ELECTRONICS and Beyond

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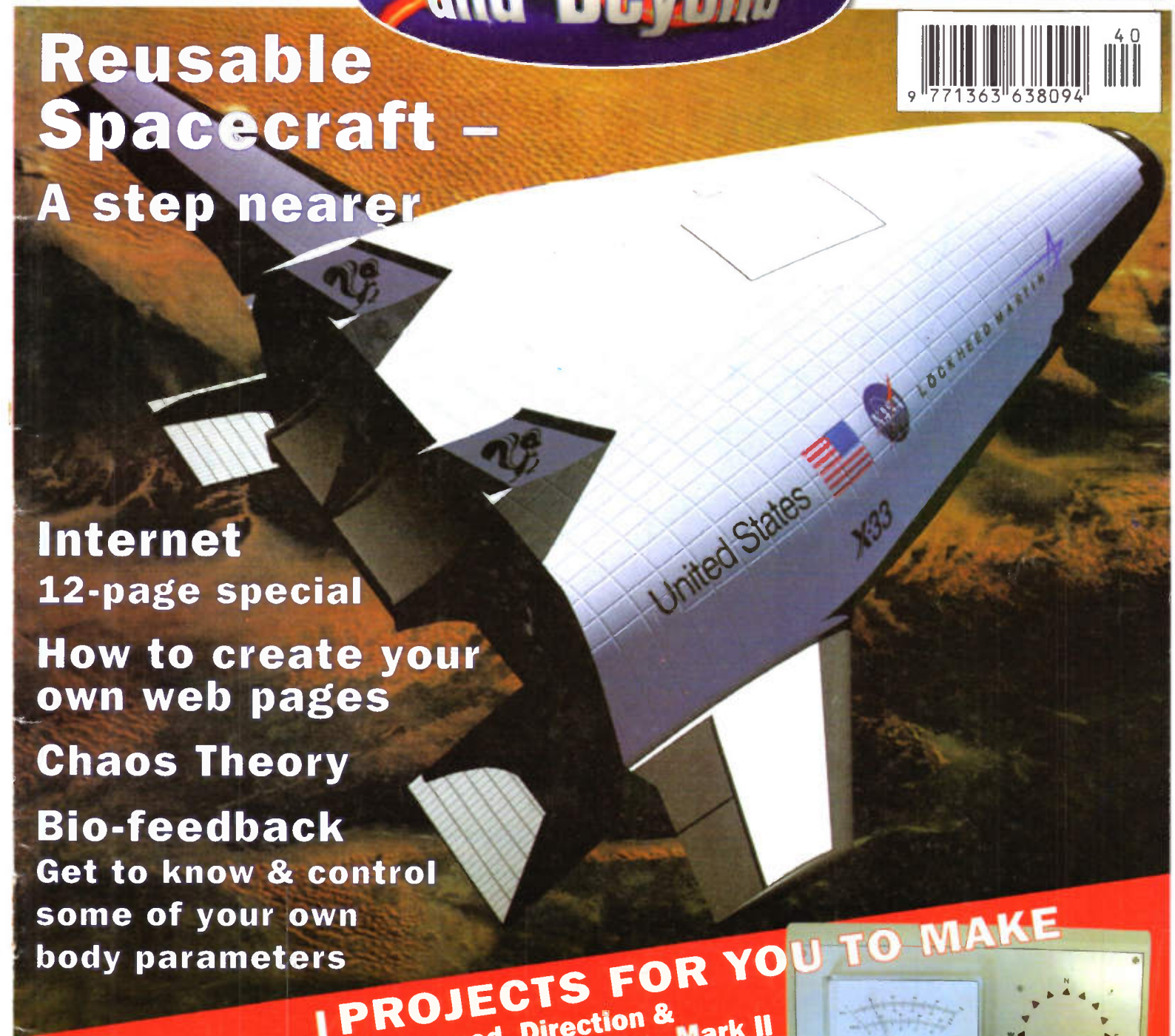

Internet
12-page special

How to create your own web pages

Chaos Theory

Bio-feedback
Get to know & control some of your own body parameters

PROJECTS FOR YOU TO MAKE

Wind speed, Direction & Temperature Indicator - Mark II

Magnetometer

LASSIE - Logic Analyser

0 to 60 Hour Start/Stop Timer

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The Maplin Magazine

THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

August 1999 Vol. 18 No. 140

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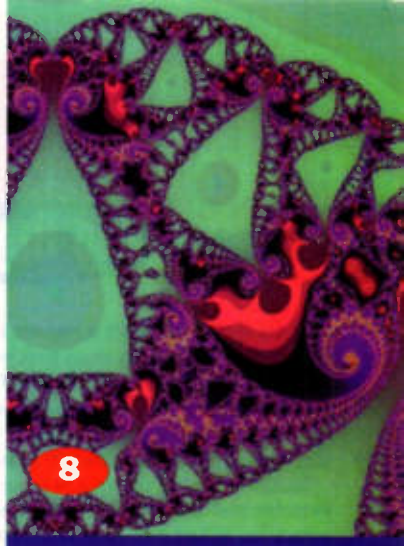
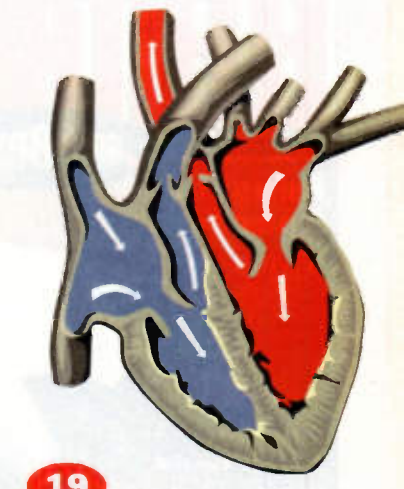




ELECTRONICS and Beyond

This month we start a regular Internet special pull-out which will include sites that we believe are of particular interest to our readers. Also for those who wish to produce their own web pages, we start a new series from Mike Holmes - Easy Web Page Creation - which takes you step-by-step from initial requirements to producing web pages.

Dr. Chris Lavers starts a two part article on Reusable Space Vehicles and the International Space Station. What is surprising is just how near this technology is to becoming a reality. In previous articles Chris has looked at propulsion systems, and as a result, the prospects for space travel in the next century look very exciting.

Much of the advancement in electronics can in many ways be attributed to the ground-breaking and pioneering work that took place at the Bell Laboratories in the USA. Gregg Grant recounts the 75 year history of this renowned research establishment.

Maplin Stores

Maplin continues its rapid growth with the opening of the Cambridge and Holborn, London stores. In the coming months stores will open in Dublin, Aberdeen, Solihull and Croydon. We will keep you informed of locations and opening dates, and all further planned locations.

Finally..

Our congratulations go to the 15 lucky winners who each have one a pair of adult tickets to the 1999 Royal International Air Tattoo at RAF Fairford, Gloucestershire on the 24th/25th July. We are sure they will have a memorable day out. Winners names will be found on page 78.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Casio Introduces New Digital Camera

The new Casio QV-7000SX digital camera has a resolution of 1.32 million pixels and offers features such as the ability to shoot a mini-movie of up to 12.8 seconds, with instant play back, HTML functionality, future and past shooting and panoramic image capture.

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

Contact: Casio, Tel: (0181) 208 0948.

MGI Turns PC into Digital VCR

MGI PURE Digital Interactive Video and Audio (DIVA) is a four-in-one software suite that transforms a Pentium III processor-based PC into a sophisticated digital home entertainment centre. Complete with the first ever software-based digital video recorder designed for the PC, the suite also includes a DVD and audio CD player and time-shift capability.

Using PURE DIVA, users can instantly replay live TV, zoom, pan, pause, fast-forward and rewind from within the software - either on their PC screen or on their TV set using a remote control.

This means that having seen, for instance, a controversial refereeing decision in a live football match, the viewer can pause the broadcast, rewind back to the 'incident', zoom in for a closer look, and pan through the scene to check what happened in a matter of seconds. Once the score has been settled, the user can then fast-forward through the time-shifted match until they return to 'real time' viewing.

Similarly using the time shift facility, the avid film fan recording a movie from 9pm to 11pm, having come home early at 9.30pm, now no longer needs to wait for the film to finish, but can simply start watching while DIVA continues to record the rest of the film.

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

Contact: MGI, Tel: (01869) 323275.

Intel Introduces 550MHz Pentium III

Intel has introduced the 550MHz Intel Pentium III processor. The Pentium III processor is designed to power an Internet experience filled with rich audio, video, animations and 3D that make information come alive.

For users who interact with the Internet or data-rich applications, the most important advances are the Pentium III processor's high clock speed and its Internet Streaming SIMD Extensions - 70 new instructions that dramatically enhance the performance of advanced imaging, 3D, streaming audio, video, and speech recognition applications.

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

Contact: Intel, Tel: (01793) 403000.

Microsoft, Xerox to Bridge Digital and Paper Worlds

Microsoft and Xerox have got in to bed together in a bid to accelerate the pace and simplify the process for sharing knowledge in the mainstream office.

Announced by Microsoft president Steve Ballmer and Rick Thoman, president and CEO of Xerox. This collaboration links the Microsoft vision of the digital nervous system and the Xerox vision to bridge the paper and digital worlds to streamline information management.

In particular, Microsoft and Xerox have agreed to share technology and work together to create new collaboration and communication solutions based on Microsoft Windows NT Embedded and Exchange Server, leveraging the powerful capabilities of the Xerox Document Centre Systems.

The vision of the paperless office continues to change as digital technology evolves. The collaboration between Xerox and Microsoft offers further proof that the future of the digital world is one that combines paper and digital worlds in a seamless manner, not one where paper is eliminated.

By working together, Microsoft and Xerox are enhancing their commitment to the enterprise by linking the industry's leading gateway for paper and digital documents, the Xerox Document Centre System, with Microsoft Exchange Server 5.5, the leading messaging and collaboration server on the market today.

For further details, check: **<www.microsoft.com>** or **<www.xerox.com>**.

Contact: Microsoft, Tel: (0345) 002000 or Xerox, Tel: (0800) 454197.

NEWS BYTES

Analysts Foresee Telecoms Restructuring

Analyst house Ovum has warned of a radical redefinition of the global telecoms landscape as the industry moves from a business model where bandwidth is scarce and expensive, to one where bandwidth is potentially plentiful and, therefore, extremely cheap.

Ovum predicts that this change will invert existing pricing models and create new market structures with new types of players, as well as transforming the operational and organisational make-up of today's operators.

For further details, check: **<www.ovum.com>.**

Contact: Ovum, Tel: (0171) 312 7318.

IBM and Nintendo Play Games

IBM and Nintendo have announced a £600 million technology agreement which will see IBM build the processors for Nintendo's next home video game console, code-named 'Dolphin'.

IBM will design and manufacture a unique 400MHz central processor featuring IBM's industry-leading 0.18-micron copper technology. The chip, dubbed the 'Gekko' processor, is an extension of the IBM PowerPC architecture.

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

Contact: IBM, Tel: (0990) 426426.

HP LaserJet Printers Celebrates 15-Year Milestone

Since their introduction in 1984, Hewlett Packard (HP) has sold more that 35 million LaserJet printers worldwide. Launching the desktop-laser-printer revolution, the original HP LaserJet printer offered a fast, quiet alternative to the dot-matrix and daisywheel printers of the time. Laser technology and HP's Printer Control Language (PCL) also offered superior print quality.

For further details, check: **<www.hp.com>.**

Contact: HP, Tel: (0990) 474747.

Growth Spurt for European Home PC Market

Spurred in part by the sale of lower-priced personal computers into the home market, European PC shipments in the first quarter of 1999 increased 20% over the first quarter of 1998, according to Dataquest.

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

Contact: Dataquest, Tel: (01784) 431611.

NEWS BYTES

IBM and Philips Collaborate on Speech Recognition

Philips and IBM have entered a cross-licensing agreement under which IBM will license to Philips its software that turns text into speech, and Philips will license IBM its software for turning speech into text. In addition, the two companies will work together to establish standards for using speech software on handheld computers made by Philips.

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

Contact: IBM, Tel: (0990) 426426.

Sony Squeezes Billion Bits of Data on a Square Inch

Sony has announced a breakthrough in tape recording density, by demonstrating the ability to store one billion bits of data on a square inch of tape. This achievement was made possible by incorporating the first use of magneto resistive heads in a helical scan tape mechanism and demonstrates the viability of Sony's next generation of AIT (AIT-3), which is set to provide 100GB of uncompressed data in a compact media cartridge and 3.5 inch drive form factor.

For further details, check: <www.sony.com/storagebysony>.

Contact: Sony, Tel: (0990) 111999.

Be Operating System and BeOS Bible Bundle Offer

Be, the developer of the digital media Be Operating System (BeOS),has bundled BeOS Release 4.0 and reference guide, The BeOS Bible, for around £50. Be develops BeOS, an operating system that provides a rich user experience especially for people who handle high bandwidth digital media, such as graphics, audio and video, in real-time on personal computers and Web devices.

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

Contact: Be, Tel: +33 1 55 91 77 30.

Stop Using Start to Stop

Softwrights' Stop Button utility claims to take the pain out of shutting down Windows 95. One click on the program's icon at bottom-right corner of screen does it all. This is quicker and less frustrating than the standard seven-step Windows shutdown procedure. A demo version of the utility is available from Softwrights' Web site.

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

Contact: Softwrights, Tel: + 1 313 278 0127.

Personal Robot Launched by Probotics

Designed for home or office, a new personal robot has been launched by Probotics. Called Cye, the compact personal robot can do a wide variety of tasks such as carry dishes, deliver mail, lead guests to a conference room and vacuum the carpet. Using wireless communications technology, Cye is controlled by Map-N-Zap, an intuitive graphical user interface (GUI) loaded on any PC.

With its PC based interface, users can Drag-N-Drive Cye on the screen and map out its environment. Cye can easily move around a home or office and learn how to navigate a new room in minutes. At a speed of three feet per second, Cye quickly moves around any room, pulling the optional wagon or vacuum attachment. But Cye is not cheap. The robot costs over £400 direct from Probotics.

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

Contact: Probotics, Tel: +1 516 767 8390.

Intel Has StrongARM for Internet Devices

Intel has disclosed details of its next generation StrongARM technology, designed to accelerate the development of advanced handheld computing products, enable new classes of low power, high performance Internet access devices, and enhanced Internet backbone products.

Based on current estimates, the next generation StrongARM technology is expected to deliver two to three times the performance of the current StrongARM generation while keeping power consumption below one-half watt. At speeds of 150MHz to 600MHz, next-generation StrongARM processors should deliver performance that scales from 185 to 750 MIPS while consuming only 40 to 450mW respectively.

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

Contact: Intel, Tel: (01793) 403000.

Radio Chip Company Spins Out of Cambridge Consultants

Cambridge Silicon Radio (CSR) has been spun out of Cambridge Consultants with £5.9 million backing. Venture capitalists 3i, Amadeus Capital Partners and Gilde IT Fund have provided the investment to establish CSR, a new company focused on the single-chip short-range radio market.

The founding team of James Collier, Phil O'Donovan and Glenn Collinson and several others from Cambridge Consultants will build CSR as a 'fabless silicon supplier', designing and engineering integrated circuits, whilst subcontracting manufacture and test to silicon foundries in Europe and Asia.

CSR will design and bring to market single-chip short-range radios which allow wireless communication between a plethora of products including mobile phones PDAs and PCs. CSR claims that it will be the first company to offer a fully integrated 2.4GHz radio, baseband and microcontroller solution on a single CMOS chip.

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

Contact: Cambridge Silicon Radio, Tel: (01223) 424167.

2.5 Gigabytes on a Penny

An IBM breakthrough in magnetic-storage disk technology will allow 20 billion bits of data (about 2.5 gigabytes) to fit in a square inch of disk space. That is three-and-a-half times the top density of currently available products, and is the equivalent of about 2,500 novels.

The photo shows two scans from a magnetic force microscope. The bottom scan shows magnetic bits that IBM's disk drive experts recently wrote on a computer hard disk at the world record density of 20 billion per square inch. Above it for comparison is a test pattern written at 6.4 billion bits per square inch, which is the typical density of a disk drive currently in use today.

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

Contact: IBM, Tel: (0990) 426426.

Milford Instruments Puts BigFoot Forward

BigFoot is a fully walking biped robot from Milford Instruments. Based on the Parallax Stamp processor, it walks by shifting weight between its two feet whilst stepping forwards, backwards or turning right or left. Twin toe switches provide obstacle detection.

BigFoot is supplied programmed but this can be changed using PC, programming cable and supplied software application. The full kit is priced £79.95.

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

Contact: Milford Instruments, Tel: (01977) 683665.

Electronic Device May Blow Whistle on Referee Inconsistencies

A new electronic device developed for the US sports market may put an end to refereeing inconsistencies in many popular spectator sports in the UK. The handheld device, which retrieves and replays video signals from instant reply machines to enable officials to double check their decisions, can be carried by referees, linesmen, umpires and the like.

It is being developed for American Football and other spectator sports that use instant replay techniques, but its makers believe it could prove valuable for a wealth of other sports that experience controversial decisions on the field of play.

To produce the Scanz Scannor, Cadence has teamed up with Scanz Communications in multimillion-dollar contract that will see Cadence provide comprehensive electronic and mechanical design services.

One target market for the device is British football, with Premiership referees having suffered swathing criticism for what have been popularly perceived as hugely inconsistent decisions.

Cadence, which has its major design centre in Livingston, Scotland, was selected by Scanz for the design project because of its breadth of design expertise and its proven ability to help companies bring electronics products to market quickly.

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

Contact: Cadence, Tel: (01344) 865425.

NEWS BYTES

Get Ahead in IT

Graduates looking to work in IT can maximise their chances and first year earnings using a new guide from DPP International. The IT recruitment specialist has produced a booklet aimed at first and second jobbers, outlining important dos and don'ts in the quest for a well-paid IT job.

The guide tackles areas such as what constitutes useful experience in the eyes of employers, from sandwich years to external interests/projects. The booklet also outlines the level of technical expertise expected by companies. Graduates are given tips on the type of questions worth asking a prospective employer.

For further information, check: <www.dpp.co.uk>.

Contact: DPP International, Tel: (0181) 332 2555.

ARM Announces ARM9E Processor

ARM has announced a new processor core, the ARM9E processor targeted at applications that require a mix of control and digital signal processing (DSP) capability. The ARM9E processor's trade-off between DSP and controller performance is difficult to achieve in a traditional system, which uses a separate DSP and microcontroller.

Applications which will benefit from this enhanced signal processing capability include hard disk drives, digital video disk (DVD) drives, mobile telephony, modems, personal digital assistants (PDAs), Internet appliances, voice recognition, automotive and industrial control systems.

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

Contact: ARM, Tel: (01223) 400400.

Cambridge Researchers Tout New Memory Chip

A team of Cambridge University researchers funded by Hitachi has announced a breakthrough in memory technology, making possible a chip the size of a thumbnail capable of holding all the sounds and images of a full-length feature film.

The Hitachi-Cambridge partnership has been pursuing single electron memory chip technology for the past 10 years. The powerful new chips consume very little power, making them ideal for palm computers, cell phones and other mobile devices, and retain their memory for up to 10 years when the power is switched off.

Hitachi scientists in Japan are converting the Cambridge technology into a form suitable for mass production, and the new chips are set to be commercially available in 2005.

For further details, check: <www.hitachi-eu.com>.

Contact: Hitachi, Tel: (01628) 585 000.

NEWS BYTES

Wang Goes Dutch

Dutch IT company Getronics has acquired struggling Wang for about £1 billion. The deal will make Getronics the top IT service provider in Europe, and give the company a significant presence in the US. Wang is one of the best-known names in the computer industry, but filed for bankruptcy protection in 1993 and has been struggling to redefine itself ever since.

For further details, check: <www.wang.com>.
Contact: Wang,
Tel: (0181) 568 9200.

Broadcom Chip Is Fastest Over Copper

Broadcom has demonstrated a new chip that can send data over existing copper-wire lines at least 10 times faster than is currently possible. The chip can send data at speeds of up to 1Gbps per second, compared to the current average of about 10Mbps to 100Mbps per second and will provide faster Internet connections and telephone services without the need for fiber-optic lines.

For further details, check: <www.broadcom.com>.
Contact: Broadcom,
Tel: (01709) 579770.

Digital TV Give Away

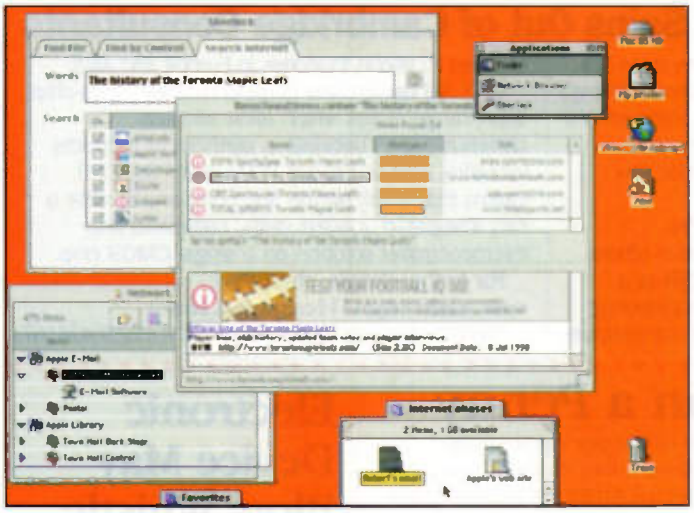
British Sky Broadcasting has announced plans to give away the set-top boxes used to receive its new digital television channels. The equipment giveaway will remove all possible barriers to digital take-up. BSkyB, which launched 140 digital channels last year, also announced that it would begin offering free Internet access plus a 40% discount on BT phone service.

For further details, check: <www.bskyb.co.uk>.
Contact: BSkyB,
Tel: (0171) 705 3000.

Venture Capital Fund for Chip Designers

Intel will be the lead investor in an alliance formed to foster companies capable of designing the next generation of Intel microprocessors. Intel will contribute £60 million of a £180 million venture fund to be used for that purpose. Intel's next chip will be the 64-bit microprocessor called IA-64.

For further details, check: <www.intel.com>.
Contact: Intel,
Tel: (01793) 403000.



Apple Introduces Mac OS 8.6

Mac OS 8.6, an update to the Macintosh operating system provides a more powerful Sherlock search feature; increases system stability; and delivers significantly improved battery life for PowerBook users. Mac OS 8.6 is available as a free update for Mac OS 8.5 customers and can be downloaded from Apple UK's Web site.

For further details, check: <www.apple.com/uk>.
Contact: Apple,
Tel: (0870) 600 6010.

What Not to Do When You Lose Your Data

Ontrack has introduced a series of frequently asked questions (FAQs) to help users react effectively when faced with data loss. Many people are confused by the software packages available on the market and the range of recovery services on offer. This often results in panic when trying to recover the data on their own, without professional advice.

The FAQs resolve these issues and include advice such as the typical causes of data loss and how to react. They also cover the length of time it takes to get data back and how users can prevent loss occurring again in the future.

Other subjects addressed by the FAQs include the varying costs of recovery, the state of the hard drive after data retrieval has taken place and what to do if your hard drive is making a strange noise.

For further details, check: <www.ontrack.co.uk>.
Contact: Ontrack, Tel: 00 800 10 12 13 14.

Best of Both Worlds Camera Combination

The Fujifilm MX-2900 a new camera features a 2.3 million pixel resolution and a 3x optical zoom lens. The digital camera melds the traditional look and feel of a 35mm SLR camera with a consumer digital camera.

With an increased focus on several progressive photographic features, such as a hot shoe mounting for an external flash along with optional 43mm filter and 28mm wide angle attachments, Fujifilm has answered the call for a consumer model with greater image capture controls.

To compose professional looking shots, the full-featured MX-2900 gives the user the power to adjust shutter speeds and select aperture settings, while the camera's manual mode allows for the examination of photography settings before the shot is recorded.

For further details, check: <www.fujifilm.co.uk>.
Contact: Fujifilm,
Tel: (0171) 586 5900.

UK Rings in the Changes

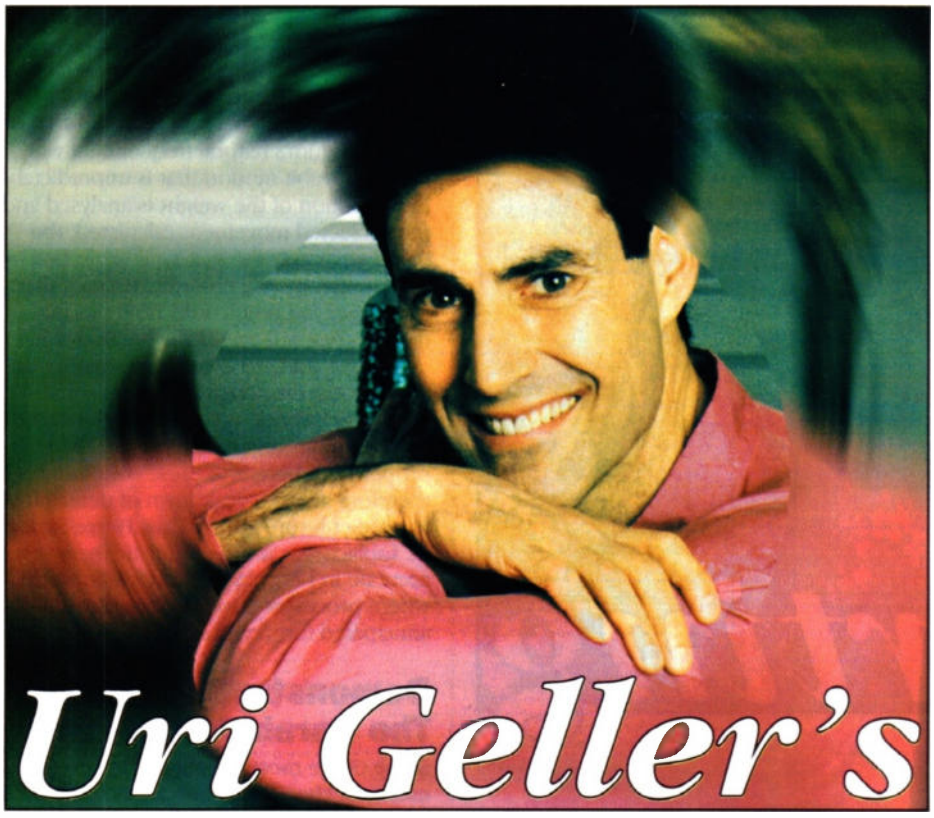
Telecoms firms have joined forces to manage major changes to the nation's telephone numbering system. Oftel first announced the changes to the national code and numbering system in January 1997. But new research shows three in four consumers and three in five businesses are unaware of the changes.

Now the National Code and Number Change (NCNC) steering group is spearheading the drive to ensure that the operation goes smoothly and the changes are communicated to users.

The first changes are currently being implemented. Premium rate providers will be offered 090 codes from now on, making these numbers easily identifiable for the first time. For example, all adult lines will ultimately begin 0909.

The move marks the countdown to 22 April 2000 when new 02 geographic codes and numbers will be introduced in six areas: Cardiff, Coventry, London, Northern Ireland, Portsmouth and Southampton.

For further details, check: <www.numberchange.org>.
Contact: Numberchange,
Tel: (0808) 2242000.



Uri Geller's EXTENDED REALITY

One day in the summer of 1988, David and Carol Agnew dropped in to see George and Ella Todd, whom they had met on their Easter holiday trip to the Austrian village of Maurach. George had taken along his Canon T50 camera, and shot several rolls of film. When they were developed, he took a quick look through them and put them away in a drawer, never giving them another thought, until Carol asked if she could see them.

She began to go through the film George had taken on their last night at the hotel, where a group including the Todds, the Agnews, and seven other tourists had put a couple of tables together for their final meal, after which they ordered some drinks and waited for the floor show to begin.

She came across the picture George had taken of the whole group and saw that it was darker than the others. He remembered that the flash had not gone off, so he had recharged it and taken another photo which came out perfectly. There was something strange about the one before, though. There were too many people in it.

Even without the flashlight, there had been enough light in the room for the automatic camera to take a slightly longer exposure, and come up with a picture in which all members of the group except one, who was just out of Frame, could be easily identified. But who was that in the middle of the group?

It was a woman dressed in white who seemed slightly larger than the others, and was also slightly out of focus. This was hard to explain in itself, as everybody else in the picture was in perfect focus. Even harder to explain was - who on earth was she?

"I felt cold and goose-pimply" Carol told a researcher later. "That," she had said to George, "is a ghost". And today, more than ten years later, that is also the conclusion of a good many of those who have seen the picture reproduced in several newspapers and shown twice on television. The print and the negative have been scrutinised by Dr Vernon Harrison, former chief scientist with the De La Rue banknote company and one of Britain's most experienced forgery detectives. His opinion: "One of the, most mysterious photos I have seen. I can't think of any plausible explanation." Nor can anybody else, it, seems.

Eight members of the group have been tracked down by members of the Society for Psychical Research and questioned at length. They have all signed statements to the effect that they were not up to any trickery, they haven't a clue who the mystery woman is (or was), and they had not seen her at the time or before, or since. The only possible solution so far was suggested by one of the SPR investigators.

"It looks to me Like Ella Todd's doppelganger, or double," he told me. "Her hairstyle and general features are similar to Mrs Todd's, although her dress is white and Ella's is dark. This may be the first time anyone has photographed a double since William Mumler a century ago, but several people have seen them, including Goethe and Maupassant who saw their own doubles. Then there are at least five Roman Catholic saints who were quite reliably reported as having been seen in two places at once."

Mumler was a jewellery engraver from Boston (Massachusetts) who became the first known 'spirit photographer' after, so he said, taking a picture of himself and finding that he was not alone - a cousin who had died several years previously was right there beside him! He soon became famous and did very well out of reuniting his sitters with their deceased loved ones - or pictures of them, at least. One day, however, be got into trouble when one of the faces that showed up on his plate turned out to be of a man who was still alive. He was accused of fraud, but acquitted for lack of any evidence against him, and was never caught cheating in any way.

The strangest photographer of all time, though, has to be a former Chicago bellhop named Ted Serios. He made his debut almost exactly a century after Mumler made his, Ted's speciality being making images appear on Polaroid photos just by clenching his fists and staring at the lens. He was closely observed by dozens of investigators for several years, producing hundreds of inexplicable photos. Some were totally white, others all black, and some showed his distorted face, as one would expect. Yet a great many others showed anything from the front of a Hilton Hotel, a Soviet spacecraft (of which no conventional photo was known at the time and a London bus to a close-up of the Queen.

People became suspicious of what he called his 'gismo', an ordinary cardboard tube that he liked to hold in front of the lens. Magicians soon found they could fake pictures something like Ted's by hiding bits of transparencies in their gismos. Ted's, however, was examined several times and found to be empty. On some occasions he never even used it, and once got a result from about fifty feet away. On other occasions he could produce pictures on two cameras at once.

Like Mumler, he was never caught cheating in any way. And if he had been, it is strange that he could not keep it up for more than a few years. He was reunited with his chief investigator, Dr Jule Eisenbud, for a 1985 television series but was unable to get any unusual pictures at all. He has not been heard of since.

A word of warning - if your camera has a wrist strap and you forget to put your wrist through it, chances are you will get a ghostly white presence on the right side of your print. This isn't a ghost, but a blurred close-up on the strap. The SPR has quite a large collection of these, and doesn't need any more. What it does need, I am told, is more like George Todd's holiday snap of that mystery guest. Or, of course, another Mumler or Serios to investigate.

Uri Geller's novel Ella is published by Headline Feature at £5.99, and his Little Book Of MindPower by Robson Books at £2.50, and Jonathon Margolis' Uri Geller Magician or Mystic? by Orion Books at £17.99.

Visit him at **www.tcom.co.uk/hpnet/** and e-mail him at **urigeller@compuserve.com**

Cavorting WITH CHAOS

PART 1

Douglas Clarkson explores the unknown!

Introduction

One of the first significant surprises of 'modern' science with its deterministic view of the world - which held that future states of the systems could be derived from previously determined states - was the arrival of quantum mechanics. This was to indicate that within the atom, events could not be known with absolute certainty, and in any event, any attempt to observe would alter the states of the system. Rigorous studies, however, of very basic mechanical systems, such as a simple pendulum exposed to just two independent forces, revealed under certain conditions, movement that was identified as chaotic. It seems that just as the quantum mechanical world does not operate in a totally predictable way, so the macro world can demonstrate its own level of uncertainty in a variety of conditions.

The exploration of boundaries between chaotic and predictable systems has rapidly expanded since the 1970's. Mathematical investigation of the world of chaos has in turn revealed a rich but surprising sequence of mathematical expressions of systems which exhibit chaotic action and which in turn can present some startling graphical representation as characterised by the various fractal families of functions.

Chaos also enters into electrical circuit design, especially where feedback with non-linear functions is defined. This is perhaps a new interpretation of problems of inherent instability of electronic design. Under normal conditions our heart rate exhibits a fairly predictable cyclic pattern. Under ventricular fibrillation, a chaotic, life threatening irregular beat manifests. The solar system has recently been extensively studied for evidence of chaotic behaviour and, yes, the planets can interact in a chaotic fashion, though it is the chaotic movements of asteroids in earth crossing orbits that is of more pressing importance.

As mentioned previously, even an experiment with a so called forced spherical pendulum can bring about surprises. This is where a pendulum can swing freely but is pulled in one line of action by a small amplitude signal - for example via a rotating wheel. Where the frequency of the excitation is a few percent less than that of the pendulum's natural frequency, it will tend to exhibit motion that is unpredictable. If the motion of the weight is analysed and the projected movement calculated, the more accurately the system is described by way of velocity and co-ordinates etc., then the longer the predictions hold out for, though they will eventually break down.

It is one thing to expect the weather or the national economy to possess some chaotic behaviour, quite another to find such a simple system exhibiting chaotic properties. There is in these conditions therefore a basic breakdown of determinism to predict future states. Thus Pierre Simon de Laplace was more optimistic than accurate in his grand deterministic world, where processes once described could be anticipated forever afterwards.

Demonstrating Chaos: The Parabola Equation

Some of the most deep insights into the nature of chaos - and our ability to model it - are provided by some of the most simple of mathematics. Thus rather than refer to chaos as an abstract quantity, it is really in order to provide some very simple examples of how it performs.

One of the nasty surprises, or liberating perceptions of the 20th century, has been a more in depth appreciation of chaos theory. It is also relevant to point out that chaos theory is a relatively new development and our understanding of chaos and all its implications remains relatively limited. There is no doubt, that a useful feature of computers relates to the ability to demonstrate chaos, even using relatively simple equations as described in the following BASIC programme- Example1. We will see however, that chaos has a somewhat nasty surprise in store for computers.

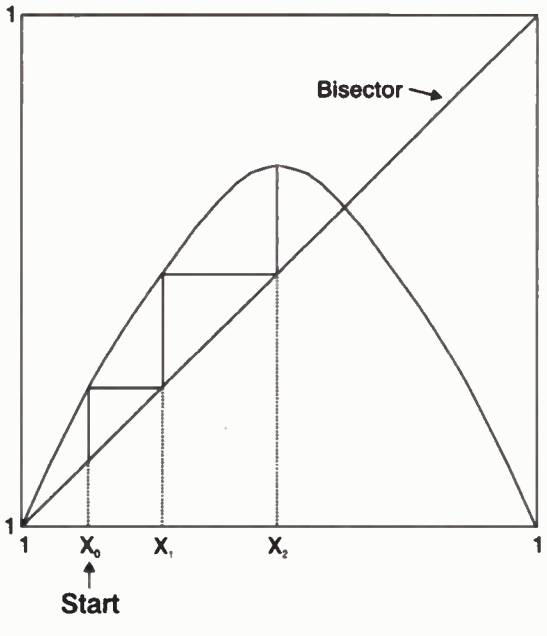


Figure 1. Process of calculating values using graphical iterator.

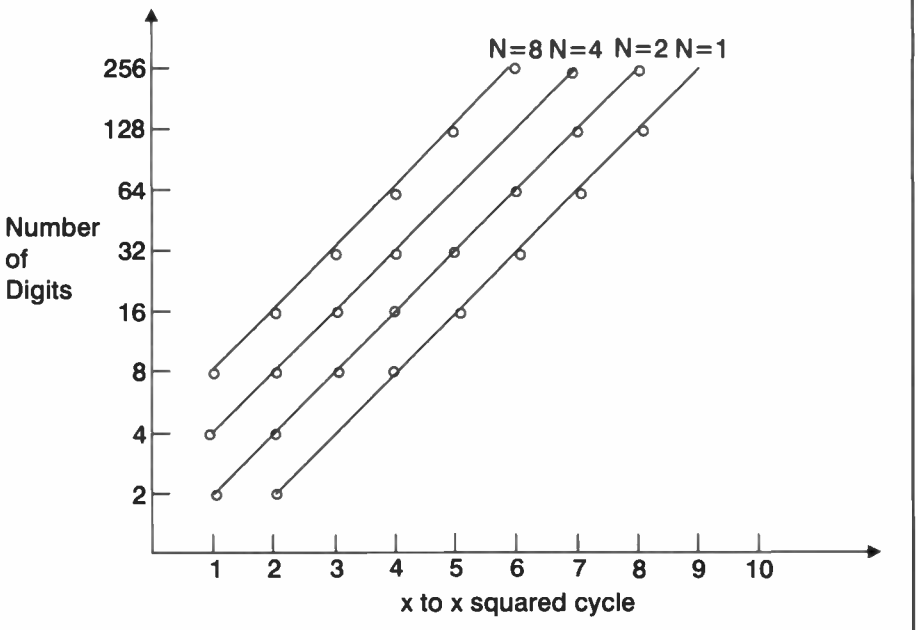


Figure 2. Increase in total digits resolution required for iterations of square of a real number.

```
1       REM   Example1
5       INPUT LMDA,X1#
10      FOR J  =  1  TO  20
20      X#   =  LMDA *X1#*(1-X1#)
30      X1#   =  X#
40      PRINT J,X#
50      NEXT J
```

This expression was initially developed to model changes in populations of living systems. Any book on chaos theory serves up this equation as a means of exhibiting chaotic behaviour. The general behaviour of the function is shown in Figure 1. The literature of 'chaos' theory is therefore forever referring back to this equation. There is a term which is proportional to the existing 'population' and another term introducing the component of competition proportional to a negative term involving the square of the population. The equation is a simple example also of a 'non-linear' system. For a range of starting parameters and for X1# having values between 0 and 1, this simple equation can produce some surprises - it can demonstrate chaotic behaviour. In the dialect of BASIC used, QuickBasic, the # character signifies double precision value of the variable. In the example, the first 20 iterations are undertaken.

For a simple scenario for a value of X1# = 0.4 and LMDA = 2, the solution rapidly drives to a static solution of value 0.5. For X1 = 0.4 and LMDA = 4, however, there is no discernible pattern to the series of numbers produced. This is a direct demonstration of chaotic behaviour. If the X1# is changed very slightly, say to 0.40000001, then by the 18th iteration a significant difference begins to manifest and the series diverges from the previous one. This is a characteristic of chaotic systems. This indicates that the ability to predict future states is limited by the uncertainty of measurement associated with a specific starting point. The more iterations that are undertaken, the greater the accuracy required to define the start conditions of the sequence.

Chaos Wipes out Any Computer

Using double precision real number format in the BASIC programme, and with a start value addition of a value of around 10-16 for X1# = 0.4 and LMDA = 4, the iteration sequence begins to detect significant differences after 42 iterations. The sensitivity of detection of changes, however, depends on the resolution of the arithmetic used. In standard real number format, the computer cannot detect changes less than around 10-11.

The ability of computers to accurately model chaotic systems is a function in their ability to carry sufficient resolution in numeric representation to pick up such effects. If extremely small numeric changes are always truncated in the arithmetic process, then the unravelling of chaos will tend to be distorted. The numbers may look precise and 'computer generated' but the computer is adding its own layer of perturbing chaos into the process.

This process of iteration of Example1 may seem very simplistic as a challenge to a computer able to calculate with dazzling speed. It is convenient to summarise values of first term, second term, third term as conveniently displayed four or five digit numbers. This most certainly, however, does not really describe the emergence of complexity among the numbers being generated as indicated in Figure 2. Take the example of 0.1001 which is described as being resolved to four digits. If this is squared, then the value of 0.01002001 is resolved to eight digits. If in turn this value is squared, the result of 0.0001004006004001 is resolved to 16 digits and so on. As this process is continued, the total number of digits required to fully express the arithmetic follows in geometric progression so that at the eighth iteration no less than 512 digits are required - even though the number itself has decreased to a very small number. The error in the computer representation, however, will tend to appear initially in the least significant digit of the representation of the number after about eight iterations and then be magnified

```
  10 REM multiplication and resolution of digits  Example2
20 DIM dgts(2000), rdig(2000), tdgts(2000) AS INTEGER
  TYPE abc
  unt AS INTEGER
  remn AS INTEGER
  nodig AS INTEGER
  digno AS INTEGER
  END TYPE
30 FOR jj = 1 TO 2000
40 dgts(jj) = 0: rdig(jj) = 0: tdgts(jj) = 0
  NEXT jj
  PRINT "input number of cycles of multiplication"
  INPUT cyc
50 PRINT "input number: format  eg  0.12324"
60 INPUT a$
  xval# = VAL(a$): REM form double precision number
70 FOR jj = 1 TO LEN(a$) - 2
80 b$ = MID$(a$, jj + 2, 1)
90 tdgts(jj) = VAL(b$)
100 NEXT jj
110 nodig = LEN(a$) - 2
  PRINT "no start digits of number = ", nodig
115 FOR cycle = 1 TO cyc
120 REM have moved digit values into the array
130 FOR jj = 1 TO nodig
140 FOR kk = 1 TO nodig
  REM undertake multiplication
150 rdig(jj + kk) = rdig(jj + kk) + tdgts(jj) * tdgts(kk)
160 NEXT kk
170 NEXT jj
200 REM have multiplied up all the terms
  REM look back through up to 2000 digits
210 FOR jj = 2000 TO 1 STEP -1
220 IF rdig(jj) < 9 THEN 270: REM check if need to carry forward
230 unt = INT(rdig(jj) / 10)
240 remn = rdig(jj) - unt * 10
250 rdig(jj) = remn
260 rdig(jj - 1) = rdig(jj - 1) + unt
270 NEXT jj
280 REM have carried forward the arithmetic
290 REM find the number of digits now
300 FOR jj = 2000 TO 1 STEP -1
310 IF rdig(jj) <> 0 THEN 340
320 NEXT jj
330 REM have filled data
330 PRINT "no end digit": END
340 REM got to first non zero digit
350 digno = jj
360 PRINT "number of digits resolution = ";
370 PRINT digno
400 FOR jj = 1 TO digno
410 PRINT USING "#"; rdig(jj);
  NEXT jj
420 PRINT "PC val = "; xval# * xval#
  xval# = xval# * xval#
430 REM copy data back to frame
440 FOR jj = 1 TO 2000
450 tdgts(jj) = rdig(jj)
  rdig(jj) = 0
  460 NEXT jj
  nodig = digno
  REM repeat for new cycle
  500 NEXT cycle
```

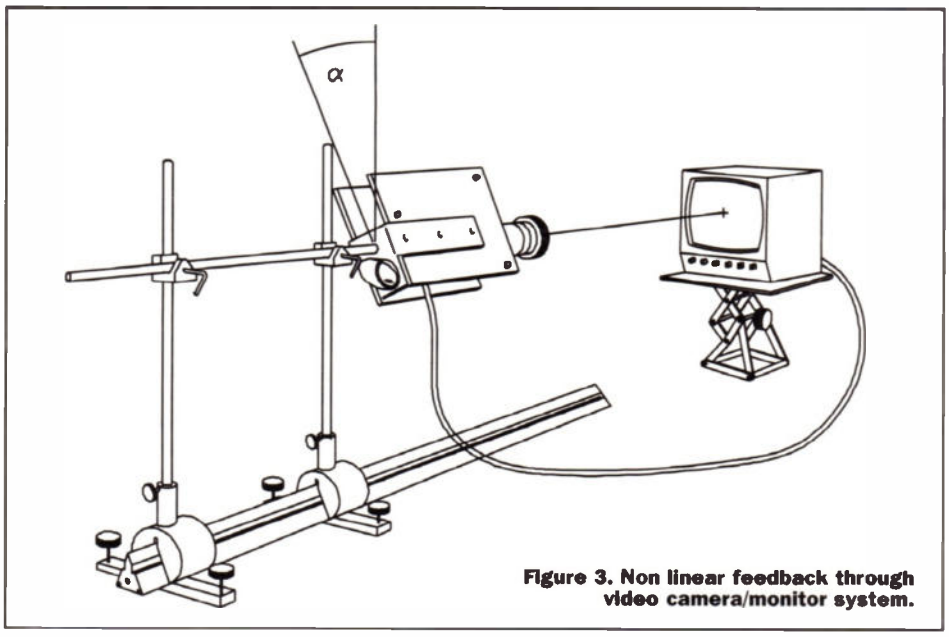


Figure 3. Non linear feedback through video camera/monitor system.

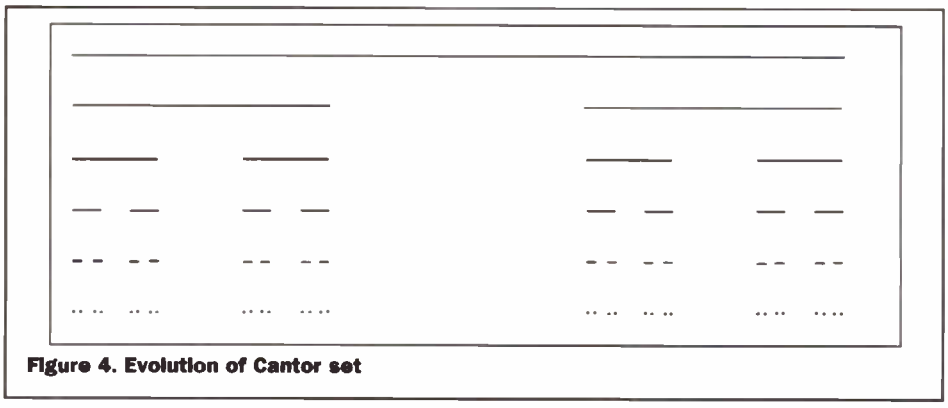


Figure 4. Evolution of Cantor set

by successive iterations.

It is indeed a bit of a paradox to use a computer to show the limits to the accuracy of its arithmetic. The programme Example2 does this to indicate the expansion of resolution required in the 'true' multiplication of real numbers. A given number is entered and then squared and the result squared in a loop of specified iterations. The programme keeps track of the total number of digits it requires to maintain total accuracy - in the example up to 2000 digits.

This is a demonstration that chaotic functions involving iteration on the x squared function, will sooner or later defeat the arithmetic integrity of any computer. By the same token, even more complex calculations will exhaust the numerical representation of the computer more rapidly.

Thus in a very real sense *'Chaos Wipes Out Any Computer.'* This rather bold statement is apparently entirely true. This fact was discovered in the very early days of using computers and was noted by MIT meteorologist E.N. Lorentz in 1956. Although computers have come a long way since then in terms of computing speed, they are still knocked over by complexity. The fact that a computer may have 10 place decimal resolution or 20 or even 100 is irrelevant to the way that a large number of successive mathematical calculations will always exhaust the numerical resolution of the calculating system. There can even be differences in accuracy of computation depending on how mathematical expressions are expressed in a specific programming language. Some computers will introduce infinitesimal differences if an expression is written as

$LMBDx_0(1-x_0)$ or $LMBDx_1 - LMBDx_1^2$.

The difference may only appear as a term of 10^{-16} in one iteration, but this is enough to cause a divergence of value between the two sets of calculated numbers. The greater effect, however, is probably truncation errors in numerical representation.

Volatile Video

One of the surprises in regards to chaotic systems is that intrinsically simple systems can be made to demonstrate them. One of the more dramatic ways of demonstrating systems with chaotic patterns is via careful use of a video camera and a TV monitor.

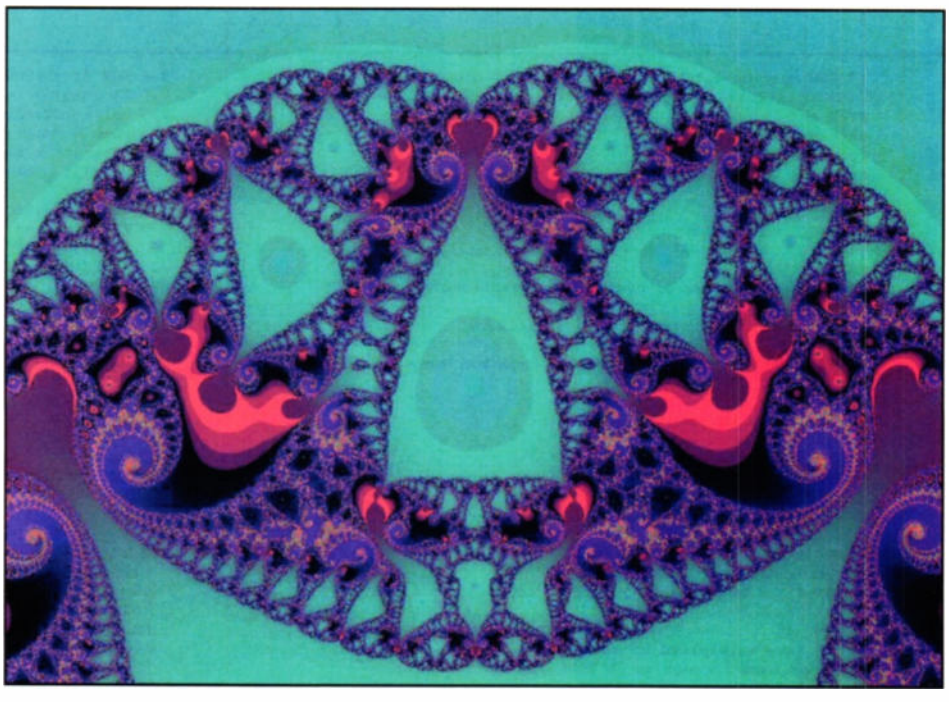
While there is familiarity with the standard 'monitor inside monitor inside monitor .....' image, there is less awareness of the effect of driving feed back when the camera is only imaging part of the monitor screen as in Figure 3. Also, the experiment works best in an almost dark room, with either the camera or the monitor inverted and with the camera axis tilted at about 45° to the vertical. The camera should have a manual iris which is gradually opened as the camera is focused on part of the monitor. It may be necessary to momentary present a light in front of the monitor to initiate the feedback process. It is possible to produce some startling and complex images of video feedback in this way. The key aspect of this exercise is that the light displayed on the TV screen is being 'cycled' in the imaging system - backwards and forwards.

Celestial Wobbles

One of the significant early contributions to chaos theory was Henri Poincare. In his analysis of celestial mechanics at the end of the 19th century, he determined that the standard methods then available could not calculate the motion of the planets within the solar system and other complex 'many body' dynamic systems.

It was not until 1966, however, that a better appreciation of the dividing line between predictable and chaotic systems was developed - rising chiefly from the work of the French astronomer Michel Heron in the structure of matter of stars in galaxies. This provided a series of equations to be used to describe chaotic motion.

There has been considerable speculation regarding the stability of the solar system and in particular the fate of the earth as a target in an asteroid shooting gallery. This comes at



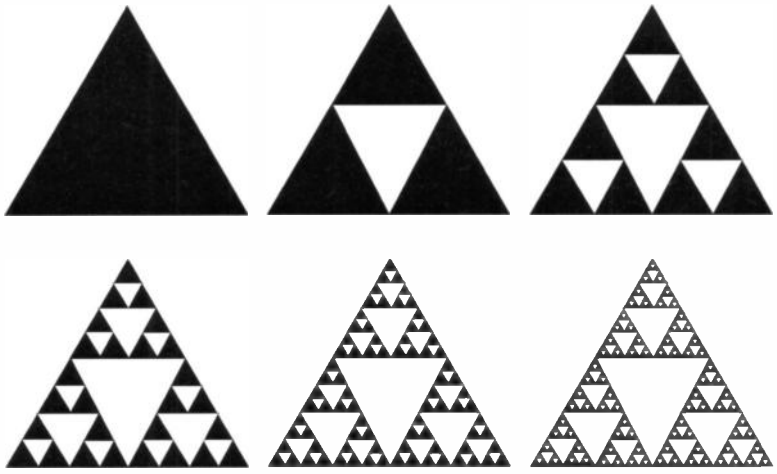


Figure 5. Evolution of Sierpinski gasket.

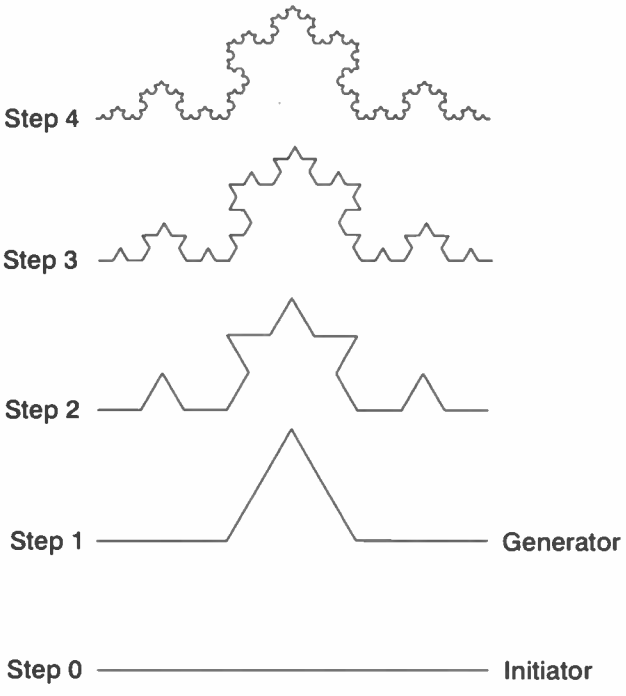


Figure 6. Evolution of the Koch curve.

a time when the number of 'hits' per century of smaller but significant asteroids is being revised significantly upwards.

On the one hand, science has demonstrated the ability to send the Voyager 2 spacecraft five billion kilometres to Neptune with an accuracy of a few thousand kilometres. This is hardly chaotic. There are, however, complex interactions within the asteroid belt that may be of a chaotic nature that could result in asteroids being moved out into potentially earth crossing orbits.

The American astronomer Kirkwood observed in 1867 that there were fewer asteroids at 2.5 Astronomical Units (A.U.) from the sun. Subsequent sparse populations were also observed at 3.0 A.U.

Although some resonant theory was suspected, the mathematical simulations necessary to demonstrate such effects were for many years too complex to prove. It was not until 1981 when a Ph.D. student, Joan Wilson, using a specialised mathematical technique that speeded up calculations, showed that the 2.5 A.U. deficit was caused by asteroids being subject to chaotic interaction with the gravitational fields of the sun and Jupiter. Also, as a result of such interactions, asteroids could potentially be sent into earth crossing orbits. This analysis has been extended subsequently to include the perturbations of Saturn and now Mars.

The Concept of Fractal Images

The world of Nature has demonstrated the feature of self similarity. Take, for example, the humble cauliflower. If the vegetable is dissected through levels from the aspect of the whole vegetable down to mini floret of width half inch, the pattern is replicated down through three or four levels of self similarity. It may not be obvious, however, but the entire decimal system shows a strong element of self similarity. Each sub division unit is in turn sub divided into another scale which can in turn be sub divided. Perhaps this is a subtle indication of the 'naturalness' of the decimal system of numeric representation. Some number sequences, which were 'discovered' as a 'classical' fractal before the term 'fractal' was coined by Mandelbrot, play a pivotal part in formulating the theory of fractal number systems and figure also in chaos theory. The so called Cantor set of numbers is constructed by means of an odd process - that of elimination.

Initially we start with a line of unit length and then discard the middle section from 1/3 to 2/3 but with the numbers 1/3 and 2/3 retained. This is repeated for each linear segment ad infinitum as per the visual process indicated in Figure 4.

Such a numeric sequence can be shown to have unique properties in defining chaotic systems. In terms of aspects of self similarity, it can be shown that a small element of the Cantor set contains a modified set of the entire sequence.

The Sierpinski Gasket and Carpet

Waclaw Sierpinski was a distinguish professor of mathematics at Lvov and Warsaw who made a major contribution to understanding of 'classical' fractal images. In defining the Sierpinski Gasket, its construction is very simple but the implications of its design are far reaching. Starting with an original black triangle as indicated in Figure 5, the mid points of the sides are selected to define four congruent triangles. The centre triangle is removed - shown as white. The design is then replicated in each pass for all the black triangles in the pattern ad infinitum. It can be imagined that for such a pattern, each zoom of the microscope would find the detail of the 'gasket' preserved.

The Koch Curve

Another of the classic 'fractal' curves is the so called Koch Curve whose construction is indicated in Figure 6. Initially starting with a straight line segment - the initiator - the centre 1/3 of the line is replaced by the segment of a triangle. This is repeated for every line of the construction - ad infinitum. The Koch curve is essentially such a construction with an infinite number of passes. The so called Koch snowflake or Koch island is derived from the basic Koch curve. This structure derived from simple mathematical concepts finds expression in the works of Nature.

The basic concept of 'self similarity' is quite central to the thinking of fractal geometry. Much of the basic mathematics relating to fractals had been identified prior to the publication of Mandelbrot's work - *The Fractal Geometry of Nature* in 1982. The works of Cantor, Julia and Koch to identify only a few, had established the mathematical significance of their structure but without a broader appreciation of their relevance in the natural world. Also, an appreciation of various of their properties could only in reality be derived by use of extensive computer facilities.

It is a curious property of the Koch curve, for example, that for each sub layer produced, the length of the curve increases by a factor of 4/3. This aspect is often compared to the task of measuring the coastline of Britain. With a very rough analysis undertaken with a pair of compasses able to mark off 100km at a time, a value of 3800km would typically be obtained. For successively smaller measuring intervals the total increases, rising to 8640 km with a compass step of 17km. This is indicative of the fractal representation.

TO BE CONTINUED...

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.

July 1999

18 July. Switched On - Internet Users Expo, Olympia, London. Tel: (0171) 636 6651.

August 1999

10 Aug. Internet Seminar, Star, Edinburgh. Tel: (01285) 884422.

23 to 27 Aug. Eleventh International Symposium on High-Voltage Engineering, London. Tel: (0171) 240 1871.

September 1999

5 to 7 Sept. ECTS - Computer & Video Games & Leisure, Earls Court, London. Tel:-(0181) 742 2828.

5 to 8 Sept. PLASA - Light & Sound Trade Show, Earl Court, London. Tel: (0171)-244 6433.

10 to 11 Sept. Computing Careers Exhibition, The Royal Horticultural Halls, London. Tel: (0171) 316 9170.

14 to 15 Sept. Broadband Year 99 - ATM & Broadband Communications, Olympia,-London. Tel: (0181) 541 5040.

15 to 16 Sept. Electronic Components Industries Fair, Olympia, London. Tel: (01799)-528 292.

15 to 16 Sept. Onboard - Electronics Assembly Exhibition, Olympia, London. Tel:-(01799) 528 292.

21 to 23 Sept. Microwave & Communication Technology, Wembley Exhibition,-London. Tel: (01322) 660 070.

24 to 25 Sept. AM Radio Show, Donington Exhibition Centre, Donnington. Tel: (01604) 790 966.

28 to 29 Sept. Business Computer Systems Show, G-MEX Centre, Manchester. Tel: (07000) 464 336.

28 to 29 Sept. Call Centre Expo - Telebusiness & Customer Service, National-Exhibition Centre, Birmingham. Tel: (0181) 742 2828.

28 to 30 Sept. Document & Workflow Management, Olympia, London. Tel: (0181)-742 2828.

October 1999

1 to 2 Oct. TheatreWorld - Theatre Productions & Management, Wembley Exhibition-Centre, London. Tel: (01895) 811 986.

5 to 6 Oct. FieldComms - Industrial Networking Show, Telford Exhibition Centre,- Telford. Tel: (0171) 417 7400.

6 to 7 Oct. Softworld in Accounting & Finance, National Exhibition Centre,- Birmingham. Tel: (0181) 541 5040.

6 to 7 Oct. TEST - Electronic Testing Exhibition, National Exhibition Centre,- Birmingham. Tel: (01203) 230 333.

12 to 14 Oct. Cards UK - Plastic Card Technology, National Exhibition Centre,- Birmingham. Tel: (0121) 767 2665.

19 to 20 Oct. Property Computer Show 99, Barbican Centre, London. Tel: (01273)-836 800.

20 to 21 Oct. Accounting IT, Business Design Centre, London. Tel: (0171) 221 1155.

26 to 28 Oct. City Information Show, Barbican Centre, London. Tel: (01865) 204-947.

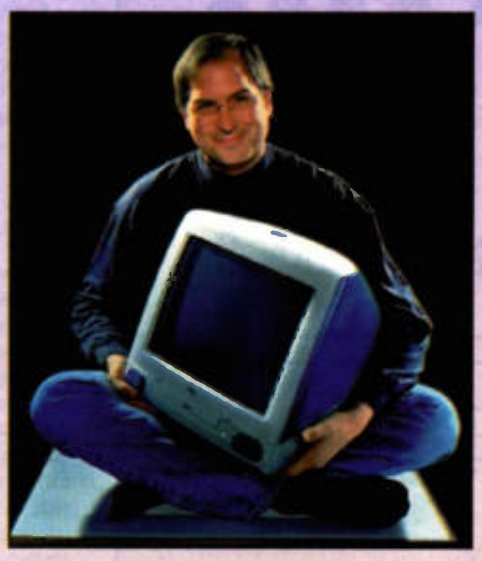
26 to 28 Oct. Computers & Networks in Manufacturing, National Exhibition Centre,- Birmingham. Tel: (0181) 232 1600.

26 to 28 Oct. Mobile Data Communications Trade Exhibition, Olympia, London. Tel:-(0181) 910 7910.

26 to 28 Oct. Windows NT - Computer Trade Exhibition, Olympia, London. Tel:-(01256) 384 000.

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 Developer Conference Attracts Record Number of Developers

Over 2,500 developers attended Apple's annual Worldwide Developer Conference up almost 50% over the previous year's conference, showing a huge return of confidence to the Apple platform.

During his keynote presentation at the conference, Apple's interim CEO Steve Jobs revealed that over 3,100 new or updated Macintosh software titles have been announced during the past 12 months.

"Over 3,100 new Mac applications are proof that developers have come back to the Mac and are investing again to make great applications The Macintosh has again become the centre of innovation in personal computing, and our developers deserve a great deal of the credit for this," said Jobs.

"Because iMac is attracting so many first-time buyers, the Macintosh platform is helping us reach new customers. Apple has shaken up the computer industry, introducing brilliantly innovative products that manage to combine elegance and power-really making our software stand out," said Larry Zulch, founder and chairman of Dantz Development, an Apple developer.

"The Apple of today is different than two years ago they are succeeding in the market and delivering on their promises. Apple's embrace of software technologies like OpenGL and the huge popularity of its new hardware make Macintosh a platform where software developers can build great products and a great business," said Rick Wyand, general manager, Macintosh business unit of Smith Micro Software

Apple also announced its new line of PowerBook notebooks that continue the product's tradition of being the fastest notebook computer in the world. With PowerPC G3 processors running up to 400MHz, the new PowerBook notebooks benchmark over twice as fast as the fastest Intel notebooks.

In addition, the new PowerBook line features battery life up to five hours. The new PowerBook line is almost 20 percent thinner and, at 5.9 pounds in weight, nearly two pounds lighter than their award-winning predecessors.

For further details, check: **<www.apple.com/uk>.**
Contact: Apple, Tel: (0870) 600 6010.

UK Leads Europe Into £400m Space Programme

The UK has led its partners in the European Space Agency (ESA) to embark on a new £400 million programme of environmental research. The 'Living Planet' programme will help scientists to understand and predict the Earth's environment and humankind's effects upon it.

For example, it will monitor the effect of global warming on the polar ice caps and measure soil moisture and other factors that are essential to the accurate modeling of climate systems.

Lord Sainsbury, Minister for Science and Space, announced a £67 million investment in the programme by the British National Space Centre (BNSC).

"The UK has taken a strong lead in devising this programme. Our scientific community has worked closely with the BNSC in identifying how to deliver a challenging value-for-money initiative, using state-of-the-art equipment and know-how," said Lord Sainsbury.

For further details, check: **<www.dti.gov.org>.**
Contact: DTI, Tel: (0171) 215 5000.

Battle Encourages Young Engineers

Industry Minister John Battle has urged the engineering industry to work together to attract more young people into the profession.

In a presentation to the Annual Congress of 'The Campaign to Promote Engineering' he said, "Engineering and engineers are central to the creative and competitive success of virtually every sector of the economy and vital to the present and future competitiveness of UK industry. We need to attract more bright young people into all levels of engineering.

"We need to communicate more effectively the value, excitement and diversity of a career in engineering to young people today. The DTI has made it clear that it is ready and willing to support efforts to attract young people into engineering if employers are prepared also to demonstrate their commitment. I have already pledged DTI money to the Campaign to Promote Engineering on condition that enough employers sign up," said Battle.

For further details, check: **<www.dti.gov.org>.**
Contact: DTI, Tel: (0171) 215 5000.

Semiconductor Industry Will See 'New Scenery' After Weathering Storm

Kicking off the 15th Annual In-Stat Forum, an annual meeting of the leading semiconductor manufacturers, Tsugio Makimoto, chief technologist for Hitachi, shared his views of the future impacts of the semiconductor industry with top-level executives from semiconductor and high-tech companies.

Makimoto explained the shifts in product segments, market structures, geographic markets and manufacturing fields that will bear consequence on the future 'scenery' of the semiconductor industry.

Following the most severe downturn in the semiconductor industry's 30-year history, Makimoto believes that the era of downsizing is behind us and that we are embarking the age of the 'Digital Nomad'.

The 'Digital Nomad' demands connectivity wherever they are and at any time. In fact, this demand for connectivity is fast becoming pervasive not only in the business community, but with the information-hungry consumer as well.

Hitachi's chief technologist, Tsugio Makimoto, shared additional insights into the Semiconductor Industry's 'New Scenery' with the audience attending the 15th Annual In-Stat. They included:

- The Japanese market will continue to shrink as a semiconductor consuming entity; growing rapidly is the Chinese market, exhibiting 15% annual growth between 1994 to 2000.
- The memory market will shrink and there will be a paradigm shift from board to chip memory.
- Hot, new technology cities will arise and challenge Silicon Valley: Austin, Boston and Seattle in the United States; Cambridge, Helsinki and Tel Aviv in Europe; Singapore, Bangalore and Hsinchu in Asia.
- The vision of the future is one where technology is multimedia, market structure is digital consumer applications and the business and consumer life-style is increasingly nomadic.
- Speech technology is the next big wave to hit computing and will have great potential in the business community.

For further details, check: <www.hitachi-eu.com>.
Contact: Hitachi, Tel: (01628) 585 000.

Eclipse Season at the Science Museum

On 11 August this year people in the south west of England will witness one of nature's most spectacular shows - the total solar eclipse. Although the path of the total solar eclipse does not pass over London, eclipse watchers will still see a 96% partial eclipse. People in Edinburgh will see an 80% partial eclipse of the sun.

The last eclipse to be seen in the UK happened in 1927 and an eclipse will not be seen again in this country for another 90 years. To celebrate the 1999 total solar eclipse the Science Museum in London is running an exhibition through to September called 'New Eclipse'.

The exhibition will help visitors understand how eclipses are predicted, how they happen and how to view the phenomenon safely on 11 August. They can see what happens during an eclipse using a model that uses the entire exhibition space.

For further details, check: <www.nmsi.ac.uk/eclipse/index.html>.
Contact: Science Museum, Tel: (0171) 938 8000.

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NOT JUST ANY OLD IRON

PROJECT

LASSIE

Ray Kent describes the construction of Lassie - not a reincarnation of a famous dog! - but a rather useful piece of test equipment.

Introduction

LASSIE - Logic Analysis System with Six Input Evaluators. A rather contrived acronym, I know, but like the dog of the same name this little tool should prove to be generally helpful and it might get you out of a tight spot sometimes! Lassie continuously monitors the logic state of up to six test points in a target circuit and shows you whether they are low, high, changing or high impedance. It's particularly useful for anyone who is experimenting with microcontrollers on a low budget, because one of the quickest ways of de-bugging is to add a few lines of diagnostic code that output values to spare ports. You can immediately see if your program has got past its start-up routine, or if your timer routine is being called repeatedly, etc.

Before making Lassie, I was 'making-do' with a single-input logic probe supplemented by lash-ups of LED's and resistors when I wanted to see more than one point at a time. This method turns out to be less satisfactory than it seems at first sight - we will go into the explanation later.

Lassie is based on an Atmel AVR 90S1200 microcontroller. I gave a short description of this device in the Solar Flare project (Electronics & Beyond, No. 137, May 1999) so I won't repeat it here. The device is electrically re-programmable and ideal for experimenting. If you want to experiment you'll need a programmer - available from Maplin - and an assembler. Atmel have a free assembler available for download. If you just want to build Lassie then you can get a pre-programmed S1200 from the author, ready to plug in and run.

Lassie is not intended to be a top-notch piece of test gear, but within limits, it's a very handy tool and the project provides an interesting introduction to digital techniques, raising some particularly interesting points with regard to sampling systems.

Everybody Gotta Be Somewhere

According to the mathematicians, computers use Boolean logic, so there are only two states - 'zero' and 'one'. In a typical circuit using a 5V supply they are represented as zero and 5V. When you move from maths into the real world of engineering you soon find out that a point that's at zero volts, because it's being driven low, is not the same as a point that just happens to be at zero volts and isn't connected to anything. A character in The Goon Show was asked why he was in a cupboard and replied "Everybody gotta be somewhere". Likewise, every point in a circuit has got to be at some potential with respect to ground. It doesn't mean that it is being driven to that potential.

As a practical example of the problems this causes, let's say you're driving a port on your target application's microcontroller high (or so you think...). You put a conventional (very high impedance) probe on the port and it shows high - it looks good. But actually you've got a bug in your code, for that port is wrongly configured as a high-impedance input instead of an output. A high-impedance line will respond to leakage from neighbouring pins and noise pick-up. It might stay high or low, it might oscillate, it might give a different reading each time you check it. A false diagnostic can be worse than no diagnostic at all.

The way to find out if a point is 'truly' logic-high is to try drawing a small current from it and see if the voltage collapses. Conversely, to find out if it is 'truly' logic-low you can test whether it is capable of sinking a small current without the voltage rising.

Polling

Lassie tests for active-high and active-low states by polling, that is it alternates between trying to source and sink a small current from the test point. Figure 1 shows a mechanical analogy for illustration (if you actually built it you'd need current limiting resistors for the LEDs). First note that S1b ensures that only one of the LED's cathodes is grounded at any time - the other LED is left open-circuit and will not be lit. When S1 is in the 'up' position channel 1 input is connected to Vcc through a 1MΩ resistor so it will only be low if the target circuit is actively pulling it low. If this is the case, the inverting buffer drives the green LED on, otherwise the green LED stays off. When S1 is changed to the 'down' position channel 1 input is connected to ground via the same 1MΩ resistor. Now channel 1 input will only be high if the target circuit is actively driving it high. If so, the non-inverting buffer will turn the red LED on. If you stand there wiggling S1 back and forth faster than the eye can see then you'll see a 'continuous' green for active-low, red for active-high and darkness for high-impedance.

That deals with the problem for a target circuit that is in a steady state, but what if it's rapidly changing state? If you represent this directly, then for a line that's oscillating faster than about 30Hz the eye will 'join the dots' and see both LEDs on together. This would be OK, but it's nicer to have them alternately flashing to represent the oscillation and in order to see the flashing they must be flashed slowly - about 20Hz maximum. This could be achieved by polling at 20Hz, but then you could miss single-event pulses shorter than 50ms. To increase the chances of catching shorter pulses we need to poll rapidly, but there's a trade-off involved. If the poll is very short there may not be time for any stray capacitance on a high-impedance line to charge or discharge through the 1MΩ resistor, and we wouldn't want to reduce this resistor too much or it would interfere with normal operation of the target circuit. The way in which Lassie deals with these issues involves three separate timing cycles.

1. Display multiplexing

This is carred out by alternating between sinking the green LEDs cathodes and the red LEDs cathodes and is carried out at a high enough frequency (about 90Hz) to deceive the eye into seeing continuous light from those which are supposed to be continuously lit.

2. Display updating

We decide which channels should show green, which red and which neither and is carried out at a low enough frequency (20Hz) for the eye to clearly see an individual flash representing a pulse.

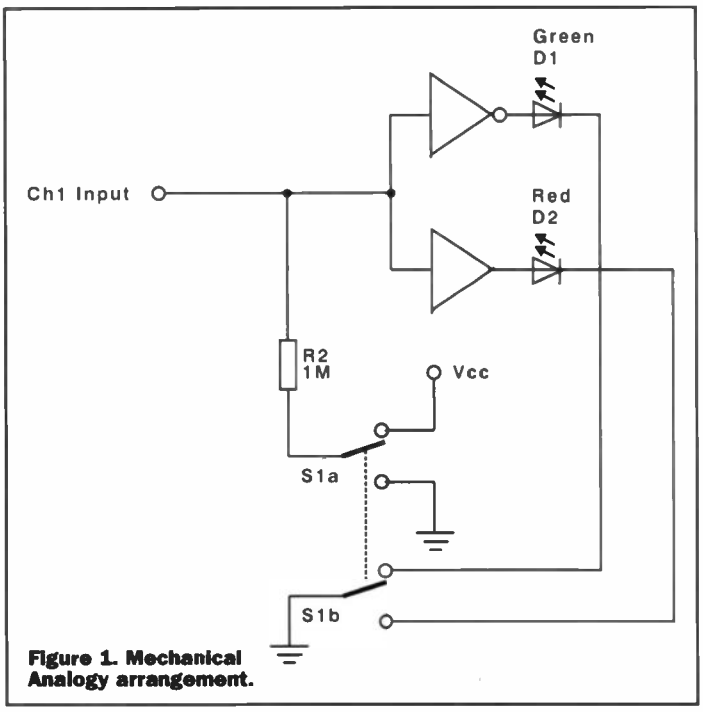

Figure 1. Mechanical Analogy arrangement.

3. Input polling

This is carried out at a much higher frequency - a number of polls are carried out on each channel before the display gets updated. If a poll returns a value different from the current display we call it an event. If the display for channel 1 is green and all the polls before the next display update return 'low' then we say there have been no events and the display will remain green. But if any of those polls returns something other then low (i.e. high or high-impedance) we say there has been an event and the display will be changed on the next display update. If more than one event has occurred then the display will be changed to show the most recent event, but note that it will definitely change - it won't go from green to green just because the latest poll returned low! In this way, the presence of events caught by the input polling will be visibly registered on the display. Note that a one-off short pulse that occurs between polls will be missed - there's no reliable way of catching such events without adding circuitry, such as a monostable, to each channel input. Lassie is therefore not a pulse-catcher for one-off pulses of short duration, but it will indicate repeated pulses even if they are short.

Referring back to Figure 1 then, S1a is not directly coupled to S1b in the Lassie implementation - the relationship is rather more complex. The overall result is that for steady-state conditions or inputs which are changing at a rate slow enough for the eye to follow, Lassie will display the inputs directly. If the rapidity of change on an input exceeds what the eye could follow, Lassie translates it into flashes that are long enough to see. You'll see clearly whether a port is oscillating between high and open-circuit, as opposed to high and low, for example.

Stray Capacitance

Figure 2 extends the mechanical analogy to look at the problem of stray capacitance on a high-impedance line under test. Assuming the capacitor is discharged to start with, when you take S1 high the voltage at the test point will not rise to 5V immediately - it takes time for the capacitor to charge through the 1MΩ resistor. How much time do we need to allow for the voltage at the test point to be near enough to 5V to give us a reliable high logic-state reading? The time constant t = RC tells us how long it will take to reduce the difference between the capacitor's present voltage and the charging voltage to 37% of its present value. After 4t seconds the error will be less than 2% of Vcc (0.1V) at worst, which is safe. So we'll allow 4t seconds for the input to settle. Lassie actually allows 1ms. This gives us t = 250μs, so C = 250pF. So we should get reliable readings for circuits having stray capacitance of up to 250pF. This is a reasonable result. Note that if we took the polling line high and read the input on the next program instruction then the settling time allowed would be of the order of 1 clock cycle, which is 1 microsecond in this case. This is a factor of 1000 lower, so stray capacitance of less than 1pF might cause false readings.

Sampling Systems & Nyquist

If you've ever looked into sampling systems, such as digital audio for CD you may have come across the Nyquist theorem. Loosely stated, it says that you'll run into problems with an input that is changing at a rate higher than half the sampling frequency. To understand the problem let's assume that Lassie is taking a sample every 1ms. What happens if the input is a precision 1kHz square wave (which would have a period of exactly 1ms)? If the first sample happens to be high then every subsequent sample will occur at the same point on the input waveform and will be high too (see Figure 3). We'll falsely register a steady-state. If the two frequencies differ by, say 1Hz, then we'll see the green and red LEDs alternating at this 'beat frequency'. The same sort of problem arises for inputs at (or near to) any integer multiple of the sampling frequency. This is a serious problem for a low 1kHz sampling frequency as it will have integer multiples at, for example, 20kHz, 21kHz, 22kHz, etc, giving us a fairly dense distribution of problem frequencies within our desired working range.

The interesting thing about this phenomenon is that it only arises from regularity. Lassie addresses the problem in an unusual way - it doesn't poll regularly. The timing between polls is randomly varied, so with a fast square-wave input each poll will have a 50% chance of occurring while the input is high and a 50% chance of occurring while it is low (see Figure 4). Given that it takes a number of polls into account before updating the display, there is a high probability of at least one sample being different from the currently displayed value. So you'll see red and green alternating (mostly) for a square wave input at any frequency - even way above the average sampling rate.

Not quite! We could defeat Nyquist completely if we actually did vary the sampling interval randomly, but Lassie, as presented here, doesn't quite do that. If you're running a digital system from a fixed-frequency clock then every system-event is tied to a clock pulse. For the processor, time is like a comb with teeth at 1μs intervals and every instruction must occur on some tooth or other, not in the gaps. So our input operations cannot be truly randomly distributed, the best we can do is assign them randomly to different teeth of the comb. They are doomed to occur at intervals of some integer number of clock pulses - all we can do is vary the integer. If our clock is running at 1MHz and the input is a square wave at 1MHz then there is no code you can write that will get an input operation to occur at some different point in the input's waveform.

The comb problem could be overcome very easily by making Lassie's clock frequency drift around a bit. The spacing between the teeth would no longer be constant and it will never stay in sync with an input. I'll leave that to one of you! As far as I'm concerned the circuit should be fine for inputs up to nearly 1MHz. Above that the chance of getting an accidental synchronisation that is visibly misleading is not far off one in a million, so I'm not worried!

The idea of randomising the sampling interval could have applications in other areas. In theory you could build up a picture of any regularly-repeating waveform from samples taken at below the waveform's

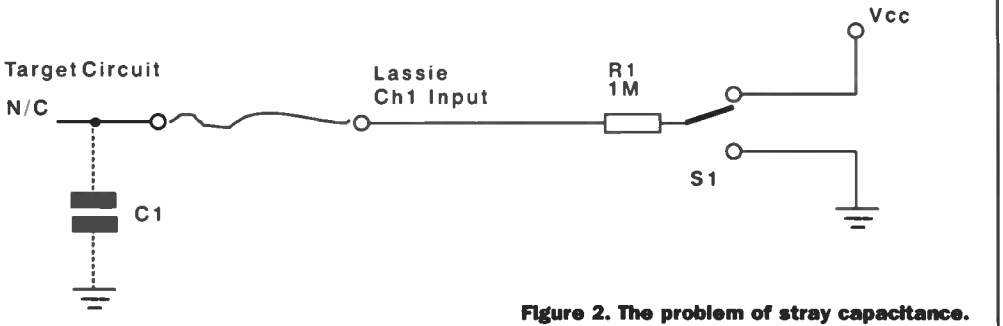

Figure 2. The problem of stray capacitance.

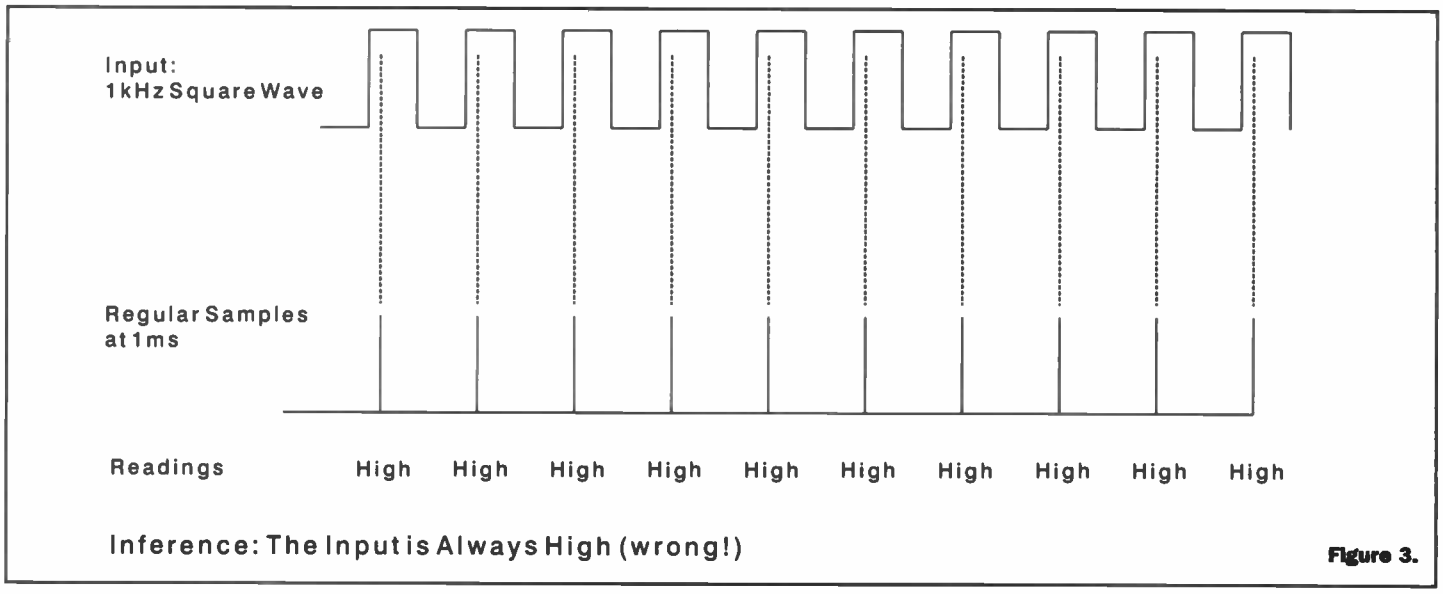

Figure 3.

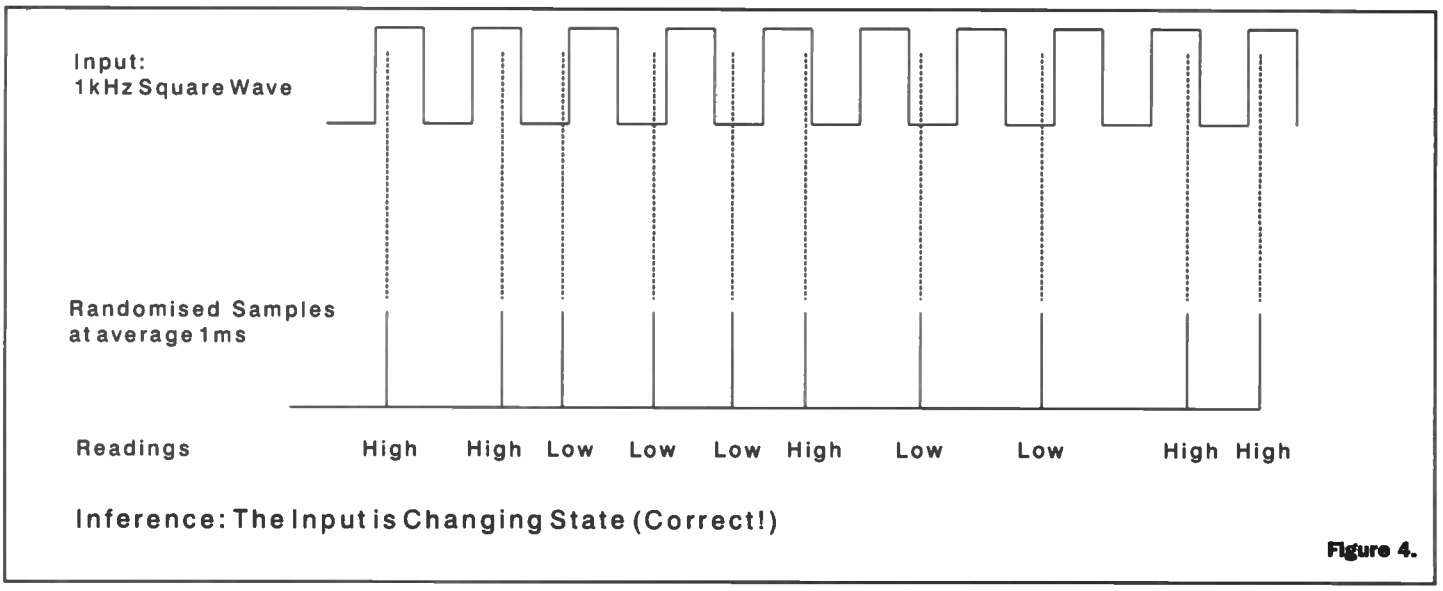

Figure 4.

frequency. I doubt if I'm the first to think of it and I'd interested to hear from readers who've already come across it.

Why Go To All The Trouble?

By now, I'm sure some of you are thinking that I've succeeded in turning a very simple problem into an awfully complicated solution and I'd be better off ditching the microcontroller and putting together a collection of window-comparators, gates, etc. Well, yes and no. My commercial logic-probe has (amazingly) about 45 components in it, and that's only single-channel. Six times 45 is 270. Lassie has just four components per channel, plus a system overhead of five, giving 29 in total. OK, I'm sure you could do a 'classic' six-channel design with a lot less than 270 components, and it can catch very short pulses which Lassie might miss, but there's not much more difference than that. As you can see, Lassie has been designed to a minimum component-count brief and all the problems have been addressed in software rather than hardware. And the software itself is shorter than the explanation of it!

Circuit Description

Lassie is designed to test 5V logic circuits and takes its supply from the circuit under test. C2 and C3 across the supply lines provide de-coupling. When power is applied, pin 1 of IC1 is held low keeping it in RESET state until C1 charges via R1. The microcontroller then comes out of RESET state and starts program execution. See Figure 5.

Inputs

The input channels 1 to 6 connect directly to ports D0 to D5 respectively. These ports are configured as high-impedance inputs - the optional internal pull-ups in the microcontroller are not activated. Each of these lines is linked via a 1MΩ resistor to Port D6 which is configured as an output and rapidly toggled between high and low states.

LED Outputs

Port B0 is taken low to sink current from the red LEDs, B1 similarly sinks current from the green LEDs. When data for the green LEDs is presented, Port B0 is re-configured as a high-impedance input in order to disable the red LEDs and vice versa. You could also disable the red LEDs by simply taking B0 high instead of re-configuring it as an input but that would put a reverse voltage of 5V (under zero-current conditions) across some of the LEDs. Some LEDs are only specified for a peak inverse voltage of 5V. It's a point you don't often see mentioned - perhaps I am being over-cautious.

The outputs for channels 1 to 6 appear on Ports B7 to B2 respectively. These are configured as outputs and source current into the LEDs through resistors R8 to R13 which limit the current from each port to about 2mA. Each output port is rated for about 3 or 4mA when sourcing current or 20mA when sinking. The LEDs that I've specified are low-current types which give a bright display. (Don't forget we can only light the green LEDs for half the time and the reds for the other half, so 2mA from the port gives a time-averaged current of 1mA through each LED). Ordinary LEDs could be used, but they're not as bright. Each of Ports B0 and B1 may need to sink current for six LEDs - giving 12mA which is comfortably within spec. The overall I/O current would be 24mA with all LEDs (appearing to be) on simultaneously (12mA out and 12mA back in). This is well within the specified maximum of 80mA for the chip.

Unused Pins

Lines XTAL1 and XTAL2 could be connected to a clock circuit to provide a higher or variable clock-speed but in this design we use the internal 1MHz RC clock so they are left unconnected. If you want to experiment with an external clock, perhaps to try out the 'unstable clock' idea mentioned earlier, then the S1200 will need to be programmed to accept it.

Software Description

Most of the interesting design issues have been covered in the discussion so I'll just give a brief outline here.

Reset

After powering up, the chip leaves RESET mode and starts program execution. We initialise the ports by setting them up as input or output as appropriate.

We initialise the timer to provide interrupts at 100 microsecond intervals - i.e. a frequency of 10kHz . Since most of the instructions are single-cycle we might hope to execute up to 100 instructions between interrupts. Much of this capacity is taken up by the ISR (Interrupt Service Routine) itself.

Welcome

The start-up routine now flashes the red LEDs in sequence left to right and the green LEDs right to left. Apart from the entertainment value, this will give you a useful indication of an intermittent power supply connection which will cause resets.

Timer

The Timer ISR (interrupt service routine) does a number of jobs.

1. Maintain a software clock (Xtim) to provide an easy way for other routines to achieve delays.
2. Maintain an EXOR random number generator which continuously generates 24-bit numbers.
3. Alternate the red and green sink lines to multiplex the LEDs (along with placing the appropriate red or green data on B7 to B2, of course).

If you looked at the code for the Solar Flare project you'll see that most of the ISR code here is 're-cycled', though the introduction of a shorter time interval has necessitated a bit of extra caution in the timer code.

Main Loop

The program's main loop first takes Port D6 low, allows 1ms for the electrical state to stabilise and then reads the inputs into the variable RedIn. Any channels that are actively high will yield 'one' bits in the corresponding bit-positions in RedIn. Channels that are high-impedance will be pulled low by Port D6 and will yield 'zero' bits, as will any actively low channels.

Next we wait for a time interval that varies randomly between 0.1 and 1.6ms. Then we take Port D6 high to test for active-low channels, in a comparable way to that described above. The data is inverted so that active low channels are represented as 'one' bits in the variable GreenIn. A second random delay of between 0.1 and 1.6ms follows.

After collecting a red-poll and a green-poll we call the routine Update_NewBuf which compares the red and green states from the latest polls with those that are currently being displayed on the LED's. Where a channel differs it places the new value in variables RedIn_New, GreenIn_New as appropriate.

So far the whole process will have taken somewhere between 2 and 6ms and we now loop back and repeat. After somewhere between about 8 and 20 loops of the polling process we'll discover that the ISR has set a flag to tell us that 50ms has elapsed so it's time to update the display with fresh data. We transfer the RedIn_New and GreenIn_New variables to the locations used by the LED multiplexing code in the ISR, so that next time the ISR kicks-in the new data will be displayed.

Construction Of The Electronic Module

Figures 6 and 7 show the PCB and component overlay. Construction is nice and easy. The LEDs listed are 3mm types but the spacing between them on the PCB should give enough room for 5mm types if you prefer. Each pair of LEDs is placed with the anodes (longer leads) connected together in the middle.

Take the usual ESD precautions with IC1. It's safest to put it in a socket. I cut two lengths of ten from a socket strip for this. The top end of IC1 (marked with a dot or cut-out) is to the left when you view the PCB from above in the normal position - i.e. inputs near to you, LEDs away from you.

I made up six eyelets by bending some solid-core copper

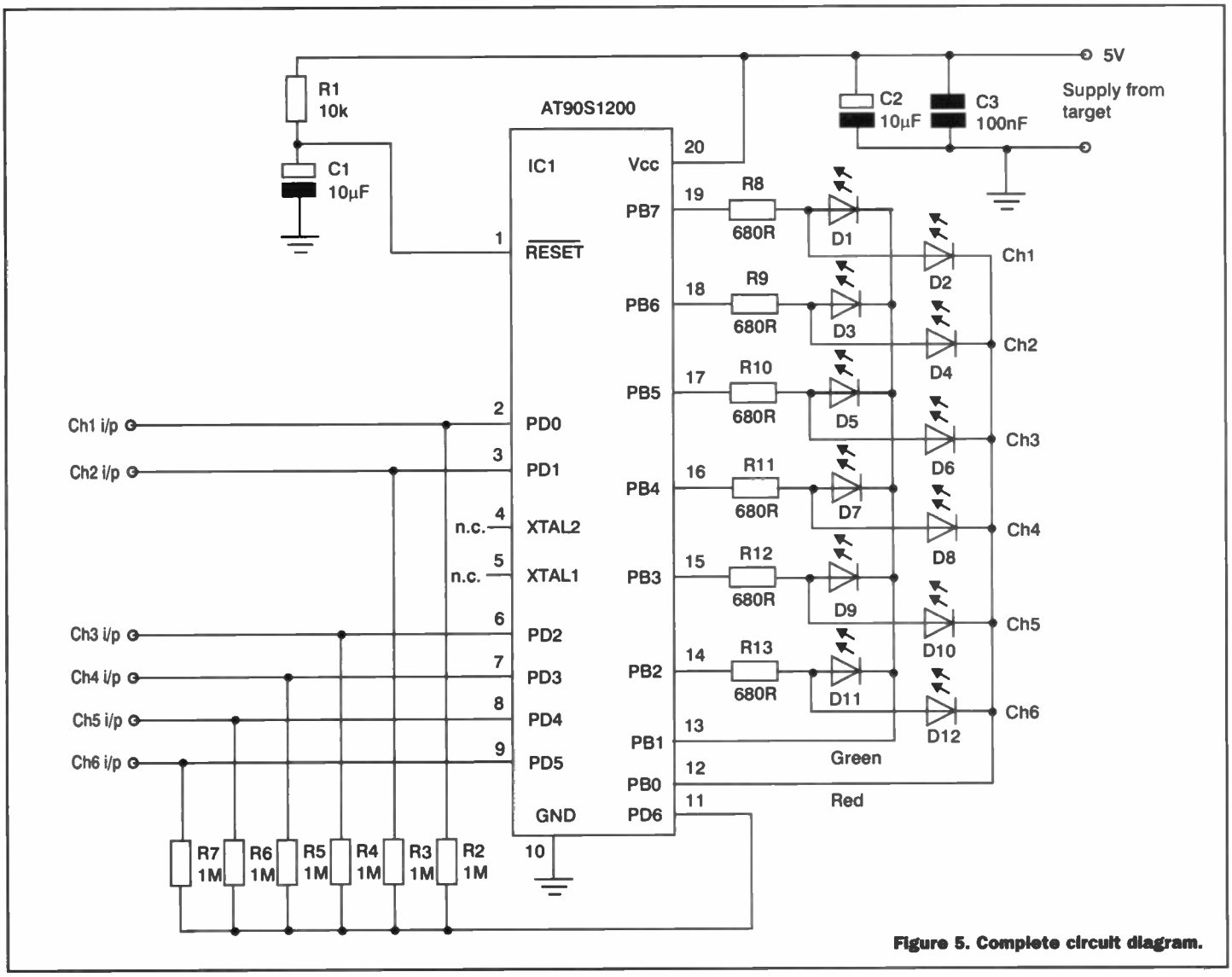

Figure 5. Complete circuit diagram.

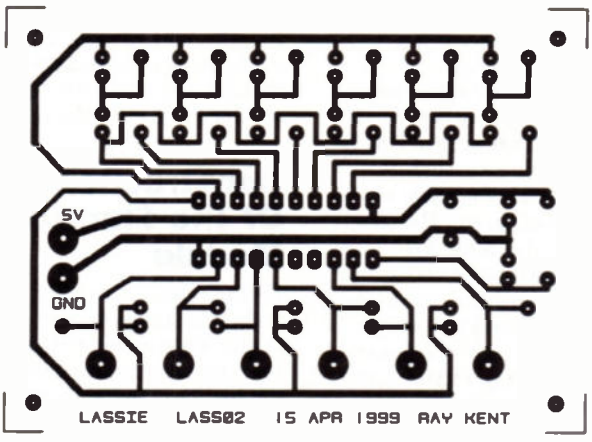

Figure 6. PCB layout.

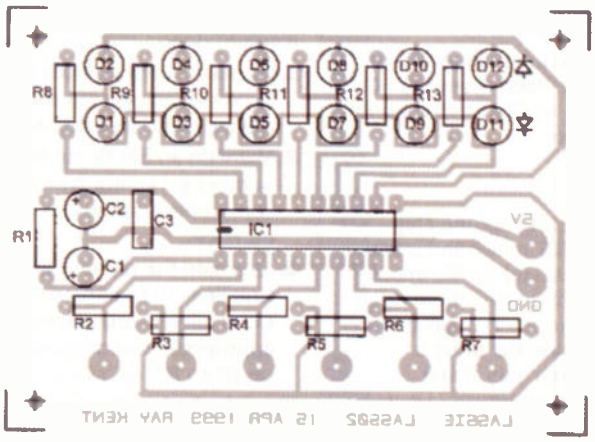

Figure 7. Component overlay.

wire from a piece of household mains cable. You can also get ready made gold-plated eyelets from Maplin, but they're not long enough to project above the front-panel if you've got IC1 in a socket. You could mount them flush on the PCB and provide bigger holes in the front-panel for poking the test-lead clips through. The eyelets are used for attaching miniature or sub-miniature probe clips.

I made a case out of an old audio cassette case - simple and cheap, but not particularly robust. A front panel label is shown in Figure 8.

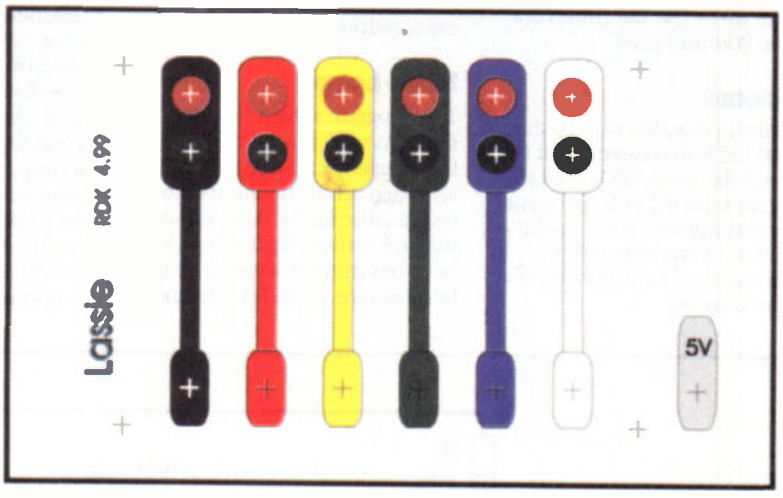

Figure 8. Front panel label.

In Use

Hook up the ground and 5V lines from your target circuit to Lassie's supply inputs before making any other connections (it's not good to drive an input when there's no supply to the microcontroller). Take care to get the polarity right - there's no protection. When power is applied Lassie should display its little power-up sequence to let you know it's working. If it doesn't, disconnect ASAP and look for the fault.

Lassie can draw up to 15mA from the supply. I once spent ages tracking down a fault in another microcontroller circuit that arose from the fact that I'd cautiously set the current-limiter on my bench supply to 50mA and occasionally the circuit asked for 60mA - it suffered 'brown-out', reset itself and merrily continued from the start again. That's one reason why I like conspicuous start-up displays.

Once you've got Lassie powered up just connect test leads to any points you want to check. If you're testing a circuit that includes other supplies, such as ±12V for op-amps, take care not to connect to any points that may have a voltage outside of the 0 to 5V range.

Bear in mind that Lassie operates probabilistically (phew!) so any single momentary reading is only probably correct. In particular the tests for high and low are separated in time and the state of the input could change between the two. If an input alternating between high and low just happens to be high on the high poll and low on the low poll then Lassie will think it's high-impedance. If that just happens to be the last event before a display update then Lassie will momentarily blank both LED's (for one-twentieth of a second). It's not likely to happen and if it does happen you're not likely to see it - just don't videotape the output and slow it down! I've described the worst case - you can only get false 'blanks', you won't get green if the input hasn't gone low and you won't get red if it hasn't gone high.

An input that's oscillating regularly at above the display frequency will not necessarily give an absolutely regular alternation between green and red, there may be slight irregularities resulting from the randomization of the polling. My commercial logic probe makes the opposite 'mistake' - it shows a regular pulse for an irregular input - so it's six of one and half-a-dozen of the other, neither of them can tell you whether the input is regular or not.

PROJECT PARTS LIST

RESISTORS

R1	10k Min Res	1	M10K
R2,3,4,5,6,7	1M Min Res	6	M1M
R8,9,10,11,12,13	680R Min Res	6	M680R

CAPACITORS

C1,2	GenElect 10µF 16V	2	AT98G
C3	0.1µF MiniEster	1	CX21X

SEMICONDUCTORS

IC1	AT90S1200/16PC	1	NR25C	* see text
D1,3,5,7,9,11	HP Mini LED Grn 2mA	6	CZ30H	* see text
D2,4,6,8,10,12	HP Mini LED Red 2mA	6	CZ28F	

MISCELLANEOUS

32 Socket Strip	1	DC17T	
S-min Probe Clip Set	1	FA96E*	pack of six leads
PCB Eyelet Terminal	1	JM02C	* pack of ten
PCB	1		* see text

The author can offer the following parts:

Drilled fibreglass PCB £5.50
Pre-programmed AT90S1200A/12PC £6.50
Software and drawings on floppy-disk £3.50

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Bio-Feedback WITH ELECTRONIC ENHANCEMENT

PART 2

In the second of this four part series David Clark looks at the biological and bio-electrical contribution to bio-feedback with electronic enhancement.

Homeostasis

On a physical level the human organism is a highly organised assembly of cells, tissues and organs kept functioning by a hugely complex interconnected collection of electrical and biochemical control systems. Linking all of these are the nervous system and the blood circulation. The nervous system is an electrical system which uses biological materials as the communication medium in place of wire, and ions instead of electrons. The blood circulation is a transport system using a fluid medium and hormones and other bioactive molecules as messengers. The brain is the control centre which consciously and unconsciously controls and monitors these systems and passes information backwards and forwards between them. This complexity and sophistication is all housed inside a protective barrier, the skin, lungs and digestive tract lining, which provides isolation from a hostile external environment and allows the control systems to maintain an internal environment within very narrow temperature and chemical concentration limits. This stable equilibrium is called homeostasis, and if it were not maintained the human organism would very quickly cease to function. Like any other system that cannot be reached or taken apart to be examined, how it works can be partly deduced from how it interacts with its environment and by detecting the side effects of its activity. Once those side effects have been detected and analysed and the processes they are part of understood, that information can be used to modify the behaviour of that system. This is the basis of bio-feedback with electronic enhancement.

Monitoring

To monitor the chemical activity of this organism involves taking samples. This means breaking the outer protective layer. This is not acceptable unless there is a valid medical reason for doing so since any such activity carries some risk, no matter how small. What's more it is not a process that can be carried out in 'real time'. The sample has to be taken away and analysed and the results returned later. This is not good enough for a feedback system. The process needs to be non-invasive and the results available as the process is occurring and changing. For bio-feedback this is relatively straightforward and involves three types of principle. These are:-

1. Electrical - activity within the body can be monitored from the outside by the electrical effects that the activity produces.
2. Mechanical - most human activities involve physical movement either as a deliberate action or as an effect of an activity.
3. Heat - as warm blooded creatures our systems need to be kept warm to operate, and part of the process of keeping warm involves the heat produced by the systems themselves. For bio-feedback the monitored parameters are the electrical activity associated with the brain, heart, muscle and skin, the mechanical effects of breathing and the action of the heart, and the temperature of the body.

Body Parts

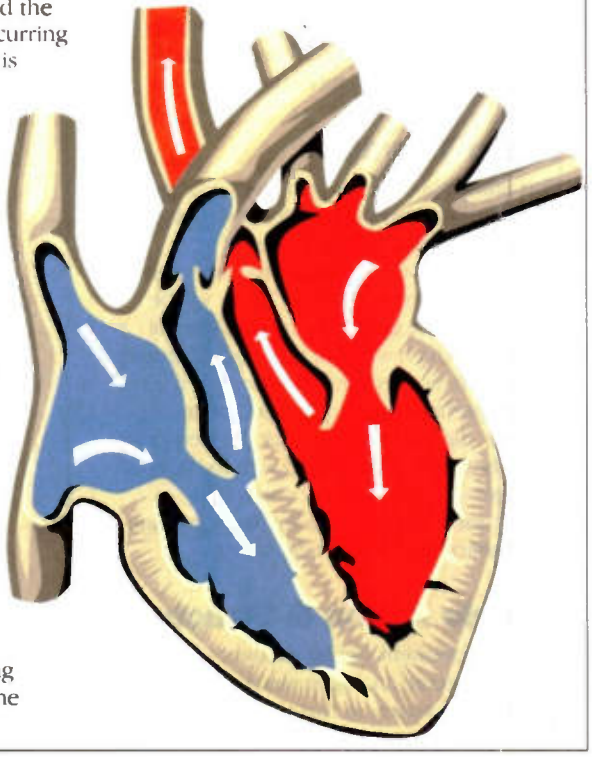
So which parts of the body are involved and how do they work?

When asked to name the two major organs of the body most people would say the heart and the brain, the seats of emotion and logic according to tradition. These two organs are examples of specialised types of tissue which are also found in other parts of the body, the brain being primarily an area of complex interconnections of nerve cells which also communicate with all other parts of the body, and the heart consisting mainly of specialised cells making up muscles which are controlled by in-built nerve cells. So a description of the working of these systems is best started with nerve cells, then looking at muscle generally, of which the skeletal system is mostly composed, and then at the heart which includes both muscle and nerve cells. Then I'll have a look at the skin which is the most important part of controlling temperature in humans. Finally for this part of the series I'll have a look at breathing which provides the oxygen necessary for all these processes to operate. As part of all these systems I'll be looking at the systems which link these, namely the nervous system and the endocrine, or hormone, system.

Brain And Nerve Cells

The nerve cell (see Figure 1) is responsible for transmitting information electrically between different parts of the body.

Although it has the same basic processes occurring within it as other cells, it has evolved to perform its specialised function by having at one part many branches, the nerve fibres, and one very long fibre which carries its signal to its ultimate destination. The many fibres at the main body of the cell all interact with similar fibres on other nerve cells; many thousands of these interactions occur between thousands of



cells. The brain is simply, if it can be called that, a collection of vast numbers of these cells interacting with each other by uncountable connections of the small fibres, and with the rest of the body by signals going to and from the brain via the long fibres. Each interaction between fibres occurs not directly but via a chemical connection at a synapse (see Figure 2), which is more effective at transmitting the potential change between cells than a direct electrical connection would be.

Since there are thousands of these connections at the surface of each cell, the number of possible pathways of information transmission is almost without limit, and it is somehow through these pathways that all the senses, emotions, memory, intelligence, patterns of behaviour and so on occur, although the processes are still not understood.

Regions Of The Brain

However, although it is not known how these processes occur, the various areas of the brain where these occur have been fairly well mapped (see Figure 3).

The functions of the brain get more complex as we move from the inner areas to the outer, which corresponds to the development of the brain through evolution (see the first part of this series). The very inner part is primarily responsible for basic functions such as distributing information to and fro between the more distant parts of the brain and the other parts of the body via the spinal cord. The next part provides the link between the nervous system and the endocrine system, being responsible for controlling hormone production. Through its connections to the other parts of the brain this is where the control of the autonomic nervous system occurs, the control system that bio-feedback with electronic enhancement concerns. The large outer part of the brain is where all the higher processes occur, receiving stimuli such as sight and sound, processing this information, controlling muscles, and creating thought, memory, learning and awareness, all the things that make us conscious beings.

Brain Waves

The activity of the brain generates voltages which can be recorded by electrodes placed on the head, and various ranges of frequencies have been found to correspond with various types of activity. These will be examined more closely in the third part of this series which will deal with the electronics involved in bio-feedback, but for each type of activity, perhaps not surprisingly, the more 'intense' the activity the higher the frequency of the brainwaves associated with the activity. This gives a good point for controlling moods and tension by bio-feedback through the monitoring of these brainwaves.

Muscle Action & Structure

Muscle movement can be thought of as equivalent to an analogue electronic positioning system, in that there are an

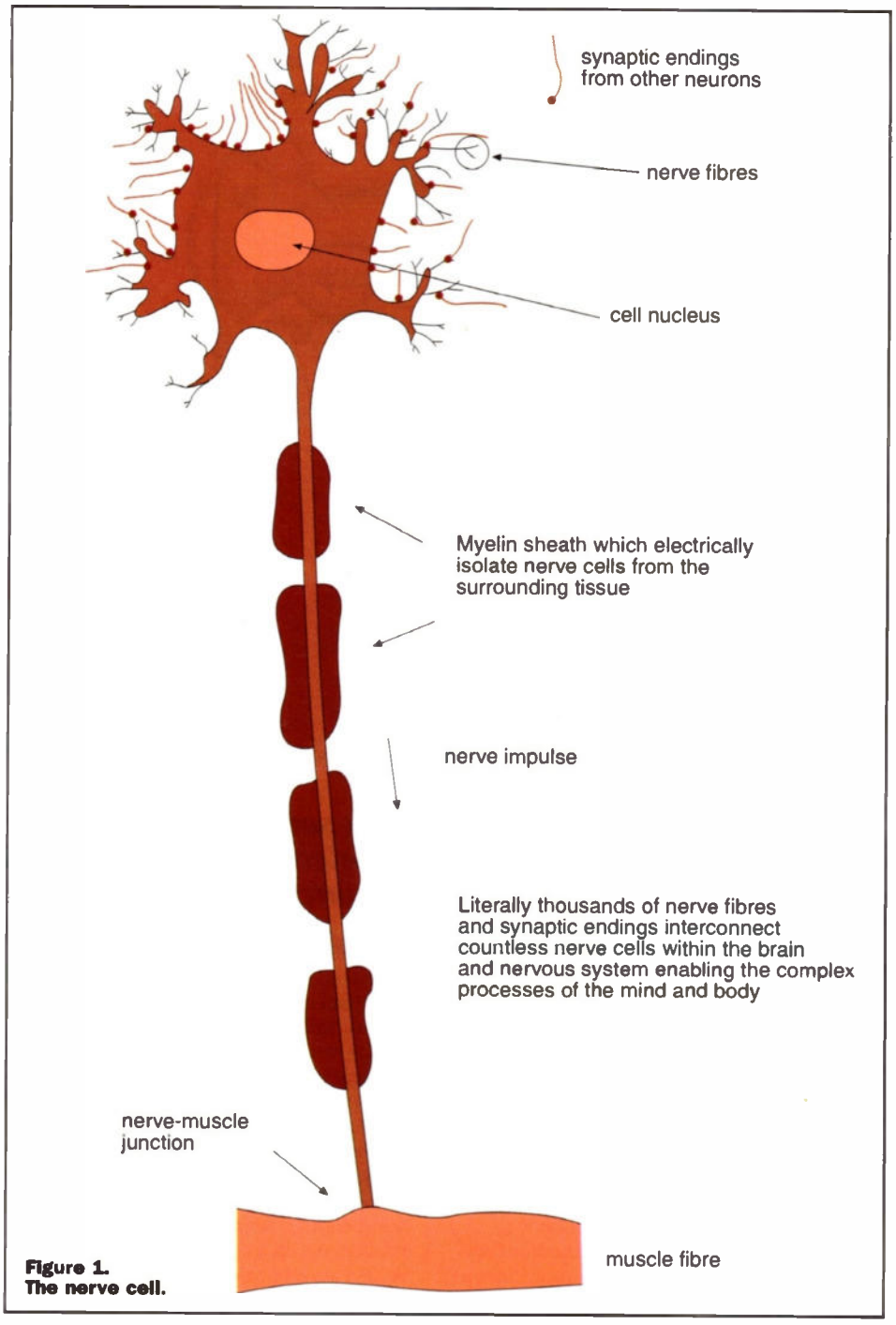


Figure 1. The nerve cell.

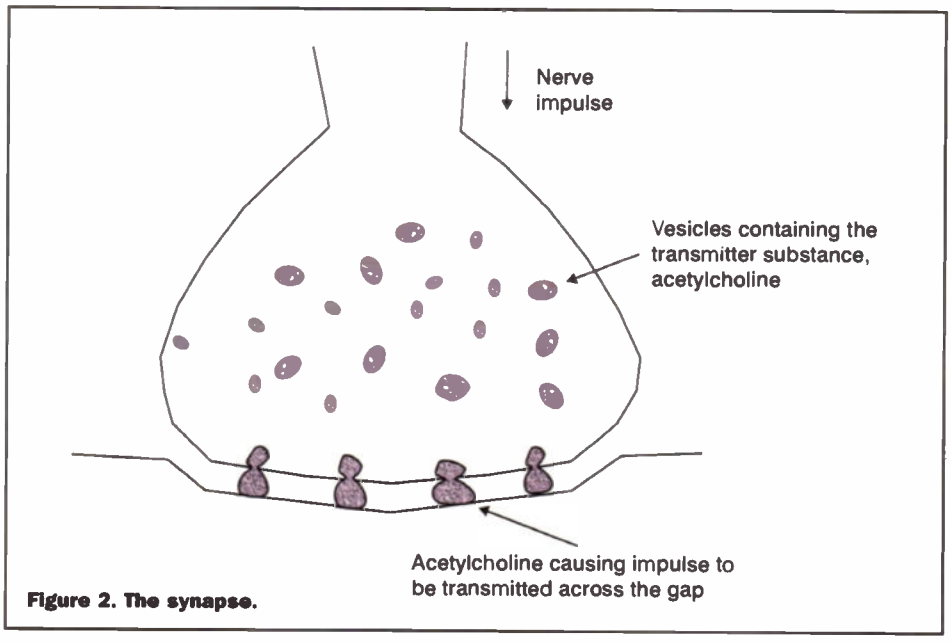


Figure 2. The synapse.

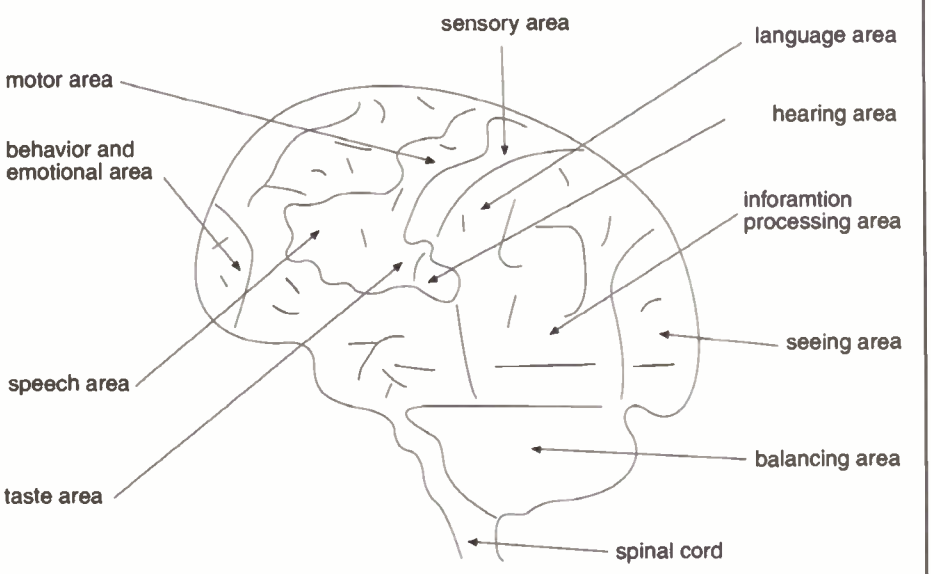


Figure 3. Brain areas.

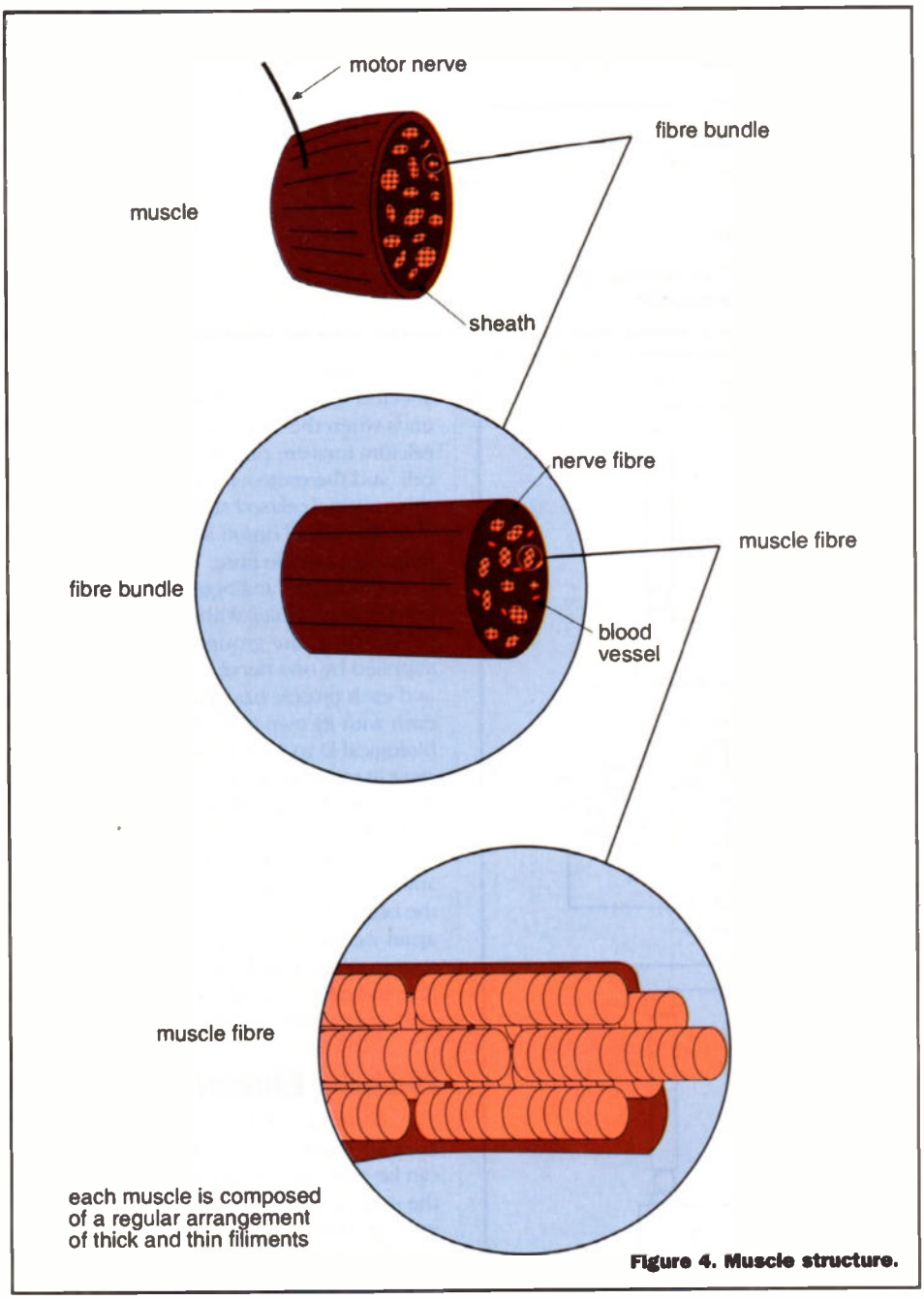


Figure 4. Muscle structure.

infinite number of positions a muscle can be in within the limits of its maximum and minimum length. However as discussed in the first part a cell can only be electrically stimulated or not stimulated, in other words it is a digital on/off two state system. So how does this translate into muscle action? Looking at the structure of a muscle shows that there are three levels of organisation (see Figure 4).

The muscle itself, which is anchored to a bone at either end by a tendon, can be considered to be a cylinder which narrows towards each end. Running lengthways from one end of the muscle to the other are smaller 'cylinders' containing bundles of muscle fibres, and each muscle fibre is itself a cylinder cell containing many smaller cylinders each of which is a tiny (1 - 2 mm diameter) thread of muscle filament. There are two types of filament, thick and thin, and within each muscle fibre many of these are grouped together to form structures which are like a series of end-to-end pistons and cylinders (see Figure 5).

However, these 'pistons' act not by pressure from the ends but by interactions between the piston outer wall and the cylinder inner wall. These interactions occur at the molecular level, each molecule acting as a miniature ratchet which moves the 'cylinders' and 'pistons' relative to each other (see Figure 6)

Each molecular ratchet can operate at around five times a second and through the combined action of innumerable pistons and cylinders the muscle contracts when stimulated by the appropriate signal from a nerve. This occurs throughout the body enabling amongst many other functions the heart beat, the ability to stand still without falling over, or if required, the co-ordination to run for a bus while carrying a bag in each hand and avoiding colliding with anyone or anything else! This gives some indication of the phenomenal complexity, sophistication and speed of information processing and control system behaviour of which the human organism is capable. An important thing to note is that muscles can only tense, or contract, whereas relaxation is a passive process that occurs when muscle tension is 'switched off'.

Taking a step backwards (so to speak!) what causes the molecular ratchets to operate? Each muscle fibre is an individual cell which can be up to 30cm long. It can be electrically excited by the transmission of the neurotransmitter acetylcholine from a nerve cell (see the section on the brain, nerve fibre and synapse action). When a muscle is inactive there are protein molecules at the end of each ratchet molecule preventing it acting as a ratchet i.e. it is a sort of molecular lubricant. When the cell is electrically excited a calcium pump, acting like the sodium pump as described in part 1 of this series, pumps calcium ions into the cell. This changes the shape of the lubricant and ratchet protein molecules in such a way as to cause the lubricant molecules to move out of the way and the ratchet action to occur, thus causing the filaments to contract, i.e. to tense the

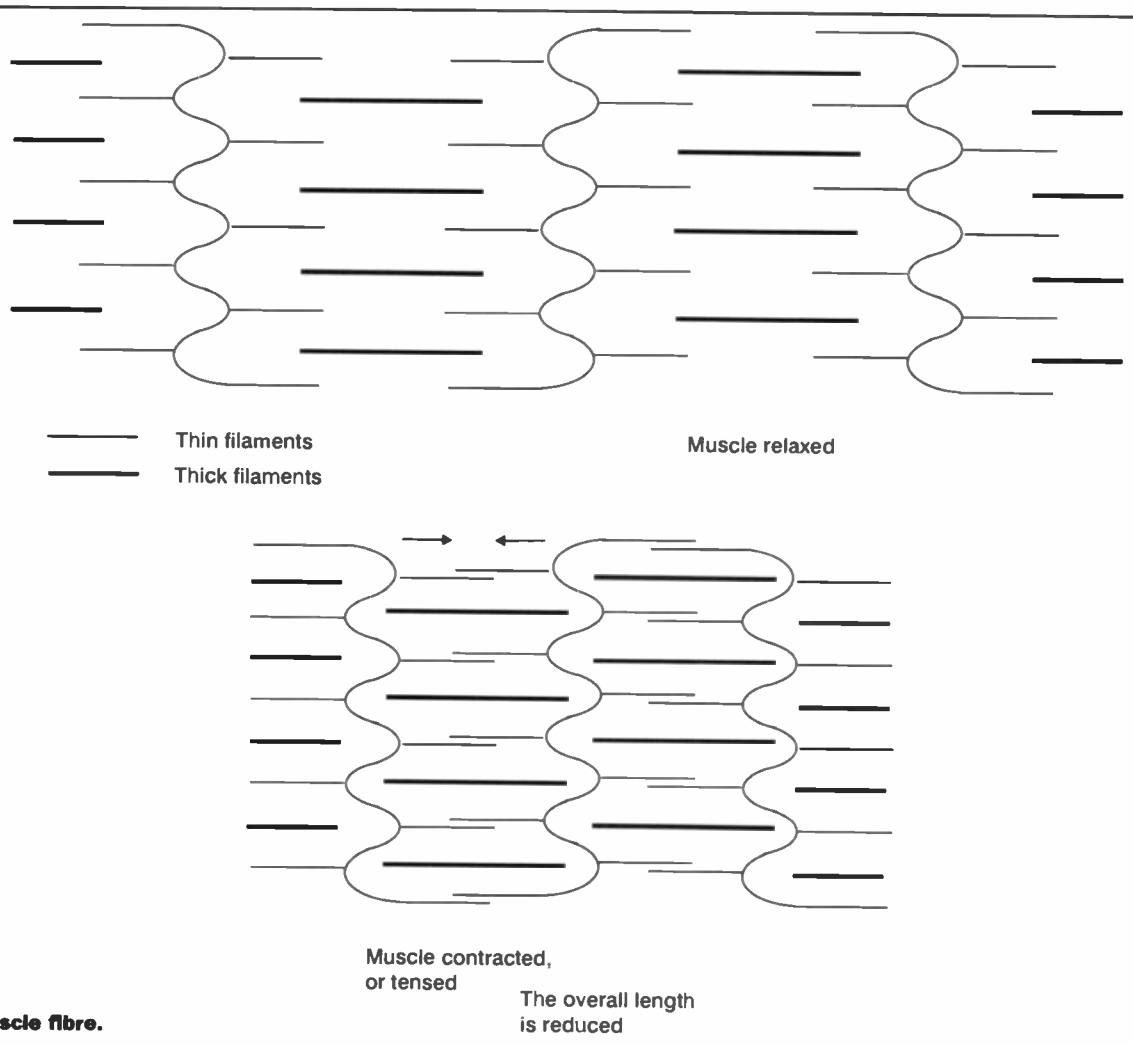


Figure 5. Muscle fibre.

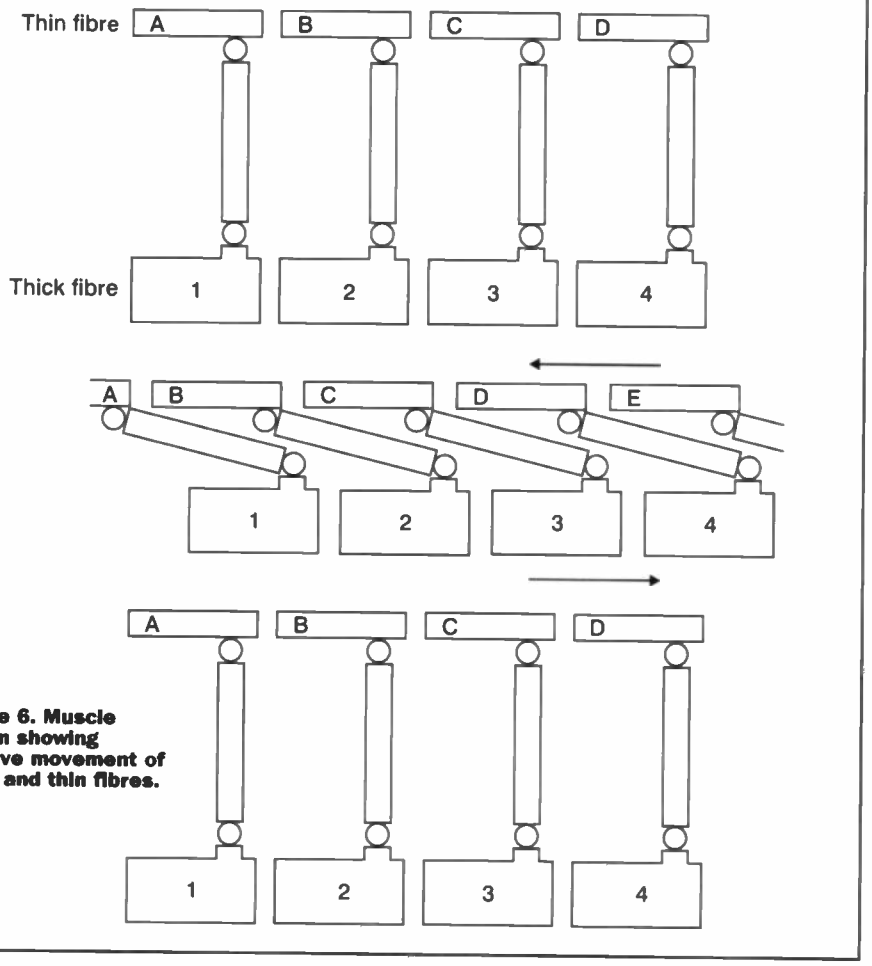


Figure 6. Muscle action showing relative movement of thick and thin fibres.

muscle fibre. All the filaments in one cell are affected by this excitation. The contraction ends when the electrical excitation ends and calcium ions are pumped back out of the cell, and the molecule filaments return to their normal relaxed shape.

So the digital on/off state applies to each individual muscle fibre. How does this translate to the 'analogue' behaviour of the muscle as a whole? Within a muscle a few muscle fibres are grouped together and supplied by one nerve, or motor neuron, and each muscle has several of these groups each with its own neuron. So this is a biological D to A converter; the degree of muscle movement or tension depends on how many nerve cells are triggered by the brain. Additionally, there are cells within the muscle which monitor the muscle tension, and this information is transmitted back to the brain via sensory nerve cells. So once again we have a control and feedback system which enables large and coarse or fine and delicate adjustments, without us even being aware of this happening.

Muscle Electrical Activity

The electrical activity of the muscle and associated cells generates voltages which can be recorded by electrodes placed on the surface of the skin over the muscle. The more physical activity there is the more electrical activity there will be. Note that if this is not due to deliberate movement or

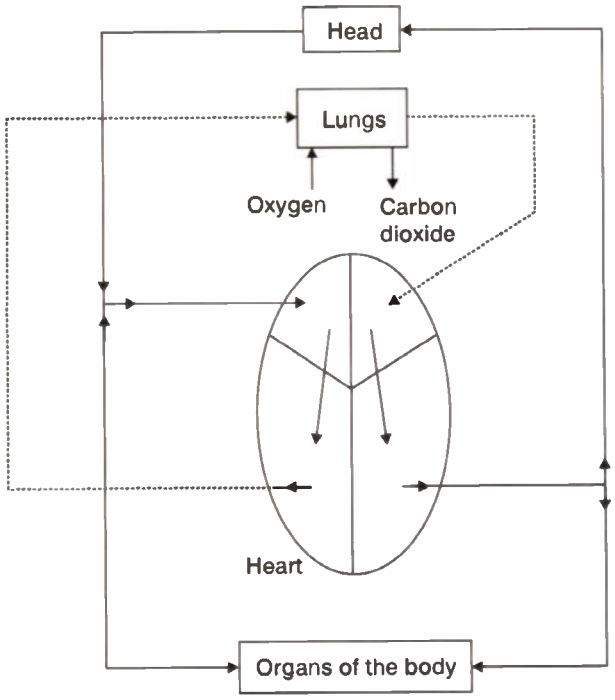


Figure 7. Blood circulation around the body.

flexing of the muscles then it must be a measure of the tension in the muscle. This muscle tension often occurs as a result of stress or anxiety, and bio-feedback can be used to train people to learn how to relax this tension, which corresponds with other relaxation techniques as mentioned in part one of this series.

The Heart - What It Does

The function of the heart of course is to pump blood around the body. The human heart is in fact a double pump allowing the blood to be pumped through effectively two different circuits, one through the lungs where oxygen is taken into the blood and carbon dioxide passed out, and one whereby oxygenated blood is sent to all the organs of the body and deoxygenated blood is returned to the heart. By having four separate chambers and valves within the heart the two circuits allow a pulsatile (the heart 'beat') unidirectional flow of blood around the body (see Figure 7).

How It Does It

The pumping action of the heart is a result of the organised contraction of the muscle tissue composing the heart wall combined with the one-way action of the heart valves. It is more or less a progressive 'squeeze' moving down the heart which pushes the blood before it and eventually out of the heart, followed by a relaxation period which allows blood to flow back into the heart. Valves ensure that the flow is only into and out of the appropriate heart chambers, veins and arteries (see Figure 8) and in the required direction.

What Controls It

A collection of 'pacemaker' cells at a point in the upper part of the heart produce a regular series of electrical pulses automatically - each pulse effectively 'kicks off' a heart beat. The progressive 'squeeze' of the muscle is controlled by electrically conducting fibres within the heart muscle fibre which channel the pulse down the outside of the heart, stimulating the muscle to contract as the pulse passes (see Figure 9).

When the pulse reaches the end of the fibre the muscles can relax until the next pulse comes along. This process occurs more than once a second throughout the life of an individual.

Monitoring

It is possible to measure the electrical activity of the heart from outside the body because the pulse is effectively a small flow of current through the heart, and this causes a small voltage to appear across the heart. This voltage can therefore be detected by electrodes at opposite sides of the heart, and since the skin is a very slightly conducting material these electrodes can be placed at the wrists. A low pass filter can be applied to mask unwanted voltages which can occur, such as the muscle voltages generated by movement. This will be examined in more detail in part three of this series.

Blood Pressure

Blood pressure is a consequence of the pumping action of the heart against the resistance to flow of the blood vessels, and so monitoring the pressure can be achieved by measuring the resistance to compressing blood vessels by for example a cuff placed around the upper arm. This blood pressure can be raised by the reaction of the body to stress and by an increased heart rate, and so bio-feedback with electronic enhancement can be used to train people to recognise changes in blood pressure caused by stress or relaxation, and thus control and lower it.

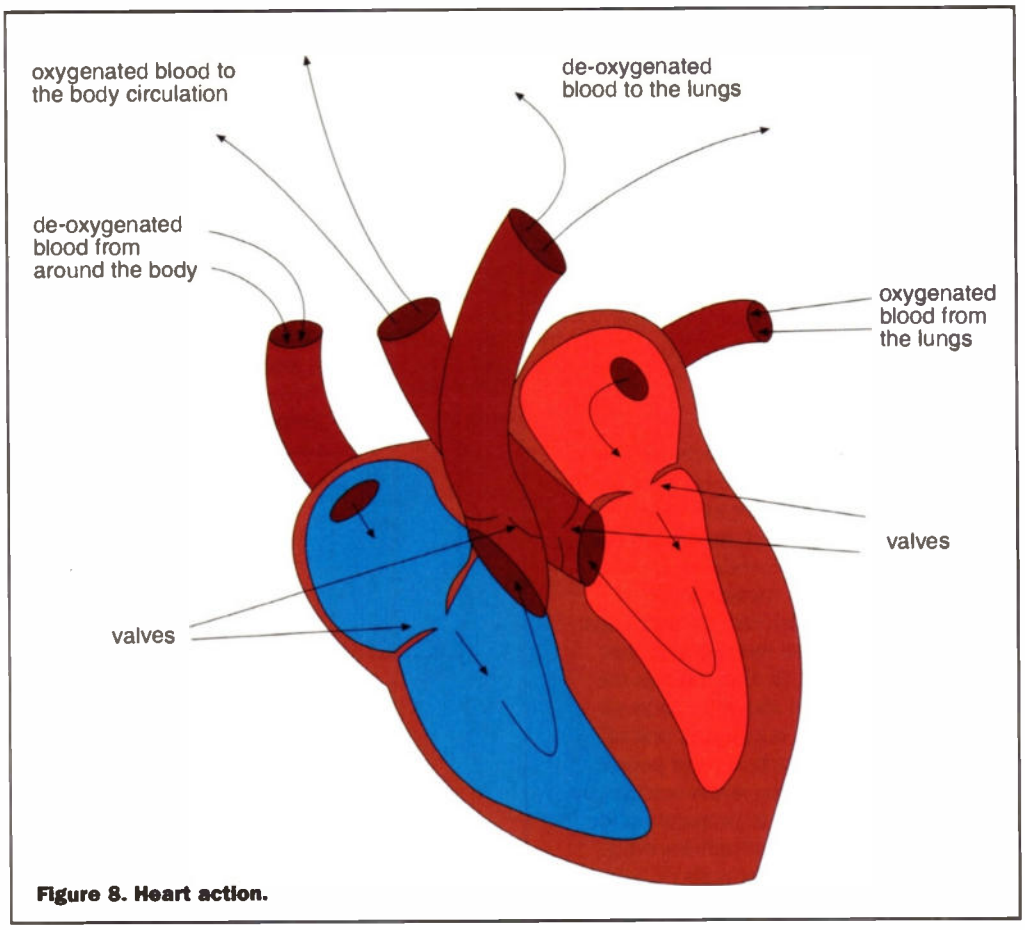


Figure 8. Heart action.

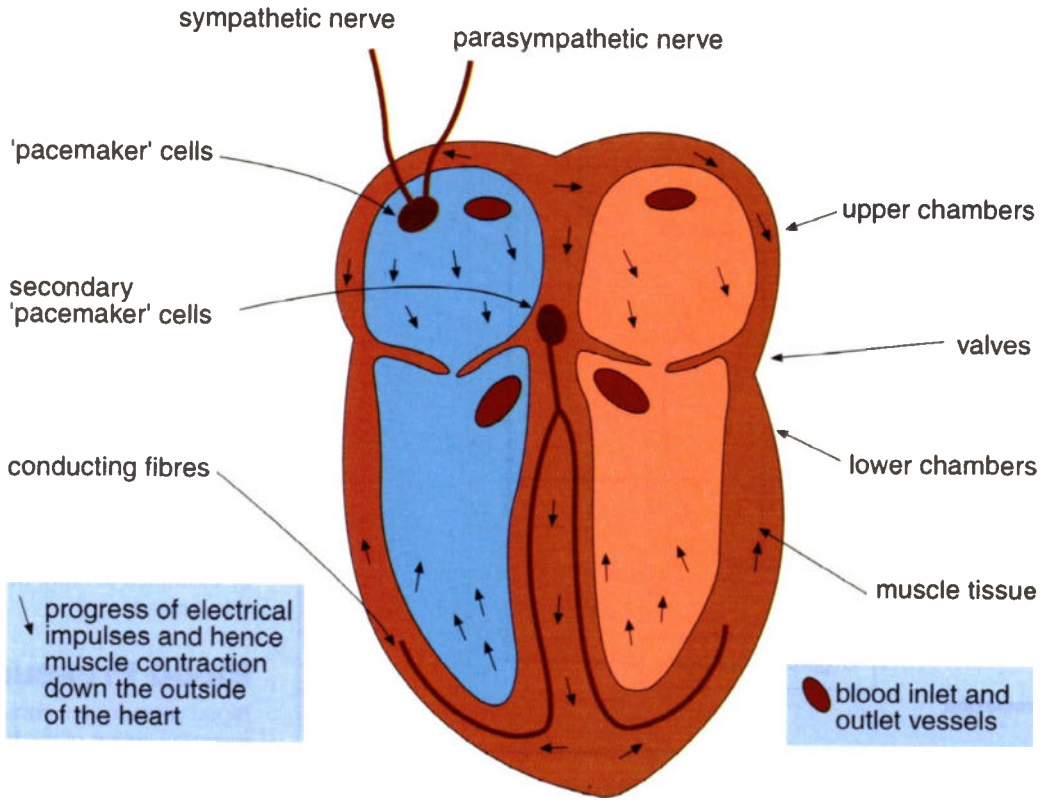


Figure 9. Heart electrical action.

Temperature Control & Skin Activity

The skin and the structures in it are the most important part of controlling body temperature in humans since they provide a large surface area through which heat loss to the environment can be controlled, once again by the positive and negative feedback mechanisms of the autonomic nervous system (see Figure 10). The main mechanisms for this are twofold. The first is by the control of the blood flow through the vessels near the surface of the skin - the greater the blood flow the greater the heat lost to the environment. The second is by the control of sweat production - the more sweat is produced the more evaporates, and this evaporation cools the surface of the skin. See Figure 11.

Sweat Control

Control of the sweat glands is achieved via the endocrine system and the nervous system. The autonomic nervous system controls the pituitary gland, situated at the base of the brain, which produces hormones which act as messengers travelling via the bloodstream to the glands which respond to those messages, in this case the sweat glands. (It also controls the adrenal glands situated above the kidneys which produce several hormones, one of which is adrenaline, which as most people will be aware increases the stress reaction by increasing heart rate etc. in preparation for 'fight or flight' as it is commonly known.)

Sweat contains many chemicals or 'salts' and so is a highly electrically conductive

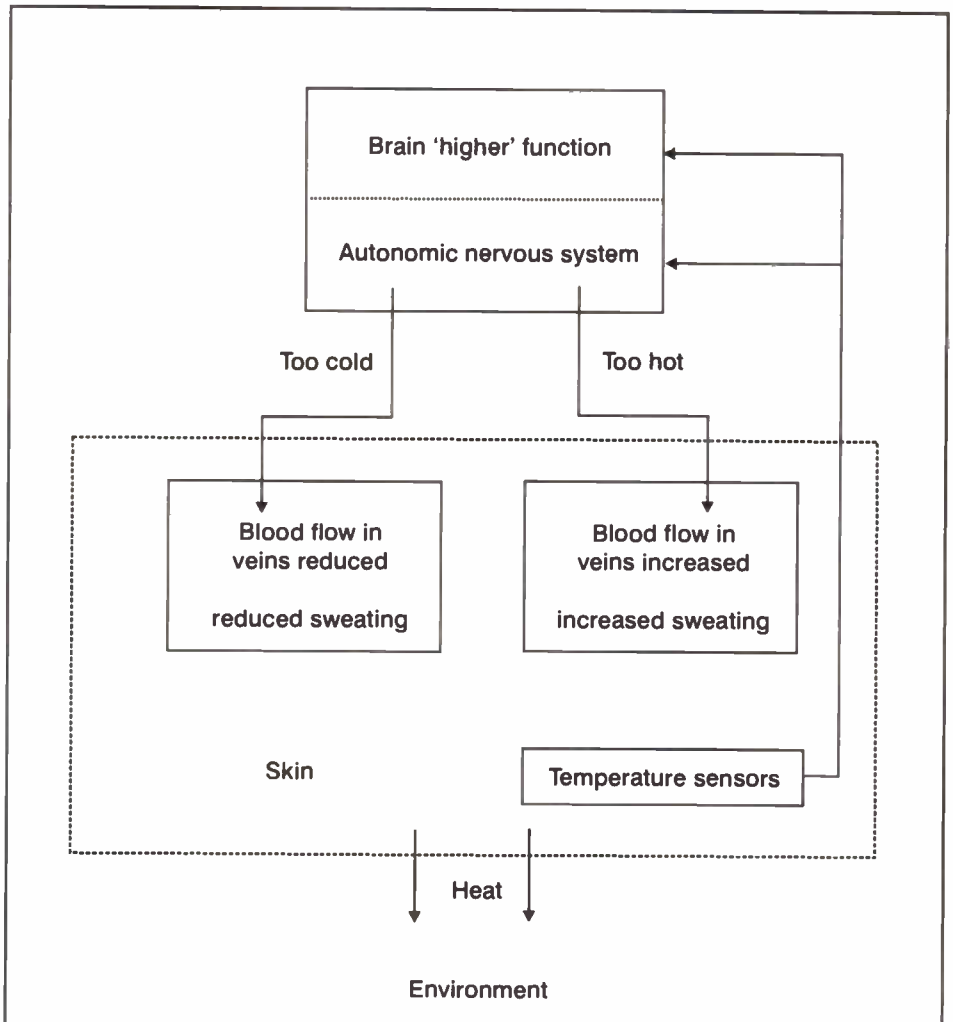
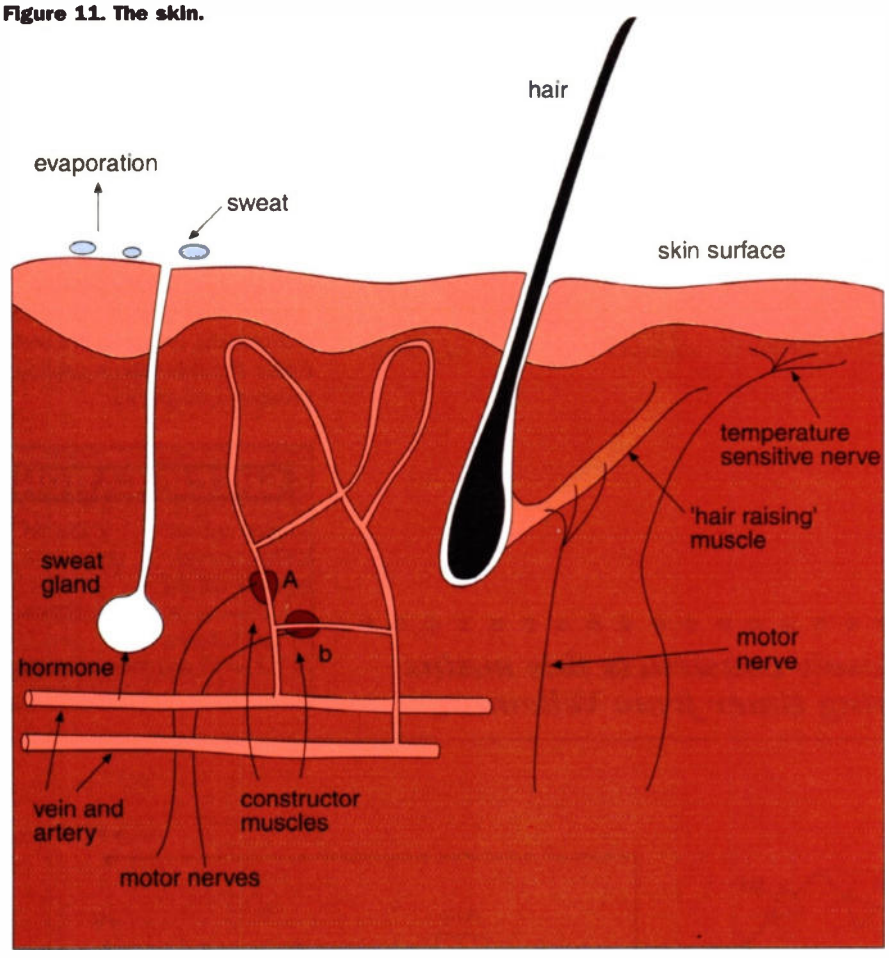


Figure 10. Temperature control.

Figure 11. The skin.



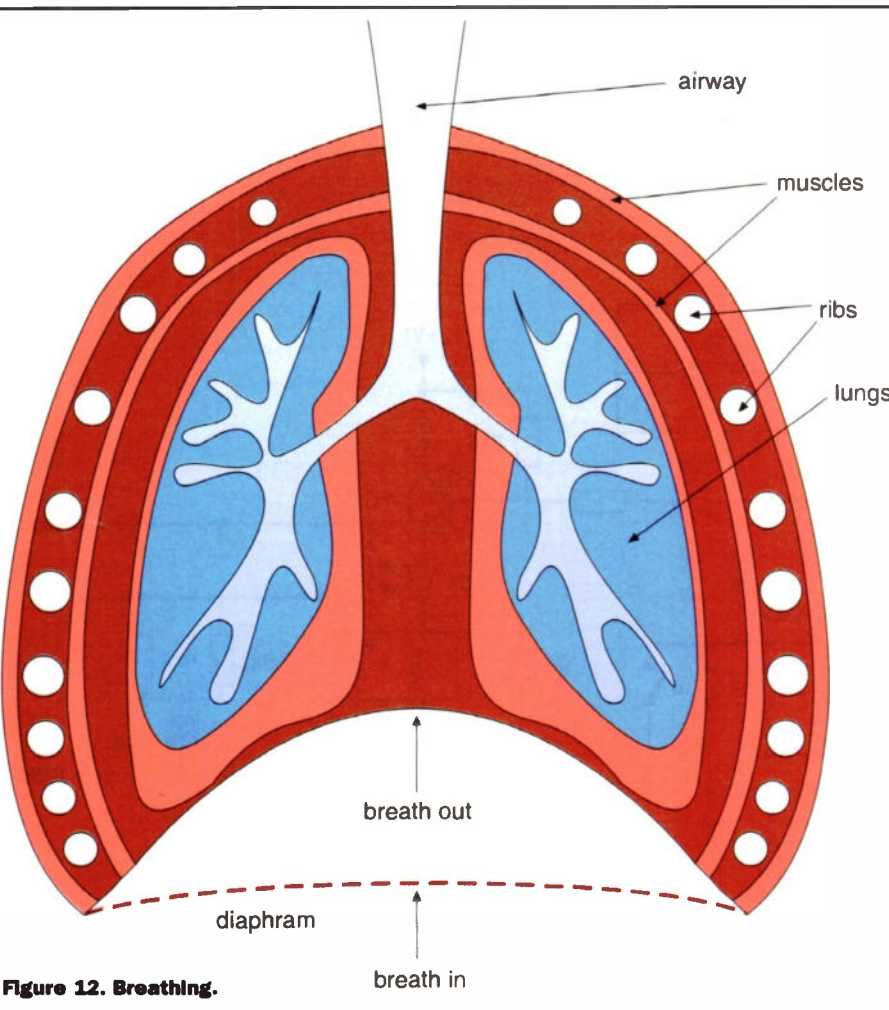


Figure 12. Breathing.

solution. Thus increased sweat gland activity is easily detected by measuring the change in skin resistance, and this is a valuable parameter for bio-feedback training.

Skin Blood Flow Control

This is achieved by control of the constrictor muscles shown in the diagram of skin structure (Figure 11). By constricting A and relaxing B, flow to the surface is bypassed and heat is retained. Conversely by relaxing A and constricting B blood flow is directed to the surface and heat loss occurs. These temperature changes are easily detected by temperature sensors on the skin surface and provide further useful bio-feedback information.

Respiration - Breathing

Breathing is a passive process in that the lungs aren't active in drawing in or exhaling air. Once again it's under muscle control, in this case the muscles of the diaphragm and around the rib cage (see Figure 12).

The diaphragm is a sheet of muscle which is a dome shape when relaxed. When it contracts it becomes flat which increases the volume inside the chest, which in turn causes air to be drawn into the lungs where oxygen and carbon dioxide are exchanged. When the muscle fibres relax the diaphragm returns to its original shape and air is pushed out of the lungs. If breathing is calm and steady usually only the diaphragm is involved, and the ribs move, i.e. the chest expands and contracts, passively as a consequence of air moving in and out of the lungs. However there are also sheets of muscle on the inside and outside of the ribs. When the muscles on the outside contract the rib cage is forced upward and outward, thus drawing air into the lungs, and when the muscles on the inside contract the rib cage is forced downward and inward, thus forcing air out of the lungs. These muscles are mostly involved in deliberate or forced breathing, so it's easy to see how they are candidates for responding to bio-feedback monitoring when rapid or shallow breathing are occurring as a result of stress or anxiety. Measuring respiration is a simple process involving monitoring the expansion and contraction of the chest wall which as we will see in the third part of the series can be done by using a system which in a way mimics the action of the process it is monitoring.

Next Part

The monitoring of all these activities can be broken down into two parts; those involving electrodes which monitor electrical activity directly, and those involving sensors that monitor some other parameter and then convert this to an electrical signal. In the third part of this series I'll be looking at the equipment and techniques that are used for this monitoring, and at how the measured signals are modified and presented in order to provide the necessary bio-feedback information.

PROJECT

Velleman Mini Kits

0 TO 60 HOUR START/STOP TIMER

John Mosely constructs this mains switching timer from Velleman.

This long duration timer offers many possibilities, especially in security and lighting applications such as a stairwell etc. Other suitable applications include audio recordings, and a dark room timer. The unit is designed to switch 230V 5A appliances, with 'course' timing set by DIP switches with 'fine' timing set by a potentiometer. Two push buttons are provided to start the timer and, if required to stop the timed sequence. The circuit diagram is shown in Figure 1.

The timer can be operated either from the mains, or from a low voltage ac supply - 24V ac 50mA. In the latter case, C7 is shorted out. The start/stop switches can be removed and replaced by open collector transistor outputs. This can be the 15-channel infrared receiver from Velleman the K6711 kit (Maplin Order Code VE77Q). An idea for this arrangement is shown in Figure 2.

It may be possible to mount the timer boards in to one of the PSU boxes with plugs available from Maplin, such as code **YU31J**, or alternatively, the free standing type such as **YU32K** might be preferable. Whatever type of enclosure you select please remember that you are dealing with mains so exercise the greatest care and follow the rules about cabling, insulation, fusing etc.

SPECIFICATION

Relay output:	230V 5A
Timer range:	3s to 60h
Power supply:	
220V ac or 24V ac 50mA	
Push buttons:	
2 (start and manual stop)	

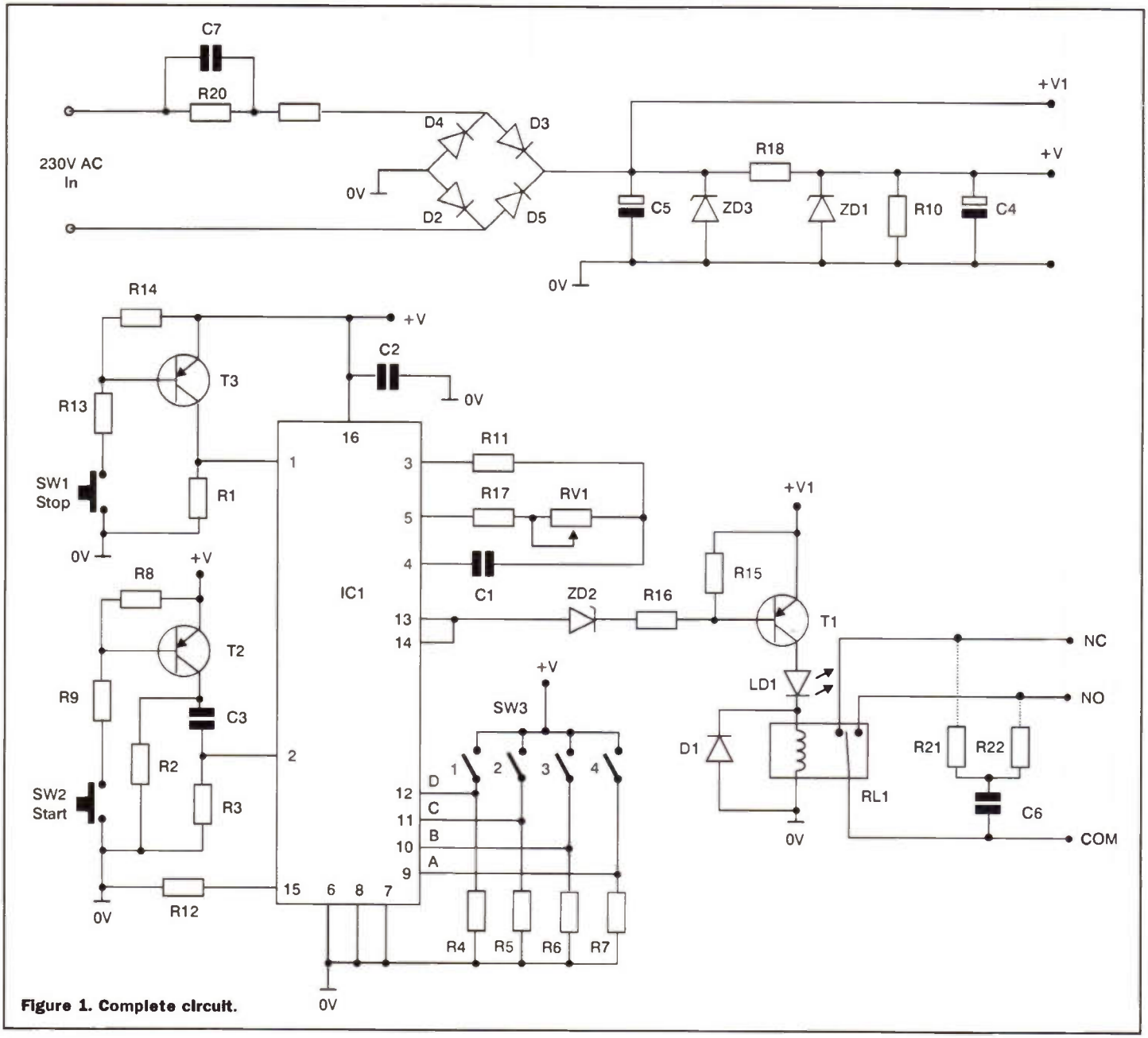


Figure 1. Complete circuit.

Construction

The timer is constructed on two separate boards - one carries the low voltage timing circuit, and the other carries the mains/power supply input, suppressor network and relay.

The relay module board is constructed first. Because the boards are small, the components are closely packed together, so some parts are mounted vertically. Start with R18, the diodes and Zeners, remembering to observe the correct polarity when inserting these components in the relevant holes. R19 and 20 are mounted vertically. If you intend to operate the timer from a 24V ac transformer (which you must do if you intend to use control stop/start from open collector transistor output), then a wire link is used for C7. If it is intended to operate from mains then insert C7. Finally fit C5 (observe polarity) and the 24V relay.

Now fit capacitor C6 vertically, and solder into the board. You will now have to decide whether you require to use 'NC' or 'NO' operation. For 'NO' mode fit R21 vertically, and solder into the board, connect the non-soldered end to the non-soldered end of C6 and neatly solder together. If you require 'NC' operation do not use R21, but in the R22 position. Note that R21 and R22 have the same value.

Velleman point out that for small loads it may be necessary to fit a lower value for C6 e.g. 22nF/400V, otherwise the voltage across the load may take some time to drop to 0V when the relay is switched off.

Finally, fit the LED which, depending on the style of enclosure used, may be at a particular height above the board, or even remote and attached to the enclosure.

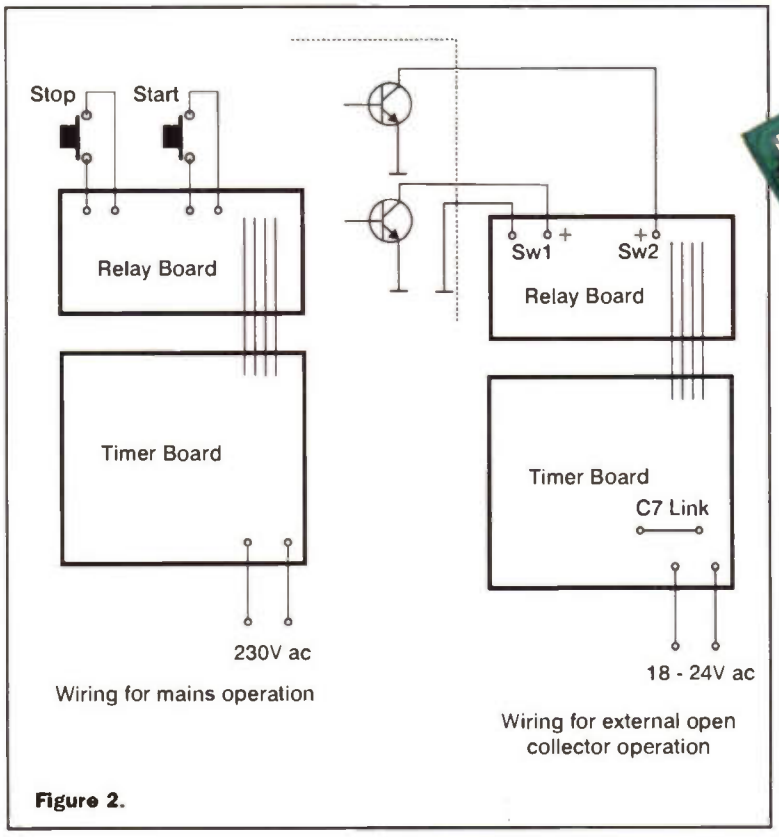


Figure 2.

Timer Module

Again, this board is compact and all the resistors except R16 are mounted vertically. Start by mounting the small components, followed by the IC1 socket, capacitors and the DIP switch - do not allow the DIP to get too hot otherwise it may be damaged. Now solder in the trimmer RV1.

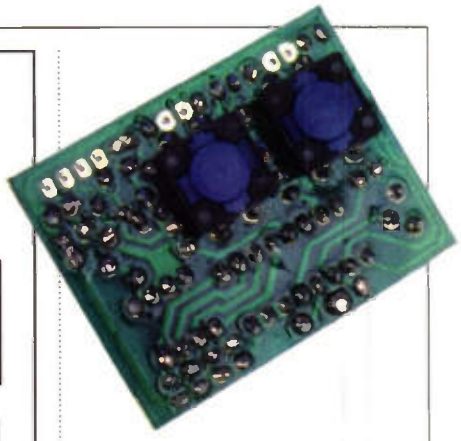
When mounting these components, in particular T2, R13, R14 and T3, make sure that the leads are as short as possible, after soldering on to the board, as the two push switches, SW1/2, are mounted on the track side of the board. As with the DIP switch, do not apply excessive heat when soldering the switches to the board as they can be easily damaged. Depending on your choice of enclosure, you may wish to mount the switches remotely.

Now fit the IC (CD4536) in to the DIL socket and using either ribbon cable or four individual leads (5cm long approx.), connect the points 'RY', '-', 'V', '+' on each board together.

Important Safety Note

Remember this is a mains powered project so exercise extreme care, if in any doubt, ask a suitably qualified electrician.

SW3 Setting 1	2	3	4	Time Range
OFF	OFF	OFF	OFF	2 - 8sec
OFF	OFF	OFF	ON	5 - 15 sec
OFF	OFF	ON	OFF	10 - 30 sec
OFF	OFF	ON	ON	25 - 60 sec
OFF	ON	OFF	OFF	50 - 110 sec
OFF	ON	OFF	ON	1.5 - 3.5min
OFF	ON	ON	OFF	3 - 7.5min
OFF	ON	ON	ON	6.5 - 15min
ON	OFF	OFF	OFF	13 - 30min
ON	OFF	OFF	ON	25 - 60min
ON	OFF	ON	OFF	50 - 120min
ON	OFF	ON	ON	100 - 240min
ON	ON	OFF	OFF	3.5 - 8h
ON	ON	OFF	ON	7 - 16h
ON	ON	ON	OFF	14 - 32h
ON	ON	ON	ON	27 - 64h



Testing

With the DIP switches 'OFF' adjust RV1 to mid range. Connect to the mains or a 24V ac supply, depending on your configuration. Remember that if you use 230V ac, then parts of the board are at this potential, so take the utmost care. It is advisable that the boards are mounted in a suitable enclosure to reduce risks. Carefully press the start button, and check that the relay operates and the LED lights. After a few seconds the relay should de-latch. Repeat the test, but this time press the stop button immediately after the start button to check that the relay again de-latches.

Adjusting

Adjustment is best set on the shortest time range, because as every you move up a range the time setting doubles. RV1 will set for fine adjustment. So if you set for four seconds on the shortest range and then set for the next range up, the time setting will now be eight seconds.

The unit works well and offers several possibilities. I often record items from the radio for playback later - some plays for instance last nearly 90 minutes, and this offers an excellent way to record such programs. ELECTRONICS

Maplin Order Code VF08J Price £14.99

0 TO 60 HOUR START/STOP TIMER PARTS LIST

RESISTORS

R1,2,3,8,14,18	1k Min Res
R4 - 7,9-13,15,16	10k Min Res
R17	180k Min Res
R19	220R Min Res
R20	100k 1W
R21,22	220R
RV1	220k

CAPACITORS

C1	22nF
C2, 3	100nF
C4	10µF 35V
C5	100µF 25V
C6	100nF 400V
C7	470nF 400V

SEMICONDUCTORS

D1	1N4148
D2, 3, 4, 5	1N4007
ZD1,	215V Zener 500mW
ZD3	24V 1.3W Zener
T1, 2, 3	BC557
IC1	CD4536
LD1	Red 5mm LED

MISCELLANEOUS

RY1	24V Relay SPST Contacts 230V 5A	
	16-pin DIL IC holder	
SW1, 2	Push-to-Make Switches	2
SW3	4-pole DIP Switch	
	PCB pins	5

Easy Web Page CREATION

PART 1

In part 1 of this new series, Mike Holmes introduces HTML, and helps you to create your first web page.

```
<!DOCTYPE HTML PUBLIC "-//SQ//DTD HTML 2.0 + all
extensions//EN">
<HTML>
<HEAD><TITLE>New Page</TITLE></HEAD>
<BODY></BODY></HTML>
```

Figure 1. The minimum required coding for an HTML document.

Getting Your Own Web Site

To be able to use a web browser and put your own HTML documents and images on the Web, you must first have access to an account with an *Internet Service Provider* (ISP). For the purposes of this discussion let us assume you have a PC with modem, subscribe to an ISP and have an E-mail account, with the ability to send and receive electronic mail.

In addition, your ISP has very likely provided you with one of the proprietary browser programs, with which you can access the *World Wide Web* (WWW).

Originally, ISPs were government and university organisations, but nowadays most are commercial sites, where anyone can have access or businesses can put their information onto the Web. In recent years a trend has seen many ISPs providing free Web space on their servers along with the basic E-mail service, so that subscribers can put up their own HTML documents, or Web pages - in short, create their own *Web Sites*.

Reasons For Wanting Your Own Web Site

For creating files that can be read by browsers (such as NCSA *Mosaic*, *Netscape Navigator*, and Microsoft's *Internet Explorer*) that are connected to the Web then a particular format has to be followed. The file format is called HTML *(HyperText Markup Language)*.

Most private users, or 'amateur webmasters', usually have a Web site for the sole purpose of airing their own personal interests or hobbies to a World-wide audience. It automatically follows then that this is also likely to generate feedback from readers and ensuing discussions by E-mail.

For anyone who has not yet encountered 'The Net' in any of its forms, the nearest analogy I can think of to describe the 'ownership' of a Web site is that it is like having your own personal glossy magazine that costs next to nothing to produce, has a world-wide distribution, is read by others for the lowly price of a local telephone call and is never out of print!

'Netiquette'

You can even advertise on your Web site. Indeed this is much preferred over the option of 'mail-bombing' Usenet newsgroups (discussion or 'chat' forums), which is universally construed as a cardinal sin. The Net has been around long enough to evolve a set of rules governing its usage, if slightly illogical in places, and which is colloquially referred to as 'Netiquette' *(etiquette for the net)*.

It extends, if slightly modified, to the Web, so you should find out what the rules are regarding your proposed use of your new Web site - your ISP should have an *Acceptable Use Policy* or similar set of rules defining how your Web space ought to be used, and things they may not want you to put on it and so on.

Standards For HTML Mark-Up

Before you can upload pages, however, you need some pages to upload! Any text editor can create an HTML file; it is basically raw ASCII. Browsers open files that consist of literal ASCII text including what's called mark-up, and from this do things like screen formatting, generating graphical forms, issuing mail messages, displaying pictures and so on. However, it's important to understand that the different browser programs do things in slightly different ways.

Consequently, it will become your responsibility as an HTML author to create correctly marked-up documents that each browser type can interpret properly. Some may be able to anticipate what you want

```
<!DOCTYPE HTML PUBLIC "-//SQ//DTD HTML 2.0 +
all extensions//EN">
<HTML>
<HEAD>
<TITLE>Main</TITLE></HEAD>
<BODY BGCOLOR="white" TEXT="black" LINK="navy"
VLINK="purple" ALINK="red" LEFTMARGIN="10"
TOPMARGIN="10">
<CENTER>
<H1><FONT FACE="Times New Roman"
COLOR="blue">This is the page called
'Main'</FONT></H1>
</CENTER>
<HR>
<P><FONT FACE="Times New Roman" SIZE="+1"
COLOR="black">This is a paragraph element
containing some text.</FONT></P>
<DIV ALIGN="RIGHT">
<P><FONT FACE="Times New Roman" SIZE="+1"
COLOR="black">This is going to be a hypertext
link to Page 2</FONT></P>
</DIV>
</BODY></HTML>
```

Figure 2. Adding text formatting instructions to a basic document.

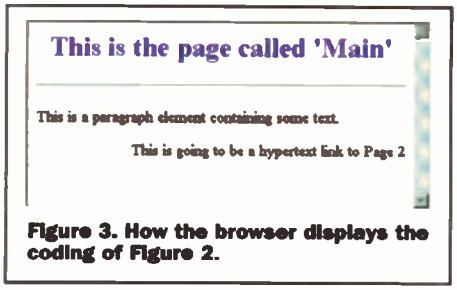


Figure 3. How the browser displays the coding of Figure 2.

them to do from sparse or incomplete code, others may not. It's an important issue because HTML documents are more easily interchanged, that is, displayed by different people using different browsers, when they *conform* to an agreed standard of format.

HTML Format

The standard HTML format is based on the *Standard Generalised Markup Language* (SGML), all HTML files are SGML files. However, the converse is not true as there are several other formats described by SGML, so most SGML files are *not* HTML).

It's easy enough to study the HTML content of any Web page - the popular browsers have a menu option (usually called 'View Source' or similar) that lets you see the HTML format of the displayed page. Moreover, you can save it to hard disk as a permanent copy for later reference.

If, while 'Surfing the Web', you see a page that contains a typographical effect, form, etc., that you like, then the easiest way of achieving the same thing yourself is to save the file with the browser (make sure it is in HTML format) and then open it in a text editor and find out how it works. Be aware though that some files may have incorrect markup, and that graphic images are not saved with the file, because they are stored as *separate files* on the server.

Note also that while the document markup itself is not copyright, the text content and images may be. This is a separate issue which we will examine later.

Required Tools

No special software is needed to make HTML pages, as initially, all you need is a PC, a word processor and a WWW browser. The word processor can be any one of your choice, but must be able to save plain ASCII text files. Some utility word processing applications, such as that provided with Microsoft *Office 97*, for example, are 'HTML aware', meaning that they may be able to help you when it comes to making hypertext links and so on. Otherwise a plain ASCII editor is more than capable; in the absence of anything else Windows *Wordpad* is adequately competent.

The second tool required is a WWW browser, to be used as a viewer to show how the page is developing as you write it. It can remain open side-by-side with the editor for the duration with the same page loaded, and when you switch windows to see the changes, you force it to show the latest edits through its reload or 'refresh' option.

Minimum Required HTML Format

According to the accepted standards for HTML markup, a Web page document must at the very least consist of:

- The document prologue identifier

- An <HTML> element 'wrapper', enclosing:
- A <HEAD> element 'wrapper', enclosing:
- A <TITLE> element
- Followed by a <BODY> element 'wrapper'

In the above, 'wrapper' is jargon meaning that the element has both opening or starting, and closing or ending - parts between which something else is contained. So in its simplest form an HTML document looks like that in Figure 1.

Although many Web authors omit it, the first line is actually required and specifies the HTML language level; the above example is just one of the various valid configurations.

A title also is always required, not only because the browser invariably displays it in its window title bar, but also because it is added to its internal history list, that is, a list of the pages recently loaded. It is this list that is browsed by the browse buttons, and if missing, a sequence number is assigned which is largely meaningless.

Naming Of Saved HTML Files

HTML documents are recognised as such by browsers through the filename extension of '.htm'. With the advent of 32-bit operating systems allowing the use of long file names (longer than the original IBM '8.3' character count limit), the extension can also be '.html'.

Apparently, adoption of the latter is favoured in teaching circles (students of HTML authoring courses are told to use '.html'), but whichever you choose you should apply your own standard of sticking to one or the other for all your own pages.

Another important consideration is to avoid using spaces in the main part. The reason is because spaces in URLs (*Uniform Resource Locators*, see below) are not allowed. So either the browser or the server software will translate spaces to their hexadecimal character representation, hence 'My First Page.htm' becomes 'My%20First%20Page.htm'. In theory this shouldn't be a problem as both systems should resolve the real name; in practice, however, some client software has difficulty with it and subsequently can't load the page.

The evolved consensus is therefore to substitute all spaces in file names for the underscore character, i.e. 'My_First_Page.htm' is acceptable in all eventualities of server/client interface.

Except - that many Web servers are mainframes, typically running the UNIX operating system. Where the IBM PC et al is not case sensitive regarding file names - they are recognised as being the same whether written in upper or lower case or a mix of both - the UNIX operating system is case sensitive.

More commonly than not, the practice is for server side file names to be written all in lower case. Consequently, while a browser running on an IBM PC makes no distinction between 'My_First_Page.htm' and 'my_first_page.htm', to the UNIX based server software they are very different things. Hence if you have a hyperlink jump on a page to 'My_First_Page.htm', but the server has it stored under 'my_first_page.htm', it will come back with 'File Not Found'.

Therefore all new HTML documents should be saved with all lower case file names to avoid such confusion.

Making Your First Page

Open a new document in your text editor, and type the minimum layout shown in Figure 1. When you have done this you can save it as say 'template.htm' (in plain text or ASCII, remember), in other words a template you can use as a basis for all further pages. Later on, you will be able to add extra basic features to the template, such as <META> elements, that new pages derived from it will automatically 'inherit.'

For now, create a real page by changing the title to read 'Main', and saving the template as 'main.htm'. This page can now be opened in the browser.

As far as the browser is concerned, at this stage the page is a local 'client side' file, not a 'real' Internet file on the real Web. Yet, you can type its URL into the 'Address' or 'Location' text input area at the top of the browser window as you could for any other known Web site page.

Suppose this page is saved in 'webpages', a sub-folder of local hard disk 'c:'. The typed URL takes the form: **file:///c|/webpages/main.htm**

The browser loads and displays the page, but which isn't very interesting to look at, as it doesn't contain anything.

Everything that is to be displayed on a page must be put in the <BODY> element wrapper (nothing contained in the <HEAD> element is displayed). So to show some text on the page it needs to be put into the <BODY> element.

Furthermore - regardless of whether it actually might work or not - the HTML standard requires that text be enclosed in a further element wrapper placed within the <BODY> element, since <BODY> can contain all sorts of other elements apart from text. The most basic text wrapper is the <P> (for 'paragraph') element.

Switch back to the editor window and split the '<BODY>' and '</BODY>' parts with a couple of carriage returns. Below '<BODY>' write: <P>This is the page called 'Main'</P>. Press 'Enter' again, and follow with: <P>This is a paragraph element containing some text.</P>; and then again <P>This is going to be a hypertext link to Page 2</P>.

Exploring Things To Do With Text

After saving, switch to the browser and force it to reload the page with 'Refresh' (or 'Reload'). At least it shows some words now, but the overall effect is still not very stimulating.

Time to exercise some of the more interesting text formatting elements. To cut a long process short, Figure 2 summarises a total number of these modifications to the page 'main', shown in red. Which of these do you think may be usefully added to the template? (Clue: BODY element 'attributes'.)

The result should redisplay in the browser something like Figure 3.

Important: beware the <FONT> element. Some authors, because they have 'fancy fonts' installed on their machine, tend to specify these because they are prettier. Unfortunately the actual font is not carried across to the client machine doing the viewing, and cannot be in the normal course of events, because the transfer of fonts over the Web comes under a group of file types for which there is no ready mechanism for automatic downloading, for security reasons (in case a virus is attached or something like that). Explicitly specifying a font that the client may not have is a common mistake made by budding HTML authors!

Hence, you cannot assume that the client machine has the same fonts as your machine uses. If the browser cannot match an explicitly defined font, it resorts to its own default as defined in its settings. If you know that your pages will be viewed on (another) IBM compatible PC having MS Windows and with all the standard Windows fonts installed, then you could explicitly use, say: FONT FACE="Arial", with a good chance it will appear as such. But if the client happens an Apple Mac it may not know what 'Arial' is.

Therefore the FONT FACE attribute also allows for a comma separated list of alternatives to be defined. Thus, if you specify 'Arial' but it turns out the client is an Apple Mac, then you could add the nearest equivalent to Arial that a Mac is most likely to have, i.e. FONT FACE="Arial, Helvetica, Univers".

The browser will use the first name in the list that matches an installed font, so that although the client has Helvetica, if it has Arial as well, then Arial will be used.

If a 'fancy font' is especially desired, the accepted way of doing it is to provide it as an image. It looks like text, but actually it's a picture - more about which we must leave until Part 2.

Text Formatting Elements Summary

The following are used for the formatting of text within a HTML document. They must all be placed within the BODY element. To combine their effects, place them inside each other.

A complete HTML language reference can be found at: **http://www.mc-h.demon.co.uk/maplin/glossary.htm**

You can also find some useful free downloads, such as the latest Microsoft Explorer 4.01 & Netscape Navigator 4.0 at: **http://www.mc-h.demon.co.uk/maplin/mapindex.htm**

<H1 - 6> ... </H1 - 6> - Six sizes of heading
<HR> - Horizontal Rule
<P> ... </P> - Paragraph
<B> ... </B> - Bold text
<I> ... </I> - Italic text

 - Force a line break
<NOBR> - Specifies that words aren't to be broken
<WBR> - Specifies that a word is to be broken if necessary
<FONT ...> ... </FONT> - Set or change font size, colour and/or name
<BASEFONT SIZE=...> - Specifies the 'default' font size for the document
<CENTER> ... </CENTER> - Centres text on the page
<DIV> ... </DIV> - Division - allow centring or left/right justification of contents
<PRE> ... </PRE> - Use text already formatted
<BLOCKQUOTE> ... </BLOCKQUOTE> - Quote text from another source
<PLAINTEXT> - For text formatting

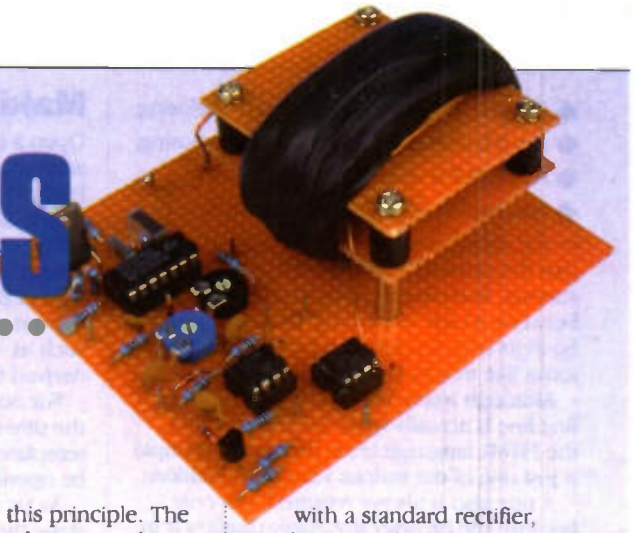
Until Next Time

In Part 2 we shall discuss how to make 'anchor' hypertext links, include inline images and how to begin uploading finished pages to your new web site, plus why you first need an 'index page' to do so. In the meantime, practice writing syntactically correct HTML, getting used to using the text formatting instructions. Think about the design of your first homepage and when next online, study other people's home pages for some ideas.

PROJECT

MAGNETOMETERS

PART 2



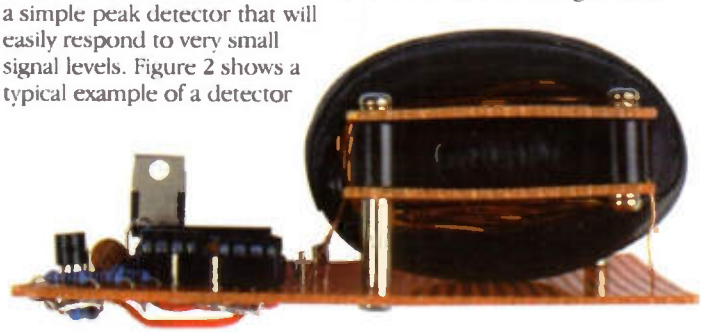
In part 2, Gavin Cheeseman gets down to some construction.

In part 1 we looked at some of the principles involved with measuring magnetic fields. This time, we take a more practical approach and look at some experimental circuits. The circuits illustrated are intended to provide a starting point and are therefore not fully optimised. They may, however, form the basis of a number of different control and measurement circuits.

Detector for Alternating Magnetic Fields

As discussed in last months article, probably one of the most effective detectors for alternating or transient magnetic fields is a coil of wire. When properly constructed this type of arrangement works very well but to measure alternating fields, the coil must be connected to an oscilloscope, multimeter or other device allowing the direct measurement of AC voltage. For many applications a DC voltage output would be much more useful.

Probably the easiest way to convert the AC output of the coil into a DC level is to use simple diode rectifier as shown in Figure 1. However, this method has the disadvantage that the output level from the coil must be enough to forward bias the diode on peaks. As a result, a simple rectifier is of very little use at small signal levels. In order to circumvent this problem an operational amplifier can be used to create a simple peak detector that will easily respond to very small signal levels. Figure 2 shows a typical example of a detector circuit using this principle. The output of the detector coil is fed to the input of operational amplifier IC1. Diodes D1 and D2 help to prevent overload, while rectifier diode D3 effectively forms part of the feedback loop of the op amp circuit. As a result, the op amp compensates for the voltage drop across the diode when it is forward biased. The output from the diode charges C3 as with a standard rectifier, and R1 provides a discharge path for the capacitor to prevent it from remaining charged for long periods. The DC voltage present at the cathode of D3 approximately corresponds to the peak voltage of the AC waveform produced by L1. Although this voltage can be used to drive a high impedance circuit directly, it is generally preferable to use a buffer and operational amplifier IC2 is used for this purpose.



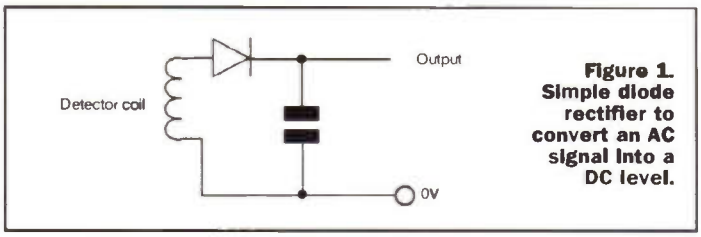


Figure 1. Simple diode rectifier to convert an AC signal into a DC level.

It should be pointed out that the output voltage produced by this type of coil based detector is heavily dependant on the coil dimensions and the frequency of the field being measured. The coil may be air spaced or wound onto a suitable core.

Construction

The circuit can be built on matrix board, or even on breadboard if for purely experimental purposes, and is relatively straight forward to construct. The layout of the circuit is not particularly critical. As with most analogue circuits it is best to keep wiring runs as short as possible.

The coil dimensions depend on the application. For general relative measurement of low frequency alternating magnetic fields such as those related to AC power lines up to audio frequencies a few hundred turns of wire on a small ferrite rod are quite effective. Depending on the application it may be necessary to provide some screening around the coil to prevent the circuit from responding to ambient radio frequency signals which may affect the output voltage. Where this is the case a screening material that has minimal affect on the magnetic flux density must be used. It goes without saying that metals containing iron and other ferromagnetic materials are unsuitable for this purpose.

The speed at which the circuit will respond to changes in input level is for the larger part determined by the values of R1

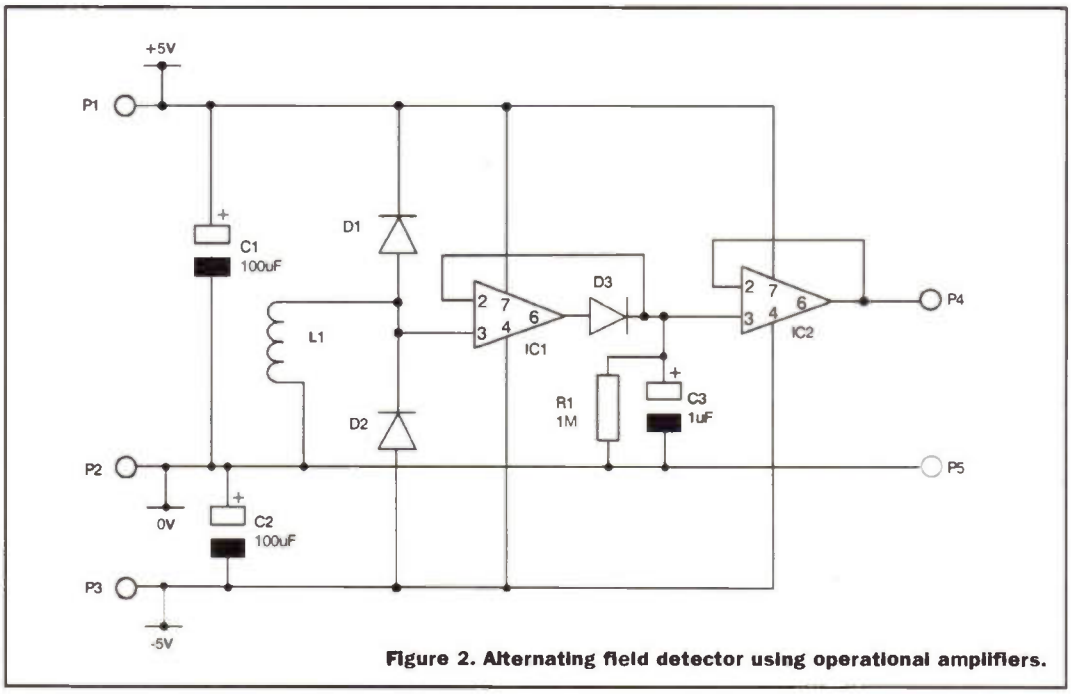


Figure 2. Alternating field detector using operational amplifiers.

and C3. Lower values provide a faster response but with the trade off that at low frequencies a considerable amount of ripple may be present at the output.

Measuring a Static Magnetic Field

Hall effect devices provide a simple method of measuring the magnetic flux density of a static magnetic field such as that produced by a bar magnet where the magnetic flux density is relatively high. Devices such as the UGN3503U are simple to use and are completely self contained requiring little or no additional circuitry to function. Figure 3 illustrates just how simple it is to connect and use these devices. The output is in the form of a DC voltage proportional to the magnetic flux density. Readers wishing to experiment with these devices are recommended to refer to the manufactures data sheets before commencing construction.

One use for this type of device is in a volume pedal for use with electric guitars and other electronic musical instruments. In this application the output of the Hall effect IC is used to control a voltage controlled amplifier. Another application is positional sensing.

A Sensitive Magnetometer

For some applications, for example when measuring the earth's magnetic field, a more sensitive detector is required. A large coil of wire can be used to detect extremely small variations in magnetic flux density; however, to obtain good sensitivity, it is necessary to use a coil of relatively large dimensions. This arrangement also has the disadvantage that it will only respond to changes in flux density. To make measurements of static magnetic fields using such a system, it is necessary to rotate the coil in the field. This provides very good results but often requires complicated mechanical arrangements especially since it is important to regulate the speed of rotation for accurate measurements.

As we discussed last month, there are various other methods of measuring static low level magnetic fields. The circuit described here makes use of a specific type of coil arrangement wound onto a ferrite ring core and is capable of providing relative measurements of magnetic flux density. A coil wound torroidally onto the core is driven with low frequency pulses such that the core is in the region of saturation. A second (detector) coil is wound around the outside of the core. Under normal conditions when no external field is present, the magnetic field around opposite halves of the coil tend to cancel, and as a result, the net field produced around the outside of the core is negligible. However when an external field is present, this creates an imbalance, resulting in an increase in the net field around the outside of the core which is detectable as an induced current in the detector coil.

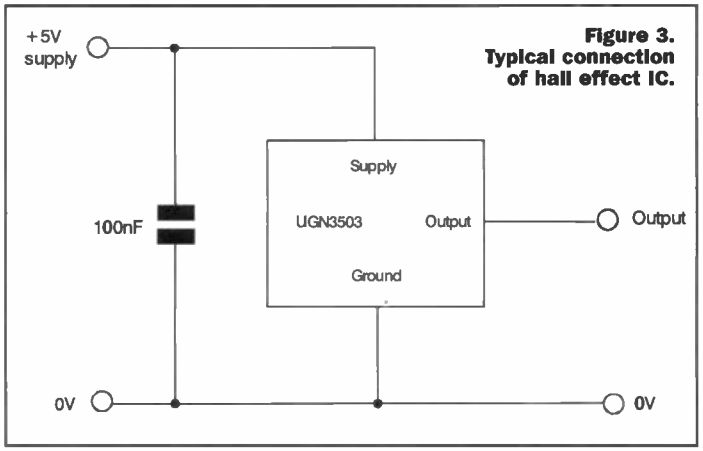


Figure 3. Typical connection of hall effect IC.

Circuit Description

Figure 4 shows the circuit diagram of the detector. Integrated circuit, IC1 (a CMOS hex Schmitt inverter) performs several functions within the circuit. IC1a - IC1c produce a low frequency short duration pulse for drive coil L1a. IC1a forms a simple square wave oscillator. The output of the oscillator is fed via diode D2 to the input of IC1b which together with IC1c forms a retriggerable monostable. The output is of the same frequency as the output of IC1a but with a much shorter duty cycle. IC1c switches on Field Effect Transistor TR1 during the period that the output is in a logic high state driving L1a with current pulses. D5 helps to limit the switching transients produced by L1a. L1b is the

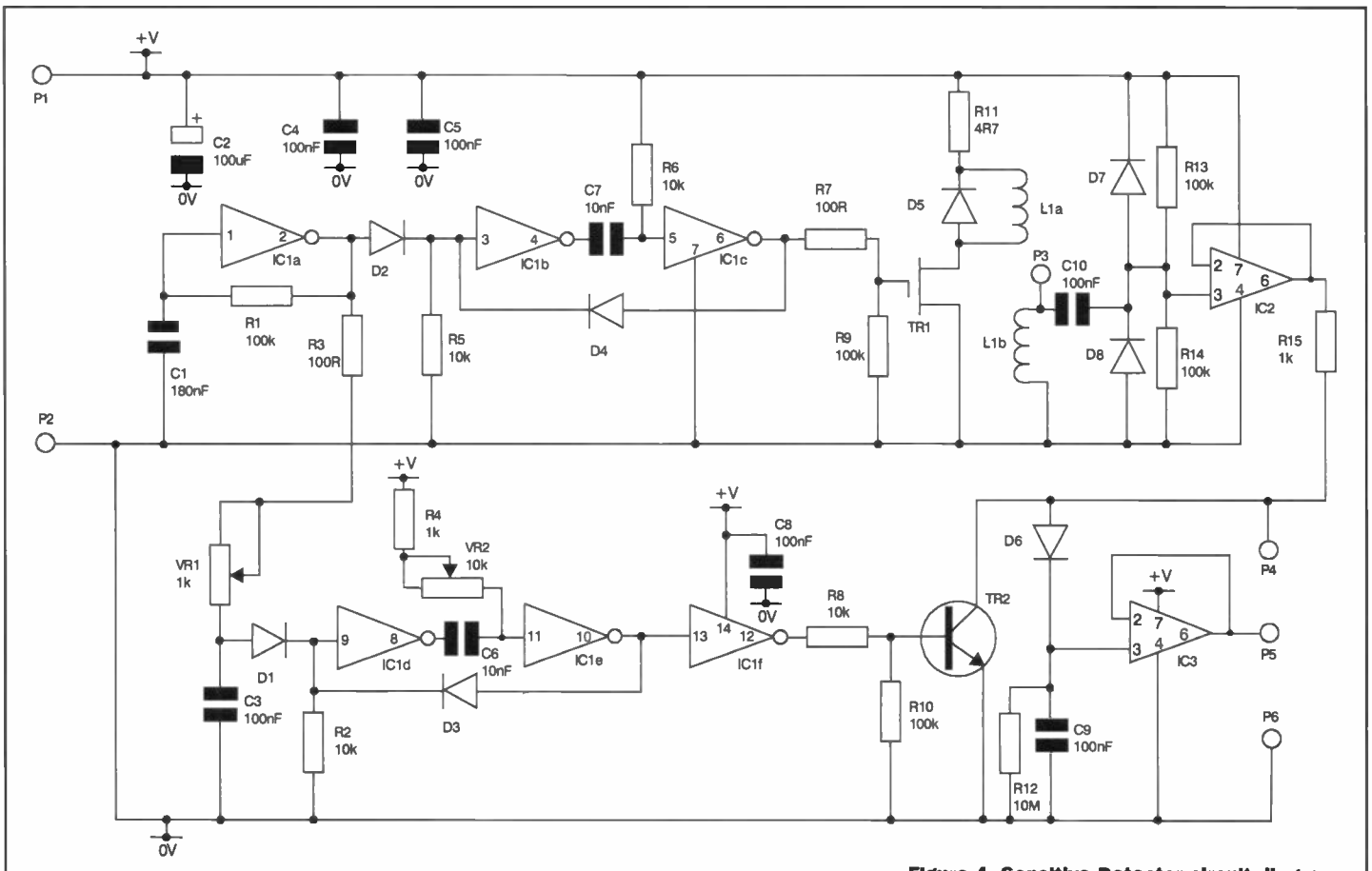


Figure 4. Sensitive Detector circuit diagram.

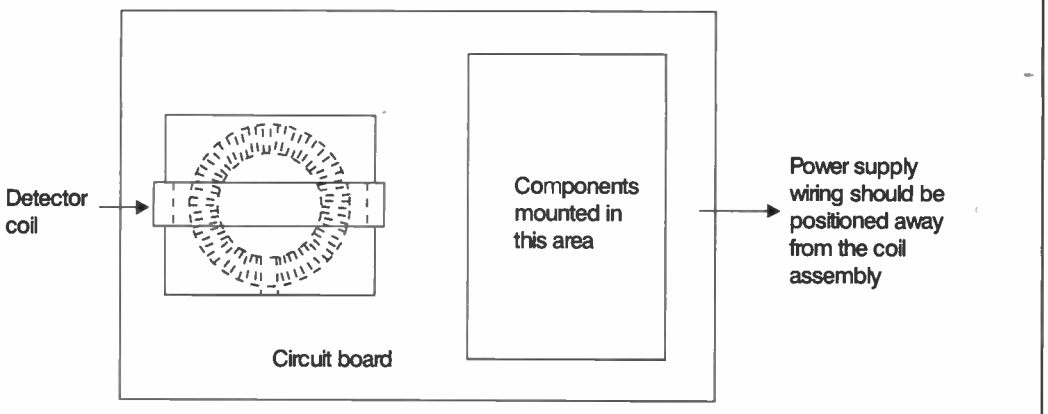


Figure 5. Detector coil orientation.

detector coil. The height of the pulse produced by L1b is partially determined by any external magnetic field present. The output from L1b is fed to operational amplifier IC2 via coupling capacitor C10. Resistors R13 and R14 provide a half supply reference at the input of the op amp. Diodes D7 and D8 limit the amplitude of the input signal if it swings significantly above or below the supply rails. The pulse waveform produced by the detector is buffered by IC2 and appears on pin 6 of the device. In addition to the required pulse there are also other unwanted transients. These are gated out by TR2 which switches the signal to ground except during the period that the required pulse is present. The drive signal for TR2 is produced by IC1d - IC1e and associated components and is derived from the oscillator at IC1a. There are two preset variable resistors. VR1 together with C3 determines the point at which the monostable formed by IC1d and IC1e triggers. VR2 determines the length of the pulse produced by the monostable. IC1f inverts the pulse output from IC1e so that it is of the correct sense to drive TR2. The waveform produced at terminal P4 consists of the buffered output from the detector coil together with the pulse produced by TR2 switching. This signal charges capacitor C9 via diode D6 with R12 providing a discharge path. The resulting DC voltage is buffered by operational amplifier IC3 and is made available on terminal P5. The output voltage at P5 is proportional to the magnetic flux density of any external magnetic field to which the detector coil is exposed. The voltage is of course offset due to the half supply reference voltage for IC2 but for relative readings this generally does not present a problem.

Constructing the Detector

The circuit may be constructed using matrix board. The circuit layout is not particularly critical, but it is best to run separate supply rails to high current parts of the circuit, for example the coil drive section. It is probably best to arrange the orientation of the coil such that the plane of the detector coil is edge-on to the rest of the circuit as shown in Figure 5. Also try to avoid running any high current power supply wiring close to the detector coil. As the coil arrangement is quite bulky is probably easiest not to fix the coil into position until all other components are fitted.

As usual, it is recommended that DIL sockets are used for the ICs to minimise the possibility of damage during installation. Make sure that all polarised components are fitted observing the correct polarity as incorrect connection may result in failure of the circuit to operate and may also be dangerous due to the possibility of explosion. The IC pinouts are shown in Figure 6 and the transistor and diode leadouts are shown in Figure 7.

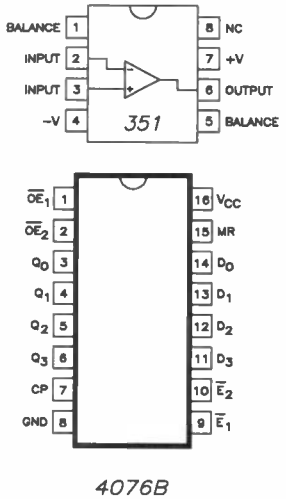


Figure 6. IC pinouts.

Pay particular attention to polarity when connecting the electrolytic capacitors. The negative lead of the capacitor is usually indicated with a negative (-) symbol on the body of the component and is usually the shortest of the two leads.

The coil is wound around a standard ferrite ring core of the type used for RF interference suppression. Figure 8 shows the winding details. The drive coil is 60 turns of 22 SWG enamelled copper wire. Allow for about 2 metres of wire when winding the coil, and try to space the windings as evenly as possible. The windings can be held in place using electrical insulating tape if necessary. It is necessary to wind the detector coil around the outside of the core and this is easiest with the help of a former. A simple former can be created using two pieces of matrix board spaced apart using threaded spacers positioned at each of the four corners. The core is sandwiched between the two pieces of board and may be fixed in position using a suitable adhesive. The detector winding consists of 300 turns of 26SWG enamelled copper wire loose wound around the former. This winding may also be held in position with electrical insulating tape where necessary. The leadouts from the windings may be looped though the holes in the matrix board to provide additional anchorage. The whole coil assembly can be mounted onto the main circuit board using nuts bolts and washers positioned at each corner.

Testing and Alignment

It is probably easiest to test and align the unit using an oscilloscope but this is not essential. Before applying power to the circuit double check the construction to ensure that there are no connection errors or poorly soldered joints. It is useful to connect a multimeter set to the current range in series with the circuit when first applying power so as to check that the current drain is not excessive.

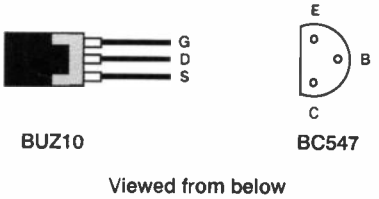
The circuit requires a 9V DC regulated power supply. The wiring diagram for the unit is shown in Figure 9. It is important that the supply voltage is stable as the final output voltage is partially derived from this. If required, a suitable regulator may be used as shown in Figure 10. Variations in supply voltage will affect the output voltage and hence the accuracy of the circuit. It may also be necessary to add additional supply filtering in some cases to prevent unwanted pulses being imposed on the power rails.

Important Note

Fusing of the power supply is required to reduce the risk of overheating in the event of a fault condition. It is recommended that an F100mA fuse is fitted in series with the positive (+V) supply rail to provide protection in the event of circuit failure. It is particularly important to provide protection, since if the oscillator stops this may result in a considerable increase in current consumption which may result in excessive heat being developed. In normal operation, the average current consumption is considerably less than 100mA due to the short pulse width used.

Some form of DC voltage indication is required to test the output of the circuit. An oscilloscope or multimeter are ideal. An alternative is to use a moving coil meter with a series resistor as shown in Figure 11. The preset resistor should be adjusted for a zero reading on the meter. The maximum output voltage from the circuit does not exceed the supply voltage when operating correctly. It is also useful to have a small magnet available - the magnet of a small

Figure 7. Transistor outlines.



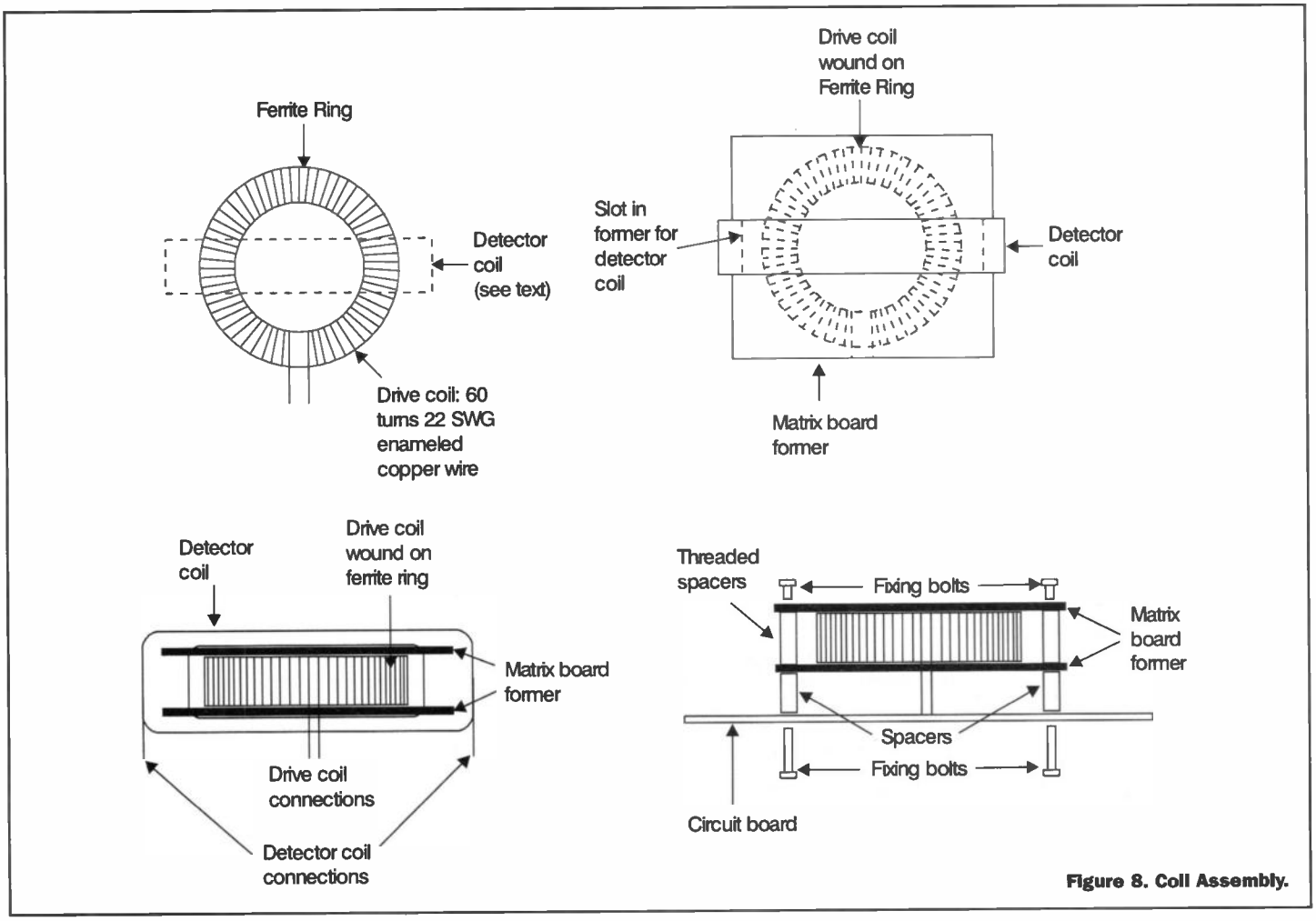


Figure 8. Coil Assembly.

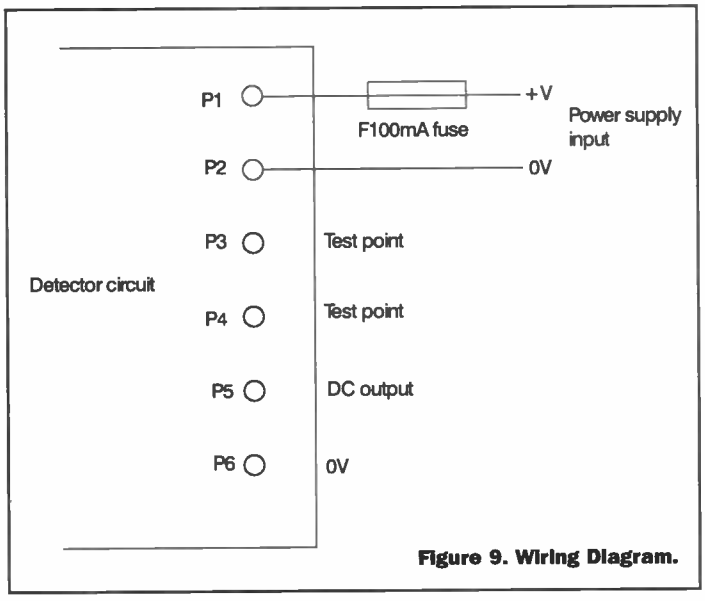


Figure 9. Wiring Diagram.

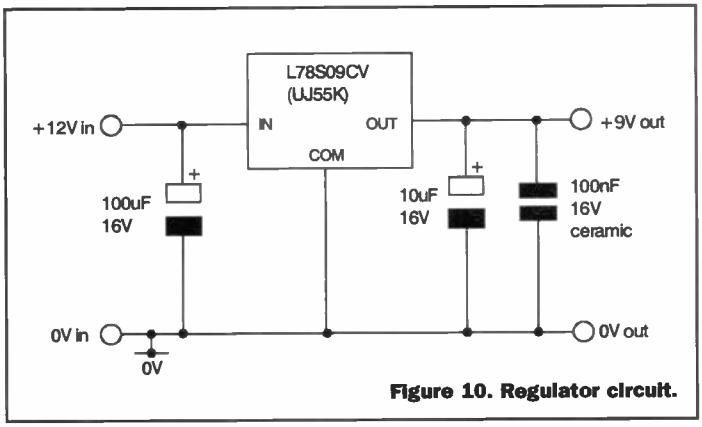


Figure 10. Regulator circuit.

unshielded loudspeaker is ideal.

Apply power to the circuit and check that the current consumption is less than 100mA. Adjust variable resistor VR2 to maximum resistance. If an oscilloscope is available check the output waveform at terminal P4. This should be similar to that shown in Figure 12. Slowly move a magnet close to the coil as shown in Figure 13. This should result in a variation in the height of the pulse. Pointing the same pole of the magnet towards the opposite side of the detector coil should result in change of pulse height in the opposite direction. Try to avoid moving the magnet very close to the detector coil as this will tend to overload the input circuit resulting in erroneous readings. In addition to the required pulse it will be seen that other (unwanted) signal variations are present. In order to prevent the unwanted components of the signal from affecting the final output level from the circuit, it is necessary to adjust VR1 and VR2 such that only the required pulses are present. Figure 14

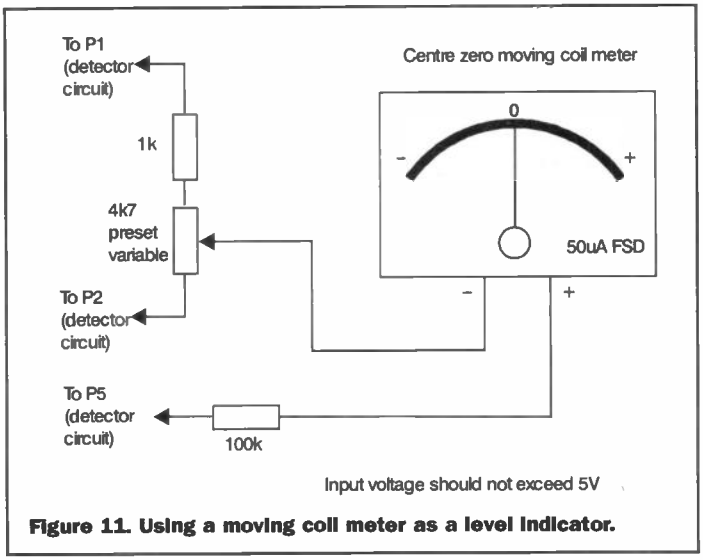


Figure 11. Using a moving coil meter as a level indicator.

illustrates the type of waveform that can be expected at P4.

The DC output from the circuit is available at P5. This output can be checked using a multimeter set to the voltage range or a moving coil meter with the appropriate value of series resistor. If a strong external magnetic field is not present the output voltage should sit at approximately half the power supply voltage. Check that the output voltage changes when a magnet is moved towards the detector coil. A voltage change in the opposite direction occurs if the same pole of the magnet is positioned close to the opposite side of the detector coil. Once again, if the magnet is positioned in very close proximity to the coil this will tend to overload the circuit.

If an oscilloscope is not available alignment of the circuit is more of a trial and error process. Check the output voltage at P5 and adjust preset variable resistors VR1 and VR2 to obtain the best sensitivity. This can be checked by slowly moving a magnet close to the detector coil. Set the presets such that the movement of the magnet is detected when it is as far away from the coil as possible. Once the unit is set up, try detecting the earth's magnetic field noting the change in output voltage as the detector is rotated through 360°.

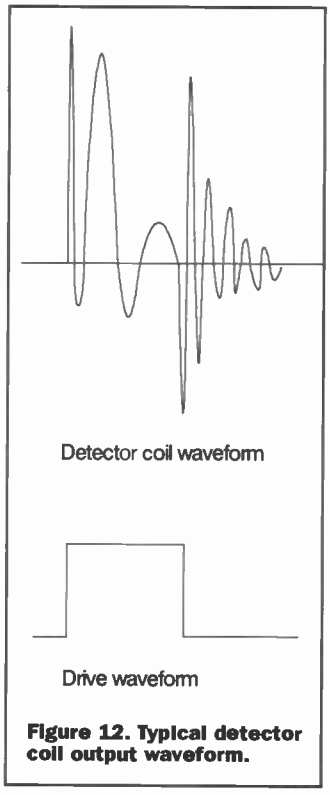


Figure 12. Typical detector coil output waveform.

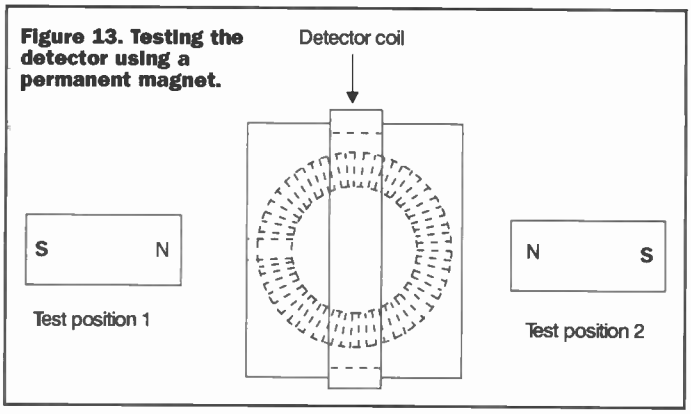


Figure 13. Testing the detector using a permanent magnet.

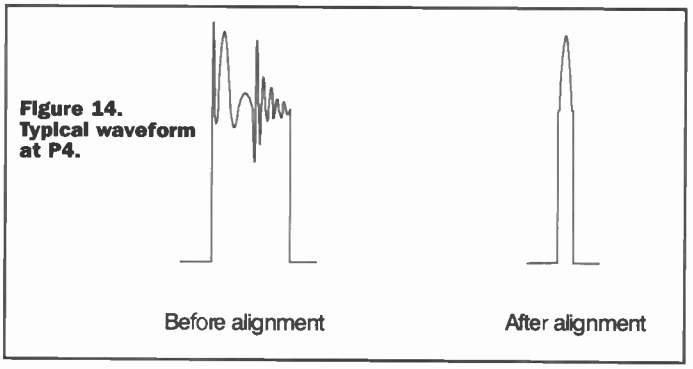


Figure 14. Typical waveform at P4.

Applications and Circuit Development

Applications of magnetometers were discussed in last months article. The detector is a general purpose experimental circuit and serves to illustrate how a sensitive magnetometer can be constructed form standard parts without the need for specialised components such as hall effect devices or magnetoresistors. In this respect it has not been designed for a specific use but can be used in many applications requiring a moderately sensitive magnetic detector. As it stands, the circuit is not calibrated but in many applications where relative readings are required, this does not present a problem.

Where improved performance is required the unit may be modified in a variety of ways; for example, to improve sensitivity, linearity and stability. If a smoother DC level is required at the output of the circuit this can be achieved using an active peak detector to detect the height of the pulses produced at P4.

It is possible to use alternative drive methods for the coil and different drive waveforms to improve the accuracy of this type of detector and more experienced constructors may wish to experiment along these lines. It is impractical to discuss the various configurations and design criteria in an article as short as this and readers are referred to relevant text books on the subject. It should be pointed out that when changing the duty cycle of the pulse driving the coil, attention should be paid to current consumption and the power dissipation in the output stage of the circuit. It may be necessary to increase the power rating of R11 and fit a heatsink to TR1.

It is also possible to wind further detector coils onto the same core (for example at right angles to the existing coil) enabling directional changes the in magnetic field to be monitored without the need to change the orientation of the coil. A magnetometer using this type of arrangement can be useful when making long term measurements of the earth's magnetic field for research purposes and in navigational applications.

For monitoring applications over long periods the output voltage from the magnetometer may be used to drive a chart recorder or data logger via the appropriate interface circuitry. It may be useful to convert the output voltage into a frequency or to serial or parallel data. This is relatively simple to arrange using off the shelf voltage to frequency or analogue to digital converter ICs. As can be seen from a look through the semiconductor section of the Maplin catalogue, there are many different types available.

Finally

We have looked at a range of simple circuits that can be used to measure magnetic fields in a variety of situations. Although the circuits described are basic, they are surprisingly effective when correctly set up and it is hoped that those interested will be encouraged to look further at this fascinating area of electronics. ELECTRONICS

ALTERNATING FIELD DETECTOR PARTS LIST

RESISTORS			
R1	1M Min Res	1	M1M
CAPACITORS			
C1-3	GenElect 100µF 16V	3	AT40T
SEMICONDUCTORS			
D1-3	1N4148	3	QL80B
IC1,2	LF351N	2	WQ30H
MISCELLANEOUS			
P1-5	Pin 2145	5 pins	FL24B
	DIL Socket 8-Pin	2	BL17T

SENSITIVE DETECTOR PARTS LIST

RESISTORS			
R1,9,10,13,14	100k Min Res	5	M100K
R2,5,6,8	10k Min Res	4	M10k
R3,7	100R Min Res	2	M100R
R4,15	1k Min Res	2	M1K
R11	4R7 10W W/W	1	H4R7
R12	10M Min Res	1	M10M
VR1	Hor Encl Preset 1k	1	UH00A
VR2	Hor Encl Preset 10k	1	UH03D
CAPACITORS			
C1	Poly Layer 0.18µF	1	WW44X
C2	GenElect 100µF 16V	1	AT40T
C3,9	Poly Layer 0.1µF	2	WW41U
C4,5,8,10	Minidisc 0.1µF 16V	4	YR75S
C6,7	Poly Layer 0.01µF	2	WW29G
SEMICONDUCTORS			
IC1	HCF40106BEY	1	QW64U
IC2,3	LF351N	2	WQ30H
D1-4,6-8	1N4148	7	QL80B
D5	1N4007	1	QL79L
TR1	BUZ10	1	UJ32K
TR2	BC547	1	QQ14Q
MISCELLANEOUS			
P1-6	Pin 2145	6 pins	FL24B
	DIL Socket 8-Pin	2	BL17T
	DIL Socket 14-Pin	1	BL18U
	20mm QB 100mA 10 Pk	1 Fuse	GJ72P
	Ferrite Filter	1	AM35Q

BT Says It's Free For You

You've got to hand it to British Telecom. See a prospective fall in profits, and it's there to plug the gap. Over the last few weeks, BT's plugged up a couple of Internet-related gaps that are of interest to us here.

First the subject of free (that is, 0800) telephone calls to the Internet. Last month we reported on one plucky Internet service provider's attempt to get the ball rolling on cheap Internet access. X-Stream has started to give free dial-up access at certain times of day (usually weekends) and nights. However, BT has obviously been watching this and has now started up its own free access service, which operates every weekend (as of June 4) from midnight on each Friday, through to midnight on each Sunday for all of its subscription-paying or annual customers of BT Internet Plan Unlimited. Customers merely have to download new dialer software in the form of a new Desktop Launcher (for Windows 95, 98 and NT4 users), or adjust their Remote Access settings (for Macintosh users) to be able to dial using the new free numbers. While the number of calls that can be made to the free numbers is unlimited, users will experience a time-out mode of operation to help keep network usage to an optimum and reasonable level. For example, the service will disconnect a user's computer after a period of 20 minutes inactivity, or 2 hours' of continuous activity. But, users can redial instantly.

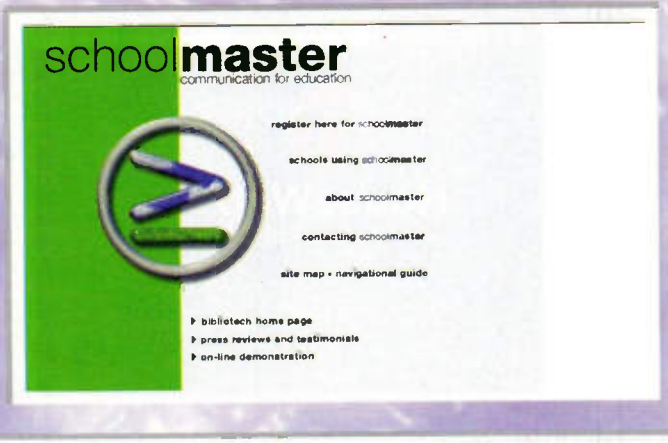
Second, the subject of voice over Internet Protocol (voice over IP, or VIP). Voice over IP has been around for few years already in one form or another. Basically, what it allows is a user to send and receive voice messages over an ordinary Internet connection with another Internet user. Now, at first sight this might not seem too remarkable. After all, if you want to speak with someone else you can simply pick up a phone and dial their number to do this much more easily. A phone call can be done at any time, and the standard line quality in the public switched telephone network (PSTN) always ensures good speech communications from anywhere to anywhere in the world. For voice over IP to work, on the other hand, both users have to be on-line to the Internet at the same time and have a reasonably good Internet connection (to allow the data speed to be high enough to carry voice). However, voice over IP does have a benefit that a user's Internet access is with a local phone call. To dial another telephone user elsewhere in the world over the PSTN you pay long distance rates. To have a voice over IP call with another user elsewhere in the world, both parties merely pay local call rates.

So, while voice over IP isn't a direct threat to BT's income at the moment, but, as Internet links improve, as people opt for ISDN connections, as companies opt for leased line connections, and as voice over IP software improves, it becomes more and more viable to use voice over IP for worldwide communications than it does to use ordinary PSTN communications. And that's where BT has stepped in to provide its voice over IP service. The service uses Microsoft's NetMeeting software, which must be pre-installed on a user's computer, and extra software has to be downloaded.

Information regarding BT's two new Internet services are available from: <http://www.btinternet.com>.

Click Free

500 schools can get themselves a free Agfa digital camera (the Agfa ePhoto 780) worth around £250 by registering with a recently-introduced on-line education community known as schoolmaster. The schoolmaster Website, at <http://www.schoolmaster.net> gives details, but the deal is that schools have to register by activating five teacher accounts along with 50 individual student accounts. Each registered user then has to reply to schoolmaster's postmaster by return. Basically, registering is free as are all accounts, so the only cost is the Internet access costs your school normally pays - the schoolmaster site doesn't even include advertising banners. If your school is one of the first 500 schools to take up the free offer, however, a super digital camera will be winging its way towards the school shortly afterwards. The offer is open to all schools, primary and secondary, state or private.



UK Business Poised to Win E-Business Race

UK firms lead Europe in terms of Internet adoption, according to a survey of European businesses announced by IBM at <www.ibm.com>.

The independent research polled 1,700 IT and business managers in the UK, France, Germany, Finland and Spain. The results established that UK companies are ahead of their European counterparts in the adoption of most aspects of e-business, including e-mail, Intranet and Internet access.

The results also show that European small businesses have started to embrace many aspects of e-business, the exception being Extranets, which are currently only being used by 15%, with only a further 13% planning to deploy an Extranet over the next two years.

HouseWeb Launches Property Portal

HouseWeb at <www.houseweb.co.uk> has expanded its online property service. Features on the new site include a dynamic system for creating property adverts, helping to bring buyer and seller together within a single environment.

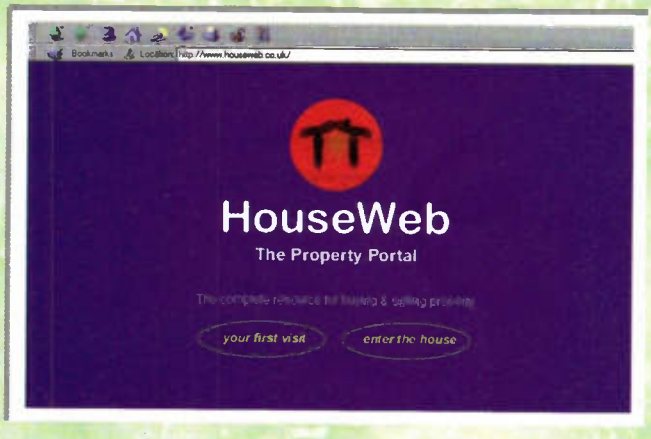
HouseWeb also offers a vast information resource for anyone seeking guidance through the process of buying, selling, renting or exchanging a property.

The new site enables anyone connected to the Internet to place their property online in less than ten minutes, reducing the lead-time for getting a house on the market.

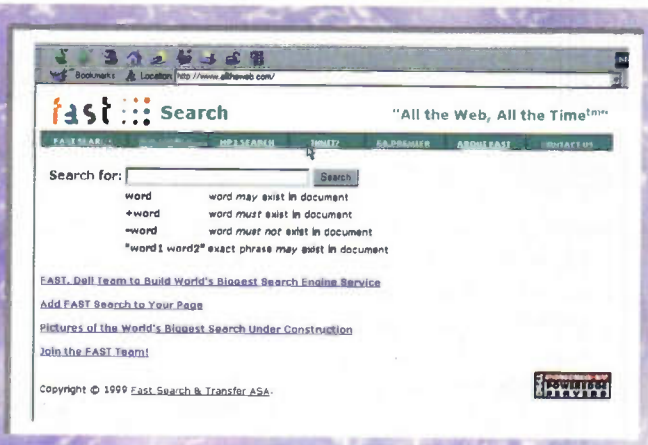
Individuals and estate agents can edit their adverts directly on HouseWeb, giving them complete control over the information they wish to display.

Each property advert includes a summarised and full description, a map of the locality and a colour photo that can be uploaded directly from the user's computer.

Sellers are also given a private mailbox to collect requests from interested parties. Currently HouseWeb is running a three month free trial for estate agents.



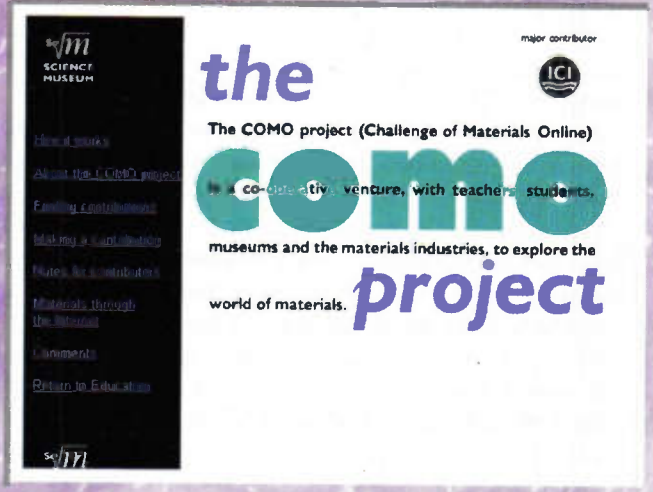
Dell Enters the Fast Lane



Norwegian start-up Fast Search & Transfer and Dell have constructed an advanced search capability using a high-performance, low-cost software/hardware system able to search virtually the entire Web. Today the search offers users 80 million searchable documents at <www.alltheweb.com>.

Fast aims to expand this search universe aggressively by leveraging its uniquely scalable architecture to offer end users the world's biggest search engine, with more than 200 million searchable documents available globally by summer 1999.

Internet Challenge of Materials Online



The Science Museum has launched an online challenge for schools at <www.nmsi.ac.uk/education/como>. The Challenge of Materials Online (COMO) initiative has been designed to encourage schools and students to make creative use of the Internet and to develop links with museums and local industries.

The COMO Project brings teachers, students, the materials industries and museums together to create and share educational ideas and resources throughout the Internet. The project is an educational tool that can be used by schools when teaching their students the key skills involved in setting up a Web site on the Internet.

With the help of the Science Museum, teachers and students are asked to design and publish Web pages on their school or college site. The page must be based on a visit to the Challenge of Materials gallery at the Science Museum, another museum, or a materials-related local business.

Once accepted they are added to the COMO database with a link from the Science Museum Web site to the school or college site. These educational resources are then accessible to anyone via the Internet in the form of a continuously developing and interlinked set of resources relating to materials, their production and uses.

WebSpell Eliminates Poor Web Spelling

Web sites are a reflection of the company or organisation they represent, and sites with misspelled words can make a bad impression. While trying to perform all the duties of creating and managing a Web site, some Webmasters may not have the time to devote to thoroughly spell check a site. Most spell checkers cannot relieve this burden because they do not understand HTML tags.

That is why ParaSoft has included WebSpell as a standard module for its new Web management environment, WebKing at **<thewebking.com>**. WebSpell is 'HTML aware' which means that it understands HTML tags and does not flag them as misspelled. This not only ensures that only actual misspelled words get corrected, but also that incorrect words with tags do not slip through simply because the Web developer has grown used to clicking 'ignore/accept' every time a tagged word gets flagged.

CNN

If you want international news, particularly with a US flavour, head for the CNN Interactive Web site at **<www.cnn.com>**. CNN is the BBC of the US and its heavyweight online presence carries an air of superiority.

The site can be personalised so that a user's news preferences load directly from the home page. This is a very neat feature. In essence, users can create their own personalised newspaper as and when they fancy catching up with the news.

Extended audio and video links to CNN reports and footage are available from the site, which like so many news sites is organised into channels such as world, US, local, politics, weather, business and sports.

European Companies Top Web Rankings

A survey of corporate Web sites by the London School of Economics at **<econ.lse.ac.uk>**, shows that six European companies place among the top 10 rankings. The study evaluated the Web sites of 120 leading international companies, ranking them according to quality and business value. Of the top 30 companies, 17 were based in the U.S., 11 in Europe, and two in Asia.

Germany's Lufthansa took the top spot, while the UK's Tesco and BT took the second and third slots. The top 10 was completed by IBM, British Airways, WalMart Stores, Deutsche Bank, Deutsche Telekom, Comcast, and Walt Disney.

New System for PC Music Stirs Concern Over Piracy

Real Networks at **<www.real.com>** has unveiled new Internet audio software that will allow users to copy, store, and play audio CDs on their PCs, as well as play music downloaded from the Web.

RealJukebox is the first complete product allowing consumers to play, record, organise, and search for music all from a single user interface. RealJukebox allows consumers to listen to their favorite music at their convenience, record CD collections to PC hard drives, find and download music from the Internet, organise and personalise music collections and take their music anywhere they wish through the use of portable devices.

The new Real Jukebox software, which will play a variety of formats including Real Networks' G2 format and MP3, is likely to intensify the current controversy over music piracy on the Web. Indeed, the recording industry is currently trying to establish a digital music technology standard that would protect intellectual property on the Internet, in order to stop the growing practice of free and unauthorised distribution of music online.

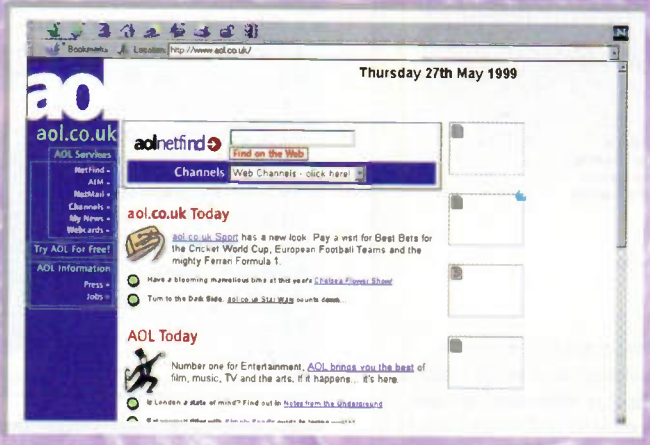
Real Jukebox addresses copyright concerns by limiting a user to making only one digital copy of an audio CD to the user's hard drive. The beta version of RealJukebox is available immediately at **<www.real.com/products/realjukebox/index.html>.**

Internet Content Rating Association to Protect Children

Internet industry leaders joined forces to create an international Internet content rating system that protects children and free speech on the Web. Formed with the backing of some of the world's best known Internet and communications companies, the new global rating system will be based on the established RSACi content rating system.

The system will be governed by a newly formed association, the Internet Content Rating Association (ICRA). The founding companies of ICRA include AOL Europe at **<www.aol.co.uk>**, Bertelsmann Foundation at **<www.stiftung.bertelsmann.de>**, BT at **<www.bt.com>**, Cable & Wireless at **<www.mcmail.com>**, Demon Internet at **<www.demon.net>**, EuroISPA at **<www.euroispa.org>**, IBM at **<www.ibm.com>**, Microsoft at **<www.microsoft.com>**, Software & Information Industry Association at **<www.siia.net>**, and T-Online Germany at **<www.t-online.de>**.

To ensure the successful worldwide deployment and acceptance of the new international system, ICRA will accept additional memberships from companies or organisations willing to join in its efforts to build and manage an internationally acceptable online content rating system.

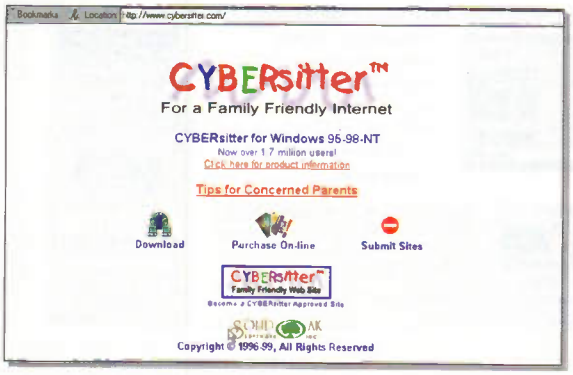


Built on the success of the Recreational Software Advisory Council's RSACi content rating system, the rating mechanism that is already embedded in Microsoft Internet Explorer and Netscape Navigator, the ICRA system will be a voluntary self-rating system that is both user and provider friendly, and culturally non-specific and objective.

To develop a system for content rating that is culturally acceptable for use in countries around the world, ICRA will hold consultations with children's advocacies, consumer groups, universities and interested parties around the globe.

Once developed, the system will be available to all Internet users as a free service. All ICRA members are committed to the establishment of an international rating system and have dedicated a considerable amount of time and resources to ensure that the public receives a valuable set of tools to control the nature of content that they and their families view on the Internet.

With the establishment of ICRA, the RSAC Board has transferred its assets (including the RSACi system) to the newly constituted ICRA to help speed the group's efforts. A number of the leading RSAC board members will join the ICRA board of directors and many of the existing RSAC staff, including Stephen Balkam, its current President, will become ICRA employees. ICRA anticipates having the new rating system available for use within the next twelve months.



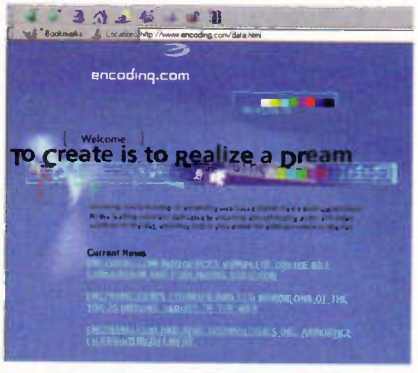
Free Snooper Tool from CYBERsitter

CYBERsitter System Snooper, a free software application available for download from **<www.cybersitter.com/snooper.htm>** will scan a PC hard disk and look for certain remnants left behind from previous Internet sessions. It will read these files and scan for some specific key words, and, if they are found, the file will be listed and easily viewed.

With the free 'Snooper' program, parents who have not installed a filtering product like CYBERsitter can still perform simple 'spot checks' of their childrens' Internet activity that can help them identify potential issues that they may wish to address with their children.

Encoding.com Launches Streaming Audio Converter

Encoding.com at **<www.encoding.com>** a creator of digital media business solutions has launched from mediaUpgrade.com, an online application that allows users to convert non-streaming or older digital media into new streaming and Internet formats. The process of digital transcoding enables content owners to create streaming and Internet media from non-streaming source files.



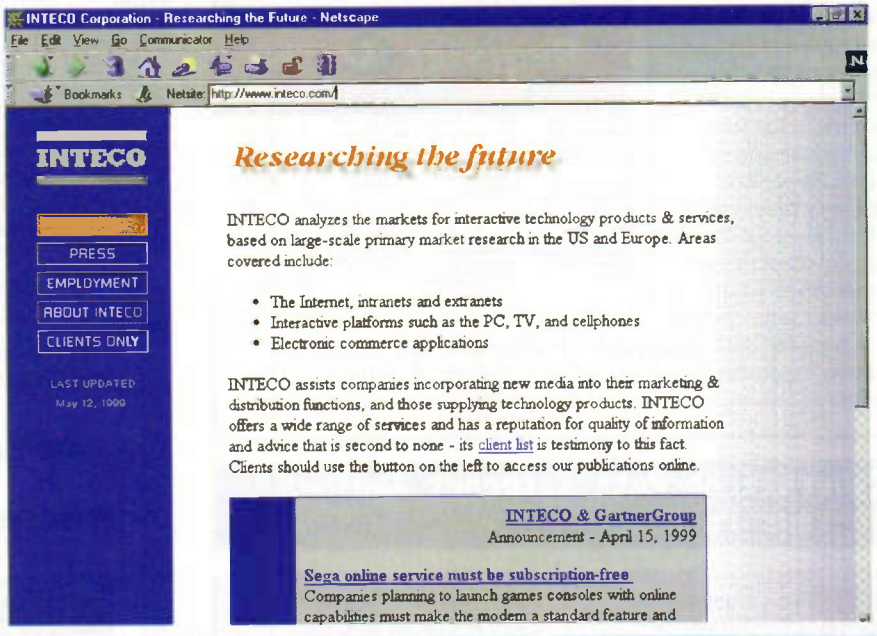
Post It Software for Web Site

California-based Third Voice at **<www.thirdvoice.com>** is offering a free software download that will allow users to post comments to Web sites. The service will also allow users to view comments posted on the sites by other users of the software. Online publishers are not expected to be happy about the offering, as the annotations can be posted without sites' permission and will appear to users as part of the original site content.

Analysis: Console Key to Online Computer Games

Online Gaming: Key Findings

- An online element is becoming the standard for games
- Computer games in the UK are not yet a consumer phenomenon
- There is no standard PC platform games. Action games run slower on a slow PC giving the player an unfair advantage Games consoles such as the Sony Playstation provide a flat playing field
- Half a million people use the PC as a games platform in the UK. By comparison there will be 7 million games consoles in use by the end of the year
- Consoles are the favourite platform for computer games
- To achieve consumer penetration, console online services must be free, with funding possibly from sponsorship
- Simplicity and reliability of online services for the game community is key. This is a very unforgiving audience



Drawing on its extensive research into consumer behaviour and attitudes analyst house Inteco at **<www.inteco.com>** believes that companies planning to launch games consoles with online capabilities must make the modem a standard feature and rely on advertising and sponsorship from major brands rather than monthly subscriptions.

Despite the widespread availability of multiplayer titles on the PC, and a great deal of attention focused on it by the specialist consumer press, online gaming in Europe has so far attracted relatively few players. Access cost has been a barrier, but the PC as a mass-market games platform also suffers from fragmentation, complexity and high cost.

Variations in the performance of processors and graphics cards give some players an unfair advantage. Combined with the unreliability of software and the necessity to obtain 'patches' and driver updates from third parties, this restricts online gaming to the technically expert, dedicated enthusiast.

Most of the technical problems that restrict online gaming via PCs could be avoided in the simpler console market as long as manufacturers do not make the consoles 'upgradeable' in a misguided attempt to follow the model of the PC hardware market – a level field for all players, and indeed for all developers, is essential. It is also vital that going online be made as easy as possible, and forcing the consumer to make a separate decision to go out and buy a modem presents a significant barrier – the modem must be an integral part of the console.

BT's Wireplay – a relatively successful service in the UK – claims around 100,000 registered users. This looks small when viewed against the number of home-PCs, at approximately 9 million, but one must remember that, according to Inteco's research, less than 500,000 of these PCs were bought mainly for games. In contrast, by the end of this year there will be consoles, bought solely for that purpose, in over 7 million UK households. As this base is replaced with online-capable devices a large online community could develop.

Until recently Wireplay required a separate monthly subscription or connection via a telephone line to a dedicated network, charged above the local call rate. BT has now removed that barrier, so that the only cost is the local-rate call, and intends to make up for the reduction in access revenue via sponsorship and advertising. Inteco believes this approach should form the template for console-oriented online services.

An attraction for service providers is that the nature of game playing keeps people online for long periods, generating significant call revenue. Furthermore, contract-based services have proved to be a barrier to both home PC Internet access and cellphone adoption.

Given that console penetration in low- and middle-income households is high, it is essential that online services offered to console owners do not involve monthly subscription charges, but are financed instead through call charges, sponsorship and advertising. It will be very difficult to persuade a family household to part with a monthly subscription fee for something as non-essential as game playing.

For the services to succeed, providers must concentrate on the fundamentals. The services must be reliable and offer the consistent performance that made Wireplay attractive. Managed tournaments and leagues, with prizes, and 'streaming' of players to ensure the experience is not short-lived and unsatisfying for the majority will encourage players to return, and create opportunities for advertising, promotions and sponsorship of events.

Inteco also recommends that service providers adopt a 'walled garden' approach. They may choose to offer links to additional games-related sites within the network – perhaps in partnership with major publishers or retailers – but must be wary of the parental concerns that would overshadow offering wider Internet access to the likely audience. In summary, they should concentrate on flawless execution for games players, rather than on broader service offerings which are not appropriate to the platform.

Sony has been successful in moving games consoles into demographic areas that many brand owners find attractive. Inteco's research shows console penetration in the younger actives segment (two people with at least one under 45; or three people all under 35; with no children and not retired) has almost doubled to 41% in the UK in less than two years.

If online services are developed and marketed correctly then console manufacturers will be in a position to deliver an attractive audience to relevant advertisers. Brand owners should consider partnerships with those offering online console services, as well as the major software publishers. Sponsorship of leagues and offering of prizes are obvious methods of achieving exposure without alienating the online audience.

The Register

The Register at <www.theregister.com> is a caustic publication, which follows the computing industry, written in the vein of that pinnacle of satire Private Eye. It goes where other IT publications fear to go and often prints what others might consider unprintable.

Check out the home page for an alternative view of what's happening in the computing industry. A series of channels such as semiconductors, networks and the Web offers sector specific news.

Cyberstereo Puts Internet Audio in Your Pocket

The D-Music Digital MP3 Player, a new MP3 device from Pine Technology at <www.pinegroup.com> records and plays back MP3 coded files, which can be downloaded freely from the Internet or encoded on a PC from the user's personal collection of audio files. D-Music also has an integrated FM radio and digital voice-recording facility, which turns the unit into a digital dictaphone supporting hours of recorded material.

D-Music has been launched for music fans who are Internet users as well as radio listeners. Because of its voice recording function, it is also ideally suited to business users who need to record comments, conferences or discussions. The device allows users to play back digital files as if it were a normal personal stereo, as well as collate and edit songs via a PC to put together personalised playlists.

The new MP3 player supports ECP/EPP/SPP parallel ports and has a built-in LCD display. It is provided with stereo earphones, DC adapter, application software and a host interface cable. Battery power is supplied through 2xAAA type standard or rechargeable batteries. The expected retail price is expected to be around £169.

Vodafone High Street Store at your fingertips

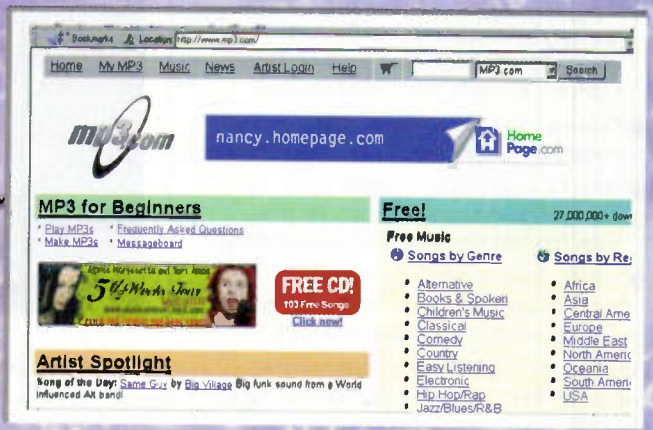
Vodafone's 24 hour online store at <www.vodafone.co.uk> has just got better. Alongside the sparkling array of 'All in one' mobile phone packages, pagers, accessories and 'Pay As You Talk' you can now buy contract mobile phone packages. This new addition to the Vodafone Retail online store means that you can now purchase almost any Vodafone product that you can find on the high street, from the comfort of your home or office.

What's in a Name: MP3

MP3 is the talk of the Internet for audio file transfer. Supporters claim that it will see the demise of the record companies, while critics say that the standard promotes piracy of CDs. What is all the fuss about?

MP3 is the file extension for MPEG, audio layer 3. Layer 3 is one of three coding schemes for the compression of audio signals – layer 1 and layer 2 being the two others.

Layer 3 uses audio and psycho-acoustic coding techniques to remove all the parts of the audio signal that can't be heard by the human ear. MP3 also adds a modified discrete cosine transform (MDCT) that implements a filter bank, increasing the frequency resolution 18 times higher than that of layer 2.



An MP3 coded audio signal is 12 times smaller than CD quality audio without, proponents' claim, any sacrifice to sound quality. And because MP3 files are small, they can easily be transferred across the Internet.

MP3 files can be played on a PC using one of any number of MP3 players. The PC equipped with a soundcard can will produce CD quality audio or can be connected to an existing hi-fi system.

Alternatively MP3 files can be downloaded to a new class of MP3 personal stereo type products which will enable the file to be manipulated like a CD in a personal CD player.

Trouble arises when copyrighted songs are distributed illegally for free over the Internet. On the other hand, musicians and pop groups are able to use the technology to sell and distribute songs from their own Web sites, thus eliminating the need for the record company as middleman.

MP3.com at <www.mp3.com> is the ultimate source for digital music downloaded from the Internet. In an average day the site has 200,000 visits to its downloads area for diverse music genres ranging from Alternative to Traditional music.

Macromedia Heads Offline

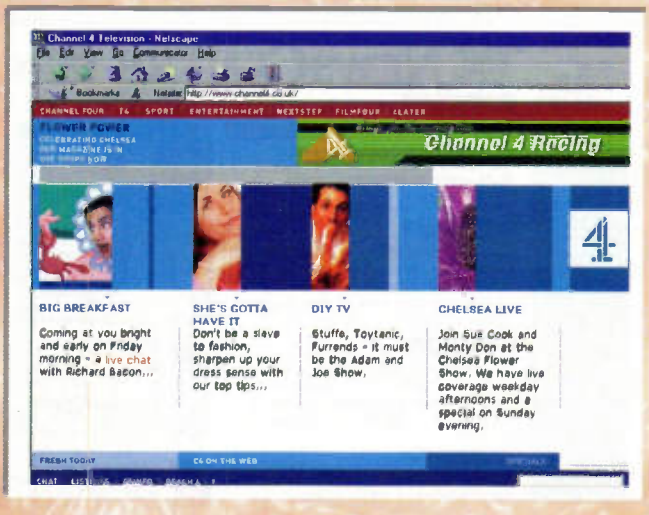
With its Shockwave and Flash multimedia formats already used on a number of commercial Web sites, Macromedia is now offering a free Shockwave remote version so that individual computer users can take advantage of games, animation, and other Shockwave multimedia material available on the Web whilst offline. Macromedia has launched a new site called Shockwave.com at <www.shockwave.com> for downloading both the remote and player versions of the software.

Rise and Fall of Pointcast

PointCast at **<www.pointcast.com>** which enjoyed a meteoric rise as push technology dominated headlines and hype several years ago, has been sold to venture-capital firm idealab for £4.2 million. In 1997, the company turned down a reported £270 million takeover bid from Rupert Murdoch's News Corporation.

PointCast's technology will now be incorporated into eWallet, digital cash software made by San Diego-based LaunchPad. The eWallet software allows people to store their credit card numbers and other information securely on their computers, for simplified online shopping.

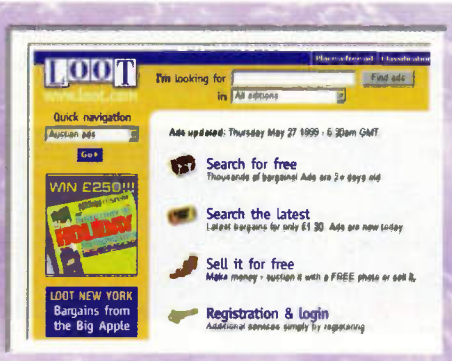
Channel 4



Expect the unexpected from Channel 4. Rather than providing summaries of news and features like other Web sites, the Channel 4 site at **<www.channel4.co.uk>** provides an extension to programme output. News content on the site is minimal. This is not so surprising, given that Channel 4 takes its news feeds from ITN. Instead the emphasis is on sport, film and entertainment. You'll find in-depth features here on the Big Breakfast, ER and Friends amongst others.

The horse racing team has a section all to itself where daily tips are provided alongside racing commentary and insight. For the total novice there is a guide to betting which goes as far as telling you how to fill in a betting slip.

Loot



If you've got something to sell, or want to buy something, you could do worse than visit Loot at **<www.loot.com>**. The site is completely free for advertisers and buyers, but users must register to gain access.

For prospective buyers, a powerful search engine drills through thousands of small ads. Users can search on sections such as cars, personals and property. The ability to sort results by region means that you can make sure that results are relevant to your local areas. Sellers much submit a detailed ad which is then scrutinised by the site's editors before being posted online. The site recently added an auction feature – looking to capitalise on the success of US online auction services such as eBay.

Sony and Microsoft Deliver Digital Music

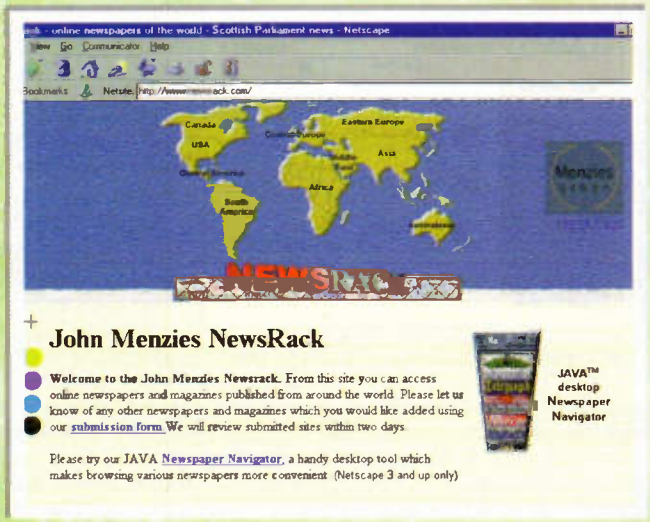
Sony at **<www.sony.co.uk>** and Microsoft at **<www.microsoft.com>** are teaming up to sell digitally delivered songs, set for launch this summer. Sony will use Microsoft's new Windows Media Technologies 4.0, which allows users to download music recordings twice as fast as anything currently available. The software reportedly sounds better than the popular MP3 compression technology, and also includes security features to foil would-be music thieves.

Guardian

The Guardian at **<www.guardian.co.uk>** was one of the first UK newspapers to branch out online. The site has its own team of journalists and carries some content from its traditional print counterpart. Register and you'll get regular updates by e-mail.

The Guardian site is a great place to visit if you want to check a TV schedule or catch up on the news. Unlike many of the newspaper sites, it is not obsessed with hard news, but carries more of a lifestyle theme.

News Rack

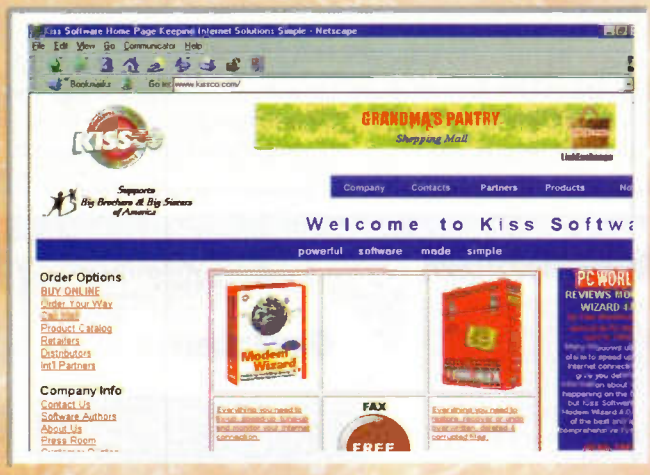


News Rack at <www.newsrack.com> is such a simple, but incredibly effective idea. It is what is known as a portal. In this case it's a portal for newspapers and magazines online – or in other words an online newsagent. Little surprise that it was created by the high street newsagent, John Menzies.

The site's home page carries a map of the world. Here your in the world's largest newsagents and you have to choose the country from which you want to check out a publication. Click on an area of the world and an enlarged map appears. Pick on the country you want and you link to lists of its newspapers and magazines.

There is also a Java applet, which you can run on your desktop to simplify the search process. Fixed links are provided from the home page to major newspapers from around the world such as the Guardian, Daily Telegraph, Le Monde and USA Today.

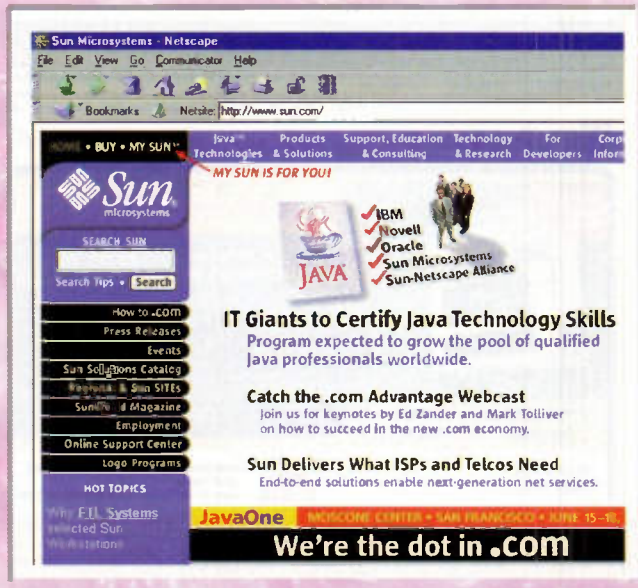
Modem Wizard Measures Connection Quality



Modem Wizard 4.0 from Kiss Software at <www.kissco.com> tells you the exact speed of your Internet connection and makes sure you connect at the fastest possible speed.

The product provides everything you need to speed-up, tune-up, fix-up and monitor Internet connections, regardless of your connection type. New technology works on any Internet Connection from modem, ISDN, cable, or T1.

Java Partner Unite for Portability



Sun at <www.sun.com>, IBM at <www.ibm.com>, Novell at <www.novell.com>, Oracle at <www.oracle.com>, and the Netscape <www.netscape.com> alliance has announced new education and certification standards for Java. The new standardisation efforts are designed to promote consistent Java development and cross-platform support. The program, code-named Jedi, will ensure that programmers work only with an approved, reliable set of Java skills and environments.

Press Association

If you hear a rumour about a UK news story, the first place you should look to find out more is the Press Association Web site at <www.pa.press.net>. The Press Association is one of the leading providers of news to newspapers. As such it competes ruthlessly with other news providers such as Bloomberg and Reuters to be the first organisation to break a story.

The Web site carries truncated versions of the stories which hit its newswires, organised across nine channels including: news, sport, politics, business, Internet, royal, entertainment, TV/radio and weather. One of the neatest features on the site is a story finder which scans the UK's leading news Web sites for user inputted keywords.

The Economist

If you're looking for commentary on international business and politics, head for the Economist Web site at **<www.economist.com>**. Here you'll find much of the content from the Economist's weekly magazine. But access is strictly on a limited basis.

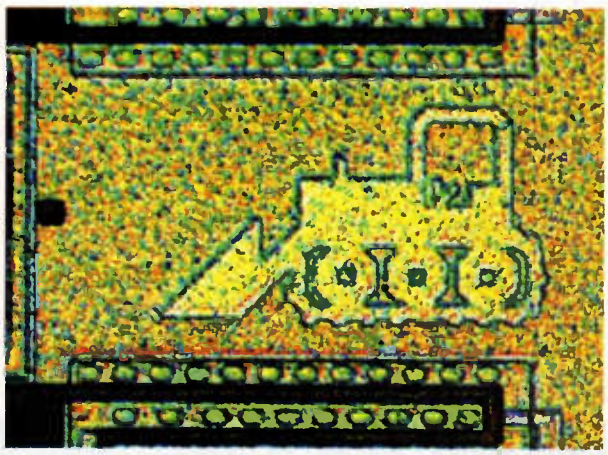
Subscribers to the print version of the Economist can search its entire contents of the Economist as soon as it is published each week, plus unlimited free retrievals from the archive and full access to the Library. If you want subscription to the Web edition on a stand alone basis, it will cost you approximately £30.

ITN

When the ITN news team upgraded its studios for the new 11pm news programme on ITV, it sharpened the image of its Web site at the same time. This site at <www.itn.co.uk> is clean and crisp leaving other sites such as the BBC News site looking distinctly cluttered.

In terms of content, the site is very similar to its BBC counterpart. On the site, ITN's news output is split across a variety of channels such as business, world and sport. In each section, stories are presented as a headline and summary paragraph with a picture, providing the opportunity for Web browsers to drill down for the full story, which typically includes a text report, audio and video.

Chips Doodles



It turns out that engineers have a passion for doodling that extends way beyond producing the odd circuit diagram on the back of a match box or old envelope.

According to researchers at the Florida State University, when designers lay out integrated circuits they often get carried away and add the occasional doodles to the metalisation.

The microscopy department of the Florida State University has been collecting these images and has set up a Web Site called Silicon Zoo to show them to the world at **<micro.magnet.fsu.edu/creatures/index.html>**.

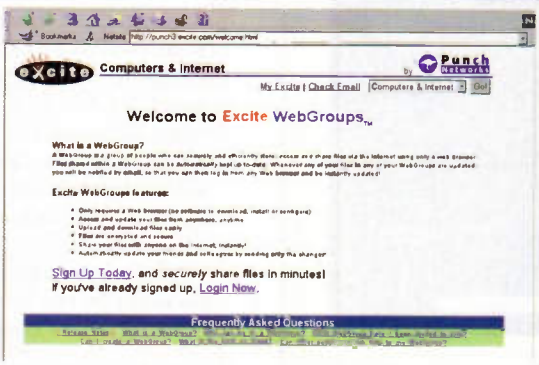
The photo shows a miniature rendition of a bulldozer that appears on a NMOS digital chip designed in 1980 for Caterpillar for use in their heavy equipment Electronic Monitoring Systems. The integrated circuit is still used in many models of Caterpillar construction equipment, including bulldozers.

Excite and Punch Networks Launch Web-Based File Sharing

Excite and Punch Networks have announced that Excite will offer Punch Networks' Web-based file sharing and collaboration service to Excite's customers via Excite's Web site.

The service, called WebGroups, allows users to instantly store, share and update files using just their browser. Visitors can sign up for the free service at **<punch3.excite.com>.**

While the Internet has made viewing and interacting with information, pictures, video and audio easier than ever, it is still relatively cumbersome to share actual files, such as word processing documents, spreadsheets and graphics via the Web. As a result, people still use e-mail or other manual methods of sharing files, such as saving to disk or faxing. These solutions are piecemeal at best.



WebGroups is an easy, secure and fast way for even novice computer users to instantly publish files to the Web and share them with their colleagues and friends.

Tune into Yahoo! Radio

Yahoo! has launched Yahoo! Radio at **<radio.yahoo.com>**, a new platform providing users with direct access to broadcast audio programming. Through agreements with Broadcast.com at **<www.broadcast.com>** and Spinner.com at **<spinner.com>**, users can tune into 10 stations of music programming 24-hours a day, seven days a week.

Yahoo! Radio programming works much like traditional radio, including station identification and advertising elements, and offers a variety of music genres such as Alternative Rock, Classic Rock, Classical, Country, Electronica, Jazz, Oldies, Rhythm & Blues, and The '80s.

Audio broadcasters are increasingly moving to the Internet in a bid to reach new audiences. Tunes.com at **<www.tunes.com>** is one of the Web's largest collection of music content and unique programming.

BT and Photo-Me to Introduce Internet Booths

BT at **<www.bt.com>** and Photo-Me are set to offer a range of multimedia services, including e-mail and Internet access, through a nationwide network of new multimedia booths.

Photo-Me booths, which have previously been used only for photography, will be replaced and redesigned to include screens and keypads. This will allow users to access the Internet; send, retrieve and print e-mail messages instantly and conveniently and create their own Web sites with pictures.

In addition, all of Photo-Me's photographic products - including ID photos, photographic fun stickers, customised postcards, photographic reprints and business cards - will be offered, which users can choose to print immediately or send electronically to an e-mail address.

The booths will also have a unique facility for users to plug in digital cameras and print out or e-mail photographic images.

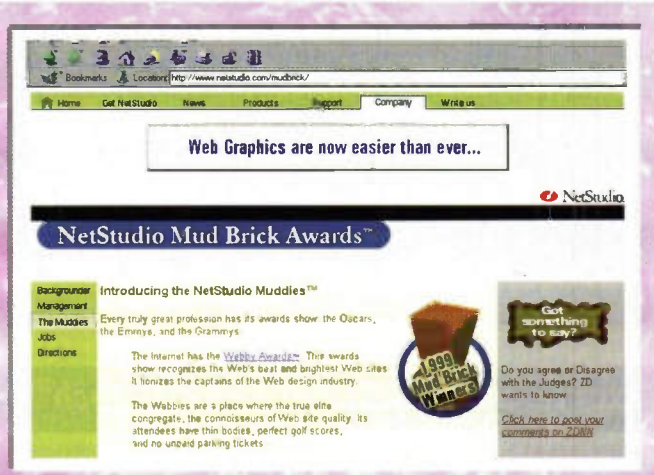
Photo-Me currently operates 4,300 photobooths in the UK and the majority of these will be replaced by the new multimedia booths which will be located in high traffic areas, such as railway stations, airports, shopping centres and supermarkets.

BBC News

With the BBC's worldwide team of new journalists contributing to the BBC News Web site at <www.bbc.co.uk/news>, its not surprising that the site has achieved a reputation as one of the world's leading news sites. What is impressive is that this often-maligned institution has adapted to new media with such a strong offering.

The front page of the BBC News site provides a summary of leading news stories on the world. Beyond this, the site is split into eleven news sections, which are: world, UK, UK politics, business, science/technology, health, education, sport and entertainment. Other features such as Talking Point provide a discussion forum for items in the news. While and In Depth feature contains detailed analysis and feature length stories.

World's Ugliest Web Sites Winners Announced



NetStudio has announced its annual NetStudio Mud Brick Awards winners for the world's ugliest Web sites. The Muddies at **<www.muddies.com>** are the Webby Awards' counterpart for the most worst-looking sites on the Web.

Amongst the winners – or losers depending on how you look at it – were Pizza Hut at **<www.pizzahut.com>**, Quaker Oats at **<www.quakeroats.com>**, Southwest Airlines at **www.southwest.com** and GEM Hosting at **<www.hostbiz.com>**.

Mud Bricks are awarded annually in three different categories: Big businesses who should know better, small to medium-sized businesses and government organisations.

Internet.com Launches InternetRadioList.com

The Radio Times has gone online. Internet.com at **<www.internet.com>** has added InternetRadioList.com at **<www.internetradiolist.com>.** The site features a global directory of over 1,500 Internet radio stations and links to live broadcasts on the Web.

InternetRadioList.com features live feeds to radio broadcasts in interest-specific categories including music, news, sports, international and talk radio. Radio enthusiasts can search for stations by language, name, country or category. Users can also find a brief description of the broadcast as well as its live or pre-recorded status.

Downloads for Windows Media Player from Microsoft and Real Network's Real Player are available on the InternetRadioList.com Web site.

Financial Times

FT.com at **<www.ft.com>** is the online version of the UK's leading and finance newspaper the Financial Times. The site, which requires visitors to register on their first visit, claims to have a larger readership – more than a million page impressions a day – than its traditional counterpart.

Once registered, readers get access much of the content from the print version of the Financial Times, but with the benefit of regular updates. Stock prices from the London Exchange and Indices such as the FTSE-100 and FSTE Small-cap are updated throughout the day on the site.

If you're looking for information on a public company, this is the place to come. A research database provides access to three years financial and company information for more than 20,000 companies around the world.

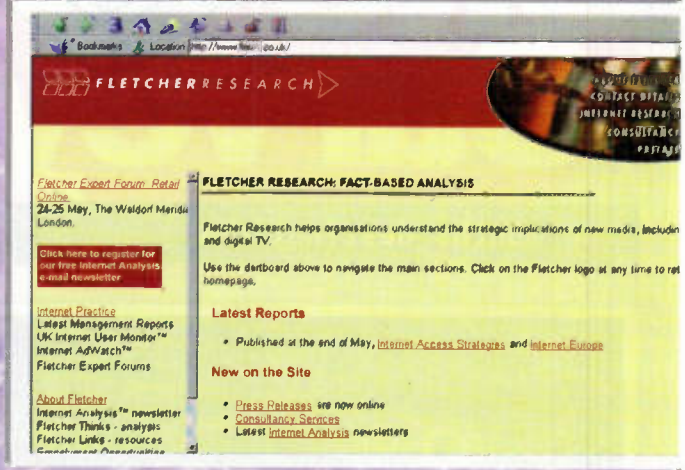
Media Online

Five years ago if you'd listened to some media pundits, you would thought that the Web was set to bring about the demise of publishers and broadcasters. In fact, in many instances the opposite has happened. The smart players have adapted to the Web and used it as a channel to promoted their core offering.

No one is making any money in this new online world, but then no one really expects too. Instead by offering a subset or extension of their existing product, publishers and broadcasters hope to tempt new readers and views across to their newspapers, radio station of television channel.

If you venture online today, you'll find radio stations broadcasting online, databases of financial data and news stories literally as they break. Here we take a snapshot at the top 10 media Web sites.

Internet Penetration Smashes 10 Million Barrier: Users Still Affluent



New research reveals the number of Internet users in the UK now exceeds 10 million. Over three million new Internet users have got online in the five months since Christmas, mainly attracted by the availability of free Internet access provided by free ISPs like Dixon's Freeserve and competing services from the likes of Tesco, Barclay's, Waterstones and Egg from Prudential.

Results from the study conducted by UK research house Fletcher Research at **<www.fletch.co.uk>** were drawn from 39,000 UK-based respondents - representing the largest online surveys completed in the UK.

The data throws up some interesting dichotomies, not least the fact that despite breaching the 10 million barrier, the Internet remains a place for the more highly educated and better remunerated Briton.

A separate survey published in May by analyst firm Inteco at **<www.inteco.com>** said that the characteristics of the first-time Internet users will begin to shift during 1999. While middle class households continue to dominate the Internet, this segment is reaching saturation, and first-time users will soon be taking on a new look.

The Inteco research shows that growth among female users will outpace that of males. Single female households comprise 30% of all households that expect to adopt Internet usage in 1999. Research also showed that middle and lower-income households account for 55% of those who intend to become Internet users in the next 12 months.

Netscape Communicator 4.6 Available for Download

Key Features of Communicator 4.6

- Browser makes it easier and faster to find information with simple keywords
- Delivers performance improvements for page loading
- Includes RealPlayer streaming audio and video player from RealNetworks.

SmartBrowsing is the key new feature of Netscape Communicator 4.6 now available for download at **<home.netscape.com>**. With SmartBrowsing, Communicator 4.6 makes it faster and easier for consumers to find helpful Netcenter services such as weather and sports information by simply entering new expanded Internet Keywords such as 'places to stay in London' into the Navigator browser location bar.

In a direct dig at Microscoft, Netscape claims that speed enhancements enable Communicator 4.6 to outperform Internet Explorer 5.0 in page loading from the top 100 Internet sites over a modem. Communicator 4.6 now also includes RealNetworks RealPlayer G2, the streaming audio and video player.

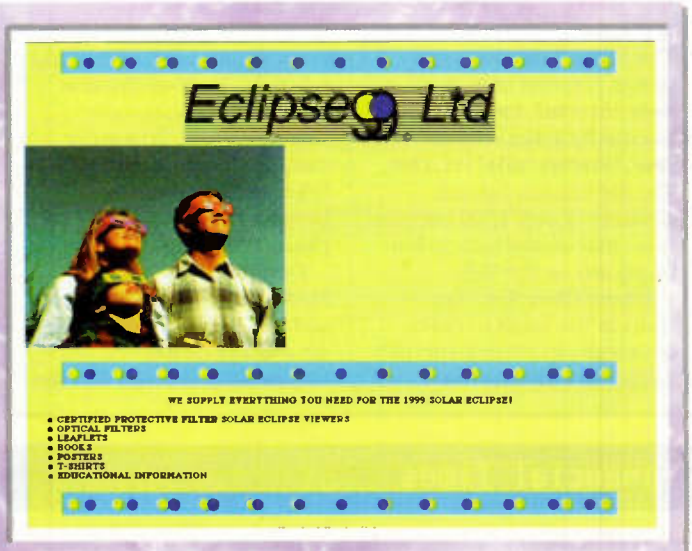
Site Survey

The months destinations

The Dark Side

If readers still aren't aware (and you must have been abroad or be called Rip van Winkle if you're not) there is a solar eclipse, viewable in Britain, on Wednesday 11 August. This eclipse is total in the far south of the UK (the path of totality passes through Cornwall and Devon), but will also provide spectacular views of a major partial solar eclipse around the rest of the UK (somewhere around 90% of the sun will be eclipsed over a large area of the country). Checkout the UK Eclipse Website, on: **<http://www.eclipse.org.uk>** for further details, and links to many more eclipse-related locations.

One of the things everyone should be aware about is that looking at the sun during an eclipse (even a total eclipse) is dangerous to the eyes. It is vitally important that everyone who intends to view the eclipse has eye protection in the form of properly approved solar filters. Further information is available on the UK Eclipse Website, and filters are available from several suppliers, including Eclipse99 Ltd, whose Website is at: **<http://ds.dial.pipex.com/eclipse99page/>.**



Apple QuickTime multimedia software has received a boost recently, with an upgrade to version 4. Currently in a highly usable late-beta stage, you can download QuickTime 4 to your computer (Macintosh and Windows versions are available), as a free download from: **<http://www.apple.com/quicktime>.** Interestingly, there have been more than three million downloads of QuickTime 4 already since its launch just a few weeks ago.

QuickTime 4 features 'streaming' of live and stored video and audio over the Internet, and is the first Internet streaming solution to use open, industry-standard protocols that allow free serving features for multimedia providers and free streaming by computer users. Leading media organisations (including the BBC) have already adopted QuickTime 4 to provide high-quality streaming of live and stored programming over the Internet. Try it yourself - once you've got QuickTime 4 installed on your computer you can view the four Star Wars: Episode I television commercials in high-quality QuickTime movie format, at: **<http://www.apple.com/quicktime/showcase/lucasfilm/commercials>.**

Future Reusable Space Vehicles AND THE INTERNATIONAL SPACE STATION

PART 1

Dr. Chris Lavers describes the latest developments in space launchers in this first part of a series.

RESEARCH NEWS

Figure 1. Space Shuttle Discovery Returns From Space. Courtesy NASA.

The present time is of considerable excitement for the world's space faring nations with the deployment of the first modules of the International Space Station (ISS). This month's article will look at the diversity in the design and testing of future reusable space vehicles for near earth orbits using advanced composite materials, improved performance, and reducing mission costs. The second and final part will focus upon the International Space Station itself, with particular emphasis on European involvement, and future space tourism. Both areas offer the opportunity to transfer government controlled technology into the civilian sphere in a similar manner to the skills transfer affected in the American civil aviation sector during the 1920's and 30's.

Future Reusable Space Vehicles

1996 will be remembered as a milestone year for space transport. It was the first time commercial space revenue exceeded government spending of $77 Billion. Growth has continued in 1997 with 150 commercial, civil and military payloads placed in orbit. According to analysts at Harvard University commercial launches will multiply in the next few years, one estimate expects 1,200 telecoms satellites to be launched between 1998 and 2007. In essence a space 'Gold Rush' is in progress which in terms of facts and figures will leave the California gold rush in its wake. Enthusiasts look to the not so distant day when both professionals and ordinary people, may leave Earth behind and head for a space station resort. The biggest barrier to overcome is the sheer difficulty, costs and risks involved. Conventional rockets, mostly developed by governments, cost approximately 20k$/kg delivered to Low Earth Orbit (LEO). The space shuttle, operated privately by United Space Alliance, a joint venture of Boeing and Lockheed Martin, costs the same as typical expendable rockets due primarily to its large scale 'Apollo' infrastructure. The shuttle has been unavailable for commercial launches since the Challenger disaster in 1986, but if outfitted for paying passengers today, with 50 passengers per flight, each would pay 48.4$M to break even!

The demonstration of advanced launching and reusable vehicles for deployment on the International Space Station (ISS) sits upon a background of mass ratios. The ideal reusable launcher would be like a normal aircraft, taking off from many Earth bases, enter desired orbit, release its payload, de-orbit, dissipate kinetic energy and land at the take-off base for its next flight after a short turn-around. The vehicle would maintain its physical integrity during mission, be flown many times and have a cost per flight compatible with the value of the mission. The vehicle would also be able to abort its mission at any time and land safely with its payload. The ideal vehicle is a Single Stage To Orbit-Reusable Rocket Launcher or SSTO-RRL. However, all current space launchers are staged to orbit and expendable (with the exception of the Space Shuttle (see Figure 1), and no SSTO-RRL exists as yet, despite its necessity.

The Problem

Because rocket propulsion is mandatory to accelerate to orbital speed, the most logical design option is to use rocket propulsion from take-off until orbit is achieved, overcoming gravity and drag losses. A spacecraft needs energy to leave the Earth's gravity field. Suppose a spacecraft weighs W at launch, if rocket thrust is greater than this the spacecraft will rise gaining gravitational energy. If the energy gained is more than WR, (R is the Earth's radius), gravity will not pull the spacecraft back to the surface. The most inefficient way to do this is to have a thrust slightly greater than the weight. The vehicle moves up slowly but runs out of fuel before achieving orbit. The most efficient approach is to launch the vehicle very quickly giving it kinetic energy so it can then coast the rest of the way, slowing down as it gains gravitational energy. The launcher will have enough kinetic energy if its launch velocity is at least 11km/s. However, a high acceleration is unacceptable for a manned launch and the tremendous heat generated by atmospheric friction, means that a compromise is needed. A constant shuttle acceleration of 30m/s/s (3g) out of the atmosphere in about 30s gains a speed of nearly 1km/s. Five minutes after launch the vehicle will reach escape velocity and Earth's gravity will have dropped by a third, and rockets may be turned off.

The ideal velocity increase, ΔV, required for SSTO is about 9km/s in order to reach LEO. All further considerations concentrate on reaching LEO, because this is the most difficult part of gaining access to space and the major hurdle to be mastered in terms or reusability. The mass that can be accelerated into orbit using rocket propulsion is given by the equation:

$$M_1/M_0 = \exp(-\Delta V/V_e)$$

where M_0 is take-off mass, M_1 is the mass which has received the ideal ΔV, and Ve the rocket

engine ejection velocity. For a given ΔV, the mass ratio M_1/M_0 increases with increasing V_e. The highest practical rocket ejection velocities are achieved by burning hydrogen with oxygen and ejecting the exhaust gases through a convergent/divergent nozzle. Averaged over the trajectory, the exhaust velocity V_e is about 4km/s. The resulting mass ratio to reach LEO is $M_1/M_0 = \exp(-9000/4000) = 0.105$ or approximately 10.5%, hence 89.5% of take-off mass must be propellants and only 10.5% of take-off mass remains available for propellant tanks, engines, and the payload. If the payload is 1% of the take-off mass the mass fraction left to build the complete launcher is 9.5%. Mass ratios of 10% are achieved with expendable stages but cannot currently be achieved for a reusable vehicle which must carry the extra provisions for recovery and reuse. To increase the mass ratio increasing V_e by 10% would give a 25% increase in mass ratio, but to achieve this would need a propulsion system producing the required thrust whilst consuming less propellant. Hence the possible benefits of future partial air breathing systems such as SKYLON a UK proposal, derived from the scrubbed HOTOL programme. If ΔV were less the mass ratio could be increased, but reducing ΔV leads to more stages to reach orbit and a secondary propulsion system. So SSTO goes if you take this route. A variety of staging options have been trialed, including an Aircraft Launched or SSTO-AL RRL, using an Antonov-225, but is not a route Europe is investigating.

RTL and DRL Systems

Return To Launch (RTL) site and Down Range Landing (DRL) systems have been investigated, where a reusable first stage rocket carries a reusable or expendable second stage rocket. In the RTL mode, the first stage returns to the launch site after separation. RTL is practical if the first stage does not re-enter too far down range. In the DRL mode the first stage provides a large share of the total ΔV and is allowed to land down-range of the launch site. The TAKANIS pilot study was conducted for ESA by Aerospatiale in the early 1990s. However, there are three configurations to maintain aerodynamically, first stage to LEO, second stage if reusable, and the composite. ESA rejected this as the expendable Ariane-5 already met their present requirements and has significant evolution potential.

In Sub Orbital Single Stage Once Around SOSS OA the Down-Range ability of the first stage is extended to complete one trip round the Earth to land back at the launch base. The first stage provides almost all the ΔV needed to reach orbit and the payload achieves orbital velocity with its own propulsion system. The payload must provide its propulsion into orbit (from 0.3 to 3km/s) to compensate for the ΔV deficit of the sub-orbital stage. For many payloads LEO is not the ultimate destination, and many acquire higher energy orbits. With reusable stages, SOSS provides the largest possible ΔV, leaving the payload to provide the complement needed to achieve orbital conditions. A greater lift-to-drag ratio at hypersonic speeds permits a greater down-range capability, a larger possible velocity deficit with respect to orbital speed, which in turn permits a greater launcher dry mass. Suitable shapes for the hypersonic glide-back flight are so called 'lifting bodies.' After achieving good aerodynamics the launcher must be evaluated in terms of Horizontal Take Off (HTO) with lifting ascent on rocket power only or Vertical Take Off (VTO). The integrated velocity losses associated with HTO are less than with Vertical Take Off (VTO) on rocket power. A conventional SSTO must rely on VTO because its low mass fraction does not permit the introduction of a heavy lifting surface on ascent (and for return glide). For a reusable vehicle, VTO creates some problems, the rocket engines which provide the thrust to lift the vehicle off the pad must be located at the base of the vehicle, which shifts the empty craft's centre of mass to the rear and compromises the aerodynamic shape in order to maintain a controllable vehicle at re-entry. VTO remains a dangerous phase and while this is normal for an expendable launcher, it is not ideal as a manned reusable vehicle! Finally VTO requires a heavy ground infrastructure which is both costly and limits the number of launch bases.

The SSO-OA launcher needs aerodynamics for its return flight, and has the ΔV savings of HTO in a lifting ascent, and the vehicle's weight is carried by the lift generated by its forward speed. Only drag generated by the lift has to be compensated for by thrust. Rocket thrust to accelerate the vehicle at the rate of 0.5g is sufficient, so the total thrust needed by a HTO is reduced, leading to reductions in engine mass, cost, and crew discomfort at launch! HTO also provides increased engine-out capability and thus greater safety. The vehicle can rest on a passive trolley on a linear ground track a few kilometres long. The vehicle accelerates under its own rocket power until the appropriate velocity is reached, causing the vehicle to lift from the trolley and continue its ascent. The HTO lifting ascent phase prolongs the time spent in the Earth's atmosphere by several minutes which may allow some form of air-breathing rocket propulsion to be added. By now the SSO-OA has many parallels with conventional aviation - horizontal movement, take-off and ascent, gliding or powered hypersonic flight, horizontal landing with similar engine-out tolerances. The vehicle can cover all speed ranges from low subsonic to near orbital through the whole depth of the atmosphere. It could also serve as a high speed global transport vehicle. Technologies being pursued envisage cruising at speeds up to Mach 5.5. A SOSS-OA with a boost glide allows global travel; the vehicle is accelerated to high speed (Mach 10-15) by rocket or rocket plus air-breathing

Figure 2. X-33 Advanced Technology Demonstrator. Courtesy NASA.

propulsion, to follow a ballistic arc in near-vacuum, re-enter and dissipate kinetic energy during a hypersonic glide at high altitude. Once this energy is dissipated, the vehicle can make a conventional aircraft landing. The advantages of boost glide for global travel are that the boost phase is pure acceleration over a small area only. Rocket exhausts contain no nitrous oxides as no air is combusted. The ballistic phase is outside Earth's atmosphere and has no damaging effect upon it. The hypersonic glide is at such high altitudes that the sonic boom does not reach the ground so that land masses may be overflown. The vehicle's high speed allows the benefit from centrifugal force to reduce the required lift and drag and provides a greater operating range. Global travel times are significantly reduced. NASA has selected Lockheed Martin to design, build and fly the X-33 test vehicle during 1999 as its future Single Stage To Orbit vehicle. Daniel Goldin stated that the X-33 will demonstrate advanced technologies that will dramatically increase reliability and lower the cost from 10k$ to 1k$ per pound into space. The X-33 program (see Figure 2) will demonstrate a fully Reusable Launch Vehicle (RLV) with no throw away parts, dubbed the *'Venture Star'*, using a half-scale prototype. Unlike earlier rocket engines the geometry of the exhaust will be controlled by its own flow, rather than by a traditional bell-shaped nozzle, giving greater efficiency, since a fixed nozzle will only be at peak efficiency at one pressure or altitude. In a bell nozzle engine exhaust gases flow through a constriction and then expand away from the centre line of the nozzle. Careful design is needed to avoid flow separation from the nozzle's walls operating at low altitude. Conventional bell nozzles are optimised for a specific altitude and ambient pressure, and perform less good elsewhere, but the aerospike automatically adjusts for optimum performance at all altitudes. In an aerospike nozzle, the exhaust is directed inwards from several smaller thrusters. This flow is directly exposed to the airstream and coupled to the external atmosphere by continual compensation. The aerospike engine incorporates linear thrusters on both sides of a central truncated cone nozzle. Hot gas from each nozzle expands along the spike on one side and into the free air on the other. The thrust is spread uniformly across the entire base of the rocket. The X-33 re-entry trajectory is designed to minimise the temperature, allowing a cooler re-entry than experience by the Shuttle (1175°C compared with 1260°C) and allows well-characterised and durable Carbon composites for the nose cap and leading edges above 980°C; InCo-617 for 700 to 980°C; and Titanium Ti-110 for temperatures under 700°C. The airframe will be made of Carbon fibre epoxy composite. For the comparatively low temperatures of the leeward side, conventional insulation blankets will be used. Temperature evaluations have been gathered by 940 hours of wind tunnel tests. Two panels of InCo-617 and Ti-110 flew on the Space Shuttle Endeavour during the STS77 mission.

Private Industry and the RLV

The program goal is to enable private industry to build and operate the RLV in the first decade of the 21st century, NASA will be a *customer*, not the operator. This represents a fundamental philosophy shift away from full Government control that has been a dogma of space launching. Even ESA, which is a non-Governmental organisation, may become so if full Political and Economic integration takes place in Continental Europe. The Lockheed Martin Skunk-Works X-33 design is based on a lifting body shape and a rugged metallic thermal protection system. It will be an unmanned vehicle rocket launched vertically to 50 miles with speeds exceeding Mach 15. Shuttle turnaround currently averages 50 days, the X-33 will need only 7 and must demonstrate a 2 day emergency turnaround time between flights. NASA has budgeted £941M for the X-33 program through 1999, while Lockheed Martin will invest £212M in its X-33 design. A full-scale version should be operational by 2005. The announced selection of the X-33 by NASA Administrator Daniel Goldin on July 2nd 1996, put paid to Rockwell's proposal and McDonnell Douglas' vertical landing rocket or DC-XA Clipper Graham- symbolic of the old *'Lost in Space'* variety, which spectacularly fell over on 31 July 1996 at White Sands Missile Range, when one of its legs broke on landing and unceremoniously burst into flames. The McDonnell Douglas design could take off and land almost anywhere but of course is not a lifting body.

ATV Development

The development of an Automated Transfer Vehicle or ATV was confirmed by ESA in October 1995 in Toulouse, France by ESA's Ministerial Council as part of the co-ordinated programme for full European participation in the ISS. The ATV will be a servicing and logistics vehicle for Station resupply like the Russian *Progress* used with partial success on the MIR Space Station! As prime contractor for the ATV Aerospatiale is responsible for overall management, system and vehicle engineering, testing, software development and vehicle verification. Daimler-Chrysler is the prime contractor for ATV production which will probably begin late 2000, subject to approval by ESA Member States. Ground processing will take place in Europe and at the Korou launch site in French Guiana. Flight operations will be controlled from the ATV Control Centre in Europe during the free-flight phase and taken over by either the Moscow Centre and/or the Space Station Control Centre in Houston, Texas when in Station approach and docking procedure.

Final contracts with Aerospatiale were signed on 25 November 1998. The first ATV launch will take place in March 2003 on an Ariane-5E rocket. The maiden launch will include specific mission objectives to provide the following ISS services:

1. Delivery of dry and liquid cargoes such as experiments, food, air and water.
2. Station refuelling, transferring propellant to the Zarya (FGB) module, built for Boeing by the Russian company Khrunichev.
3. ATV propulsion provides orbit correction and allows for attitude control of the station (the current Hubble Telescope loses some 15km between re-boost phases).
4. Station waste removal followed by controlled destructive re-entry of the ATV.

Payload Capability

The ATV (shown in Figure 3) carries dry and liquid cargoes up to 7.5tonnes and a download up to 6.5tonnes for a projected 400km, 51.6° inclined orbit. The upload cargo could consist of 5500kg of dry cargo carried in a pressurised environment, up to 840kg of water, 100kg of air, oxygen or nitrogen, and 860kg of propellant for Station refuelling and re-boosting.

ATV Mission Profile

The Ariane-5E launch will inject the ATV into a 300×300km transfer orbit taking 50 hours to complete. All ATV operations are monitored from the European Control Centre via NASA's Tracking and Data Relay Satellite (TDRS) system. Following this a series of reconfiguration and check-out operations is performed, notably solar array deployment. A series of phasing manoeuvres is performed to bring the ATV to the station altitude of 350-460km. 90 minutes before the ATV enters final approach, mission authority is transferred to the Mission Control Centre in Houston or Moscow. 30km from the ISS, the ATV performs final approach and docking manoeuvres automatically over a five hour period, with automatic or manual over ride capability held by the Station crew to trigger a collision avoidance manoeuvre should any problem develop. Upon detection of the first contact between the ATV docking system and the Russian Service Module, the ATV thrusts to ensure capture and then triggers an automatic sequence of docking operations. The ATV may remain attached to the ISS up to 6 months. During this phase, the ATV's hatch remains open unless closed to minimise power required from the Station. The crew manually

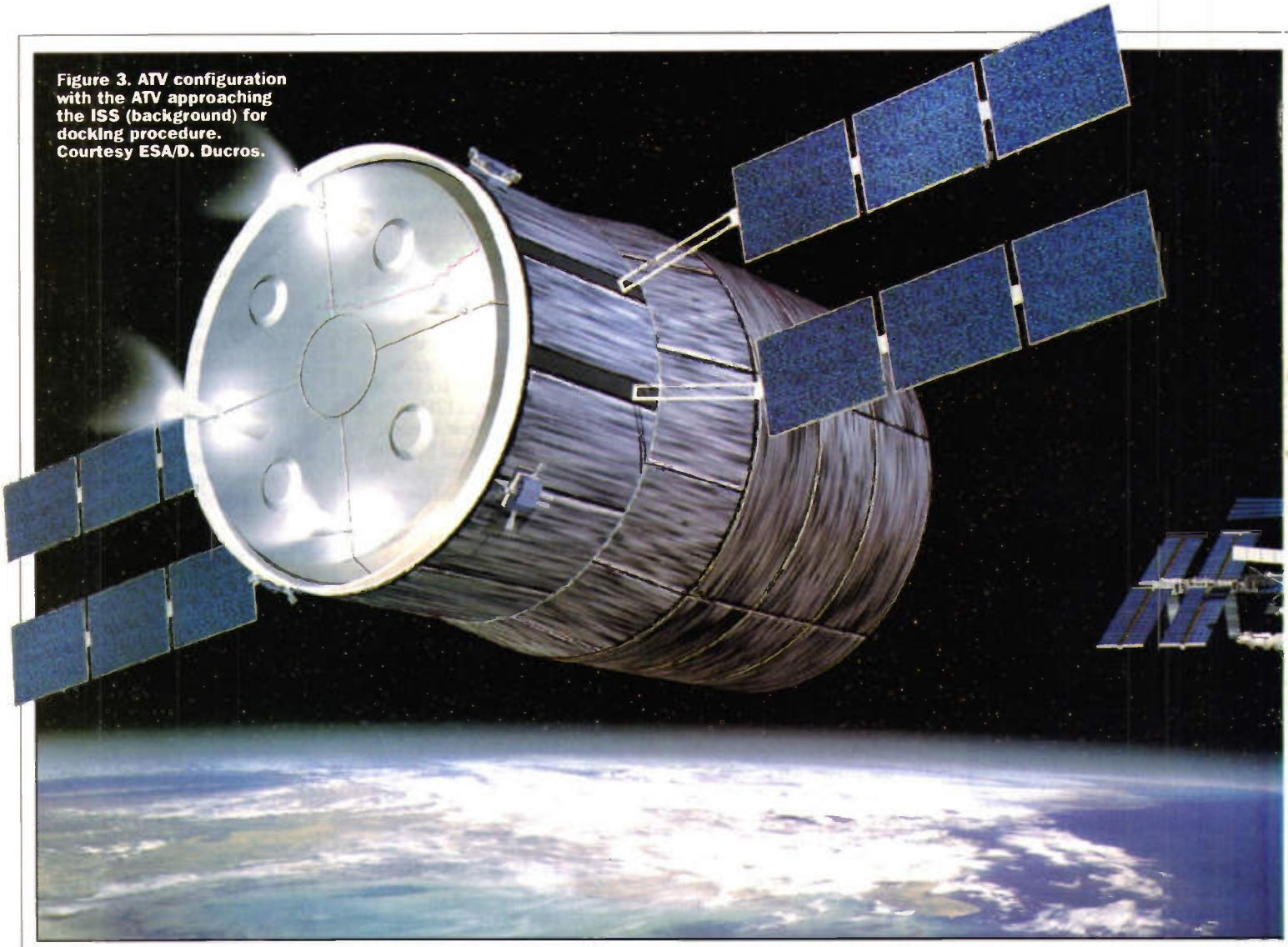


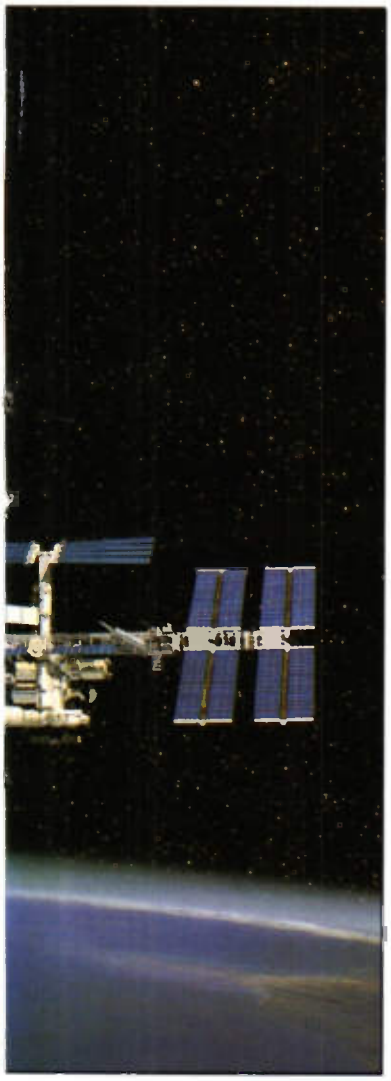
Figure 3. ATV configuration with the ATV approaching the ISS (background) for docking procedure. Courtesy ESA/D. Ducros.

Figure 4. The Destructive re-entry flight of the ATV. Courtesy ESA/D. Ducros.

unloads cargo through a pressurised passageway with dry cargo located in a pressurised environment in the secondary Cargo Carrier structure. Propellant tanks in the external module of the Cargo Carrier carry up to 300kg of fuel and 554kg of oxidiser. The ATV is reactivated during attitude control and re-boosting operations, allowing the four 490N thrusters of the main propulsion system to be employed, or the twenty 220N attitude control system thrusters. After Station departure the ATV automatically performs manoeuvres for de-orbiting and controlled re-entry into Earth's upper atmosphere, safely burning up. Guidance, navigation and control calculations are based on two Global Positioning Satellite (GPS) receivers for position estimation, four

Length	10.1m
Maximum diameter	4.5m
Span with solar arrays deployed	18.3m
Power supply	3.8kW after 6 months
Spacecraft dry mass	4.6 tonnes
Cargo Carrier dry mass	3.9 tonnes
Net cargo mass	Up to 7.5 tonnes
Total ATV maximum mass at launch	20.5 tonnes

Table 1. ATV Characteristics.



gyroscopes and two Earth sensors for attitude estimation, and on two rendezvous sensors for final approach and docking. Communications with the ATV are provided by two S-band systems: a ground communications link and a proximity link for communications with the Station. Four deployable solar arrays generate the ATV's power. Rechargeable batteries are used to cover eclipse periods and directly power the equipment, plus non-rechargeable batteries are also used during certain flight phases. During the attached phase, the ATV requires about 600W from the Station. Each solar arrays consists of four wings with three panels on each. Both gallium arsenide and efficient silicon cells are used. Power at start-of-life may be 3.86kW pointing towards the Sun, falling to 3.8kW by the end of its operational life.

Vehicle protection against the space environment is provided by multi-layer insulation coverings. External radiative coatings (aluminised secondary surface mirrors or absorptive black paint) are optimised locally. Passive radiators and 100 active heaters are also used where necessary, particularly during the attached phase. The ATV spacecraft structure is also protected by a multi-layered 'Meteoroid' and 'Debris' system.

X-33	Venture Star
Length 63ft	Length 127ft
Width 68ft	Width 128ft
Takeoff weight 273,000lbs	Takeoff weight 2,186,000lbs
Fuel LH2/LO2	FuelLH2/LO2
Fuel weight 210,000lbs	Fuel weight 1,929,000lbs
Main Propulsion	Main Propulsion
2 J-2S Linear Aerospikes	7 RS2200 Linear Aerospikes
Take-off thrust 410,000lbs	Take-off thrust 3,010,000lbs
Maximum speed Mach 15+	Maximum speed Orbital
Payload to Low Earth Orbit N/A	Payload to Low Earth Orbit 45,000lbs

Table 2.

Figure 6. Digitally mastered Artistic Splashdown of the ARD in the Pacific Ocean. Courtesy ESA/D. Ducros.

Protection System

Propulsion and Reboost systems use mixed oxides of nitrogen (MON, oxidiser) and monomethyl hydrazine (MMH, fuel) stored in eight identical 1m diameter Titanium tanks pressurised with Helium stored in two high-pressure tanks regulated to 20bar. Tanks can accommodate up to 6760kg of propellant for navigation and re-boosts. Each of the 490N main engines can provide a specific impulse of over 310Ns, and 20 attitude control thrusters of 220N each and a minimum impulse of 5Ns. The major ATV characteristics and vital statistics are given in Table 1. The ATV is an expendable supply vehicle for the transport of equipment and propellant to the ISS and must be destroyed during re-entry (Figure 4). Thermodynamic calculations must guarantee that burn-up occurs in the upper atmosphere so that no parts of this large vehicle fall to earth. However, the Atmospheric Re-entry Demonstrator (ARD) is a guided re-entry vehicle of the Apollo type launched on the third Ariane-5 test in October 1998 (see Figure 5). The successful splashdown is simulated in Figure 6.

TO BE CONTINUED...

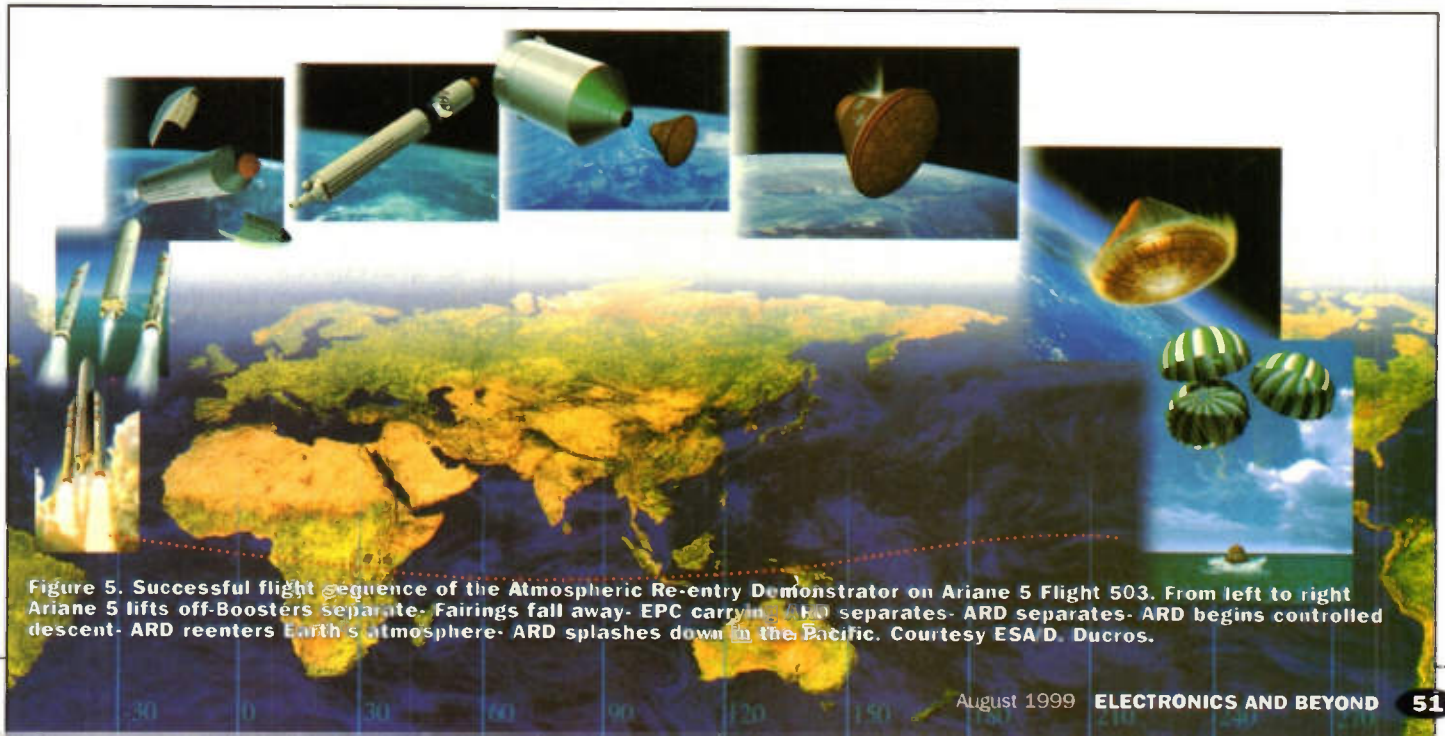


Figure 5. Successful flight sequence of the Atmospheric Re-entry Demonstrator on Ariane 5 Flight 503. From left to right Ariane 5 lifts off-Boosters separate- Fairings fall away- EPC carrying ARD separates- ARD separates- ARD begins controlled descent- ARD reenters Earth's atmosphere- ARD splashes down in the Pacific. Courtesy ESA/D. Ducros.

Bell Labs - 75 YEARS OF INNOVATION

Gregg Grant looks at the history of this pioneering research establishment.

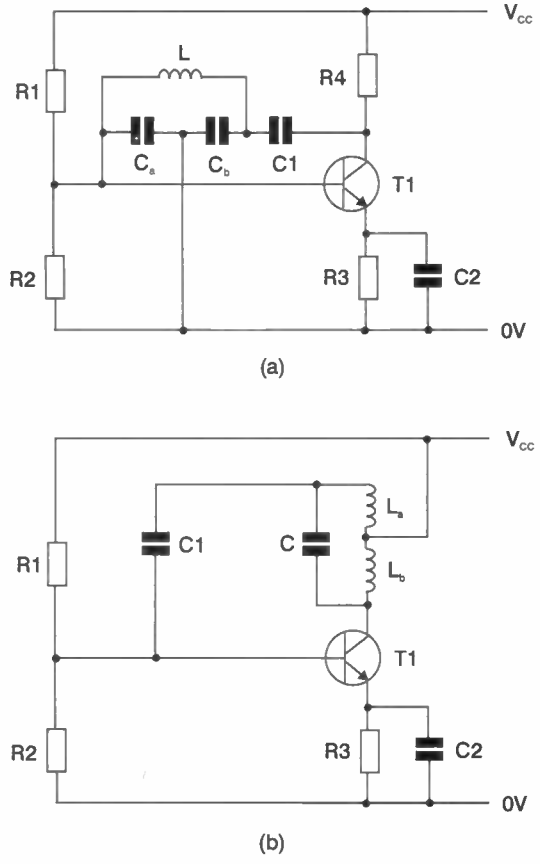


Figure 1. Two of the most enduring oscillator designs: a) the Colpitts circuit: b) the Hartley circuit.

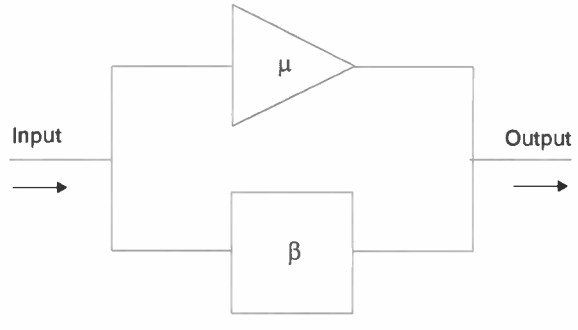


Figure 2. The Negative Feedback Amplifier concept.

Introduction

Bell Telephone Laboratories - known throughout the world simply as Bell Labs - are 75 years young. Until recently probably the only non-profit-making organisation of its kind anywhere, it has earned an enviable reputation for scientific and technical innovation in electronics and telecommunications. Moreover, as a seedbed for Nobel Prizewinners, it has rarely been equalled.

Starting Up

Bell Labs were but one result of the most lucrative patent ever issued. This was United States Patent number 174,465, granted to the Scots-born immigrant Alexander Graham Bell in 1876, for his invention of the Telephone. It would be the first of some 18 patents granted to Bell in his own name, although he did share a further 12 with various collaborators. No less than 14 of these patents - some 47% - dealt with improvements to his original device.

In 1879 the National Bell Telephone Company was set up, its authorised capital standing at $850,000. Telephone growth in the United States was little short of spectacular, due in the main to Bell's policy of leasing his equipment to local companies.

In the following year Western Union, having rejected Bell's invention and regretting this mistake, began to develop its own telephone system. Bell promptly sued for patent infringement, the resulting legal wrangle being finally settled by Western Union moving out of the Telephone business and Bell - in return - agreeing to cease competing in the telegraph field. This arrangement was to last for 17 years.

But there were catches, Bell had to purchase Western Union's telephone equipment and to do this, the American Bell Telephone Company was created. Two years later, Bell bought the Chicago-based Western Electric Manufacturing Company, the makers of much of Western Union's telephone equipment. The company became the product manufacturing arm of the Bell organisation.

Another problem was interconnection, created by the very success of the telephone. Increasingly, demand outstripped the number of available lines between city exchanges. Consequently in February 1885 the American Telephone and Telegraph Company - the later, mightier AT&T - was created, expressly to lay and operate the telephone lines throughout the continental United States.

Alexander Graham Bell himself had demonstrated the importance of basic research and in 1883, the Bell organisation set up an experimental section. Almost a quarter of a century later, the engineering departments of AT&T and Western Electric were centralised in New York City. This centralisation was the beginning of what would become, in 1924, the Bell Telephone Laboratories. Located at Murray Hill, New Jersey the laboratory rapidly developed a freedom in its research activities that was at once admired and envied elsewhere, even in some universities.

This came about because the Bell system was, in effect ' . . . a legally sanctioned monopoly with regulated profits' ' and so could write off the laboratory's costs as

Year	Invention/Development
1931	Research engineer E. Bruce invents the wideband Rhombic HF Antenna.*
1936	Invention of the Cold Cathode Trigger Tube, by research engineer S. B. Ingram.**
	Paper on 'Hyper-Frequency Waveguides' published by J.R. Carson; S.P. Meade; S.A. Schelkunoff and G.C. Southworth.
	Voice Coder - the 'Vocoder' - developed to analyse pitch and energy content of speech waves.
1939	Engineers at Bell Labs invent the Radio Altimeter.
	Research physicist A.W. Horton invents the OR gate.
	Engineers G. Stibitz, T.C. Fry and S.B. Williams develop the 'Complex Computer,' which began operation in the following year, remaining in daily use for nine years.
1941	Research physicist W.H.T. Holden invents the AND gate.
	Bell physicist J.H. Scaff re-names the British physicist A.H. Wilson's defect and excess types of semiconductor p-type and n-type.
	J.H. Scaff and H.C. Theurer manufacture melts of silicon.
1947	Bell Labs develop CHIRP, or Pulse Compression, for radar.
1948	Engineers G.K. Teal, J.B. Little and M. Sparkes grow germanium single crystals, devising a unique way of preparing p-n junctions. They rapidly followed their early success with n-p-n grown-junction transistors, which possessed many properties earlier predicted by their colleague William Shockley.
	Claude E. Shannon and William Weaver Publish their paper 'Mathematical Theory of Communications' in the Bell Labs Technical Journal.
1950	Bell Labs develop the diffusion process for p and n transistors.
	Howard Christensen, O.L. Anderson and Peter Andreatch develop Thermo-Compression Bonding, a technique particularly useful for connecting transistors to other electronic circuit elements.
	Russel S. Ohl and William Shockley develop the Ion Implantation technique for semiconductors.
	Richard W. Hemming devises the code called after him for correcting machine-caused errors in digital computers. This discovery would develop into a new area of research, termed Error-Correcting codes.
1951	The Modem invented. As a result, transmission speeds increase by 700% in less than 20 years. The late 1950s speed of 1200 baud had, by the early 1970s, become 9,600 bps.
1952	Research engineer S. Darlington invents the Darlington Pair circuit.
1953	R.F Mallina and colleagues develop the mechanical basis of wire-wrapped joints.
1954	Research physicists D.M. Chapin, C.S. Fuller and G.L. Pearson invent the Solar Battery.
1956	C.S. Fuller's research lays the foundation for the Diffusion Process for preparing p-n junctions. The result would be transistors capable of handling very high frequencies.
	The first transistorised computer - the Leprechaun - built at Bell Labs.
1957	Research physicist U.F. Gianole invents the Plated Wire memory.
	Research physicist C.J. Frosch develops the Oxide Masking Process for silicon.
1958	The Field Effect Varistor - based on the principles of Shockley, Dacy and Ross - is invented.
1959	Tantalum Thin Film circuitry developed by D.A. McLean, N. Schwartz and E. Tidd.
	M.M. Atalla discovers the materials combination for an Insulated Gate Field Effect Transistor (IGFET). This turns out to be silicon dioxide as the insulator and silicon as the semiconductor.
1960	H.H. Loor, Howard Christensen, J.J. Kleimock and H.C. Theurer develop Epitaxial Crystal Growth for transistor fabrication.
*	See 'Electronics & Beyond' No. 118, October 1997 article Hang 'em High!
**	See 'Elektor Electronics' Vol. 20 No. 219, February 1994 article All Gas and Vapour.

Table 1. Inventions and Developments at Bell Labs 1930-1960.

business expenses. That this approach to research was worthwhile, despite what individuals and other organisations thought of monopolies, would be amply borne out over the coming decades.

Early Successes

The principle concern of the Bell organisation of course was the improvement of telephone systems. All its research effort - in devices as well as techniques - was directed to this end.

One of the earliest improvements in telephone transmission was the Loading Coil, invented and patented by Columbia University's Professor Michael Pupin in 1899. Its successful application in telephony, however, was the work of one of the great names in communications engineering, Edwin H. Colpitts.

Born in Pointe de Bute, Canada in 1872, Colpitts already held a Bachelor's degree in engineering from Mount Allison university New Brunswick when, in 1896, he earned another at Harvard. As the century drew to a close, he joined the American Bell Telephone Company.

He began what would become a 38-year career working on the development and application of loading coils to telephone circuits with another distinguished Bell engineer, George A. Campbell. Indeed it was as a result of his work with Campbell that communications engineering began to understand the band nature of modulated signals, as opposed to the single frequency of the communicating channel.

Campbell developed the electronic filter in 1909 and, in the following year, produced the earliest filter response curves, the result of his mathematical analysis of his design. Two years later Low Pass filters were in use and Colpitts had '. . had invented one of the most famous and enduring of electronic circuits,' [2] the Push-Pull amplifier. He followed this with the oscillator called after him in March, 1915. This was approximately a month after another Bell physicist, Ralph Hartley, revealed his oscillator circuit. Both are shown in Figure 1.

Hartley too had a long career with Bell Labs. He had graduated from the University of Utah in 1909, immediately sailing to Britain to become a Rhodes Scholar at Oxford. There, he graduated with a BA degree in 1912 and a BSc in physics in the following year. On his return to America he joined the Western Electric Laboratories and by 1915, was the managing engineer for Bell System's radio telephony tests, his specialisation being the development of radio receivers. It was during this period that he announced his oscillatory circuit, on February 10th.

By 1920, Hartley's interests turned to telephone repeaters and carrier transmission, firstly with Western Electric and then, after 1924, with Bell Labs. Another of his achievements was the development of Hartley's Law, linking time, information and bandwidth.

This new insight into communications theory was put forward by its originator in his paper 'Transmissions of Information,' in 1927, at an international conference in Italy. Some 21 years passed before Information Theory advanced further when another Bell Labs physicist, Claude Shannon, introduced noise into Hartley's equations in his famous two-part paper 'The Mathematical Theory of Communication,' first published in the Bell System Technical Journal. Since its publication, the paper has been termed simply *Information Theory*.

By the end of his career, Ralph Hartley held some 72 patents. His colleague George Campbell also held a number of patents, almost all of which had been drawn up for him by J. R. Carson, a mathematician colleague at Bell Labs.

Carson in fact had another achievement to his name, besides his skill as a patent author. He was the first researcher to realise that only one sideband was required for the transmission of a speech-modulated carrier frequency. He also put forward the concept of Carrier Suppression, and so takes precedence as the inventor of Single Sideband (SSB) transmission and reception in 1915.

Three years later '. . the first commercial application of single-sideband showed that it was possible to use this technique to increase channel capacity.' [3] As the century progressed and the High Frequency (HF) band become even more crowded still, the technique began to be widely used.

Bell engineers were among the first to use the word *electronics* in relation to their profession. In 1919, A.T. & T engineers classified elements of telephone repeaters as either electrodynamic, electronic or gaseous. Yet the word had a slow acceptance, and it would not be found in any dictionary before 1940.

In 1926, Edward L. Norton - with a Master's degree from Columbia to add to his BS degree from the Massachusetts Institute of Technology (MIT) - began work at Murray Hill on network analysis. The result of his research would be the theorem named after him, a technique for analysing complex electronic circuits by deriving a simpler equivalent version of parallel resistance and a current source. This complemented the French telegraph engineer Léon Thévenin's theorem of 1883, which used series resistance and a voltage source, itself another solution to a problem caused by long distance line difficulties.

Norton remained at Bell Labs for the rest of his career. His interests were wide, embracing relay theory, data processing, automation and guided missiles. He was, for example, the patentee of the Nike missile's guidance system. On his retirement in 1963, he held over 20 patents.

Nineteen twenty-seven was a year of major developments at Bell Labs. The first Cable Television (TV) transmissions in the United States were carried out by research engineer Herbert Ives between Washington and New York. A Nipkow Disk was used for both transmission and reception. However, undoubtedly the development of the year was the concept of Negative Feedback, or NFB.

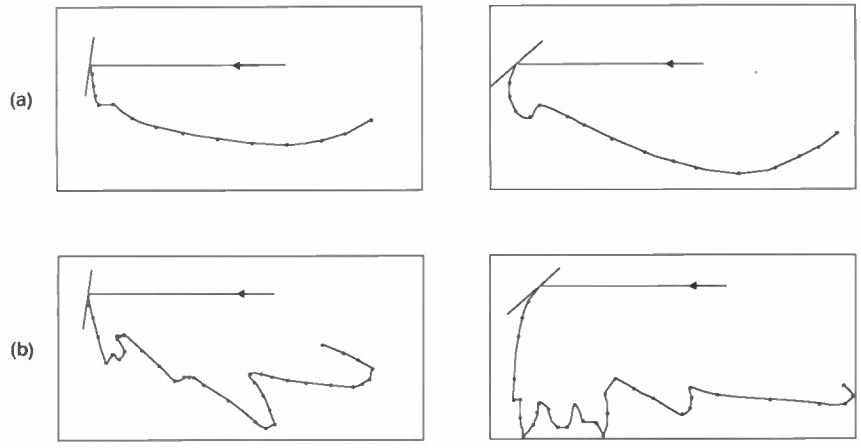


Figure 3. Davisson's 1925 curves for electron-scattering from nickel. Diagram (a) shows the curves for polycrystalline material, whilst Diagram (b) illustrates those resulting from small, single crystals. The difference between these curves was the earliest evidence of the wave nature of particles.

Basically, Harold Black's aim was simple and entirely in keeping with the raison d'être of Bell Labs: that of improving telephone communication. What he came up with however improved much more than telephone circuits. It fundamentally changed the communications industry.

The problem was the distortion common in all amplifiers. If - as Black hoped - designers were to increase the number of telephone channels which could be pushed through an amplifier, then this difficulty had to be beaten.

In August 1927, Black was travelling to work on the ferry across the Hudson River when, suddenly, a solution to the problem came to him: why not feed an amplifier's output back to its input in antiphase? The concept of the Negative Feedback Amplifier - illustrated in Figure 2 - was born.

Like many of us who get what appears - at the time - to be a good idea, he reached for paper to jot down his concept whilst it was still fresh in his mind. The nearest piece of paper to hand was his *New York Times* for that day, the 2nd of August. This newspaper ended up containing sketches for impedance matching between a feedback amplifier's output and a telephone line, signed by Black and his colleague E.C. Blessing.

By the year's end, Harold Black had built a working model of his conceptual amplifier, and found that distortion had been reduced by '. . . 100,000 (50db), more than enough to crack the problem . . . previously encountered in a telephone line when many amplifiers were used.' [5] The price paid was small: the sacrifice of some amplification.

Many 'experts' throughout the world thought that Black's concept would never work and Patent Offices on both sides of the Atlantic were equally as dismissive. The American Patent Office took no less than nine years to recognise Black's work and the British were no better. They would not move without a working model!

In 1932, Black's concept of Negative Feedback - long abbreviated by all electronics engineers to NFB - was put on a firm mathematical footing by two mathematical physicists at Bell, Harry Nyquist and Hendrik Bode. Nyquist's Criterion - or the Nyquist Diagram - showed the conditions required to prevent NFB amplifiers from oscillating and Bode improved the design of the feedback loop. NFB became an essential element of electronic design.

The Great Years

Throughout the 1930s, 40s and 50s, Bell Labs made many contributions to the development of electronics generally, the major ones of which are shown in table one. They also earned the first - of a number - of Nobel Prizes.

Bell Nobel Men

Particles Are Waves?

The first Bell Labs physicist to be awarded the Nobel Prize in physics was Clinton J. Davisson, who shared the 1937 award with the British physicist Sir George Thomson, for their discovery of the diffraction of electrons by crystals. Working independently, Davisson and Thomson demonstrated ' that a beam of electrons having a common velocity exhibits diffraction (a wave property) when impinging on a crystal lattice,' 'as shown in the curves of Figure 2.

Both men had carried out their experimental work a decade earlier and their results were the earliest evidence that wave systems were indeed associated with moving particles. This confirmed the hypothesis put forward by Louis de Broglie in 1925.

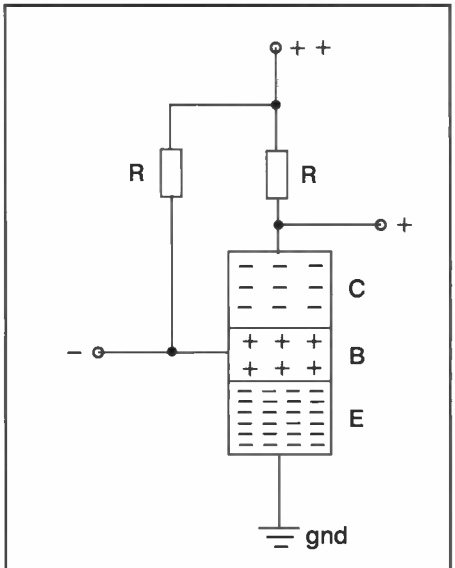


Figure 4. A bipolar n-p-n transistor circuit.

The Transistor

Undoubtedly the most famous Nobel Laureates at the Bell Labs however were William Shockley, Walter Brattain and John Bardeen, the co-discoverers of the transistor.

The research behind the device was begun in 1932, when Brattain and a colleague began to investigate semiconductors. In the course of this work, they found that rectification was - in reality - a surface property.

Seven years later, Shockley was attempting to make a semiconductor diode amplify as well as rectify. Although he failed in this, he wrote in his laboratory notebook that he felt it was possible to create a semiconductor device that could amplify.

Like much else, semiconductor research was interrupted by World War Two. By 1946 however, the research began again at Bell Labs, under Shockley's leadership. In the following year Bardeen and Brattain were experimenting with germanium when they discovered the Transistor Effect, which they first demonstrated on the 27th December, 1947.

They had placed two tiny metal contacts, a mere 0.005cm apart, on the surface of their germanium sample. Applying a small, variable current to one contact produced a greatly changing output at the other. The Point-Contact Transistor was born.

Some four weeks later, Shockley developed the Junction Transistor, which enabled control of the impurity distribution, resulting in either a p-n-p or n-p-n configuration within the semiconductor, the latter shown in Figure 4. The valve had been replaced at last.

Bell Labs developed the transistor of course because of their enduring concern with their prime function, that of improving telephone switching circuits. The new device however proved to be far more than simply a replacement for the valve. It would completely change the electronics industry, setting it off in an entirely new direction. All three physicists shared the 1956 Nobel Prize in physics for their discovery.

The Maser

The idea for the Maser - an abbreviation for *Microwave Amplification by Stimulated Emission of Radiation* - came originally from Albert Einstein. He had stated that if a photon struck a high energy molecule, that molecule would revert to a lower energy state and - at the same time - emit a photon of identical wavelength and direction of motion as the impacting photon.

Consequently two photons could then go on to strike two more high energy molecules with similar results. This effect would be rapid and culminating in an avalanche of photons all with the same wavelength - in other words monochromatic - and streaming in the same direction or - put another way - coherent radiation.

All of which made Bell Labs physicist Charles H. Townes consider the likelihood of taking this concept to its obvious conclusion: producing a very, very intensive beam of microwave radiation.

Townes had spent World War Two working on the design of navigational aids and radar bombing systems and so was aware of the increasing importance of microwaves. He also knew that the ammonia molecule vibrated 24 billion times per second.

Now if such molecules were raised to a greater energy level by, say, subjecting them

to either heat or electricity prior to exposing them to a microwave beam whose frequency was that of the ammonia molecule - i.e. exactly 1.25cm - you would end up with a far more powerful beam at the same wavelength.

In 1953, Townes finally succeeded in building a working Maser, using ammonia gas as his amplifying medium. He pointed out that what he had done for microwaves could also be done for virtually any wavelength, including light itself. Five years later, in collaboration with another Bell physicist, Arthur L. Schawlow, Townes laid down the conditions for LASER - *Light Amplification by Stimulated Emission of Radiation* - action. A Laser, in short, is simply an optical Maser. Later, Townes built another Maser using a ruby, an illustration of which is shown in Figure 5.

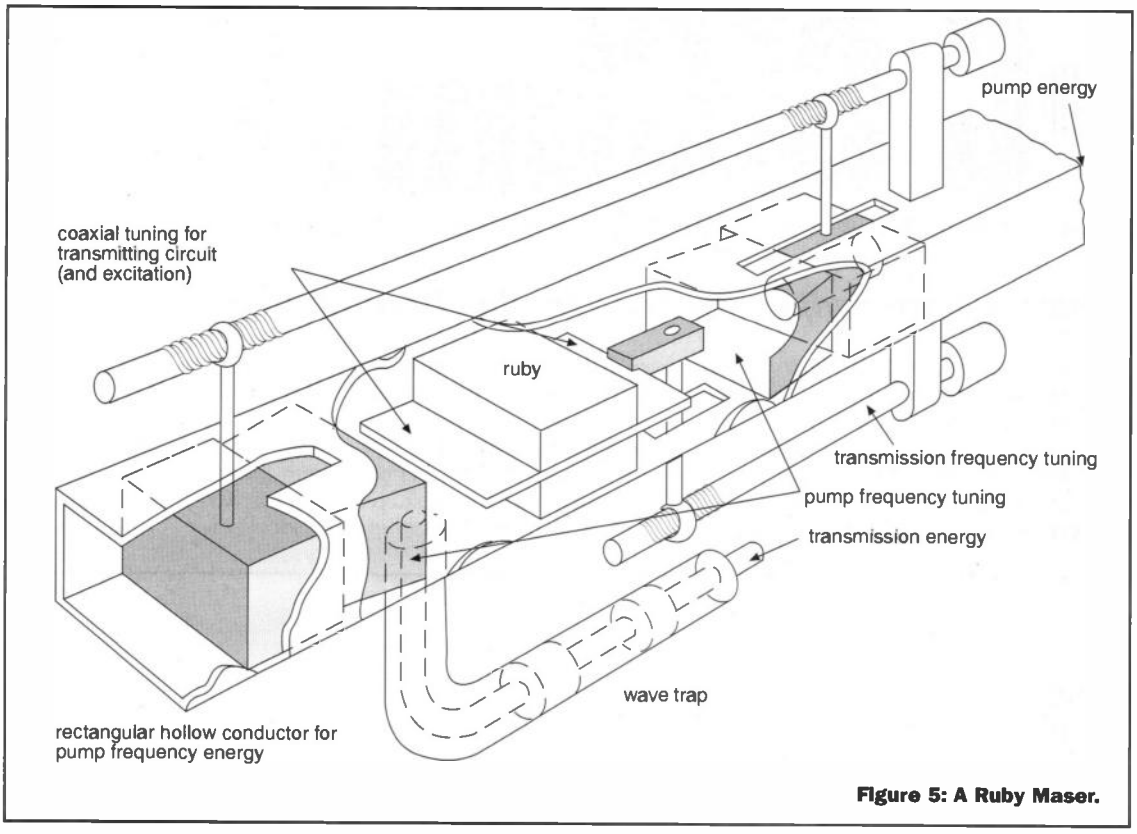


Figure 5: A Ruby Maser.

Maser action takes place so swiftly that transmitters and amplifiers operating on this principle are - to all intents and purposes - free of noise. Moreover, these devices can measure power outputs as low as 10-28 watts!

In 1964, Charles Townes shared the Nobel Prize in physics for his work on the Maser, which has subsequently led to both oscillators and amplifiers based on the principle. Seventeen years later Arthur Schawlow - now a professor at Stanford University - also shared the Nobel Prize for his work on Lasers.

The Act of Creation

In 1960, America launched *Echo 1,* the first passive communications satellite. The driving force behind the launch was the distinguished Bell engineer John R. Pierce, who had great faith in the future of satellite communications. This was an experiment involving microwave reflections from the satellite, the reception of which would be via an approximately 7m, horn-shaped antenna, designed and built at Bell Labs.

Four years later two Bell radio astronomers, Arno Penzias and Robert Wilson - shown in Figure 6 - decided to use the antenna to measure the intensity of the radio waves being emitted by the gas surrounding the galaxy.

Penzias - whose advisor as a graduate student had been Charles H. Townes - had joined Bell Labs in 1961, precisely because of the facilities for radio astronomy. Wilson, a Texan, had earned his PhD at the California Institute of Technology, (Caltech), with a thesis on radio astronomy.

By May of 1964 they became '. . worried when they found that their detector was picking up more noise than it ought to.'[6] They checked and re-checked their equipment, even evicting a couple of nesting pigeons from the antenna - and cleaning its interior - in the process.

On resuming their study the result was the same: the detection of the noise that had stopped them earlier whose intensity, it appeared, corresponded to that which a black body source would emit at a temperature of around 3.5K. Puzzled, the pair turned for advice to the astronomer Robert H. Dicke.

Dicke pointed out that the physicist George Gamow had, some 15 years earlier, put forward the idea that if the universe was - as a number of scientists thought - the result of a vast explosion, then there ought to be some residual evidence of this. Gamow had worked out that such evidence would take the form of a background radiation, one which was typical of a universe whose average temperature would now be little more than some three degrees above absolute zero.

What Penzias and Wilson had found, it seemed, was the earliest of all fossils: the remaining shards of the horrendous explosion that had created the universe originally. This momentous discovery earned Penzias and Wilson the 1978 Nobel Prize in physics.

Towards The Future

In 1984, AT&T was divested of its monopoly of the American telephone service. For Bell Labs, this spelt the end of research pure and simple. Other worldly concerns now entered the picture such as costs, budgetary constraints and market forces.

Figure 6. Robert Wilson (left) and Arno Penzias with the 7m horn-shaped antenna, designed and built at Bell Labs. (courtesy of Bell Labs/Lucent Technologies)

The organisation that had averaged virtually a patent per day over almost threequarters of a century and - in the process - given the world Talking Pictures, the Cellular Phone and the C Programming language had to face new rivals and altogether different conditions.

Presently, it is in the throes of embracing this new future. An organisation renowned among engineers and electronics physicists for its innovative design ability must now promote itself to the world at large.

The names AT&T and Bell for example will have to become as famous to customers seeking communications and electronics entertainment equipment as - for instance - Intel is in computer products.

One recent development for example is a solid-state memory card that can hold an entire cassette of songs, playable on a device no bigger than a pager. If a product like this is not commercial, then what is? AT&T Bell it seems is developing marketing instincts every bit as formidable as its three quarters of a century of scientific and engineering skills.

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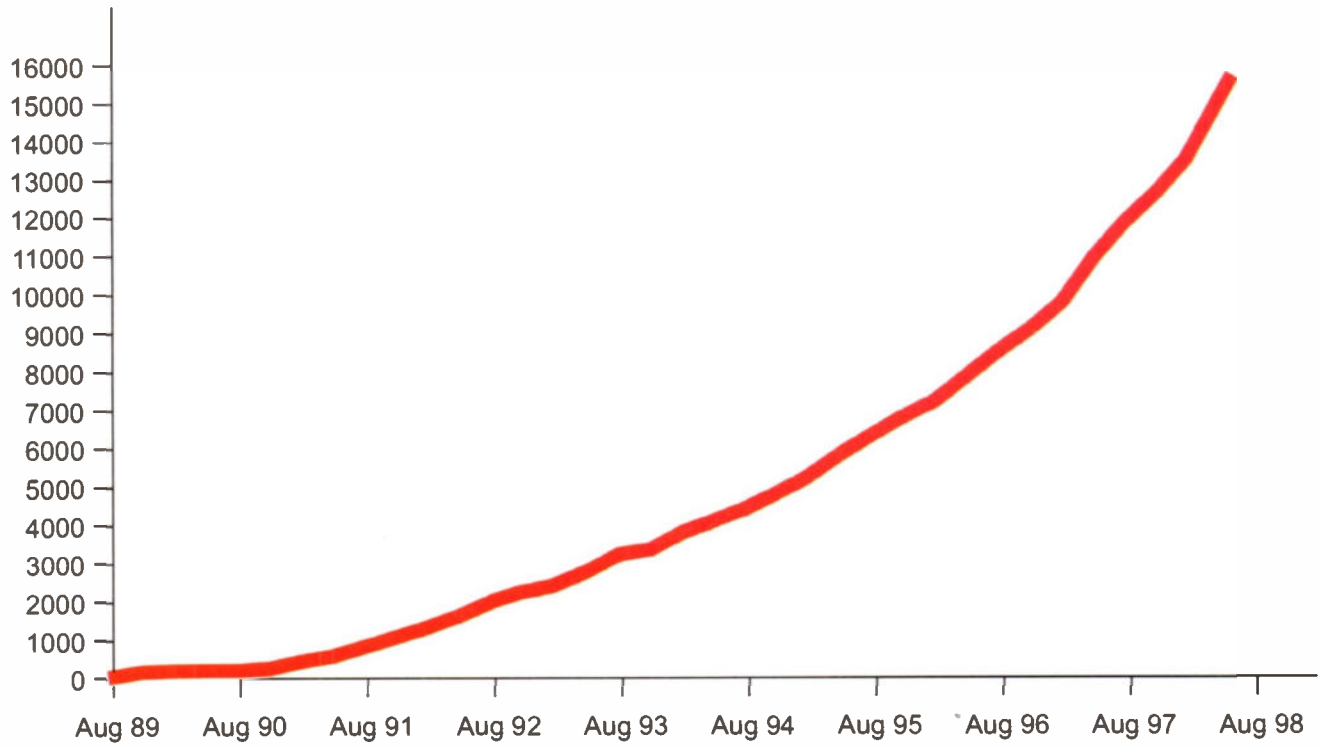
PC SECURITY

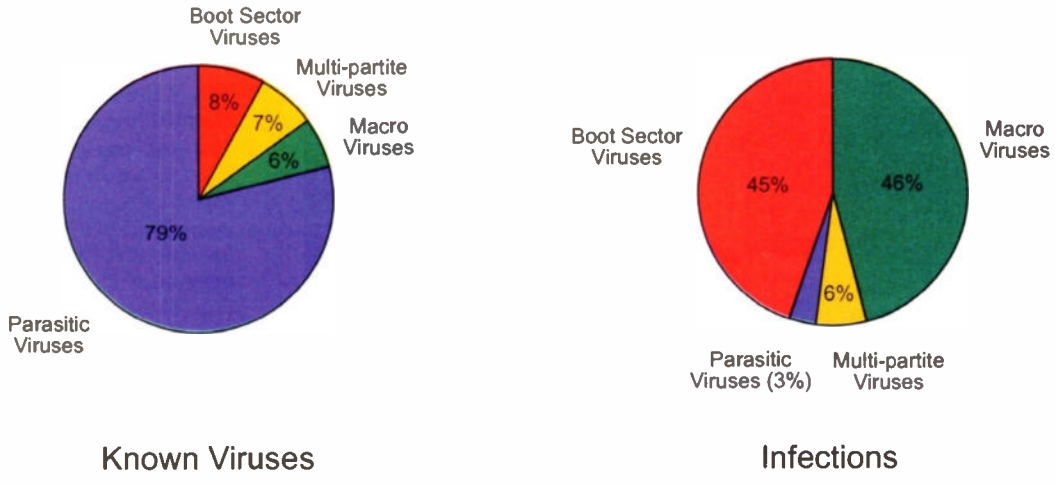
PART 3

In part 3, Mike Bedford investigates the dreaded virus!

A virus attack is probably the computer-related security risk that PC users fear most. To a degree, much of this fear is psychological as people tend to fear that which they can't see. So, for example, diseases, nuclear energy and global warming are higher up most people's league table of risks than more visible threats such as getting run over by a car. This isn't to say that a fear of the unseen is irrational. As we'll see later, it's the fact that viruses aren't immediately visible that makes them spread so rapidly. It also complicates their detection and eradication. Furthermore, statistics show that this certainly isn't something which can just be ignored. The most recent report on computer security produced by the National Computing Centre in association with the DTI lists virus attacks as the fourth most common risk reported by British companies. In terms of cost, however, virus attacks jumps into second place with an average incident costing £3,690. Only theft is more expensive – the average cost here is £17,557 per incident. The cost of a virus attack is, of course, related to the size of the company suffering this mishap. So the cost to a small company or a home user will, in all probability, be significantly less. Even so, this is certainly something to be taken seriously. In addition to the purely financial costs, a virus attack can result in considerable inconvenience and, if proper backups have not been made, the loss of data



The number of known viruses is still growing exponentially. Source: Sophos (Aug. 1998)



Proportions of known virus types and types of virus infection. Source: Sophos (Aug. 1998)

Examples of what might be seen on screen in the event of a virus attack.

which cannot be replaced. Unfortunately, therefore, there's a great deal of ignorance and mis-information about viruses. The aim of this article, the third in our series on computer security, is to provide some background information on viruses and give some hints on how to prevent a virus attack.

So What's a Virus?

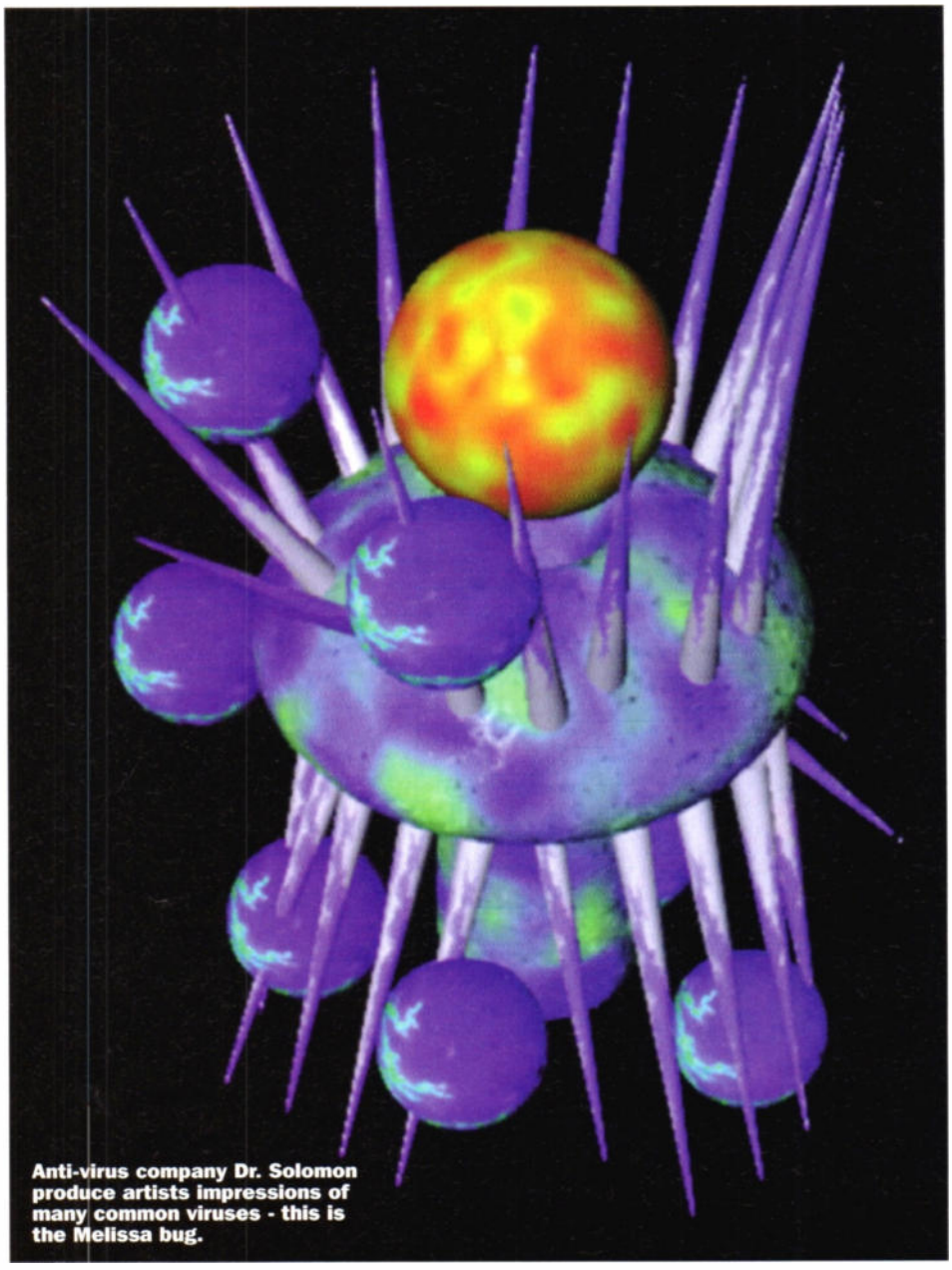
A virus is nothing more than a piece of software which replicates itself from one computer to another. It isn't necessarily harmful, the only factor which makes it a virus is its ability to spread. In all probability, the first viruses were written, quite innocently, by software engineers for research purposes and they just 'escaped' into the wild. Many of the viruses around today are still of this type – the result of some sort of non-malicious, albeit misguided, experiment. Unfortunately, the potential for viruses to do some serious damage was soon recognised and other less scrupulous people jumped on the bandwagon. We can only guess at the thinking of the virus writer. There are cases where viruses have been written for financial gain – people have attempted to extract payment from companies for disabling viruses which threatened to do serious damage. In the main, it seems that the motivation is some sort of inexplicable delight in causing inconvenience to others.

So we have that class of virus, the one which we read so much about in the press, which has a so-called payload. Even a virus with a payload will remain dormant for some time. During this time it does nothing more than infect other files on the computer in the hope of infecting other

So What do Viruses Look Like?

With most viruses, you'll never know you've been infected unless an anti-virus package tells you so. And even destructive viruses don't normally advertise themselves, they just release their payload when the time comes. Just occasionally, though viruses display some characteristic screen. We thought you may be interested to see what these look like so we've reproduced a selection with this article.

systems as and when those files are shared with other computer users. For maximum effect, it is important that viruses do remain dormant for a period of time. If they revealed themselves immediately, the scope for infecting other files and systems would be much reduced. The payload will eventually be released, either after a preset time or on a specific trigger date, and can take many forms. Some simply write a message – often of an anarchistic nature – to the screen. Some are little more than an annoyance. The Form virus, for example, causes a bleep every time you press a key on the 18th day of a month. Others, however, have more serious payloads. The Jerusalem virus deletes any program you attempt to run. Fortunately, however, it is only executable files which get destroyed by this virus so it's possible to re-install them, having first got rid of the virus. More serious still, viruses such as Michelangelo reformat the hard disk thereby destroying everything on the disk. But even this isn't the most harmful sort of payload. In this instance, it's immediately obvious what's happened and, so long as you have a backup, you can restore all your lost files. You will, therefore, have lost a day's work or a week's work depending on how frequently you backup the system. If, however, the virus just makes subtle changes to you data files, it could be a long time before you discover what's been happening. And by the time you do discover it, all your backups will have been affected too. You might have to go back weeks or months to get to a backup you can trust.

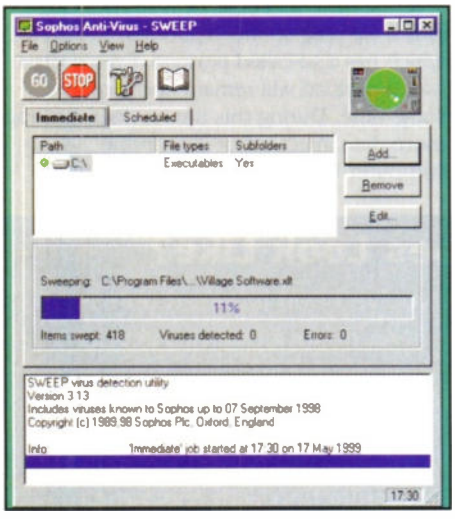


Anti-virus company Dr. Solomon produce artists impressions of many common viruses - this is the Melissa bug.

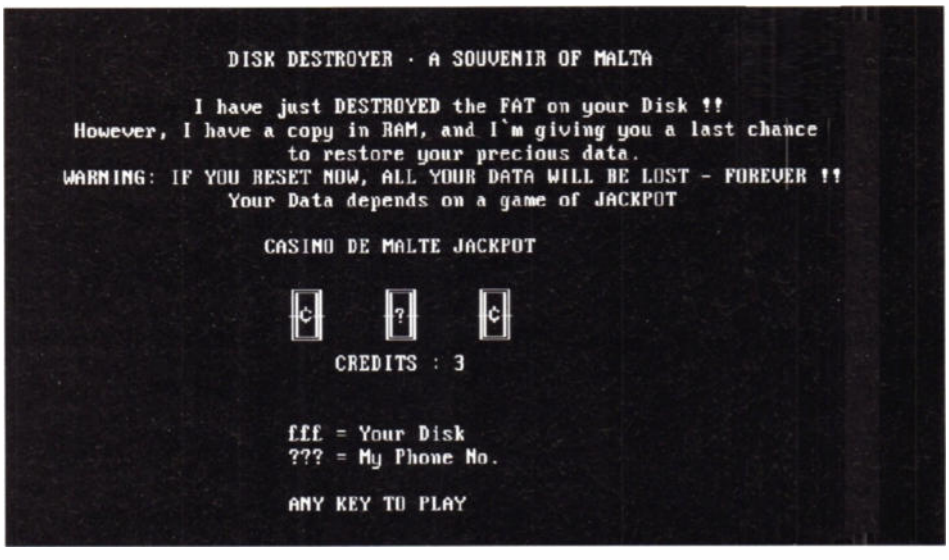
Virus Types

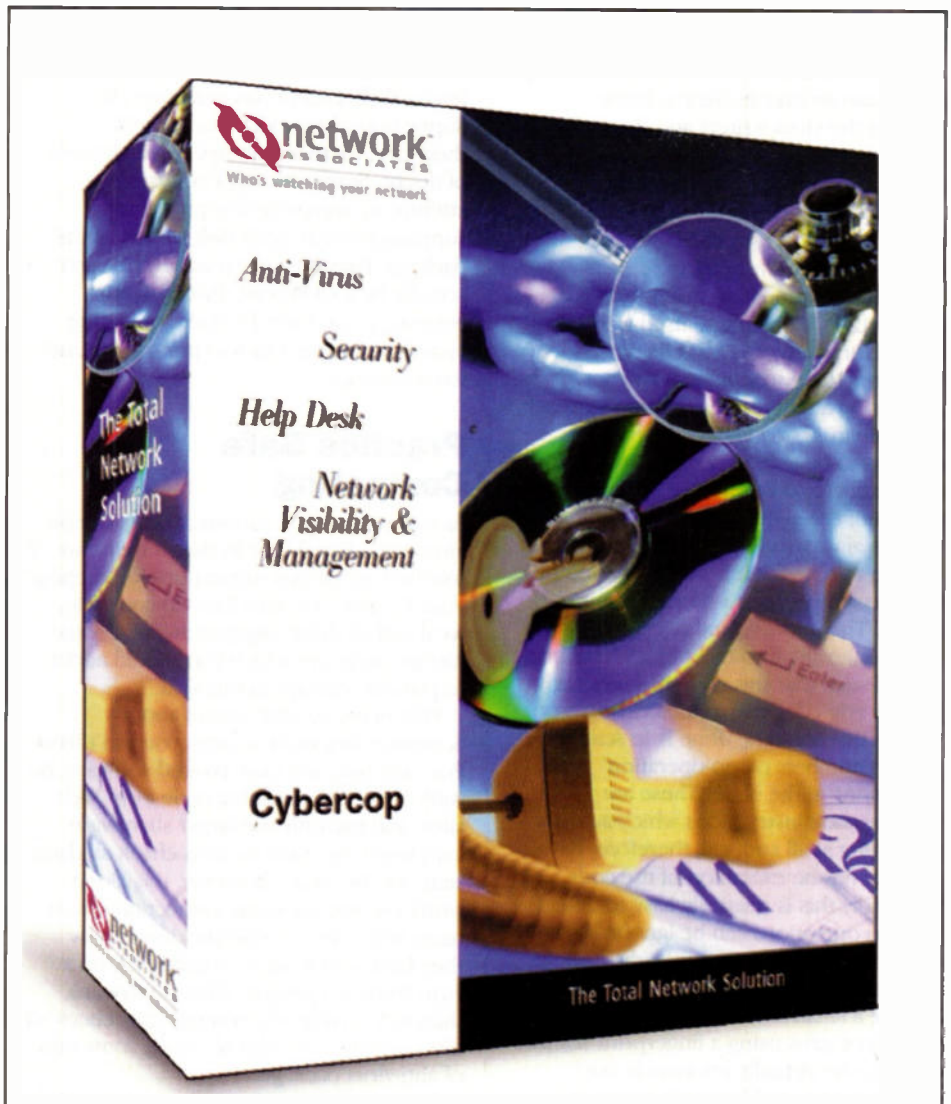
So we've seen that viruses differ in whether or not they have a payload and, in the case of viruses which do have a payload, the seriousness of that payload. But there are more fundamental differences concerned with how viruses replicate themselves. Let's take a quick look at the different categories of virus.

The first type of virus we'll investigate is the boot sector virus. This type infects the boot sector of either a hard or a floppy disk and is spread by exchanging floppy disks. A boot sector virus cannot be spread via e-mail, the Internet or a bulletin board. The boot sector is the portion of a disk which is executed when a PC is first switched on – it's job, normally, is to boot (i.e. start up) the operating system. However, even if you try to start up your PC with a non-system disk in the floppy disk drive, a program is still run from the boot sector. This is the program which tells you that the disk is a non-system disk and that you should remove the offending disk and press any key to continue. Clearly, the program in the boot sector could be a self-replicating program. A boot sector virus is just such a program. First of all it behaves like a normal non-system disk by displaying the usual



Virus scanner Sophos Sweep in action.





Network Associate's network security products includes virus protection.

message. This way, the user doesn't become suspicious. However, it also infects the hard disk's boot sector. Now, whenever the PC boots, the infected boot sector code causes a memory resident program to be loaded. This sits in the background whenever the PC is in use and intercepts any attempts to write to a floppy disk. The end result is that every time the PC writes to a non-infected floppy disk, the boot sector is infected in addition to the expected data being written to the disk. As soon as such a disk is sent to another PC user, the possibility exists for the virus to be spread. We'll look at virus prevention later, but one common sense protection against boot sector viruses is never to boot from a floppy disk. In other words, don't ever leave a floppy disk in your PC when you switch it off. If you do, the next time you switch it on, the PC will run whatever program is in its boot sector. Admittedly this is easier said than done, however, it is possible in most computers' BIOS to inhibit booting from floppy disks. On the rare occasion you might need to do this, it can be re-enabled in Setup.

Perhaps the most obvious way for a virus to spread is now one of the rarest, although examples are still 'in the wild.' It is executable files (i.e. normal programs) which are infected by a piece of virus code being tagged onto the start. This is called a parasitic virus. In the simplest of cases the act of running an infected program causes it to search out and infect another, as yet, uninfected file. More complicated viruses of this type go memory resident, intercepting attempts to run any program and infect the executed program at that time. Viruses of this type are spread from one machine to another by exchanging executable files, something which is a relatively rare occurrence – one reason, presumably, for their decline. However, there have been cases of this type of virus being spread on distribution disks directly from a software house and on magazine cover disks. Both these eventualities should now be considered as extremely remote though. However, accepting illegal copies of software is a risky business and, even if you don't have any moral objections, the risk of a virus infection should make you think twice.

The final type of virus we'll take a look at is extremely common and seems likely to grow more rapidly than any other type. This is the macro virus, the first type of virus which can infect a data file as opposed to an executable file. The reason that data files - spreadsheets or word processor document, for example - can be infected with a virus is that most of the popular office automation packages now include a macro facility. This allows, for example, a Visual Basic program to be embedded in a Word document and run whenever the file is opened. As an alternative to doing something useful, these macros can infect other files and even release a payload – this is what a macro virus does. The reason macro viruses are so popular is that they're easier to write than other types of virus, data files are commonly exchanged between PCs, and infected files can be spread via the Web or via e-mail attachments in addition to on a floppy disk. The latest versions of Microsoft Word and Excel will warn you if you're about to open a file containing macros and give you the option of disabling those macros. If you have an old version of a word processor or spreadsheet package without this facility it may be worthwhile upgrading. You should also make sure that you haven't inadvertently turned this checking feature off, although, it is turned on when you first install the Microsoft Office Suite. Of course, the presence of a macro in a document isn't always indicative of the document being infected with a virus - it could be that they are there for some genuine purpose. However, if you receive a document from an unknown source which contains a macro, it would be as well to disable macros until you've checked it out.

Virus Protection

So how can the harmful effects of viruses be prevented? In the final section 'Practice Safe Computing' we summarise the various measures you should take to safeguard your data from viruses. In this section, however, we'll look in some detail at one of the methods listed there - the use of an anti-virus package. The purpose of anti-virus packages is two-fold. First, they can detect the presence of viruses on your PC and secondly, they can remove any viruses which are found. There are a number of ways of detecting viruses and each has its advantages and disadvantages. Here, we'll take a look at the most common methods.

The first few types of anti-virus products examine boot sectors and files, either executable files or data files, in an attempt to detect the presence of viruses. They can be run by the user or run every time the PC is started up and in these cases will examine every potentially infected file. Alternatively, some products are memory resident and will automatically check individual files when they are about to be executed. There are three different ways in which this sort of product can work.

The first type of product is the checksum scanner. Here, when the scanner is first installed and run, it calculates a checksum for each executable file on the disk. A checksum is the result of a calculation involving every byte in the file and is unique to a particular file. If a change is made to the file the checksum will change. So, to check a file, the scanner calculates the checksum and compares it with the stored checksum for that file. Any discrepancy indicates that the file has changed and, in the case of an executable file, this will

normally mean that it's been infected by a virus. Clearly a checksum scanner isn't appropriate for detecting macro viruses, however, since data files regularly change. The other disadvantage with a checksum scanner is that it won't detect viruses which are already infecting files when the package is first installed and run. In other words, this will only work if you can be sure the PC is clean when you install the checksum software. The advantage compared to the virus scanner, which we'll look at next, is that the scanner doesn't need to know anything about specific viruses and doesn't, therefore, need regular updates.

When a virus infects a file it adds some executable code, which can be either native processor code or macro code, to that file. Since a piece of code is a sequence of bytes, most viruses can be detected by looking for a particular group of bytes which is the known fingerprint of that virus. This is the principle of the fingerprint scanner often just referred to as a virus scanner. This will work with boot sector viruses, viruses in executable files and macro viruses. However, the main drawback has already been mentioned. A virus scanner will only detect viruses it knows about, and since new viruses are constantly being written, this is a major problem so old scanners will be less than 100% effective. For this reason, suppliers of virus scanners offer an update service. Users receive an update every quarter or every month and this augments the scanner's list of known viruses.

Another comparatively new type of scanner is referred to as a heuristic scanner. Now, instead of looking for specific sequences of bytes, the scanner looks for code which is typical of the sort of thing found in viruses. For example, it might look for code which specifically searches the hard disk for .exe or .com files, a rather suspicious task which could be indicative of a virus. In theory, the heuristic scanner doesn't need updating as a virus scanner does. In practice, though, this type of scanner will need updating, albeit not as frequently, since virus writing techniques change in order to prevent detection by existing heuristic scanners. Heuristic scanners suffer from a high level of false alarms.

The final type of virus detection software is not a scanner at all in that it doesn't examine files. Instead, it scrutinises what packages do as they're actually running. Some actions are considered to be virus-like behaviour and will be blocked and the user alerted. The user can then choose either to continue execution or to terminate the package. Such activity includes, for example, writing to the boot sector of a disk. As with the heuristic scanner, this type of anti-virus package needs less frequent updating than a fingerprint scanner does but is prone to false alarms.

Viruses Fight Back

In the early days a virus simply replicated and possibly released a payload after a given delay or on specific dates. However, as anti-virus products started to appear, virus writers started putting additional features in viruses. Features, that is, to avoid detection by anti-virus software. And so we have an ever escalating battle between the virus writers and the writers of anti-virus products. In this section we'll look at some of the techniques used to prevent detection and the additional methods employed by the anti-virus industry to circumvent them.

The first method is to make the virus polymorphic, a technique used to prevent a virus being detected from its unique fingerprint. One technique is to encrypt the virus, using a different encryption key each time the virus is copied. Of course, the virus has to be able to decrypt itself before it can execute so there must be a small amount of code, the decryption code, which is always the same. Clearly it will be possible to scan for this code but even here the virus writers have a trick up their sleeves. The unencrypted decryption code can be quite small so techniques have been devised such that this code changes each time it's copied. One obvious example of the way this could be done is to scatter random numbers of 'no operation' instructions in the code. These are machine code instructions which actually do nothing at all and will, therefore, have no affect on the execution of the code. Admittedly this is relatively easy to detect since no operations can be ignored by anti-virus software but there is clearly a whole range of things which can be done to disguise a small amount of code. Detecting this sort of virus using a fingerprint scanner alone can be virtually impossible but checksummers and heuristic programs would be more successful. As we've seen, these are not universal panaceas either. For this reason, most experts suggest using a mixture of anti-virus tools.

The second main type of virus which attempts to prevent detection is the stealth virus. As we've seen, most viruses are memory resident. In other words, they wait around in the PC's memory, intercepting attempts by other programs to write to disk and using the opportunity to infect the file being written to. It's also possible, of course, to intercept attempts by other programs, including anti-virus packages, to read from the disk. Now, for example, if the virus detects that a program is trying to read the boot sector, instead of allowing that program to see what is actually in the boot sector (i.e. the virus) it returns the data which would have been there had the disk not been infected. The anti-virus software concludes, therefore, that the disk isn't infected with a boot sector virus. The obvious way to prevent stealth viruses from performing this trick is to make sure it's not resident in memory when the anti-virus software is run. But since it always will be in memory if the PC's been booted from an infected disk, the only safe way is to boot it from a clean system floppy disk rather than the hard disk. However, we do have a chicken and egg situation here. Certainly you can make a floppy boot disk but you can't be sure that it won't be infected unless the hard disk on the PC you used to create it was clean. But how do you know whether it is virus free without the clean floppy disk? Unless you make the clean floppy boot disk on a brand new PC, therefore, there will always be an element of doubt. Some anti-virus companies attempt to overcome this problem by supplying a clean boot disk as part of the package. For copyright reasons this can't actually be a DOS boot disk, instead it contains a cut down DOS-like operating system adequate only for running the anti-virus software.

Practice Safe Computing

As we've discussed various aspects of how viruses work and how to detect them, we've touched on various suggestions for keeping your PC and data virus free. To conclude, we'll pull all these together and add some further measures which you should adopt to prevent mishaps in this area.

First of all, be very careful about accepting files from sources you can't trust. For example, don't use pirated software, be wary about downloading code from Web sites, and use only the larger shareware suppliers who claim to virus check all disks sent out. Be aware, however, this alone won't provide adequate protection - most users with infected systems don't know they have a virus so you could pick up a virus from any source. What this means, therefore, is that you should really check all disks and files you receive using some sort of anti-virus package.

To protect against boot sector viruses, be very careful about leaving floppy disks in the drive when you switch your PC off. If you don't normally boot from floppies, disable booting from floppies in the BIOS setup.

To protect against macro viruses use the latest versions of software which will warn you if you're about to open a file containing macros. Make sure you have this feature enabled.

Choose a good anti-virus package and make sure you use it, not just for checking out suspect files or disks but as a regular check on your hard disk. Pick a package which employs a mixture of the anti-virus methods we've looked at. The computer monthlies regularly review anti-virus software and these reviews should help you to pick a suitable product.

Make sure you have a clean floppy boot disk to prevent stealth viruses from hiding themselves. Either pick an anti-virus package which includes a clean boot disk or make one yourself. Be aware, though, that you really need to do this on a brand new PC and if this isn't possible, you should really re-format your disk, re-install Windows and your application software and start from scratch. If you're not prepared to do this there will always be an element of doubt.

Make sure to keep adequate backups from which you can restore your data if none of the forgoing precautions works and you end up being infected with a destructive virus.

COMMENT

by Keith Brindley

Sir Clive Sinclair is in the news again, and whenever he makes news, it's something the electronics industry has to read and make note of. He's been talking recently of a planned move back into producing a computing device, along a not dissimilar path to earlier computing devices of his.

It's actually been a long time since Sir Clive produced anything akin to a personal computer. Recently, he's been better known for battery-driven bike motors and trikes, and miniaturised personal radios. But, by all accounts, Sir Clive's seen a marketplace niche for a new type of computer, and he's always keen to make a profit on a new product that fits into a market where other products simply don't or won't go.

In the early part of the 1980s, Sir Clive Sinclair's vision was of a new type of cheap personal computer. At a time when conventional personal computers cost thousands of pounds, devices such as the Sinclair ZX80 and ZX81 computers became instant successes with ordinary people, who wouldn't otherwise have been able to afford or even get to use a computer at all. While they were - in their own way - niche devices, they sold extremely well, and made Sinclair one of his fortunes. A whole generation of users became computer programmers virtually overnight. From then till the end of the 1980s, Sinclair personal computers drove the home (and to a small degree - the educational) personal computer market. It wasn't until the industrial personal computer manufacturers got their collective act together at the latter part of the 1980s that things changed. Nowadays, cheap personal computers abound - still far more expensive than Sinclair's range, but infinitely more powerful.

It's this 'infinite' power that Sir Clive's perceives as an opening for him to enter the fray once more with a new computing device. While it's a long way from being manufactured yet, Sir Clive pointed the way recently as to what shape the new computer will take. For a start, he's absolutely convinced that this incredible power that modern personal computers possess is largely irrelevant. The majority of personal computers are of a Wintel form - running the Windows operating system software with a processor family of hardware based around the Intel x86 range. He knows that this partnership ties these computers into an upward spiral of complexity that's largely over the heads of most users. Windows is a huge operating system, with vast hardware requirements both in terms of processing power and memory. Each new family of Intel's x86 processor range means that the next generation of Windows can be run. Each new generation of Windows requires an increased processor capability - and so it goes on.

But it doesn't have to. Sir Clive points to the phenomenally successful Linux operating system. Linux is available as open source software - in other words, people are free to use and develop it as long as any developments they make are ploughed back into the public domain. As such, it's incredibly stable, incredibly powerful, has a wide range of software already available to run on it, yet best of all is small (with few system overhead requirements). Linux runs on comparatively weak personal computers, but with a power some see as far in excess of Wintel personal computers. So, Sir Clive views Linux as one possible way back into the cheap personal computer market. But what of the processor. He looks at modern personal computers and sees the vast array of processor, memory and peripheral chip requirements as superfluous and almost laughable. What do most users do with their brand-spanking-new PC? They word process, or maybe surf the Web and send a few email messages. That's a lot of unnecessary power wasted.

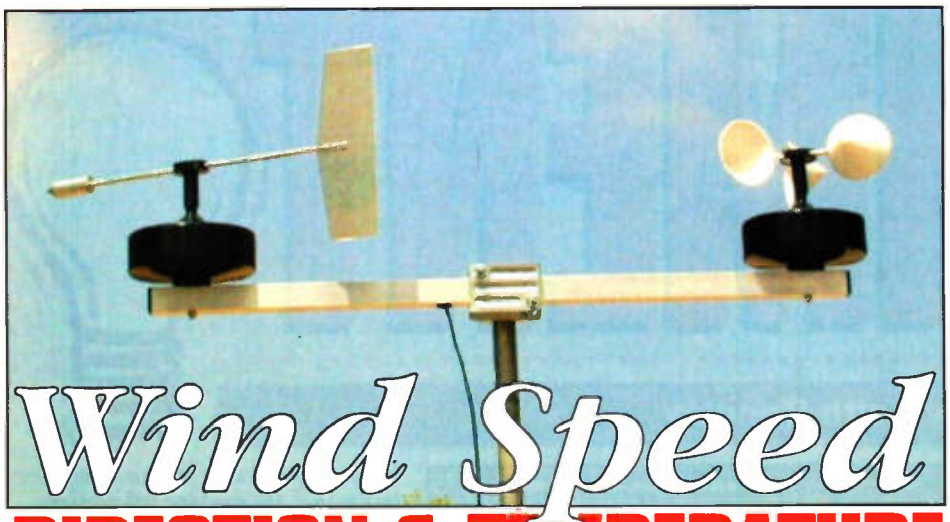
Sir Clive points to Sony's PlayStation as an example of what he means - a device that is built for a specific purpose, and does that task unquestionably well and in a way that no general-purpose personal computer could ever hope to match. The forthcoming PlayStation II, Sir Clive feels, is going to 'shake people up because the performance is so striking." He feels that the answer to personal computers is not the ever-increasing complexity of modern personal computers, but a measured view of what is required by the user. His machine will probably feature a single processing device that contains all the memory, communications and input/output features and facilities needed on a single chip. That way costs can be mininised, yet performance maximised.

Readers may find themselves a little sceptical. All this sounds like the proposed NetPC project of a couple of years ago, that attempted to create a new type of personal computer requiring minimal hardware (a NetPC box connected to a server) using a new operating system (Java). Its main aim too was to release the Wintel stranglehold. A great aim, but the NetPC hasn't really taken off. Most companies have stuck to the more traditional Wintel personal computer-style products. So will Sir Clive's venture break ground where the NetPC fails? Of course, it's impossible to say until he tries it. Sir Clive Sinclair has a special place in the hearts of many people - particularly here in the UK - as an entrepreneur and personality to be revered. But will his new personal computer - if it ever sees the light of day - be the ZX80 of the new millennium? Or will it just be the next C5?

If Sir Clive pitches the new device as a games machine he's got a vast array of quite cheap products and software that he's got to beat - and that's an unlikely challenge. If he pitches it as a personal computer, on the other hand, he possibly stands more of a chance. Personal computers, in their current form, are still quite expensive when you consider what most users want from them, as well as being incredibly complex for the average punter. If he could undercut them in cost by, say, 50% or more then one battle's won. If he could show that powerful software exists from launch day then another battle's over. If they could be extremely simple to use, then a third battle goes to his advantage. The war, however, as any technology watcher like the readers of this column can tell, will consist of more than just a handful of battles.

Only time will tell. With Linux, or a similar proven low overhead operating system, at its heart, and a purpose-built processor it could find itself the most desired computing product ever. But others have tried something similar and not managed it.

The opinions expressed by the author are not necessarily those of the publisher or the editor.



Wind Speed

DIRECTION & TEMPERATURE INDICATOR - MARK II

PART 1

Dr. Mike Roberts describes an upgrade to the excellent Maplin Weather Station project - providing both cost reduction and performance improvement.

Introduction

This gives another chance to build the excellent Maplin Weather Station. The original base unit has been dropped by the catalogue. I presume this is due to the DAC chip no longer being available. The full project here includes both a base unit and a PC link. The base unit can be stand alone. Alternatively it can be built to use only the PC link. This project is a must for anyone participating in weather related activities. Weather forecast accuracy does not seem to be too bad these days but it is often out in its timing. This unit gives good current local data with both independent display and PC display.

My interest in wind speed and direction indicators stems back 20 years when 'Heathkit' (showing my age here!) did a kit for something like £200. I wanted the gear to help me decide when I should fly my radio controlled aircraft. I eventually found a way to access the Heathkit parts and built a system using Heathkit hardware but my own electronics, and this set-up has been spinning away for the past 12 years. The original unit was standalone, and later I added a PC link using a 4 byte ISA parallel input card similar to the Maplin programmable I/O card (LP12N).

The drive to upgrade the system came from the phasing out of ISA slots in modern PC motherboards. Sooner or later I was going to have to either design a PCI digital input card or redesign the wind speed electronics using a serial link. I settled for the latter.

My original unit used a two wire power and data (current loop) connection to the external sensors. I have retained this feature. However, rather than using my own data transmission code, I decided to transmit the data from the head unit as serial bytes at 9600 baud so that it could be simply converted to RS232 and fed to a PC.

I wanted to retain the continuous display of wind speed of my unit. The display for the Maplin unit was only updated twice a second when on 100mph range and every two seconds when in the 25mph range. Using the computing power of a microcontroller the analogue meter in this new unit is updated 10 times a second. This includes a switchable digital filter to give a smoothed reading so the running average can be displayed.

I always try to keep the costs down. This was part of the reason for going to a two wire rather than multi-core system on my original unit. I thought that including a temperature measurement would be useful, as in the Maplin original. However, this could be achieved much more effectively by placing a sensor in the wind speed and direction head. No temperature module or extra wiring would be required. Adding features like this is easy once one has decided to use a microcontroller to process the information. Serial data transmission to a PC would avoid the need for a special PC input card. The last area of saving came from seeing a way to reduce the number of rather expensive opto-switches by one, and then using a modern equivalent at nearly half the price. The net effect of these improvements is a complete system cost close to £200 including the hardware, electronics, case, power supply and PC software. This is not bad - containing 20 years inflation! Also a 'bare bones' system using the PC only for the display can be built for about £125.

Principle of Operation

My target specification was to have speed (0-100mph), direction (16 point compass) and temperature (resolution 0.5°C).

From the original *Electronics and Beyond* articles (issues 31, 33) I knew that 16 pulses per revolution would give 500 Hz at 100 mph. So calibration would not be required. I planned to use a 'Gray' scale to sense the 16 compass points. This is what enabled the reduction of the number of sensors by one. See later. Putting a temperature sensor in the head would be straight forward using the analogue input feature of the microcontroller. The microcontroller could then process the information and send it as serial data. The next questions were how frequently to send the data and how to represent the speed.

After considering a number of options I concluded that the best solution was to transmit the speed, direction and temperature data 10 times a second. The speed data could then be the pulse count during the previous 1/10th second. A count of 50 would represent 100 mph. Greater resolution could the be achieved by summing the latest reading with the previous reading. Now a count of 100 would be equivalent to 100mph. This makes the data processing somewhat easier!

Clearly the PIC microcontroller could do the counting of the pulses coming from the speed sensor. Unfortunately the simpler microcontrollers have only one internal counter. It was more convenient to use this counter with the system clock to set the 1/10 sec timing. I then considered doing the counting in software using an interrupt routine. This was not possible as at the fastest wind speeds there is not enough time to send a byte of serial data between count inputs. Hence I resolved to do the speed pulse counting using an external binary counter. Only 6-bits are needed (64) as the maximum count in 1/10 second is 50 at 100mph. This in theory gives the system a peak range of 126mph.

The direction in the original Maplin unit was set by a 4-bit binary number, starting with 0 for North and incrementing clockwise. This system makes decoding easy. However, this can give a problem with the sensing of the direction. The reading on the margin between two adjacent segments can

FEATURES

Wind speed:	0-100 mph, 0-87 knots
Direction:	16 points compass
Temperature:	-40°C to +70°C
Display:	Analogue, Digital, PC (via serial link)

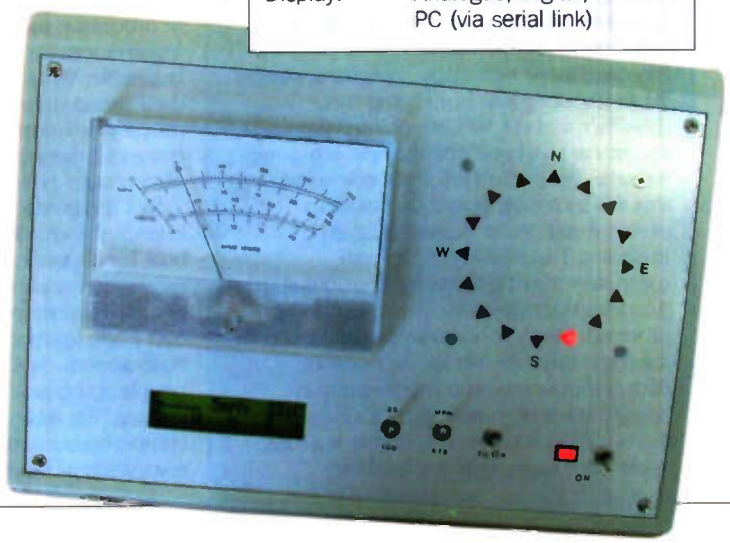


Image 1.

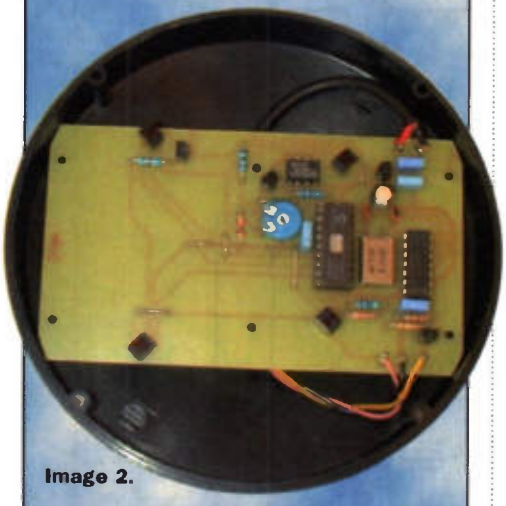


Image 2.

Image 3.

Image 4.

be misinterpreted. For example between segment 3 (0011) and 4(0100) one might get a mixture of the individual bits and get a reading of 0111 which is seven. This problem was overcome on the Maplin unit by having an additional opto-switch which triggered the reading in the middle if the segment. This has the small disadvantage of introducing some hysterisis as the segment reading is only triggered when the direction is already nearly half way into the segment. All these problems can be overcome and the additional opto-switch removed by using a 4-bit 'Gray' code and converting this code to the segment number via a lookup table in the PIC microcontroller. The magic of a Gray code is that only one bit changes between each segment. Hence on the margin there can only be ambiguity on one bit and the reading can only be the code on one or the other side of the dividing line. Test this out on Table 1. You will also notice that the top two bits both have a string of eight sequential '1' bits, 4 digits (90°) out of phase. Hence they can use the same track on the code disk as long as the opto-switches are 90° apart. This simplifies the code disk and maximises the diameter of the code rings, reducing the scope for angular error.

Decimal	Binary	Gray
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

Table 1. Gray Code.

The temperature sensor gives an output voltage of 10mV/°C, with a reference of 750mV at 25°C. Normally the PIC measures analogue voltages with the 5V supply representing 256. It is also possible to make the analogue input measure with respect to an external voltage (between 3-5V). If this external voltage is set to 3.84V and the temperature sensor output is amplified by 3 the decoding becomes easier as 1 unit of analogue input is equivalent to 5mV or 0.5°C (3.84 (256 x 3)). A few quick sums will show that subtracting 100 and dividing by two converts the binary reading to °C.

Circuit Description - Head Unit (see Figure 1)

The main consideration here was to keep the current consumption down to make the detection of changes in current easier and hence give reliable data transmission. The supply voltage at the head could also vary due to transmission losses. For these reasons the infra red diodes in the five opto-switches, which are the major consumers of current, are all wired in series. The current is controlled by R1 and TR1. The voltage drop across each IR diode is 1.24V and the base-emitter junction of TR1 is 0.6V. R1 (68R) with the remaining 0.68V sets the current to 10mA. The current will be achieved as long as the supply is greater than 5 + 2 x 1.24V i.e. 7.48V. This is less that required for the regulator IC1 and so is not a limit.

The temperature sensor is IC2. The output is amplified by one half of IC3 (the other half is not used) and fed to the RA2 input of the microcontroller. The voltage reference is set by R4,5 and VR1. I checked the temperature stability of the 5V output of the regulator IC1 as this is divided down to provide the reference. In the range from ambient to 0°C there was no significant variation.

The direction is sensed by opto-switches OS1 to OS4. These are read by the RB0 to RB3 inputs to IC4.

The speed is detected by opto-switch OS5. TR2 sharpens up the waveform to trigger the 7 bit binary counter IC5. The six least significant bits are read by the microcontroller through RB4- RB7 plus RA0, RA1. R7 and C6 force a reset of the microcontroller on power up.

So where is the output? It is simply R6! A low output from the microcontroller to this resistor consumes an additional 10mA. Hence the data put to output RA4 can be detected by the base unit through the variation in current.

Base Unit (see Figure 2)

This comprises two main sections. The first, very simple part, is the current detection and conversion into RS232 levels for sending to a PC. The current is sensed by R1 and amplified by times two and reflected to the negative rail by TR1, R2 and R3. The DC component is removed by C1. R4 removes the sensitivity to small variations in current. The data at the collector of TR2 is inverse serial data which can then be converted to RS232 format by IC2 and also fed into the base unit display system. The few components here are the only essential part of the base unit (with the 5V regulator IC1). The RS232 conversion chip IC2 and its associated components need only be used if the PC link is required. Equally the system can run just using the PC link and avoid the rest of the base unit circuitry. Of course the ideal is to use both.

The base unit display section uses a microcontroller again. The input/output requirements look staggering at first. It needs:

serial data input from head	1
panel switches	3
calibrate input	1
data to alphanumeric display	8
alphanumeric display control	2
DAC for analogue output to meter	8
compass LEDs	16
Total	**39**

It is neither sensible nor economic to configure the I/O with 39 lines. It is much easier to use an 8-bit data output bus and read this sequentially into the various outputs. With the PIC16C55 there are enough input/output lines to use Port C as an output data bus and take the other inputs and outputs to dedicated lines. Additional outputs are required to clock the data from the data bus to the compass LEDs and DAC. The I/O usage is then:

Port A		
RA0	LEDs South	out
RA1	LEDs North	out
RA3	serial data	in
Port B		
RB1	calibrate	in
RB2	range	in
RB3	mph/kts	in
RB4	filter	in
RB5	control/data (display)	out
RB6	enable (display)	out
RB7	DAC	out
Port C		
RC0-RC7	data bus	out

Software - Head Unit Microcontroller

Once I had worked out what had to be done the programming was easy. I used one interrupt routine, triggered 100 times a second. This is achieved simply by using a 3.2768MHz crystal which is divided by four to produce the system clock and then by 32 for the timer clock which triggers an interrupt when it overflows every 256 counts to give 100Hz. A software counter from 1 to 10 then managed the tasks. The analogue reading of the temperature sensor is triggered in time slice nine. The speed and direction data is read and decoded and the data transmitted (3 bytes) in slice 10.

I needed to find a way to identify the data (i.e. which byte is which). The direction data only uses the bottom 4-bits (0-15 or 00000000 - 00001111 binary). The speed count only needs the bottom 7-bits. With the temperature all the bits are used - but it would require the very unlikely event of a temperature greater than 70°C to make all the top 4-bits '1'. Hence I could make the direction byte unique by setting these top 4 bits to '1'. This byte is transmitted first. The direction and temperature data bytes follow as bytes two and three respectively.

- The direction is read as the Gray scale and decoded via a lookup table to '0' representing North and '1', '2' etc. going clockwise round the compass.

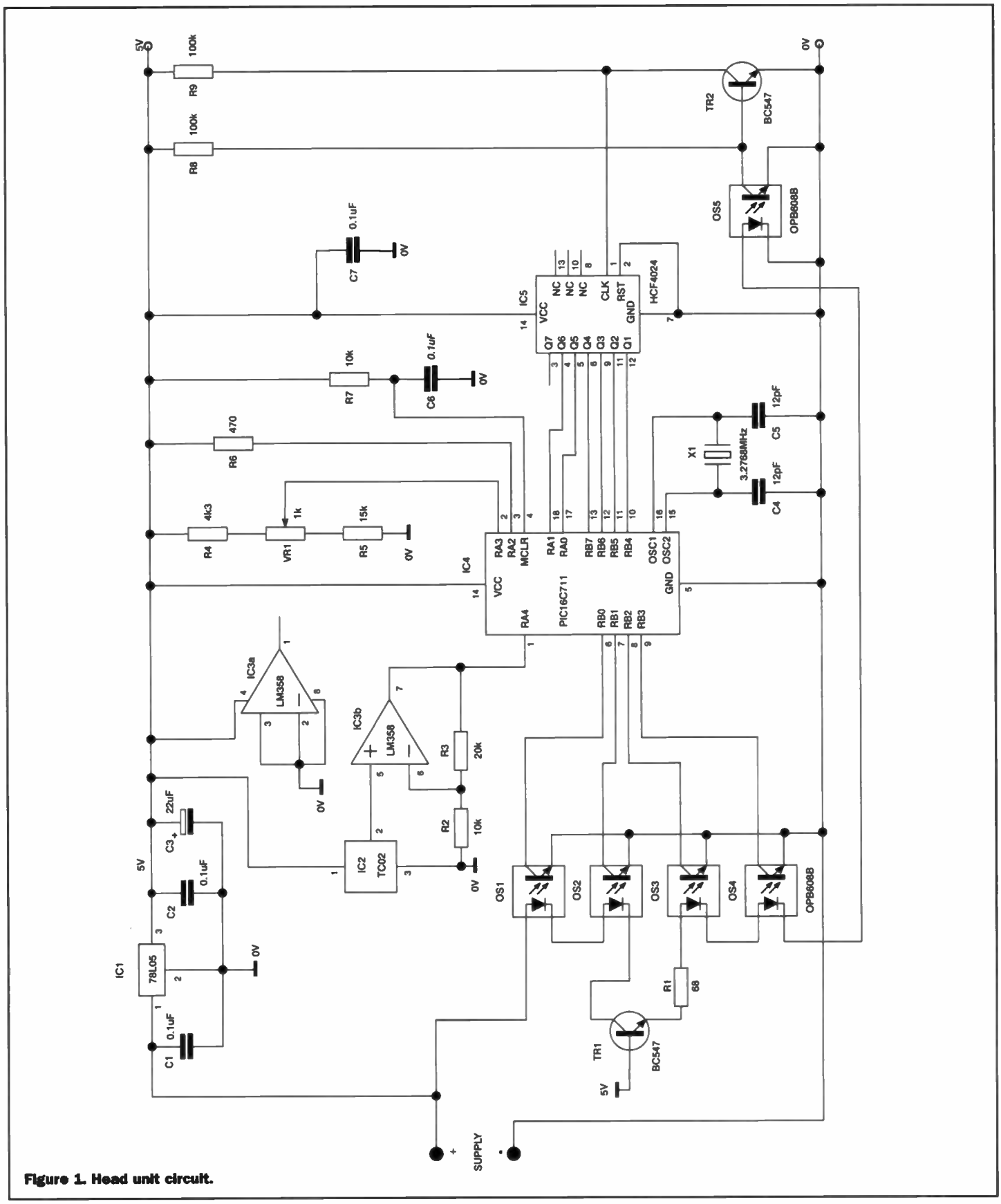


Figure 1. Head unit circuit.

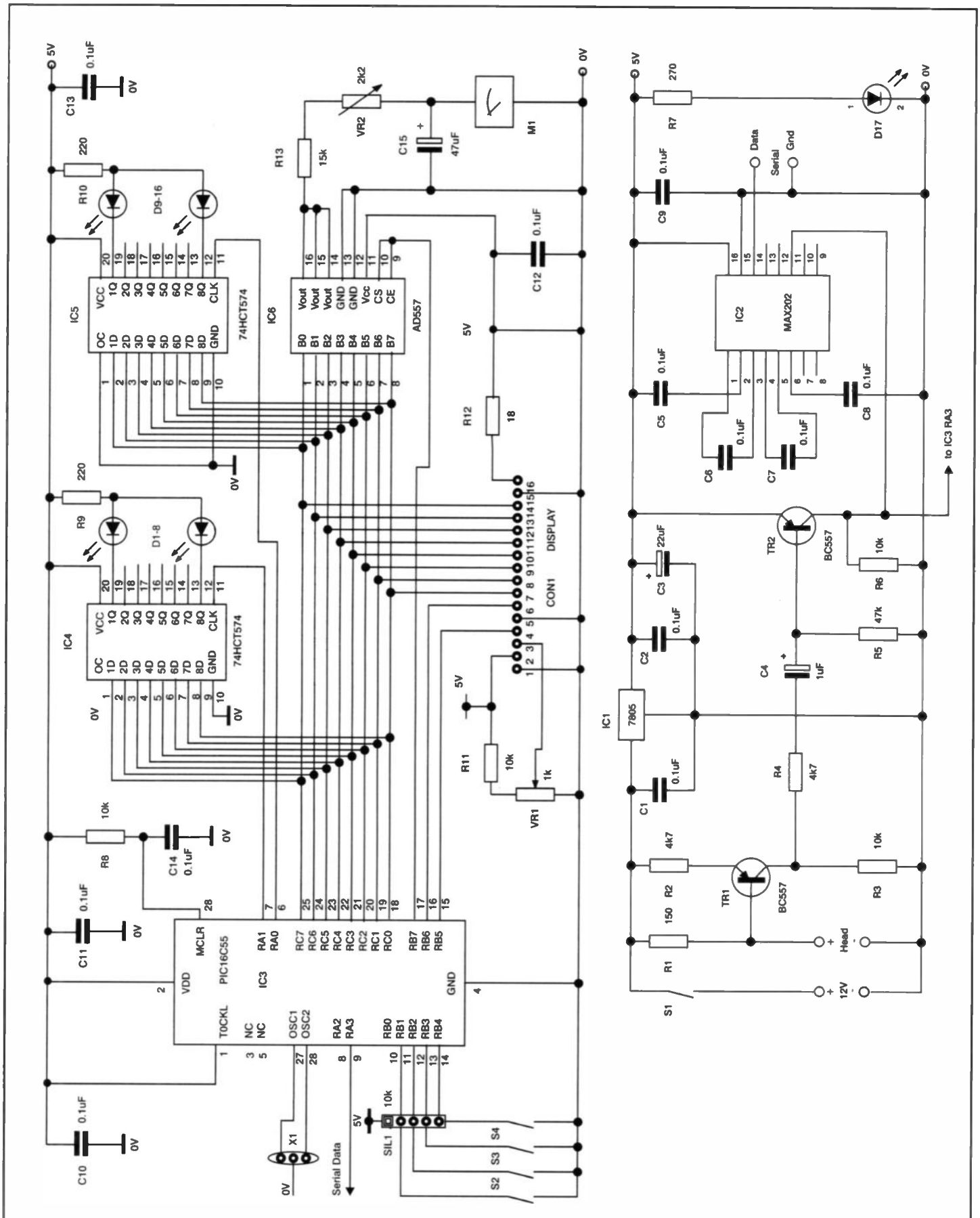


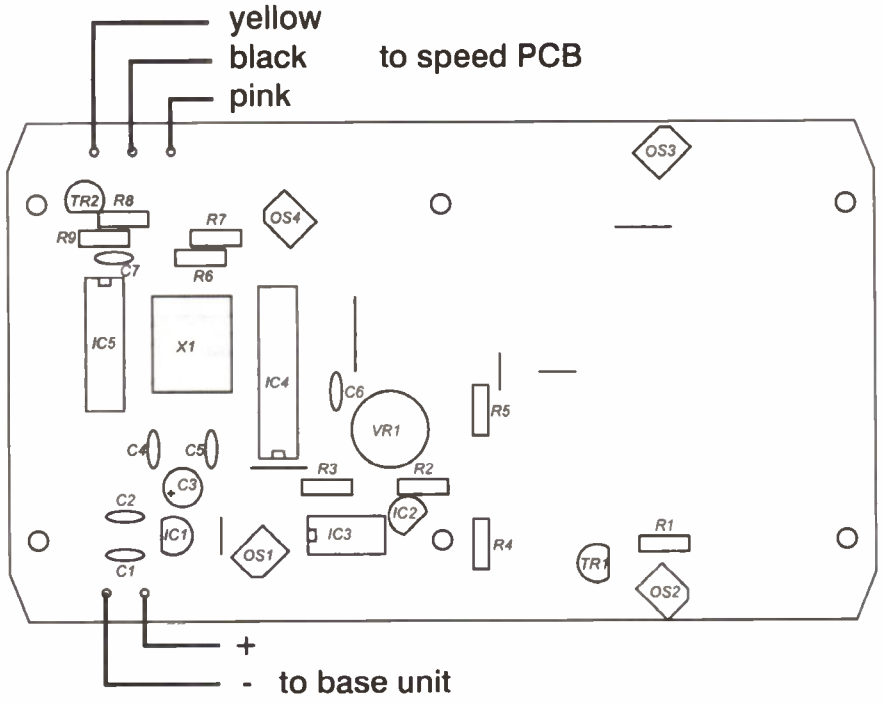
Figure 2. Base unit circuit.

- The speed information is the count in the previous two 1/10th second.
- The temperature data byte is the reading from the microcontroller ADC. This still has to have 100 subtracted and then be divided by two by the base unit/PC to give the reading in °C.

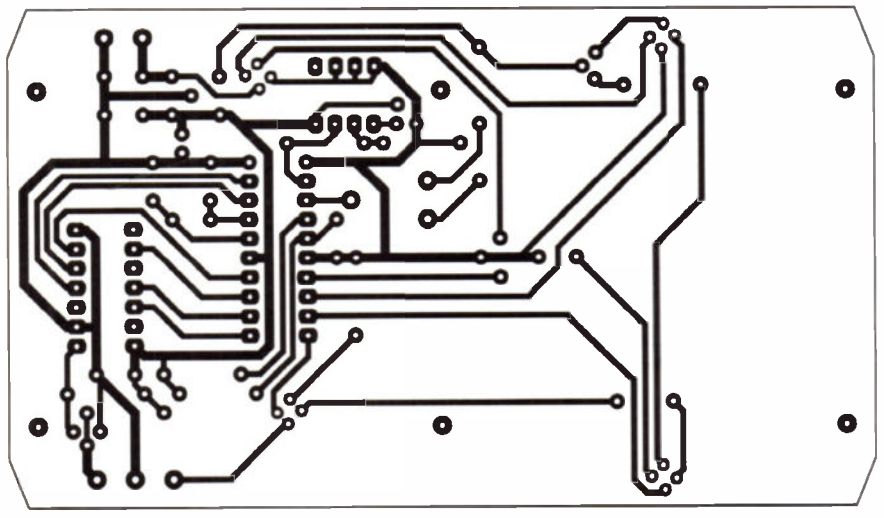
Base Unit Microcontroller

This uses a very simple controller with no interrupts. When it has completed its tasks it sits and waits for the next set of serial data. It the looks for the unique top four bytes of the direction data. After it has received this and then received two more bytes it processes the information and sends it to the alphanumeric display, the compass LEDs and the digital to analogue converter (DAC) for the analogue wind speed meter.

Two output data bytes are needed for the 16 direction LEDs. These are created by setting the bit corresponding to North to '1'



Head unit component overlay.



Head unit PCB Foil.

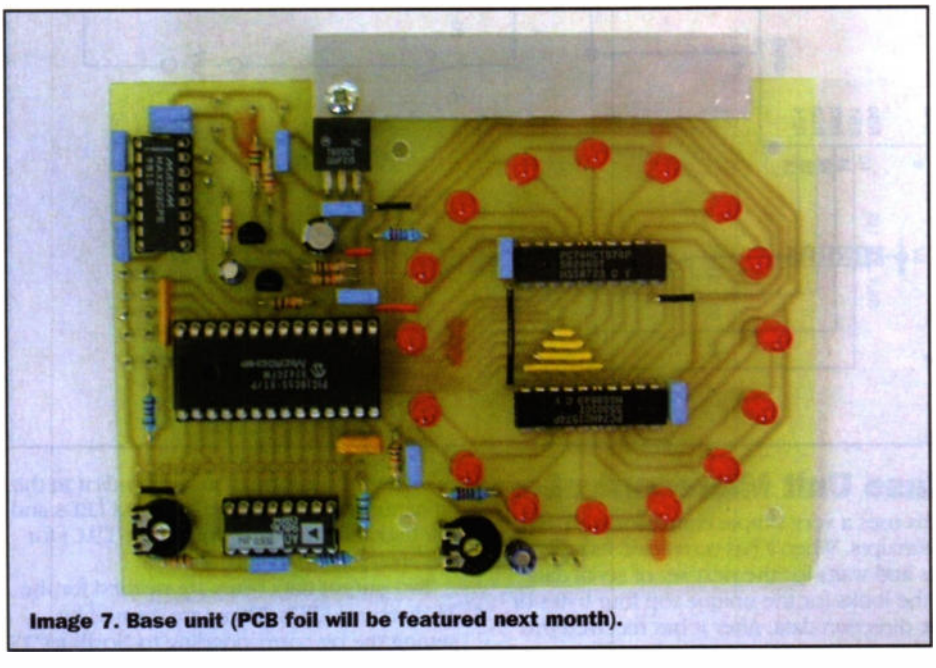


Image 7. Base unit (PCB foil will be featured next month).

and then shifting it clockwise by the number from the direction data before clocking it to the octal latches IC4,5 via IC outputs RA1, RA0.

The temperature data conversion is easy to perform and send in °C as part of the data to the alphanumeric display.

The speed data needs more complex processing than might initially be realised. If this were used in its raw form the readings would jump in 4% increments when the analogue display set to the 25mph range. With data being updated 10 times a second this could give jittery display not really representative of the rotation of the anemometer.

The solution to this is to add a digital filter to provide some smoothing. A very effective filter (as used in industrial controllers) can be made using the formula:

$$out_n = out_{n-1} + k(data_n - out_{n-1})$$

'k' is the filter constant. A value of 1 gives no filtering. Values less than 1 give an exponential weighting of the all the previous readings. The next trick is to choose values of k equivalent to 1/2, 1/4, 1/8 1/16 etc. so that the multiplication can be achieved simply by shifting the binary numbers right the appropriate number of times. The use of two byte arithmetic provides the additional resolution required to use the full resolution of the analogue to digital converter (0-255). I found that a value for 'k' of 1/8 gave a smooth fast response. With the 'filter' input set to 'on' this is changed to 1/32. The time constant in 'normal' mode is about 3/4 second and in filtered mode about 3 seconds.

I used a value of 200 decimal to give a full scale reading on the meter. This allows readings above the full scale (like a real analogue meter) but not quite round the stop! The filtered values are multiplied by two when on the 100mph range and by 8 when on the 25 mph range. This is achieved by shifting the two byte value left one or three bits respectively.

You may have noticed that the data bus connections to the DAC are reversed (7 to 0, 6 to 1 etc.). This was done to greatly simply the PCB layout. A few shifts and the bits are reversed ready for clocking into the DAC.

Closing the calibrate input pins forces a full scale output of '200'. This makes the adjustment of the meter range easy. Since this only has to be done once I did not put this input onto the panel.

The bar graph display of wind speed in the alphanumeric display is generated pixel by pixel and formed into five of the eight user definable characters in the display. The diamond pointer for the direction is a 6th user defined character.

A last little challenge was to convert the wind speed value from mph to knots for the digital display when requested by the input switch. The conversion factor is 0.8684. I wanted to avoid getting into floating point arithmetic. Again a few quick sums shows that the conversion factor is very close to 1 - 1/8 - 1/128. The mph value can be divided by 8 and 128 by shifting right three and seven times respectively. One is then left with simple subtraction. This gives conversion accuracy within one bit, but with less code and faster execution.

Next month we will feature the PC software, construction and parts list.

TO BE CONTINUED...

Using Voltage REFERENCE & TEMPERATURE SENSOR ICS

PART 1

In the opening episode of this 3-part series, Ray Marston shows how to use various popular 'voltage reference' ICs.

This 3-part series looks at practical applications of various precision voltage reference, current source, and temperature sensor ICs. Most of the ICs specified in the series are commercial grade types, manufactured by National Semiconductor and various other companies, and are widely available. Many are also made in 'industrial' and 'military' grades, with greatly enhanced specifications. This opening episode of the series deals exclusively with modern voltage reference ICs.

Device number	V_{ref}	Voltage tolerance at +20°C	Drift ppm/°C (max)	Reference Operating current
LM329B	6.9V	±5%	50	0.6 - 15mA
LM336B-2.5	2.49V	±2%	54	0.4 - 10mA
LM385	Adjustable (1.235 to 5.3V)	±2%	54	13µA - 20mA
LM385-1.2	1.235V	±2.4%	150	15µA - 20mA
LM385-2.5	2.5V	±3.0%	150	20µA - 20mA

Figure 1. Voltage reference IC selection chart (National Semiconductor 'commercial grade' shunt-output devices, with 0-70°C operating range).

Voltage Reference IC Basics

Voltage reference ICs are simple units that house a precision temperature-compensated voltage reference device and an output buffer stage. The reference can be of the 'band-gap' type, which generates a stable low-noise output of (usually) about 1.22V, or of the 'subsurface Zener' type, which (in modern devices) usually generates a stable output of about 6.9V. The output buffer acts as a current-boosting (and sometimes voltage amplifying) regulator, and may be of either the shunt or the series type; ICs with shunt outputs can normally be used in exactly the same way as a simple Zener diode voltage regulator. Figure 1 gives basic details of five popular 'commercial grade' voltage reference ICs manufactured by National Semiconductor. Details of these five ICs are as follows:

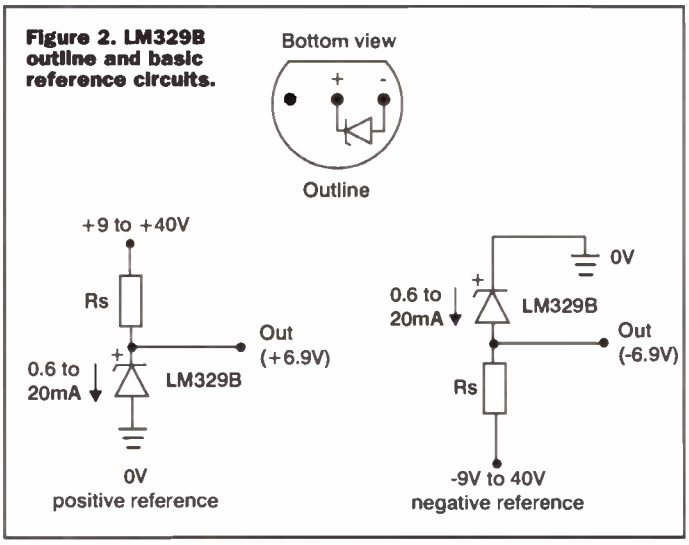
The LM329B

The LM329B is a low cost Zener-based precision 6.9V reference that can operate over the full 0.6mA to 15mA current range; it is usually housed in a 3-pin plastic package, as shown in Figure 2, which also shows basic ways of using the device as a positive or a negative 6.9V reference; in these circuits the Rs value is chosen to set the desired operating current, as in a normal Zener diode. Figure 3 shows a simple way of boosting the LM329B output via a non-inverting op-amp stage to make a 10V reference generator (a precise 10V can be set by trimming the 'Cal' control).

The LM336B-2.5

The LM336B-2.5 is a low-cost band-gap based precision 2.5V (nominally 2.49V) reference voltage generator and is housed in a 3-pin TO-92 plastic package. Figure 4 shows the IC's outline and basic usage circuits. The IC's third pin can be used to either trim the

Figure 2. LM329B outline and basic reference circuits.



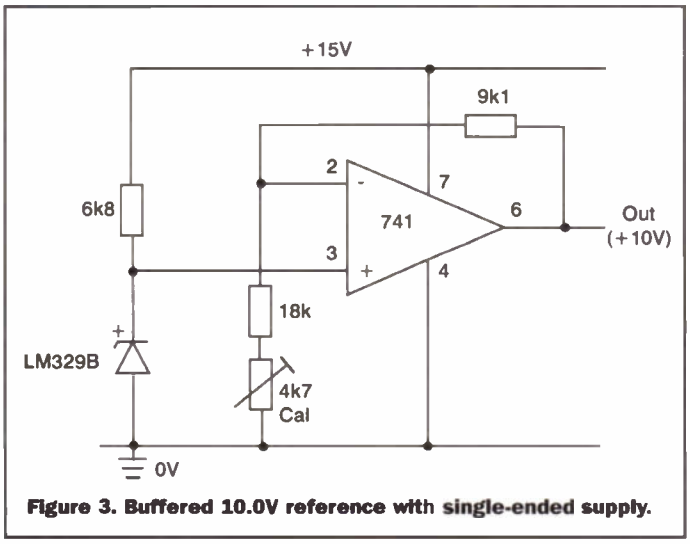


Figure 3. Buffered 10.0V reference with single-ended supply.

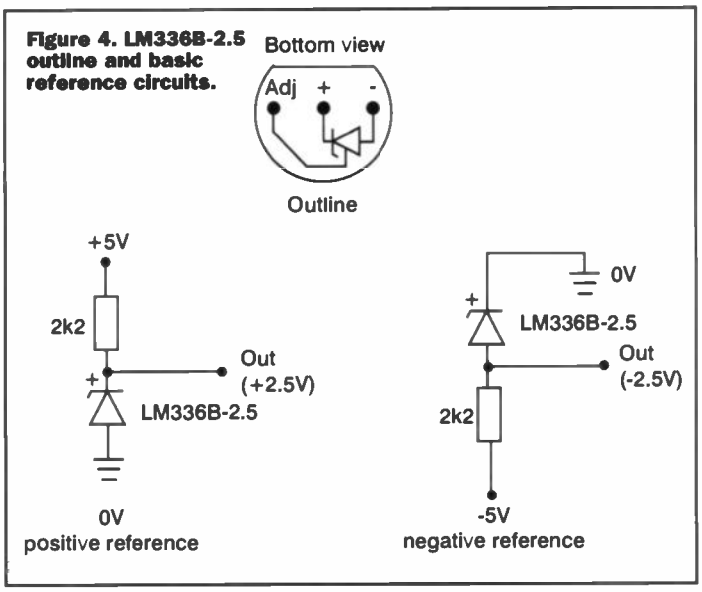


Figure 4. LM336B-2.5 outline and basic reference circuits.

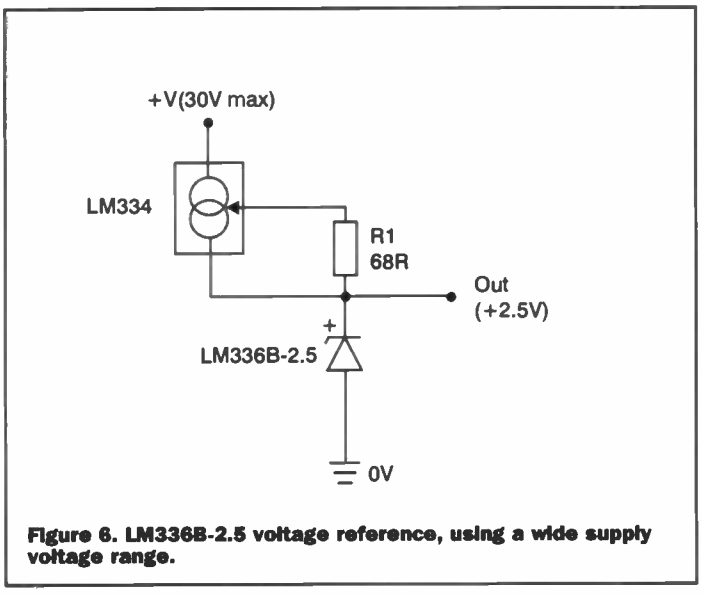


Figure 6. LM336B-2.5 voltage reference, using a wide supply voltage range.

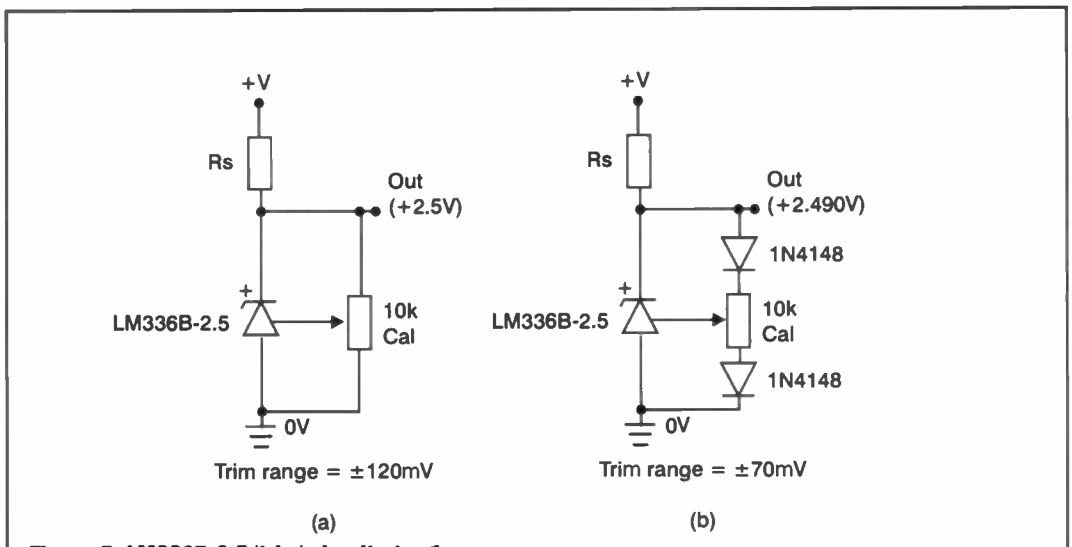


Figure 5. LM336B-2.5 'trim' circuits to give (a) voltage and (b) temperature coefficient compensation.

output voltage by about ±120mV, as shown in Figure 5(a), or to trim the IC for minimum temperature coefficient (in which case the output must be set to 2.490V), as shown in Figure 5(b) (where D1 and D2 must share the same thermal environment as the LM336B-2.5 IC).

Note that the LM336B-2.5 can be operated from a widely variable supply voltage (up to 30V maximum) by feeding it via an LM334 constant-current generator IC (described in detail next month's episode of this mini-series), as shown in Figure 6 (where R1 sets the constant-current value at 1mA).

Figure 7 shows how the LM336-2.5 IC can be used - in conjunction with an external squarewave generator - to make a squarewave 'voltage calibration' generator for use in oscilloscopes, etc. In this circuit, the 2N3904 transistor shunts the LM336-2.5 IC, and is alternately driven fully on (saturated) and fully off via the external squarewave generator (which usually operates at 1kHz and can thus provide a 1ms timebase calibration function); the variable Cal control is trimmed to give an accurate 2.5V peak-to-peak squarewave output.

The LM385- series

The National Semiconductor LM385- series of ICs combine a band-gap reference and a shunt booster to make 'micropower' devices that can operate at currents ranging from a few microamps to 20mA. There are three basic devices in the series; the LM385-1.2 is housed in a TO-92 package and generates 1.235V output; Figure 8 shows the ICs outline and basic application circuits. The LM385-2.5 is housed in the same type of TO-92 package and generates a fixed 2.5V output; Figure 9 shows two basic usage circuits for this IC. Finally, the plain 'LM385' is a 3-pin version that can be adjusted, via its FB (feedback) terminal, to give a precision 'micropower' reference in the range 1.235V to 5.3V; Figure 10 gives details of this device.

Note in the Figure 8d and 9b circuits that the LM344 device is an adjustable constant-current generator IC, and will be described in some detail in Part 2 of this mini-series.

Miscellaneous Voltage Reference ICs

Several companies other than National Semiconductor manufacture popular types of voltage reference ICs; amongst the best known of these are Harris Semiconductor, SGS-Thomson, and Analog Devices. The remaining sections of this month's article briefly describe the most popular voltage reference ICs produced by these three manufacturers.

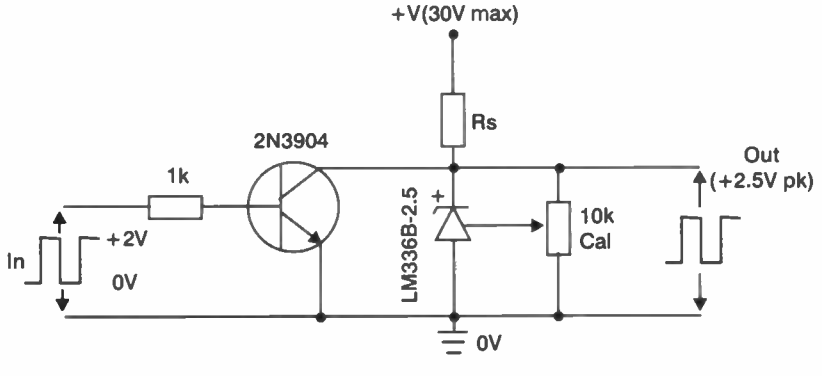


Figure 7. LM336B-2.5 squarewave voltage calibrator generator circuit.

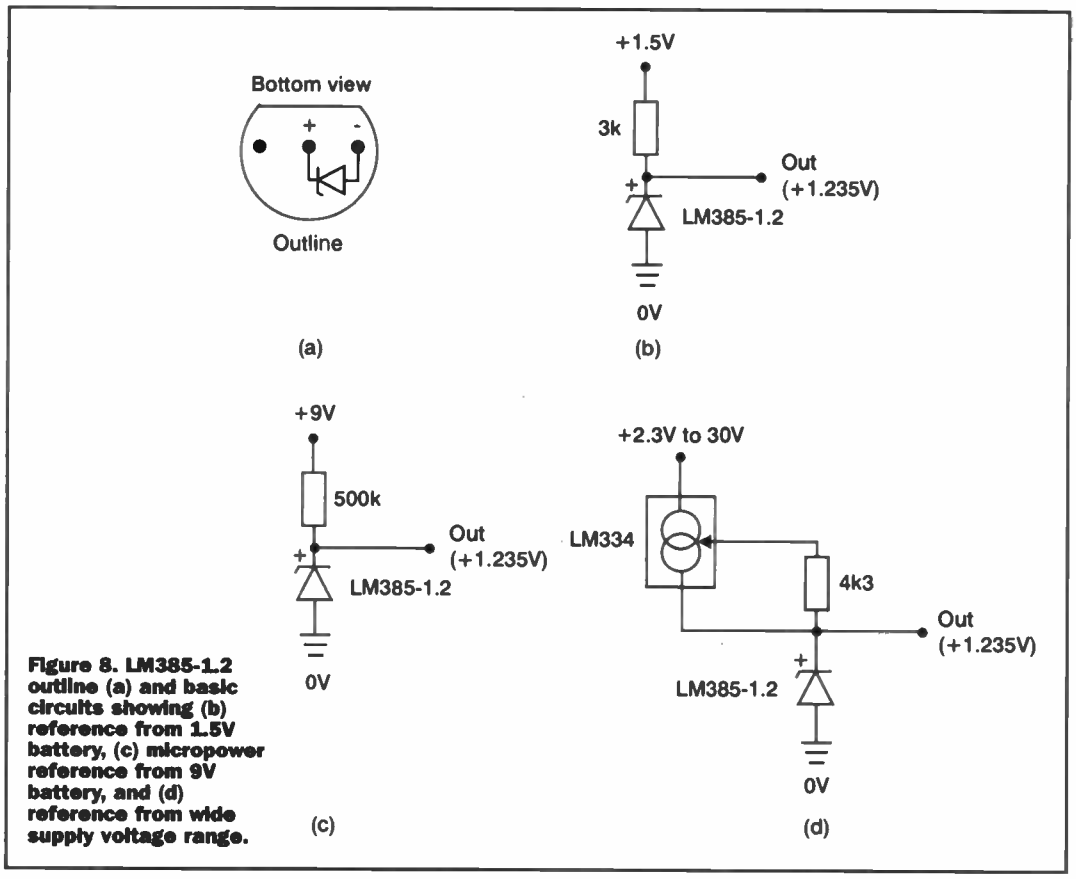


Figure 8. LM385-1.2 outline (a) and basic circuits showing (b) reference from 1.5V battery, (c) micropower reference from 9V battery, and (d) reference from wide supply voltage range.

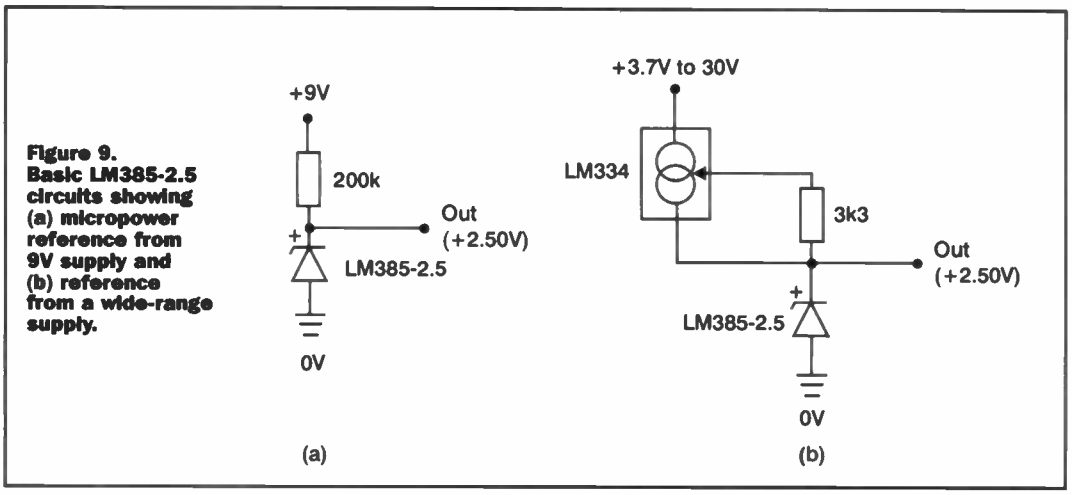


Figure 9. Basic LM385-2.5 circuits showing (a) micropower reference from 9V supply and (b) reference from a wide-range supply.

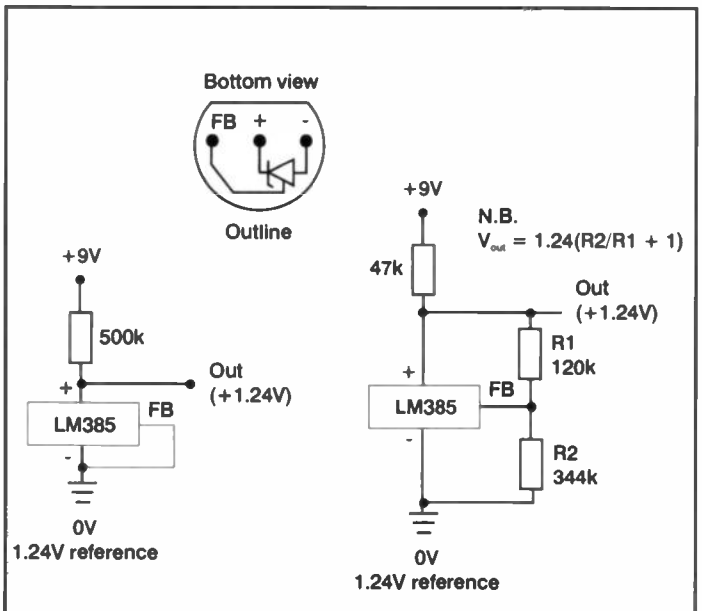


Figure 10. LM385 outline and basic application circuits.

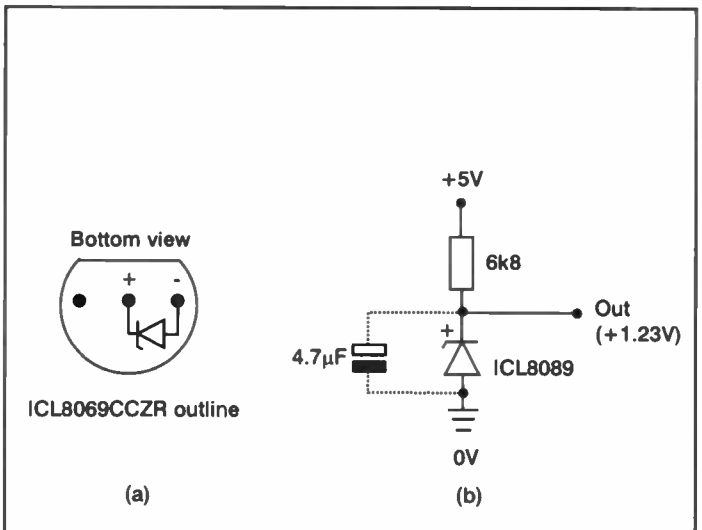


Figure 11. ICL8069CCZR outline (a) and basic ICL8069 application circuit (b) as a 1.23V reference generator.

The ICL8069 (Harris Semiconductor)

The ICL8069 is a temperature-compensated band-gap voltage reference IC with a typical output voltage of 1.23V at an operating current of 500µA. The IC's operating current can be varied over the range 50µA to 5mA, and its output voltage typically shifts by only 15mV when the current is varied over this range. The ICL8069 is produced in eight sub-types (each defined by a four-letter suffix); the best known of these is the ICL8069CCZR, which is housed in a TO-92 plastic package, can be used over the full 0 to 70°C temperature range, and has a typical output voltage temperature coefficient of 0.005%/°C.

Figure 11 shows the IC outline that is specific to the ICL8069CCZR, together with the basic application circuit that applies to all ICs in the ICL8069 range. This particular application circuit is designed for use with a 5V supply with the 6k8 resistor setting the IC's operating current to a nominal value of 550µA. The optional 4µ7 capacitor can be used to enhances circuit stability if the IC's output is loaded by capacitances in excess of 200pF. Finally, Figure 12 shows the basic ICL8069 IC used as a 100mV reference voltage generator for use in an ICL7107 (or similar) DVM (digital voltmeter) IC circuit; RV1 must be trimmed to set a precise 100mV output between the DVM IC's Ref Hi and Ref Low input terminals.

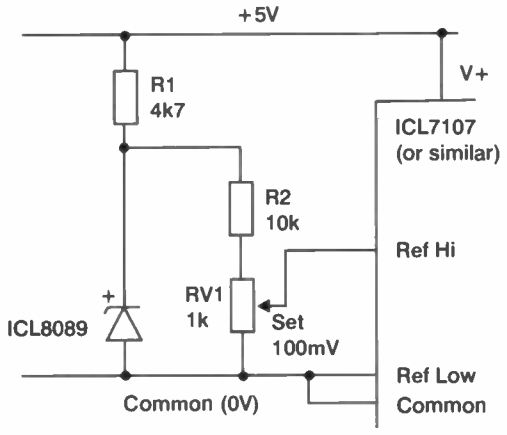


Figure 12. Basic ICL8069 100mV reference generator for a DVM IC circuit.

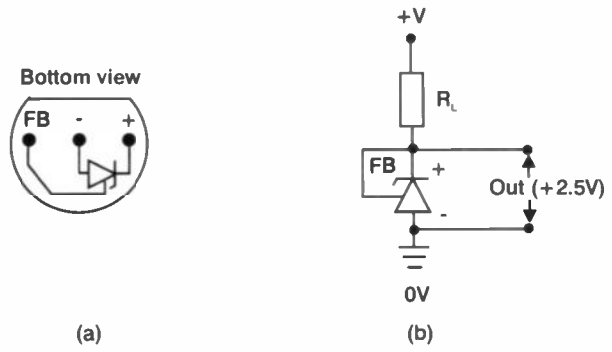


Figure 13. TL431CZ outline (a) and basic application circuit (b) as a 2.5V reference generator.

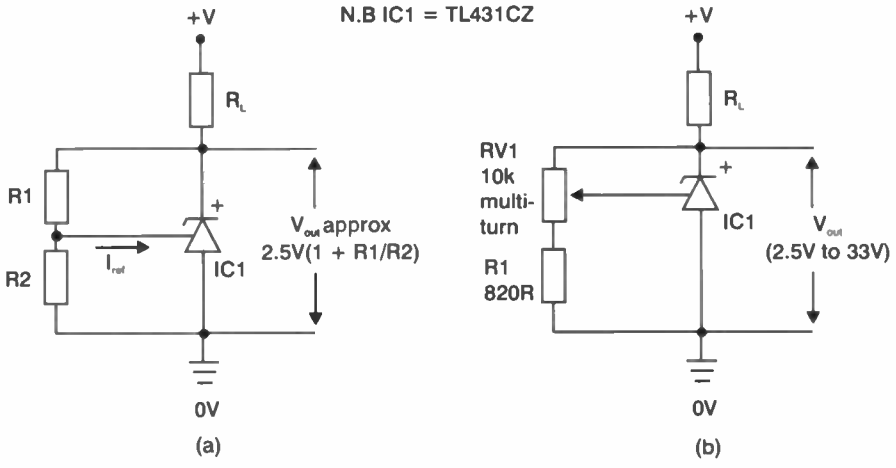


Figure 14. Basic TL431CZ application circuits as (a) a programmable reference voltage generator and (b) a variable reference voltage generator.

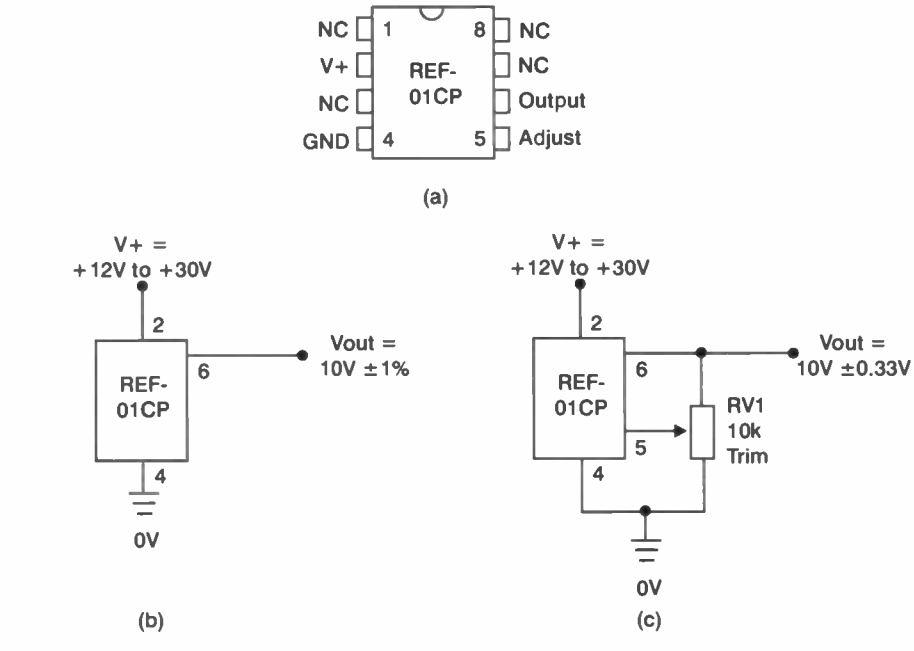


Figure 15. Outline (a) of the REF-01CP, plus basic application circuits as (b) a fixed and (c) a trimmable 10V reference generator.

The TL431CZ (SGS-Thomson)

The TL431CZ is a temperature-compensated band-gap voltage reference IC with a programmable shunt output that can be set to any value between 2.5V and 36V via two external resistors. The IC is housed in a 3-pin TO-92 package, can be used over the full 0 to 70°C temperature range, and can (within sensible power dissipation limits) be operated at load currents in the range 1mA to 100mA. Figure 13 shows the outline of the TL431CZ, together with its basic application circuit as a 2.5V (nominal) reference voltage generator.

Figure 14a shows how to use the TL431CZ as a programmable reference voltage generator in which the output voltage can (when the IC is powered from an adequate supply source) be set at any value within the range 2.5V to 36V via the R1/R2 potential divider. The basic Vout formula shown in this diagram is valid if the current flowing through the series-connected R1/R2 potential divider is at least 100 times greater than Ibias, which has a maximum value of 5.2μA (1.8μA typical). Thus, to generate a 10V output, R1 must equal 3xR2, and the R1/R2 combination must have a total resistance of less than 20k.

Finally, Figure 14b shows how to use the TL431CZ as a variable reference voltage generator, in which the output voltage is fully variable from 2.5V to 33V via multi-turn pot RV1. Note in both Figure 14 circuits that the RL value should be chosen to set the IC's operating current to 1mA or greater (0.5mA absolute minimum).

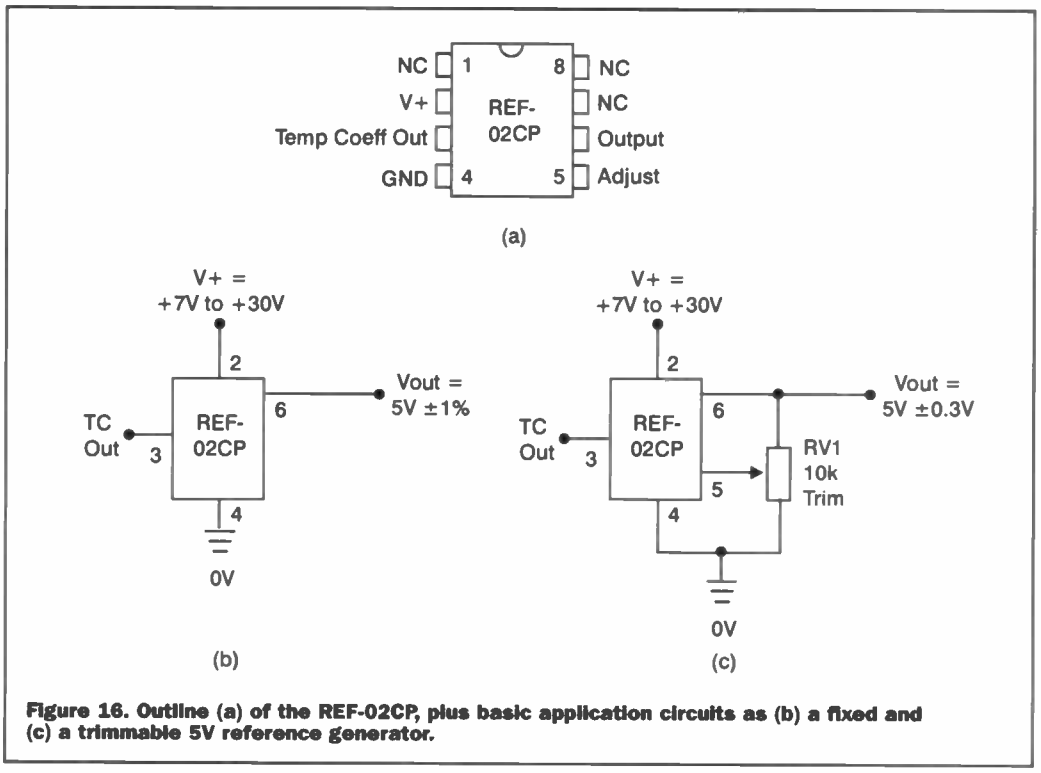


Figure 16. Outline (a) of the REF-02CP, plus basic application circuits as (b) a fixed and (c) a trimmable 5V reference generator.

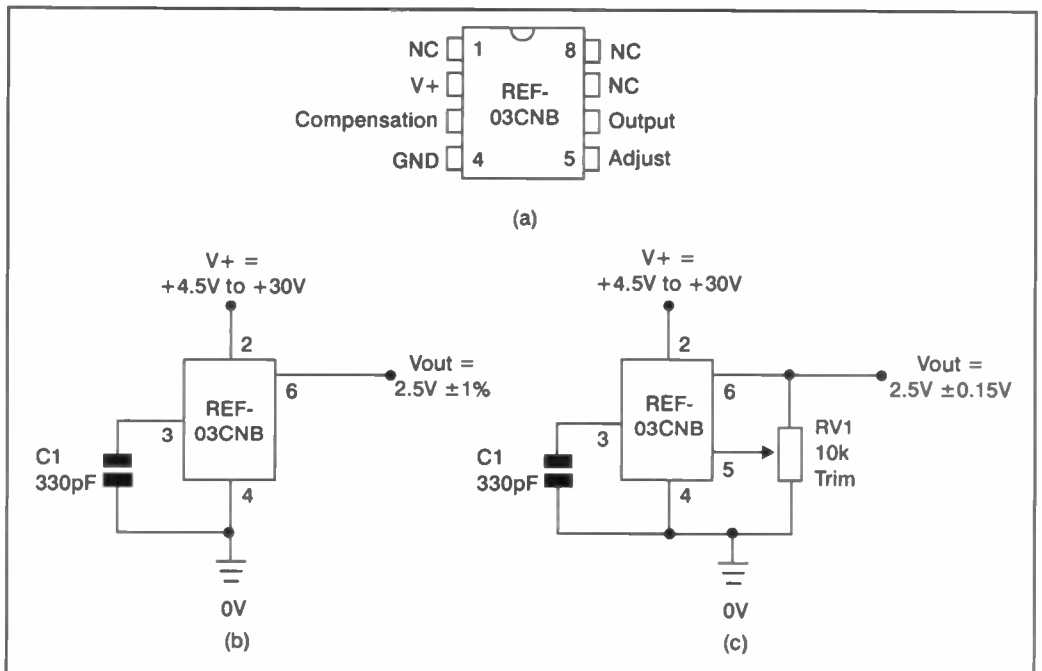


Figure 17. Outline (a) of the REF-03CNB, plus basic application circuits as (b) a fixed and (c) a trimmable 2.5V reference generator.

The REF-0x series (Analog Devices)

Analogue Devices manufacture a variety of precision voltage reference ICs, the best known of which are their 'REF-0x' series of laser-trimmed bandgap devices with short-circuit proof outputs. There are three basic ICs in the series; the REF-01 type generates a basic output of 10V, the REF-02 type generates an output of 5V, and the REF-03 type generates an output of 2.5V. In all cases the output voltage has a basic precision of ±1%; the output voltage can, however, easily be externally trimmed (by up to ±3.3% in the REF-01, and up to ±6% in the REF-02 and REF-03) via an external 10k pot. Note that the REF-02 provides a regular 5V output, plus an additional high impedance temperature-sensitive 'temperature coefficient' (TC) output voltage that changes linearly from 577.5mV at 0°C to 724.5mV at 70°C.

The REF-01, REF-02 and REF-03 are each produced in a number of sub-types (each defined by a multi-letter suffix), offering a variety of packaging and parameter options. The most popular of these ICs are the REF-01CP, the REF-02CP, and the REF-03CNB, which are each housed in an 8-pin plastic package, can be operated over the full 0 to 70°C temperature range, draw a basic operating current of 1mA, can provide up to 20mA of output load current, and consume a self-limiting current of 30mA under shorted-output operating conditions.

Figures 15 to 17 show the IC outlines and basic application circuits of the REF-01CP, the REF-02CP, and REF-03CNB. In each case, diagram (b) shows the IC used in its basic (fixed output voltage) operating mode, and diagram (c) shows it used in the trimmable output mode. Note in Figure 16 that the temperature-sensitive 'TC' output of the REF-02CP is provided on pin-3 of the IC.

THE CAMBRIDGE STORE

Manager Mark Stephens recalls the grand opening of Maplin's latest store.

Well our new store in Cambridge opened its doors for business on 22nd May with the tape being cut by Sandy Black, Group Financial Director. The opening day exceeded expectations with people queuing outside from before 8.00 am, and considering the size of the store, it did not take too long to fill with customers making it almost impossible to move!

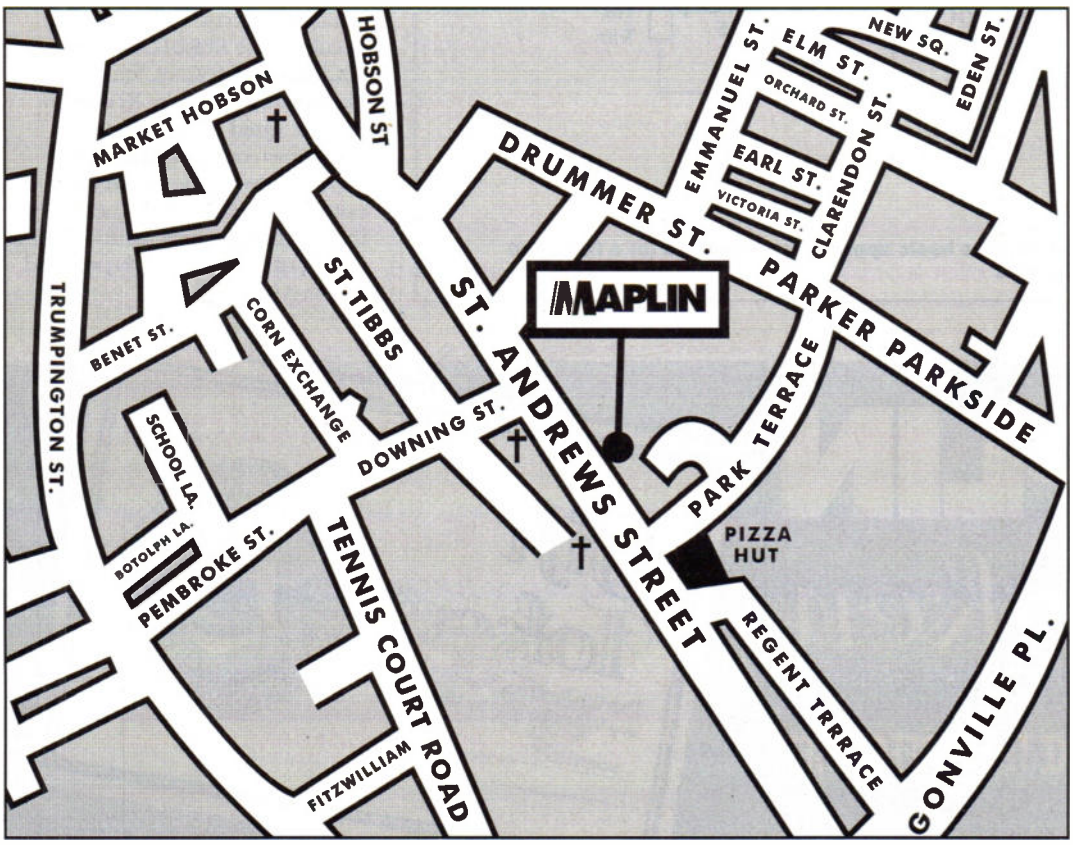
Shoppers are able to choose from an impressive 37,000 strong product range, both in the store and in the Maplin Catalogue - helped by my enthusiastic and highly trained staff. Everything from the latest in-car hi-fis, speakers, home and business security systems, the latest telecommunications, computer accessories and specialist tools are on show.

Graham Caldwell, Retail Operations Director at Maplin Electronics chose the St. Andrews Street site because Cambridge is one of the homes of technology within the country. There is a great community here filled with customers who use Maplin, and our quality products and services appeal directly to this type of location.

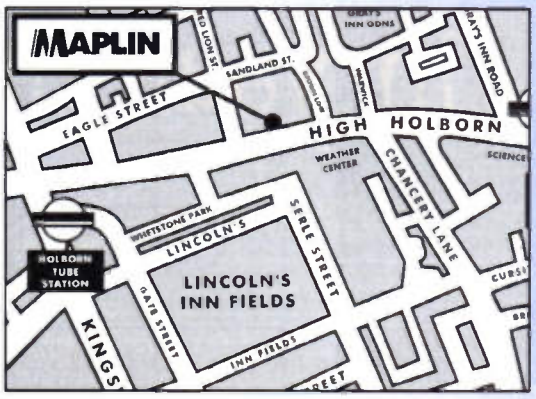
Our special opening offers were in great demand - the Sony Radio/CD players and Canon BJC250 colour printers being particular popular with our many customers. The first weeks trading went fantastically well, with us exceeding our budget easily as both old and new Maplin customers passed through our doors purchasing everything from resistors to computers.

So it only leaves me and my staff to say a big thank you to all our customers for making the store opening a huge success and we hope to be able to assist you all again very soon - keep buying!

The 2,500sq. ft. Cambridge store is located at 46 - 48 St. Andrews Street (tel: 01223 369 758).

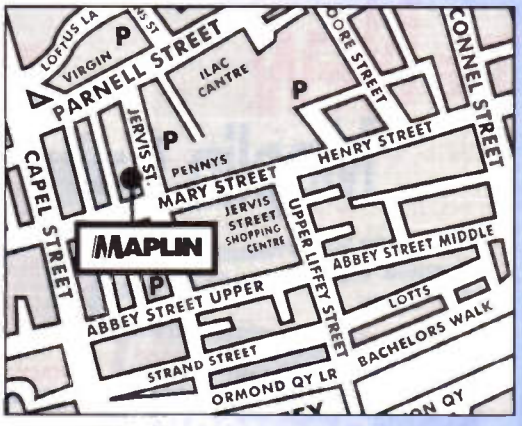


STORES LATEST



Our central London 1,600sq. ft. store opened for business at 52- 54 High Holborn WC1 (tel: 0171 224 8164) on Tuesday the 22nd June.

Our first store in Eire will be opened by a very special celebrity on the 17th July. This large 5,000sq ft store is located at 1 - 4 Jervis Street, Dublin (tel: 01878 2388).



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TECHNOLOGY WATCH

with Martin Pipe

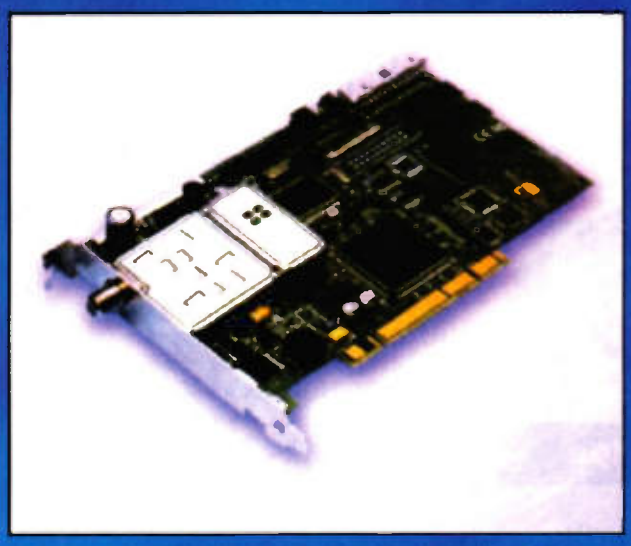
Every year, companies involved with satellite and cable broadcasting technology converge at Earls Court in London. The Cable and Satellite Europe trade shows have, for over a decade, been a showcase for set-top boxes, head-end equipment, RF signal distribution, test gear, satellite operators and microwave electronics. If you are a satellite TV enthusiast, this trade show will give you some idea of the receiving equipment you will be able to purchase in the near future. Over the last couple of years, the focus has shifted towards multimedia delivery - hence the change of the shows name to Mediacast. MPEG2-compliant DVB-standard (Digital Video Broadcasting) receivers - digital set-top-boxes - first made an appearance in 1995. At the most recent show, which took place at the beginning of May, you could not see much that was not DVB-compliant. The major receiver manufacturers, such as Pace, Echostar and Nokia, were all showing off their latest wares. On demonstration were receivers for terrestrial services (DVB-T, as used by onDigital) and the more established satellite broadcasts. The main difference between the two boxes is in the tuner - terrestrial and satellite DVB employ different transmission frequencies and modulation schemes.

The majority of the DVB satellite receivers on show were free-to-air (FTA) models. Many European satellites, including Astra and HotBird, relay hundreds of channels that do not require a subscription or conditional access module (the digital ages equivalent of a decoder). Broadcasters love the fact that ten or more digital channels can be crammed onto a single transponder - with analogue, it was one channel per transponder. The transmission costs per channel are thus greatly reduced - note that hiring a transponder on a popular high-powered satellite works out at several million pounds per year! As a result of these slashed costs, most of the European terrestrial broadcasters are now simulcasting on digital satellite. If you were to invest in a FTA receiver and a motorised dish, the world of European television would be open to you. There are, of course, dozens of analogue channels still out there - although many will probably move to digital as soon as enough viewers have DVB receivers. Several manufacturers, including Echostar and the unfortunately-named Lemon, proudly showed off receivers capable of picking up both analogue and FTA digital channels. The Echostar AD200IP has an in-built positioner capable of moving a motorised dish to the required satellite, while the positioner-upgradable Lemon Volksbox incorporates the ability to receive Astra Digital Radio (ADR).

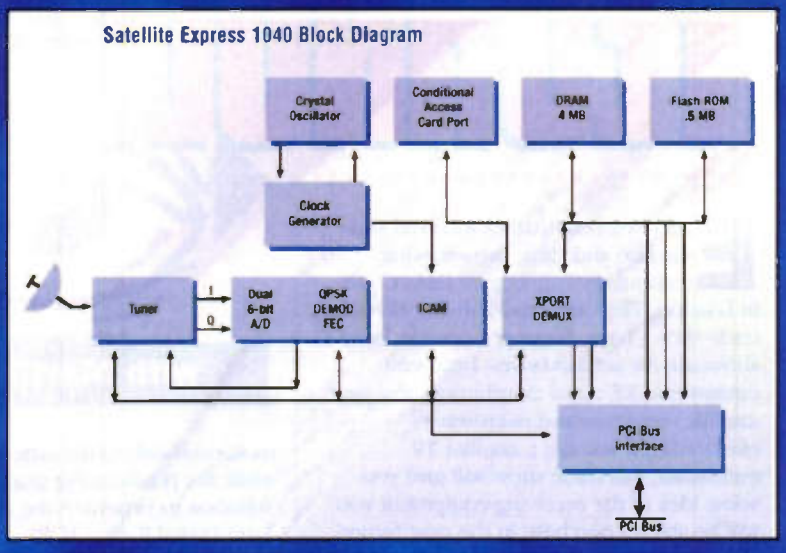
On the subject of digital audio, Nokias latest 9800 DVB Mediamaster set-top box has one particularly interesting trick up its sleeve. Its currently the only such receiver to incorporate a SPDIF digital audio output. Thanks to this neat - but simple - provision, the best possible audio recordings can be made if you have got a self-contained CD burner or Minidisc deck! Needless to say, that digital output could also feed an audiophile-quality DAC to give the highest-quality sound you've ever heard from satellite! Unfortunately, the 9800 misses out on its predecessors most interesting feature - a SCSI port. Connect up a CD-ROM drive to this, and your previous-generation Mediamaster (for example, the 9200) would play Video CDs. Third-party enthusiasts wrote replacement firmware capable of doing all kinds of interesting things with

The Cable and Satellite Europe Trade Show.

Digital output available on the back of the Nokia DVB Mediamaster.



DVB receiver that fits into a PC slot from Broadlogic.



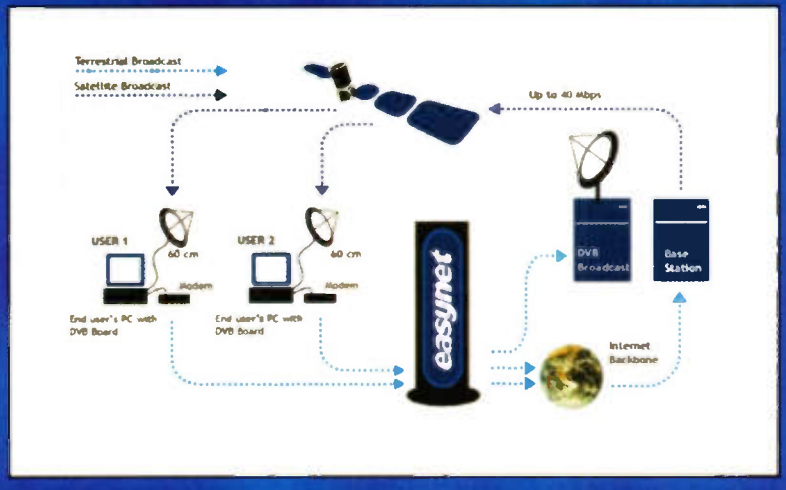
the SCSI port. You could, for example, save video/audio datastreams to a connected PCs hard disk - essentially converting it into a digital VCR! Other software allowed still frames to be grabbed over SCSI!

Indeed, the Nokia Mediamaster has been a long-term favourite with the more technical satellite TV enthusiast. Those enthusiasts have added other features to the firmware, making it one of the most flexible free-to-air receivers currently around. Whether they receive the 9800 with as much enthusiasm remains to be seen. You may have SPDIF, but connectivity is certainly lacking in other areas. Although there is no SCSI, there is a serial port (for software upgrades), but there is no S-video output or LNB loopthrough. The latter connector, which was also missing on previous models, allows an analogue receiver to be hooked up simultaneously. There are some advantages, though. First of all, there is a good deal more processing power, making the receivers user interface much faster. Secondly, you get a standardised Common Interface (CI) slot. CI modules, which do not look dissimilar to notebook PCMCIA peripherals, will make the addition of conditional access modules much easier in the future. Remember that its not just the free-to-air broadcasters who have warmed to DVB! Unfortunately, we are unlikely to see one of these plug and play CI modules for the Mediaguard conditional-access system specified by Sky Digital. Murdoch presumably likes to have complete control over who is able to watch his service...

Pretty much every recent FTA receiver has a CI slot, rendering it future-proof if you decide to go for pay-TV at a later stage. One receiver, the Micronik TV-Box 1000S, will hold up to four CI CAMs with the appropriate extension board! Although Mediaguard isn't catered for, you can buy the relevant modules for various conditional-access systems (e.g., Conax and Viaccess) here in the UK. Unfortunately, they are fairly expensive - as are the similarly grey-imported subscriptions... The 9800 has an embedded CAM for Irdeto, one of the most popular (and most hacked) conditional-access systems. Just as well - there is no CI Irdeto CAM yet available. Other CI-friendly FTA receivers, including the Micronik, do have hardware-specific slots for Irdeto CAMs though. The final interesting feature of the 9800 is its adherence to the OpenTV electronic programme guide (EPG)/user interface.

OpenTV, which was represented by its own stand at the show, is becoming very popular and several other DVB receivers - such as the Galaxis IQG.1, adhere to the standard. In addition to current/next programme details, OpenTV has a keyword search mode so that you can track down programmes of the genre you are interested in. Of course, the broadcaster must be OpenTV-compliant, and you must have the relevant subscription and CAM for non-FTA channels. Programmes can be bookmarked, and the receiver will tell you when they begin - or even switch to the appropriate channel. A programme-category search mode is also offered. OpenTV also provides

Eutelsat control room.



Easysat Internet service.

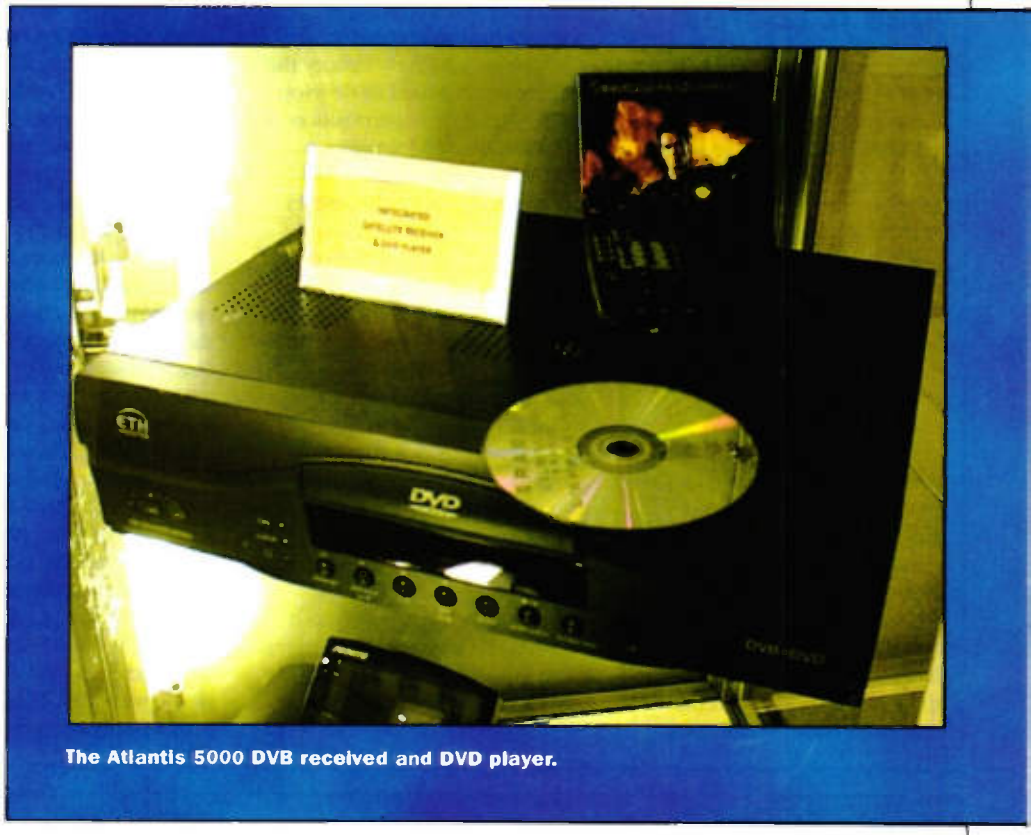
an access path to the Internet, and this is supported by the IQG.1. Basic Web surfing, electronic shopping/banking and E-mail are hence, theoretically, all possible. But, unfortunately, these facilities are only available to bona fide subscribers in Europe. Sky Digital will shortly offer a similar service to its UK subscribers, but only via a Digibox.

Ah yes! DVB and data - this was one of the most exciting developments at Earls Court. You can already buy DVB receivers that fit into one of your PCs spare PCI slots. A number of manufacturers, including BroadLogic, sell these devices. They retail for between £300 and £400, which is about the same amount of money that you would pay for a stand-alone FTA receiver. Although you can watch FTA channels on your PCs monitor, this is only the beginning. Satellite operators Eutelsat and Astra are both working with Internet service providers to provide fast Internet delivery over spare transponders - the DVB standard has evolved to support the transmission of computer data as well as digital MPEG audio/video. User-originated examples of data (such as web page/FTP file requests and e-mail) are sent over a modem in the normal way. The return path, which tends to be somewhat more bandwidth-intensive, is achieved via satellite. In the UK, Eutelsat is working with Easynet to provide the Easysat Internet service. Easynet claims that its service will deliver data at a typical speed of 15 kilobytes per second. Theoretically, it could yield 256 kilobytes per second, but this would presumably be achieved from Easynets own server and even then only if things are not busy!

So how does it work? Once the DVB receiver card is installed and the appropriate software loaded, the user obtains a special dial-up account from Easynet. This re-routes the IP return path so that the data travels via satellite rather than the modem. Easynet use a spare transponder on the pan-European Eutelsat HotBird satellite. The uplink facility, which is provided by BT, is connected to Easynets DVB-IP gateway via dedicated leased lines. Easynet claim that its system has combined capacity of 40 megabits per second - this is shared by all of the Easysat subscribers who are connected at that time. If its service takes off, extra transponders will presumably be booked and extra land-based network infrastructure invested in. At the receiving end, the users satellite dish - one of 80cm diameter is needed - picks up the uplinked information and passes it to the DVB receiving card. This then decodes the IP packet and gives it back to the operating system. DVB is very resilient - a quarter of the transmitted information is dedicated to error correction. As a result, the system should be reliable. Just as well, since Easynet is initially aiming the service at businesses. It should eventually become viable for consumers - Sky, after all, will soon provide Internet access via its set-top boxes. It's no substitute for proper PC-based satellite internet access. Just imagine how fast you could download MP3 files - well, in theory anyway. More details on Easysat can be had on **http://www.easysat.co.uk.** Other information can be obtained from the joint BT/Eutelsat/Easynet site **(http://www.convergence1.com.)**

Across on the Astra stand, one could experience the joys of AstraNet - a service that is clearly intended to compete head-on with Eutelsats offerings. Indeed, its very similar in concept and functionality. Six UK service providers have signed up to offer AstraNet, which is distributed via the Astra 1x satellites. Here in the UK, you will only need a 60cm dish. Many of Astras analogue TV broadcasters are moving to digital, relinquishing transponders that could be used for data traffic. What really makes AstraNet stand out, however, is the promise of two-way data traffic via satellite. In other words, your modem (and, better still, your phone line) become redundant. I can imagine that you will be charged according to the amount of data transported, which is perhaps more sensible than charging for the amount of time spent on-line (the phone bill, in other words). The snappily-named Astra Return Channel should be available in 2000 - the required transponder technology will be fitted to the forthcoming Astra 1K satellite.. Basically, the LNB mounted at the focal point of your dish will have a transmitter as well as a receiver on board. The return path will, according to LNB maker Cambridge, be in the 29.5-30GHz region. One can already imagine the fun that LNB designers will have keeping the two sections isolated - note that the RF power could be several watts! Cambridge reckons that its first Return Channel LNBs should sell for under £200.

Basically, Astra Return Channel will put a VSAT (Very Small Aperture Terminal) in the home! VSAT systems currently exist, but they are aimed at broadcasters and businesses, and cost thousands of pounds. Licensing is something that needs to be worked out - with Astra Return Path, you could effectively become a broadcaster! Astra says that transmit data rates can be as high as 150 kilobits per second. Theoretically, there is nothing to stop you from leaving your PC permanently connected to the Internet. If so, you could have a registered domain name point to your IP address, and set your machine up as a low-bandwidth Web server! It's unlikely that Astra would allow this to happen - after all, those 30GHz inward-bound transponders will have to cater for a consider amount of pan-European traffic! Astra Return Path does, after all, have applications other than Internet access - home shopping, pay-per-view movie ordering and other examples of interactive television, for example. More information on AstraNet can be found, perhaps unsurprisingly, on the Web. Unfortunately, Astras web design genies have designed their site **(www.astra-net.com)** so that it will not work unless you have got IE4 or Netscape 4 on your web site. Internet and TV is just one of the areas of digital convergence. On the stand of one Far Eastern manufacturer (ETH), you could see a combined FTA DVB receiver and DVD player. And why not? Both media, after all, employ MPEG-2 video/audio compression! However, the functionality offered by the Atlantis 5000 was rather basic in both areas. Like Internet data delivery, it does show the way forward though.



The Atlantis 5000 DVB received and DVD player.

Martin Pipe welcomes comments and ideas. E-mail him as: whatnet@cix.compulink.co.uk Or look out for him online! His ICQ ID is: 15482544

Was it There?

Dear Sir

Graham Marett's dismissal of the Participatory Anthropic Principle (July Issue) as being contrary to both science and religion (' speculative science at its worst' and 'most orthodox religious thinkers would hesitate to suggest that the universe was prepared in advance') is a little harsh. The Participatory Principle is quite compatible with both the standard (Copenhagen) theory of quantum physics and with orthodox Buddhist teachings on 'emptiness of inherent existence' (Refs 1 and 2).

According to the Participatory interpretation, the universe began as a quantum fluctuation in the limitless void. In the absence of an observer, the evolving universe remained as a 'multiverse' - a coherent quantum superposition of all logically possible states. Throughout its early history the universe continued to develop as an immense superposition of probabilities. All logically possible states of matter, physical constants, properties and laws were simultaneously present and evolving into ever increasing diversity.

But, according to both quantum theory and Buddhist teachings, as soon as an observer's mind makes contact with a superposed system, all the numerous possibilities collapse into one actuality. At some instant one of these possible alternative universes produced an observing lifeform - an animal with a nervous system which was sufficiently evolved to accommodate mind. The first act of observation by this mind caused the entire superposed multiverse to collapse immediately into one of its numerous alternatives. (Refs 3 and 4).

That one alternative version of the multiverse was not just the first configuration to be inhabitable by mind. The fact that it was the first configuration also guaranteed that it was the only configuration. All uninhabited alternative universes, ranging from the nearly-but-not-quite habitable few, to the anarchic and unstructured vast majority, were instantly excluded from potential existence. The evolving multiverse was thus always destined to resolve itself into a sufficiently ordered state to allow itself to be observed.

The Participatory Principle does raise some interesting questions as to the nature of mind. According to the theory, the present state of the universe is the product of the mind of a sentient being. But if that being's mind was nothing other than its material brain, which itself was nothing other than an aggregate of subatomic particles, then how did that one particular configuration of particles cause the collapse of a superposed system billions of times its size, and of which it was a part? This is an area where theoretical physicists and Buddhist philosophers could doubtless have an interesting discussion. - my guess is that most physicists would agree with Graham Marett's final paragraph in saying that the physical universe led to the origin of mind, whereas most Buddhists would view this as putting the cart before the horse.

Ref 1 - Revel, J-F and Ricard, M, tr Canti, J. The Monk and the Philosopher - page 57 (London: Thorsons/HarperCollins, 1998, ISBN 0 7225 3649 6)

Ref 2 - Revel, J-F and Ricard, M, tr Canti, J. The Monk and the Philosopher - pages 93 to 94. (London: Thorsons/ HarperCollins, 1998, ISBN 0 7225 3649 6)

Ref 3 - Penrose, Roger; The Emperor's New Mind, page 381 (London: Vintage, 1990, ISBN 0 09 977170 5)

Ref 4 - Paul Davies, The Mind of God, page 224 ff (London: Penguin, 1993, ISBN 0 14 015815-4).

Brian Loveless
Ulverston

You raise some interesting points which one would normally consider complex and even contentious, in particular the Participatory Anthropic Principle. We realise that we have only taken a gentle 'dip' into this fascinating topic, but hopefully gave our readers an introduction and 'taster'. We agree that it is has been known for sometime that a parallel exists between Quantum Theory and statements made by Buddhism and eastern mysticism. Nevertheless, Quantum Theory is a very fascinating area that we hope to explore in future issues of the magazine. To end, surely we must also look at the way we define 'life' (in its conscious organic form), and how other lifeforms fit into the pattern of things before we can get to grips with our place in this known universe. (No replies of 42 please!)

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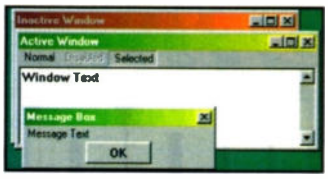


Software HINTS & TIPS

This month Mike Bedford explores some of the facilities available in Windows 98 which are not present in Windows 95.

So far in this column we've restricted ourselves to looking at Windows 95 or at features which are common to Windows 95 and 98. However, nearly all new systems are now shipped with the latest operating system and a lot of Windows 95 users will have upgraded. So we feel this is a good time to start looking at Windows 98. This month we'll take a look at some of the new features which were launched with Windows 98. In particular, we'll look at some of the new ways in which you can customise the appearance of your PC. Admittedly this is purely cosmetic but many people do like to personalise their systems. In future columns, we'll look at other – more useful – new facilities in Windows 98.

Title Bars

Most Windows 98 users probably haven't discovered our first new feature. OK, it is a bit quirky, but did you realise that you can now colour the title bars on windows in a graduated manner? This contrasts with Windows 95 where you could pick just a single colour for active windows and another single colour for non-active windows.

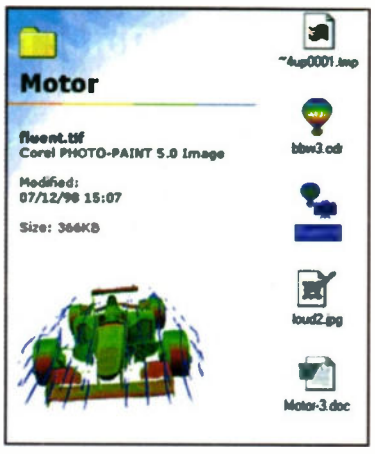
From the start button, select Settings.> Control Panel > Display > Appearance. Select 'Active Title Bar' in the 'Item' list box and then select a pair of colours for the corresponding 'Color' and 'Color 2'. The effect will be shown in the preview Window. When you're happy with this, you can do the same for inactive windows by selecting 'Inactive Title Bar' as 'Item'. A totally tasteless colour scheme which I discovered in my experiments is shown here.

Desktop Icons

The Active Desktop is a major topic in itself so we won't address this new feature of Windows 98 at this stage. However, there is some additional scope for customising the desktop even if we forget about the Active Desktop for now. For example, it's an easy task to change the desktop icons for My Computer, the Recycle Bin, My Documents and the like.

Click right on the desktop – i.e. the background which you'll see if you're not displaying any windows. From the menu which is displayed, select Properties and the Display Properties window is displayed. So far, all this would have worked in Windows 95. What is different, however, is that this window has some new tabs. Click on the Effects tab and you'll be shown a list of desktop icons. Select one, My Computer for example, and click on the Change Icon button. You can now select a new icon although you may not think any of the ones presented are particularly appropriate. Note, however, that you can browse through the disk for other icons and you can even design your own icon as a .BMP file and use it on the desktop. The portion of screenshot shows a Macintosh-style waste basket icon which I designed and have used in place of the standard Recycle Bin icon. You can use any paint package for designing an icon or, if you don't have a suitable package, you can use Paint (accessed by Start > Programs > Utilities > Paint) which comes as a part of the standard Windows installation. Make your icon 64 pixels square and don't use the background colour in the icon as this will just disappear when it's displayed on the desktop.

Note also that the page which we've just seen for changing desktop icons can also be used for switching between small and large icons.



Windows Explorer

The other area of cosmetic customisation we're going to take a look at is the Windows Explorer, a facility which you probably make full use of. If, on the other hand, you tend to use My Computer for manipulating files instead of Windows Explorer, exactly the same customisation facilities are available.

Facilities for viewing files and folders as small or large icons, list or details are the same as in Windows 95 and this is something we've already covered in this column. Viewing a folder as a Web page, however, is completely new. This facility is turned on and off by clicking on the 'as Web Page' entry in the View menu. You'll notice that the major change in the Web page view is a margin down the left hand side. This margin has the title of the folder at the top, a bit of cloud graphics and an area which will tabulate details of any files selected. A very useful feature is that files can be previewed just by clicking on them once (or by moving the pointer over them if you've selected 'Web Style' as a Folder Option as we'll see later). A screen shot shows the preview facility in action.

But perhaps the most significant change to the appearance and behaviour of folder windows in Windows Explorer is when Web Style is selected from View > Folder Options > General. The major difference from an operational point of view is that file and folder names will be underlined as are links on Web pages and you only need to click on them once to open the file or folder. This contrasts with double clicking in the Classic Style. And even just moving the pointer over a filename is sufficient to preview the file, so long as Web View is turned on.

Additional customisation options are also available in Web Style. The easiest form of customisation is to apply a background to a folder – you can have different background patterns for each folder. To apply a background pattern, select View > Customise this Folder > Choose a Background Picture. A list box will give a few options, alternatively you can browse for a graphic file, either a standard one or one you've created yourself.

A more ambitious bit of customisation involves opting for 'Create or Edit an HTML Document' rather than 'Choose a Background Picture.' The first time you do this, an HTML file which describes the current appearance of the folder will be created. On this and all subsequent occasions, this file will be opened in an editor thereby allowing you to modify it. Explaining exactly how to do this is beyond the scope of this column since the process involves writing HTML code. However, if you have written Web pages in HTML, you may like to give it a go. Even if you've never dabbled in HTML before, you could still try some experiments. If you get it wrong it's easy to discard all the customisation. And by editing the HTML file, the sky's the limit. You can add graphics of various types, you can change fonts, text sizes, colours, you can add textual descriptions of the contents of the folder and so on.

So that's a few ideas on ways of customising Windows 98. Do experiment for yourself, after all, if you go wrong you can easily revert to the original settings.

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.

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