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AVR BCD 7-Segment Display
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THE MAPLIN MAGAZINE
ELECTRONICS and Beyond

September 1998 Vol. 17 No. 129

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Editorial
Editor Paul Freeman-Sear BSc (Hons)
Technical Author John Mosely
Editorial Assistant Lynda Hardy
News Editor Stephen Waddington BEng (Hons)
Technical Illustration Set Square Designs

Production
Design Layout Artist Karen Harris
Photography Librarian Mavis Williams
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Management
Manager
Paul Freeman-Sear BSc (Hons)
Marketing Services Manager
Steve Drake

Subscriptions
Maureen Harvey
Tel: (01702) 554155 Ext. 311.

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ELECTRONICS and Beyond

At last the BBC are awakening the radio listeners of Great Britain to the imminent arrival of digital radio, with car radios being the first and most logical beneficiaries of the new system - albeit at a price. Nevertheless, the arrival of a new and radical means of transmitting news, music and information is another jump in the development process, and Ian Poole in his article Digital Broadcasting, and Martin Pipe's Technology Watch both look at this exciting technology. However, it may not be a new piece of Hi-Fi hardware that provides us with the ability to hear CD quality radio, but the PC - read on!

It is not just the BBC who have been quietly advancing technology, but the car manufacturers too have been slowly, but surely, developing perhaps the next generation of cars. In the first of a two part series we look at electric and hybrid electric vehicles, and see how the manufacturers are making some astonishing developments in methods of propulsion.

This month we have books, educational software and free tickets to the Hi-Fi Show to give away so do drop us a line and try your luck, and remember to have a look at the accompanying special offers booklet which gives big discounts on a selection of new items to be found in the next Maplin Catlaogue - but hurry, these offers are only available for a limited period.

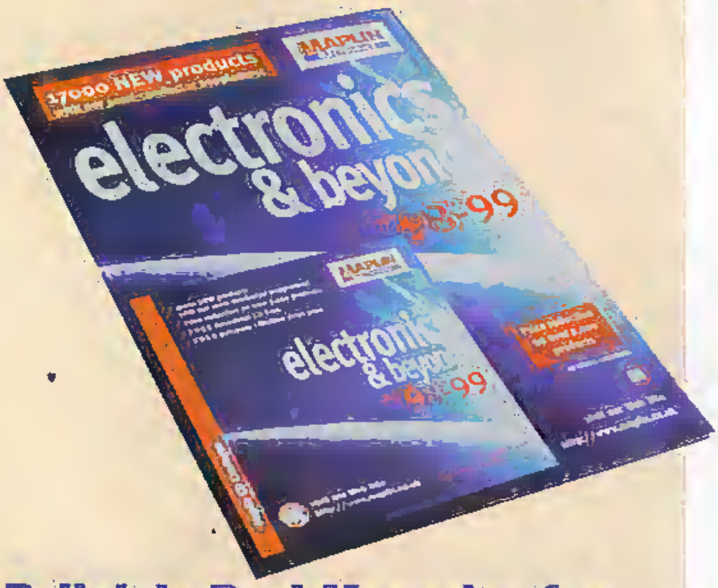
Congratulations

Congratulations go to subscribers W. Barlow of Rossendale, and K. B. Taylor of Winchester who have each won an Iomega Zip drive, N. Tree who receives a £10 New World payphone card, K. A. Morris and Brian Murrissey who each receive a £5 card and Peter Bestel, Philip Stevenson, Dusty Miller, George Lovell, S. Walton, Harold Stevenson and Peter Blake who each receive £3 cards.

Maplin Catalogue on CD-ROM

The next Maplin catalogue on CD-ROM will feature two CDs, one will include the complete Maplin range of products and the other IC specification and pin-outs plus Demon Internet connection details. Next month we will include a free copy of the products CD-ROM, so remember to get your copy of Electronics and Beyond early, as we sold out of the last issue with the CD-ROM on within a few weeks. The following month, issue 131, will include the second CD-ROM with the IC specifications.

Paul Freeman-Sear, Publishing Manager



Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Sega Announces Dreamcast

The game console of the future was announced in the US this month. It's going to take 18 months before it hits the streets, though Sega boss Bernard Stolar announced a new video game console called Dreamcast that he said would hit the market for Christmas 1999.

Dreamcast features 128-bit performance, an independent 3D graphics engine, a dedicated 3D sound chip, a memory and portable game card with built-in LC screen, and standard networking features for multi-player gaming. Sega has partnered with Microsoft, Hitachi, Yamaha, NEC, and VideoLogic to produce Dreamcast.

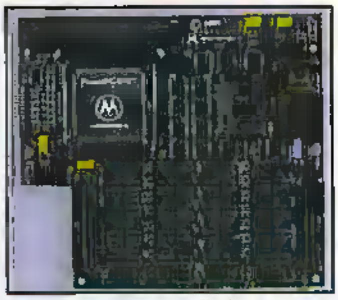
For further information, check: www.sega-europe.com.
Contact: Sega, Tel: (0181) 995 3399.

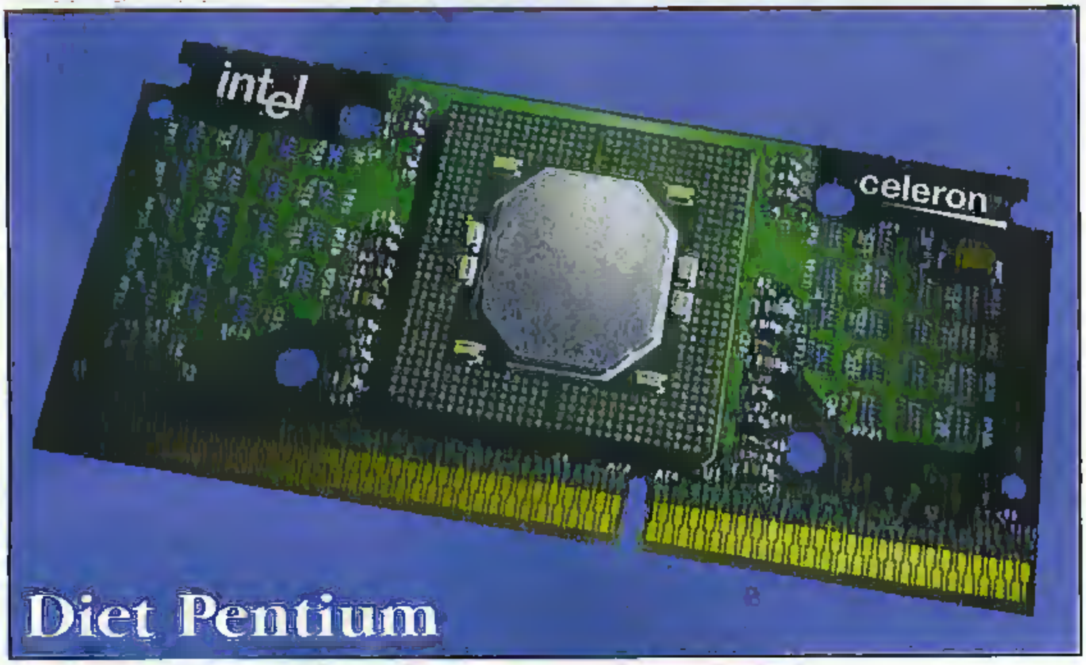
Motorola and IBM End PowerPC Alliance

It's all over. Some predicted that a divorce would be inevitable. Motorola is assuming sole control of the PowerPC chip design centre in Austin, Texas, which previously had been operated as a joint venture between Motorola and IBM. Motorola will now wholly own the facility, which is the principal designer and promoter of the PowerPC chip.

For further information, check: www.mot.com.

Contact: Motorola, Tel: (01293) 404343.



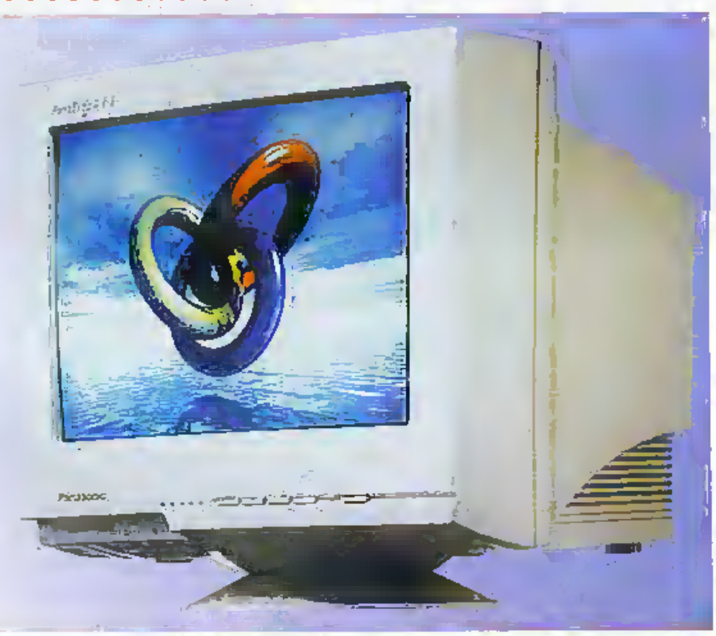


Diet Pentium

The first cut down version of the Intel Pentium processor has rolled off the production line. Named the Celeron, the new Intel device is targeted at low-cost PCs. But with a 300MHz clock, the processor provides balanced performance for many of today's applications, ranging from standard business programs to educational titles for consumers.

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

Panasonic Launches 15in. Monitor



With 17in. monitors fast becoming the standard for PCs, it's unusual to find a company launching a 15in. product. The PanaSync S50 is a 15in. cathode ray tube (CRT) device. Nothing unusual there. What is unusual is its price and quality. The monitor costs approximately £180 and has a 1,280 by 1,024 resolution with a refresh rate of 75Hz.

For further information, check: www.panasonic.co.uk.

Contact: Panasonic, Tel: (0500) 404041.

Telcos to Fight Back Against IP Threat

New IP services from voice, fax and data traffic will affect future telcom operators' revenues, but not as significantly as predicted, according to a new report from analyst house Ovum. The report, titled 'IP: the Impact on Teleco Services and Revenues' claims IP telephony and fax providers are now focusing their attention on the lucrative international traffic market in an attempt to undercut telco revenue streams.

For further details, check: www.ovum.com.

Contact: Ovum, Tel: (0171) 312 7265.

NEWS BYTES

Samsung Honoured In Queen's Awards to Industry

Samsung Electronics Manufacturing (UK) based on Teesside has won The Queen's Award for Export Achievement. During the 12 months to September last year Samsung exported to 26 countries, particularly targeting the emerging economies of Eastern Europe. New markets during that period have included India, the Czech Republic, Slovenia and the Ukraine. The company has also exported to North America.

Samsung manufactures colour TVs, computer monitors and microwave ovens on Teesside. The Wynyard Park site was officially opened in October 1995 by Her Majesty The Queen and Chairman Lee of Samsung.

For further details, check www.samsung.com

Contact: Samsung, Tel: (0181) 391 8213

RSGB Past President Library Raises £11,000

The library of the late Len Newnham – RSGB past president and a key figure in the Society's early years – sold for more than £11,000 at auction in London in May.

Some 2000 books, mostly on radio telegraphy, plus periodicals and trade catalogues from the 20s and 30s, were sold. Several lots attracted far higher bids than expected. For instance, lots which included a third edition copy of 'Signalling Across Space Without Wires' by Oliver Lodge and a first edition copy of Wireless Telephony' by Ernst Ruhmer, which were expected to go for around £100, fetched £880.

Len Newnham, who died in 1994, joined the RSGB in 1925, served on the Council for 23 years and became President in 1958. His callsign – G6NZ – is now held by his widow Margaret.

For further details, check: www.racal.com.

Contact: RGSB, Tel: (01707) 660888.

London Rail Line Gets Major Security Boost

A CCTV (Closed Circuit Television) system serving the North London Line is now operational following its completion for Railtrack by Racal Telecom. The project costing in excess of £600,000, has introduced new standards of security for customers, staff and property at 11 stations on the line.

A total of 50 cameras are now linked by fibre optic technology to the CCTV control room in Willesden where their input is being continuously monitored and recorded. Of these, 14 cameras are movable pan, tilt and zoom units that enable staff to obtain detailed images of security problems. It is expected that the new system will make a significant contribution to customer safety and help develop confidence in the rail network as a safe and dependable means of transportation.

For further details, check: www.racal.com.

Contact: Racal, Tel: (01344) 481222

NEWS BYTES

Triacs Simplify Domestic Appliance Control

Philips has extended its line-up of power semiconductors for use in domestic appliances by introducing a new range of high-sensitivity 1A triacs in a space-saving industry-standard TO92 package.

Featuring maximum gate trigger currents of 3mA and 5mA respectively, BT131-Series and BT132-D Series triacs can be driven directly from the outputs of low-power microcontrollers or logic ICs – simplifying drive circuit design and reducing component and assembly costs. They are suitable for controlling continuous load currents up to 0.5A without additional heatsinking or loads up to 1A with a simple clip-on heatsink.

Applications for these versatile triacs include small motor, heater and solenoid control in appliances such as washing machines, dishwashers, refrigerators, freezers and extractor fans. They can also be used as a gate-driver for larger, less sensitive triacs.

For further details, check: www.semiconductors.philips.com.

Contact: Philips Semiconductors, Tel: +31 40 272 20 91.

'Internet-in-the-Sky' Partnership

Teledesic and Motorola have become partners in the development and deployment of Teledesic's global, broadband 'Internet-in-the-Sky' satellite communications system. Boeing and Matra Marconi Space, Europe's leading satellite manufacturer, will round out the team of founding industrial partners.

Motorola will be the prime contractor for the global technology team that will spearhead the engineering and construction of the world's first advanced telecommunications network to provide high-speed data connections to businesses, institutions and individuals everywhere on Earth – regardless of location. The team will combine the technical efforts now under way on the 'Internet-in-the-Sky' system pioneered by Teledesic and the Celestri broadband satellite system conceived by Motorola.

For further information, check: www.mot.com.

Contact: Motorola, Tel: (01293) 404343.

Nortel Acquires

In what could be the largest acquisition of a networking company ever, Nortel formerly Northern Telecom, has made a long-expected move to buy Bay Networks for a cool $9.1 billion. The deal, which has been rumoured for months, turns telecommunications powerhouse Nortel into a major networking force alongside the likes of 3Com and Cisco.

For further information, check: www.nortel.com.

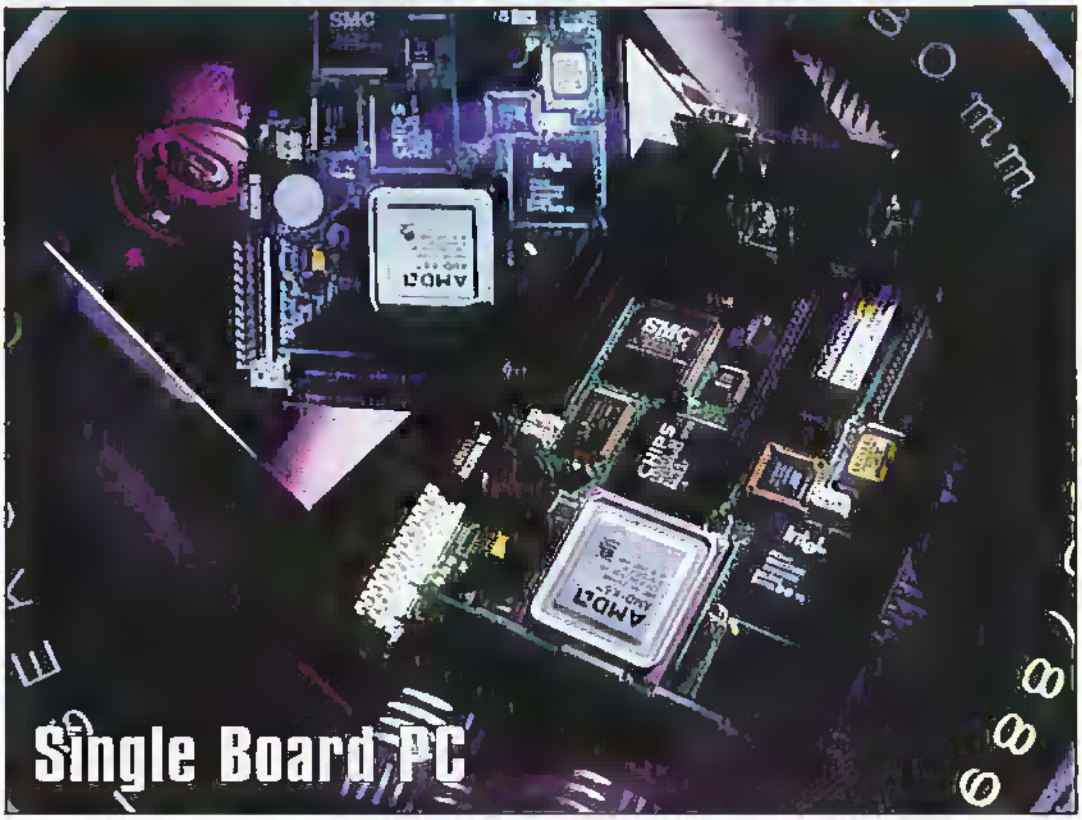
Contact: Nortel, Tel: (01628) 813000.

Russians Bank on AMP Cabling

AMP has two contracts to cable the Moscow branch of the Central Bank of Russia and the city's tax inspection office. The contacts, jointly worth in excess of £250,000 are for the design and installation of cabling systems to cope with voice, video and data.

For further details, check: www.amp.com.

Contact: AMP, Tel: (0800) 267666.



Single Board PC

Blue Chip Technology has launched a powerful single board computer for audio, graphics and video applications. The 200MHz Pentium product has 64MB DRAM, 512KB L2 cache, an on-board SoundBlaster audio card and plug-in flash options for diskless operations.

For further details, check: www.bluechiptechnology.co.uk. Contact: Blue Chip Technology, Tel: (01829) 772000.

Portable Add-ons Power PCs on Planes

Ask computer users what they like most about Portable PCs and they are likely to say that they enjoy the freedom to have access to applications such as e-mail, Word, Excel and PowerPoint while on the move. Ask them what they like least and they'll say flat batteries.

But this no longer need be the case with the Portable Add-ons Airline-Car Power Adapter.

The device incorporates a dual plug that can power and recharge a notebook from either a car cigarette lighter or one of the new in-seat power systems now installed in business class by major airlines such as Delta, United, American and Virgin.

For further details, check: www.portable.co.uk.

Contact: Portable Add-ons, Tel: (01256) 361333.

Ferranti Receives Millennium Endorsement

An electronic tracking system developed by Vision Control Systems (VCS) part of Ferranti Technologies has been selected as a Millennium product. The VCS eye-tracking system is

believed to be the world's first commercially available technology of its kind. By innovative integration of a miniature CMOS camera with holographic optics operating in the infra-red spectrum, VCS is able to provide precise information about what an individual's field of vision.

For further details, check: www.visioncs.com.

Contact: Ferranti Technologies, Tel: (0161) 624 0281.

Life on the Ocean Waves for Vodafone

MarineGuard and Vodafone have teamed together to develop a global positioning system (GPS) to enable pin point tracking and monitoring of boats across the world.

The GPS system automatically activates an alarm if an intruder is sensed on a protected boat, whilst at the same time transmitting an alarm call to one of MarineGuard's monitoring stations via the Vodafone GSM network. Using GPS technology, the operator knows within seconds the exact position and status of the boat and warns the appropriate authority as well as remotely cutting off the craft's engine.

For further details, check: www.vodafone.co.uk.

Contact: Vodafone, Tel: (07000) 500100.

Repair Scratched CDs

They said CDs were indestructible – it was never really true. Most people have at least a couple of CDs in their collection that jump tracks because of scratches on the disk's surface.

Ten years or more after the launch of the CD there is now a solution in the form of CDfender from Virgin Euromagnetics. CDfender's polycarbonate film will repair all scratched CD formats, including music and multimedia.

CDfender is made from a special polycarbonate film, which has the same physical characteristics as the CD it protects. This means that the laser can read the CD through CDfender without interruption.

Contact: Virgin Euromagnetics, Tel 01293 776252.

UK Holding its Own in Information Race

Business use of the Internet rose by 40 per cent in the UK in 1997, according to a new report – 'Moving into the Information Age – International Benchmarking Study 1998' – which was launched this month by the government sponsored ISI Programme for Business.

The report concludes that firms in the UK are increasingly aware of the opportunities that new technologies offer, with 86 per cent believing information and communications technologies are important for business competitiveness.

But with their European competitors taking the lead in the use of high technology equipment such as ISDN lines, mobile phones, Local Area Networks and PCs, UK companies with under 100 staff need to respond to the challenge of exploiting these business opportunities.

Contact: ISI Programme for Business. Tel: (0345) 152000.

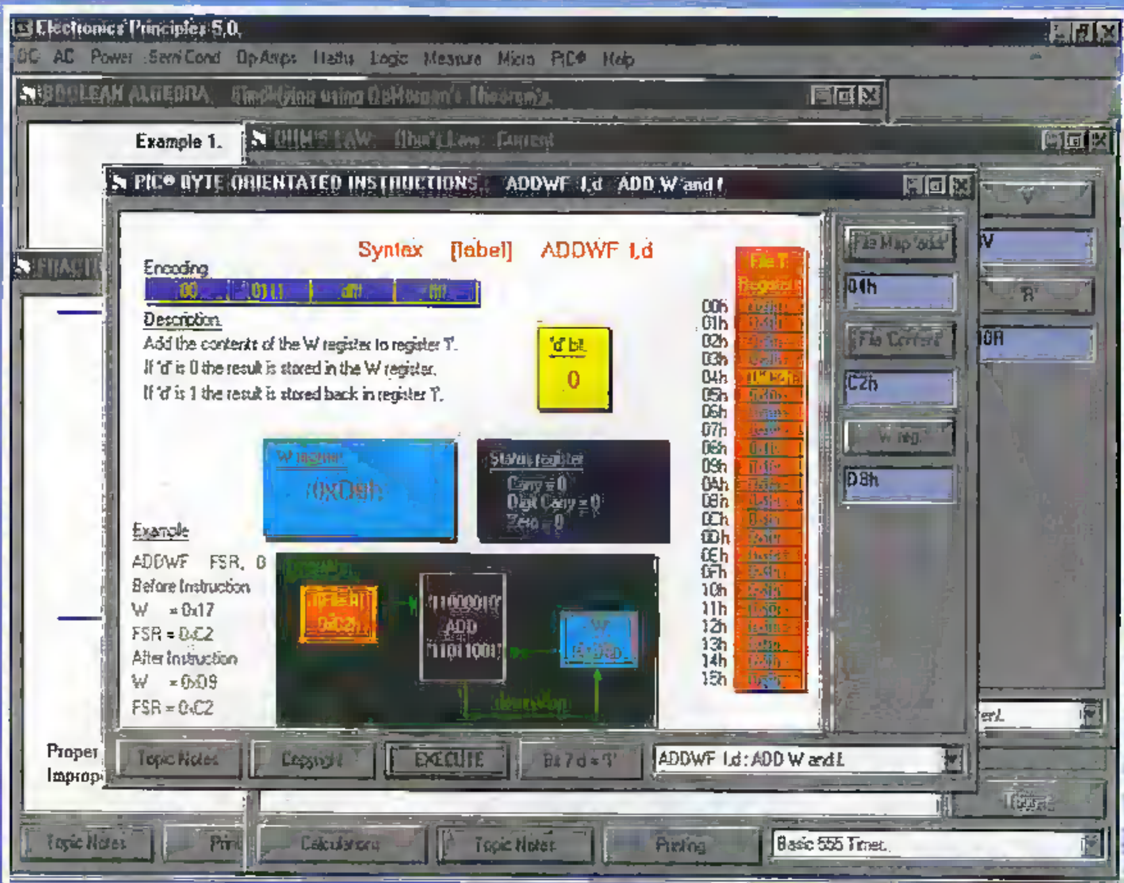
For further information, contact: www.isi.gov.uk

Electronics Principles 5.0

'A COMPLETE PC BASED ELECTRONICS COURSE'

If you are looking for an easy and enjoyable way of studying or improving your knowledge of electronics then this is the software for you.

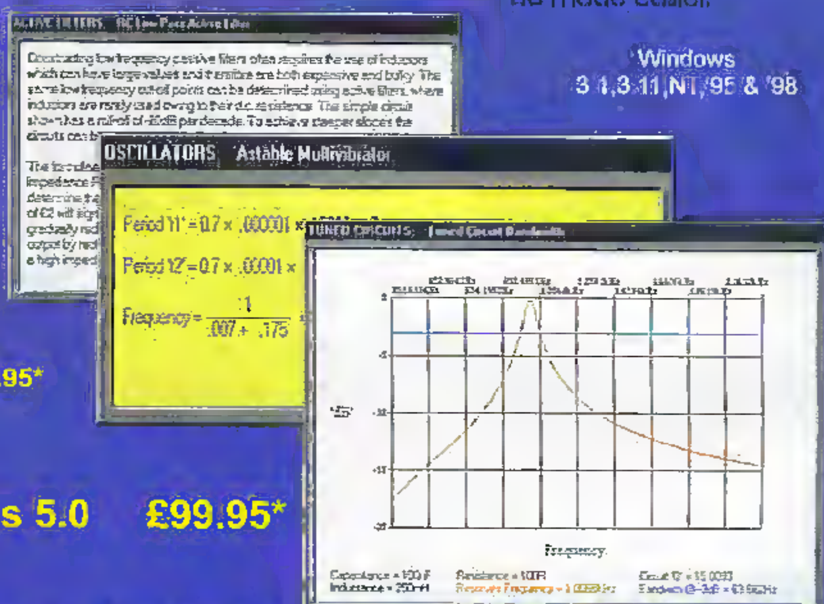
Now includes the PIC16F84 & PIC16C71 hardware and instruction set.



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

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

Telephone for a list of the 560 topics included.



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*UK and EC countries add £2 per order for post & packing. VAT should be added to the total.
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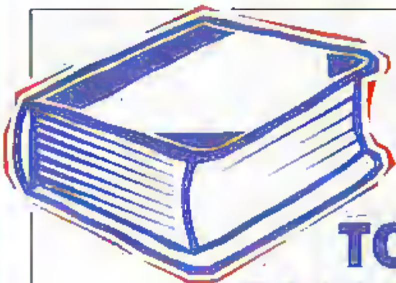
Switch, Delta, Visa and Mastercard orders accepted - please give card number and expiry date.
Cheques & Postal Orders should be made payable to EPT Educational software.



MAPLIN ELECTRONICS

TOP 30 BEST SELLING BOOKS

POSITION THIS MONTH	ORDER CODE	BOOK TITLE	CAT PAGE	UNIT PRICE INC VAT
1	AD31J	Beginners Guide To PIC	161	£19.94
2	AA11M	PC Support Handbook	131	£22.50
3	WT77J	Robot Bonanza	156	£19.99
4	WT70M	VHF/UHF Frequency Guide	185	£12.95
5	WZ32K	Home VCR Repairs	194	£14.99
6	WC08J	Towers Transistor Book	157	£24.95
7	WS20W	Art of Electronics	173	£35.00
8	AN46A	Modern Electronics Manual	165	£39.99
9	WM82D	Speaker Cabinet Designs	128	£9.95
10	AA75S	Loudspeaker Cookbook	129	£22.99
11	WP47B	Scanners	185	£9.95
12	WS76H	Servicing TV & Video	194	£30.00
13	RL06G	Radio & Electronics Engineer's Pocket Book	157	£12.99
14	NJ07H	Upgrading & Repairing PC's	131	£46.99
15	WZ90X	IEE Wiring Regs	167	£35.00
16	AA55K	Upgrade PCs/Dummies	132	£18.99
17	CR98G	Pocket PC Ref	132	£12.99
18	AA95D	Network For Dummies	134	£17.99
19	ZD26D	Win 95 for Dummies	142	£18.99
20	WS84F	Electric Motors & Drives	168	£16.99
21	NJ09K	Build Your Own Pentium PC	133	£15.99
22	AA93B	Maplin Starting Electronics	171	£9.99
23	AN38R	Electrical Appliances	168	£6.99
24	WS12N	Radio Communication	186	£20.00
25	WT46A	The Satellite Book	195	£19.99
26	WT32K	IBM PC Assembly Lang	149	£24.95
27	GS27E	Practical Electronic Control Projects	183	£5.99
28	LY04E	IC 555 Projects	183	£3.99
29	WT92A	Electric Motors	168	£6.95
30	WP64U	Modern Wiring Practice	168	£16.99

Digital Radio
THE FUTURE OF RADIO BROADCASTING

Ian Poole looks at this revolution in sound broadcasting.

Digital Audio Broadcasting, or Digital Radio as it is now termed is becoming well established. Over 100 million people across Europe and Canada are within the current service area of these transmissions. This is all part of a forward looking plan to launch the service by making it available to people in advance of a wide variety of equipment being on the market

The technology is a one of the biggest revolutions that has ever occurred in sound broadcasting. Not only does the system provide a degree of sound quality which has not been available until now, but is also provides a plethora of service that are new to radio. These include the delivery of digital data, visual information, and information categorisation. Furthermore that number of services provided can be changed according to the requirements of the moment.

In the coming months and years this new service will start to be seen increasingly and as the new equipment is launched onto the market prices will fall, making it far more attractive to the ordinary listener. Even now a number of new approaches are being developed that will see the way in which radio is broadcast and used change dramatically, keeping it in line with today's technology.

Why go digital?

In many instances the current VHF FM system works very well. It is capable of giving good performance when used with a hi-fi tuner and a good antenna. This is the way in which it was intended to be used when it was first introduced. Now the vast majority of listeners use portable radios or listen in the car. Under these circumstances reception can be far from ideal. Reflections, and holes in the coverage mean that the signal will suffer in one way or another even in areas of good coverage.

Another problem that is encountered is that of tuning. There is such a variety of stations coming from an enormous variety of different locations that it is often difficult to locate the correct one. Even when the correct station is located, it may not be received on the optimum frequency. Whilst RDS helps considerably with the problem it is by no means the complete answer, and when developing a new digital system the ease of operation was at the forefront of the thinking.

Improved use of the available radio spectrum is another issue. With the increased number users needing access, spectrum efficiency is a major issue. The current services do not use the spectrum very efficiently. The national BBC network of Radio 1, 2, 3, and 4 each occupy 2.2MHz of space. Local radio also requires a large amount of spectrum because frequencies cannot be re-used too frequently otherwise interference will result. This means that the whole of the band between 87.5MHz and 108 MHz is packed full of stations, many of which are not listened to by people in the locality.

A further reason for adopting a digital system is to keep radio at the forefront of technology. With a vast number of advances being made in technology it is necessary to ensure that the services that radio provides keep in tune with the expectation of the public. Better audio quality, improved ease of tuning and operation, combined with more data services mean that a new system in keeping with the advances that are being made. The introduction of digital radio means that radio services will be able to meet the needs of the public for many years to come.

How it works

In order to produce a digital system that operates satisfactorily under the conditions required for digital radio a large amount of work was undertaken. Nicam digital stereo sound had been successfully launched some years before, and this operated particularly well. However, it was always realised that this would be used with a directional antenna and would not suffer the problems with reflections that would be encountered with radio. Additionally the bandwidth required to accommodate a full stereo signal would need to be reduced to ensure efficient use of the spectrum. The technical standards for digital radio were developed under the auspices of the European Eureka Project 147. This consortium consisted of manufacturers, broadcasters research bodies and network operators.

There are two main areas of the system that are of general interest. There is a digital coding and compression system, and secondly there is the modulation system.

The digital encoding and compression system successfully reduces the audio data rate for a high quality 20kHz audio signal down to 128kbits/sec, a sixth of the bit rate for a similar quality linearly encoded signal. Further reductions can be made by reducing the audio bandwidth.

To achieve these reductions the incoming audio signal is carefully analysed. It is found that the ear has a certain threshold of hearing. Below this the signals are not heard. Additionally if a strong sound is present on one frequency then weaker sounds close to it may not be heard because the threshold of hearing is modified.

The other key to the operation of digital radio is the modulation system. Called Coded Orthogonal Frequency Division Multiplex (COFDM) it provides the robustness required to prevent reflections and other forms of interference from disrupting reception.

The system uses about 1500 individual carriers that fill around 1.5MHz of spectrum. The digital modulating signal is spread across these carriers so that if interference is encountered in one area then sufficient data is received to reconstitute the required signal. Guard bands are also introduced at the beginning of each symbol, and the combined effect is such that the system is immune to delays consistent with signals 60km further away than the primary source.

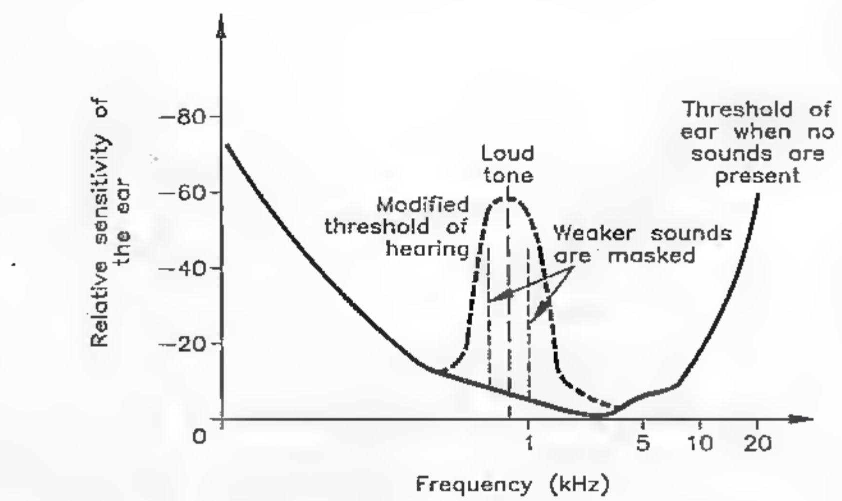


Figure. 1 The threshold of hearing of the human ear.

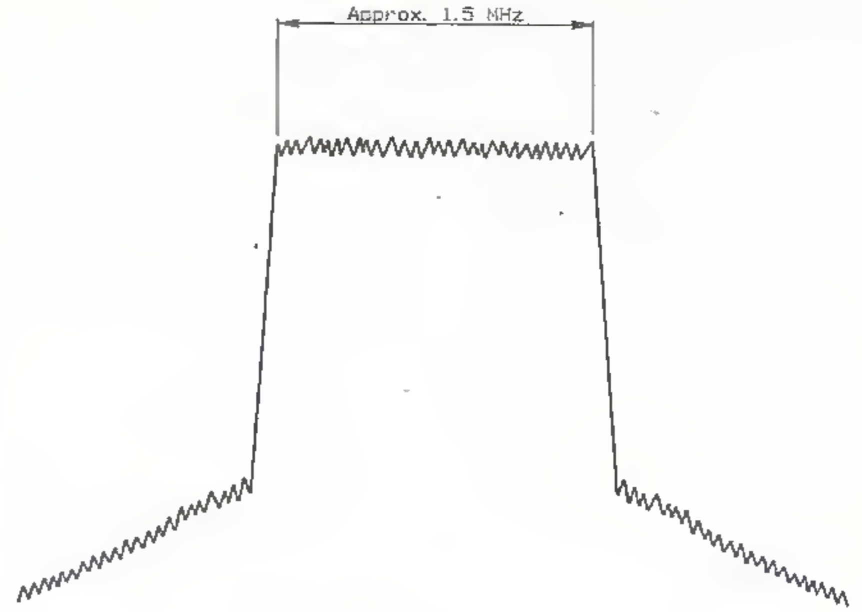


Figure. 2 Spectrum of a Digital Radio Signal.

With this level of immunity the system can operate with other digital radio transmitters operating on the same frequency without any ill effects. This means that it is possible to set up a system where all the transmitters for a network operate on the same frequency. This in turn makes it possible to set up single frequency networks throughout an area in which a common 'multiplex' is used. Even though it may appear that this is a recipe for poorer reception caused by several transmitters using the same frequency, the opposite is actually true. It is found that out of area signals tend to augment the required signal. It also means that small areas of poor coverage can have a small transmitter on exactly the same frequency filling in the hole and further improving reception in adjacent areas.

A further advantage of the system is that it requires less power than the more traditional transmitters. For example those that carry the main BBC networks from the main transmitting sites like Wrotham in the South East of England run at powers of around 100kW. The cost of the electricity alone is a significant factor in the BBCs running costs. This does not take into account any environmental issues that arise from generating these huge levels of power. The new system enables much lower powers to be used, bringing benefits of cost and benefits to the environment.

Programmes carried

A single multiplex can carry several stations at once. This can also be varied according to the quality required by each channel, and whether they are to be carried in stereo or mono. Currently the BBC are offering Radio 1, Radio 2, Radio 3, Radio 4, Radio 5 Live and a number of additional experimental audio and data services. This means that one transmission occupying 1.5MHz can carry the five main BBC networks as well as a number of other channels.

For the additional audio services, the BBC is experimenting with a variety of services including BBC Radio Five Live Sports Plus, BBC parliament, BBC Extra, UK Top 40, BBC Country, BBC Opera, BBC Jazz, and BBC Now. These services are not all available at the same time, but are changed through the day.

Band Allocations

In the UK a spectrum allocation between 217.5MHz and 230MHz has been reserved for digital radio transmissions. This gives a total of seven blocks of 1.55MHz, each able to carry a multiplex of services. The BBC national services will occupy one block and the Radio Authority will franchise the reminder. The national broadcasters like Classic FM, Talk Radio and Virgin have been guaranteed access to a national multiplex.

The BBC local radio services will also be catered for by having guaranteed access to the local multiplexes that are being set up. Local independent radio will have a large amount of access, to these multiplexes, and the Radio Authority is starting to advertise for these now.

In other countries as well spectrum is being made available. Within Europe spectrum is being made available either in Band III as in the UK or in L band between 1452MHz and 1467MHz. The upper part of the band between 1467MHz and 1492MHz will be reserved for satellite delivery of digital radio.

Digital Facilities

Being digital in nature this new form of broadcasting offers many possibilities for transmitting data, both in support of the sound programmes being broadcast, and as separate data information. In the UK the capacity allowed for data has been limited to 10% of the available capacity. Although this could conceivably be increased the primary function of this service is to broadcast audio, and this will remain the main aim of the broadcasters. However the additional data capabilities do add exciting possibilities for the service.

In the first instance it will be possible to support what is called programme associated data. This would include information in support of the programme being broadcast. It could include the name of the artist or track being broadcast, phone-in number's and any other relevant information. This could make the programmes being broadcast far more enjoyable.

Currently the BBC has begun an experimental service to provide live text captioning alongside the BBC Parliament service that relays the debates in Parliament. The caption provides information that includes the name of the MP speaking, their party, along with the constituency and post held and the business of the house that is being discussed. To achieve this the data travels from Westminster to the BBC's political HQ at Millbank. Then it is fed into the BBC's data distribution network serving Central London and it is picked up directly by the London Control Room at Broadcasting House where it passes into the DAB data inserter for transmission on the multiplex. This whole process takes less than a second. At the receiver, the data appears as scrolling information. Stephen Mulholland, editor BBC Digital Radio said, "It represents an initial step on the road towards a multimedia vision for the radio of tomorrow."

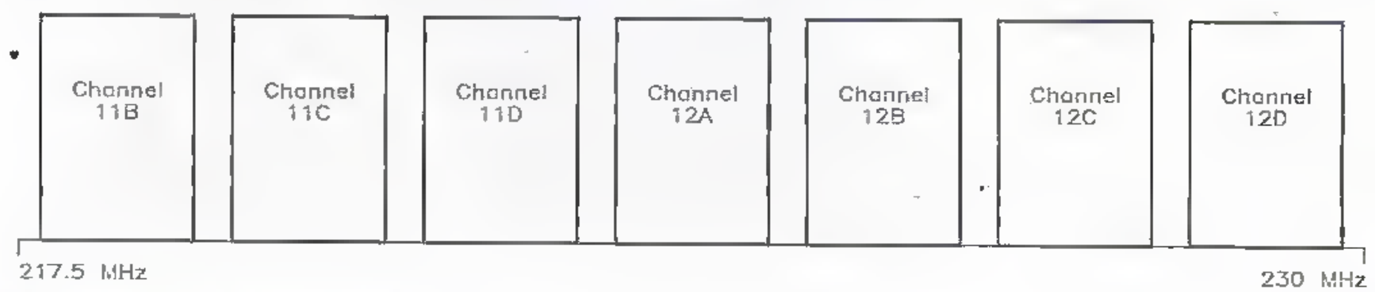


Figure. 3 Multiplex allocations in the UK.

On top of this there are a host of new facilities that could be included. Broadcasters are still experimenting with what they can do, and what the public might want. One possible use is for the provision of an advanced form of travel service. This could be linked in to a navigational system in the car to provide information about what problems could be encountered on the route being taken.

Another experiment that is being undertaken is for the transmission of internet type text and pictures using html. This would be aimed mainly at the user who would be receiving these transmissions on equipment linked into a computer. Alternatively, other ideas are emerging for displaying these pictures on a small display associated with the receiver.

Many of these ideas are still in the early stages of development. If they are to become standard digital radio facilities then further development will be required. One of the main requirements will be to develop a common standard for their use, and this is already under way.

Situation so far

The BBC launched its first digital multiplex for London in 1995 broadcasting from five transmitters around London. This experiment was expanded to cover the Birmingham area and was joined by two other commercial multiplexes operating under Radio Authority restricted service licences, one operated by the NTL, the transmission service provider, and the other by the GWR group of stations. These multiplexes included the familiar stations heard broadcasting on the regular wavebands such as Classic FM, Virgin, Talk Radio, Kiss, Melody and Sunrise. Similar pilots were also operated around Birmingham.

Now the system is being installed across the country. By the spring of this year the BBC was able to reach over 60% of the population, i.e. over 30,000,000 people, from a total of 27 transmitters, with the ultimate goal of extending the network to reach virtually the whole population. The transmitters cover major urban and metropolitan areas in the UK as well as the motorways that connect them. Coverage extends from the West and South East of England to the Midlands and the more heavily populated areas of the North of England, Central Scotland, South Wales and Northern Ireland.

Abroad

Many other countries have shown considerable interest in digital radio. Within Europe there is naturally significant support. In Germany a number of pilot services are already operational where both public and private sector broadcasters are evaluating the system. In fact, about a quarter of the services available on the digital system are not being broadcast on an analogue system. France is also adopting the system and currently has three multiplexes running in the Paris region.

In other European countries Sweden has launched a pilot system and is expanding it to reach over 70% of the population. Belgium and the Netherlands are also advanced with their introduction of pilot services.

Further afield many other countries are keenly interested. Canada has a pilot service operational as do Singapore, India, China and Israel. Australia has also stated its interest to adopt the system.

Unfortunately there are some exceptions. The main one is the USA where it has been stated that the format of the Eureka 147 system is not compatible with the style of broadcasting adopted there. They have run a number of trials using the Eureka system but instead they appear to be adopting a different system known as Digital Audio Radio System (DARS).

Japan is undecided. Although they have indicated support for the Eureka system, they are waiting to see the full outcome of the situation in the USA. As a manufacturing nation they would like to see a universal standard adopted, but now this seems very unlikely and it remains to be seen which system Japan will adopt.

Equipment

One of the main problems with the launch of digital radio has been the availability of the equipment. A large investment has been required from the equipment manufacturers. The heavy reliance on digital signal processing techniques has meant large development programmes. There have also been problems with the fact that the early implementations required high current levels. These solutions would not be suitable for portable receivers, and for in car and home applications heat dissipation was a problem. Furthermore these multi-chip solutions made the equipment large and bulky as well as making the manufacturing costs high.

Some sets have been on the market for some while, but at a price. Kenwood have had a DAB unit to operate with some of their standard car radios. At a cost of around £1200 each they were only for the real connoisseurs. However, even at this price a surprising number were bought. Grundig also marketed their DCR 1000 DAB radio.

To bring the sets within the reach of most people the price obviously needed to come down. Now it appears that many of the problems have been solved and chip sets are becoming available. These chips are smaller and their power consumption has been reduced to a point that is acceptable. Also, they can meet the cost targets that had to be put in place to enable sufficient sales to be made. The first radios are being

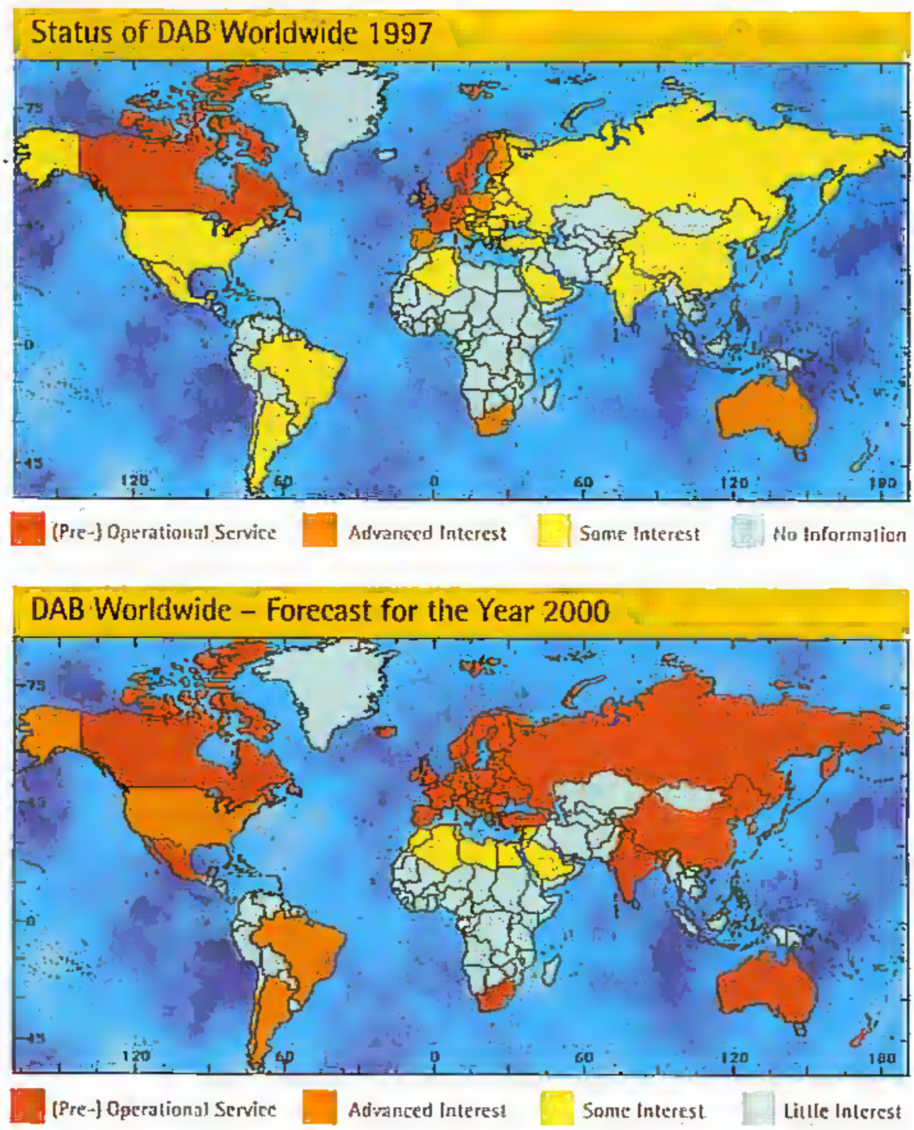


Photo 1. World-wide interest in the Eureka 147 for of Digital Radio. (Photo courtesy BBC)

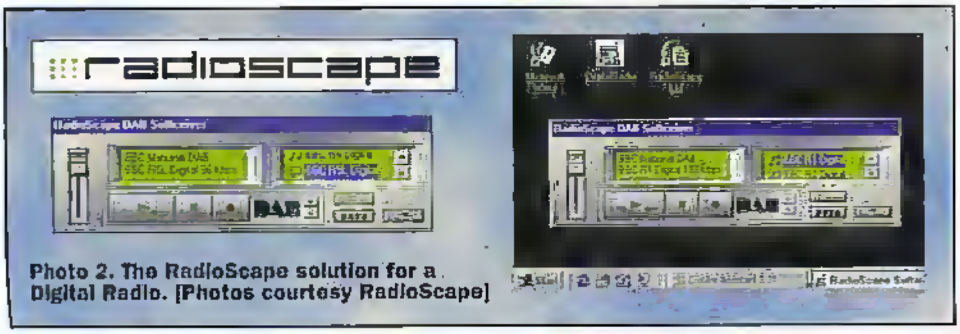


Photo 2. The RadioScape solution for a Digital Radio. [Photos courtesy RadioScape]

launched about now, and the cost of a typical car radio will be around the £500 mark. However this is expected to fall once the sales rise and the technology becomes more established. Most of these first offerings are in the form of an additional unit to connect into an existing radio. For example Blaupunkt are offering their D-FIRE unit to connect into new versions of their Stockholm RCM128 and Toronto RDM128 models. Like other manufacturers they do not expect a receiver with integral Digital Radio until after the year 2000.

These chip sets contain all the base-band processing required in the radio. In most solutions at least two chips are required. However, in a recent announcement Bosch and LSI Logic revealed their joint development of a single chip digital radio system. The chip called D-FIRE decodes the full DAB streams at all the specified rates, a first for the market. The chip was developed in just 12 months and they will be fabricated using a 0.35 micron process. This is required because of the very high level of integration required to accommodate all the processing needed for digital radio. Products are scheduled to have started hitting the market by now.

More sets are due to hit the market shortly. On June 17th this year the BBC announced the first five manufacturers to launch their receivers. The names included Blaupunkt (Bosch), Clarion, Grundig, Kenwood, and Pioneer. Sets are expected to be on the market around September or October this year. Although the prices have not been mentioned they are anticipated to be in the £500 region. Most of the other main names are expected to launch their offerings shortly after this, they should be available in the shops in the not too distant future.

The first market area that firms are addressing is the car radio market. This is seen as the major area with the most demand. Hi-fi tuners are expected to follow. In fact a prototype tuner and midi system have already been seen. However, portable radios are generally following on behind. The problem with them is that the current consumption of the digital radio solution is still higher than that currently encountered and this will significantly reduce the battery life. To make them viable low current solutions are required.

Other new innovations will hit the market. In view of the digital nature of the new system, and the amount of data likely to be transmitted, many are looking at developing cards for PCs. This will enable data to be manipulated and displayed on the screen. Bosch themselves are looking at this possibility, and another company called RadioScape has produced a software design that will operate on an MMX Pentium based machine, millions of which are in use around the world. In terms of hardware a superhet radio down converter is used to enable the raw digital stream too be passed into the PC where all the processing is accomplished. This is particularly interesting because it may offer a low cost entry point into Digital Radio for many people. It has been estimated that the boards and software might ultimately be produced for as little as £100.

For the future a vast number of new ideas are appearing. The BBC have devised a number of futuristic looking ideas. Whilst these may appear different to many of the radios we see today, many of the antenna restrictions of radios used today may not apply.

Is it worth it?

Market research indicates that the public want a better service, particularly for in car entertainment. This is why broadcasters like the BBC are investing such large sums to install the infrastructure ahead of the launch of sets for the public.

But what of the reaction so far? Wynne Jenkins of Drive Time, a car radio dealership (and Digital Radio stockist) based in Chiswick and Kingston is very enthusiast about the new system. The CD quality combined with the lack of fadeouts he says is tremendous. He also commented "Radio 5 Live is superb for the World Cup. On the medium wave band the transmission would be lost going under a bridge – and this would occur just as the crucial goal was scored. Not so with Digital Radio. The transmission is seamless along the motorways and areas that have been covered. No re-tuning as you move from one coverage area to the next, it's just there."

Future

The broadcasters have set the pace by ensuring that the digital radio infrastructure is in place before radios are available. This step of faith means that the service will be established and a significant portion of the population will be able to receive the transmissions. By doing this a demand for the radios will be created and digital radio will become established sooner. Despite the fact that the USA does not appear to be following the same route as Europe, the Eureka system is likely to gain more support world-wide. It has a head start and appears to meet the needs of most nations. As a result we are likely to see a rapid growth in the number of digital radios once they are on the market and the prices start to fall.

Photo 3. The radios of the future. [Photos courtesy BBC]

Socket SAFETY!

Andy Douglas, Sales & Marketing Director at Smiths Timeguard Limited discusses the safety aspect of RCDs and their applications.

Single switched RCD socket.

Day in day out, we all place remarkable faith in the mains electrical installations and the many devices and appliances we plug into them. That goes for professional electricians as well as the layman and woman!

Tragic as the well-publicised accidents which do occur are, they do serve to broaden awareness of the need to take common-sense precautions when handling 230V of potentially lethal power. It is my guess that most plug-in RCDs are only ever put into service when the lawn mower comes out. The most effective protection has to be hard wired!

A simple and safe option is therefore to install sockets with RCD protection built in. Smiths Timeguard's latest development in RCD socket design means that models which are direct replacements for any single or double gang socket are now available. These can simply be wired into existing, standard back boxes.

It can be argued that new or refurbished homes will typically benefit from consumer units, which provide RCD protection, but it can be a nuisance to have half the house trip out just because, say, a tumble dryer develops a short. These days it can take half an hour to go around the house resetting all the timers that people have on televisions, videos, ovens, microwaves, alarm clocks etc. Even worse would be a situation where supply to a domestic or commercial freezer was cut off because of a minor fault elsewhere in the building. Far better to have local protection to isolate the faulty appliance in milliseconds, leaving other appliances unaffected.

The RCD sockets now on the market provide the ideal solution, and they are recommended for use with larger appliances such as washers, dryers and freezers as well as the obvious high-risk items like gardening equipment and DIY tools. Until now, RCD sockets have lacked switches, so that they have not been obvious replacements for traditional sockets. Now that switched RCD sockets are at last available, this objection is easily overcome – all the more so because they have been launched with prices well below their unswitched predecessors!

Horses for courses

Installers are now almost spoilt for choice when it comes to RCD sockets, and you should be aware of the features and benefits of the different types available before deciding which is appropriate for each application.

First there is the choice between metallic and white plastic casings. Metal casings are ideal for commercial and industrial applications or for installing in domestic garages and outhouses. There is a premium of a few pounds to pay for the extra ruggedness provided by a metal casing, but the price differential is not so wide as to deter you from making the right choice.

Where looks are more important, such as inside offices, shops or homes, then traditional white plastic casings will obviously be the best option.

With the new Smiths range of RCD sockets, both outlets on the double sockets are covered with RCD protection. It is, of course, easy to isolate one half of the twin socket by simply turning off the switch. The other half will still be protected by the RCD.

Spur type RCD.

Latching or non-latching?

The next decision to make is whether a latching or non-latching RCD socket is appropriate: it is important to get this right and look for a socket range which gives you a choice between the two.

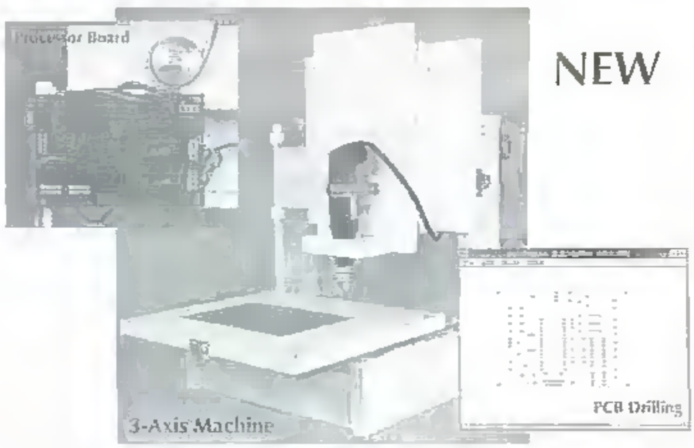
Remember that RCDs will trip in the event of a power failure, not just because of an electrical fault within the appliance. Indeed, for applications such as machine tools it is vital that they do so. However, with equipment such as commercial or domestic freezers, it is important that power can be restored as soon as mains power is available again. Mechanically latching sockets are designed to do just this. Other applications for latching RCD sockets could be safety, security or display lighting.

Conversely, 'non-latching' sockets (also known as electrically latching) will not allow the power to be restored until the socket has been manually reset, ensuring that the user is always prompted to check out the appliance before trying to use is again. Resetting the socket is a simple matter of pushing a button. This feature should be regarded as essential for sockets, which will be used to supply machine tools, or for virtually any appliance in the home.

Finally, be sure to double check that any RCD sockets you choose comply with the latest British Standards. You should look for BS7288 and BS1363.

The following types are available from Maplin Electronics

RCD Protected Sockets - Unlatched		
MS76H	- White single socket	£30.99
MS77J	- Metal single socket	£34.99
MS78K	- White double socket	£37.99
MS79L	- Metal double socket	£42.49
RCD Protected Sockets - Latched		
MS31J	- White single socket	£32.49
MS32K	- Metal single socket	£36.99
MS33L	- White double socket	£39.99
MS34M	- Metal double socket	£44.99
MS35Q	- RCD Spur	£34.99



MOISTURE DETECTOR

Gavin Cheeseman describes a simple, versatile project.

FEATURES

- Compact Design
- Operates from PP3 Battery
- Simple 3 level Reading
- Gives Audible and Visual Indications
- Built-in Test Probes

Introduction

Often, situations arise where it is necessary to determine whether a significant amount of moisture is present in a material, for example in house walls. There are several different methods of measuring moisture content in materials. These range from heating a sample of the material in an oven and comparing its weight before and after drying to measuring the quantity of gas produced when the water present in the material reacts with a specific chemical compound. Although these methods can produce an accurate analysis of moisture content, they can be time consuming and usually involve taking a sample of the material to be tested.

In the practical situation a quick check is often required to determine possible problem areas before more detailed investigations are carried out, and the Mini Moisture Detector is designed with this in mind. This project allows possible damp areas to be easily located and provides a simple audio visual indication.

SPECIFICATION OF PROTOTYPE

Power supply voltage:	9V DC (PP3 or equivalent).
Power supply current:	20mA approx.
Yellow LED switch-on threshold:	700MΩ
Red LED switch-on threshold:	150MΩ
Approximate Dimensions:	150 x 36 x 30mm inc. probes.

PROJECT RATING 2

The Circuit

The project makes use of the fact that many building materials exhibit a lower resistance when they have a high moisture content than when they are dry. The quantities of water present are usually relatively small and so the level of resistance that we are dealing with is often consequently high, usually far in excess of the range provided by many off the shelf continuity testers.

Referring to Figure 1 it may be seen that the circuit is based around readily available op-amp and comparator ICs, and is designed to operate from a standard 9V PP3 type battery. The power supply is connected between P1 (+9V) and P2 (0V). Capacitor C6 serves as general supply rail de-coupling whereas C2 and C4 provide high frequency de-coupling for the ICs.

The material under test is connected between P3 and P4, in series with R1, effectively forming a potential divider. The voltage drop across R1 is directly dependent on the resistance of the material under test. Because the order of resistance being measured is in the region of hundreds of megohms, the voltage drop across R1 can be quite small. It is therefore necessary to provide some amplification to obtain a usable voltage level; this amplification is provided by operational amplifier, IC1.

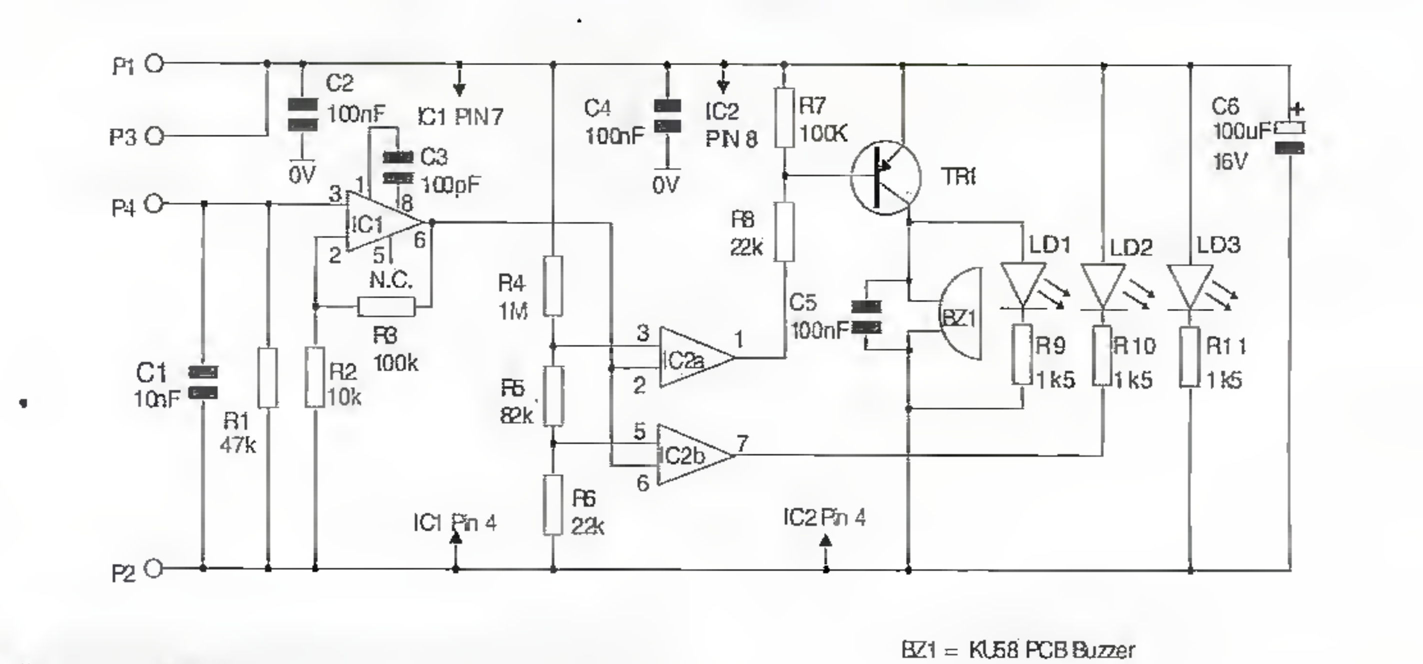


Figure 1. Circuit Diagram.

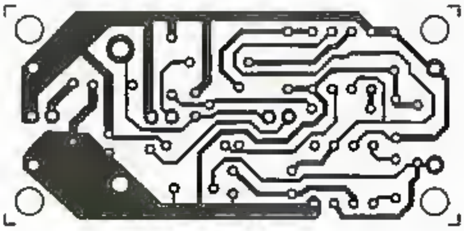


Figure 2. PCB Layout (a) Track.

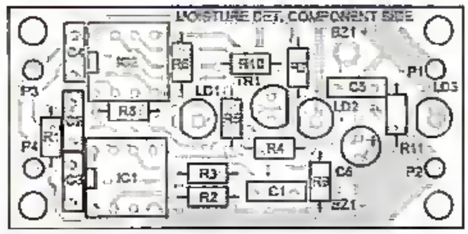


Figure 2. (b) Component layout.

Resistors R2 and R3 set the gain of the op-amp and C3 ensures stable operation. It should be noted that the CA3130E device chosen for this application allows operation at input voltages down to 0V and will operate comfortably from a single rail supply.

Because of the high impedance at the input of IC1, there is a tendency for the circuit to pickup 'hum' from the AC mains supply. This effect is minimised by C1 which provides a high frequency roll off, reducing the response of the circuit at mains power line frequencies.

The output from IC1 is fed to both inputs of IC2, a dual comparator. The switching threshold of IC2a and IC2b is determined by the voltage at IC2 pin 3 and pin 5 respectively. This voltage is set by R4, R5 and R6. When terminals P3 and P4 are open circuit the voltage appearing at the inputs to IC2 is negligible and the comparator outputs remain in a high condition. If the resistance between P3 and P4 falls this results in a rise in voltage at the input to IC1, which is inversely proportional to the resistance. This voltage level is amplified and fed to the comparator inputs of IC2. If the voltage exceeds the threshold set for IC2b, then IC2 pin 7 will switch to a low condition illuminating LD2. Resistors R9 – R11 limit the current to the LEDs. If the comparator input voltage also exceeds the limit set for IC2a then IC2 pin 1 will switch low, turning on TR1 and illuminating LD1. Under this condition, power is also switched to piezo buzzer BZ1 which emits a continuous 'beep' tone. Resistor R8 limits the current to the base of TR1 and R7 ensures that the transistor switches off properly when the comparator output is disabled. Capacitor C5 helps to reduce any unwanted switching noise from BZ1. LED LD3 provides a 'power on' indication, and when LD1 and LD2 are not illuminated, also effectively indicates that the circuit input is high resistance.

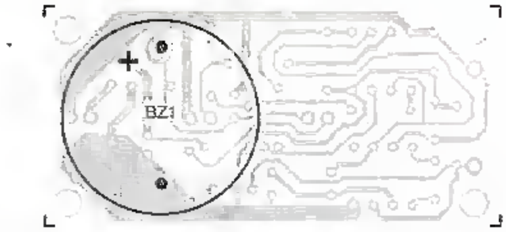


Figure 2. (c) Fitting the buzzer on the track side.

PCB Construction

It is recommended that the circuit is constructed on printed circuit board (PCB). Fibreglass PCB material is preferred as it possesses superior insulating properties when compared to cheaper alternatives. A PCB layout is shown in Figure 2. In order to keep the size of the PCB small, the components are mounted relatively close together and track spacing is close. Therefore extreme care is required when soldering to ensure that the no unwanted short circuits are created.

Insert and solder the components to the PCB referring to the component overlay shown with the PCB layout. Do not fit the LEDs or BZ1 until all of the other PCB mounted components are in place. Take care to ensure that polarised components are fitted observing the correct polarity. Capacitor C6 should be inserted such that the negative (-) symbol on the side of the component is positioned away from the positive (+) symbol on the component overlay. It is recommended that the ICs are mounted in sockets. The ICs should be fitted such that the notch at one end of the IC corresponds with that on the overlay. Similarly, transistor TR1 should also be fitted to correspond with the outline shown.

The PCB pins should be inserted into the PCB and carefully pushed into position using a hot soldering iron. Do not apply excessive force to the soldering iron when carrying out this procedure as this may damage the iron and could be hazardous. Simply allow the pins to heat up for a moment before applying pressure. When the pins have reached a suitable temperature they can be easily pushed into position. Once in place the pins should be soldered. Please note that pins are not required for P3 and P4.

The LEDs should be fitted as shown in Figure 3. It is important that these are mounted at the correct height. Once again, ensure that the LEDs are fitted observing the correct polarity. The anode (positive) is the long lead and the cathode (negative) is the short lead and is normally also marked by a flat edge on the body of the LED. On the component overlay, the flat edge of the outline indicates the cathode.

At this stage it is a good idea to check your work to ensure that everything is soldered correctly and that there are no dry joints or solder short circuits. Pay particular attention to areas of the PCB where track spacing is small. After BZ1 is fitted this restricts access to the track side of the PCB.

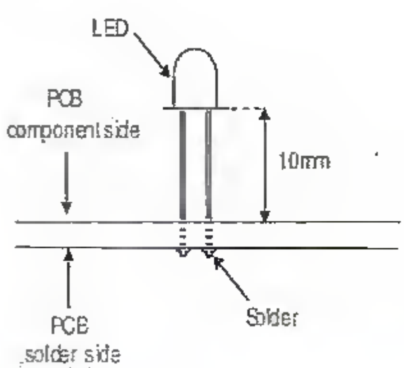


Figure 3. Mounting the LED's.

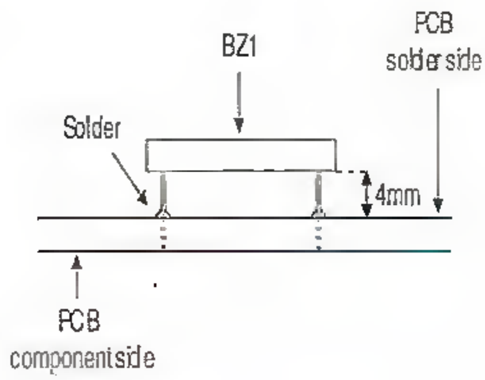


Figure 4. Mounting Buzzer BZ1.

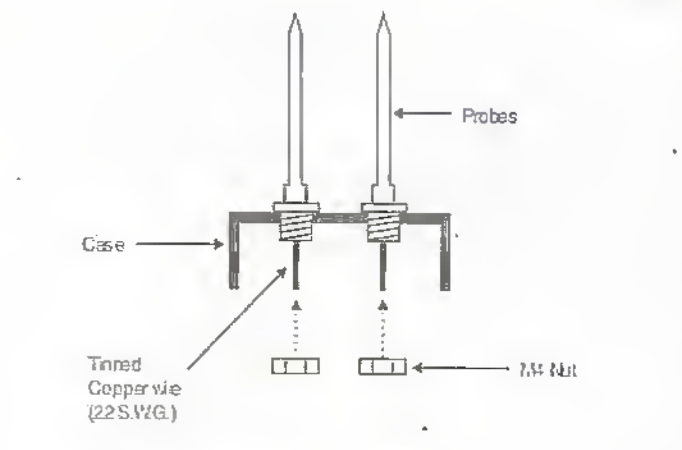


Figure 5. Fitting the probes to the case.

After fitting all other PCB mounted components it is then time to mount the piezo buzzer, BZ1 (see Figure 4). This is mounted directly onto the track side of the PCB and some care is required to avoid melting the buzzer housing. The buzzer height is important since if it is mounted too high above the surface of the PCB the board will not fit into the specified case. The polarity of the buzzer connections is shown on the component overlay as 'BZ1+' and 'BZ1-'.

PCB Installation

The recommended case for the Mini Moisture Detector is Maplin stock code FT31J and the PCB layout and dimensions have been determined with this in mind. The test probes used are Maplin stock code FK32K. The plastic body of the probe should be unscrewed and discarded leaving just the metal probe tip, screw thread and solder bucket. Solder a short length of 22SWG tinned copper wire or a component lead offcut to the probe tip ensuring that the solder does not flow over onto the thread. Any soldering should be carried out before mounting the probes onto the case as the plastic case melts very easily. After soldering, allow plenty of time for the probes to cool before handling. The probes have M4 threads and can be attached to the case using M4 nuts as shown in Figure 5. Make sure that you tighten the nuts fully. Washers are not used due to the short thread on the probes, therefore, it is recommended that a suitable thread locking adhesive is used to prevent rotation.

With the exception of the wiring connecting of the test probes to the circuit board, it is best to complete all external wiring before installing the PCB in the case. Figure 6 shows the wiring diagram. The connection between slide switch S1 and terminal P1 on the PCB can be made using insulated hook-up wire. The wire connection from the probes should be trimmed to a suitable length, inserted into the appropriate holes in the PCB (P3 and P4), and soldered directly onto the track side once the PCB has been fitted into position in the case.

Drill the necessary holes in the case before installing the PCB and fix S1 in position using M2 countersink head screws. The PCB overlay can be used as a drilling template for the fixing holes and LED holes. Don't forget to allow adequate room for the battery in the case. The PCB is mounted on spacers as shown in Figure 7. It should be noted that the nuts have been allowed to slightly overlap the PCB tracks in places in order to maintain the compact size of the PCB. In general this does not present a problem, but to ensure that there are no unwanted effects from inadvertently touching the mounting screws, it is recommended that nylon washers are used between the fixing nuts and the PCB.

Testing the Detector

Once the PCB is installed, and all wiring is in place, the unit can be tested. Connect a 9V PP3 type battery to the battery clip and fit it into the case behind the PCB. The battery is a fairly tight fit but there should be adequate room.

Set the power on/off switch (S1) to the 'on' position. With the probes open circuit only the green LED should be illuminated indicating that the unit is switched on and there is a very high resistance between the probes. This normally indicates that the material being tested is dry. Apply a short circuit to the probes. Now all three LEDs should illuminate and the buzzer should emit a constant tone. When the short circuit is removed, the unit should revert to the original state where only the green LED is illuminated.

The above procedure checks the basic operation of the unit; however, under some conditions, where the resistance between the probes is considerably less than open circuit but is not low enough to illuminate the red LED, only the green and yellow LEDs will illuminate. This 'intermediate' condition is not easy to simulate unless you can connect a resistance between the probes with a value between around 100Ω and 500Ω. These thresholds are approximate and are subject to some variation. If you have a number of very high value resistors to hand (in the high megohm region), you can connect these in series to produce a resistance in this range. Otherwise, the easiest way to check that the detector is operating correctly is to find a piece of material that produces an intermediate reading. One way to simulate this is to slightly moisten a piece of absorbent paper or cardboard and connect this between the detector probes. Take care not to expose any part of the unit other than the probes to water as this may damage the circuit. Initially, the moistened material should light all three LED's but as the moisture evaporates an intermediate condition should be produced. Because it may take some time for the moisture to evaporate to the appropriate level it is best to carry out checks at regular intervals rather than leaving the detector switched on and connected.

Finalising Construction

If everything is working correctly, construction can be completed. It is useful to attach a self adhesive pad to the battery to hold it in position in the case. Give everything a final check and screw the case lid into position. Attach the label (Figure 8) onto the front panel using general purpose adhesive.

Using the Mini Moisture Detector

To obtain a reading, press the detector probes into the material to be tested. It is often adequate to take a reading by simply touching the probes onto the material without actually penetrating the surface. In other cases you may wish to make measurements under a surface covering and this is the reason that needle probes were chosen as opposed to surface contact types. Of course, if you press the probes into the material, this will usually permanently damage the surface so choose an area that is not on view if aesthetics are important.

As discussed, the Mini Moisture Detector provides a

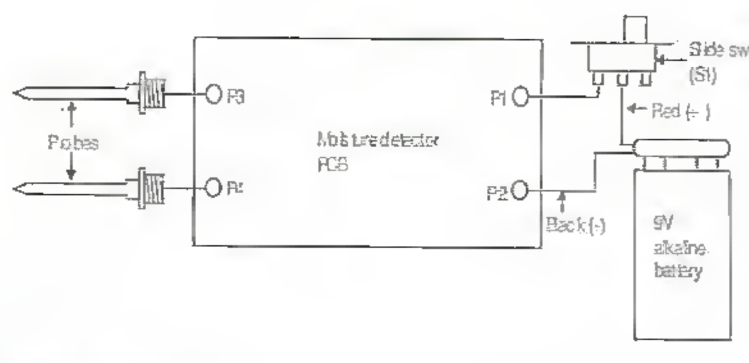


Figure 6. Wiring Diagram.

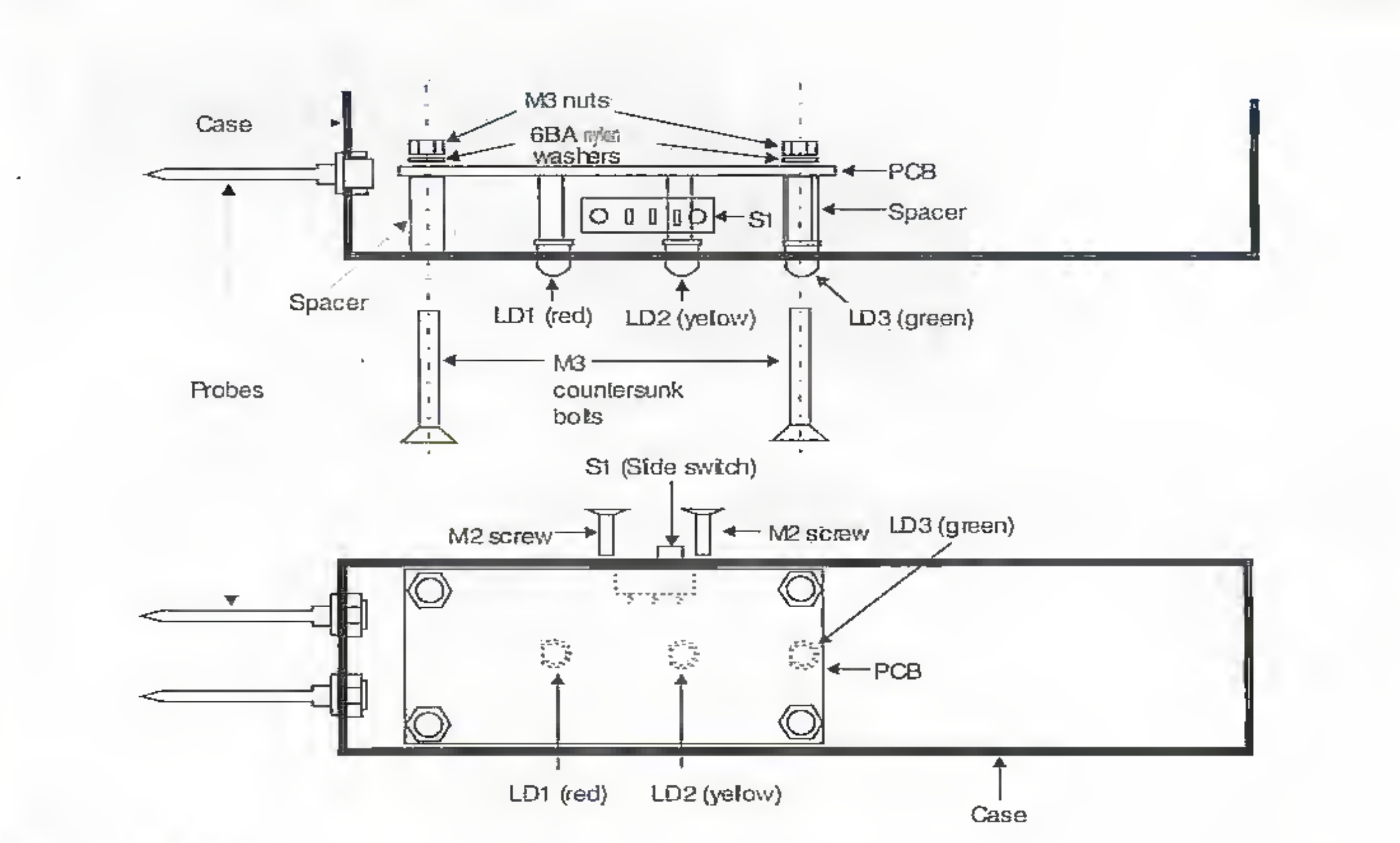


Figure 7. Assembly Diagram.

three level indication. When only the green LED is illuminated this indicates a dry (open circuit) condition. When the green and yellow LEDs are lit this indicates an intermediate condition where there is possibly some moisture present. When all three LEDs are illuminated there is a reasonable chance that the material under test has a significant moisture content. Under this condition, buzzer, BZ1 is also active.

As with most simple detectors of this type, the Mini Moisture Detector has its limitations and if users are aware of these, the results will be more meaningful. The unit is intended to act as a 'rough guide' and is not intended to provide a definitive reading. It is useful when trying to trace the source of dampness in walls, detecting unwanted high resistance areas in static sensitive environments etc but is not intended to be a replacement for more expensive and accurate devices. Of course, the Mini Moisture Detector is looking at differences in the resistance of the material under test and is not measuring the actual quantity of water present. Users should bear in mind that because the detector looks for a low resistance to indicate a damp condition, it is possible that some materials, which are poor insulators may produce a damp indication when they are in fact dry. This may be the case with metal backed wallpapers and materials containing conductive particles such as carbon. The unit can also be affected by strong ac fields. This may manifest itself as a warbling sound form BZ1 as opposed to the usual continuous tone.

Where possible, if moisture is detected and the source of this is unclear, test a known dry piece of the material first to confirm that the unit gives the appropriate indication. In all cases users are advised to seek professional advice before carrying out any work as a result of readings obtained.

Other Applications

In addition to detecting the presence of moisture, the Mini Moisture Detector can also be used to provide a general indication of the insulation properties of a material and to indicate electrical leakage. This can be useful for fault finding in tracing possible areas where insulation breakdown has occurred in a circuit. If the red LED is illuminated and BZ1 is active this indicates poor insulating properties. However if the unit is connected to long cable runs or circuits which are significantly inductive it may provide a false reading due to ac pickup.

WARNING

The unit should not be used to determine electrical safety as the insulating properties of materials can vary with applied voltage. Do not connect the tester to live apparatus under any circumstances as this may result in damage to the unit and a serious hazard to the operator.

Adjusting the Detection Threshold

The switching thresholds for IC2 were determined from experiments carried out with the prototype unit on a variety of different materials and were found to be adequate for most situations. However, readers may wish to experiment with the circuit by changing the switching thresholds and this can be easily achieved by modifying the values of resistors R4 – R6. In this way, it can be arranged for the unit to trigger at a higher or lower resistance. In order to avoid excessive current consumption it is recommended that the values of R4 – R6 are kept above a minimum of 10k. The input resistance of IC2 is very high indeed and in practice, resistor values considerably over 1M can be accommodated without significantly degrading the performance of the circuit.

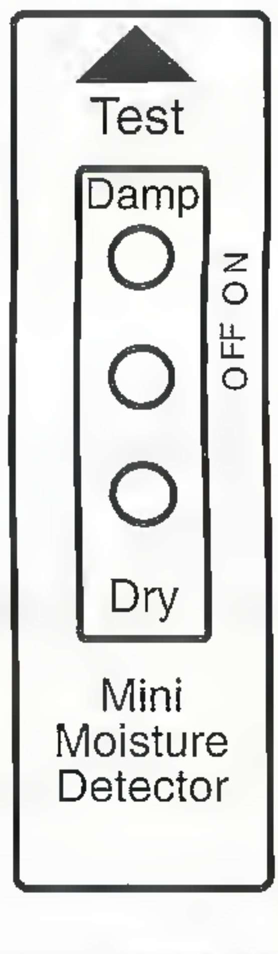
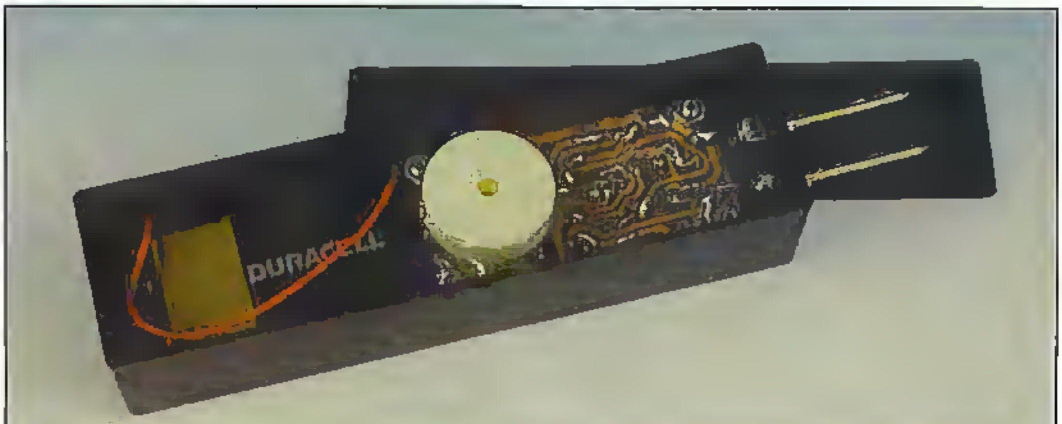


Figure 8. Front Panel Label.

Finally

With modified detection thresholds, it should be possible to use the Mini Moisture Detector in horticultural applications such as determination of the relative moisture content of soil, helping you to decide whether or not your plants are getting enough water. It would be necessary to experiment with different resistor values to achieve the appropriate detection thresholds for a specific application.



Internal layout.

PROJECT PARTS LIST

RESISTORS

R1	Min Res 47k	1	M47K
R2	Min Res 10k	1	M10K
R3, 7	Min Res 100k	2	M100K
R4	Min Res 1M	1	M1M
R5	Min Res 82k	1	M82K
R6, 8	Min Res 22k	2	M22K
R9, 10, 11	Min Res 1k5	3	M1K5

CAPACITORS

C1	Monores Cap 0.01uF	1	RA44X
C2, 4, 5	100nF Disc	3	YR75S
C3	Ceramic 100pF	1	WX56L
C6	Genelect 100uF 16V	1	AT40T

SEMICONDUCTORS

IC1	CA3130E	1	QH28F
IC2	LM393N	1	UH30H
TR1	BC558	1	QQ17T

MISCELLANEOUS

LD1	LED Red 5mm 2mA	1	UK48C
LD2	LED Yellow 5mm 2mA	1	UK50E
LD3	LED Green 5mm 2mA	1	UK49D
	Pin 2141	1pk	FL21X
	PCB F.Glass Sm Sngl	1	HX01B
	Small Narrow Box	1	FT31J
	Solder Test Prods	1	FK32K
	SP Slide	1	FF77J
	PP3 Clip	1	HF28F
	M3 Spacer 1/2in	1pkt	FG34M
	M3 16mm Pozi Screw	1pkt	JC70M
	M2 10mm Pozi Screw	1pkt	JC66W
	Isoshake M3	1pkt	BF44X
	Steel Nut M3	1pkt	JD61R
	Steel Nut M4	1pkt	JD60Q
	Nyl Washer 6BA	1pkt	BF84F
BZ1	PCB Buzzer	1	KU58N
	DIL skt	2	BL17T

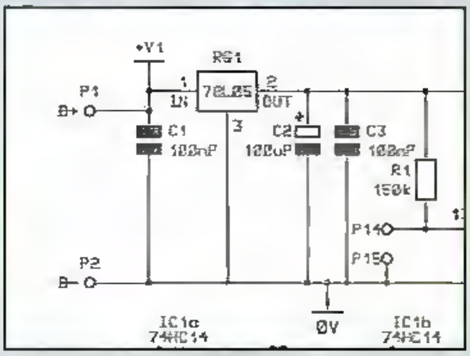
TOTAL COST £19 APPROX.

CORRIGENDA

418MHz low power Tx/Rx modules in August 1998, issue128

In the article on 418MHz low power Tx/Rx modules in August 1998, issue128, in figure 1, the transmitter circuit, pin 3 on the regulator RG1 (78L05), must go to the 0V rail. In figure 4, the receiver circuit, terminal P15 is connected to pin 16 on IC1 the M145027B-1.

Figure 1.



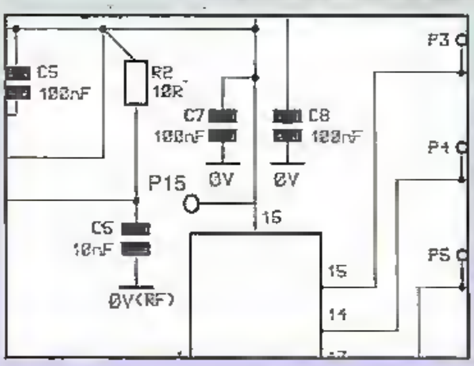


Figure 4.

Evolution of X-RAY TECHNOLOGY

Douglas Clarkson looks at the history and evolution of this life-saving science.

Introduction

The old adage – every picture tells a story – is certainly true of the x-ray image. What we see involves the generation of a field of x-ray photons which interact with tissue in a highly characteristic manner and with the image being formed traditionally using essentially photographic processes. Each of these specific steps in the sequence of image production is governed by a well defined set of physical laws. Over the years, developments have continued to optimise the information content of the resulting images and with at the same time a desire to reduce the dose of ionising radiation to the patient.

Generating X-Rays

The basic technique of producing x-rays has not fundamentally changed since the discovery of x-rays by Röentgen in 1895. Figure 1 indicates typical designs of x-ray tubes where a pulse of excitation voltage accelerates electrons onto a heavy metal target such as Tungsten although Molybdenum tends to be used predominantly for lower energy exposures such as are used in mammography. These elements have a high melting point and also a high atomic number, which in turn increases the probability of fast moving electrons being attenuated in the target. However, the higher heat capacity of Molybdenum causes it to be incorporated in anode designs to increase exposure throughput. The alloying of Tungsten with 10% of Rhenium provides a greater resistance to pitting on the anode surface and consequently is used to prolong the life of an x-way tube.

An important practical parameter for an x-ray set is its duty cycle – i.e. that fraction of the time within which it can accelerate electrons. The rapid heat built up in the target area can easily degrade performance or even damage the unit. Some x-ray tubes have a so called rotating anode design which allows the area of active heat dissipation to be considerably increased. Diameter of rotating anode disks can vary from 5 cm for mobiles to around 11cm for powerful sets for angiography. Radiation cooling of the anode is an effective means of dissipating the absorbed thermal energy. Speeds of rotation are typically around 3000rpm.

It is essentially the high voltage which is chiefly responsible for the heating of the anode. At, for example, 100keV, and 500mA current for 0.2 second, the total energy provided per exposure is 10,000J.

As the stream of accelerated electrons strike the anode target a range of processes take place. As the electrons suffer rapid de-acceleration, the majority of their kinetic energy is simply degraded to heat as kinetic energy of the atoms of the target material. The rapid de-acceleration produces so called 'braking radiation' or bremsstrahlung. The maximum energy of these x-ray photons is determined by the maximum energy of the electrons that strike the target and is given by the anode voltage. The 'tail' of low energy x-ray photons will contain photons of near zero energy. Since, these photons would normally be readily absorbed even by soft tissue and carry essentially no imaging information, they are routinely absorbed by

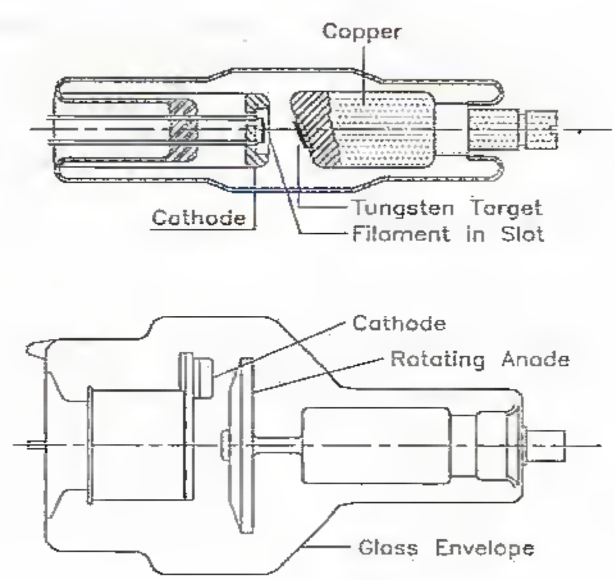
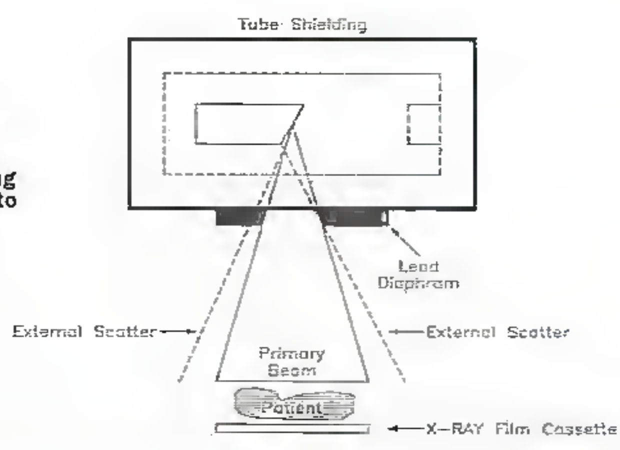


Figure 1. Typical design of x-ray tube. a) stationary anode. b) rotating anode.

Figure 2. Basic geometry of the conventional plane x-ray diagnostic radiology, showing use of tube shielding and lead diaphram to reduce field of external scatter.



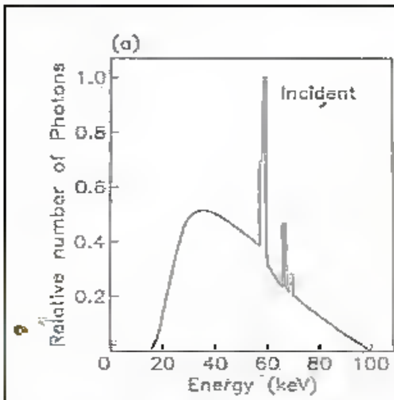


Figure 3. A typical x-ray spectra derived from a Tungsten anode and incorporating filtration.

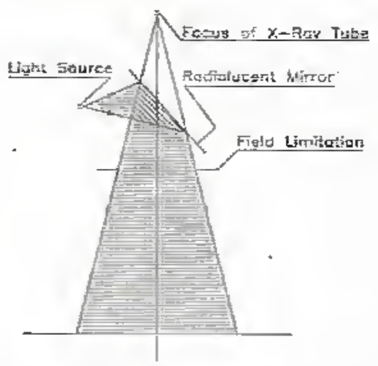


Figure 4. Light beam diaphragm for projecting optical outline of x-ray exposure on patient.

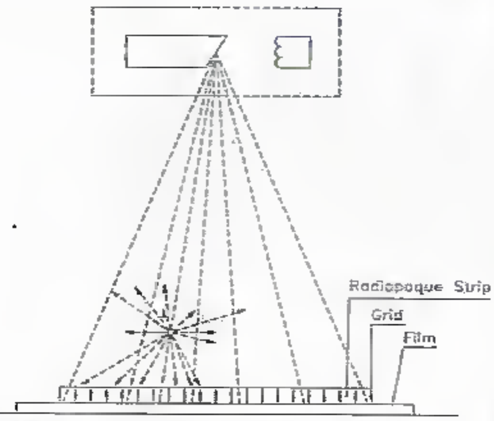


Figure 5. Reduction of scatter in final image by use of grid.

'filtration' using thin sheets of Aluminium or Copper. Such filtration in an integral part of most x-ray systems designed to reduce the dose of x-rays received by the patient but without adversely affecting image quality. A typical filtration thickness would be 2.5mm of Aluminium.

The x-rays behave essentially as if they originate from a small focal spot so that the essential geometry of the imaging is that of a point source as indicated in Figure 2. Obviously, the smaller the size of the point source the sharper will be that of the resulting image. Typically the focal spot will be approximately 1 to 2mm in diameter. The shielding of the tube and structure of the lead diaphram is important for reducing the field of external scatter.

The energy of the incident electrons on the target material can also disturb the energy balance within the associated electron shells of the target atom. When an electron in the K shell of a Tungsten atom is given sufficient energy to break free from the atom, electrons from less tightly bound shells can cascade down to fill the gap within the K shell. The electron in turn radiates a photon corresponding to the difference in potential energies it experiences within the coulomb field of the nucleus. For Tungsten, the equivalent values of these emitted photons is in the range 58keV to 67.7keV.

A typical x-ray spectrum with these characteristics is indicated in Figure 3. This is essentially the curve of 'braking' radiation with absorption of lower energies due to filtration and superposition of characteristic K shell x-ray emissions. For a given x-ray set, the variable parameters of the beam spectra will be the maximum keV, the tube current and the time of exposure. Typically these latter two variables are expressed as mAs (milli Ampseconds). In terms of image size, the aperture of the system can be altered from a maximum size down to as small a rectangular area as required. The degree of filtration will tend to be constant throughout the product lifetime of a given x-ray set. A light beam diaphragm projects an equivalent optical image aperture to assist in outlining correctly the area being imaged as indicated in Figure 4.

Modern x-ray sets automatically select maximum keV, and mAs product for a broad range of commonly identified investigations. But, on many older systems setting of the keV and mAs parameters are still undertaken manually. Some simple x-ray systems such as used in dental investigations have only a single keV setting. The chief advantage of high keV settings is that resulting x-ray radiation is more penetrating – allowing useful imaging of the abdomen and pelvis to be undertaken. Modern systems can also utilise automatic exposure control to ensure that images are correctly exposed.

Grids in the Image Plane

One of the problems of a conventional x-ray is the fact that scattered x-rays produced inside the imaged tissue can contribute to the film image without adding any diagnostic information. The use of a secondary grid is indicated in Figure 5 where scattered photons tend to be absorbed before they register on the x-ray film. The grid is constructed of a series of metal strips between which is enclosed radioluscent material. The most effective form of this device is the focused grid which is constructed so that the alignment of the grid elements match up with the emission direction of photons as they would emerge from the point source of the x-ray beam.

Unfortunately, while the contrast is improved by reduction of scattered photons, the pattern of the metal x-ray grid is invariably present in the resulting x-ray. This effect can be minimised by moving the grid at a constant rate during the x-ray exposure. This is the function of a so called 'Bucky' unit. The use of these grids will act to increase to some extent patient doses – though the quality of the resulting x-ray will be higher as regards the sharpness of images. These refinements can add significantly to the cost to such x-ray systems.

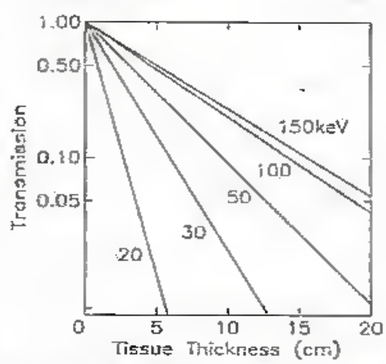


Figure 6. Transmission characteristics of photons of specific energies appropriate for soft tissue.

Tube Wear and Tear

It is interesting to consider the factors which determine x-ray tube life. During the operation of the tube, Tungsten from the hot filament and from the hot anode target is released and deposited on the inner surface of the glass tube. This acts very much like an additional electrode in the tube, and in time, increasing numbers of electrons striking the walls of the tube cause alteration and degradation. Ultimately, this can cause loss of vacuum in the tube.

X-Ray Generation: The Future

It is perhaps interesting to speculate about possible future developments in x-ray generation. The chief challenge would be in improving the image quality and at the same time reducing the dose to the patient.

Figure 6 indicates the transmission characteristics of photons of specific energies appropriate for soft tissue. If a 100keV maximum energy is required for a thick exposure of say 15cm, then x-ray photon energies below this value are more highly absorbed and provide less information for the imaging process.

There would be an advantage in utilising a specra such as indicated in Figure 7, where the energy content of the spectra is well controlled and narrow and could be 'tuned' to required energy limits. The concept of generation of monoenergetic photons is well established within laser technology though at much smaller photon energies. Working with excimer lasers, photon energies of the order of 20eV corresponding to around 100nm wavelength have been developed. Even if photons of the required energy could be generated, the practical problems of containing, guiding and mapping the photons to the target area would be significant.

Synchrotron technology is already used by 'big science' to provide very intense and essentially monoenergetic x-ray photons for experiments to investigate the structure of matter. In theory it would be possible to develop a relatively small synchrotron source to deliver monoenergetic x-rays. The x-rays would be generated when the electrons are 'bent' or 'wiggled' relative to their previous flight direction and hence undergo acceleration. However, the uniformity and field extent of these beams are probably not ideal for diagnostic radiology work. Also, the economics of this approach have never been considered to bring any significant benefit to conventional x-ray imaging technology. It is

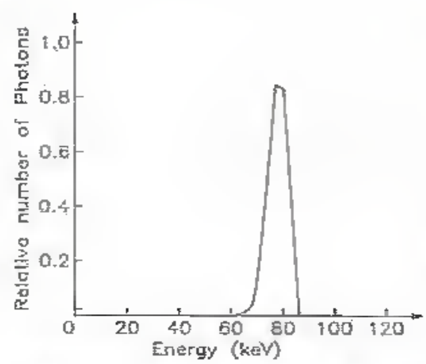


Figure 7. Idealised narrow energy spectra for optimising contrast information.

interesting to speculate, whether diagnostic x-rays will be produced in the same tried and tested method in 100 years time.

Betatron technology, where electrons are radiated within spiral paths in compact chambers, is utilised in industry to develop very intense high energy x-rays for industrial inspection applications such as verification of welding of oil pipelines. There has been no move to use this technology within diagnostic radiology—presumably because existing techniques provide sufficiently intense outputs.

Image Reception Systems

It is very seldom that x-ray film is used on its own as a means of recording an x-ray image. Improved image sensitivity is achieved by means of so called screens which trigger additional light photons to be released and hence be recorded on the film. The construction of direct exposure x-ray film is indicated in Figure 8. The thin layers of film emulsion are structured on either side of a thin base layer. While the actual process of producing a x-ray image is a series of complex stages, some of which are as yet poorly understood, the key process relates to sensitising grains of silver halide within the film emulsion.

Because the grains carry the atoms of Silver (Ag), Chlorine (Cl) and Bromine (Br) of atomic number 47, 17 and 35, the grains will have a dominant effect on attenuation of the x-rays. The outcome of this process is the sensitising of grains of silver halide by trapped electrons released by the x-ray photons. It is these sensitive grains that become fixed by the developing process as black areas and with the unsensitised grains being removed by the developing process. However, some unsensitised grains will also be fixed by the developing process.

Figure 9 indicates a set of so called characteristic curves of optical density against the log of relative exposure at the film. This is the curve which maps to an optical density for a given relative quantity of ionising radiation presented to the film. At the top end of the exposure, where the maximum number of grains are being sensitised, the response will tend to flatten off as the remaining unsensitised grains become sensitised. At the low end of the exposure involving film screens where it may take more than a single light photon to sensitise a single grain, it takes longer before the central linear section is attained.

The value of the slope of this linear section is termed the film gamma and is typically in the region of between 2 and 3. It is the relevant skill of the radiographer to determine the characteristic of the x-ray exposure so that the range of clinically important information is as far as possible within the log-linear portion of the characteristic curve. In passing, these concepts of characteristic curves also apply to conventional film photography (see references).

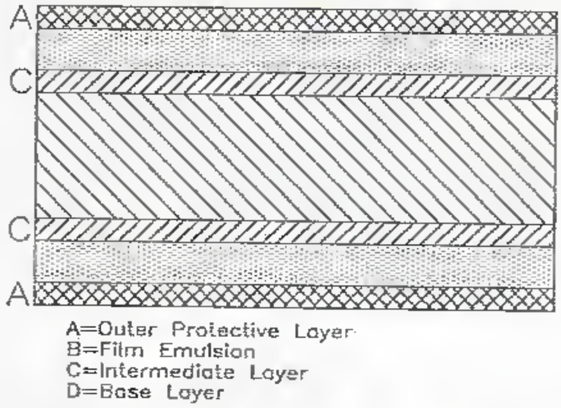


Figure 8. Cross section through direct exposure x-ray film.

Figure 10 indicates how a screen can be used in either a single or double mode. It is important for final image quality that the film is in direct contact with the surface of the screens over the entire area, otherwise image quality will suffer through poor light coupling.

The use of film screens in conventional x-ray radiography is essential for dose reduction. The generally preferred low values of dose associated with modern x-rays techniques has resulted in direct radiography now being redundant. The essential comparison between relative efficiencies of 'film only,' and a modern rare earth screen is indicated in Figure 11a and Figure 11b. When efficient screens are used, only a few percent of the film blackening is actually due to direct sensitising of grains due to electrons released by the x-ray photon. When using film screens, the spectral response of the film is also required to be matched to the wavelength of light photons released by the screen.

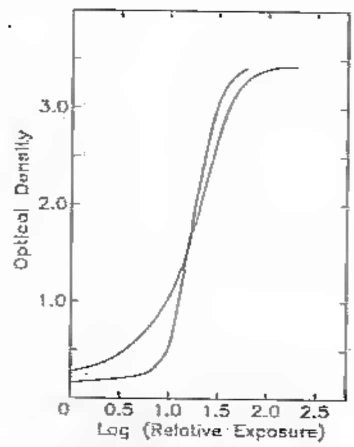


Figure 9. A set of so called characteristic curves of optical density against the log of relative x-ray exposure.

In the more complex clinical systems, x-ray equipment manufacture encompasses a wide range of scientific, technical and engineering skills with patient safety an essential parameter. Specific points of difficulty relate to management of high tension supply cables and suspension of heavy system directly above patient. Competition between companies in the field is intense with essentially three groupings of manufacturers – North America with the largest market followed by Europe and Japan.

An x-ray system consists of a range of interconnecting sub-systems. The ergonomics, design and ease of control can often be key aspects of system selection. It is increasingly common for 'outside' technologists, such as those from the car industry, to be involved in the design of such medical equipment in order to give it a sleek and appealing style. Photo 1 indicates a streamlined system with an advanced elevating table showing the GE Compax 40 E table system.

Mobile x-ray systems are widely used in a hospital environment for imaging a wide range of patients on wards and intensive care. A typical mobile system is indicated in Photo 2.

Measuring Radiation

The Radiation Absorbed Dose relates to the actual energy absorbed (in Joules) per Kg by a specific medium. The unit of absorbed dose is that of the Gray. This can be thought of as the component of energy which is

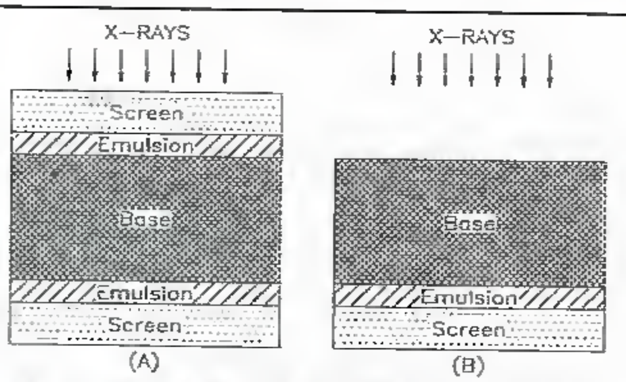


Figure 10. Utilisation of double (A) and x-ray single screens (B). The double screen provides for the highest sensitivity though the single screen provides for a sharper image.

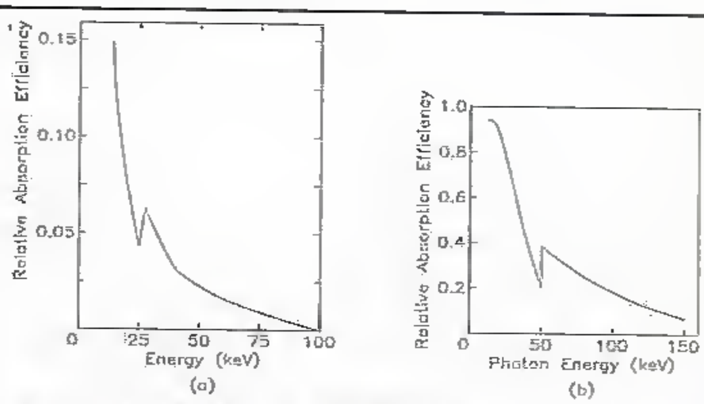


Figure 11. a) Efficiency of x-ray film alone b) efficiency of rare earth screen.

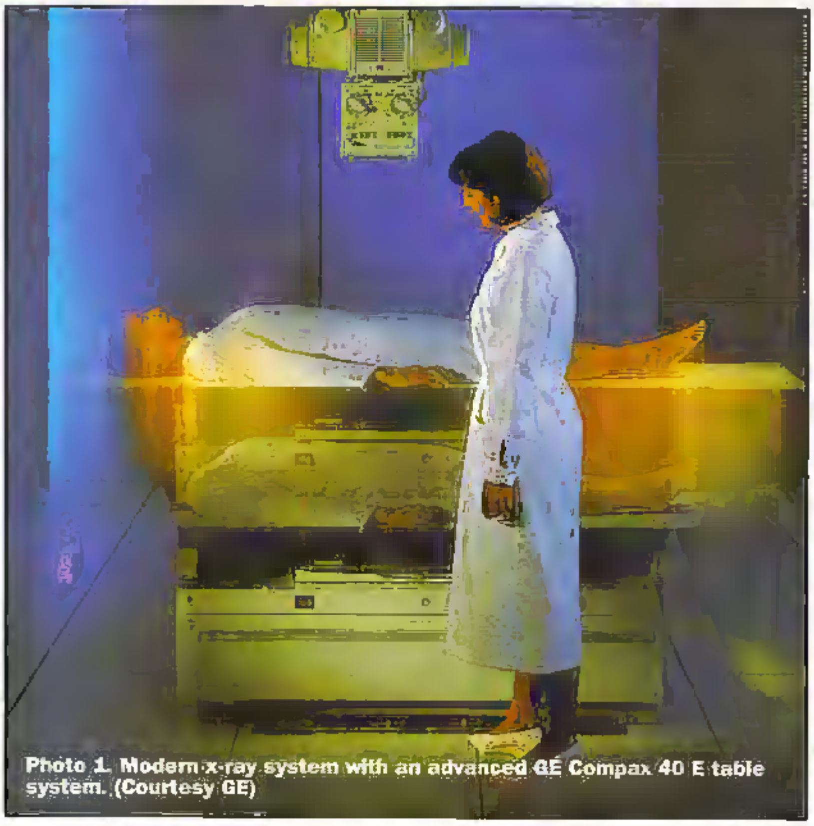


Photo 1. Modern x-ray system with an advanced GE Compax 40 E table system. (Courtesy GE)

Photo 2. A typical mobile x-ray set – The GE AMX4+ (Courtesy GE)

absorbed by a specific medium. The dose equivalent in units of Sievert is given by :-

dose equivalent = absorbed dose (Gy) x Q x N

where Q is the quality factor which reflects the ability of the particular type of radiation to initiate tissue damage. For the present N is assigned a value of 1 and reflects the possible effect of dose rate or system of fractionation of the radiation into smaller doses of radiation. For x-rays, gamma rays and electrons the value of Q is unity and for alpha particles Q has a value of 20.

The dose equivalent is calculated as the true indication of dose taken up by the body for radiation induced effects and is summed from various tissue compartments within the body which are exposed. The annual level of background radiation within the UK is around 1mSv and with the main variation relating to Radon exposure.

Patient Doses

Various surveys have been undertaken of the variation in radiation dose from a specific well defined type of x-ray examination such as chest or abdomen. Even within a given hospital, with a range of x-ray sets, film and operators, a maximum to minimum ratio of around 5 is typical and the maximum variation over investigations can range as high as 50 between imaging centres as indicated in table 1.

Examination	Dose per examination (mSv) Mean	Min.	Max.
Lumbar spine	2.15	0.37	7.37
Chest	0.05	<0.01	1.32
Skull	0.15	0.01	0.50
Abdomen	1.39	0.12	9.94
Pelvis	1.22	0.09	5.77
Barium Meal	3.83	0.6	24.39

Table 1: Typical range of patient doses for a selection of commonly undertaken x-ray procedures. (Courtesy NRPB)

As a practical approach to patient dose reductions, there are initiatives to replace less efficient Calcium Tungstanate screens with rare earth screens and to use carbon fibre based plastic x-ray table tops in x-ray couches. These initiatives alone could achieve a significant reduction in patient dose.

The actual relative picture of the annual average dose to the UK population indicates that of the global total from all contributions, natural and artificial, the contribution from medical exposure is around 12% of the total. There are subtle changes within this assessment. The use of Computerised Tomography x-ray (CT) is increasing while some conventional x-ray examinations are being undertaken using Magnetic Resonance Imaging (MRI) and also ultrasound.

In 1983, the total number of x-ray examinations in UK hospitals was estimated to be around 25 million – with the figure having increased by 2.3% from 1977. The level of dental examinations in the UK in 1985 was estimated to be around 8.5 million.

The basis for any radiological examination involving x-rays is that the risk of not undergoing the examination far outweighs the very slight risk of undertaking it. The cycle of capital investment for x-ray equipment is quite long, at least in the order of between 10 and 15 years for many NHS hospitals. Also while many professional groups of clinicians, radiologists, radiographers and physicists are working towards reducing patient doses, this initiative is not matched by any significant capital investment to achieve this aim. But, significant advances in some centres have been made in reducing the radiological exposure to children.

Digital Radiology

The immediacy of the information age and the flexibility it provides in handling data of all types has been applied to the field of conventional diagnostic radiology. With image capture systems, an image is created as an array of (x,y) co-ordinates over a range of digital values according to the dynamic range of the image A/D capture system. This system provides a much more extensive range of options for the display, processing, storage and transfer of images. For example, the field of telemedicine, provides scope for remote analysis of such images over distances of thousands of miles. A range of data processing options including noise reduction, edge enhancement, subtraction of background during angiography etc, provide increased flexibility in both initial exposure and final reporting of image.

One of the more basic approaches to 'digital' imaging systems relates to the capture of an image using direct fluorographic techniques where a TV image is derived from x-rays absorbed by the screen and then captured. One technology pioneered by Fuji Film relates to energy activation of long lived phosphor material by x-rays and with subsequent read out of light signal by a scanning laser system which detects the released light using a light guide and photomultiplier system.

Towards Film-Free Radiology

A new company, Trixel, in France, being a joint venture between Thompson Tubes, Philips Medical Systems and Siemens Medical Engineering Group, is developing a new method of detecting x-rays digitally. The key component of the technology incorporates amorphous silicon technology which is evaporated onto a glass substrate. This layer is structured in a matrix of individual photodiode and switching elements which is in turn covered with a scintillator. The wide dynamic range of amorphous silicon provides the potential for deriving images with low x-ray dose compared to conventional film methods.

Another advantage for the use of the new technology is the fact that images can be

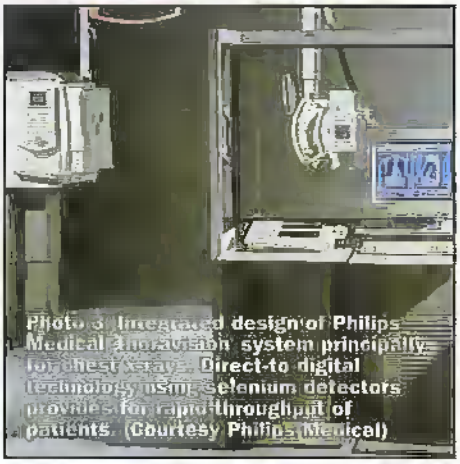


Photo 3. Integrated design of Philips Medical Thoravision system principally for chest x-rays. Direct-to digital technology using selenium detectors provides for rapid throughput of patients. (Courtesy Philips Medical)

displayed directly after exposure – in contrast to having to wait for conventional film to be developed. Such a system is due for release during 1998.

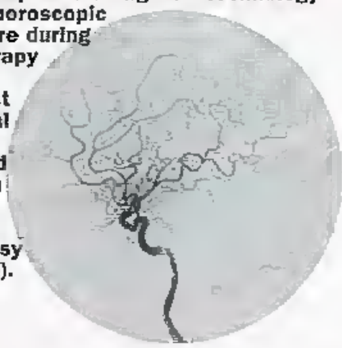
New terms are emerging in the world of diagnostic radiology. PACS (Picture Archiving and Communication Systems) represents an environment for the capture and archiving and distribution of diagnostic images using a range of imaging modalities. The conventional work of diagnostic radiology is rapidly moving in this direction – investment permitting. The main drives in this market are systems for Computerised Tomography X-Ray and Magnetic Resonance Imaging which by their very nature are highly dependent on computer technology – though increasingly the diagnostic radiology market is waking up to the advantages of PACS.

The DICOM (Digital Imaging Communication in Medicine) standard provides a general range of interconnecting data definitions for networking together a range of imaging devices including those of diagnostic radiology. This essentially provides for a non-dependent vendor market. The DICOM standard has been established by the ACR (American College of Radiology) and NEMA (National Electronic Electrical Manufacturers Association). This is an example of standards being essential to harnessing technological developments.

Data Storage

The problems of storage and retrieval of x-ray data within health care are significant. With even the best manual system, there are invariably problems with lost or misfiled records, which both results in significant time wasting for clerical, nursing and clinical staff. Also, x-rays which cannot be located may have to be repeated. Most major companies in diagnostic radiology are investing heavily in image archiving systems. At St. Thomas' in London where typically 1,000,000 x-rays will be taken in a five year period, the Siemens Sienet Magic View system has been implemented as a data archive system and with a noted improvement in efficiency of managing such records.

Figure 4. High resolution 1024x1024 image captured using CCD technology from fluoroscopic exposure during angiograpy where contrast material is injected through the heart. (Courtesy Toshiba).



World Wide Web Contacts

There are already many sites on the web which host material relating to 'diagnostic radiology' and which is itself a good starting point for web searches. Some of this material relates to public relation pages of commercial companies such as Kodak, Agfa, Siemens and Philips and others relate to academic and educational organisations active in undergraduate and post graduate medical training.

A small subset of these addresses include:-

http://www.rad.washington.edu/
http://eve.therad.rpslmc.edu/diag-sites.htm
http://www.medical.philips.com/clinical/index.htm
http://www.agfa-medical.com

Summary

The first x-ray that Röentgen took of his wife's hand required about 30 minutes of exposure to produce. In over 100 years both the understanding of the production of x-rays, their use as a means of diagnosis and the more general effects of radiation on the human body have advanced considerably. During this time, x-rays have saved countless lives and eased the suffering of many. It is curious to relate that potentially x-rays could have been detected some 20 years previously, and that the x-ray age could have been even longer than it is at present. However, it seems likely that advances will continue to be made in the drive towards 'direct digital' systems which will improve image quality and hopefully provide for even greater advances in patient dose reduction.

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'Radiation Exposure of the UK Population – 1993 Review,' J.S. Hughs and M.C. O'Riordan, NRPB-R263

'Patient Dose Reduction in Diagnostic Radiology, Vol 1, No3,' NRPB

Points of Contact:

Press and Information

National Radiological Protection Board, Chilton, Didcot, Oxfordshire, OX11 0RQ

Tel. 01235 831600 web: www.nrpb.org.uk

Institute of Physics and Engineering in Medicine, 4 Campleshon Road, York, YO23 1WE,

Tel: 01904 610821 (Professional group with range of publications including those relating to x-ray technology, dosimetry and safety)

Further Information:

NRPB Wallcharts:

'Medical Radiation at a Glance'

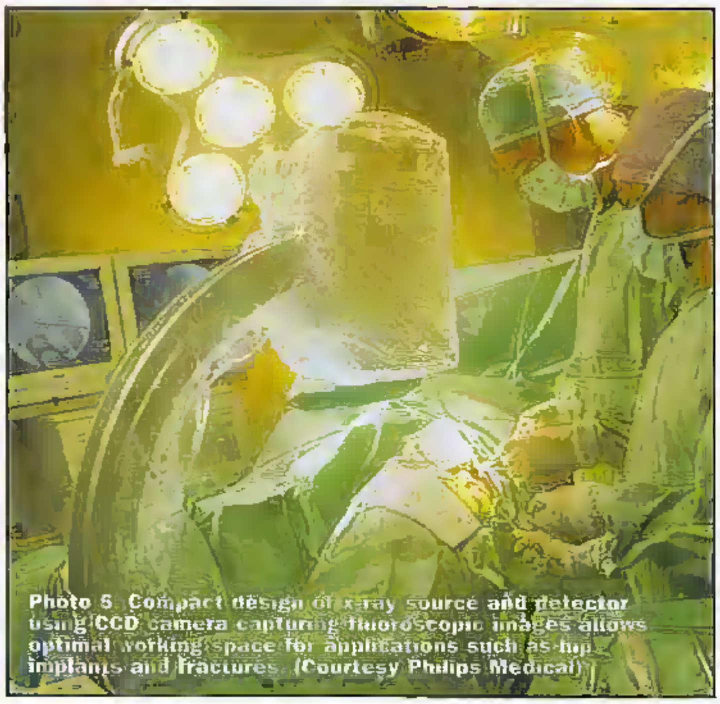


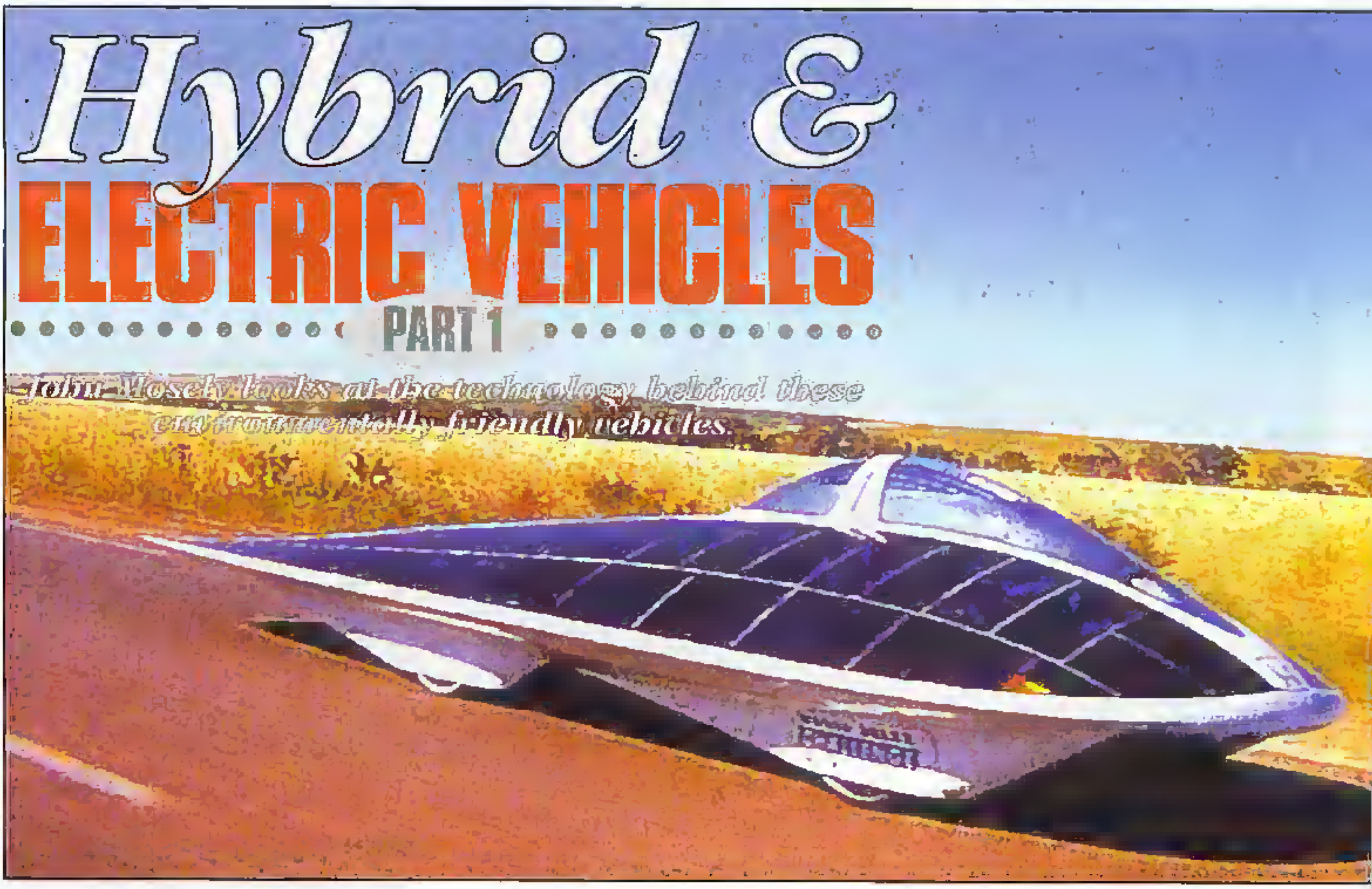
Photo 5. Compact design of x-ray source and detector using CCD camera capturing fluoroscopic images allows optimal working space for applications such as hip implants and fractures. (Courtesy Philips Medical)

Photo 6. Design of modern 'bucky' system where scatter grid is moved at constant rate over the exposed field to improve image contrast. (Courtesy Philips Medical)

Hybrid & ELECTRIC VEHICLES

PART 1

John Mosely looks at the technology behind these environmentally friendly vehicles.



If we forget about the humble milk float, then serious development of electric powered vehicles has been going on for over 25 years, and production vehicles are now available. Development of the hydrogen-powered fuel cell electric vehicle (FCEV), potentially the ultimate eco-car, is progressing at a steady rate, and may well be ready for commercial production in the early part of the next century.

Alternatively, development of compressed natural gas (CNG) vehicles began in the early 80s, and because CNG has a high octane rating, it allows higher compression ratios to be used with improved thermal efficiencies and reduced Carbon Dioxide emissions.

However, the development of these alternative vehicles requires that certain problems be addressed those being typically range, cost and durability. It also requires a new energy supply infrastructure. We will not go to petrol stations for refuelling, but 'power' stations.

Solar Power

No doubt we have all seen the Honda commercial on television showing their solar powered car which was designed for the fourth World Solar Challenge held in 1996 in Australia. 46 cars from 13 countries took part in this endurance test. It started from Darwin in northern Australia, and finished 3000km later in Melbourne southern Australia.

The Honda two-man 'Dream' car uses 4,500 monocrystaline silicon solar cells which are connected in the same way that roof tiles are lapped over each other, and held using conductive epoxy resin, see Figure 1. 104 (13 x 8 array) cells form a panel structure laminated with a polycarbonate surface material and silicon resin, and have a total output of 1.9kW, and a solar cell efficiency of 23%. Yuasa provided a silver-zinc battery to supply power when it is raining or overcast, and is recharged during sunny periods when it is not required to power the vehicle. This battery weighs 40kg and has a nominal capacity of 3.24kWh. A digitally controlled 'peak power tracker' (Figure 2) is used to take care of variations in solar panel output, due to the change in weather, and the charge state of the battery.

The motor is a highly efficient dc brushless motor which is an in-wheel design using an inner rotor mechanism, and drives the left rear wheel. The output is rated at 6kW, and provides a top speed of 140kph, and a cruise speed of 100kph.

Electric Vehicles

At present the most favoured battery is the nickel-metal hydride type, which offers a range performance twice that of current lead acid batteries, and in terms of durability, it is hoped that they will have a life expectancy greater than lead-acid batteries. The disadvantage is that they are very expensive to produce, but mass production should move price downward.

Honda identified potential buyers for electric vehicles as those who tend to have relatively short commuting distances, multi-car households and those with a strong environmental conscience. The car needed to be versatile for a variety of journey types, it had to be safe, efficient and posses a clean and quiet powertrain. In terms of styling, the requirement was for a contemporary look, yet one that was clearly distinguishable as an electric vehicle. The Honda EV in its production form meets all these requirements and more.

The drivetrain power and the battery pack (24 x 12V batteries) are mounted underneath the vehicle in a totally separate compartment. This has the effect of lowering the centre of gravity, producing a high driving position for good visibility, and a flat floor for easy entry and exit.

The Honda drivetrain, which drives the front wheels comprises the motor, the

Photo 1. Honda 'Dream' car with solar panels.

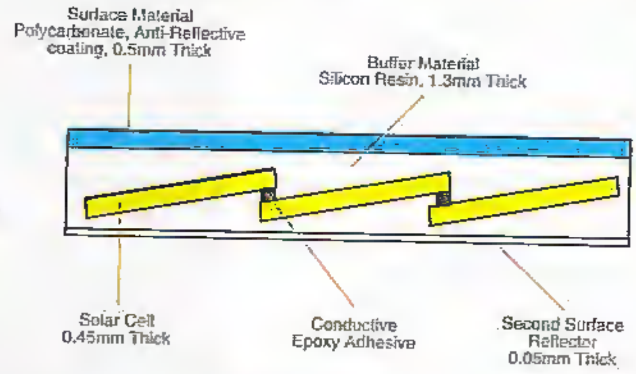


Figure 1. Honda 'Dream' car solar panel construction.

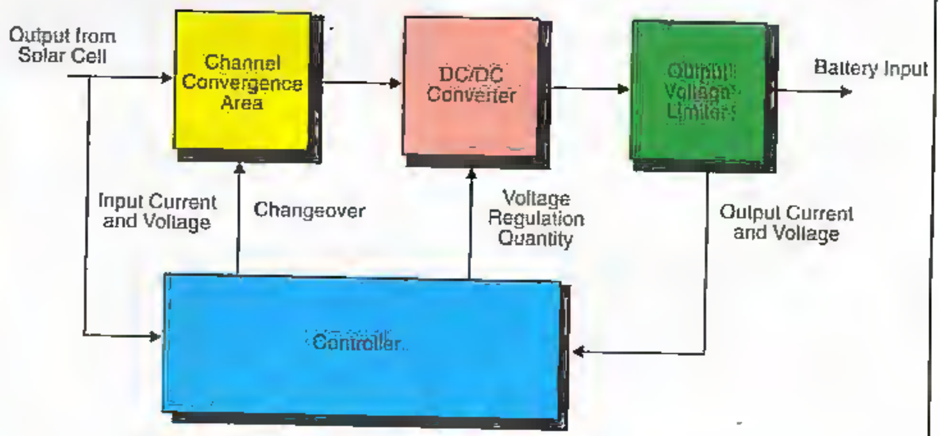


Figure 2. 'Peak Power Tracker' from Honda 'Dream' car.

controller and the transmission. The dc brushless motor contains rare earth high strength magnets and achieves 96% peak efficiency. Its performance over a wide range of speeds and loads can transmit power efficiently through a fixed ratio transmission with a parking lock system. Maximum motor torque (275Nm/203lb ft) is available from 0 to 1,700rpm, and is comparable to the torque from a three litre internal combustion engine. Maximum power (49kW) is achieved at 1,700rpm, and remains constant to the 8,750rpm maximum.

The power electronics are fully integrated into a single water-cooled power control unit mounted at the front of the car. The power supply is switched on by the 'ignition' switch and the motor control unit analyses the driver's instructions. This manages the motor via the controller. The controller uses IGBTs (insulated gate bipolar transistors) which are solid-state high voltage switching devices. A PWM (pulse width modulation) control system maintains the power at the best level. The phase control system – advanced angle control, field weakening control – optimises motoring in both urban and 'motorway' conditions.

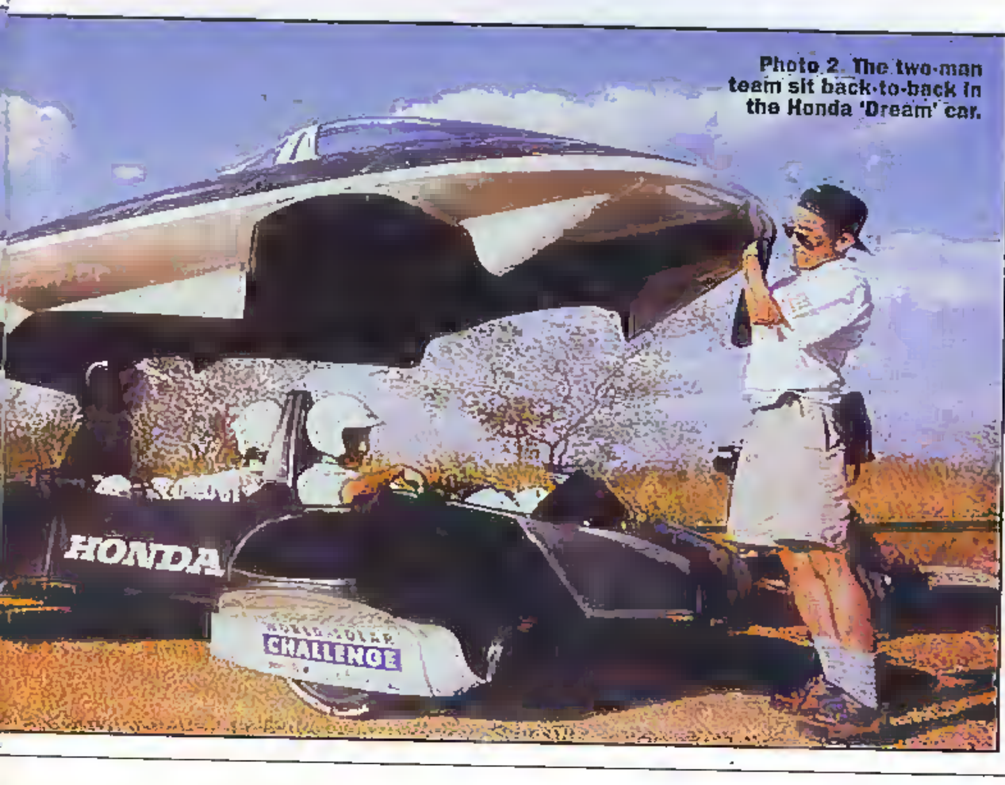


Photo 2. The two-man team sit back-to-back in the Honda 'Dream' car.

Regenerative Braking

Regenerative braking, with ABS, is included to take advantage of the energy recovery that is possible with electric vehicles. Regenerative brakes work on the principle that when decelerating or braking, kinetic energy from the wheels is converted back into electricity. Three electronic control units combine hydraulic and regenerative braking.

Energy is recovered both under braking and with no throttle. During normal braking, the regenerative power increases linearly with the applied brake force, while during downhill driving, with no throttle, the regenerative braking increases with the steepness of the slope. An electric vacuum pump operates in the same fashion as 'power-assisted' braking in conventional cars.

Personal Commuter Vehicles

Toyota are producing a whole range of 'alternative' forms of vehicles. The personal commuter vehicle, the 'e-com,' is a compact 2-seater car. It was designed for safety, performance, comfort and practicality, with advanced microcomputer control to maximise energy efficiency. Once again sealed nickel-metal hydride batteries (160kg), rated at 20Ah, are mounted under the floor, and have a cruising range on a single charge of 100km. An on-board charger allows charging from the domestic mains supply. This amounts to 2.5 hours for a 230V supply. Battery voltage is rated at 288V (Figure 3).

The drivetrain comprises a permanent magnet motor paired with a three-shaft, single-speed 8.17 reduction gearbox. Peak output at 2,200 to 3,500rpm is 19kW with maximum torque, 80Nm, obtained at 2,200rpm. Top speed is 100km/h.

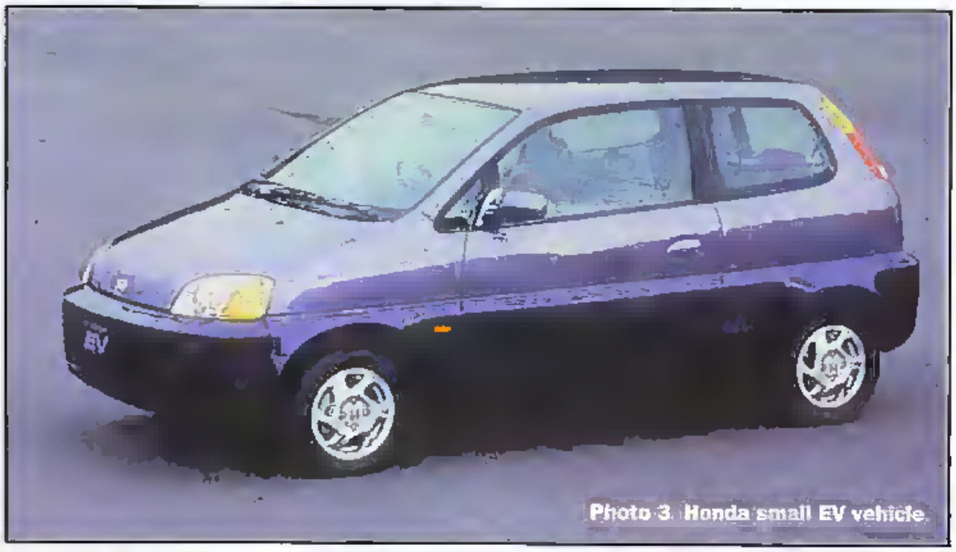


Photo 3. Honda small EV vehicle.

The Hybrid System

In recent years a compromise has been developed that combines two currently available power sources to produce a hybrid vehicle that combines the advantages of the internal combustion engine and the electric motor. Two such basic systems are available – the series hybrid and the parallel hybrid (see Figure 4).

The series hybrid system uses the engine to power a generator, which produces electricity for the electric motor that drives the wheels. The low-output petrol engine operates almost continuously in its high-efficiency range, charging the battery while it runs. One disadvantage is that the electric motor is larger and heavier than in the parallel system.

The parallel hybrid system uses both the engine and the motor to drive the wheels, and allocates the power of each according to the driving conditions. The petrol engine can power the wheels and charge the batteries simultaneously.

The Toyota Hybrid System (THS) combines the best features of both types of hybrid systems, and uses a 16V 1500cc petrol engine in conjunction with a brushless, ac, 30kW permanent magnet synchronous electric motor (Figure 5). During start-up and at low speeds the electric motor drives the wheels, but during normal driving, the engine provides most of the power to the wheels and charges the nickel-metal hydride battery pack. When additional power is used the elecric motor kicks in, powered from the battery pack. The distribution of engine and battery power is computer controlled, and will alter depending on driving conditions, ensuring smooth, responsive performance. Benefits of this system are that the engine operates constantly in its peak efficiency range, and the battery pack never needs external charging. Additionally, in city stop/start driving, the electric motor provides much of the power to the drive wheels so the system offers twice the fuel economy of conventional vehicles with only half the carbon monoxide, hydrocarbon and nitrigen dioxide emissions are up to one tenth of current regulations. The result is a medium size vehicle with an amazing 89mpg fuel consumption, and a top speed of 100mph!

Power Split Device

A planetary gear arrangement is used to allocate engine output between the drive wheels and the generator, and by controlling the generator rate of rotation, the power split device functions like a continuously variable transmission. Engine output is directed in to the planetary carrier and out through the sun gears to the generator and through the ring gear to the motor and the drive wheels (see Figure 6).


Photo 4. Engine compartment of Honda EV.

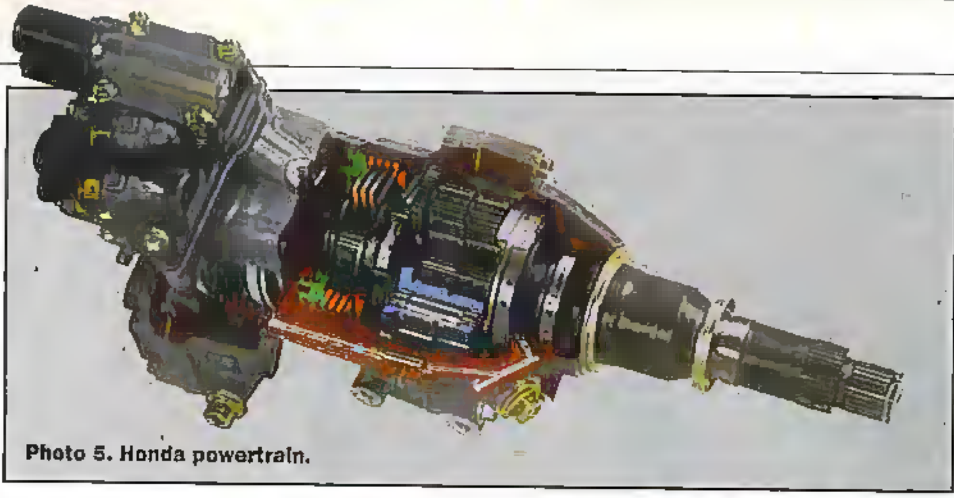


Photo 5. Honda powertrain.

Engine

In conventional petrol engines the compression ratio and the expansion ratio are set the same, with the compression ratio set to prevent 'knocking.' In a high expansion ratio cycle engine, the compression and expansion ratios are set independently. A higher expansion ratio allows more of the cylinders expansion pressure to be converted to drive power, and increase thermal efficiency. The engine has a smaller combustion chamber and uses intelligent variable valve timing to continuously change the inlet valve opening and closing to match operating conditions. During the compression stroke the closing of the inlet valve is greatly retarded which means the actual compression starts when the air intake valve is closed. This makes the expansion ratio substantially higher than the compression ratio. Engine revs is limited to a maximum of 4000 which not only increases fuel efficiency but allows the engine to be made from smaller, lighter parts, than for corresponding higher revving engines. This results in less friction, reduced weight and improved fuel economy.

Power distribution from the petrol engine is determined by factors such as the amount of pressure on the accelerator, vehicle speed and battery charge. The proportion that is used for traction is balanced with the need to generate electrical power. Electrical power produced by the generator may then be used to operate the electric motor, which can help propel the vehicle. When the vehicle stops or decelerates at low speeds, the petrol engine automatically stops to conserve fuel. When accelerating from rest, initial power is provided purely by the electric motor, with the petrol engine coming on line later. Similarly at low speeds, or where the engine is operating at low revs, fuel is cut-off and drive is provided by the electric motor.

A by-product of using an electric motor is

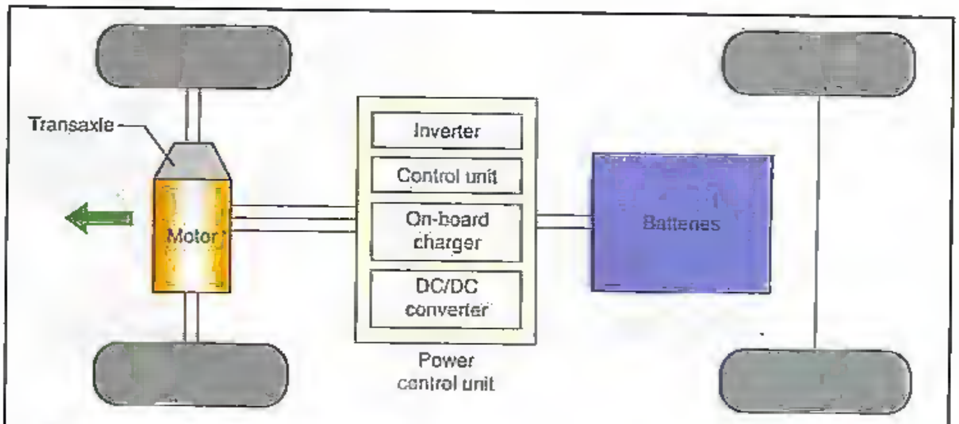


Figure 3. System diagram of Toyota 'e-com' car.

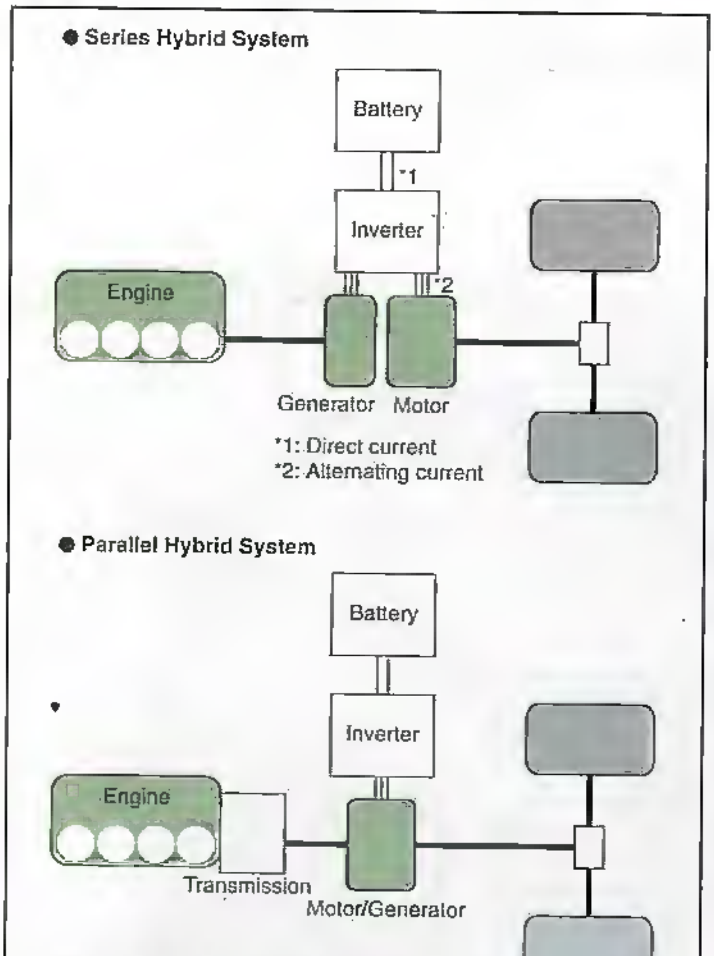


Figure 4. Series and parallel hybrid systems.

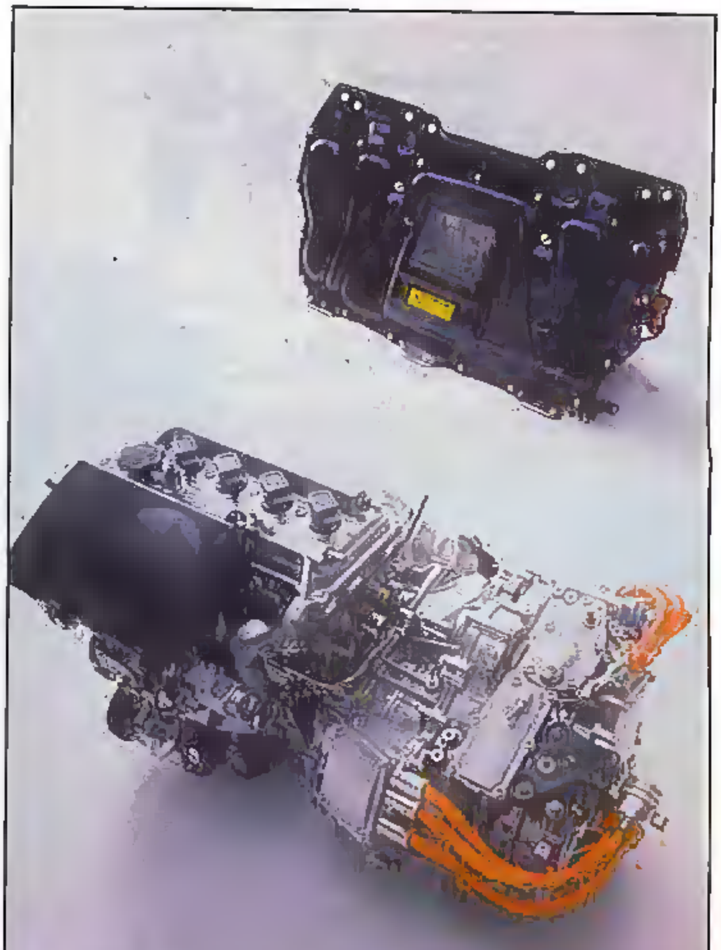


Photo 6. Toyota 'Prius' hybrid engine.

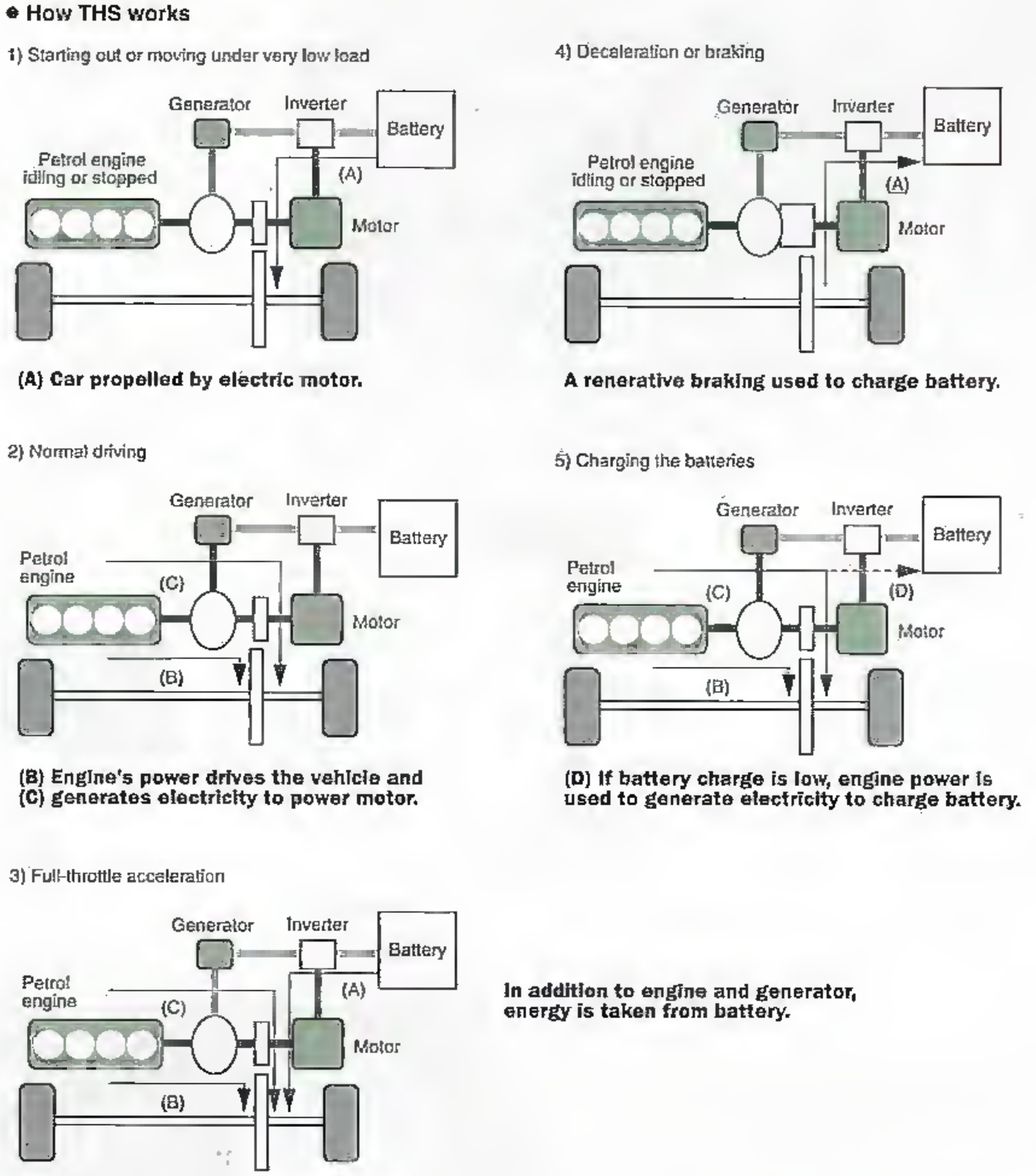


Figure 5. Toyota THS system.

that it can be used to generate electricity to charge the battery pack. When decelerating or braking, kinetic energy from the wheels is converted back into electricity. When the driver applies the brakes, both a conventional hydraulic braking system and the regenerative brake system operate, with priority going to the regenerative braking system to maximise energy recovery.

Toyota Prius

The Toyota Hybrid System has been used in the Prius (latin for 'ahead' or 'advanced'). A sleek five seater saloon that has been on-sale in Japan since last December at approximately £9,200. Unfortunately, Toyota have not decided to sell the Prius in the UK, although it is their intention to developed the concept for global introduction. Figure 7 compares fuel economy and CO_2 volume emission between the Prius and a similar conventional vehicles.

Next month we look at European efforts at hybrid engines and fuel cell electric vehicles.

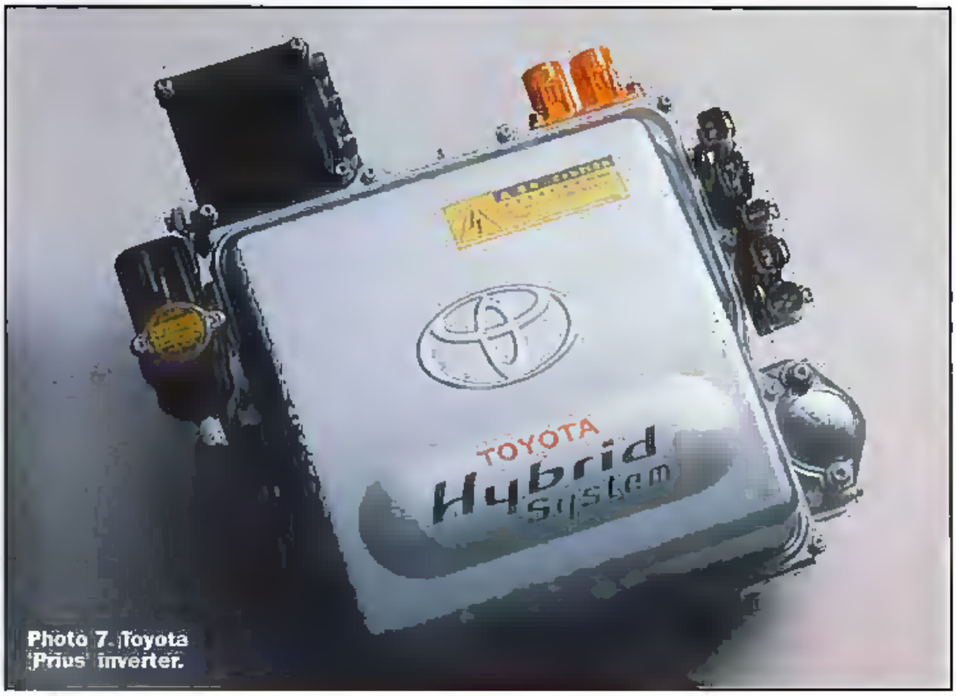
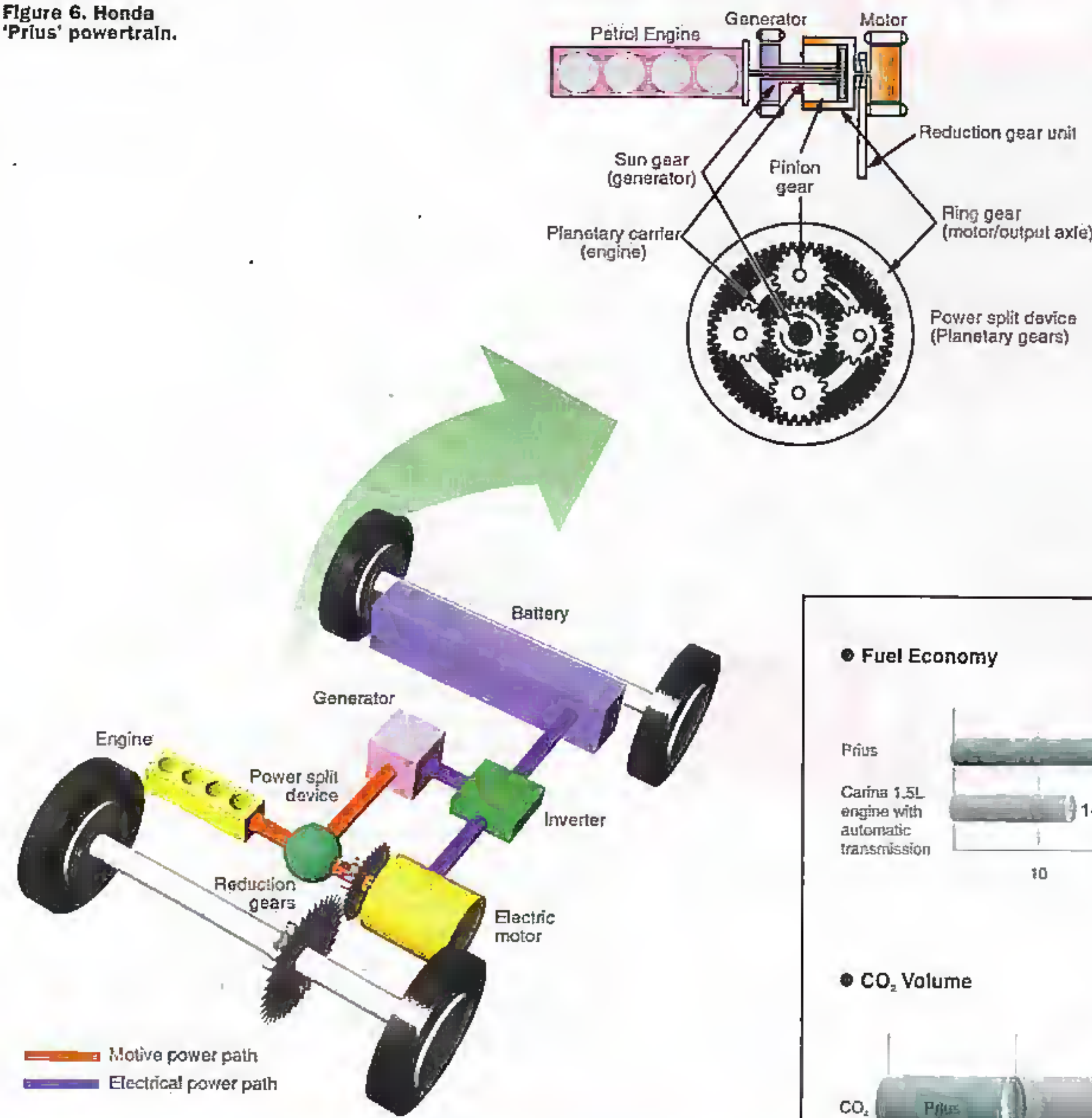


Photo 7. Toyota 'Prius' inverter.

Figure 6. Honda 'Prius' powertrain.



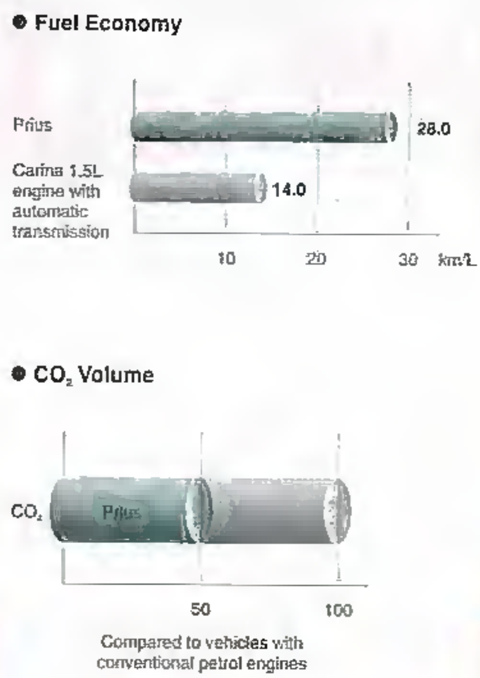


Figure 7. Honda 'Prius' fuel and CO² volume comparison with conventional vehicle

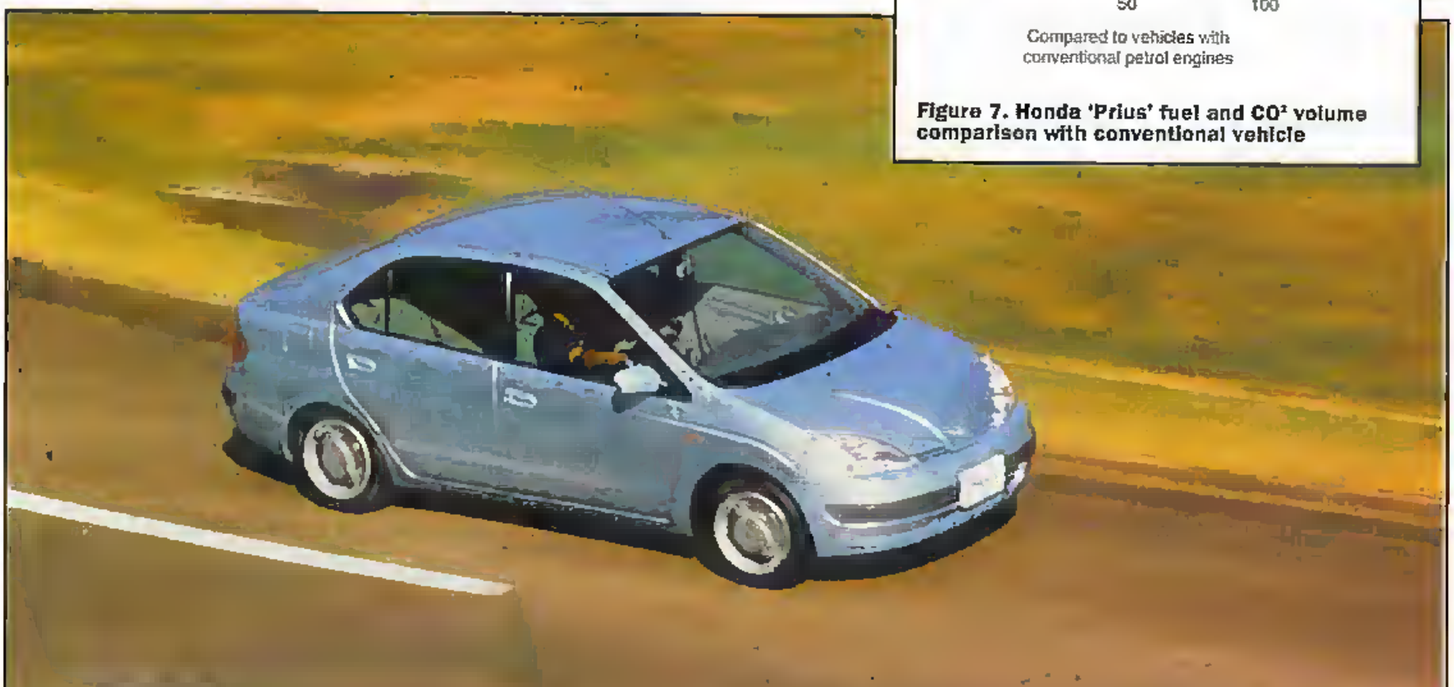


Photo 8. Toyota 'Prius'.

PROJECT

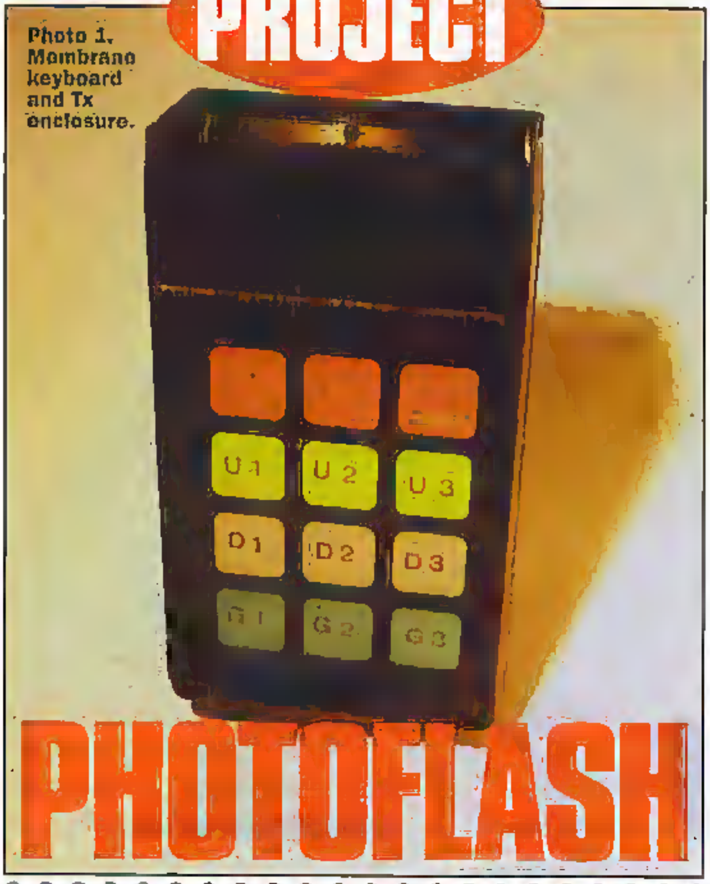


Photo 1. Membrane keyboard and Tx enclosure.

PHOTOFLASH

Charles Webb describes how to greatly increase the versatility of a standard photographic flash gun.

Introduction

With PhotoFlash a standard photographic flash gun acquires a versatility that can only be equalled by the much more expensive units typically used by a photographic studio. Control of the flash intensity either from the camera or manually will expand the range of creative lighting at every photographer's command.

Operation

A modern flashgun has three main contacts on its hotshoe. When the centre contact is grounded to the side contact of the shoe the flash will fire whilst it will rapidly turn off when the quench terminal is grounded to the side contact. The chart (Figure 1), taken from manufacturer's figures, shows that the longer the flash is allowed to fire the greater the power output, and hence the more light produced. PhotoFlash controls the power of the flash by varying the time delay between firing and quenching the flash.

PROJECT RATING 3

The least expensive flashguns available have only centre and side contacts and no method of controlling the output power. They can only be fired at full power. The next range of flashguns have an optical feedback or auto setting, where the light reflected from the scene to the flashgun is used to control the flash output. PhotoFlash can fire both these type of flash guns but cannot control their output power.

Flashguns that are dedicated to a particular camera range have electrical contacts in the foot for fire and quench. Each particular camera range has a proprietary method of arranging these contacts and the shoe drawn in Figure 2 is for a Nikon compatible gun. Other ranges will have different configurations but will broadly operate in the same manner.

A modern camera should be equipped with TTL (through the lens!) flash control. When the shutter is opened, to allow light to reach the film, the camera flash will fire if there is insufficient ambient light. As the camera flash fires a sensor measures the amount of light falling onto the film and turns off the flash when the correct exposure has been achieved. When using a second or slave flashgun the slave flash should also be controlled by the camera. With the 'right' camera, connecting cord and flashgun this is possible. Usually the equipment is limited to the products of one camera manufacturer and full compatibles.

For non compatible equipment another method of controlling the slave flash is to monitor the camera flash and to fire the slave flash when the camera flash fires and then quench it as the camera flash extinguishes. Even if the slave flash is providing the majority of the illumination the TTL system in the camera will measure the amount of light falling through the lens and onto the film and quench its internal flash, and thus the slave unit, when sufficient exposure has accumulated.

The infra-red (IR) remote handset controls the three functions of up to four PhotoFlash units. First, it enables the photographer to manually fire the slave flash from a distance. This is useful when measuring the flash output from the position of the photographic subject. Second, it controls the amount of power put out in manual mode with 64 steps. Third, the enable control allows the slave flashes to be selectively triggered by the camera flash. Setting up a number of slave flashes is eased if they can be fired individually or in groups for evaluation and then together for the final exposure.

Circuit Description

The system is designed as an interlocking trio of subsystems. Each will work alone and the others can be added at a later time when needs change.

The slave flash fire and remote quench subsystem (Figure 3) consists of a light amplifier D4, IC6a, IC6b followed by two mono stables IC7a and IC7b, with IC7a firing on a positive going edge and IC7b firing on a negative going edge. When the camera flash fires and so sharply increases the light level there is positive going pulse produced on the output of IC6a. The increase in voltage is picked off by the Schmidt trigger IC6b and the positive edge of the output pulse triggers IC7a which fires the flash through TR1. When the light from the camera flash decays the resultant negative edge will trigger IC7b and quench the slave flash.

TR1 and TR2 in open collector mode are used to connect to the fire and quench circuits of the

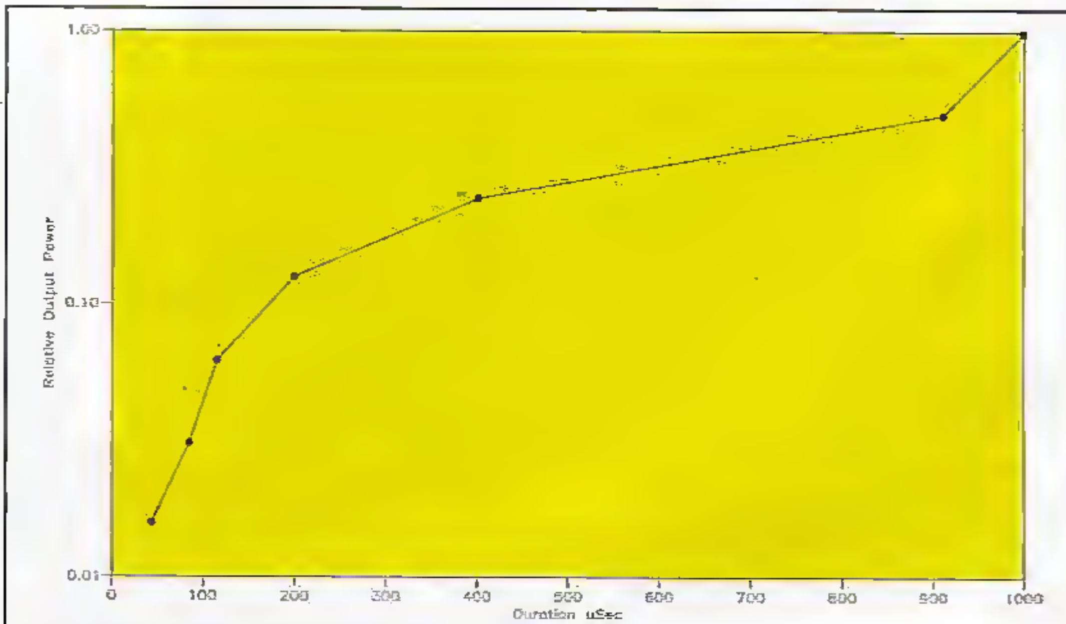


Figure 1. Power Output Vs Duration of Flash.

slave flashgun. No voltages from the PhotoFlash controller are impressed on the slave flash. Some older flash guns may have an output voltage on the centre 'firing' pin of 200V or so. In this case TR1 and TR2 should be changed to say a MPSA42 (UL29G), with a 300V rating.

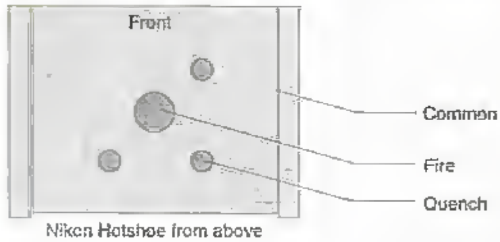
The 3ms duration of the output pulse of IC7a simulates a camera mechanical shutter opening of 1/250 second. The quench signal will only be accepted by some flashguns whilst the 'shutter' is 'open'.

From experiment very simple circuits are sufficient to fire the slave flash but it is more difficult to detect a clean end of the light pulse from the master flash.

The manual power control consists of IC2, IC5 and ancillary components. IC2 is an electronically alterable potential divider with the output on pin 6 a set fraction, in 64 steps, of the voltage between pins 1 and 4. When the slave flash fires D1 is illuminated causing the output of IC5a to go high. C1 commences to charge towards the positive supply and when its voltage exceeds that from the potential divider IC2 the output from IC5b will go high so turning on the quench transistor TR2.

It is necessary to measure the firing duration of the slave flash from when the light is detected

Figure 2. Hotshoe connections.



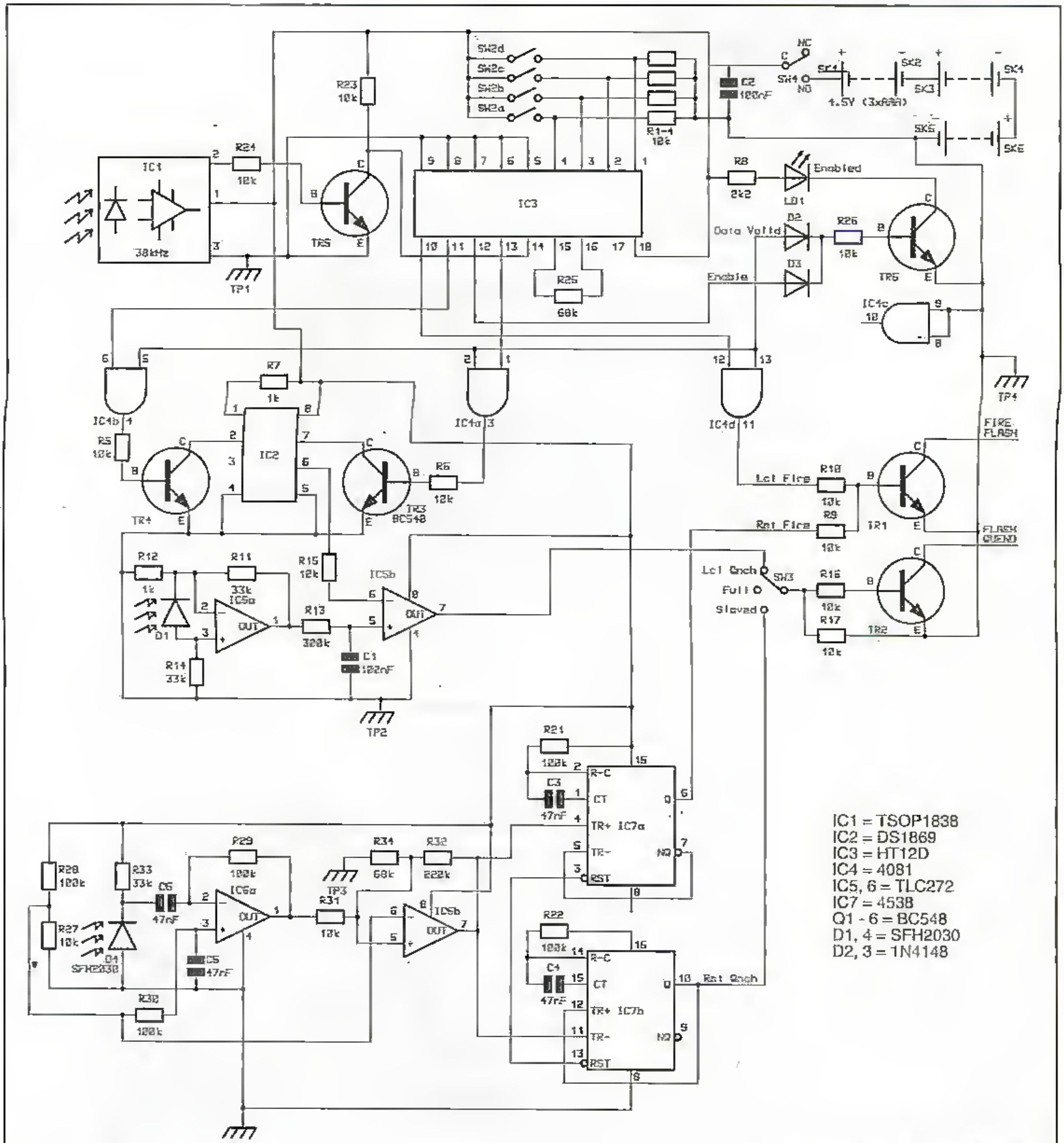


Figure 3. Receiver circuit diagram.

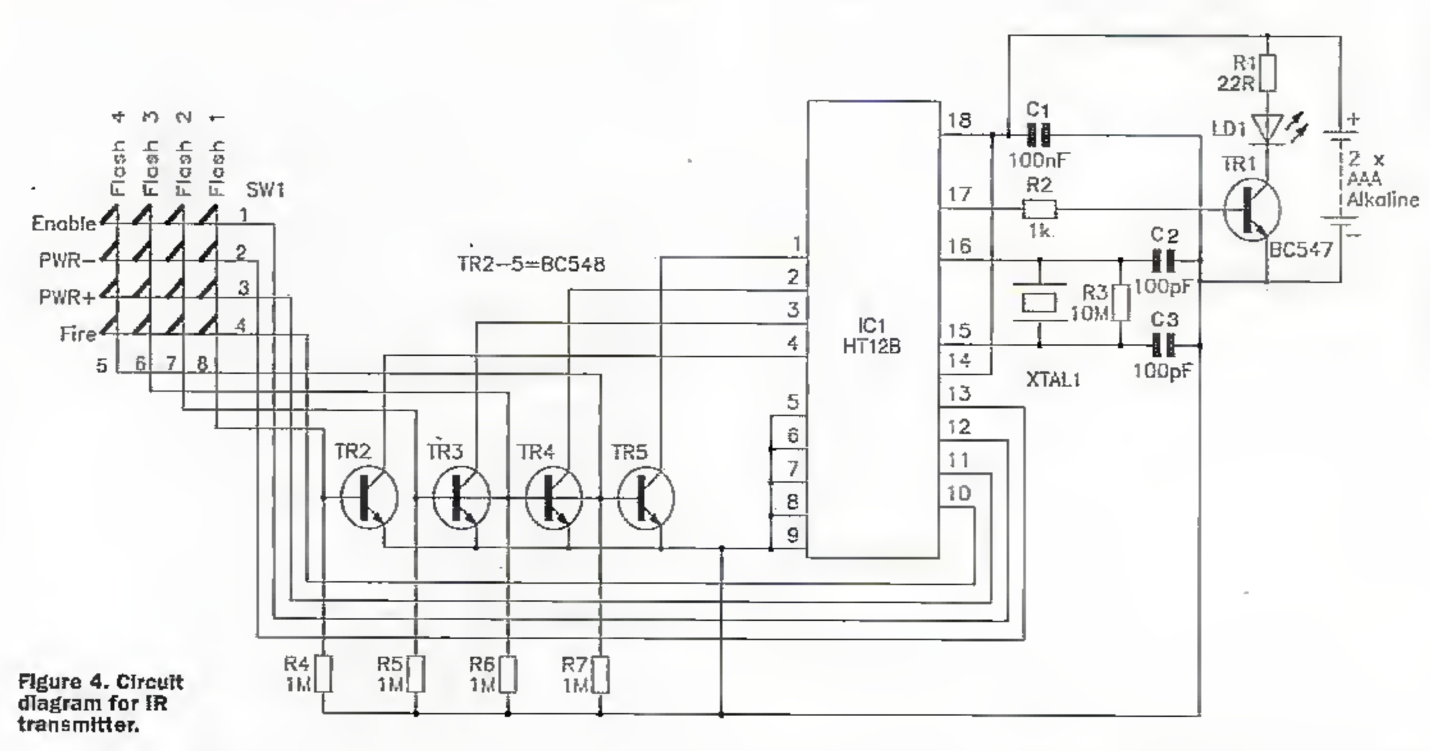


Figure 4. Circuit diagram for IR transmitter.

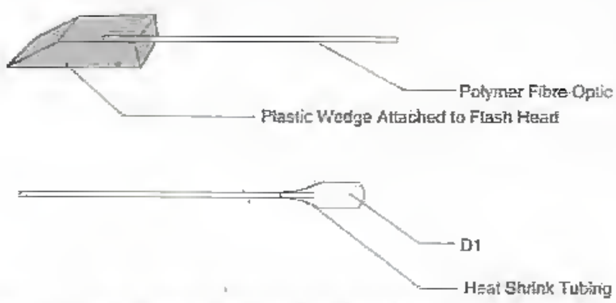


Figure 5. Plastic light guide and connection to D1.

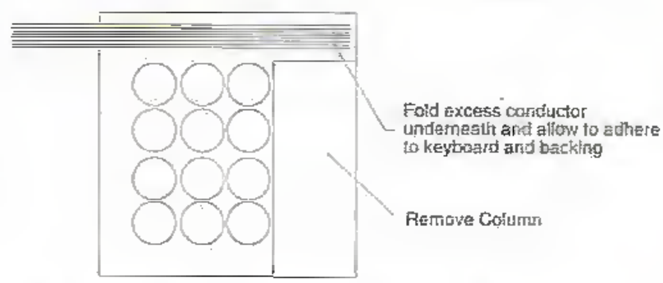


Figure 6. Cutting down the membrane keyboard to 3 x 4.

since there is a considerable delay (some 400μS seems typical) between grounding the centre contact and the flash emitting light.

The electronic potential divider IC2 is controlled by the simulated push buttons TR3 and TR4. A momentary closure of TR4 will increase the divider position by one notch whereas a closure on TR3 will decrease the position. If a push-button is depressed for one second or more then the divider will change by 10 positions per second until either the minimum or maximum position is reached. If the remote control facility is not required then TR3,4 can be replaced by mechanical push-buttons.

The third subsystem is the IR remote control transmitter (Figure 4) and receiver. The data is impressed upon a 38kHz IR carrier to increase the effective range and data integrity, the carrier being generated by dividing the 455kHz of the ceramic resonator XTAL1 by 12. The HT12B encoder also has the facility of being in standby mode until one or more of the data lines are taken low. The low quiescent current (a few μA) helps to ensure long battery life. When a key is pressed the connected data line is taken to within a diode drop of ground, thus turning on IC1, and at the same time the corresponding address line is also forced low. As a result the columns of the keyboard correspond to different addresses whilst the rows correspond to different controlled functions. The IR is generated by TR1 which passes a current of about 20mA through the LED.

At the receiver, see Figure 3, the received IR is amplified and demodulated by IC1. Q8 changes the sense of the data and presents it to the decoder IC3. If four correct sequential transmissions are received then DATAVALID is asserted and the new data latched on outputs D0 to D3. IC4 ANDs the received Data with the DATAVALID signal to force the three signals other than ENABLE to be only momentarily valid. The ENABLE line is latched high to allow the flash sensor to activate via the CLR inputs of IC7a, b.

LED1 will flash when valid data is received and turn on continuously when the ENABLE signal is high signifying that this unit will respond to an external flash stimulus.

Construction

Construction of the units onto the PCBs should cause few problems though the prospect of soldering surface mount devices may cause apprehension. A earthed soldering iron with a 1 mm or smaller bit is required together with some 22SWG solder.

First mount the SM (surface mount) resistors and capacitors. Melt a small bump of solder onto one of the pads. Using a pair of tweezers manoeuvre the SM component into the correct position and then melt the solder. The SM device will settle into the solder. The other end can then be soldered into circuit normally.

The same technique will work with IC7. On each of the 16 pads put a small amount of solder and also tin the ends of each leg. Position IC7 with the correct orientation (if pin 1 is not marked then the legend is readable when viewed from pin 1) on top of these solder bumps. Applying a small amount of downward force on IC7 whilst heating each leg in turn should cause each leg to sink into the solder mounds. Check all connections with a magnifying glass and a small point (sewing needle or something equivalent) to make sure that they have bonded. The above is contrary to the usual practice of applying solder and flux to the heated joint. However it appears to give reliable joints.

On the receiver board the height of IC1, LED1 and D4 should be controlled so that they line up with the appropriate apertures in the enclosure. The legs on D1 should be left long enough to bend it over by 90° as shown in Photo 3. D1 seems to collect enough light from the local slave flash through the lid of the specified enclosure. The transmission can be made more specific using a polymer light fibre optic, as shown in Figure 5, to transmit the light from the

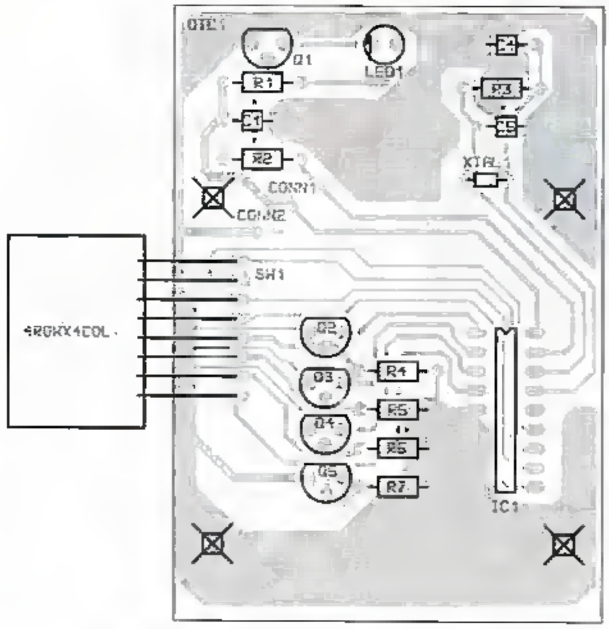


Figure 7. Component overlay for transmitter PCB.

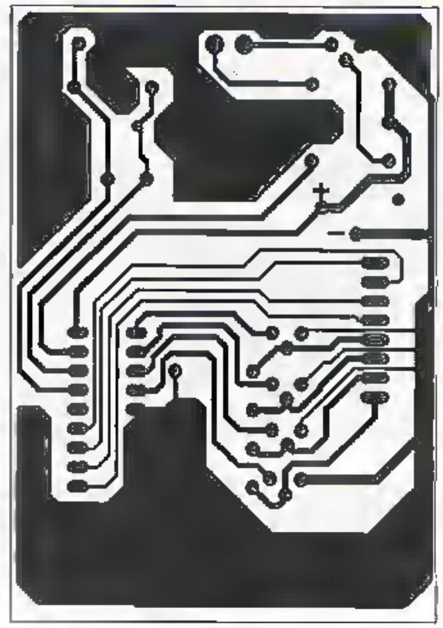


Figure 8. Underneath copper layer for transmitter PCB.

slave flash. The fibre can be fastened to the PCB using hot melt glue; and the enclosure may be painted on the inside to make it opaque.

The flash sensor D4 should only receive light from the camera flash. To this end the photodiode is mounted in a short aluminium tube and the joint is sealed with a piece of heat shrink tubing. The open end of the tube should point towards the vicinity of the controlling flash when the unit is in use.

Generally, all the non semiconductor parts should be soldered in followed by the non CMOS semiconductor parts followed by the CMOS parts. Check carefully that the power supply and ground joints on the top of the board have been soldered where required (with a larger soldering iron to achieve soldering temperature). The

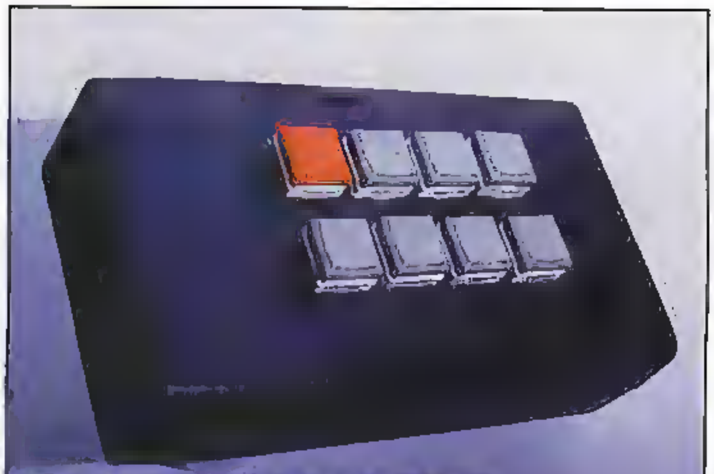


Photo 2. Discrete Keyboard and Tx enclosure

battery clips need to be firmly soldered to both sides of the board, and any through connections must be soldered both sides. The IR diode D1 on the transmitter should be checked with an resistance meter for correct electrical orientation.

The keyboard for the IR transmitter is specified as a 4 x 4 membrane assembly and the connection trace for this will have to be brought down through a suitable slot cut in the top of the box. The top of the specified box is only wide enough for a three column by four row keyboard and the membrane unit may be cut down to fit. Take great care not to cut any of the ribbon cable traces and refer to Figure 6 before wielding the scissors. In a like manner the key board may be reduced to one or two columns. Purchasing a ready made keyboard of the correct size may mean that the row and column connections are not compatible with the PCB layout shown.

My own experience suggests that the membrane keyboard (Photo 1) though good looking is not totally reliable and this effect is compounded by the lack of tactile feedback associated with membrane switches. As an alternative discrete key switches cross wired and mounted on a piece of 0.1in. perforation strip board which in turn is mounted to the lid of the box may not look as professional (Photo 2) but it is more pleasant to use and has proven reliable.

Before powering up for the first time check visually that there are no solder bridges or dry joints and that an ohm meter indicates a non short circuit across the power lines.

The first mechanical consideration of the receiver unit is the provision of a connection to the foot of the flash gun. Usually a suitable shoe can be purchased from a pre used camera shop or by buying the correct cable for the make of flash gun and modifying the connections accordingly. Alternatively, a simple shoe can be bought and modified by adding additional contacts. With basic metal

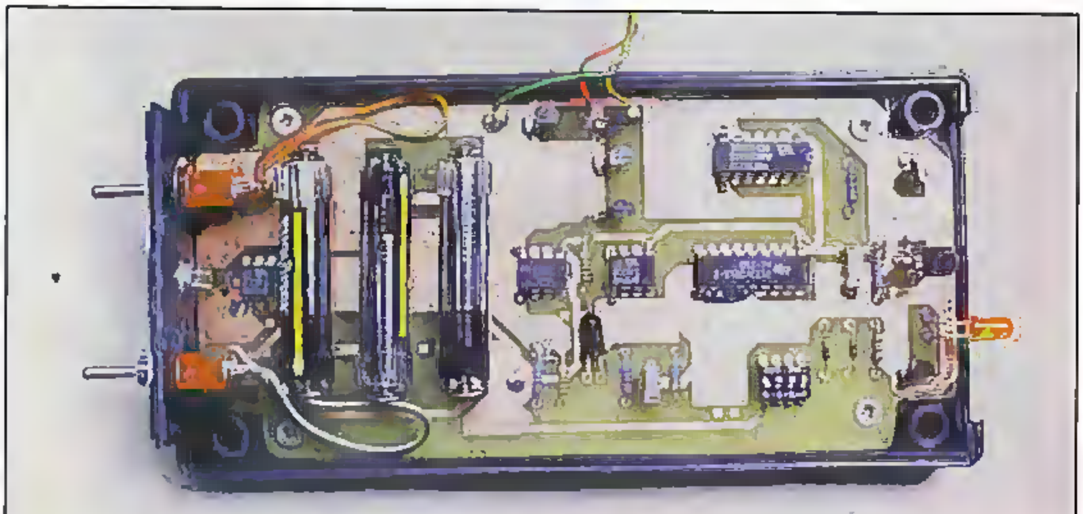


Photo 3. Rx interior showing Aluminium tube for flash sensor D4.

Photo 4. Receiver & flash gun on tripod.

working tools and patience a shoe can be fabricated from a piece of 1in. wide brass strip. When all else fails the foot of the flashgun can be taken apart and an additional 3-pole socket added in wherever there is space. Be aware that the internal generator in a flashgun may produce several hundred volts across a hefty capacitor; a nasty shock can be the result of not checking it is completely discharged prior to commencing work.

Mounting the receiver assembly to a lighting stand or tripod is done with the photographic industry standard 1/4in. 20 turns per inch (tpi) Whitworth threaded nut fastened to the other edge of the enclosure (Photo 4). The nut used is a piece of aluminium drilled and tapped to size but it should be possible to find a suitable nut and using epoxy glue fasten it to the inside of the enclosure. Some form of attachment ability is useful both for positioning the PhotoFlash assembly and because the flashgun tends to make the whole rather top heavy.

Testing and Use

The IR diode in the transmitter should emit a just visible glow when a key is pressed. The current consumption should rise to around 10mA. If there appears to be a fault check the keyboard and diode for correct connections before investigating further.

In the receiver set all the address switches to the on position (shorted) and then open the switch corresponding to the address required. The switch nearest to the battery end corresponds to channel 4. When the address is correct the LED should flash as data is received. If the LED stays on when the appropriate enable transmitter key is pressed then the Remote Control system is

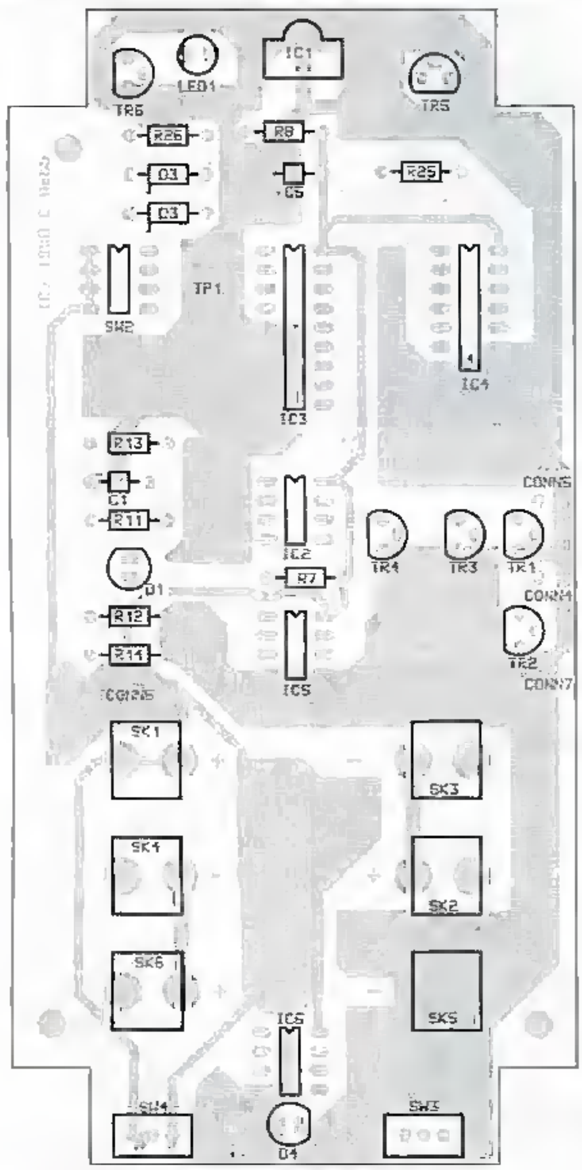


Figure 9. Component overlay for receiver PCB.

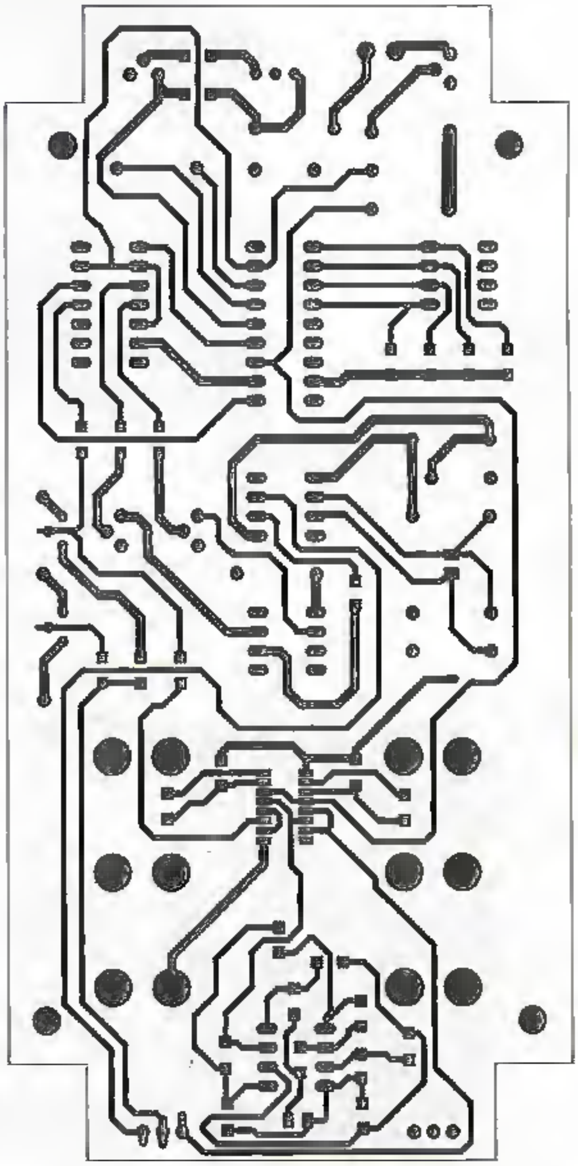


Figure 10. Underside copper layer for receiver PCB.

probably working correctly. A response range of about 10m should be obtainable. Attach a flash gun to the shoe and measure the voltage on the fire and quench pins. These should be in the region of 15V and 5V. Fire the flash using the remote control to check that the fire circuit is operational.

Set SW3 to the local position and confirm that the flash puts out a variable amount of light depending upon the setting imparted to IC2. If this does not appear to work check the orientation of D1 and for any dry joints around IC5. In a low light environment check that a nearly zero voltage is present at IC5 pin 1 and pin 7, and that the remote control can alter the voltage on pin 6 of IC5. Put a bright continuous light close to D1 and check with a voltmeter that a logic high propagates through the circuit elements culminating in the turning on of TR2.

Use the remote control to set the 'enable' line high, illuminating LED1. Set SW3 to the remote position and fire a flashgun so that it can be seen by the sensor D4. The slave flash should fire in synchrony. If not check the integrity of the connections around IC7 and measure the voltages on each pin looking for shorts or open circuits. Check that the enable line is holding pins 3 and 13 high. It is difficult to confirm the operation of IC6 without a scope but a voltage blip (as seen by a voltmeter) should appear on the output pin 7 in response to a flash fired at D4.

The remote quench may checked by forcing it to respond to a long or short flash pulse from the camera. Set up the camera and PhotoFlash so the flash units of both will illuminate a nearby white surface. Taking a picture of this surface should produce a very low power flash from the slave. Replacing the white surface by a black one should cause a more powerful flash. Errors suggest that the connections around IC7 are faulty.

As an example of the use of the system imagine that you are going to take photographs at a party held in a large room with a white ceiling. Place one or more PhotoFlash units in the room set to illuminate the ceiling and adjust their positions for the most even illumination reflected onto the guests below. Set each SW3 to the remote position and set 'enable' on. At the party use your camera with its built in flash as normal. The slave flashes will illuminate the room that is beyond the camera flash and should give you a set of pictures without that inky dark background. Careful arrangement can make it appear as though you did not use a flashgun at all!

The manual mode (set SW3 to the full or local positions) is of most use when illuminating a still life (or perhaps a portrait) where the ratio of illumination from various light sources needs to be fixed. A flashmeter will be found to be a useful adjunct in this situation.

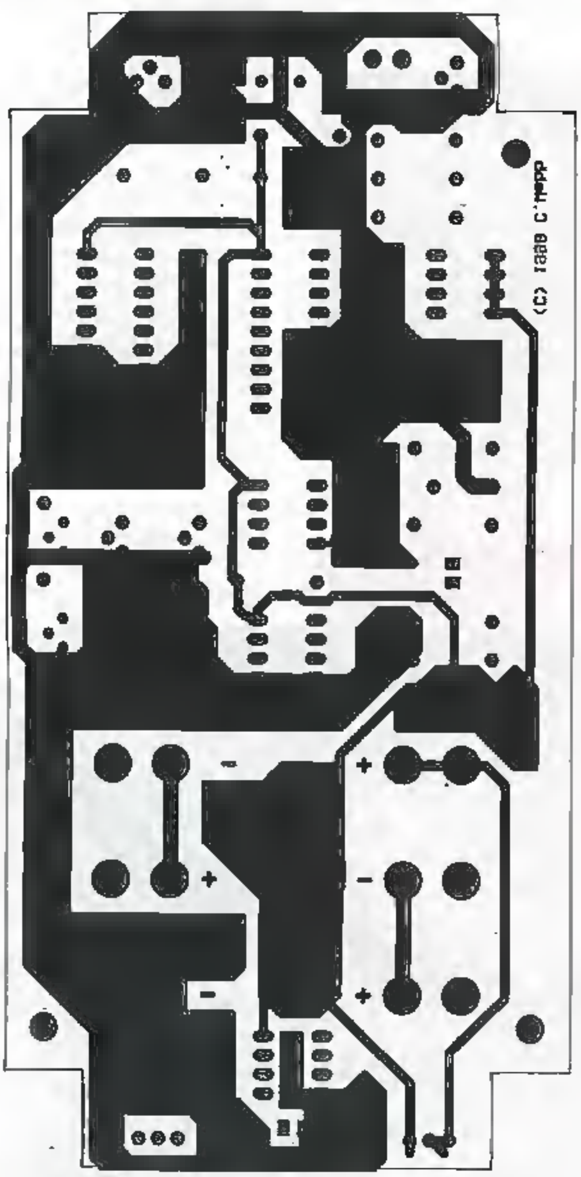


Figure 11. Topside copper layer for receiver PCB.

TRANSMITTER

RESISTORS		
R1	22R Min Res	M22R
R2	1K Min Res	M1K
R3	10M Min Res	M10M
R4, 5, 6, 7	1M Min Res	M1M
CAPACITORS		
C1,	100nF	WW41U
C2, 3	100pF	BX28F
Semiconductors		
IC1	HT12B	JA33K
TR1	BC547	QQ14Q
TR2, 3, 4, 5	BC548	QB73Q
MISCELLANEOUS		
XTAL1	455kHz Ceramic Res	UL61R
LED1	SFH487	CY88V
SK1, 2 ,3, 4	AAA PCB Clip	GU65V
SW1	16-W Keypad	JY04E
Box	Type Sml	LH90X
Batt Holder	AAA x 2	JB83E
Batteries	AAA type 2 reqd.	JY50E
PCB		
Assorted Screws		

RECEIVER

RESISTORS		
R1, 2, 3, 4, 5, 6, 9, 10, 16, 15, 17, 23, 24, 27, 31	10k Surface Mount	DJ17T
R21, 22, 28, 29, 30,	100k Surface Mount	DJ22Y
R32	220k Surface Mount	DJ23A
R33	33k Surface Mount	DJ19V
R34	68k Surface Mount	DJ21X
R7, 12	1k Min Res	M1K
R8	2k2 Min Res	M2K2
R11, 14	33k Min Res	M33K
R13	300k Min Res	M330K
R25	68k Min Res	M68K
R26	10k Min Res	M10K
CAPACITORS		
C1, 2	100nF	WW41U
C3, 4, 5, 6	47nF	DH99H
SEMICONDUCTORS		
TR1, 2, 3, 4, 5, 6	BC548	QB73Q
IC1	TSOP1838	NU67X
IC2	DS1869	LF21X
IC3	HT12D	AE18U
IC4	4081	QW48C
IC5, 6	TLC272	AV68Y
IC7	4538	AB23A
D1, 4	SFH2030	CY90X
D2, 3	1N4148	QL80B
LED1	Red LED	CZ31J
MISCELLANEOUS		
SW2	Quad DIL Switch	JH08J
SW3	1P SPTT	FH01B
SW4	SPDT Switch	FH00A
SK1, 2, 3, 4, 5, 6	AAA PCB Battery Clip	GU55V
Box	Type D009	ZB02C
Batteries	AAA type 3 reqd.	JY50E
PCB		
Screws		
Connecting Wire		
Whitworth 1/4in 20tpi nut		

An Asteroid Strike
WHAT WOULD IT LOOK LIKE?

RESEARCH NEWS *Special*

Steven Spielberg's new blockbuster movie - with its computer-animated interpretation of a comet striking Earth - promises to be a big hit at the box office. But computer scientists at Sandia National Laboratories are creating some big bits of their own. Stephen Waddington reckons that they may have a better approximation of what a real asteroid catastrophe would be like.

Using virtual reality techniques, decades of experience in shock physics, advanced computer programs, and the world's fastest computer, scientists at Sandia National Laboratories have recently completed one of the largest hypervelocity impact physics calculations ever performed.

Asteroid Hit

In the latest computing scenario, an asteroid a little under a mile in diameter strikes the Atlantic Ocean 25 miles south of the US East coast. To model the event the scientists broke up a 120 square mile space that roughly approximates the New York City metropolitan area, the air above, and the water and earth below, into 100 million separate cubes, or grids.

Sandia's Teraflops supercomputer then calculated what happened inside each cube as the asteroid splashed down. The cubes were reassembled to produce a three-dimensional moving picture of the collision. The Teraflops, currently the world's fastest computer, performs more than one trillion mathematical operations per second.

The simulation is no video game; the calculations take into account the real-world laws of physics governing time, temperature, pressure, gravity, the densities of water and earth, and hundreds of other considerations to create an accurate prediction. What's more, the resulting computer simulation can be explored using interactive virtual reality techniques.

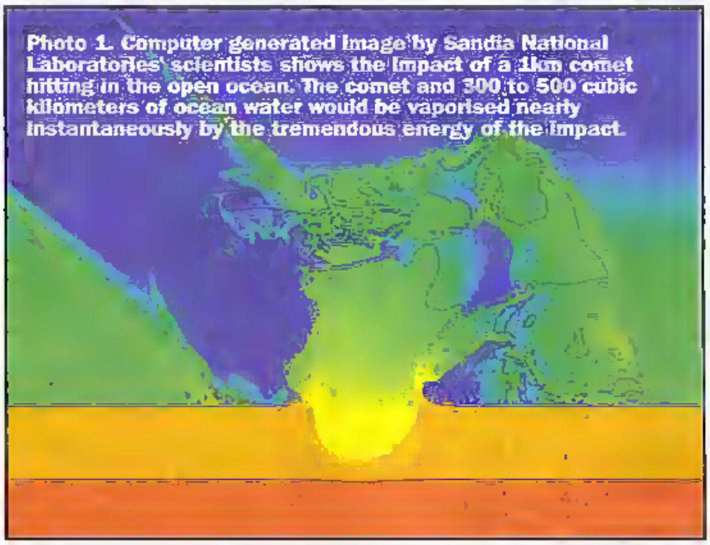


Photo 1. Computer generated image by Sandia National Laboratories' scientists shows the impact of a 1km comet hitting in the open ocean. The comet and 300 to 500 cubic kilometers of ocean water would be vaporised nearly instantaneously by the tremendous energy of the impact.

The simulations in Quick Time format, other illustrations, and links to information about other Sandia comet modelling work are available on the Web at `http://sherpa.sandia.gov/asteroid/` and `http://www.cs.sandia.gov/projects/comet.html`.

The work supports Sandia's US Department of Energy (DOE) mission to use the world's highest-performance computers to develop computer codes that can one day model the extremely complex physics that occur during a nuclear weapon blast. In the absence of real-world nuclear testing, DOE and the

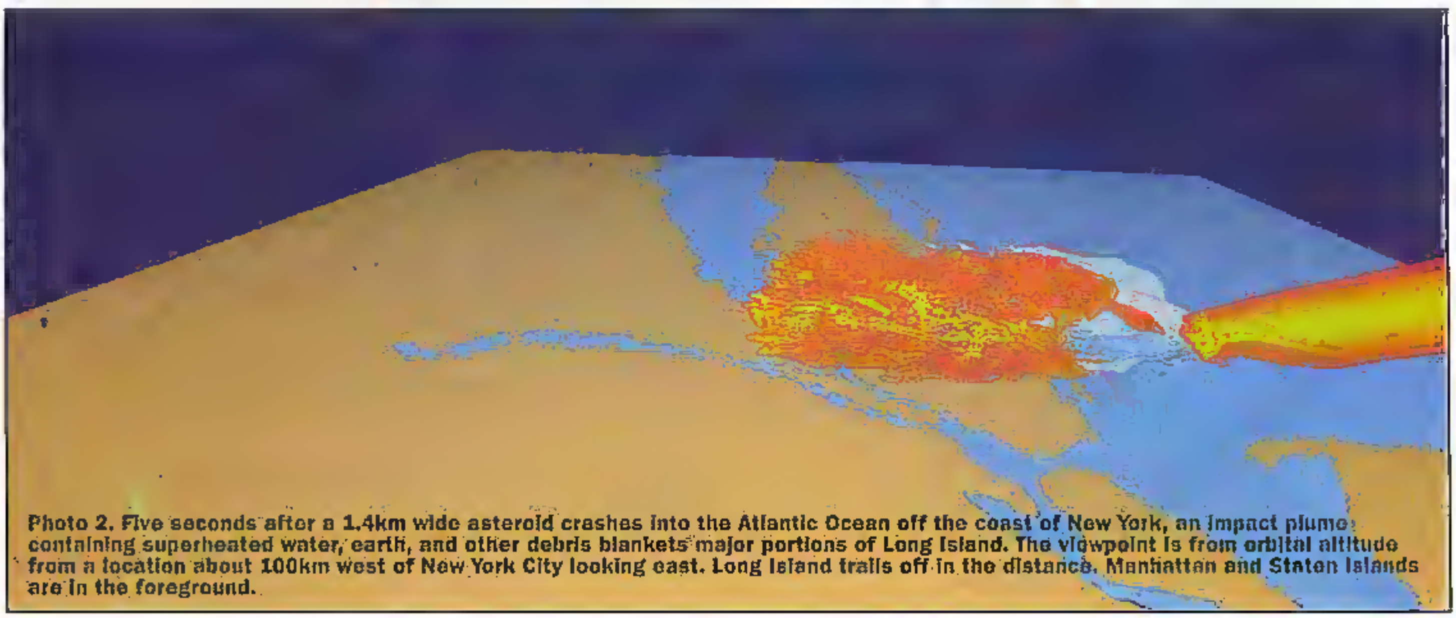


Photo 2. Five seconds after a 1.4km wide asteroid crashes into the Atlantic Ocean off the coast of New York, an impact plume containing superheated water, earth, and other debris blankets major portions of Long Island. The viewpoint is from orbital altitude from a location about 100km west of New York City looking east. Long Island trails off in the distance. Manhattan and Staten Islands are in the foreground.

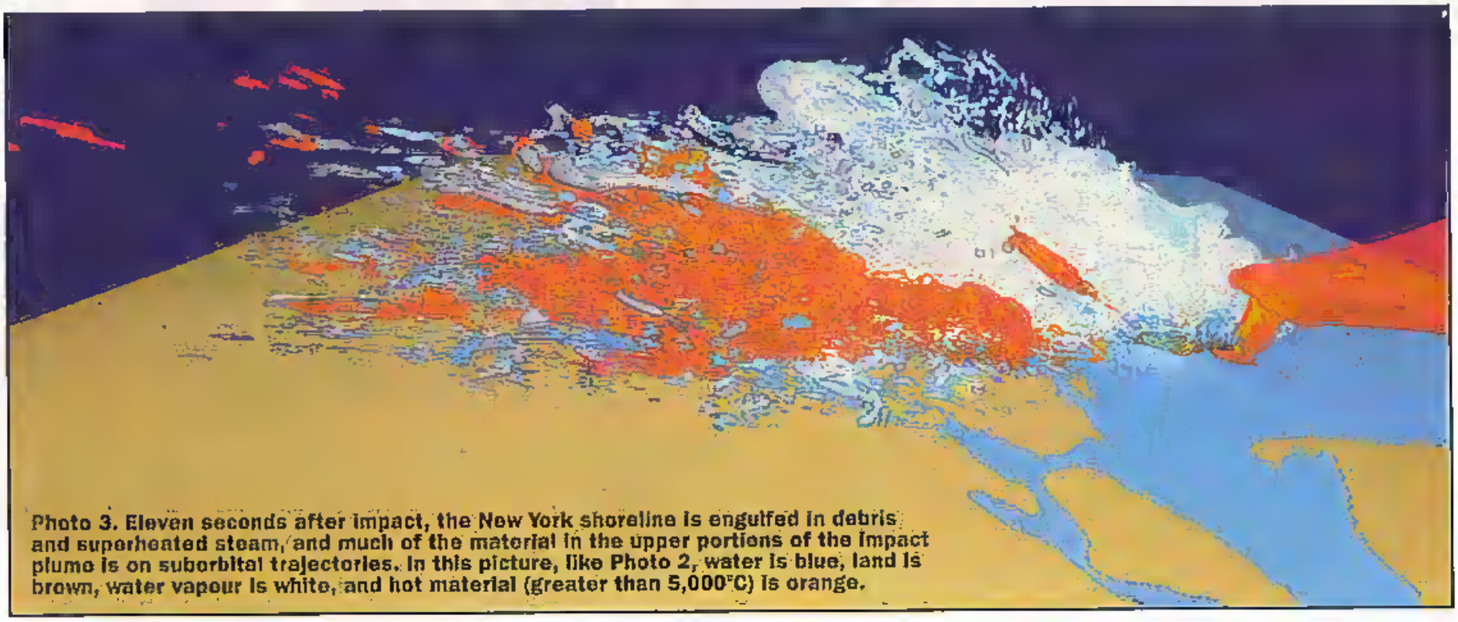


Photo 3. Eleven seconds after impact, the New York shoreline is engulfed in debris and superheated steam, and much of the material in the upper portions of the impact plume is on suborbital trajectories. In this picture, like Photo 2, water is blue, land is brown, water vapour is white, and hot material (greater than 5,000°C) is orange.

weapons labs are developing continually more powerful supercomputers and computer codes to simulate the complex 3-D physics involved in nuclear-weapon performance and to accurately predict the degradation of nuclear weapon components as they age in the stockpile. Simulating comet impacts provides an opportunity to test and improve the codes.

How Did Spielberg Do?

So what would happen during such an impact, really? According to the simulation, the impact would vaporise the asteroid, deform the ocean floor, and eject hundreds of cubic miles of superheated water vapour, melted rock, and other debris into the upper atmosphere and back into space.

"Much of the debris would then rain down over the world for the next several hours and also form a high global cloud," says David Crawford of Sandia's Computational Physics and Mechanics Department. Assuming the impact was on the East Coast of the US, the shock wave from the impact would level much of the North East.

The heat would incinerate cities and forests there instantaneously. The global cloud would then lower temperatures worldwide, and a global snowstorm would likely ensue and last several days to several weeks, initiating a 'nuclear winter' that would create more hardships for earth's inhabitants.

"An impact of this magnitude can be expected to occur on Earth about once every 300,000 years and approximates to what scientists consider to be the global catastrophe threshold," said Crawford.

So how close is Spielberg's interpretation of the event to the Teraflops' virtual predictions? "The movie makers didn't have the benefit of the world's fastest computer, but they produced superior visuals that appear remarkably realistic," says Arthurine Breckenridge of Sandia's Computer Architectures Department.

In the movie preview, the comet strikes at an angle and raises a symmetrical steam cloud, she says, which probably wouldn't happen. "We now know that the vapour cloud produced by an impact is initially asymmetric, sending more material in the direction of the ricochet." The movie does realistically depict a tsunami that would surely follow an ocean impact, she says.

Unrepeatable Experiment

The Teraflops simulations employ 'massively parallel computing,' a computing approach pioneered by Sandia in the late 1980s. In massively parallel computing, thousands of discrete computing tasks are assigned to several hundred separate computing 'processors' inside the supercomputer. The computing tasks are accomplished simultaneously and their results reassembled. All of today's high performance supercomputing employs a massively parallel approach.

In the most recent 100-million-cell calculation, the Teraflops used 8,192 of its 9,000 processors. The entire calculation lasted 18 hours. Sandia has done similar calculations on its high performance computers, including a 54-million-cell simulation of a comet striking the ocean. In 1994, Crawford and Sandia scientist Mark Boslough accurately simulated what would happen when Comet Shoemaker-Levy 9 plunged into Jupiter's atmosphere. Months later, the world's astronomers watched the Sandia-predicted event unfold in real life through the Hubble space telescope.

"A lot of major breakthroughs in science are going to come from these kinds of calculations," Boslough says. He notes that the impact simulations are something that can't be done any other way. "It's almost like doing an experiment - one you could never do. One you would never want to do."

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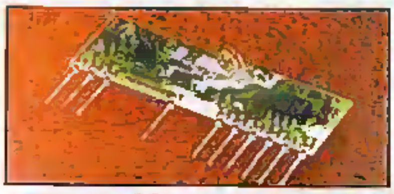

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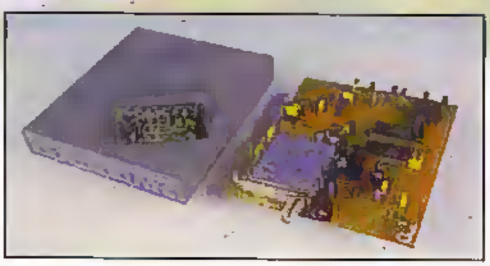

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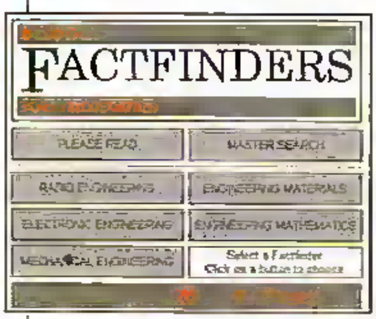
Newnes Factfinders FOR WINDOWS

Titles from the Newnes Pocket Book Series are now available on floppy disc, we loaded up two titles and took a look.

The Newnes Pocket Book series have proved to be highly successful and provide the reader with a wealth of fundamental information, facts and figures. Butterworth-Heineman are now producing titles from the series on two 3.5in floppies. The first two titles are the *Electronic Engineer's Factfinder* by Keith Brindley, and *Radio Engineer's Factfinder* by John Davies.

Loading and Using

Installation is simple, running the set-up program on disc 1 provides a Factfinder folder



ready for the program to be run. The Factfinder library can be built-up title by title or installed several titles at a time. The opening Factfinder screen, or Bookself as it is referred to within the titles, allows you to select the desired title. Buttons for Factfinders not yet installed link to title information and a printable order form.

Newnes have used the Windows 3.1 Help engine, which makes the titles compatible with Windows 3.1, Windows for Workgroups, and Widows 95. The program has been optimised for a 16 colour display with a 640 x 480 pixel resolution. A 486 processor is the minimum requirement, and each title takes up just 2.5Mb of disk space. Eventually the series will build into a complete electronic database that is easy to use, bolts on to a basic PC, and provides convenient, economical and low memory access to a wealth of engineering data. Each of the Factfinders builds up in to a coherent data library with the ability to search for a topic or item of data across all the Factfinders purchased.

Navigation

The master search button, located on the Bookself screen allows you to search by a keyword across all the titles that have been installed. Hypertext links allows the user to navigate their way around the material quickly and easily. Labels, buttons or highlighted text provide links to related topics.

Additional explanations, diagrams etc., are sometimes provided as pop-up topics which appear on clicking the pop-up label and cancelled if the mouse is clicked a second time. A hand cursor indicates that there is a hypertext link.

Format

The Factfinder screens are arranged so that the Contents listing is visible at all times along side the main window – a very convenient feature.

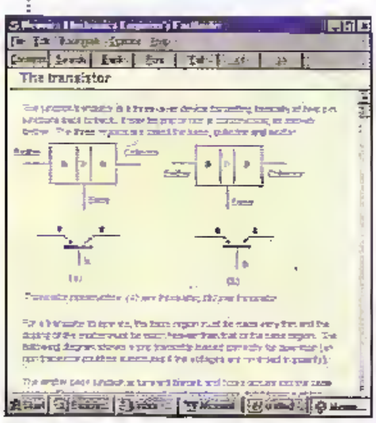
Where a table in the Factfinders extends beyond the visible page, the topic window can be maximised and the Contents closed using the closed button. This is also useful should a full screen display be required for demonstration purposes.

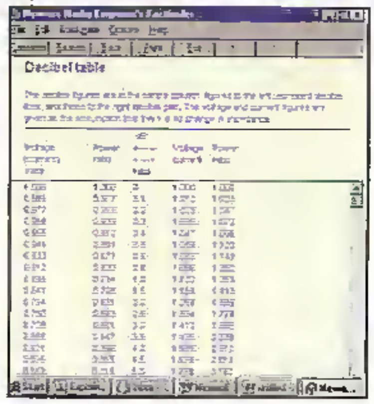
The WinHelp Annotate facility permits user notes to be associated and saved with the Factfinder. The button-bar Print button or File/Print menu allows printing of a page to a suitable configured printer.

Contents

The Electronic Engineer's Factfinder covers transistor characteristics, ICs and pin-outs, all basic electronic formulae, data and circuits and systems. This package is intended for electronics engineers, designers, service engineers and students of electronic engineering.

Radio Engineer's Factfinder covers all aspects of radio and communication engineering, and includes wave principles, the decibel scale, instrumentation and power supplies, equipment types and encryption methods, connectors and interfaces. The Factfinders are intended for radio and electronic engineers, designers, service engineers, students of RF engineering.





Conclusion

This package from Newnes (Butterworth-Heinemann) provides a very convenient and useful source of fundamental facts, figures and data, that can sit on your PC hard drive, occupy the minimum of space, and can be accessed quickly and easily for reference. If I have one gripe it has to be that the UHF television channel and transmitter information could do with updating – where's the Channel 5 information?

It is hoped that later this year Maplin Electronics will be stocking the series.

10 COPIES TO GIVE AWAY!

We have five copies of each of the Electronics and Radio Engineer's Factfinders to give away – just fill in the coupon, not forgetting to tick the one you would like, and the first 10 drawn from the hat will receive a copy. Send your entries to:

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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.

August 1996

23 to 28 August European Conference on Artificial Intelligence, University of Sussex and University of Brighton, Brighton. Tel: (01273) 678 448.

September 1996

1 to 4 September Control Conference, University of Wales, Swansea, IEE. Tel: (0171) 240 1871.

1 to 4 September UKACC CONTROL 98, University of Wales Swansea, IEE. Tel: (0171) 240 1871.

2 to 4 September Electrical Generator Applications, Vacation School, Burleigh Court, Loughborough University, IEE. Tel: (0171) 240 1871.

5 September Systems on A Chip, Colloquium, University College Dublin, IEE. Tel: (0171) 240 1871.

7 to 9 September Embedded Systems Conference Europe, Royal Ascot, Berkshire. Tel: (0181) 855 7777.

8 to 10 September Farnborough International Technology Conference – Technology for Business Advantage, Conference, Savoy Place, London, IEE. Tel: (0171) 240 1871.

9 to 11 September Sixth UK Mechatronics forum International Conference Mechatronics 98, Hotel Billingehus Conference Centre, Skovde, Sweden, IEE. Tel: (0171) 240 1871.

11 to 15 September International Broadcasting Convention, IBC 98, RAI, Amsterdam, IEE. Tel: (0171) 240 1871.

13 to 16 September Safety Critical Systems, Vacation School, the Moller Centre, Cambridge, IEE. Tel: (0171) 240 1871.

14 to 17 September Vacation School on Communication Network Design, Vacation School, Christchurch College, Canterbury, IEE. Tel: (0171) 240 1871.

15 September Internet Enabled Manufacturing – the Cyber Factory, Colloquium, Imeche, Birdcage Walk, London, IEE. Tel: (0171) 240 1871.

16 September Ford Motor Company, Dagenham, Dagenham, Essex, IEE. Tel: (0171) 240 1871.

17 September Radio Amateur Course, 6.30pm in room T7.2 - Tower Block, Highbury College, Portsmouth. Tel: (01705) 283212.

20 to 23 September Residential Course on Universal Mobile Radio Communications, Residential Course Pembroke College, Oxford, IEE. Tel: (0171) 240 1871.

21 to 23 September Power Electronics and Variable Speed Drives, Conference, Savoy Place, London, IEE. Tel: (0171) 240 1871.

21 to 23 September Seventh International Conference on Power Electronics & Variable Speed Drives. Savoy Place, London, IEE. Tel: (0171) 240 1871.

22 to 23 September Enterprise in Transition, The Commonwealth Institute, Kensington, London. Tel: (01908) 373311.

23 September The Future Use of Intelligent Automation and Robotics in the Utility Industries, Colloquium, North West Water Laboratories, Warrington, IEE. Tel: (0171) 240 1871.

30 September Simulation Conference, University of York, IEE. Tel: (0171) 240 1871.

30 Sept to 2 Oct International Conference on Simulation, Innovation Through Simulation, University of York, IEE. Tel: (0171) 240 1871.

1 October Presidents Inaugural Address by Dr J M Taylor, Savoy Place, London, IEE. Tel: (0171) 240 1871.

5 October Towards Safer Electrical Installations, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

5 to 6 October Practical FieldBus and Device Network Protocols for Engineers, London. Tel: (0181) 335 4014.

7 October Artificial Intelligence-Based Applications for the Power Industry, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

What's On?

London Plays Host to Biggest Ever ECTS

As an array of research confirms that the interactive entertainment industry is at a global all-time high, over 1,000 new games and home software products are expected to be unveiled in London in the Autumn as the European electronic entertainment industry gears itself up for its biggest event of the year.

Taking place at London's Olympia between 6 to 8 September, ECTS is Europe's premier trade expo for the games and consumer software industry. ECTS 98 will feature more exhibitors than ever before across its three halls. More importantly, it will also provide the trade and press with a sneak preview of the games and consumer software and hardware technology that will take the games industry into the new Millennium.

Interest has been heightened by the interactive entertainment business storming to a new all time high on the back of the Sony Playstation phenomenon, the emergence of Nintendo 64 and the continued strong growth in the PC sector. Combined industry revenues are now topping those generated by either the film or music industries. Sales of PC and console games in the UK alone are anticipated to pass the £1billion mark in 1998.

A report recently published by business analysts Coopers & Lybrand predicts that the US market will expand by around 30% in 1998, making it a $7billion territory. Similar growth levels are expected in Europe, which accounted for $4.4billion of the world's games market last year and where Sony will boast an installed base of 13,000,000 Playstations by January 1, 1999. The global total is expected to hit 50,000,000 by March 31st 1999.

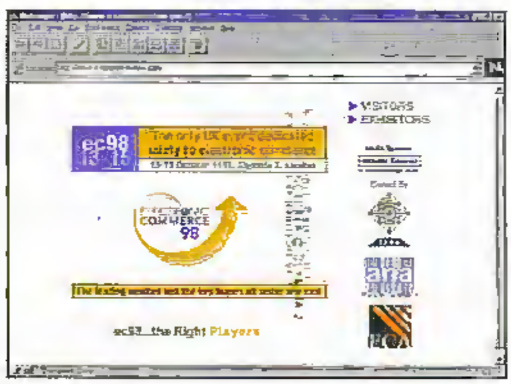
Sony is expected to be one of the key attractions at ECTS 98, with a new wave of software plus new marketing plans due to be revealed. However, global rival Nintendo will be determined to give the company a run for its money with the very latest N64 games on show for the first time.

Other major exhibitors include Acclaim, Cendant, Eidos, Hasbro, Infogrames, Intel, LucasArts, Microsoft and Psygnosis. Toy giant Lego will also be launching its new software division. With products aimed at the 2 to 16 year olds market, Lego Media International is thought to be planning a major presence in software as it seeks to fulfil its parent's ambition of becoming the world's most powerful brand amongst families with children by 2005. Readers can register online for ECTS 98 at <www.ects.com>.

Electronic Commerce 98 Preview

Electronic Commerce 98 <www.e-commerceshow.com> will be held at London's Olympia from 13 to 15 October 1998. This three day exhibition and conference will make electronic commerce understandable to non-technical managers, and includes discussions on the application of leading edge technologies. Conference themes include the growing use of the Internet, opportunities for supply chain collaboration and taking electronic commerce to the consumer.

Electronic commerce is transforming the way business is conducted, improving speed and efficiency and fundamentally changing the nature of business relationships. The dramatic increase in the use of the Internet underlines the growing importance of these new ways of working for businesses of all sizes and across all sectors.



New Products FROM THE FORTHCOMING CATALOGUE

Mobile Satellite Systems from Maxview

Maxview have introduced a range of mobile satellite systems with a choice of either 35cm, 48cm or 60 cm dishes. The Omnistat 35 (order code NB07H, £149.99) comes with a 35cm dish, enhanced LNB, support arm and fixing accessories. The unique elevation adjustment system and the zone location map on the back of the dish make disk location and alignment painless. Primarily intended to be used with your existing receiver/decoder, the system is supplied with comprehensive fitting instructions for quick and easy installation and removal. A self-adhesive bracket (screw holes are provided for permanent installation) is available for fixing Omnistat 35 to the side of a touring vehicle (order code NB11M, £10.99).

Omnistat 48 (order code NB08J, £225.99) is supplied with a 48cm dish, universal LNB, flylead, 'F' connections and fixing instructions. Omnistat 60 (order code NB09K, £259.90) is the 60cm version. For either version, the dish is intended for permanently fitting to the Omnistat 'Through the Roof Fixing Mast.' This unique and ingenious mast (order code NB10L, £64.99) is designed to mount inside the wardrobe of a touring vehicle. The horizontal and vertical adjustment system allows you to align the satellite dish from inside the vehicle. The mast can easily be retracted for travelling. Again you will need to use an existing receiver/decoder with either system.

RDS Radio

This stylish portable FM/AM radio with illuminated LCD display features the latest in RDS technology, with PS and PTY buttons that allow you to display the station name and/or station details (order code NA25C, £34.99).

Digital Tape Recorder

This attractive, state-of-the-art digital recorder is offered at a great price - no waiting for tapes to rewind, as clear and repeatable recordings are now instantly available, with time, date of each recording and the total number of messages readily displayed. The flash memory stores up to 60 minutes of recordings, indefinitely, plus recordings can be easily downloaded to your PC for long term storage and use. 'VOX' (voice activated) recording is standard (order code NA63T, £129.99).

NA60Q (£199.99) is the kit version with two connectors for recording telephone calls. The Watson mike fits comfortably in the ear for recording from all phones including mobiles, and the modular handset connector plugs into suitable handsets for recording calls automatically. One extra feature is a unique auto-reverse facility that allows you to continually record the last 45 minutes, so you can always refer back to your conversations.

Printers

This catalogue sees the introduction of a wide range of quality printers that start from as little as £100. The Canon BJC-250 (order code LX82D, £99.99) is an A4 colour printer with 360 x 360dpi colour resolution in a compact size. This low-cost, versatile printer is ideal for home and small business, and with Canon's unique BC-09F fluorescent cartridge (order code KX61R, £28.99) you can print bright fluorescent colours for maximum impact. Prints on to A4, B5, A5, letter, legal letter size and even DL envelopes. Measuring just 316 x 215 x 171mm means the printer will fit into the smallest study, bedroom or office.

For those requiring a more sophisticated printer, at a realistic price, then the HP DeskJet 690C+ (order code LX78K, £179.99) is hard to beat. This A4 colour printer features a 600 x 600dpi resolution with a print speed of 5ppm for monochrome printing. Now you can produced high impact documents, reports, graphs, charts, brochures and banners with pictures and graphics in minutes.

When only the quality of a laser printer will do, then the HP Laserjet 6L (order code LX77J, £299.99) must be the first choice. This quality laserjet will print on to paper, envelopes, labels, postcards and even transparencies, with a 600 x 600dpi resolution at upto 6ppm.

If you need to print to A3, then the Canon BJC-4650 (order code PQ81C, £279.99) is the answer. This great easy-to-use full colour bubblejet printer will work with a PC or Apple Mac. The range of cartridges available means you can create all kinds of professional looking documents. The high quality dye based inks in the resistant colour cartridge are

All prices shown are the normal Catalogue prices from 1st September 1998

RDS Radio - £34.99, NA25C

Digital Tape Recorder - £149.99 NA63T

HP Deskjet 690C - £179.99, LX78K

HP Office Jet 590 - £349.99, LX83E

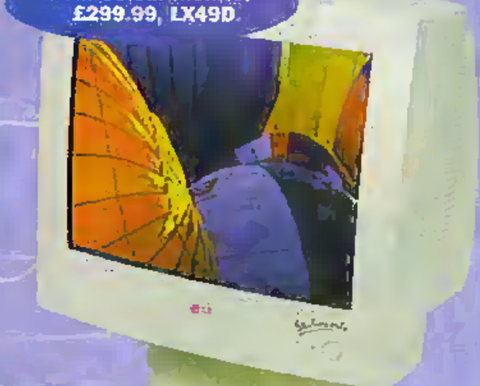
32x Speed CD-ROM - £69.99, LQ93B.

56k Internal Modem - £89.99, PQ76H.

Voodoo 3D Graphics Card - £89.99, PQ75S.

4Mb S3 Video Card - £39.99, KM99H.

DVD Rom Drive - £199.99, PQ83E.



17in Colour Monitor £299.99, LX49D.

water-fast, smudge-proof and fade resistant, which means you can print on to a variety of media - glossy photographic paper, transparent film, plain paper and envelopes, plus even T-shirt transfers and fabric sheets. A resolution up to 720 x 360dpi can be obtained, with a print speed of 4.8ppm.

Finally, the HP OfficeJet 590 (order code LX83E, £349.99) is a cost-effective, mutli-function machine for home or office. Featuring a high quality graphics colour printer, a fax machine which uses plain paper, a copier and a 300dpi scanner with TWAIN interface, this stylish machine will soon become an indispensable piece of office or home equipment.

For multimedia applications, a 32-speed CD-ROM (LQ93B, £69.99) is now the norm, and to vastly improve graphics, the Voodoo 3D Graphics Card (order code PQ75S, £89.99) is a must. Working in series with your existing 2D SVGA card, this card is based on the famous 3D fx chipset and produces truly stunning graphics. For those who need just a PCI bus video card then the 4Mb S3 Virge Graphics card can't be beaten - offering 16,800,000 colours at 1024 x 768 pixel resolution (order code KM99H, £39.99).

Getting on to the Internet could not be easier with this 56k camera ready, internal modem (order code PQ76H, £89.99). A Windows 'plug-and-play' modem that can be used as a answering machine, fax send/receive, faxback and file transfer.

DVD (digital versatile disk) has now arrived, and people are beginning to take notice. This truly digital medium has a capacity of up to 17Gbytes of data on a single disk and delivers the very best audio and video quality. This new Creative Labs Encore DVD ROM drive (order code PQ83E, £199.99) will read both new DVD and the older CDs, and features the latest picture enhancement technology for high definition and smoother full screen video images.

To take advantage of all this new hardware that offers the best video quality, requires a monitor up to the same standards. A 15in monitor is now considered a minimum, and the one stocked by Maplin (order code LX48C, £149.99) from LG Electronics fits the bill, offering a 1024 x 768pixel display with 0.28mm dot pitch and digital controls. For those who require a bigger screen, then the 17in monitor (order code LX49D, £299.99) also from LG Electronics is on of the best. Again this monitor features 0.28mm dot pitch, up to 1280 x 1024pixel display and digital controls.

Long Life, Low Energy Fluorescent Tubes

These compact fluorescent tubes are a direct replacement for standard light bulbs (GLS), but with the added bonus of lasting up to 10 times longer and using up to 80% less energy compared to conventional bulbs. By using an electronic ballast they have a quick start, and are available in either bayonet (BC) or Edison screw (ES) fittings in various power rating.

Additionally, you can pick either the normal double loop type, or the more compact shorter but slightly wider version. All are attractively priced at £7.99.

Continuing the low-energy, long-life lighting theme is this stylish black finished desk lamp with a 11W fluorescent tube. The lamp has an adjustable spring balanced arm with a lamp that adjusts in all directions, and features an integral on/off switch. One additional advantage of using a replaceable fluorescent lamp is that it runs at a lower temperature than conventional bulbs (order code PH36P, £29.99).

Home electrical safety is a key issue now, and a plug-in RCD adaptor (order code PG71N, £14.99) is a very affordable solution for using with portable electrical equipment such as lawnmowers, hedge trimmers and power tools etc. Rated at 230V ac 13A (3kW), with a trip current of 30mA and a trip speed of typically 40ms.

PA Loudspeakers

Maplin have stocked Eminence loudspeakers for some time now, and the latest ranges from this renown manufacturer continues the high standards and performance that we have come to expect from them. All types feature a kapton coil former with a polymide-imide coated copper voice coil, APS ferrite magnet, a paper cone with a solid composition paper dust dome and a plasticised cloth (linen) cone edge. The speakers are designed to be used in the most demanding applications from lead guitar, keyboards, vocals to bass in clubs and sound reinforcement systems.

The 'Beta' range have a pressed steel chassis and are rated at 150W. Available in 8in (order code XG43W, £41.99), 10in (order code XG46A, £42.99). 12in (XG49D, £39.99), and a 12in dual cone extended response (order code XG50E, £49.99) and 15in (order code XG52G, £52.99). The 'Delta' range again have a pressed steel chassis, but are rated at 300W. Available in 10in (order code RC92A, £54.99) and 15in (order code XG53H, £61.99).

The 'Kappa' 15in speaker is rated at 400W and features either a pressed steel chassis (order code RC94C, £84.99), or a die-cast aluminium chassis ('Kappa Pro' order code AB90X, £119.99). The 600W 'Omega Pro' also has a aluminium die-cast chassis. and is available in 15in (order code RC95D, £164.99) or 18in (order code RC96E, £169.99). For those who prefer the 60s 'electric rock' sound, then the 12in 100W 'Guitar Legend' (order code XJ51F, £46.99) is the answer.

Double Loop Type — all at £7.99

Order Code Fitting BC	ES	Power	Equivalent Power	Length
HN45Y	PG21X	9W	40W	140mm
HN46A	PG22Y	11W	60W	155mm
HN47B	PG23A	15W	75W	183mm
HN48C	PG24B	20W	100W	200mm

Compact Type — all at £7.99

Order Code Fitting BC	ES	Power	Equivalent Power	Length
PG25C	PG28F	15W	75W	143mm
PG26D	PG29G	20W	100W	153mm
PG27E	PG30H	23W	120W	165mm

Books

Maplin have traditionally stocked a wide and diverse range of electronics and related books. Two interesting music related books are the *Making Music with Digital Audio* (order code LD27E) which discusses why digital audio gives you more flexibility, higher quality, and more creative power than multi-track tape recorders, and *Recording the Guitar* (LD22Y) which is a must for all budding and experienced guitarists. Both books are from PC Publishing and are at the special price of £8.99.

Butterworth-Heinemann are a well established publisher of technical and electronics books, and Maplin have introduced the *Made Simple..* series of books retailing at the very affordable price of £8.99. For a very readable guide to electronics for GCSE, C&G, and GNVQ students, then *Electronics Made Simple* (order code LD23A) by Ian Sinclair is a must. For those who need to find out more about multimedia and the Internet then *Internet Made Simple* (order code LD26D), and *Multimedia For Windows 95 Made Simple* by Simon Collin (order code LD20W) are worth a read. The series even covers *Windows NT*, written by Lilian Hobbs (order code LD18U).

There can be very few of us who have not read a book from publishers Babani, and several new editions have been added to extensive list from Maplin. The world of PICs is intelligently explain by Bob Penfold in *Introduction to PIC Micros* (order code NT82D, £5.99). Owen Bishop's book *Practical Remote Control Projects* (order code NP71N, £5.99) provides a wealth of circuits and circuit modules for use in remote control systems. For those who want a more gentle introduction to the world of C++ programming then M. Walmsley's book *Programming in C++* (NT88V, £6.99) is an ideal choice.

The Dummies series from Transworld have been universally successfully with a style that has been both amusing and easy to read and enjoy. If you need more information about the year 2000 problem, then *Year 2000 Solutions For Dummies* (order code LD93B, £23.99) may well provided the answers. Small businesses will find three books in the series extremely useful in improving productivity and enhancing sales and services - at £23.99 each with a CD-ROM they offer excellent value. For those using Office 97, *Small Business Office 97 for Dummies* (order code LD89W) is essential reading. The modern office has to share resources, so *Networking For Dummies Small Business Edition* (order code LD90X) helps you plan, build and run an affordable network. Finally, how can the small business not afford to have access to the Internet - e-mail, video conferencing and marketing are just a few of the benefits that can be gained. *Small Business Internet For Dummies* (order code LD91Y) will be indispensable.

Microcontroller DEVELOPMENT USING THE STAMP ARCHITECTURE FUNDAMENTALS

PART 2

I/O Features

Unless you are a confident machine code programmer, microprocessor development is at best hard work. But it needn't be the case. As we saw last month the BASIC STAMP architecture uses a dialect of BASIC as its development language. Here Stephen Waddington take a closer look at the I/O capabilities of the STAMP architecture.

Last month we took an initial look at the specification of the BASIC STAMP 1 (BS1) and BASIC STAMP 2 (BS2) devices. In this article we'll look at the I/O control feature of the BS1. The BS1 has eight tristate I/O pins each of which can be defined individually as a high impedance input, 0V output or 5V. The state of the pin can be changed at any point within a program.

As we learnt last month, STAMP devices can be programmed using a dialect of BASIC, called Parallax BASIC (PBASIC) which is far easier to understand than any form of machine code. Table 1 provides a summary of the BS1 instruction set, with individual instructions grouped according to their functionality. The majority of the I/O commands will be covered in this feature. For further details of the BS1 instruction set check the 'BASIC STAMP 1 Manual', a copy of which can be downloaded in Adobe format from the Parallax Web site – please refer to the resource list at the end of this article.

Input

First off, let's take a look at how to use the 8 I/O pins of the BS1 as inputs. The first task is to define which pins are to be used as inputs. This is achieved in one of two ways; either by using the *INPUT* and *OUTPUT* commands, or by using the setting the *dir* register.

To set *pin0* as an output using the *OUTPUT* command simply use the following expression:

```
OUTPUT 0
```

To achieve the same effect using the *dir* register, the follow expression can be used:

```
dir = %00000000
```

Remember that last month we learnt that binary numbers can be used within PBASIC by placing a percentage sign (%) in front of the number.

Of the possible ways of setting the I/O pins for input and output, the *dir* register is the preferable expression, since it enables all eight I/O pins to be set simultaneously. For example to set bit 0 to 3 as outputs and bits 4 to 7 as inputs, use the expression:

```
dir = %00001111
```

Having configured *pin0* as an input, the next task is to develop an electronic circuit to create either a 0 or 5V input. Figure 1 shows a double pole switch used to connect between ground and zero. Note that input pins on the STAMP device should always be tied to either 0 or 5V to prevent a floating error.

Reading off a value from an input pin is very straightforward as the BS1 assigns a register to all its inputs. To read a single pin, use the *LET* command as shown below. Remember that use of the expression *LET* is optional. The microcontroller reads the value of *pin0* and stores it in the variable status.

```
status = pin0
```

If *pin0* was connected to 5V when its value was recorded, status would read 1. If on the other hand, *pin0* input was connected to 0V when its value was recorded, then status would read 0. This technique if most often used to trigger an *IF…THEN* conditional loop as shown below.

BRANCHING	BRANCH	Branch to address specified by offset.
	GOSUB	Branch to subroutine at address. Up to 16 nested GOSUB's are allowed.
	GOTO	Branch to address.
	IF...THEN	Compare and conditionally branch.
	RETURN	Return from subroutine.
LOOPING	FOR...NEXT	Establish a FOR...NEXT loop.
NUMERICAL	LET	Use of LET command is optional. Performs variable manipulation, such as A=5, B=A+2, etc. Possible operations are add, subtract, multiply, divide, max. limit, min. limit, and logical operations AND, OR, XOR, AND NOT, OR NOT, and XOR NOT.
	LOOKUP	Lookup data specified by offset and store in variable. This instruction provides a means to make a lookup table.
	LOOKDOWN	Find target's match number (0 to n) and store in variable.
RANDOM		Generate a pseudo to random number.
DIGITAL I/O	OUTPUT	Make pin an output
	LOW	Make pin output low.
	HIGH	Make pin an output high.
	TOGGLE	Make pin an output and toggle state.
	PULSOUT	Output a timed pulse by inverting a pin for some time.
	INPUT	Make pin an input.
	PULSIN	Measure an input pulse.
	REVERSE	If pin is an output, make it an input. If pin is an input, make it an output.
	BUTTON	Debounce *BUTTON*, perform auto to repeat, and branch to address if *BUTTON* is in target state.
SERIAL I/O	SERIN	Serial input with optional qualifiers and variables for storage of received data. If qualifiers are given, then the instruction will wait until they are received before filling variables or continuing to the next instruction. Baud rates of 300, 600, 1,200, and 2,400 are possible. Data received must be with no parity, 8 data bits, and 1 stop bit.
	SEROUT	Send data serially. Data is sent at 300, 600, 1200, or 2,400 Baud, with no parity, 8 data bits, and 1 stop bit.
ANALOG I/O	PWM	Output PWM, then return pin to input. Used to output analogue voltages (0 to 5V) using a capacitor and resistor.
	SOUND	Play notes. Note 0 is silence, notes 1 to 127 are ascending tones, and notes 128 to 255 are white noises.
	POT	Read a 5 to 50kΩ potentiometer and scale result.
EEPROM ACCESS	EEPROM	Store data in EEPROM before downloading BASIC program.
	READ	Read EEPROM byte into variable.
	WRITE	Write byte into EEPROM.
TIME	PAUSE	Pause execution for 0 to 65,536 milliseconds.
POWER CONTROL	NAP	Nap for a short period. Power consumption is reduced
	SLEEP	Sleep for 1 to 65,535 seconds. Power consumption is reduced to approximately 20μA.
	END	Sleep until the power cycles or the PC connects. Power consumption is reduced to approximately 20μA.
PROGRAM DEBUGGING	DEBUG	Send variables to PC for viewing.

Table 1. Summary of the BASIC STAMP instruction set.

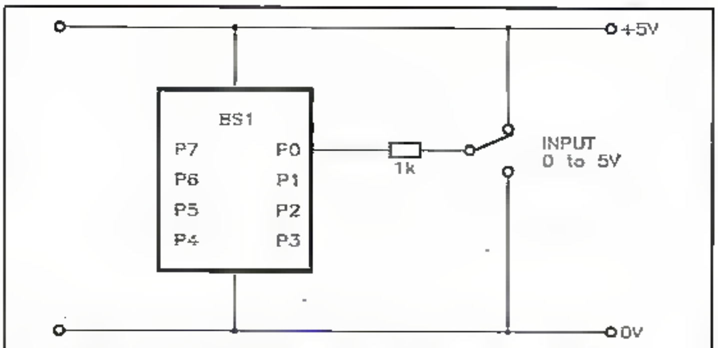


Figure 1. Connecting a switch to the STAMP to demonstrate usage of the INPUT command.

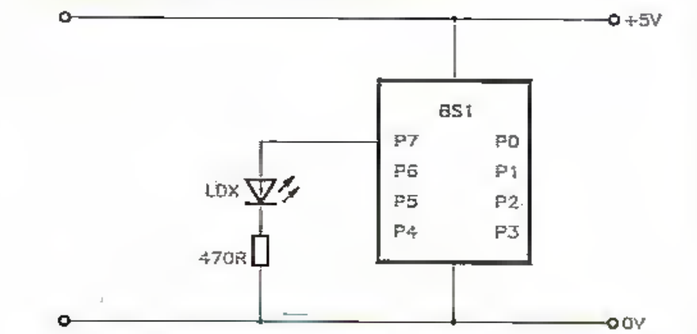


Figure 2. Connecting an LED to the STAMP to demonstrate the OUTPUT command.

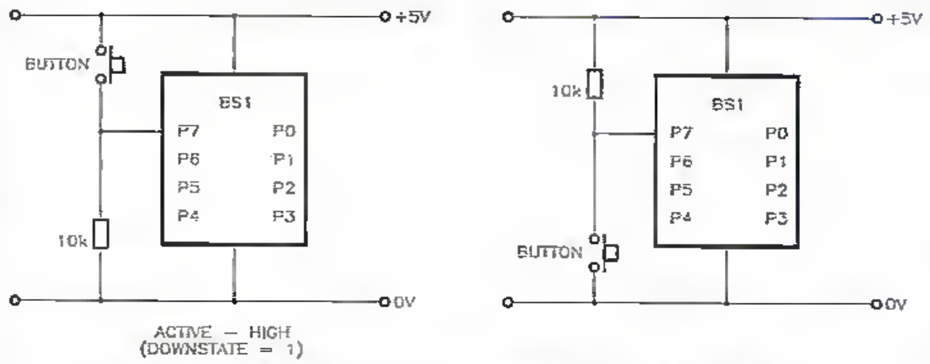


Figure 3. Example circuits using the *BUTTON* command for active-high (downstate = 1) and active-low (downstate = 0).

```
If status = 1 then start_programme
```

Here the program reads status and then jumps to the location *start_programme* if the pin is high.

Output

Now let's look at how to use the BS1 for output. Again the first task is to define which pins are to be used as outputs. And again, this can be achieved either by using the *INPUT* and *OUTPUT* commands, or by using the setting the *dir* register.

To demonstrate *OUTPUT* command connect an LED and a 470Ω resistor to pin7 of the BS1 as shown in Figure 2. Now try the following commands.

```
OUTPUT 7
HIGH 7
```

If we had connected the LED and resistor combination to pin5 instead, we would have written:

```
OUTPUT 5
HIGH 5
```

Buttoning Down Inputs

There are always a couple of ways of approaching a design problem with the STAMP. For example another type of input command enables a switch to be read directly. The *BUTTON* command tests the state of a push-button or latched-switch. The command is incredibly versatile since it debounces the input, performs auto-repeat and for a program branch if the *BUTTON* is in target state. *BUTTON* circuits may be active-to-low or active-to-high as shown in Figure 3.

When you press a button or flip a switch, the contacts make or break a connection. A burst of electrical noise occurs as the contacts bounce against each other. The *BUTTON* command debounce feature prevents this noise from being interpreted as more than one switch action.

BUTTON also enables the STAMP to react to a *BUTTON* press the way a PC keyboard does to a key press. When you press a key, a character appears on the screen. If you hold the key down, there's a delay, then a rapid fire stream of characters appears on the screen. *BUTTON*'s auto-repeat function configured to work the same way.

The only difficulty with using this command is the complexity of its syntax. The *BUTTON* command requires no less than seven variables to be preset by the programmer:

```
BUTTON pin, downstate, delay,
rate, bytevariable, targetstate,
address
```

- Pin is a variable/constant (0 to 7) that specifies the I/O pin to use.
- Downstate is a variable/constant (0 or 1) that specifies which logical state is read when the *BUTTON* is pressed.
- Delay is a variable/constant (0 to 255) that specifies how long the *BUTTON* must be pressed before auto to repeat starts. The delay is measured in cycles of the *BUTTON* routine. Delay has two special settings: 0 and 255. If set to 0, the routine returns the *BUTTON* state with no debounce or auto to repeat. If set to 255, the routine performs debounce, but no auto to repeat.
- Rate is a variable/constant (0 to 255) that specifies the auto to repeat rate. The rate is expressed in cycles of the *BUTTON* routine.
- Bytevariable is the workspace for *BUTTON*. It must be cleared to 0 before being used by *BUTTON* for the first time.
- Targetstate is a variable/constant (0 or 1) that specifies which state the *BUTTON* should be in for a branch to occur (0 = not pressed, 1 = pressed).
- Address is a label that specifies where to branch if the *BUTTON* is in the target state.

Button Action

BUTTON is designed to be used inside a program loop. Each time through the loop, *BUTTON* checks the state of the specified pin. When it first matches downstate, *BUTTON* debounces the switch. Then, in accordance with targetstate, it either branches to address (targetstate = 1) or doesn't (targetstate = 0).

If the switch is kept in downstate, *BUTTON* tracks the number of program loops that execute. When this count equals delay, *BUTTON* again triggers the action specified by targetstate and address. Hereafter, if the switch remains in downstate, *BUTTON* waits rate number of cycles between actions. The important thing to remember about *BUTTON* is that it does not stop program execution. In order for its delay and auto-repeat functions to work, *BUTTON* must execute from within a loop as shown below.

```
INPUT 0                              'make pin0 and input
OUTPUT 7                             'make pin7 an output
b2 = 0                               'clear workspace variable to be used by
                                     'the BUTTON command

button_loop:
BUTTON 0,0,200,100,b2,0,skip 'Go to skip unless pin0=0.
TOGGLE 7                             'Invert LED connected to pin0

...'                                 Other instructions.

skip:
GOTO button_loop                     'Skip toggle and go back to BUTTON_loop
```

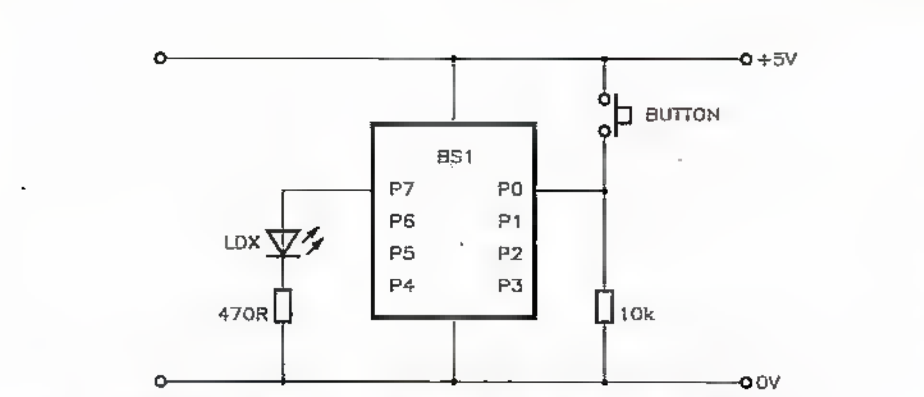


Figure 4. Using input and output to build a simple control application.

Here is a case in point. To output an audio sound, you merely connect a capacitor and loudspeaker combination to one of the I/O pins as shown in Figure 5 and then use the *SOUND* command as shown below:

```
SOUND
pin,(note,duration,note,duration)
```

- Pin is a variable/constant (0 to 7) that specifies the I/O pin to use.
- Note(s) are variables/constants (0 to 255) which specify type and frequency. Note 0 is silent for the given duration. Notes 1 to 127 are ascending tones. Notes 128 to 255 are ascending white noises, ranging from buzzing (128) to hissing (255).
- Duration(s) are variables/constants (1 to 255) which specify how long (in units of 12ms) to play each note.

This program is intended to operate in conjunction with the circuit shown in Figure 4. It toggles (inverts) the state of an LED on pin7 when the active to low switch on pin0 is pressed. When the switch is held down, *BUTTON* waits, then rapidly auto-repeats the Toggle instruction, making the LED flash rapidly. When the switch is not pressed, *BUTTON* skips the Toggle instruction and the LED on pin7 is unaffected.

Programming

Now let's look at developing what we have learnt so far into a program and introduce the *PAUSE* command. *PAUSE* holds program execution for the specified number of milliseconds between 0 and 65,525. Consider the program below.

```
OUTPUT 7
HIGH 7
PAUSE 3000
LOW 7
END
```

With the LED/resistor connected to pin7 and the program loaded, the LED will light for three seconds and then extinguish. The pause command merely inserts a pause of variable length. At the moment once the program has execute the BS1 stops. Let's make a small modification to make thing a bit more interesting:

```
OUTPUT 7

loop:

HIGH 7
PAUSE 3000
LOW 7
PAUSE 3000
GOTO loop

END
```

Now the LED will light for three seconds, extinguish for three seconds and then light for three seconds. The process will continue until the battery is disconnected or another program is loaded into the STAMP.

Other Flavours of I/O

So we're in control. What next? Well the BS1 is not limited to single bit input or output. It can handle audio, pulse width modulation (PWM) and serial pseudo RS 232 communication. And on the input side, it can measure pulse widths, read serial communications and read a variable resistance of between 5kΩ and 50kΩ.

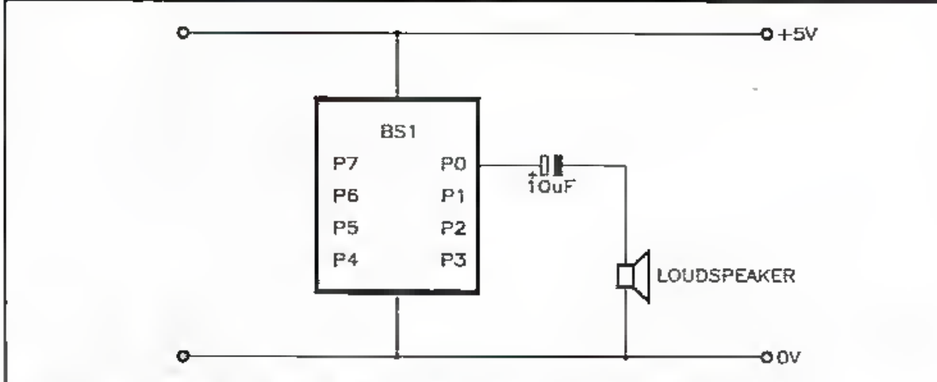


Figure 5. Connecting a loudspeaker to the STAMP to take advantage of the SOUND command.

Audio Output

Everything about the BS1 is so straightforward. PBASIC contains a number of sophisticated commands which could not otherwise be emulated using a microprocessor without a considerable level of machine code level experience. These commands such as *PAUSE, SOUND, POT, SERIN* and *SEROUT* are almost like macros which the programmer can call upon to achieve a desired function.

The notes produced by *SOUND* can vary in frequency from 94.8Hz (1) to 10,550Hz (127). If you need to determine the frequency corresponding to a given note value, or need to find the note value that will give you best approximation for a given frequency, check the BS1 manual. The program below shows an example of the sound command. Here the command steps through ascending tones from 0 to 256 and outputs the tone to pin1.

```
FOR b2 = 0 to 256
SOUND 0,(b2,10)        'Generate an ascending tone (b2) on pin0
                       'with 10ms duration
NEXT
```

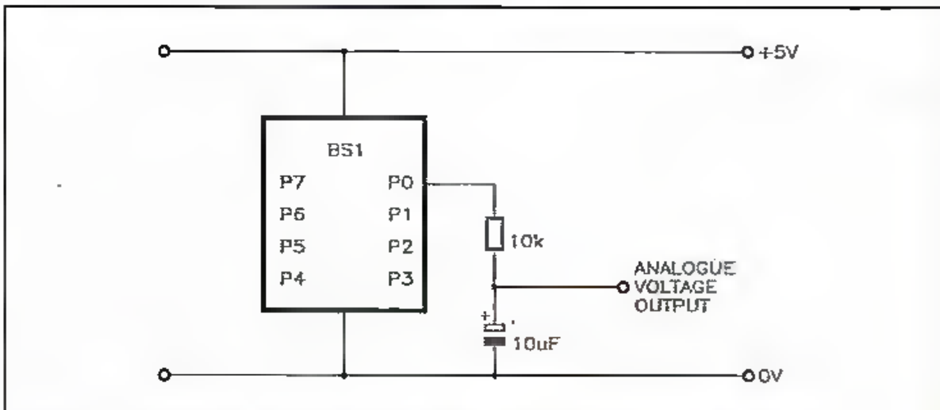


Figure 6. Configuring the STAMP for analogue output using the PWM command.

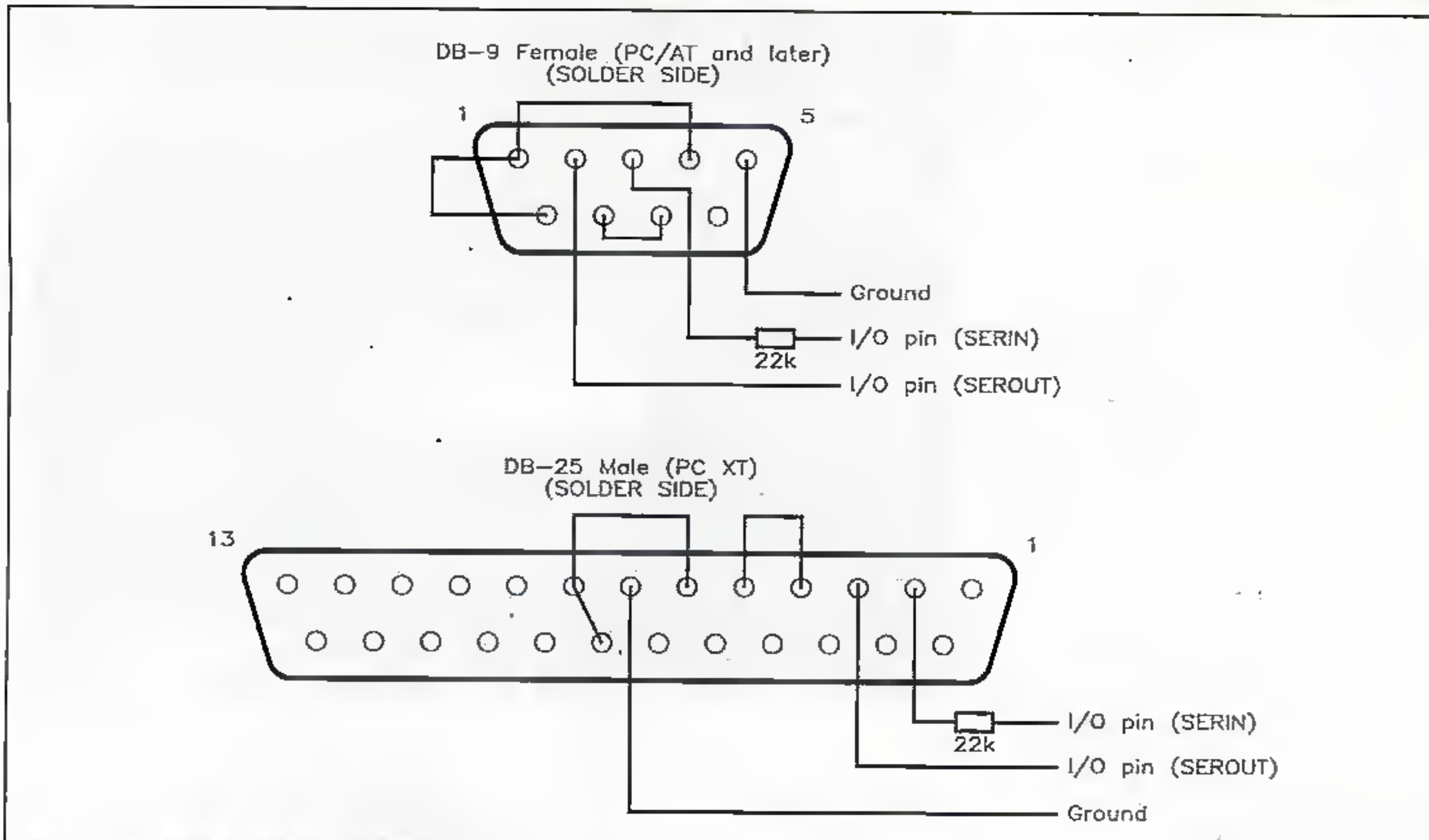


Figure 7. 9 and 25-pin serial connection to a PC.

PWM

PWM can be used to generate analogue voltages (0 or 5V) through a pin connected to a resistor and capacitor to ground; the resistor – capacitor junction is the analogue output as shown in Figure 6. Since the capacitor gradually discharges, PWM should be executed periodically to update and/or refresh the analogue voltage. The PWM syntax is as follows:

```
PWM pin,duty,cycles
```

- Pin is a variable/constant (0 to 7) which specifies the I/O pin to use.
- Duty is a variable/constant (0 to 255) which specifies the analogue level desired (0 to 5 volts).
- Cycles is a variable/constant (0 to 255) which specifies the number of cycles to output. Larger capacitors require multiple cycles to fully charge. Each cycle takes about 5ms.

PWM emits a burst of 1s and 0s whose ratio is proportional to the duty value you specify. If duty is 0, then the pin is continuously low (0); if duty is 255, then the pin is continuously high. For values in between, the proportion is duty/255. For example, if duty is 100, the ratio of 1s to 0s is 100/255 = 0.392, approximately 39%. When such a burst is used to charge a capacitor arranged as shown in the schematic, the voltage across the capacitor is equal to (duty/255) * 5. So if duty is 100, the capacitor voltage is (100/255) * 5 = 1.96V.

This voltage will drop as the capacitor discharges through whatever load it is driving. The rate of discharge is proportional to the current drawn by the load; more current equates to faster discharge. You can combat this effect in software by refreshing the capacitor's charge with frequent doses of PWM.

Serial Communication

Here is another great example of the ability of BS1 to implement a sophisticated degree of functionality in a single command. *SERIN* and *SEROUT* allow the programme to send and read serial data at speeds of up to 2,400 baud. Data can be sent and received with no parity, 8 data bits, and 1 stop bit. To send serial data, the command syntax is as follows:

```
SEROUT
pin,baudmode,({#}data,{#}data,...)
```

- Pin is a variable/constant (0 to 7) that specifies the I/O pin to use.
- Baudmode is a variable/constant (0 to 15) that specifies the serial port mode. Baudmode can be either the # or symbol shown in the table. The other serial parameters are preset to the most common format: no parity, eight data bits, one stop bit.
- Data is byte variables/constants (0 to 255) that are output by *SEROUT*. If preceded by the # sign, data items are transmitted as text strings up to five characters long. Without the #, data items are transmitted as a single byte.

SEROUT makes the specified pin a serial output port with the characteristics set by baudmode. It transmits the specified data in one of two forms; either a single-byte value, or a text string of one to five characters.

Here are some examples:

```
SEROUT 0,N2,400,(65)
```

SEROUT transmits the byte value 65 through pin0 at 2,400 baud, inverted. If you receive this byte on a PC running terminal software, the character "A" will appear on the screen, because 65 is the ASCII code for "A".

```
SEROUT 0,N2,400,(#65)
```

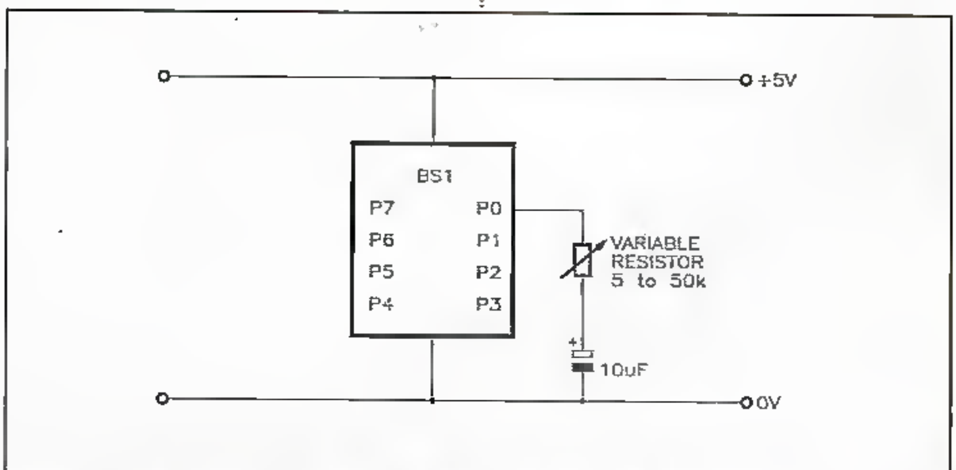


Figure 8. Connecting potentiometer to the STAMP via a capacitor to ground.

SEROUT transmits the text string "65" through pin0 at 2,400 baud, inverted. If you receive this byte on a PC running terminal software, the text "65" will appear on the screen. When a value is preceded by the # sign, *SEROUT* automatically converts it to a form that reads correctly on a terminal screen.

To send data to a PC serial port from the STAMP, all you need is some wire and connectors, and terminal communication software. Wire the connector as shown in Figure 7 and use the inverted baud modes. The STAMP's serial output can only switch between 0 and +5V, not legal 10V RS 232.

The syntax for *SERIN* is very similar to the *SEROUT* command. The *SERIN* command itself is fast enough to catch multiple bytes of data, no matter how rapidly the host computer sends them. However, if your program receives data, stores or processes it, then loops back to perform another *SERIN*, it may miss data or receive it incorrectly because of the time delay. Use one or more of the following steps to compensate for this:

- Increase the number of stop bits at the sender from 1 to 2
- Reduce the baud rate.
- If the sender is operating under the control of a program, add delays between transmissions.
- Reduce the amount of processing that the STAMP performs between SERINs to a bare minimum.

Going to POT

The final command we're going to look at in this article, is to measure short pulses a stage further, and to enable the BS1 to read analogue inputs. The *POT* command allows the BS1 to read a 5 to 50kΩ potentiometer, thermistor, Photocell, or other variable resistance. The pin specified by *POT* must be connected to one side of a resistor, whose other side is connected through a capacitor to ground as shown in Figure 8. The STAMP measures the resistance by timing how long it takes to discharge the 0.1µF capacitor through the resistor. If the pin is an input when *POT* executes, it will be changed to output. The command syntax is as follows:

```
POT pin,scale,variable
```

- Pin is a variable/constant (0 to 7) that specifies the I/O pin to use.
- Scale is a variable/constant (0 to 255) used to scale the instruction's internal 16-bit result. The 16-bit reading is multiplied by (scale/256), so a scale value of 128 would reduce the range by approximately 50%, a scale of 64 would reduce to 25%, and so on. The Alt-P option, outlined below, provides a means to find the best scale value for a particular resistor.
- Variable is used to store the final result of the reading. Internally, the *POT* instruction calculates a 16-bit value, which is scaled down to an 8-bit value. The amount by which the internal value must be scaled varies with the size of the resistor being used.

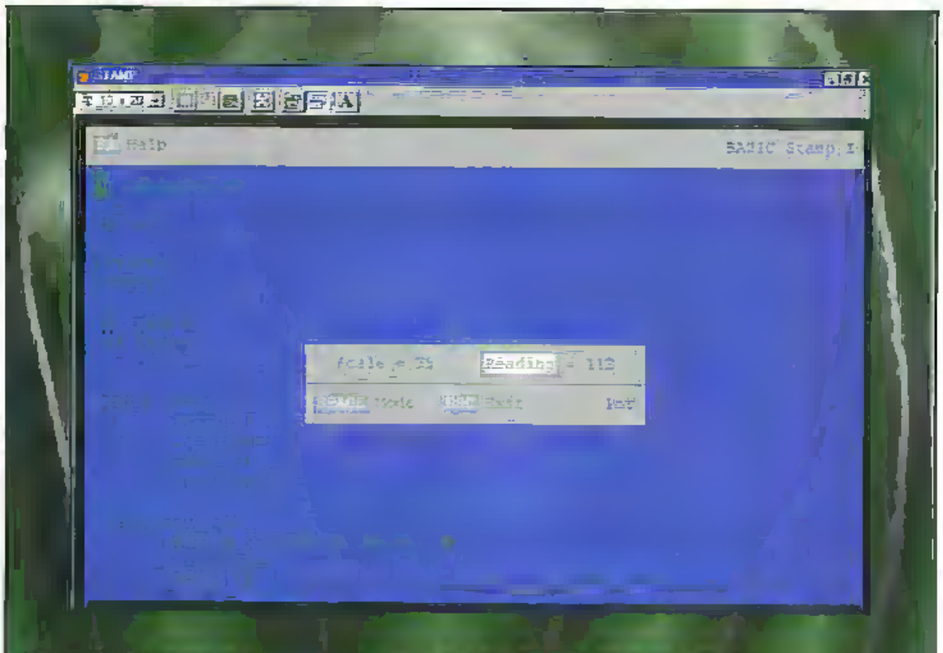


Photo 1 Calibrating a potentiometer using the STAMP PBASIC editor

To calibrate the post and find the best scale value, connect the resistor to be used with the *POT* instruction to the STAMP, and connect the STAMP to the PC. Press Alt-P while running the STAMP's editor software. A special calibration window appears as shown in Photo 1, allowing you to find the best value.

- The window asks for the number of the I/O pin to which the resistor is connected. Select the appropriate pin (0 to 7).
- The editor downloads a short program to the STAMP.
- Another window appears, showing two numbers: scale and value. Adjust the resistor until the smallest possible number is shown for scale.

Once you've found the smallest number for scale, you're done. This number should be used for the scale in the *POT* instruction. Optionally, you can verify the scale number found above by pressing the spacebar. This locks the scale and causes the STAMP to read the resistor continuously. The window displays the value. If the scale is good, you should be able to adjust the resistor, achieving a 0 to 255 reading for the value. To change the scale value and repeat this step, just press the spacebar. Continue this process until you find the best scale.

Once you've determined a scale, you're ready to include the command in a program. The example below shows how to include the *POT* command within a program. The code below reads the potentiometer and then outputs the value over a serial output at 300 baud.

```
pot_code:

POT 0,100,b2         'Read potentiometer on pin0
SEROUT 1,N300,(b2)   'Send potentiometer reading over a 300 baud
                     'serial output

GOTO pot_code        'Repeat the process
```

Resources

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

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

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

Next Month

In the last article in the series next month, we'll look at how to incorporate the BS1 into an electronic system and examine a series of control applications.

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Making Music WITH DIGITAL AUDIO

For readers who are interested in music and digital audio, this fascinating book by Ian Waugh shows how to make direct to disk recordings on the PC. We have reproduced a chapter to give you a flavour of the book.

The last 10 to 15 years have seen a remarkable increase in the number of 'alternative' music markets, especially for the computer musician. For example, in the 1980s, who would have thought that you could make a living writing music for computer games, creating sound effects, recording and designing sounds for sample CDs, creating MIDI files, scoring QuickTime movies or writing music for company presentations? Even selling music software is big business, and if you can talk as well as play – and heck, you don't even need to be able to play very well! – there are jobs in sales and as demonstrators.

Computer-based music systems have brought high quality music making to everyone. But as well as 'traditional' functions such as writing songs and music, computers have brought us music for another purpose – multimedia.

What is multimedia?

Multimedia became a buzz word in the early 90s. It was uttered with careless abandon and few of the so-called experts who used it then knew what it meant! But now we do.

Multimedia is simply a combination of different types of media – sound, graphics, text, video, animation and so on – wrapped up in one big homogenous package. There is usually some sort of interaction within the program allowing the user to click on items on-screen to see new information, watch movies and hear sounds. In fact, the term multimedia could now be applied to a wide range of software from games to encyclopedias.

Multimedia audio

One thing most multimedia packages have in common is poor quality audio. Not necessarily poor quality music, but audio which is the lo side of hi fi. This has been true since the early days of multimedia. At that time, most people were running a 386 – a 486 if they were rich – and compromises had to be made in order to play the videos, do the animation and play some audio all at the same time.

Video was compressed and played back at less than the ideal frame rate. Early audio was often 8-bit with a sample rate of 11.025kHz – or 22.05kHz if you were lucky. Many of these habits have stayed with the multimedia business, partly to allow older machines to play multimedia software. However, many developers are now upping the quality and, of course, the minimum PC spec required to play the titles.

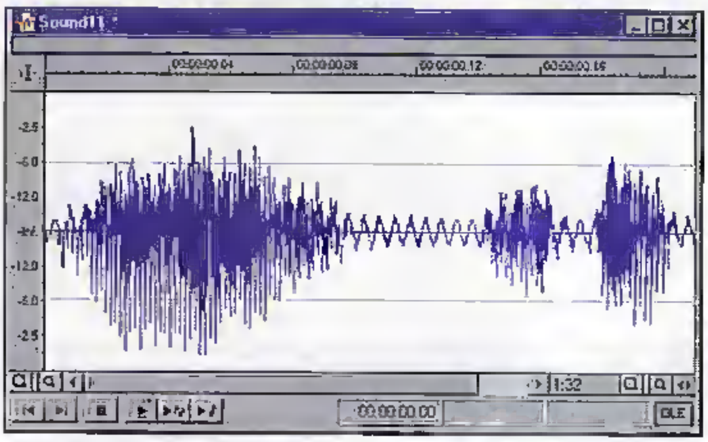


Figure 13.1 Normalising may not make much difference to the overall level of this file.

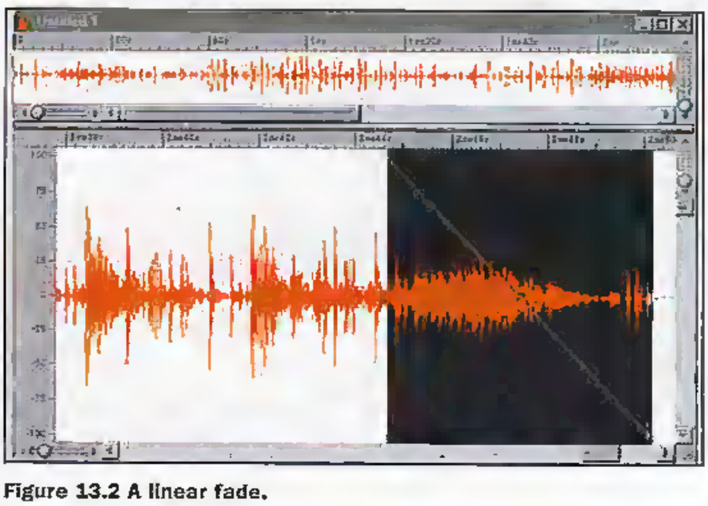


Figure 13.2 A linear fade.

INFO

Many titles now have CD quality audio although the user does, of course, need a PC system capable of playing it, and that includes good speakers. The politics of the situation will doubtless be discussed until we all have a Pentium 500, but as music developers it's our job to do the best we can within the limitations of the situation, and that means producing the highest quality audio whether its 24-bit, 16-bit or 8-bit.

One odd aspect of multimedia, however, is the relative importance placed on video and audio. If someone asked you whether you would rather watch a video with poor picture quality and excellent sound or one with excellent picture quality and poor sound, what would you say?

Without trying it, it's probably a difficult question to answer but research has shown beyond any doubt that we can put up with very poor quality video as long as we can hear what's going on. Audio has a far greater influence on our perception of an audio/visual presentation than does the video – and the multimedia developers have ignored this for years.

Getting the right balance

If you are producing a lot of files for a project, it's important that all their volume levels have the same perceived volume. It's amazing how many projects have had files which played at different volumes levels. This doesn't happen much now with commercial titles.

Normalising is a good place to start but it doesn't automatically do the job. If a file has a strong peak but a low average volume, normalising may not make much difference to the general level as you can see from Figure 13.1. Normalising this file will barely have any effect.

Dynamics processing such as compression and loudness maximisation can be used to good effect, however, but don't overdo it – you may need to use it again if you have to convert the sample rate.

It's important to realise the difference between the actual level of a file and the perceived volume. As we know from Chapter 2, bass frequencies, for example, can have very high

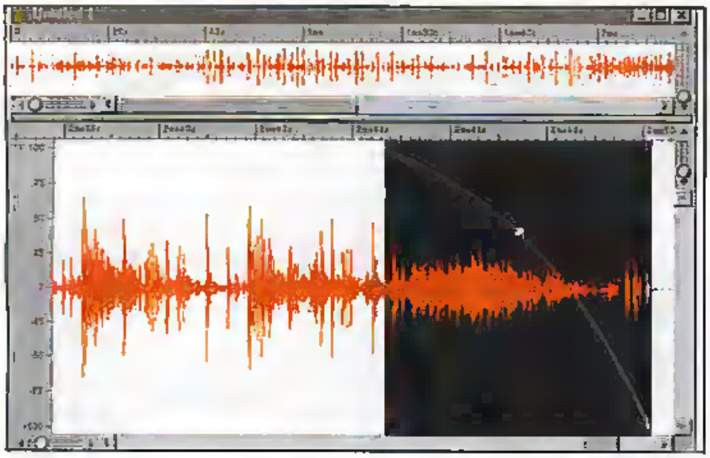


Figure 13.3 A logarithmic fade.

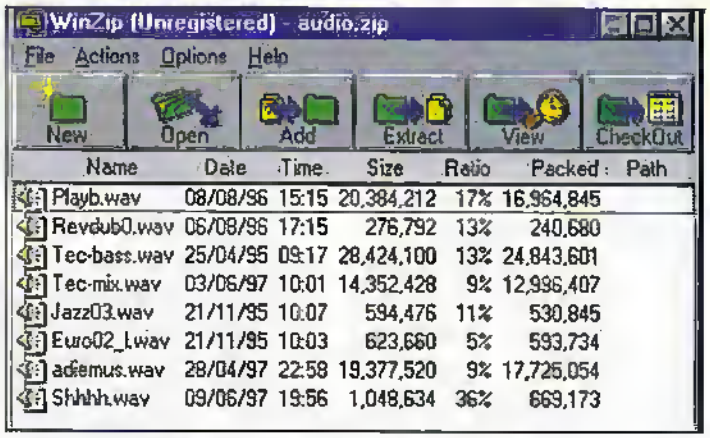


Figure 13.4 The WinZip compression utility can be used to compress any computer data including programs and Wave files.

levels but we may not perceive them as being very loud. The perceived volume is something you need to check with your ears.

If some files have to be louder than others, see if the program itself can control the playback volume. If you reduce the gain of a file, the noise will increase, too.

Use a logarithmic fade rather than a linear fade to reduce noise. If a piece fades slowly, a linear fade, Figure 13.2, will give the audio lots of time to get lost in the noise towards the end of the fade. A logarithmic fade, Figure 13.3, fades more slowly at the start and more quickly towards the end giving less time for noise to become evident.

Space savers

If you're creating music for multimedia, the first thing to do is to persuade the producer that high quality audio is important. Perhaps they will agree but the systems intended for playback won't allow it. Not much you can do there. However, if they aren't convinced of the importance of good audio, create a little presentation yourself using various combinations of good and bad video and audio and see what the reaction is.

But if, for one reason or another, you need to reduce the file size or quality of the audio, there are two options you can look at either singly or together – audio compression and file conversion.

Sometimes the choice will be determined by the systems the project is expected to play on. For example, the systems may not support 16-bit audio, they may have a mono speaker or they may not be powerful enough to deliver high quality audio along with other demands such as the video. Or it could be that the media the project will be distributed on doesn't have enough space for 16-bit 44.1kHz files, in which case you ought to look at compression.

Stereo vs. mono

If it's a question of space, stereo files takes twice the space of mono files so it may be worth considering sacrificing stereo for smaller mono files.

But you can do so much with a stereo recording. The careful placement of sounds can heighten the overall impact of the music, and effects such as the S1 StereoImager can enhance a normal stereo image considerably. Active panning can add to the excitement of a piece, too.

The decision obviously depends on the content of the audio files, but if you want to stick with stereo there are other options to look at.

Sample rate and resolution conversion

Most of the issues regarding the downsampling of files have already been covered but here's a summary. If a file has to be reduced to a lower sample rate and/or resolution, the usual method is to proceed as shown at bottom of page.

Audio compression

Another option to consider is compressing the audio. There are two approaches to this – compress the audio data files on the distribution medium for the user to decompress on installation, or use a system which compresses the audio data itself and decompresses it during playback in real-time. There are several systems of compression in both camps.

If you want to keep your audio as high quality a possible, you'll want a loss-less compression system, which means that the data can be compressed and then decompressed back to its original form without losing any information at all. However, most systems which offer this don't compress the data by much or else cannot be used in real-time. There's usually a trade-off somewhere.

WinZip

You can compress audio files off-line using an archiver compression utility such as WinZip, Figure 13.4. This can be used to compress any computer data including programs and it's a loss-less system. WinZip is actually a shell which makes it easy for Windows users to access a range of compression systems which include ZIP, ARJ, LZH, ARC and TAR. ZIP is far and away the most common compression system.

WinZip is useful if you need to pack a lot of data into as small a space as possible for inclusion on a distribution disk or over the Web, for example. The installation routine, which the programmer would write to install the multimedia application onto the user's hard disk, would decompress the files.

However, as you can see from Figure 13.4, this form of compression does not save a lot of space, maybe about 11-12 percent. The savings depend on the content of the file. If there is a lot of silence in it, the file will compress very well. The last file in the illustration, Shhhh, is mainly silence and it has compressed far more efficiently than the other files which contain music and vocals.

INFO

Archivers are widely used on the Net. They make it easy to group lots of files together for distribution and compress them *en masse*. The compressed archive doesn't take as long to download as the individual uncompressed files would, and grouped files help ensure that odd essential files don't go astray.

- Get the level right as described in chapter 11 of the book.
- Convert the sample rate, say from 44.1kHz to 22.05kHz or, if you must, to 11.025kHz. Referring to the Nyquist limit (Chapter 3), you'll notice a drop in the high frequencies.
- You may like to run the signal through a compressor or loudness maximiser at this point. And apply a touch of EQ to make up for those frequencies which were lost, but don't overdo it – you are working with more sonically-limited material.
- Convert the sample resolution, if required, to 8-bit. Using a processor such as the L1 Ultramaximiser will maximise the volume level and make the most of the downsampling with its dither facilities.

INFO

Codec: short for compression/decompression (although some sources say it stands for coder/decoder). It's a routine which compresses audio as it is recorded and decompresses it while it's playing back.

Figure 13.5 Typical list of codecs.

Figure 13.6 Adding codecs to your system.

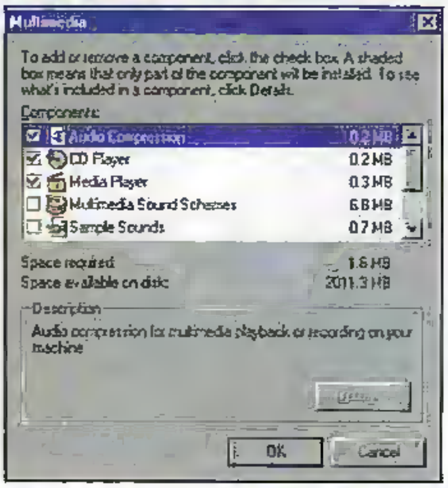
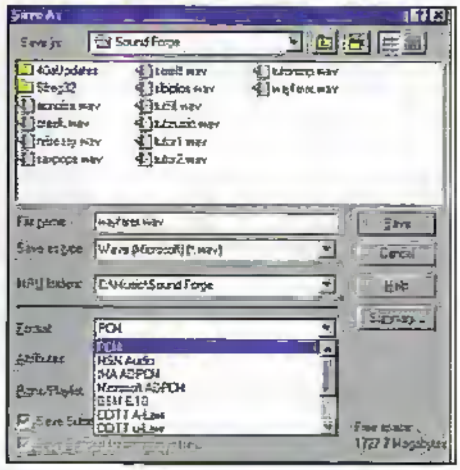


Figure 13.7 Sound Forge's Save As ... dialog offers a range of compression formats.



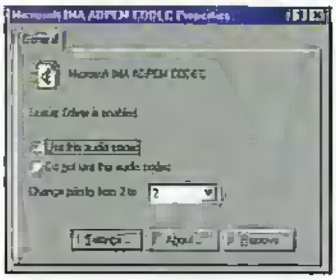


Figure 13.8 Selecting a codec for use in Windows 95.

The other disadvantage of this form of compression is that the files cannot be compressed or decompressed on the fly, so as a real-time playback system, it's no good at all.

Codecs

The other option is to use real-time compression and decompression – a codec. And there's no reason why you couldn't use a codec and also wrap the whole thing up in a ZIP archive, too.

The nice thing about codecs is that the major ones come with Windows 95. Open the Multimedia Control Panel, select the Advanced tab and click on the + in front of the Audio Compression Codecs entry. You should see a list similar to that in Figure 13.5. If yours is different, it just means you have a different set of codecs to the ones installed on my machine.

If there are no codecs in your system, open the Add/Remove Programs Control panel, select the Windows Setup tab, highlight the Multimedia option

Figure 13.9 The RealAudio Player.

and click on the Details button. You'll see an Audio Compression entry there, Figure 13.6. Click on the box, click on OK and follow the prompts which ask for the Windows 95 CD or disks.

Codecs are handled by the ACM (Audio Compression Manger) which is similar in concept to plug-ins in that any program which supports the ACM can use any of the codecs. Sound Forge, for example, hooks into the ACM and when you select Save As, you'll be offered a list of compression formats, Figure 13.7. If you add more codecs to your system, they'll appear here, too.

Codecs can compress and decompress data on the fly. However, Sound Forge does this off-line when loading and saving files. You probably won't notice any time difference but, as there is no hurry to compress a file, the program

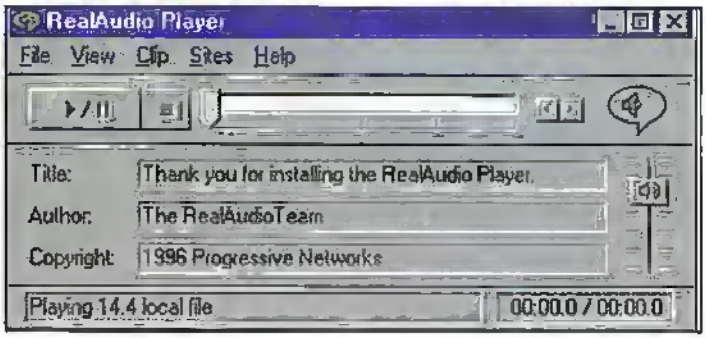


Figure 13.10 NetShow supports Microsoft's ActiveX technology.

can perform the optimum compression which ought to ensure the best quality file possible.

Compression usually takes longer than decompression so while you may need a nippy PC to compress on the fly, decompressing can usually be done in real-time on most systems.

There are video codecs, too, which you'll also see in the Advanced section of the Multimedia Properties page. When video started to become popular as one of the ingredients of multimedia, it was necessary to compress the files because they were so large, especially when users didn't have such powerful computers as we have today.

Different codecs are suitable for different purposes. PCM (Pulse Code Modulation) is an uncompressed format used by many synthesisers which use wavetable or sample-base sounds.

ADPCM (Adaptive Differential – or Delta – PCM) stores the difference between samples rather than the sample itself, and it uses mathematical algorithms to reduce the number of bits required to store the data. The result doesn't sound as if it had been recorded on a 4-bit system!

There is more than one method of ADPCM and they aren't always compatible. Two of the most common are Microsoft's ADPCM and IMA's (International Multimedia Association) ADPCM.

The CCITT (Consultative Committee for International Telephony and Telegraph), based in Genva, has given its name to several standards including one for audio compression which reduces the files to 8-bit.

The GSM (Groupe Spécial Mobile) standard was initially for mobile phones and in 1989 responsibility was transferred to the ETSI (European Telecommunications Standards Institute).

The table on the left shows a brief summary of some common codecs:

So there is a wide range of codecs suitable for a variety of purposes. But there are trade-offs:

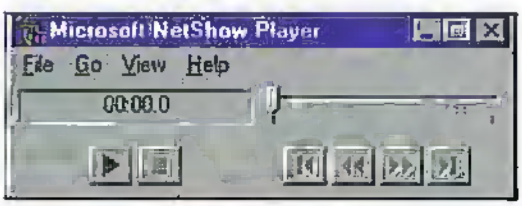


Figure 13.11 Configuring codecs in Windows 95

Codec	Format	Comments	Size of file required to play for 1 sec
PCM	44.1kHz, 16-bit, stereo	Loss-less, standard 'CD quality'	172K
ADPCM	44.1kHz, 4-bit, stereo	Popular codec suitable for many general uses	43Kb
CCITT	44.1kHz, 8-bit, stereo	Good quality, suitable for many files including music	86Kb
GSM	44.1kHz, mono	Not ideal for high quality music	8Kb
TrueSpeech	11.025kHz, 1-bit, mono	Very low quality, really only suitable for speech	2Kb

Table showing some common codecs.

- Most codecs are lossy types, as opposed to the loss-less compression of WinZip. That means the quality will not be as good as the original.
- Although codecs can work on-the-fly, they do take time so you may have to allow more time for them being opened and played. The exact time depends on the codec algorithm and the system it is running on.
- The system the file is to play back on must have the codec, too, which means this must be ascertained before distribution or the codec must be distributed with the software which could prove difficult if the codecs are copyrighted. Even though a codec is freely available from a Web site, it doesn't necessarily mean anyone can distribute it. And not all audio software can use compressed files. Sound Forge, for example, supports all ACM-compatible systems but other software may not.

Using codecs

To use a codec, highlight it in the Multimedia Properties list, Figure 13.5, and click on the Properties button. This will open a box similar to that in Figure 13.8 which lets you decide whether or not it can be used. It also has a priority number which you can change. If two or more codecs could be used in a particular situation, then Windows uses them in order according to their priority number.

Click on the Settings button and you'll see a window similar to that in Figure 13.9. In the Compression and Decompression boxes, select sample rates from the drop-down menus.

If a file has a sample rate lower than that in the Compression box, then the codec will compress the data in real-time. However, be aware that higher sampling rates require more processing power and if your computer can't handle the compression there may be breaks in the sound.

On playback, any file which has a sampling rate lower than the entry in the Decompression box will be decompressed in real-time. Again, if your computer can't handle it, the playback may suffer. The Auto-Configure button sets the two boxes to values which are best suited to your computer.

Audio files for the Internet

The Web is making increasing use of music and is alive with graphics, animations, video and audio content. All these types of data are large and require time to download by the user. Most people aren't prepared to sit and wait while a file downloads so companies have developed compression technologies for streaming this type of data over the Web. The most well-known are Progressive Network's RealAudio, Microsoft's NetShow and Macromedia's ShockWave.

They work in similar ways. The audio is saved in a special format which is transmitted over the Net when the user logs on and accesses the Web page. You need a special player or plug-in for your Web browser to play it. The essential part of the process is that the player plays the audio as it is arriving – the user doesn't have to wait until the complete file has been sent.

The RealAudio system, for example, uses an encoder, available from the RealAudio Web site (see Appendix for details), to convert Wave files into RealAudio format. The RealAudio Player, Figure 13.10, plays the file using familiar record and play controls.

NetShow, Figure 13.11, supports Microsoft's ActiveX technology and plays ASF (ActiveX Streaming Format) files and live ASF streams. The files can be played locally or from a NetShow or HTTP server.

ShockWave can stream graphics as well as audio data and can be used for animated interfaces, interactive demos and games as well as for speech and music. Again, the ShockWave player is free from the Macromedia Web site

As the Web develops, this type of streaming technology will become more common. However, you still need a fast and uninterrupted connection to get the most from these systems.

INFO

With a streamed audio file, the player plays the audio as it is arriving – the user doesn't have to wait until the complete file has been sent

Summing up

Many of the problems surrounding the creation of music for multimedia are to do with the 'low level' system it is assumed the final users will have. We can do almost anything if the PC is powerful enough but we must bear in mind that everyone does not have the latest technology and we should create compatible audio with that in mind.

This is also a major area of concern with audio for the Web. Most Web designers and the companies which create streaming software have direct Net connections and seem to forget that the average user is linked via a BT line via a 28.8 modem or possibly a slower one.

So, when you are considering the final file format for your audio, consider what sort of system your target audience is likely to have and cater for the lowest common denominator. If there is room on the distribution media or system, include two sets of data – one for the LCD and one for a more high-end system. That way, those who have the power will be able to more fully appreciate your work.

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Club Corner

ARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (CM0JCN). Tel: (01569) 731177.

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Bury St. Edmunds Amateur Radio Society. Meetings held at Culford School, 7.30pm for 8.00pm on the third Tuesday of each month, unless otherwise stated. Further details from Kevin Waterson, (G1GVI). 20 Cadogan Road, Bury St. Edmunds, Suffolk IP33 3QJ. Tel: (01284) 764804.

Crystal Palace and District Radio Society meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, (G3DSC). Tel: (0181) 699 5732.

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Electronic Organ Constructor's Society. Details of programme magazine, membership and details of provisional dates of regional meetings for 1998 from: Don Bray (Hon. Sec.), 34 Etherton Way, Seaford, Sussex BN25 3QB. Tel: (01323) 894909, Fax 01323 492234.

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The Lincoln Short Wave Club meets every Wednesday night at the City Engineers' Club, Waterside South, Lincoln at 8pm. All welcome. For further details contact Pam, (G4STO) (Secretary). Tel: (01427) 788356.

The Lincoln Short Wave Club Meetings every Wednesday from 7.45pm at Lincoln Railway Sports and Social Club, The Ropewalk London. Lincoln Hamfest 98 on Sunday 13th September. Contact: Cliff Newby G3EBH. 25 Sudbrooke Lane, Nettleham, Lincoln, LN22RW. Tel 01522 750637. Packet BBS G3EBH @gb7dx.#26.gbr.eu.

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SEEMUG (South East Essex Mac User Group), meet in Southend, every second Monday of each month. For details Tel: Michael Foy (01702) 468052, or e-mail to mac@mikefoy.demon.co.uk.

Southend and District Radio Society meets at the Druid Venture Scout Centre, Southend, Essex every Thursday at 8pm. For further details, contact: P.O. Box 88, Rayleigh, Essex SS6 8NZ.

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Wakefield and District Radio Society meet at 8.00pm on Tuesdays at the Community Centre, Prospect Road, Ossett, West Yorkshire. Contact Bob Firth, (G3WWF), (QTHR), Tel: (0113) 282 5519.

The (Wigan) Douglas Valley Amateur Radio Society meets on the first and third Thursdays of the month from 8.00pm at the Wigan Sea Cadet HQ, Training Ship Sceptre, Brookhouse Terrace, off Warrington Lane, Wigan. Contact: D. Snape, (G4GWG), Tel: (01942) 211397 (Wigan).

Winchester Amateur Radio Club meets on the third Friday of each month. For full programme contact: G4AXO, Tel: (01962) 860807.

Wirral Amateur Radio Society meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the the first and third Wednesday of every month. Details: A. Seed, (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

Wirral and District Amateur Radio Society meets at the Irby Cricket Club, Irby, Wirral. Organises visits, DF hunts, demonstrations and junk sales. For further details, please contact: Paul Robinson, (G0JZP) on (0151) 648 5892.

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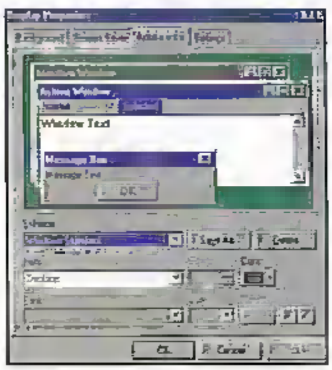
Software HINTS & TIPS

Your PC screen doesn't have to look the same as everyone else's. This month Mike Bedford looks at customising Windows 95.

In all probability, the overall appearance of Windows 95 on your PC is exactly the same as when you first took the PC out of its box. If so, you'll have a greenish-blue desktop, all the windows will be predominantly grey and the toolbar will be at the bottom of the screen. In other words, it'll look just the same as everyone else's PC. But it doesn't have to be this way. There's lots of scope to personalise Windows, to change things either to fit in with your personal preferences or to echo a corporate identity. In a single page, we can't expect to cover every area of customisation but when you've tried out those things which we describe here, you might be inspired to discover other areas for yourself.



Changing Colours

The desktop is what you see when you're not displaying any windows or when your windows are not occupying the full screen. And since this occupies the full screen, it's one of the major areas for customisation.

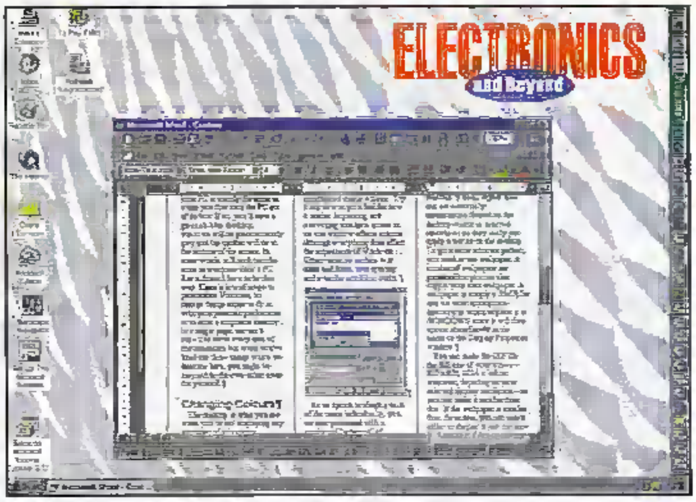
The most obvious change you can make is to the colour of the desktop and this is very straightforward. Simply move the mouse pointer over the desktop and press the right mouse button. Select 'properties' from the menu which is displayed and the *Display Properties* window will appear. Now select the *Appearance* tab and you'll see a window like that shown above. This is the page from which you can change the colour of the desktop or, for that matter, the colour of most other elements of Windows including menus, buttons and title bars. If you change the colour of the desktop you'll probably also have to change some of these other colours to get a co-ordinated colour scheme. Try it out now to get a feel for how it works. In passing, not everything you have access to on this window affects colours although everything does affect the appearance of Windows. Other variables include text sizes and fonts, icon spacing and even the scroll bar width.

As an option to changing each of the items individually, you are also presented with a number of 'schemes' of co-ordinated colours, text sizes and so forth. Some of these are quite tasteful alternatives to the default scheme, whereas others, like the one shown, are most decidedly acquired tastes. Some are clearly intended for the visually handicapped.

The Desktop

Returning for a while to the desktop, picking a different colour is only one of the options available here. When you first pull up the *Display Properties* window, the first tab presented is dedicated to properties of the desktop. Specifically, you can select a pattern or a wallpaper.

The default selection is no pattern and no wallpaper so the desktop ends up as just the single colour which we've already experimented with. However, try selecting different patterns from the menu and you could even try creating your own pattern using the edit option. Note, however, that you don't get a very good impression of the appearance of a pattern in the small preview window. To get a real feel for a pattern, you'll have to apply it and look at the actual desktop. Of course, if you don't like your selection, you can always return it to its original setting.



The patterns have a reasonably small repeat area and are essentially monochrome (based on the desktop colour) so they really just apply a texture to the desktop. To get a more sophisticated pattern, you need to use wallpaper. A number of wallpapers are provided but you can also supply your own. A wallpaper is simply a .BMP file and the most appropriate directory in which to place it is /WINDOWS/ since it will then appear immediately in the menu on the *Display Properties* window.

You can make the .BMP file the full size of your screen - 800 x 600, 1024 x 768 or whatever, depending on your selected display resolution - or you can make it smaller than this. If the wallpaper is smaller than the screen, you can select either to display it just the once in the centre of the screen or to tile it, that is to repeat it to fill the screen. Do be careful with your use of wallpapers, however, as you can easily end up with a very muddled looking screen. Perhaps the most successful type of wallpaper has a plain or textured background with a smallish logo in the top right hand corner. The following screen shot shows the use of a wallpaper based on the *Electronics and Beyond* logo.

The Taskbar

The taskbar is the official name of the bar at the bottom of the screen which contains the Start button and into which application buttons appear. But did you know that it doesn't have to sit at the bottom of the screen? In fact, if you want to be able to make use of the complete screen area, it doesn't have to be displayed at all.

Moving the taskbar from its usual position at the bottom of the screen couldn't be simpler. Move the mouse pointer into the taskbar, hold down the left mouse button and drag the taskbar to either the left, top or the right hand edge of the screen as required.

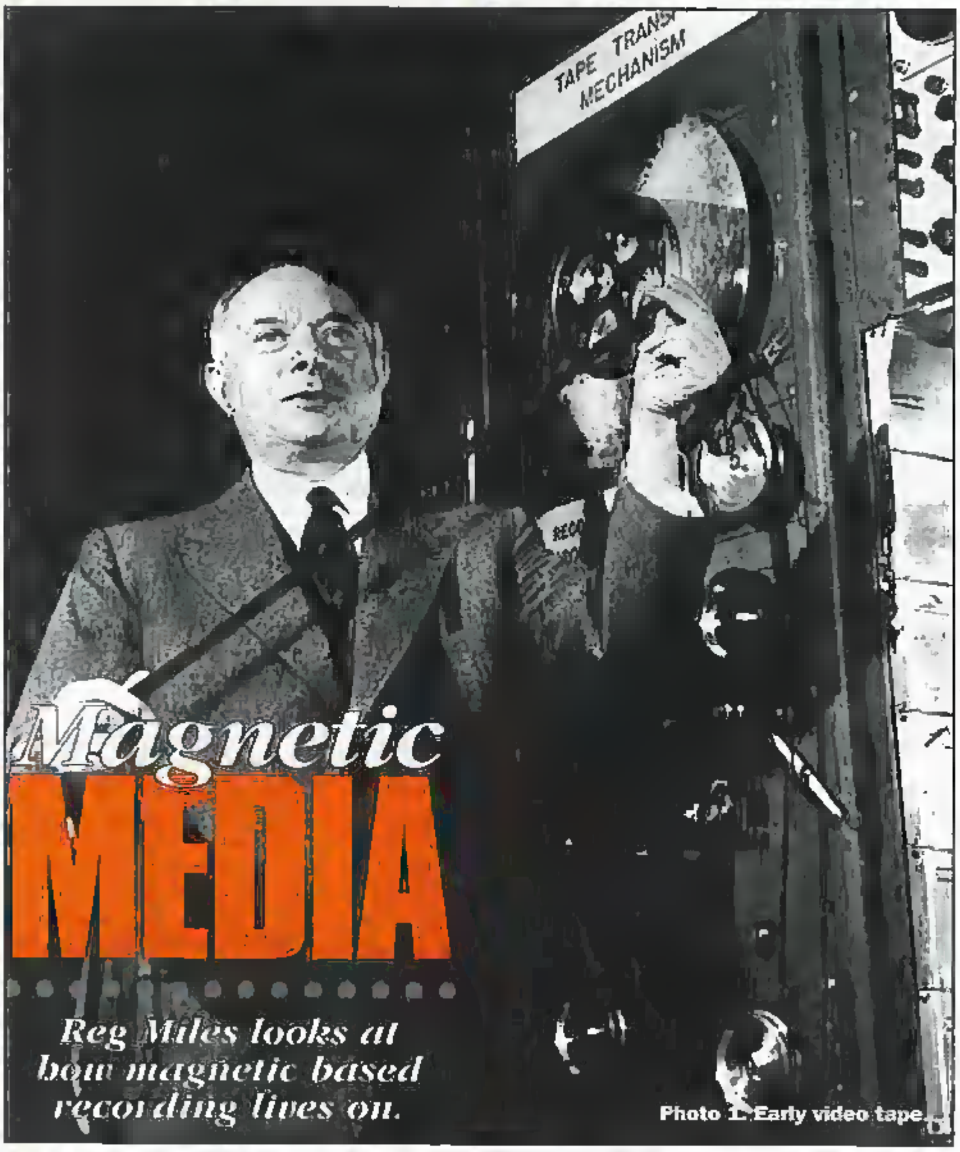
Want a bigger taskbar so that you can you can display more full-sized applications buttons? Easy, click with the left mouse button in the taskbar and then move the mouse pointer over the top edge of the taskbar (or the appropriate edge if the taskbar is no longer at the bottom of the screen) and you'll notice that it changes to a double-ended arrow. Hold down the left mouse button and drag the pointer to expand the taskbar.

If the taskbar is taking up too much screen area, even at its default size, you can configure it to appear only when you move the pointer near to where the taskbar would be displayed. To do this, click with the right mouse button in the taskbar and select 'properties' from the menu to display the Taskbar Properties window. Now select *Auto hide*.

Other Areas

There are lots of other ways you could customise Windows and as always, my suggestion is to experiment. Other areas to investigate are customising the Start menu, using screen savers, altering the screen resolution and/or the number of displayed colours and changing the sounds associated with Windows events. I'll leave you to figure out exactly how to make these changes.

And finally, everything in this column relates to Windows 95 but this is just about to be replaced by the much-hyped Windows 98. No doubt it will be 'all change' so we may well return to customisation once Windows 98 has become properly established.



Magnetic MEDIA

Reg Miles looks at how magnetic based recording lives on.

Photo 1. Early video tape.

While the long promised, cheap, high capacity solid-state recording medium remains promised, and optical recording is still in its infancy, magnetic based recording continues to be developed and refined.

Audio/video tape

Magnetic tape has the longest history, going back more than sixty years. For much of that time it had complete dominance of audio recording, and still retains the lion's share. With video it has always been dominant and only now is it beginning to face challenges. Only with computers has its role been no more than a peripheral one: its linear nature making it unsuitable for anything other than data backup and, briefly, program carrier. For while it can store large amounts of analogue or digital information very cheaply in small cassettes that can easily be carried around, access to that information is comparatively slow.

Video tape provides the best example. It must endure the greatest stresses, being wrapped halfway around a spinning drum with two or more heads indenting the tape and passing diagonally over it at writing speeds of several metres per second. Yet must accurately record the luminance, chrominance, audio and control signals, and be able to read the tape many times without noticeable loss of picture quality or synchronisation.

Composition

It is composed of four basic components – base film, magnetic particles, binder and backcoat. The base film will usually be either polyester or for thinner tapes, stronger polyethylene naphthalate (PEN). Until recently all the magnetic particles were either ferric oxide, probably doped with something like cobalt to improve their magnetic properties, or chromium dioxide, which has good magnetic properties in its own right. However, only VHS/S-VHS continues to use these conventional tapes: the trend to narrower tapes and tracks, particularly with digital formats, has meant that all other formats have had to adopt either metal particle (MP) or metal evaporated (ME) tapes whose greater magnetic efficiency compensates for the inevitable loss of performance due to the reduced area available for magnetisation. In addition, the size of the magnetic particles has had to be reduced and their quantity increased over the years both to improve the general performance, and to allow the recording of ever shorter wavelengths resulting from the use of smaller head drums.

Magnetic particle structure

Magnetic particles are composed of chemically grown magnetic crystals (Figure1 shows an ideal representation of a conventional particle and Panasonic's particles which have enlarged magnetic crystals to reduce energy loss by minimising wasted space). This acicular shape is the most effective for a particle. The smaller its axial ratio – longer and narrower – the weaker is the internal demagnetising field and so the more induced magnetism can be retained. The actual length of these particles is about 0.3μm or less. While their overall size is expressed in terms of specific surface area (SSA), which represents the total surface area of one gram of magnetic particles – for a basic VHS tape about 30 square metres/gram.

Both oxide and MP tapes require a binder to hold the particles. In the latter case the particles must be coated with an oxide layer first to prevent them rusting away. The main ingredients of a binder are a wetting agent to separate the particles which would otherwise clump together – particularly smaller ones; solvents to maintain fluidity during coating; lubricants to reduce the coefficient of friction, commonly fatty acid or fatty acid ester; non-magnetic abrasive polishing particles that help keep the head free of dirt, smooth over minor scratches on the head surface, improve tape to head contact, and help protect the tape surface from head impact; possibly carbon particles to prevent electrical charging; and elastomers to give flexibility, adhesion and cohesion characteristics (Figure 2).

The dispersion is then coated onto a 'jumbo' roll of base film about one metre in width. This will have a thickness of 5-14μm, depending on the format and how much tape has to be eventually squeezed into the cassette. The same applies to the thickness of the coating; but the occurrence of thickness losses at the short recorded wavelengths limits it to a maximum of about

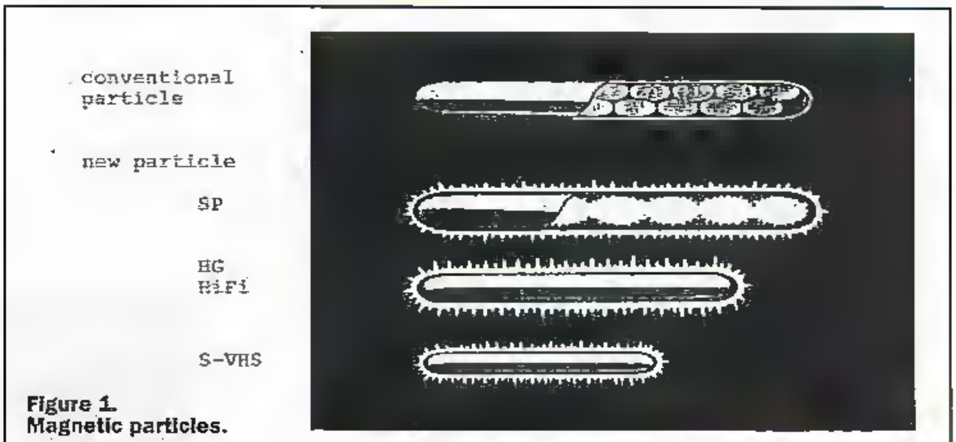


Figure 1. Magnetic particles.

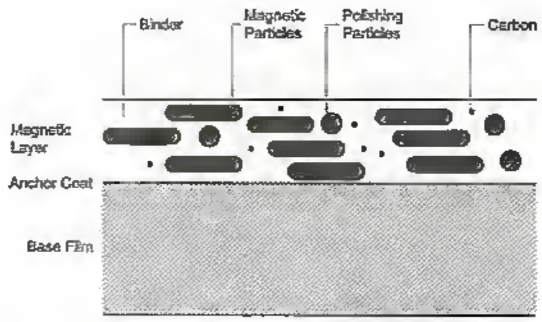


Figure 2. Composition of the magnetic layer.

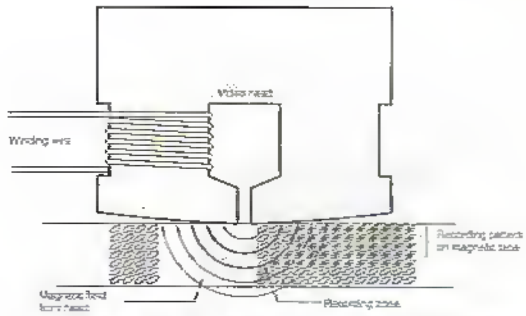


Figure 3. Perpendicular particle orientation. Diagram showing the magnetic field output form the recording head, and the magnetic pattern recorded on the tape's magnetic layer.

6μm, and it is generally two-thirds that or less. The particles are then aligned in the desired orientation by passing the tape through a magnetic field whilst drying. For VHS/S-VHS this will normally be longitudinally; but for the formats that use MP tape with wavelengths of around 0.5μm the orientation will normally be diagonal when viewed in cross section – tilted relative to the surface. This is because the magnetic field from the recording head contains perpendicular elements (Figure 3), and as the wavelength gets shorter these elements become more important and, in vector combination with horizontal components, result in an increase in the number of diagonal components.

The jumbo then undergoes a calendering process by passing through rollers that produce high pressure and temperature to give the surface a smooth finish (Figure 4). This improves the uniformity of magnetisation, reduces the noise level and enhances the carrier-noise ratio (C/N) – the difference between the carrier signal output level and background noise measured in decibels. Tapes are also given a backcoating: for as calendering reduces friction on the surface so the friction of the base film

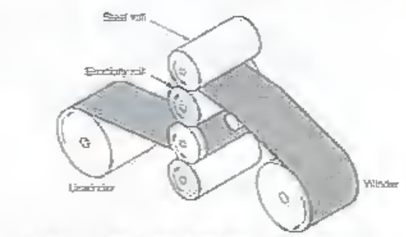


Figure 4. The 'calendering' process to control surface smoothness continuously passes a coated tape between a high temparature, high pressure metal roller and an elasic roller.

becomes greater by comparison, causing instability while running – backcoating reduces the coefficient of friction. It is composed of carbon particles and various pigments, and is generally less than 1μm in thickness. Because it reduces friction backcoating also reduces the generation of static electricity. Other functions are to protect the base film from physical damage, and to make the tape fast wind and rewind more evenly. The jumbo roll is then passed through a slitting machine that cuts it into the required widths to be wound onto reels and placed into cassette shells.

Metal evaporated tape

With metal evaporated tape the only similarity is the jumbo roll, the slitting and the winding onto reels, otherwise the process is completely different. It is manufactured using a vacuum oblique evaporation process that deposits a thin metal film of about 0.2μm thick onto the base film. The process takes place in a vacuum chamber (Figure 5): the alloy of mainly cobalt and nickel is fed into a crucible where it is heated to several thousand degrees Celsius by an electron beam causing it to evaporate. Oxygen is introduced during evaporation to produce oxidised cobalt, and the evaporated material condenses onto the base film which is turning on a chilled drum. The metal builds up in columnar structures (Figure 6), giving an extremely high packing density to maximise recording of the less than 0.5μm wavelengths. This metallic layer is then covered with a hard carbon overcoat layer to provide physical protection; which, in turn, is coated with a surface preparation layer to provide lubrication and to prevent the metal rusting. Lastly, the base film is backcoated.

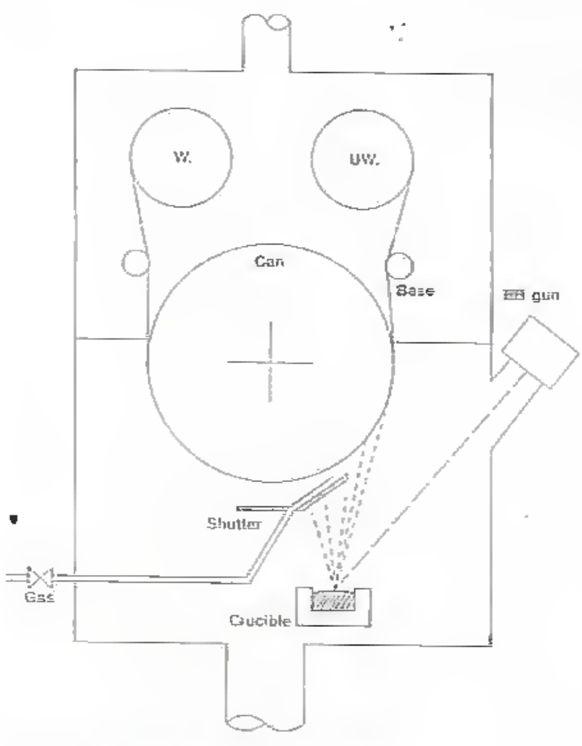


Figure 5. The metal evaporation process.

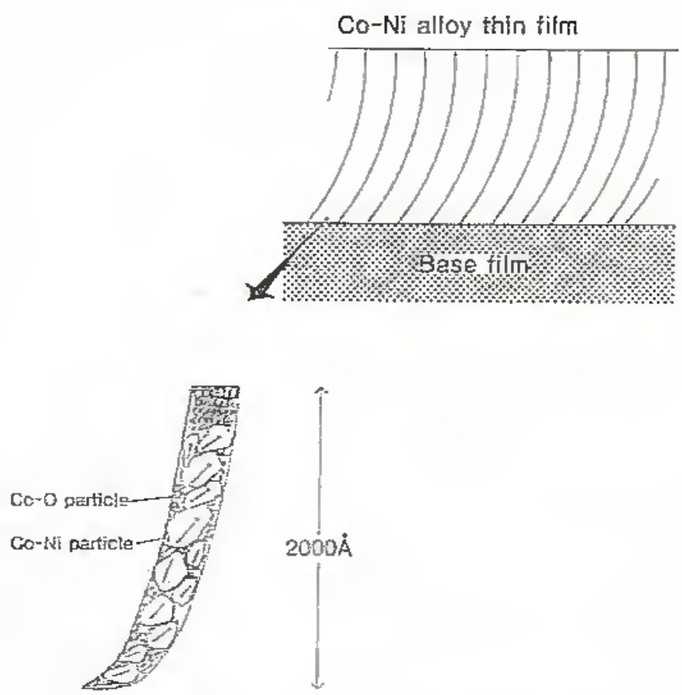


Figure 6. The columnar structure of metal evaporated tape.

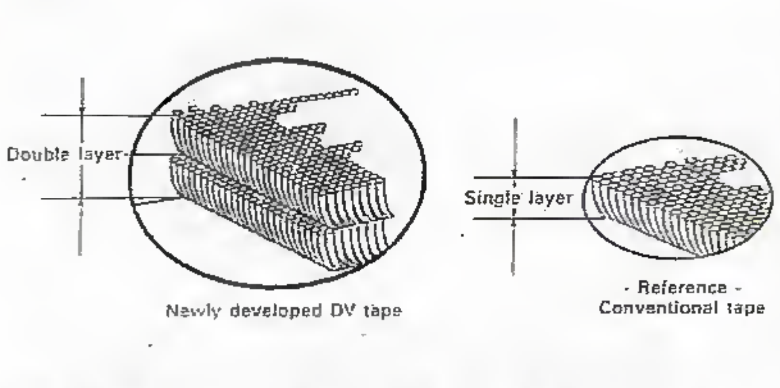


Figure 7. Double coated metal evaporated tape. The digital signal is recorded on two vapourated thin layers to give a powerful output and lower noise.

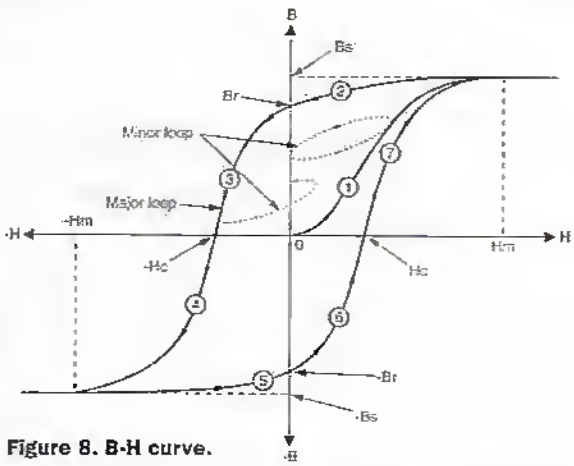


Figure 8. B-H curve.

Double layer tape

Recently, there has been a trend towards applying double layers of magnetic material to cope with the different frequencies and their depth of penetration into the magnetic medium. In VHS/S-VHS the recorded signals are, in descending order of frequency and penetration depth, video on an FM carrier, depth multiplex audio on two FM carriers, direct recorded colour under, and linear audio. The upper layer therefore uses fine particles to accomodate the high and mid-range frequencies, and the lower layer has larger particles for the low frequencies. Fuji was the first to achieve this, and is still the only manufacturer to coat the two layers simultaneously (a technique borrowed from their colour film production). 8mm/Hi8 does not use depth multiplex audio recording with separate heads but records FM (or PCM) audio through the video heads. Although linear audio is specified it is never used because the magnetic layer of MP and, more so, ME is too thin to give an adequate S/N ratio. Fuji has also applied double coating technology to produce a tape for Hi8 that combines the durability of MP with the enhanced performance of more expensive ME tape. In this case a thin upper layer of fine magnetic particles is applied over a layer of non-magnetic spherical titanium particles about one-sixth the size of the former. This tough layer provides the foundation for an extremely smooth surface layer which, after high pressure calendering, is packed down to just 0.3μm. This high packing density provides the low and mid-range response that complements the high frequency performance provided by the thin layer and smooth surface. It was originally named Super Double Coating, but now goes by the name of Advanced super Thin-layer and high-Output Metal Media – ATOMM, for short. Digital recording requires greater recording densities and bandwidth than analogue recording. For its Digital Video (DV) tapes Sony has introduced a double ME layer (Figure 7).

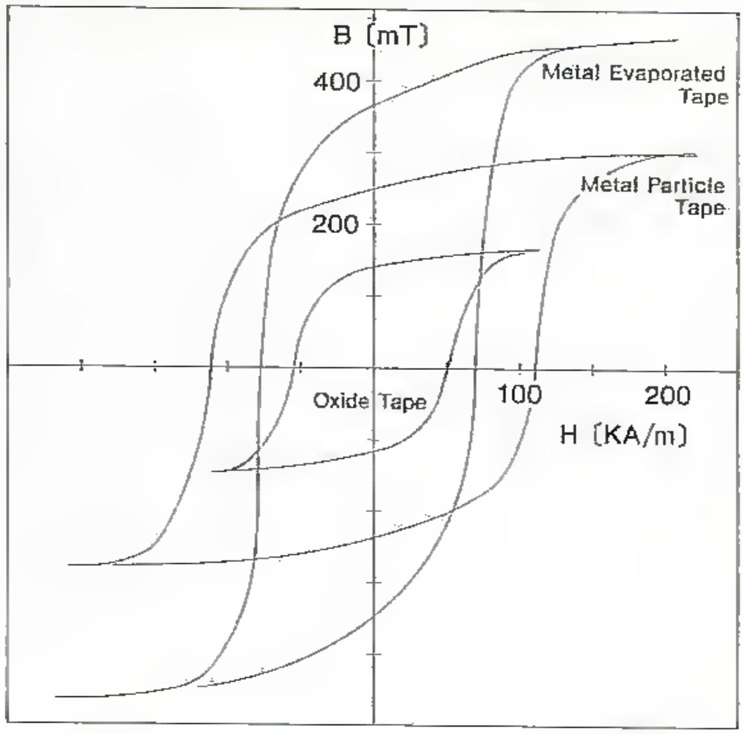


Figure 9. B-H curves for oxide, MP and ME tapes.

Magnetic properties

The critical properties of a magnetic medium are expressed by its residual magnetic flux density or retentivity (Br) and its coercivity (Hc) – in milliTeslas (mT) and kilo-Amperes per metre (kA/m) respectively. The former being the amount of magnetism that the material can retain after the record current is removed; the latter being how much external magnetism is required to reduce the magnetic flux density to zero. In the case of double layer tapes, the upper layer will have higher figures than the lower layer.

Magnetic recording makes use of the non-reversible properties of the magnetic medium, illustrated by a graph called the B-H curve. Figure 8 shows the principle: the external magnetisation H is increased in the positive direction from the point of origin (AC demagnetisation point); during this process flux density B is increased as indicated by curve 1 which is called the initial magnetisation curve; there is virtually no further increase in B after H reaches a certain value (Hm), the value of B at this point is called the maximum flux density (Bs); if H is then gradually decreased from this point the B decreases as shown by curve 2 instead of going back down curve 1 – the magnetisation at H = 0 is the residual flux density (Br); if H is then applied in the negative direction B decreases as shown by curve 3 until it finally reaches zero – the size of H at this point is the coercive force; if H is further applied in the negative direction saturation is reached at a point -Hm symetrically opposite to Hm; increasing H again in the positive direction results in B following the curve indicated by 5 through 7. The curves 2 through 7 form the hysteresis loop. The ratio of the residual magnetic flux density (Br) to the maximum magnetic flux density (Bs) in the B-H curve is called the squareness ratio (Br/Bs), and is an indication of how much magnetism remains in the magnetic material after the external magnetising force is removed. Figure 9 shows B-H curves for oxide, MP and ME tapes.

Floppy disk

The 3.5in floppy disk (or diskette) is similar to basic video tape in that it uses an oxide coating – although only about 0.9μm in thickness. This is applied to both sides of a polyethylene terephthalate (PET) substrate; giving a total thicknes of 77μm (Figure 10 shows the surface detail of Sony's Micro Floppy Disk – but then the company did invent the format). As the disk spins it becomes rigid. Its smooth rotation is aided by the disk liners (Figure 11), which also help to clean the disk surfaces. Data is written to the disk as changes in magnetic flux and read as induced electrical pulses by a combined read/write head.

The floppy disk is beginning to move

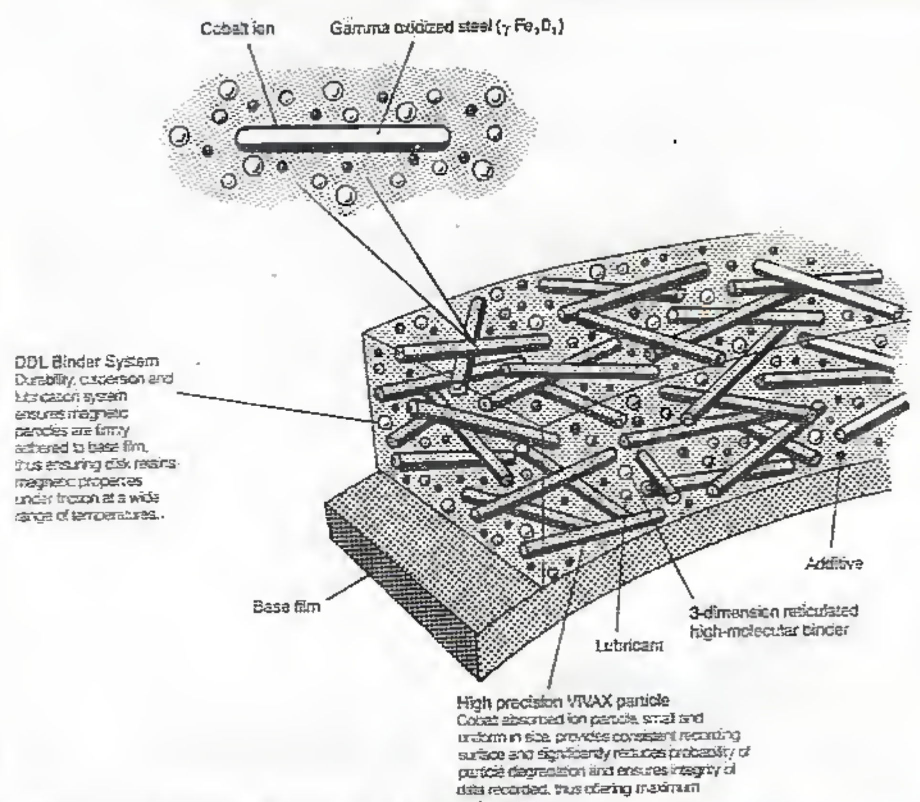


Figure 10. Surface details of floppy disk.

beyond the confines of the computer. Sony, for example, has a couple of digital still cameras that use it for image storage. The Digital Mavica can store 30-40 JPEG compressed images in Standard mode or 15-20 images with less compression in Fine mode – both at 640 x 480 VGA resolution and 24-bit RGB colour depth.

But the formatted capacities of the Double Density (DD) and High Density (HD) floppy disks of 720kB and 1.44MB are now looking decidedly meagre in the face of ever increasing amounts of data. The 2.88MB Extra Density (ED) disk just did not offer enough extra capacity to make it successful.

Photo 2. Sony Digital Mavica floppy disk camera.

The super disk

Anyway, it was soon eclipsed by the 3.5in LS-120 'SuperDisk' with its 120MB capacity and drives that could also read and write conventional floppy disks. This was developed by Compaq, Imation (3M), Matsushita and Mitsubishi. It employs a laser in the drive to ensure the necessary tracking precision for the head to read and write the condensed data on the LS-120 disks.

The latest attempt to increase the capacity of the floppy disk is HiFD, due to be launched this year. Jointly developed by Fuji and Sony, it will combine Fuji's ATTOM technology with Sony's drive technology to give a 200MB capacity. Like the LS-120, it will be capable of reading and writing standard DD and HD floppy disks. To this end it has a dual discrete gap head with a fine gap to read and write the condensed data in the HiFD ATTOM coating and a standard gap for ordinary floppies, plus it is a flying head type similar to the heads used in hard disk drives (with no laser required for tracking).

Other flexible disks, such as Iomega's Zip and Jaz disks, are not compatible with floppy disks. But the latter does offer up to 2GB capacity, thus rivalling many hard disks.

Hard drives

Which, as the name implies, have a rigid substrate. This can be metal, plastic, ceramic – even glass has been used. For low capacity drives an oxide coating provides the magnetic medium, with an exceptionally smooth finish. However, most hard disks use a thin film of cobalt alloy applied either by sputtering or electroplating to achieve much greater storage densities and smaller disk sizes. This can be as little as 2in, but is generally 2.5, 3.5 or 5.25in. Whatever the size, the surfaces are generally lubricated to minimise wear during drive start-up and power-down – although the heads do start and finish in a data-free landing zone at the innermost location on the disk. Once the disk begins rotating an air bearing is formed and the heads fly about 100nm over the surface. The rotational (or spindle) speed is usually 3600, 5400, 7200 or 10,000rpm (the last three being first achieved by Seagate).

Figure 12 shows a drive, with the head/disk assembly (HDA) containing the key components: heads, voice coil actuators, disks and frame. It is known as a voice coil actuator (or motor) because of its similarity to a loudspeaker coil, with the coil currents reacting with the magnetic field to move the actuator assembly and head. The numbers of discs and read/write heads varies according to application and capacity, but can be as many as 14 and 28 respectively (there are heads for both disk surfaces).

The higher capacity disks employ magnetoresistive (MR) read heads instead of the normal induction type. MR heads rely on changes in resistance to sense magnetic fields; unlike induction heads they are not speed dependent and so data can be written at the same density across the whole disk, and the more sensitive the MR head the smaller the data bits it can detect – hence the increase in storage capacity.

Digital disk recorders

As with floppy disks the hard disks are moving out of computers and into other applications, thanks to their rapid access. Digital disk recorders (DDR) are beginning to challenge analogue and digital recorders

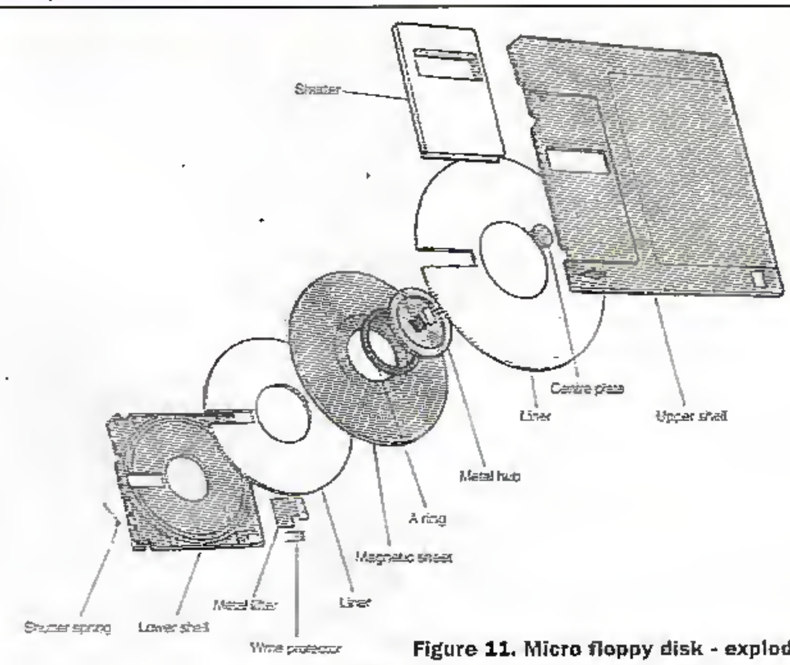


Figure 11. Micro floppy disk - exploded view.

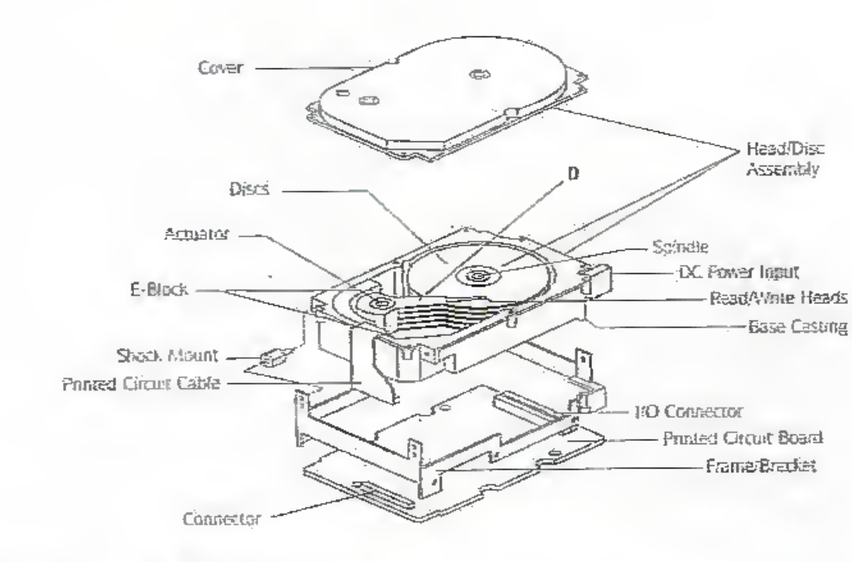


Figure 12. Hard disk drive.

(audio and video) as the cost of gigabytes fall and disk capacities climb into the tens of gigabytes. Hard disks have also made an appearance in cameras. In the broadcast field Avid can supply 2.2 or 4GB removable drives, giving up to forty minutes of component video with four 48kHz audio channels, and full editing facilities in the field. While, in the consumer and business markets, Hitachi's MPEG camera uses a 260MB PCMCIA disk to store up to 20 minutes of MPEG-1 audio and video or just under 3000 JPEG still images.

Magneto-optical

Magneto-optical (MO) is the bridge between magnetic and optical media. And enables storage at great density due to perpendicular magnetisation. There are 3.5 and 5.25in types specifically for computer data and, more widely known, Sony's 2.5in MiniDisc (MD) used to carry digital audio and computer data – making it a good example of the MO principle.

Writing can only be achieved by a combination of magnetism and heat – thus data cannot be erased by external magnetic fields. The MD uses a magnetic field modulation direct overwrite process. The heat comes from a 780nm laser mounted under the disc which is turned up to about 4.5mW (Figure 13). This raises the temperature of the magneto-optical layer to just above the Curie point (in this case 180°C, although other MO discs can be up to 200°C) causing the perpendicular magnetic dipoles to loose their alignment. The non-contact magnetic head above the disc then realigns them; applying a magnetic field strength of 8-24kA/m depending on the application (portable devices will be close to the minimum level). As the disc rotates and the heated area moves away from the laser beam the temperature drops below the Curie point and the magnetic alignment is fixed. Reading is achieved by the laser alone – turned down to about 0.6mW so that it does not heat the layer. The process relies on the Kerr effect. The laser light is polarised as it is reflected by

Photo 3. Hitachi MPEG PCMCIA disk camera.

the data bit, with the axis of polarisation rotating slightly depending on the magnetic alignment (Figure 14). The laser beam then passes through a polarising beam splitter which distributes it to one of two photo detectors where it is assigned a '0' or '1'.

The disc consists of six layers (Figure 15). There is a substrate of polycarbonate resin – as used for CDs; the amorphous magnetic layer composed of mainly cobalt, ferrite and terbium; this is sandwiched between two dielectric layers that protect it from atmospheric substances and ion particles released from the substrate under high temperature and humidity, and also serve as an optical enhancer; a reflective layer that absorbs heat when writing and reflects the laser beam when reading; and a top protective layer. Giving a total thickness of 1.2mm. The dielectric, magnetic and reflective layers are together just 0.2µm thick and are applied to the substrate using a sputtering process: while the 10µm protective layer is subsequently coated on and hardened by exposure to UV light.

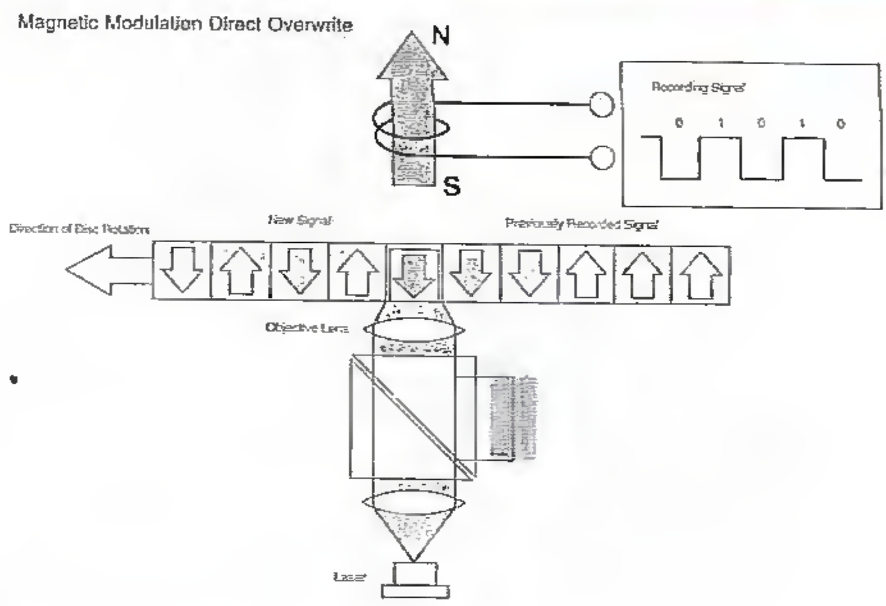


Figure 13. Writing data on a magneto-optical disk.

Photo 5. Denon MiniDisk recorder.

Dimo communicator

Getting away from MiniDisc, Olympus has launched its 'dimo' communicator that enables any of its digital still cameras to directly download images to its 3.5in 230MB portable MO drive. It is interfaced by RS232C to the camera and by SCSI-2 to the drive. Two buttons on the device transfer either all images or just the last one taken to the disk. Up to 10,000 JPEG compressed images can be automatically indexed and stored. Thus making it ideal for those users who need to take many images on location shoots. MO is also used as the means of storage in some DDRs.

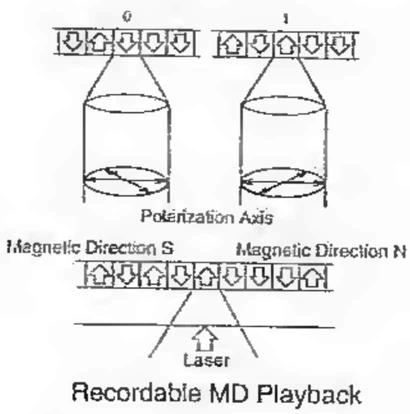


Figure 14. Reading data from a magneto-optical disk.

You will notice that the disc has a spiral groove (Figure 15 again). This is used to find places on the disc when writing and reading and to maintain a constant linear velocity (CLV). It can do this because the inner walls of the groove are not parallel (Figure 16) and thus 'wobble' to give a 22.05kHz carrier frequency at the scanning velocity of 1.2m/s; and this carrier is then modulated with the positional information. The groove also acts as a tracking guide for the laser.

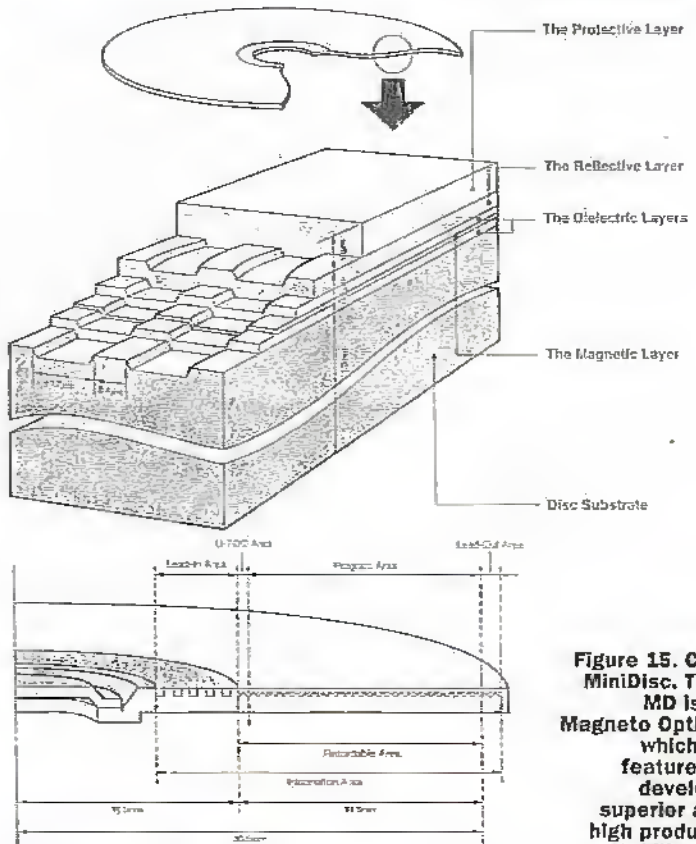


Figure 15. Construction of MiniDisc. The Recordable MD is based on the Magneto Optical Disk, from which the MD's own features were further developed to give it superior audio use, and high product quality with stability and reliability.

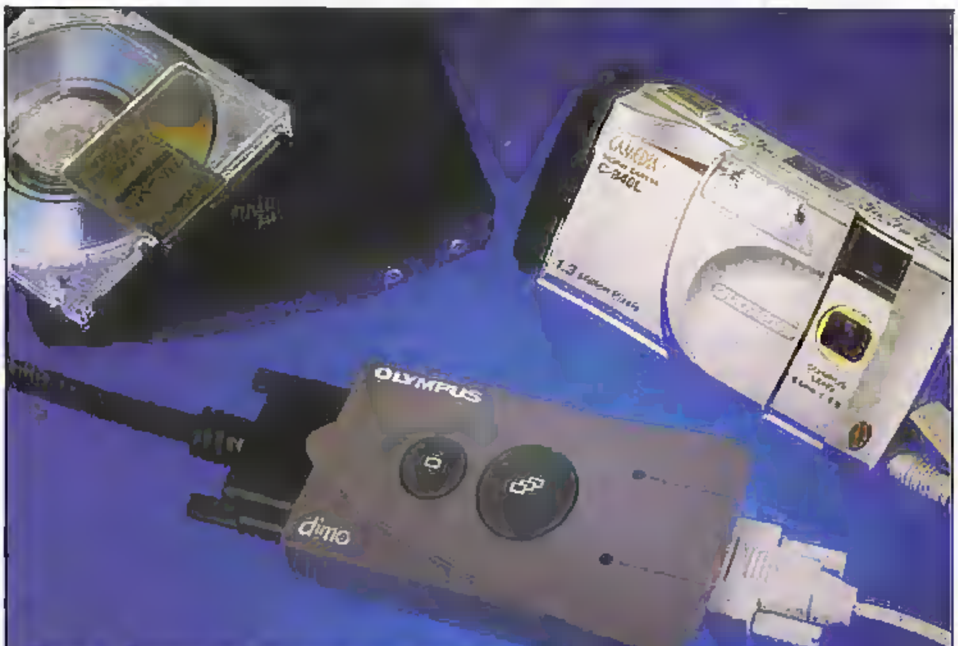


Photo 6. Olympus dimo magneto-optical storage.

The future

Although magnetic and magneto-optical technologies are being challenged by optical ones, advances in technology are indicating that the potential of magnetism has barely begun to be realised. For just as thin film technology has allowed considerable increases in recording density, so films consisting of just a few atoms thickness will push it up to new heights. And the unconventional magnetic properties of such ultra-thin films, or combinations of films, should create many new applications.

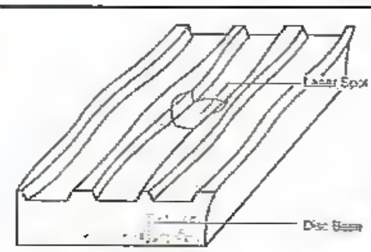


Figure 16. Wobbled groove on MiniDisk.

Get more from VISUAL BASIC 3

PART 6

In this final part, Mike Holmes looks at HPJs, Pop-Ups and 'Help!'

The Basics

You will need the following tools and files to create even the simplest Windows help file:

1. The WinHelp application itself, WINHELP.EXE. When you create a help system, you are actually creating a resource file that is used by the WinHelp application.
2. A suitable word processor for creating the topics in the correct format, and which must be able to save files in Rich Text Format (.RTF), and create *footnotes* that are identified by the custom marks $, #, K, and +. Typically Microsoft Word for Windows™ seems to be a common choice.
3. A word processor or text editor that can save files as ASCII text, for creating the help project (.HPJ) file. Windows own NotePad™ can do this.
4. The Microsoft Windows Help Compiler HC31.EXE (or for Windows 3.0, HC30.EXE). This compiles the .RTF sources and links any bitmaps used to create the final help file used by WinHelp.
5. The error message resource file HC31.ERR. This contains the warning and error messages that WinHelp produces if there are any problems during the compile.

Tools for Advanced Features

6. Microsoft™ Hotspot Editor (SHED.EXE). This creates *Segmented HyperGraphic* (.SHG) files. These are derived from bitmaps (.BMP) that have been segmented into hotspots, such that when the user clicks on one of the defined segments, either a pop-up or another topic is displayed, or a WinHelp macro is executed.
7. Drawing or painting software for creating bitmap illustrations and custom buttons, and which can save them as .BMP. (Besides bitmaps, WinHelp can also use Windows metafiles (.WMF).)

Creating A Simple Help File

These are the basic steps for creating a simple help file:

1. Write the topics that make up the help file. Save them as Rich Text Format (.RTF) files.
2. Write a *Contents* topic. This is the first one displayed by WinHelp when it loads, and is typically a list of topic jumps, like a contents page. Save it as a Rich Text Format (.RTF) file.

Figure 1. Writing the title of a topic in a 'typical' word processor.

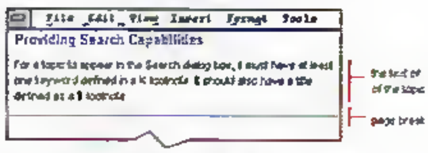


Figure 2. Finishing the body of the topic and adding a page break.

3. Write the help project (.HPJ) file. Save it as a text file, but it must have the extension .HPJ, *not* .TXT.
4. Compile the topics into a help resource (.HLP) file by running HC31.EXE in a DOS window, giving it the name of the .HPJ as a following parameter. The .HPJ determines which .RTF and .BMP files are to be included in the final help file, and how it is to be organised, but let's try to concentrate on one thing at a time.
5. If writing for Windows '95, you may also create a Windows '95 compatible 'CoNTents' (.CNT) file. This will produce the 'Contents' start-up window, containing a topics list tagged by the little book and page icons, that is peculiar to Windows '95. (Actually you can make one for any other 'old' help file too. More of this later).

Writing A Help Topic

Using the word processor, write a title on the first line of the topic, as demonstrated in Figure 1. Titles serve the same purpose online as they do in print, to identify the topic (or chapter) and describe its contents. To make the title stand out, it can be emboldened using a different type size, emphasis or colour.

Below the title, write the *text* for the topic, as shown in Figure 2. You need not worry about line length for paragraphs; the text in the compiled help file wraps automatically when it reaches the right-hand edge of the display window.

At the end of the topic you *must* insert a *page break* (the only exception being that it is the last topic in the document). Page breaks tell WinHelp where the ends of the topics are. These are not 'pages' in the true sense, as they would be printed, but

Figure 3. Adding the 'topic header' to the title using a series of footnotes.

separate topics in the same document; they can equally be very short or very long and have nothing to do with paper sizes.

You should be able to format the text as you would for any other document, using different fonts, type styles, colours, lines and boxes - but remember that this information will be viewed on the *monitor*. Moreover, you can only employ fonts such as will exist in the final user's system. Therefore, one is typically restricted to the *Arial* or *Times New Roman* fonts that come as standard with Windows. Any 'odd ones' will be converted to the nearest equivalent by WinHelp.

'Topic Headers' - Inserting Footnotes

WinHelp uses a system of *custom footnotes* to identify topics and to provide navigation controls. It precludes that the word processor used *must* be able to make footnotes. These are called 'custom' footnotes because they are not identified by sequential numbering as may be more familiar to footnotes' writers and users. Typically, you will have four standardised footnotes for each topic, in the form *footnote-character* used to identify *a purpose*. These are:

\# *Context string* - uniquely identifies the topic.

$ *Title* - appears as the topic title in the Search Dialogue window and in the History list.

K *Keywords (with optional phrases)* - these will appear in the Search Dialogue window.

\+ *Browse sequence* - Determines the order of the topics when the user browses through them using the *browse buttons*.

For each topic you must do the following:

1. Move the text insertion point to where you want the footnote identifier to be placed, typically before the first character of the first line of the topic.
2. Specify which footnote mark to use (#, $, K, or +), and insert the footnote. (Word for Windows™ provides a dialogue box for specifying the footnote identifier).
3. Move the text insertion point to the footnote itself, if it has not already been moved there by the word processor.
4. Type the appropriate information for the footnote. Examples are shown in Figure 3.

Adding Hotspots Or Topic Jumps

Now that topic headers exist, a 'hotspot' or 'topic jump' can be made as text or a graphic that the user can click on to initiate some action. It can initiate a jump to another

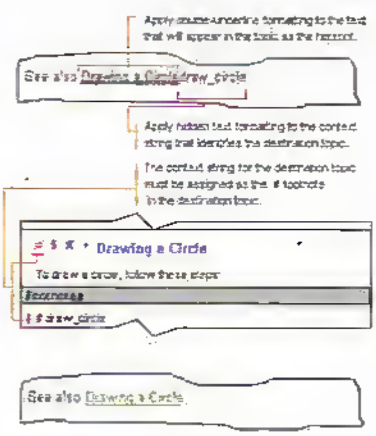


Figure 4.
a: How a topic jump or 'hotspot' is written and linked to a topic context string created with a '#' footnote;
b: what it looks like in WinHelp.

topic, display a topic in a different window, or execute a macro. Most often simple words or phrases are turned into hotspots.

To create a hotspot that jumps to a different topic:

1. Type the text or insert the graphic you want to appear as the hotspot.
2. Highlight the text, and apply *double-underline* formatting to it. In Word for Windows™, highlight the word or words and display the Character format dialogue box, then choose *Double* from the *Underline* selection list.
3. Immediately following the text or graphic from step 1, type the *context string* of the destination topic as specified by the # footnote for the 'topic header'.
4. You *don't* want the context string to show in the final help file, so highlight the context string part and apply *hidden text* formatting to it (in Word for Windows™, highlight it then click the *Hidden* check box in the Character format dialogue window).

To create a Contents topic for your help system, you need to create a first topic that contains all the titles of your topics. Then you make each title into a hotspot that jumps to the topic named: see the example in Figure 4a. In the final help file, the hotspot appears as *underlined green text* as shown in Figure 4b (regardless of what colour it was at the document formatting stage).

A contents topic is a topic that lists the sections of your help system. Each item is hot, so that the user can click it to display the named topic.

WinHelp assumes there is a main contents topic. By default, every help system has a *Contents* button on the button bar, and WinHelp assumes that the *first topic* in the *first* of your help source files is this Contents topic. When the user clicks that button, the main contents screen is displayed (except Windows '95 if a .CNT file exists). How such a contents page should work is illustrated in the schematic Figure 5.

Prior to final compilation, the document must be saved in *Rich Text Format* (.RTF), this being the only format that the help compiler can understand. It must have an .RTF file name extension, but it is also a good idea to save source documents in the *native* file format used by your word processor as well. This makes it easier to return to the files for further editing later.

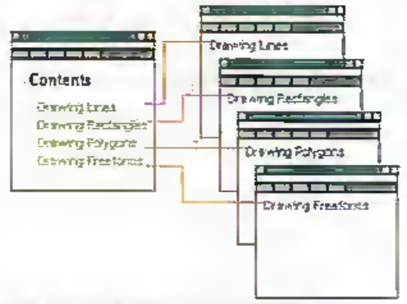


Figure 5. Schematic showing how a list of topic jumps on a 'contents page' link to different topics (usually shown in the same primary window).

About Rich Text Format

Rich Text Format (.RTF) files consist of pure ASCII text containing no control characters of any kind. Formatting information is provided by a means of format 'keywords' describing the format, with text to which the format applies enclosed within braces ('{}'). The code words are preceded by a back-slash ('\') interpreted as the start of a control character sequence.

The basic purpose of RTF is to allow formatted files to be transported between different typesetting or DTP applications, whose generic file types are not otherwise compatible; also across platforms, for example PC to Macintosh, etc.

Writing the Help Project File

Before the help file can be compiled, *a project file* must be created, which is a text file containing information that the help compiler must use to construct the final help file.

The layout of this is very similar in aspect to a Windows initialisation file. The minimum sections would typically be [OPTIONS], [CONFIG], [FILES], [BITMAPS], [MAP]. Example:

```
; Help project file for Windows Help

[OPTIONS]
CONTENTS=Main_toc
TITLE=My Windows Help
ERRORLOG=MYERR.LOG

[CONFIG]
BrowseButtons()

[FILES]
TOC.RTF
GETSTART.RTF
BASICS.RTF
TASKS.RTF
REFERENCE.RTF

[BITMAPS]
; none

[MAP]
Edit_Window      0x0001
Control_Menu     0x0002
Maximize_Icon    0x0003
Minimize_Icon    0x0004
```

[OPTIONS] Section

This should contain at least:

CONTENTS = *context_string*, which is the context string of the main contents topic. If you do not include it, WinHelp uses the first topic in the first file as the contents topic.

TITLE = *title*, which is the name that appears in the *title bar* of the main help window.

ERRORLOG = log_filename, where errors are written if any occur during compilation. This log is a useful reference for debugging your help system. When you include this line in the project file, HC31.EXE creates the file automatically when you compile.

HPJ [OPTIONS] Section Summary

BMROOT	Specifies the directory containing the *bitmap* files named in the *bmc, bml* and *bmr* statements in topic files and listed in the [BITMAPS] section. New for Windows 3.1.
BUILD	Specifies which topics to include in the build.
CITATION	Specifies a string that is *appended* to topics that are copied from Windows help instead of the COPYRIGHT string. New for Windows 3.1.
COMPRESS	Specifies the type of compression to use during the build.
CONTENTS	Specifies the context string of the Contents topic for a help file. New for Windows 3.1.
COPYRIGHT	Adds a *unique* copyright message for the help file to the 'About' dialogue box. This was new for Windows 3.1.
ERRORLOG	Puts compilation errors in a file during the build. Was new for Windows 3.1.
FORCEFONT	Forces *all* authored fonts in the topic files to appear in the specified *different* font when displayed in the help window.
ICON	Specifies the icon file to be displayed when the help file is minimized. New for Windows 3.1.
LANGUAGE	Specifies a different sorting order for help files authored in a Scandanavian language.
MAPFONTSIZE	Maps a specified font size in the topic file to a *different* font size in the compiled help file.
MULTIKEY	Specifies an *alternative* keyword table to use for mapping topics, keyed to a footnote character other than 'K', the default.
OLDKEYPHRASE	Specifies whether the compiler should use the existing key-phrase table or create a new one during the build. New for Windows 3.1.
OPTCDROM	Optimises the help file for CD-ROM use. New for Windows 3.1.
REPORT	Controls the display of screen messages during the build process. Can be 'ON' or 'OFF'.
ROOT	Specifies the directories containing the topic files listed in the [FILES] section.
TITLE	Specifies the text displayed in the title bar of the help window when the file is opened.
WARNING	Specifies the level of error-message reporting the compiler is to display during the build. Can be '1' (fatal only) to '3' (verbose').

options can appear in any order within the [OPTIONS] section.

Table 1.

The options section can have a large variety of different entries. A more complete list of all the possibilities is shown in Table 1.

[CONFIG] Section

BrowseButtons(): if you include this line, the browse buttons '>>'(Next) and '<<' (Previous) will be added to WinHelp's button bar. To implement browse sequences, you must also add browse identifiers to the topic headers as '+' footnotes.

The [CONFIG] section basically executes WinHelp macros at start-up ('BrowseButtons()' is a macro). It would be here that customised menu and toolbar button creation macros would also be put.

[FILES] Section

RTF_filename_n is the name of an .RTF source file. Include all the .RTF files that make up your help system. List each file on a separate line. They can be in any order, except, if you do not include a CONTENTS= line in the project file, WinHelp assumes that this will be the first topic in the first file in this list.

[MAP] Section

Consists of a series of definitions in the form *context-string context-number,* but only applicable if a # footnote exists for each topic listed.

The *context number* corresponds to a value that the parent Visual Basic application passes to Windows help in order to display a particular topic. This is optional, but in previous examples I've cited for invoking WinHelp as an API call, the API function also needs the context number passed as a long integer. In the above examples the hex numbers '0x0001' etc. are not quite correct for this function or even the common dialog object.

Hence the [MAP] section supports two additional statements for specifying context strings with associated context numbers:

The first variation has the form:

#define context-string context-number

The *context-string* (# footnote) and *context-number* parameters provide numeric aliases needed for context sensitive help and by WinHelp as an API call:

```
[MAP]
;     Context        Context  Context
;     String         Number   Title
;
#define Topic0100 21100     ;Start
#define Topic0002 21002     ;Contents2
#define Topic0003 21003     ;Contents3
#define Topic0004 21004     ;Contents4
```

whereupon the VB API call statement 'X = WinHelp(Me.hWnd, App.HelpFile, HELP_CONTEXT, CLng(21001))' begins to make more sense.

An alternative is: '#include "filename"', where the filename parameter, which can be enclosed in either double quotation marks or angle brackets(<>), specifies the name of a file containing one or more #define statements.

In another variation you can define the context strings listed in the [MAP] section either in a help topic or in an [ALIAS] section. If you use this it must precede the [MAP] section in the help project file.

[ALIAS] Section

The [ALIAS] section assigns one or more context strings to the same topic alias: *context-string = alias,* where *context-string* specifies the context string (# footnote) that identifies a particular topic.

Alias specifies the alternative string or alias name. This string is provided in an additional '#' footnote. Thus an alias string has the same form and follows the same conventions as the topic context string.

Context strings must be unique for each topic and cannot be used for any other topic in the help project, the [ALIAS] section provides a way to delete or combine help topics without re-editing your files. The following section example creates several aliases:

```
[ALIAS]
sm_key=key_shrtcuts
cc_key=key_shrtcuts
st_key=key_shrtcuts      ; all combined into Keyboard Shortcuts topic
?=edittxt
wrptxt=edittxt
?=edittxt                ; all combined into Editing Text topic.
```

The Primary Window

Ordinarily, the primary window is the default help window. (Although the application that calls help can be programmed to open help in a secondary window.) If you do not specify any pop-up windows or secondary windows, all help topics will appear in this window.

The default attributes (size, position and colour) are defined in the project file. Only one primary window can appear at one time, but you can use macros to change its attributes when the user displays a new topic or clicks a hotspot, button, or menu item. If the calling topic is displayed in this primary, then only the context name is required as the parameter to load the new topic into the same window.

Compiling The Help File

Only after the .HPJ is completed and saved can any attempt be made to compile the help file. Before doing so, make sure that: all source topic files have been saved as Rich Text Format (.RTF); all of these are in the same directory, together with HC31.EXE, HC31.ERR, The project (.HPJ) file, and all referenced bitmap (.BMP) or SHED (.SHG) files. While it is possible to put the files in different directories, you need to specify what these are in the project file, see [ROOT] and [BMROOT] in Table 1.

The compiler is run at DOS level by typing: HC31 project_name, where project_name is the name of your help project file without the filename extension.

About Different Kinds Of Windows

There are four kinds of windows available for displaying topics and other items in WinHelp. Their styles are summarised in Figure 6.

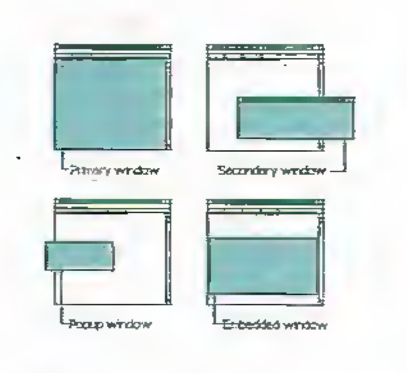


Figure 6. The four different types of WinHelp windows.

Secondary Windows

A secondary window is a separate window that remains on screen until it is explicitly closed, either by the user or by a macro that you build into the help. The default attributes (size, position, and colour) are defined in the project file. You can define several secondary windows in the project file, and several can appear together on screen. To load the other topic into a secondary window, the hotspot must use an expression like 'Topic0006>Window1' as the context string. This can also be done with the macro *JumpId():* JumpId("filename", "context-string")

Pop-up Windows

A borderless pop-up window appears on top of the primary window (with a shadow under it), and is automatically sized to contain the topic that appears in it. Only one pop-up window can be displayed at one time. Any ordinarily defined topic can be displayed as a pop-up using the *PopupId()* macro: '!PopupId("second.hlp", "second_topic")'.

Otherwise a modified hotspot link can be made specifically to display a pop-up by applying a *single underline* attribute to the topic jump text as opposed to double underline. This is followed by a hidden context string in the usual way. A topic intended exclusively for a pop-up only needs the '#' and '$' footnotes.

Embedded Windows

An embedded window is a rectangular area within a topic that can be used to display or run certain objects that cannot otherwise be included in help. For example, an embedded window can be used to display 256-color bitmaps, run animation sequences, or play audio. In addition, authors can write their own DLL's (Dynamic Link Libraries) to display or run other multimedia objects.

Defining Window Attributes - [WINDOWS] Section

You can define the title, colour, default location, and default size of all six windows by listing them in the help project (.HPJ) file. Note that only one primary window can be specified for a help file. A last section in the .HPJ file called '[WINDOWS]' can include this line: "caption", (left, top, width, height), window-style, (main-back-colour), (non-scroll-back-colour), on-top-flag'. The section then begins to look like:

```
[WINDOW]
Main = "My Help", (0, 511, 1024, 512),
0, (255, 255, 255), (128, 128, 128), 0
```

If caption is blank ('Main = ,') or there is no 'Windows' section, then the compiler takes the CAPTION property from 'Options'.

There are two important things to note about window sizing. The default size for all windows is the screen size. The scaling factor, as written between the first set of brackets above does not follow the convention of screen pixel units, for example. In WinHelp, window sizes are specified by an arbitrary scale, where both the maximum width and the maximum height are specified as 1024, even though the screen is rectangular. Hence, a secondary window that is 500 x 500 is *not* square, but *rectangular* in proportion to the screen.

The other is that the following zero, the *window-style*, does not mean 'minimised' as in Visual Basic, but 'normal'. Finally, colours are always specified as an RGB group. Of course there's a default of white in the first case and mid-grey for a non-scrolling region, and you can resort to this by simply writing: "(,,),(,,)" for the colours.

The 'on-top' flag is '0' for none (normal), or '1' to stay on top. These attributes are the same for secondary windows. A complete 'Windows' section can be:

```
[WINDOWS]
MAIN = "Catalogue", (90, 0, 840, 1020), 0, (255,255,255), (255,255,255), 0
Window1 = "Additions", ( 170, 90, 839, 930), 0, (255,255,255), (192,192,192), 0
Window2 = "Window2", (90, 0, 840, 1020), 0, (255,255,255), (192,192,192), 0
Window3 = "Window3", (90, 0, 840, 1020), 0, (255,255,255), (192,192,192), 0
Window4 = "Glossary", (90, 0, 840, 1020), 0, (255,255,255), (192,192,192), 0
Window5 = "Index", (90, 0, 840, 1020), 0, (255,255,255), (192,192,192), 0
```

Context Sensitive Help

Visual Basic provides a way for assigning help context strings directly to its user-interface objects in the *ContextID* property. When the application calls help, it can pass to WinHelp the same context strings you used to identify topics in your help file whose name is specified in the *App.HelpFile* property, as illustrated in Figure 7. This is in addition to making the *WinHelp()* API call in code.

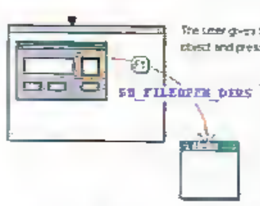


Figure 7. How a Visual Basic application passes an object's ContextID property to a help file named in its App.HelpFile property when F1 is keyed.

The Windows '95 Contents File

Windows '95 users will have noticed that when they open a help file that was apparently compiled for Windows '95, directly from Windows itself (i.e. in an explorer), they get a different 'Contents' display window, that is not the start-up topic of the help file.

The Windows '95 'Search' window in WinHelp is quite unlike the Windows 3.x version. It has a 'tabbed notebook' style, where the last tab ('Find') can be clicked on to generate a database of words that the user can subsequently use to search for topics in more detail than may be provided by the normal keywords list ('Index'). This database (if created) is maintained by Windows '95 WinHelp (32-bit version) in the associated .GID file.

In summary then the total number of help file types used are:

```
for Windows 3.x:  filename.HLP

for Windows '95:  filename.HLP  filename.CNT  filename.GID
```

Of particular interest here is the .CNT file. If WinHelp32 finds a .CNT with the same primary name as the .HLP, it attempts to read the .CNT. If this was correctly written, the window looks like that in Figure 8.

This is in place of the first start-up topic - the help file's main window shouldn't initially show at all. The user can then double-click on the little book icons to reveal further drop-down lists of topic titles, or go directly to the 'Index' or 'Find' tabs.

You'd think that a special compiler was required to create help files that are fully compatible with Windows '95 - in fact, all that is required is the .CNT, and it is merely an ASCII text file that can be written with Windows' NotePad, which anyone can try for any one of their older help files if they have Windows '95. The trick is to compose it properly. Line by line, the essential elements of a Windows '95 .CNT text file are as follows:

`:Base hmhelp.HLP>main`

Defines the base or 'host' help file and, optionally, the window it is to be displayed in ('>window').

`:Title Help File Maker Help`

The title to display in the title bar of the 'Contents' tabbed window.

```
:Index Help File Maker Help =
hmhelp.HLP
:Index hmhelp.cnt
:Index helpref.hlp = helpref.hlp
```

Keywords lists of the specified files will be added to the 'Index' list, in other words merged into the keywords list of the *base* help file.

```
:Link helpref.hlp
:Link cwh.hlp
```

The specified files become part of a group having the base or 'host' file as their own base, all of whose topics are to be shown in the same set of help windows provided by WinHelp. In order for any of the linked files to do the same for the 'host', they must also have .CNT files specifying a link to the 'host'.

`:include another.cnt`

Merge another .CNT into this one at the position of the 'include' instruction. This can be one for a completely different help file.

1 About

2 About Help = Topic0002

Topic jump strings. The number is the indent; '1' is 'root', '2', '3', etc. specify nested sub-listings. '0' makes the line invisible. If the entry has no '=' and topic label, it is displayed as a book icon, otherwise it is shown as a '?-page' icon and performs a topic jump.

2 About Help = Topic0002>Window1

Loads the topic into Window1.

2 About Help = Topic0002@hmhelp.hlp

2 About Help = Topic0002@hmhelp.hlp>Window1

Jumps to topic in the (other) help file specified as '@' (at).

2 Creating Windows Help=!JumpContents("cwh.hlp")

Runs the macro following the '!' command (run a macro).

If WinHelp32 can't intepret a line then it remains invisible. WinHelp32 creates .GID files automatically.

Believe it or not there are many more things that can be done in help files - the subject of creating custom menus and buttons alone would fill an article by themselves, and I haven't discussed the manifold ways of using bitmaps. This is covered in more detail in the help files that accompany a tool I created called Help File Maker, that I was obliged to do for developing ever more sophisticated help files. If you would like a copy of this please apply privately to the author, P. O. Box 5773, Laindon, Essex SS15 5FJ. Maplin Electronics plc and its associates cannot be held responsible for the accuracy or otherwise of this information.

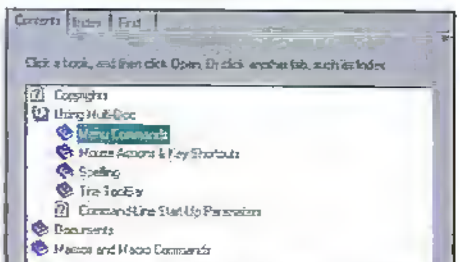


Figure 8. Windows '95's Contents window is invoked after writing a .CNT file.

Words of SCIENCE

PART 2

Science: The Lifeblood of Language

by Gregg Grant

Introduction

Some years ago, in an essay entitled *'Unknown to Jane Austen'* the late Marghanita Laski noted that, apart from the contribution of science, few other areas of human activity were introducing new words into the English language. Francis Fukuyama, in his book *'The End of History and the Last Man'* put forward the view that, of all mankind's activities, only science could be regarded as culminative and directional.

More recently, that fine journalist Bill Bryson - in his tome *'Mother Tongue'* - observed that where *Webster's Third New International Dictionary* contained 450,000 words and the revised *Oxford English Dictionary* some 615,000 words, such figures are only part of the whole. Science and technology between them would at least contribute the same amount again!

Fine: but does this apply to **every** branch of science and technology, or merely to certain select areas only? Does it, for example, apply to electrical and electronic technology? Yes, as it happens, it does. Indeed as we shall discover in Part Three, electrical technology has been, from its inception, a major contributor to the Mother Tongue.

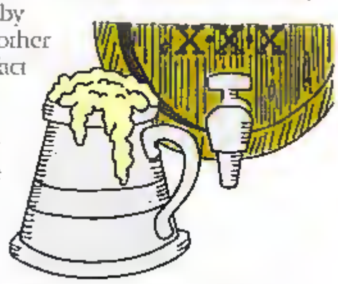
Expanding a Language

English is, in so many ways, a mongrel language. One of the foremost influences on our native tongue was Latin. From the early sixteenth century onwards, English borrowings from this ancient language were extensive, the majority of which were either technical - such as concrete and distillation - or scientific, as in comet and equator.

By 1600 what had begun as a trickle was now approaching a flood. Many words were absorbed as they were, in their Latin form and spelling. Some examples of this are *species* (1551), *cerebellum* (1565) and *radius* (1597). As the eighteenth century approached, further additions included *specimen* (1610), *apparatus* (1628), *focus* (1644), *lens* (1693) and *antenna* (1698).

Other technical, scientific or mathematical terms 'lifted' from Latin included *area, calculus, equilibrium, momentum, pollen, series* and *vacuum*. All of the above words are, generally speaking, those introduced through the written word rather than via speech.

Of course, English borrowed from other languages and dialects too, for British commercial and nautical interests were world-encompassing over a lengthy period. Linguistically too, English enjoyed a considerable advantage in that it possessed an adaptability and grammatical informality unequalled by almost any other tongue. In fact it still does.



Larynx and *cosmos* for example have come to us from classical Greek. French has given English *acoustic* and *cube* whilst Italian has provided *cornice* and *cupola*. *Cargo* and *cask* on the other hand have both come from Spanish. Occasionally English has taken whole expressions from another language, one example of which is *running amok*. This is a Malaysian phrase, whilst *going berserk* is of Viking origin.

Arabic has given us *zero* - from 'sifr,' the 'null point' - and *zenith*, that point in the sky directly above your head. Finally Dutch - a variant of German, as indeed English is - has contributed *splice and stipple* and - on a less technical note - *booze* and *brandy!*

However, in the last century and a half science and its acolyte technology have provided literally thousands of new words and phrases in the course of explaining their advances in understanding the world about us. Many of these words and terms of course were created by specialists for themselves and their fellow specialists, yet many of them passed into general use.

Vocabulary Extension

A language can improve its vocabulary in a number of ways, the most common being the one we've just looked at: the importation of ready-made words and phrases from other languages. Another method - and a very old one too - is the creation of Self-Explaining Compounds, examples of which are *hitchhike, jet propulsion* and *streamline*. A third technique of vocabulary extension is developing Common Words from Proper Names.

A good example of this is Macintosh, the ubiquitous 'Mac.' It is a waterproof fabric, made originally by dissolving rubber in low-boiling naphtha, a technique invented by the Glasgow chemist Charles Macintosh in 1823.

Another example of this technique is *Galvanise*. This is the process of giving sheet iron a zinc coating by electro-chemical means, so as to prevent the formation of iron oxide, better known as rust. The technique takes its name from the eighteenth century Italian physicist Luigi Galvani.

Samuel Morse too looked closely into language prior to announcing his code to the world, in 1838. He'd borne in mind the predominance of certain letters in the course of the code's development, the most used of which was the letter **E**. Thereafter, Morse considered, the pecking order was as in Figure 1.

Forty-six years later, in 1884, the German-born American inventor Ottmar Mergenthaler patented the Linotype Machine. Controlled from a keyboard, the device could set a whole line of type at one time. For the next 75 years the machine - and its unusual keyboard - would be the mainstay of printing and publishing.

Mergenthaler's keyboard was arranged so that the most used characters circulated the

E T A O I N S H R
D L C U M W F G
Y P B V K J X Q Z

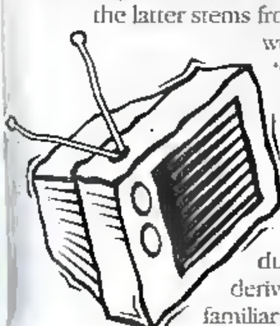
Figure 1. Morse's view of the most used letters in the English language in descending order.

Figure 2. Mergenthaler's keyboard for his Linotype Machine of 1884.

most rapidly. His investigation into the printing business and the English language gave him a letter order far removed from the QWERTY keyboard, already a familiar tool, as can be seen from Figure 2.

Other languages of course also provide compounds formed from their elements, one example of which is *Scope*. It comes from a classical Greek word meaning 'a watcher.' *Stethos* is the Greek word for breast and *Oscillare* is a Latin word meaning 'to swing.' Hence the compounds Stethoscope and Oscilloscope. *Tele* on the other hand is classic Greek for 'far,' which has given us Telephone and Television.

Many words and descriptive expressions in science and technology are composed of such dual linguistic elements. Other examples are *Fluoro* and *Broncho*. The former derives from the Latin *Fluere*, meaning 'to flow,' whilst the latter stems from a classical Greek word meaning 'windpipe.' By linking both words with Scope, we derive the familiar Fluoroscope and Bronchoscope.



Another dual-element derivative is the long familiar *Panchromatic*. It comes from two Greek words, one of which means 'All,' whilst the other can be translated as 'Relating to Colour.' The combination is used to indicate a film which is sensitive to all colours.

Prefixes and suffixes are other elements in the enlargement of a language's vocabulary, as are newly invented words - or Coinages - as they are termed. One example of the latter is *Kodak*. It began life as a trademark, before being used to describe almost all cameras or types of photographic film. *Zipper* was originally coined by the B.F. Goodrich Company in 1925, it being registered as the name for a boot with a side fastener. Shortly thereafter, it became the name for the fastener itself!

Scuba on the other hand is an example of a coinage from the first two or more letters of words describing a device or technique. In 1943, two Frenchmen, naval officer Jaques-Yves Cousteau and engineer Emile Gagnan invented a Self-Contained Underwater Breathing Apparatus, which they termed the Aqualung. It was Scuba however that caught on and today scuba diving - another example of a Self-Explaining Compound - is a popular leisure activity, worldwide.

Finally, another way of extending a language's vocabulary is to give old words new meanings. Examples of this technique abound in technology, such as 'calling up,' on the telephone, 'taking off' in an aircraft and 'standing by' whilst operating a radio transmitter. In fact, it's possible to date a technology's introduction into everyday use by the general public's familiarity with the words associated with the new development. Table 1 illustrates this useful pointer from the early nineteenth century to the opening of the present century, and the coining of 'Television,' the now ubiquitous TV.

Television? I hear you ask, puzzled. Whatever happened to radio then? This is by no means the least of the anomalies we'll uncover over the next few months as we explore the words of electrical and electronic engineering.

My interest in this absorbing subject is that of Avionics - yet another dual linguistic element composition - technical author and occasional journalist, concerned alike with technology, language and grammar. And talking of the latter, the word once meant *Magic*. In fact the older form of the word - *Grammarye* - still means exactly that. Another form of the word is *Glamour*, which also has a somewhat magical ring to it.

So what has this to do with disciplined fields like electrical and electronic engineering? Nothing so nebulous, ephemeral as magic involved there, surely? Wrong!

A great deal of phenomena - another sixteenth century introduction, this time from the Greek *phainesthai*, via Latin - hitherto thought of as magical turned out to have an electromagnetic explanation, as we'll discover, next month.

Year	Technology
1834	*Concrete* - in the sense of a mixture of crushed stones and cement - first introduced.
1835	The railway arrives, as shown by the introduction of *Turntable*, *Locomotive* and - of course - *Railway*.
1839	*Photography* is introduced to the world as a result of William Henry Fox Talbot's invention of the photographic negative paper.
1841	An American quotation of this date is the earliest mention of *Refrigeration*.
1856	*Cable* enters everyday speech, just prior to the laying of the first transatlantic telegraph cable in 1857-58. She/he *Cabled* me became the standard expression for using this form of 'getting in touch.'
1870	That the electrical industry is setting out to dominate the world's power supply market is illustrated by *Alternating current*, *Dynamo* and *Commutator*. All three terms became commonplace at this time.
1899	Mass entertainment begins to make a mark on the general public, as indicated by new words such as *Cinema and Moving Picture*.
1904	The word *Television* is first coined by its master prophet, the British electrical pioneer A.A. Campbell-Swinton, some 20 years before the introduction of the word *Radio*.

Table 1. The Introduction of a Technology and the Adoption of its Language.

Atmel AVR MICROCONTROLLER

Kevin Kirk of Kanda Systems Ltd. describes a simple application to get you started.

The AVR microcontroller from Atmel has been causing quite a stir recently in the electronics press. Is it any wonder, this range of 8-bit RISC processors are fast, code efficient, low cost and to top it all have flash program memory – so you can program them time and time again on your board using in-system programming! The range has been designed for ease of use and appeal to both the hobbyist and the company designer alike.

This article looks at some practical aspects of designing with the AVR device. The following application is based around the AT90S1200 version of the AVR family as it is low-cost and readily available. This particular device features 1kbyte of flash memory, 64-bytes of EEPROM, 15 general purpose I/O lines, 32 general purpose working registers, internal and external interrupts programmable watchdog timer and an SPI serial port for program downloading. Note that at the time of writing there are five versions of the device available that can be purchased from Maplin. As well as the 1200 version there is the AT90S8515, which is the biggest in the range with pwm, 8K of code space and 4 x 8-bit ports, the AT90S4414, which is the same as the 8515 except that it has 4k of code space. The AT90S2313 is a 20-pin device with all sorts of goodies on it including serial port, pwm, dual counters etc. The AT90S2323 is basically the same as the 2313, in terms of memory etc. but it comes in an 8-pin package. Please refer to the latest Maplin Catalogue for types and prices.

The suggested application is intended to stimulate your creative juices, so you can start working on your own projects, which I'm sure the editor of *Electronics and Beyond* would love to see. No PCB have been designed for the application – I will leave that bit up to you!

The methodology for most of the circuits is that you will want to connect the Kanda Systems In-System Programming (ISP) interface (part of the AVR Starter Kit available from the Maplin catalogue) on a fairly continuous basis to your circuit. This enables you to make changes and tweaks as you explore the system and refine its operation. This is one of the major advantages of the AVR devices - you can reprogram them up to 1,000 times in-situ without having to resort to EEPROM erasers or programming voltages. This feature has been built into the circuit with connections via a 10-pin, 0.1" pitch dual header. The AVR Starter Kit includes an assembler, simulator, programming software, in-system programming cable and a battery powered device programming module.

AVR Starter Kit Maplin order code NR20W Price £76.36 inc VAT.

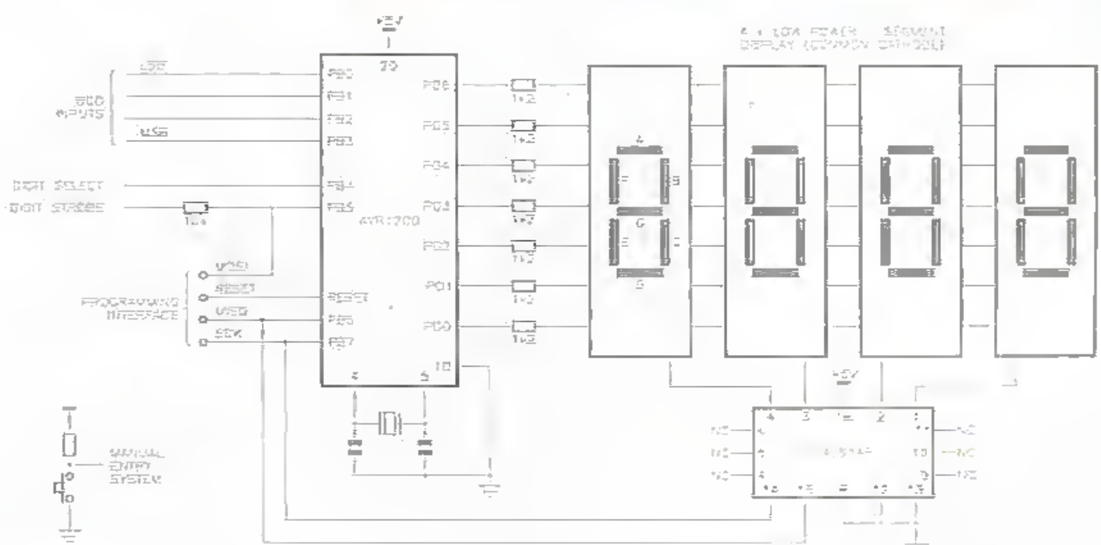


Figure 1. Circuit diagram.

AVR Workshop Maplin order code NW61R Price £149.99.

BCD to Quad (multiplexed) 7-segment display (Figure 1)

Its all very well being able to drive an LED or two directly from a microcontroller, but to get any meaningful data out you really need to go over to some form of multi-segment display. The best known of these is the 7-segment display which can display all 10 numeric characters plus a few alpha characters (A, B, C, D, E, F etc.). To make the display really meaningful you need to display more than one set of characters, four being an ideal number. This opens up all sorts of possibilities for displaying values, messages etc. There are ICs around that will do this job for you but they tend to be expensive and/or difficult to obtain., so this application is designed to allow you to create a 4-digit display with the minimum of parts. Humans, for some obscure reason, have decided on a numbering system based around the digits 0 to 9, instead of the eminently more sensible hexadecimal (that is 0 to15 or 0 toF), so the input is BCD (binary coded decimal). Although, we can make this little system work with either BCD or Hex - in fact you can make it display whatever you want - try experimenting!.

As you can see from Figure 1, the circuit is not particularly complicated consisting of two devices. The first is the AT90S1200 and the other is a decoder/driver, which is used to select the display device we want to drive. The system for driving four devices from one set of outputs is called multiplexing. In essence what this means is that you switch on each of the devices in turn and rely on the persistence of the human eye to create the illusion that the digit is displayed permanently. This technique is very common as it reduces power consumption and device resources. It is for this reason that if you see a film on the TV where there is, say, a digital alarm clock, the digits tend to flash as the frame speed of the camera is out of sync with the display multiplexed speed.

So we are using the AVR to decode the incoming data, which is in BCD format, and then convert that into the 7-segment codes. Because there are four possible digits, each of which requires BCD data, and to limit the number of lines devoted to data input we are using two input lines to select the digit and latch it into the device. The methodology is quite straightforward. On switch-on, you enter the BCD code (which for test purposes could be via a BCD switch), and then take the digit strobe high then low. The first digit (the very right hand one) now has its data latched in. The digit select line is then taken high then low, which selects the next digit. This whole exercise is repeated for all four characters (valid BCD, strobe it into the latch).

The valid data is now stored in the device. We will store these values in four consecutive EEPROM addresses (after all we have 64 at our disposal). This means that even if the power is subsequently switched off the system will display the loaded values when it is switched back on again. These values will then be converted into their respective 7-segment display codes. If you look at the diagram you will see that the segments are numbered (lettered?) from A to G. These correspond to the AVR port pins: The way it works is that in order to display

A	PD6
B	PD5
C	PD4
D	PD3
E	PD2
F	PD1
G	PD0

the digit '1' you light up segments B and C and leave the rest dark. In this system you put a '1' out on the port to light a segment and a '0' to leave it dark. So the databyte you would put out on the port is $30, which is 0110000 in binary. Incidentally, the $ sign means that the value is a hex number. To display a '2' you light segments A, B, G, E and D, which corresponds to a value of $6D (binary 110 1101). I think you can see the pattern emerging. So what we now need to do is to create a look up table which contains the codes for the various digit display options. To save time I'll do this for you, they are:

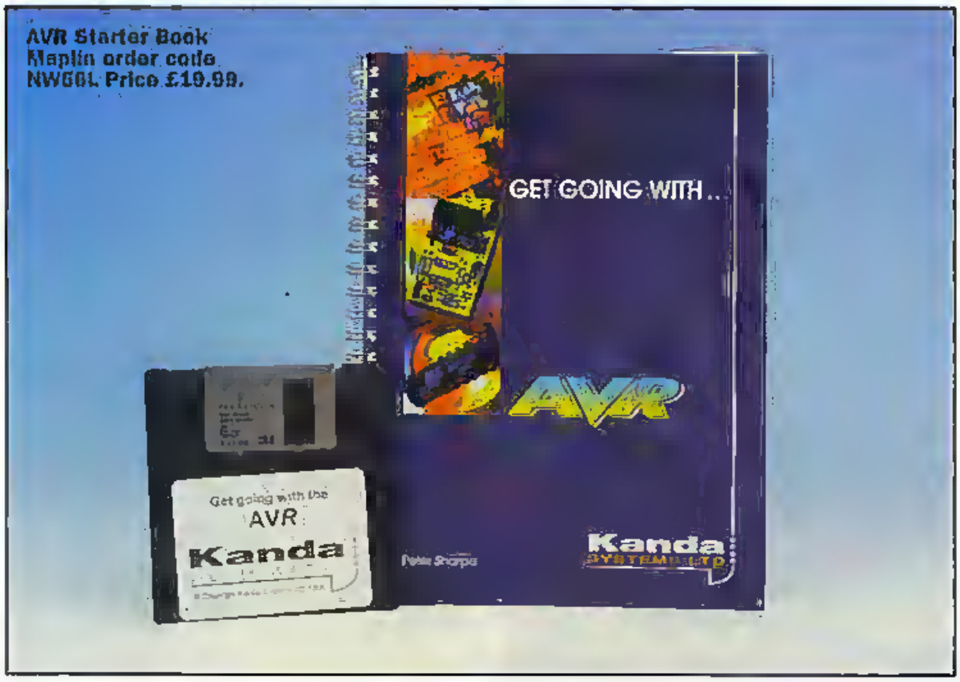
So now we have the conversion codes, but

Digit	Value
0	$7E
1	$30
2	$6D
3	$79
4	$33
5	$5B
6	$5F
7	$70
8	$7F
9	$73

what are we going to do with them? We are putting the values in the form of numbers, which can be equated to addresses. So if we had some form of non-volatile storage we could store them sequentially in there and then merely look them up using the number we put in as the address. As luck may have it, the AVR just happens to have just such storage (you knew I was going to say that didn't you?) in the form of EEPROM. To save time we can load these values into the programming software and it can do all that for us. If you are using the AVR Starter Kit from Maplin you can simply open the new project, go to the EEPROM editor, and simply enter those numbers in sequence. So far so good.

Now the code. For this you are going to need the assembler which comes with the AVR Starter Kit (or which can be downloaded from the Atmel website `http://www.atmel.com`). We need to effectively split the code into two distinct parts - the first is the data loading and the other is the display decoder/driver. But before we do anything else, we need to set up the ports so they are either inputs or outputs, which is achieved by writing to the data direction registers (DDRB for port B and DDRD for port D). A '0' sets that corresponding bit to input and a '1' to output. The ports we are using are:

Port	Bit	Function	Bit Setting
B	0	BCD – LSB	0
B	1	BCD – NLSB	0
B	2	BCD – NMSB	0
B	3	BCD – MSB	0
B	4	Digit Select	0
B	5	Digit Strobe	0
B	6	Display Select 1	1
B	7	Display Select 2	1
D	0	Segment G	1
D	1	Segment F	1
D	2	Segment E	1
D	3	Segment D	1
D	4	Segment C	1
D	5	Segment B	1
D	6	Segment A	1



AVR Starter Book Maplin order code NW66L Price £19.99.

This yields a DDRB value of $03 and a DDRD value of $7F (Note port D only has 7-bits). In order to put these out to the I/O space we must use a spare register so we'll use R17. The code now looks like this:

```
LDI   R17,$03
OUT   $17,R17
LDI   R17,$7F
OUT   $11,R17
```

Note that I'm using the physical address values for DDRB ($17) and DDRD ($11). You could use the names instead, as long as you ensure that the assembler has the right library file loaded (you do an include at the beginning, see an example program that comes with the assembler for how to do this). However, if you do it this way it will always work.

Next we will look at the methodology for getting the data entered. Here we need to watch the data strobe line and when it goes high we'll load in the data value on the BCD inputs. This will happen at switch on, or a reset, so the digit pointed to is the right hand one, or LSD). This is done as shown in listing 1.

```
In_loop1: SBIS $16,5     ;look for pin b going high ($16 is port B inputs)
          RJMP in_loop1  ;loop if it isn't
          IN   R18,$16   ;get the value
          ANDI R18,$0F   ;Flush the top nibble
          OUT  $1D,R18   ;store in eeprom data register
          LDI  R17,$10   ;load eeprom address
          OUT  $1E,R17
          SBI  $1C,1     ;perform eeprom write
eloop1:   SBIC $1C,1     ;wait for it to finish
          RJMP eloop1
sloop1:   SBIC $16,5     ;wait until strobe goes low again
          RJMP tloop1
ds_loop1: SBIS $16,4     ;look for next digit select
          RJMP ds_loop1  ;loop if it is not set.
ds_low1:  SBIC $16,4
          RJMP ds_low1   ;wait for it to go low again
```

Listing 1.

Well that's entered one digit! Note that in order to write to the EEPROM you need to load the address and data into special registers and then set the write bit. Then you keep reading this write bit until it goes low (usually after 2-3ms) which will indicate that the write has been done. You can see why it is easier to load the EEPROM data for the display decoding (which will never change) at program time rather than write a slew of code to do it as part of the main program code.

Now all we have to do is repeat this using EEPROM address $11 for the next digit, $12 for the next etc. We'll just cut and paste at this stage. It can be done a more elegant way, but we have no shortage of code space so this will suffice. I'll leave the actual code listing until the end, because now I want to concentrate on the display driving. The way this works is to get the value from the EEPROM which we will then use as a pointer to get the decoded value from EEPROM and then put it out on the port. We then select the digit and it will be displayed.

This does raise an interesting little problem as we want to do two things at once. We need to set up a time-out to determine when the next digit needs to be displayed, and get input data at the same time. To overcome this problem we will use an interrupt from the timer, which requires us to set up the interrupt vectors (a tetchy way of saying addresses) which live at the start of the program (shown in Listing 2).

```
Reset: RJMP   main       ;Reset Vector
       NOP               ;External Interrupt Vector
       RJMP   Digits     ;Timer Interrupt Vector
       NOP               ;Comparator Vector
Main:  LDI    R17,$05    ;Set Timer prescaler to max (/1024)
       OUT    $32,R17
       LDI    R17,$02    ;Set Timer interrupt up
       OUT    $39,R17
       LDI    R17,$80    ;Set General Interrupt bit
       OUT    $39,R17
       LDI    R19,$14    ;Seed timer loop counter with 20
       CLR    R20        ;Clear Digit Pointer
```

Listing 2.

What will happen now is that every 1024 clock cycles the program will jump to the interrupt service routine (ISR) called Digits, which, if you are using a 4MHz crystal (or

```
Digits: DEC   R19       ;Look for loop counter time out
        BRNE  Quit      ;return to main program if it hasn't
        MOV   R21,R20   ;get digit pointer
        SBR   R21,7     ;set top bit to point to data value
        OUT   $1E,R21   ;data address in eeprom
        SBI   $1C,0     ;read eeprom
        IN    R22,$1D   ;store it
        OUT   $1E,R22   ;use it as a pointer
        SBI   $1C,0
        IN    R22,$1D   ;Decoded value
        OUT   $12,R22   ;Put it out on the port
        ANDI  R21,$03   ;flush all except digit pointer bits
        LSR   R21
        LSR   R21
        LSR   R21       ;put digit select on right port pins
        INC   R20
        ANDI  R20,$03   ;flush all bits except 2 bottom ones
Quit:   RETI
```

Listing 3.

```
Reset:    RJMP main     ;Reset Vector
          NOP           ;External Interrupt Vector
          RJMP Digits   ;Timer Interrupt Vector
          NOP           ;Comparator Vector
Main:     LDI  R17,$05  ;Set Timer prescaler to max (/1024)
          OUT  $32,R17
          LDI  R17,$02  ;Set Timer interrupt up
          OUT  $39,R17
          LDI  R17,$80  ;Set General Interrupt bit
          OUT  $35,R17
          LDI  R19,$14  ;Seed timer loop counter with 20
          CLR  R20      ;Clear Digit Pointer
          LDI  R17,$03
          OUT  $17,R17
          LDI  R17,$7F
          OUT  $11,R17
In_loop1: SBIS $16,5    ;look for pin b going high ($16 is port B inputs)
          RJMP in_loop1 ;loop if it isn't
          IN   R18,$16  ;get the value
          ANDI R18,$0F  ;Flush the top nibble
          OUT  $1D,R18  ;store in eeprom data register
          LDI  R17,$10  ;load eeprom address
          OUT  $1E,R17
          SBI  $1C,1    ;perform eeprom write
eloop1:   SBIC $1C,1    ;wait for it to finish
          RJMP eloop1
sloop1:   SBIC $16,5    ;wait until strobe goes low again
          RJMP sloop1
ds_loop1: SBIS $16,4    ;look for next digit select
          RJMP ds_loop1 ;loop if it is not set.
ds_low1:  SBIC $16,4
          RJMP ds_low1  ;wait for it to go low again
in_loop2: SBIS $16,5    ;look for pin b going high ($16 is port B inputs)
          RJMP in_loop2 ;loop if it isn't
          IN   R18,$16  ;get the value
          ANDI R18,$0F  ;Flush the top nibble
          OUT  $1D,R18  ;store in eeprom data register
          LDI  R17,$10  ;load eeprom address
          OUT  $1E,R17
          SBI  $1C,1    ;perform eeprom write
eloop2:   SBIC $1C,1    ;wait for it to finish
          RJMP eloop2
sloop1:   SBIC $16,5    ;wait until strobe goes low again
          RJMP sloop2
ds_loop2: SBIS $16,4    ;look for next digit select
          RJMP ds_loop2 ;loop if it is not set.
ds_low2:  SBIC $16,4
          RJMP ds_low2  ;wait for it to go low again
In_loop3: SBIS $16,5    ;look for pin b going high ($16 is port B inputs)
          RJMP in_loop3 ;loop if it isn't
          IN   R18,$16  ;get the value
          ANDI R18,$0F  ;Flush the top nibble
          OUT  $1D,R18  ;store in eeprom data register
          LDI  R17,$10  ;load eeprom address
          OUT  $1E,R17
          SBI  $1C,1    ;perform eeprom write
eloop3:   SBIC $1C,1    ;wait for it to finish
          RJMP eloop3
sloop3:   SBIC $16,5    ;wait until strobe goes low again
          RJMP sloop3
ds_loop3: SBIS $16,4    ;look for next digit select
          RJMP ds_loop3 ;loop if it is not set.
ds_low3:  SBIC $16,4
          RJMP ds_low3  ;wait for it to go low again
in_loop4: SBIS $16,5    ;look for pin b going high ($16 is port B inputs)
          RJMP in_loop4 ;loop if it isn't
          IN   R18,$16  ;get the value
          ANDI R18,$0F  ;Flush the top nibble
          OUT  $1D,R18  ;store in eeprom data register
          LDI  R17,$10  ;load eeprom address
          OUT  $1E,R17
          SBI  $1C,1    ;perform eeprom write
eloop4:   SBIC $1C,1    ;wait for it to finish
          RJMP eloop4
sloop4:   SBIC $16,5    ;wait until strobe goes low again
          RJMP sloop4
ds_loop4: SBIS $16,4    ;look for next digit select
          RJMP ds_loop4 ;loop if it is not set.
ds_low4:  SBIC $16,4
          RJMP ds_low4  ;wait for it to go low again
Digits:   DEC  R19      ;Look for loop counter time out
          BRNE Quit     ;return to main program if it hasn't
          MOV  R21,R20  ;get digit pointer
          SBR  R21,7    ;set top bit to point to data value
          OUT  $1E,R21  ;data address in eeprom
          SBI  $1C,0    ;read eeprom
          IN   R22,$1D  ;store it
          OUT  $1E,R22  ;use it as a pointer
          SBI  $1C,0
          IN   R22,$1D  ;Decoded value
          OUT  $12,R22  ;Put it out on the port
          ANDI R21,$03  ;flush all except digit pointer bits
          LSR  R21
          LSR  R21
          LSR  R21      ;put digit select on right port pins
          INC  R20
          ANDI R20,$03  ;flush all bits except 2 bottom ones
Quit:     RETI
```

Listing 4.

resonator it isn't fussy), will work out at every 2.5ms, This is a bit quick for our purposes (we want to change digits every 50ms or so), so we need to slow it down. By a startling piece of good luck, 50/2.5 gives us a nice integer to work with of 20. So every 20th time we see an interrupt we'll change digit. Now all that's left to do is to write some code to read a value from the EEPROM, use it as an address to point to the decoded value and put that value out on the port. This should look something like Listing 3.

The LSR instructions may not be completely obvious but what they are doing is lining up the pointer bits from the digit address with the ports. So the code in full looks like Listing 4.

If you want to experiment a little why not try loading different digit decoded values into the eeprom at program time. Then you could display certain letters (up to 16 different ones) by putting in binary values.

This design example was based around the low cost AVR Starter Kit available from the Maplin catalogue, but you may want a more comprehensive design environment for your next AVR design, why not discover the benefits of the AVR Workshop (order code NW61R). The AVR Workshop includes a device function monitor and single stepping, an integrated development environment for Windows which allows seamless design migration between the AVR builder (software to easily set up device peripheral – it produces the code for you!), professional IAR assembler, device simulator and programming software. The hardware consists of an application board with on-board speaker, LEDs, switches and RS232 provision so you can fully test your designs along with a free in-system programmer. All Kanda Systems products come with free product lifetime technical support via our unique Gold Card scheme.

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Radioactivity
A CENTURY OF CONTROVERSY
PART 4

Greg Grant Looks at Radiation and Health

Medical Radiation

The radiation doses to which we are all subjected - to a greater or lesser extent - vary considerably. Generally speaking however, the dosage from man-made radiation is much less than that which is emitted naturally. Up to 1986, some 40 people per annum were killed in mining accidents in the United Kingdom (UK) alone. Yet this fact is given little or no prominence. If, however, as many as one tenth of this figure had been killed in a civil nuclear accident, it would have been headline news world-wide. In fact "probably no myth is more widely believed than that radiation is continuously escaping from nuclear plants and killing people." [1]

In his book 'Radiation & Human Health,' Dr Jonathan Mensah shows just how extensive natural radiation is. This fact is illustrated in Table 1, where nuclear and other man-made radiation are shown to amount to a puny 1.7% of the total!

Given these figures, how did the nuclear industry come to get such an atrocious press and near-pariah status world-wide? Largely as a result of its beginning, whose first product was the bomb dropped on the Japanese city of Hiroshima in August, 1945. Three days after this initial detonation a second, plutonium, bomb was dropped on another Japanese city, Nagasaki. The casualties resulting from the second strike numbered 40,000.

A month after the first bomb had been dropped the Australian journalist Wilfred Burchett, of the London Daily Express newspaper, arrived in Hiroshima. On September 5th his newspaper published his historic exclusive report, the first newspaper account anywhere to describe radiation sickness.

In the following May, the New York Times newspaper dispatched the author, journalist John Hersey, to Hiroshima to discover what had actually happened to the city and to those who had survived history's first nuclear bomb strike. Hersey's 30,000 word account " . . related, in straight narrative form and in a sober, matter-of-fact style, what happened to six ordinary Hiroshima people on that extraordinary day." [2]

The New York Times devoted its August 31st issue to Hersey's account and the entire print run sold out in hours. It was also carried by broadcasting networks of the stature of the British Broadcasting Corporation (BBC), and the American Broadcasting Corporation (ABC), as well as being serialised, or syndicated, in other newspapers, periodicals and journals. Subsequently, it was also published as a book. To the general public it was clear that nuclear science and technology were ultimately destructive, no matter which way one looked at it. The view remains predominant, despite the figures of Table 1.

Shortly after the publication of Wilhelm Rontgen's paper, Columbia University's Michael I. Pupin took the first X-ray photograph in the United States (US). Seven years later, the German surgeon George Perthes discovered that X-rays could inhibit tumour growth and proposed that the new radiation be used in the treatment of cancer.

In 1900, Walter B. Cannon graduated in medicine from Harvard, joining the Neurological faculty as a lecturer. He became one of the earliest physiologists to use X-rays and developed bismuth compounds to enable soft internal organs to be seen on X-rays.

However, the dangers inherent in X-rays had already been noted. In 1906 Becquerel - no less! - discovered that radiation had to be taken seriously. He accidentally burned himself through carrying radioactive material in his pocket! Another early experimenter to discover that X-rays could harm human tissue was the American electrical engineer Elihu Thomson. He deliberately exposed one of his fingers to the new radiation and accurately noted the burns that resulted.

In the course of the following decades, other investigators developed both cancer and radiation burns in the course of their work. One clinician noted for his careful studies of the rates of mutation under both natural and artificial conditions was the American medical scientist Hermann J. Muller.

In 1927, he carried out a classic series of experiments demonstrating the effects of X-rays on insects, proving that such radiation could increase mutation rates by as much as 150 times. Having held research and academic

Radiation Type	Percentage of Total Radiation
Natural Background Radiation	67.6%
Medical Equipment in General	30.7%
Other Man-Made Radiation	1.55%
Nuclear Plant and Equipment	0.15%

Table 1. Radiation Exposure of the United Kingdom Population.

Figure 1: Relative radon gas concentrations in the United Kingdom.

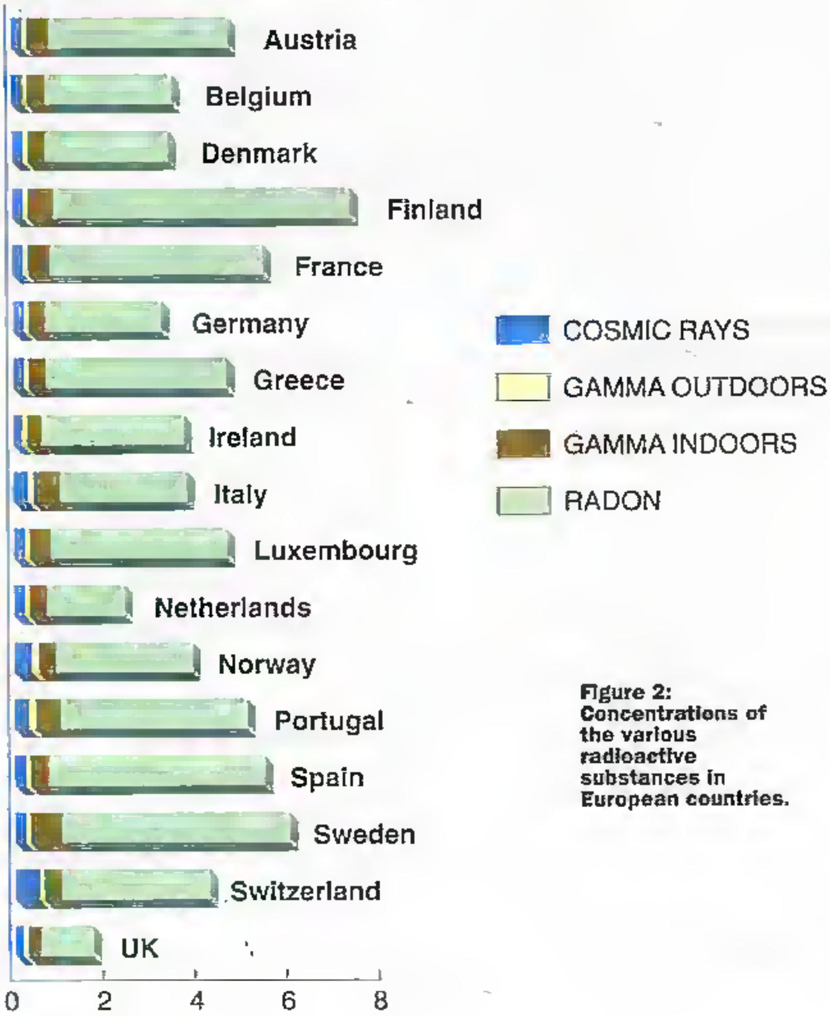

Figure 2: Concentrations of the various radioactive substances in European countries.

posts in Moscow, Leningrad and Edinburgh, Muller returned to the US in 1940, where he continued his research. His experience of the widespread genetic effects of the irradiation of germ cells, frequently leading to lethal mutations, meant that he took a jaundiced view of X-rays. By the time of his return home, he had already begun to campaign against the dangers of such irradiation for the human race. In 1946, he was awarded the Nobel Prize in Medicine for his work.

Such research, and the deaths of some 100 people as a result of exposure to X-rays, led to a greater awareness of the dangers to which physicists, physiologists and other medical personnel are exposed in the course of their work. This stimulated the development of the new scientific discipline of radiobiology, one of whose founders was the British physicist Louis Gray.

In fact, the largest source of man-generated radioactivity in the UK results from the activities of the medical profession. Radioactive substances and X-rays are used in the treatment and diagnosis of a wide variety of diseases. Doses vary from patient to patient and from illness to illness. However, the average medical radiation dose in the UK is some 370 mSv per annum, although some doses can be a few hundred times stronger than this.

Moreover, the average dose has increased in recent years due to greater use of Computed Tomography (CT) scanning which gives higher doses than conventional radiographic equipment. Radioactive substances are also used in the chemotherapy treatment of cancer, where individual target tissues can be subjected to *very* high doses indeed.

Radon Gas Doses

X-rays of course are by no means the only form of radioactive substance that is a potential danger to health. Another substance that gives cause for concern is the radioactive gas Radon. Half of all the radiation to which the majority of people in the UK are exposed, results from radon gas leaking from the ground.

Radon levels or concentrations are measured as the amount of gas detected in a cubic metre of air. One Becquerel per cubic metre - $1Bq/m^3$ - means one disintegration every second, per cubic metre of air. The UK National Radiological Protection Board, the NRPB, have shown that the majority of homes in Britain have reasonably low levels of this ubiquitous gas, they averaging around 20 Bq/m^3.

Not all areas of the country have levels as low as this of course. In the Radon map of Figure 1, relative concentrations are shown as peaks. In some areas - for example Northeast Scotland; the Midlands; the Highlands; the southeast corner of Northern Ireland and Southwest England - levels are more than 10 times the average leakage figure.

Outdoors, Radon readily disperses and, as a result, levels are low. But, indoors matters are entirely different. Depending on the locality, indoor levels can build up due to the nature of the terrain on which a property is built, the ventilation and the local atmospheric conditions. Nevertheless, as Figure 2 illustrates, the UK has the lowest concentrations of both radon gas and cosmic ray penetration in Europe.

Ultra-Violet Radiation

As early as 1893, the 33-year-old Danish physician Niels Finsen established that Ultra-Violet (U-V) radiation could kill bacteria as well as cure the skin disease lupus vulgaris, or tuberculosis of the skin.

In fact U-V radiation can produce both direct and indirect effects on the human body. The direct effects are limited to the surface skin, because such rays have low penetrating power. This, of course, is how we all acquire a suntan. The indirect effects result in damaged skin cells releasing histomine, which causes skin inflammation.

In 1913 the French physicist Charles Fabry showed that at heights of 6 to 30 miles, significant amounts of the three-atom molecule Ozone were present in the atmosphere. As a result, this region is occasionally termed the ozonosphere.

This layer prevents the more energetic U-V radiation from the sun, which is life-threatening, from reaching the earth's surface.

Seventeen years after Fabry's discovery another chemical revelation took place, one that would be paradoxical to say the least. Refrigerators and air conditioning units (ACUs) had been practical realities since 1876 and 1902 respectively, using gases such as sulphur dioxide and ammonia. Unfortunately, these gases were poisonous and gave off choking odours. Therefore, a leak in either an ACU or a refrigerator was not simply uncomfortable, it was dangerous too. What was required of course was a refrigerant that was non-poisonous, easily evaporated, odourless and stable.

In 1928, the Frigidaire Division of General Motors began a search for just such a substance. Two of their industrial chemists - Thomas Midgley Jr. and Albert Henne - had "... decided that certain compounds of carbon containing both fluorine and chlorine might be suitable, although compounds of fluorine had sometimes been reported to be toxic." [3]

Two years later, having closely studied the chemical literature, Midgley prepared difluorodichloromethane, a fluid with "... a molecule consisting of a carbon atom to which two chlorine atoms and two fluorine atoms were attached." [4] Midgley's creation in short was a *Chlorofluorocarbon*, or CFC.

This substance, it was later discovered, could be used in a number of other ways too, principal among them being as a propellant for spray cans. Frigidaire teamed up with the chemical giant Du Pont, and created the Freon division at Du Pont's to produce, and further develop, CFC chemistry. In other words, ACUs and refrigerators moved from the industrial, catering and office environments into the home.

CFC chemistry had some unforeseen effects. Having been sprayed into the air or leaked from either ACUs or refrigerators,

Radioactivity	Cause	Effect
Cosmic Rays.	From the atmosphere.	Some 100,000 cosmic ray neutrons and 400,000 secondary cosmic rays penetrate the average person every hour.
Alpha & Beta Particles. Gamma Rays.	Through normal breathing.	As a result of breathing, around 30,000 atoms disintegrate in our lungs. This disintegration produces both alpha & beta particles as well as a quantity of gamma rays.
Potassium & Uranium atoms.	Ingestion of food & drink.	Around 15,000,000 potassium-40 atoms and some 7,000 natural uranium atoms disintegrate inside each and every one of us every hour.
Gamma Rays.	Natural radiation of the soil and building materials.	More than 200,000,000 gamma rays pass through each and every one of us every hour from these two sources.

Table 2. Natural radiation exposure per individual.

some CFCs drifted into the upper atmosphere. Once there of course they came up against the ozone layer.

In 1974, two American environmental scientists, Mario Molina and F. Sherwood Rowland, put forward the view that such CFCs were, in fact, eating away at the ozone layer, a view later substantiated by scientists of the British Antarctic Survey, who confirmed that there was a 'hole' in the ozone layer above the South Pole.

Mankind's protection against excessive U-V radiation in other words was quietly vanishing. Two years later, the US Academy of Sciences reported that Freon could indeed deplete the ozone layer and, in 1978, CFCs were banned for use as spray propellants in the US.

Work-Related Radiation Dosage

Both man-made and natural radioactivity contribute to occupational radiation dosage. By far the most exposed of the nation's workforce are those whose professions take them into, or close to, natural radioactive sources. The vertical bar chart in Figure 3 illustrates the number of workers in each dosage range. Over 250,000 UK employees receive less than 5mSv of radiation per annum.

By far the largest group of employees prone to occupational radiation - some 50,000 approximately - are those whose jobs are located in the radon-abundant areas highlighted in Figure 1. Even in those areas individuals rarely receive annual doses of more than 5mSv.

One particular specialisation which receives a higher dosage than other professions is military and civil aircrew. The reason for this is that the dosage from cosmic rays increase with both latitude and altitude. Frequent air travellers - for example air couriers and the Queen's messengers - receive even greater dosages perhaps than aircrews. High energy particles of course have no difficulty penetrating an aircraft fuselage!

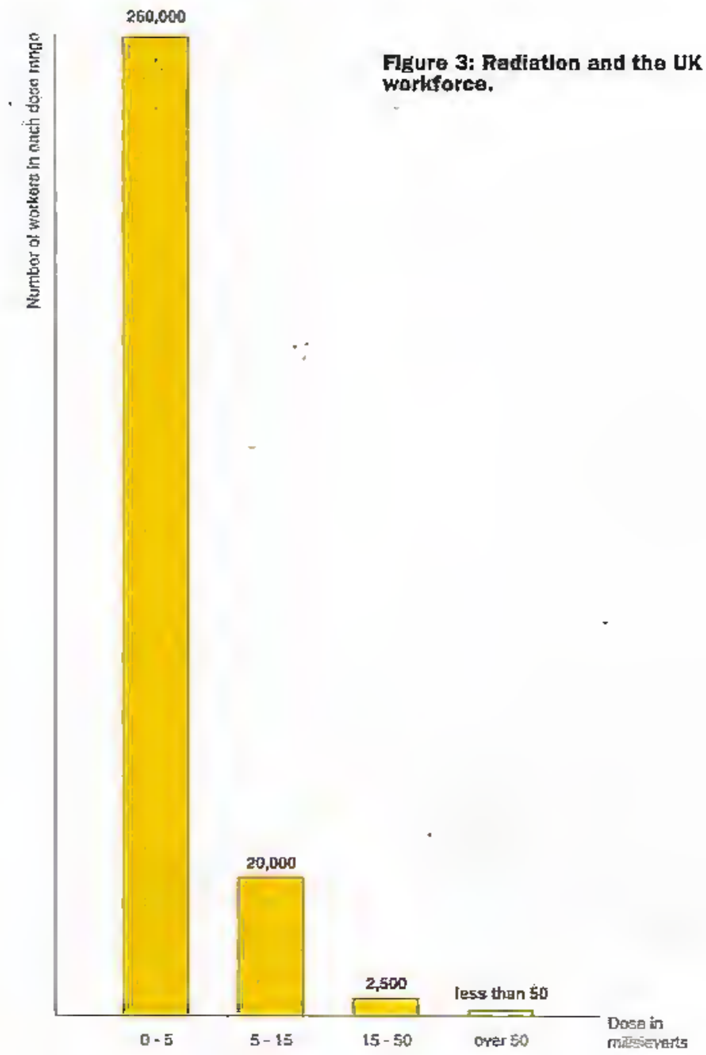

Figure 3: Radiation and the UK workforce.

Food and Drink

Even in our pleasures, one of which is undoubtedly food and drink, we cannot - it seems - escape natural radioactivity. One example is crustaceans. All members of this species, shellfish particularly, concentrate natural radioactive materials. Therefore, if an individual is particularly fond of shellfish and eats very large quantities of them, she or he could receive a dose of natural radiation roughly 50 times higher than normal.

There is also the matter of radiation introduced into foodstuffs to preserve them. In America in 1968, the Nuclear Materials Equipment Corporation began the sterilisation of potatoes and bacon by irradiating them from a radioactive cobalt-60 source. However, shortly afterwards the Commissioner of the US Food and Drug Administration, James L. Goddard, refused to allow radioactively sterilised tinned ham to be passed for human consumption by the US Army.

All of the above facets of radiation and health, where individuals are concerned, are summarised in Table 2, above.

There is, of course, one aspect of radioactivity we have not, so far, looked at - the nuclear industry, and this will be the subject of the final piece in this series.

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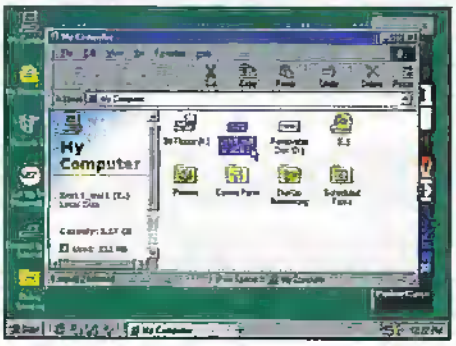
COMMENT

by Keith Brindley

Main desktop — Windows in Windows 98 by default have a quasi-Web browser style. This can be turned off or further expanded with various system options.



Despite the intervention of the US Department of Justice and, it seems, almost despite the will of the whole wide world, Microsoft finally made it and released the latest version of its operating system software, Windows 98, at the end of June. It's taken all but a month or two short of three years for this latest update to hit the streets, and many would be forgiven for thinking that the latest version must be significantly improved.

It is, and it isn't – depending on how you look at it. There aren't any mind-bogglingly stupendous new additions to its feature set, unlike the release of Windows 95, which represented a totally new way of using a computer for most PC users. But what it does bring to the PC desktop is greater stability and a few neat additions that go almost undetected if you're not sure what you're looking for. So, in these respects Windows 98 does represent progress.

Stability's all very well, of course, and Windows 98 is certainly much more stable than Windows 95. But is your computer crashing twice a day instead of five times a day worth the upgrade price? I'm jesting, of course, Windows 95 wasn't particularly that unstable, although Windows 98 is certainly better than its earlier incarnate. Integral to a computer's stability is the maintenance tools available for the user. Among others, Windows 98 uses an adept tool in its Maintenance Wizard, and that is a utility that co-ordinates and allows scheduling of three supplied tools (although third-party tools can be added by users). The tools are a disk defragmenter, a disk scanner and a disk clean up. These are powerful utilities that can help to make a PC more reliable, by giving it at least the basis of self-maintenance. They won't isolate every problem you might come across in the lifetime of a computer, but they should work to lower the number of problems encountered, especially if the tools are used on a regular basis.

Of the new other additions in Windows 98, some are worthy of note. First off, Windows 98 at last adds full in-built support for new hardware variants that other operating systems have had for a while now, such as infra-red ports, PCMCIA card slots, DVD players, TV tuner boards, Intel MMX microprocessors, and a new port that's destined to become the computer communications bus of the near future, the universal serial bus (USB). All these things will become commonplace, and hence, cheaper simply because of the sheer volume of numbers of Windows PCs and their users.

Windows 98 also adds extra versatility in terms of how it controls the computer it's running on. A new disk file system is included called file allocation table 32 (FAT32) that improves on the older file allocation table (known simply as FAT) by allowing larger hard drives to be used (2Gb used to be the limit) without partitioning, and also reduces the space wasted on larger drives. Effectively, using FAT32 means that small files are saved in a block on a drive more according to their actual file size, rather than by a pre-defined and larger block size. With large numbers of small files on a large drive, significant amounts of hard drive space become usable. There are improved power management techniques, designed to make use of modern advanced power management hardware, letting PCs take control of system hardware by spinning down hard drives, shutting off monitors, forcing the central processor into sleep mode and so on when the system isn't being used. There are also several improvements in Internet connectivity with the aim of making connection both easier for the user and more reliable.

So, all-in-all, Windows 98 does boast an impressive list of new features and bug corrections so, overall, it has to be the way forward for millions of PC users around the world. And, if anything else needs to be said in order to persuade Windows 95 users to upgrade as soon as possible, it's that Windows 98 is Year 2000 compliant. Upgrading means that you get a new-found level of operating system security against the millennium bug, unlike all earlier versions of Windows.

Start menu — Windows 98 Start menu appears similar to that of Windows 95. Although not featured in Windows 95, the Channel Guide is familiar to any user of recent versions of Microsoft Internet Explorer.

Maintenance wizard — Windows 98's in-built maintenance tools in the form of Maintenance Wizard. Here you set and schedule tasks to help keep your computer in tip-top shape.

But how does it feel in use? Is there a benefit to using it in terms of ease, power or ability? Well, ease-of-use is largely a personal matter. Readers may be aware that the reason behind the current US Department of Justice's lawsuit against Microsoft is that Windows 98 uses its in-built Web browser (Internet Explorer) as the basis of how users access files and programs on the computer itself. In other words, you can access computer items in the same way as you access items when you're logged onto the Internet – clicking a hyperlink rather than double-clicking a physical desktop-based icon. This in turn means that the distinction between desktop and Internet is somewhat blurred. In the extreme, the Windows interface can be adjusted such that it's difficult to tell the difference at all. Some would argue (me included) that this actually is a backward step. The Internet and how we access it at present is because of its historical text-based limitations, not because it has the better method of file negotiation. A better model I feel is to improve the Internet interface so that it is more like a physical computer desktop. If you've ever used a decent and modern FTP client that uses the computer desktop approach rather than the Web's hyperlinked version you'll know what I mean.

That aside, it's an easy job to switch off preferences within Windows 98 so that the interface is according to the classic desktop way if you're not convinced of the efficacy of hyperlinked file negotiation. However, once you do that it's not unreasonable to think that it's just the same as Windows 95 – so is the upgrade worth it? Microsoft's numerical listing of Windows 98 shows they think it's a relatively minor upgrade too. The System Control Panel lists Windows 98 as version 4.1, Windows 95 on the other hand was listed as version 4.0. Progress, at least in terms of Windows, is in quite small steps, isn't it?

Setting the standard

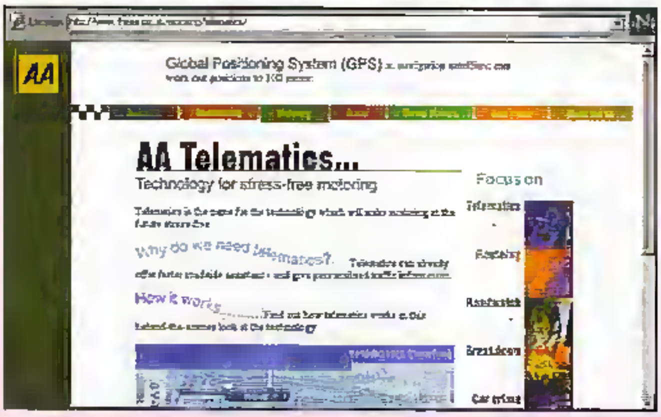
While email is presently a text-only system – the beauty about it is this very simplicity – there are moves to extend the format shortly. It's always progressively been extended of course, and the most recent standard to be applied to it has been the multipurpose internet mail extension (MIME) that is now the almost universal mail format followed by nearly all the world's Internet service providers. Basically, if an email program is MIME-compliant, it can send and receive mixed-media files such as video, sound, and even binary data in the form of applications and so on, to another MIME-compliant email program on another user's computer without problem.

The latest proposed standard, put forward by the Internet Engineering Taskforce (IETF), is set to allow whole Web pages or sites to be attached to single email messages. The standard, which is to be known as MHTML (MIME encapsulation of HTML documents), allows the individual components of a Website to be sent as attachments to an email message. Upon receipt, this is reassembled allowing the receiving user to view the Website without actually needing Web access. All this will be done in a text-based way, so that the mailing system itself doesn't need to be upgraded; just the sending and receiving mail programs.

In effect, being able to send HTML-based Web pages as email attachments will mean that the Internet isn't an essential ingredient in the communications method. For example, a company's employees can send Web pages to each other across an internal network, to pass on vital multi-media information without expensive Internet access. This could have large repercussions in cost, with companies being able to restrict access to the Internet to specific employees. The downside is that attached Web pages with large amounts of multi-media information could clog up internal networks.

The standard will be taken up very quickly. Microsoft already has an early version in use in its Outlook 98 email product, and Lotus intends incorporating the final version in the next release of Lotus Notes by the end of the year.

AA Demos Car of the Future Online



The AA has devoted a section of its Web site at <www.theaa.co.uk/motoring/telematics> to de-mystify and explain in-car technology, how it works and the benefits it can bring end-users.

In-car technology, or telematics as it is known, is a combination of satellite positioning, digital mapping and a hands-free mobile phone. This easy-to-use technology opens up a wealth of new services to motorists that will take the stresses and strains out of driving.

The combination of the three technologies is brought down to road level using a small telematics control unit fitted to a vehicle and connected to an aerial. This enables the cars precise location to be constantly calculated using the satellite positioning system and feeding this information to the telematics control unit.

Using a hands-free mobile phone, telematics technology enables motorists to be put straight through to an AA call operator at the touch of a button. This direct contact with AA call operators offers motorists faster roadside assistance and personalised route guidance incorporating local traffic. Soon, telematics will be used to detect when there has been a vehicle collision, alert car owners when their car alarm has been activated and so notify the driver of potentially unauthorised usage, track a stolen vehicle, and lock/unlock cars remotely.

In the future, telematics will be able to deal with problems even before they occur. The telematics unit will be linked to the engine management system, a warning will be given to the AA call operator and if the warning is serious enough then the operator can ring the driver to offer an AA patrol to check. Telematics units will also be used to gather floating car data, by interrogating vehicles about location and speed, thus providing instant information on where traffic problems are occurring and where the traffic is flowing most freely.

Netscape Introduces 'Smart Browsing'

Netscape <www.netscape.com> will shortly launch Navigator 4.5, which will enable what it is calling 'smart browsing'. It does this by embedding capabilities such as keyword searching directly into the browser and adding a 'smart updating' button in the browser to shorten the process of downloading software upgrades.

Navigator 4.5 will be married to a massive database of keywords that will allow surfers to accomplish searches more quickly. A user will be able to visit an Internet site simply by typing ordinary English words, such as 'Maplin Electronics', rather than a formal URL, such as <www.maplin.co.uk>.

Like Yahoo!, AOL, and Microsoft, Netscape wants to be a portal site for users surfing the Web. For this reason, it will integrate a way to give computer users quick access to features of Netscape's Netcenter site so that the service will work more like an integrated computer desktop. Netcenter 2.0 will also feature free e-mail and personalised news, stocks and weather.

New Browser Goes For a Song

If you're fed up with playing second fiddle with Microsoft and Netscape, play your own tune with Opera. It's a brand-new Web browser that eschews most of the gobbledygook that's taken over the main two existing Web browsers recently. It sticks basically to the HTML 3.2 standard and doesn't go in for Java or its derivatives, but that's to its advantage. It's fast, sleek, and incredibly cool. There's a Windows version out now, and ports to MacOS, Linux and other operating systems should be out shortly. Try it out, by downloading it from <http://www.operasoftware.com>. We'll look at it more closely another month.

AOL Deploys High-Speed V.90

AOL <www.aol.co.uk>, has deployed the International Telecommunications Union (ITU) standard V.90 modem protocol for high-speed 56K access throughout its AOL network. AOL has been testing V.90 internally for several months. Previously, AOL was offering its members two different 56K modem protocols, the x2 modem technology developed by US Robotics and the K56flex technology developed as a joint effort between Lucent and Rockwell.

The two standards are not compatible with each other, and have required AOL members to select an AOL access number based on the type of high-speed modem they were using. As a result, AOL access numbers are currently listed as either K56flex or x2. Once the network is upgraded to V.90, users with modems that can achieve higher speeds will be able to do so with any V.90 telephone numbers in the network.

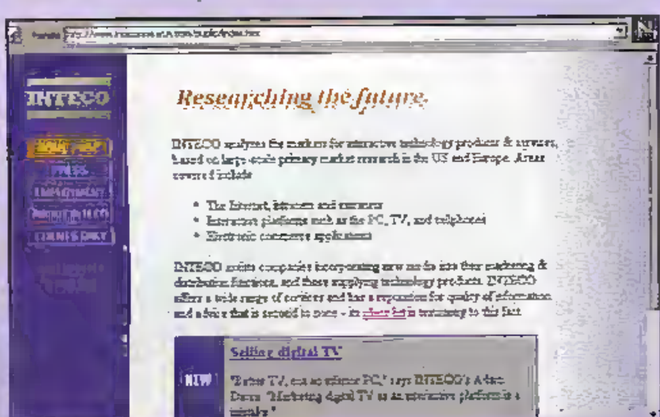
Inteco Research Reveals Low Awareness of Digital TV

63% of all households had read, seen, or heard something about digital TV. However, households that already subscribed to cable TV were no more aware of digital TV than the average. Awareness in satellite-subscribing households was only slightly higher at 67%.

These survey results published this month by analyst house Inteco's at <www.inteco.com> confirm that while there is some interest in using the TV as an interactive platform, such services will not drive subscriptions and the PC will remain the primary platform for activities such as Internet access, certainly for the next five years.

While cable companies can, to some extent, push the move to digital, converting satellite subscribers requires the creation of user pull, and more effort in educating the base is needed.

When asked about digital TV in detail, only 42% expressed interest in interactive services, compared with 73% who were attracted by the prospect of better audio visual quality.



Open University Spreads Net Worldwide

Last year the Open University (OU) <www.open.ac.uk> became one of the world's first academic institution to conduct distance-learning over the Internet. This facility is now available to students in the far-flung corners of the globe, for whom orthodox paper-based courses, with support over the telephone, were impractical or prohibitively expensive. The OU claims this latest development marks a major innovation in large-scale supported distance learning.

Internet-based tuition was initiated by the OU's Faculty of Maths and Computing and piloted on both its undergraduate course 'Fundamentals of Computing' and postgraduate course on 'User Interface Design'.

The pilots were an enormous success and have now been extended to several courses on the postgraduate Computing for Commerce and Industry (CCI) programme.

The system includes Web-based automatic course registration, examinations using encrypted papers downloaded via the Web at strictly supervised examination centres, and an electronic assignment-handling procedure incorporating student submissions, marking and monitoring. The courses also employ Internet conferencing and access to a variety of pertinent Web resources.

CompuServe Unveils Ultimate Online Resource

E-mail Edwina in Edmonton, chat to Charlie in Chile and discuss driving with Diane from a comprehensive new CompuServe Community which features the full range of popular communications products and services plus handy tips, advice and special offers.

The Communications Community, accessed by typing GO COMMUNICATIONS from within the CompuServe environment, or by clicking the icon on Communities <www.cis.com>, is designed to appeal to all types of user, whether they wish to enhance their messaging capabilities, debate the latest news or simply chat away to friends. Both novice and experienced users will be able to use the Community to discover new information that they can begin to use straight away.

An e-mail information facility provides details of useful applications and services such as personal mail aliases, sending business documents as attachments and collecting voice mail and faxes via e-mail.

The Community is a convenient place to catch up with news on communication services that have just been launched or enhanced, find out about the latest developments in CompuServe's renowned Forums and get details of forthcoming online events. CompuServe members also have an opportunity to take advantage of a special introductory offer to try JFAX, the international e-mail based fax service, free for 30 days.

Satellite Spy Photos Take to the Web

Satellite photos, once the exclusive realm of spies, are now available on a Microsoft Web site. TerraServer <www.terraserver.microsoft.com/terra_how.htm> is the world's largest Web database and makes the detailed images available starting from £5.00. Among the images featured on the site are formerly classified Russian spy photographs sharp enough to pick out objects 2m across.

The Best gets Better

For Mac users everywhere, the latest release of URL Manager Pro should be of interest. As its name suggests, it's a utility that allows you to coordinate all the URLs you gather together as you journey around the Internet and its vast array of services. URLs of all descriptions such as email addresses, Web sites, FTP locations and so on, can all be held within URL Manager Pro, then manipulated and accessed just as if they were physical files on the Mac's desktop. It's basically an alternative to bookmarking URLs in a Web browser, of course, just far more adaptable and far more powerful. That being said, the real power of URL Manager Pro is that it's linked to your Internet applications so that clicking the URL launches the respective applications. Clicking a URL Manager Pro email address for example, opens your chosen email program and creates an automatically addressed new email message. Clicking a Website URL opens your chosen Web browser and goes to the location. Better than this, URL Manager Pro shares menus with your Internet applications, so saving a URL into URL Manager Pro is a simple menu choice or keyboard shortcut. Groups of URLs in any text document can be added directly from pop-up Contextual Menus too, providing you install the Internet Address Detectors that accompany the package. URL Manager Pro really is the best way to take control of your URLs. Download it from <http://www.url-manager.com/> and it'll be the second best thing you've ever done (after buying your Mac, that is!).

Site Survey

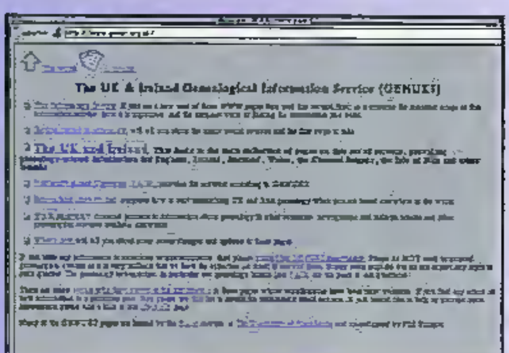
The month's destinations

Stone Pages, at: <http://www.stonepages.com> is a fascinating Website offering all sorts of information on the stone circles, dolmens, standing stones, cairns, barrows and hillforts of Europe. The two Italians who have built the site are actually touring Scotland between May and the end of July, to visit about 150 of Scotland's prehistoric sites, so take the Ancient Scotland Tour hyperlink from the home page to find out about the trip. In conjunction with the Scottish Cultural Resources Access Network, a Millennium Project to digitise Scotland's human history and material culture, the aim is to produce an educational Website and a CD-ROM about the stone monuments around the country.

Genealogy enthusiasts in the UK (and around the world, for that matter) should check out the UK and Ireland Genealogical Services Website at <http://genuki.org.uk/>. It's a rich site, full of links and information on genealogy. Your family tree may not be as inaccessible as you think.

Finally, a couple of interesting Websites in the US. First is a simply wonderful site, setup with the explicit aim of providing just about any and every flag anyone might possibly ever want. From ordinary country flags, through pirate flags and beyond, this is the site, at <http://www.ultimateflags.com> that you need to visit for that special occasion.

Biker Billy, believe it or not, is a famous television chef in the US. At the moment he's on the road, filming and hosting a documentary of the Harley-Davidson 95th Anniversary ride to Milwaukee. Famous not only for his outrageous behaviour and, cooking apparel, he's also a pioneer of the rather spicy cuisine – well, OK, spit-hot food! His Website's at <http://www.bikerbilly.com> and is definitely worth a look-see.



in the pipeline

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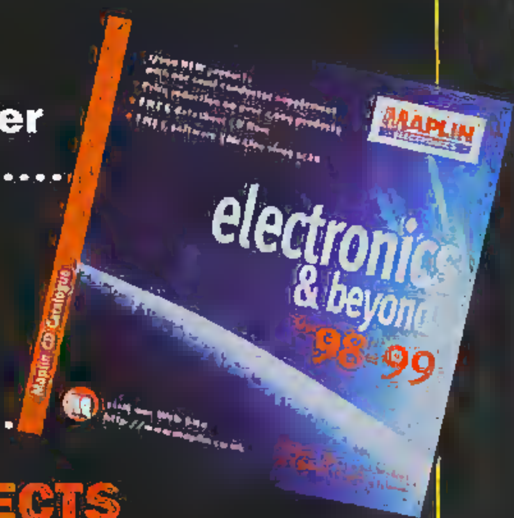

PROJECTS

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Power for a Logging System

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FEATURES

Photonic Bandgap Structures

Opto Electronics Systems and Circuits

Computer Managed Crop Sprayers

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Project Ratings

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

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

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

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

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

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

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 31st August (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.

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If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Sales Dept. may be able to help. You can obtain help in several ways: ❶ Over the phone, telephone (01702) 556001 between 9.00am and 5.30pm Monday to Friday, except public holidays; ❷ By sending a facsimile, Fax (01702) 554001; ❸ Or by writing to Technical Sales, 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 Sales 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 (minimum £17) 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.

TECHNOLOGY WATCH

with Martin Pipe

Last month, we examined the forthcoming phenomenon of digital television. The public launch of this radical new broadcasting technology is now getting closer, and at the time of writing the BBC and BSkyB had just started hyping up their imminent services. Radio, sadly, tends to be seen as the poor relation of television. Since September 1995, the BBC has been quietly conducting trials of digital terrestrial radio broadcasting. The network has now developed to the point where 60% of Britain's population can now receive it - if they knew about it, that is... In September, the Radio Authority will be issuing digital broadcast licences to commercial broadcasters.

The system chosen for use in the UK, Europe and other parts of the world - Digital Audio Broadcasting (DAB) - is the result of ten years of international collaboration under the auspices of the Eureka 147 project. DAB contains the ability to transmit data, both in streamed and packet mode, at 'air interface' rates of up to 2.3Mbps, as well as the ability to transmit programme associated data (PAD) to accompany audio broadcasts. PAD items could include small program applets (written in Java or some such language), detailed programme listings and digitised photographs. Seamless auto-retuning - as currently provided by RDS-equipped radios - will also feature. As with RDS, this benefit will be realised primarily in car audio.

Central to the DAB concept is the idea of multiplexing - something that also forms the basis of digital television broadcasting. A number of services - both pure data and digital audio - can be broadcast together on the same channel. The services that make up this multiplex, or ensemble, can be of varying data rates - influential factors here include the amount of PAD sent, audio compression rate and the level of error protection chosen. The Eureka 147 specification allows for operation at VHF or L-band frequencies. In the UK, DAB broadcasting will take the VHF route, with transmission frequencies occupying a spectral slot between 217.5MHz and 230MHz.

DAB specifies an air interface known as *coded orthogonal frequency division multiplex* with *quadrature phase shift keying*, or COFDM/QPSK. Here, each terrestrial multiplex is transmitted on 1536 closely-spaced RF carriers, which occupy a total bandwidth of 1.55MHz. Each of these carriers is responsible for only a small portion of the total data. Compare this system with the somewhat simpler - but more wasteful - analogue radio broadcasting, which relies on the modulation of a single carrier. DABs main advantage is efficient use of the available bandwidth. It also takes care to eliminate the effects of multipath distortion, which is responsble for ghosting on TV pictures and distortion with FM reception.

Corruption of the audio-carrying datastream of a DAB signal could be disastrous. To get around this, DAB employs a complex error detection and correction coding scheme. This ensures that the signal can be reconstructed, even if a section of the multiplex is corrupted.

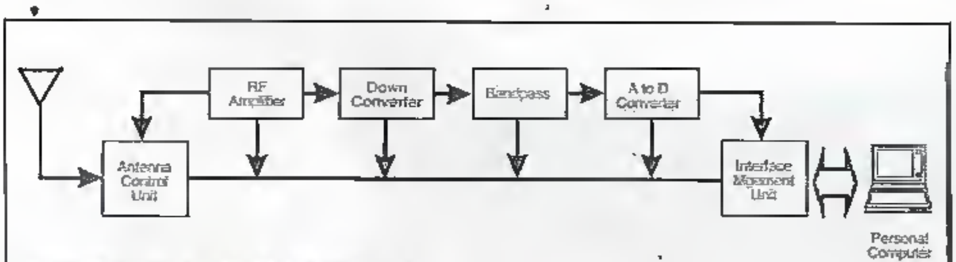
The audio compression scheme chosen for DAB is based around the use of sub-band coding. Indeed, its the same MPEG-1 audio system that I examined in my CD audio series late last year - albeit Layer 2, rather than Layer 3. It ensures a maximum audio quality that, to most ears, will be as good as CD quality. The quality will depend on the number of channels that the multiplex will have to carry - chances are that the radio stations we currently hear on low-fi medium wave will be transmitted at high compression rates to give similar levels of quality to the ones we are currently used to. At the other end of the scale, the CD-quality services - presumably those currently available on VHF/FM - will be transmitted at the highest rate of 192kbps.

As regards the services currently broadcast on VHF/FM, we hope that the broadcasters won't feed the DAB transmission network with the horrible distortion-laden - and hence to my ears, quite often unlistenable - outputs from compressor-limiters. The primary purpose of compressor-limiters, which started polluting the airwaves in the late 1980s, is to squash the dynamic range of the audio signal so that hiss becomes less of a problem in areas of inadequate signal strength (primarily due to an inadequate aerial, or movement in a vehicle)., or perhaps even to tailor the sound for naff-quality car audio systems.

Advertising sales managers on commercial stations love it - after all, the potential catchment area is increased and they can sell airtime at higher rates. The worst offenders are, in my opinion, Radio One, Capital and Kiss FM - all of which play music with a very restricted dynamic range anyway. Why, then, do they bother with further compression? The thing is that compressor-limiters are not necessary with DAB - its free from the signal-to-noise limitations of analogue FM (as with most things digital, you even get it or you don't). What's more, DAB receivers - notably ones intended for use in the cars that will form the systems first great market - will have a built in audio compressor. This is intended for situations where high ambient noise is encountered, such as road use. Lets hope that broadcast engineers aren't lazy, and go to the trouble of feeding the DAB transmission network with the pre-compressor/limiter audio signals.

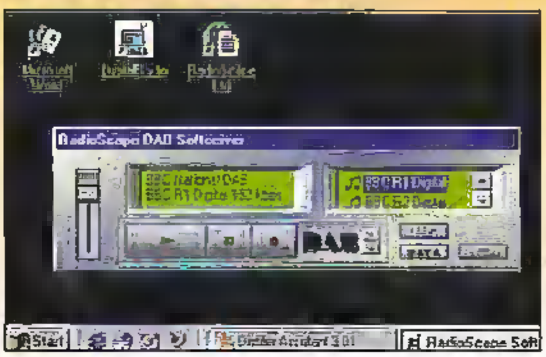
The big problem with DAB is likely to be the cost of the hardware - which, despite decent UK coverage, you cannot buy at the time of writing. By the autumn, however, things should start moving. You can bet your bottom dollar that in the first few years of the systems commercial life, the big consumer electronics companies will be milking the early adopters for all they're worth. One Japanese manufacturer, for example, has a poorly-publicised DAB hi-fi tuner for home use. The cost? Around £1000, which is rather expensive bearing in mind that the technology is, although advanced, hardly leading-edge. In terms of chippery, digital TV set-top boxes are rather more complex, and will sell for around £400 to £500 - and that's without the expected subsidy.

Fortunately, the major consumer electronics companies will not have it all their own way if the products developed by a small British start-up begin selling in large quantities. Radioscape (`http://www.radioscape.com`), based in north-west London, has developed a DAB receiver that sits in a PC. Its likely



Block diagram of a DAB receiver for a PC.

cost? Between £50 and £80. The low price stems from the fact that, wherever possible, the receiver design is implemented in software. The processing power of a PC is more than enough to carry out the significant DSP work involved. We have seen software-implemented MPEG video players - some of which deliver better quality than dedicated hardware versions - and emulators that allow other computers to be simulated. Not to mention RecordIt - Iomegas real-time MPEG Layer II audio encoder/decoder. Decoding MPEG audio is easier than encoding it, and this perhaps explains why Radioscape reckon that their DAB software radio will run quite happily in the background whilst other tasks, such as word processing, are being conducted. The company claims that its software radio only uses 5% of the processing power of a P166 MMX.



You have to get the signal into the PC in the first place, and this requires some hardware. This collection of electronics, which is built into a PCI expansion card, is much simpler than that associated with conventional self-contained DAB receivers. Indeed, its nothing more than a DAB receivers front-end - it contains the VHF RF and IF stages, and an analogue-to-digital decoder. This ADC will place the decoded datastream on the PCI bus, where it can be attacked by the Radioscape software and the results fed to the PC soundcard. A PCMCIA version of the hardware is also envisaged. Not only would this brighten up the lives of laptop users, but it would allow mobile radio engineers to assess transmitter coverage.

Indeed, Radioscape has designed two versions of the receiver software. Both employ the same hardware, and both were originally written in C++. The first software that will be available is essentially a DAB test-set. This product, which will provide a wide variety of information about the received DAB signals, is intended for broadcast engineers and equipment manufacturers. The design has been licensed to a European company, which will start selling these test sets in the autumn. But what of the consumer version? Radioscape claims to be currently in negotiations with a PC peripheral manufacturer. If all goes to plan, we could start seeing DAB softceivers - as they have been christened - on sale some time next year.

A major advantage of the Radioscape system is that provision has been made for the raw MPEG audio datastream to be written to the hard disk for subsequent replay. As a result, you get perfect recordings. Bearing in mind the comparatively low data rate (192kbps), the average hard disk could store hours of broadcasts. As an alternative, they could be written or copied to a CD-R, Zip disk or some other storage medium. Theoretically, these MPEG files could also be converted off-line into WAV files. These could be edited digitally, and subsequently used to burn a Red Book-compliant audio CD. The implications for the illegal bootlegging of concert material, for example, are enormous. You will effectively get a CD with a sound quality that is imperceptibly different from that of the original studio output - the record industry must be worried about this!

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk