ELECTRONICS and Beyond

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JULY 1999 NO. 139 £2.65

What Makes a Good Website?

Find out inside!

The Anthropic Principle

Does man have a unique place in the universe?

Digital 8

Another format?

New advanced materials to prevent icing

PROJECTS FOR YOU TO MAKE

- Sound Generator
- One Channel Audio Light Effect
- SRAM Tester
- Numerical Readout for Geiger-Müller Counter

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Britain's most widely circulated magazine for electronics!

THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

July 1999 Vol. 18 No. 139

Projects

Features

Regulars

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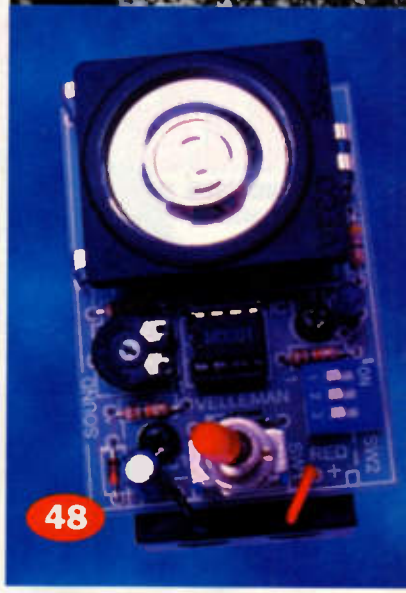

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P.O. Box 777, Rayleigh, Essex, SS6 8LU.
Tel: (01702) 554155.
Fax: (01702) 554001.
Lithographic Reproduction by Planagraphic Studios,
18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UY.
Printed by St Ives (Gillingham) Ltd.,
Grant Close, Gillingham, Kent, ME8 0QB.

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Fax: (01702) 554001.

UK Newstrade Distribution
Maplin Electronics PLC.

Export Distribution
Comag Magazine Marketing
Tavistock Road, West Drayton, Middx, UB7 7QE

ELECTRONICS and Beyond

This month we feature a wide and diverse range of topics for you to read - one in particular that is thought provoking - Graham Marett's article on the Anthropic Principle - which will hopefully open the minds of readers who are not conversant with this thinking.

Gavin Cheeseman in his Magnetometer project looks at a variety of different ways to measure magnetic fields and investigates various applications for magnetic sensors. This will be followed by practical applications and circuits.

Reg Miles continues his analysis of home digital technology with an in-depth look at video digital 8. In passing, it has been reported that the ITC are planning to look at what to do with the television frequencies and sites etc. when they finally pull the plug on the present analogue transmissions. Sky TV are also proposing to give away free set-top decoders for its digital service. It can only be a few years away before all our home entertainment is completely in a digital format!

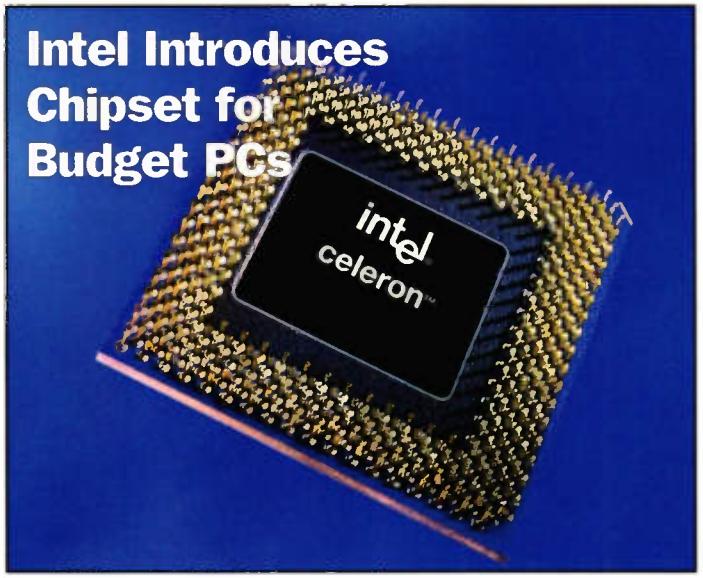
The Decline Continues

We have read recently that there are over 10% less students, compared to last year, applying for electronic courses at colleges and universities. This will surely lead to a further decline in the number of qualified electronics people that the country can call upon. Indeed, except for mathematics this downward trend seems to be across engineering and science courses in general.

Unfortunately, the youngsters of today seem to be tempted to those occupations that redistribute wealth rather than help create it - probably because these jobs pay more. So unless we can make science and engineering more attractive to both boys and girls then it does not bode well for the future.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT



Intel has introduced the Celeron processor 466MHz and the Intel 810 chipset, two products that bring increased performance and capabilities to value PCs. The Celeron 466MHz processor is now Intel's fastest processor for budget PCs, providing great performance for today's applications and Internet access.

Specifically designed for budget PCs, the new Intel 810 chipset integrates 3D AGP graphics and enables software-based audio, modem and DVD capabilities. The Intel 810 chipset brings higher levels of performance and new technologies to low-cost PCs while integrating capabilities that would otherwise require dedicated hardware add-in cards. For further details, check: <www.intel.com>.

Contact: Intel, Tel: (01793) 403000.

Government Scheme Beats Traffic Delays

Later this year, the Highways Agency will launch the first phase of the UK's first ever Intelligent Transport Systems (ITS) national test site to give motorway drivers real-time information on delays, poor weather conditions, forthcoming roadworks, and motorway congestion. The pilot scheme will operate between Swansea and Gatwick and Heathrow airports from June this year, and is expected to run for two years.

The solution, managed by the Transport Research Laboratory (TRL), uses a mobile data network, to transmit detailed information on local traffic and weather conditions, to in-vehicle terminals. Car manufacturers such as Jaguar and Rover who are also involved in the project will fit the terminals.

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

Contact: The Highways Agency, Tel: (01344) 770783.

CDT and HP to Collaborate on Polymer Research

Cambridge based CDT and Hewlett-Packard have formed a joint development program to develop light-emitting polymers for consumer applications.

Researchers from both companies will explore ways to combine HP's technology expertise in silicon and opto-electronics with CDT's light-emitting-polymer technology to make a high-density display with more vibrant colours, wider viewing angles and lower manufacturing costs than conventional liquid crystal displays.

Light-emitting polymers are organic polymer materials that actually emit light when a voltage is applied to electrodes on both sides of the material. In contrast, liquid crystals do not emit light and require a backlight to be seen in the dark.

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

Contact: CDT, Tel: (01223) 276351.

E-Business Culture Breeds New Employee

A new industrial order, based around the Internet and electronic business, will see the emergence of a new breed of employee - the so-called 'high-value knowledge worker'. In turn, e-business will empower these knowledge workers. As a result employers will need to take new measures to attract and retain their employees services if they are to compete effectively in an e-business environment.

This is one scenario painted by a new white paper issued by IBM Global Services. Entitled 'De-generation and Re-generation', the white paper draws on extensive pan-European research into how an e-business culture could fundamentally change organisations and the way they conduct business.

The paper highlights the opportunities that e-business presents to individuals and organisations. At its heart, the paper argues that success in e-business is not just about implementing technologies - it requires re-thinking the way business is done in an organisation, and perhaps even a change in business culture.

For further information, check: **<www.ibm.com/services>.**

Contact: IBM, Tel: (0990) 426426.

Xerox Announces 'No New Products'

Xerox held a bizarre press conference last month where it announced no new products. Instead, the company revealed a strategy to mobilise its global direct-sales force behind an initiative that, over a 10-year horizon, Xerox claims will grow to represent as much as 50% of its business and act as a catalyst for the company's sustained digital growth.

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

Contact: Xerox, Tel: (0800) 787787.

NEWS BYTES

Time to Replace the Mouse?

The US Patent Office has issued a patent to Innovative Device Technologies granting it ownership of intellectual property described as a hand-held, business card-sized, 20-function Internet navigation device. Called the Internet Surfpad, the device gives personal computer users on all platforms, and eventually Web TV users, a more convenient way to navigate the Web.

Whereas traditional browsing requires a desktop mouse or other pointing device to control typical on-screen Web browser functions or Web site options, such as Back, Forward, Home, Up, Down, and Search, the Internet Surfpad puts all that control into a hand-held device that users can work like a television remote control - comfortably sitting back in their chairs rather than hunched over a desk.

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

Contact: Innovative Device, Tel: +1 949 476 6036.

Microsoft Acquires Interactive Objects for Audio CE Development

Interactive Object's has sold its digital audio player technology to Microsoft and agreed to develop additional streaming technology for the Windows CE operating system. Interactive Objects' audio player provides the first stereo playback software for the Palm-size PC market, supporting Microsoft's new Windows Media Technologies 4.0.

For further details, check: <platform.infoapp.iobjects.com/products/media_player.htm>.

Contact: Microsoft, Tel: (0345) 002000.

New Mouse Needs No Mat

Microsoft has developed a new mouse that uses optical electronics in place of the traditional mouse ball and slotted photo-transistors. In order to determine the direction of movement, the new mouse uses a digital signal processor to capture images through a small lens on the bottom of the device.

Microsoft believes the device will work on almost any surface, including wood, paper or cloth, but is not useable on desktops made of glass or highly polished marble. The new devices are expected to be on the market in September.

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

Contact: Microsoft, Tel: (0345) 002000.

NEWS BYTES

Mobile Data Helps Provides Fast Call-Out Response

Thames Water is set to convert its field service operation to real-time wireless data communications via the RAM Network. Phase I will see an initial roll-out to 1,100 field staff in 1999.

The RAM Network will now handle over 5,400 service calls a day and will provide real-time, two-way wireless data communications for field staff who are responsible for servicing and maintaining commercial and domestic water mains for over 12 million UK customers.

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

Contact: RAM, Tel: (0500) 992120.

Sony One Eyed Compact PC

Sony has announced the VIAO C1, an ultra compact Windows '98 Notebook PC with a built in video and stills camera. The machine's camera can capture digital still and motion pictures together with sound via it's 270,00 pixel CCD.

The VAIO C1 is housed in a rather cool magnesium alloy casing, incorporates a 266MHz MMX Pentium processor, a 4.3GB hard drive and 64 MB of RAM, upgradeable to 128MB. The product is available now priced £1,400.

For further details, check: <www.sony-cp.com>.

Contact: Sony, Tel: (0990) 424424.

IP Networks Two Years Away

Telecommunications networks based on Internet Protocol (IP) platforms will not be deployed for another two years, according to a report from telecoms consultancy, Analysys.

The report entitled 'Next Generation Networks: Integrated IP Architectures' finds that there are still missing elements in the architecture for carrier-scale IP networks, particularly the voice gateways, end-to-end call control, quality-of-service support (except when over ATM) and network management facilities.

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

Contact: Analysys, Tel: (01223) 341300.

Toshiba Drives Up DVD-ROM Speeds

The Toshiba SD-M1212 provides transfer rates six times that of first generation drives: 6X speed playback for DVD-ROM (8,112 KB/sec) and a full 32X speed maximum playback for CD-ROM (4,800KB/sec). In Ultra DMA mode, a specification recommended as part of the PC 98 System Design Guide, the drive offers burst transfer rates of 33.3MB/sec.

For further details, check: <www.toshiba.com/taec>.

Contact: Toshiba, Tel: (01932) 841600.

BP Goes Solar

BP Amoco has announced that around 200 of its service stations worldwide are to incorporate solar power - the largest single project of its kind ever undertaken.

The first phase of the two-year programme will see up to 400 solar panels installed on each canopy at some 200 service stations across eleven countries in a $50 million, 3.5MW project, saving around 3,500 tonnes of CO^2 emissions every year.

As a result of this project, BP Amoco will become one of the world's largest users of solar power. It is already one of the world's largest manufacturers of solar cells and modules.

The level of power generated will vary from site to site. But at each, the solar panels on the canopy above the pumps will generate more clean energy than is consumed by the site's lighting needs and the power requirements of the pumps below.

The installations, which will be connected to the local electricity networks, will allow any excess electricity to be exported during the day and the shortfall imported at night.

BP Amoco managing director Chris Gibson Smith and Patrick Lambert, head of the renewable sources of energy unit at the European Union celebrated the launch of the project by switching on the solar installation at the company's latest 'solar station' at Perivale, West London.

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

Contact: BP Amoco, Tel: (0171) 496 4000.

3Com Dominates Handheld Market

Industry watcher Computer Economics expects 3Com Palm Systems to continue to dominate the handheld market, even as Microsoft CE makes gains and the rest of the competitors quickly loose ground.

While 3Com Palm Systems will gain market share for the next four years, then remain static at 60 percent of the market from 2002 to 2003, Microsoft will gain market share in each of the next five years.

Handheld computer shipments will increase from a total of 6.5 million units in 1999 to 14 million units in 2003. The number of low-end models being shipped will grow at a faster rate than the number of high-end models.

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

Contact: Computer Economics, Tel: +1 760 438 8100.

Entrepreneur Secures £5 Million for UK Internet Start-up

Bob Jones is one of the UK's most successful technology entrepreneurs having founded and built a series of highly flourishing data communications companies. Sonix, his most recent venture, was sold in May 1995 to US networking giant 3Com for more than £40 million.

History may very well be about to repeat itself. Jones has raised more than £5 million venture funding for Internet equipment-company, Equiinet. Equiinet was formed in January 1998 with funding from the company's directors. Its Internet access product, NetPilot, was launched in April 1998 and won a best of show award at Networks Telecom '98.

The new investment will enable Equiinet to embark on a major recruitment programme for development and sales staff. Country-specific and Pan-European channel partners are also being sought to complement Equiinet's UK infrastructure and there are plans to open offices in five major European centres during the next six months.

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

Contact: Equiinet, Tel: (0870) 6081530.

Future Fridge Brings PC into the Kitchen

A concept 'fridge of the future' built by Frigidaire and ICL includes a home shopping terminal in the form of a touch screen computer with bar-code scanner installed in the refrigerator door.

The home shopping terminal may allow the user to create shopping lists and place orders direct to their favourite supermarket for home delivery. A built-in bar code reader using a 3D laser similar to the scanners used in stores even allows the user to swipe their products into a grocery list.

In addition, the PC unit could store recipes, household records and the like for instant access. With Internet access, plenty of additional online cooking information is instantly available to be downloaded.

Since the refrigerator is often the central focus of the kitchen with a patchwork of magnets, calendars and Post-It notes, the unit could also function as a home message centre, e-mail centre and household management terminal. It may even be possible to include interactive Web TV in the kitchen.

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

Contact: Frigidaire, Tel: +1 800 668 4606.

NEWS BYTES

Epson Challenges Photo-Finishing Industry

Epson has introduced the Epson Stylus Photo 750, designed with the digital enthusiast in mind. The new printer produces superior photo-lab quality output. The EPSON Stylus Photo 750 can print a 4-by-6-inch photo in approximately one minute and an 8-by-10-inch photo in only two minutes.

The Stylus Photo 750 is both PC- and Macintosh-compatible, allowing simultaneous connection and auto-sensing between both platforms for maximum flexibility. The printer also features native Universal Serial Bus (USB) connectivity for both Windows 98 and Macintosh platforms, including the iMac.

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

Contact: Epson, Tel: (01442) 261144.

Manufacturers Team for Voice Standards

Leaders in speech recognition and mobile technologies have announced the formation of the Voice Technology Initiative for Mobile Enterprise Solutions (VoiceTIMES).

VoiceTIMES' goal is to co-ordinate the technical requirements needed for companies to build and deploy solutions using voice technologies and handheld mobile devices.

Inaugural VoiceTIMES alliance members include Dictaphone, e.Digital, IBM, Intel, Norcom Electronics, Olympus and Philips.

For further details, contact: <www.software.ibm.com/speech/overview/business/voicetimes.html>.

Contact: IBM, Tel: (0990) 426426.

Toshiba Lifts Elevator Records

Toshiba Corporation has been selected to provide the world's fastest elevators for the world's tallest building. The ultra-high speed elevators are part of a package of 63 elevators and 34 escalators that Toshiba will supply to the Taipei Financial Centre, a new tower complex in the heart of Taiwan's capital, scheduled for completion 2002.

Toshiba will provide a total of 63 elevators for the Taipei Financial Centre. Two ultra high-speed elevators that will shuttle from the level-one basement to the 89th floor observation deck at a maximum speed of 1,000 metres per minute; a mere 39 seconds, all in quiet, vibration-free comfort.

The new elevator's performance is designed to surpass that of all other elevators now in operation, including those in Yokohama's Landmark Tower, currently the world's fastest, with a maximum speed of 750 metres per minute.

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

Contact: Toshiba, Tel: (01932) 841600.

NEWS BYTES

Single Chip Power Meter Kills Mechanical Counterpart

With the introduction today of a new integrated analogue-to-digital converter (ADC) chip by Cirrus Logic's Crystal 'power meter on-a-chip', is set to cause the demise of traditional mechanical meters.

In the face of electric industry deregulation and the need for continuous improvement in customer service, the new electronic meters promise utility companies better access to information needed to establish more flexible customer rate plans.

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

Contact: Cirrus, Tel: (01628) 472211.

MIT Students Make Plan to go to Mars

Here's a university project with a slight difference. MIT students are writing a business plan for a £35 billion mission to Mars they envision as a joint venture between NASA and ThinkMars, a company the students hope to start.

The team of students entered NASA's Mars mission business plan competition in December and were selected as one of six teams to develop its preliminary strategy into a comprehensive plan for getting to Mars.

In June those six teams will present their work at a conference in Houston. NASA plans to incorporate aspects of each plan into its own blueprint for human exploration and development of the red planet.

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

Contact: Massachusetts Institute of Technology, Tel: +1 617 253 1000.

Intel and Proxim Home Network Alliance

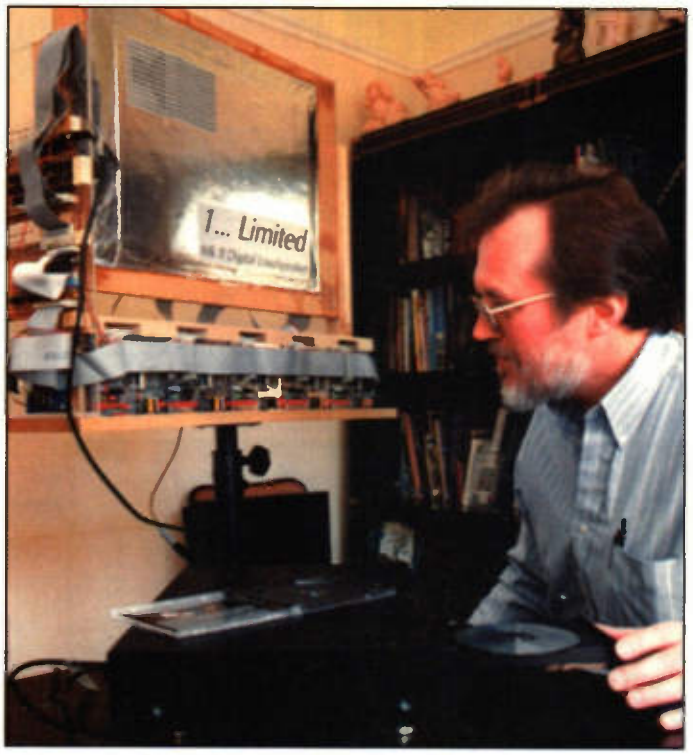
Intel and Proxim have completed a technology agreement which see Intel make an equity investment in Proxim.

Proxim, a leading supplier of wireless LAN products, and Intel are currently working together to develop wireless home networking products based on the HomeRF Shared Wireless Access Protocol (SWAP) specification.

The SWAP specification provides a standards-based solution that is designed to enable a broad range of interoperable consumer devices to use wireless data and voice communications in and around the home.

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

Contact: Intel, Tel: (01793) 403000.



1... Limited's Gets Millennium Product Status

1... Limited, has been granted Millennium Products status by the Design Council after the Prime Minister Tony Blair challenged business to show that Britain is the creative powerhouse of the world.

1... Limited's DLS technology is based on a fundamentally new design approach. The company has developed a truly digital loudspeaker that can be connected directly to digital audio signals such as a CD, digital TV, DAB equipment and DVD player without the need for a power amplifier or other audio equipment.

For further details, check: <www.uno.to>.

Contact: 1... Limited, Tel: (01223) 422290.

Stop Thief

Over 400,000 cars are stolen every year in the UK - many of which are never recovered. To address this problem, a new sophisticated car tracking system called Trackstar has now been developed by Trafficmaster.

Trackstar is a unique system that uses Trafficmaster's nation-wide network of sensors and transmitters to recognise a stolen car's ID and through a direct communication link, identify the car's exact location and direction of travel.

The system is then able to safely slow the vehicle down to around 15mph in a controlled manner reducing the risks involved in a high speed Police chase. Trackstar can therefore provide better functionality than GPS or other systems currently available, at a much-reduced cost.

Due to be launched this year, Trackstar will be distributed though major motor manufacturers and will be priced at under £200 with an annual subscription of around £60.

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

Contact : Trafficmaster, Tel: (01908) 249800.

MIT Researcher Could Save Millions

A Massachusetts Institute of Technology (MIT) professor has come up with a quick and easy test, which, with the pulse of a laser, can analyse the thin films, used in microelectronics components. The same optical method may one day be used to provide an early-warning signal for eye disease or to 'optically switch' materials from one phase to another.

All this is part of a program developed by Keith A. Nelson, professor of chemistry at MIT, a member of the Institute's Materials Processing Centre and the Centre for Materials Science and Engineering. Nelson and his research group study how materials respond when they are irradiated by pulsed laser light.

Applications for this work range from adding to basic knowledge about complex materials to the practical test for thin films that may save the microelectronics industry millions of dollars annually in testing costs.

Another far-off goal is the ability to 'optically control' the structure and behaviour of materials, with intriguing prospects including ultra-fast optical signal processing and optical fabrication of unique material structures.

"Much of the 'art' in our efforts comes through understanding how light, especially in the form of short pulses, interacts with matter and how the interactions can be exploited to characterise or control materials," Nelson said.

In microelectronics manufacturing, a silicon base is coated with one thin layer after another. Copper, tungsten and other metal layers have precisely specified thicknesses that range from 100 angstroms, or about how much a fingernail grows in one second, to 10,000 angstroms, or one-thousandth of a millimetre. Variation in the thickness of the metal layers is a major cause of device failure and low microelectronics manufacturing yields.

To make sure that each film layer is the right thickness and is properly adhered to the layer below it, manufacturers have had to perform painstaking tests with expensive equipment. These tests destroy the sample, at huge cost to the industry. Nelson's non-destructive, non-contact optical test, which uses a laser device that fits into a briefcase, can measure film thickness to within about one layer of atoms (1 to 3 angstroms) in one second, and at the same time check for proper adhesion.

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

Contact: Massachusetts Institute of Technology, Tel: +1 617 253 1000.

Software HINTS & TIPS

by Mike Bedford

Windows Explorer and the My Computer utility do similar things but in different ways. Here we a look at My Computer.

I often find myself apologising for stating the obvious in this column and this month is no exception. Many of you will use My Computer on a regular basis and so much of what we cover here will be second nature. Other people, though, will have never dabbled with My Computer. This month we address Windows Explorer users. Perhaps My Computer won't enable you to do anything you can't already do but you may just find it more intuitive. I'm assuming that you're using Windows 95 but My Computer works the same way under Windows 98 so long as you select 'Classic Style' rather than 'Web Style' in View > Folder Options. We'll look specifically at how Windows 98 differs in a future column.

A Name Change?

First of all, just a small point but My Computer doesn't have to be called My Computer. You'll find the icon in the top left corner of the desktop if you haven't moved it and you can change its name just as you would change the name of a file. Simply click on the icon to select it, click on it again after a short gap, and you'll find that the name 'My Computer' is highlighted. Now simply type in the new name and then just click somewhere else. You'll notice that I've renamed it as 'Mike's Computer'.

My Computer

To start up My Computer, or whatever you might have renamed it as, simply double click on the icon. You'll find that a windows similar to that shown below is displayed.

It contains icons for each of your disk drives plus a few extras such as the Control Panel and the Printers window. Try clicking on the icon for the hard drive and you'll find that a list of folders and files is displayed in much the same way as with Windows Explorer. And as with Windows Explorer you can choose to view large or small icons, a brief list or full file details. So far we really haven't seen any reason to use this utility instead of Windows Explorer. However, why don't you try the following? Under View > Options > Folder, make sure that the 'Browse folders using a separate windows for each folder' option is selected (this happens automatically in Windows 98 so long as you're using the 'Classic Style' view as detailed earlier). This option does exactly what it says and allows you to view more than one folder at the same time – try it out. This is something you can't do in Windows Explorer and it's a potentially useful facility. You don't even have to use the same view in each window. Each window has independent control over the various options so you could, if you like, view large icons in one, small icons in another, a list in a third and details in a fourth Window. To change the view of a particular window, use the View menu. The currently selected view is indicated by a bullet. On the reverse side of the coin, My Computer doesn't allow you to view the hierarchical structure of the file system as Windows Explorer does. Each of these tools, therefore, has useful facilities which the other doesn't offer. What I suggest, therefore, is that you aim to become familiar with both these utilities and select the one which seems most appropriate to the task in hand.

File Manipulation

If you're familiar with Windows Explorer then most of the methods of manipulating files in My Computer are pretty much the same. Undoubtedly, though, some readers will be just finding their feet with Windows so let's run through some of the things you can do to files once they're displayed in a window.

To execute a package, double click on its icon. Similarly, double clicking on a data file such as a Word file or an Excel file will open up that file in the appropriate package. To rename a file, carry out the same sort of operation as the one we used to rename My Computer, that is, click on the icon twice (not too rapidly in succession or Windows will see this as a double click) and type the new name before either pressing Enter or clicking elsewhere. And to delete a file, select it by clicking on it and then press the Delete key. You'll be asked to confirm this choice. Actually, this method doesn't genuinely delete the selected file – it just moves it to the recycle bin from where it can later be recovered if you discover that you'd deleted it in error. If, on the other hand, you want to truly delete a file (but be careful, once you do this it's gone for good) hold down the Shift key while you press Delete. Actually, everything I've just described using key strokes can also be done using the appropriate entry in the File menu. Personally I prefer the key stroke method – I find it quicker – but if you're a confirmed pointer and clicker, do investigate the File menu. In fact, when you've finished reading this column, take a look through all the My Computer menus since there's quite a lot which we don't have space to cover here.

Moving & Copying

The other main thing you'll need to do in My Computer is to move and copy files. If you're at all familiar with Windows then you probably don't have to be told how to move a file, after all, it's pretty intuitive. Simply select a file and, while the mouse button is still held down, drag it to its new location – that is, into the Window displaying the target destination. To copy a file, that is to put a copy of it somewhere else but to leave the original in place, simply hold down the Ctrl key while you drag the file. A plus sign will appear next to the mouse pointer to indicate that you're copying rather than moving.

Finally, if you want to move or copy multiple files (or delete them, for that matter) you need to know how to select more than one file. Having selected one file, you can select additional files by holding down the Ctrl key while you click on them. Alternatively, if you want to select a group of files, select the first, hold down the Shift key and click on the last file in the group. The other method of selecting a group of files is to press down the mouse button while the pointer is in the appropriate window, and drag a so called marquee around the files you want to select. The marquee box is shown as a dotted line and all files which are enclosed by that dotted line will be selected. You can also use a combination of these methods. For example, having selected a group of files by either of the methods described, you can add additional single files or groups of files using the Ctrl key, and a combination of the Ctrl key and the Shift key or the Ctrl key and the Marquee method, respectively.

Bio-Feedback WITH ELECTRONIC ENHANCEMENT

PART 1

In the first of this four part series, David Clark looks at the basic principles behind this 'alternative' therapy.

Introduction

As the end of the second millennium AD approaches an increasing number of people are beginning to move away from the idea of relying solely on the more conventional methods of healthcare. Whether this is part of a desire to find a more 'spiritual' aspect of life in an increasingly material world or merely a fashionable idea is a matter for conjecture, but without doubt there is an increasing interest in a number of so-called 'alternative' treatments available, such as acupuncture and herbal medicine. Many of these have long-standing historical basis; most of the drug products of the major pharmaceutical companies for example were initially 'discovered' by extracting chemicals from plants which were used as 'folk' remedies often by so-called 'primitive' cultures. Many too seem to stem from eastern religions, but a common theme among these alternatives is the treatment of the body as a whole entity, whereas conventional medicine usually treats different parts of the body, or illnesses, in isolation, using powerful drugs or surgery which almost inevitably carry side effects and risks.

Alternative Therapies

Among the important alternative therapies are bio-feedback, acupuncture, herbal medicine, massage, meditation, and yoga. The basis of the effectiveness of bio-feedback stems primarily from the benefits of reduction of psychological stress and tension and the consequent removal of the physical symptoms which can develop from the continuous presence of this, and so parallels can most easily be drawn with other alternative techniques mainly aimed at mental and physical relaxation and removal of tension, the most obvious being perhaps yoga and meditation. Yoga has become primarily associated with the physical postures adopted and held for long periods of time, but it is in fact part of an Indian philosophy dating to around the 2nd century BC involving among other things, learning to control mental activities in order to enter a state of purity and consciousness, liberated from the physical world. This involves several stages of preparation, some using posture, breath control and meditation (see yoga text), which have recognisable similarities to bio-feedback techniques.

Meditation involves training the mind to concentrate and restrict awareness of external factors. Again this has similarities to bio-feedback techniques, and it has been used on its own by modern practitioners to control pulse and breathing rates. It has been shown in many cases to be effective in controlling the symptoms of migraines and high blood pressure. The use of meditation has been recorded world-wide since ancient times and in one form or degree is part of most widespread religions and philosophies; Indian Yoga, Buddhist Ch'an in China and Zen in Japan, in the use of mantra, the Islamic prayer or 'dhikr' and of course Christian prayer. Apart from its religious significance it is routinely used purely as a calming technique in many cultures.

The Holistic Approach

A major point about these alternative therapies is that they are necessarily 'holistic' in nature, in that the body, mind, emotions, activities and environment are all involved and the balance of each of the aspects that make up an individual are not greatly disturbed.

Although these approaches are often thought of as alternative, increasingly some are in fact more 'complementary', being used alongside more conventional techniques, and indeed some aspects of ancient philosophies are being brought 'up-to date'. As an example low voltage alternating current connected to acupuncture needles has been used in some cases to provide effective action as opposed to the more conventional twisting of the needles once in position. Acupuncture is used all over the world, although most people will recognise it as a Chinese technique. It dates back more than 4500 years and came out of the ancient philosophy theory of the yin and the yang which represent opposites in the human body equally as much as throughout the universe. (See the yin and yang text.)

Yoga

In the western world Yoga has mostly come to be represented by its physical exercise aspects, separated from the complete philosophy. It is not part of any particular religion (though it is a common part of Hindu practice and Tibetan Buddhism), but it is a form of religious activity which is aimed at enabling the person practising it to return to a form of spiritual purity. This purity, it is believed, was lost as the world evolved, and yoga is an attempt to reverse the process of becoming less and less 'pure' by rising through eight stages, each of which requires teaching and guidance. These eight stages can be briefly summarised as follows.

The first stage is 'restraint', which involves abstinence from what some religions might call sin i.e. stealing and greed, the second is 'observance', requiring for example austerity, cleanliness and study. The third stage is the familiar 'posture' stage involving the ability to remain in one of the prescribed postures for extended periods without distraction.

The fourth stage is the 'breath control' stage involving exercises to stabilise breathing and encourage respiratory relaxation. The next stage is 'withdrawal', the ability to remove attention from external objects, the sixth being the ability to concentrate on an object of meditation for a long period of time, called 'holding on'. The seventh takes this further by gaining the ability to meditate without being aware of oneself; this is 'concentrated meditation', and in the final stage, 'self-collectedness', the individual is unaware of being separate from the object of meditation.

The yin and yang

The yin and yang symbol associated with the ancient Chinese philosophy.

According to the origins of this philosophy the whole universe exists through two forces which balance by opposing and interacting with each other. These forces originated with the T'ai Chi, the ultimate source of all reality. Initially yin was represented by the cold northern side of a mountain, and the yang by the hot southern side, but as the philosophy developed yin became the earth and all things dark and passive, and was represented by the tiger, whereas the yang became the sky and all things light and active, and was represented by the dragon.

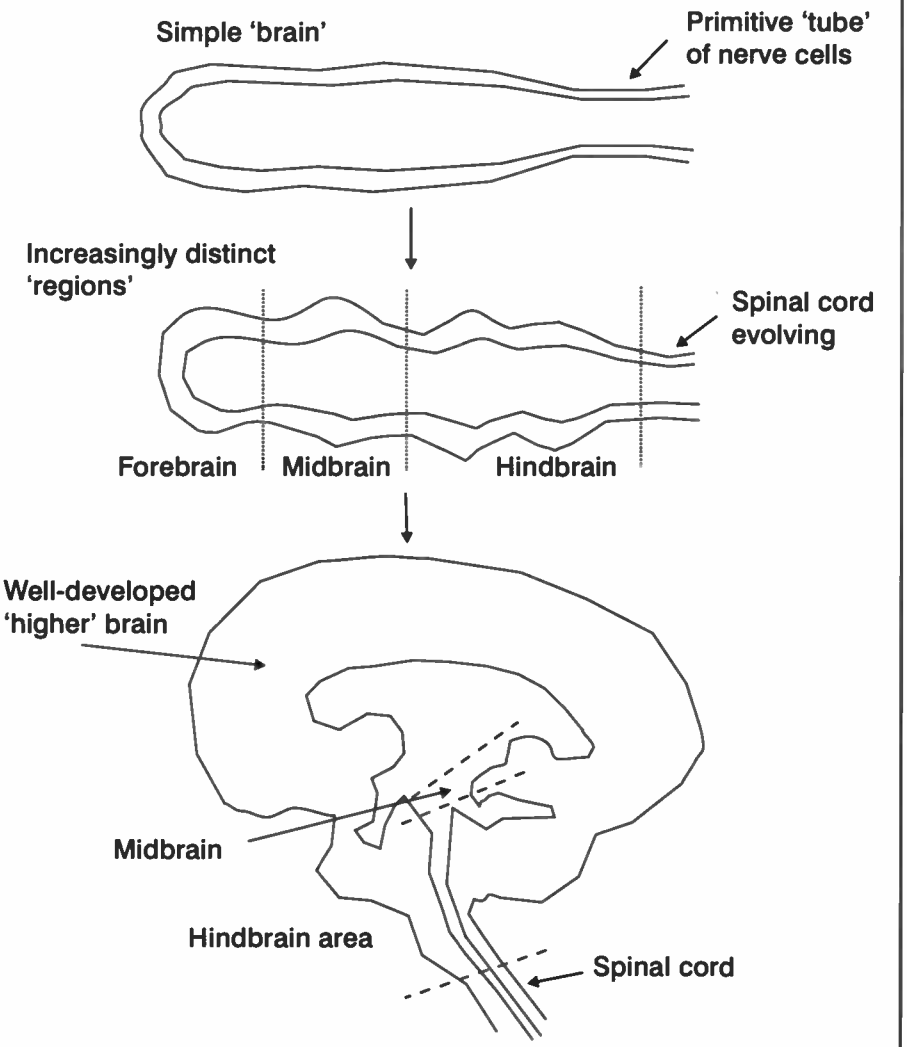


Figure 1. Brain Evolution.

Many people might think this a dubious basis for relying on pain relief during major surgery but it is routinely used as an anaesthetic in China. Although it has not been determined exactly how it works, one theory is that it selectively blocks impulse transmission in the central nervous system, which is one of the processes involved in the bio-feedback techniques that will be examined in this series.

Another important aspect of some of these relaxation techniques used in meditation and yoga is the fact that an individual in some way takes more control over their own body through control of their thoughts or mental state. This also is where bio-feedback has common ground with these ancient established regimes.

Bio-feedback could in many ways be thought of as the point where an alternative or complementary philosophy meets modern technology. Although usually described as 'training' rather than 'treatment', bio-feedback relaxation techniques claim to have been used successfully in treating many conditions involving pain , anxiety and stress. Table 1 indicates some of these conditions and treatments.

- anxiety disorders
- headaches
- epilepsy
- high blood pressure
- chronic muscle tension and pain syndromes
- stress management techniques and relaxation therapies
- concentration improvement for education and meditation
- control of brain waves for spiritual development and inner tranquillity

Table 1. Problems Successfully Treated With Bio-feedback.

This level of success should perhaps not be surprising, since the bio-feedback with electronic enhancement technique involves monitoring many of the body's metabolic functions that are used as diagnosis tools in conventional medicine, and in fact some people claim that bio-feedback is the only form of complementary medicine with a scientific basis. Most of the metabolic functions will be familiar to many people as they include body temperature, heart rate, blood pressure, brain waves, muscle activity, skin activity and respiration rate and digestive secretions. The state of the parameter being monitored is output by the electronics as some form of visual or audible indication. This is observed by the person undergoing training, and they learn to alter these values to a point where the desired effect is achieved. So modern technology rather than controlling is used to allow an individual to take control.

Although the training aspect of this technique is obviously important, in this series I'll be placing the emphasis on the physical rather than the psychological aspects. Specific areas to be covered include how bio-feedback works, the electronic, physical and biological/biochemical/bio-electrical principles on which it is based, and how the equipment used functions. I'll also be including some suggestions for some construction projects to try out some of the simpler techniques involved.

The Basic Principle

The basic principle is very simple. The effects of stress on the human animal (which have been shown to be similar in other mammals) are fairly well known and manifest themselves in ways that will be familiar to anyone who has felt 'stressed', or has found themselves in a stressful situation without necessarily realising that they do feel stressed. The most common symptoms are an increased heart rate, cold and/or sweaty hands, rapid and shallow breathing and a dry mouth. Less immediately obvious are raised blood pressure and tension in the muscles, often of the back. Least obvious of all is an increase in certain types of brain, nervous system and hormone activity. Whilst these may be recognised as applying in obviously stressful situations, a lesser but continuously present degree of these effects can have longer term health consequences. All bio-feedback with electronic enhancement does is make a subject aware of these effects and allow them to use their own will to control them. First, some of the background aspects.

Evolution

It is generally accepted that human beings have evolved over millions of years and that this line of development can be traced back to the most primitive single celled organisms. Darwin deduced this from observation; however modern analytical technique can not only confirm this but also provide much more information. For example one particularly powerful tool is the analysis of DNA, the chemical that makes up the genes that define our inherited characteristics. This technique has highlighted the fact that some DNA sequences in humans match those of more primitive organisms which indicates shared forerunners. Another fascinating detail is that the small structures which exist within all cells called mitochondria, which are the parts of a cell that generate the energy enabling a cell to live, are very similar to bacteria. This indicates the fact that at some point in evolution a simple organism probably incorporated a bacteria into itself. This enabled an energy production system to evolve which allowed the development of much more complex systems, leading eventually of course to Homo sapiens.

The First Stage

This evolution is also reflected at other levels in humans and is very relevant for bio-feedback. The simplest early organism would have responded to stimulus in a very primitive way; perhaps a chemical detector on a part of its outer wall would cause some change in another part of its wall that caused it to move towards that chemical, which could be some sort of vital nutrient that could be absorbed by the organism. Or a chemical in the cell wall which could respond to light would cause the organism to move towards that light. These simple actions needed no specialised information transmission pathway and certainly no decision making process, but eventually would evolve into specialised parts of more complex organisms, such as smell receptors and eyes.

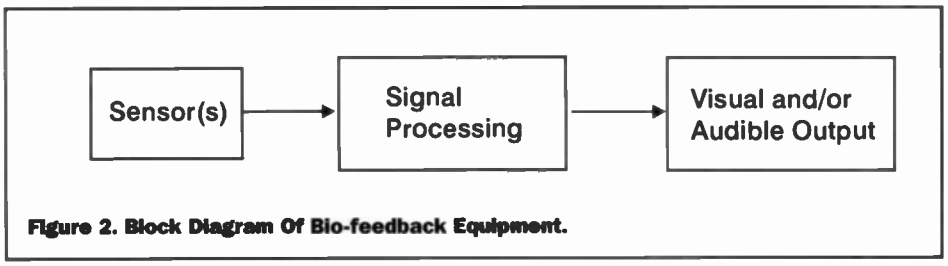


Figure 2. Block Diagram Of Bio-feedback Equipment.

Organ	Sympathetic effect	Parasympathetic effect
heart	increases heart rate	decreases heart rate
lungs	dilates bronchioles	constricts bronchioles
adrenal gland	secretes adrenaline	no effect
blood vessels of skeletal muscles	dilation	no effect
blood vessels of skin	constriction	no effect
sweat glands	increased secretion	no effect

Table 2. The Effect On The Body Organs Of The Autonomic Nervous System.

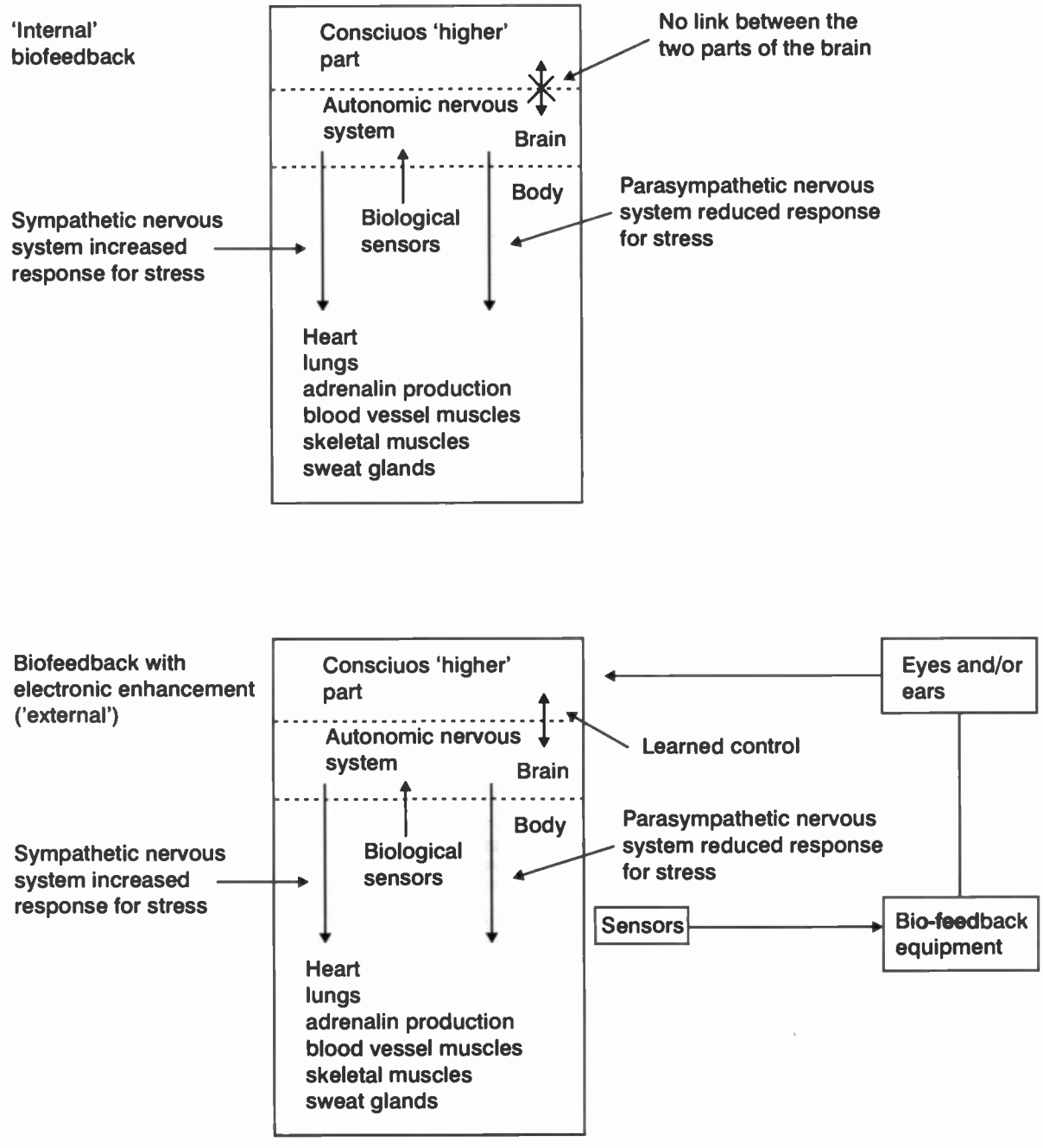


Figure 3. Internal And External Feedback Paths.

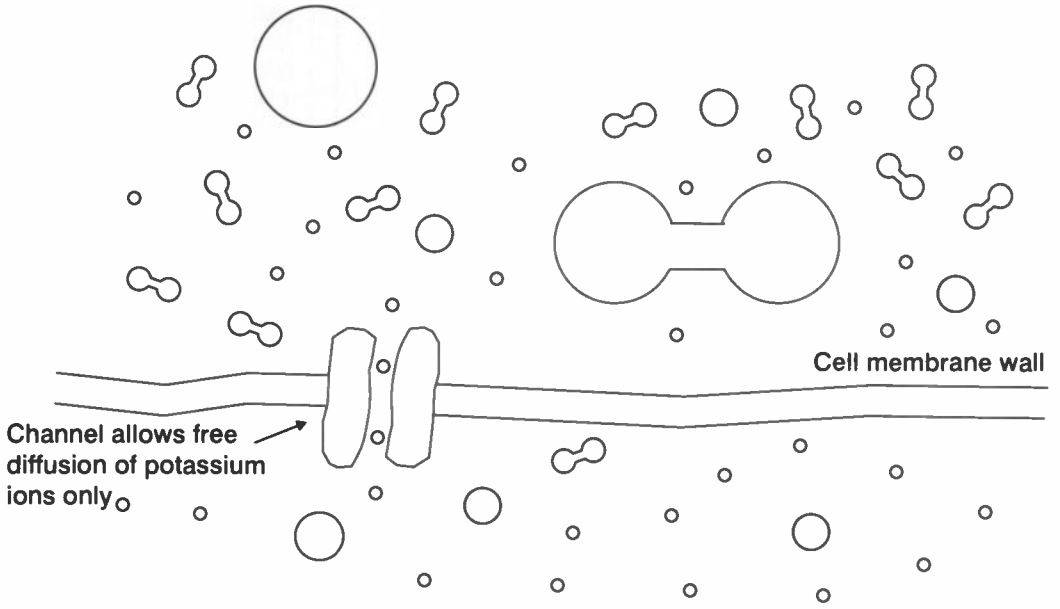


Figure 4. Cell Membrane Diffusion.

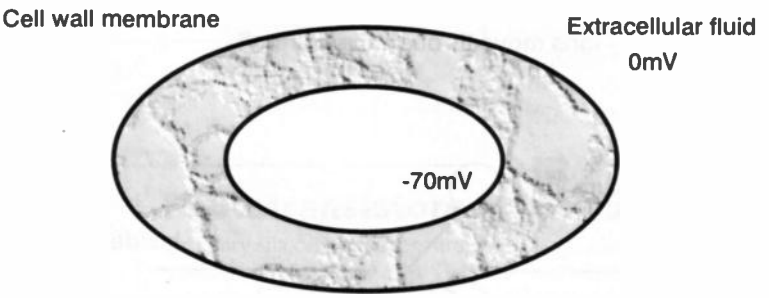
More Complexity

Further development over millions of years has led to the evolution of a nervous system in many forms of life. However initially this would not have been one involving an area that would be recognised as having a specialised dedicated function, but would simply be a 'web' of interconnections between various parts of the organism. This would enable a reflex action to occur whereby a particular sensor which was triggered by the stimulus it had evolved to detect, would then directly transmit a signal to other specialised cells which responded in the particular way that those cells had evolved to perform. This is obviously a much more sophisticated system of behaviour but again involves no conscious decision making; the reflex occurs automatically.

The Third Level

The third system to evolve, although these changes occurred gradually, not in single enormous steps, involved the development of a centralised nervous system where a large portion of the nervous system was situated in what was recognisably a discrete organ, namely a brain. (See Figure 1.)

This evolved in a way that allows voluntary actions to be made, in other words something happens as a result of a decision to do it, not as an automatic reaction to something. This of course requires thought, and is arguably part of what we call consciousness. Bio-feedback allows us to use the decision making, higher functions of the brain to take a degree of control over a part of the nervous system called the autonomic nervous system, which is responsible for the control of the activities of the internal organs without there being any awareness of these activities. The autonomic nervous system uses the part of the brain which in evolutionary terms developed before the higher functions and its functioning was once thought to be completely outside an individual's conscious control.



Normally the potential inside a cell is -70mV relative to the fluid outside the cell (the 'extracellular fluid')

A nerve cell also has a potential difference between inside and outside the cell wall, but can be more than a metre in length and carries impulses from the brain to muscles and glands, and from sensory organs to the brain

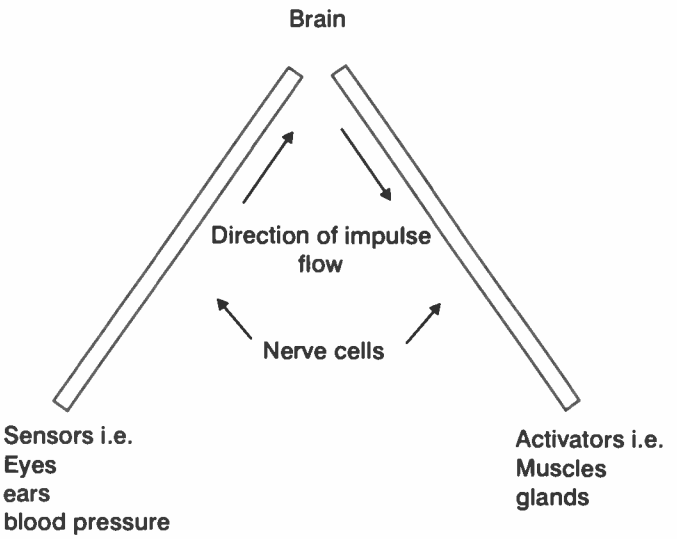
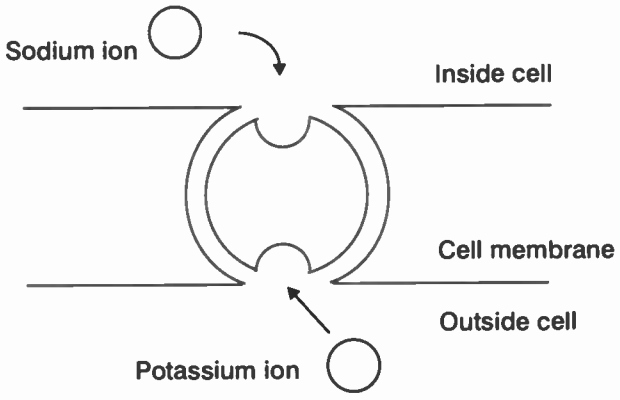
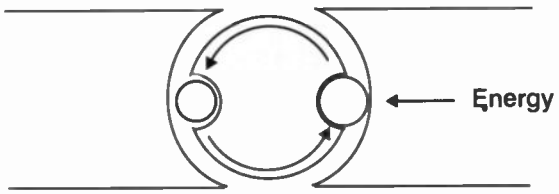


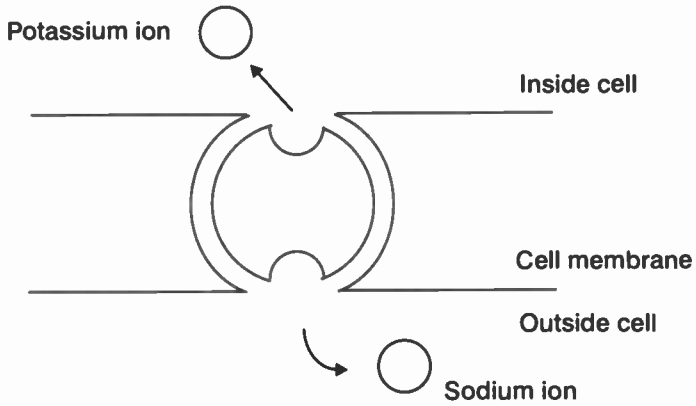
Figure 5. Cell Potential Difference.



Step 1 - ions move into the exchange pump



Step 1 - ions move through the cell wall



Step 3 - ions leave the pump at the opposite side of the cell to the entry side

Figure 6. The Sodium-Potassium Exchange Pump.

The Autonomic Nervous System

The autonomic nervous system part of the whole nervous system is evolution's biological equivalent of positive and negative feedback, and is the body's system for dealing with stress. In response to signals transmitted along nerves to the brain from sensor cells, other nerve cells carry signals from the brain to the organs of the body. These nerve cells functionally fall into two categories, called the sympathetic and the parasympathetic nervous systems. The sympathetic nervous system prepares the body for stress, and the parasympathetic system reduces stress. Table 2 shows the effect on the body organs of the two systems.

So already we can see the possibility of being able to take control of the subconscious parts of our selves. What is needed is a way of linking the two functions of the brain that are normally unaware of each other, and we can do this with electronics, and what's more in a way that doesn't involve a trip into the operating theatre!

The Role Of Electronics

Most useful electronic systems involve a sensor that detects something, some signal processing that affects the output of that sensor, and an output device that does something determined by the output of the signal processing. In principle a biological system is no different. The body's five senses, sight, sound, taste, smell and touch send information to the brain, the brain processes it in some way (whether we are aware of it or not), and then sends signals to various parts of the body which do different things as a consequence. The major difference is that a biological system, in particular the brain, is infinitely more complex.

What a bio-feedback with electronic enhancement system does then, is give the brain an extra system or pathway for receiving conscious information of which we would normally be unaware. It does this by reporting the activity of internal organs via monitoring the effects of that activity on the outside of the body, and then translating that activity into a form that can be recognised by our senses, the most useful being sight and sound. This form is simply that of an indication on a meter or light display (or a computer monitor for some computer based systems), or some form of musical tone. (See Figure 2.)

By being trained to recognise the state of mind to get into to control this indicator, for example a calmer state of mind, or with less muscle tension, the mind can consciously control the activity of the internal organs. A link is being made between two parts of the brain that doesn't exist in nature. In a successful training or treatment, symptoms are alleviated by consciously reducing the activity of the body organs causing those symptoms. Figure 3 shows the relevant feedback paths.

So what's going on inside the body and how is it monitored from the outside?

Inside The Body

The main processes of interest for bio-feedback are electrical activity, mechanical activity, and heat loss through the skin surface. The important electrical parameters are voltage and resistance; the mechanical ones pressure and movement, and heat loss is measured via skin temperature.

Electrical activity is monitored with electrodes placed on the skin, which are used to monitor heart rate (electrodes on the insides of the wrists), brain activity (electrodes on the head), muscle activity (electrodes on the shoulder, jaw and scalp) and skin resistance (electrodes on the fingers). Blood pressure can be monitored using a cuff around the upper arm, and respiration is measured by use of a strain gauge around the chest. Skin temperature is commonly measured using sensors on the fingers. The electrical activity of the brain differs between various parts depending on which senses and functions are predominant at any moment, but it also can vary significantly between the left and right halves of the brain. This can be monitored by multiple pairs of electrodes on the head; however the activity in the right and left halves of the brain also appears to be reflected in the temperature difference of the skin at the left and right hands, so having two channels of temperature monitoring, one on one finger of the left hand and one on the equivalent finger of

the right, enables this to be observed.

As part of the holistic nature of bio-feedback training, several of these monitoring systems are often used at the same time, particularly where computer based systems are available.

I will be looking in more detail at the processes of the organs of the body which are of relevance for bio-feedback with electronic enhancement in the second part of this series, and at the electronics involved in bio-feedback in the third part, but before this the general electrical activity of human cells needs to be examined.

Biological Cell Electrical Activity

The electrical activity of biological cells is a consequence of the movement of ions of substances such as sodium, potassium and calcium. In some ways this is similar to the movement of electrons within metals, in that the ions move through cells and tissues with differing degrees of freedom depending on the nature and the structures of the biological material of which the cells and tissues are composed. The membranes which make up cell walls play a major role in this process, as they contain various structures specifically evolved to perform these functions, as will be seen.

As mentioned sodium and potassium ions have particularly important roles in the electrical activity of all cells, and calcium ions are especially important in muscle function, which I will be looking at in the next part of this series. The structure of cell membranes is such that potassium ions can diffuse freely into and out of cells (see Figure 4), whereas sodium ions can't pass through the cell wall.

As a result a concentration gradient occurs which results in there being a potential difference of around 70mV across the cell wall membrane, the inside of the cell being negatively charged relative to the environment outside the cell. (See Figure 5.)

However, when a cell receives some form of stimulus to which it can respond the membrane suddenly becomes permeable to sodium ions. These rush into the cell and the cell polarity is reversed, i.e. the inside becomes positive relative to the outside. The permeability to sodium is only temporary however, and after this the potassium ions, being able to move freely through the membrane, flow out of the cell, repelled by the excess positive charge inside the cell. The cell potential thus returns back to its normal, resting value. Finally, a structure in the cell wall acts as a sodium-potassium exchange pump (see Figure 6), swapping the now excess sodium ions inside the cell for potassium ions on the outside so that as well as the voltage across the membrane having returned to normal, the concentrations of sodium and potassium inside the cell return to normal so that another excitation can be responded to.

All this bio-electrical activity causes a voltage pulse to occur around the cell, and this can influence other cells around it if they are capable of responding to it. Most importantly, if the cell is a nerve cell, the voltage pulse can travel along the nerve to excite another cell at its ending. (See Figure 7.)

This is biologically equivalent to a current flowing through a wire, and detecting this electrical activity with electrodes, along with monitoring the non-electrical consequences of this, such as chest wall movement, with other types of sensors, is the basis of some of the bio-feedback techniques which will be examined.

Next Month

In the second part of this series I'll be looking in more detail at the biological and bio-electrical processes involved in bio-feedback with electronic enhancement.

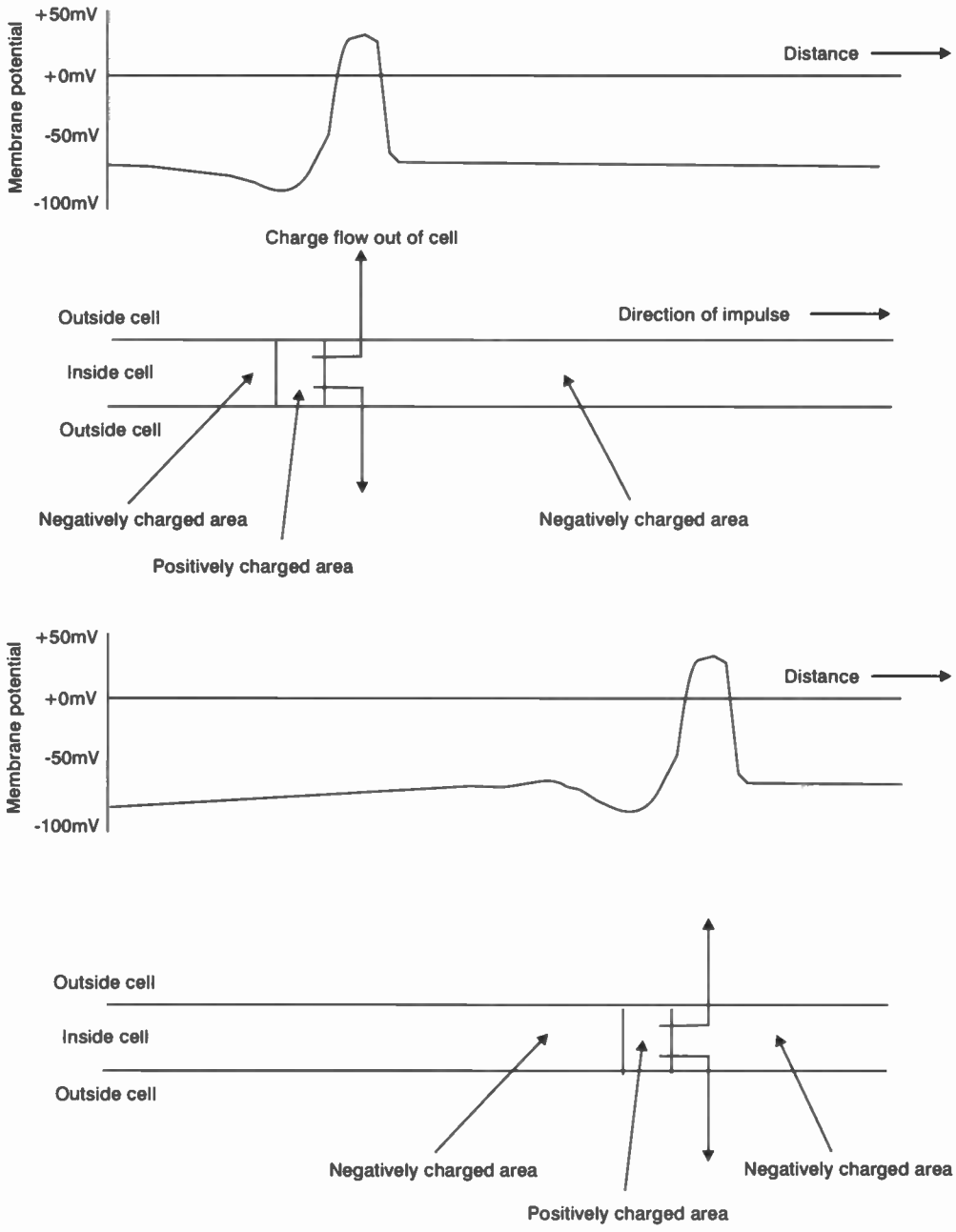


Figure 7. Propagation Of A Nerve Pulse.

Steps to Better SOLDERING

Jonathan Atkins IENG, Technical Manager at Antex (Electronics) Limited gives some hints and tips to better soldering.

Introduction

The ability to solder is an essential skill for anyone involved with electronics. A single bad joint can take hours of fault-finding to isolate, and considerably raise the stress levels of the constructor!

The soldering process enables two metal surfaces to be joined by addition of a molten filler, which 'sets' to form a solid connection. In electronic work the filler is a an alloy of 60% Tin and 40% Lead. This alloy is supplied in the form of a wire with cores of flux running through it. The flux is a very aggressive chemical, activated by the heat of the soldering iron. It's job is to strip away all of the grease from the surfaces to be soldered, thus ensuring that the solder will flow properly.

Choosing the Right Equipment

With a soldering iron, the factors to consider are power consumption, tip temperature and tip profile. An iron with a higher power does not mean a higher tip temperature, rather that there will be more heat energy available to heat up physically larger items. Thus a power of between 12W and 25W is fine for simple boards and small wires. A good example of this type of iron is the Antex CS18 shown in Figure 1.

The TCS iron in Figure 2 will provide up to 50W for boards with heatsinks or power planes. It can also automatically control the tip temperature. Although solder will melt at 183°C, an unregulated iron will run at about 420°C, this gives plenty of heat to make the joint regardless of it's size. An iron which will automatically keep to the optimum soldering temperature of between 320°C and 380°C has several advantages:

- tips will last longer;
- fluxing will be more efficient;
- less irritating fumes will be given off;
- the risk of damaging nearby components is minimised.

The task of the soldering tip is to transfer the power developed by the heating element into the joint. The quicker the heat transfer, the better the joint, so it is important to consider the profile of the tip. Maximum heat transfer will occur when there is the largest possible surface contact between the tip and the joint. As can be seen in Figure 3, a fine pointed bit will give a very small contact area. In general terms the cross section of the tip flat should be as large possible given the physical size of the joint.

When working with CMOS devices there is always the risk of causing electrostatic damage to them. To avoid this you should always ensure that the tip of your iron is securely earthed. This will always be the case with mains powered irons, but care is needed with low-voltage irons that need no safety earth.

In the vast majority of cases the standard electronics solders mentioned above will be suitable. A word of warning though - they contain rosin based fluxes, the fumes from which can cause respiratory irritation. Always work in a well ventilated area and if you suffer from any chest problems consider buying some rosin-free solder.

Finally, burns to both limbs and to workbench can be avoided by using a stand for your iron, as in Figure 4.

The Right Technique

Cleanliness is everything, most soldering problems are due to the fact that solder will not wet to a dirty surface. To complement the cleaning action of the flux it is good practice to wipe the PCB surface with a small amount of solvent, and to avoid touching it with bare fingers.

Figure 1. Antex 18W soldering iron.

Figure 2. Antex TCS 50W soldering iron for boards with heatsinks and power planes.

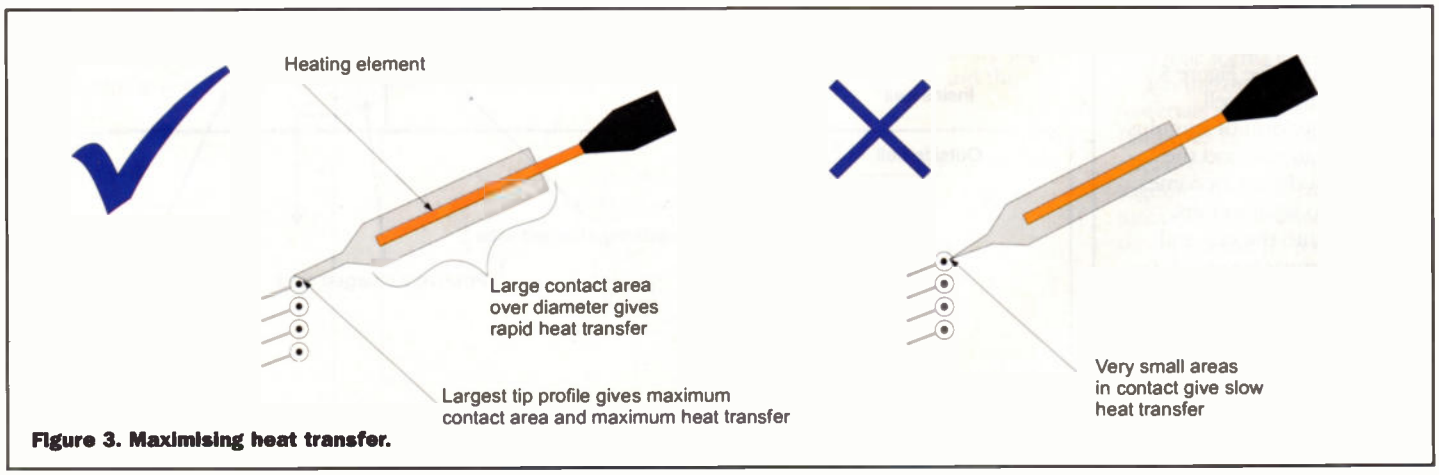


Figure 3. Maximising heat transfer.

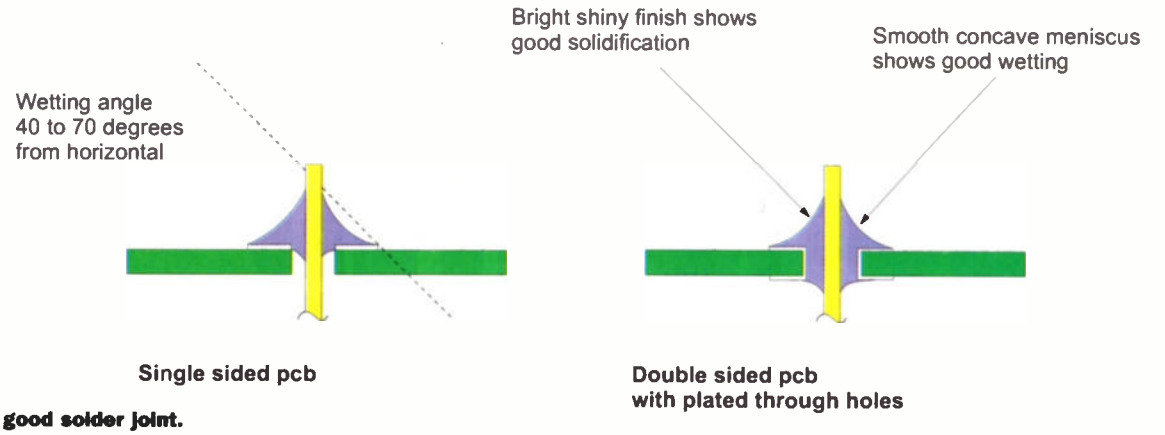


Figure 5. A good solder joint.

The state of the iron's tip is often neglected. Solder applied to the tip should flow quickly across the whole area and stick to it. This is good 'wetting' as the tip needs to be kept in this state when not in use, particularly if it is to be switched on for long periods. Should a tip be difficult to wet then it is likely that a layer of hard oxide has built up. This can be removed by the use of a compound such as the Multicore Tip Tinner and Cleaner. These products should be used sparingly as they consist of a concentrated flux that will reduce tip life

For best results follow the following sequence:

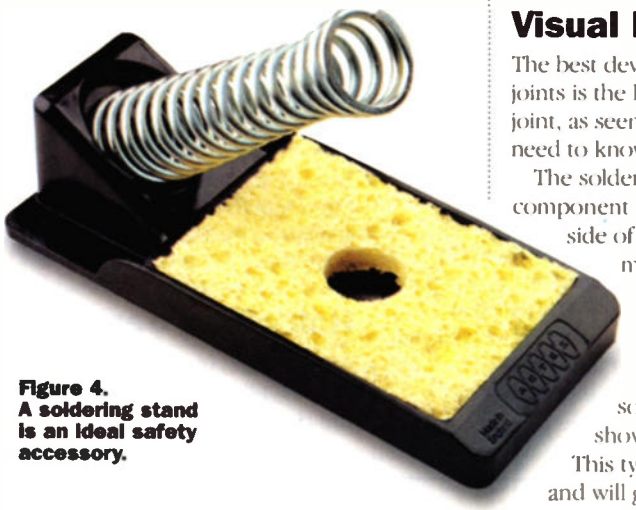


Figure 4. A soldering stand is an ideal safety accessory.

- Wipe the tip on a damp sponge and wet it with a small amount of solder;
- Apply the iron to one side of the joint and then feed in solder from the other;
- Allow the flux to work on the surfaces and the solder to flow across the whole joint, this should take no more than a couple of seconds;
- Remove the solder, then the iron;
- Allow the joint to cool and solidify without any disturbance.

If a joint is taking too long to make it is likely that the iron being used does not have enough power, or the joint surface is too dirty.

Visual Inspection

The best device for detecting faulty soldered joints is the human eye. The shape of a joint, as seen in Figure 5, will tell all that you need to know.

The solder needs to completely wet the component lead and the pad on the solder side of the PCB. A consistent, concave, meniscus should be formed with an angle of between 40° and 70° from the horizontal.

If any of the components have moved during solidification of the joint this will show up as a dull, grainy, finish. This type of joint is said to be 'dry' and will give a very high resistance.

Applying the iron for too long will cause spikes of solder to form which may bridge to other connections, causing a short circuit. If the profile of the joint is convex, rather than concave, then there is too much solder in place.

If you do have a joint which looks in need of rework don't be tempted to just reapply the iron. This is unlikely to succeed as the solder in place will have no flux in it, so the flow across the joint will be worse than when it was first made. Better to remove the solder, using a desoldering pump or copper braid, and make the joint again.

Conclusions

By careful choice of soldering tools, and by following the simple principles outlined in this article, your chances of finishing with a working PCB are greatly improved. ELECTRONICS

Further Information

If you have any further soldering queries, try the FAQ section of the Antex website, **(www.antex.co.uk)**

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Tel: 01822 613565, Fax: 01822 617598
email: **atkins@antex.co.uk**

Maplin stock a wide range of Antex products, see the Soldering Equipment & Accessories section of the latest Maplin Catalogue.

Magnetometers & ASSOCIATED TECHNIQUES

Gavin Cheeseman gives an insight into this fascinating topic with a project next month.

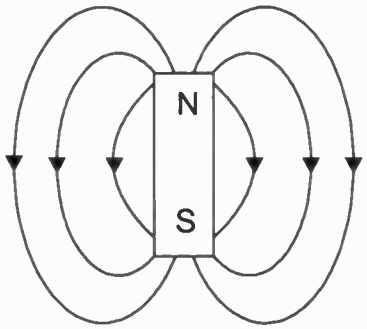


Figure 1. Conceptual illustration of the magnetic lines of force around a permanent bar magnet.

Introduction

In this article we look at a variety of different ways to measure magnetic fields and investigate various applications for magnetic sensors. A wide variety of measurement and sensing techniques are in use providing different levels of sensitivity and accuracy. These considerations, together with cost and complexity determine which method is employed in any given application. The intention is not to give an in depth theoretical analysis but to provide the reader with an overview of the kind of techniques in common use. The study of magnetism is a complex subject and readers requiring further information regarding magnetic theory are referred to standard text books on the subject.

Units of Measurement

There are a variety of different parameters to consider when measuring magnetic fields. Firstly the field has direction. If you move a compass close to a bar magnet, the magnet will deflect the compass needle. The orientation of the needle depends on the position of the compass relative to the magnet. Figure 1 provides a conceptual illustration of the lines of magnetic force around a bar magnet. The arrows show the apparent direction of the magnetic field. The compass needle will tend to point away from the north pole of the magnet (marked 'N') and toward the south pole ('S').

Further parameters relate to the 'strength' of the magnetic field. The magnetic flux density is effectively a measure of the 'amount' of magnetism per unit area or the density of the flux lines (analogous to contours on a map). The SI unit of magnetic flux density is the Tesla (symbol 'T'). Another common unit used when measuring magnetic flux density in cgs units is the Gauss (symbol 'G'). Sometimes magnetic field strength is also quoted. This is usually measured in A/m (amps/metre). An alternative (gaussian) unit is the oersted (symbol Oe). There are also a variety of other units in use.

Basic techniques

Probably the simplest form of magnetometer is a coil of wire. Exposing the coil to an alternating magnetic field results in an alternating current being induced in the wire. This effect may easily be demonstrated using the arrangement shown in Figure 2. As the position of the permanent magnet changes with reference to the coil a current is induced in the coil windings. This current may be displayed on a centre zero moving coil meter. The polarity of the current induced in the coil is determined by the direction of movement. The speed at which the magnet moves affects the current level induced in the coil. Moving the magnet more rapidly produces a faster change in flux density and results in greater deflection of the meter. The tendency for a coil of wire to react in this way when exposed to a changing magnetic field is often put to good use in audio frequency transducers such as microphones and pick-up coils, and in fact forms the basis of AC transformers. The magnitude of the induced current is partially determined by the frequency and intensity of the varying magnetic flux and partially by the coil dimensions. This type of fixed coil detector is suitable for measuring alternating magnetic fields such as those produced by power lines and other rapid changes in magnetic flux.

In order to measure a stable (non-alternating) field, such as that produced by a stationary permanent magnet, it is necessary to move the coil in the field. As the coil moves through the magnetic field, current is induced in the windings as illustrated above. If the coil is continuously rotated at a known speed, the current flow will be relative to the magnetic flux density. This type of sensor, although very simple in concept, is capable of providing accurate readings with good sensitivity when properly arranged. However, because a relatively large coil is often required to provide good sensitivity, these units can be quite bulky.

Hall effect Sensors

Another type of detector makes use of a phenomenon known as the Hall effect as illustrated in

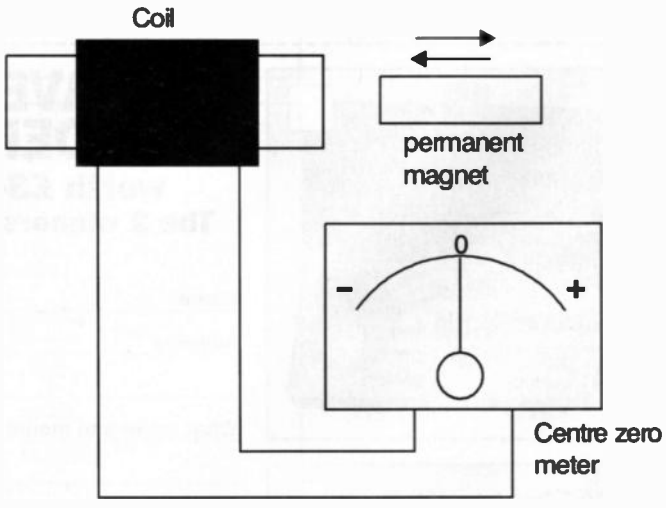


Figure 2. Simple arrangement to illustrate how a magnetic field induces current flow in a conductor.

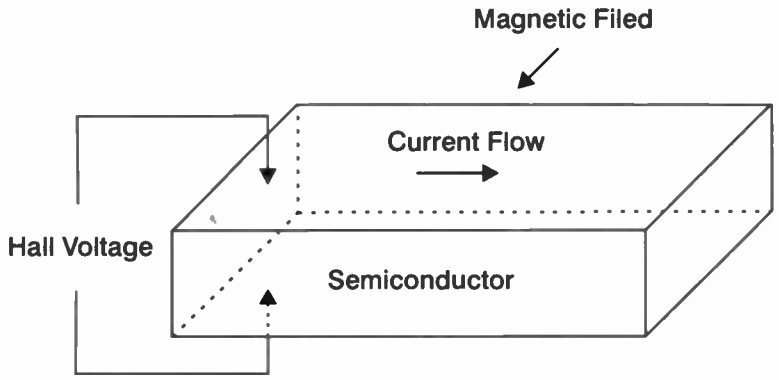


Figure 3. Simplified illustration showing the functionality of a Hall effect sensing element.

Figure 3. This effect is produced when current flowing in a conductive material is influenced by an external transverse magnetic field. As a result, a voltage proportional to the magnetic flux density is set up in the material. Hall effect devices typically make use of semiconducting material as the conductive medium. Integrated sensors using Hall effect technology are readily available. An example is the UGN3503U IC (Maplin code GX09K). This is a 3 pin device comprising an internal Hall effect sensing element, an amplifier and a buffer all on one chip. The device provides an output voltage proportional to magnetic flux density. Hall effect switches are also available providing a magnetically controlled switched output. These devices are ideal for use at medium to high magnetic flux densities and find many applications particularly in industrial control. They offer the advantage that they do not normally require alignment and are pretty much ready to use as supplied. In the example shown in Figure 4, the Hall effect sensor is used to sense the movement of gear teeth. This setup is only suitable for use with gears made from ferrous materials. A small permanent magnet is attached to the rear of the Hall effect IC. The presence of ferrous metal in proximity to the magnet affects the flux density. Therefore each time a gear tooth passes the Hall effect device there is a variation in output voltage from the sensor. The output pulses can be shaped and counted providing an accurate method of measuring the rotational speed

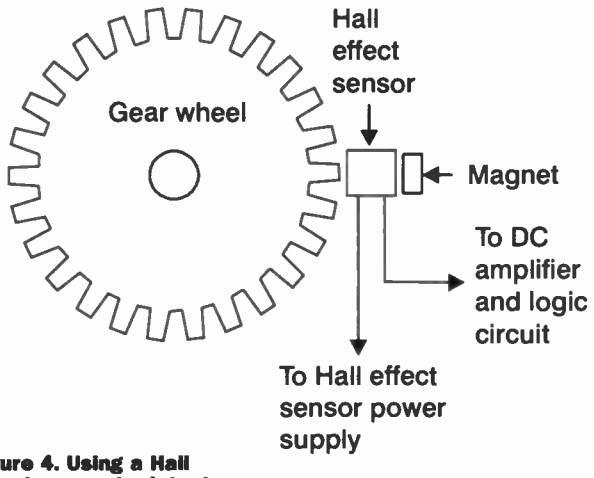


Figure 4. Using a Hall effect sensor to detect the movement of ferrous gear teeth.

of the gear wheel. This general principle may be adapted to a whole range of proximity detection applications. The maximum frequency that the sensors will respond to varies considerably but is typically in the range of a few kHz.

A further application of Hall effect devices is in current sensing. As the magnetic field around a current carrying conductor is directly related to the current level, the sensors may be used to monitor relative current in an electrical system without the need to break the circuit. This technique has the advantage of providing good electrical isolation and therefore does not significantly load the circuit being measured. Applications in this respect include over current sensing in power supply systems and relative power measurement.

Magnetoresistive Sensors

Another type of magnetic sensing element is the magnetoresistor. As the name implies, these devices exhibit a change in resistance dependant on the magnetic flux density. This is a field that is rapidly changing and it is quite possible that the use of magnetoresistive sensors will become considerably more common place in the future. In their basic form, the devices produce a relatively small resistance change for a relatively large change in the magnetic field. Therefore, as with Hall effect devices, careful design techniques are required in order to obtain optimum performance. In recent years, magnetoresistive materials that exhibit a much larger change

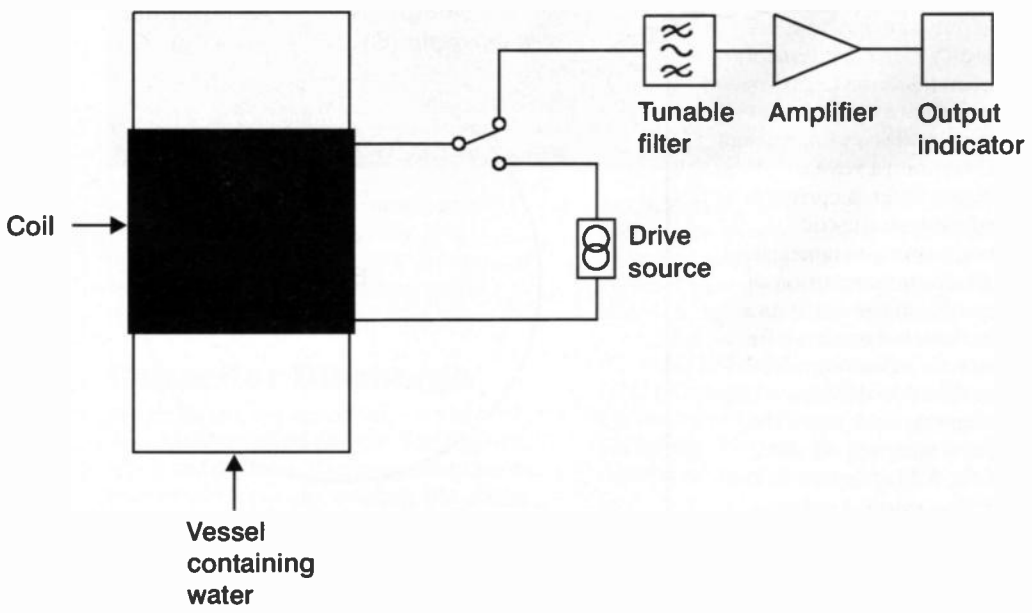


Figure 5. Simplified conceptual illustration of a proton magnetometer.

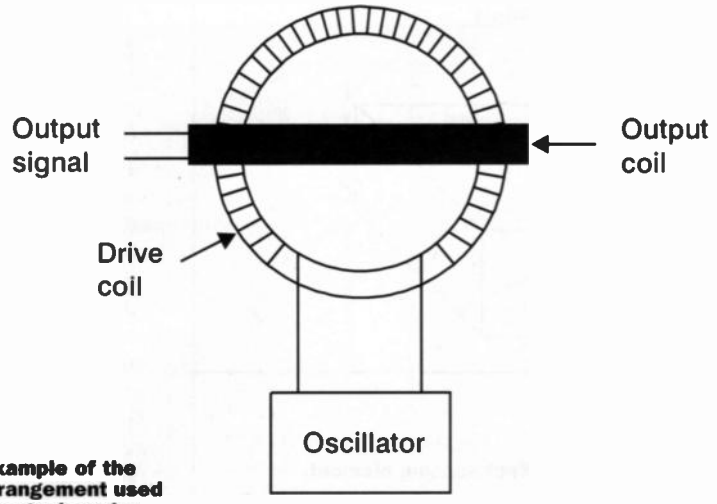


Figure 6. An example of the type of coil arrangement used in a fluxgate magnetometer.

in resistance have been produced but this is still a developing field. Applications of magnetoresistors are similar to those discussed for Hall effect devices. In addition they find applications in navigational equipment such as electronic compasses.

Nuclear Magnetic Resonance

Magnetometers based on a phenomenon known as Nuclear Magnetic Resonance (NMR) provide a method of measuring the absolute value of a magnetic field and are capable of high accuracy and sensitivity. These devices operate on a totally different principle to those mentioned so far, utilising the resonance produced in specific atomic nuclei when acted upon by an external magnetic field. Often radio frequencies are used to initially excite the atomic nuclei.

The proton magnetometer operates by detecting resonance set up in the nuclei of hydrogen atoms (protons). The system may consist of a coil arrangement located around a vessel containing water. A current is passed through the coil, creating a strong magnetic field that affects the orientation of the protons in the water. As a result, there is a tendency for the protons to become aligned in one direction determined by the magnetic field. When the current is switched off, the magnetic field collapses. At this point, if an external magnetic field is present, the protons become re-aligned under the influence of the external field. However, because the protons are spinning, this re-alignment is not instantaneous. Instead, the protons precess to the new orientation (governed by the laws of quantum physics). The frequency at which this precession occurs is directly related to the magnetic flux density allowing accurate magnetic field measurements to be made. A second coil may be used to detect the field produced by the precessing protons or alternatively the drive coil may be switched so as to drive detector circuitry. Figure 5 shows a simplified conceptual illustration of a proton magnetometer. The output from the device may be presented in a number of ways ranging from a directly audible tone to a computer interface. The arrangement used is very much dependant on the intended application.

Unlike most of the other sensors discussed, magnetometers based on NMR do not allow measurement of the direction of the magnetic field. Although initially, this may appear to limit the usefulness of the technology, this is not necessarily the case. In some applications, for example, where it is required to measure small changes in flux density, the sensitivity of the system often outweighs the limitations. There is also the great advantage that the data from the device are output as a frequency rather than a voltage or current level and as a result it is possible to achieve a high degree of accuracy.

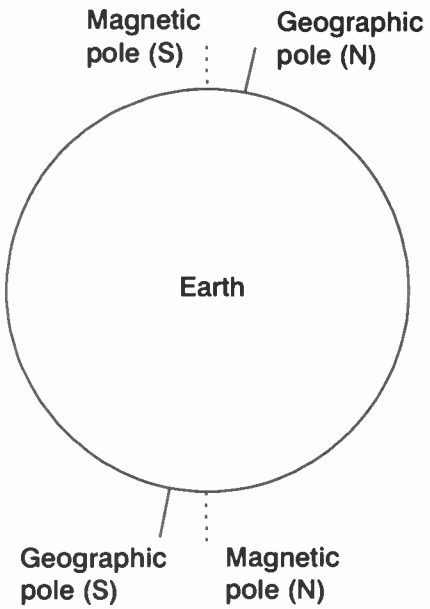


Figure 7. The earth's magnetic poles do not correspond with the geographic poles and are continuously drifting.

The Fluxgate Magnetometer

Yet another method of measuring magnetic fields is the Fluxgate magnetometer. Once again this is capable of providing very good sensitivity as well as directional data. The device finds uses in a wide range of applications in the laboratory and in navigational aids such as compasses.

The heart of the device is a series of coils wound onto ferromagnetic core material. A single toroidal core may be used. The characteristics of the core material are fundamental to the correct operation of the device. A simplified example of a possible coil arrangement is shown in Figure 6. An alternating signal is applied to the drive coil such that an alternating magnetic field is set up in the core. The amplitude and frequency of the drive signal is such that the core is in the region of saturation on signal peaks (as the signal voltage increases this no longer results in a corresponding increase in magnetic flux). During the part of the cycle that the core is saturated, the drive current increases considerably. A second coil wound around the outside of the toroidal former acts as a pick-up coil. When the core is exposed to an external magnetic field, an imbalance occurs. This imbalance results in current pulses being induced in the pick-up coil of an amplitude relative to the magnetic flux density. Suitable circuitry is required to separate out and process the relevant pulses in order to provide a meaningful reading.

The above arrangement is a typical example and there are a number of variations. For example, rods may be used in place of the toroidal core.

SQUIDs

The SQUID or Superconducting Quantum Interference Device is one of the most sensitive magnetic sensor technologies, capable of measuring very small changes in magnetic flux. The device requires very low temperatures (a few degrees above absolute zero) to operate and can be complex and costly to implement. Therefore the use of this type of sensor is usually confined to specialised applications.

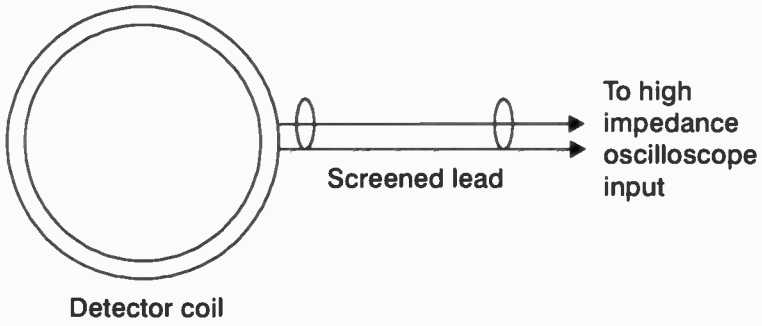


Figure 8. A simple 'near field probe' for detecting alternating fields.

Applications

Applications for magnetic sensors and associated technologies are becoming considerably more diverse as time moves on. In addition to some of the more standard applications such as proximity sensing there are also a host of more unusual uses. For example Magnetic Resonance Imaging (MRI) uses Nuclear Magnetic Resonance techniques to build up an image. Equipment operating on this principle is sometimes used in a medical environment to provide images of internal parts of the human body such as the brain.

Magnetometers can also be used to detect large ferrous objects or mineral deposits deep in the ground. It is possible to do this by detecting small localised variations in the earth's magnetic field. By taking readings at different positions, it is possible to determine the position of buried objects with a relatively high degree of accuracy. Such variations can be small, so use of a sensitive detector is essential. Magnetometers used in this application are often based on the Fluxgate or NMR principles. As mentioned previously, proton magnetometers produce an output which varies in frequency with magnetic flux density. This is convenient as the outputs from two sensors positioned a short distance apart can be combined to produce a series of mixing products. One of the mixing products is equal to the difference between the two detector frequencies. If the magnetic flux density is equal at both sensors, the difference between the two frequencies is negligible; however, a variation in the magnetic field caused by a ferrous metal object below one of the detector coils will result in a notable difference between the output frequencies of the two sensors. When the outputs are mixed, the difference manifests itself as a low frequency modulation of the output signal that when amplified may be audible as a warble. The frequency of the difference signal will be determined by the degree of variation in magnetic flux density between the two sensors.

Another common use for magnetometer technology is in research into the earth's magnetic field. The earth's magnetic field is not stable as some may expect but is subject to continuous variation. There are a number of reasons for this including the effects of the 'solar wind' a stream of high energy charged particles emitted by the sun. It is solar emissions that are responsible for the atmospheric phenomenon known as the northern lights or aurora borealis at high northern latitudes and the aurora australis in the southern hemisphere. The sun is in a constant state of flux and particle output varies depending on solar conditions and on periodic effects such as the 11 year sunspot cycle. Emissions from the sun are not only responsible for creating spectacular atmospheric light shows. Study of these phenomena are of increasing importance as a solar storm may result in a serious threat to satellite and terrestrial communications and disruption of navigational systems. In addition, many conventional short wave broadcast and communications circuits actually rely on ionisation of specific layers in the upper atmosphere (the ionosphere) to propagate the radio signals around the world. The condition of these ionised layers is heavily dependant on solar conditions. Monitoring various parameters of the earth's magnetic field provides an important source of data in studying the effect of solar particle emissions on the earth's atmosphere.

Changes in the earth's magnetic field can also result from changes inside the earth which can be of interest to geologists. The magnetic poles do not correspond with the physical north and south poles but are continuously drifting (see Figure 7). For example the magnetic north pole is currently somewhere in northern Canada. This has important implications for navigation. It is also interesting to note that the Earth's magnetic and geographic poles are actually opposite, so the magnetic south pole is closest to the geographic north pole and so on.

Control and Proximity Sensing Applications

As mentioned earlier, magnetic sensors such as Hall effect devices may be applied to a whole range of control applications both in industry and the domestic environment. We looked at the use of a Hall effect sensor for detecting the movement of teeth on gear wheels. This arrangement can be easily adapted to suit a range of practical circumstances. For example, to measure the movement of non-ferrous or non metallic objects a small magnet may be attached to the object.

Hall effect devices can be used in electromusic applications such as keyboards to indicate when a key is pressed. This gives the musician more control than a simple set of contacts. A linear Hall effect device will produce an output voltage proportional to the relative position of the key. This information can be processed so as to detect how rapidly the key is depressed and used to adjust the characteristics of the envelope produced by the instrument. A similar application is in volume pedals, where the output from a Hall effect sensor can be used to determine the gain of a voltage controlled amplifier. The arrangement must be such that when the pedal is operated, the position of an internal magnet is varied relative to the Hall effect sensor. This type of system can effectively be used in place of mechanical potentiometers which often become noisy after a period of use due to dust deposition and wear to the resistor track.

AC Fields

Of recent years there has been considerable interest in alternating magnetic fields produced by power lines and many pieces of electrical equipment. Alternating fields can adversely affect the operation of electrical apparatus. There has also been much discussion relating to the effects of alternating fields on the human body. Many biological processes involve chemical reactions in which electrical charges play an important role. Electrically charged particles are heavily influenced by magnetic fields and one area of possible concern is that intense alternating magnetic fields may significantly affect biological activity in the body.

The level of alternating fields in the average home can be relatively high. This is not surprising when you consider that many pieces of equipment operate from the AC mains supply which is alternating a frequency of 50Hz. Also some appliances contain internal oscillators operating at higher frequencies.

A simple coil based detector or 'near field probe' (see Figure 8) is useful is detecting relative levels of AC fields. This can be as simple as a few turns of wire wound into a loop and connected via coaxial cable to the input of an oscilloscope. A portable unit with a similar coil arrangement connected to the input of a small audio amplifier can also be useful when detecting mains cable runs in walls etc.

Next Month

This time we have looked briefly at a variety of different sensor technologies and magnetic measurement techniques. Next month we will look at the practical aspects of magnetometer design and there will be some experimental circuits. ELECTRONICS

In Cyberspace, NOBODY CAN HEAR YOU SCREAM...

You want to make the most of your web site - for marketing and perhaps even e-commerce. But no-one seems to be visiting. How can you attract more traffic, from the right kind of people? Charles Newman shows how to put yourself on the Cyberspace Map.

Put your business on the web, watch the visitors pour in - and watch your business boom. That's the theory. The practice is rather different. All over the world, more and more business people are spending more and more of their time scratching their heads and asking "where are all those visitors I was promised?"

The good news is that there are plenty of things you can do to generate higher levels of 'traffic.' The less good news is that you'll have to work at it. Putting up a web site is absolutely nothing like buying an ad in a trade magazine or your local paper. To be successful with web marketing you have to think not only like an advertiser - but like a publisher too.

There's no doubt about the opportunities. Best estimates currently put the number of Internet users at 95 million. According to US-based Internet watchers Datamonitor, the global Internet population will reach 250 million in 2002, and 300 million by 2005. There is also a vast number of web sites trying to attract their attention - which partly explains why the majority of web sites attract a mere trickle of visitors each day. A typical company's web site is doing well if it generates more than a few thousand page-accesses a month. For many businesses, that's simply not enough to justify the investment.

Pulling out isn't an option. Forrester Research, yet another US-based web-watcher, has estimated that the value of business-to-business e-commerce on the web for this year should top $100 billion, and more than double that, to $251 billion, for 2000. Revenue is expected to grow faster as the Internet reaches what Forrester calls the 'e-commerce threshold,' with the number of companies and customers online growing to a point when e-commerce becomes not only viable, but commonplace. By 2003 revenue could reach - wait for it - $1.3 trillion.

So how can you get a slice of this lucrative action? Here are six steps to success: web site design, search engines, doorway pages, directories, content and email newsletters.

Website design

Few web site designers know much about marketing on the web, yet the way a web site is constructed is one of the most important factors in the success of a web site as a marketing tool. Here are some do's and don'ts:

- Don't put big images and animated gifs on your site. It's so easy for visitors to your site to go elsewhere when they see that it is taking too long to download.
- Don't ask your visitors to jump through hoops. Don't put visitors to your site off by asking them to download special software before they can see your Shockwave animation or read your PDF file.
- Don't use frames on your web site: search engines don't like them and if you're not careful they might simply ignore your site.
- Do make use of meta-tags: Meta-tags are lines of HTML in the 'head' area of HTML documents which is not displayed by browsers. They have been devised for a number of reasons - for example so that web pages can be classified quickly and automatically by the all-important 'search engines'. Without meta-tags, some search engines won't even notice your web site's existence!
- Do use your homepage to promote the content on your site: use your homepage like a good magazine uses its cover - to 'sell' the content behind it.

Search engines

Search engines (and directories - we'll come to them later) are the most important marketing tools on the web. Ninety-five per cent of web surfers start their voyages of cyber-exploration from one or other of them. If you're not on the search engines then you're not really on the web.

Now register your site with the major search engines. There are only a few that really matter: Excite, Alta Vista. Infoseek, Web Crawler, HotBot, Snap, MSN, Lycos and GoTo are the big ones. You can submit your site to them from their home pages - there's no charge and the whole job needn't take you more than 30 minutes. Some of the engines will add you to their listings within 48 hours; others take up to 6 weeks.

Registration by itself is almost pointless, however. Try it and then search each of them by entering a typical phrase that a would-be visitor might enter - electronics +retailer +London, for example - and watch as the engines 'fetch' page after page of web sites - but not yours. You might strike it lucky and your site may rank highly in one engine - but it certainly won't rank highly on all of them. Why not?

All search engines are basically word-matching systems: they're looking for files which contain the key words 'electronics' and 'retailer' and 'London'. But that's where the similarity ends. Some of them only 'read' meta-tags; some don't read them at all; some only read the first 20 words or so. Some 'read' the entire file, others read only the first 200 words or so.

Even more significantly, all search engines use different relevance criteria and algorithms to help them decide how to rank the 20,000 documents they eventually identify which share those keywords. Some look for the number of times the keywords appear, others look for the frequency with which they appear throughout the document and others assess the 'prominence' of the words in the file. Some stop counting after a certain number - some after three, others after seven, some not at all. Some include text which wouldn't appear in a browser - for example the 'alt' text that is associated with images, or 'comment' text.

So here's a major problem: your web site is highly unlikely to rank well in any of the engines, or if, by some fluke, it ranks well in one, it will be virtually ignored by the others.

Doorway Pages

The solution is to build special 'doorway' pages - one for each major search engine. This way you can construct each doorway

page to 'appeal' to specific engines - one for Lycos, one for Infoseek, one for Alta Vista and so on. When a surfer visits one or other of your doorway pages he or she is then directed 'through it' to your web site. When properly constructed, doorway pages can dramatically increase visitor numbers.

How do you build doorway pages? The simplest way is to enter a relevant key word search on each search engine and download the top three or four sites to your local hard disk. Then look at the source HTML and see just how many times the key words have appeared, and where, in each document. Also note how often they have appeared together, whether in upper or lower case, and how long the entire document is, as well as the individual meta-tag elements. Then copy the structure as closely as you can. It's a jungle out there in Cyberspace. Dog eat dog...

Once you achieve a higher ranking, you have to work hard to keep it. Because they compete with each other on providing the best possible quality 'fetches' for their users, the search engines are changing and enhancing their relevance criteria and ranking algorithms all the time. Each time they change, your web site is likely to bump down the rankings. Another problem is that new sites are being registered on the engines every second of the day. Some may have been structured just like yours, to rank high on search engines' fetches. Whatever the reason, without regular attention, your site will slowly drift down the rankings.

It is important to monitor each doorway page on a monthly basis - once you start attracting serious traffic to your site you won't want to loose it. Simply search by your keyword phrase across all the search engines and, where you see your site loosing its ranking, go to the top sites, as before, to analyse precisely what it is about them that the search engine seems to like so much.

Directories

For all their importance, search engines are not the most important 'Portals' on the web. Yahoo takes that prize - by a distance. Of all the surfers who try to navigate their way through the net, almost half start from Yahoo.

The reason for Yahoo's popularity is simple: instead of a computer at its heart, it has humans. A big team of 'editors' receive submissions from web site owners, assesses whether they should or should not be included in the Yahoo index, and then decides precisely where it should go. So Yahoo is well structured, simple to use, its content is good - and it is the most valuable web 'property' in Cyberspace.

Submitting your site to Yahoo is simple but inclusion in the index (few sites are rejected) can take months. The service is so slow that Yahoo recently inaugurated a paid-for 'express' submission service specifically for business applications. Cost is $199. It's good value.

Yahoo is facing growing competition. Open Directory works in the same way as Yahoo - although its 'editors' are all volunteers. Supported by Netscape and building alliances with other big web 'properties' Open Directory could represent the first real threat to Yahoo's position. It is certainly worth registering your site there also.

Content

The three rules of successful retailing, they say, are: position, position, position. On the web it's content, content, content. Attracting visitors to your site is only half the battle for what you need is something which brings them back, time and time and time again - and that 'something' is content.

Forrester Research asked a big sample of web surfers what brought them back to sites which they had already visited. Top of the list of reasons was content, then ease-of-use, followed by quick downloading and frequent up-dating. So how can you develop content which will turn your first-time visitor into a regular?

First ask yourself, who is your target market? Electronics hobbyists in Manchester? Or printed circuit board manufacturers throughout the country? Or metal detectives? Identify a defined target market and ask yourself what kind of information you can provide which will interest them. New product announcements and reviews? Price surveys? Do's and don'ts? A directory of suppliers? A web site 'forum' for enthusiasts? Perhaps even a back index of Electronics & Beyond? *(We have thought of this and we are working on it - Ed)*

Email Newsletters

Now you have something to draw your target market onto your site. When they come, offer to send them a monthly free email newsletter covering their area of interest - all they have to do is leave their email address with you. From now on you should email a monthly newsletter to all those individuals. It should include short summaries of longer documents that you have added to your web site - and embedded hot-links which can take the reader straight to your site to read the full version. Include 'New dates for your Diary' and an embedded hot-link back to your site where a full calendar of events is available. If you can set up a busy discussion forum you can use your email newsletter to tell your readers about new postings and discussion 'threads'.

Now the marketing platform has been established, that part of the job is over. You have defined your target market, you have used the web to bring it to you, and to establish on-going communication with it. What you do with it now is up to you...

Further information

Charles Newman is a consultant with MMP, a specialist web marketing consultancy. MMP's webMASter web marketing tools including MASIndex, MASPromote, MASAlert, MASForum and MASPublish. Full details are available at www.mmp.co.uk/mmp or on 01273 380040.

Photo 1. Sony Video Movie prototype.

DIGITAL 8

Reg Miles plots the history of this video format.

With the launch of the Digital8 format Sony has increased the lifespan of the 8mm format, and provided a lower cost entry to digital video than DV.

In the Beginning

The 8mm story began nineteen years ago with the announcement by Sony in July 1980 of its prototype 2kg, colour 'Video Movie' camera-cassette recorder (Figure 1a), which used one of the new CCDs, and had a Home Editor for playback (Figure 1b). It also used a new tape size, 8mm wide, contained in a tiny 20 minute cassette (and metal, not oxide). Sony's intention was to eventually replace the 8mm cine camera with its video equivalent (actually, the cine market was never a large one, due to the cost of the short lengths of film and the inconvenience of showing them after processing; the electronics companies were well aware that with video as the medium there was the potential for something much bigger).

When Sony announced Video Movie it invited other manufacturers to discuss means of developing a common format for that purpose. In September 1980 Hitachi showed a similar prototype 'Mag' camera, with Matsushita (Panasonic) following in February 1981 with their 'Micro Video System'. The three companies then began discussing how standardisation could be achieved; and invited JVC, as the inventor of VHS, and Philips, as the inventor of V2000, to participate in their deliberations. In January 1982 the five announced the main parameters of what was then called '8mm Video' (although 7-8mm tape was specified). In March 1982 122 manufacturers got together to devise the full details.

It then went very quiet. With the only disturbances being caused firstly by JVC who, in 1983, showed a prototype VHS-Compact camcorder with a four head drum that had been reduced from the standard 62mm to 41.3mm; then shortly after by Sony with a Beta prototype having a single, dual-azimuth head drum reduced from 74.5mm to 44.7mm. Sony then launched this 'Betamovie' at the beginning of 1984. Then in April 1984 the 8mm Standardisation Committee as it had become announced the specifications for the new format. Followed in the summer by the launch of JVC's VHS-C 'VideoMovie' model.

8mm Video Specifications

The 8mm Video specifications were evolutionary, exploiting the advances that had occurred since the development of the half-inch formats. Thus, FM azimuth recording is used for luminance and converted subcarrier phase shift recording for chrominance (Figure 2). With the mono audio modulated onto an FM carrier at 1.5MHz. The specifications also allow for PCM stereo audio recorded on extensions of the video tracks (Figure 3). Instead of a linear control track an Automatic Track Finding system is used, similar to V2000. During recording pilot signals of four different frequencies are recorded (Figure 4a) frequency modulated in with the video and audio signals on the tracks. During playback the slightly wider head (Figure 4b)

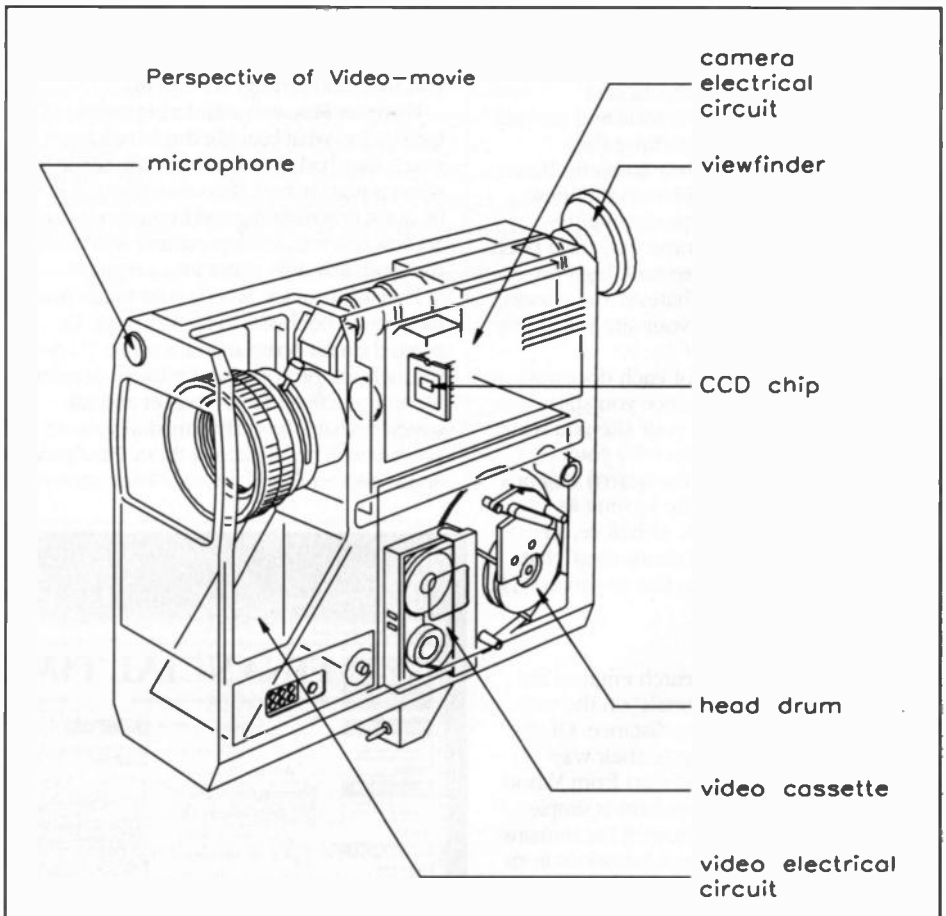


Figure 1a. Sony Video Movie prototype.

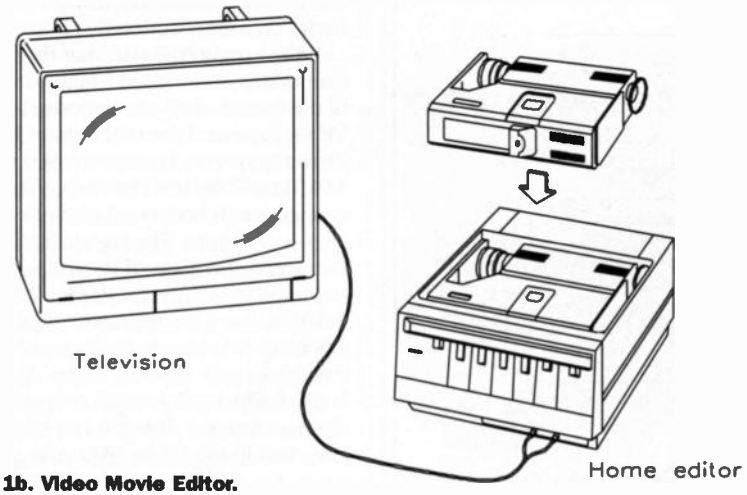


Figure 1b. Video Movie Editor.

Photo 2. First 8mm camcorder - Sony CCD-V8.

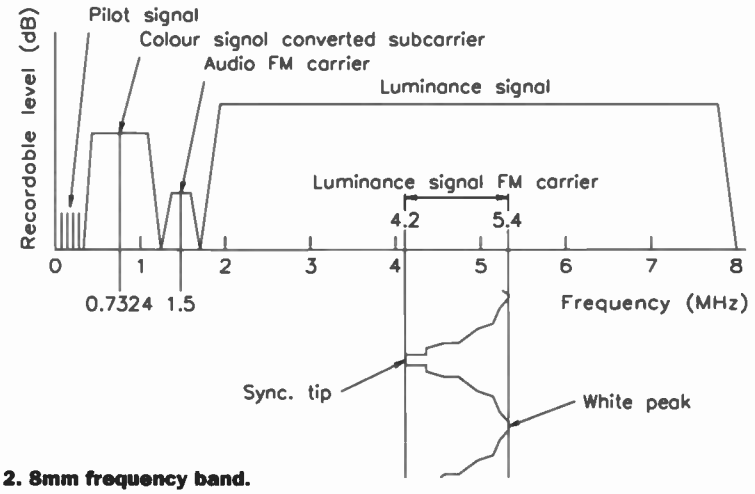
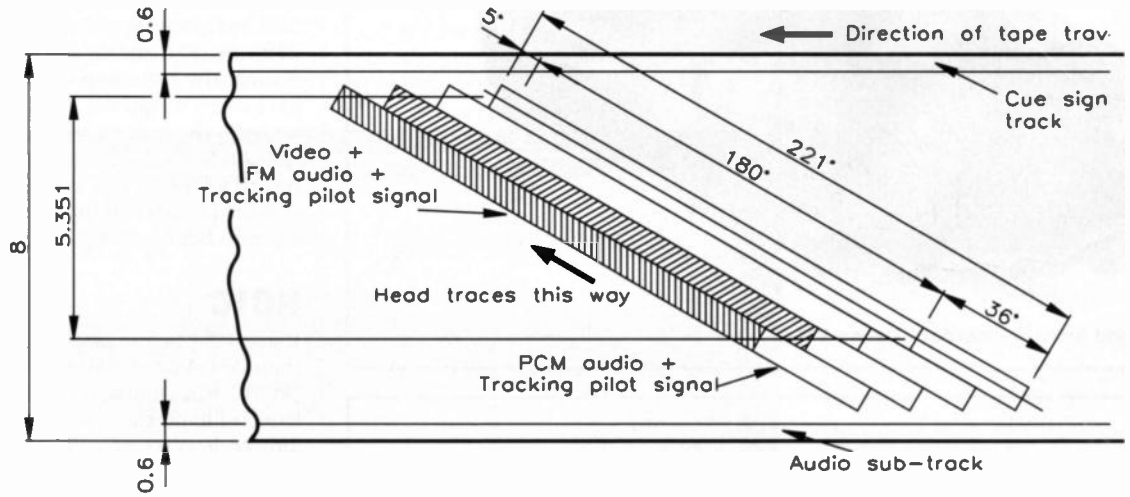


Figure 2. 8mm frequency band.

picks up small amounts of f2 and f4 signals in addition to the full output of f1: f2 and f4 are continuously compared and if one exceeds the other then the capstan speed is varied to rebalance them and bring the speed back to 20.051mm/s (10.0255mm/s LP) - the same applying to the other tracks.

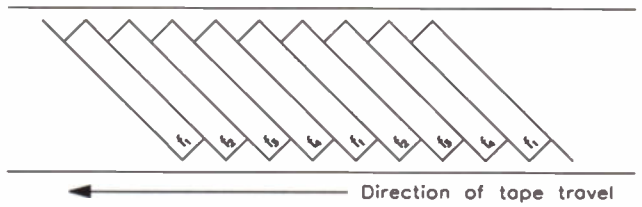
First 8mm Camcorders

The first 8mm camcorders were launched in 1985 - Sony's CCD-V8 followed by Canon's VM-E1. Three years later FM stereo was announced. This was achieved by adding a second carrier at 1.7MHz to provide a right channel (Figure 5). In order to maintain compatibility the original 1.5MHz (now left channel) carrier contains L+R information and the right channel L-R, so the 1.5MHz carrier continues to act as



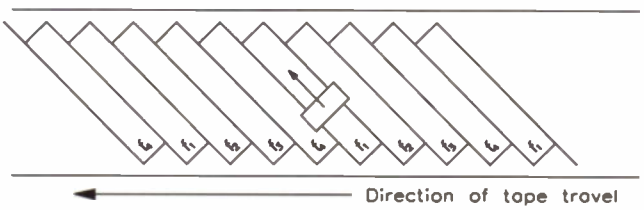
Item (with PAL system)	Specifications
1. Tape width	8mm
2. Tape speed	20.051mm/sec
3. Drum diameter	40mm
4. Relative head-to-tape speed	3.1m/sec
5. Video track pitch	34.4um
6. Video track width	34.4um
7. Cue signal track width	0.6mm
8. Audio sub-track width (including guard band width 0.1mm)	0.6mm
9. Video track angle (stationary tape)	4°53'6"
10. Video track angle (running tape)	4°54'58.8"
11. Video head azimuth angle	±10'
12. H-alignment	+2H

Figure 3. 8mm track structure.



f_1 = 101.02 kHz f_3 = 162.76 kHz
f_2 = 117.19 kHz f_4 = 146.48 kHz

Tracking Pilot Signals



Head and Tracking Pilot Signals

Figure 4a/b. Automatic tracking.

Photo 3. Second 8mm camcorder - Canon VM-E1.

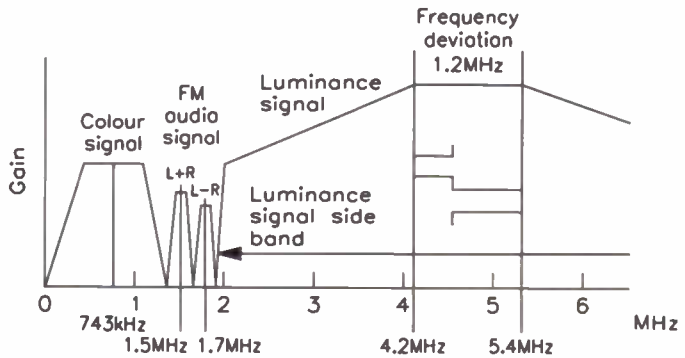


Figure 5. 8mm stereo FM audio.

mono when stereo recordings are played back in a mono camcorder.

1988 was also the year that the 8mm Committee announced a high-band version of the format - Hi8 - in response to Super-VHS announced the year before. In this the carrier frequency has been raised from 5.0MHz to 7.0MHz (Figure 6). This allowed an increase in horizontal resolution from 250 lines to 400 lines. The higher carrier frequency also allowed the frequency deviation to be increased from 1.2MHz to 2.0MHz, giving an improved tonal range and S/N ratio. In addition, the luminance and colour are kept separate and a YC connection is used, which minimises cross colour and dot interference. The first Hi8 camcorder was launched in the UK in 1989 - the same year in which the first FM stereo models appeared.

That was also the year in which a mini head drum was announced and launched. This followed the pattern set by the four head VHS-C drum - being the more practical of the two. A single head should have a 360° tape wrap - but that is impossible. Thus Betamovie had a 300° wrap: this was scanned in 1/60s; for the remaining 1/300s necessary to cover 360° (1/50s) the pickup tube, later CCD, was scanned below the image area until the head re-contacted the tape - ruling out internal playback and an electronic viewfinder. But it did reduce the larger Beta drum by more than two-fifths, whereas a four head configuration gives a reduction of one-third.

The 8mm drum is 26.7mm. The reduced circumference necessitates a 50% increase in tape wrap to 270° to maintain the length of the video tracks (Figure 7). However, the full 292° wrap is still insufficient to allow for PCM audio; that would have required a wrap of 332°, and created tape loading problems. A 50% increase in speed is also required, to 2250rpm, to maintain the writing speed of 3.1m/s. The recording sequence is (Figure 8): 1 and 4 record the first A and B fields respectively, then 3 and 2 record the second A and B fields...and so on. The next head to record following 270° behind. With the pair of A field heads and the pair for the opposite azimuth B fields being 180° apart.

RCTC

It was 1991 before anything else happened; then Rewritable Consumer Timecode (RCTC) was launched. This followed the launch the previous year of Vertical Interval Timecode (VITC) for VHS(-C). RCTC is recorded between the video and PCM audio sections of the track as a digital packet (Figure 9). It consists of hours, minutes, seconds and frame number (1-25) to accurately identify each frame for editing. The area is also used to record a data code for a note of the date and time, and index signals for locating the start of recordings. Because RCTC is in its own section of the track it can be added to tapes after recording; this cannot be done with VITC which is recorded in a spare line at the beginning of the video track.

Since then the format has remained consistent, with companies concentrating on adding features to the products. They were also concentrating on the development of DV, and its launch in 1995.

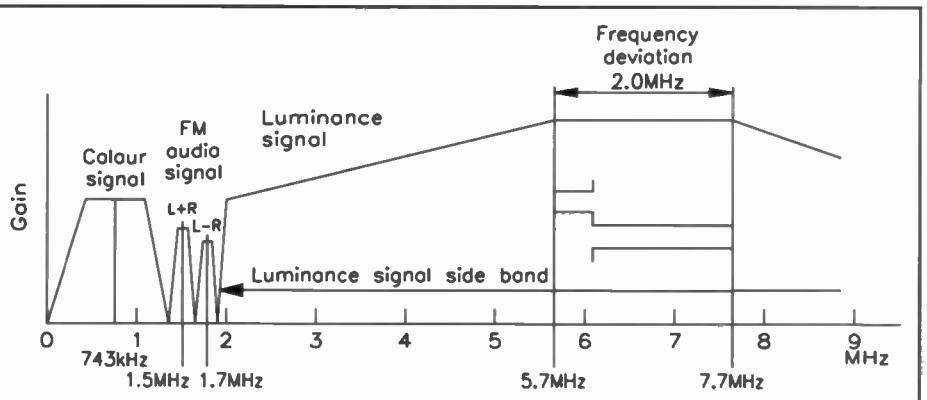


Figure 6. Hi8 frequency band.

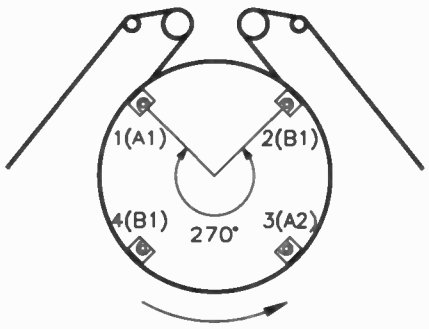


Figure 7. Mini head drum.

DV and DV 8mm

It was soon after the DV launch that Sony began thinking of developing a digital version of the 8mm format. This would allow existing 8mm/Hi8 users to upgrade to digital while still being able to play their analogue tapes (backwards compatibility was considered essential). Also tapes with both analogue and digital recordings. It would also provide access to digital recording at a lower cost than the DV format. And so, after two years of development work, Digital8 has arrived in the shape of four Sony camcorders. Although, as yet, no other company has expressed its intention of producing D8 equipment.

Digital recording is done on Hi8 tapes - metal particle or metal evaporated. It is also possible to use 8mm tapes, but Sony does not guarantee full compatibility when played back on another D8 camcorder. And, although 8mm and Hi8 analogue recordings can be played in D8 camcorders, it is only possible to record Digital8.

The format is ascertained by the differences in the signal frequencies used by 8mm, Hi8 and D8 - up to 7MHz, 10MHz and 21MHz, respectively. For analogue the drum speed is then set to 1500rpm and the tape speed to either SP or LP; for digital the drum speed is tripled to 4500rpm, giving a writing speed of 9.3m/s, and the tape speed is increased to 28.695mm/s (there is no D8 LP). This increase in tape speed means that a PAL Hi8 tape will only last for two-thirds of the time specified. One head width is used for both analogue and digital - it is also shared between PAL and NTSC. The heads 19μm width is perfect for the 16.34μm D8 tracks (PAL and NTSC), and reasonable for the 20.5μm NTSC SP analogue tracks, but it is rather lost in the 34.4μm PAL SP tracks (the PAL tracks are wider to compensate for the shorter minimum wavelength: 0.57μm against 0.70μm for 8mm, 0.44μm against 0.54μm for Hi8). There must therefore be some loss of amplitude. And auto tracking presumably requires some additional processing? Separate circuit boards are used for digital and analogue signal processing. With outputs provided for both types of signals from both types of recordings. The digital output being the now standard IEEE 1394 high speed serial interface (Firewire or i.Link).

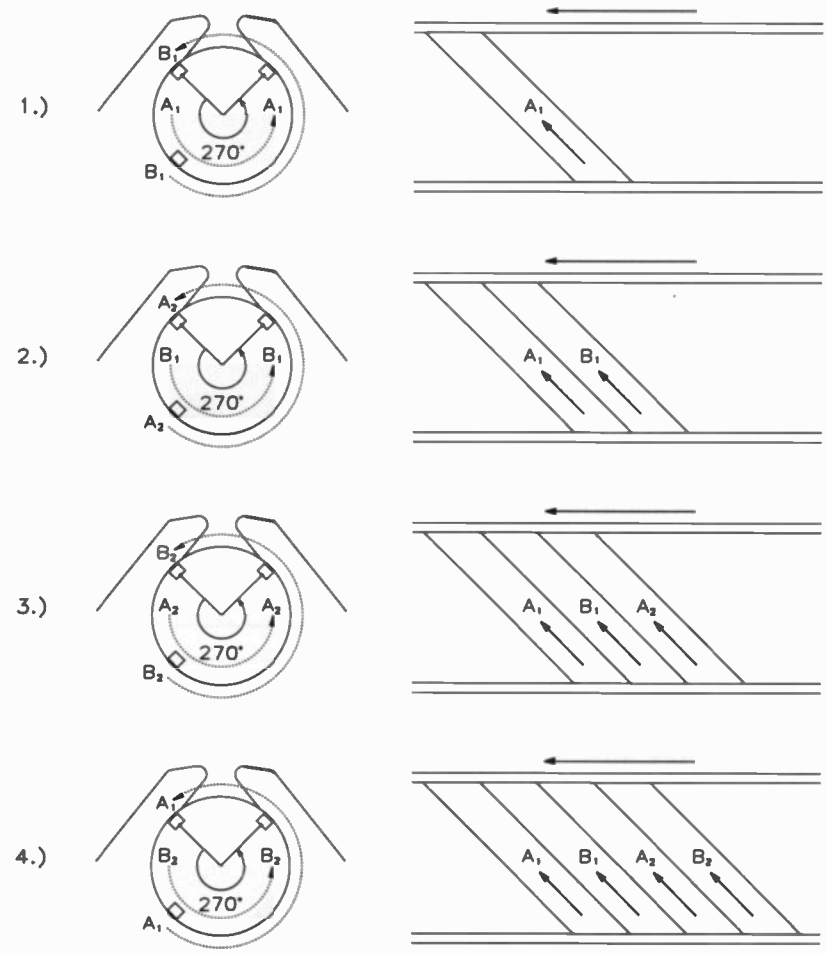


Figure 8. Head recording sequence.

Photo 4. First stereo FM camcorder - Canon A1.

Photo 5. First HI8 camcorder - Sony CCO V900.

applied, using Reed Solomon code, and the result is recorded, with a horizontal resolution of up to 500 lines (as with DV).

Digital Track Configuration

The digital track configuration is identical to that of DV, but D8 records two tracks for each pass of the head (Figure 11). Thus, twelve tracks per frame in DV become six in D8 (giving 150 tracks per second for both 25Hz PAL and 30Hz NTSC).

The insert and track information (ITI) sector is largely devoted to the auto tracking data, but also contains information on insert edits. There are two PCM audio modes: 16-

Component Digital Signal

The component digital signal consists of luminance (Y) and the colour difference signals (R-Y and B-Y) - Figure 10 shows the signal flow. Once in component form the signals are sampled: Y at 13.5MHz, and colour at 6.75MHz; but the latter only on alternate lines, giving a 4:2:0 sampling structure (NTSC samples both colour signals at 3.375MHz on every line, giving 4:1:1). Each of the three components is then quantised to 8-bits. And converted into binary notation to become the digital signals. These are then compressed using a discrete cosine transform (DCT) based system for its ease of computation. Coding is on an intra-frame basis, that is the frame is treated as a unit rather than as two discrete fields, which is more economical, but does mean that unwanted motion artefacts can occur with rapid subject movement. The output ratio is 5:1. Error correction is then

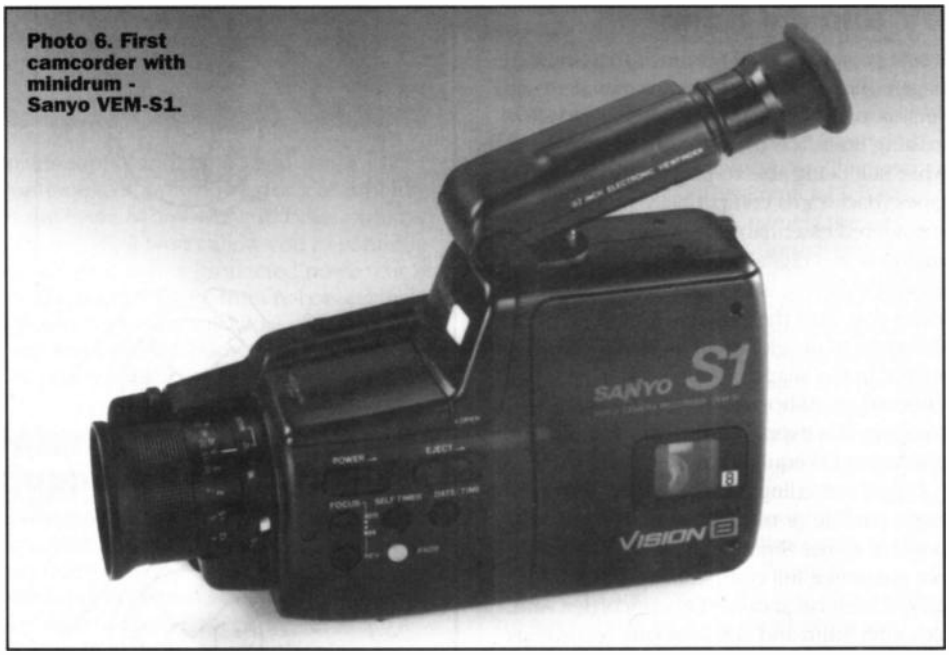


Photo 6. First camcorder with minidrum - Sanyo VEM-S1.

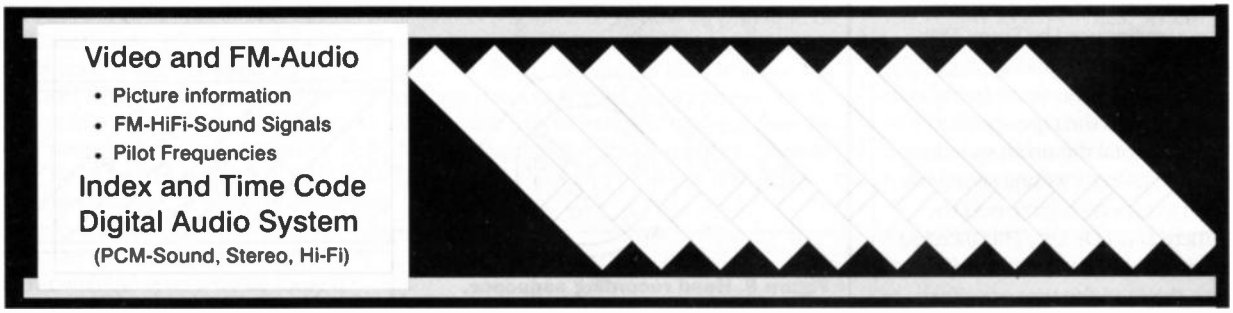


Figure 9. RC timecode.

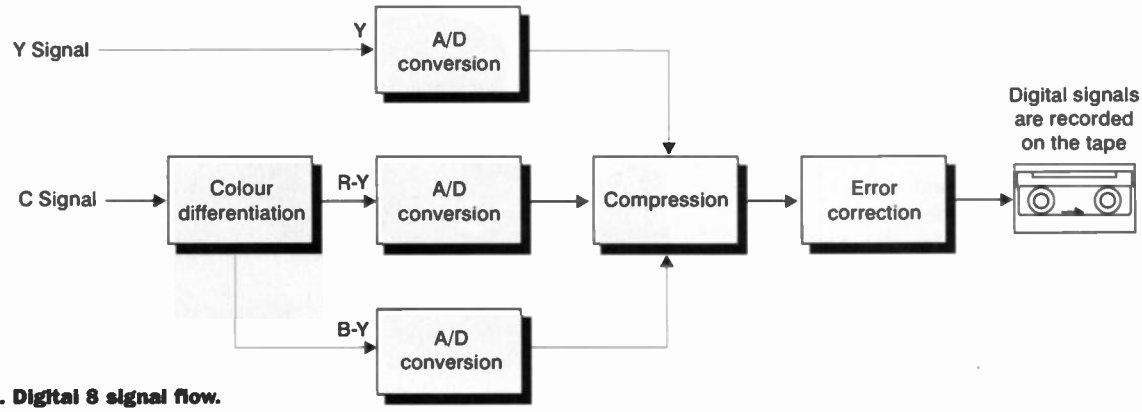


Figure 10. Digital 8 signal flow.

bit linear stereo, with a sampling frequency of 48kHz; and 12-bit non-linear, dual stereo, sampled at 32kHz. Audio dubbing is not available on D8 camcorders. DV tape has a thin metal evaporated layer that allows overwriting, but, because D8 also uses thicker metal particle tape, a flying erase head would be needed to fully erase the existing audio before any new audio could be recorded. This process requires accurate timing and signal processing, with power consumption that apparently makes it unsuitable for camcorders and is more costly, too. The track ends with the sub-code sector which contains timecode, index ID, and the location of still pictures shot in 'photo mode'. There is also a facility for recording auxiliary data in the video tracks to provide information such as date and time, the camera settings used, etc.

The four D8 camcorders that have been launched are, in ascending order: DCR-TR7000, DCR-TRV110, DCR-TRV310 and DCR-TRV510. All but the TR7000 have a colour LCD, their screen sizes being 2.5in, 3.5in and 4.0in respectively. The TR7000 does have a colour viewfinder, as does the TRV510. The shared features include electronic image stabiliser, 20x optical/80x digital zoom, and infrared recording with slow shutter speed for use in total darkness. An infrared output allows wireless

Photo 7. Sony DCR-TRV110 Digital 8 camcorder.

connection to a TV or VCR, using an optional receiver. Additionally, the TRV510 has a digital still camera function with a built-in 2MB flash memory holding 20 fine or 33 standard mode images.

All models have a lower price than DV camcorders with similar specifications. Which is the advantage of this new format. The advantage of DV is that the camcorders can be made smaller, thanks to the 21.7mm drum and smaller cassette, and include the features necessarily left off Digital8. ELECTRONICS

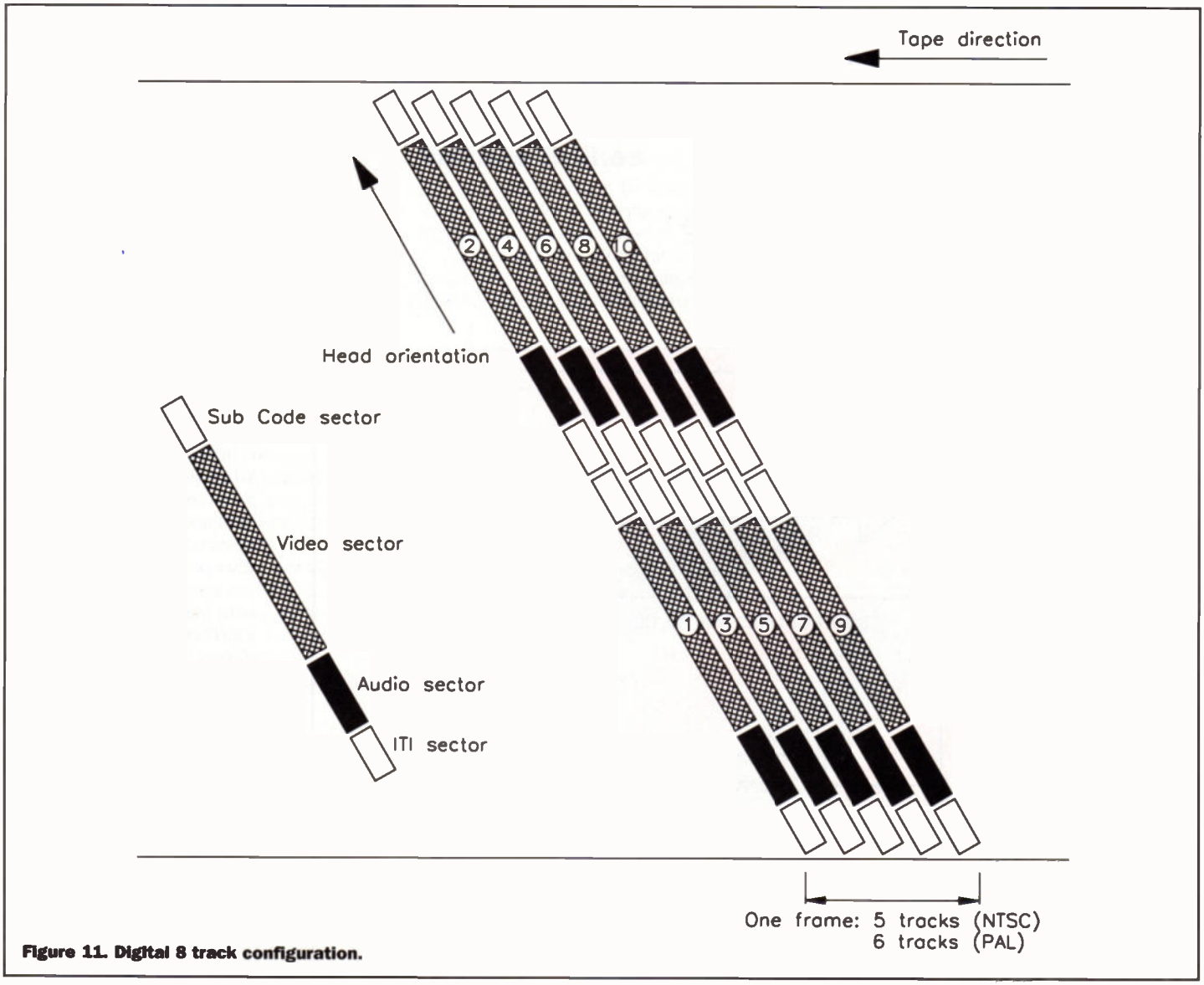


Figure 11. Digital 8 track configuration.

PROJECT

SRAM TESTER

R. Grodzik uses his favourite microprocessor, the PIC, to produce this versatile SRAM tester.

Introduction

The volatile static RAM has been widely used in microprocessor 'Trainers' utilising 8-bit processors such as the Z80, 6502, 8088 and 8031. Invariably, the SRAM used has a small memory size of typically, 2K bytes (type 6116) or 8K bytes (type 6264). These SRAMs are also used in countless numbers of terminals and EPOS systems where they are used as video buffers, holding the ASCII characters which are presented to the VDU. This project performs a simple test to determine whether the SRAM is good or faulty by writing 55H (01010101) and AAH (10101010) to consecutive memory address locations throughout the RAM, and then reading that location. If any bit location is stuck at a logic 0 or logic 1, then the memory is defective, and a red LED indicator will light. If the entire SRAM passes the test a green LED will light. Figure 1 shows the block diagram for the tester.

Circuit Description

The SRAM tester is a portable unit and therefore is battery powered. Figure 2 shows the full circuit diagram. In order to conserve battery power and reduce current consumption, this project has been designed around the PIC16C55XTP embedded controller, which has a sleep mode in which the system clock stops and current consumption is reduced to a matter of microamperes. The power management circuitry consists of four parts:

1. A voltage switch based around transistor Q1 which supplies battery power to the SRAM sockets S1 and S2 whenever switch SW1 is pressed to initiate the test.
2. A battery supply consisting of a rechargeable 3.6V NiCd battery which is connected permanently to the PIC. Note that jumper J1 is used to disconnect power so that the PIC may safely be inserted into the board. A simple charging circuit consisting of a 470Ω resistor (R9) requires an external DC voltage from any mains adaptor capable of supplying 12 to 15V. Note that if the unit is used with the adaptor connected for extended periods of use then a 100nF capacitor needs to be fitted across the battery since any mains ripple on the DC supply from the adaptor will cause circuit malfunction.
3. The power for the two ripple counters (IC2 and IC3) is supplied by the PIC via port line RA1. Each port line of the PIC can source 20mA which is much more than is required by these CMOS devices. Just before sleep mode is entered, Port line RA1 is cleared to a logic 0, effectively shutting down these two ICs.
4. The reset/sleep circuit consists of R1, R2, C1 and switch SW1. Normally, the PIC is held in it's SLEEP state. When first powered on. i.e. when the circuit has been built and finally jumper J1 is inserted, the PICs firmware tests port line RA0 for a logic low condition. This line is held high via R2, and R1, the 'GOTO CONT' instruction, directs the PIC to execute the SLEEP instruction. Whenever switch SW1 is pressed, a reset is applied to the MCRL line which 'wakes up' the PIC, and this time port line RA0 is at logic low via the switch and a previous instruction which had cleared the SCAN1 line low. Program execution now jumps to the main testing routine via instruction 'CALL SWITCH'. When testing of the SRAM is complete, the sleep state is once again entered.

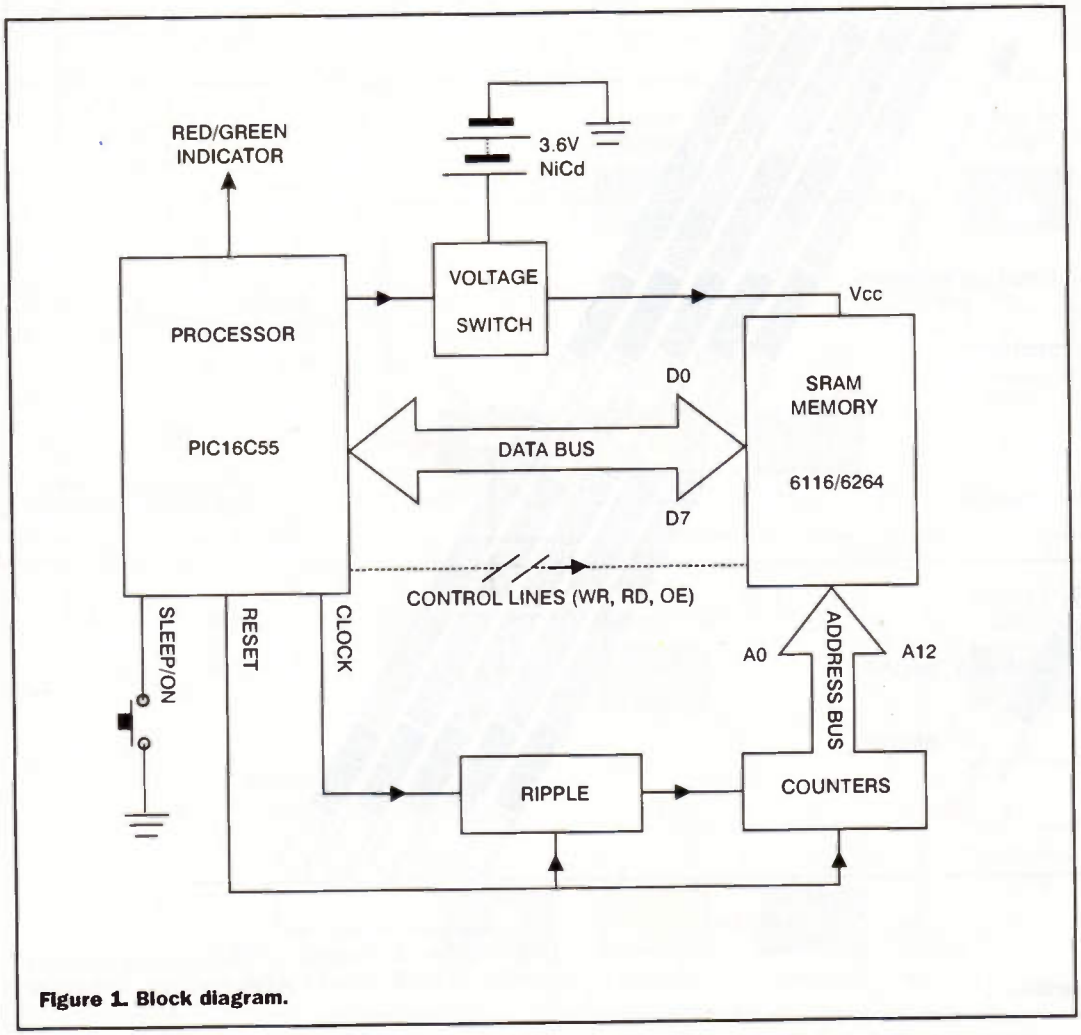


Figure 1. Block diagram.

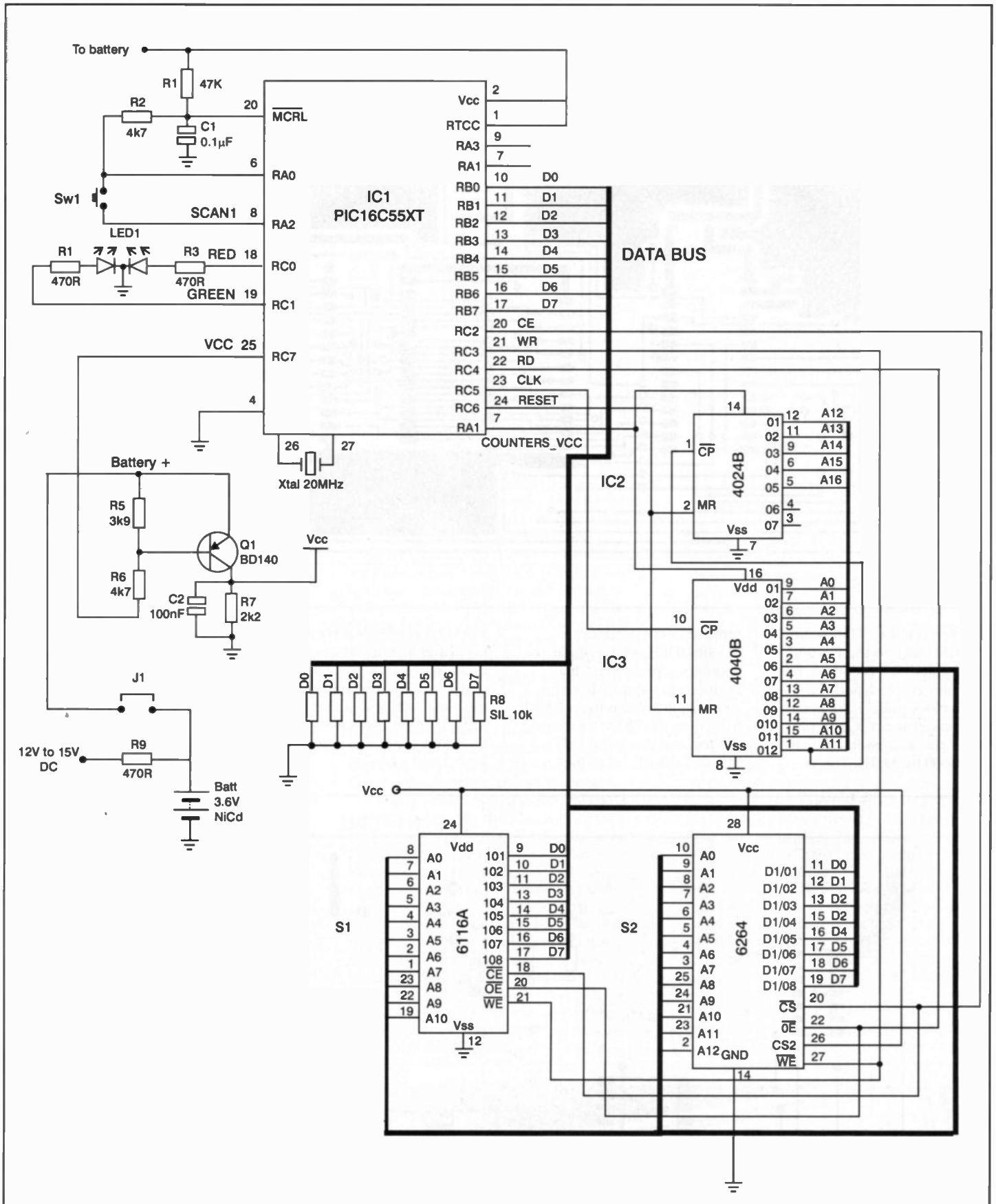


Figure 2. Main circuit diagram.

The SRAM to be tested (type 6116 or 6264) is inserted into socket S1 or S2. Note that turned pin sockets must be used for these sockets since continual removal of used IC from conventional (cheap) sockets will soon render them unusable. If required, ZIF (zero insertion force) sockets may be used since the PCB layout allows for these physically bigger sockets. Switch SW1 is pressed and since the clock used is 20MHz, it only takes a fraction of a second for the RAM to be tested. If the green LED lights up then SRAM is OK. A faulty device will light the red LED. When the switch is released, the LED is extinguished and the PIC goes back to 'sleep'.

Meanwhile in the short interval in which the switch has been pressed, a lot has been going on....

If a 6116 RAM has been inserted then a total of 2048 8-bit locations have been tested. Two counters (IC2 and IC3) are cascaded together to supply a binary count to the address lines A0 through A10. Port B of the PIC delivers a data byte (55H) on the data bus to the RAM. A write pulse is issued and

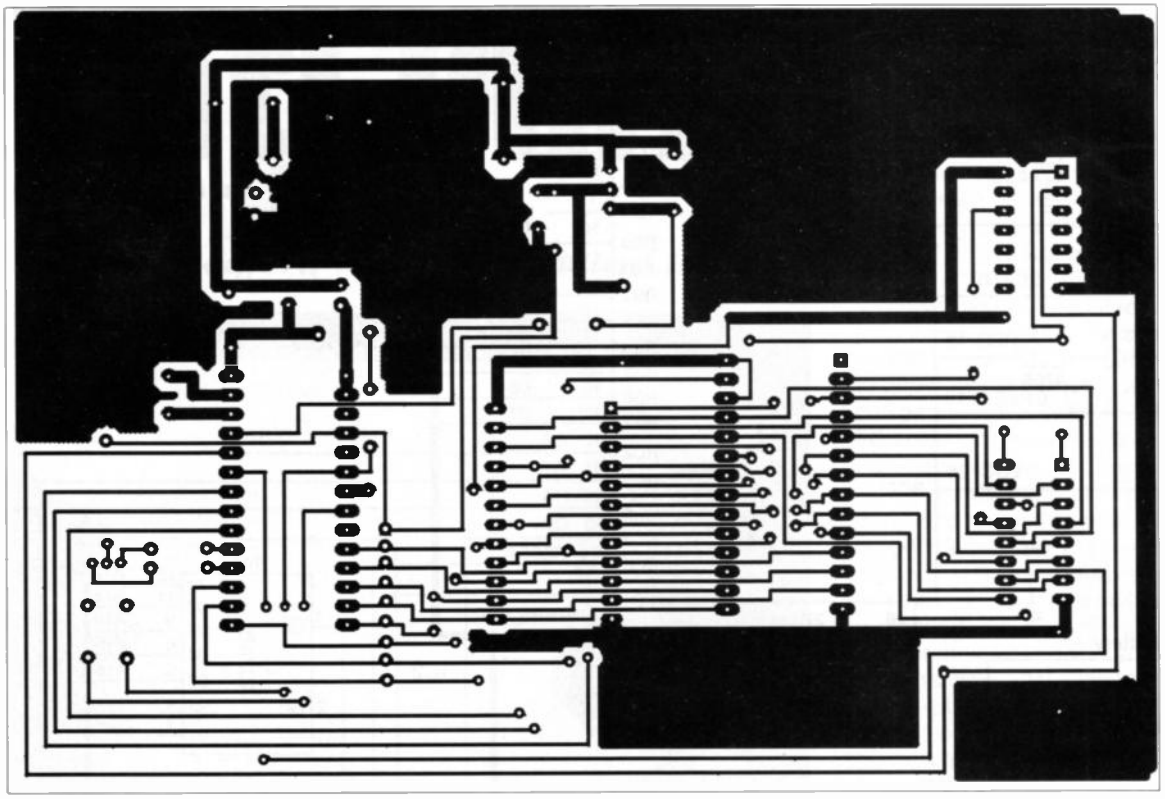


Figure 3. PCB foil.

then a read pulse. 8-bit data is then read back to the PIC and interrogated. If it is correct, has been uncorrupted, and still is 55H, a clock pulse is applied to the ripple counter IC3 on pin 10 and the address increments from 0000 to 0001H. This is repeated until the address reaches 07FH on the ripple counters address lines. If all locations in memory have been successfully written to and read from then the SRAM has passed the test and the green LED lights. If a single bit of the 16834 bit positions is corrupt no matter at what address location, the test fails. The entire process is repeated, but this time AAH is sent to the RAM. Each bit location therefore writes and reads a logic 1 and a logic 0.

Construction

The circuit was built on a single-sided PCB with wire links. The pads for these links must be drilled using a tungsten carbide 0.6 mm drill. The links (0.5 mm) diameter single strand wire are

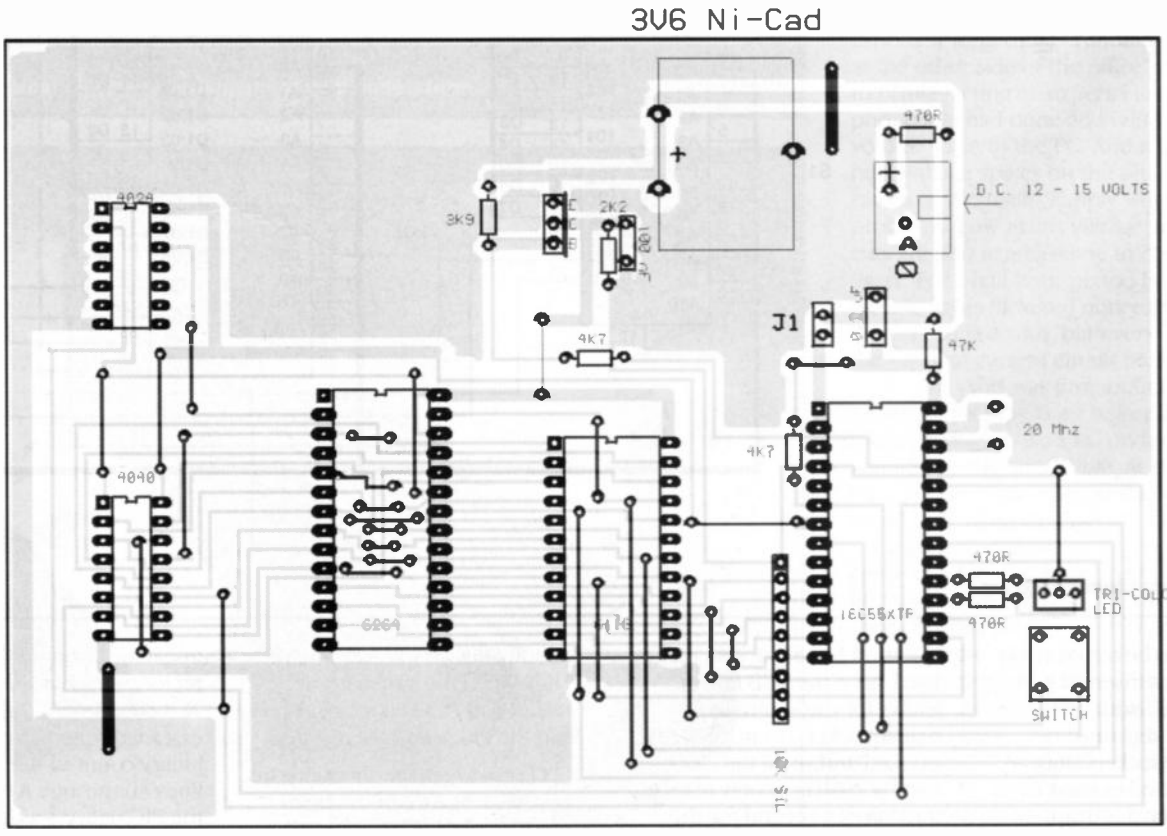


Figure 4. Component positioning.

```
LOC  OBJECT CODE     LINE  SOURCE TEXT
  VALUE

                     0001  ;RAMTEST.ASM
                     0002
                     0003  LIST p=16C55
                     0004
                     0005
0001                 0006  RTCC EQU 1 ;RTCC
0002                 0007  PC EQU 2
0003                 0008  STATUS  EQU    3     ;STATUS    REGISTER
0005                 0009  PORT_A  EQU    5     ;PORT A
0006                 0010  PORT_B  EQU    6     ;PORT B
0007                 0011  PORT_C  EQU    7     ;PORT C
  0012
  0002               0013  SCAN1   EQU    2
  0000               0014  SW1     EQU    0
  0001               0015  COUNTERS_VCC   EQU    1
  0016
  0000               0017  RLED    EQU    0
  0001               0018  GLED    EQU    1
  0002               0019  CE      EQU    2
  0003               0020  WR      EQU    3
  0004               0021  RD      EQU    4
  0005               0022  CK      EQU    5
  0006               0023  RESET   EQU    6
  0007               0024  VCC     EQU    7
                     0025
                     0026
  0017               0027  MSEC_20 EQU    017H
  0008               0028  DB1     EQU    8
  0008               0029  GP      EQU    8
  0009               0030  DB2     EQU    9
                     0031
  000A               0032  BLOW    EQU    0AH
  000B               0033  BHIGH   EQU    0BH
                     0034
                     0035
                     0036  ORG     0
0000                 0037  START
0000 0000            0038  NOP
0001 0000            0039  NOP
0002 0C01            0040  MOVLW   1
0003 0005            0041  TRIS    PORT_A
                     0042
0004 0CFF            0043  MOVLW   0FFH
0005 0025            0044  MOVWF   PORT_A
                     0045
0006 0C00            0046  MOVLW   0
0007 0007            0047  TRIS    PORT_C
                     0048
0008 0CFF            0049  MOVLW   0FFH
0009 0027            0050  MOVWF   PORT_C
                     0051
000A 0C00            0052  MOVLW   0
000B 0006            0053  TRIS    PORT_B
                     0054
                     0055
000C 0545            0056  BSF     PORT_A,SCAN1
                     0057
000D 0407            0058  BCF     PORT_C,RLED
000E 0527            0059  BSF     PORT_C,GLED
                     0060
                     0061
                     0062
000F 0C40            0063  MOVLW   .64
0010 002A            0064  MOVWF   BLOW
                     0065
0011 0C80            0066  MOVLW   .128
0012 002B            0067  MOVWF   BHIGH
                     0068
0013 0069            KEYON
                     0070
0013 092E            0071  CALL    DELAY
0014 0445            0072  BCF     PORT_A,SCAN1
                     0073
0015 0004            0074  CLRWDT
0016 0605            0075  BTFSC   PORT_A,0
0017 0A24            0076  GOTO    CONT
0018 0545            0077  BSF     PORT_A,SCAN1
                     0078
0019 0525            0079  BSF     PORT_A,COUNTERS_VCC
001A 092E            0080  CALL    DELAY
001B 05C7            0081  BSF     PORT_C,RESET
001C 04C7            0082  BCF     PORT_C,RESET
                     0083
001D 0939            0084  CALL    SWITCH
                     0085
                     0086
001E                 0087  DEBOUNCE
001E 0545            0088  BSF     PORT_A,SCAN1
001F 092E            0089  CALL    DELAY
0020 0445            0090  BCF     PORT_A,SCAN1
0021 0004            0091  CLRWDT
0022 0705            0092  BTFSS   PORT_A,0
0023 0A1E            0093  GOTO    DEBOUNCE
                     0094
0024                 0095  CONT
0024 0427            0096  BCF     PORT_C,GLED
0025 0407            0097  BCF     PORT_C,RLED
                     0098
0026 0445            0099  BCF     PORT_A,SCAN1
0027 05E7            0100  BSF     PORT_C,VCC
                     0101
0028 04C7            0102  BCF     PORT_C,RESET
0029 04A7            0103  BCF     PORT_C,CK
                     0104
002A 0C00            0105  MOVLW   0
002B 0026            0106  MOVWF   PORT_B
                     0107
002C 0425            0108  BCF     PORT_A,COUNTERS_VCC
002D 0003            0109  SLEEP
                     0110
                     0111
002E                 0112  DELAY
002E 0C17            0113  MOVLW   MSEC_20
002F 0028            0114  MOVWF   DB1
                     0115
0030                 0116  DLY1
0030 0004            0117  CLRWDT
0031 0069            0118  CLRF    DB2
0032 02E8            0119  DECFSZ  DB1
0033 0A35            0120  GOTO    DLY2
0034 0800            0121  RETLW   0
                     0122
0035 0123            DLY2
0035 0004            0124  CLRWDT
0036 02E9            0125  DECFSZ  DB2
0037 0A35            0126  GOTO    DLY2
0038 0A30            0127  GOTO    DLY1
                     0128
                     0129
0039 0130            SWITCH
0039 0525            0131  BSF     PORT_A,COUNTERS_VCC
003A 0507            0132  BSF     PORT_C,RLED
003B 0527            0133  BSF     PORT_C,GLED
003C 04E7            0134  BCF     PORT_C,VCC
003D 0587            0135  BSF     PORT_C,RD
003E 092E            0136  CALL    DELAY
                     0137
                     0138
003F 0139            CYCLE
                     0140
003F 0447            0141  BCF     PORT_C,CE
0040 0C55            0142  MOVLW   055H
0041 0026            0143  MOVWF   PORT_B
0042 0467            0144  BCF     PORT_C,WR     ;WRITE
0043 0000            0145  NOP
0044 0567            0146  BSF     PORT_C,WR
                     0147
0045 0CFF            0148  MOVLW   0FFH
0046 0006            0149  TRIS    PORT_B
                     0150
0047 0487            0151  BCF     PORT_C,RD     ;READ
0048 0000            0152  NOP
0049 0206            0153  MOVF    PORT_B,0
004A 0587            0154  BSF     PORT_C,RD
004B 0F55            0155  XORLW   055H
004C 0743            0156  BTFSS   STATUS,2
004D 0A7E            0157  GOTO    FAIL
                     0158
004E 0C00            0159  MOVLW   0
004F 0006            0160  TRIS    PORT_B
                     0161
0050 04A7            0162  BCF     PORT_C,CK
0051 05A7            0163  BSF     PORT_C,CK
0052 0000            0164  NOP
0053 02EA            0165  DECFSZ  BLOW,1
0054 0A3F            0166  GOTO    CYCLE
                     0167
0055 0C40            0168  MOVLW   .64
0056 002A            0169  MOVWF   BLOW
0057 0000            0170  NOP
0058 02EB            0171  DECFSZ  BHIGH,1
0059 0A3F            0172  GOTO    CYCLE
                     0173
                     0174
005A 0C40            0175  MOVLW   .64
005B 002A            0176  MOVWF   BLOW
                     0177
005C 0C80            0178  MOVLW   .128
005D 002B            0179  MOVWF   BHIGH
                     0180
005E 05C7            0181  BSF     PORT_C,RESET
005F 04C7            0182  BCF     PORT_C,RESET
                     0183
0060 0184            CYCLE_2
                     0185
0060 0447            0186  BCF     PORT_C,CE
0061 0CAA            0187  MOVLW   0AAH
0062 0026            0188  MOVWF   PORT_B
0063 0467            0189  BCF     PORT_C,WR     ;WRITE
0064 0000            0190  NOP
0065 0567            0191  BSF     PORT_C,WR
                     0192
0066 0CFF            0193  MOVLW   0FFH
0067 0006            0194  TRIS    PORT_B
                     0195
0068 0487            0196  BCF     PORT_C,RD     ;READ
0069 0000            0197  NOP
006A 0206            0198  MOVF    PORT_B,0
006B 0587            0199  BSF     PORT_C,RD
006C 0FAA            0200  XORLW   0AAH
006D 0743            0201  BTFSS   STATUS,2
006E 0A7E            0202  GOTO    FAIL
                     0203
006F 0C00            0204  MOVLW   0
0070 0006            0205  TRIS    PORT_B
                     0206
0071 04A7            0207  BCF     PORT_C,CK
0072 05A7            0208  BSF     PORT_C,CK
0073 0000            0209  NOP
0074 02EA            0210  DECFSZ  BLOW,1
0075 0A60            0211  GOTO    CYCLE_2
                     0212
0076 0C40            0213  MOVLW   .64
0077 002A            0214  MOVWF   BLOW
0078 02EB            0215  DECFSZ  BHIGH,1
0079 0A60            0216  GOTO    CYCLE_2
                     0217
                     0218
007A 05E7            0219  BSF     PORT_C,VCC
007B 0527            0220  BSF     PORT_C,GLED
007C 0407            0221  BCF     PORT_C,RLED
                     0222
007D 0800            0223  RETLW   0
                     0224
                     0225
007E 05E7            0227  BSF     PORT_C,VCC
007F 0427            0228  BCF     PORT_C,GLED
0080 0507            0229  BSF     PORT_C,RLED
0081 0547            0230  BSF     PORT_C,CE
                     0231
0082 0800            0232  RETLW   0
                     0233
                     0234
                     0235
                     0236
                     0237  ORG     01FFH
01FF 0A00            0238  GOTO    START
                     0239
                     0240  END
                     0241

SYMBOL               TABLE

LABEL                VALUE

BHIGH                000B
BLOW 000A
CE   0002
CK   0005
CONT 0024
COUNTERS_VCC         0001
CYCLE                003F
CYCLE_2              0060
DB1                  0008
DB2                  0009
DEBOUNCE             001E
DELAY                002E
DLY1                 0030
DLY2                 0035
FAIL                 007E
GLED                 0001
GP 0008
KEYON                0013
MSEC_20              0017
PC 0002
PORT_A               0005
PORT_B               0006
PORT_C               0007
RD 0004
RESET                0006
RLED                 0000
RTCC                 0001
SCAN1                0002
START                0000
STATUS               0003
SW1                  0000
SWITCH               0039
VCC                  0007
WR 0003
__16C55              0001
```

Source code Listing.

inserted as follows:

- Cut a length of wire approximately twice the length of the link.
- Insert one end of the wire through one of the connecting pads so that the wire protrudes about 3 mm and solder in place.
- Pull the wire taught and grip the wire with long nose pliers at a point 1/8 of an inch beyond the second connecting pad and bend the wire at a right angle.
- Insert the wire through the pad, solder and cut off the excess.

After inserting all IC sockets, it is worth performing a continuity test of all connections marking off the connections on the circuit diagram as you progress. A visual inspection should locate any solder bridges between pads and tracks - easily done, especially areas where the tracks traverse between the IC pads !

A 4MHz or 20MHz crystal may be used but the high speed PIC must be used for the 20MHz clock. This is available pre-programmed from the author. Please see note in parts list.

Insert all passive components and the battery. Now check for voltage on the PIC socket (pins 1 and 2). Using a piece of wire, connect pin 25 on the PIC socket to ground. Battery voltage should now appear on pins 24 of RAM socket S1 and pins 26 and 28 of RAM socket S2. Disconnect this wire.

Remove jumper J1 and insert all the ICs, and the PIC. Now insert J1 and press switch SW1. The red LED will light (no RAM in socket). If nothing happens, then its time for some debugging. Since the firmware executes in a fraction of a second a long (say 50ms) delay routine is inserted in the main loop of the program. The source code is then re-assembled and now there will be sufficient time for a logic probe to be used. Note that a separate 5V supply is required for the logic probe with a common ground 0V connection. The following can now be checked:

1. A clock on pin 23 IC1.
2. A clock on pin 22 IC1.
3. A clock on pin 21 IC1.
4. Activity on these lines will indicate that the clock, read and write lines are active.
5. A divide-by-2 clock on successive lines A0 - A12. i.e. a halving of frequency as the logic probe is moved up the address lines. Finally, remove the delay routine and reassemble the source code.

PROJECT PARTS LIST

RESISTORS		
R1	47K Min Res	M47K
R2, 6	4K7 Min Res	M4K7
R3, 4, 9	470R Min Res	M470R
R5	3K9 Min Res	M3K9
R7	2K2 Min Res	M2K2
R8	10K SIL Array	RA30H
CAPACITORS		
C1, 2	100nF Mylar	WW21X
SEMICONDUCTORS		
Q1	BD140	QF08J
IC1	PIC16C55HSP (See Note)	
IC2	4024	QX13P
IC3	4040	QW27E
MISCELLANEOUS		
Xtal1	4MHz for PIC16C55XTP	FY82D
	or 20 MHz for PIC16C55HSP	UJ09K
Batt	3.6V NiCd Battery	BN24B
	24 pin turned pin socket	FJ67X
	28 pin turned pin socket	FJ68Y
	0.1 inch header and jumper	JW59P/UL71N
	tricolor LED	GW62S
	Push to make switch	KR88V
	Power socket	As Reqd.

NOTE

A Preprogrammed PIC (20MHz) is available from the author priced £13.50 including P&P at:R.Grodzik (MICROS), 53 Chelmsford Road, Bradford, West Yorkshire BD3 8QN.

COMMENT

by Keith Brindley

Multiprocessing is the key word these days in computer processor manufacturing circles. Its very mention is sufficient to create stand-up rows between processor engineers. Nobody in the business seems to be open-minded about it, and everyone has an opinion as to which way to go.

I'll explain what the controversy over multiprocessing is shortly, but first a potted history. Since computers were first developed there have always been arguments over the type of processor to use. Most PCs (indeed, any that run DOS or Windows operating systems) use what's now known as a complex instruction set computing (CISC) processor - a device that is able to utilise a large number of programmable instructions to do a large number of tasks. Effectively, designers create a list of possible instructions that matches the list of possible tasks the processor could be called upon to do. Other PCs, though, use what's called a reduced instruction set computing (RISC) processor - which uses a small number of instructions to build more complicated instructions to fulfill the same large number of tasks. The basis of this is that for 90% of the time processors are used to perform just 10% of their possible instruction set. By clearing out the 90% of rarely-used instructions, RISC-based processors gain a useful simplicity.

While the majority of PCs are based on CISC processors, RISC computers have certain advantages in the short term. They are considerably less complex as they use fewer transistors, so are smaller. As a result they generate less heat, they are generally faster, and they are cheaper to make.

Several computer manufacturers have exploited the RISC advantage, in both high-end workstation computers, as well as more mainstream personal computers. However, as the bulk of the computer market is based on the Windows operating system - which as far as the PC is concerned currently runs exclusively on CISC processors - this advantage hasn't been properly taken up, apart from a few notable exceptions. Future generations of processors are about to amplify this difference, simply because processors are becoming increasingly complex. In the dim past, a processor with ten thousand transistors was considered large. Now processors with millions of transistors are the norm. In a couple of years time, hundreds of millions of transistors will be supported on next-generation processors. Intel - the manufacturer of processors that the Windows operating system works on - is virtually throwing transistors at its next-generation processor (codenamed Merced). Interestingly, Merced is loosely based on RISC principles, but has in-built into it some CISC-style complexity of its own. Depending on how you look at it, Merced is therefore the best or the worst of both worlds. For all its complexity, Merced is likely to outperform current generations of standard RISC processors by around 30%, although it brings with it the standard CISC disadvantages of higher costs, greater heat, and larger size.

Processors in general are becoming more and more complex, and this trend will obviously continue. Personal computers are generally accepted to have a lifespan of only a few short years: it's a vicious circle - design better processors and more complex software can be designed for them; more complex software requires better processors, and so on. It's this that keeps sales of computers up year after year, and this that drives the designers of processors onwards to each new generation of device.

Concurrent with this complexity increase, processor designers are turning their attention to multiprocessing as an architecture for future computers - where a computer contains more than one processor working in parallel to undertake tasks. There are two main ways that multiprocessing can work. First is a method that simply uses more than one complete processor device side-by-side. Effectively, you just use two or more processor chips to form your multiprocessing computer. This method works reasonably well and several computers are available that work in this way. For want of a better term, computers built on this principle can be called multiple, single-stream processors. A second method of multiprocessing however is to build a single processor device that houses more than one internal processing engine. Using the same terminology as before, such a device could be called a single, multiple-stream processor.

There are advantages and disadvantages to each approach. Multiple, single-stream processors are obviously easier to create - just take a few ready-built processors and put them together to form a single computer. Multiprocessing computers based on Merced will probably work this way. Single, multiple-stream processors, on the other hand (particularly if they're RISC processors), will be far smaller, generate less heat, and be significantly faster. However, there's a limit to how many multiple-stream processors you can get onto a single device.

There's little doubt that the benefits of multiprocessing are huge, and have yet to be fully realised. The downside is that it takes an operating system properly capable of controlling multiple processors to reap the real rewards multiprocessing offers. Windows doesn't support multiprocessing at all yet, and it's generally accepted that it will be three to four years before it can do so effectively. So even with Merced, which will probably allow multiple, single-stream processing when it sees the light of day, the multiprocessing advantage won't be immediately available.

On the other hand, it's not too big a job to create single, multiple-stream processors from existing RISC designs. And operating systems to drive multiprocessing RISC architectures already exist (or at least, are in final developmental stages). Apple's Mac OS X (pronounced 'oh ess ten' will be able to do this on its release at the end of this year. This provides an interesting window of opportunity for Apple and its processor developers, Motorola and IBM. The RISC processors Apple already uses in its Mac range of PCs already beat Intel's Pentium processors in Windows-based PCs, in terms of performance (the iMac's 333 MHz PowerPC RISC chip easily beats Pentium 450 MHz CISC devices). A proper multiprocessing operating system such as OS X, coupled with single, multiple-stream processors such as next-generation PowerPC RISC devices could effectively see a 200 to 400% performance increase over Merced-based Windows PCs. Of course, it is easy to sit here and say how things should go. There's an awful lot of things that can go wrong, too, though. Still, the next year or so will be an interesting time in the multiprocessing PC world.

WHY ARE WE

Graham Marett philosophises and discusses the

Modern techniques of graphics and image manipulation have become so sophisticated that we have grown accustomed to the idea of media reports being accompanied by high quality pictures. Recent advances have enabled the interested amateur to produce work of a quality only available before to professionals

Being constantly exposed to a wide range of high quality images can perhaps give us a somewhat jaded point of view, but once in a while an image is published which causes us to catch our breath and reflect on our own humanity. It is rare for science to yield such powerful images, but few of us can fail to have been moved by some of the astonishing images of the universe revealed by the Hubble Space Telescope.

Of the many stunning Hubble images one in particular has captured my own imagination in a way that few astronomical photographs have achieved: the Hubble 'Deep Field' (reproduced in the May issue of *Electronics and Beyond* to accompany Douglas Clarkson's article on the mysteries of the universe). At first glance this image seems unremarkable: just a picture of a bunch of galaxies, the likes of which we are accustomed to seeing in many books and magazines on astronomy. Why is the deep field so special?

The image, actually built up from over 300 separate exposures during hundreds of Hubble orbits over a ten day period, is of a carefully chosen part of the sky offering a 'window' through regions of bright stars and known galaxies into the most remote parts of the universe. Covering less than one fifteen-millionth of the sky the image shows thousands of galaxies close to the edge of the known universe, and is a forceful reminder that our universe is populated by many billions of galaxies, each composed of billions of stars. Such a concept must cause even the most cynical amongst us to pause for thought and reflect on our own place in the universe, especially

Weak Anthropic Principle (WAP): The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirements that there exist sites where carbon-based life can evolve and by the requirements that the Universe be old enough for it to have already done so.

So the Weak Anthropic Principle basically says that observation can only be made if intelligent life exists to do the observing.

Strong Anthropic Principle (SAP): The Universe must have those properties which allow life to develop within it at some stage in its history. Because:

1. There exists one possible Universe ' designed' with the goal of generating and sustaining 'observers'. Or...
2. Observers are necessary to bring the Universe into being (Wheeler's *Participatory Anthropic Principle (PAP)*). Or...
3. An ensemble of other different universes is necessary for the existence of our Universe (which may be related to the Many World interpretation of quantum mechanics).

And the Strong Principle says intelligent life must exist.

Final Anthropic Principle (FAP): Intelligent information-processing must come into existence in the Universe, and, once it comes into existence, it will never die out.

And so, the Final Principle says it must continue for ever.

HERE?

Anthropic Principle.

when coupled with recent research showing that many if not most stars are likely to be accompanied by planetary systems.

As Douglas Clarkson suggested in his article, deep issues such as the origin and nature of life, human consciousness and the universe itself lie in the domains of religious and philosophical thought as well as in the fields of scientific observation and theory. If we are to consider the philosophical as well as the scientific implications of the role of humanity in the universe, we should perhaps start with a purely philosophical question:

Are We Here?

Such a question may seem trite and pointless, but it was the great seventeenth century French mathematician and philosopher René Descartes who first explored this idea in depth when he asked himself how he could tell for certain that his waking thoughts were not a dream.

His *First Meditation*, published in 1641, contained classic philosophical arguments which are still debated today. Descartes started by rejecting his own beliefs and opinions, and then attempted to construct a view of the world built only on hard logical considerations. He soon realised that he had no 'proof' of the existence of anything, and speculated on the possibility that an omnipotent God had implanted in his mind the images of earth and sky (and Hubble photographs?) that made up his conscious and unconscious thoughts.

Cogito ergo Sum ('I think therefore I am') was Descartes famous conclusion that the only thing he could be sure about was the existence of his own mind. All knowledge about the external world was fed to his mind by his senses, which could not always be trusted and which could not guarantee a clear distinction between reality and dreams. The bizarre possibility that he himself might be a character in someone else's dream does not seem to have occurred to Descartes!

It is tempting to dismiss such outlandish thoughts as nonsense only worthy of those individuals lacking more 'serious' matters to occupy their minds, but in the small hours of a sleepless night such philosophical musings can nag at the mind and demand consideration. Readers interested in pursuing such ideas may like to try the surprise best-seller of 1995 by Jostein Gaarder, *Sophie's World*. Apart from being an entertaining yarn with an unexpected twist in the tail Gaarder's book provides a lucid introduction to philosophy in general.

Descartes 'dream-world' may offer an easy escape from the need to explain the nature of the universe (after all, if the universe we perceive is just a figment of our overworked imagination, who needs scientific explanations?), but common sense tells us otherwise. However, 'common sense' itself may be suspect: Einstein was well aware that relativity theory seemed to defy common sense, but he pointed out that 'common sense is that layer of prejudice laid down in the mind prior to the age of 18'. We should perhaps make our escape from these philosophical entanglements and hastily move on after making the tentative assumption that we live in a 'real' universe after all!

Where is Here?

The combination of dull British weather and bright modern street lighting seem to conspire to deny us good views of the night sky most of the time. However on a clear, moonless night the vault of the heavens is still a magnificent sight, with many wonders to be seen.

But just how far into the universe can we see? If, like most of us, you live in or near a suburban area, your view of the night sky will reveal several hundred stars grouped into the familiar constellations. Everything you see lies within a radius few thousand light years, which is an awe-inspiring distance when you consider that it takes only about 8 minutes for light to reach us from our own sun.

However on an astronomical scale this distance is puny: our own Milky Way galaxy is estimated to be about 100,000 light years in diameter, and the great spiral of Andromeda is over 2 million light years from us. If you are fortunate enough to observe the sky from a remote mountain far from city lights you can enjoy the spectacle of the faint band of the Milky Way, composed of hundreds of thousands of stars, and if your eyes are sharper than mine you may make out the faint misty patch of the Andromeda galaxy (best viewed through binoculars or a small telescope).

Big telescopes, and of course the Hubble Space Telescope, can peer billions of light years into the outer reaches of the universe, and see such wonders as quasars and gamma ray bursters (recently reported as the brightest objects ever observed, although sadly not visible to the unaided eye) at the limits of the observable universe.

The image of the universe built up in this way appears to be uniform in all directions, leading to the illusion that we are at the centre of things with quasars close to the 'rim' of the universe. This is a false impression, and the universe would almost certainly appear to have the same large-scale structure from whatever point it was viewed (and perhaps it is being viewed from other vantage points by sentient beings in some remote galaxy!)

When Are We Here?

We are fortunate to live on the surface of a planet which is hospitable to life in many ways (age, chemical composition,

temperature range, atmospheric protection from harmful radiations, amongst other considerations). I shall leave aside for the moment the possibility of other kinds of life which may have evolved under very different conditions (*'It's life, Jim, but not as we know it'* to quote the famous phrase from *Star Trek!*)

Apart from our special location in space, it has been pointed out that our location in time is also critical in a fundamental way. Astrophysicists are in broad agreement that the universe originated some ten to fifteen billion years ago with the Big Bang, and has evolved over time to its present state. This 'evolution' of the universe included the coming into existence of the forces of nature which we now take for granted (gravitation, electromagnetic and nuclear forces), as well as the creation of atoms themselves. In particular the 'heavy' elements which are vital to life (carbon, oxygen, nitrogen and many more) did not exist in the early universe, but required the complex physics of nuclear fusion for their synthesis in the interior of stars.

It can be argued that the exceedingly improbable events leading to the formation of conscious life were only possible at all after the universe itself had evolved to a certain state. Furthermore, the time it has taken for life to evolve from primitive microbes to conscious beings coincides almost exactly with the stable lifetime of our own sun. In 1983 the astrophysicist Brandon Carter delivered a lecture to the Royal Society in which he drew attention to this remarkable 'coincidence', pointing out that intelligent beings can only observe a universe which is conducive to their own existence, and so should not be surprised to find that things are the way they are.

Anthropic Principle

This linkage between the properties of the universe and our own existence as conscious observers was called the anthropic principle (*anthropic:* of or pertaining to human beings) by Carter, who introduced the term ten years before his Royal Society lecture. It implies that our own existence necessarily imposes certain constraints on how the universe could have evolved.

This idea may seem rather self evident, but Carter pushed the concept further by arguing that humanity was likely to be a short-lived phenomenon in a universe which only offered a brief 'time-window' conducive to the existence of conscious beings. This is highly speculative science, and the idea that we can make meaningful predictions about life in the universe millions or even billions of years in the future strikes most scientists as absurd.

Weak and *Strong* Anthropic Pricinciple

Carter's original (and to many people trivial) version of his principle has been called the *weak* anthropic principle, in contrast to a more controversial form known as the *strong* anthropic principle which has been proposed by some physicists and cosmologists.

Could we be Elsewhere?

Can we imagine a universe in which conditions would *not* allow the existence of conscious life? Fantasy is a common and natural part of our mental processes, and much of our cultural heritage of art and literature is built on fictional ideas. We all regularly indulge in daydreams and the construction of 'what if' scenarios as part of our everyday lives. But does it make sense to fantasise an entire universe devoid of life? This is a complex philosophical question, but mathematicians have pointed out that there is no *logical* reason for other kinds of universe not to exist.

The strong anthropic principle builds on this idea, arguing that other universes can and probably do 'exist' (whatever the word means in this context), but that our own existence in the particular universe we inhabit is due to the fact that the properties of our universe are 'just right' for conscious life to have evolved. This argument may seem tautological (shades of the mindless football crowd chant *'We're here, because we're here, because we're here, because we're here!'*), but it can be pursued even further to imply that in our universe the evolution of conscious life was inevitable.

Perhaps the best objection to the strong anthropic principle is the philosopher's tool known as Ockham's razor (from the medieval scholar William of Ockham). This principle states that we should not suppose the existence of things which are not required to explain the observed facts (incidentally, Ockham's razor is also a powerful tool against pseudoscience of all kinds). But don't forget Einstein's corollary: 'Everything should be made as simple as possible, but not simpler'!

So Why are we Here? - Participatory Anthropic Principle

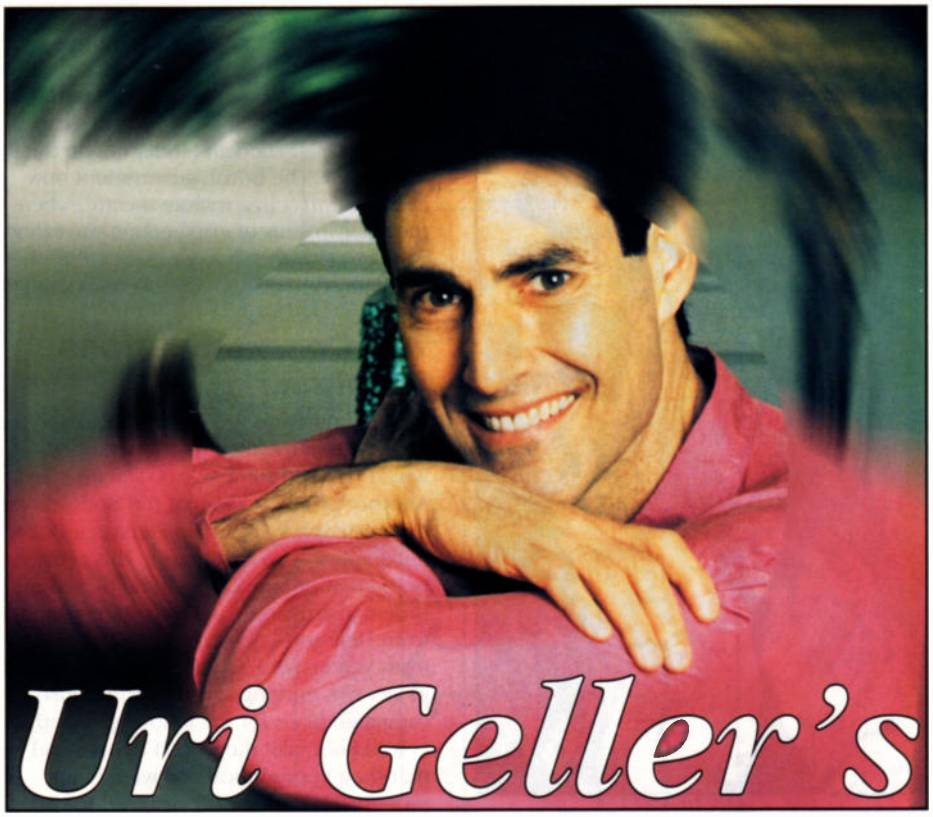
If the premises of the strong anthropic principle are dubious, then the even stronger claims (sometimes known as the 'participatory' or 'final' version of the anthropic principle) made by some thinkers are speculative science at its worst.

In this illogical version of the principle the universe (or some higher sentient being) must have 'known we were coming' (as it has been put by Freeman Dyson), which is why the conditions in the universe have worked so nicely to our advantage. Such an extreme view of the origin and nature of the universe cannot be tested in any way, nor can any meaningful scientific theory be linked to such a view. Even most orthodox religious thinkers would hesitate to suggest that the universe was prepared in advance for our arrival like some biologist's culture dish on a cosmic scale.

Modern cosmology is highly mathematical, and current thinking on the mathematical marriage of the two pillars of modern physics, quantum theory and relativity, seems to indicate that things are the way they are because they could not logically be any different. We are of course left with the uncomfortable thought that logic itself may be suspect (certainly the rules of logic seem to be suspended in my own dreams, so perhaps Descartes dream-universe is devoid of logic?)

As is so often the case with the 'big issues' of science we seem to have come full circle, and see that scientific theory must once again grapple with philosophical and theological fundamentals. Of all the wonders of the universe our own consciousness is the greatest mystery of all, a magical gift which allows us to reflect on our own existence and our place in the cosmos. It is an ironic thought that our minds allow us to question and suspect the integrity of the very universe which led to the origin of mind itself. ELECTRONICS

Hubble Telescope picture of stars forming in the Eagle Nebula (about 7000 light years away). Courtesy NASA STSC.



Uri Geller's EXTENDED REALITY

Can Animals Predict Earthquakes?

I was in Cyprus a few years ago, giving a talk in a Nicosia hotel, when the big chandelier in the middle of the room suddenly began to shake and tinkle. Some people in the audience told me later they thought - at first - it was another example of my powers in action, but luckily we all soon realised what it was, especially when the wall began to crack: an earthquake. It was the second one I had been in, and I missed a third by only a couple of days, and it made me interested in looking for ways in which they can be predicted. The tragedy is that while a major quake can kill thousands of people in a few seconds, just a few minutes' warning would mean that people could get out of doors and very probably survive.

To my surprise, I found that there are several ways in which earthquakes have been correctly predicted, both by machines and people, and also by several kinds of animals, birds and fish. The earliest report I have found dates from 1835, when a British meteorologist named Robert Fitzroy, on a visit to a town in Chile, saw a huge swarm of screaming sea birds flapping around as if in a panic. Then all the dogs seemed to be rushing out of their houses. Ten minutes later, an earthquake flattened the whole town.

Exactly a hundred years later there was a huge quake in India when 50,000 people died in the town of Quetta. Among the survivors were the soldiers and airmen from the large British military base, and many of them had premonition stories to report. One had noticed birds hopping around on the ground a few hours before the quake and avoiding their usual tree perches. Another was woken up by the persistent whining of his dog, who may have saved his master's life since he was wide awake at three in the morning and was able to get outdoors in time. A six-month-old baby saved his own life by yelling and screaming until his parents carried him to their bed - half an hour before a falling beam flattened his empty cot. He had never cried at night before, they noted.

One distinguished survivor of the Quetta quake was the future Viscount Montgomery of Alamein. About four hours before the blast, his wife Betty was doing some silk embroidery when she noticed the silk had suddenly gone rigid. She thought this odd, and a dinner guest thought it might be something to do with electricity in the air, as indeed it was.

Nature seems to send out all kinds of early-warning signals before earthquakes, and some of these have been instrumentally recorded. In 1964, it happened that a magnetometer was running in a lab close to the epicentre of the massive quake that destroyed Kodiak, Alaska. Its chart, which was retrieved from the wreckage, showed a sharp and sudden increase in the intensity of the geomagnetic field about an hour before the event.

This was published in the journal Nature, and the same thing happened about thirty years later when a Californian scientist obtained a similar recording. This was announced on the BBC Tomorrow's World programme as if it was a new discovery. Clearly, the idea of magnetic monitoring is taking time to catch on, although it seems a fairly simple process.

It is certainly one that many animals already know about. In Japan, they have been studying the behaviour of fish just before earthquakes, and have noted several forms of unusual activity. Deep-sea fish come to the surface, smaller ones look for shallow water, and sometimes whole shoals simply clear off altogether. A scientist has observed octupuses staggering ashore 'as if drunk', as he put it.

At Stanford University in California, scientists have studied the behaviour of chimpanzees during pre-quake periods and noted a correlation, though as far as I know they have not been able to predict any specific event. Russians believe that if you find a snake frozen to death it means there is a quake coming and the snake knew it.

Perhaps we should also be studying ducks. In the city park of Freiburg in Germany there is a statue of one with its head in the air, beak pointing upwards. It is a memorial to the night in 1944 when a duck woke up the whole neighbourhood with its frantic quacking. For some mysterious reason this was taken as an air-raid warning, and many headed for the shelters. Many who did not were killed, as was the heroic duck. Wreaths, I am told, are still being laid at the statue.

So we have plenty of data, but still no dependable way of predicting the exact time and place of a quake (or an air raid). The Chinese made a breakthrough when they did make a successful prediction in 1975 when, after noting changes in well water levels, geoelectric currents and animal behaviour, they evacuated the area of Liaoning, province just in time. However, you cannot win them. all. The people of Beijing were kept out in the open for several days waiting for a quake that never happened, and the authorities were unable to do anything, about the Tangshan eruption, the worst in terms of loss of life for over 300 years.

Even so, I can't help feeling that it should be possible to design a reliable earthquake prediction system. It would have to be a multi-disciplinary operation, making use of everything from sunspot readings, geoelectric and magnetic measurements and radon emission detectors to careful study of animal activity.

And when they build the station, I hope they don't forget the silk curtains and the duckpond.

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**

Figure 1. Signalling by Heliograph, South Africa, 1899. Courtesy National Army Museum, Chelsea, London.

The First RADIO WAR

Gregg Grant recounts how the Boer War was to see the introduction of radio communications in to the armed forces.

Introduction

A century has passed since the Boer War broke out in October, 1899. This conflict has been termed The Last of the Gentlemens' Wars, and whilst the description may well be true in the light of subsequent conflicts, it was also the first Radio War.

Shortly after the conflict began on the 11th October 1899, the Marconi Wireless Telegraph and Signal Company '. . suggested to the military authorities that wireless telegraphy should be used for ship-to-shore operations at Cape Town, Durban and other ports of disembarkation.'[1]

Trouble with the Telegraph

The reason the Company had put forward this suggestion was simple: shipping congestion in the roadsteads. This was hardly surprising, given that Britain was in the process of shipping some 250,000 regular troops to the conflict. There may, however, have been another reason: the perceived inadequacies of that jewel in the British communicative crown, the telegraph.

Towards the end of May 1899 the British High Commissioner in South Africa, Sir Alfred Milner, had been holding talks in Bloemfontein on the future of the Transvaal with the President of the Boer Republic, Paul Kruger.

However, Milner's '. . dependence on the telegraph system . . . and its not entirely satisfactory nature as a medium for conveying the subtleties of diplomatic thinking on which lives depend - was demonstrated by the part it played in the events leading up to the outbreak of the South African War.'[2]

After six days of talks, each man turned down the proposals of the other. Milner, without troubling to cable London, promptly declared the meeting terminated. Yet the Colonial Secretary, Joseph Chamberlain, had already dispatched a cable to Milner, requesting he do nothing in haste.

Milner did not respond to this request for a week, his reply admitting that he had made a mistake in breaking off negotiations. He further apologised for the fact that London and the Cape had been at cross purposes, but nevertheless felt that this state of affairs was inevitable, given the fact that one couldn't explain everything in a cable.

The Boers issued an ultimatum on the 9th of October. The British government now faced a conflict in a remote theatre, where their only means of instant communication wasn't exactly the strategic asset either the Admiralty or the War Office were looking for.

The Communications Problems

The first problem facing the British was the sheer size of the theatre of operations, which covered some 600,00 square miles. Another problem was that the Boers tapped the telegraph lines. Philip Pienaar, a Boer telegraphist who took part in this activity, noted that on one occasion he picked up orders instructing '. . Hamilton to march from Heilbron . . Broadwood . . to move from Ventersberg.'[3] What he'd tapped into in fact was nothing less than the British campaign plans for the following month!

It did not take the British long to find out that their communications were being monitored. They swiftly resorted to codes, for the simple reason that a total ban on the use of the telegraph would have irreparably crippled the army's command structure.

At the beginning of the war however '. . officers relied on the heliograph, a method of signalling with mirror-directed sunlight, which depended on the weather and could be seen by the Boers.'[4]

This equipment is shown in use in Figure 1. The instrument - similar to the heliostat - was used to reflect the sun's rays in a continuous beam, so as to enable a location to be sighted over a long distance in - for example - surveying. The signalling version used two adjustable mirrors, the beam being interrupted by a key-operated shutter, thus creating the dots and dashes of the Morse Code. The climate of South Africa - sunshine and a clear atmosphere - was ideal for this type of communication, which reached a level of effectiveness and efficiency which it had rarely reached before. Indeed the South African War was the apogee of the heliograph as a signalling instrument.

The New Communications

A year before the conflict broke out, '. . Marconi had developed his wireless telegraph to the point when it was possible to give a demonstration to parties likely to be interested.'[5] The demonstration took place on that great British military hearthrug, Salisbury Plain, in front of representatives from the two armed services and the Post Office.

The Royal Engineers representative put in a report which impressed his superiors, so much so in fact that they swiftly established an experimental wireless telegraphy unit at Aldershot. Indeed the first sales of '. . equipment by the Marconi company was to the British War Office in 1898,'[6] and by 1900 the military '. . had evolved their own first army trial wireless set.'[7]

In fact both sides were well aware of the potential of wireless telegraphy. On December 9th 1899, the New York Herald newspaper ' . . reported that British forces in South Africa had captured from the Boers some wireless equipment which had been made in Germany and closely resembled Marconi apparatus.' " However, the new wireless telegraph equipment - which had so impressed the Royal Engineers - proved to be a total failure. Why?

The military authorities took the advice of the Marconi Company, up to a point. They dispatched sufficient equipment for the setting up of five radio stations in the theatre of operations, along with engineers to install, commission and operate them.

By the time the equipment and personnel had arrived at the Cape however, the military had changed both their minds and their plans, an indication in itself of how crucial accurate, immediate communication was in a situation such as the one evolving in South Africa.

They promptly asked the engineers to volunteer for military service in the war zone. In short order, each engineer found himself in charge of a small communications unit, comprising troops from the Telegraph Section of the Royal Engineers and a horse-drawn wagon - similar to the Cable Wagon shown in Figure 2 - for the radio equipment.

The power supplies for these radios were large-capacity dry batteries and jelly accumulators. The masts - provided by the War Office - turned out to be jointed, bamboo rods some 50 feet in length and each communications unit was also supplied with two, six-foot linen Baden-Powell box kites.

From the outset however the new technology ran into problems, some of which it was already becoming familiar with but could - at this time - do little about, such as static interference. At Kimberley for example, static discharges were a major headache, drastically reducing the sensitivity of the coherers. The static was but one result of fierce dust storms, which tore down the bamboo masts and rendered the kites ineffective, for it proved impossible to synchronise them in the air at different locations at the same time.

Consequently the kites were replaced by 14-foot balloons, but they too succumbed to the high winds and the dust, they being set adrift almost as soon as they were erected. In the course of a six-week trial under a Royal Engineers officer, Captain J.N.C. Kennedy, the radio stations were faulty for half of the time.

Marconi defended his engineers and their equipment. In a paper he read to the Royal Institution in February 1900, he criticised the War Office for the unsuitable masts they had supplied. Ten days later, the Director of Army Telegraphs ordered that the Kimberley line of radio stations be dismantled!

Where the army gave up, the Admiralty moved in, requesting the use of three of the army sets, which they installed in their vessels on blockade duty in Delagoa Bay. In fact, the navy ended up with all of the army's Boer War radio equipment, which was used successfully at sea for a number of years.

The Aftermath

The South African War was a watershed, in communications as well as in other military matters. Four years after the peace agreement ending the conflict, the War Office set up a committee to look into the army's communications service. The committee's report made some far-seeing recommendations, among which was the creation of a Director of Telegraph and Signalling and the formation of a Signals Service. As so often in the past - not to mention the future - financial constraints put a limit one what could be achieved.

However, by 1910 the word 'Telegraph' had been replaced in army parlance by 'Signal' and two years later the expression 'Wireless' was officially recognised with the creation of a wireless company. In 1913 training was put on a more intelligent footing with the amalgamation of the Telegraph School - based at Chatham - and the Army Signal School at Aldershot.

As to equipment, the new arm was still using that employed against the Boers, such as Wheatstone automatic telegraphs and Magneto telephones, augmented by buzzer telephones in the forward areas for linemen and the artillery. Visual signalling was still very much an option, flags and heliographs being used by day, Begbie lamps by night.

However, wireless equipment remained, so far as the army was concerned, untrustworthy from a security point of view and unreliable from a technical angle. Consequently, what little radio equipment was available on the outbreak of war in 1914 was allocated to the cavalry!

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3: Lee, Emaneol (1985): To *The Bitter End: A Photographic History of the Boer War,* Viking Penguin Books Ltd., Harmondsworth. Page 33.

4: Ibid [3], Page 32.

5: Wedlake, G.E.C. (1973): *SOS: The Story of Radio Communication,* David & Charles, Newton Abbot. Page 89.

6: Aitken, H.G.J. (1976): *Syntony & Spark: The Origins of Radio,* John Wiley & Sons, London. Page 232.

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8: Op. Cit. [5], Page 90.

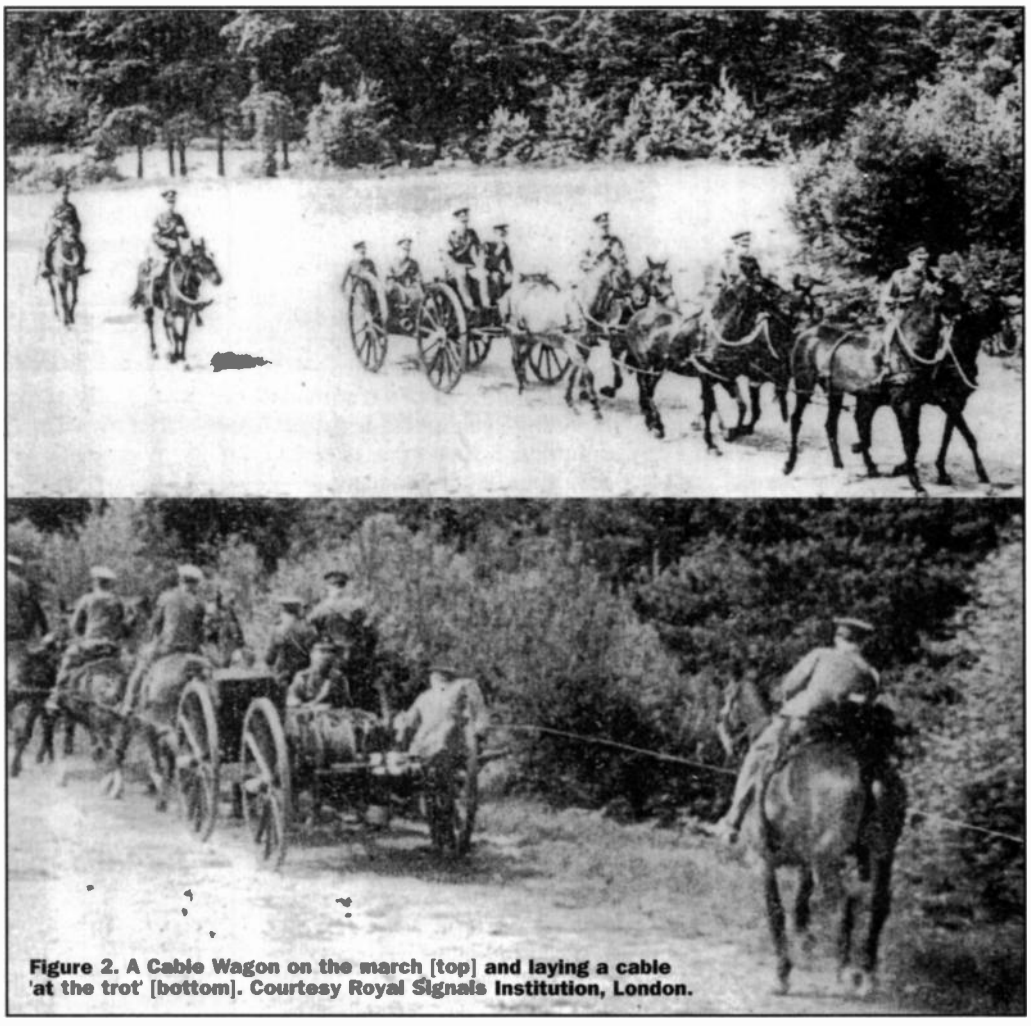


Figure 2. A Cable Wagon on the march [top] and laying a cable 'at the trot' [bottom]. Courtesy Royal Signals Institution, London.

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.

June 1999

5 to 9 June. Application Development '99, Queen Elizabeth Conference Centre, London. Tel: (01306) 631331.

7 to 11 June. 16th International Teletraffic Congress, IEE, Edinburgh International Conference Centre. Tel: (0171) 240 1871.

8 June. Internet Seminar, Star, London. Tel: (01285) 884422.

8 to 10 June. Environmental Technology Show, NEC, Birmingham. Tel: (0181) 910 7732.

12 to 15 June. Seventh International Conference on Image Processing and its Applications, Manchester. Tel: (0171) 240 1871.

12 to 15 June. Seventh International Conference on Image Processing and its Applications, Manchester. Tel: (0171) 240 1871.

16 to 17 June. Business Intelligence '99, Olympia, London. Tel: (0181) 879 3355.

21 to 23 June. People in Control an International Conference on Human Interfaces in Control Rooms, Cockpits and Command Centres, IEE, University of Bath. Tel: (0171) 240 1871.

29 June to 1 July. Networks Telecom, National Exhibition Centre, Birmingham. Tel: (0181) 742 2828.

30 June to 4 July. BBC Tomorrow's World Live, Earls Court, London. Tel: (0171) 402 2555.

July 1999

6 July. Internet Seminar, Star, Old Trafford, Manchester. Tel: (01285) 884422.

26 to 28 July. Third International Conference on Advanced A/D and D/A Conversion Techniques and their Applications, University of Strathclyde, Glasgow. Tel: (0171) 240 1871.

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

1 to 3 Sept. Ninth International Conference on Electrical Machines and Drives, Canterbury Christ Church College. Tel: (0171) 240 1871.

7 to 10 Sept. Ninth International Conference on Artificial Neural Networks, IEE Conference on Artificial Neural Networks, University of Edinburgh. Tel: (0171) 240 1871.

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

28 to 30 Sept. Document and Workflow Management '99, Olympia, London. Tel: (0171) 620 3636.

29 to 30 Sept. Softworld in Accounting & Finance - Autumn '99, National Exhibition Centre, Birmingham. Tel: (0181) 541 5040.

October 1999

6 to 8 Oct. Database Expo '99, National Exhibition Centre, Birmingham. Tel: (0171) 620 3636.

6 to 8 Oct. Information Management Events '99, National Exhibition Centre, Birmingham. Tel: (0171) 620 3636.

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?

3Com Sees Further Increasing E-Business Demand

3Com Chairman Eric Benhamou believes that the rapid deployment of broadband connections to Internet users and the media-rich applications the connections enable will generate millions of new customers seeking to conduct online commerce.

"High bandwidth technologies, like broadband, make shopping online a more informative experience and economical choice, and will create an exploding opportunity for businesses with the right strategy and model," said Benhamou during a presentation at the end of April to the FORTUNE/Stanford Graduate School of Business Summit on the E-Corporation.

3Com is a leader in broadband technologies that enable all communications traffic including networking data, voice, and video to run over a single wiring infrastructure, including coaxial cable and telephone lines.

According to a recent study by Merrill Lynch, online business-to-consumer transactions are expected to rise to between £21 billion and £43 billion by 2002, up from about £5 billion a year in 1998. 3Com estimates that the installed base of broadband subscribers will increase from approximately two million this year to more than 14 million by 2002.

"As the network infrastructure expands, the scope and impact of e-business will grow accordingly," Benhamou said. "For example, handheld Internet access through products like the PalmVII wireless connected organiser will further push the boundaries of e-commerce by providing instant access to Internet data."

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

Contact: 3Com, Tel: (0118) 927 8200.

Blair Welcomes Oracle Investment

Prime Minister Tony Blair has welcomed an investment of £6 million from Oracle Corporation's chief executive, Larry Ellison, to help UK school children learn through Internet technology.

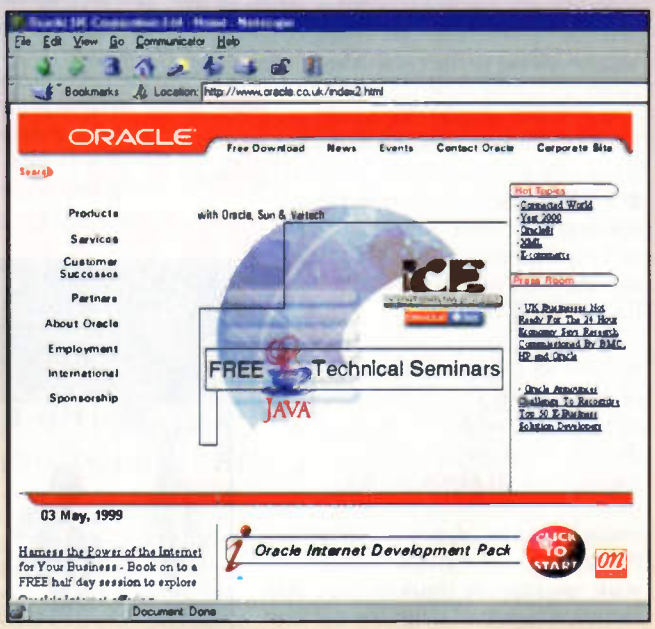
The company's investment will fund the development of the Oracle Millennium Project which aims, in its initial phase, to provide an email address and web-based learning facilities to 10,000 UK school children.

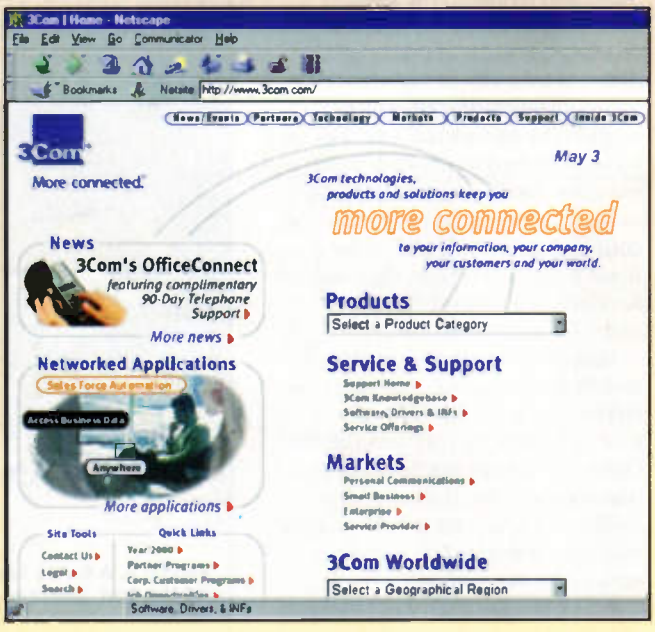
Speaking at a joint press conference on April 30 at The Wise Group in Glasgow, the Prime Minister welcomed this investment as part of the drive to realise his vision of a National Grid for Learning. The announcement of the investment was made on behalf of Larry Ellison by Philip Crawford, managing director of Oracle UK and Ireland.

The Oracle Millennium Project is currently in a pilot phase in the UK at the Whitehill School in Glasgow; Walthamstow School for Girls in East London; and the IoM Youth Club in the Isle of Man. The pilot phase is administered and supported by Oracle in conjunction with UK learning technology research centre Ultralab.

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

Contact: Oracle, Tel: (0118) 924 0000





Road Ahead for Foresight Vehicle

The latest phase of the Government's Foresight Vehicle programme, which aims to develop technologies for the next generation of vehicles, has been announced today by John Battle, Minister for Energy and Industry.

Announcing the publication of the Foresight Vehicle Strategic Plan, Battle said, "This strategy is a welcome and important step forward for the programme. Foresight Vehicle is about creating vehicles for the 21st century. It aims to make the most of our research capability and engineering imagination to develop components and systems that can be applied to a wide range of vehicles.

"But it is only by integrating work on new and alternative powertrain, advanced electronics, telematics and materials, that we will competitively create the safe, intelligent, clean, efficient and economic vehicles that we need for a cleaner environment and sustainable transport systems. This is the unique technological proposition of Foresight Vehicle," said Battle.

"Britain has the engineering excellence to be a centre of world class automotive design and manufacture. The Foresight Vehicle programme is translating vision into practical action, supporting over £25 million of innovative research through the Foresight Vehicle LINK programme," added Battle.

The programme aims to support development in four keys areas as show in the table below. Further details of the programme can be obtained from Dr Mike Sporton, Foresight Vehicle programme co-ordinator, GrenTek Limited, Grenville House, 81 Grange Road, Solihull, West Midlands, Tel: 0121 706 8827.

Foresight Plan Goals

These are:

- Environmentally-friendly propulsion systems leading to far better emissions performance.
- New materials applications to produce light-weight alternatives to present structures.
- Advanced, never-fail electronics with higher functionality replacing heavier mechanical systems and making driving easier for the ageing population.
- Telematic systems giving the driver information to increase journey efficiency and allowing for smoother traffic flow.

Exploring the Science Behind Sustainable Living

With greater emphasis than ever before being placed on introducing global and environmental education on the primary school educational curriculum, the Centre for Alternative Technology in Machynlleth, Powys, is offering its younger visitors a unique exploration into the science of sustainability.

Sustainable Science is an innovative new project that explores the science behind how the earth works. Theatre, hands-on workshops and a very special trip to the beginning of time are available to all children visiting the Centre.

Designed to inform and inspire its participants, Sustainable Science introduces the concept of Gaia - the science of how the living planet works and offers practical solutions to the problems which are now worrying the world's ecologists.

Sustainable Science is free to all visitors to the Centre for Alternative Technology, and is on offer during the Whit, Summer and Autumn half-term school holidays.

For further details, check: **<www.cat.org.uk>.**

Contact: Centre for Alternative Technology, Tel: (01654) 702400.

Making Waves Work

Energy Minister John Battle has launched a new wave power programme on behalf of the UK Government. Initially, the programme will monitor the development of projects contracted under the third Scottish Renewables Order and call for proposals for research, development and demonstration.

As part of his announcement on the Renewables Review paper in April, Battle said, "New work commissioned in the course of the Government's new and renewable energy policy review and a new report by the Foresight Marine Panel suggest that wave energy could contribute to UK energy supplies in the longer term."

"Further research into wave energy is needed to re-assess its potential and conduct the necessary R&D which is directly relevant to some of the more promising wave energy technologies in order to show whether wave energy can be made competitive. This is likely to require the testing of components and devices," said Battle.

"I therefore propose to expand the objectives of the Department's new and renewable energy programme to include new work on wave energy technology. I have always been convinced that wave energy has a place in the future of this country's energy mix. I am pleased to see that our analysis supports that view, and delighted that the latest Scottish Renewable Order includes three wave energy projects," said Battle.

Oceans cover three quarters of the earth's surface and represent a large natural energy resource. If successfully developed, wave energy might generate as much as 2,000TWh annually worldwide.

"I am pleased to be taking this first step in developing wave energy in this country. We are well placed to develop this energy form since much of our own shore is pounded by the North Atlantic. Waves around our shores offer a theoretical resource of around 50TWh of electricity. We now need to try and find the keys to unlocking that potential," added Battle.

For further details, check: **<www.dti.gov.uk>.**

Contact: Department of Trade and Industry, Tel: (0171) 215 5000.

PROJECT

Circuit Maker

VELLEMAN GEIGER COUNTER ENHANCEMENTS

Christian Hoskins adds numerical readout to this popular kit.

Circuit Operation

In Figure 1, IC1 is a 7555 timer used in its astable mode to provide a frequency of approximately 1Hz. IC2 is used to divide this frequency by 64 to provide a cycle length of approximately 1 minute (on pin 2), and this is further divided to provide a cycle of approximately 1 hour (on pin 1). SW1 is used to select the length of the measuring period. Just in passing, the use of logic gates, or an ICM 7240 programmable counter, was considered in order to give exact division by 60, but was felt to add unnecessarily to the component count and complexity.

IC3a and C2 are used to generate a short positive pulse across R5 at the end of the measuring period. IC4a provides a negative pulse to pin 34 (STORE) of IC5 in order to update the display. The rising edge of this pulse is fed to C4 and IC4b to provide a negative pulse to pin 33 (RESET) of IC5 to reset the counter to zero ready for the next cycle.

IC4c and IC4d are configured to hold pin 34 of IC5 low for the duration of the first measuring period. This is so that the changing count can be observed on the display. Without this, the display would remain blank for the first measuring period (a distinct disadvantage when using the hourly measuring period!). For the second and subsequent measuring cycles, the previous reading is held on the display until the new count has been determined.

SW2 resets the count to zero by resetting IC5, IC1 and IC2 (via IC3b). It also resets the monostable based around IC4c and 4d.

The signal from the Velleman Geiger detector is fed to the counter via link C. D7 and R15 ensure that the level does not exceed the supply rails of IC5. The signal is taken from the output of N5 because at this point the pulse is only a few hundred microseconds in duration and can be used to provide a much higher count per second than if the output were taken from link D.

If the counter display reaches 6000, pin 28 (CARRY) of IC5 goes high. C6 and IC3d hold the buzzer on for approximately 90 seconds to indicate a moderately high radiation and sustained radiation level. If this happens, it indicates an equivalent or higher level of radiation than 0.7 Millirem/hour. IC3c and D6 allow the capacitor to discharge if SW5 is opened or pin 28 goeslow.

With BUZ1 reinstalled in the new circuit, link D is routed via SW4 so that the audible indication can be switched off. VR2 allows a preset adjustment of the buzzer loudness, which was rather high on my original kit. LD1 provides a visual indication each time radiation is detected. Points A & B link to the supply rails of the original circuit. Zener diode ZD1 drops the supply so that the supply to IC5 is within the 3-6V range specified by the manufacturer.

PROJECT PARTS LIST

RESISTORS

R1	390k Min Res	M390K
R2, 5, 7	100k Min Res	M100K
R3, 8, 13	47k Min Res	M47K
R4, 9	270k Min Res	M270K
R6, 11, 12, 15	1M Min Res	M1M
R10	10k Min Res	M10K
R14	56k Min Res	M56K
R16	470R Min Res	M470R
VR1	1M 22Turn Cermet	UH28F
VR2	10k Cermet	WR42V

CAPACITORS

C1	1µF 63V Min Elect	VH03D
C2, 3, 4	4.7nF Monores	RA42V
C5, 6	100µF 16V Min Elect	VH13P

SEMICONDUCTOR

IC1	ICM7555IPA	YH63T
IC2	4040B 12-Stage Counter	QW27E
IC3	4070B Quad exc OR	QX26D
IC4	4011 Quad NAND	QX05F
IC5	ICM722IPL 41/2-Digit Counter	FP62S
TR1	BC548	QB73Q
D1-7	1N4148	QL80B
ZD1	5.1V 0.5W Zener	QH07H
LD1	3mm Blue LED	JA20W
DISP1	4½-Digit LCD Display	PF54J

MISCELLANEOUS

SW1	1-pole 3-way Sw	FF76H
SW2	Push-to-Make Sw	FH59P
SW3-5	ON/OFF Toggle	FH97F
Box	VeroBox 305	LH51F
	Stripboard	As Reqd.

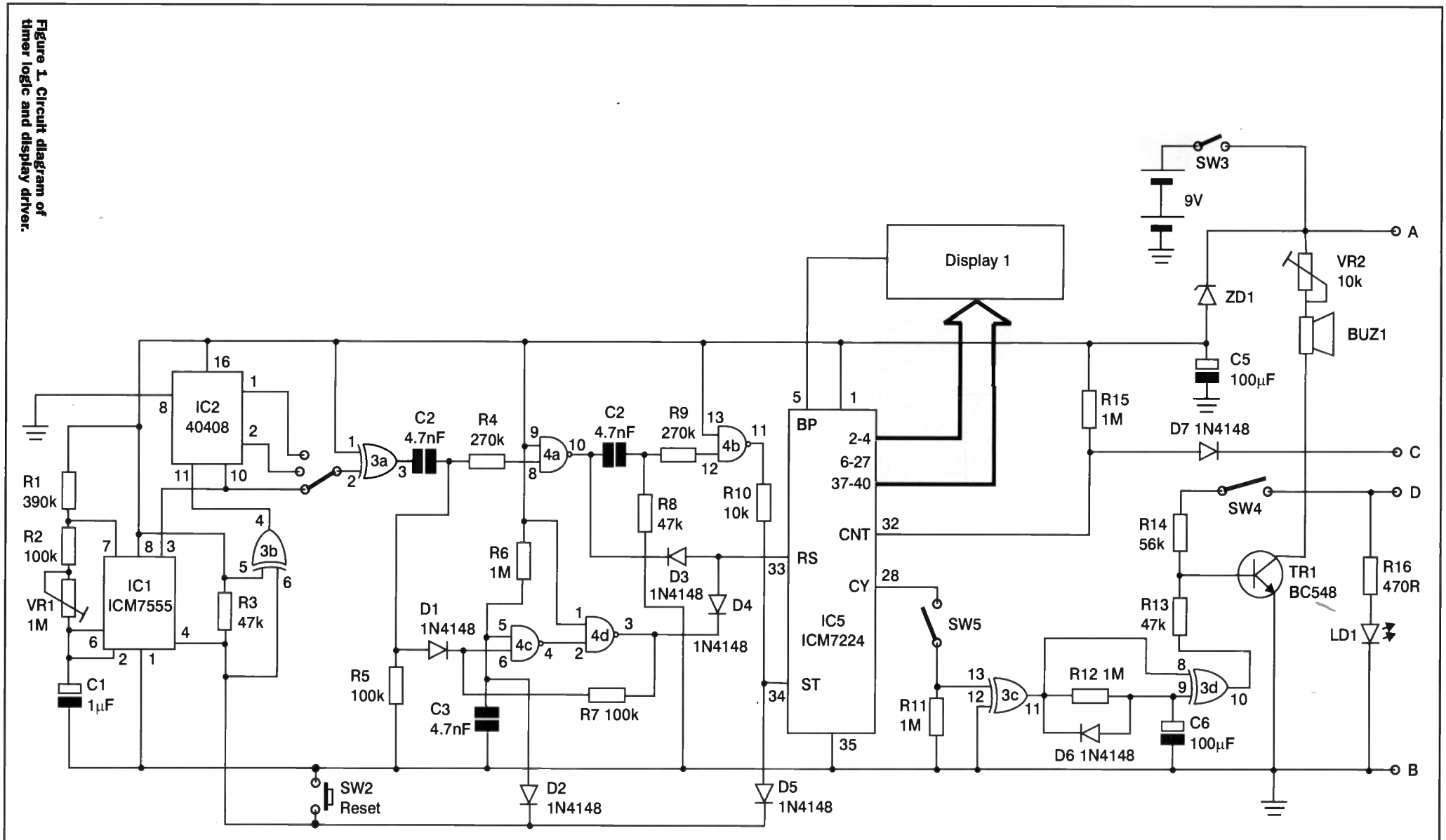


Figure 1. Circuit diagram of timer logic and display driver.

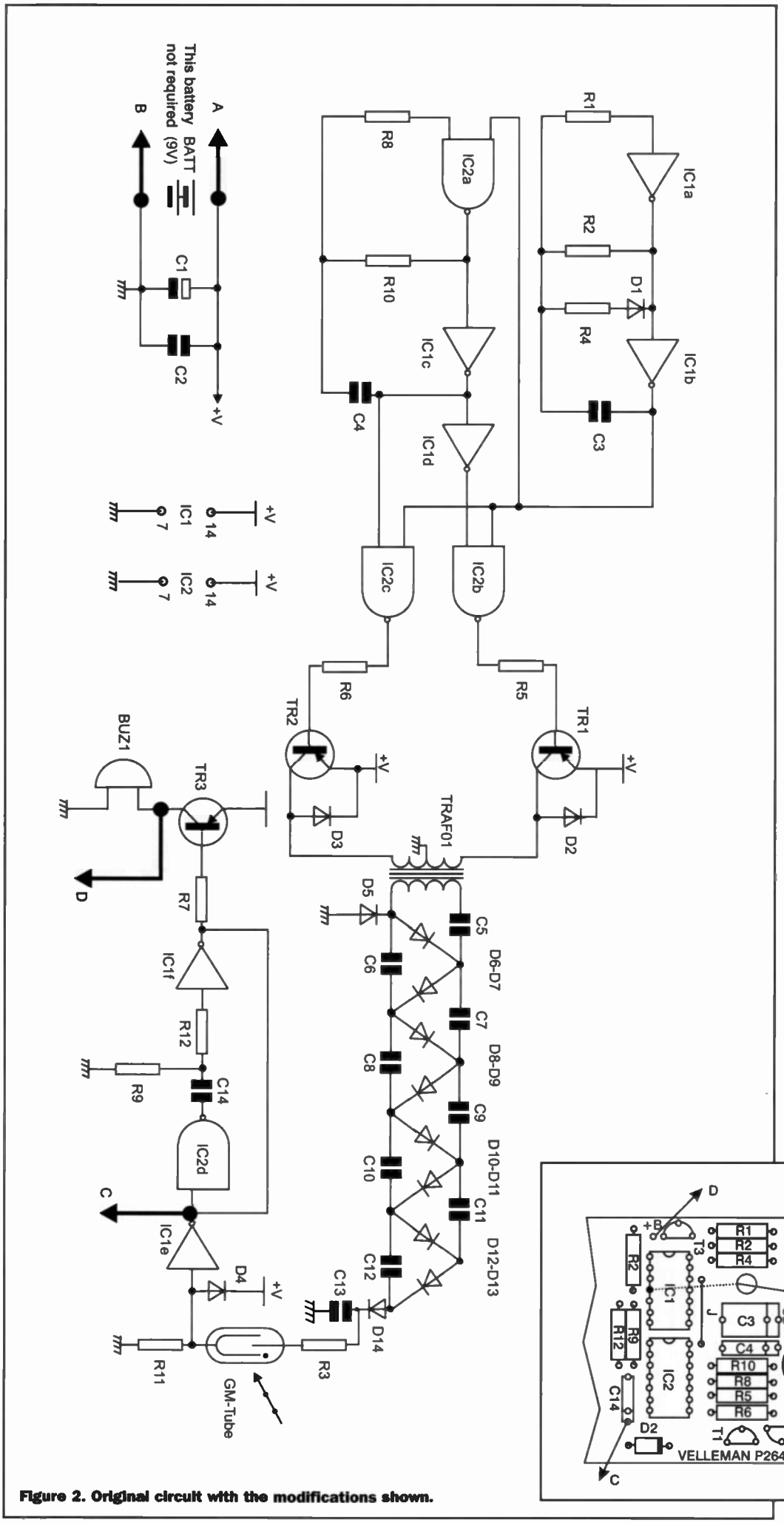


Figure 2. Original circuit with the modifications shown.

Figure 3. Take-off points on Velleman PCB.

It was my intention to use the Zener diode in the usual configuration, with the anode connected to each, but I found that the minimum cathode current for regulation was rather high given the need to keep current consumption to a minimum. A regulator such as the LP2950 might be a more elegant solution and would facilitate a low battery detect option.

Construction

The project was built on a piece of 39 x 29 stripboard, with the LCD mounted on a smaller piece of board. This allowed me to mount the original PCB, the stripboard and a PP3 side by side in a Verobox 305 (18 x 11 x 5.5cm).

On the Velleman board, see Figure 2 & 3, the original battery clip is replaced by links A & B, and the buzzer is removed and link D attached to the positive buzzer terminal. Finally, link C was soldered to Pin4 of IC1 on the bottom of the Velleman PCB. Before soldering, Link C was passed through one of the holes originally intended for the buzzer mounting, thereby giving mechanical protection to the otherwise vunerable connection.

Calibration and Use

VR1 was adjusted so that the 'minute' timing period is exactly one minute, giving a 0.94s 'second' and a 64 minute 'hour.' Alternatively, VRl can be adjusted to give an exact 'hour', with a 0.88s 'second' and a 56s 'minute.'

Whichever method is chosen, the circuit provides a measuring function which is internally consistent.

At my home in north London, there seems to be 50-60 counts per hour. At work in central London the figure is 40-50. The lowest reading I've regularly obtained is approximately 20 counts per hour on the Victoria Line.

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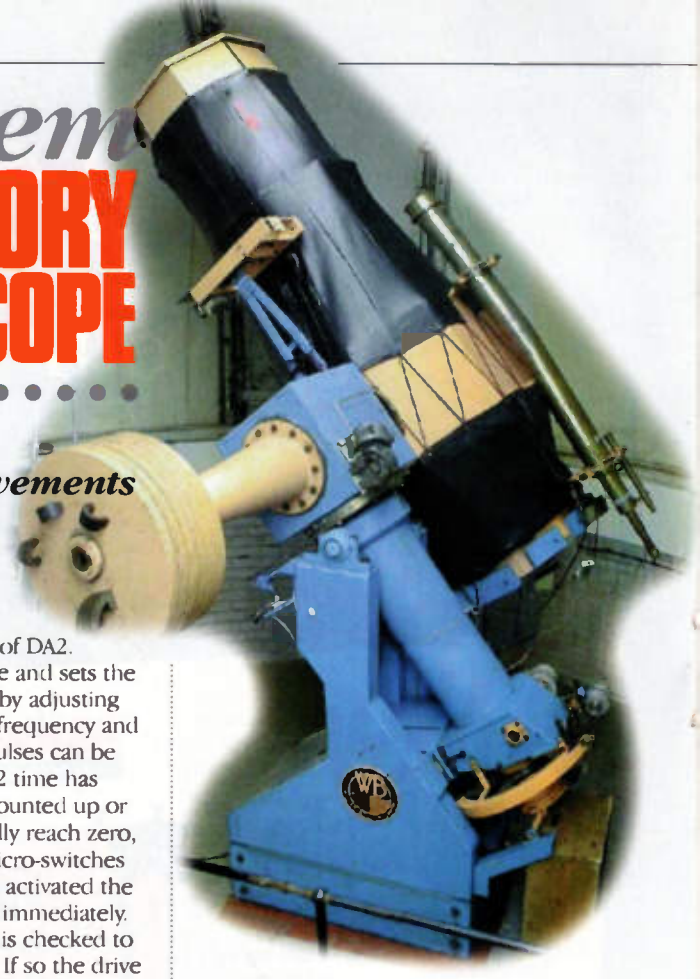
★ Ivex PCB CAD Package	★ ESD Tools	★ Using 7-segment Displays	★ Using 7-segment Displays	★ Towards a Theory of Everything
★ LED Graph Circuits	**REVIEW** Lego Media	**REVIEW** Panasonic IC Recorder	★ Towards a Theory of Everything	**REVIEW** Brother Has The Magic P-Touch

New Drive System FOR KEELE OBSERVATORY 24" REFLECTOR TELESCOPE

PART 2



Keith Garwell continues his detailed improvements to the Keele Observatory telescope.

New Declination Drive

An important consideration with this drive is that it is not time critical, nor is the step frequency critical, the only requirement is that steps are not missed. The declination is driven only on request by the observer. As a consequence the driving can be implemented in software. The only hardware required is two lines from the PC to the hardware module where the arrangement is exactly the same as REV in Figure 4 ie. a pair of open collector transistors convert the PC output, step and direction, to the requirements of the driver.

Figure 7 shows an outline of the dec routine. When it is called the details passed to it are the number of steps required and the direction. The terminology used for direction in the previous system had caused confusion so I solved this by the simple practice of referring to direction as being 'towards the motor' or 'away from the motor.' The photograph showing the tangent arm will make this clear.

Returning to the routine, the first action is to set the direction line and then to enter a loop to generate the step pulses. The number of steps is counted down each time round the loop, which ends when the value becomes zero.

The loop turns the step line on and then enters a wait which is a simple count up from zero to the value of DA1. DA1 is one of the variables saved in a file and effectively defines the time for which the step pulse is turned on.

This is followed by turning the step line off and then entering another simple loop which counts up to the value of DA2. Again this value is held in a file and sets the time the step line is off. Thus by adjusting these two, DA1 and DA2, the frequency and mark-space ratio of the dec pulses can be set as required. When the DA2 time has expired the value of steps is counted up or down as necessary to eventually reach zero, after which the declination micro-switches are tested. If either of these is activated the drive to the motor is stopped immediately. After this check the keyboard is checked to see if a key has been pressed. If so the drive is again stopped immediately. Bear in mind that none of this activity interferes with the RA system as the interrupts take precedence.

System Parameters

A list of system parameters is shown in Figure 8.

Several of these we have already met but that leaves one or two in need of explanation.

- RC1 and CPITL are associated with two of the users commands which concern requests for moves in RA. To achieve these (described later) it is sometimes necessary to stop the drive or accelerate it above normal speeds to save time. To do this the RA step frequency has to be ramped up/down quickly but without loosing count of the steps. This involves the software following an exponential produced by the CR network at the input to the oscillator pin 5. See Figure 4 (last month). RC1 gives the time constant to be used and CPITL sets the trigger level at which point the drive reverts to normal tracking.
- CDTRA is just a conversion value used by the RA arithmetic, and similarly DSPAS.
- TAT, tangent arm travel, is the number of steps required to traverse the lead-screw from end to end. A user command is provided which causes the declination drive to find the value by experiment. The figure is needed because one of the displays on the user console shows the amount of travel available in either direction in degrees, minutes and seconds.

```
int step_dec(long int steps,int direction,int stop_flag)

  set the direction line on or off

loop until steps is 0
   turn the step line on
   wait loop counting from 0 to DA1
   turn the step line off
   wait loop counting from 0 to DA2
   if the direction is towards the motor add 1 to steps
       if not subtract 1 from steps
   read the dec micro switches
       if a switch is activated then finished
   if a key has been pressed on the keyboard then finished
   repeat the loop
   finished

end of routine
```

Figure 7. Outline dec routine.

System Parameters

3308	S1	Steps per cycle of timing routine ie 36 interrupts
0	V1	Add V1 to cum_dif every
0	V2	V2 cycles
1.9	RC1	Time constant for +ve moves
30.0	CPITL	Trigger level for move_neg to return to tracking
0.055	IBI	Interval between interrupts
300	DA1	Used to adjust the mark-space
100	DA2	ratio and frequency of dec pulses
-0.0006	CDTRA	Convert cum_dif to change in RA
10.57	DSPAS	Dec steps per arc second
98000	TAT	Tangent arm travel in steps
100	MCT	Move Complete Trigger
375	CCDX	Pixels on x axis
242	CCDY	Pixels on y axis
648.0	CCDRA	Span in secs of x axis (RA)
492.0	CCDDE	Span in secs of y axis (Dec)
100	MVSW	Move switch in steps
1000	PD	Paddle delay
30000	FMD	Focus mark delay
30000	FSD	Focus space delay
1.0	FMTS	Focus microns to steps
1000	FBL	Focus back-lash

Figure 8. System parameters.

- MCT another figure used by the move instructions.
- Various CCD cameras can be used on the telescope all having different fields of view and different numbers of pixels on the X/Y coordinates. These figures are specified by CCDX, CCDY CCDRA and CCDDE so that if there is a camera change another file with the corresponding camera data can be selected.
- MVSW and PD are associated with the hand-paddle controls which can be used to adjust the telescope position. Usually whilst setting up prior to observation.

Things change. Even as I write and since starting this article we have fitted remote focusing to the camera mount. FMD, FSD, FMTS and FBL are associated with this. More later.

User Interface

The user commands are shown in Figure 9 and are, I imagine, more or less self explanatory. The characters in brackets after some of them show what parameters are required. For example setpos has six parameters, the RA position in hours, minutes and seconds, followed by the declination position in degrees, minutes and seconds. Typing the commands and parameters is provided with a backspace to clear mistakes and trailing zeros can be omitted. For example setpos on its own will set all zeros, and setpos 1 2 3.1 will just set the RA to 1 hour, 2 minutes, 3.1 seconds.

A command is always followed by an acknowledgment from the system. For example the above command would be acknowledged by the displayed figures changing, whilst commands with no parameters are echoed on completion. The command track will be followed by tracking from the system. Examples are given in Figure 10 which shows the screen layout.

User Commands:

For RA

track	start tracking
rate	change rate ie. S1
halt	stop tracking
zero	set cumulative error to 0

For DEC

centre	move tangent arm to centre of lead-screw
pole (1-1)	set pole to 1 or -1

For both

setpos (hmsdms)	setposition RA and Dec goto
(hmsdms)	goto specified position RA and Dec
moves	move Ra and Dec specified seconds
movem	move RA and Dec specified minutes

For CCD

pixctr (xy)	centre camera on X/Y values pixels
pixmov (xyxy)	move camera from X/Y to X/Y pixels

General

vars	save or load a file of system variables
ccd	save or load a file of system variables
focus	adjust focusing by a positive/ negative amount
padset	use the padhandle buttons for setting
padguide	use the padhandle buttons for guidance
quit	quit the program

Figure 9. User Commands.

The remainder of the screen shows commands as they are given until the bottom of the screen is reached when the command window starts to rack up, but still leaving the top lines containing the data and command prompts on display.

A diagnostic display is also available (although it is not advertised on the display!), which permits testing the control lines, checking the free-running frequency of the RA oscillator, and displaying all the values appearing during tracking. This was originally built-in for the initial commissioning but it has been useful on occasions since then.

Of the one or two commands that require an explanation, rate is perhaps the first. This allows S1 the tracking constant to be changed if for example the atmospheric refraction has changed, or the telescope is bending! If the conditions are likely to be repeated the constants can be saved to a named file using the ccd or vars commands.

Padset and padguide are the two commands that allow the padhandle to be used. Padhandle seems to be an acquired name which refers to a set of control buttons on a mounting (handle) which is at the end of a cable, which in turn can be used upstairs alongside the telescope or downstairs in the control room. Padset gives fast actions whilst padguide is more of a fine control.

Achievements

The improvements achieved are approximately 10 times better than the original requirement. Whilst tracking the maximum error appears to be less than 0.05 seconds of arc over the short term. Here short term seems to translate into any requirement that has been needed so far, and the system is now in regular use by under-graduate and post-graduate students. I know that this is a vague statement but the pressures of observation naturally are on its use rather than spending time doing extended tests. Especially with the weather that we have in England!

I expect that long term accuracy will be governed by the PC clock. As the normal crystal has a figure around 50ppm/ °C. This will probably be no problem once the temperature has stabilised, and the operating environment seems to be quite consistent.

The Future

Some of the future is already in the past! Whilst this article has been in preparation remote focusing has been added to the system.

Having achieved the objectives it was decided to fit remote focusing. The focusing was originally performed by manual adjustment on the camera mount. This usually meant climbing some mobile steps to reach the adjustment at the remote end of the telescope body. Apart from being uncomfortable and difficult physically it was not very accurate.

Adding a remote focusing system improved the seeing because the presence of a person no longer affected it by stirring or warming the atmosphere. In addition it was calibrated and adjustable on line. Moreover the focus position is retained and has shown up some quite unexpected errors e.g. filters changing focus. Which reminds me that I should mention that both the focus position and the position of the tangent arm are recorded in file whenever they are changed. This enables the positions to be recovered whenever the system is switched on.

The camera platform is supported on three screwed rods and can be moved by rotating three pulleys threaded to match the rods. A ribbed belt raps round the three pulleys (also ribbed of course) and a driving pulley mounted on the gearbox output shaft. The gearbox provides a right-angled input shaft driven by a small stepper motor.

The software contains a routine very similar to the declination routine with the exception that an additional section ensures that the stepper always rotates in the same direction as it approaches the correct position. This is simply to avoid the effects of any backlash in the mechanics.

Four system parameters are assigned to the focusing (Figure 8). FMD and FSD set the frequency and mark-space ratio exactly as for the declination drive. FMTS is a conversion constant (it is not 1 but I don't honestly know what the real value has been found to be!). Finally FBL sets the backlash figure to a 1000 which seems to work well enough i.e. the last 1000 steps of an adjustment are always in the same direction. Moving in one direction this makes no difference but moving in the opposite direction 1000 is added to the move and then it is finally reversed and a 1000 steps made to compensate for the addition.

Finally at some time in the future we hope to correct the cyclic error in tracking by adjusting the tracking rate automatically. This hopefully will be a simple arithmetic job as the error is believed to be due to the chain drive between the gear box and the worm and certainly looks like the sum of two sine functions.

We also hope to correct mechanical flexure in the telescope by a similar process of modifying the tracking rate as the attitude of the telescope changes. Perhaps by using a look-up table once the form of the error has been determined.

Although this system is entirely specific to the Keele Telescope its principles may be applied to other systems. Correspondence with the author will be welcomed at:

5 College Road, Alsager, ST7 2SS,
or by phone Tel: 01270 875159.

ELECTRONICS

```
RA HMS    1     2     27.02    Pole Normal          TA travel AFM  2  32  20.87
Dec DMS   0     0     15.00    Focus 881174μm       TM  0   2  10.65
Commands are: For RA - track, rate, halt, zero.
For DEC - centre, pole (1-1). For both - setpos (hmsdms), goto (hmsdms),
moves, movem (RA Dec). For CCD - pixctr (xy), pixmov (xyxy).
General - ccd, vars, focus, padset, padguide, quit.

track  tracking
setpos 1 2 27 0 0 15
```

Figure 10. User screen display.

PROJECT

Velleman Mini Kits

SOUND GENERATOR & ONE CHANNEL LIGHT EFFECT

This month John Mosely looks at two more of these starter kits.

The sound generator kit (which is not in the current Maplin catalogue) features four sound effects –machine gun, fire engine, ambulance and police siren. The one channel light effect, although simple, does involve the mains directly, so should not be attempted by the beginner unless suitably supervised. These kits should easily be built and made to work within an hour - assuming there are no disasters!

Once again, the kits included all the necessary components to make the kit work – except the PP3 battery for the sound generator - and as we have said before, offer an inexpensive introduction to the world of electronics. The PCBs are of an excellent quality, with component legend and corner mounting holes.

Construction notes are graphical and contain very little, if any text, but are more than adequate to help construct the kit. Colour coding for each resistor is included, as is semiconductor, IC and diode orientation. The board legend is very clear and detailed, which all helps to reduce the chance of error.

Sound Generator

This kit includes everything except a box and the battery. Once assembled, and the battery is in place, then the kit forms a neat stand-alone project. See Figure 1 for circuit details.

The small components are inserted first remembering to check orientation of the diodes, transistors, and electrolytic capacitor. The larger items are inserted next. Remember to be careful when handling the little speaker/sounder, as it has a very delicate 'cone' and can easily be damaged. The IC is inserted last.

Testing

When all the solder joints have been checked, and you are happy that the component layout is correct, insert the battery. Check that the on/off switch works and you should hear a sound effect. RV1 adjusts the pitch of the sound and the DIL switches selects the desired effect. Flick the little DIL switches in turn to confirm all four effects are available.

The resultant sound level is more than loud enough, and battery consumption is moderately low, so battery life should be long. This is an easy and novel kit for the beginner and student .

Maplin Order Code VT28F
Price £4.99

SOUND GENERATOR PARTS LIST

RESISTORS

R1, 2	1k Min Res
R3	100k Min Res
R4	47R Min Res
RV1	220k Preset

CAPACITORS

C1	100µF MinElect

SEMICONDUCTORS

D1	1N4007
ZD1	3V Zener
T1	BC337
IC1	3561

MISCELLANEOUS

SW1	SPDT On/Off Switch
SW2	3-Pole DIP Switch
LS1	Sounder
	8-Pin DIL Socket
	PP3 Battery
	PP3 Battery Holder

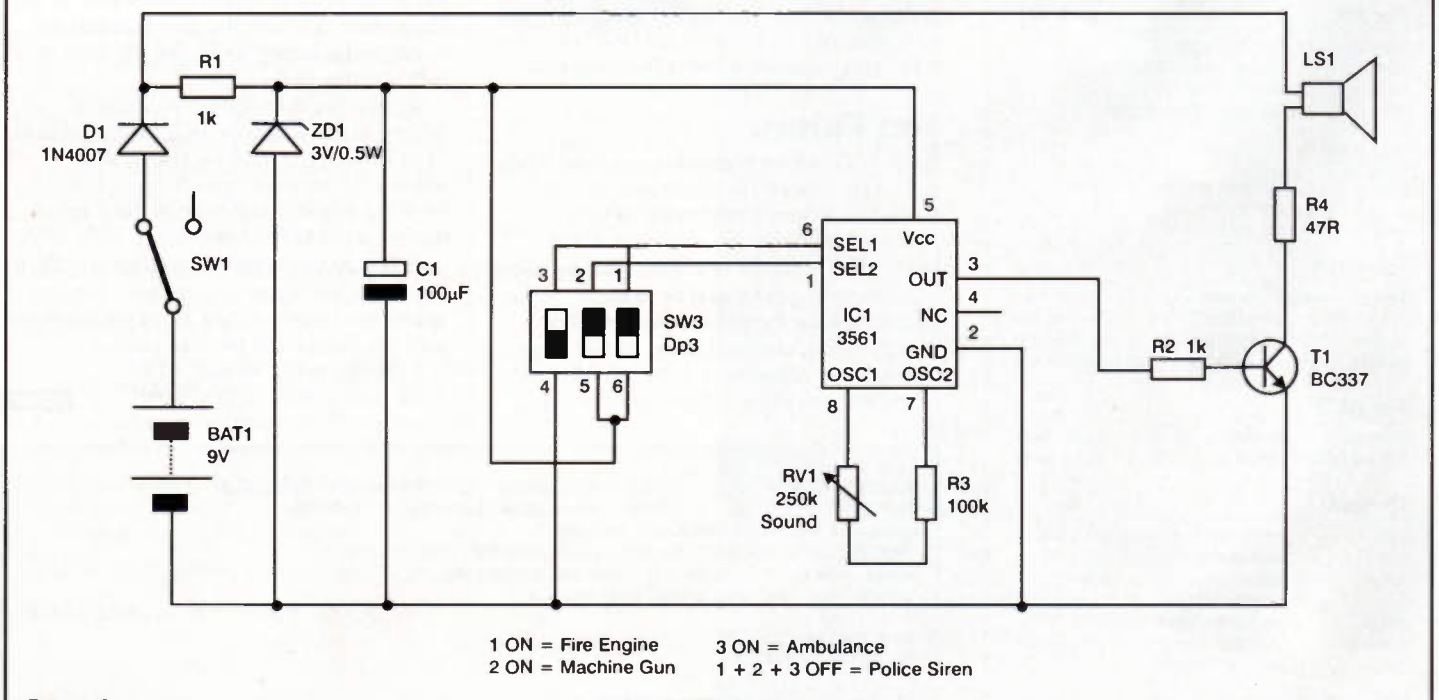
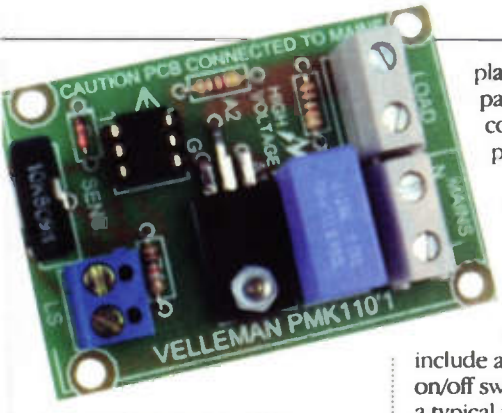


Figure 1.



Simple Single Channel Light Effect

This little circuit (see Figure 2) is designed to modulate a light bulb according to a music signal applied to its input. The music input is taken directly from the loudspeaker output of an amplifier, or the loudspeaker terminals, and has adjustable input sensitivity from 2W to 60W. The circuit will drive a 230W maximum load at 230V AC (or 120W at 120V AC). This allows several lamps to be used, which can be of different colours, to produce interesting light effects. Obviously, more circuits can be constructed to greatly increase the number of lamps that can be used. For anyone planning a Millennium party this offers a very cost effective way of providing a light show.

Since mains is involved in this project, then the finished board must be mounted in a suitable plastic box, must be suitably fused, and include a double pole mains on/off switch. Figure 3 indicates a typical wiring diagram.

Construction

Once again mount the small components first followed by the connectors, the preset resistor, transistor and the triac. The opto-isolating triac can be inserted into its 8-pin DIL socket last. Note that the socket for the input signal is a different type from the two sockets used for mains connections. The terminals spacing are different - the spacing in the mains sockets is wider, and in the kit I constructed the mains sockets were off-white in colour compared to blue for the music input.

When you have selected a suitable box, drill and mount the on/off switch, grommet, cable clamp and fuseholder. Do not use a fuse rated at more than 1A. Mount the board using insulated stand-offs, remember that the board needs to be mounted near to one of the smaller sides so that access can be obtained to adjust RV1. A plastic tool is supplied for this adjustment. When satisfied with the board position, carefully mark, and cut-out an access hole in the side of the box.

After you have checked your wiring and have made the necessary connections to the mains, the lamp and a loudspeaker, switch on and select your music. If the lamp does not flash adjust RV1 to increase sensitivity. It may be necessary to increase the volume on the amplifier to produce a satisfactory result.

The kit worked very well and could certainly form part of an interesting and moderately price light show. ELECTRONICS

Maplin Order Code VX99H
Price £4.99 (PCB and components only)

Important Safety Note
Please remember that brightly flashing lights can have serious effects on certain people, so do be careful.

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

ONE CHANNEL LIGHT EFFECT PARTS LIST

RESISTORS

R1	1k Min Res
R2	470R
R3	100R
RV1	10k Preset

CAPACITORS

C1	100nF 250V AC

SEMICONDUCTORS

D1	1N4148
T1	TIC206M Triac
IC1	K3020P Opto Triac

MISCELLANEOUS

SK1	2-Way Screw Socket
SK2, 3	2-Way Screw Socket
	20mm Fuseholder
	20mm 1A fuse
	Plastic Box MB2
	Grommet
	8-Pin DIL Socket
	Lamp Holder
	Suitable Mains Lead
	Cable Clip
	Insulated Stand-Off pillars 4 reqd.

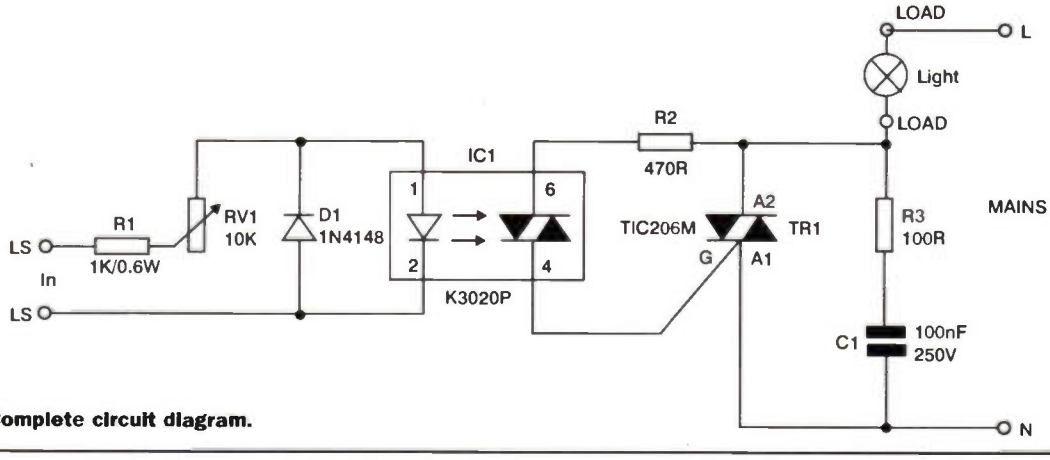


Figure 2. Complete circuit diagram.

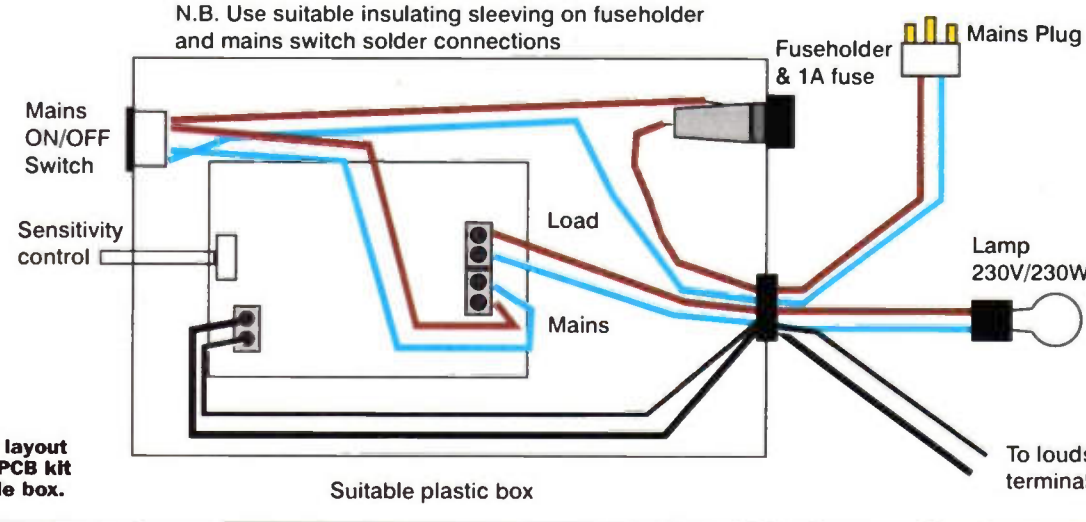


Figure 3. Suggested layout of placing PCB kit in a suitable box.

ALPHABETS & TECHNOLOGY

In this final part Gregg Grant looks at the connection between alphabets and technology.

Introduction

This series began with the link between science and language. Its ending is on a somewhat different note: the connection between alphabets and technology.

The earliest technologists of course were the printers, and so technology is seen as a Western development. In fact, technology is no more an Occidental achievement than the 'European' alphabet. However, taken together, they've conquered the world, despite Asia - and China particularly - being technologically far in advance of the West for many centuries.

The Chinese however didn't bring their achievements to full fruition, ie into widespread, everyday use. Why?

Europe and the Pictogram

The 26-letter alphabet used throughout Europe is a development of the old Western Semitic alphabet of Ugarit, now the Syrian city of Ras Shamra, an illustration of which is shown on the Syrian stamp of figure one. It was this alphabet, with its roots in pictograms - from the Latin *pictus,* meaning 'to paint' - which brought about man's greatest intellectual achievement, his differentiating of spoken sounds and their notation with phonetic - from the Greek *phonetikos,* meaning 'speak' - symbols.

The European letter **A** for example descends from the Old Semitic *aleph,* meaning 'an ox.' In fact in its pictographic form it was a crude sketch of a bull's head. The second letter of our alphabet too comes from the same source, this time *beth,* meaning ' a house.'

This alphabet spread outwards from Phoenicia, freighted aboard the greatest trading ships of the age such that - today - the Greek, Latin and Cyrillic scripts are derived from it. Moreover, the southern and central Asian scripts of the Mongols, Uighur Turks and the Manchus all trace their ancestry back to the alphabet of Ugarit.

However, the Ugaritic wasn't all-conquering. The East Asian cultures weren't at all taken by the notion of alphabetisation and so clung to their ideographic, essentially unphonetic, script.

Asia and the Ideogram

The Chinese convert speech into writing via an ideographic-pictographic arrangement, the basic unit of which is the *radical.* The words used in the many Chinese dialects are made up from some 214 radicals, which can either be grouped together to form more complex words, or stand alone.

Figure 1. The Development of the Chinese Ideogram.

One example is teardrop. This is made up from the radicals for *eye* and *water* linked together. The radicals representing *bird* and *mouth* give song. Since each word must have its own symbol, Chinese script is - quite simply - enormously complex, and runs to some 48,902 characters according to the most comprehensive lexicon, the *Dai Kanwa Jiten.* Around 4,000 of these are in everyday use. Figure 1 illustrates the development of the Chinese ideogram, down through the millennia.

Dictionaries too are complex in the extreme. Unlike Western dictionaries, which are arranged around the letters of the alphabet, Chinese dictionaries are divided into 214 chunks, based on the radicals. This though is but a partial solution for, to get the meaning you want, you've got to search through each chunk for the particular spelling you're after.

If Chinese script appears complicated, the Japanese linguistic 'system' appears even more so, it being a troika - from the Russian *troe,* meaning 'three' - of two syllabic alphabets and a pictographic character system. The latter, termed *Kanji,* consists of 7,000 symbols of Chinese origin whilst the two alphabets - the *Katakana* and the *Hiragana* - each have 48 characters.

Katakana - frequently abbreviated to Kana - is used for foreign words and phrases. However, since a great many of the kanji characters have any number of meanings - not to mention pronunciations - the second syllabic alphabet was created. Hiragana is written as tiny symbols above the main text - not unlike the way we occasionally use superscript - to inform the reader which of the numerous Kanji interpretations is being used in this particular context.

That this is deadly serious stuff can be gathered from the fact that the word *Ka* has no less than 214 separate meanings! Nor does it end there. Japanese - unlike Chinese - does not have an unambiguous one-to-one correspondence between the sound and the character. This means that a Japanese character can be read in Sino-Japanese, a form of pronunciation derived from Chinese. In this form however there are, once again, two possible ways of reading it.

Naturally, each character has a purely Japanese equivalent word and here too complication is the order of the day, for even this word can have more than one equivalent among the mass of characters! Naturally, these complications affected Asian technological developments from an early stage.

Asian Technology

In the book *Dream Pool Essays,* the high mandarin Shen Kua described the invention of movable type by Pi-Sheng around 1045, some 21 years before the Norman Conquest and four centuries before Johann Gutenberg's parallel development in Europe. Shen himself was one of China's greatest scientific technologists, at once an engineer, astronomer, mathematician and - on at least one occasion - an army commander. He was also the first scientist, engineer or technician - Asian or European - to write about the Magnetic Compass.

Although he immediately recognised the tremendous importance of this innovation, Shen appeared either unable or unwilling to develop it further, let alone to its full potential. On Pi-Sheng's death, Shen Kua kept the first font of movable type as a precious possession.

A number of reasons have been put forward for Shen's lack of developmental drive where movable type was concerned, none of which are entirely satisfactory on their own. Obviously the sheer number of ideograms needed simply to get by on an everyday basis would have been a formidable obstacle in themselves, against the creation of movable type.

Moreover the mandarinate was - by and large - the most literate of Chinese, their very power depending on their intellectual abilities. This, in turn, meant triumphing in a variety of examinations, all of them requiring formidable reading and writing skills. The mandarins therefore were the upholders of the status quo, and so unlikely to approve so radical a reform as the alphabetisation of the Chinese script! In Japan too, attempts to introduce movable type - which were made more than a century before Gutenberg - also failed. Nor did matters improve when Asia came into contact with the technologies of Europe, from the middle years of the sixteenth century onwards.

Among the earliest of modern technological headaches for the Chinese was the Telegraph and its operating system, the Morse Code. They cracked this problem by allocating a number to every - and I mean *every* - word in their ideography. Unsurprisingly, this system was every bit as cumbersome as the problem it had been created to take care of, but it did have one advantage. Occidentals who knew no Chinese ideographs could translate a Chinese telegram by turning to the reference book holding the numbers.

Another problem for the Chinese was the typewriter. In the hands of a European this device, with its 47-key operating board, appeared an obvious labour-saving machine, well worth having. The Chinese keyboard - by comparison - was simply enormous. Trained typists struggled to execute more than around 10 words per minute (wpm), and this on a machine that handled but a fraction of the ideographs available. In fact, if the QWERTY keyboard feeding my computer as I type this were extended to accommodate the 50,000 or so ideographs, it would be some fifteen feet long and five feet wide!

Therefore Chinese pre-industrial technological achievements lay moribund in their homeland. Europeans however would later take the trouble to understand them and exploit their potential. They had the humility to learn from Asia. The Celestial Empire would later prove to lack this quality.

In Japan too, barriers to developing movable type were no less formidable and blighted a number of early attempts at developing such a system. The Japanese differed from the Chinese in one respect however: they imported and copied ideas and devices from the West, watches being but one example. The Chinese however rejected any such ideas.

Although this tells us a great deal about each nation's respective future, even today - despite their stunning technological-industrial achievements - the Japanese still have immense problems with their orthographic - from the Greek *orthos,* meaning 'straight' and *graphos,* meaning 'to write' - system.

With the advent of computers, the problem - if anything - increased. To begin with the Japanese had no background in keyboard manipulation. Therefore the elementary skills involved in - for example - preparing this article is a new, and far from simple, acquisition. Secondly, since it requires around 7,000 symbols to write Japanese compared with 100 or thereabouts for the majority of occidental languages, Japanese computers have to be much more powerful than an equivalent Western model. Occidental lettering for example can be displayed on a computer screen in about 35 dots. Japanese ideographs on the other hand need as many as 576 dots to give a clear and unambiguous image.

The Japanese could get round these problems in only one way: learn an Occidental language so as to be able to use a personal or office computer. The language chosen was almost invariably English, as it was steadily becoming the world's lingua franca.

Nowadays however, the Japanese use a technological solution of their own. They employ a keyboard of katakana syllables which are converted to kanji characters on the screen. The nearest Western equivalent would be something like one hundred per cent, where we would hit the keys for **one**, and then **hundred**, followed by those for **per** and finally **cent**. The screen display however would read **100%**.

The Future

Currently, electronic imaging technologies - in themselves further developments of alphabet-based movable type - are aiding Asia to come to terms with its convoluted linguistic systems. Modern methods of image transmission and identification, such as facsimile and optical character recognition (OCR), are overcoming many difficulties.

OCR is already able to handle some cursive - from the Latin *currere,* meaning 'to run' - writing and calligraphy, from the Greek *Kallos,* meaning 'beauty' plus *Graphia,* the Greek word for 'writing.' In countries like China, Japan and Korea - where calligraphy has a status akin to that of painting - such technological advances will be watched closely. Nevertheless, such devices do not circumvent the problems inherent in non-alphabetical systems.

We've already noted science and technology's contributions to the English language particularly, as well as to other European languages. Their greatest contribution to Asiatic linguistic systems could lie, not in the expansion of their vocabularies, but in the complete structural overhaul of the languages themselves. Such a system would have many advantages, not least the easy assimilation of foreign words and phrases, particularly those dealing with science and technology.

Such a change however may be some years in the future, for it will require nothing less than the re-education of entire nations.

PC SECURITY

PART 2

In part 2 – Mike Bedford looks at electrical threats.

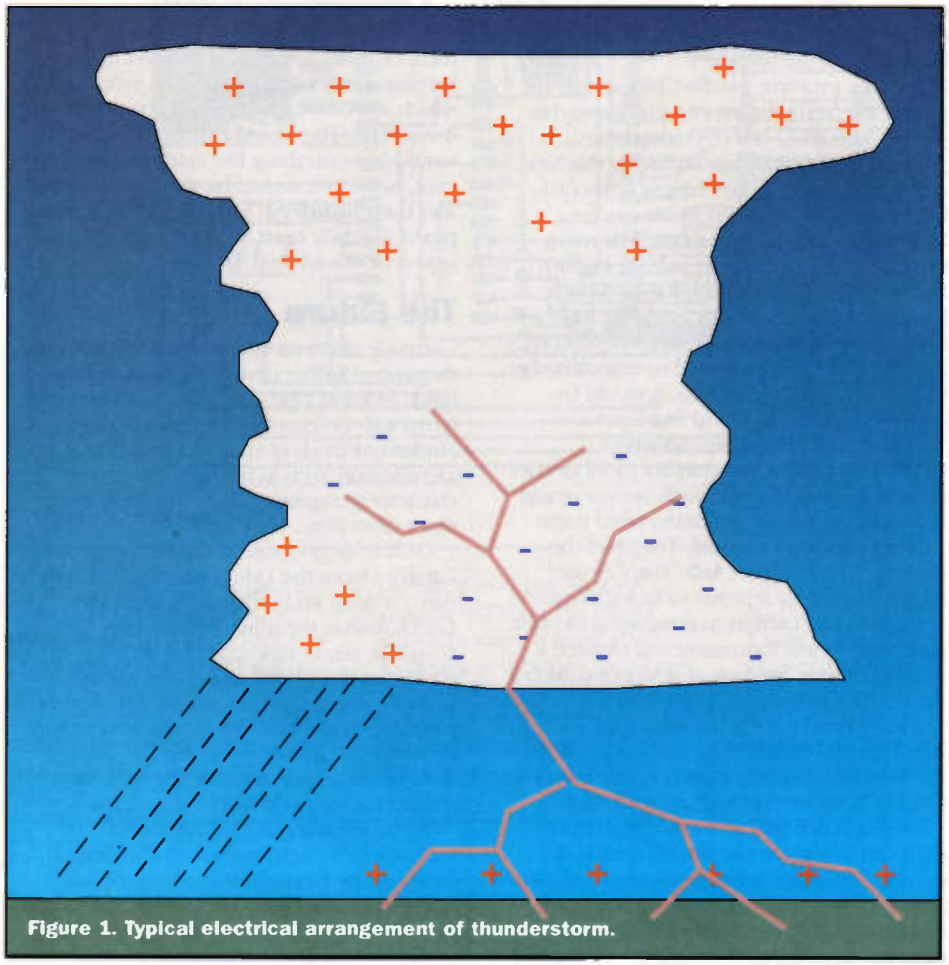


Figure 1. Typical electrical arrangement of thunderstorm.

Photo 1. Typical mains protection devices.

When the road running past your house has turned into a raging torrent, when the rising water is fast approaching the kitchen door and when the drainage gully is totally blocked with silt, it's time for action. And so, as the thunder crashed overhead, I found myself laying flat out in eighteen inches of flood water with my arm disappearing into the murky depths, dredging evil smelling slime out of the road drains. Mayhem was averted but only just. "What has this to do with PC security?", you might well ask. Well, just as having your house flooded is something which most people think only ever happens to other people, the same goes for computer security risks. And if having your PC stolen - the subject of last month's article - seems unlikely, having it struck by lightning must seem an even more remote possibility. Yet on this same summer day a couple of years ago, as I was drying out inside and congratulating myself on having saved the house from a deluge, the neighbourhood was rocked by one of the loudest thunder crashes I've ever heard. At the same time, all the telephone bells in the house sounded briefly. I thought nothing more about this until I came to use my PC the next day and found that the modem was totally dead. Clearly, the same electrical spike on the phone line which had caused the telephone bells to sound had wiped out some sensitive components in the modem. An isolated occurrence, you might think, and surely lightning never strikes twice - but you'd be wrong. A few weeks later on returning to the office after another weekend of particularly violent electrical storms, I found that the parallel port on my PC was no longer functioning. Admittedly there was no evidence that the storms were to blame but I certainly had my suspicions. After all, how often do you hear of parallel ports dying? In this case, I believe that the especially long cable - running to a printer at the other side of the office - was partially to blame, acting as an aerial just as the phone line had done and conducting a high voltage spike to the PC. And it isn't only high voltage spikes on the phone lines, data cables or the mains supply which can cause problems. Low mains voltage and power cuts are also troublesome to computer users. For a half hour period last week the electric lights flickered noticeably. Dodgy lights I can live with, but every few minutes the residual current circuit breaker tripped as a result - this was just about enough time for Windows to re-boot before the next trip. Clearly trying to use a PC under these conditions was impossible. At the best I'd have got no work done, at the worse the PC could have been damaged.

I tell these stories just to prove that problems due to voltage spikes and mains fluctuations do happen. A major aim in this series of articles on computer security is to cause you the reader to wake up to the various security risks which threaten your PC. These are not problems which only ever happen to someone else they are real threats which can and do happen to large numbers of people. In this series, we're interpreting the phrase 'computer security' as any unexpected threat which could lead to the loss of hardware or data. Certainly this

includes malicious action by a third party and in this category we covered computer theft last month and will look at viruses in a future article. However, it also includes natural or accidental threats. The subject of this month's article is a group of closely related natural security risks - that of voltage spikes, power fluctuations and power cuts.

Lightning Investigated

"There's more chance of being struck by lightning". Next time you hear that phrase used to suggest that some occurrence is very unlikely, try telling it to former US Park Service Ranger Roy Sullivan. Whilst working in the mountains of Virginia, Roy was struck by lightning on seven separate occasions between 1942 and 1976. His hat was set on fire, his hair was set on fire twice, he was burnt on his eyebrows, shoulder, stomach, chest, and ankle, and on one occasion his boot was blown off. Amazingly, though, given some of the statistics we're about to see, he survived all seven lightning strikes.

So what causes lightning? Surprisingly, although it's now over 200 years since Benjamin Franklin first started researching electrical storms, scientists are still not fully aware of exactly what happens. We'll stick to the simplified version of events, but any uncertainty over the details certainly doesn't lessen the threat posed by lightning. Similarly, even if we don't fully understand how voltage strikes end up on our phone lines and mains supplies we can, at least, give some guidance on how to prevent a catastrophe. So with that disclaimer out of the way, here's the simplified story of an electric storm - see Figure 1. Unlike most objects we come across which are electrically neutral, thunder clouds have separate areas of negative and positive charges caused by hail and ice crystals falling through their supercooled regions. More specifically, a thunder cloud tends to be positively charged at the top and negatively charged at the bottom although pockets of positive charge can also occur at the bottom, especially where precipitation takes place. Because dissimilar charges attract each other, the ground immediately below a thunder cloud tends to become positively charged, mirroring the predominantly negative charge at the cloud's base. As this separation of charges continues to build up, the potential difference increases until it's sufficient for a flow of electrical current to takes place through the air. The initial flow is of electrons from the cloud to the ground. This flow takes place in a series of steps, each covering 50m to 100m and punctuated from the next step by a delay of a few microseconds. When this so-called stepped leader - which is generally invisible - approaches the ground, a rush of positive particles takes place in the opposite direction resulting in an ionisation of the air. With a conductive path thereby established, a massive flow of current - the return stroke - takes place from the ground to the cloud. This releases vast amounts of energy and is potentially harmful to people, trees, buildings and electronic equipment.

The potential difference required to cause a lightning strike will be several hundred megavolts and the peak current can be over 400kA although 30kA is more typical. The power dissipation could, therefore, be a few hundred billion watts. OK, the duration is extremely short but, nevertheless, a violent storm can generate as much power as a small power station. Needless to say this has scope for causing some pretty serious damage. In recent years, American insurance companies have reported over 300,000 separate lightning-related claims per year totalling over $300 million and accounting for around 5% of all claims.

Photo 2.

Voltage Spikes

It's not uncommon for the tabloids to run stories of television blowing up and kettles melting during electric storms. It's not hard to appreciate how a direct hit to a TV aerial could, indeed, cause some major damage. Stories of melting kettles due to strikes on the mains supply have more of an apocryphal sound to them. We'd certainly have to assume that the householder had chosen to replace all the fuses with six inch nails for such catastrophic damage to occur. Even if mishaps of this type do genuinely occur, though, what normally happens to PCs is obviously rather different. When I suffered lightning related computer damage, I didn't find a charred mass of plastic and iron, I found something which looked like my PC had always looked, it just didn't work properly. In fact, damage can be even more pernicious. As with static damage to ICs, lightning induced damage may not have an immediate effect. Instead, the equipment may become less reliable with a culmination in catastrophic failure somewhere down the line.

Just as the ground attracts lightning


Photo 3.

Photo 4. P-note mobile surge protector.

strikes, so too will electricity pylons and phone lines. A strike to such a conductor could, clearly, cause the voltage to exceed its normal value by a huge margin for a short period. There are other possible mechanisms whereby this sort of thing could happen - it isn't only in the event of a direct strike that spikes or surges could be produced. Lightning causes a broadband pulse of electromagnetic radiation - we can see the visible light and we can hear crashes on car radios. If the storm is sufficiently close to a cable, it is possible, therefore, for a current to be induced in it. Similarly, a current could be induced in a cable which runs close to a cable which has suffered a strike. Spikes or surges can also be non lightning related. Not as severe, but far more common, are over-voltage transients due to the switching of large inductive loads such as heavy industrial equipment. Even the chokes in fluorescent light fittings can generate appreciable spikes. Obviously the electricity and phone companies are well aware of the eventuality of high voltage pulses and invest heavily in protection equipment in order to safeguard consumers. However, no protection equipment will be 100% effective which means that there will still be a risk of high voltage spikes remaining on the supply. These spikes will be short-lived and so are extremely unlikely to damage non-sensitive electrical equipment such as vacuum cleaners and lights but electronic equipment, and PCs in particular, are much more at risk. Whether your PC will survive such an incident is extremely difficult to predict. If your house or office is in a built-up area and hence close to the electrical sub-station or telephone exchange then your chances are much improved. If, on the other hand, you live in a remote area, distant from any protection equipment, things could be very different, especially in the event of a nearby lightning strike. In neither case, though, does it make sense to assume that you're safe. As with all areas of computer security, if you invest a modest amount now, you could prevent suffering a major loss in the future.

Protection Equipment

There is a vast amount of protection equipment on the market which claims to offer protection against high voltage transients on the mains, on telephone cables and on network cables. Large price differences suggest that they differ significantly in their effectiveness and, to a degree, you get what you pay for. Note, however, that as in so many areas, the law of diminishing returns applies. In other words, double the price doesn't give you double the protection.

Various components can be used to

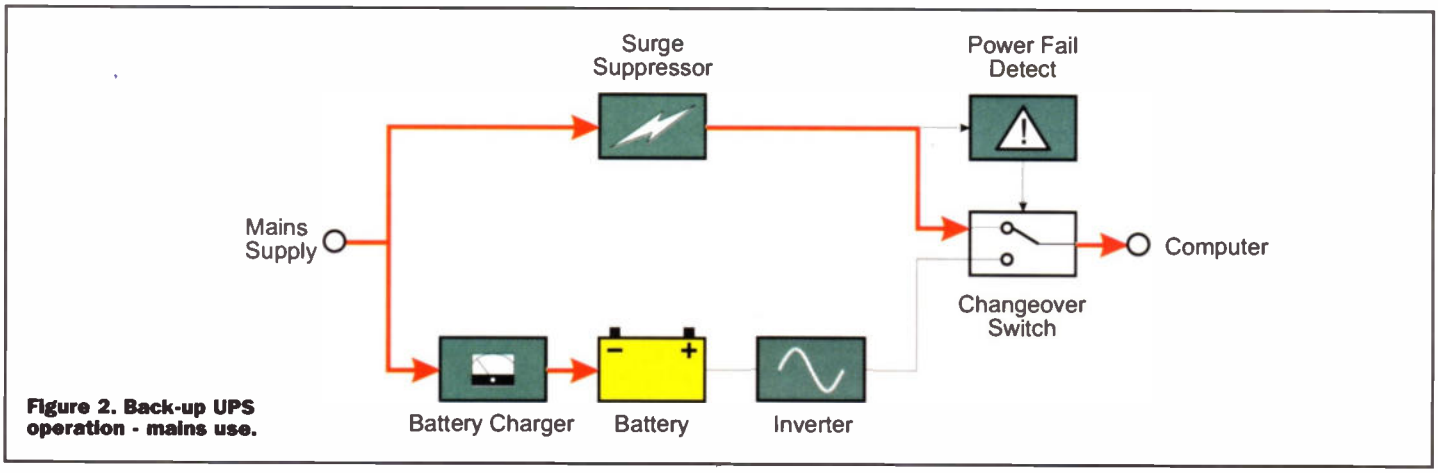


Figure 2. Back-up UPS operation - mains use.

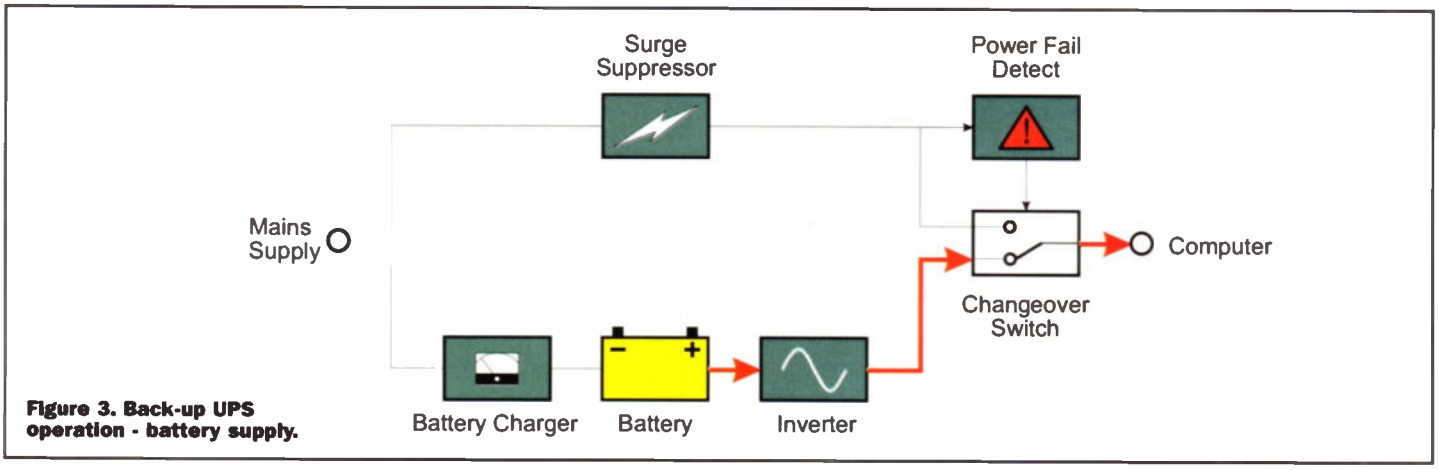


Figure 3. Back-up UPS operation - battery supply.

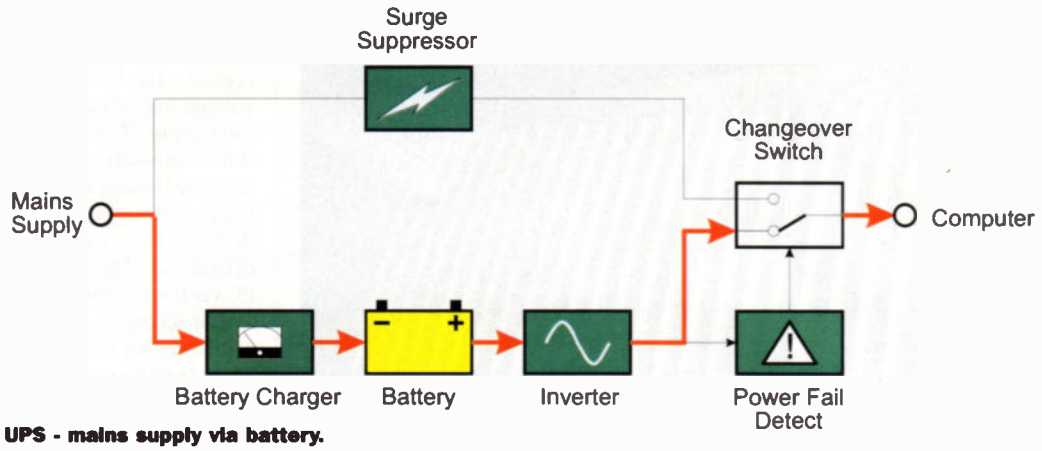


Figure 4. On-line UPS - mains supply via battery.

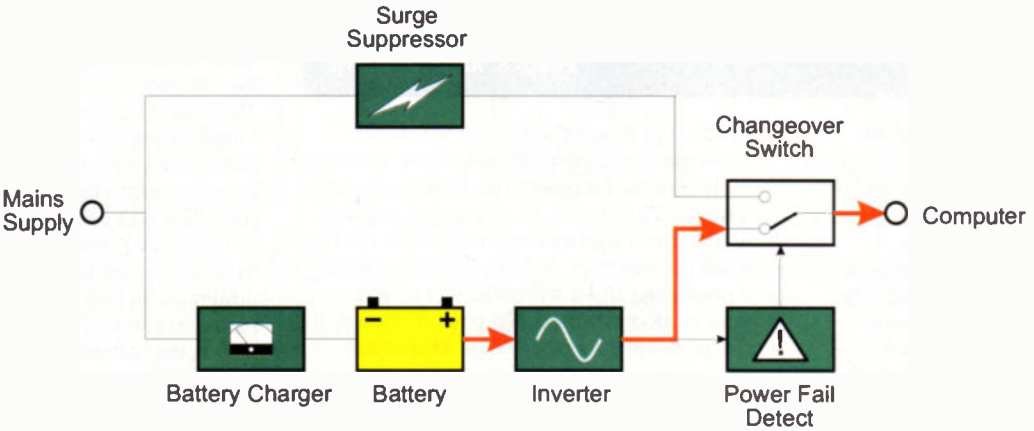


Figure 5. On-line UPS - battery supply.

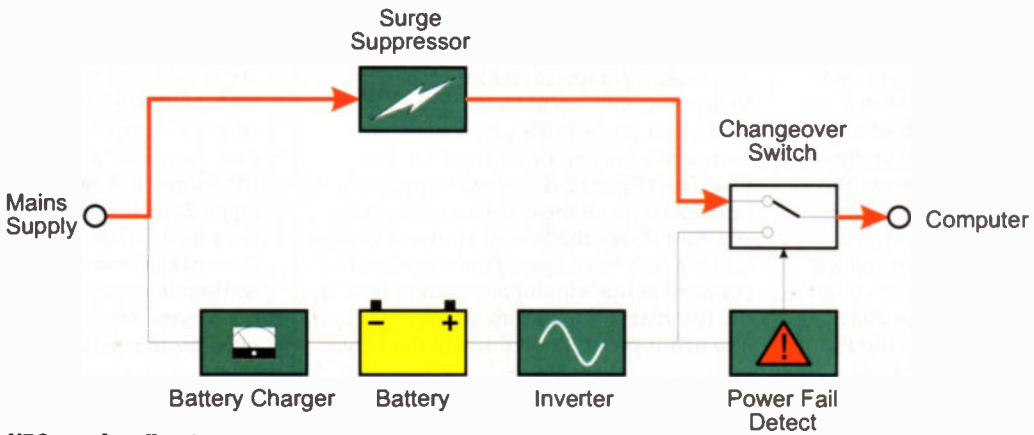


Figure 6. On-line UPS - mains direct.

provide a degree of surge suppression. These include gas-filled discharge tubes, surge relays, circuit breakers, fuses, Zener diodes and metal-oxide varistors. Components differ in the amount of energy they can dissipate and the speed at which they operate. They also differ in the voltage to which they'll limit the supply and the amount of current they can handle. Unfortunately, no one component is a universal panacea. The devices which tend to be the fastest are not able to dissipate much energy and vice versa. For this reason, the better protection equipment normally has a combination of devices, some fast ones and some which are slower acting but can dissipate more energy; some which clamp the supply to a low voltage and some which can handle plenty of current. But despite knowing something about the components used in these devices, it's very hard to tell which kit will be the most effective. To a large degree, therefore, you'll have to accept the word of the suppliers since you're not likely to have any test equipment to put those claims to the test. There is a British Standard, namely BS6651, which covers lightning protection and, in Appendix C, specifies the required performance of mains surge protection equipment. However, this is aimed specifically at protecting large buildings so is, perhaps, not too relevant for home and small business users. Nevertheless, it may be worthwhile selecting kit which is specified as a BS6651 category A device, that is kit which is intended for use at the mains outlet. These differ from the category B and C devices which would be fitted in the distribution system and where the supply enters the building respectively.

Mains Failure

As we've already seen, electricity companies provide a degree of protection against voltage transients. The most drastic form of protection is the circuit breaker which, in the event of a sufficiently large surge, will cut the supply. Various faults in the distribution system will also cause these circuit breakers to trip. An automatic mechanism will attempt to close the breaker after a ten second delay and, if the cause of the trip was an intermittent surge as opposed to a permanent fault, the supply will be restored. However, a ten second trip is sufficient to cause considerable inconvenience. Digital clocks will need resetting, central heating controllers will need re-programming, and of more relevance to this article, any un-saved work on your PC will need re-doing. Unlike the case in some counties I've visited

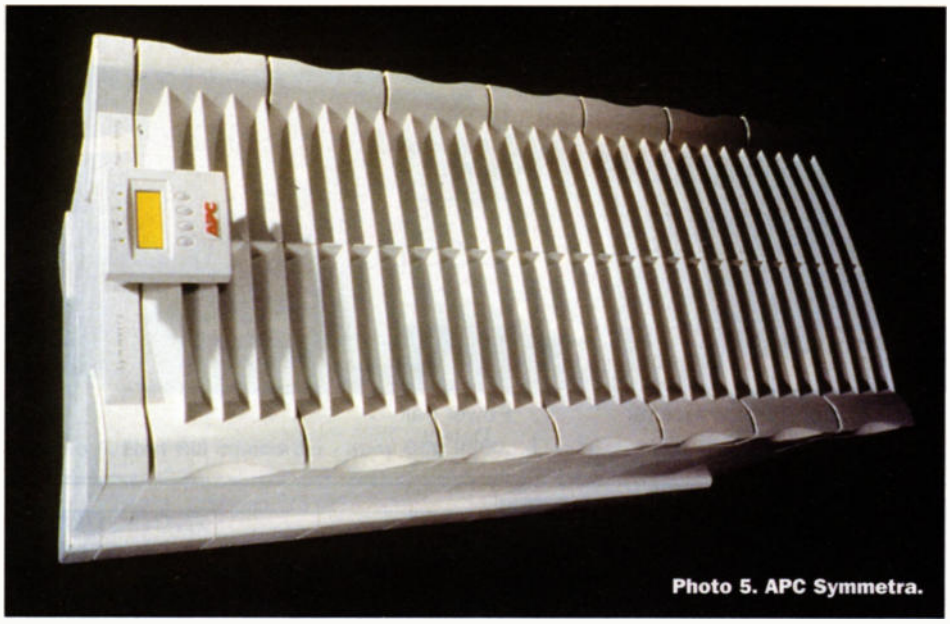


Photo 5. APC Symmetra.

in which power cuts are almost a daily occurrence, loosing the supply is a relatively rare occurrence in the UK but it certainly shouldn't be discounted, especially if you live in a remote area. Furthermore, if interruptions to the supply entering our homes and offices are relatively rare, the same cannot be said for interruptions caused within the building. As more premises are being fitted with residual current circuit breakers, safety records are improving but the likelihood of disruption to the supply is increasing. If a bulb blows, there's a significant possibility that the residual current circuit breaker will trip rather than the circuit breaker on the lighting circuit. And this, of course, takes down the sockets too. Finally, we also have to consider power sags and brown-outs. Brown outs are protracted periods of under voltage and are comparatively rare in the UK. Nevertheless, if they do occur and the voltage is sufficiently low, PCs may behave erratically or re-boot. More common is a sag, that is a short duration drop in voltage lasting a fraction of a second. PCs can often tolerate a very short power sag but there will, of course, be a point at which the PC can't cope and at this point, it will reboot. Any unsaved data will be lost.

Mains failure isn't a security risk in the same way as the voltage spikes we've looked at or computer theft which we investigated last month. These risks result in the loss of or damage to hardware. And it's a common mistake to only consider threats which affect hardware. To many businesses, the data residing on a machine is far more valuable than the hardware. OK, it's unlikely that mains failure will wipe out a data file (although conceivably this could occur if you happened to be saving that file at the time of the power cut) but time is valuable. And if you're not in the habit of saving your files regularly, a power cut could result in the loss of a considerable amount of work. To a home user, time doesn't equate to money in quite the same way but loss of work is, nevertheless, still very annoying. The way to prevent mishaps due to mains failures is to invest in an interruptible power supply (UPS). This is a unit containing a battery which is connected between the mains supply and the PC and which will continue to supply power for a few minutes in the event of a power cut. Unless you buy a huge UPS, it won't allow you to continue working through a protracted power cut but it will prevent your PC from re-booting during a power sag and it will allow you to save your work and shut down your PC cleanly if the power shows no signs of returning.

Interruptible Power Supplies Investigated

To the uninitiated, one UPS is pretty much the same as another. However, there are two quite different technologies, each of which offers its own advantages. To help you make a choice, therefore, let's take a look at the competing technologies.

The first type of UPS we'll look at is known as a backup or off-line UPS. Two diagrams (Figure 2 & 3)show its principle of operation – in all these diagrams the bold red lines shows the flow of electrical current and the thin black lines signify an electrical connection but without any current flow. In the first diagram the mains supply is present. The mains power flows through the surge suppressor and a changeover switch to the PC. The mains supply is also used to keep the battery fully charged. The inverter converts the low battery voltage to mains voltage and although 240V will be present at the output of the inverter, no current will be drawn since the PC will be operating directly from the mains via the upper path. When the mains supply fails, the power fail detector causes the changeover switch to operate so that the battery now supplies the PC via the inverter.

The second type is the on-line UPS and, as before, we have a pair of diagrams to show how it operates with and without mains power present see Figures 4 & 5. Unlike the case with the backup design, even when the mains power is present the equipment operates from the battery via the inverter. The mains supply simply trickle charges the battery. When the mains supply fails, the current path from the battery via the inverter to the PC remains the same. The only difference is that the battery is no longer being trickle charged. You'll notice that there's a part of the circuit which we haven't mentioned at all, namely the upper path. This isn't used under normal conditions or when the power fails so it doesn't appear to be necessary. In fact, it's quite possible to design an on-line UPS without this upper path and some of the cheaper designs do omit it. But batteries and inverters are, perhaps, more fault-prone than most electronic equipment, so the upper path is a backup circuit to provide continuity in the event of circuit failure. If the power fail detector recognises that there is no output from the inverter it switches in the direct path to the mains supply instead - see Figure 6.

The pros and cons of the two approaches are not difficult to understand. Since the backup design involves a changeover switch which will operate in the event of power loss, there will be a short duration sag on the supply as it switches. Whether this is a major issue is open to debate and we can reasonably assume that this is something the vast majority of PCs should be able to withstand just as they can cope with mains-borne sags. Manufacturers of on-line UPSs, needless to say, have a rather different view

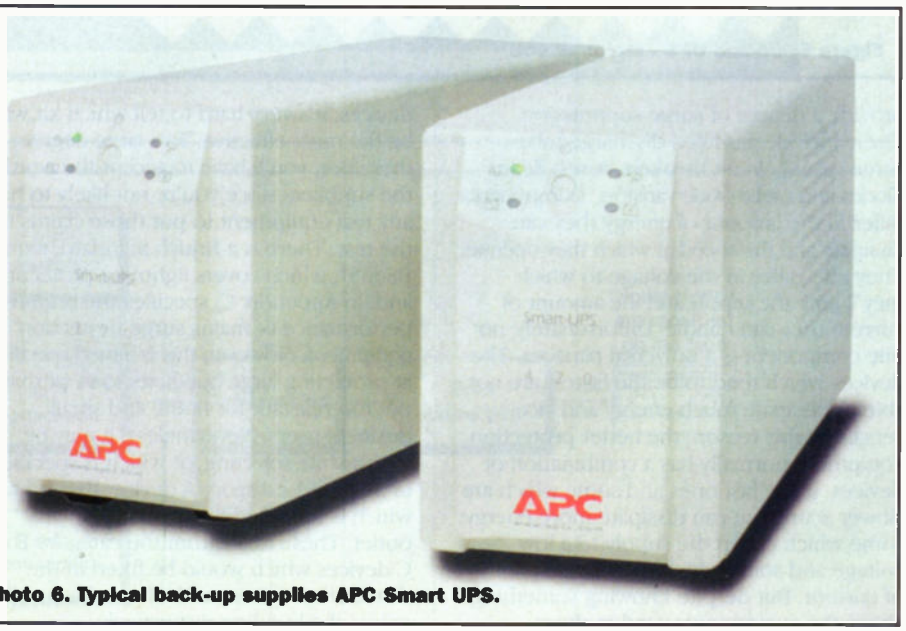


Photo 6. Typical back-up supplies APC Smart UPS.

and will indicate that this is something which should be avoided at all costs. Except in the event of circuit failure, the changeover switch in an on-line UPS doesn't operate so there should be no power glitches as the mains supply is cut. However, converting mains power to a low voltage DC supply and then back to 240V AC is inefficient so on-line UPSs could increase a PCs power consumption although some of the more modern designs are remarkable efficient. Also, cheaper on-line UPSs include a square wave or a stepped wave inverter and so do not produce a true sine wave AC supply. There are suggestions that this can stress a PC's power supply. Of course, the same could be true of an off-line design but in this case, this is only relevant during power cuts whereas with on on-line design the PC operates from the inverter all the time. One other thing to consider is the degree of mains spike suppression offered by the UPS. Obviously the on-line design is better in this respect since, except under fault conditions, the PC is totally isolated from the mains. This is not the case with the backup type although most UPSs do contain a surge suppressor. Nevertheless, the surge suppressor is often intended, primarily, to protect the UPS itself and has a fairly minimal specification. Even if you have a UPS, therefore, it may also be worthwhile obtaining separate surge protection equipment.

Having decided on the basic technology, your buying decision comes down to the capacity of the UPS. Capacity can mean two quite different things and both should be considered. First of all it specifies the largest load the UPS can withstand. For an ordinary PC a small 250VA unit should be adequate. However, if you have a huge server and want to attach additional peripherals such as a printer you'd be well advised to add up the power ratings and buy a UPS accordingly. Do be aware, though, that many UPSs will only have a couple of output leads so if you do want to connect more than just a PC base unit and a monitor, you may have to buy an IEC distribution board too. Capacity can also refer to how long the unit can supply current from its batteries and this will depend, obviously, on the current being drawn from it. If you only intend to shut down your PC cleanly in the even of a power failure, five minutes is perfectly adequate but if you need to be able to continue working you'll need something more. And finally a word about what happens following a power failure. If you're not at your PC when the failure occurs and it's daytime so the lights aren't on you may be oblivious to the fact there's been a power cut. And by the time you find out the battery in the UPS could have been drained and your PC will be off. Having a UPS wouldn't have done you any good, therefore. So most UPSs have an alarm which sounds following a mains failure to call you back to your PC to do whatever is necessary. But even this doesn't help if you're out of ear-shot so some UPSs have a data connection to the PC which can trigger a controlled shut-down automatically. This supervisory software is user configurable so that you can decide what ought to happen in the event of a failure.

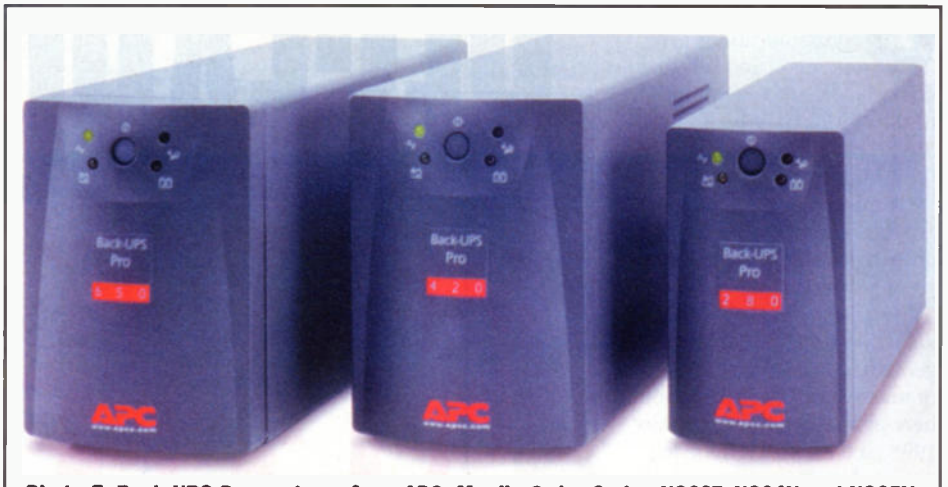


Photo 7. Back UPS Pro systems from APC. Maplin Order Codes UC63T, UC64U and UC65V.

COMMON SENSE

As in so many areas of computer security, simply applying a bit of common sense can do a lot to protect your valuable equipment. Whether or not you decide to invest in surge protection equipment and interruptible power supply, it;s very easy to provide additional protection at very little cost.

I've often heard it suggested that PCs should be left on 24 hours a day, seven days a week, 52 weeks a year. The argument is that turning them on and off stresses the power supply and results in premature failure. OK, I can see there could be an element of truth in this but PCs are, nevertheless, designed to be switched on and off daily, they tend to be reliable, and they're probably under warranty. A PC constantly left on, on the other hand, will consume up to £75 worth of electricity per year more than one only turned on for eight hours a day (depending on its power-saving options), and is three times more likely to suffer failure due to mains surges. I think I've made my point.

We've looked at the possible mechanisms by which spikes can get into phone lines and data cables so don't make cables longer than necessary and don't run them alongside potentially dirty' mains cables for any significant length. If you're in an office which is fitted with a lightning conductor, you should keep any cables well away from the lightning conductor's down lead even though it will be on the outside of the building.

Finally, if a thunder storm is looming, it could well be a good idea to unplug the phone line from your modem or the phone socket on the rear of your PC.

Sources

The Maplin catalogue is a good source of many of the types of products we've discussed in this article. Take a look at the sections on Computer Products for UPSs and an extensive range of surge suppressors for mains, phone lines and data cables, or you could try the major PC suppliers.

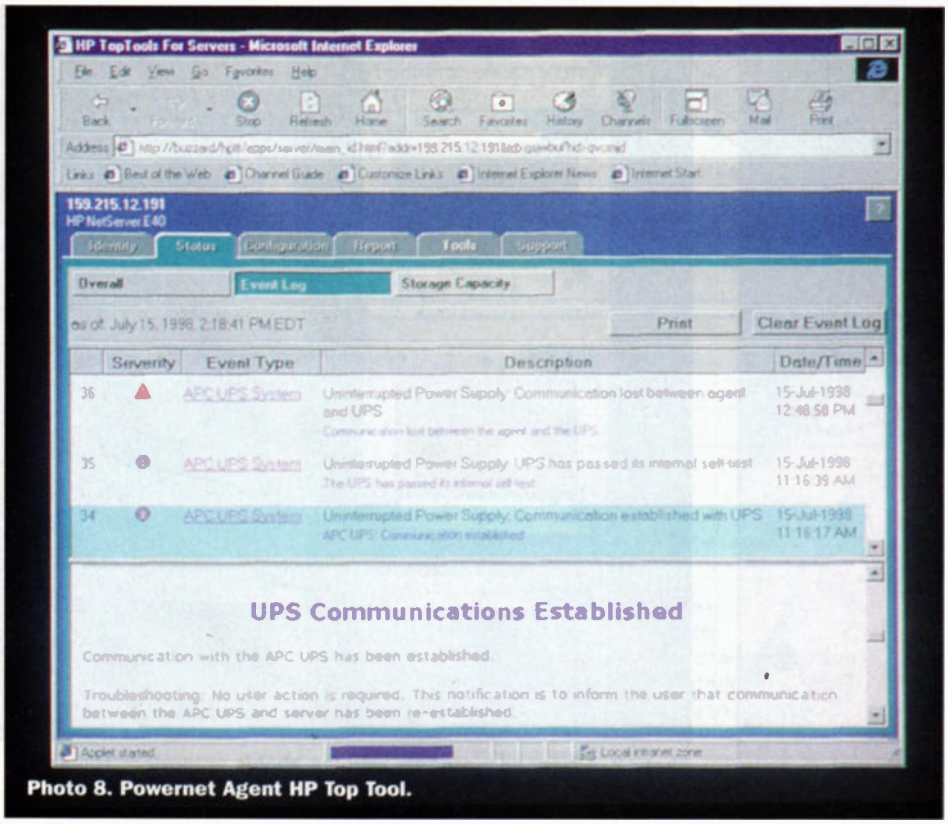


Photo 8. Powernet Agent HP Top Tool.

RESEARCH NEWS

by Dr Chris Lavers

Advanced Materials Aid De-Icing of Microwave Communications Antennas in Labrador, Canada.

Operation of microwave communications networks and relay stations in the hostile Arctic winter environments of Northern Canada pose some very unique problems not encountered in more temperate climates like our own. NewTel Communications, a Canadian company has experienced extremely severe icing on their microwave relay towers, generated spectacular pictures of microwave tower icing, seen here at Monkey Hill in January 1998 (see Photo 1). Rime ice accumulations on microwave antennas and receivers, such as the Monkey Hill site in Labrador, can over time damage and seriously degrade electronics systems performance simply on account of the weight of ice distorting the antennas. Two of the worst sites for ice damage are located at Sand Hill near Cartwright, and at Monkey Hill near Makkovik, where rime ice thicknesses in excess of 1.5m have been measured! NewTel Communications have upgraded their facilities to operate at a frequency of 6GHz instead of 900MHz, but the 6GHz (H-Band microwave system) frequency is of special concern since the reduced wavelength results in an increased sensitivity to ice accumulations and possibly greater signal loss. The Centre for Cold Ocean Resources Engineering (C-CORE) Memorial University of Newfoundland is currently designing and installing a mechanical system to prevent accumulation of ice on radomes. Work there is co-ordinated by Jerry English who is just about to install a test panel at Monkey Hill to evaluate various advanced materials which hinder the formation of ice on their external surfaces and ensure low cost maintenance. Basically if there is no ice on the surfaces then there will be no damage! Materials which successfully repel and delay the onset of rime ice accumulation, having so called 'ice-phobic' properties are in great demand. Test samples have been provided by space based companies from within Canada and Europe.

Photo 1. Rime ice accumulation on microwave antennas at Monkey Hill Labrador. Courtesy of C-Core.

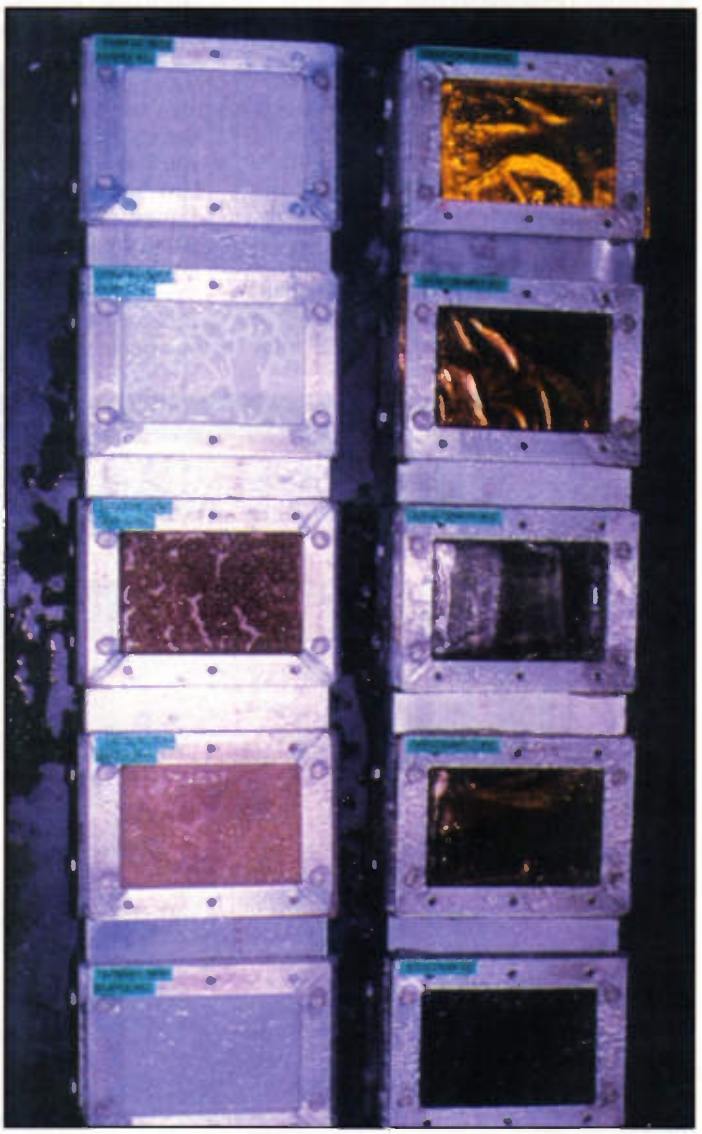


Photo 2. Advanced materials with ice-phobic properties subjected to ice and snow accretions in the laboratory with a 0.125 inch deposit of rime ice. Courtesy of C-Core.

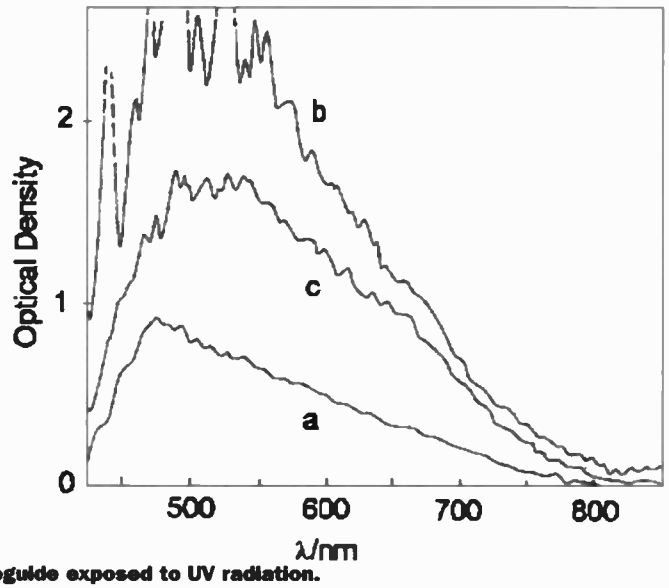


Figure 1. Waveguide exposed to UV radiation.

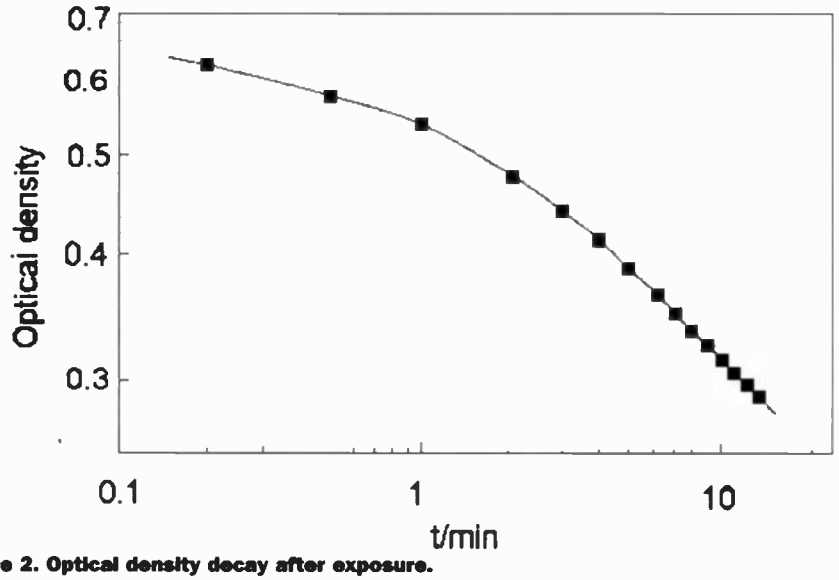


Figure 2. Optical density decay after exposure.

Many specialist coatings developed by the European Space Agency's own program have good anti-ice properties and are particularly attractive candidates.

In the near future the electromagnetic transmissivity of these materials (needed to be high to ensure good microwave reception) will be measured right across the frequency range between 900MHz to 6GHz. The propagation of microwave signals through ice of various thickness has already been extensively characterised by a number of researchers. Personnel from Daimler-Benz, more familiar for its automotive and aerospace products, have asked to participate in the Labrador based project. Figure 2 shows some snow and ice build-ups on some of the material samples obtained from Daimler-Benz and a number of other companies, Cametoid Ltd (partnered by Chevron Canada and C-Core), Diavac AMC Ltd (a UK company) and RST (Raumfahrt Systemtechnik GMBD from Germany). So far the most promising materials tried, are shown in Photo 2, and listed in table 1. Diavac provided some interesting ultra-thin carbon coatings on mylar sheets with interesting diamond-like properties, prepared under various temperature and vacuum conditions. RST provided rigid materials while Cametoid provided a vacuum deposited coating on a flexible substrate. Daimler-Benz provided samples having both flexible and rigid materials with ice-phobic properties.

Company	Material Type	Comments
Cametoid	Coated aluminium	Flexible
RST	Loran-S	Rigid
Daimler-Benz	PTFE coated glass fabric	Flexible
	PTFE coated PTA fabric	Flexible
	TFM coated glass fabric	Flexible
	TFM coated aramide fabric	Flexible
Diavac ACM Ltd	DLC coated Mylar film:	All samples are flexible
	5 min at 200V one side	
	20 min at 200V one side	
	5 min at 300V one side	
	10min at 300V one side	
	5 min 300V both sides	

Table 1.

Ice-phobic properties of these materials were also measured through a simple scratch test with one of the DLC coated mylar films giving the most promising results. These same materials have been recently installed on a super Puma helicopter to evaluate how they inhibit in-flight ice accumulation and help preserve aerodynamic performance. They will also be installed on a drilling ship operating in the Grand Banks over winter. If all these trials are successful C-CORE believe that it will open up new markets for applications of these materials in hostile working environments: for Arctic installations, helicopters, fixed wing aircraft, ships and oil rigs (Chevron Canada has expressed keen interest in testing out some of these ice-phobic materials on their exploration well drillings ships or rigs). On oil rigs freezing sea spray, particularly in the Arctic ocean, can be a major problem. This project is ongoing and the test materials will be evaluated during the winter of 1998/1999. Originally the test panel was to be deployed in early March 1998, but a freak ice storm caused some of the antennae on the tower to break away, with winds of over 200km/hour experienced!

For further information about protecting microwave communications in extremely hostile environments contact: E-mail: **<genglish@morgan.ucs.mun.ca>** or telephone (709) 737-2594 Fax (709) 737-4706 or write to: Jerry English C-CORE Memorial University of Newfoundland, St Johns, Newfoundland, Canada A1B 3X5. **<http://www.mun.ca/ccore>.**

New Optical Ultra-Violet Radiation Sensor

Since the terrible nuclear disaster at Reactor 4 just outside the Ukrainian city of Pripyat, (now called Chernobyl) in 1986, there has been a vast amount of research to try and develop radiation sensors which can be operated in hostile operating environments without the need to risk the health and lives of human operators. A pioneering group of researchers in Japan have successfully demonstrated a sensitive optical waveguide sensor which when deployed at

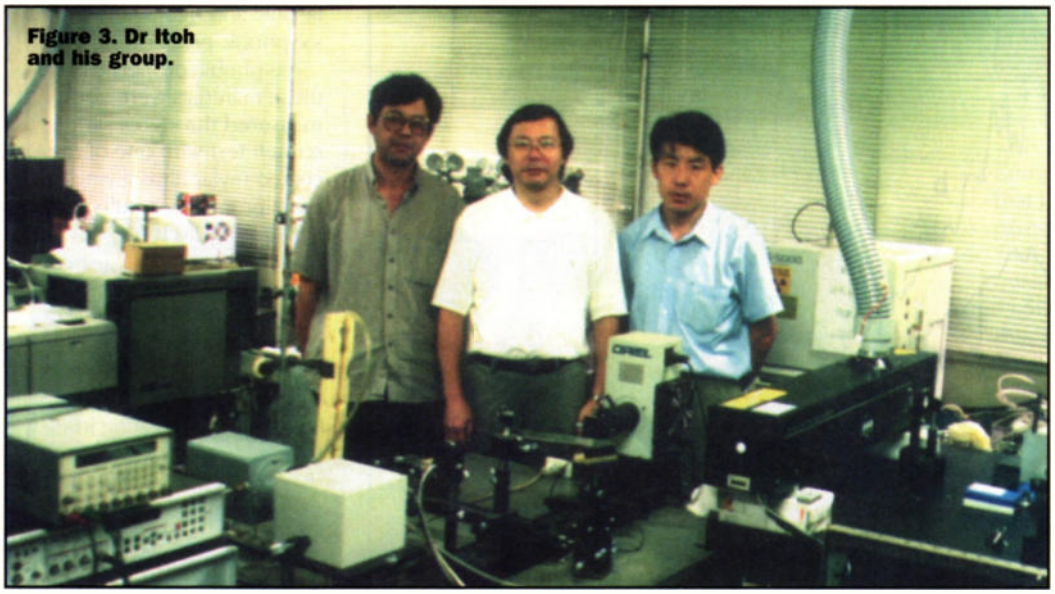


Figure 3. Dr Itoh and his group.

the end of an optical fibre system may lead to safe monitoring of hazardous radiation and chemical species remotely.

The Japanese group is led by Professor Kiminori Itoh, of the Institute of Environmental Science and Technology, Yokohama National University, and by Professor Murabayashi who has been developing optical sensors for nuclear environments ever since joining the Institute for Material Research at Germany's Nuclear Research Centre in 1971 (1971-1973). He is also currently engaged in research on optical waveguide sensors and the photocatalytic reaction for water and air treatment. Flat optical waveguides are fabricated by 65min immersion in potassium nitrate at 385°C. UV induced bleaching has long been known to have a temporary effect on optical fibre transmission loss. Flat waveguides are well suited for measuring the transient nature of UV induced bleaching due to their long interaction length. 2μm deep waveguides were examined with 255nm Hg lamp exposure and an intensity of 3.8mW/cm². Spectra were recorded after (a) 15sec (b) 60sec illumination, and monitored (c) 1min after irradiation was halted. The spectrum shows a reduction in optical transmission, in (a) and (b), for a 1cm optical path Figure 1.

For short irradiation, guided light intensity returns to its original level in several minutes. Recovery times seem to be linear for short irradiation. For long exposure, recovery time is slow, and almost irreversible. Considering the known nature of glass exposure, recovery will be enhanced by heating (as in thermoluminescent dosimetry). Spectra taken with an optical multichannel analyser resemble those reported from X-ray doses exceeding 16.6kR/min for several minutes. These results have been repeated in optical quality glass such as BK7. The decay of the waveguide change extend from 1 minute to many hours, (giving an approximately linear decay in log-log plots) A typical glass optical density vs time is shown, Figure 2. The decay is rather complicated and when the mechanism is better understood will serve as the basis for a waveguide UV radiation and perhaps X-ray sensor. Dr Itoh is shown at centre in Figure 3, with two Chinese researchers, Dr Qi Zhimei, an expert on semiconductor gas sensors (right), and a taller Abliz Yimit from Xinjiang University in the far west of China (left)! In front of them is equipment for waveguide spectroscopy, shown in outline in Figure 4. However, let us hope that emergency needs for such remotely deployable sensors is rare indeed.

Forthcoming Electronics and Electronics related conferences

30 June-2 July 1999 **Integrated Electro-Optics Devices and Systems** will be held at the Centre for Professional Advancement, Oudezijds Voorburgwal 316A, 1012 GM Amsterdam, The Netherlands. Fax +31/20/620.21/36 Phone +31/20/638.28.06 Learn how to design electro-optic devices. Understand how to evaluate these devices for use in system applications. Explore the characteristics and advantages of fibre-optic/integrated optic devices and systems.

International Conference on Ageing Studies and Lifetime Extension of Materials, 12-14th July 1999 at St Catherine's College, Oxford. Contact Dr Les Mallinson, AWE Aldermaston, Reading RG7 4PR UK Tel +44 (0) 118 9827993 Fax +44 (0) 118 9824739

4th International Conference on Laser Metrology, Machine Tools and Robot Performance. Northumbria University, Newcastle UK, Contact Fax +44 191 227 3684.

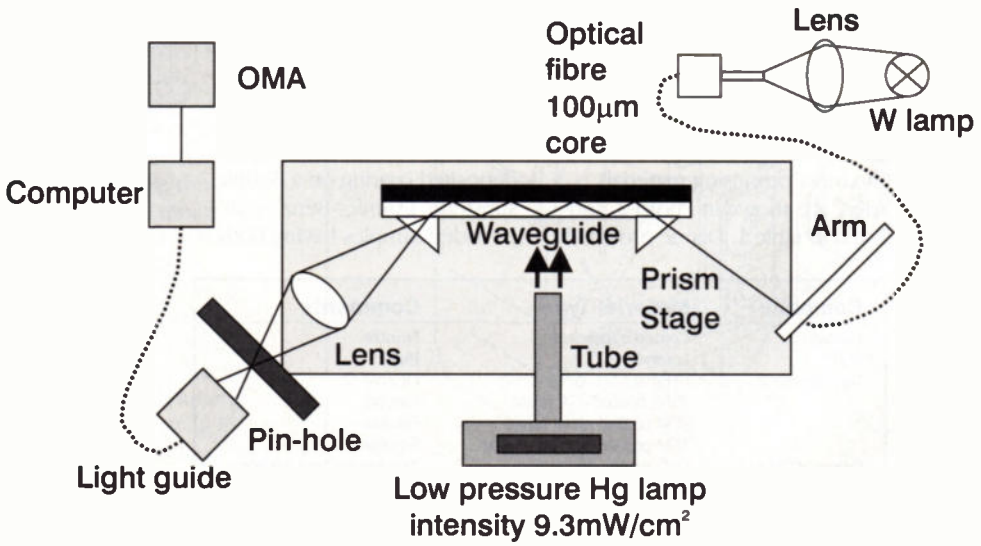


Figure 4. Waveguide spectroscopy kit.

Electronics IN AGRICULTURE

PART 10

Electric Fences

George Pickworth continues his fascinating series with a look at electric fences.

Photo 1. An electric horse fence, note the wide tape conductors (courtesy of Eddie Pailin Dist. Ltd.)

Introduction

The electric fence, introduced to the UK (as far as I remember) by the Wolseley Sheep Shearer Company in the 1930's, is the most versatile fencing system ever devised. See Photo 1. It paved the way for the mechanical hedge cutter, shown in Photo 2, which came into general use during the 1960s and ultimately brought about the demise of traditional hedges and fences.

Traditional

Traditionally, hedges were made stockproof (barrier to farm animals) by a technique known as cutting and laying. See Photo 3. The strongest hedges were the so called Leicestershire 'bullock' hedges which provided an effective barrier to beef cattle which once fattened the county's rich pastures.

Cutting and laying a hedge was a skilled and time consuming operation and it accounted for much of the farm maintenance budget. The mechanical hedge cutter was an attractive alternative but the problem was that no machine was capable of making hedges stockproof.

However, the fact that mechanically trimmed hedges were not stockproof became progressively less significant as ever more pasture land was planted with arable crops. Indeed, if a field was required for grazing by livestock, a temporary or semi-permanent electric perimeter fence could be quickly erected at low cost. So, the electric fence and the mechanical hedge cutter thus neatly complemented each other. Hedges provide food and shelter for a variety of birds and other wildlife but of particular importance, they provide corridors for wild life moving across the country, for example, from one area of woodland to another. Progressive farmers use mechanical hedge cutters so as to give the hedge a triangular cross section with a broad base; this enhances the hedge row as a wildlife corridor - see Figure 1. In fact such hedges are more beneficial to wildlife than traditional cut and laid hedges.

The Fence

An electric fence is essentially cord or netting made conductive by being interwoven with fine wire; it is supported by insulators attached to posts or stakes. The fence is connected to one terminal of the energiser whilst other terminal is connected to the earthing electrode. See Photo 4 & Figure 2.

The energiser delivers periodic, typically 1Hz, high voltage pulses during which a potential difference exists between the wire and earth. So, if an animal makes contact with the wire the circuit is completed via the animals feet and it receives an electric shock. See Figure 2.

To be effective, the pulse must the have a potential of at least 1.5kV and carry a charge of least 0.2 Joule - this is enough to give the unwary a very unpleasant jolt! Repetition frequency should not be less than 1Hz. See Photo 4.

Modern energisers deliver up to 3.2 Joules at 5kV which is approaching the limits laid down by British, European and International safety regulations. Notices, warning the public not to touch the wires have to be posted when electric fences run near to places open to the pubic.

Lower Resistance

Light gauge galvanised iron wire was originally employed as the fence wire but as already mentioned, this was superseded by polyethylene cord interwoven with several strands of fine wire, generally referred to as 'polywire.'

Because of its durability, stainless steel wire was commonly used with polywire but because of its high resistance it has largely been superseded by aluminium or copper wire especially for long fences.

Photo 2. A mechanical hedge cutter that produces a broad base hedge with a flat top (courtesy of McConnel Ltd.)

Photo 3. A traditional cut and laid hedge. They no longer have any practical application in modern farming, but landowners are encouraged to perpetuate these skills alongside roadways where the hedges are aesthetically pleasing. Photo by author.

Photo 4. A battery powered energiser connected to a net wire sheep fence.

Animals

Electric fences are not only used to keep a wide range of farm animals within enclosures, but to keep out marauding animals, such as foxes and dogs. Electric fences are also effective in keeping foxes out of wild bird sanctuaries. The number and height of the wires depends on the type of animals involved, for example, wires set low with a poultry fence and high with a deer fence. See Figure 3.

A single strand of polywire suspended on insulators about 1m above the ground is generally all that is required as a moveable cattle fence for 'strip grazing.' More about this later. 'Tread-in' metal stakes are generally employed with moveable fences as the stakes are easily inserted and removed, as shown in Figure 2. A semi permanent fence usually has three wires spaced 250, 550 and 900mm above the ground. Sheep were notorious for making gaps in even the best maintained hedges and wandering off to where they believed the grass was greener. Indeed, when I was a school boy during the early 1930s, my grandfather was for ever repairing such gaps whilst I was sent to round up the sheep.

Today, sheep farmers use either a permanent electric fence consisting either of four stands of polywire, or a moveable polywire netting fence often referred to as flexinet. See Photo 4.

Horses were traditionally kept in paddocks with post and rail fencers but whilst being very attractive such fences are expensive both to construct and maintain. Electric fences were an alternative. Unfortunately, horses had problems in seeing a polywire fence, but this was overcome by using wide tape interwoven with fine wire, referred to as 'polytape' as shown in Photo 1.

Electric fences around horse paddocks are normally permanent or semi permanent installations but polytape is not unattractive and is now widely accepted.

A drawback with all electric fences is that they have to be frequently checked for faulty insulators and contact by vegetation; this is of particular importance with fences suspended close to the ground. Some farmers use a lawn mower to maintain the grass under the fence.

Pasture Management

Sheep and horses prefer to nibble short grass, while cattle wrap their tongue around a bunch of grass and adopt a tearing action. This makes cattle more suited to grazing taller grass.

If left to their own devices, sheep and horses will selectively graze shorter grass and neglect taller grass which results in a patchwork of overgrazed and undergrazed pasture. The rejected patches of grass often become weed infested and this is a typical feature of paddocks grazed exclusively by either sheep or horses.

Traditionally, farmers overcame the problem of selective grazing by mixing cattle with horses and sheep and whilst this technique does equalise grazing to a limited extent, depending upon the ratio of the various animals, it is far from ideal.

Strip Grazing

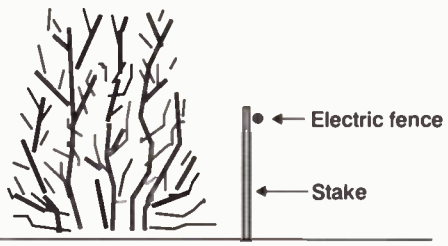
A far more efficient method of pasture management is known as strip grazing but this only became practicable following the introduction of the electric fence. Indeed, it was the first application for electric fences in this country. See Figure 4.

With strip grazing, the electrified wire is advanced across a field in stages so as to provide just sufficient fresh pasture each day for a given number of animals. The grazed strips are then allowed to rest and be grazed later in rotation. However, the system does require a portable drinking water supply.

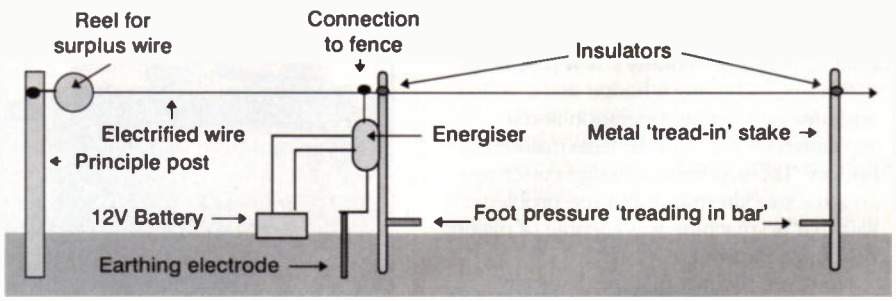
Leaf/Root Balance

The root system of grass balances itself with its leaf area. So, if grass is continually grazed, as is usually the case when animals remain for long

Figure 1. Cross section of mechanically trimmed broad based hedge.



This hedge has a flap top, a broad base which serves as a wild life corridor. Some farmers prefer a triangular cross section. See Photo 2. Also note electric fence.



N.B. See also Photo 5.

Figure 2. A single wire electric fence used for strip grazing with cattle.

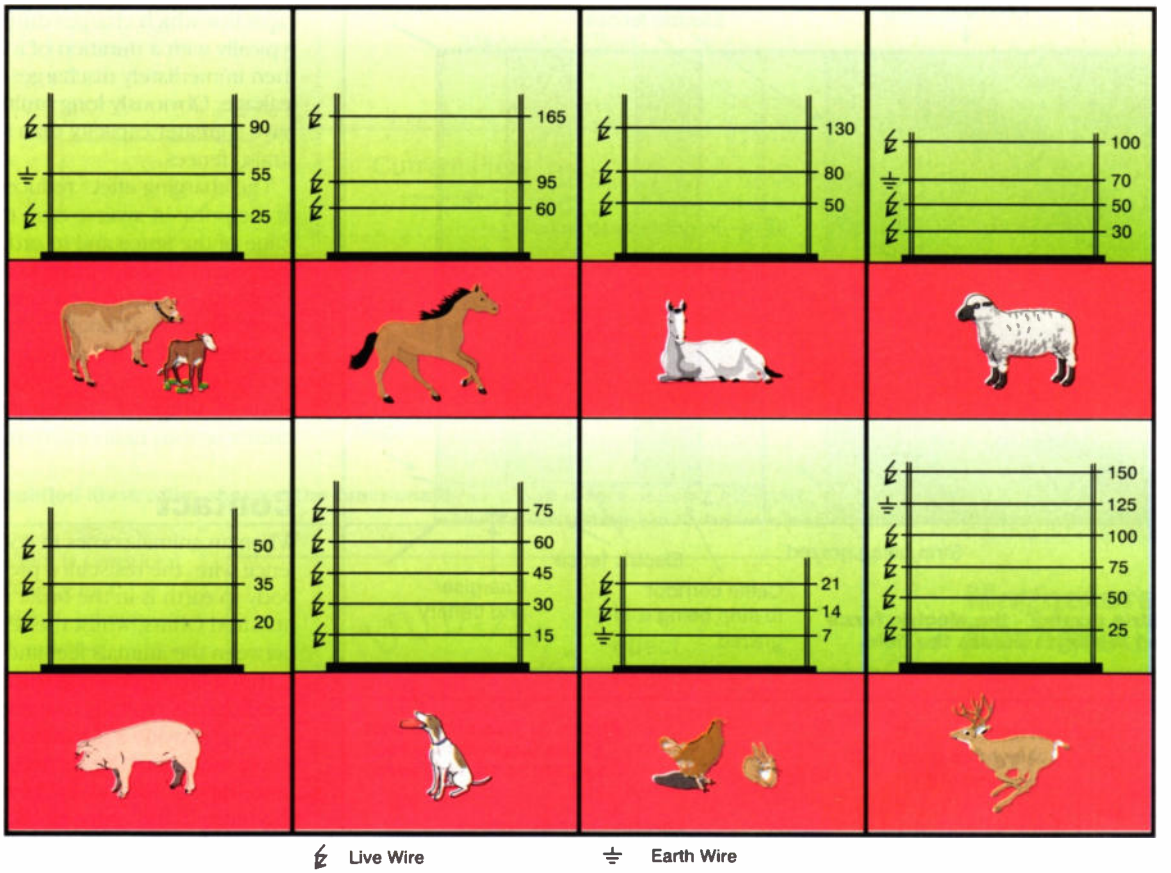


Figure 3. Diagram showing recommended height (cms) and number of strands for use with various animals.

periods in a single field, the grass root system is, in effect, similarly grazed and therefore unable to fully develop. See Figure 5.

If continuous grazing is carried to the extreme, there is a dramatic decline in the vitality of the grass and invasion of the pasture by unpalatable and often poisonous weeds. So, by periodically allowing the grass to grow to its optimum height and therefore develop a strong root system, it makes rapid re-growth after grazing and yield is maximised.

The Fencer

With early electric fences, the energising pulse was generated by a solenoid type induction coil in conjunction with a mechanical interrupter. A high voltage pulse was developed across the coil's secondary winding each time current flowed through its primary winding but this would be suddenly interrupted and the magnetic field would collapse.

Under no-load conditions, the potential of the pulse could theoretically rise to infinity but in practice the resistance and capacity of the fence with respect to earth presents a load. Nonetheless, electric fencers have protection devices to prevent excessively high potentials from developing if not connected to the fence. More about this later.

Interrupters

Mechanical interrupters were based on a spiral-spring-escapement similar to that of a clock - operation is shown in Figure 6. However, around 1960, the spiral spring escapement was replaced by a transistorized timer and switching transistor which eliminated problems inherent in mechanical interrupters. See Figure 7. The switching transistor approach also eliminated the need for the external magnetic field to operate the escapement. So induction coils were replaced by much more efficient closed field transformers.

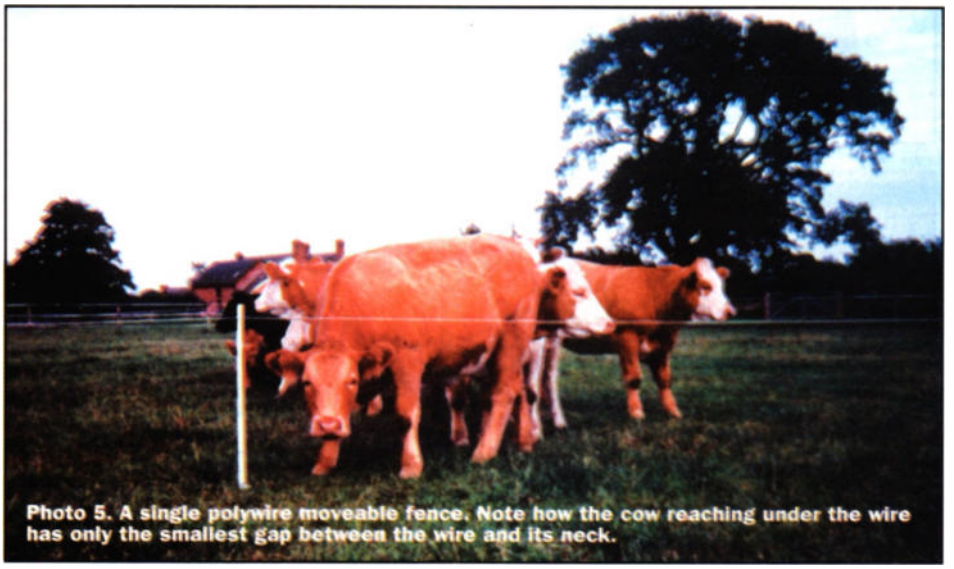


Photo 5. A single polywire moveable fence. Note how the cow reaching under the wire has only the smallest gap between the wire and its neck.

Capacitor Discharge

Modern fence energisers are invariably of the capacitor discharge type. See Figure 8. When the capacitor discharges through the transformer's primary winding, the energy stored in the capacitor is transferred via the secondary winding to the fence wire at a much higher potential.

A further advantage of capacitor discharge method is that the energy stored in the capacitor can be precisely controlled and therefore the magnitude of the pulse. In fact, the charge in the capacitor in Joules is taken as the power rating for each model of energiser. See Data Sheet.

A disadvantage of the capacitor discharge system is that with battery powered energisers an inverter is required to step up the 6V to 12V DC supply to the 100V to 600V DC required to charge the capacitor. On the other hand, with mains powered energisers, the capacitor charging current is derived via a transformer and rectifier.

Rating

The fence is technically an open circuit but leakage across insulators and vegetation touching the wire normally presents a small but significant load which reduces the energiser's no-load peak voltage. See Data Sheet.

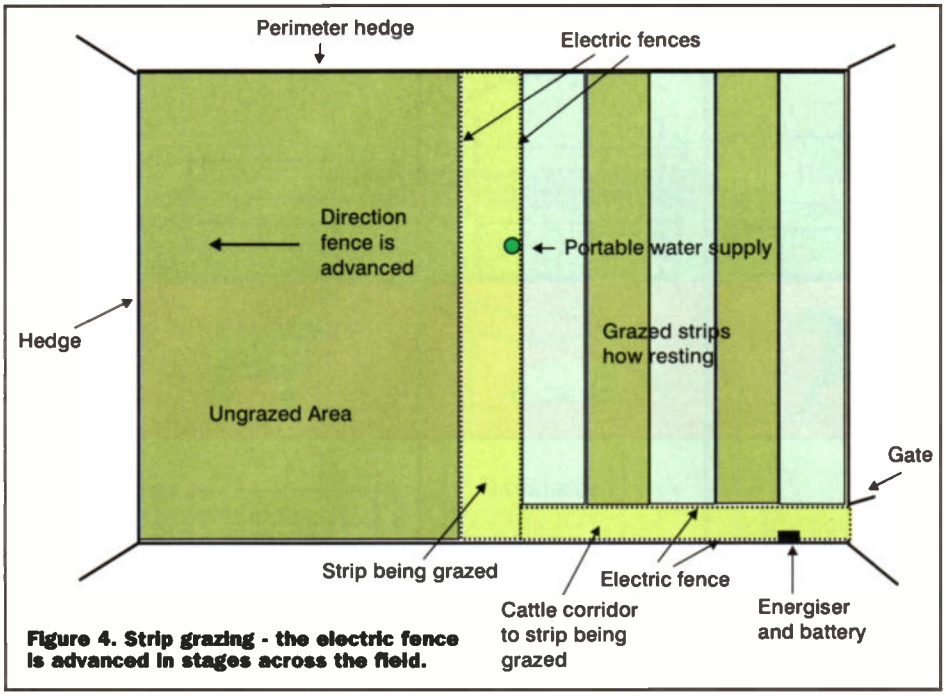


Figure 4. Strip grazing - the electric fence is advanced in stages across the field.

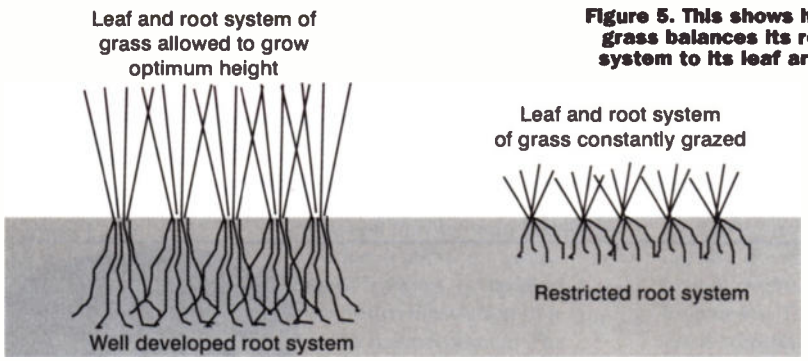


Figure 5. This shows how grass balances its root system to its leaf area.

Photo 6. A battery powered fence energiser (courtesy of Eddie Pallin Dist. Ltd.)

Photo 7. A solar powered fencer (courtesy of Tanton Ltd.)

Class	Power Supply Volts	Charge Joules	Voltage kV On-Load 5kΩ*	On-Load 500Ω**	No Load	Current Consumption	Max Fence Length km
Standard	9-12V DC	0.14	4.5	1.1	5.5	20-28mA	3.0
Medium	12V DC	1.2	3.8	3.0	5.5	150mA	30
Super	12V DC	2.5	5.0	4.0	7.0	300mA	50
Standard	240V AC	0.2	5.2	2.5	8.0	2W	6.0
Medium	240V AC	1.6	4.5	3.0	6.5	2.5W	30
Super	240V AC	3.2	5.0	3.3	7.5	3.5W	60

*5kΩ Typical fence insulation including contact by vegetation *500Ω Contact by an animal
N.B Max fence length refers to a single wire fence, which has to be proportionally reduced with multi-wire fences.

Data Sheet A. Fenceman™ Energisers - kindly supplied by Eddie Pallin Distribution Ltd.

The fence/earth also behaves as a capacitor which charges during each pulse, typically with a duration of a few millisecs, then immediately discharges through leakage. Obviously long multi strand fences have a greater capacity than short single strand fences.

The charging effect reduces the potential of the pulse in inverse ratio to the capacity value of the fence and in order to maintain the potential of the pulse at an effective level with longer fences, energiser power has to be proportionally increased.

However, if an insulator breaks down and arcing occurs, then the fence behaves as a Marconi 'untuned' spark transmitter and causes serious radio interference.

Contact

When an animal comes in contact with the fence wire, the resistance presented by its body to earth is in the order of a few hundred Ohms, whilst the resistance between the animals feet and the energiser's earthing electrode under ordinary U.K. conditions is typically of the same order.

So, to provide a good match to the fence, the resistance of the secondary winding of a fence-type induction-coil or transformer is therefore in the order of 10kΩ. Unfortunately, the resistance of very dry soil is too high for the fence to be effective, but this drawback can be partially overcome by employing additional wires as a substitute for the earth. The reasoning being that the animal will come into contact with both wires. See Figure 3.

Battery Powered

Battery operated fencers are completely portable and ideal for use in fields some distance from the farmstead. Unfortunately, batteries and indeed energisers are sometimes stolen from remote fields. See Photos 4 & 6.

Current consumption with a modern capacitor discharge type energiser varies from 35mA for a standard energiser to 300mA for high power types used with very long fences. Mains powered fencers are rated at 2W to 3.5W - see Data Sheet A.

A car battery can therefore operate a standard fencer for several months before recharging is necessary. Moreover, once the animals have learnt that the fence gives them an unpleasant shock, the energiser can be switched off, thus saving on batteries. Indeed, it need not be switched on until the animals began to realise that the wire is not energised.

Solar Powered

Solar powered fencers provide an attractive alternative to battery operated fencers and avoid problems associated with charging accumulators - as shown in Photo 7.

The 'Fi-Shock' ESO 440 solar powered energiser, for example, has an output of 7.5kV ±2kV, a pulse repetition rate of 1Hz, and can energise a single fence line up to three miles long. The energiser is actually powered by an integral 4V sealed lead acid accumulator which is charged by the solar

panel. Daylight is sufficient to charge the accumulator, direct sunlight is not necessary. Unfortunately, solar powered fencers are just as vulnerable to theft as battery powered fencers.

Farmstead Based

The great advantage of a farmstead based energiser is that they can be installed in a secure building and be mains powered. However, whilst this overcomes the problem of security and charging accumulators, the drawback is that a transmission line is required to connect the energiser to fences in distant fields.

Cables with a high voltage insulation are required at the farmstead but a normal electric fence usually serves as the transmission line across open fields. Problems occur where the transmission line crosses a farm roads so the wire is either elevated to provide clearance for cattle or tractors, or buried.

Access to the enclosure created by an electric fence is by making a gap in the fence and connecting one wire to an insulated, spring-loaded hook, whilst the other wire is terminated in a ring attached to a post. To close the gap, the loose wire is simply hooked to the ring; the insulation allows this operation to proceed without switching off the energiser. This is of particular significance with mains powered energisers located some distance away in the farmstead

Zambia

Way back in 1953 when I was an agriculturist in Northern Rhodesia (Now Zambia) I installed an electric fence on the government experimental agricultural station that I was developing. It was intended primarily for strip grazing improved pastures by a herd of Jersey dairy cows.

I arranged a demonstration of the fencer for African herdsmen with their chief in attendance. The herdsmen could not believe that the single plain wire supported on flimsy stakes could hold back a herd of native cattle. Yet, despite the herdsmen's efforts to 'persuade' the cattle to break through the wire, none did!

Unfortunately, after the demonstration, the chief decided to touch the wire and before I could stop him he gave a tremendous yell and leaped into the air. Such a display was quite undignified for a chief.

However, he was a progressive chief and keen to see the introduction of new technology. So, after dramatically describing the power of the fence from his own experience, he burst out laughing whilst everyone else cheered. On this amusing note I end this study.

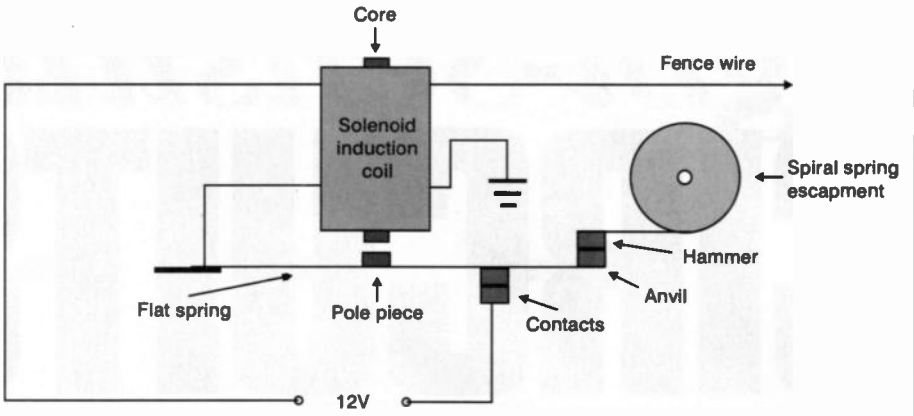
My thanks go to the following people for their assistance in the preparation of this study:-

Cecil Banks: electric fence pioneer, Sutton Coldfield

Roger Bridges: Eddie Pailin Distributors

Miles Calcott, Farmer, Tamworth

Quentin Tanton: Tanton Limited



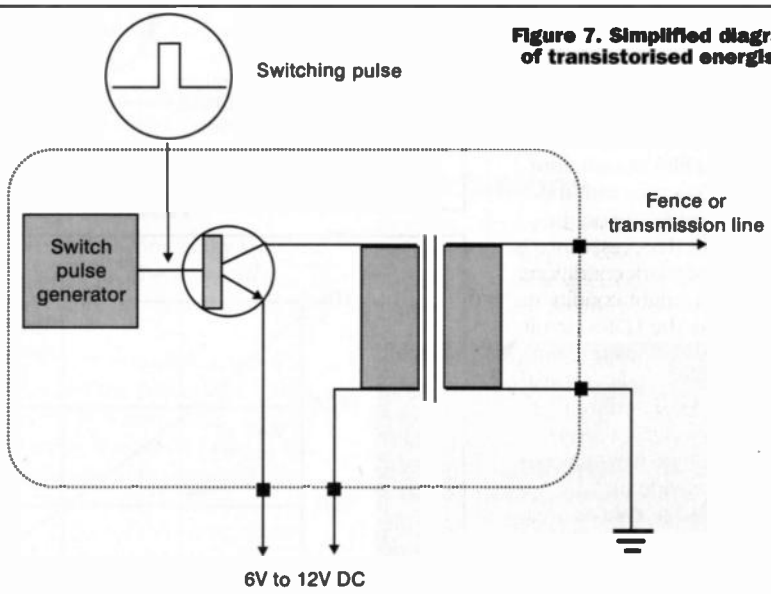
At start of cycle, the hammer presents a lighter pressure on the anvil thus bending the flat spring downwards and closing the contacts.

The resultant magnetic field attracts the pole piece thus causing the spring to bend upwards, at the same time, the contacts open and the anvil strikes the hammer causing the escapement to wind up.

Pressure on the flat spring is released, the contacts remain open for about 1sec until the escapement unwinds, then the cycle is repeated and the hammer once again presses against the anvil, thus closing the contacts.

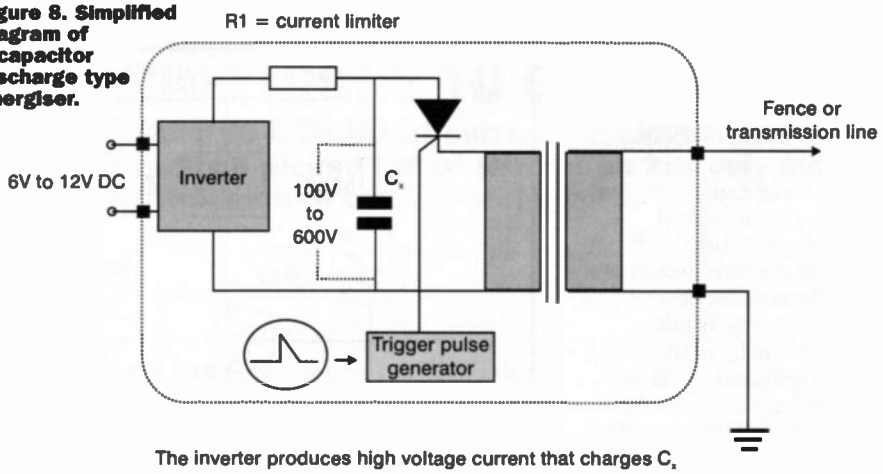
Figure 6. Diagram of an early escapement type fence energiser.

Figure 7. Simplified diagram of transistorised energiser.



The switching pulse is just long enough for current flowing through the transformer's primary winding to saturate the core. Energy is stored in the magnetic field. Repetition rate is typically 1Hz.

Figure 8. Simplified diagram of a capacitor discharge type energiser.



The inverter produces high voltage current that charges C_x through R1. Each time the thyristor is triggered, energy stored in the capacitor is transferred to the fence via the transformer

Light-Sensitive CIRCUITS

Ray Marston describes the basic operating principles and applications of a variety of light-sensitive devices.

LDR Basics

Electronic optosensors are devices that alter their electrical characteristics in the presence of visible or invisible light. The best known devices of these types are the LDR (light dependent resistor), the photodiode, the phototransistor, and the PIR (passive infra-red) detector.

LDR operation relies on the fact that the conductive resistance of a film of cadmium sulphide (CdS) varies with the intensity of light falling on the face of the film. This resistance is very high under dark conditions and low under bright conditions. Figure 1 shows the LDR's circuit symbol and basic construction, which consists of a pair of metal film contacts separated by a snake-like track of light-sensitive cadmium sulphide film, which is designed to provide the maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light.

Practical LDRs are available in a variety of sizes and package styles, the most popular size having a face diameter of roughly 10mm. Figure 2 shows the typical characteristic curve of such a device, which has a resistance of about 900Ω at a light intensity of 100 Lux (typical of a well lit room) or about 30Ω at an intensity of 8000 Lux (typical of bright sunlight). The resistance rises to several megohms under dark conditions.

LDRs are sensitive, inexpensive, and readily available devices with power and voltage handling capabilities similar to those of conventional resistors. Their only significant defect is that they are fairly slow acting, taking tens or hundreds of milliseconds to respond to sudden changes in light level. Useful LDR applications include light- and dark-activated switches and alarms, and Figures 3 to 9 show some practical circuits of these types; each of these circuits will work with virtually any LDR with a face diameter in the range 3mm to 12mm.

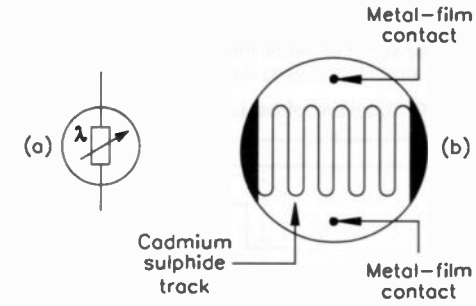


Figure 1. LDR symbol (a) and basic structure (b).

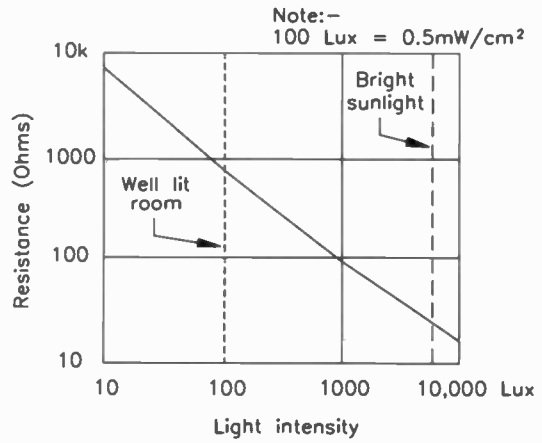


Figure 2. Typical characteristics curve of a LDR with a 10 mm face diameter.

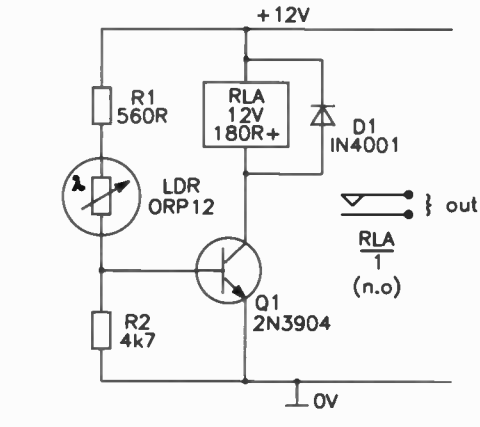


Figure 3. Simple non-latching light-activated relay switch.

LDR Light Switches

Figures 3 to 5 show some practical relay-output light-activated switch circuits based on the LDR. Figure 3 shows a simple non-latching circuit, designed to activate when light enters a normally-dark area such as the inside of a safe or cabinet, etc. Here, R1-LDR and R2 form a potential divider that controls the base-bias of Q1. Under dark conditions the LDR resistance is very high, so negligible base-bias is applied to Q1, and Q1 and RLA are off. When a significant amount of light falls on the LDR face the LDR resistance falls to a fairly low value and base-bias is applied to Q1, which thus turns on and activates the RLA/1 relay contacts, which can be used to control external circuitry. The relay can be any 12V type with a coil resistance of 180Ω or greater.

The simple circuit of Figure 3 has a fairly low sensitivity, has no facility for sensitivity adjustment, and its light trigger points vary with variations in circuit supply voltage and ambient temperature. Figure 4 shows a very sensitive precision light-activated circuit that suffers from none of these weaknesses. Here, LDR-RV1 and R1-R2 are connected in the form of a Wheatstone bridge, and the op-amp and Q1-RLA act as a sensitive balance-detecting switch. The bridge balance point is quite independent of variations in supply voltage and temperature, and is influenced only by variations in the relative values of the bridge components.

In Figure 4, the LDR and RV1 form one arm of the bridge, and R1-R2 form the other arm. These arms act as potential dividers, with the R1-R2 arm applying a fixed half-supply voltage to the non-inverting input of the op-amp, and with the LDR-RV1 divider applying a light-dependent variable voltage to the inverting terminal of the op-amp. In use, RV1 is adjusted so that the LDR-RV1 voltage rises slightly above that of R1-R2 as the light intensity rises to the desired trigger level, and under this condition the op-amp output switches to negative saturation and drives the relay on via Q1 and biasing resistors R3-R4. When the light intensity falls below this level, the op-amp output switches to positive saturation, and under

this condition Q1 and the relay are off.

Figure 4 circuit is very sensitive and can detect light-level changes too small to be seen by the human eye. The circuit can be modified to act as a precision dark-activated switch by either transposing the inverting and non-inverting input terminals of the op-amp, or by transposing RV1 and the LDR. Figure 5 shows a circuit using the latter option; this circuit also shows how a small amount of hysteresis can be added to the circuit via feedback resistor R5, so that the relay turns on when the light level falls to a particular value, but does not turn off again until the light intensity rises a substantial amount above this value. The magnitude of hysteresis is inversely proportional to the R5 value, being zero when R5 is open circuit.

A Bell Output LDR Alarm

The Figure 3 to 5 light-activated LDR circuits all have relay outputs that can be used to control virtually any type of external circuitry. In some light-activated applications, however, circuits are required to act as audible-output alarms, with a bell or siren-sound output, and this type of action can be obtained without the use of relays. Figure 6 shows a practical 'alarm bell output' circuit that gives a direct output to an alarm bell, which must be of the self-interrupting type that consumes an operating current of less than 2A. The circuit's supply voltage should be 1.5V to 2V greater than the nominal operating value of the bell.

Figure 6 circuit uses a Wheatstone bridge (LDR-RV1-R1-R2) and an op-amp balance detector to give the precision sensing/switching action (as described in the basic Figure 4 circuit), but its output drives the alarm bell via an inexpensive SCR; the basic circuit can be converted into a dark-activated alarm by simply transposing RV1 and the LDR; hysteresis can also be added if required.

Note in the Figure 6 circuit that, although the SCR is a self-latching device, the fact that the bell is of the self-interrupting type ensures that the SCR automatically unlatches repeatedly as the bell operates (and the SCR anode current falls to zero in each self-interrupt phase). Consequently, the alarm bell automatically turns off again when the light level falls back below the trip level.

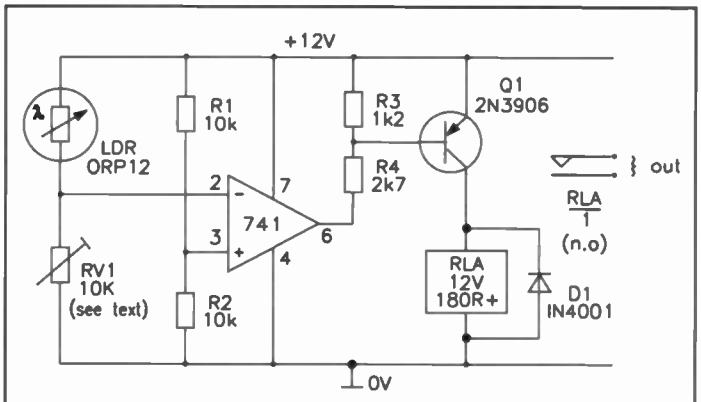


Figure 4. Precision light-sensitive relay switch.

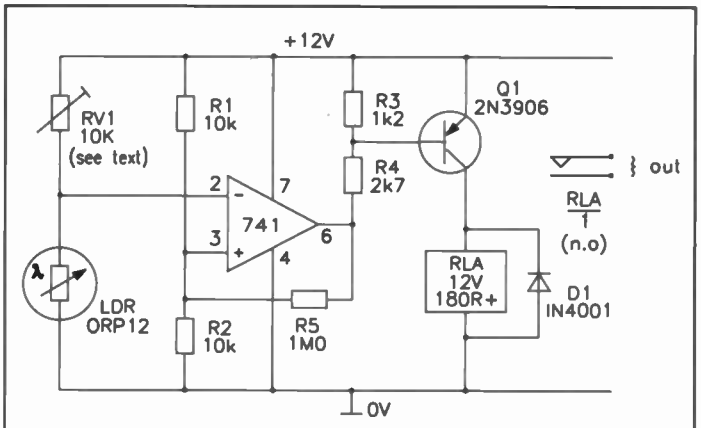


Figure 5. Precision dark-activated switch, with hysteresis.

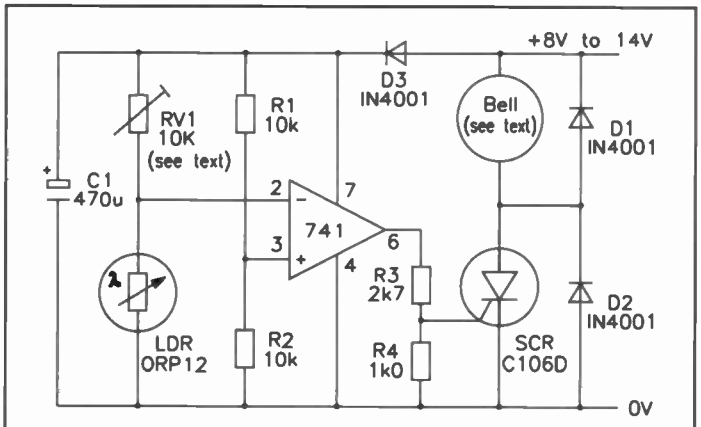


Figure 6. Precision light-activated alarm bell.

Siren-Output LDR Alarms

Figures 7 to 9 show ways of using CMOS 4001B quad 2-input NOR gate ICs as the basis of various light-activated 'siren-sound' alarms that generate audible outputs in loudspeakers. The Figure 7 circuit is that of a light-activated alarm that generates a low-power (up to 520mW) 800Hz pulsed-tone signal in the speaker when the light input exceeds a pre-set threshold value. Here, IC1c and IC1d are wired as a 800Hz astable multivibrator that can feed tone signals into the speaker via Q1 and is gated on only when the output of IC1b is low, and IC1a-IC1b are wired as a 6Hz astable that is gated on only when its pin-1 gate terminal (which is coupled to the LDR-RV1 potential divider) is pulled low.

The action of the Figure 7 circuit is as follows. Under dark conditions the LDR-RV1 junction voltage is high, so both astables are disabled and no signal is generated in the speaker. Under 'light' conditions the LDR-RV1 junction voltage is low, so the 6Hz astable is activated and in turn gates the 800Hz astable on and off at a 6Hz rate, thereby generating a pulsed-tone signal in the speaker via Q1.

The precise switching or gate point of the 4001B IC is determined by the threshold voltage value of the IC, and this is a percentage value of the supply voltage: the value is nominally 50%, but may vary from 30% to 70% between individual ICs. In practice, the switching point of each individual 4001B IC is very stable, and the Figure 7 circuit gives very sensitive 'light'-activated alarm triggering.

Figure 8 shows the circuit of a self-latching light-activated alarm with a 800Hz monotone

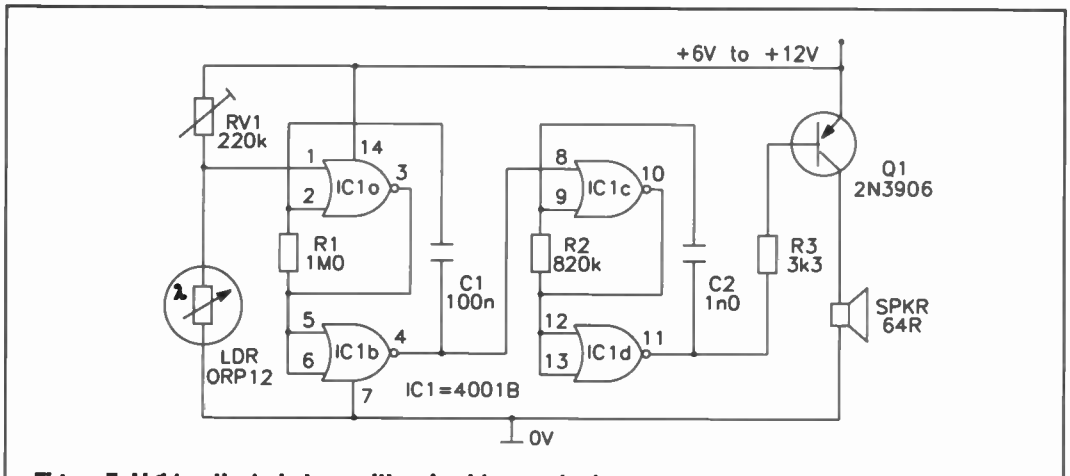


Figure 7. Light-activated alarm with pulsed-tone output.

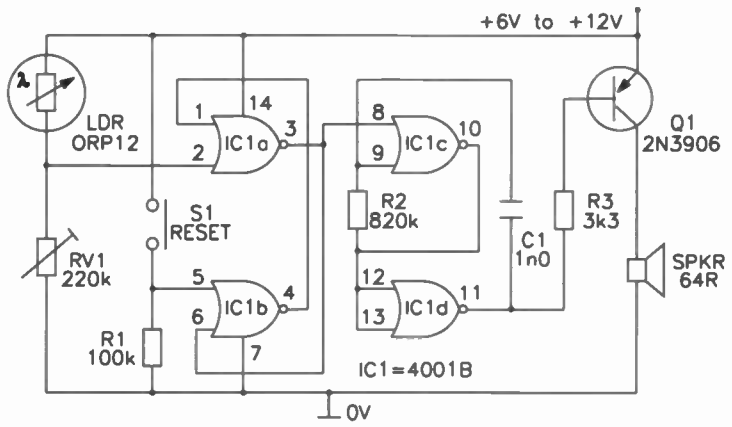


Figure 8. Self-latching light-activated alarm with monotone output.

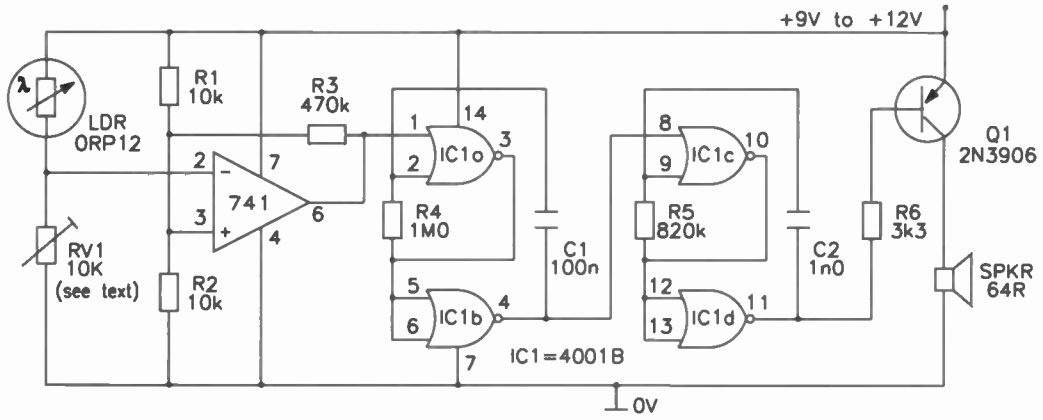


Figure 9. Precision light-activated pulsed-tone alarm with hysteresis.

output. In this case IC1c-IC1d are again wired as a gated 800Hz astable, but IC1a-IC1b are wired as a bistable multivibrator with an output that (under dark conditions) is normally high, thus gating the 800Hz astable off. Under bright conditions, however, the LDR-RV1 junction goes high and latches the bistable into its alternative 'output low' state, thereby gating the 800Hz astable on and generating the monotone alarm signal; once latched, the circuit remains in this 'on' state until dark conditions return and the bistable is simultaneously reset via S1.

Note that the light/dark operation of the Figure 7 and 8 circuits can be reversed by simply transposing the LDR-RV1 positions. The sensitivity levels of these two basic circuits are adequate for most practical purposes, but can, if required, be boosted (and the trigger-level stability increased), by interposing an op-amp voltage comparator (of the basic Figure 4 or 5 type) between the LDR-RV1 light-sensitive potential divider and the gate terminal of the CMOS waveform generator, as shown in the Figure 9 circuit; resistor R3 controls the hysteresis of the circuit, and can be removed if the hysteresis is not needed.

The circuits in Figure 7 to 9 generate fairly modest values of acoustic output power, with the power input to the 64Ω loudspeaker reaching a maximum value of 520mW when using a 12V supply. The available output power can, however, easily by boosted by feeding the circuit's output to low-impedance horn-type loudspeakers via simple power-boosting amplifiers.

Photodiodes

Cadmium sulphide (CdS) LDRs are sensitive but slow-acting devices. They are ideal for use in slow-acting direct-coupled light-level sensing applications, but are not suitable for use as optical sensors in medium- to high-speed applications. The ideal optical sensors for use in the latter applications are the silicon photodiode and the silicon phototransistor.

In its very crudest form, a photodiode is a normal silicon diode minus its opaque (light-excluding) covering. If a normal silicon diode is connected in the reverse-biased circuit of Figure 10, negligible current flows through the diode and zero voltage is developed across R1. If the diode's opaque covering is now removed (so that the diode's semiconductor junction is revealed) and the junction is then exposed to visible light in the same circuit, the diode will pass a significant reverse current and thus generate an output voltage across R1. The magnitude of the reverse current and the output voltage is directly proportional to the intensity of the light source, and the diode is thus truly photosensitive.

All silicon junctions are photosensitive, and a basic photodiode can - for most practical purposes - be regarded as a normal diode housed in a case that lets external light easily reach its photosensitive semiconductor junction. Figure 11a shows the standard photodiode symbol. In use, the photodiode is reverse biased and the output voltage is taken from across a series-connected load resistor; this resistor can be connected between the diode and ground, as in Figure 11b, or between the diode and the positive supply line, as in Figure 11c.

In reality, the physical form of a normal silicon diode's pn junction is such that the device exhibits fairly low optical sensitivity; all practical photodiodes use special types of junction design, to maximise their effective photosensitivity. Most photodiodes come in one or other of two basic types, being either 'simple' photodiodes or PIN photodiodes. Figure 12 illustrates some basic points on these subjects.

Normal silicon junction diodes use the basic form of construction shown (in symbolic form) in Figure 12a, in which the device's p- and n-type materials are moderately thick (and thus fairly opaque) and are effectively fused directly together to form the device's junction; the relatively high opacity of the pn junction's materials gives the junction fairly poor photosensitivity. In a simple photodiode, the photosensitivity is greatly increased by using a very thin (and thus highly translucent) slice of material on the p-type side of the junction, as shown

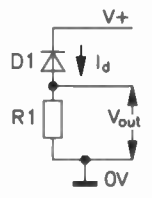


Figure 10. Reverse-biased diode circuit.

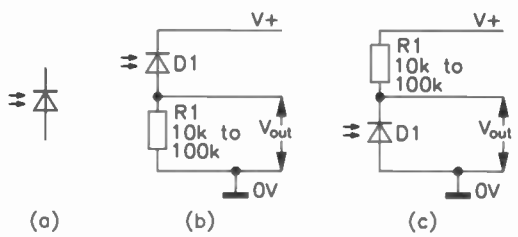


Figure 11. Photodiode symbol (a) and alternative ways ((b) and (c)) of using a photodiode as a light-to-voltage converter.

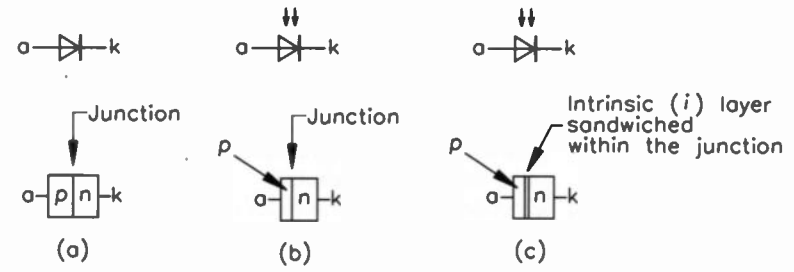


Figure 12. Symbol and basic construction of (a) a normal silicon junction diode, (b) a simple photodiode, and (c) a PIN photodiode.

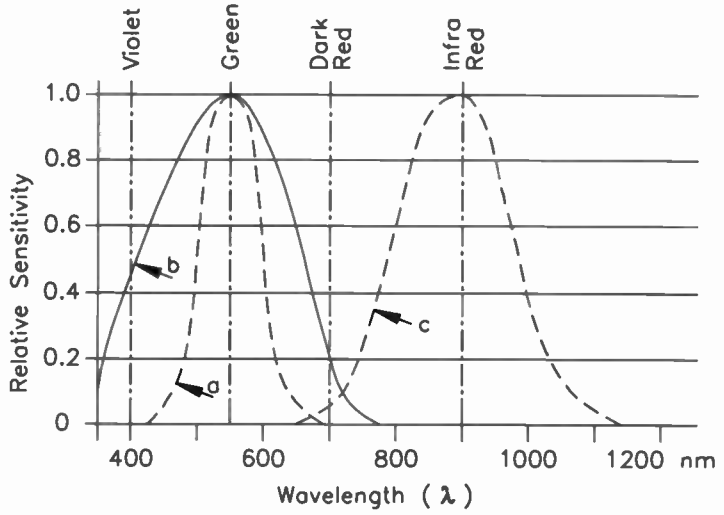


Figure 13. Typical spectral response curves of (a) the human eye and (b) general-purpose and (c) IR photodiodes.

in Figure 12(b); external light can be applied, via a built-in lens or window, to the opto-sensitive pn junction via this thin slice of p-type material.

Simple Figure 12b type photodiodes have minimum on/off switching times of about 1ms, and can thus be used at maximum pulsed or switched operating frequencies of about 300kHz. The prime cause of this relatively long switching time is the high capacitance that occurs at the device's junction, between the p- and n-type materials. This problem is greatly reduced in PIN photodiodes, in which a very thin slice of intrinsic ('I') or 'undoped' silicon material is interposed at the junction between the p- and n-type materials, as shown in Figure 12c, thus greatly reducing the p-to-n junction's capacitance value.

Modern PIN-type photodiodes have typical minimum on/off switching times of about 10ns, and can thus be used at maximum switched-mode operating frequencies of about 30MHz, which is adequate for the vast majority of practical optoelectronic applications (in cases where even higher switching frequency optical sensing is required, special ultra-high-frequency avalanche-type photodiodes can be used).

Photodiodes can be designed to respond to either visible light or to IR light. The human eye has the type of spectral response curve shown in curve 'a' in Figure 13. It has a maximum sensitivity to the colour green, which has a wavelength of about 550nm, but has a low sensitivity to violet (400nm) at one end of the spectrum and to dark red (700nm) at the other. General-purpose visible-light photodiodes have typical spectral response characteristics like those shown in curve 'b' in Figure 13, and infra-red (IR) types have the type of response shown in curve 'c'.

Phototransistors.

Ordinary silicon transistors are made from an npn or pnp sandwich, and thus inherently contain a pair of photo-sensitive junctions. Some types are available in phototransistor form, and use the standard symbol shown in Figure 14a. Figures 14b to 14d show three basic ways of using a phototransistor; in each case the base-collector junction is effectively reverse biased and thus acts as a photodiode. In (b) the base is grounded, and the transistor acts as a simple photodiode. In (c) and (d) the base terminal is open-circuit and the photo-generated currents effectively feed directly into the base and, by normal transistor action, generate a greatly amplified collector-to-emitter current that produces an output voltage across series resistor R1.

The sensitivity of a phototransistor is typically one hundred times greater than that of a photodiode, but its useful maximum operating frequency (usually a few hundred kHz) is proportionally lower than that of a photodiode. Most phototransistors are manufactured in 2-pin form, with only the device's collector and emitter made externally available; 3-pin types can be used in any of the basic configurations shown in Figure 14. Some phototransistors are made in very-high-gain Darlington form.

Note in the Figure 11 and 14 photodiode and phototransistor circuits that, in practice, the R1 load value is usually chosen on a compromise basis, since the circuit sensitivity increases but the useful operating bandwidth decreases as the R1 value is increased. Also, the R1 value must, in many applications, be chosen to bring the photo-sensitive device into its linear operating region.

IR Pre-Amp Circuits

Photodiodes or phototransistors are often used as the sensing elements at the receiver end of light-beam alarms, remote control, or fibre optic cable systems. In such applications, the signal reaching the photosensor may vary considerably in strength, and the sensor may be subjected to a great deal of noise in the form of unwanted visible or IR light signals, etc. To help minimise these problems, the systems are usually operated in the IR range, and the optosensor output is passed to processing circuitry via a low-noise pre-amplifier with a wide dynamic operating

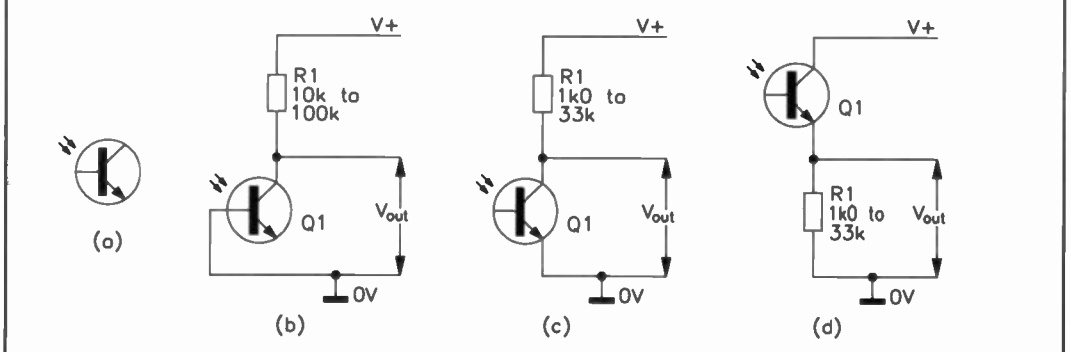


Figure 14. Phototransistor symbol (a) and alternative ways (b) to (d) of using a phototransistor.

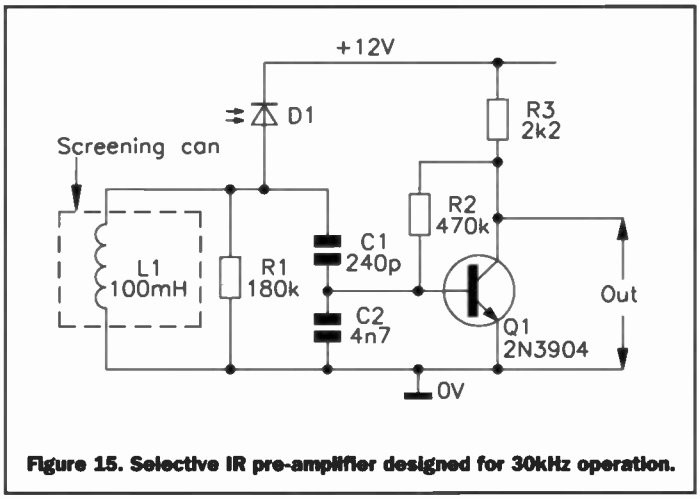


Figure 15. Selective IR pre-amplifier designed for 30kHz operation.

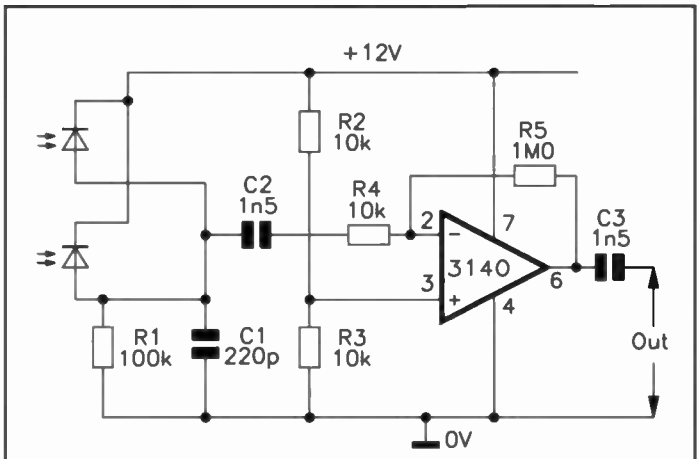


Figure 16. 20kHz selective pre-amp for use in IR lightbeam applications.

range. Figures 15 and 16 show typical examples of such circuits, using photodiode sensors.

The Figure 15 circuit is designed to detect an IR optical signal that is switched at a 30kHz rate. Photodiode D1 senses the IR signal and feeds it into 30kHz tuned circuit L1-C1-C2, which is lightly damped by R1. The resulting frequency-selected low-noise output of the tuned circuit is tapped off at the C1-C2 junction and then amplified by Q1.

Figure 16 shows a 20kHz selective pre-amplifier circuit for use in an IR light-beam alarm application in which the alarm sounds when the beam is broken. Here, two IR photodiodes are wired in parallel (so that beam signals are lost only when both diode signals are cut off) and share a common 100k load resistor (R1). R1 is shunted by C1 to reject unwanted high-frequency signals, and its output is fed to the x100 op-amp inverting amplifier via C2, which rejects unwanted low-frequency signals.

PIR Movement-Detecting Systems

IR light-beam alarms are active IR units that react to an artificially generated source of IR radiation. Passive IR (PIR) alarms, on the other hand, react to naturally generated IR radiation such as the heat-generated IR energy radiated by the human body, and are widely used in modern security systems. Most PIR security systems are designed to activate an alarm or floodlight, or open a door or activate some other mechanism, when a human or other large warm-blooded animal moves about within the sensing range of a PIR detector unit, and use a pyroelectric IR detector of the type shown in Figure 17 as their basic IR-sensing element.

The basic Figure 17 pyroelectric IR detector makes use of special ceramic elements that generate electrical charges when subjected to thermal variations or uneven heating. Modern pyroelectric IR detectors such as the popular PIS201S and E600STO types incorporate two small opposite-polarity series-connected ceramic elements of this type, with their combined output buffered via a JFET source-follower, and have the IR input signals focused onto the ceramic elements by a simple filtering lens, as shown in the basic PIR detector usage circuit of Figure 17. It is important to note at this point that the detector's final output voltage is proportional to the difference between the output voltages of the two ceramic elements.

The basic action of the Figure 17 PIR detector is such that, when a human body is within the visual field of the pyroelectric elements, part of that body's radiated IR energy falls on the surfaces of the elements and is converted into small but detectable variation in surface temperature and corresponding variation in the output voltage of each element. If the human body (or other source of IR radiation) is stationary in front of the detector's lens under this condition, the two elements generate identical output voltages and the unit's final 'difference' output is thus zero, but if the body is moving while in front of the lens the two elements generate different output voltages and the unit produces a varying output voltage.

Thus, when the PIR unit is wired as shown in the Figure 17 basic usage circuit, this movement-inspired voltage variation is made externally available via the buffering JFET and dc-blocking capacitor C1 and can, when suitably amplified and filtered, be used to activate an alarm or other mechanism when a human body movement is detected. In practice, pyro-electric IR detectors of the simple type just described have, because of the small size (usually about 20mm²) and simple design of the detector's IR-gathering lens, maximum useful detection ranges of roughly one metre. In modern commercial PIR movement detecting security units, however, this range is usually extended to at least ten metres with the aid of a large (about 2000mm²) multi-faceted external IR-gathering/focusing plastic lens, which splits the visual field into a number of parallel strips and focuses them onto the two sensing areas of the PIR unit.

Figure 18 shows the typical PIR sensing pattern of a commercial 'intrusion detector' unit designed to protect a normal-sized room in domestic-

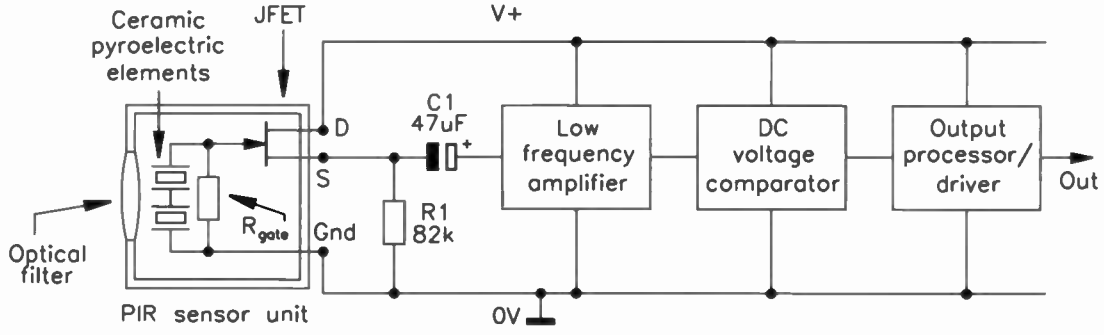


Figure 17. Basic PIR detector usage circuit.

type applications. In this example the unit is mounted on a wall at a height of seven feet and is aimed downwards at a shallow angle, and the multi-faceted plastic lens splits the visual field into a large number of vertical and horizontal segments. Any person moving through a single segment will activate a single trigger signal within the PIR sensor; a person moving through the entire visual field thus produces numerous triggering signal, but a stationary IR source produces no signals. Most intrusion detectors of this type incorporate 'event counting' circuitry that will only generate an alarm-activating output if three or more trigger signal are detected within a few seconds, thus minimising the chances of a false alarm due to sudden changes in temperature caused by the auto-activation of time-switched security lights, etc.

The lens-generated PIR sensor pattern shown in Figure 18 is the type usually used to protect single rooms in domestic burglar-alarm systems. Alternative lenses offer different ranges and coverage patters for various special types of application; amongst these are the 'pet' type, in which the field's vertical span is restricted to 2.5 to 6.6ft above ground level to avoid activation by domestic pets while giving good sensitivity to normal humans, and the 'corridor' type, in which the field's horizontal span is restricted to about 20 degrees to give long-distance coverage (typically about 30m) of narrow corridors and passageways.

Note that, because high-quality commercial PIR security units of this basic type are widely available at comparatively low cost, it is not practicable (on aesthetic and cost-effective grounds) to try to build similar units on a DIY basis.

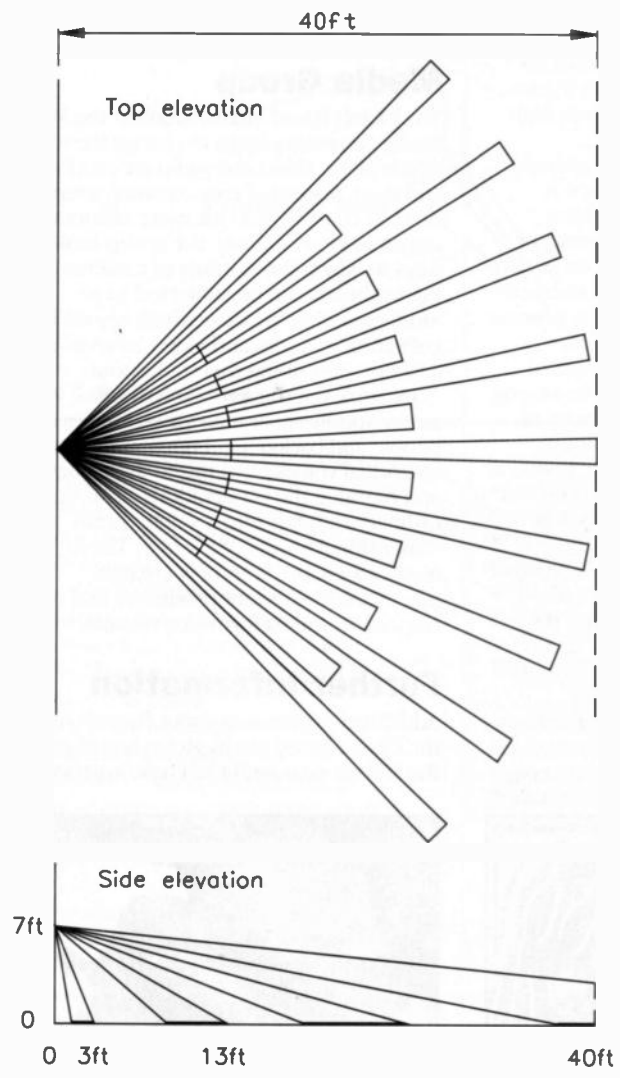


Figure 18. Typical PIR sensing pattern of a commercial 'intrusion detector' unit designed for normal domestic-type applications.

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

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

The Need For Inspiration

Dear Sir,

As a self-employed Electronic Design Engineer specialising in test equipment, I found the earlier editions of *Electronics* interesting and very helpful. In the latter years of the publication our needs and interests have diverged. I now look elsewhere for those bright circuit ideas which used to come from your contributors and readers.

As one who has gone from the cats-whisker through bright emitter valves, transistors, and ICs, it seems difficult to see where the next generation of enthusiast will get his inspiration. Perhaps he won't need it, perhaps he will not exist in a form that I would recognise. From personal experience, I know that there is still a requirement for a wide variety of electronic units, often computer interfaces, that cannot be supplied by the big manufacturers or at least not within any sensible budget.

I understand the need to be economically viable (don't we all!), but there ought to be room for what is left of the 'old' enthusiast who thinks in terms of resistors and capacitors, active devices and pence, and the 'newer' ones who probably think in terms of sub-units and pounds.

I have, over the years, made substantial use of the range of Maplin Projects. Quite often not as they were originally intended to be used. They are excellent basic units and can often be adapted for wider use. For example, I have used the 150W MOSFET amplifier (LP56L) as a 120W static inverter at 500Hz and even as an 80W unit at 40KHz. Such lateral thinking might give a boost to the Magazine and Projects alike.

I wish the Magazine well, but I do question whether its' sights are overshadowed by the £ sign. The latest issues do seem to be leaning rather more towards basic electronics but, alas, not enough to hold my attention.

E. Alder
Pembrokeshire

As we have mentioned before, the majority of our readership is around middle-age, and from your letter it is obvious that you are a 'mature' constructor. It would be true to say that we have all probably constructed a wide range of circuits that suit our requirements over the years, and so it probably gets more difficult to find circuits that 'take-our-fancy.' Cost is a major factor - in the sixties, I build my first valve amp because I could not afford to buy one , which is probably equally true for many of our readers. Today, the reverse is also certainly true, unless it is something particularly special or unique you are after.

We try to select projects that are varied, novel and practical, and hopefully stimulate the younger reader, student and beginner. You say that you believe there is a desire for computer interface projects, which we would not disagree with, but then we get letters from readers complaining that we have steered to far down the 'computer' road!

On a more practical note perhaps you would like to submit your ideas, outlined in your letter, to the magazine either as projects or circuit ideas, we would certainly be pleased to consider them for inclusion.

Compliments to Uri

Dear Sir

I would like to convey my compliments to Uri Geller with regards to his feature in *Electronics and Beyond*.

Having regularly purchased many electronics magazines over the years I have only recently settled for a couple - *Electronics and Beyond* being my main regular magazine. I must say that I find his feature fascinating and I find the articles compliment the rest of the magazine quite nicely - Uri's article being one of the reasons I have continued to purchase Electronics and Beyond. Please accept my compliments and gratitude.

Once again thank you

Anthony Lynch
(abridged extract of email to Uri Geller)

Dear Mr Geller

With regards to your column in *Electronics and Beyond magazine*.

Everyday, the scientific community is coming up with claims and schemes to make the human condition look more ridiculous and ultimately obsolete. A typical example is the criticism you received from some about your column in *Electronics and Beyond*.

Its is because of people like yourself, whether they be showman, genuine mystics or just plain rascals, that the human race will stop and think perhaps before they surrender to the machine.

The weirdest thing about these so called logical people with all the answers is, they cannot accept the order and precision of the Earth itself.

Anyway keep up the good work!

Mark
(abridged extract of email to Uri Geller)

Thanks to these two readers for their kind comments.

Web and TV Collide IN HYPERSOAP

Researchers at MIT Media Laboratory in Boston, Massachusetts, US, are applying Web techniques to popular TV programmes to enable users to hotlink from items on the programme. Here Stephen Waddington investigates the research project amusingly named HyperSoap.

Have you watched a programme on the BBC recently? Chances are that the presenter directed you towards a Web site for further information about the programme. Eastenders, BBC News, Food & Drink, Changing Rooms – they're all at it.

The Web is becoming the fast sheet of the nineties for broadcasters, replacing both Ceefax and the telephone hotline as a channel for further information about a programme or topic. Its little wonder that the BBC Web site is one of the most popular Web sites in the UK.

On the other side of the Atlantic, a group of researchers has recognised the potential of the Web as an extension of television. Researches at the MIT Media Laboratory in Boston, Massachusetts are exploring ways of integrating television and the Web.

Additional Shopping Channel

The Lab recently produced a soap opera as shown in Photo 1 that lets viewers select clothing and furnishings with a special remote control, and see an item's price and purchase information on a pop-up screen display. The program, called HyperSoap, offers an engaging and entertaining form of interactive shopping, and an alternative to the printed product catalogues that stores and manufacturers mail and distribute to customers.

HyperSoap lets viewers interact with the program at the click of a button in much the same way that a person can click on words and pictures in a Web document for links to additional content. Researchers claim that the core technology behind the HyperSoap project enables a broad new range of applications well beyond product placement.

"We believe it could be a way of creating entirely new forms of programming which engages the viewer in unprecedented ways," said Michael Bove, head of the Media Lab's Object-Based Media group.

"For example, new kinds of documentaries and educational programs can be created such as a nature program that lets children go on safari and collect specimens with their remote control. Other programs might provide instruction on everything from flying an airplane to surgery," added Bove.

Computer Recognition

HyperSoap was created with authoring software developed at the Media Lab. The software allows a producer or graphic artist to quickly indicate desired regions or objects in a video sequence as shown in Photo 2, and thereafter the system tracks those objects automatically, and with high precision as shown in Photo 3.

Researchers claim that this is a significant advance over existing technology, which either requires manually marking object locations in each and every video frame, or which tracks so coarsely that only one or two moving regions can be identified in any scene.

By automating and improving the process of object recognition, the Media Lab's technology reduces the manual work of interactive content creation, while improving the quality. As a result, literally dozens of items - ranging from an actress' blouse, skirt, necklace, and earrings to the items on her desk - are selectable during a program.

"While it is easy for people to look at the world and instantly recognise objects - a person, a table, an animal - getting a computer to recognise objects is a tricky problem. Our new software works by training the computer to recognise what each object looks like in terms of the way it moves and its colours and textures," said Bove.

Exploring new video production methods in addition to designing the underlying video processing technology, the Media Lab team was also interested in understanding how additional aspects of TV production are affected when creating programs with hyperlinks.

"A traditional soap opera is created with very specific timing and flow, which does not lend well to hyperlinks and viewer interruptions. In HyperSoap, scripting and directing were modified to allow, and even encourage, interaction with the products as part of the viewing experience," said Bove.

Dynamic graphic design experiments were also conducted to determine the best way of showing the additional product information.

Reaching the Market

The Object-Based Media group is also to explore other programming channels. These could include a CD or Digital Video Disc (DVD) that customers could receive in the mail, in place of a printed catalogue, and view on their personal computers. In the future, the ability to view hyperlinked video programs may be built into digital television sets, or set-top boxes for cable or satellite services.

In another application, department stores could have TV-equipped kiosks that would engage customers in a lively drama, and allow them to view and select products of interest by simply touching the screen. The kiosk could also provide information about products, such as sale prices, or directions to the departments in which the items are displayed.

Media Lab's Object-Based Media Group

The Object-Based Media Group at the MIT Media Laboratory seeks to change the way in which digital video and audio are produced and used. Instead of concentrating simply on data compression for more efficient transmission of signals, the group looks at ways in which the outputs of cameras and microphones can be subjected to an 'understanding' process which results in a collection of audio and video 'objects' and a 'script' describing their behaviour.

Examples of this process include automatically separating video images into people and background portions, extracting individual voices from mixed audio signals, and merging the observations of several ordinary cameras into a single three-dimensional model of a scene. These new methods enable both new creative directions for content producers and more responsive media forms for viewers.

Further Information

Additional information about HyperSoap and the Object-Based Media group is available on the Web at `<www.media.mit.edu/hypersoap>`.

Photo 1. Researchers at MIT created a Soap Opera as a vehicle to trial hyper linking from video to the Web.

Photo 2. Standard frame of video with key elements marked-up for hot linking.

Photo 3. Video frame with hot linked areas zoned as hot link elements.

TECHNOLOGY WATCH

with Martin Pipe

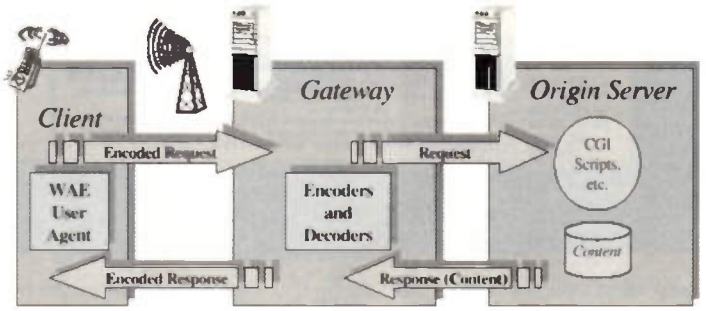
If you have a more than passing interest in cellular data, then there is a new buzzword to learn. WAP, or Wireless Application Protocol, has been introduced to standardise wireless content delivery on the next generation of mobile phones. In other words, you will soon be able to access data services, including a stripped-down version of the Web, as long as you have a suitable mobile phone. These new WAP-compatible phones will be equipped with display screens larger than those we are used to, and will feature some kind of navigation control (such as a trackball or roller wheel). The prime movers behind the WAP Forum standards body (http://www.wapforum.org) include Unwired Planet - now called Phone.com, these guys originally developed the microbrowser software that every WAP phones firmware must contain - and major infrastructure/handset manufacturers, such as Motorola, Nokia and Ericsson. As its name suggests, the microbrowser is a cut-down version of the software familiar to anybody who surfs the Web.

You can expect to see some wonderful new applications on your WAP phones microbrowser screen. These include interactive information services (travel timetables and localised service directories, for example), commercial applications (such as on-line banking, booking and shopping) and e-mail. Many network operators currently offer one-way information services via the pager-like SMS (Short Message Service). These include lottery results, football scores, delayed stock prices and news headlines. As it currently stands, you ring up the networks customer support number and arrange for the services of interest to be delivered to your handset when appropriate. In some cases, its possible to invoke these services via the Internet. If you are a Cellnet subscriber, for instance, check out http://www.genie.co.uk. SMS offers a limited amount of interactivity (you can reply to messages, and that's about it), and the length of each message is restricted to a hundred or so characters.

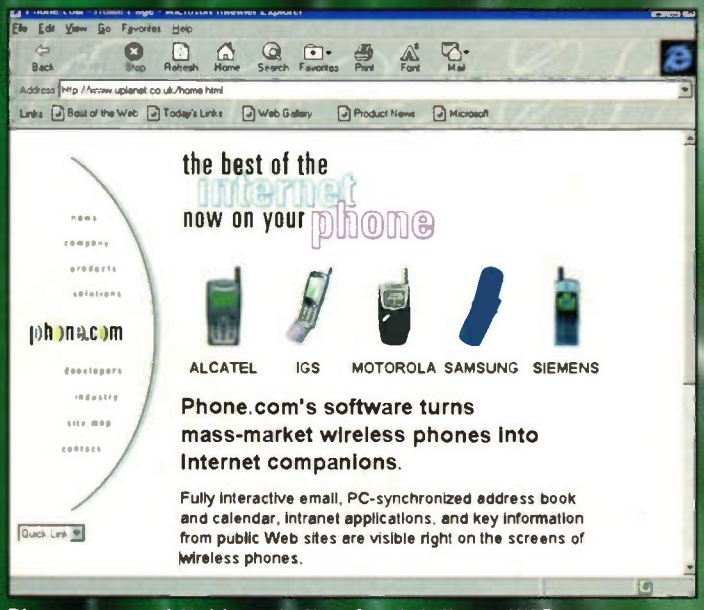
WAP, which is currently being trialled by all four UK networks, does not suffer from these constraints. However, the low speeds offered by the data-carrying provisions of current mobile systems (9600bps, in the case of GSM) will have a major impact on the possible data types. Those with experience of the Web are use to pages made up from fancy layouts, animations, video and sound. But then again, their PC probably connects to the Internet at 57600bps (well, if they are very lucky). Such embellishments clearly will not apply in the world of WAP. In most cases, those screens will display nothing more than a list of text options, perhaps with icons. The monochrome display built into one of the first commercially available WAP phones - Nokia 7110 - has a resolution of 96 x 65 pixels. Big compared with other cellphones, but positively microscopic when compared to a typical PCs colour screen. Designing a Web site for mobile phone access is clearly going to be quite a challenge!

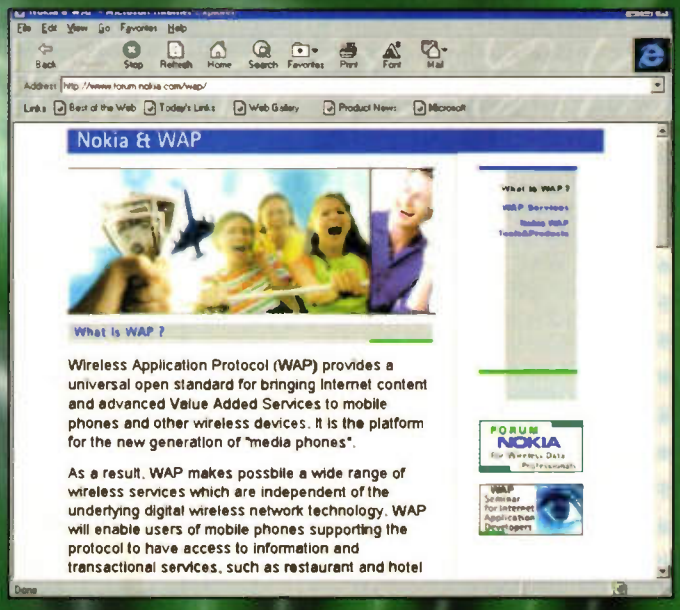
To help matters, the WAP standard includes a set of protocols that cover the whole process of wireless content delivery. One of the most important is a variant of HTML, known as WML (Wireless Markup Language). Its been heavily optimised for transmission over GSM data limited bandwidth (9600bps).

WAP block diagram.



WAP Programming Model





Phone.com and Nokia websites for details on WAP.

Argo interactive website.

BBC website.

WML pages will offer fewer options than the HTML web sites most of us are familiar with. This is essential, or those small screens would appear rather cluttered. Indeed WAP web sites will be rather simpler than their HTML cousins, to aid navigation. Sites that sell on the quantities of information available will need to offer it via more advanced multi-layered menus. As an exercise in bandwidth conservation, larger images (such as maps) will only be sent if they have been specifically requested.

There is still the headache of Web simulcasting, however. Site operators will effectively have to maintain two sites - one in HTML, and another in WML. This could prove to be a logistical nightmare. The software industry is, as we speak, working on solutions. One of these companies, Argo Interactive (http://www.argogroup.com), has developed Nectar - Web server software that detects how the user is connecting to the site, and formats compatible pages on the fly. The same core information database can thus simultaneously cater for regular surfers, as well as WAP-connected ones, with the minimum of fuss. During its trials, Argo Interactive has been co-operating with BBC Interactive, as well as the Internet departments of various mobile phone companies.

JavaScript, pioneered by Sun Microsystems (http://www.sun.com), is well-known in Internet circles. Programs (or applets) written in this platform-independent language range from site navigation aids to Lottery number predictors. When requested by users (or called up by the browser), they are downloaded from the Web server. Often, they are buried in HTML pages. Once the applets are on the users hard disk, a virtual machine built into the browser compiles and runs them. As with HTML, JavaScript is incompatible with WAP - the hardware requirements are too great. To this end, the WAP Forum has specified a conceptually-similar version known as WMLScript. A major difference between WMLScript and JavaScript is that the processor-intensive work, which is achieved by the virtual machine software in Java-compatible systems, is carried out by the server instead. The requested programs are compiled into bytecode specific to the phone being used, and then downloaded to it.

Theoretically, WMLScript programs that are not related to the Internet could also be downloaded to a mobile phone. Such programs - which will allow phone owners to, for example customise their handsets - are likely to be offered initially on the respective manufacturers web sites as a sales trigger. Enthusiasts and commercial software developers are likely to jump on the bandwagon once the WAP technology becomes established. One of the first contenders will probably be an applet that allows you to edit your phones ring tone. Depending on the hardware capabilities of the handset in question, we should see appointment books, and SMS/e-mail editors that are a good deal user-friendlier than the ones built into current mobile phones.

Users will probably have to delete one program before another can be transferred to the limited amount of memory built into the phone - for this reason, some handsets may have the ability to synchronise data with a desktop or notebook PC. The latest GSM phones have IrDA infra-red transceivers, which could be pressed into service here. As time goes by, the computing power and memory capacity of mobile phones will steadily increase. Todays GSM phones are a good deal more intelligent than those of five years ago, and this trend is set to continue. More power opens up the potential to do more. We might, for instance, eventually see a pocket navigation system built around CURSOR - a recently-developed positioning system that applies triangulation techniques to adjacent GSM base stations.

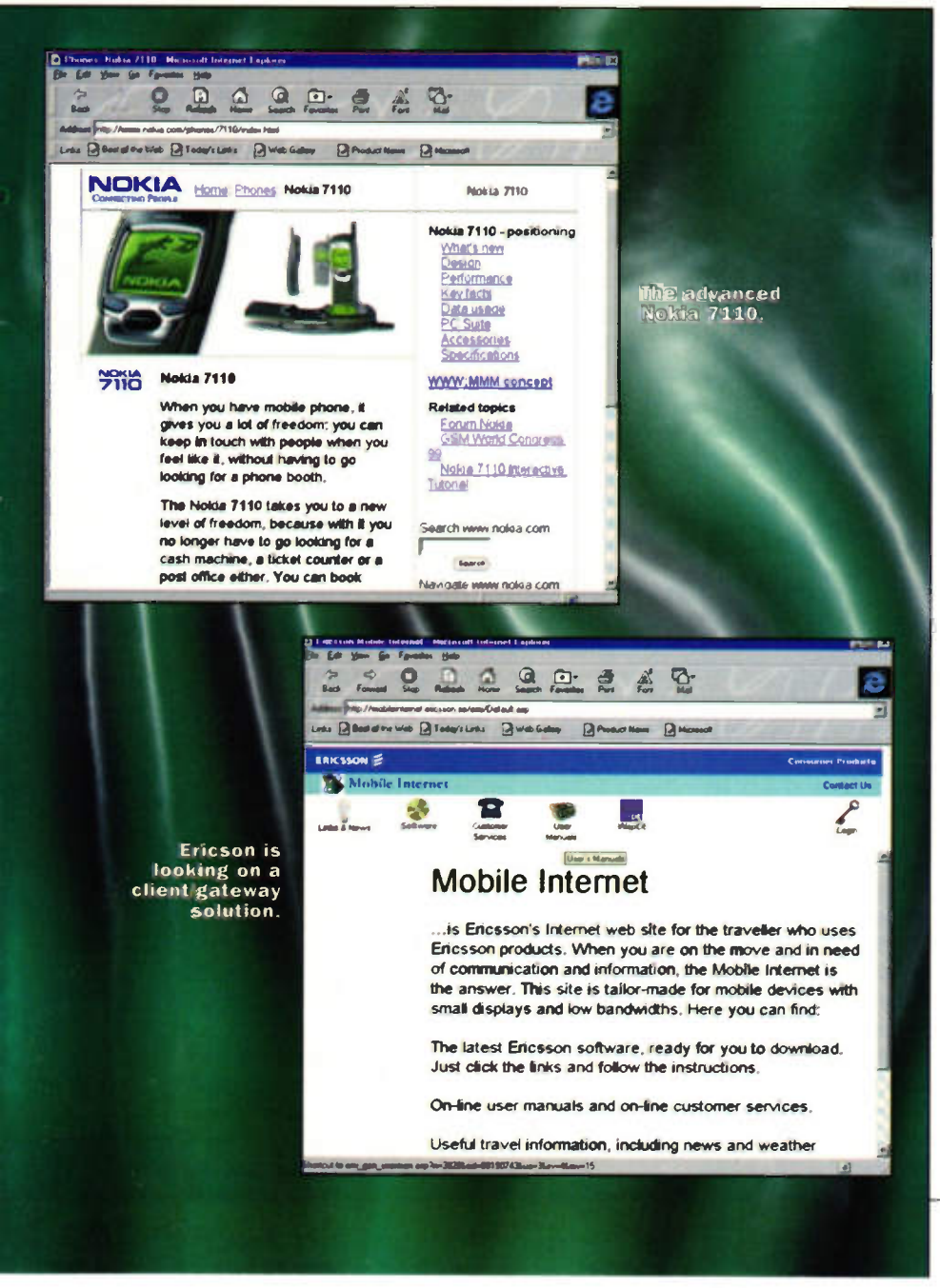
To improve the data transfer rates available to WAP-type applications, Ericsson is working on a client/gateway solution known as WebOnAir Filter. Here, the user's web browser connects to a special client proxy, rather than directly to the ISP's proxy server. This client proxy, which runs on the same machine as the user's web browser, communicates with a special gateway proxy program that resides on the ISP's server. WebOnAir works by filtering out superfluous code, adapting image quality and compressing information prior to transmission. Ericsson claims that WebOnAir Filter reduces page download times by a factor

BBC website on a Nokia phone.

of three. Its very much a stop gap solution, however. The next generation of mobile communications, UMTS (Universal Mobile Telephone Service), will offer much-improved data transfer speeds. UMTS will, out of interest, be supported by WAP.

Another interesting development is GPRS (General Packet Radio Services), which is being trialled by the UKs main cellular networks. GPRS, which will require subscribers to invest in new hardware, increases the maximum uncompressed data rate available through GSM to 115,200bps or more. This system, which employs Internet-style packet transmission, will form part of the UMTS specification. The cellular network operators like GPRS because its more efficient than current GSM data systems, which allocate guaranteed bandwidth to callers. With GPRS, radio resources are only allocated when data is actually being transmitted. Theoretically at least, GPRS subscribers could stay on-line permanently - they would only be charged when data is actually transported. At least one network (Cellnet) plans to deploy GPRS across its GSM network by the end of the year.

Greater bandwidth does, of course, open up more applications. Future WAP phones will be equipped with larger displays, perhaps even colour ones. Advances in video compression technology - Orange, amongst others, is looking into this - will enhance these information services. With the current SMS incarnation, you can arrange for football scores to be sent to your phone. In the future, you might also be able to view player biographies (complete with photographs), and perhaps also watch a video clip of that important goal being scored!



Alcatel, Motorola, Nokia and Ericsson are currently in the process of launching suitable products. Nokias new 7110 dual-band GSM handset meets all of the WAP requirements - it has in-built data compatibility, microbrowser software, and a larger-than-usual display. As a nod to the mouse, the 7110 has a thumbwheel-type device (the NaviRoller) for selecting menu options, together with intelligent text-entry that guesses the next letter courtesy of an in-built dictionary. The 7110 is an expensive handset, but prices will fall with time. Within a couple of years, we can expect to see WAP-compatible phones offered on prepay tariffs.

Those who wish to experiment with WML page design may be interested in another piece of software available from Ericsson - the WapIDE Service Development Kit. This suite, which can be downloaded from one of Ericssons web sites (`http://mobile internet.ericsson.se/emi/Default.asp`) is an integrated development environment that allows content providers and operators to design WAP services and applications. The two files required (development kit and runtime environment) add up to nearly 10Mb, and when I visited it the site was rather slow. Be prepared, then, for a long wait!

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

Free really means FREE

There are many free Internet service providers popping up all over the place these days. Most of these offer free Internet access, in that you pay nothing for the service — although you still have to pay your telephone service provider for the price of any phone call you make to log onto the Internet via your ISP. It's here where the free Internet service providers make their money — they each get a portion of the money that British Telecom makes from its customers who make the telephone calls to the Internet service provider.

However, one Internet service provider actually offers free telephone calls too - using a free 0800 number! The service - X-Stream - is the first of its kind in the UK and is worth considering if you're on the lookout for a new Internet service provider. Don't think that all calls you make will be free, mind you. X-Stream operates in the same way that all the other free Internet service providers do in the main, and only offers the free 0800 access number at certain times and dates (usually at night, and often only at weekends). Nevertheless, it's a step in the right direction towards cheaper Internet access, and obviously worth trying out if you want to carry out some large file downloads or you're a night bird. As X-Stream provides a local rate access number at all other times it's no more expensive than other free Internet service providers anyway, and you could save a packet depending on when you access the network.

The downside of the service is that X-Stream software has to be used that displays a small advertising banner over the top of your Web browser. This is quite unobtrusive however, and doesn't detract from general Internet use in any major way. The X-Stream software is free for anyone to download and use, although at the moment it's only available for Windows users. A Mac version is promised, so interested Mac users should register now. X-Stream's URL is: <http://www.x-stream.co.uk>.

Faster than ISDN

One of the problems with Internet access is the speed (read: lack of speed) of some connections. Even with a 56K modem, access speed is still limited partly by your phone connection, but mainly by your Internet service provider itself. All Internet service providers only have a limited access capability themselves to the Internet, and this access capability is shared between all of their subscribers who are logged on. At peak times, access capability is shared across a maximum of connected subscribers and it's not unusual to find that access is only at a snail's pace. While your 56K modem might be able to make a phone connection of around 45K (a typical value) it's more the case that actual access can be as low as a mere 1K or so

New satellite services aim to sidestep this logjam, by using digital video broadcasting (DVB) technologies to carry Internet data. While DVB allows several hundred digital television channels to be broadcast along single links, it has also been developed to carry TCP/IP traffic (of the sort on the Internet) alongside digital television signals. It's this fact that developers hope will allow satellite and cable television subscribers the ability to have fast Internet access. The idea behind these ventures is that a standard direct-to-home satellite link connected directly to a computer fitted with the appropriate card will provide a downlink capable of 40M speeds. Users will link to the service over a standard phone connection for uploading and control. As most users spend more time downloading than they do uploading, the resultant asynchronous connection is ideal for high-speed Internet access.

Convergence1 is an Internet access service based on the DVB principle, which is maintained by British Telecom, Eutelsat, and Easynet. While currently in late development stages, Convergence1 is in trial, and has been proving successful over the past few months. For further information, try the Convergence1 Website, at: <http://www.convergence1.com/home.html>, and also the DVB Group Website, at: <http://www.dvb.org>.

NetPartners and Inktomi Develop Filtered Web Access

NetPartners at <www.netpartners.com> and Inktomi at <www.inktomi.com> are developing a product which will integrate NetPartners' WebSENSE with Inktomi's Traffic Service to enable Internet service providers and corporations to provide high-performance Internet content filtering for all users on their networks.

WebSENSE is an Internet access management system that allows organisations to monitor, report, and manage Internet access for users on their networks. The software helps to reduce exposure to legal liabilities, lost employee productivity, and non-work related demands on computer resources caused by frivolous Internet usage.

Inktomi Traffic Server is a carrier-class network cache platform designed to help Internet infrastructure and content providers scale their networks. Traffic Server helps ISPs, backbone networks, and hosting providers deliver enhanced quality of service, increased bandwidth efficiency, and a broad range of value added services.

Roof With a View at FT.com

FT.com, the news and business information web site from the Financial Times is offering a unique 'live' view of the London skyline and construction of the Millennium Bridge to internet users around the globe.

The user-controlled Canon WebView cameras are hosted by FT.com on its new Millennium Bridge Web site at <www.mbridge.ft.com>. Through the new web site users are able to manipulate the zoom, pan and tilt of WebView cameras located on the roof of the Financial Times building and across the River Thames at the City of London school.

The cameras offer fantastic live views of both north and south banks of the river, London's first new pedestrian bridge for over a century, and London landmarks including St. Paul's Cathedral, the new Tate Gallery of Modern Art and the Globe Theatre.

Sign on the Electronic Line

It will now be possible to sign Adobe Acrobat Forms naturally with a handwritten signature following an agreement between two US companies. Communication Intelligence, a supplier of pen-based software solutions is partnering with VeriSign to deliver an innovative solution to sign electronic forms and conduct electronic transactions with Adobe Acrobat 4.0.

Using Communication Intelligent's patented signature verification technology, Sign-it Secure will verify a user's handwritten signature and release a VeriSign Private Key. This will make the document tamper-proof and allow recipients of the document to authenticate the identity of the document's author.

Sign-it Secure is expected to be available to consumers next month and will be available for download from Communication Intelligence's Web site at <www.cic.com>. Consumers will have the opportunity to try Sign-It Secure for Adobe Acrobat 4.0 and a VeriSign test certificate for a free 60-day trial period.

Lycos Passes Yahoo

The Lycos Network at <www.lycos.com> has surpassed the Yahoo sites to become the most visited hub on the Web with 51.8% audience reach, according to the latest Media Metrix report for March 1999. The Lycos Network, the fastest-growing Web portal, now attracts 31.9 million unique visitors monthly. The properties in the Lycos Network grew a total of 34.9% in unduplicated reach since April 1998, driven both by the dramatic growth of the individual sites and the circulation of traffic throughout the Network. The other leading portals declined in audience reach during the same period.

Audience Reach	March 1999	April 1998	Percentage Change	Unique visitors [millions]
Lycos Network	51.8	38.4	+34.9	31.9
Yahoo Sites	50.8	52.1	-2.5	31.3
Excite Network	30.6	32.8	-6.7	18.9

Source: Media Metix, March 1999

Build a Car on Toyota Site

Most car manufacturers these days have an Internet presence of some description but very few can boast a site that really is state of the art. Toyota have shown real commitment to succeeding on the Internet at <www.toyota.co.uk> and giving customers a service and experience which is second to none.

Built using the One to One Marketing software tool from BroadVision, it gives Toyota the ability to supply the user with information that they are likely to be interested in rather than bland mass marketing.

Visitors get the opportunity to visit the Virtual Showroom, in which they can build their ideal car, using all the traditional components such as model, colour, engine size, interior trims and then save it in their personal showroom.

The experience is as real as talking to a dealer but in a more relaxed environment, to make it as close to the usual buying process as possible.

eBay Cuts Deal With AOL

Online auctioneer eBay at **<www.ebay.com>** has agreed to pay AOL at **<www.aol.co.uk>** a massive £45 million over four years in exchange for a prominent presence on AOL's Web sites. The new agreement, which significantly expands the two companies' existing alliance, gives eBay greater access to AOL's 16 million members, and ties AOL more closely to one of the Web's most popular sites for electronic commerce.

Video Paint Effects for Video and Web

Anexa.com at **<www.anexa.com>** develops the infrastructure required to host and manage a Web community. The company has recently expanded its capabilities enabling anyone with Internet access to create a media-rich community for their club, organisation, family and friends instantly. People can interact intimately and share experiences easily by combining photos, graphics, images, sounds, descriptions, and comments. But the best bit is that it is all free.

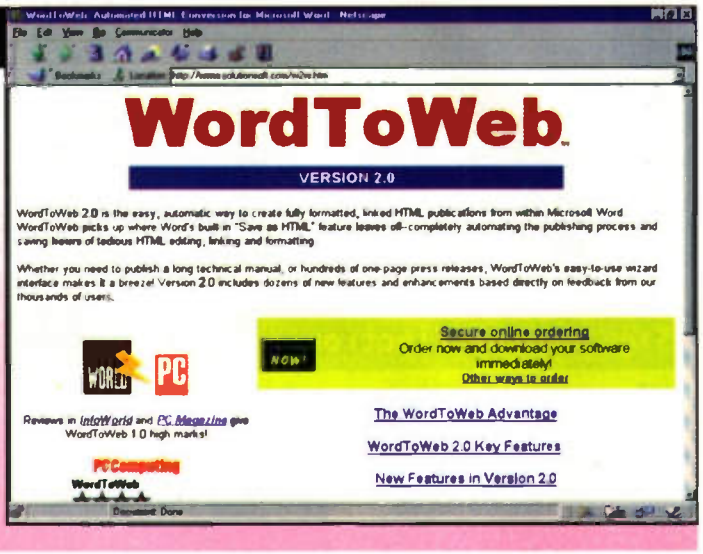
WordToWeb 2.0 Automates HTML Conversion

WordToWeb 2.0 is an upgrade to Solutionsoft, a Microsoft Word-based HTML conversion tool which unlike the 'Save as HTML' feature in Word automates the entire document conversion process - eliminating hours of error-prone HTML editing and formatting.

WordToWeb 2.0 can automatically convert hundreds of Word documents to HTML and can also break long source documents into a series of linked HTML pages.

In addition, WordToWeb creates an online table of contents and index and will handle cross-references, footnotes, navigation links, background/formatting and other details. Documents can be re-converted to HTML at any time with a single click of the mouse - making it easy to keep online information up-to-date even when the source documents change frequently.

A fully functional evaluation copy of WordToWeb 2.0 can be downloaded now from Solutionsoft's Web site: **<www.solutionsoft.com/w2w.htm>**



Develop Free Online Communities

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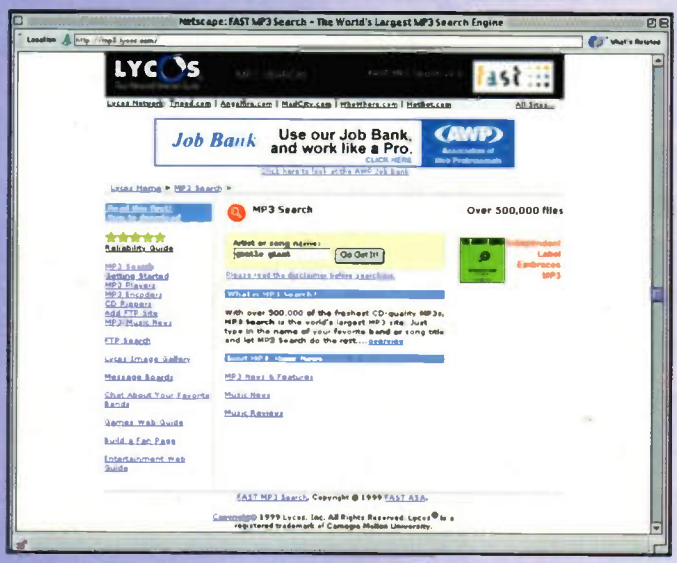
Web Site Offers Free Technology Support

<www.TechPointer.com> is claimed to be the first technology support portal. Its provides a one-stop central resource for all computer and Internet related questions and problems. All inquiries posted on the site will be answered for free by technology experts 24 hours a day, 365 days a year, within 4 hours.

There is a massive database of FAQs and a live chat room for even faster solutions. The TechPointer experts are specially trained to answer questions at all levels of need.

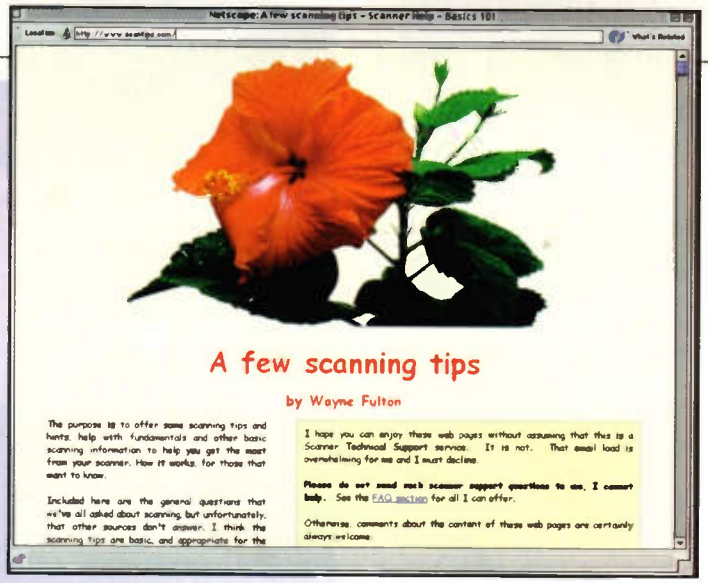
Site Survey

The month's destinations

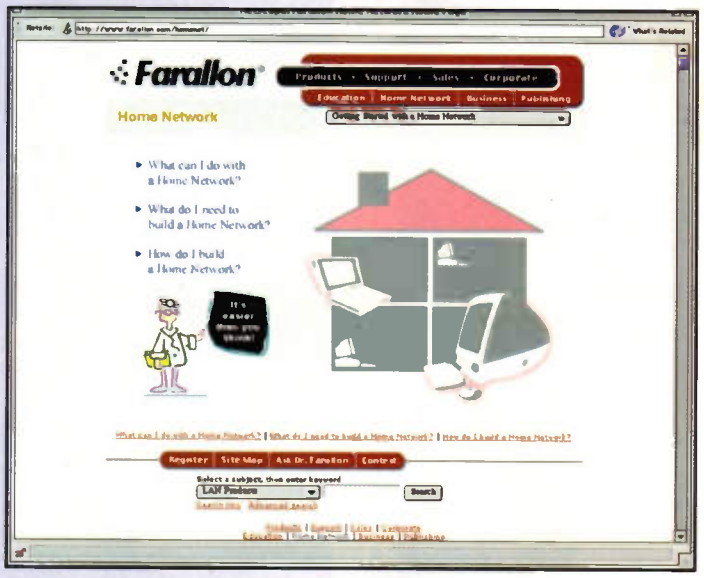


Afficionados of the MPEG Layer 3 file format - more commonly known as mp3 - know that high quality music can be saved in the highly compressed format on computer disk. It's relatively easy to create your own mp3 files, from your personal CD collection, to save on your computer, and it's also relatively easy to download mp3 files off the Internet. Finding sources of mp3 files isn't always too easy though, but the Lycos search engine has a special engine specifically for locating mp3 files. Just type in the artist or track name you want, and you'll probably find a link here: **<http://mp3.lycos.com/>**. Also on the site are several appropriate links to get information about mp3, or to download mp3 encoding, decoding and playing software.

Many personal computer users have a scanner to allow digitisation of photographs and slides into computer file formats, for display on screen or printing. Unfortunately, as many of these find, scanning isn't as easy as it looks particularly if you want good results. Knowing your lines per inch from your sharpening filters seems to be a strange black art when you're faced with a jaggy image or a huge file size. If this is your problem, then checkout: **<http://www.scantips.com/>**, where you'll find a user-friendly introduction to the vagaries of scanning, with plenty of tips and pointers to get the best out of your digital images.



In a similar vein, many home personal computer users have a desire to network two or more computers with a printer and have no idea where to start. Despite the fact that networking seems a complicated and technical issue, it actually has a rather easy conclusion in most instances. Manufacturer of networking products, Farallon understands the home networker's needs and has a Website which covers home networking (although the information isn't specific to just home computer networking), at: **<http://www.farallon.com/homenet/>**. Here you'll find all the information you need to get started networking.



Multimedia Management from Kodak

MediaQuest is a neat piece of software from Kodak that enables businesses to control media assets such as images, artwork and video clips from a centralised location, yet provide access to users worldwide over the Web.

Picture Network International (PNI) a subsidiary of Kodak has being using the technology that underpins MediaQuset for years to manage millions of images for its online stock photography services, Publishers Depot and the new PictureQuest at **<www.picturequest.com>**.

MediaQuest supports all file types - from image and video files, to presentation and word processing files. Assets are easily loaded, and are captioned and catalogued online using either keywords or conversational English to describe each asset.

Project Ratings

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

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

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

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

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

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

Ordering Information

Kits, components and products stocked at Maplin can be easily obtained in a number of ways: ❶ Visit your local Maplin store, where you will find a wide range of electronic products. If you do not know where your nearest store is, telephone (01702) 554002. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance; ❷ Write your order on the form printed in this issue and send it to Maplin Electronics PLC, P.O. Box 777, Rayleigh, Essex, SS6 8LU. Payment can be made using Cheque, Postal Order, or Credit Card; ❸ Telephone your order, call the Maplin Electronics Credit Card Hotline on (01702) 554000; ❹ If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (01702) 552941. If you do not have a customer number, telephone (01702) 554002 and we will happily issue you with one. Payment can be made by credit card; ❺ If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place your orders directly onto the Maplin computer 24 hours a day by simply dialling (01702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system; ❻ Overseas customers can place orders through Maplin Export, P.O. Box 777, Rayleigh, Essex SS6 8LU, England; telephone +44 1702 554000 Ext. 376, 327 or 351; Fax +44 1702 554001. Full details of all the methods of ordering from Maplin can be found in the current Maplin Catalogue.

Internet

You can contact Maplin Electronics via e-mail at `<recipient>@maplin.co.uk` or visit the Maplin web site at `http://www.maplin.co.uk`.

Prices

Prices of products and services available from Maplin shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%). Prices are valid until 1st July 1999 (errors and omissions excluded). Prices shown do not include mail order postage and handling charges. Please add £2.95 to all UK orders under £30.00. Orders over £30.00 and MPS Account Holding customers are exempt from carriage charges.

Technical Enquires

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Service Dept. may be able to help. You can obtain help in several ways; ❶ Over the phone, telephone 0897 501353 between 9.00am and 5.30pm Monday to Saturday, except public holidays (calls charged at £1/min BT rates); ❷ By sending a facsimile, Fax (01702) 554001; ❸ Or by writing to Technical Services, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Services are unable to answer enquires relating to third-party products or components which are not stocked by Maplin.

Maplin 'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini-Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service return the complete kit to: Returns Department, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Enclose a cheque or Postal Order for the servicing cost (£24/hr min + parts) as indicated in the current Maplin Catalogue. If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost, plus parts. A kit building service is on offer for any of our kits. Please contact our customer service department for any pricing details.

in the pipeline

ELECTRONICS and Beyond

Don't miss another great assortment of entertaining and easy-to-make projects and essential electronics information aimed at the novice constructor.

Issue 140 will be on sale Friday 2nd July

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Magnetometer

Weather Station

LASSIE - Logic Analysis System with Six Input Evaluators

FEATURES

Chaos Theory

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USB 56K MODEM

Catalogue Price £79.99
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SAVE £20

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