the reproduction quality is compromised.



Arkiv moving coil cartridge.



Low-cost and even budget hi fi turntables are equipped with moving magnet cartridges.



If you're prepared to spend £1,000 on a cartridge and write it off when the stylus wears out, you too could enjoy the superior sound quality of a moving coil cartridge.

But although the design of the turntable bearing as such is a purely mechanical job, it is, of course, driven by an electric motor. Not particularly high-tech, you might think, but you'd be wrong. Although budget turntables may be driven from a fairly ordinary electric motor, audiophile products have specialised motors which are driven by highly advanced precision power supplies. And as you go up the range, a tiny circuit board hidden in the plinth is replaced by a separate power supply which sits next to your turntable. Perhaps the best known example is Linn's £750 Lingo which powers their £1,000 LP12 turntable. But why does it have to go in a separate box? According to Linn, there are two good reasons. First of all, there's just too much electronics to cram into the plinth and secondly, electronic power supplies generate magnetic fields. And since the operation of the cartridge involves detecting the tiny relative movement of a magnet with respect to a coil, stray magnetic fields are best kept well away.

So what about the cartridge, the first bit of electronic kit which actually handles the audio signal? First of all, a bit of background about how it works. The business end of the cartridge – the bit which comes into contact with the record – is a tiny diamond stylus which travels along the groove and is driven laterally in step with the musical information. The stylus is attached either to a magnet close to a fixed coil or a coil close to a fixed magnet. Either way, the movement of the stylus causes a relative motion between the magnet and the coil and a tiny electrical signal results. You'll notice that either the coil or the magnet can move, depending on the design, and it's this difference which differentiates an ordinary cartridge from an audiophile cartridge. A moving coil design offers far superior quality to a moving magnet design. Let's take a look at why this is.

If you're building a coil to move inside a magnet it's got to be tiny and with few turns. If, on the other hand, you're building a coil inside which a magnet will move, it's got to be larger and it can have more turns. At first sight, you might think that the larger number of turns is the favoured option as this will result in a larger signal and, therefore, a better signal to noise ratio. In fact, although having a smaller signal does place more constraints on the amplifier, it doesn't actually jeopardise quality. The size of the coil is far more important – the smaller coil has a lower impedance and a lower inductance. The result of the lower impedance is that, despite having a lower output voltage – typically 200μV as opposed to 5mV with a moving magnet – the power delivered to the amplifier is greater. And the result of the lower inductance is that the coil shows virtually no resonance. And whereas it may seem a trivial problem to compensate for the resonance in the amplifier to produce a flat response, in practice, this is very difficult. However, there's more to this than just the electrical characteristics. With a moving magnet cartridge, since the stylus and magnet assembly is comparatively cheap and because a stylus will, eventually, wear out, the stylus/magnet assembly is made to be replaceable. And although a plug-in stylus won't be quite as firmly attached to the body of the cartridge as a permanent one – the cost saving in making it removable is considered to be worth the degradation in sound quality which results from a 'sloppy' linkage. With a moving coil design, however, the coil is responsible for a large proportion of the cost of the entire cartridge. So making this replaceable is a much less attractive proposition. And if you don't have to make it removable, it can be permanently bonded to the rest of the cartridge with a corresponding improvement in quality. Not only does a moving coil cartridge cost, perhaps, £1,000 compared to say £150 for a moving magnet design, but when the fact that you can't replace the stylus is taken into account, this isn't exactly a cheap solution. OK, some manufacturers will refurbish moving coil cartridges rather than insisting you buy a new one, but even then, if you listen to a lot of music, the cartridge cost alone could well be quite a few hundred pounds a year.

Finally, a word about amplification. The amplifier is featured next month but there's one amplifier consideration which is peculiar to playing vinyl records. As we've seen, cartridges produce very small electrical signals, much smaller than the signal generated by a CD player or a tuner. And as such, the amplifier has to amplify the output from a cartridge more than the signals from other sources. It also has to provide RIAA equalisation – boosting the bass and cutting the treble – to cancel out the messing around which recording engineers do to cram more music onto the disk. The part of the amplifier which carries this out is called the phono stage and is absent on some of today's amplifiers, especially those at the bottom end. So if you want to use such an amplifier with a turntable, then you'd have to buy an external phono stage. Of course, we're talking about quality amplifiers so they'll almost certainly include a phono stage. However, if you're looking for the very best, you may still choose to buy a top-end phono stage as an upgrade to the phono stage in your amplifier. Linn offer such a unit, the Linto, for £850.

Next Month we will look at the rest of the system and how much a top quality system will set you back.

in the pipeline

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Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering, side cutters, pliers, wire strippers, and screwdriver). Test gear not required and no setting-up needed.

Easy to build, but not suitable for absolute beginners. Some test gear (e.g. multimeter) may be required, and may also need setting-up or testing.

Average. Some skill in construction or more extensive setting-up required.

Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.

Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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Maplin CD-ROM

by Mark Brighton

You will find that the latest Maplin CDROM catalogue included free with this magazine is better than ever before! The new look catalogue program incorporates many of the improvements suggested by you, the customers, in response to our first ever CDROM catalogue release in March of this year.

The catalogue CD will run under Windows '95 or '98, or on later Apple MAC operating system based machines. It will also run on older machines still using the Windows 3.1 or 3.11 operating systems, provided you are using the latest set of 32-bit file extensions supplied by Microsoft (Win32s version 1.3). Please note that a full copy of these extensions are supplied on CD1 under the 'Win32s13' directory on the CD. Use File Manager to open this directory and double click the 'setup' program (Windows 3.1/3.11 users only).

After you have followed the instructions on the CD packaging and installed it on your PC or MAC, you will find that the program auto runs for the first time immediately in order to locate and identify the location of its main database file on the CD. After that has happened, you may run the program by just double clicking the shortcut on your desktop (or by using any of the other shortcuts liberally dotted around your Windows 95/98 machine).

Now, the opening screens of the catalogue program feature a number of buttons leading to the free software on CD2. Please bear in mind that you don't yet have CD2 (order next months Electronics and Beyond early to avoid disappointment!!), so if you do click on one of those buttons, you will be prompted to insert CD2 and led into a blind alley! Seriously, should you do that by mistake, or by trying to access one of the data sheets, project guides, or technical articles on CD2, you will have to use the old three fingered salute (Ctrl-Alt-Del) and 'End Task' to get out of the program.

Once into the menu screens proper, you will find that all of the main browser controls are much the same as on the previous release of the CD. The look and feel has changed and, we think, improved. We have worked hard to iron out the bugs that inevitably were overlooked in our very first CDROM catalogue.

You may use the product drill down under 'Product Category Search' to find the products you need, or one of the search facilities provided under the buttons at the top of the 'Products' screen, or you may simply type known stock codes into the 'Add to Order' facility on the 'Enter Order' screen. There is also a specialised search or finder for semiconductors, which searches over 18,000 semiconductors now available from Maplin. Please note that this fully wild carded search will find any test string anywhere within the part number database and return all results, but it will now take a considerable time to do this!

Clicking on the result line will display the catalogue entry for that product if one exists (note that primary Maplin part numbers are at the top of the search result list). All product codes may be entered on the 'Enter Order' screen mentioned above, and will automatically offer you a price dependent on the quantity required. Note also that some semiconductor and other component parts may have extra price discounts for far higher quantities than those shown in their catalogue entries. The pricing under the 'Add to Order' button on the 'Enter Order' or 'Product Details' screen will take this into account and offer you discounted pricing when appropriate.

Fairly detailed instructions for the use of this CD catalogue are to be found on the 'Maplin & Catalogues' screen under the 'Catalogue' button. There are also free text and Word document versions of these instructions, and a 'readme' file, on the root directory of the CD. The Adobe Acrobat reader program is also to be found there as 'Ar32e301' and the Microsoft Active Movie player (amov.exe) required by some early versions of Windows 95. Don't forget that this catalogue program was written for SVGA displays and requires a setting of 800 x 600 with Hi-colour mode. Happy browsing!

Remember CD2 is on next months magazine, on sale 2nd October.

Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

September 1998

1 to 4 Sept. Control Conference, University of Wales, Swansea, IEE. Tel: (0171) 240 1871.
1 to 4 Sept. UKACC CONTROL '98, University of Wales Swansea, IEE. Tel: (0171) 240 1871.
2 to 4 Sept. Electrical Generator Applications, Vacation School, Burleigh Court, Loughborough University, IEE. Tel: (0171) 240 1871.
5 Sept. Systems on A Chip, Colloquium, University College Dublin, IEE. Tel: (0171) 240 1871.
7 to 9 Sept. Embedded Systems Conference Europe, Royal Ascot, Berkshire. Tel: (0181) 855 7777.
8 to 10 Sept. Farnborough International Technology Conference – Technology for Business Advantage, Conference, Savoy Place, London, IEE. Tel: (0171) 240 1871.
9 to 11 Sept. Sixth UK Mechatronics forum International Conference Mechatronics '98, Hotel Billinghus Conference Centre, Skovde, Sweden, IEE. Tel: (0171) 240 1871.
11 to 15 Sept. International Broadcasting Convention, IBC 98, RAI, Amsterdam, IEE. Tel: (0171) 240 1871.
13 to 16 Sept. Safety Critical Systems, Vacation School, the Moller Centre, Cambridge, IEE. Tel: (0171) 240 1871.
14 to 17 Sept. Vacation School on Communication Network Design, Vacation School, Christchurch College, Canterbury, IEE. Tel: (0171) 240 1871.
15 Sept. Internet Enabled Manufacturing – the Cyber Factory, Colloquium, Ireche, Birdcage Walk, London, IEE. Tel: (0171) 240 1871.
16 Sept. Ford Motor Company, Dagenham, Dagenham, Essex, IEE. Tel: (0171) 240 1871.
20 to 23 Sept. Residential Course on Universal Mobile Radio Communications, Residential Course Pembroke College, Oxford, IEE. Tel: (0171) 240 1871.
21 to 23 Sept. Power Electronics and Variable Speed Drives, Conference, Savoy Place, London, IEE. Tel: (0171) 240 1871.
21 to 23 Sept. Seventh International Conference on Power Electronics & Variable Speed Drives, Savoy Place, London, IEE. Tel: (0171) 240 1871.
22 to 23 Sept. Enterprise in Transition, The Commonwealth Institute, Kensington, London. Tel: (01908) 373311.
23 Sept. The Future Use of Intelligent Automation and Robotics in the Utility Industries, Colloquium, North West Water Laboratories, Warrington, IEE. Tel: (0171) 240 1871.
30 Sept. Simulation Conference, University of York, IEE. Tel: (0171) 240 1871.
30 Sept to 2 Oct. International Conference on Simulation, Innovation Through Simulation, University of York, IEE. Tel: (0171) 240 1871.

October 1998

1 Oct. Presidents Inaugural Address by Dr J M Taylor, Savoy Place, London, IEE. Tel: (0171) 240 1871.
5 Oct. towards Safer Electrical Installations, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.
5 to 6 Oct. Practical FieldBus and Device Network Protocols for Engineers, London. Tel: (0181) 335 4014.
7 Oct. Artificial Intelligence-Based Applications for the Power Industry, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.
8 Oct. Radar System Modelling, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.
8 Oct. Year 2000 – Controlling the Industrial Risk, Colloquium, Savoy Place, IEE. Tel: (0171) 240 1871.
8 Oct. Cellular Manufacture & New Product Introduction, Technical Visit, Malvern Instruments, IEE. Tel: (0171) 240 1871.
8 to 9 Oct. Practical FieldBus and Device Network Protocols for Engineers, Southampton. Tel: (0181) 335 4014.
12 to 13 Oct. Practical FieldBus and Device Network Protocols for Engineers, Bath. Tel: (0181) 335 4014.
12 to 13 Oct. Workshop on Practical Local Area Networks (LANs) for Engineers, London. Tel: (0181) 335 4014.
12 to 14 Oct. Second International Conference on the Detection of Abandoned Land Mines, Edinburgh, IEE. Tel: (0171) 240 1871.
13 to 15 Oct. Information Management '98, NEC, Birmingham, Tel: (0181) 742 2828.
14 to 16 Oct. Second International Conference on Partial Discharge, Edinburgh. Tel: (0171) 240 1871.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?

Apple and Microsoft Celebrate First Anniversary of Macintosh Alliance

At the opening keynote address at Macworld Expo New York on July 8, Apple and Microsoft celebrated the progress made since the two companies since their milestone alliance a year ago at Macworld Expo Boston.

The new spirit of co-operation brought on by the agreement, resulted in the timely release of Microsoft Office 98 Macintosh Edition, integration of the Microsoft Internet Explorer browser in Apple's new iMac and Mac OS 8.1, and the convergence of Java technologies on the Macintosh platform.

"Although our relationship was first met with boos at Macworld a year ago, it has blossomed and is delivering some really great products to our joint customers. Our colleagues at Microsoft continue to demonstrate that they're genuinely interested in creating great Macintosh products such as Microsoft Office 98 and Internet Explorer 4.0," said Steve Jobs, Apple's interim CEO.

Ben Waldman, general manager of the Macintosh business unit at Microsoft, added, "Microsoft believes that Macintosh is a great platform for applications and leading-edge Internet technologies, and we're especially excited about Apple's new iMac, which complements our efforts to make Microsoft products easier for consumers to use."

"The agreement made between Apple and Microsoft nearly one year ago has truly impacted the Macintosh industry in a positive way. The new spirit of co-operation between the two companies has been a key factor in Apple's comeback and successful product introductions over the past year. As a long-time Apple follower and supporter of the Macintosh platform, I look forward to additional progress in the coming year," said Tim Bajarin, president of Creative Strategies.

Over 175 application software titles for Apple's consumer iMac were unveiled at Macworld by third party software developers. Companies releasing new titles included: Adobe Systems, Blizzard Entertainment, Disney Online, Eidos, Feral Entertainment, GoLive Systems, Intuit, The Learning Company, Lucas Learning, MacSoft, Mattel, SegaSoft and Simon & Schuster Interactive.

"The iMac is re-igniting software developers' excitement to be on Macintosh. As Apple reenters the consumer market with iMac, there will be tremendous business opportunities for Macintosh software developers," said Jobs.

Included in the many titles recently introduced are popular games such as Tomb Raider II and Unreal, as well as innovative products such as Barbie Fashion Designer CD-ROM, Cosmopolitan Virtual Makeover, CyberStudio Personal Edition, Disney's Blast Online website, Elmo's Reading: Preschool & Kindergarten, Reader Rabbit's Toddler, Starcraft, Starship Titanic and Star Wars DroidWorks.

"Tomb Raider II starring Lara Croft is an unprecedented success which will be a must-have title this holiday season for iMac customers. We are proud of our involvement with Apple during the launch of a product as exciting as iMac and the opportunity to place Lara Croft alongside one of the world's strongest brands. Apple's move back into the consumer market is great news for Eidos and for the millions of Mac customers around the world who want to play our games," said Charles Cornwall, CEO of Eidos.

Hardware companies further fueled Apple's consumer momentum at Macworld by announcing new Universal Serial Bus (USB) add-ons for iMac including floppy disk drives, joysticks, game pads, printers and cameras. Together, both hardware and software companies have unveiled more than 200 new products for Macintosh since iMac was introduced.

For further details, check: www.apple.com.
Contact: Apple, Tel: (0181) 569 1199.

English and Welsh 'Mice' Win World Titles

Students from Aberaeron Comprehensive School in Wales and Sawston Village College, Cambridge beat off challengers from around the UK to win their respective classes in the Schools World Micromouse Championship which was held at the University of Manchester in June.

The team from Aberaeron, Daniel Boshier, Huw Watkins and Adam Allen, all aged 13, and their mouse 'Y Saethwr' won the School Standard Award with a time of 7.2 seconds. They received a prize of £75 and a much coveted brass cheese trophy.

Peter Hall and Peter Shelton, both Year 10 students from Sawston, and their mouse 'Les Scargo', also received a cash prize and trophy for winning the Schools Super Standard category.

Micromice are small electronic robotic vehicles which must be able to navigate a two-dimensional maze in the fastest possible time.

Organised by the Institution of Electrical Engineers (IEE) the Schools Micromouse

Competition is designed for children aged 11-16 to encourage learning in mechanics, electronics, computer programming and team working.

Competition in the 1998 Championship was fierce, with 'mice' from throughout the UK travelling to Manchester for the contest. Time trials and qualifying heats were held during the day and the fastest mice went forward to the finals.

Second Prize in the School Standard section went to a team from Woodbridge School, Suffolk and their mouse 'Sniffer'. 'Lionel' mouse from Bancroft School, Essex, came in third and fourth prize was taken by a team from Dane Court Grammar School, Broadstairs in Kent, with their mouse 'Jim'.

Second prize in the Super Standard section went to a team from Tonbridge School in Kent and their mouse 'B.E.N.S.' Third prize was awarded to 'Benjamin' mouse from Bolton School.

For further details, check: **www.iee.org.uk.**

Contact: IEE, Tel: (0171) 240 1871.

Consumer Electronics Industry on Course to go LIVE for '98

Consumer electronics companies are putting the finishing touches to their stands for Live '98, the bi-annual industry showcase. The exhibition is set to take place over the period 24 to 27 September at Earls Court.

Live '98 has already signed up some of the big industry players such as Sanyo, Pioneer, Philips, Toshiba, Sony, Grundig, Marantz, Sharp and Hitachi.

The show this year sees a £500,000 investment by Miller Freeman into special features, which will be used to target visitors. A Vision of the Future will lead people in to the show, giving them a glimpse of all the innovations on offer.

There will also be a virtual reality area, a small office/home office (SOHO) section and a digital broadcasters cafe, as well as a brand new hi-fi and home entertainment section with sound proofed rooms in association with What Hi-Fi? Magazine.

For further details, check: **<www.live98.co.uk>.**

Contact: LIVE 98, Tel: (0171) 341 9341.

E-mail your views and comments to: AYV@maplin.demon.co.uk

Write to: *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU

Tidal Problems

Sir

The explanation for two tides a day by Science Line (August 1998) is so oversimplified as to be actually incorrect. Although there are centrifugal effects in the picture, they are so subtly neutralised by other effects that it is the residual gradient of the gravitational field (the classic origin of the description 'tidal effect') which remains as the cause.

M. White
Malvern, Worcs

Nicole Aebi of Science Line replies

Having looked into your suggestion that differential gravitational forces are to blame, we can quite easily say, "Yes you're right. How can we have got it so wrong?" Sorry!

This is one of those questions that we though we'd got it right, as it has been in our 'repertoire' for so long now. I can offer nothing for an excuse except to say that we deal with 50,000 calls a year and we're bound to make mistakes.

In addition, the fact that the Earth and the Moon have a common centre of gravity, the baycentre, is important. You can't just take into account the Moon's gravity so we were not completely wrong!

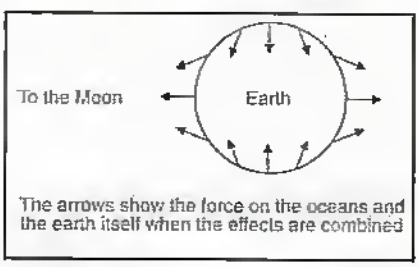
This is the corrected version:

Why are there two tides a day?

It is easy to understand why there's one tide each day – the Moon simply pulls the water on the side nearest to it, to create a bulge. But what about the bulge of water on the other side of the earth, how does that get there? Well there's two things going on here to create this effect. The first is also the Moon's fault. The moon exerts a gravitational pull on all things on the earth, including you and me. The important thing is that it doesn't pull on all the bits evenly. The closest bits get pulled the most, the furthest bits get pulled the least. In effect, stretching out the Earth.

But, the moon doesn't simply go round the Earth – the two are going round a common centre of gravity. This isn't at the centre of the Earth but slightly off-set. Imagine sitting on a roundabout not quite in the middle. You get thrown outwards, and that's exactly what happens with the Earth – the centre of the earth isn't in the middle of the 'roundabout'.

These two effects combine to create the forces shown in the diagram below:-



The arrows show the force on the oceans and the earth itself when the effects are combined

Lack of Simple Projects

Sir

May I echo the sentiments expressed by your correspondent Dave Marsden from Hull in his letter in Electronics and Beyond August 1998.

I was weaned on early electronics magazines such as Practical Wireless – when it cost about 1/9 in old money -Radio Constructor and Practical Electronics, plus the odd edition of Wireless World – although I did find that a bit 'high tech' for me in its day. I appreciate that the days of valve amplifiers and radios are long gone unless one wants to spend a fortune on components, but even in your magazine not so long ago there were simple little projects to build that didn't cost a lot and were quite useful, but nowdays you seem to specialise in very high tech articles which are of very little interest to the average amateur constructor.

R. J. Abraham
Winchester, Hants

We are always open to suggestions from readers for projects that they would like to see in the magazine, so please let us have your ideas and we will endeavour to oblige.

LEGO MINDSTORMS

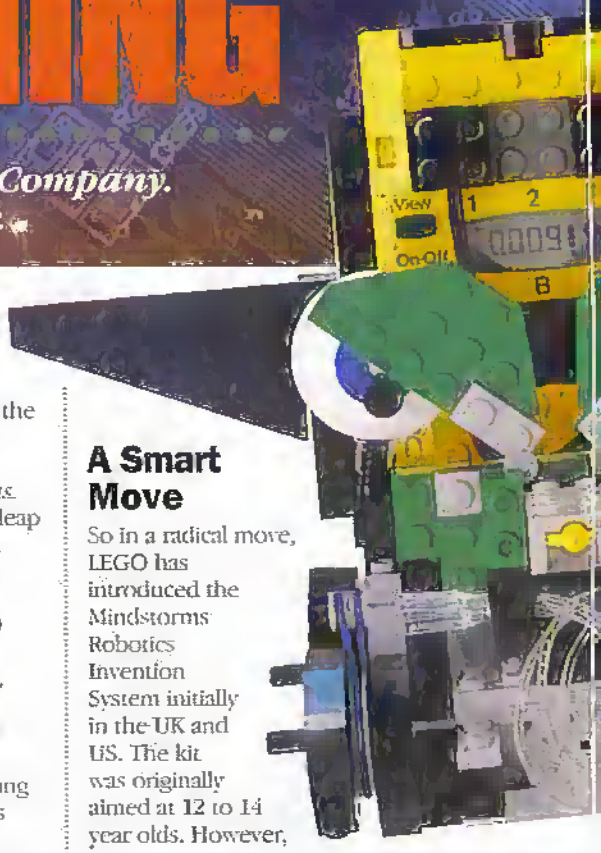
Power of Robotics @ Your Command

ROBOTICS

INVENTION SYSTEM

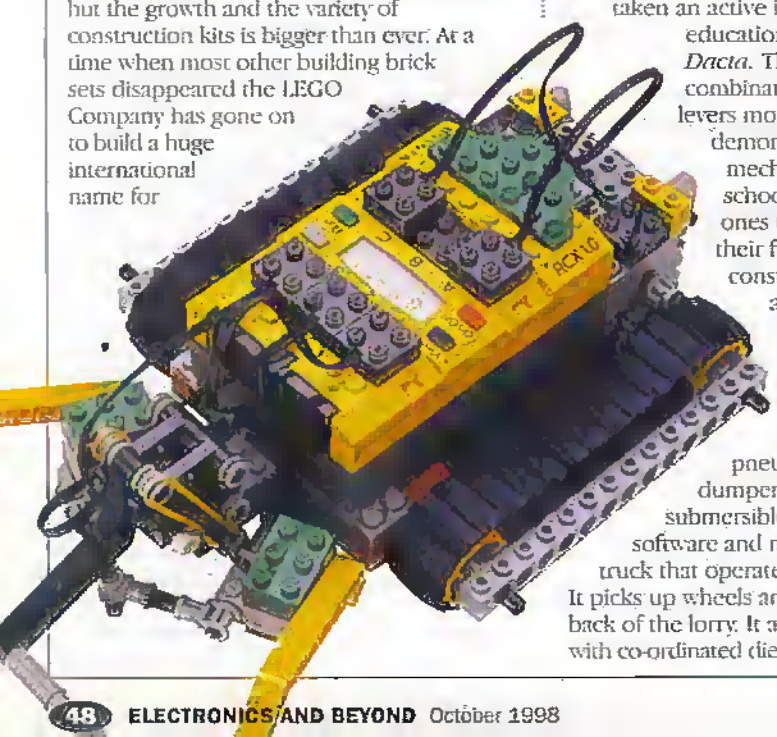
MINDSTORMING

A radically new creative toy from the LEGO Company. An overview by Paul Freeman-Sear.



Time was, when us forty somethings in our youth would be content with our lot – of building bricks. They were simply shaped and in bright primary colours. In those days fewer LEGO sets were around and you would mostly build your own designs 'freestyle', now a term coined by the LEGO Company using off-the-shelf packs of bricks. Today it is a completely different story. Company philosophy still remains the same along with the infamous studded brick, but the growth and the variety of construction kits is bigger than ever. At a time when most other building brick sets disappeared the LEGO Company has gone on to build a huge international name for itself making and selling coloured plastic bricks and toys. With associated LEGO names like *Duplo, Primo, System, Dacta* and *Technic* and now a growing number of theme parks to feed the ever demanding leisure industry, the internationally known name is about to launch another brandname – *Mindstorms*. The LEGO Company is about to make a leap into the computer robotic control arena.

For many years the company has taken an active interest in the education sector with LEGO *Dacta*. This is essentially a combination of wheels, cogs, levers motors and bricks to demonstrate motor mechanical actions to school children. Also young ones that wish to impress their friends with their constructional prowess have also had access to the LEGO *Technic* range for many years now. This is again a bewildering array of constructable pumped pneumatic and motorised dumpers, lorries, cars and submersibles with CD ROM software and more recently a tipper truck that operates by a barcode reader. It picks up wheels and dumps them into the back of the lorry. It also comes complete with co-ordinated diesel engine sound effects.



A Smart Move

So in a radical move, LEGO has introduced the Mindstorms Robotics Invention System initially in the UK and US. The kit was originally aimed at 12 to 14 year olds. However, in a recent survey carried out by the company in the US, the survey suggested more adults were interested! I also know that there will be some even younger exceptional children that would love to get their hands on it. So as a compromise, LEGO has designated it for 12 years and upwards.

The philosophy behind these toys is that it would give our children the groundwork to develop problem solving skills and to gain a knowledge in programmable robotic control. Children have been able to try their hand at the Mindstorms robots at the Legoland leisure park at Windsor for a short while.

ROBOTICS

INVENTION SYSTEM

SET INCLUDES:

- RCX MICROCOMPUTER
- CD-ROM SOFTWARE
- 727 PIECES, INCLUDING:
  - 2 MOTORS
  - 2 TOUCH SENSORS
  - 1 LIGHT SENSOR
- CONSTRUCTOPEDIA
- 12 GUIDED CHALLENGES
- INFRARED TRANSMITTER

Infrared transmitter requires a 9-pin serial port on your PC

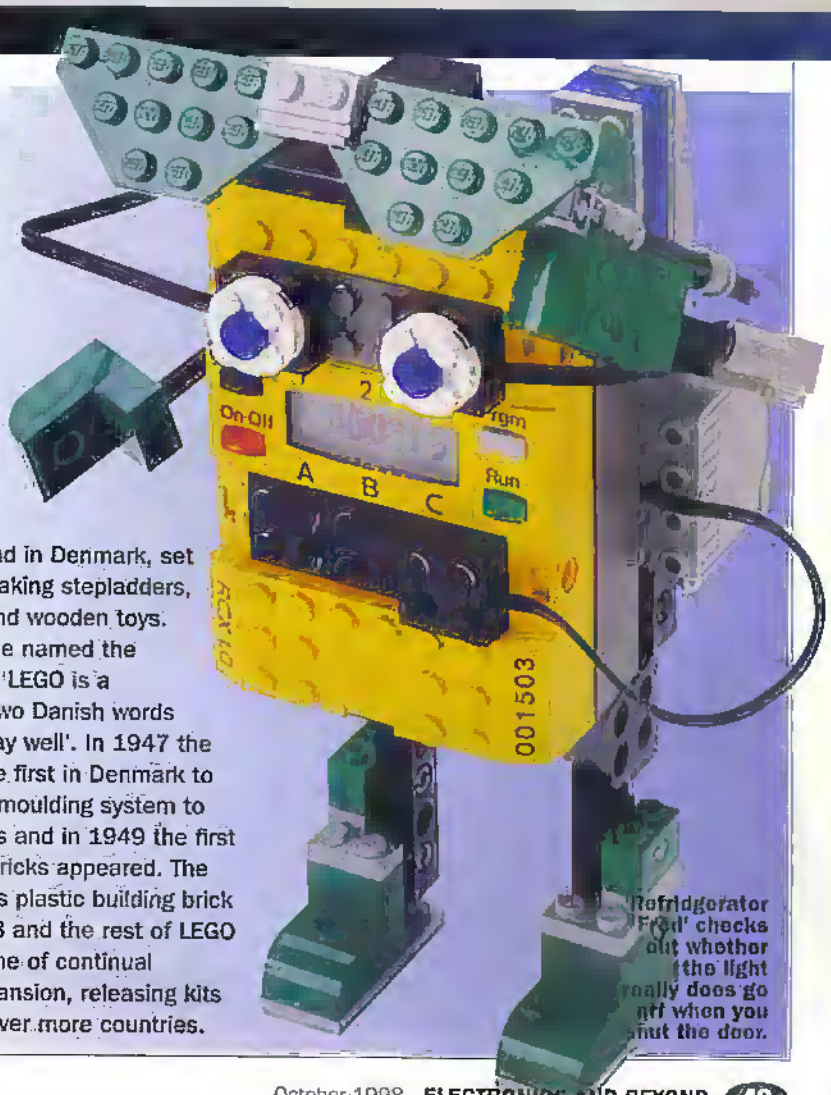
PC and monitor not included.

MIT and the RCX brick

LEGO has been working with a department known as the Media Laboratory at the Massachusetts Institute of Technology for over 10 years now. The result of that research is a product which LEGO has called an RCX module. It's a programmable 8-bit microprocessor with memory that will fit into a large LEGO brick. With a combination of light, touch and rotation sensors, the RCX will react to its surroundings by sending control messages to the electric motors connected to it, and hence the RCX brick will control your robotic type construction through a series of programmed commands downloaded from the child's or adults PC. These commands enter the brick via an infra-red wireless link from your PC. The infra red link works up to a range of eight metres and one RCX robot can even talk to another robot via this link. An LCD display on the RCX informs the operator of various commands.

A brief history of LEGO time

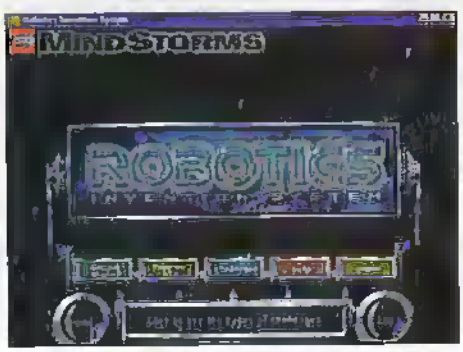
Way back in the misty depths of time, 1932 to be precise, Ole Kirk Christiansen, a carpenter and joiner from Billund in Denmark, set up a business making stepladders, ironing boards and wooden toys. Two years later he named the company 'LEGO'. 'LEGO is a combination of two Danish words which means 'play well'. In 1947 the company was the first in Denmark to buy an injection moulding system to make plastic toys and in 1949 the first plastic building bricks appeared. The patent for today's plastic building brick was filed in 1958 and the rest of LEGO time has been one of continual success and expansion, releasing kits year on year in ever more countries.



'Refridgerator Frank' checks out whether the light really does go off when you shut the door.

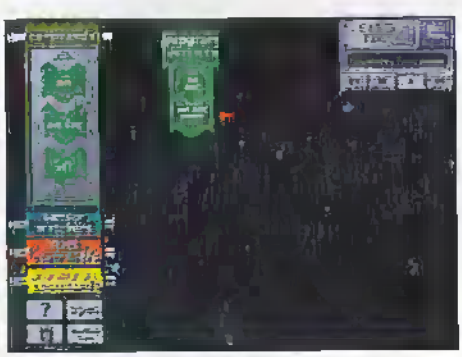
It's in the box!

The first kit, to be launched this September/October is a 700 piece set. Now that's a 'biggy' for LEGO and it includes



two motors, light and touch sensors and lots of building parts including mechanisms, gears and wheels. The package includes a CD-ROM to download appropriate software in order to program the RCX module in a user friendly manner. There's an infra-red tower that sends your programmed messages from your PC to the robot without the use of wires. Of course you get the RCX Microcontroller. This is the oversized Lego brick with inputs, outputs, LCD monitoring and a bit of programmable control inside.

You also get what LEGO call a 'Constructopedia'. Joining two parts of words together, is the now more fashionable way to generate a new word in our vocabulary – anyway it's a building guide to aid construction with plenty of hints and suggestions. The tease is that it does not explain exactly how to build models from start to finish. No, a child requires a little bit of intuition in order to complete the challenge – now that's what I call excellent educational philosophy!



Each sets includes a Robotics Network membership. This is an exclusive number to log on to the LEGO Mindstorms web site for the first time – good thinking LEGO. That's just one of the ways to keep track of customers.

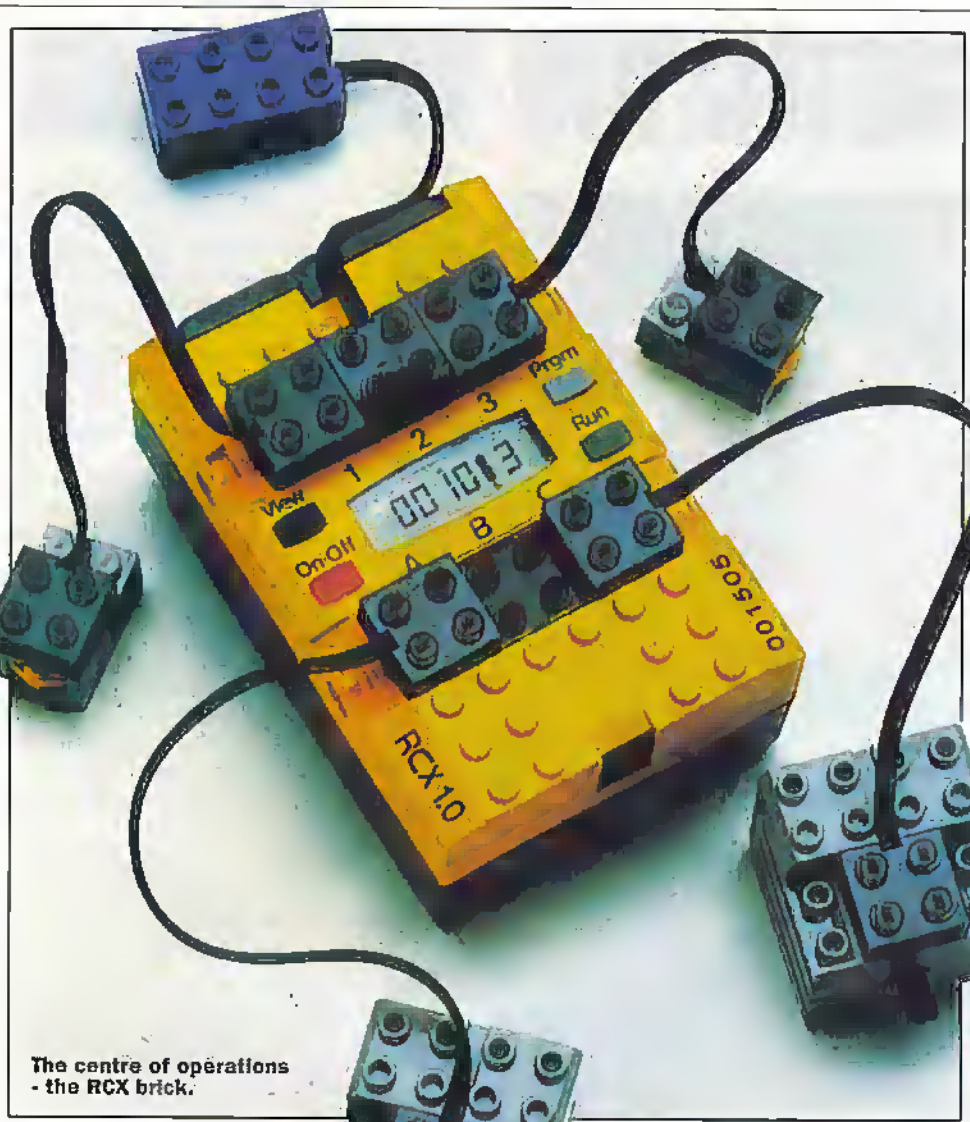
How does it all work?

Firstly before you get started you'll need a Pentium 90MHz PC or greater with 16MB of RAM, a CD ROM drive and a sound card.

There are three main procedures to carry out. The first is to design and construct your robot around the RCX brick using motors, sensors and other LEGO bits. This can be done with helpful hints from the manual on how to put certain operating functions together. The other interesting idea is to take up the challenge from the PC to build a particular type of robot.

Next you need to load up the software from the CD ROM and begin to create a programme for the invention using RCX programming code. Just to make sure you understand what's going on, you have to go through the training course when you first log on to the CD-ROM. The RCX program code is a user-friendly programming language rather like locking selected bits of jigsaw together as shown in the screenshots shown below. There are standard commands within the software, like on/off for set periods of time, setting up power and direction, standing time, beeping and tone. You can even program your own tune by specifying the pitch through this command. You can look at and characterise sensor information for touch, light, rotation

LEGO *Mindstorms* robotic basketball player.



The centre of operations - the RCX brick.

and temperature sensors. 'Loop' information can be supplied with conditions through a command called Stack controllers. This might be for example how many times you want the program to run with maybe a 'Wait Until' command for a light or touch sensor to be activated.

The next operation is to download the program to the RCX using the infrared transmitter. The model is then ready to run and will interact with its surroundings on its own. The RCX can be powered using an external power source for static inventions such as robots, or by batteries for moving robots (rovers).

As time and space does not permit me to go further, a more detailed discussion of its user attributes should come later once the kit has been fully evaluated.

Inter LEGO Speak

Have you ever wondered why LEGO is so successful? Part of the reason is probably because The LEGO *Group* is in tune with customer needs. It has

an Advisory Board of global thinkers. They mull over aspects of learning philosophy and product evaluation and applications, and then feed it all back to LEGO, this includes *Mindstorms* and suggested new products. Full marks for taking note of grass-root opinion!

Mindstorms Global Internet Community

Ok so now you have the kit and you have produced a good idea or robot-type machine that can make the tea, why not tell everyone out there on the global net. You can have 'Your shout on the Net', via the website `www.Legomindstorms.com`. This is a new site for LEGO. Those, young and old, keen to vent their ideas and display their own robot creations to the world can do so by creating their own home page as a forum for discussion on this web site. They also will be able to download new programs that LEGO place on the net, swap ideas and consult experts, or should I say 'exbots'?

The Set-You-Back factor

The 700+ piece Robotics Invention System will set you back many pound coins, or as they say in Harrods; this carries a price tag of around £160 sir with expansion sets from around £40. How's your bank balance dad?

The LEGO *Mindstorm* sets are initially available at specially selected stores across the UK in late September/early October including Maplin Electronics.

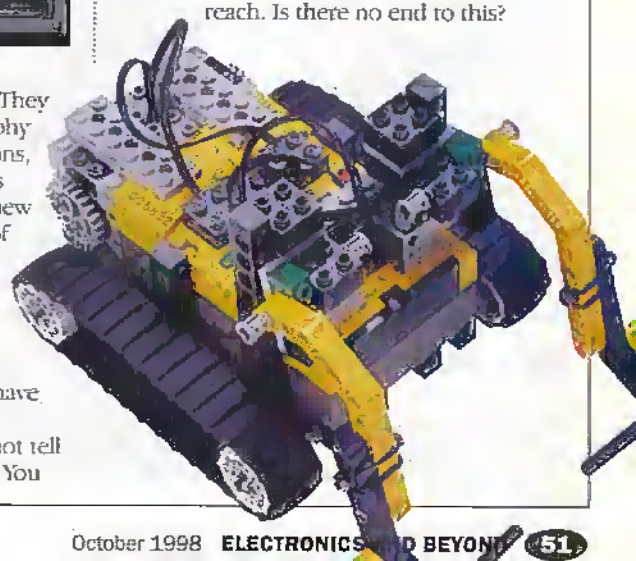
You need to call this LEGO telephone number: **0845 606 2043** to find out about your nearest store.

Coming soon

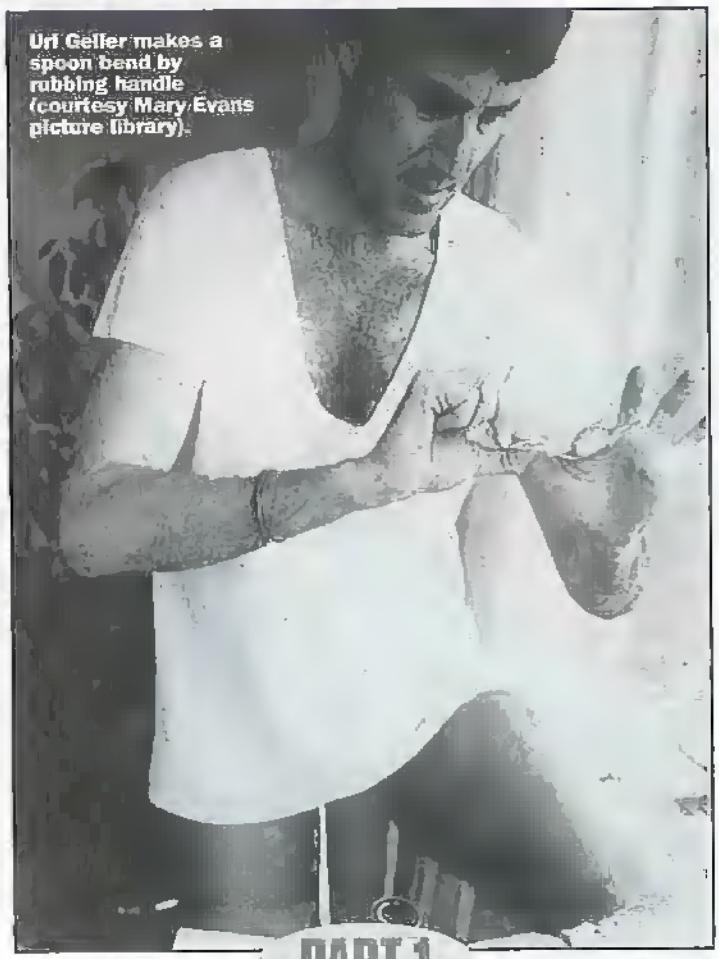
The first two expansion sets called Robo-Sports and Extreme Creatures will also be available later this year. The first, Robo-Sports provides a creative individual with a kit to design robots that shoot hoops, flick pucks and dart through an obstacle course. Extreme Creatures will let you to build animal-like creatures from your imagination. The sets include fibre-optic strands to send light to parts you never thought you could reach, a snapping claw, a pincer grab and a wagging tail mechanism. Again each set has a 'Constructopedia' and CD-ROM software to keep you occupied for many hours.

And There's More – A Mars Rover please!

An exciting area of remote viewing using a buggy and your PC will soon be possible using 'The Exploration Mars Expansion Set'. This is due out in 1999, and will include a video camera and possibly a transmitter that will enable children to build their own Mars rover models. Children will be able to control their own rover buggy using an on-screen control panel on the PC. Children could then discover brave new worlds looking upwards from the floor and get into places where other buggies can't see or reach. Is there no end to this?



PSYCHO-KINETIC BIO-FEEDBACK


Uri Geller makes a spoon bend by rubbing handle (courtesy Mary Evans picture library).

PART 1

This month David Aldous discusses this fascinating topic and next month constructs a trainer and movement detector.

The apparatus described in this article (with construction next month) was designed and developed as a means of obtaining some form of quantitative data on Psycho-Kinetically (PK) induced object movement, and also as a means of 'training' the operator to bring any displayed PK abilities under at least a modicum of control. To do the latter, some form of conversion and feedback of the detected movement to one or more of the five biological senses is necessary. This is called Bio-Feedback.

Bio-Feedback techniques are not new. They have been used in the psychology field as a means of assisting a subject to bring under conscious control, anything from heart rate to anxiety states. In principle, all that is required is for there to be some means of detecting changes in bodily or psychological conditions, which are usually under the control of the autonomic nervous system and which normally function at an 'unconscious' level, also a means for converting the detected changes into a form recognisable at the 'conscious' level. These require suitable transducers. The term transducer being a compound word from Greek and Latin languages: Trans = Greek for 'across' and Ducer = Latin, meaning 'to bring about a change' (in something). Literally, the word means to bring across a change in one 'something' or system and reflect that change in another (different) 'something' or system. In effect, just as with electronics, where once you have a suitable 'transducer' to convert a real-world phenomena (e.g. [say] temperature, pressure etc.,) into an electronic signal according to some reliable law (linear, logarithmic, inverse square etc.,), you can do almost anything with it. At an electronic level one can then amplify, attenuate, filter, change its internal relationships – all of which are applications of signal 'processing' techniques – then finally, convert it back again to its original format – or to a different format altogether (e.g. sound to light and light to sound for example).

PK – What is it?

Psycho-Kinesis is a relatively new name for what many readers – particularly those who enjoy science fiction stories – used to be called Telekinesis, or TK. The use of the term PK has largely arisen since the early 1960's, when Professor J B Rhine studied the phenomena at Duke University, North Carolina, USA. The term literally means 'Mind movement', or more accurately, movement induced by the mind. It is a compound word derived from the Greek words, Psychos = Mind and Kinos = movement or motion. The older name, Telekinesis, is also a compound word, also from the Greek, Tele = at a distance and Kinos (see above), which literally means 'Movement at a distance' to emphasise the non-contact nature of such movements. Rhine coined the new name to reflect the 'psychological' aspect of such interactions.

As a subject, PK has a long history and appears to be at the back of many unusual happenings throughout recorded history. Those readers who have at least a passing interest in the weird and wonderful stories that emerge in the popular press, news programmes and even the X-files, or Fortean TV, will have heard of – or seen – objects moving about without any evident means of doing so, sometimes quite violently. Many will also have at least heard of so-called 'Poltergeist' activity (this is another compound word, this time from the German Polter = noisy; and Geist = spirit, or ghost, and literally means 'Noisy Spirit'). Having witnessed such events at first hand, the author has no doubts as to their reality! NB: At this juncture the author must make it absolutely clear that 'Religion' has nothing whatever to do with the matter and that we are here dealing with a natural – if somewhat strange – phenomena, which seems to have played a part in human life for a very long time, and may yet have further part to play in man's future development. Religion tends to grab hold of PK-type events and then weave them into its fabric, often in the form of so-called 'miracles', not the other way round.

Virtually all readers will have heard of, or seen, the psychic Uri Geller, and at least heard of his prowess at bending metal without any normal forces being applied. This appears to be an example of PK being applied in a quite specific manner. Tests have shown that some of the metal bent and then broken by Uri, shows signs of unusual molecular realignment at the site of the break and of a nature not compatible with normal forces being applied. The author knows several individuals who have this ability but has not unfortunately been able to produce these effects himself. One well known author, Michael Crichton, of *Jurassic Park* fame, has this ability. His book, *Travels* (Pan Books, 1988. Reprinted 1994), is an account of his personal journey not only to many remote places of the globe, but also to his inner self. Along the way, he records a specific experience of attending a spoon bending party in southern California. On page 318 to 321 of his book, in the chapter entitled *Spoon Bending*, he describes how with his partner, Anna Marie, both tried their hand at this and succeeded. In his later observations on this and other so-called psychic phenomena and the attitudes of scientists to phenomena such as PK, on pages 355 to 377 in the chapter entitled: Postscript: *Skeptics at Cal Tech*, he gives a very concise overview of the subject and scientific attitudes towards it. He also provides a useful bibliography for further study. It is well worth reading. There are many other books available on this and related subjects and a useful overview of PK phenomena is given in Chapter 6, pages 130-144, of a little book by Liz Maclaren, in the *Brockhampton Reference Series*, entitled: *Mind Over Matter*. A short but up to date bibliography of this and related subjects is given on page 183. The *Brockhampton* books are a series of small format, encyclopaedic-type information

TRAINER & MOVEMENT DETECTOR

books on a wide variety of topics, ranging from Vitamins to Saints (?!) (e.g. Dictionary of Vitamins; Guide to Letter Writing; Dictionary of Saints, to mention but three).

Other well known names associated with PK phenomena also spring to mind. Names like Nina Kulagina (also known as Nelya Kulagina), a Russian psychic and former Red Army Sergeant, who had the ability to move small objects near her fingertips, when concentrating on a quite different form of psychic activity (so-called 'blind' colour perception). All sorts of small objects would move, ranging from a box of matches to metal objects weighing a few ounces. The distances involved were up to about 3 inches and the nature of the movements often quite unusual. Kulagina could also do something that Uri Geller has demonstrated several times on TV – the deflection of a compass needle. Kulagina pre-dated Geller by several years, but due to the frosty atmosphere of the cold war period, never became very well known outside Russia due to the lack of communication which prevailed at that time. A fuller account of Kulagina and her abilities will be found in Reuben Stone's book: *Mysteries Of the Mind* (a Library search should turn this up as it is now out of print). A more recent researcher in this field is Dr John Hastead, who wrote about his experiments in PK whilst Professor of Physics at Birkbeck College, London, in the early 1980's. One of the things Dr Hastead discovered and recorded was the ability of certain child subjects to cause a group of paperclips in a sealed tube to 'scrunch-up' into an entangled mass without anyone touching them. Another discovery, and one of great relevance in respect of metal bending phenomena as demonstrated by Geller and others, was the fact that certain materials were 'bent' by subjects. This was despite the fact that such bending was not normally possible without the use of extremely high temperatures, and in one case, was impossible to achieve by normal means at the speed which it was actually observed to take place. Some of Hasted's work in this field was published in the *Journal of the Society for Psychical Research* (the SPR), of which the author is a member. (NB: The Society does not hold any corporate views and any expressed in this article are therefore entirely those of the author). It appeared in the June 1980 issue (Volume 50, No. 784). Earlier works on this and related matters by him going back to 1972 and 1979 are also to be found in the SPR Journal and other publications.

Of more recent date, is an account of what is termed 'Macro PK' (e.g. it happens on a large, 'real world' scale of substantial physical objects). This took place in Poland and was originally delivered as a paper read out at the *6th International Conference of Psychotronics* in Zagreb (in the former Yugoslavia, now Bosnia Herzegovina). The author was a retired academic, Roman Bugaj. It was reprinted in the *SPR Journal in January 1996 (Volume 61, Number 842)*. It is an intriguing account of a well-observed series of PK manifestations resembling the more classic poltergeist-type activity, which was witnessed by several scientifically trained observers and the majority of which observations took place in good light. Some PK testing apparatus was employed in the investigations.

A useful exploration on the nature of PK and theories about it is contained in a paper by D Scott Rogo entitled: *Theories About PK: A Critical Evaluation*. This was also published in the SPR Journal in the June 1980 issue (Volume 50, No. 784, the same issue as Hastead's work). Issues of the SPR Journal can be obtained by the public at some libraries, or by direct purchase from the Society, subject to availability of reprints. (See bibliography). A further book dealing with PK and other subjects is: *PSI Psychic Discoveries Behind The Iron Curtain*. This is by Sheila Ostrander and Lynne Schroeder. Published by ABACUS (Sphere Books) in 1973, it is now out of print, but may be available in some libraries. It contains accounts of various Russian and other (then) Iron Curtain psychics, including the PK medium, Nelya Mikhailova, who was investigated by Dr Zdenek Rejdak of Prague. Nelya Mikhailova had the ability to selectively move small objects placed on a tablecloth in front of her just by concentrating on them. Objects such as what appear to be a salt-shaker, a box of matches and a small wallet are shown in one photograph in the book.

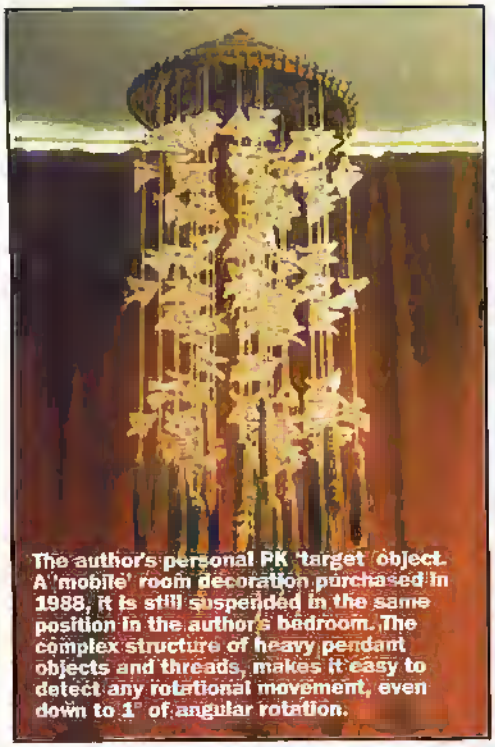
A book written specifically about poltergeist activity, which includes a very interesting section on computer analysis of cases, including those displaying PK-type activity, is entitled: Poltergeists, by Alan Gauld and A.D. Cornell, both of whom are also members of the SPR and known to the author. It is now out of print, having been originally published in 1979 by Routledge & Keegan Paul.

In the authors personal experience, object movements apparently induced by PK are often quite small and simply present some curious anomalies to everyday experience. If, like the author one regards these as being intriguing enough to follow up and investigate, one often finds they reveal more of the psychological attitudes of 'official' science to the subject of observed phenomena in general, and the possibility of discovery of anything fundamentally new in particular, rather than a willingness to really find out what is going on in the world and try to explain it. That said, when one witnesses a heavy Onyx lamp rise about two inches into the air, shake, then slowly settle down again with the lamp shade following slightly later, one is still apt to be disconcerted by even these 'small' movements! All this can of course lead to heated arguments and many attempts to try and explain away the observations – often with more pure faith required in these supposed 'explanations' than it would take to just accept the reality of the observation! However, the author is not trying to prove anything – just get down to the nuts and bolts of investigating a real and observable phenomena, with which he has had personal contact for over 50 years!

Nina Kulagina, the Russian PK medium (courtesy Mary Evans picture library).

Training and Bio-feedback:

The idea of being able to train someone to utilise PK at a conscious level is not knew or unique to the author, but has been tried by several other researchers in the field and with varying degrees of success. One such attempt in the form of a training programme, was made in the USSR (Russia), following on from research into the PK abilities of Nelya Mikhailova, as outlined previously. Alla Vinogradova, a young Russian woman, was a subject on such a programme and did apparently



The author's personal PK 'target' object. A 'mobile' room decoration purchased in 1988, it is still suspended in the same position in the author's bedroom. The complex structure of heavy pendant objects and threads, makes it easy to detect any rotational movement, even down to 1° of angular rotation.

A close-up of the pendant objects (polished pebbles) showing the attractive banding and shaping. Some of the coloured beads mentioned previously can also be seen.

learn to consciously control her PK abilities. A photograph of her in action appears in the Abacus book mentioned previously. Dr Zdenek Radjek has also attempted PK training. Several TV programmes have also been made which deal with the subject of PK and possible mechanisms for its interaction with scientific experiments. One recent programme appeared in the *Horizon* TV Series and showed such techniques as attempting to influence the rate of radioactive decay (significant results were observed), and another was to influence the way in which a set of small spheres, released at the top of a frame containing dividers which caused 'random' bounces, would fall into various compartments at the bottom. Again, some significant results were obtained. (NB: This is similar to the Amusement Arcade game of *Shove Penny* where coins are released into the top of a similar frame and one then has to try and get them to fall into a particular pile, with the intention of dislodging it and collecting the coins).

In terms of PK, and the subject matter of this article, since PK's exact nature remains as yet unknown and its also functioning at a seemingly 'unconscious' level, a direct PK-electronic transducer and, even more importantly, an electronic-PK transducer, remain yet to be invented (or discovered?). The method we therefore have to adopt in order to observe PK, record it in action, and feed data back to the experimenter or subject, is simply to find a reliable means of displaying when an otherwise stable system (mechanical, electronic or atomic) is being affected by PK. Such a method must detect and measure the changes in that system, then find a way of converting the detected changes into a format that can be recognised by at least one of the normal five senses that human beings are provided with. In practice, such a conversion (called transducing) will be to either visual or auditory format (or both), since these are the two most dominant senses with which we are familiar. It is theoretically possible to convert or transduce PK-induced observations into any of the other three (touch, taste and smell), but the practical problems of doing so themselves require specialised transducing techniques. (As a 'tongue-in-cheek' aside, the mind boggles somewhat when the idea of transducing to smell is considered – what might be used as end-to-end 'scale limits'? Rotten eggs for one and *Chanel No 5* for the other?!). I'll leave this to the readers imagination!

The fundamental requirements of any detection system are that whatever detection technique is used, it should not itself interfere with whatever changes are being detected. This is simply a recognition of the need to keep what is known in science as 'the observer effect', to a minimum. In practical terms, no scientific experiment is completely free from this, and it is recognised that whenever a system of any kind whatever is being 'observed' or 'measured', any 'observations' or 'measurements' obtained are not going to be the exact equivalent of those taking place in the system when unobserved, but are always going to reflect the fact of observation and any attempt to measure them. As a familiar example, try measuring the current in a low-voltage circuit with an ordinary multi-range test meter on a suitable Amps range. The results are markedly not what theory (Ohms Law) would predict, but reflect the insertion of the meter's own characteristics (internal resistance/volts drop) into the system under observation. As with the rest of science, problems with measurement led to the consideration of possible solutions and it is now possible to observe current changes in our simple system indirectly. In the case of current changes, this can now be done by utilising a naturally produced side-effect of the current – the magnetic field. For ac, the 'clamp-on' ammeter was developed (by AVO). For dc, we can now use 'Hall-effect' devices. Both rely on the fact that there is a known relationship between strength of field and current magnitude and so, in effect, changes in current level, have been 'transduced' into changes in a magnetic field format and, from then on, into an electronic signal for processing/indication.

In the authors design presented in this 2 part article, these 'observer effect' problems are overcome by using acoustic (sound) waves for the observation function, acoustic transducers (e.g. microphone and resonant crystal receivers) to convert observed changes to an electronic format, phase discrimination techniques for the detection function and finally, conversion of the detected changes to visual format (meter readout) plus auditory format (movement to continuous frequency change) for the bio-feedback function. Other conversions into these formats are also possible, including 'bargraph' (visual) and 'stepped-tone' discrete frequency shift (auditory).

Acoustic microwaves:

It is not well publicised that since sound waves travel much more slowly in air than radio waves in free space – a reduction of almost a million-fold is involved – then when one compares the wavelength of signals at these widely different frequencies and in the two media, one is struck by the fact that compared to a radio frequency signal in the Gigahertz spectrum (microwave region), which may have a wavelength of anything from few centimetres down to millimetres, that an acoustic wave in the ultrasonic range (e.g. @20 kHz and above) will have exactly the same wavelength range! In practice, this means that for a much easier to implement technique, one can make use of microwavelength signals for measuring/indicating movement. Effectively, one can use 'Acoustic microwaves!' Exactly the same formulae can be used to calculate wavelength/frequency requirements, provided the relative velocities are known accurately. In the case of radio waves, the velocity in free space is 300,000,000 metres per second (m/s) and most readers will be familiar with the formulae:-

$$\text{Wavelength } (\lambda) = \frac{\text{Velocity}(v)}{\text{Frequency } (f)}$$

and:

$$\text{Frequency } (f) = \frac{\text{Velocity}(v)}{\text{Wavelength } (\lambda)}$$

In terms of sound, the relative velocity is 341.98 metres per second (m/s), but with the proviso that this varies with temperature and pressure (thus also, altitude). The quoted figures are therefore strictly only true at 20°C and at sea level. In practice, unless one lives on top of a mountain (Swiss/Austrian readers take note!), the value of 342m/s can be used without serious error. There is simply no point in being that 'picky'!

A quick calculation for 40kHz, the most common ultrasonic frequency used in remote control applications, yields that the following wavelengths are involved (based on m/s and

Hertz), where λ = wavelength; f = frequency; v = velocity:-

$$\lambda = v/f$$

λ = 342/40,000 = 0.00855 metres.

Converting to cm (X100) gives
λ = 0.855cm

Converting to mm (X1000) gives
λ = 8.55mm

The same calculation applied to a signal of 40GHz, which is in the microwave region, yields the following:

(Based on simplifying the formulae to 300/MHz in order to keep track of the zeros!)

λ = 300/40,000 = 0.0075 metres.

Converting to cm (X100) gives
λ = 0.75cm

Converting to mm (X1000) gives
λ = 7.5mm

From which it can be seen that the relative wavelengths lie in exactly the same region. The difference being that 'Acoustic microwaves' are approximately 14% longer for a frequency reduction of 1,000,000 times, as a result of the numerical disparity of the relative wavelength calculations (342 as compared to 300 in the formulae). As with microwaves, sound waves can be guided down tubes (waveguides), and reflected by objects (targets). It is the latter technique which is utilised in the authors design presented here.

Personal background and attitudes towards PK

Before going much further down the design route for the actual equipment, it is worth pondering the following points:-

1. In any scientific experiment, one must try to reduce the observer effect to a minimum. However, in the case of PK, what we are actually dealing with IS the observer effect in its most naked form! It is a direct interaction of the observer with a system and without the aid of any transducing devices whatever. A moments thought will allow one to realise that if any system can be affected by PK, then there can be no such thing as a truly scientific experiment in which the observer effect is minimised – except in theory. It then becomes possible to consider that all attempts to minimise the observer effect are, in reality, only ways of minimising known methods of unwanted or unintended interaction. It is this particular problem which is at the root of all the objections of 'official' science to considering PK a subject worthy of scientific study, or of even of 'believing' in its existence.

2. The existence of PK throws much of what science claims to have discovered about the world and its known interactions into question, since it requires a fundamental rethink in attitudes to accommodate it. Nonetheless, the effect is real and won't just go away because we don't like it. Science has never truly progressed in its attempts to explain and quantify the world we live in by burying its collective head in the sand. All that does is to expose a sensitive area of the (collective) anatomy to an unexpected pedial contact from an unseen source (work it out for yourself!).

3. From the authors personal experience over 50 odd years of life, unusual effects, explainable by PK, do exist and have been observed on many occasions. What is needed is an inclusive explanation – not a rejection – of reality.

The author has experienced PK effects ever since childhood and the starting point for his curiosity goes back to 1946 and an incident which occurred whilst walking back to the house of an aunt with whom he had been staying, after visiting a playmate who lived nearby. This involved the author walking down a short but lonely country lane. Nearing the end of the walk, a sudden feeling of what could only later be described as an 'electric expectancy' developed and caused him to look round. There, floating in the air behind him as if attached to the ends of someone's (invisible) finger tips, were five small pebbles. As he watched, these were suddenly flung to the ground. The author made it home in record time! Another incident was in 1948. In those days, before the invention of pull switches (yes, it is that long ago!), if one wanted to switch off the bedroom light without getting out of bed, one had to have an extension cord carrying a pendant-type light switch wired into the ceiling rose and then a cable carrying the switch suspended over the bed head. When one switched off the light, this switch would swing in pendulum fashion, sometimes tapping on the wall. This happened on one occasion and annoyed the author. Rather than try to reach up and stop it by hand, he just wished that it would stop – and it did! However, when the 'wish' subsided, back came the tapping again even several minutes later, only to stop again when attention was given to it. This curious effect was filed away and forgotten about until the mid 1960's, when J B Rhine's work with PK at Duke University began to be published in the popular press. The author then decided to try the idea of influencing a freely suspended object to swing and to this end, attached a small, push-type light switch to a lamp shade in his bedroom by means of a cotton thread. Repeated attempts to get this to move (swing) whilst laying on the bed in a relaxed state failed miserably, despite the mental effort equivalent of a 'busted gut' being employed. The author became so fed up that he made a spinning gesture with his hand towards the object, accompanied by the well known feeling of: Oh S*d it!! At that, the switch suddenly swung around in a large circular motion, as if being spun by an invisible hand! The author was so startled that he nearly fell out of bed!

Almost the final link in the chain of events which eventually led to the design presented here, goes back to the 1970's and 80's, when on various occasions around Christmas time, the author found himself seated on a comfortable sofa, warm and fully replete from Christmas dinner, idly contemplating the Christmas decorations swinging in the hot air from the gas fire. Memories of the 'pendant light switch episode' in childhood came back and having nothing better to do, he attempted to influence this otherwise random swinging. Much to his surprise, there did seem to be a correlation between the intention and the observed effect. Later, on going upstairs to the bedroom for something, he decided to try and get the lamp shade in the bedroom rotating, since it seemed that this form of motion was easier to control. Again to his surprise, an effect was observed which correlated with the intention and could not on this occasion be attributed to air movements. Rotations of about ±15°-20° were observed and confirmed by the fact that patches of light from the lamp shades structure moved over the walls of the room. Much later, a 'mobile' room decoration in the form of a wickerwork disc, from the periphery of which were suspended several heavy, elongated and polished 'pebbles', was purchased during a trip to the seaside. This was installed in the main bedroom, suspended from a hook in one corner of the room. The author found this a 'mentally attractive' object (an observed pre-requisite for some people with PK ability) and he began experimenting with it. Soon, similar rotations of 15°-20° were observed and also, quite significantly, an ability to stop and reverse the direction of rotation before this would naturally occur were also observed. The author has used this object as a PK 'target' for several years and at various times has recorded the rotations on videotape with the aid of a small surveillance-type TV camera he built from a Maplin kit.

The final trigger factor which led to the production of the instrument dealt with in this article, came when the author happened to have had an article on a loosely related piece of equipment (it also used sound waves) rejected. The rejection however carried a tag line suggesting that this magazine might be interested in an article on a psychic research subject. Further discussions with the editor followed, and the culmination was that the apparatus presented here finally received the impetus required to make it from the depths of the authors mind into actual hardware, and thence to the writing of this article. The idea has been around in the authors head for several years, but needed something like this to convert it to a reality. My thanks therefore go to the Editor, Mr Paul Freeman-Sear, for his interest.

Having now set the tone of discussion (and probably raised the hackles of many readers to boot!), the author stands by all his foregoing statements, but would ask that readers recognise that the apparatus presented in this 2 part article is not a means of proving the existence of PK, but rather a means of observing it in action and, if possible, 'taming' it to bring it under some form of conscious control.

The arguments for and against the existence of PK are purely academic. Metaphorically speaking, let's now try and find out how to drive the real car sat on the driveway, instead of working out ways of proving there is (or is not) an engine under the bonnet of a hypothetical vehicle in the garage!

More next month plus constructional details.

The author is a 58 year old retired former lecturer at a major Northern Tertiary College. He has experience of teaching theoretical and practical electronics subjects to City and Guilds 224 Electronics Servicing, and B-Tech levels. He has also spent some time in industry as a design engineer. Before that, he spent several years as Chief Research Electronic Equipment Design Technician at a major Northern University and during that time, spent 10 years teaching hobby level, practical electronics in Local Authority Evening Schools. His initial grounding was in Radio & TV Servicing.

Partial Bibliography

Authors note

This partial Bibliography has been compiled principally from sources available to the author, or of which he has knowledge, and is not meant to be exhaustive. However, reference to the relevant Bibliographies of the listed works will give a fuller overview of further sources. Works marked with an asterisk (*) each have a very extensive Bibliography and will provide a starting point for more exhaustive literature searches. Wherever possible, the ISBN (International Standard Book Number) reference has been given to aid location of the work. This Bibliography has also been compiled with the emphasis primarily on PK and the relevant related subject of so-called 'Poltergeists', hence the detailed presentation of section and chapter references etc., Readers should note that other areas covered in each work will almost certainly overlap with this aim and so a general reading of the works presented here is recommended, perhaps after studying the specific areas listed. To give balance to the whole subject, a general reading of the volume: "The Mind Race" (No. 13 in list), is recommended - particularly the indicated Parts and Chapters - as an accompaniment to all the other works, since although primarily concerned with "ESPsype" experiences such as Telepathy and Remote Viewing etc., it is a down-to-earth overview of psi and, very importantly, its potential for practical use, although emphasis is given in some of the foregoing works to research in the old Soviet Union (USSR), and other former Communist Countries and to 'cold war' viewpoints, this simply reflects the political situation at the time they were written and does not detract from the validity of the information.

D Aldous.

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The following are to be found in the Journal of the Society for Psychical Research (SPR), except where noted. Requests for reprints of these items, or for copies of the relevant Journal etc., should be addressed to:

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Volume 56: Part 210, January 1976. Directly Observable Voluntary PK Effects: A Survey and Tentative Interpretation of Available Findings from Nina Kulagina and Other Known Related Cases of Recent Date. by H. H. J. Keil; Benson Herbert; Montague Ullman and J. G. Pratt.

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1) The Problem of Telekinetic Phenomena: Part I. A Proposal for Active Research. by Colin H. Brookes-Smith. March 1966.

2) The Problem of Telekinetic Phenomena: Part II. Hints on Using Tables: Comments: Random Sequence Generator. by K. J. Batchelder. & Colin H. Brookes-Smith. September 1966.

3) The Problem of Telekinetic Phenomena: Part IV Manual of Advanced PK Experiments and Procedures. by K. J. Batchelder. & Colin H. Brookes-Smith. 1970.

Acknowledgment: The author would like to acknowledge the contribution made by the work of the above two pioneering researchers, in stimulating his own interest in producing PK activity detection apparatus.

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ELECTRONICS and Beyond

Words of SCIENCE

PART 2

In part 2 Greg Grant looks at Electricity: A Natural Phenomenon

Introduction

Even today, more than a generation into the space age, strange happenings in the heavens still have the power to awe - indeed sometimes intimidate - us. The feeling that dire portents usually emanate from the sky, remains deeply rooted in the human subconscious.

The most recent example of this of course was the comet Hale-Bopp, discovered by amateur astronomers Alan Hale and Thomas Bopp, which held a considerable portion of the planet's population enthralled as it made a rare visit indeed to our small segment of the observable universe, early last year.

Another, earlier, spectacular heavenly happening - albeit one seen through the mighty Hubble telescope - was the comet Shoemaker-Levy Nine's impact on Jupiter. This is another event that had a world-wide TV audience mesmerised - yet another word derived from a proper name, this time the Austrian physician Anton Mesmer - throughout an entire week.

In times past, the heavens were, so far as man was concerned, the location of the gods and the events taking place there were regarded with great foreboding. None more so than the fabulous displays of colour that, from time to time, seemed to take place at the extremities of the world.

The Aurorae

In times past - as indeed it still is today - the *Aurora* was one of the most spectacular sights in the heavens. It concentrated in the polar regions as a pale green glow initially, a few hours after sunset. It then brightened until phantom curtains of green, magenta and gold shimmered across the sky.

The first direction that primitive man noticed was that in which the sun rose, for that was the direction from which came firstly light, secondly warmth. The first word used to describe the phenomenon of sunrise was the Sanskrit *Usas*, which was derived from another Sanskrit word meaning 'shining.'

From the Sanskrit expression the Greeks evolved Eos and the Romans *Aurora*, these words being the Greek and Roman expressions for both *the Dawn* and the *Direction* of the dawn. Furthermore *Orient*, which also means 'East,' comes from the Latin *Orior*, meaning 'to rise.'

To the ancients, the aurora appeared to be something of a dawn, although it could hardly be said to have any connection with the sun. In fact, as we now know, it has a great deal indeed to do with the sun, which only came to light in the present century. The nuclear war which rages continuously on the sun's surface destroys some four million tons of matter every second. A wind storms outward from this battleground at a speed of 300,000 km/second, laden with protons and electrons.

A mere eight minutes and twenty seconds later, this hurricane-force wind hits the earth's upper atmosphere, pumping energy into the atoms and molecules of the air, causing them to glow. This is the driving force behind the stunning beauty that is the aurora, whose light derived its name from the one aspect of it that seemed so very remarkable to the early, naked-eye observers of the heavens: its direction.

Electrons of course are negatively-charged particles and so are deflected by the Earth's magnetic field. Consequently, they hit the planet's atmosphere at its extremities, the polar regions. To an observer in the northern hemisphere, the aurora is seen in the North and so it is termed the Aurora Borealis, derived from *Boreas*, the word used in both Greek and Latin for the North Wind. *Aurora Borealis* therefore means 'Northern Dawn.'

Conversely, an observer in the southern hemisphere sees the aurora in the South. In Latin, *Auster* is the word for the South Wind, and so the southern version of this striking display is termed the *Aurora Australis*, or the 'Southern Dawn.'

Our word East has equally as complicated a pedigree. It descends not only from the Sanskrit, Greek and Latin expressions already touched upon, but also from the Old High German *Ostar*, meaning 'to the east' and the Old Norse *Austr*.

The Ionosphere

The idea that the atmosphere - from the Greek word *atmos*, meaning 'vapour' and another Greek word, *sphaira*, meaning 'globe' - might have an electrical nature was first put forward in 1839, by the German mathematical genius Karl Friedrich Gauss. He thought that the variations in the earth's magnetic field could be caused by electrical currents in the upper regions of the atmosphere. His reasoning was simple. He suspected that the aurora was caused by similar means, an idea that would anticipate the many links between auroral and ionospheric science unveiled in the present century.

The 'reflecting' layer in the upper atmosphere was discovered by Marconi, in 1901. A year later Kennelly and Heaviside came up with the idea of a 'conducting' layer by way of explaining Marconi's achievement. However, the first man to suggest that the reflection of radio signals was the result of ionisation by solar radiation was Oliver Lodge.

The one man who made atmospheric science his own was Sir Edward Appleton, but he did not coin the term. That was the work of another radio physicist, who would later become a radar pioneer: Robert Watson-Watt. He first introduced the word in 1926, although it didn't appear in any scientific paper or journal until 1929. It is another Greek expression, the first of many associated with our planet's atmosphere. So, let's begin at the bottom of the atmosphere and work our way up.

Troposphere

Comes from the Greek *tropos*, meaning 'a turn' or 'change,' as this is where the air really does change. The region is around 18 kilometres (km) thick at the equator and some 6kms thick at the Poles.

It's in this region that some 75% of the planet's air mass and water vapour are confined. The air temperature decreases with height fairly uniformly, at around 6.5°C/km.

Stratosphere

This zone is immediately above the Troposphere and is twice as deep, ending at an altitude of over 50km. The word Stratosphere comes from the Latin *stratos*, meaning 'something flat in layers' or 'to spread,' because within this region the air is actually visibly layered. In this area, the air temperature generally increases with height.

Mesosphere

Above the Stratosphere is the Mesosphere, which comes from the Greek word *misos*, meaning 'middle.' It's between 80 and 100km above the Earth's surface and is characterised by a rapid decrease in temperature with height. At the Mesosphere's ceiling for example, the temparature falls to -143°C, the lowest *natural* temparature level recorded anywhere within Gaia's environment.

Thermosphere

This word comes from the Greek *thermos*, meaning 'hot,' and with very good reason. Its 400km-depth of air which runs into the Exosphere, is so thin that its density is no greater than one millionth of an atmosphere.

Temperatures soar to over 1,000°C, even though particles are so few and far between. Nevertheless, there are sufficient of them to reflect radio signals.

Ionosphere

This is the region familiar to all communications engineers. It extends from approximately 60km to about 1,000km above the planet's surface.

It encompasses the upper portion of the Stratosphere, all of the Mesosphere and Thermosphere and breaks into the lower *Exosphere*. The region has a high concentration of free electrons, formed as a result of ionising radiation entering the atmosphere from space.

It's in this area that the three major radio reflecting regions are located. The D region extends from 60 to 90km approximately, the E region from 90 to 150km and finally the F region - that with the highest concentration of free electrons - from 150 to 1,000km above the Earth.

Exosphere

Comes from the Greek word exo, meaning 'outside,' or 'beyond,' because this really is the outer limit. The base of this region is between 500 and 750km above the Earth's surface, a truly rarefied atmosphere in which the gas laws no longer operate.

Here, the ionisation is so total that the particles form a plasma - from the Greek plassein, meaning 'to mould' - which is constrained by the influence of the Earth's magnetic field.

Two areas of high-intensity particles, one at 3,000km and the other at 15,000km, form the *Magnetosphere*, which was discovered by the Explorer IV satellite as recently as 1958. The region was originally termed the Van Allen Belts, after the American scientist in charge of the experiment, but was later renamed more in the tradition of the other atmospheric layers.

Nowadays, the layers between the Troposphere and the lower Thermosphere are more usually referred to as the *Middle Atmosphere*, whilst the expression *Upper Atmosphere* is used for the regions above about 100km. What was formerly known as Atmospheric Science is now termed *Aeronomy*, from the Greek words *aer*, meaning 'air' and *nomia*, which relates to *nomos*, meaning 'law.' It is, in other words, the science of the upper atmosphere as a whole. Yet even today, there is still no universally accepted terminology for the atmosphere.

New discoveries of course have always involved new linguistic developments, and none more so than electricity. Next month, we'll take a look at the astonishing achievements of the two men who virtually created the language of electricity.

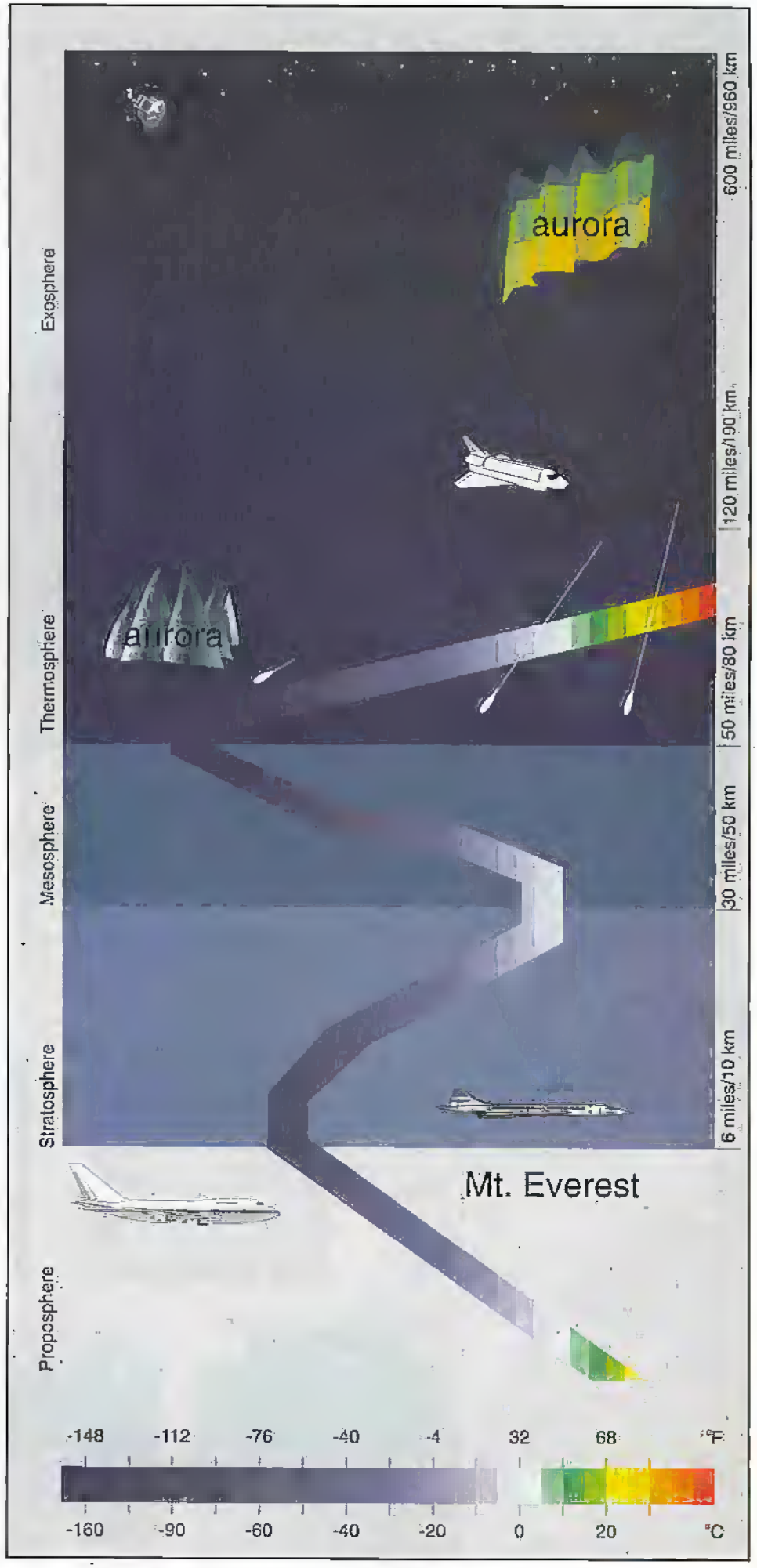

Figure 1. The Earth's atmospheric layers. The line weaving its way upwards is a temperature plot of the layers below the Exosphere.

Experimenting WITH C & C++ PROGRAMMES

by Peter Brunning

Martin Edwards reviews this new book.

BASIC and assembler. The idea being to provide all the advantages of the speed and efficiency of assembler yet with the convenience of BASIC. Peter Brunning says that in an ideal world we should first learn to programme at the grass roots level using assembly language and later go on to using C and C++. Even so, his new book starts by assuming that the reader has absolutely no prior knowledge of programming in any language, although obviously you are expected to be familiar with the operation of a PC.

The first thing that *Experimenting with C & C++ Programmes* does is to clarify something that is a mystery to all casual onlookers. What is the difference between C and C++ and which should we learn? In essence the book takes the view that C++ is merely an extension of C, while in reality knowing there is a bigger difference. This works, we are assured, because we will only be learning the parts of C which are directly useful on the learning curve of C++. So we learn to programme in C and C++. I like that simplicity!

The introduction promises us a slow and steady ride on the learning curve of C, but explains that before we can start we need to understand the outline requirements. Chapter 2 gives us a quick overview. In the space of 16 pages and seven example programmes which we type in, we are taken from a standing start to producing a programme with a professional feel, covering keyboard input, screen printing, loops and variables. Thankfully, Chapter 3 takes us right back to the starting line and that is where the real fun starts.

Before I go on I should explain that the kit of parts includes two C compilers which between them can be used to perform all the experiments, but although not absolutely essential, we are recommended to purchase Borland Turbo C++ when we get to the programmes using graphics - about half way through the book.

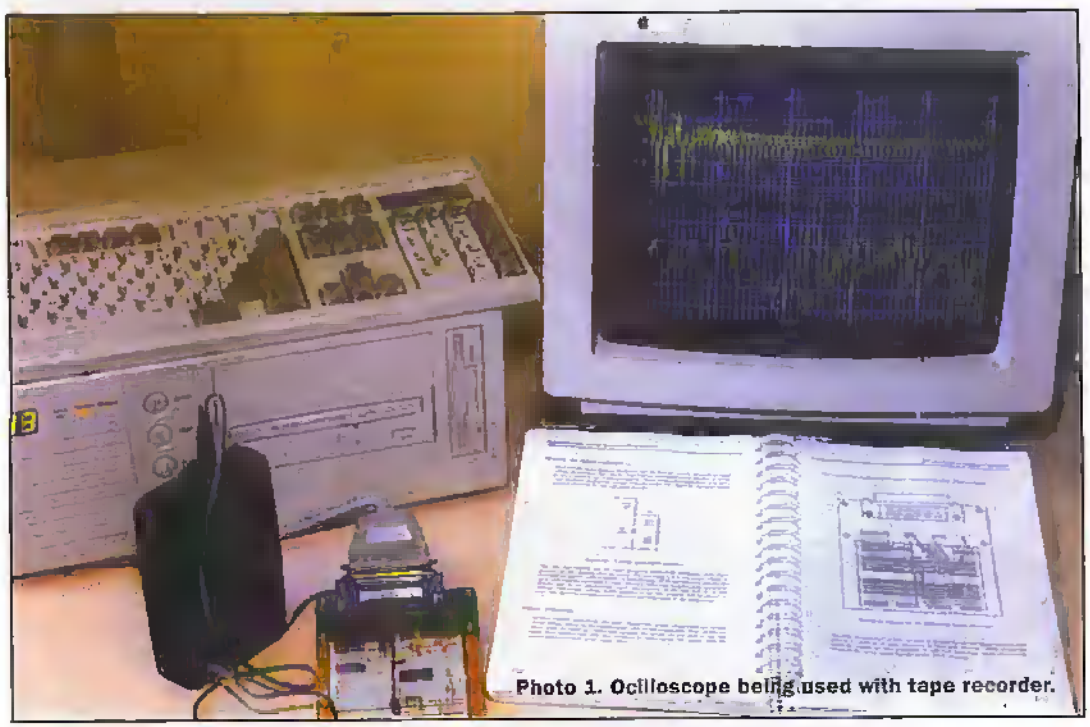

Photo 1. Oscilloscope being used with tape recorder.

Previously when I looked at programmes written in C or C++ I had never imagined that I could actually learn to programme using these collections of curly brackets and strange sounding words. I have programmed in BASIC for many years and more recently in assembly language, but whenever I looked at a C programme my mind went blank. Was it BASIC scrambled just enough to upset my brain or was it really a powerful programming language. I was inclined to think the former.

Almost exactly a year ago I was asked to review Peter Brunning's first book *Experimenting with PC Computers* and he certainly proved his point that assembly language is not too complicated when approached in a practical way. Since then I have become a regular programmer in assembler although I still write many programmes in BASIC.

C programming is supposed to bridge the gap between

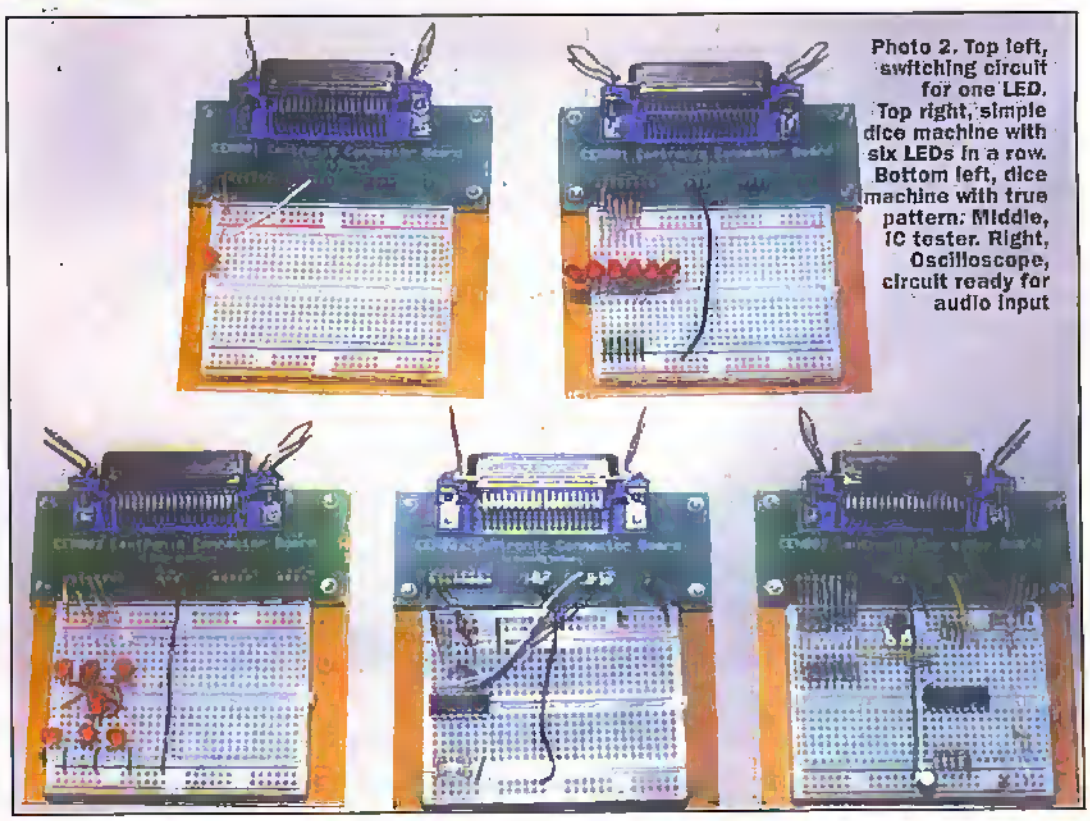

Photo 2. Top left, switching circuit for one LED. Top right, simple dice machine with six LEDs in a row. Bottom left, dice machine with true pattern; Middle, IC tester. Right, Oscilloscope, circuit ready for audio input

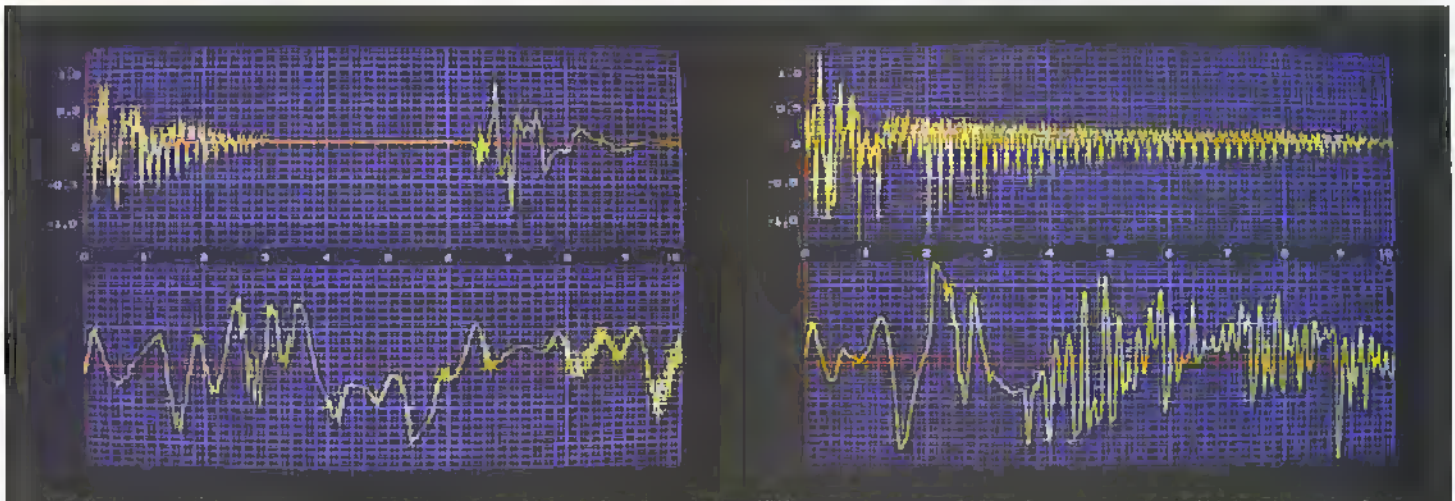

Photo 3. 'Bang' (left) and 'Beep' (right) displayed by taking 6000 samples over 0.5 seconds top trace shows the full 0.5s by displaying even 10th sample. Lower trace shows a 10x expansion of top trace, by displaying all the first 600 samples.

Chapter 3 uses the same simple circuit as in the first book *Experimenting with PC Computers*. This consists of an LED connected through a resistor to one of the output lines of the printer port and returning via one of the ground lines. We are given precise instructions on how to fit these components into the plugboard so even someone with no knowledge of electronics will find it easy. When the two components are fitted the plugboard is plugged onto the end of the printer lead. Then we write programmes in C to turn the LED on, turn it off, make it flash using a *for* loop, introduce keyboard control with a *while* loop, and then polish the programme with an *if* statement.

I found this extremely easy to understand particularly as I have worked through the first book, and my view of C programming mellowed almost to the point of over confidence. Until that is, I saw the exercises for Chapter 3 - how on earth can I be asked to answer these? I am expected to write my own programme to put three LEDs through a traffic light sequence! But determined not to look at the answers in the back of the book, I engaged my brain almost to hurting point and scribbled out my ideas. Alright so it was easier than it first looked and after a few near misses my green, yellow and red LEDs operated just as they should, and I sat back with a big smirk on my face. Chapter 3, and I have just written my very own original programme in C.

During Chapters 4 and 5 we build two dice machines. The first simply lights six LEDs in sequence, the dice number being indicated by the LED which is left on at the finish. In the second attempt we arrange seven LEDs in the same dot pattern as found on dice and modify the software to light up the correct patterns of LEDs. This is very clearly explained with circuit diagrams, layout diagrams and point to point wiring instructions, and the software, although getting quite complex, is pleasantly easy to follow.

In Chapter 6 we build a digital IC tester and write the software to automatically display the truth tables of dual input AND, NAND, OR and XOR gates. We modify the circuit and software to display the truth table for a 4-input NAND gate. We interconnect two NAND gates to produce a bistable circuit and write the software to show how this circuit performs as the building block for a frequency divider.

Now it is time for pure theory. Chapter 7 and 8 between them explain all the essential functions for C programmes. This also takes us back over the ground that we have already covered through doing the previous 13 experiments, but these chapters go into much more detail. The sections about structures and pointers are rather daunting and it is a relief to know that we are not expected to understand all this theory before we can continue.

From here on the experiments take an interesting twist. At first it seemed that we would be repeating the experiments of the first book until I realised that this time the circuits and the software are much more sophisticated. We convert the D/A converter to A/D conversion using an ultra low power comparator IC, experiment with various graphs, use CGA and VGA graphics, and find out how to use the real time clock with C. Then we get to the real task - optimising our newly built oscilloscope for use with audio waves.

In the first book the audio oscilloscope has quite a crude display with no graticule or any other form of calibration. This time we are working with the fine lines and multi-colours of VGA graphics so we gradually programme the software to create a very pleasant display with the y-axis calibrated in voltage and the x-axis calibrated in fractions of seconds.

Our 'scope is given two displays. The upper shows either the actual sampled waveform or a 10x digitally compressed display, and the lower shows a digital expansion of the sampled waveform of between 2x and 10x. 5x giving the most useful appearance. The triggering can be free running, single shot triggered or continuously triggered, and the trigger polarity can be set for positive or negative going.

I found the oscilloscope worked a treat with my portable tape recorder. I recorded my own voice and displayed the waveforms of single words such as 'bang' and 'beep.' Then I took the example of the author and used my electric organ playing middle C to test the calibrations of the x-axis using the closest to a sinewave that I could find.

In Chapter 18 we resort to adding a section of assembly language within our C programme as we squeeze the last ounce of performance out of our hardware. We optimise the assembler, change the IC comparator chip to one with higher current and higher speed, adjust the software, and our final circuit with its optimised software operates more than twice as fast as when we started. A fascinating example of software and hardware development. We end on an easier note with Chapter 19 showing us how to save and retrieve our waveforms to and from the disc drive.

So there it is. And what do I now think of C? Yes, it is easy to understand, and I have understood more of the programming in this book than I did when working through the first book. Yes, C does take much of the drudgery out of programming while maintaining that all important feature - speed of operation.

Experimenting with C & C++ Programmes gets my seal of approval. It is an excellent introduction to C programming. The book covers everything you are likely to need to know about C, and for the matter C++, for a long time although it is not and does not claim to be a complete works on the subject. The author has successfully woven a fine line between too much and too little information.

The other big question is should you work through the first book *Experimenting with PC Computers* before you start C programming. Ideally the answer is yes, but this is a real world. *Experimenting with C & C++ Programmes* does not assume that you have any starting knowledge of programming, so you are free to choose.

Overview

The book is a weighty 240 x 170 mm with 340 pages and finished with wirobinding so that it always opens flat. It costs £24.99 **(Maplin code NW47B)**.

The full 'unmade' kit of parts can be purchased for £39.99 **(Maplin code NW48C)**, or if you already have the kit for the first book you can purchase a top up kit for £22.99 **(Maplin code NW49D)** which is exactly the same but without the plugboard and leads.

No soldering is required to perform the experiments but the plugboard and leads need to be assembled and soldered before you can start, and do take note that the kits do not include the book so you need to order a book and a kit.

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20W mono	VX50E	£24.99
30W mono	VX51F	£29.99

Matching pre-amplifier modules are available and include a Hi-Z microphone module **(order code VX39N, £7.99)**, a Lo-Z (600Ω) microphone module **(order code VX40T, £7.99)**, constant output level pre-amp **(order code VX42V, £11.99)**, a stereo magnetic cartridge pre-amp **(order code VX44X, £14.99)** and a stereo spatial effect generator **(order code VX46A, £19.99)**.

If you have a spare CD player handy, then you can play video CDs with this MPEG1 decoder **(order code VX81C, £99.99)**. Installation is very easy, just three connections and a couple of simple track cuts to provide feeds to the decoder.

Sound Production

For budding guitarist there are three new fully featured guitar amplifiers housed in rugged wooden constructed cabinets and a comprehensive range of controls. The 10W version **(order code NA10L, £59.99)** is for practice and small venues. The powerful 25W **(order code NA12N, £94.99)** features an 8in speaker and overdrive, and the 35W version **(order code NA13P, £129.99)** is

intended for lead guitar and stage use.

Finally, for the disc jockey there are two disco kits from Soundlab – the entry level Kit20 **(order code NZ04E, £265.99)** and the professional Kit30 **(order code NZ06G, £399.99)**. Both feature two quality turntables, mixer, headphones etc.

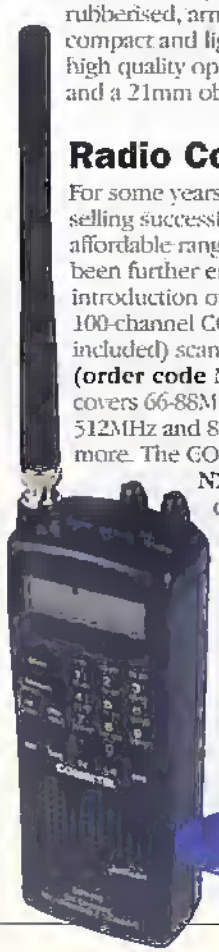
Telescopes

Two new telescopes have been introduced to the Catalogue, a 150x refractor telescope **(order code NA48C, £49.99)** and a 200x reflector type **(order code NA49D, £129.99)**. The refractor telescope is an entry level astronomer with aluminium tripod, high quality optic, Hygens type eyepiece and 2x finderscope. The reflector version is for the more serious astronomer and has an aluminium tripod, a medium duty alt-azimuth mount for fine adjustment during observations, and a 5 x 24 finderscope.

For more basic magnification suitable for hill walking, bird watching etc., then the compact prism monocular **(order code NA50E, £16.99)** is a real bargain. This rubberised, armoured monocular is compact and lightweight and features high quality optics, a 8x magnification and a 21mm objective lens.

Radio Communications

For some years now, Maplin has been selling successfully the Commtel affordable range of scanners, which has been further enhanced with the introduction of several new models. The 100-channel COM214 FM/AM (air-band included) scanner retails at under £100 **(order code NX07H, £99.99)** and covers 66-88MHz, 108-174MHz, 406-512MHz and 809-956MHz, plus much more. The COM510 **(order code NX04E, £199.99)** is a 400-channel full-coverage (500kHz to 1300MHz) hand-held scanner that is lightweight, compact and stylish. For the airband enthusiast the TAD-1 PLL digital AM/FM receiver **(order code NW46A, £49.99)** offers a superb range of features at an exceptional low price.



Telecommunications

The AN309 answering machine from Betacom **(order code PP83F, £17.99)** is a low-cost, modern styling machine with an impressive specification – memo, call screening, call intercept, remote access etc., and uses a standard micro-cassette (supplied). For those requiring superior quality sound reproduction, then the RP7010 digital answering machine **(order code PP93B, £24.99)** from Geemarc is an ideal choice. The machine records, digitally, up to 14 minutes of clear messages, with time and date stamp, full remote access, voice prompt, plus a two digit message counter. If space is a premium, then the Betacom TA309 combined telephone and answering machine is the perfect solution at a very affordable price **(order code PP84F, £24.99)**.

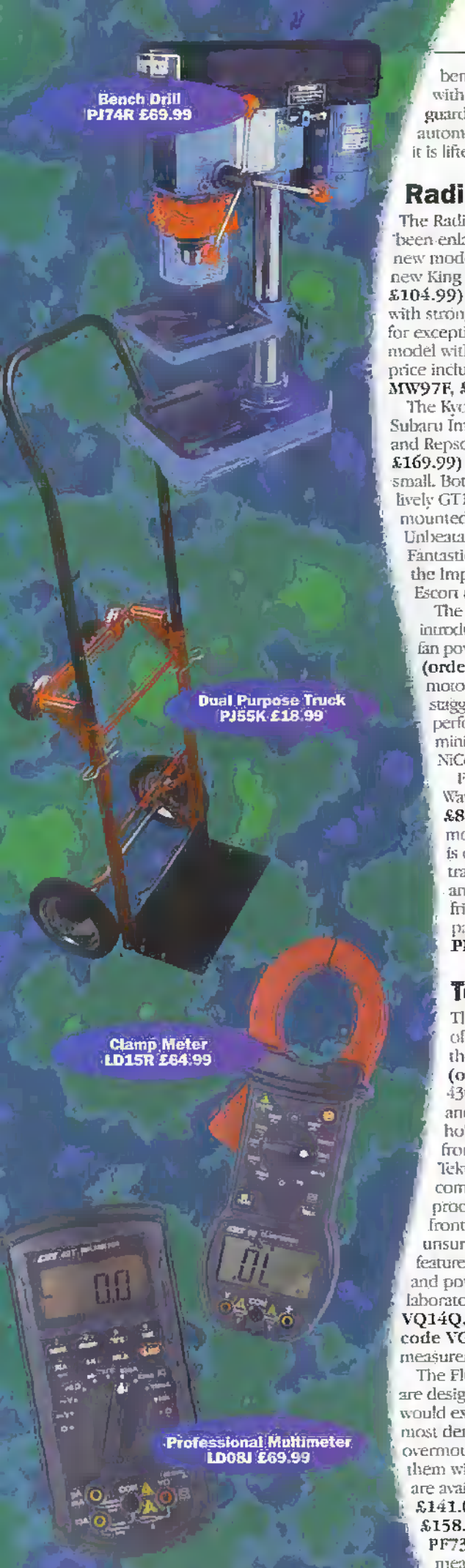
The adoption of the digitally enhanced cordless telephone (DECT) standard has brought about an effective solution to eavesdropping on private conversations by scanners plus crystal clear reception. Binatone have brought out a range of exciting telephones to take advantage of this new standard. The Eurotel 1500 **(order code PP89W, £99.99)** base station can register upto six handsets, with each handset able to register with upto four base stations. Other features include 10 memories, programmable 'hotline' numbers, a choice of six ringing tones and four volumes, call timer, LCD display of useful information etc. The Eurotel 2000 **(order code PP90X, £129.99)** combines the features of the Eurotel 1500 with a 14 minute digital answering machine. Finally the Eurotel 3000 **(order code PP91Y, £149.99)** provides the ultimate combination of DECT handset, corded phone and base with a 14 minute digital answering machine. Additional handsets are available for all the Eurotel models **(order code PP92A, 69.99)**.

Tools

This ingenious universal socket from Gator Grip **(order code NF89W, £24.99)** contains 54 steel pins which retract to grip securely hex nuts, square nuts, wing nuts, and even broken and rusted nuts. It will fit any nut from 1/4in to 3/4in and 7mm to 19mm, and is supplied with a reversible ratchet and a power adaptor for use with drills and powered screwdrivers.

Moving heavy loads and rubbish is made easy with this 3-in-1 handy truck **(order code PJ55K, £18.99)** from Clarke. The truck can be used sack truck, rubbish bag holder, or folded as a four wheel trolley for heavier loads – and at this price how can anyone not afford to have one.

Also from Clarke, is a range of power tools for the handyman and professional. The 16-piece cordless drill set features a variable speed, reversible 12V drill with six position torque control and 10mm keyless chuck. The kit includes drill bits, screwdriver bits and extension, three hour battery charger and a tough moulded case. To complement this kit is a 140W orbital sander **(order code PJ68Y, £19.99)**, a 350W variable speed jigsaw **(order code PJ67X, £44.99)** and a hot air gun **(order code PJ69A, £19.99)** with two heat settings of 375°C and 495°C. For the true handyman and workshop there is a 150W 5in bench grinder **(order code PJ75S, £29.99)**, and a high quality five speed



bench drill **(order code PJ74R, £69.99)** with depth gauge, tilting table and chuck guard. The belt guard features an automatic cut-out which stops the motor if it is lifted whilst the machine is in use.

Radio Control

The Radio Control Modelling section has been enlarged with the addition of many new models. For those into off-road fun the new King Blackfoot **(order code MW92A, £104.99)** is the latest release from Tamiya with stronger suspension arms and dampers for exceptional handling. A very impressive model with a massive saving on a special deal price including radio gear etc. **(order code MW97F, £174.99).**

The Kyosho's new bigger than 1:10 scale Subaru Imprezza **(order code PP72P, £169.99)** and Repsol Ford Escort **(order code PP71N, £169.99)** really make the competition look small. Both models are powered by Kyosho's lively GT12S CR pull start ic engine which is mounted in the middle of the car. Unbeatable performance and endless fun! Fantastic savings on special deal prices for the Imprezza **(order code PP77J)** and Escort **(order code PP76H)** at £229.99 each.

The flying enthusiast is catered for by the introduction of Kyosho's new electric ducted fan powered aircraft the T-33 Shooting Star **(order code PP68Y, £99.99).** The 8.2V motor, which is included, develops a staggering 400g of thrust for outstanding performance. Requires 4-channel RC with mini servos, electronic speed controller, NiCd and charger to complete.

Finally, for the sailor there is the Wavemaster **(order code MW98G, £89.99)** from Kyosho which is a scale model of a typical F1 tunnel hull, which is constructed from ABS plastic and traps a cushion of air between the boat and the surface of the water to reduce friction and move the boat faster. A package deal is available **(order code PE66Y, £155.99).**

Test Equipment

This catalogue sees the introduction of more professional multimeters from the low-cost autoranging model 49T **(order code LD08J, £69.99)** with a 4300 counts large display, a durable and robust housing with protective holster to the more sophisticated offers from Tektronix and Fluke. The Tektronix TX digital multimeters combine high performance digital signal processing technology with a simplified front panel and large display with unsurpassed accuracy and a full range of features. Both models are ideal for electronics and power systems measurements in the laboratory or field. Model TX1 **(order code VQ14Q, £240.88)** and Model TX3 **(order code VG15R, £293.75),** with temperature measurement, are available.

The Fluke 70 Series III are a new range and are designed to a very high standard – as you would expect from Fluke – and built for the most demanding situations with a tough overmoulded 'body armour.' Fluke supply them with a lifetime warranty. Three models are available, Fluke 75 **(order code PF71N, £141.00),** Fluke 77 **(order code PF72P, £158.63)** and Fluke 79 **(order code PF73Q, £176.25)** with true RMS measurement. The Fluke 80 Series III is

Gator Grip
NF89W £24.99

the latest evolution of this trusted and highly respected range of multimeters with lifetime warranty and large backlit 4000 count display and a higher basic accuracy than their predecessors. The range includes the Fluke 83 **(order code PF74R, 252.62),** and the true RMS Fluke 85 **(order code PF75S, £287.88)** and Fluke 87 **(order code PF76H, £311.38).**

Clamp meters have not been accessible to the electronics hobbyist and electricians due to their prohibitive cost. Maplin has now introduced a range of affordable clamp meters offering excellent features and build quality. They will measure ac and dc to 600V, ac current to 700A (model 91 to 1000A) resistance, frequency, continuity and diode test function. All feature a 3½ digit 1999 count display with high resolution. The basic model is the 98 **(order code LD15R, £64.99),** model 98T **(order code LD16S, £74.99)** is true RMS, and model 91 **(order code LD17T, £99.99)** measures ac current to 1000A and dc current to 1200A.

Finally, developed in conjunction with the Open University, the GS2020 **(order code VI95D, £703.82)** is a PC-based multi-functioned instrument operating under Windows, and can be used with any PC including portables. The GS2020 incorporates three instruments – a dual channel 20MHz 'scope, a 2MHz digital waveform generator and a four-output power supply. The Windows software allows the instrument sections to be used simultaneously or independently. Further technical specifications on this unique product are available on request.

GIVE AWAY!

We have six Universal Sockers from Gator Grip worth £24.99 each to give away to the first six coupons pulled from the hat on the 9th October 1998. Send your entries to:

The Editor, Electronics & Beyond,
PO Box 777, Rayleigh, Essex, SS6 8LU.

Name _____

Address _____

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Post Code _____

Multiple entries will be disqualified. You may photocopy this coupon.

PROJECT

Logging SYSTEM PSU

Kevin Garwell looks at a different type of uninterruptible power supply.

Introduction

This article is really an account of my solution to a particular problem, and is intended as a model from which minor changes to the design might offer the solution to similar sets of problems.

One of my interests is atmospheric electricity. Given sufficiently sensitive ammeters (well pico-ammeters) it is possible to measure the current between the atmosphere and the ground. There seems to be three factors which affect this current: The air conditions, what we call windy or calm and so on. The clouds which can be strongly charged as in thunder storms, and the upper atmosphere which becomes charged due to the effects of UV light and particles ejected by the sun - the solar wind. Very often these upper atmosphere effects are masked by conditions nearer the ground but given a very stable situation it is possible to observe the changes caused, particularly with the advent of dusk and dawn. Experiments in this and the equipment used were described in the *Electronics and Beyond* issues 117 and 118 under the title of *Thunder & Lightning*.

Originally there was one serious bug in the system. With the advent of a thunder storm (electrical storm due to highly charged clouds) it all got very exciting - until the mains went off!

Unfortunately our, or I should say the village, supply comes over open fields nearby and is a prime target for some real electrical activity.

Previously my system used a small micro with built-in digitisers to read the instruments measuring the current to ground and light intensity. The data being saved in memory. As the memory was not very large data was dumped daily to an IBM look-alike via a serial link for saving on disc and subsequent analysis. I should say perhaps that the micro and instruments were located away from the house whilst the Amstrad (IBM look-alike) was in the house.

Towards the end of 1994 I decided that the current system had really gone as far as it could. The digitisers were only 5-bit so the scale only had 64 divisions. This was plenty for the light meter, but very restricting for the current measurements because of the range covered from measuring upper atmosphere currents to those produced by a storm. Plus the ever present spectre of loosing all the information if the mains went off at one of the interesting bits!

I had acquired a digitiser that can be driven via an RS232 link and whose resolution was variable from 8- to 16-bits, and it soon became obvious that this should be driven from an IBM PC or look-alike which was fitted with floppy disc(s), and a serial interface for the ADC. It must be either battery operated or capable of being battery operated and, perhaps more importantly, mustn't cost a fortune. I am an OAP after all!

The obvious choice, to me at least, was one of the early Amstrad portables the PPC512 or PPC640. Yes you guessed it! One with 512K of memory, or the other with 640K. Both had one or two 3.5 inch disc drives, serial port and parallel port. Most importantly, they would run from a car battery. Therefore, all that was necessary was a small sealed 12V battery and charger and lo and behold, a mains failure proof PC! (Take it from here on that in my case PC stands for an IBM look-alike but in fact any similarly equipped machine would be suitable. It's just that I was brought up on PCs having little or nothing to do with Apple Mac, Atari, Acorn or others).

Looking round at the price of secondhand machines I guessed I should be able to get an Amstrad for under a £100 and after a bit of looking, especially in the columns of the local paper, I got one for significantly less. Problem number one solved!

The next problem is of course the equipment - the instruments. It's no good having a processor busy reading instruments that have lost their power! So we come to what this article is really all about. 'No-break' power supplies - especially no break power supplies for instruments as opposed to general purpose power supplies providing 240V ac.

The System Design

A little more background is necessary. Over the years I have made it a practice that all instruments run from 12V dc. This has the advantage that they do not have their own power supplies. As rarely more than two are in use at any one time, two small 12V 100 mA supplies meet most requirements. With one big beafy 4A variable voltage as a backup just in case!

Except this time, since the electronics housed in the garage required ±12V and the PC needs 12 - 15V at about 200mA, and more when a disc drive is energised.

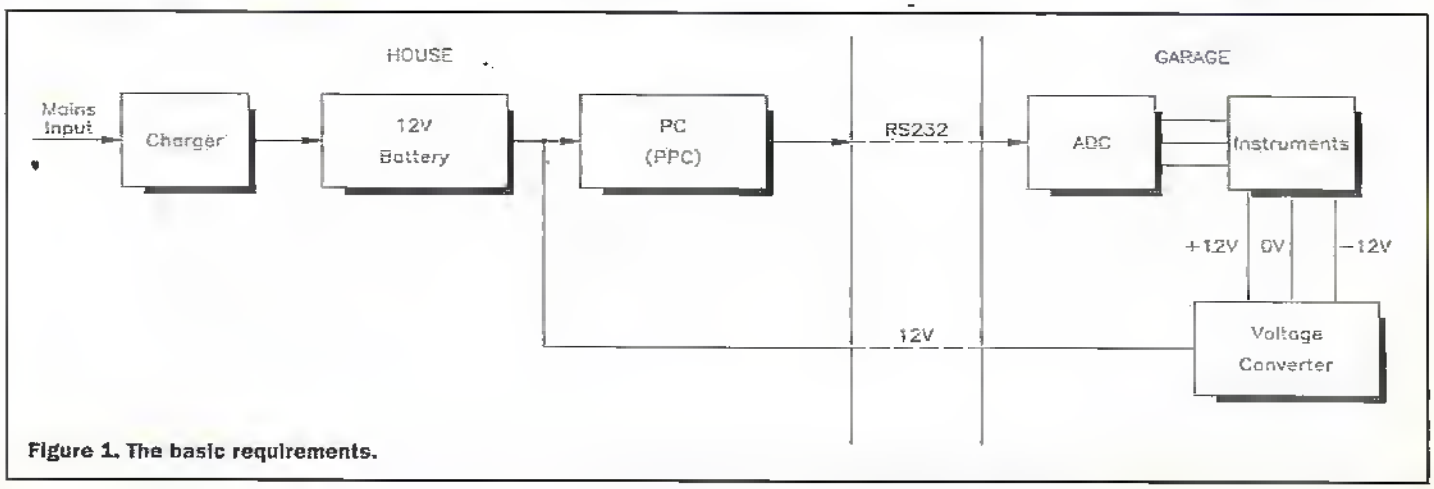


Figure 1. The basic requirements.

A normal no break mains supply seemed an unnecessarily cumbersome and expensive solution since the smallest is usually around 100W. The magnetising losses in the transformer would use more power than the instruments!

The more elegant, cheaper and neater solution is suggested in Figure 1. Use a battery charger to keep a battery charged (surprise!) and use a voltage convertor to generate the actual working supplies from the battery. There would then need to be three lines for the RS232 link plus two lines for the 12V supply. None of these would be carrying many milliamps and therefore no hefty cables would be needed.

Survey of Voltages

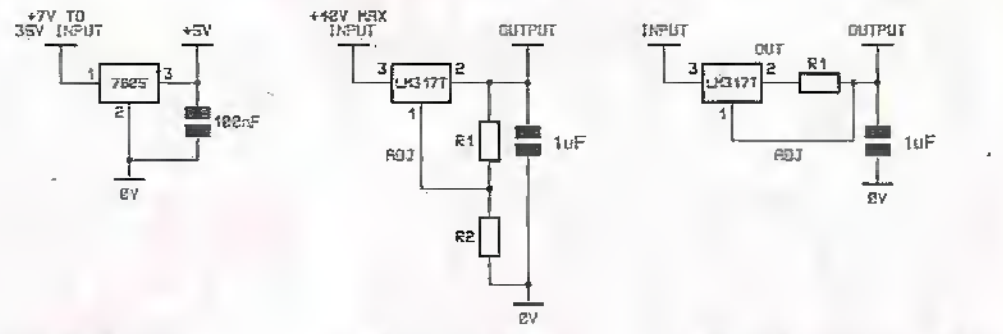
Life is complicated by the conflicting voltage requirements of Figure 1. In this system the battery is operating in the float mode i.e. the mains is normally supplying the required current for the electronics plus sufficient to keep the battery fully charged. Only when the mains goes off is the battery used. Which means that the battery voltage will be about 13.6V (see later comments on batteries and charging). However, if the mains fails and the system reverts to battery power the battery voltage will fall to 12V.

Fortunately the PC was designed to run over this range (and in fact better than this). However, the voltage convertor in the garage must be able to do this also. As we shall see later, power conversion and in particular regulation requires what is known as headroom i.e. a 12V regulator requires to be supplied with more than 12V. The usual difference is at least 3V.

The Battery and Charger

First a few thoughts about the battery.

- The load current will be around 0.5A occasionally going higher to perhaps 1.5A when the PC disc drive operates.
- It will be situated in the house along with computer equipment and therefore a fully sealed one is desirable.
- It must be designed for float use.
- 12V is required.
- It must supply the load for 3 or 4 hours as being more than the usual breaks and in any case sufficiently long to capture the important data.



a) Standard fixed voltage regulator. b) LM317T regulator. c) LM317T as a current limiter.

Figure 2.

Yuasa do a range of small sealed batteries and a suitable one appeared to be the NP2. 1-12 (order code XG74R), that is 12V 2.1A/h.

These batteries can be mounted in any position. However, because they are sealed the charging must be carefully controlled and a constant voltage charger is used with current limiting where the maximum charge current depends on the ampere-hour capacity. For a 12V battery the charger voltage must be between 13.5V and 13.8V. The maximum charge current for the NP2.1-12 is 3.8A.

As the normal load current is about 0.5A approximately a 1A charge would be sufficient to recharge a fully discharged battery in a reasonable time.

The LM317 Series and its Equivalents

We know from the comments on batteries that both the charging current and the charging voltage must be carefully controlled to awkward values, but the LM317 comes to the rescue as it can be used as a voltage regulator or a current regulator. The LM317 series range from a maximum current of 100mA to 1.5A.

Figure 2a shows the standard fixed voltage regulator where the regulated output appears between pin 2 which is 0V and pin 3 which is output. Figure 2b shows an LM317 as a regulator. Although this is still a 3-terminal device its operation is quite different. The internal workings are such that it attempts to adjust the voltage on pin 2 to maintain a voltage difference of 1.25V between pins 1 and 2. Consequently in Figure 2b the voltage across R1 is 1.25V. The current taken by the adjust terminal pin 1 is about 50μA and so if the resistor values are reasonably small it can be ignored. The current through R1 and R2 are then the same.

We know there is 1.25V across R1 so the voltage at pin 2 must be the voltage across R2 + 1.25. The current is common so the voltage across R2 is

$$1.25 \times R2/R1$$

and hence the total voltage

$$(1.25 \times R2/R1) + 1.25$$

Figure 2c shows the LM317 as a current limiter. Again, it will adjust the output at pin 2 in an attempt to achieve 1.25 volts across R1. If the voltage is less than that it will increase the output voltage. In the limit that there is no current through R1, i.e. no load, the output will rise until limited by the input voltage less the internal drop (about 2V). When current flows if the voltage across R1 starts to exceed 1.25V the LM317 will start to reduce the output. The current is thus limited to that which will give 1.25V across R1.

The charger is based upon the LM317T regulator which is the 1.5A version. One to set the voltage and one to set the maximum current.

Figure 3 shows the complete circuit. Starting with a quite conventional 15V supply. Transformer T1 has two 15V secondary windings connected as shown followed by D1 and D2 a pair of 3A diodes and a 4700μF 25V capacitor C1. A red LED power on indicator is provided, supplied via R1. R2 is a 1Ω resistor and the regulator will attempt to achieve 1.25V across this resistor. Setting the maximum current to pin 3 of the second device at 1.25A. R5 is a trimming resistor to allow the value of R4 to be adjusted. Ignore it at the moment i.e. assume for the following it does not exist.

Again the second device will attempt to maintain 1.25V across R3. The ratios of R3 and R4 are chosen such that with 1.25V across R3 the voltage across R4 is 12.35V (13.6 - 1.25). R3 is 220Ω, R4 = 2k2 If every thing

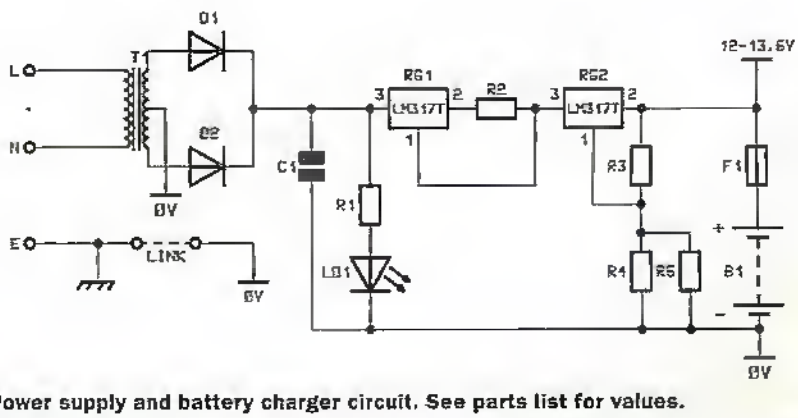


Figure 3. Power supply and battery charger circuit. See parts list for values.

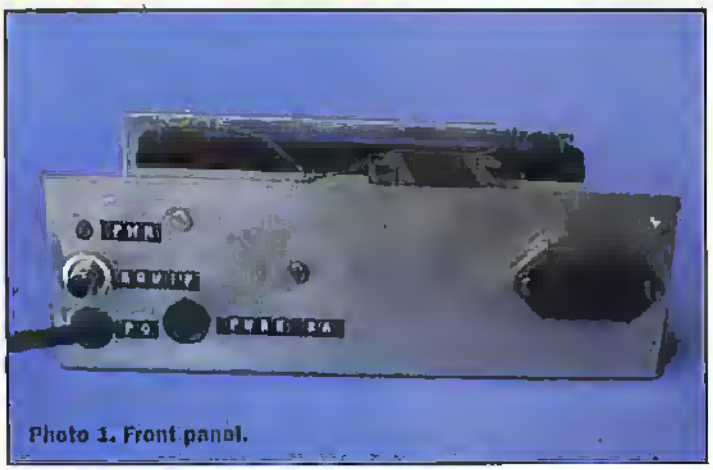


Photo 1. Front panel.

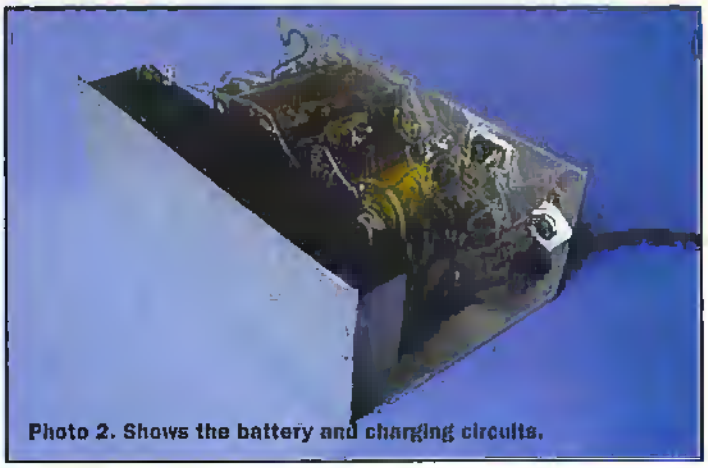


Photo 2. Shows the battery and charging circuits.

was perfect this would give 12.5V across R4 and an output of 13.85V. Which is where R5 comes in. It is an AOT resistor (Adjust On Test) and in my case 100k gave an output of 13.55V which is within the required band.

The picture is finally complete with a fuse F1 and the battery B1. The Fuse F1 Is A Must. These small batteries pack a real punch and a lot of current can flow (up to 75A!) if the output load becomes faulty for any reason. In my case it's a 2A fuse, but the value will be determined by the anticipated load current for the application. The maximum on my system is just over 1.6A. The next highest round number is near enough. but: it must be there, as the weakest link in the chain!

Charger Construction

There are no special requirements other than safety (more in a moment) and the box size is set very much by the battery size and the transformer size, so once again the choice is up to the constructor. Photo 1 shows the front panel (7.75 x 2.75 inches in my case) and as we are just peeping over the top the battery is visible at the rear and the transformer at the front just to the left of the mains socket.

There are no switches - they can be moved accidentally and this is a no-break device! Switching off can be done by unplugging the mains supply

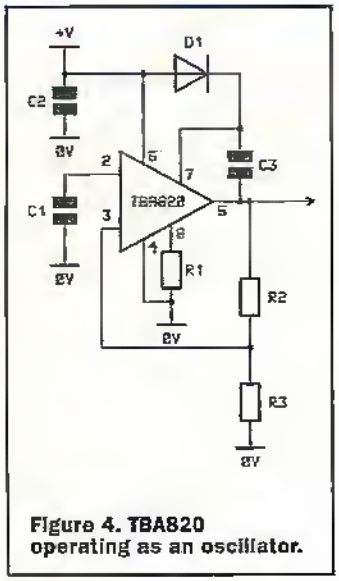


Figure 4. TBA820 operating as an oscillator.

and removing the battery fuse.

It is usual to connect the 0V line to mains earth, however, at one stage of the game I had problems with earth currents on the link between computer and equipment (before using the design in Figure 1) and found that isolating the charger 0V from mains earth solved the problem. The remote equipment was securely earthed to mains earth.

As a result, below the power-on LED there are two 12V outlets. The top one, the phono socket is isolated from the case so that 0V may, or may not, be connected to mains earth as required. Below this is the lead to the PC. This was originally fitted with a plug for connecting to a car cigarette lighter socket but now goes straight into the unit.

I am afraid the whole thing is not very elegant. No paint, and Dymo labels on the front panel. As an excuse I will claim that the construction was done in a hurry!

The screw showing above the fuse holds one of the LM317Ts, the other screw to the right and below holds the other. Mains input is via a standard IEC connector.

Photo 2 shows the 'behind the scenes view' and yes, it is 'birds nested'. The transformer is bolted in and the large capacitor is held with a nylon strap. As a metal case is used why not use it as a heat sink? Correspondingly the 317s are bolted to it - but don't forget the insulation set as the mounting tag is not isolated. With those four components fixed it seemed hardly worthwhile building a PCB for the few remaining components. Five resistors which are easily supported by the fixed items.

The white piece showing is the insulating washer for the phono socket. I don't believe such a thing as an insulating kit is available but it is quite easily made from two pieces of plastic with a 0.25in hole drilled through them. To prevent the threaded portion of the socket from touching the case cut a sliver from a piece of plastic pipe which is 0.25in bore. (Often to be found at shops selling brewers items). The hole through the case must of course be large enough for the piece of pipe to fit, 3/8in in my case.

Whilst speaking of isolating the 0V line from the case, don't forget, the metal box *must* be connected to mains earth. This is very much a safety requirement. A simplified version of the requirements for mains equipment is that if you can touch it and its metal then that metal must be *securely* connected to earth. The connection can just be seen in Photo 2 in the top corner of the front panel.

Voltage Conversion

There are a number of configurations suitable for voltage changing. One of the simplest uses an op-amp as an oscillator to drive an arrangement of capacitors and diodes as a diode pump. A very useful variation on this theme is shown in Figure 4 using a TBS20.

Many will recognise the TB820 as a miniature audio amplifier, very similar to a power op-amp. However, in Figure 4 it operates as an oscillator running at approximately 40kHz with the components listed in the parts list.

In operation R2 and R3 provide the positive feedback to cause oscillation whilst R1 and C1 set the frequency. However, a very important part of this configuration is the D1, C3 combination. By means of this bootstrap the output, pin 5, very nearly swings between +V and 0V. The D1, C3 combination does this by raising the supply to the internal output stage drivers

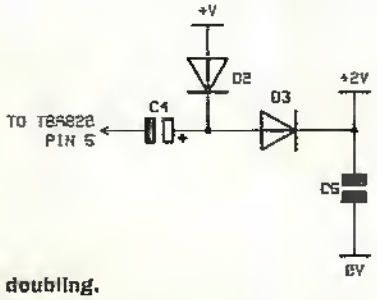


Figure 5. Voltage doubling.

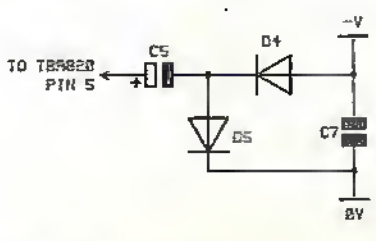


Figure 6. Generating a negative supply.

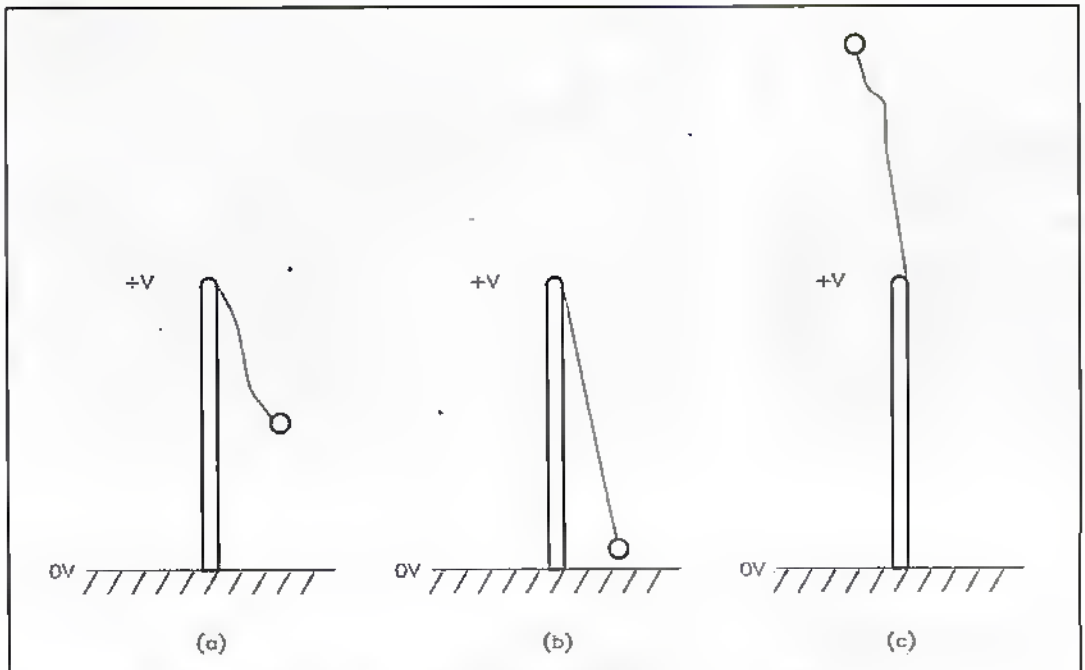


Figure 7. Simple analogy to explain back emf in an inductor.

above the voltage of the supply rail. The peak-to-peak output voltage is thus very nearly equal to the supply voltage.

By adding the capacitors and diodes of Figure 5 to Figure 4 the output voltage can be doubled. As we have already seen the output, pin 5, swings between +V and 0V. Starting at the point where it is positive as it falls C4 will charge via D2 and eventually will have the full rail voltage across it. Following this the pin 5 voltage swings positive to +V and the voltage on the positive side of C4 will swing up to plus 2V and via D3 charge C6 up to approximately twice the rail voltage.

In a similar fashion, adding the circuit of Figure 6 to Figure 4 allows a negative supply to be generated. In this case as pin 5 voltage goes from 0 up to +V, C5 will charge but this time the opposite way round, the negative side being held at 0V by D5. As pin 5 is driven back towards 0v the negative side of C4 will be driven below 0V to approximately -V. This in turn will charge C7 via D4.

1N4148 diodes and 10µF capacitors are suitable throughout. If the load is fairly heavy the output voltage will droop slightly - mostly due to the forward resistance of the diodes. If you are desperate for the last millivolt try using 1N4001 diodes instead as these have a much lower forward resistance.

The TBS20 scheme is very convenient, its simple and efficient. Where the load and supply is constant and the voltage required is not specific its a very useful scheme. I have used it several times, for instance to generate the negative rail for RS232 systems. And of course the output need not stop at +2V or -V. Other multiples of V can be obtained by suitable diode/capacitor combinations.

Its principle drawbacks are that only multiples of V are available and there is no way of achieving regulation without adding a conventional regulator. The fact that such regulators require headroom of 2V to 3V, increases the input voltage and of course wastes power.

For the basic scheme under discussion the input (battery) voltage is going to change and compensation for this would be very wasteful. A much better alternative is one of the switching regulators. These provide excellent regulation, the output voltage is fully adjustable and can be of either polarity. Moreover they are efficient, usually better than 70%, require very few external components and will operate over a wide range of input voltages. I chose the L78S40 by National Semiconductor as being representative of this type of regulator, it also happens to be in the Maplin catalogue.

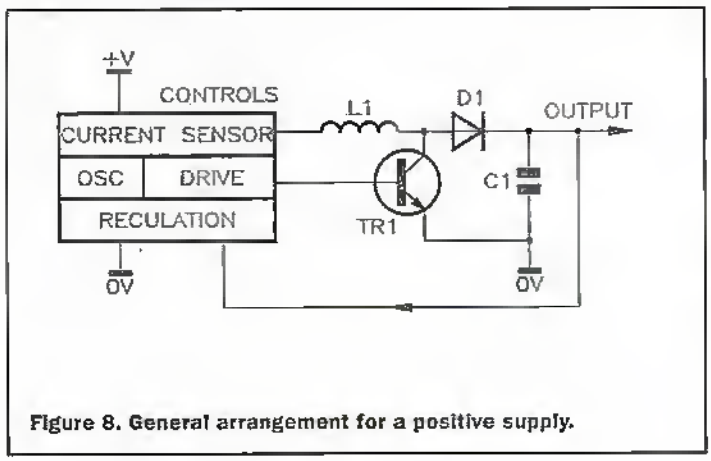


Figure 8. General arrangement for a positive supply.

The Switching Regulator

The fundamental principle on which it works is quite different to the previous scheme for it relies for its operation on a small inductor. If we remember

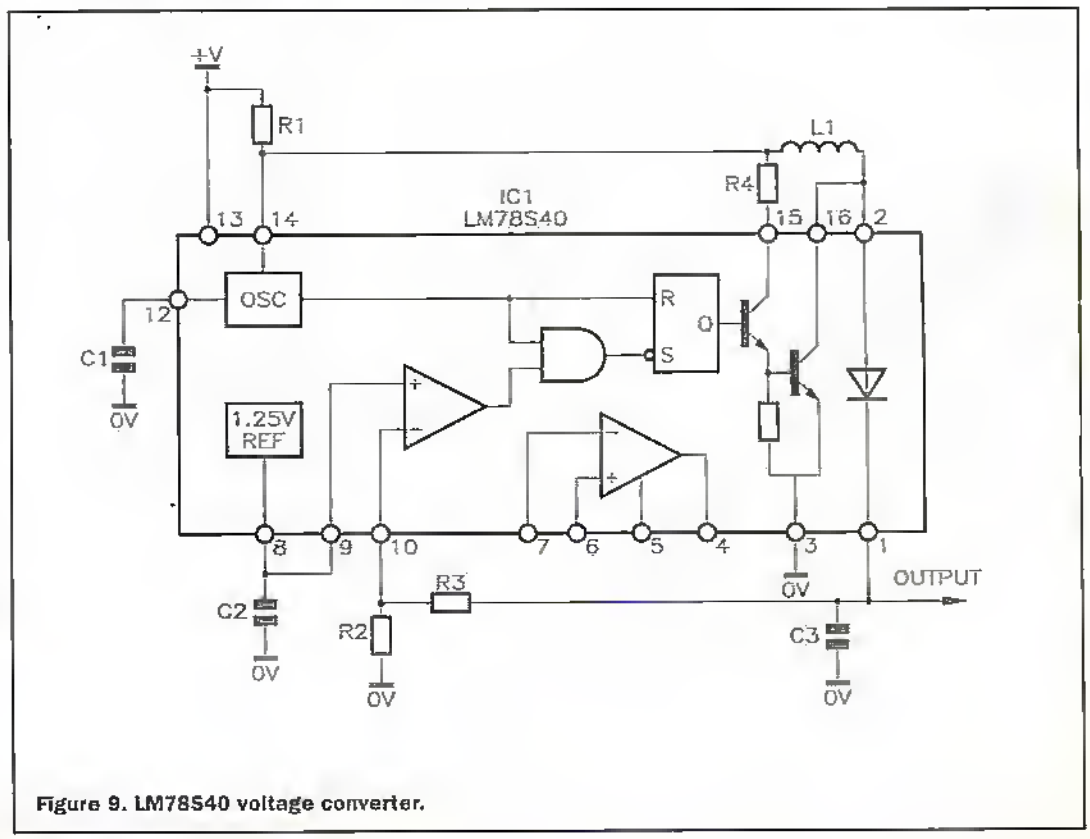


Figure 9. LM78S40 voltage converter.

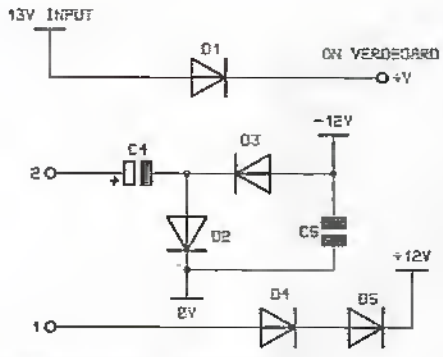


Figure 10. Deriving the negative supply.

our physics from school or wherever, if a current is passed through an inductor and then switched off a back-emf is generated by the inductor. In fact the emf is dependant upon the rate of change of current and with the advent of the semiconductor the rate of change can be very high and consequently the emf generated can be high also.

Perhaps one of the simplest analogies is to imagine a post standing up vertically from the ground. The ground representing 0 volts and the top of the post representing the voltage of the positive supply. To the top of the post is attached a length of elastic say half the length of the post with a weight at the end representing the load. Figure 7a. If the elastic is now stretched so that it reaches the ground, Figure 7b (current through the inductor), and then released, (current switched off), the result is shown in Figure 7c. The energy stored in the elastic will make the weight fly up above the top of the post and the end of the elastic represents the available voltage.

A small stretch of the imagination is required to visualise the opposite! A hole is dug next to the post and the elastic fastened to the bottom of the post. The elastic is then stretched to the top of the post (current) and released, whereupon it flies down into the hole - representing a voltage lower than 0V. To avoid confusing the issue someone had switched off gravity during the experiment!

Basically, all we need to generate a voltage higher than the available supply voltage is an inductor with one end connected to the supply and the other to the collector of a transistor the emitter of which is connected to 0V. (I should have said grounded!). Switch the transistor on to cause current to flow through the inductor and then switch it off and the collector will be taken positive above the supply by the inductor emf.

Life is not quite that easy as there are a number of extras required. The transistor must be able to withstand the higher voltage and the current through the transistor must be limited to a safe value.

The duration of the current turned on by the transistor must be variable so that the voltage generated can be varied. The on/off cycle must be rapid so that the output does not change in large steps. This will also help to keep the inductor small.

Figure 8 suggests the general arrangement for a positive supply. A control module contains an oscillator which provides the on/off pulses to drive the switching transistor TR1 which will switch the current in inductor L1. Diode D1 feeds the inductor emf into the smoothing capacitor C1,modified by current sensing and voltage regulation.

The complete system works as follows. In the control system the oscillator will turn the drive to TR1 on. The current through L1 is sampled by the current limiting. If the current approaches the limit allowed for TR1 then the drive to TR1 will be turned off. At the same time the regulation will compare the voltage at the output with the required voltage. When this is reached the on time for TR1 will be shortened so that less energy is stored.

Thus the current limiting and the voltage regulation define the time that TR1 is conducting in each cycle.

The LM78S40

Figure 9 shows the LM78S40 version of this type of voltage converter. Everything inside the solid line is on the chip and that really is very nearly everything. The numbers on the lines crossing the solid line are the pin numbers of the chip - a 14-pin DIL. The equivalent of L1, D1, C1 and TR1 in Figure 8 are on the right in Figure 9. D1 and TR1 being built in while the C1 of Figure 8 becomes C3 in Figure 9. On the actual chip, TR1 is a Darlington pair capable of handling 1.5A. The current sensing for L1 is provided by R1 (top left). The chip senses the difference between pin 13, the positive supply to the chip, and pin 14 allowing 250 to 350mV before resetting the flip-flop to turn off the Darlington. A suitable value for R1, 0.33Ω is easily made up by using three 1Ω resistors in parallel. C1 connected to pin 12 sets the frequency of oscillation to approximately 40kHz and C2 decouples the reference supply

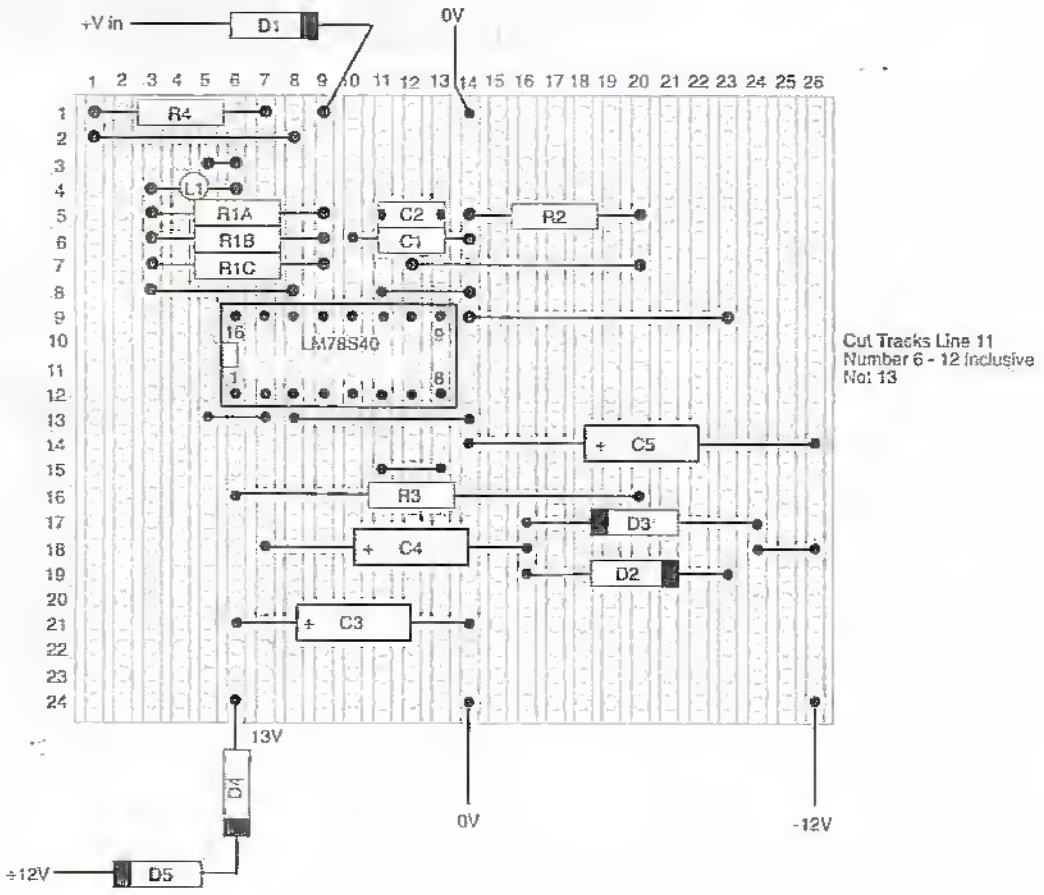


Figure 11. Matrix board layout. Tracks cut are line 11, numbers 6 to 12 but not 13. See text for values of R1, A, B and C.

at pin 8 linked to pin 9 the positive input to the on chip op-amp.

R2 and R3 set the output voltage by dividing it down for comparison with the internal reference. In other words the output voltage is equal to:

$$1.25 \times (R3 \div R2)/R2$$

The spare op-amp connected to pins 4 to 7 is for use in other configurations but is not powered up until pin 5 is connected to the positive supply. A variety of arrangements are given in the data sheet for voltage shifting one way or another which is why so many of the of the internal connections are made available.

The LM78S40 In Action

Just to recap, the object of all this is to generate positive and negative 12V supplies from an input which according to forecast will vary between just over 13.5V whilst the mains is available and will fall to around 12V when the mains goes off.

The circuit used is exactly that shown in Figure 9 with R2 equal to 10K and R3 equal to 100K. The positive rail voltage is just over 13.5V which in my application is near enough, its the regulation that matters. If there's need to have the voltage accurate then the easiest by far is to use a fixed resistor in series with a variable instead of R1 (or R2 for that matter). For instance a 5k variable or preset in series with 8k2. The manufacturing spread for the internal reference voltage is allowed too much latitude to enable the resistors to be calculated accurately. The specification allows it to be between 1.180V and 1.310V.

Nearly Something for Nothing

As well as the positive rail for my application a negative rail is needed also. The voltage is not critical so long as it's around 12V but good regulation is essential. Certainly the data sheets give the required configuration and so two LM78S40 could be used. However, I discovered a much simpler way, cheaper too! Thinking back on Figure 9 for a moment - pin 2 of the chip is busy leaping up and down to accord with our 'elastic' model. In point of fact it will be leaping up and down between about 600mV above the output (the series diode must be allowed for) and just a 100 or so millivolts above the 0V rail as the switching transistor is turned hard on. The excursions therefore are around 14V.

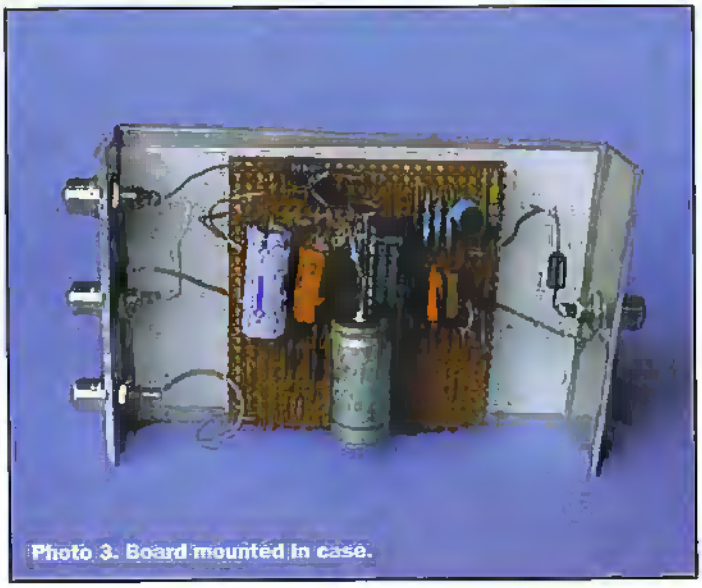


Photo 3. Board mounted in case.

So I thought, why not try a circuit derived from Figure 6 and shown in Figure 10. Connected to pin 2 of the regulator C4, C5 and D2 and D3 are the equivalents of Figure 6. (The other diodes in Figure 10 are discussed in a moment.

First attempts gave a negative output but the regulation was poor. Experiment showed that increasing the capacitor values helped but that the real culprit was the forward resistance of the 1N4148 diodes. Changing these to the 1N4001 and the capacity values of Figure 10 gave a nicely regulated supply of -12.5V.

Construction

This time a circuit board is called for and I used matrix board. Photo 3 shows the board installed on an aluminium case.

Unfortunately the board was built before I had the bright idea of possibly getting both positive and negative rails from the same board. However, the idea worked well enough but there had to be some minor adjustments to achieve the required voltages. Plus the fact, as I discovered, that regulators can be a bit pernickety if the input voltage range covers the required output voltage. There are therefore three diodes which are only there to correct the in and out voltages.

In photo 3 the right hand side is the input (12V to 13.5V) and the left hand side shows the output connectors. The upper two are the positive outputs and the bottom one the negative. You will see that there is a diode on the right in series with the input, and on the left two more diodes in series with the positive output. These are just above and to the left of the LM78S40 and are not actually mounted on the board. They are just to balance the positive output with the negative.

That was almost an aside, back to the construction. The final arrangement is a combination of Figure 9 the original switching regulator circuit, plus the items shown in Figure 10. In Figure 10, D1 is the diode in series with the positive input, whilst D4 and D5 are the two diodes in series with the positive output as described above.

Then, still in Figure 10, C4 and C5 along with D2 and D3 are the components added to produce the negative output. The input to this diode pump is from pin 2 of the LM78S40.

The complete arrangement is shown on the matrix board component layout, Figure 11. The three diodes used for minor voltage adjustment and which are not mounted on the board are shown. That is diodes D1, D4 and D5.

PROJECT PARTS LIST

PSU (Figure 3)		
R1, 4	2k2 Min Res	M2K2
R2	1R 2.5W	S1R
R3	220R Min Res	M220R
R5	AOT	
C1	4700µF 35V Electrolytic	AU21X
IC1,2	LM317T	UF27E
LED	Red LED	WL84F
T1	0 - 15V x 2, 30VA	YK11M
B1	12V 2.1Ah Sealed Lead Acid Battery	XG74R
F1	2A Fast Acting Fuse	CZ79L
	20mm Panel Mount Fuseholder	DA59P
Case	As Appropriate	
VOLTAGE CONVERSION (Figure 4, 5, 6)		
R1, 2	10k	M10K
C1	10nF	CX18U
C2	100nF	CX21X
C3	22µF 35V	AT56L
C4 - 7	10µF 63V	AT77J
D1 - 5	1N4148	QL80B
IC1	TBA820M	WQ63T
+12V SUPPLY (Figure 9)		
R1	0.33R(3 x 1R in parallel)	M1R
R2, R3	See Text, typically 10k	M10K
	and 100k	M100k
R4	180R	M180R
C1	10nF	CX18U
C2	100nF	CX21X
C3	470µF 25V	AT51F
IC1	LM78S40	UF37S
L1	330µH inductor	AH35Q
-12V SUPPLY (Figure 10)		
C4	100µF 25V	AT48C
C5	1000µF 25V	AT52G
D1 - D5	1N4001	QL73Q

Software HINTS & TIPS

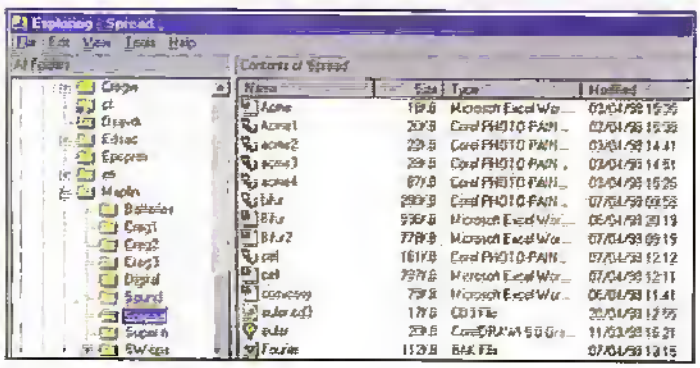
by Mike Bedford

Most people use Windows Explorer but many don't make the most of it? Here we investigate some of its lesser known features.

If you use your PC extensively you'll already know some of what's covered in this column. However, unless you've spent a lot of time tinkering around with Windows Explorer, it's unlikely that you'll know it all. Plus what you know will probably be different from what someone else knows. The fact is that – as with so many utilities and applications – Windows Explorer offers lots of different ways of doing things. Some methods suit some people whereas others will have different preferences. It may just be, however, that the reason you adopt one method is that you don't know about the alternatives. So let's investigate.

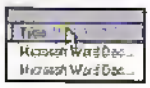
Viewing Files

Unless you've started playing around with the different options, Windows Explorer on your PC will look something like that shown below.



On the left you'll see the directory structure and on the right you'll see the files in the selected directory. The files will be listed in alphabetical order with tiny icons showing the file type, plus the size and the creation date. Surprisingly, those file types which Windows 95 knows about won't have their extensions shown, and this can be confusing. For example, Windows knows that both .doc files and .rtf files are produced by Word so it shows them both with the Word icon. But what if you have two files, one called file.doc and the other doc.rtf? In the default scheme, you won't be able to tell them apart. However, if you select Options from the View menu, one of the options is to show all DOS file extensions.

While on the subject of file types, if you're searching for files, it's often easier if they're sorted by the type first then alphabetically. This couldn't be easier—simply click on the Type heading at the top of the list (as shown below) and you'll find that all the Word files appear together, all the Corel files will be together and so forth. Similarly, by clicking on the appropriate heading, you can sort the list by size or by creation date.



One other thing you may find useful is to suppress the display of the file type, size and creation date information in order to see more files without scrolling. To do this, select List from the View Menu.

OK, let's now move on to take a look at how to make things look radically different. We started off with the Details view and we've just introduced the List view. However, the View menu offers two other options, namely the Large Icon and the Small Icons view. Both of these are reminiscent of the Windows 3.x way of doing things and may appeal to those who have recently used the earlier version of Windows. If you select Large Icons you'll end up with a display like that shown below. An advantage of this view is that – unless you've selected Auto Arrange Icons on the view menu – you can drag the files around the screen to position them as you wish. The Small Icon view is, of course, just the same but since the icons are smaller, you see more on the screen at once.

Manipulating Files

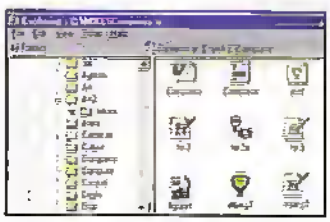
OK, that's enough on just looking at your files. The main purpose of Windows Explorer is, of course, to manipulate your files. And almost certainly you'll know how to move, copy, delete and rename files. However, if you are new to the Windows Explorer, here's a quick recap.

To do anything with a file you first have to select it by clicking on it – this action will cause the file to be highlighted. Don't double click on it as this will cause the file to be opened with the appropriate application (unless that's what you want to do, of course). At this stage you can delete or rename the file by selecting the appropriate option in the Edit menu but, if this is the way you manipulate your files, there's an easier way.

To delete the file, just press the Delete key. You'll be asked to confirm the action and if you click on the Yes button, the file will be put in the Recycle Bin. And if you want to delete it properly, as opposed to putting it in the Recycle Bin, hold down the Shift key before you press Delete.

To rename the file, click on the file again, and the highlighting will change. You can now either type a new file name or – if you first press any arrow key – you can edit the filename.

To move and copy files, you can drag them from one place to another. If you simply drag without holding down any keys this will move the file but if you hold down the Control key before you drag, the file will be copied. In copying, you'll end up with two copies of the file, one in its original location and one in the new directory. It's easy to see that you're copying a file rather than moving it since the file will have a plus sign attached to it as you drag.



And if you have the toolbar displayed, this gives you a third way of manipulating files or, for that matter, doing many of the other things we've discussed. We don't have time to describe the toolbar in detail here but why don't you experiment (on duplicate files in a temporary directory).

Something a bit 'Cleverer'

We're not going to cover everything in one page but here are a few tricks you may not have discovered.

Did you know that you can delete, move and copy multiple files at once? To select a group of files which are listed together, click on the first file in the list, hold down the Shift key and click on the last file. And to select multiple files which aren't all together, select the first file and then hold down the Control key while you click on each additional file. Now, delete, move and copy will work on all these files at once.

And did you know that you can see what's in many of your files without starting up the appropriate application. Just select the file and then select the Quick View option in the File menu. So long as Quick View is installed and it supports the file type selected (some files can't be viewed in this way) a window opens showing the file contents.

Another useful Windows Explorer facility is File Find which is an option in the Tools menu. It's fairly obvious how to use this powerful facility which will allow you, for example, to find a file for which you can remember the name but not the directory you stored it in. In fact, File Find allows you to do all sorts of clever things as you'll discover when you start to use it.

And as a final tip, did you know that you can drag a file right off the Windows Explorer onto the desktop. This is particularly useful for files which you use regularly.

Well, that's all we have space for this month but I trust you'll try these things out for yourself and, in so doing, discover some other useful facilities in Windows Explorer. But don't forget, deleted files can be lost for good so do make copies before experimenting.

Practical LED INDICATOR AND FLASHER CIRCUITS

Ray Marston describes a variety of LED indicator and LED flasher circuits in this special feature article.

Introduction

The most widely used of all optoelectronic devices is the simple LED (light emitting diode), which emits a fairly narrow bandwidth of visible (usually red, orange, yellow or green) or invisible (infra-red) light when its internal diode junction is stimulated by a forward electric current. LEDs have typical power-to-light energy conversion efficiencies some ten to a hundred times greater than a simple tungsten filament lamp and have very fast response times (less than 0.1ms, compared to tens or hundreds of milliseconds for a tungsten lamp), and are thus widely used as visual indicators and as simple 'flashing light' units; a variety of such circuits are shown in this article.

LED Basics – Introduction

Figure 1 shows the standard symbol that is used to represent a LED in this article, together with its basic anode (a) and cathode (k) terminal notations. LEDs are pn junction diodes, usually made from gallium

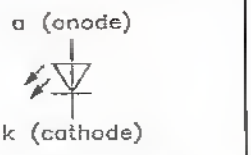
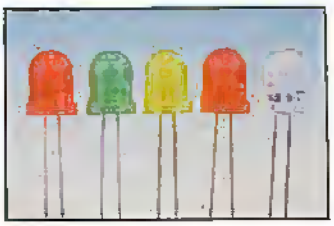


Figure 1. Standard LED symbol, together with its terminal notations.

arsenide (GaAs) or aluminium-gallium arsenide (AlGaAs) types of semiconductor materials, and emit light when stimulated by a forward current. Roughly 2V are developed across them when passing a useful forward current; Figure 2 lists the typical forward volt drops (Vf) of different coloured standard 5mm diameter LEDs at forward currents of 20mA. If a LED is reverse biased it starts to pass significant current at a fairly low voltage value (typically 3V to 5V) and eventually avalanches (zeners) at higher voltages.

LEDs are available in a variety of styles, the most popular being the 'round' type that has the basic shape shown in Figure 3 and which is readily available in standard diameter sizes of 3mm, 5mm, 8mm, or 10mm. Round LEDs use a clear or coloured plastic case with a lens moulded into its dome, and are designed to be viewed end-on, looking towards the dome, as indicated in the diagram. The LED case has a polarity-identifying 'flat' moulded into the side of its base adjacent to the cathode lead, which is usually shorter than the anode lead when untrimmed. Special fittings are readily available for fixing most sizes of LED to front panels, etc.

One important but confusingly named LED parameter is its 'viewing angle', at the extremes of which the LED's optical output intensity falls to half of its maximum axial value. Some LEDs give a diffused output, in which the light intensity falls off gradually beyond the viewing angle and is thus clearly discernable over a wide angular range; others (particularly 'Hyperbright' types) have a sharply focused output in which the light intensity falls off very sharply beyond the specified viewing angle.



LEDs are available in five different 'brightness' categories, which are usually known as Standard, High Brightness, Super Bright, Ultrabright, and Hyperbright. The brightness level is usually specified in millicandelas (mcd), with the LED passing an operating current of 20mA. The table of Figure 4 presents typical optical output-power and viewing-angle figures for the five types of 5mm round LED. Note in the 'red' LED column that the Ultrabright and Hyperbright devices (which use water-clear lenses) are 143 and 500 times brighter respectively than a standard red LED.

In use, a LED must be wired in series with a current-limiting device such as a resistor. Figure 5 shows how to work out the resistance (R) value needed to give a particular current from a particular dc supply voltage. Thus, if a red LED is required to operate at 20mA from a 10V supply, R needs a value of (10V – 2V)/0.02A = 400R. In practice, R can be connected to either the anode or the cathode of the LED.

A LED can be used as an indicator in an ac circuit by wiring it in inverse parallel with a 1N4148 (or similar) silicon diode, as shown in Figure 6, to prevent the LED being reverse biased; the LED is fed with half-wave current in this mode, so – for a given brightness – the 'R' value must be halved relative to that indicated in the Figure 5 dc circuit.

Colour	Red	Orange	Yellow	Green	Blue
Vf (typical)	2V	2V	2.1V	2.2V	3.3V

Figure 2. Typical forward voltage values of standard LEDs at a current-limited value of 20mA.

LED Type	Viewing Angle	Red	Green	Orange
Standard	60°	7mcd	5.2mcd	8mcd
High Brightness	40°	30mcd	25mcd	50mcd
Super Bright	30°	125mcd	120mcd	140mcd
Ultrabright	25°	1000mcd	—	—
Hyperbright	25°	3500mcd	—	—

Figure 4. Typical optical output power figures – in millicandelas – of five basic types of 5mm round red, yellow and green LEDs.

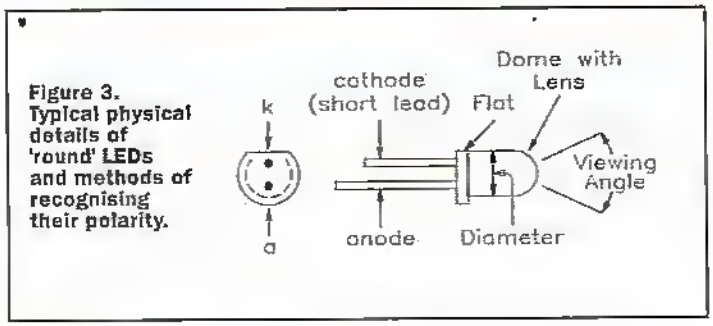


Figure 3. Typical physical details of 'round' LEDs and methods of recognising their polarity.

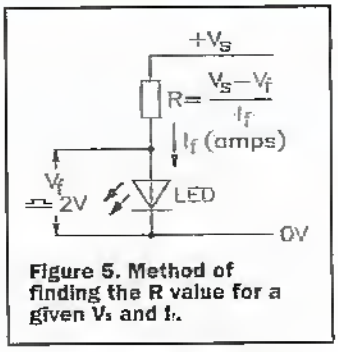


Figure 5. Method of finding the R value for a given Vs and If.

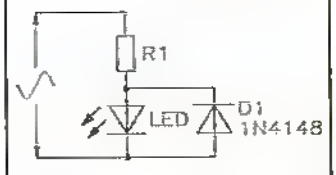


Figure 6. Using a LED as an indicator in an ac circuit.

Special-Purpose LEDs

LEDs are readily available in a variety of special-purpose forms, the best known of which are the 'direct connection' type, the 'flasher' type, and the multi-colour types.

Direct connection LEDs are designed to be connected directly across a fixed-value dc or ac voltage source. For dc voltage types take the basic form is shown in Figure 7(a) and incorporate a current-limiting resistor that is housed in the LED body in 5V and 12V types, or in one of the LED leads in higher voltage types. For ac voltage types (usually designed for use with 110V or 230V supplies) the basic form is shown in Figure 6 but are usually housed in an insulated panel-mounting assembly.

Flashing LEDs take the basic form shown in Figure 7(b) and have a built-in integrated circuit that gives the flashing effect. They are available in red, green and yellow, have a typical flashing frequency of 2Hz, and can (typically) use 6V to 12V dc supplies.

Multi-colour LEDs are actually 2-LED devices; Figure 8 shows a 'bi-colour' device that comprises a red and a green LED connected in inverse parallel, so that the colour green is generated when the device is connected in one polarity, and red is generated when it is connected in the reverse polarity. This device is useful as a polarity or null indicator.

Figure 9 shows another type of multicolour LED, which is sometimes known as a 'tri-colour' type. This comprises a green and red LED mounted in a 3-pin common-cathode package. This device can generate green or red colours by turning on only one LED at a time, yellow by turning both LEDs on by equal amounts, or any colour between green and red by turning both LEDs on in the appropriate ratios.

Multi-LED Circuits

If several LEDs need to be driven from a single power source, this can be done by wiring all LEDs in series, as shown in Figure 10, provided that the supply voltage is significantly greater than the sum of the individual LED forward voltages. This circuit thus consumes a minimum total current, but is limited in the number of LEDs that it can drive. Any number of these basic circuits can, however, be wired in parallel, so that any number of LEDs can be driven from a single source, as shown in the 6-LED circuit of Figure 11.

An alternative way of simultaneously powering several LEDs is to simply wire a number of the Figure 5 circuits in parallel, as shown in Figure 12; note, however, that this circuit is very wasteful of supply current (which equals the sum of the individual LED currents).

Figure 13 shows a 'what not to do' LED-driving circuit, in which all the LEDs are wired directly in parallel. Often, this circuit will not work correctly because inevitable differences in the forward characteristics of the LEDs causes one LED to hog most or all of the available current, leaving little or none for the remaining LEDs.

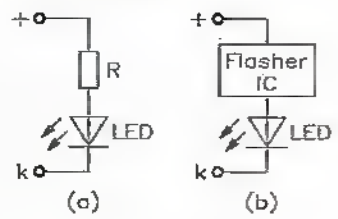


Figure 7. Basic form of a direct connection dc LED (a) and a flasher LED (b).

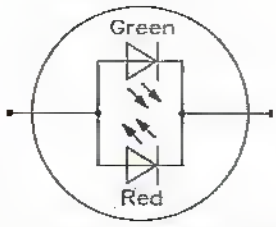
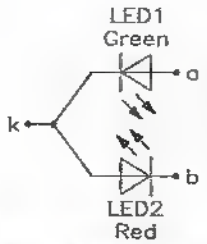


Figure 8. Bi-colour LED actually houses two LEDs connected in inverse parallel.



Output Colour	Red	Yellow	Green
I,LED1	0	15mA	15mA
I,LED2	15mA	15mA	0

Figure 9. Multicolour LED, giving three colours from two junctions.

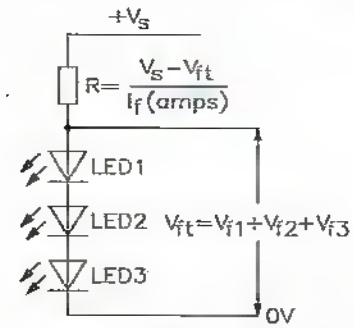


Figure 10. LEDs wired in series and driven via a single current-limiting resistor.

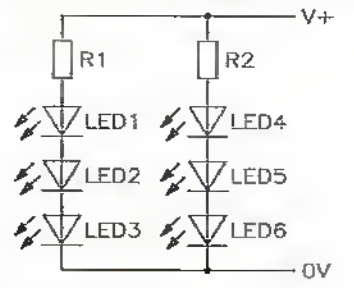


Figure 11. Any number of Figure 10 circuits can be wired in parallel, to drive any number of LEDs.

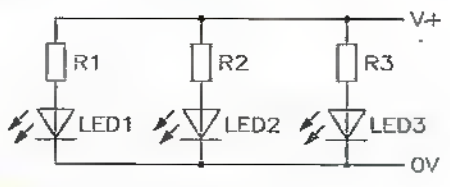


Figure 12. This circuit can drive any number of LEDs, but at the expense of high current.

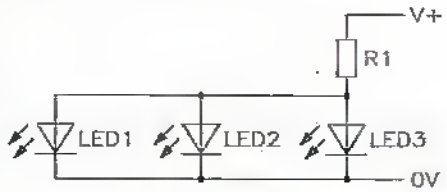


Figure 13. This LED-driving circuit may not work; one LED may hog most of the current.

LED Flasher Circuits – Simple Designs

One of the simplest types of LED display circuit is the LED flasher, in which a single LED repeatedly switches on and off, usually at a rate of one or two flashes per second. A 2-LED flasher is a simple modification of this circuit, but is arranged so that one LED switches on when the other switches off, or vice versa.

Figure 14 shows the practical circuit of a transistor 2-LED flasher, which can be converted to single-LED operation by simply replacing the unwanted LED with a short circuit. Here, Q1 and Q2 are wired as a simple 1Hz astable multivibrator, in which Q1 and LED1 turn on as Q2 and LED2 turn off, and vice versa, and in which the astable switching rates are controlled by the values of C1-R3 and C2-R4.

Figure 15 shows an IC version of the 2-LED flasher, based on a 555 or 7555 timer IC that is wired in the astable mode, with its main time constants determined by the C1 and R4 values and giving a cycling rate of about 1Hz (one flash per second). The circuit action is such that output pin 3 of the IC alternately switches between the ground and the positive supply voltage levels, alternately pulling LED1 on via R1 or driving LED2 on via R2. The circuit can be converted to single-LED operation by omitting LED2 and R2.

Figure 16 shows a useful modification of the above circuit, in which the flashing rate is made variable via RV1,

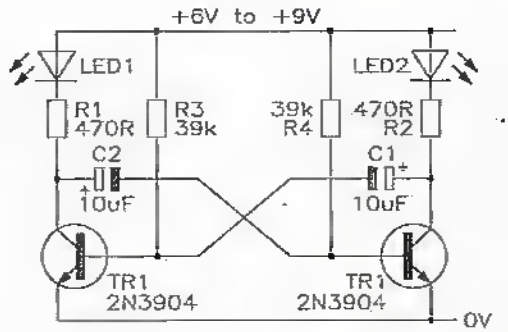


Figure 14. Transistor 2-LED flasher circuit operates at about 1Hz.

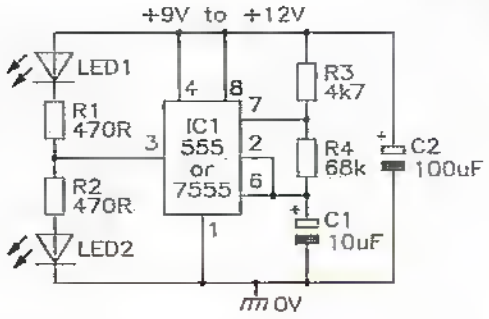


Figure 15. IC 2-LED flasher circuit operates at about 1Hz.

and two pairs of series-connected LEDs are connected in the form of a cross so that the visual display alternately switches between a horizontal bar (LED1 and LED2 ON) and a vertical bar (LED3 and LED4 ON), thus forming a visually interesting display. The cycling rate is variable from 0.3 to 3 flashes per second.

Micropower LED Flashers

Simple LED flasher circuits of the types shown in Figures 14 to 16 consume mean operating currents of several milliamps. Micropower LED flashers, on the other hand, consume mean operating currents that are measured in microamps (typically ranging from 2mA to 150mA), and are intended mainly for use in battery powered 'emergency indicator', 'battery state', and 'burglar deterrent' applications.

In emergency indicator applications, micropower LED flashers can be used to indicate the positions of emergency exits, lanterns, torches, alarm buttons, or safety equipment, etc., under dark conditions (perhaps caused by a failure of a main lighting system). When used as battery state indicators, they are often fitted in smoke alarms and other low-current long-life units that are powered by 4.5V to 12V batteries. When used as burglar deterrents, they are prominently fitted to real or dummy burglar alarm control or alarm/siren boxes or CCTV cameras, etc.

To understand the basic principles behind micropower LED flashers you must first learn some basic facts concerning visual perception, as follows.

The human eye/brain combination is sharply attracted by sudden changes in visual patterns or light levels; it is particularly sensitive to some types of flashing light. Figure 17 shows the typical 'light flash' response of the human eye/brain combination when presented with a bright LED-generated pulse of light.

Note from Figure 17 that the flash must be present for at least 10ms to be seen (perceived) at full brilliance, and that – when the flash terminates – the 'persistence of vision' effect causes the perceived brilliance to decay fairly slowly, typically taking 20ms to fall to 50% of its maximum (pre switch-off) value. Consequently, the eye can only see flashing lights as individual flashes if they are separated by a period of at least 20ms; if they are separated by less than 20ms they are seen (because of the 'persistence of vision' effect) as a continuous light.

Also note from Figure 17 that – if the flashes are separated by at least 20ms – the brain 'sees' the individual flashes at full brilliance if they have a duration of 10ms or greater, but sees them at diminishing brilliance at durations below 10ms (a 2ms flash appears at roughly 1/5th of true brilliance; the perceived brilliance falls off rapidly at durations below 1ms). The perceived duration of a 20ms flash (30ms) is only 50% greater than that of a 10ms flash (20ms).

The human eye/brain combination is very sharply attracted by flashing lights that have repetition periods in the approximate range 0.5 to 5 seconds, but is less attracted by flashing lights that have repetition periods above or below this range.

Modern low-cost Super Bright LEDs, when generating a 10ms or longer light pulse, produce a brightness level that is adequately eye-catching for most practical purposes when pulsed by a 2mA current.

When the above sets of facts are put together, it transpires that the 'ideal' micropower LED flasher – when using a Super Bright LED – should produce a pulse with a duration (d) of 10ms at a current (I) of 2mA, at a repetition period (p) of 2 seconds (= 2000ms). Note that, under these conditions, the mean current (Imean) of the LED is given by

$$I_{mean} = I \times d/p$$

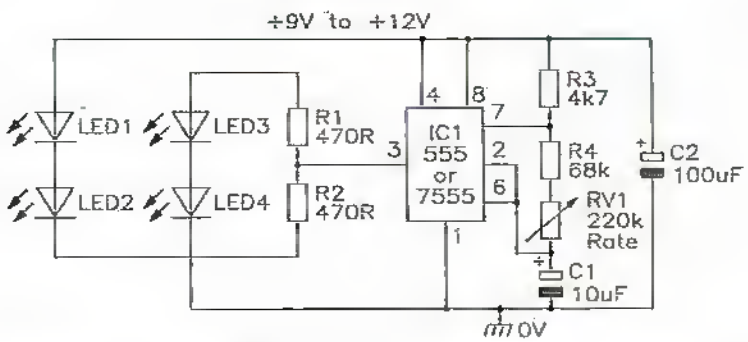


Figure 16. The rate of this 4-LED double-bar flasher is variable from 3 to 0.3 flashes per second.

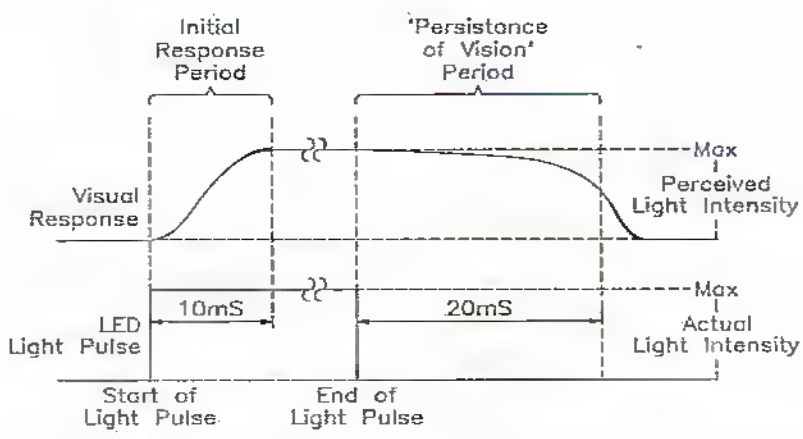


Figure 17. Typical 'light flash' response of the human eye/brain combination.

V+	R3	Current Drain	
		Loaded	No Load
3V	1k5	68uA	60uA
4.5V	1k5	80uA	70uA
6V	2k2	86uA	75uA
9V	3k3	97uA	85uA
12V	4k7	107uA	95uA

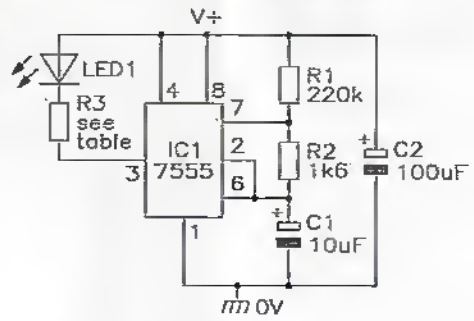


Figure 18. Circuit and performance details of a 7555-based micropower LED flasher unit.

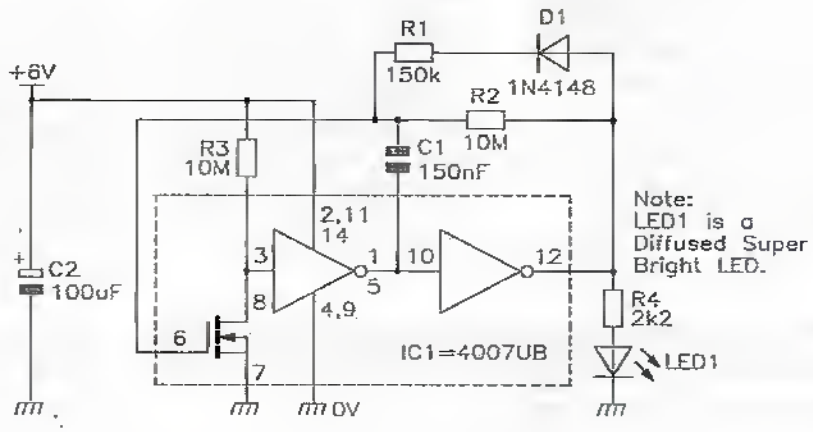


Figure 19. This 4007UB-based micropower LED flasher circuit consumes a mean current of 12mA at 6V.

and is a mere 10mA in this particular example (at a 30 second repetition period, I_{mean} is a minute 0.67mA).

In practice, the actual mean current consumed by a micropower LED flasher circuit is equal to the sum of the LED and the driver currents, and is inevitably higher than the minimum figure indicated above. Figures 18 and 19, for example, show two alternative micropower LED flasher circuits that – when powered from 6V supplies – consume total currents of 86mA and 12mA respectively.

The Figure 18 circuit is designed around a CMOS 7555 'timer' IC that is used in the astable mode and typically consumes an unloaded operating current of 75mA at 6V. In this mode, C1 alternately charges up via R1-R2 and discharges via R2 only, thus generating a highly asymmetrical output waveform on pin-3, which pulls the LED on via current-limiting resistor R3 during the brief 'discharge' part of each operating cycle. The Figure 18 table summarizes the circuit's performance details when optimised for operation at various spot voltages in the range 3V to 12V.

The Figure 19 circuit is designed around a CMOS 4007UB IC, which contains two complementary MOSFET transistor pairs plus one CMOS inverter, all housed in a 14-pin DIL package. In this application the IC is wired as a micropower ring-of-three asymmetrical astable multivibrator which – when powered from a 6V supply – drives the LED on for 10ms at 2-second repetition intervals: the ON time is controlled by C1-R1, the OFF time by C1-R2, and the LED current (2mA nominal) is controlled by R4. The circuit consumes an unloaded operating current of 2mA, and a loaded current (when driving the LED with 2mA pulses) of 12mA.

Note that the basic circuit of Figure 19 can be used at any supply voltages in the range 4.5V to 12V, but that the actual component values must be selected to suit the specific supply voltage used. Also note that, at supply voltages of 6V or greater, the circuit can drive two or more series-connected LEDs without increasing the total current consumption, provided that R4's value is altered to set the LED ON currents at 2mA.

The table of Figure 20 shows the nominal life expectancies of various types of alkaline cell/battery when continuously driving various types of micropower LED flasher circuit. The data relates to the circuits of Figure 18 (drawing 86mA at 6V) and Figure 19 (drawing 12mA at 6V), and to the once-popular but now obsolete LM3909 'LED flasher' IC (scheduled to be withdrawn from production by National Semiconductor in 1998/99), which draws a minimum operating current of 320mA.

Note in Figure 20 that the 'predicted cell/battery life' figures relate to cells/batteries that have initial (unused) life expectancies of five years, i.e., in which their charges leak away at a steady rate of 1.67% per month. The total in-use monthly capacity drain equals the sum of the leakage and the loading drain figures, and forms the basis of the life prediction figures shown in the table.

Low-Voltage Micropower Led Flashers

The basic micropower LED flasher circuit of Figure 19 can – if its component values are suitably selected – be reliably used at an absolute minimum supply voltage of 4.5V. If you have an application where you need to drive this basic flasher circuit from a 3V battery, you can do so by using the 3V battery to directly drive a super-efficient voltage-doubler circuit based on the popular ICL7660 IC, and use the 6V output of the doubler (connected directly across C2 in Figure 19) to power the 6V version of the Figure 19 circuit, which in this case will consume a mean current of 24mA from the 3V battery.

Alternatively, if you need to drive the basic flasher circuit from a 1.5V cell, you can do so by using the cell to drive a cascaded pair of ICL7660 voltage-doubler circuits, and use their 6V output (connected directly across C2 in Figure 19) to power the 6V version of the Figure 19 circuit, which in this case will consume a mean current of 48mA from the 1.5V cell.

Alkaline Cell or Battery Type	Capacity per cell or battery	12µA Load		86µA Load		320µA Load	
		monthly capacity drain & predicted cell/battery life					
		drain	life	drain	life	drain	life
AAA (1.5V)	1Ah	0.88%	3.3yrs	6.28%	1.0yrs	23.4%	0.3yrs
AA (1.5V)	2Ah	0.44%	4.0yrs	3.14%	1.7yrs	11.7%	0.6yrs
C (1.5V)	6.5Ah	0.135%	4.6yrs	0.97%	3.2yrs	3.6%	1.6yrs
D (1.5V)	13Ah	0.07%	4.8yrs	0.48%	3.9yrs	1.8%	2.4yrs
PP3 (9V)	0.55Ah	1.59%	2.8yrs	11.4%	0.6yrs	42.5%	0.2yrs

Figure 20. Table showing the life expectancies of various types of alkaline cell/battery when driving micropower LED flasher circuits.

@Internet

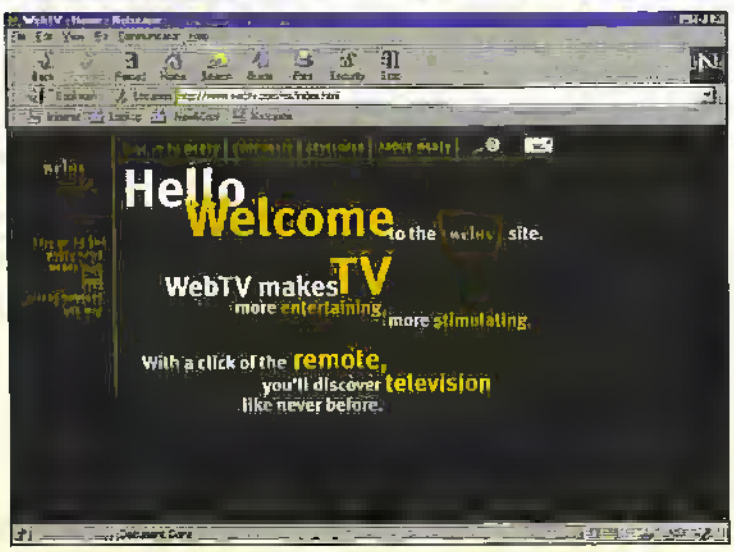
Get Real

Many readers will already be using Real's audio and video Internet software - even if they don't realise it. Several Internet service providers supply it free-of-charge with the software they provide new subscribers to get their computers up-and-running on the Internet. Basically, the components RealAudio and RealVideo are utilities that allow fast downloading and playing of audio and video content while surfing the Internet, and as such they work more or less in the background without much interference from the user. It's become a more-or-less de facto standard on the Internet, with most Websites that offer live online streaming of multimedia components opting to use the system. Users that surf to those Websites can hear and see the multimedia content as long as they have the user components installed. The sorts of multimedia content that can be used varies enormously. Several radio stations for example, have a live online Web page, so that surfers can log on and hear the radio broadcasts as they are surfing. The version most Internet service providers bundle is the limited freeware version, but the Plus version of the software offers greater ability (for a small price). Version 5 is current.

Things move on, of course, and Real is already sampling a new version of the software, code-named G2,

which is currently in a late beta stage. Real is letting interested users download it to try out. The Real Website at `http://www.real.com` gives details. G2 offers better audio and video quality, a hi-fi audio display, tunable bass and treble with a 10-channel graphic equalizer, adjustable picture quality, along with an automatic updating feature to keep your software at the most recent version. The music codec software (the bit that compresses and decompresses the sound at each end of the link) is said to increase frequency response by up to 80% over a 28.8K modem link.

WebTV Networks and BBC Announce UK Trials



Microsoft's WebTV Networks <www.webtv.com> and the BBC <www.bbc.co.uk> have announced they will begin development of an extensive trial that will offer interactive television to a group of test participants in the UK.

The trial will use the TV Crossover Links™ Web page locator feature, developed by WebTV Networks. TV Crossover Links complement and enhance TV viewing by providing quick and easy access to Web sites that are directly related to a wide range of high-quality TV programmes. The interactive trials will be conducted using the BBC's broadcasting facilities.

The collaboration between WebTV Networks and the BBC is the second part of a countrywide trial of enhanced television services throughout the United Kingdom. The first element of the WebTV Networks trial, which was announced in March, provides Internet access via standard televisions to a select group of test participants in the United Kingdom through the combined efforts of BT, providing network access, and Pace Micro Technology PLC, providing WebTV Networks set-top boxes. The final phase of the trial, slated for later this year, will provide enhanced content for the BBC's digital television services to selected participants.

When the viewers watch programmes that feature embedded TV Crossover Links, an icon appears that offers viewers the option of visiting a related Web site. The trial participants will enjoy news, information and entertainment across a range of general subjects such as natural history, drama, the arts, education, leisure, science and comedy. Through the Web sites and e-mail, viewers can contribute their views and knowledge directly to the BBC and other viewers.

The digital portion of the trial, slated for later this year, will enable WebTV Network's trial participants to receive enhancements to BBC television programmes transmitted from the BBC's United Kingdom-wide Digital Terrestrial Television (DTT) service. The trial will be among the first transmissions of interactive digital content from the United Kingdom's new digital terrestrial network.

Dun & Bradstreet Chooses CompuServe For Online Deal

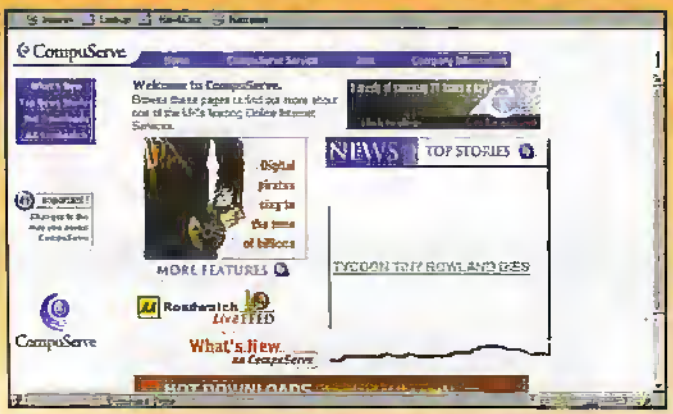
CompuServe has cut a deal with Dun & Bradstreet to provide CompuServe members with UK and European company reports on a pay per view basis, at competitive prices that vary according to the degree of depth of detail required.

The new service is aimed at individuals or small to medium sized businesses that require access to high quality company information but only wish to pay for the specific reports they require rather than having to pay an annual subscription.

For private investors and accountants the service will be invaluable for rapid access to information on credit evaluations and payment analysis on potential customers/suppliers, for researching companies, evaluating financial performance for investment purposes, for competitor information and for job seeking purposes.

The web-based menu interface provides access to UK and European business reports. Business ID reports (company snapshots) are available free of charge. Reports vary from £2.95 for a UK Business Profile, to £15 for a UK Business Premium Report and from £3.25 for a European Business Profile, to £27 for a European Business Premium Report.

CompuServe Offers Flat Rate Pricing Scheme



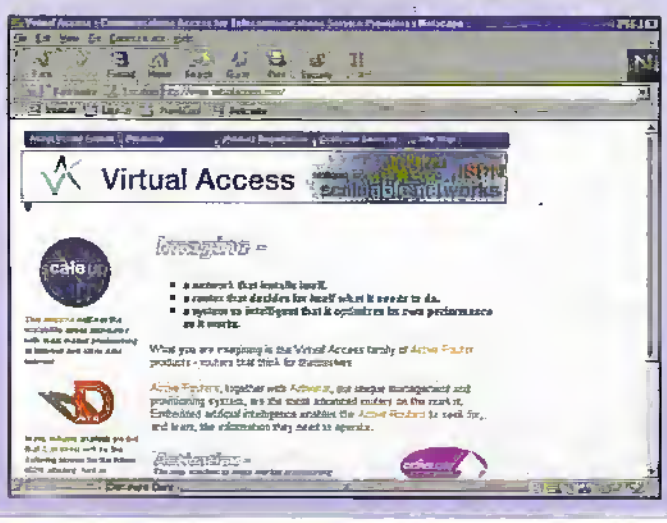
CompuServe <www.compuserve.co.uk> has announced a flat rate pricing plan as part of a move towards providing a more flexible and cost effective pricing model for its members. Members will now have the option of paying a monthly fee of £17.95 for unlimited online usage time. The current standard pricing plan - £6.50 per month fee plus £1.95 per hour thereafter remains in place'.

By offering the Flat Rate Pricing Plan, CompuServe members will now have the flexibility to choose an option that best suits their online usage needs. Those members that spend a large amount of time online can look forward to making substantial savings with the Flat Rate Pricing Plan. The plan will also appeal to those members uncomfortable with a connect-time model or who wish to know exactly what they spend each month. The existing plan will continue to appeal to the less frequent user.

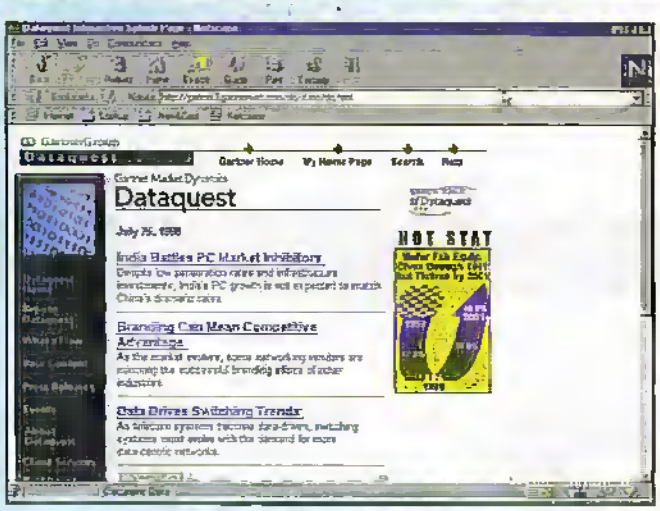
UK Small Businesses Missing Out On Internet Commerce

A staggering 64% of the UK's small to medium enterprises (SMEs) still do not have access to the Internet, according to independent research commissioned by UK IT company Virtual Access <www.virtualaccess.com>. The report warns that the future competitiveness of the UK's SMEs is in jeopardy as, at a time when the world of Internet commerce is set to explode, few companies are equipped to exploit it.

The research reveals that currently only 36% of SMEs use external email within their businesses and, within this group, only 10% use it extensively. Even fewer companies - only 28% - give employees access to the Internet and, out of these, only 6% use the Internet extensively. In addition, only 22% of SMEs have websites and only 6% of these companies use their sites extensively. Moreover, just over half of SMEs said they had no plans to develop Web sites.



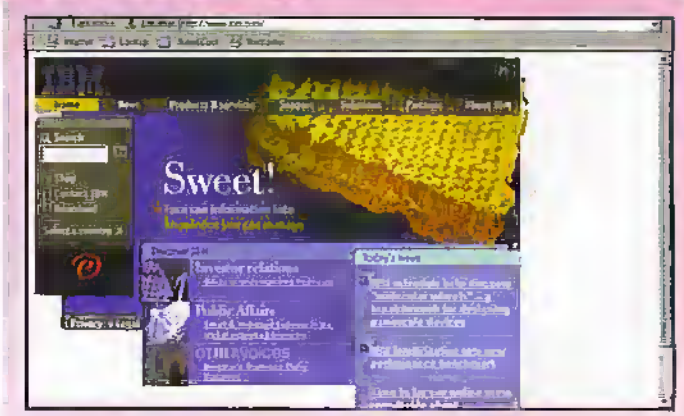
Software Companies Fight For Piece of Web Server Market



Software vendors are trying to position their products to take advantage of the growing Web server software market, which grew 88% in 1997 with worldwide revenue surpassing £150,000,000, according to Dataquest <www.dataquest.co.uk>. Netscape was the leading vendor in the Web server software market in 1997, as its market share increased to more than 50%. Dataquest analysts said the market will become much more competitive as leading software vendors begin to focus on this market.

Dataquest analysts said the extensible mark-up language (XML)-based standards will allow all vendors an opportunity to expand into this marketplace. XML is a formal language that can be used to pass information about the component parts of a document to another computer system. XML is flexible enough to be able to describe any logical text structure, whether it be a form, memo, letter, report, book, encyclopaedia, dictionary, or database.

IBM Keyboard Designed For Easy Internet Access



IBM has unveiled an innovative keyboard that provides quick and easy access to the Internet and other applications. The Rapid Access Keyboard is customised with one-touch access to the Internet, favourite applications, audio CD controls, power management and help screen.

The Rapid Access Keyboard combines the comfort and familiarity of a standard 104-key keyboard layout with 14 convenient Rapid Access Buttons that control the following: four hot keys provide access to your favourite applications, including instant access to an Internet browser; five CD control buttons, play, stop, pause, and track forward or back; three volume control buttons up, down and mute; and an instant one-button suspend key for power management.

BBC + MS WebTV

The BBC has started a trial of interactive television services with an as yet unspecified number of users in the UK. The system is to use Microsoft's acquired WebTV system as the basis of what it's called advanced television services (ATS).

In the trial, users will be able to access links to the BBC's own Website directly from viewed programmes, using the television handset. Watching, say, Tomorrow's World and following on-screen details, viewers will be able to access interactive information directly.

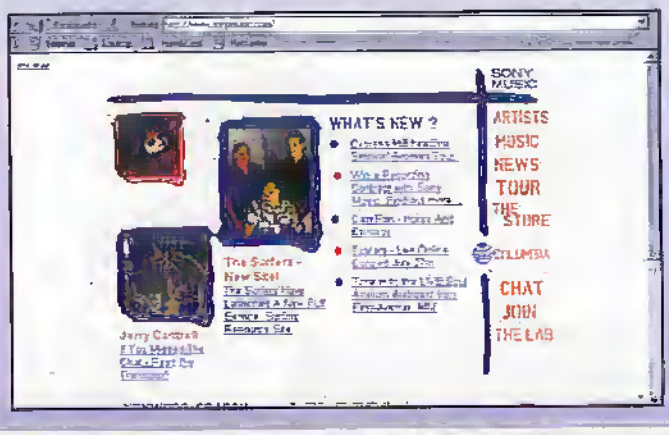
This is interesting, if only because it's use of the Internet in a non-classic way, that is, a computer is not being used to do the surfing. People from all walks of life have been telling us for years that computers and entertainment media such as television are about to merge, but so far, there's not yet been a practical way for this to happen. Perhaps WebTV is the way. But from the sounds of the trial, it's just another gimmick that's being added to an already chockablock television set in the corner. What, with satellite set-top receivers, digital terrestrial set-top boxes, videocassette recorders, cable television set-top receivers, DVD players, to name but a few, it's beginning to look like the old box in the corner's had puppies. It remains to be seen whether there's a runt among the litter though, and whether Web-based interactive television is the runt. We'll give out more details of the Beeb's trial system as we get them.

Sony and RealNetworks Launch Video Music Network

Sony and RealNetworks have teamed to form the Video Music Network, which can be accessed through RealNetworks' RealPlayer G2 on the Internet at no charge.

The Web service, played through the RealPlayer G2 and accessible only through Sony Music's Web site at <www.sonymusic.com>, will stream multiple channels of full-length music videos featuring Sony Music recording artists.

The service utilises RealNetworks' RealSystem G2 to create and deliver synchronised multi-media presentations of audio, video, images, and text streams, allowing consumers to simply click on links for additional artist information and audio and video samples.



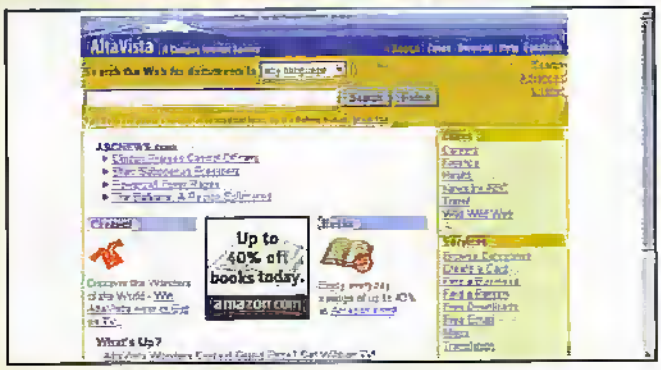
Companies War Malicious Code

A group of vendors has teamed up with the International Computer Security Association (ICSA) <www.icsa.net> to form a Malicious Mobile Code Consortium, aimed at combating the corrupt Java applets and ActiveX controls.

Malicious applets are capable of freezing a user's screen, slowing PC performance to a crawl, or even scrambling a hard drive. Founding members include Advanced Computer Research, Computer Associates, Cybermedia, Digitivity, Dr Solomon's Software International, eSafe Technologies, Finjan, Internet Security Systems, Quarterdeck, Security-7, Symantec and Trend Micro.

The consortium will focus on educating companies and consumers, developing product-certification standards and testing, and providing a venue for information exchange.

Alta Vista Gets Face Lift

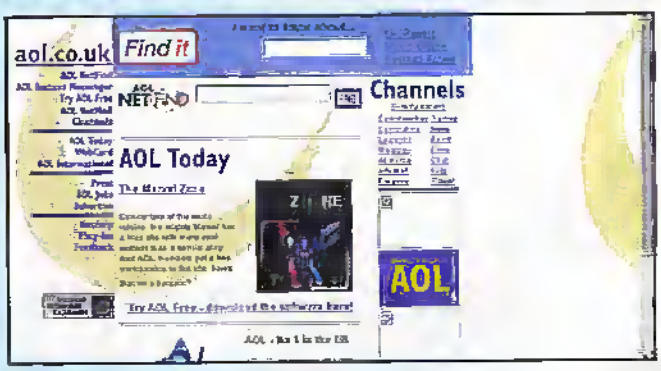


Painters and decorators have spent the last month sprucing up the AltaVista online search site <altavista.digital.com>. Digital reckons that the new look and feel will make the search for information faster and easier. AltaVista is the largest information resource on the Web with more than 140 million indexed pages.

But changes to Alta Vista are not limited to this cosmetic makeover. Since the beginning of the year, AltaVista has added zone-specific content enhancements and advanced search capabilities, making it a portal destination on the Web.

Zone specific content areas make it easy for users to access information about entertainment, finance, health, and travel with the click of a mouse. Users are taken directly to their subject area and from one location, can search the Internet for more extensive information.

AOL Takes UK Number One Slot



AOL UK <www.aol.co.uk> has clocked up 450,000 UK members. This means that AOL UK is now the Number One Internet service provider in the UK. Earlier this year AOL completed its deal to acquire CSi, which is currently the second largest provider in the UK.

AOL UK has closed a range of interactive marketing, advertising and e-commerce deals with N2K, Quixell Auctions, Thornton and others. AOL UK is also the first AOL country service to premiere AOL Radio, bringing AOL streaming technologies to the computers of its 450,000 members.

AOL can be sampled free of charge for 50 hours during your first month. Ring 0800-279-1234 to obtain FREE AOL Software and information about our new flexible pricing plans. For conditions and membership details, install AOL software.

Site Survey

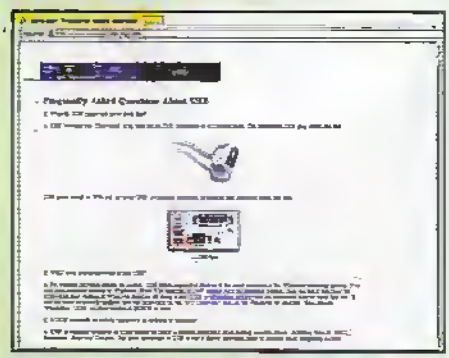
The month's destinations

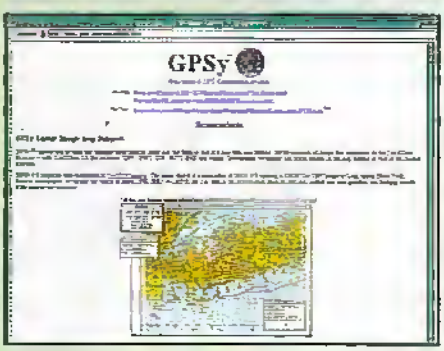
In another column in this month's issue references are made to a selection of Websites regarding Global Positioning System (GPS) receivers and software. Garmin's Website, at `http://www.garmin.com` gives details of its wide range of GPS receivers. Similarly, Magellan's GPS receivers are detailed at its Website, at `http://www.magellangps.com`.

The computer software used in the review of Garmin and Magellan GPS receivers is GPSy. The GPSy Website gives full details and is worth a trip, even if you haven't got a Macintosh (GPSy is a Mac-only program), as it shows the sort of things you should be looking for in a GPS-related program for whatever computer you use.

The BBC has opened up a new Web page that's intended to act as a portal service for all that's inside its whole Web system, as well as outside too. While it's not got a particularly up-to-date feature list, it does give a good introduction to the Beeb's Web services and the search engine is pretty effective. Check it out at `http://www.webguide.beeb.com`.

The computer literate among our readers will know that the universal serial bus (USB) is the forthcoming new standard to connect serial devices such as printers, scanners, keyboards, and even mice, to our computers. It's fast (some 2Mbps can pass along its simple and convenient cabling) and it's very versatile. To date, though, there's been a dearth of USB devices which can be used. That's not because computer hardware doesn't support the standard. USB ports have been present on many computer motherboards for a while now, but software support has been lacking. However, the recent release of Microsoft's Windows 98 has full support for USB, so expect it to become mainstream very soon. If you're not convinced, take a peek at a couple of Websites that go into depth about USB and why we should all be using it. A list of frequently asked questions (FAQs) is at `http://www.kavi.com/usb/faqs.html` while the USB Organization's site at `http://www.usb.org` shows the main advantages of the bus.



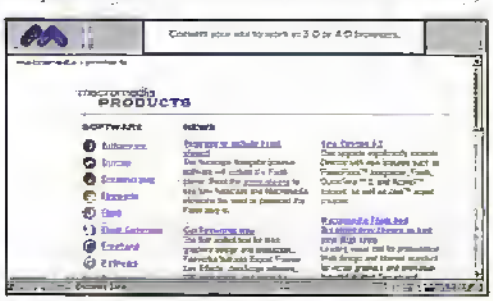


Java Generator for Macintosh

Macromedia has announced a new public beta of Flash Generator for authoring graphic templates on Power Macintosh platforms. Flash Generator can now also output JPEG and PNG files, in addition to binary Flash files, GIF and animated GIF. The new public beta is available for download free of charge at `<www.flash.com/generator>`.

Flash Generator is powerful new server-based software that uses templates created in Flash 3 to create Web graphics on the fly with dynamic data. Web designers can use Flash 3 to create graphic templates, which are linked to a data file and then served by Flash Generator. By automating the process of linking database content to Web site graphics, Flash Generator enables Web designers to create real-time headlines, mastheads, advertising, interactive maps, schedules, charts, graphs and more.

The public beta of Flash Generator is also available for Microsoft Internet Information Server (IIS) on Windows NT, and Microsoft Personal Web Server (PWS) for Windows 95. The public beta of Flash Generator works with templates created in Flash 3 for PowerMacintosh, Windows 95 and Windows NT. Interested parties should contact Macromedia Corporate Sales for information on pricing. Flash Generator will be available in Summer 1998.



TECHNOLOGY WATCH

with Martin Pipe

Over the last two or three years, digital photography has become a major growth industry. Many of the major film players, such as Kodak and Olympus, now market digital cameras. Oh yes, and Maplin sells them! With traditional cameras, you remove the rewound 35mm film cartridge and take it to a photo lab for developing. Your pictures are then returned to you as prints, transparencies or – in some cases – as a PhotoCD that can be read by a PC. If your images are intended solely for computer-related work, such as desktop publishing or multimedia, then the digital camera is a much quicker alternative. Even the quickest high street photo processing labs have a one-hour lead time – and that's normally quite an expensive option.

The pictures that you take with a digital camera are stored in memory – either internal, or a removable card – and can be transferred to a PC or Macintosh as soon as the camera is brought 'back to base'. Most digital cameras are supplied with a serial connecting cable that transfers the stored images at speeds of up to 115,200bps. There are alternatives, however. Sony's new Mavica FD5 camera stores images on a standard high-density floppy disk that can be read by a desktop PC. You can also buy memory-card readers that connect to a PC's parallel port – in addition to its ergonomic benefits, transfer rates are much faster than a serial connection.

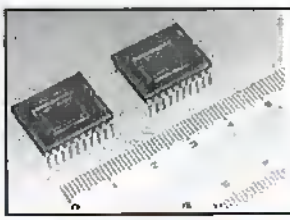
Digital photography is becoming a de-facto choice in some industries – for example, engineering consultancy, estate agency and newspaper photography. In the latter case, reporters are being equipped with a laptop computer and an expensive professional high-resolution digital camera. After the shoot, the PCMCIA hard disk storage medium is removed from a slot within the camera, and is inserted into a similar slot on the PC. After processing with Photoshop, the image (and the associated copy) is sent to the newspaper via a dial-up line, mobile GSM data connection or ISDN depending on what's available.

Inside a digital camera, a high-resolution CCD chip replaces the photographic emulsion behind the shutter. The output from this is fed into three 8-bit ADCs – one for the red component of the picture, one for green and one for blue – this gives the so-called '24-bit photo-realistic' colour depth. The outputs from the ADCs are then sent to a hardware JPEG (Joint Photographic Expert Group) compressor. JPEG compression, which was originally conceived for digital photography, greatly reduces the size of an image without significantly impairing quality.

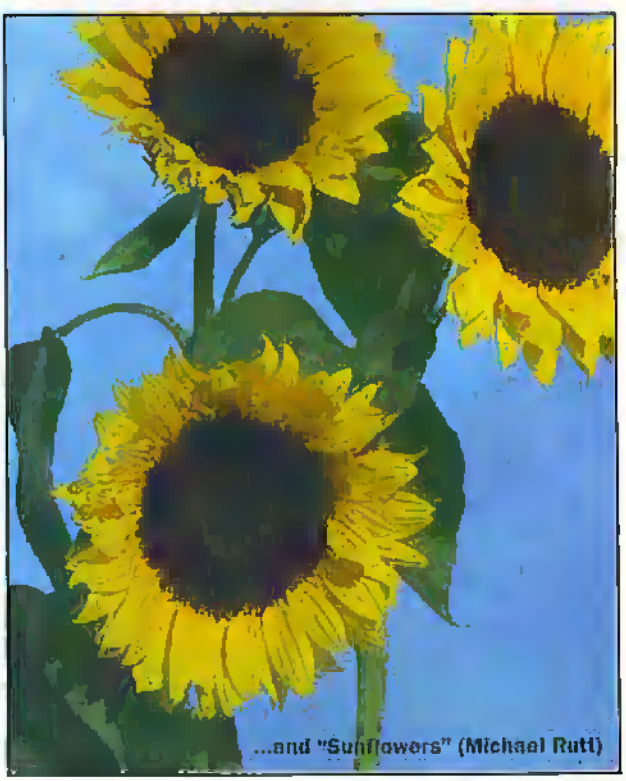
Hence, more images can be fitted into the same amount of memory. To give you a rough idea of how effective the typical digital camera's JPEG implementation is, a high-res 170k picture from the camera would be 3Mb in size if it was to be left uncompressed. After compression, the image is written to flash RAM. The average modern digital camera is supplied with between 2 and 4Mb, in a removable card. One camera, the semi-professional Polaroid PDC2000, has 40 and 60Mb options – this model, however, uses the TIFF image format.

The small files generated by consumer digital cameras lead to new photographic applications. Many people, for example, are sending their digital camera-derived pictures to friends, family and colleagues on the Internet. Even a high-res (1152 x 864, on my latest-generation camera) JPEG picture only occupies around 180kb, provided that the medium quality (higher compression) mode is selected. There's very little difference between the higher and lower compression modes – this is a testimony to the excellence of modern hardware JPEG encoders. If you go for lower resolution (typically VGA 640 x 480, which is the highest supported my most digital cameras), then the images might only be 75kb in size. Files of these size can happily be sent as an e-mail attachment.

Most cameras also have a limited-resolution LCD screen, so that you can get a CCD-eye view of the scene. The screen can also be used to preview captured images. Those with a professional need, love this facility. It provides a safeguard against dud pictures – there's nothing more galling than having to return to a particular venue, such as a house being offered for sale, to re-take photographs. Unfortunately, the LCD and its associated backlight guzzle battery power like nobody's business. Even without the



Toshiba TCD5603D CCD imager.



...and "Sunflowers" (Michael Ruti)

screen on, the average digital camera might only take 100 or so pictures on a fresh set of alkaline batteries – most of the current drain (which can peak at 1.5A in some cases) can be attributed to the CCD and associated circuitry. But with the display on, you might only get 70 snaps. Hardly surprising that the camera manufacturers are paying considerable attention to this problem.

Power consumption is not the only significant disadvantage of digital photography. The biggest disadvantage is that of resolution. With film, it's the pigment size that determines resolution – with CCD sensors, it's the number of pixels. Decent-quality film, as used by professional photographers and enthusiasts, has a very fine pigment. This is capable of a resolution several orders of magnitude better than that of the digital camera's average of 640 x 480 pixels. Although this difference might not be too apparent on a 5 x 7 print – if you're largely uncritical, that is – it becomes very noticeable when enlargement is applied.

Digital camera manufacturers are now introducing 'megapixel' models, and these offer much better resolutions. My own camera, for example, has a maximum resolution of 1152 x 872 – this is sufficient for some publishing work. Indeed, the Konica camera in question was used for some of the pictures in the removable media article printed elsewhere in this magazine. The aforementioned Polaroid PDC200 has a resolution of 1600 x 1200. Still far short of film's best, but a step in the right direction and suitable for some higher-end applications previously restricted only to film.

However, that device is a rather expensive £2000 or so – it's aimed at very serious enthusiast and semi-professionals. There is, however, some light on the horizon. Toshiba (**http://www.toshiba.co.jp**) has recently introduced a colour CCD, with 1.66 million pixels arranged in a 3:2 aspect ratio, primarily for building into consumer-priced digital cameras. The active picture area, according to Toshiba, is 1548 (h) x 1032 (v) pixels. One-off samples of the TCD5603D are now available for around $230 – if bought in bulk, the price should come down significantly. Out of interest, Toshiba reckon that the TCD5603D sensor is the 'world's most pixel-packed'. I don't think that Polaroid would agree – and in any case, astronomy has for some time benefited from sensors that offer 4 million pixels or so. That said, those sensors are highly-specialised, produced in small quantities and sell for a small fortune.

Another disadvantage concerns the cameras themselves. With the exception of professional news cameras, which sell for several thousands of pounds, digital cameras are rather basic – presumably to keep costs down, and user-friendliness up. Indeed, consumer types are modelled in low-end 35mm compact cameras in terms of features. Lenses are built in, and in most cases you can't even manually adjust focusing – where variable-focus is offered, it tends to be automatically-controlled.

Keen photographic enthusiasts are used to the flexibility of single lens reflex (SLR) cameras. With these, you get manual control over all elements of photography (focus, shutter speed, etc.) allowing better pics or creative effects to be obtained. In addition, lenses are interchangeable. Whether you want very wide-angle or long-distance photographs, the appropriate lens can be twisted into position. Hardly surprising that, serious photographers aren't giving up on their SLRs yet. If they want digital images, they get their film negatives scanned in and put on PhotoCDs, or invest in a good flatbed scanner.

Another advantage of SLR photography is that you get through-the-lens (TTL) monitoring. In other words, what you see through the viewfinder is the scene as the lens sees it. This allows the scene to be accurately composed, and focusing to be finely adjusted. The TTL viewfinder also gives a good idea as to what the eventual photograph will look like. Cheap cameras (and most digital types) have a separate optical viewfinder that looks out onto the scene via an independent window in the front of the camera. It only gives the photographer a rough idea of what will be captured on film – greater accuracy requires the LCD screen. The only affordable digital camera with a TTL viewfinder is the £1000 Olympus C-1400L. This model is based on the more upmarket compact cameras, which offer some SLR-type features.

But what of the SLR owner who wants to get into digital photography? An American company known as Imagek (**http://www.imagek.com**) claims to have devised a digital camera insert for SLR cameras that will sell for around $1000. It is claimed that the EFS-1 (Electronic Film System) will have a resolution of 1280 x 1024 pixels, and a sensitivity equivalent to 100 ASA film. Physically, the EFS-1 takes the form of a flat plate, which contains a CMOS sensor chip positioned so that it aligns with the camera's shutter. The latter is probably being made by Imagek's Californian semiconductor manufacturer parent, Irvine Sensors.

At the end of the plate is a cylinder that contains the electronics – this fits where the 35mm film canister would normally reside. A display on the EFS-1 cartridge, visible though the back of the camera (if it has a window), provides status information such as remaining battery life and the number of shots left in memory. Imagek claim that the EFS-1 has sufficient flash memory to store up to 30 images, although we're not told the associated resolution/compression rate. A

EFS-1 in SLR camera.

The EFS-1 'drop in' unit, initially intended for high-end Nikon SLR bodies.

supposedly 'lossless' proprietary compression system is employed, and not the JPEG industry-standard. To download images – 1.4Mb each, or so Imagek say – to a personal computer, the EFS-1 is removed from the camera inserted into a docking carrier with parallel-port or SCSI cables. Both Mac and PC platforms are apparently catered for.

If the EFS-1 does actually exist – nobody, to the best of my knowledge, has actually seen one yet – it would offer several key advantages. First, and most obviously, the benefits of your existing SLR camera, lens and accessory collection are retained. In addition, you can switch between film and digital photography depending on the application. Unfortunately, there's no LCD screen for previewing previously-captured pictures. In any case, I personally remain to be convinced of the EFS-1's existence.

I am concerned about some of the technical issues. Most importantly, how is the thing powered? Digital cameras consume lots of power, and I can't see how an object the size of a 35mm film canister can contain not only the electronics, but also batteries of sufficient capacity to power them for a practical period. The EFS-1 could be powered by the camera's batteries, but the tiny button cell in a SLR typically powers only a light meter. It is almost certainly not meaty enough for anything else. One other possibility is that power is taken from the power-wind battery supply.

Additionally, how does the insert know when the shutter is released, and that capture should commence? Older cameras have very little electronics, and won't provide any trigger signals that the EPS-1 could work from. The electronics would need to be very fast indeed if the device uses light from the shutter release to not only switch the EPS-1 out of low-power standby, but capture the image as well!

Finally, because the length and design of the film channel varies from camera to camera, Imagek will presumably have to produce a range of devices to fit the most popular models. It has been rumoured, however, that the product will initially be available for high-end Nikon SLR bodies.

At the same time, a photographic magazine reports a distribution Imagek tie-in with set-top box maker Pace, and an estimated price of '£650'. Some EPS-1 images are reproduced here from a web site. After all, it would be the answer to many photographers' prayers. If the EPS-1 makes it to the marketplace, one of the big camera companies will surely jump in and buy up Imagek – lock, stock and barrel.

E-mail your comments or suggestions to Martin Pipe at whatnetecix.compulink.co.uk.

MEMORY PRICES

THE LATEST NEWS

With the likely closure of the Siemens £1.2 Billion factory in Tyneside memory prices are extremely volatile at the moment. There is huge overcapacity in the market and mergers of the major memory producers cannot be ruled out. Texas Instruments, one of the original manufacturers of DRAM (Dynamic Ram Access Memory), have sold their production to Micron Technology one of the rising stars in the memory market.

Siemens does not believe that they need the capacity and are pointing the blame squarely at the South Koreans and the debt relief from the IMF. Prices for 16M Bit chips, the main item on a module have fallen from $55 to just over $2. A fall of over 90%. This is well below production cost of around $5. This situation cannot last which is why semiconductor manufacturers are closing production facilities and lowering production. Prices are very good at the moment but likely to rise over the next few months as manufacturers try to recover their losses.

MAPLIN ELECTRONICS

A range of DRAM modules for use as memory expansion in computers including PCs, Apple MACs and Amigas, is available. All parts supplied are original and unused. SIMMS supplied by Maplin are branded manufacturers, chips on selected third party boards.

They are sold with a 'no questions asked' lifetime guarantee and all modules are stored and handled in anti-static environments.

72-PIN SIMMS

Code	Size	ExVAT	IncVAT
NT00A	16M	£17.10	£19.99
NT01B	32M	£26.37	£30.99
NT02C	32M	£25.52	£29.99

EDO - TYPE

Code	Size	ExVAT	IncVAT
NT03D	4M	£6.80	£8.00
NT04E	8M	£9.35	£10.99
NT05F	16M	£14.45	£16.98
NT06G	32M	£26.37	£30.99

UNBUFFERED 3-3V 168-PIN DIMMS

Code	Size	ExVAT	IncVAT
NM25C	16M	£18.71	£21.99
NM26D	32M	£26.37	£30.99
NM27E	64M	£59.56	£69.99
NM28F	128M	£113.18	£132.99

PC100 DMMS

Code	Size	ExVAT	IncVAT
VG55K	32M	£38.30	£44.99
VG56L	64M	£63.82	£74.99
VG57M	128M	£123.40	£144.99

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