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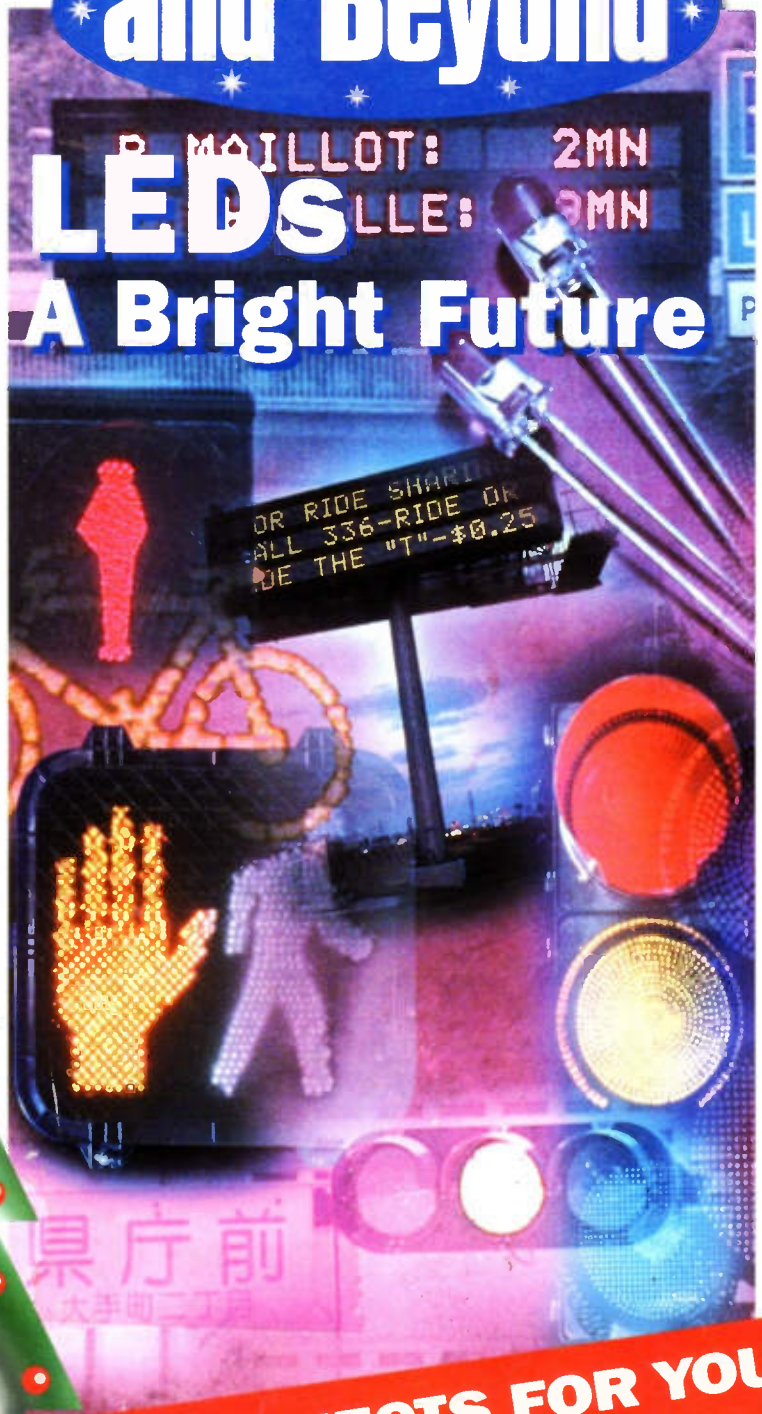
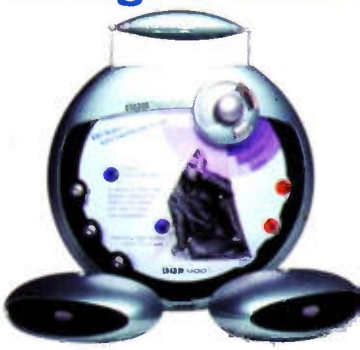


The Latest Trave Information on Digital Radio



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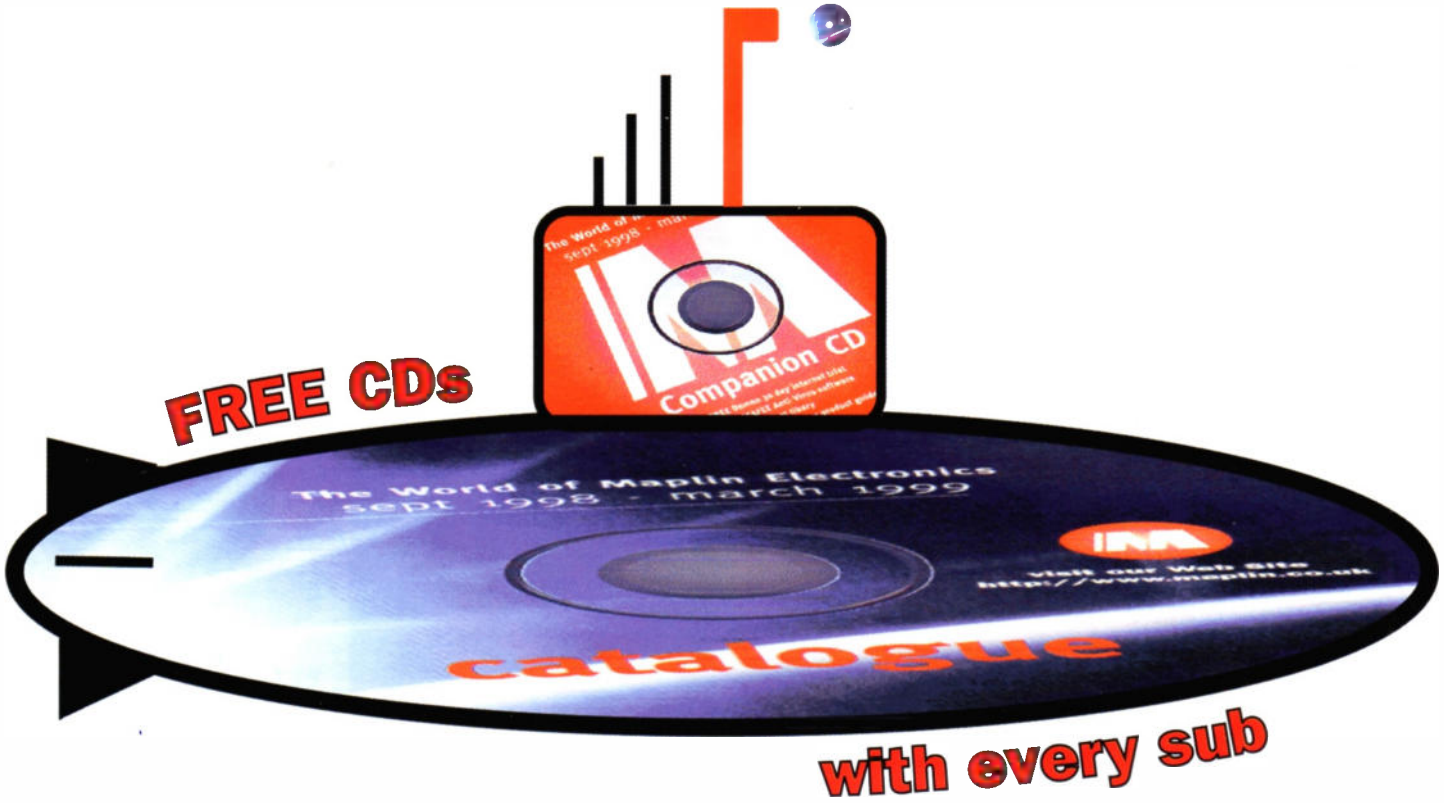

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THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

January 1999 Vol. 18 No. 133

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Features

Regulars

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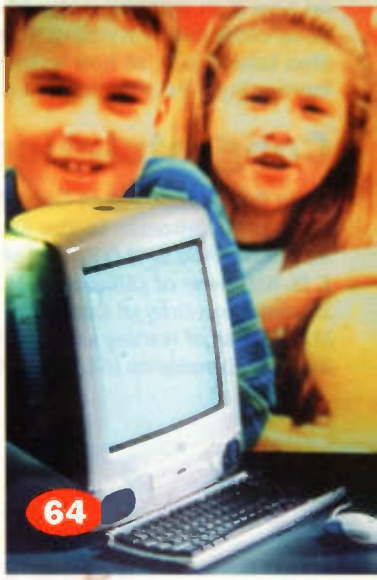

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ELECTRONICS and Beyond

This month we are giving away a free PCB to make a festive flashing Christmas tree, and if you haven't got the components in the spares box, we are able to offer all the bits at a knock down price - see page 13. LEDs also feature in an article by Mike Bedford who looks at choosing LEDs and the types available, plus a project using bright red LEDs to display that all important message. Neil Johnson, describes the latest addition to his IBUS expansion family, with a project that lets you use the serial port to talk to the IBUS.

We cover a diverse range of fascinating electronic and scientific topics in this issue. There is an article on how high velocity water is used to hygienically and accurately cut everything from food to metals. We also take a look at how solar energy is being increasingly incorporated in new building design.

Congratulations

Go to Peter Mackwell of Selby North Yorkshire who wins the superb Velleman Digital Storage 'Scope for the PC - well done! And to R O'Keeffe of Maidenhead, J. D. Robinson of Oldham, D. H. Mitchell of Leyton, J. Barrington Gray of Corby, Jim Aitken of Reigate and M. W. Divall of Hartley who each win a pair of tickets to the BBC Experience in London. Congratulations to you all.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Nintendo Adds Colour to Game Boy

Nintendo has announced a line-up of full-colour games to launch with its new Game Boy Colour system in time for Christmas. The pocket-sized, portable game system displays games in bright colours and will be available in two hardware variations: purple and transparent purple

For details, check: **www.nintendo.com.**

Contact: Nintendo, Tel: 1 800 255 3700

IBM and Fujitsu Announces Record-breaking Drives

IBM has announced the highest capacity notebook computer hard disk drive for premium notebook computers. It holds 14.1-gigabytes (GB) or about four times as much information as the average notebook hard drive contains today. The Travelstar 14GS does not weigh much more than a baseball yet it can hold all of the double-spaced typed text on a stack of paper 2,338 feet high.

The 17 mm-high drive is not much thicker than a cassette tape, yet it can hold more than 10,000 1-megabyte (MB) digital photographs, 140 CD-ROM programs of 100 MB each or several hours of MPEG-2 video.

Meanwhile Fujitsu this month became the first company to offer Giant Magneto-Resistive (GMR) heads with the introduction last month of a complete family of new enterprise, desktop and mobile products. Fujitsu's advanced GMR head technology offers extensive benefits in the form of performance and reliability.

GMR heads provide a dramatic improvement in signal-to-noise ratio over previous generations of MR heads, allowing them to read more closely packed magnetic data bits. This enables more data to be stored on smaller or fewer platters.

As a result, GMR enables Fujitsu to offer industry-leading capacity points of up to 36.4 GB on 3-inch diameter media with the same number of platters as previous generation 18 GB products.

For further information, check: `www.fujitsu-europe.com`; and `www.ibm.com/harddrive`.

Contact: IBM, Tel: (0990) 426426; and Fujitsu Europe, Tel: (0181) 573 4444.

AIWA Launches High-Capacity Tape Drive

AIWA has fortified its presence in the computer peripherals market with the introduction of a 10GB standalone tape drive. The external AIWA drive provides PC and laptop users with a convenient, high-capacity medium to backup large files and operating systems – all on a single tape cartridge. Data transfer occurs at 50MB/minute, requiring about 20 minutes to backup 1GB of data.

For further information, check: `www.aiwa.com/csd`.

Contact: AIWA, Tel: +1 949 862 0200.

NEWS BYTES

NEC Develops Fingerprint ID System

NEC has developed a new technology for a fingerprint identification system that can separately register each of the user's fingers, allowing a computer to automatically identify and configure the system to the user's requirements.

Contact: NEC Europe, Tel: (0171) 353 4383.

Altran Creates 200 New UK Jobs

Altran Technologies, the Paris-based technology group, is creating 200 new jobs in the UK, many of which may be in the electronics sector. The new jobs, which are being created through Altran's UK technology consulting group, will double the size of the group's existing workforce.

Contact: Altran, Tel: +33 1 44 09 64 00.

Callunacard Doubles Its Memory Power

Calluna Technology is ramping production of its new 1040MB Callunacard. The Type III PC card, with the same footprint as a credit card and only 10.5mm thick, offers the world's largest storage capacity in any PCMCIA format.

The demand for more data storage space, particularly from laptop users, is rocketing. Most laptops in use have around 2GB of storage space on the internal drive – the 1040MB Callunacard can provide an extra 1GB of space with no installation procedures or configuration necessary.

For further information, check: `www.callunacard.com`.

Contact: Calluna, Tel: (01592) 630810.

Business as Usual for Local Government Despite Millennium Bug

UK local authorities are bullish in the face of concerns about the 'Millennium Bug' reveals the 1998 Local Government Technology Survey conducted by software house ISE. 93% of respondents to the survey said that their authority planned to buy and install new technology as normal in 1999, with only 1% of councils instituting a moratorium on software purchases in the run up to the new millennium.

Year 2000 compliance was cited as the most important issue in information technology (IT) deployment by 47% of respondents in the survey of senior local government IT personnel, suggesting that councils' business-as-usual policies have not been arrived at lightly.

Contact ISE, Tel: (0113) 244 1404.

NEWS BYTES

Check-Out Siemens PCs at Tesco

Shoppers at Tesco will soon be able to purchase a Siemens Personal Computer along with their regular grocery shopping. From the beginning of November, Tesco stores across Britain will begin selling Siemens' Xpert 7620C home PCs. The product will be available in more than 60 stores in the run up to Christmas and sales of several thousand PCs are anticipated.

For further information, check: **www.sni-epc.co.uk.**

Contact: Siemens, Tel: (01252) 555312.

Shuttle Acquired in Digital Convergence Deal

SCM Microsystems has an acquisition agreement with privately held Shuttle Technology Group, for $33 million. Founded in the UK with operations in Madras, India, Taiwan and Fremont, California, Shuttle specialises in developing secure, reliable access and interface technology for OEM manufacturers such as Hewlett Packard, Imation, Panasonic, NEC, Olympus and SyQuest. Shuttle recently entered the security market with the fingerprint recognition device.

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

Contact: SCM Microsystems, Tel: +1 408 370 4888.

Harris Sues Apple for Dropping the Newton

Harris has sued Apple for allegedly breaking a licensing agreement between the companies when Apple cancelled its Newton handheld computer technology in February. Harris said that by that time it had already negotiated contracts to develop millions of dollars worth of products based on the Newton.

For further details, check: **www.harris.com.**

Contact: Harris, Tel: +1 407 727 9207.

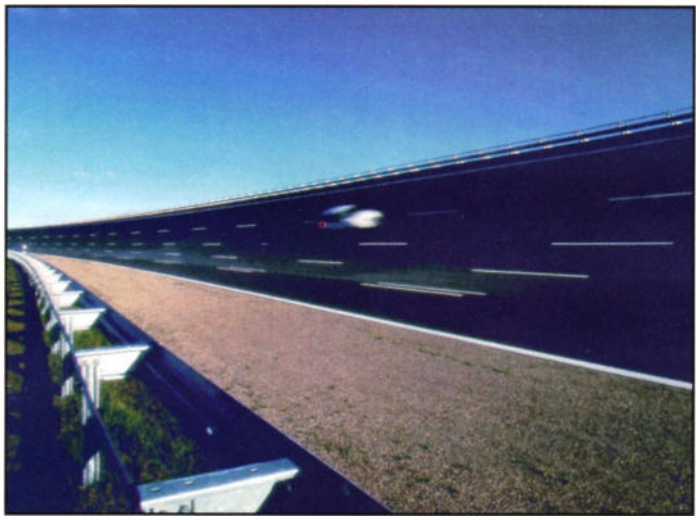
Corporates See In E-Commerce Before Millennium

E-commerce will be in use at almost half of UK companies within the next twelve months, according to research by Star. Of the 200 blue-chip respondents to the Internet specialist's annual survey, 41% stated they will be using e-commerce before the Millennium. Of these, 25% will implement an entire system and 22% will introduce a Virtual Private Network to encourage closer commercial ties between partners.

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

Contact: Star, (01285) 647000.

Mercedes Launches Automotive Testing Facility



EG&G and Mercedes-Benz have opened Europe's newest and largest automotive testing facility, the Papenburg Proving Ground in Germany. EG&G, which is based in Wellesley, US, will operate and manage the facility. The agreement between EG&G, a diversified engineering firm, and the world's foremost automaker marks a step forward in developing the next generation cars and trucks.

For further information, check: **www.mbuk.mercedes-benz.com.**

Contact: Mercedes, Tel: (01908) 245000.

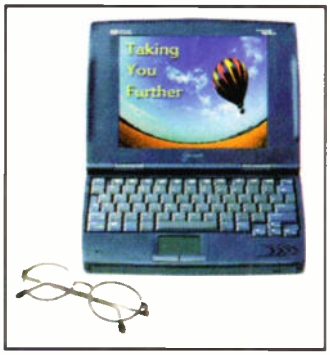
HP Launches New Brand of PC Companions

HP has introduced a new brand of handheld PCs – the HP Jornada Handheld PCs – based on the new Windows CE operating system. The first product in this new family, the HP Jornada 820 Handheld PC, is a 2.5lb e-mail companion that delivers unparalleled convenience and communications capabilities.

Mobile professionals no longer have to face the challenges of connecting to e-mail from crowded airport lounges or distant locations. They can type continuously for 10 hours in Pocket Word without recharging the battery.

In addition, an optional, extended battery pack increases battery life for up to 15 hours without altering the size of the unit. An instant-on Intel StrongARM 190MHz processor eliminates boot-up time, and a built-in 56Kbps v.90 modem and user-friendly HP dialup application provide quick access to e-mail and the Web.

For further information, check: **www.hp.com/handheld.**



Contact: HP, Tel: (0990) 474747.

IBM POWER3 Chip Performs Like Eight Chips in One

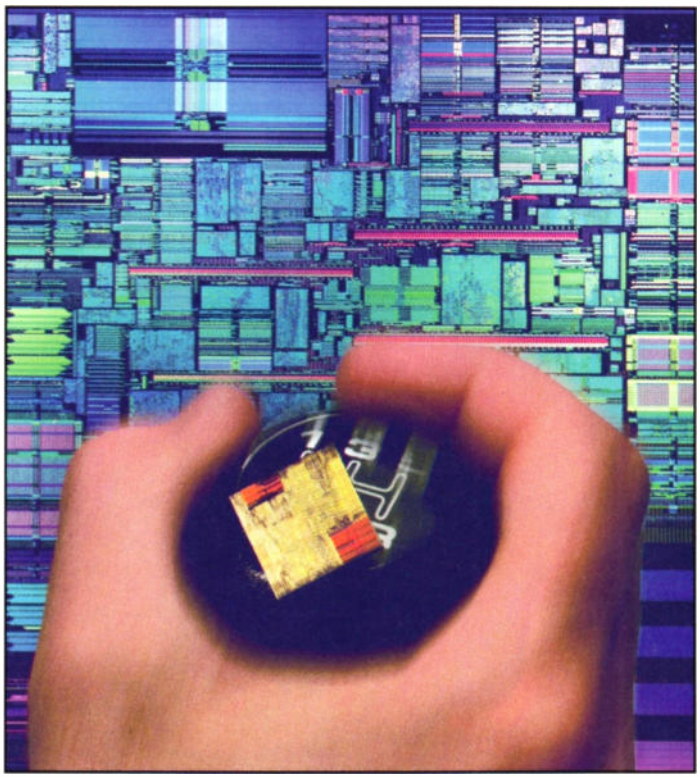
IBM has launched a new, more powerful microprocessor, the POWER3 that performs like eight chips in one. The 64-bit POWER3 microprocessor is a RISC-based chip developed for IBM's UNIX workstations and servers.

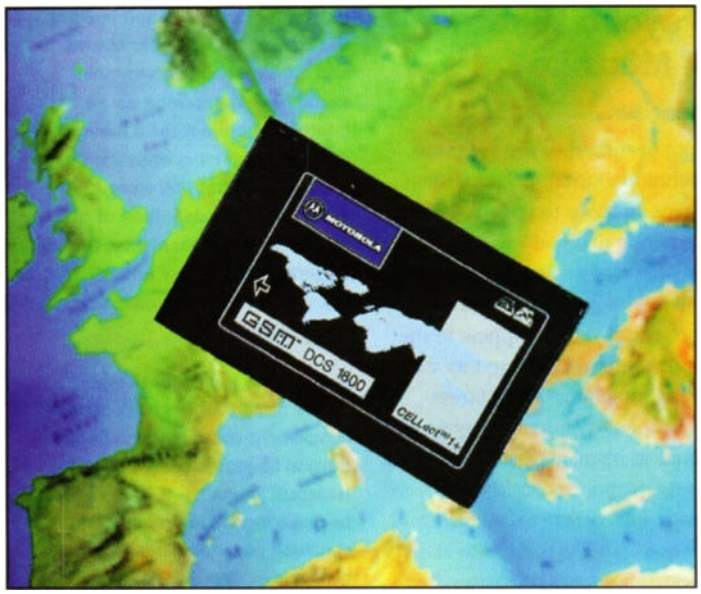
The POWER3 is built specifically for the demanding graphic, analysis and simulation programs used by aerospace, automobile and drug manufacturers.

Unlike a typical PC microprocessor, the chip features eight execution units fed by a 6.4 gigabyte-per-second memory subsystem, allowing the POWER3 to outperform competitors' processors running at two to three times the clock speed.

For further information, check: **www.chips.ibm.com.**

Contact: IBM, Tel: (0990) 426426.





Motorola Delivers Soft GSM Modem With Compression

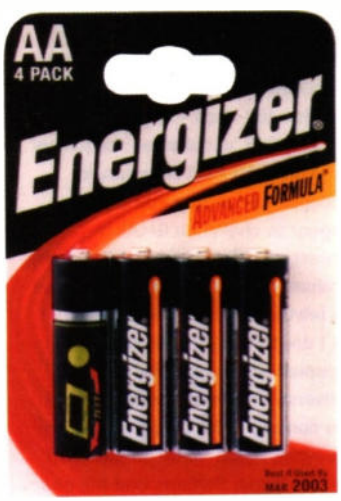
Motorola has launched a soft modem, a simple, low cost intelligent GSM cable that removes the need for a PC data card. The SmartCELLect soft modem has been developed for mobile computer users who want to send and receive faxes, e-mails and surf the web when on the move without the need for modem hardware.

Compatible with a wide range of digital cellular handsets from Motorola, the SmartCELLect soft modem operates under Windows 95, Windows 98 and NT 4.0. Incorporating Motorola's proprietary Digital Data Fast compression technology, the SmartCELLect soft modem is capable of effective data throughput rates of up to 56,000bps on GSM digital cellular networks.

For further details, check: **www.communicate.co.uk.**

Contact: Motorola, Tel: (01256) 316800.

Battery Has Advanced Formula



Energizer has launched a new battery called the Energizer Formula which it claims delivers unsurpassed performance across a wide variety of applications. The Energizer Advanced Formula AA is reckoned to outlast the Duracell Ultra AA in heavy use applications by up to 20%.

For further information, check: **www.energizer.com.**

Contact: Energizer, Tel: +1 800 383 7323.

How to Choose the Right Four Letter Word

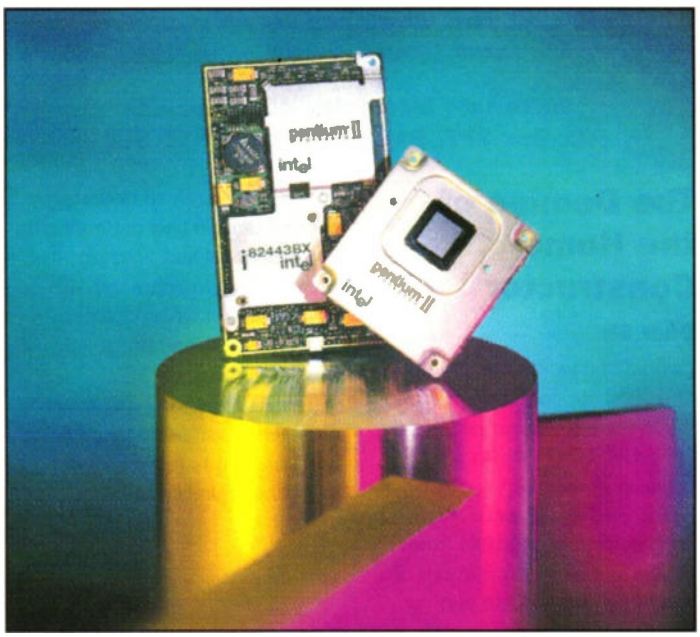
Hermstedt, the digital communications solution provider, has launched a white paper on ADSL (Asymmetric Digital Subscriber Line). The paper is designed to help IT and telecoms managers identify the technology that best suits their company's needs. It reflects the current interest in ADSL as an emerging telecommunication technology.

Hermstedt's white paper identifies six types of user ranging from the home-based 'Net junkie' to the multi-national corporation 'high-wire high flier'. The paper recommends a communications solution for each type, choosing from ISDN BRI (basic rate), ISDN PRI (primary rate) and forthcoming ADSL technology. To obtain a copy of the white paper, please contact Hermstedt.

For further information, check: **www.hermstedt.com.**

Contact: Hermstedt, Tel: 0171 242 4060.

Intel Acquires Shiva for Networking Solutions



Intel and Shiva have entered into a definitive merger agreement. The acquisition is aimed at rapidly expanding Intel's networking product line with remote access and virtual private networking (VPN) solutions for the small and medium-sized business.

VPN technology utilises the Internet to create secure network connections between multiple local area networks (LANs), separated by long distances, for the cost of a local Internet connection. Intel, the world's largest chipmaker, is also a leading manufacturer of computer, networking, and communications products.

For further information, check: **www.intel.com.**

Contact: Intel, Tel: 01793 403000.

BT Trials the Next Generation in Communications

BT has announced the start of the Interactive Services Network (ISN) trial that will deliver interactive applications in North and West London. The ISN trial will run until March 1999 and uses Asymmetric Digital Subscriber Line (ADSL) access technology supplied by Alcatel, Fujitsu and Westell.

The ISN facilitates end user access speeds of up to 2Mbps into homes, small businesses and remote enterprise locations. Information can be sent out at speeds of up to 256Kbps over existing copper wires and allows simultaneous use of the normal telephone service.

The BT ISN trial is aimed at Service Providers wishing to offer their customers access to high bandwidth data services. It also targets businesses with mobile or home-based staff requiring remote access to the Internet or corporate Intranets.

The trial uses ADSL access technology, which allows BT to utilise the capability of the existing PSTN network. As ADSL provides a significant increase in bandwidth capabilities, the ISN trial enables Service Providers to deliver a diverse range of new network services for both business and residential customers, including video on demand, fast internet access, home shopping and banking.

For further information, check: **www.isntrial.bt.com.**

Contact: BT, Tel: (0800) 800800.

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

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

The Demise of the Home Constructor

Dear Sir

I would like to add my thoughts to the debate on the demise of the Electronics Enthusiast, a can-of-worms subject which was originally opened by Dave Marsden.

The plethora of electronic goodies that are available from Maplin as well as any number of Tottenham Court Road and Edgware Road stores that are ready-built products must also hold a great responsibility for the demise of the home constructor. Why spend hour after hour building and de-bugging a project when a similar item can be bought ready-built, working and looking ten times better than any home workshop effort? There is zero incentive to built it yourself. There was a time not many years ago when Edgware Road was London's home of electronic components. When last in London at the beginning of 1998, all the component stores had either disappeared or were mainly complete product box shifters. Says a lot about hobby trends.

EMC rules and regulations have done much to strangle small business, and I wholeheartedly agree with the Editor in that the cost of meeting the EMC regs is a burden. One-off custom designs are often to costly to undertake – and the same is true of developing constructional kits. Sensible, pragmatic approaches to EMC emissions and susceptibilities seem to be beyond the abilities of the bureaucrats.

Thanks for a good magazine, but a few more audio projects and articles (analogue please) would be appreciated.

Gareth Connor
Zimbabwe

Many thanks for your kind comments about the magazine, and we are aiming to include analogue audio projects in the future.

Your comments about ready-made products is certainly true, but I would like to believe that a genuine enthusiast would want to construct a project for the pleasure, reward and satisfaction that comes from building a project. There must be few other careers, hobbies/pastimes that require a reasonable knowledge of many disciplines e.g. electronics, electrical, mechanical/metalwork, woodworking etc. This is very much a 'hands-on' career and hobby, and I am very much afraid that youngsters today tend to veer away from such occupations.

By the way, has anybody got any designs for a vocoder or an aural exciter - Ed

Psycho Kinetics – A Mistake?

Dear Sir.

I am disturbed to see a serious technical journal such as yours devoting space to pseudoscience, and hope that you will reassure me that this was a mistake which will not be repeated (I note that the articles did not appear in the April issue, so I assume that you were not joking!) High Street newsagents routinely carry several times as many magazines devoted to the paranormal as they do magazines of serious science, and I would not like to see the Maplin Electronics journal crossing the divide. The supposed increase in interest in such matters as PK, flying saucers, astrology or the 'X-files' may reflect a lamentable lack of knowledge of real science by a gullible public, but does not reflect the views of those with a serious interest in science and technology.

Graham Marett
Rickmansworth

David Aldous replies

I would like to respond to a letter from reader Graham Marett, which was passed to me by the Editor.

Graham Marett seems to hold the view that he has exclusive access to the totality of knowledge in the whole Universe. Further, that he is therefore somehow qualified to decide what does – or does not – constitute a 'mistake' on the part of the Editor, Mr Paul Freeman, in accepting an article that would appear to challenge Graham Marett's version of reality. Quite why Graham Marett should think himself so privileged is not made clear, but as I don't even pretend to comprehend the totality of the Universe – with my human mind, I am content to let things remain as a psychological 'Mexican stand-off' on this issue. Perhaps God will one day enlighten us all as to what the Universe is about? All in good time!

More specifically, some of main the points Graham Marett presents, can best be answered as follows:-

1) It isn't a series on psycho kinetics at all – just an article which had to be split into several chunks, simply because it was too long to fit in one issue, about a piece of equipment which has more than one use. Presumably, if I had not mentioned the initial reason for designing and building the device, then Reader Marett and others of similar viewpoint would have regarded it as an interesting project for a movement detector – which is what the device actually is! What therefore determines the definition of the term "pseudoscience" that Graham Marett applies to my article? The equipment – or it's possible applications?

2) I am sure the editor thanks reader Marett for the back-handed compliment about Electronics and Beyond Magazine being a "serious technical journal!" – It is, but only because it does not try and condition people's minds to going up blind alleys, into that contentious territory where ones mind can only be fed on the ubiquitous "pap" of "received wisdom" (!?).

3) As I made clear in the article, so-called "serious science" (his phrase), is all too ready to put up explanations for unusual events/phenomena, which may or may not be classifiable as "paranormal," but which explanations themselves actually require more mental convolutions – and even just pure faith – to accept, rather than a straightforward acceptance of the fact that unusual events do happen and need investigating. I quite deliberately did not offer any explanation for these events because I just do not know enough about them. I simply know that I have experienced these events myself, and therefore have the perfectly sound basis of personal experience to spark my own curiosity and willingness to investigate in an open-minded manner. As I also said, science has never progressed very far in explaining the world by burying it's (collective) head in the sand.

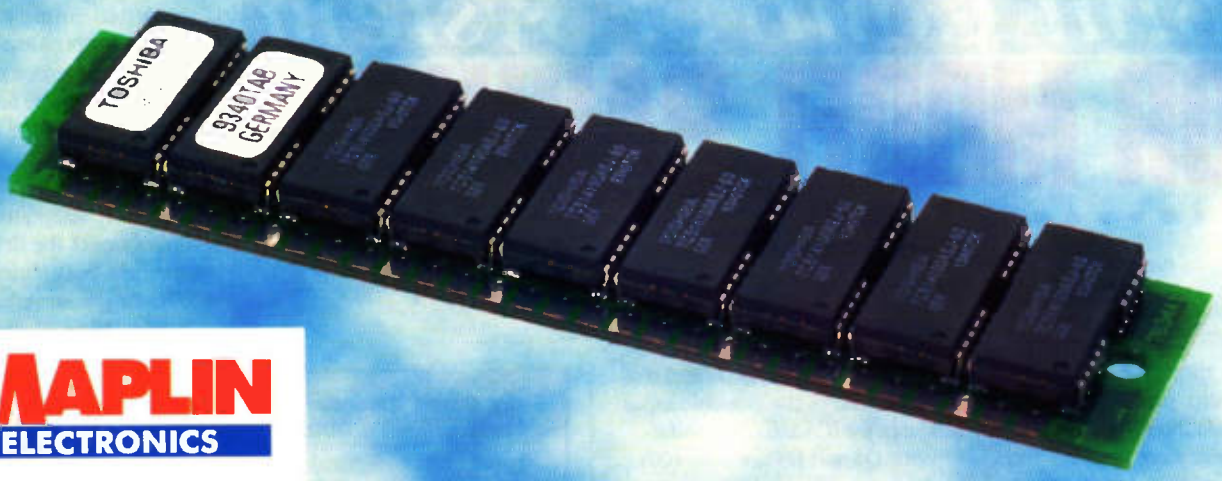
In conclusion, reader Marett's letter is a perfect illustration of something I said in the introductory part of the article, to the effect that discussion of the topic (PK), often reveals more about the attitudes of official science to it, rather than a willingness to learn anything new about the Universe. Overall, reader Marett's letter displays a breathtaking arrogance about human beings believing in their capability to fully and completely comprehend the Universe! Perhaps a suitable motto for those holding such collective views might therefore be: "Join us and help darken our lightness."

David Aldous

MEMORY PRICES

MEMORY MARKET UPDATE

A firmer price picture is in place but only in synchronous DRAM. Older technologies are becoming expensive as manufacturers are starting to pull out of them particularly Fast Page Mode memory modules and to a slightly lesser extent EDO. The big news this month is that Siemens, who announced the closure of their factory in Tyneside earlier this year, have now put their entire components division up for sale after it was reported that the group had sustained losses of over 1.2Billion DM, approximately £444,000,000. Given the very fragile and depressed state of the components market other sales and mergers cannot be ruled out. Maplin now have available generic notebook memory at very competitive prices and will maintain our competitive prices as long as possible.



MAPLIN ELECTRONICS

A range of DRAM modules for use as memory expansion in computers including PCs, Apple MACs and Amigas, is available. All parts supplied are original and unused. SIMMS supplied by Maplin are branded manufacturers, chips on selected third party boards.

They are sold with a 'no questions asked' lifetime guarantee and all modules are stored and handled in anti-static environments.

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NM27E	64M	£57.01	£66.99
NM28F	128M	£122.35	£143.76

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Code	Size	ExVAT	IncVAT
NT00A	16M	£17.10	£19.99
NT01B	32M	£26.37	£30.99

EDO - TYPE

Code	Size	ExVAT	IncVAT
NT03D	4M	£5.77	£6.77
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PROJECT

Point Control System FOR MODEL RAILWAYS

PART 2

In part 2, Ian King describes the decoder board and construction.

Last month the main circuit board, power supply and basic interconnections for this project were detailed and that was all that was required for a working system operated by push button switches or similar. In this second and final part we will look at a simple decoder board to allow the electronics to be driven from an 8-bit parallel computer/microprocessor port and a status board which could easily be developed by the constructor into a mimic display.

Decoder Board

The Decoder Board detailed here is based around three, 4-16 line decoders (4514BE) and provides set and reset signals to 24-point channels (i.e: 3 x 16 = 48). As can be seen from the schematic in Figure 8, the four LSB lines (D0 – D3) from the microprocessor parallel port connect to the decoder ICs which are enabled by a low level on their inhibit input (pin 23).

Only one decoder chip can be allowed to be selected at a time and this is ensured by arranging for the appropriate inhibit input to be selected by a further 2-4 line decoder (74HC139) connected to port data lines D4 and D5. It should be noted that only three of the possible input states for IC4 are used and if both D4 and D5 are zero (00) then no outputs will be enabled. More details of the software required will be covered shortly. The two MSB lines (D6 and D7) are not used in this application but are available for other purposes and appropriate connection points are provided on the PCB. It is important that a connection is made between the 0V line of this project and the 0V line of the port/micro being used to ensure correct operation.

The PCB foil and legend are given in Figure 9 and construction is very straightforward, using sockets for the ICs and ensuring that the polarity of the electrolytic and tantalum capacitors is observed. There are also seven wire links to be inserted, one of which is beneath IC2! Instead of the PCB connectors, Veropins can be used for the interconnections to the point control boards if desired.

Unfortunately, the output pins of the 4514BE do not run in numerical order and care is needed to ensure that the correct outputs are connected to the appropriate point board inputs. Of course any errors could be corrected in software, but to keep things logical (pun not intended!), Table One details the suggested way to interconnect the first eight channels. Subsequent channels follow a similar pattern using outputs 16 to 31 and 32 to 47.

Point Board Input	Decoder Board Output	Point Board Input	Decoder Board Output
Set (1)	0	Set (5)	8
Reset (1)	1	Reset (5)	9
Set (2)	2	Set (6)	10
Reset (2)	3	Reset (6)	11
Set (3)	4	Set (7)	12
Reset (3)	5	Reset (7)	13
Set (4)	6	Set (8)	14
Reset (4)	7	Reset (8)	15

Table 1. Decoder Board Connections.

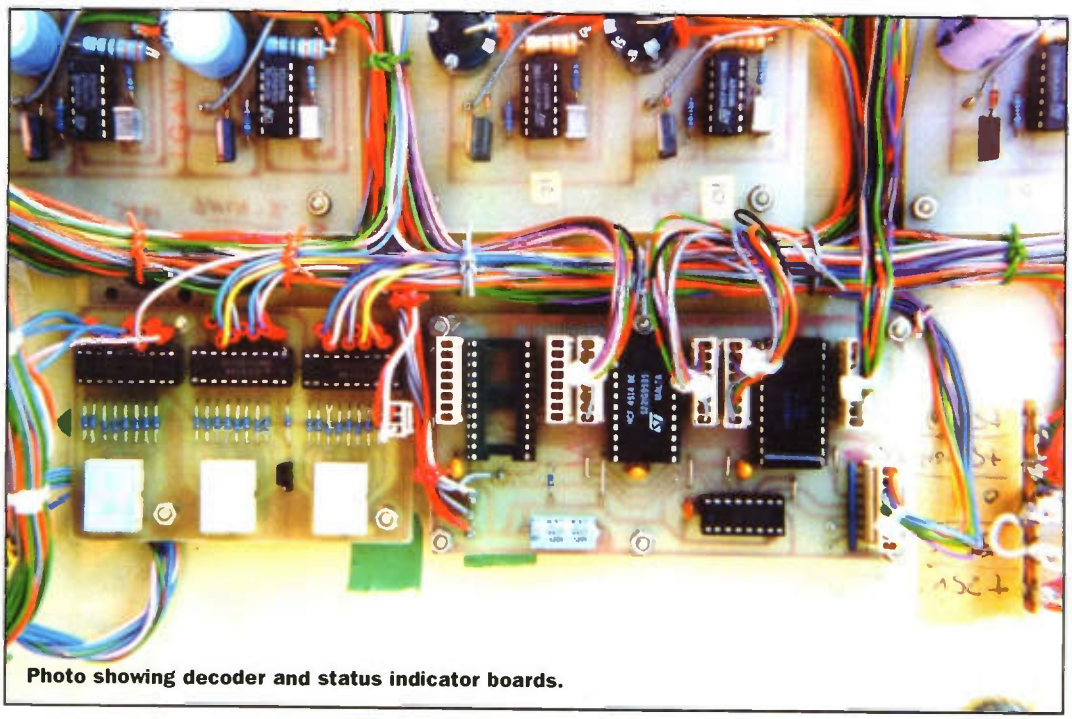


Photo showing decoder and status indicator boards.

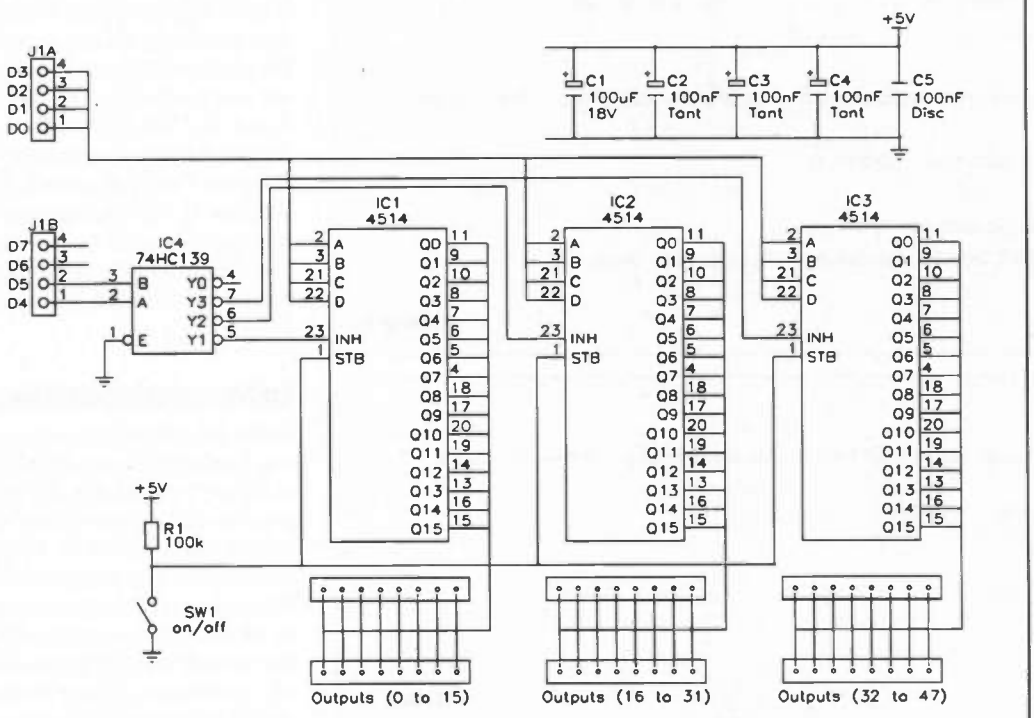


Figure 8. Decoder schematic.

a bus transceiver (74LS245).

Used as an octal buffer this is capable of providing up to 15mA to each segment of the display and with the addition of a series resistor the current is in practise limited to 10mA. A jumper is included to allow the displays to be 'switched off' when not required, to save energy and unnecessary heat dissipation by the power supply regulator (Reg2). This operates by connecting the buffers' enable input to either supply rail as required.

Construction is very straightforward using the small single sided PCB shown in Figure 11 and it is possible to fit the 7-segment displays into sockets rather than soldering directly to the PCB if preferred. Sockets can be adapted by carefully cutting a larger IC socket (i.e. 24, 28 or 40 pin) into smaller strips of 10 pins (5 each side).

It will be up to the constructor

Status Indicator Board

This status board was added to the project to simplify software debugging away from the railway and the circuit schematic is shown in figure 10. A LED simply shows the status of the latch in each point channel but it was not desirable (or even possible) to drive the LEDs directly from the HCF4043 latch used in the point control circuit. This device is unable to provide sufficient current, so it was necessary to buffer each latch output, and as the display to be used was of the 7-segment variety, it was convenient to use

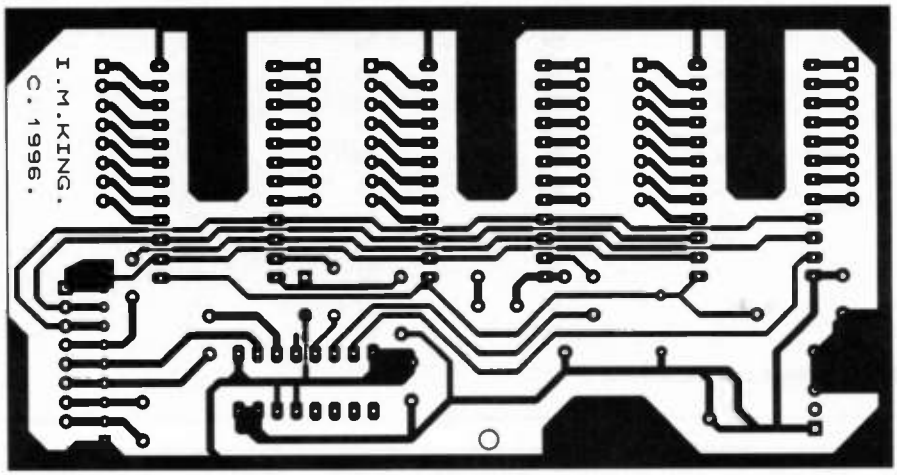


Figure 9a. Decoder PCB.

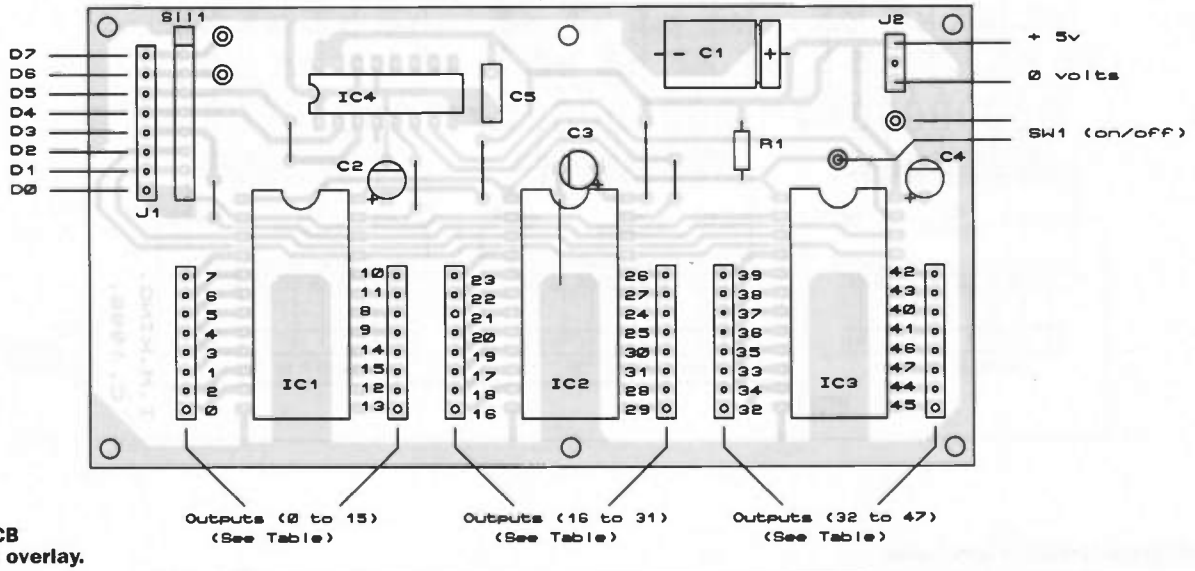


Figure 9b. Decoder PCB component overlay.

```
          ;This module resets all points at boot-up.
setup:    ld a,0fh  ;low counter value
count:    add a,02  ;
          ld b,a    ;retains value of counter as Acc. becomes
zero after cp
          out (0ch),a ;out to points
          call delayr3   ;
          cp 03fh ;high counter value
          ld a,b    ;restores counter value in Acc.
          jr nz,count ;
          ret     ;
```

Listing 1.

```
DELAYR3::      EXX
     ex af,af' ;
          ld BC,5555h    ; Loop counter***in use to be min. 08h (but use
0Ah)***
LOOP:     DEC BC    ; Decrement counter
          LD A,B    ; Check end of loop
     OR C
          JR NZ,LOOP     ; loop
          ex af,af' ;
          EXX
     RET
::END
```

Listing 2.

Point Motor Number	Set Data Value	Reset Data Value	Point Motor Number	Set Data value	Reset Data Value
1	10	11	13	28	29
2	12	13	14	2A	2B
3	14	15	15	2C	2D
4	16	17	16	2E	2F
5	18	19	17	30	31
6	1A	1B	18	32	33
7	1C	1D	19	34	35
8	1E	1F	20	36	37
9	20	21	21	38	39
10	22	23	22	3A	3A
11	24	25	23	3C	3C
12	26	27	24	3E	3F

Table 2. Port values and functions.

to decide how the information is to be displayed (and hence how the inputs are connected to the point board status outputs) but as a guide I used segments F, E, A, G, D, B, C and DP (Decimal Point) to represent channels 1 to 8 respectively (See Diagram 1). This arrangement was then repeated for the other two displays driven by outputs from point channels 9 to 16 and 17 to 24.

Interconnections

Developing the interconnections and prototype layout, detailed in Figure 7 last month, the full project will look something like that shown in Figure 12. There is no reason why a completely different approach should not be tried, but I have stuck with that already started, for the sake of completeness. There are no special wiring conventions to follow other than to ensure that the wiring to the computer port includes a 0V connection to ensure correct operation.

Software Hints and Tips

The actual software required to be written by the user will depend on the equipment to which the decoder is connected and this might be a Pentium II PC running a high level program or a humble microprocessor port for which the code is written in assembly language

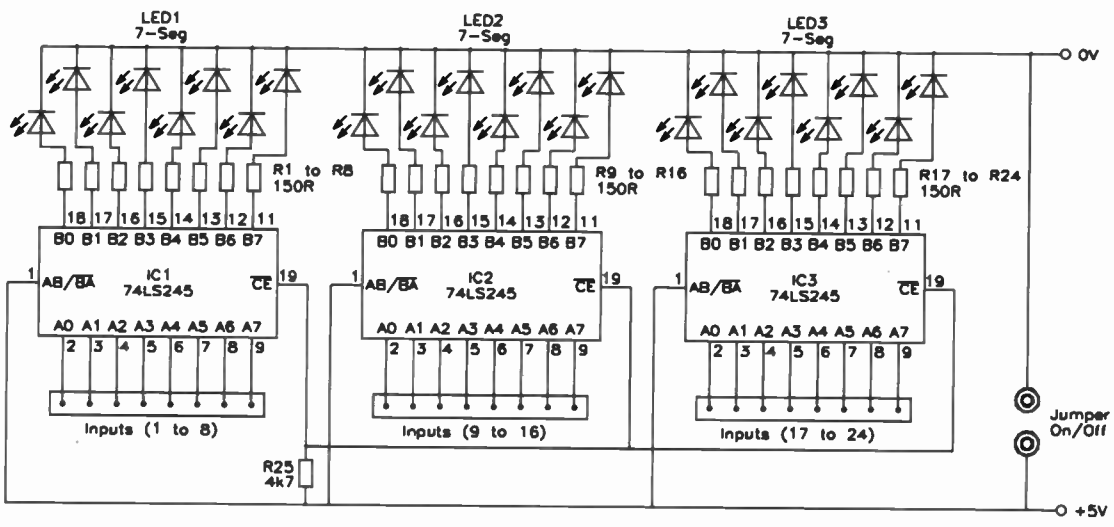
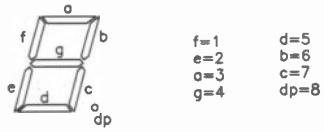


Figure 10. Status indicator schematic.

etc. In my case it is the latter situation, but the rules are the same, whichever!.

The point motor boards should power up correctly with all of the input latches in the reset state, however, it may well be the case that some of the actual points have been left in the wrong position. It is a good idea to include some code in the initialisation of the main program to reset all of the point channels in turn. The Decoder Board will operate very fast, but not as fast as the Z80 with a 4MHz clock! and a delay loop will need to be included between each data word being sent to the port. An example of the code for the initialisation is shown in Listing 1.

Diagram 2. LED segment numbering.



The accumulator register is set up with the hex value 0F (decimal 15) and then this is incremented by 2 to 17 (hex 11) and then output to the port. A check is then made to see if the highest reset address has been reached (else the loop will go on forever!): if it has not, the process is repeated again, resetting the next point (whose address is 2 higher) until the highest address is reached, when the module returns to the main program. The label delayr3 is the delay counter module referred to before and given in Listing 2.

It will be noticed on the third line, that Register BC is loaded with 5555 hex and this is for testing and diagnostic purposes to allow the points to reset/operate slowly. By experimenting it was found that the lowest value (for fastest operation) was 8 but to be safe a value of 0A hex or even 0F hex is advisable. Of course a different processor and clock speed will alter these values but experimenting will do no harm!.

At this stage the reader may be wondering why each reset address is 2 away from the last and now is therefore a good time to provide a list of all the valid addresses accepted by the decoder board and their function. Note that all data in Table 2 is in hexadecimal.

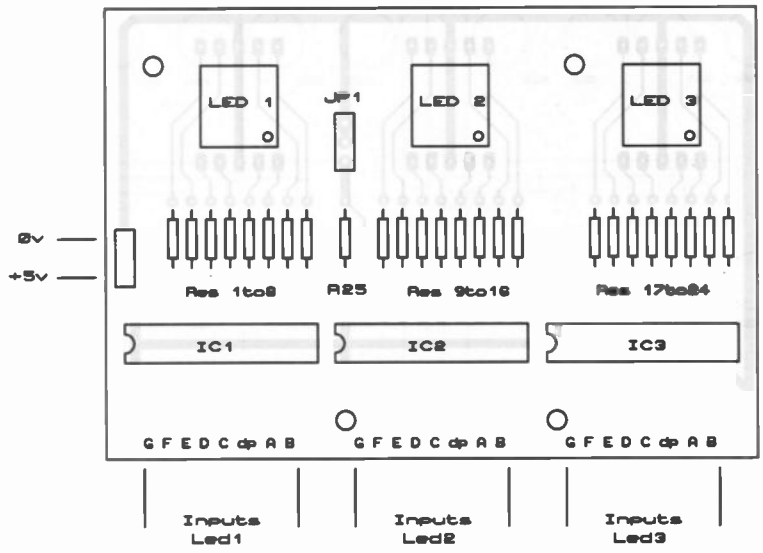


Figure 11a. Status indicator component overlay.

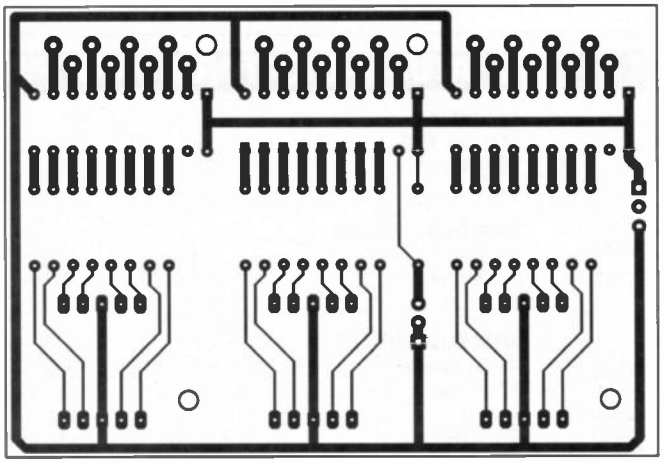


Figure 11b. Status indicator PCB.

Further Developments

If the constructor has progressed this far, he/she should possess a reliable and adaptable system which will provide a platform from which to progress to an automated control system. A mimic panel could be added, but instead of using the status indicator circuit featured here, another computer port could be used to drive a multiplexed set of LEDs. This same panel could also be fitted with switches to control the points individually or by route selection. The system would then operate by the user pushing a switch on the panel, which would be read by the computer. The appropriate point(s) would then be automatically switched and a sensor under the point motor would send back a confirmation to the computer that the point was set/reset correctly and the route would be displayed on the panel. This will take a lot of hard work to implement but could be very rewarding and I would suggest looking at the 8279 Keyboard/Display interface chip (Maplin Code YH51F) as a starting point.

Further Reading

Electronic Circuits for the Computer Control of Model Railways by R A Penfold (Bernard Babani BP180)

Complete Book of Model Railway Electronics by Roger Amos (Order Code, WC02C)

Practical Electronic Control Projects by Owen Bishop (Order Code, GS27E)

Practical Electronic Model Railway Projects by R A Penfold (Order Code, GS29G)

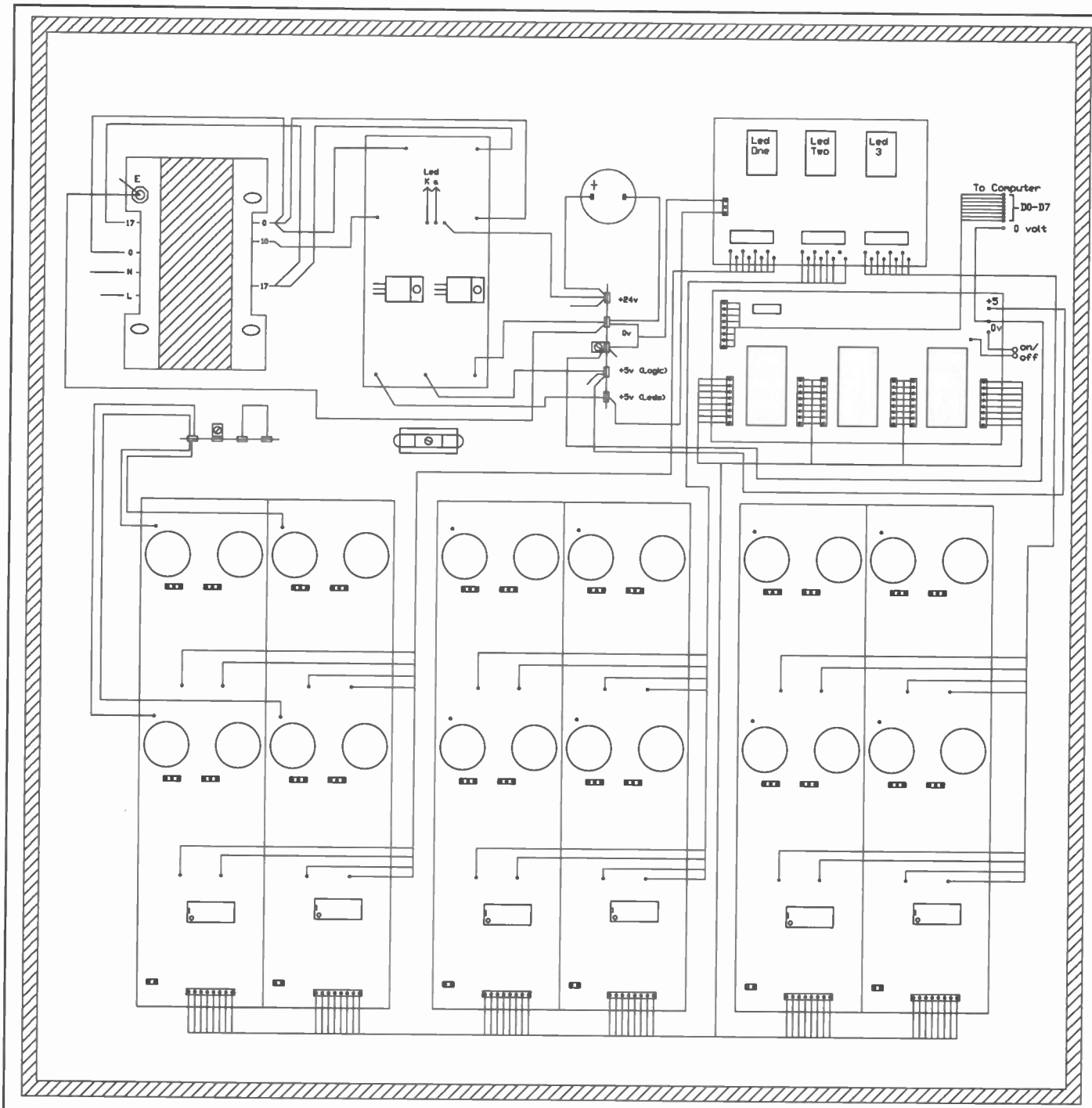


Figure 12. Full interconnection details.

DECODER BOARD PARTS LIST

RESISTORS – all 0.6w 1% unless stated

100k	(1x)	M100K
47k Sil	(1x)	RA31J

CAPACITORS

0.1µF Disc	(1x)	YR75S
0.1µF Tant	(3x)	WW54J
100µF 35v	(3x)	AT08J

SEMICONDUTORS

HCF4514	(3x)	QW85G
74HC139	(1x)	UB35Q

MISCELLANEOUS

DIL16 Skt	(1x)	BL19V
DIL24 Skt	(3x)	BL20W
PCB Pins	(24x)	(FL24B)
PCB	(1x)	(See Text)
SPST Switch	(1x)	(As Req'd)

OPTIONAL

PCB Latch Pl 8w	(1x)	YW13P
PCB Latch Pl 3w	(1x)	BX96E
Latch Hsg 8w	(1x)	YW23A
Latch Hsg 3w	(1x)	BX97F

STATUS INDICATOR BOARD PARTS LIST

RESISTORS

Min Res 150R	(24x)	M150R
Min Res 4k7	(1x)	M4k7

SEMICONDUCTORS

74LS245	(3x)	YF91Y
DIL Skt 16	(3x)	BL19V

MISCELLANEOUS

7-Seg Display	(3x)	FR41U
PCB Pins	(24x)	FL24B
PCB	(1x)	(See Text)
PIN STRIP	(as reqd)	JW59P
PIN JMPR	(1x)	UL71N

OPTIONAL

PCB Latch Pl 3w	(4x)	BX96E
Latch Hsg 3w	(1x)	BX97F

LED CHRISTMAS TREE PROJECT

John Mosely makes a festive display with the PCB supplied free with this issue.

The PCB given free with this issue allows a festive LED illuminated Christmas tree to be painlessly constructed for decoration in a variety of locations. The project is ideal for the beginner, requiring the minimum of tools and no setting up. The dual monostable multivibrator circuits, see Figure 1, produce a two to three per second flash rate, but because of component tolerance variations, the multivibrators are not in sync so produce a very pleasing display.

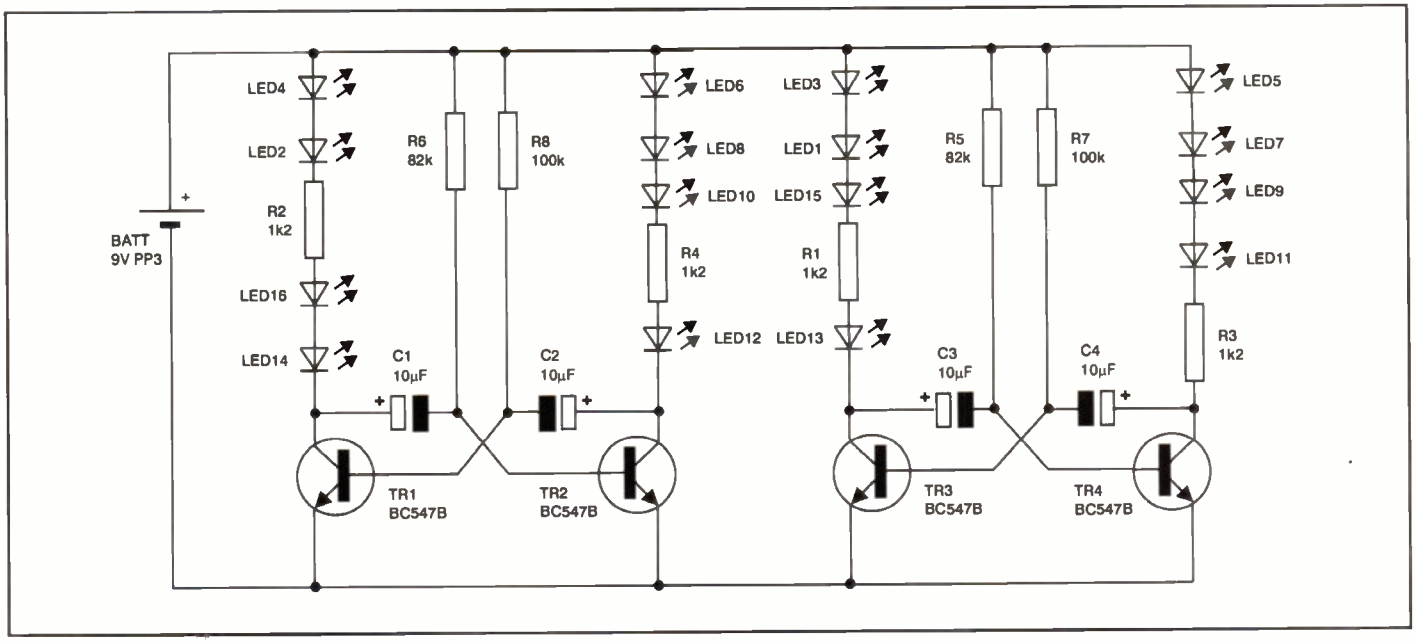
Construction

Construction is very straight forward. Start by inserting the resistors, followed by the capacitors, transistors and finally the LEDs. Remember to cut-off all component legs protruding beyond the solder joints. It is important to observe the polarity of the four electrolytics, and the LEDs. The short leg on the LEDs is the cathode, and is next to the flat on the body – the flat is clearly marked on the legend on the PCB. When finished it is worth checking the joints and looking out for any solder that may have flowed across the tracks.

An alkaline PP3 battery should last for many hours, as current consumption is a miserly couple of mA.

The suggested battery holder in the parts list allows the tree to mounted in a variety of positions with the battery remote from the tree. A small hole at the top of the tree is provided for attaching to a suitable surface, clip etc.

If you buy the kit of components to complete the project, then the supplied battery box is screwed to the PCB and allows the Christmas tree to be free-standing. ELECTRONICS



PROJECT PARTS LIST

RESISTORS

R1,2,3,4	Min Res 1k2	M1K2
R5,6	Min Res 82k	M82K
R7,8	Min Res 100k	M100K

CAPACITORS

C1,2,3,4	Gen Elect 10µF 63V	AT77J

SEMICONDUCTORS

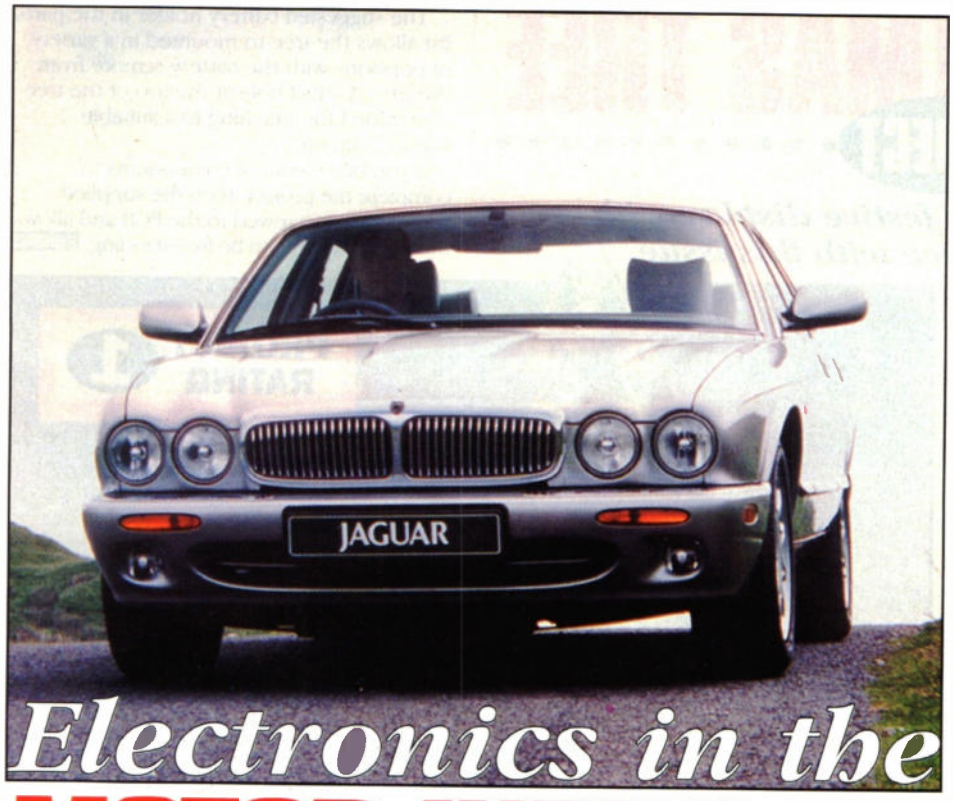
TR1,2,3,4	BC547B	QQ14Q
LED1-16	3mm Red LED	WL32K

MISCELLANEOUS

BATT	9V PP3 Battery	NC97F
	PP3 Battery Box	CK65V
	PP3 Clip	HF28F

A kit of components (excluding battery) to complete the project is available, order code VG59P, for £2.99. Additional PCBs can be purchased for £2.49, order code PV14Q.

A complete kit (excluding battery) is available, order code VX74R, for £4.99.



Electronics in the MOTOR INDUSTRY

PART 2

Mike Bedford looks at ways of making cars greener, using electronics.

The era of the oily rag and the spanner is now well past. This was the message we gave last month in the first part of our series on automotive electronics. For whereas progress on motor vehicles remained relatively slow for many years, over the last couple of decades we've seen a rapid rate of change. A major part of this change has been the introduction of electronic and microprocessor systems. In fact, some of the more esoteric motors on the market now boast as many as forty microprocessors which control anything and everything from the engine through the suspension to sophisticated navigation systems.

In last month's article, our emphasis was on the use of electronic systems to improve vehicle performance. This month we'll be looking at systems which help to make cars safer and more environmentally friendly. But despite the fact that enhancing performance is an anathema to much of the road safety and the green lobby, as we pointed out last month, performance improvement and environmental improvement sometimes can't be divorced. For example, if you can use electronics to make an engine twice as efficient, you can either use the extra power to improve top speed and acceleration or you can cut the engine size without affecting performance and thereby make it greener. Certainly the boy racer and the environmental activist will differ on which approach car manufacturers ought to take but the technology can often be the same for both. In the main, we covered these dual purpose systems, which could be used either to improve performance or to improve fuel efficiency, last month so let's start this month's investigation by looking at those electronic systems which have been designed exclusively to make cars greener.

Electric Vehicles

The subject of electric and hybrid vehicles was covered recently in a series of articles by John Mosely so I won't bore you by repeating essentially the same material here. However, we really can't adequately cover the subject of using electronics to make cars greener without at least touching on the subject. To the man in the street, the electric car is a universal panacea as far as environmental issues are concerned. Our man in the street will admit that the performance of electric cars leaves something to be desired but will suggest that, as zero emission vehicles, they address all the concerns currently being voiced about global warming. Of course, this is a rather naive view. Sure the electric vehicle itself produces almost no exhaust fumes but it doesn't take a genius to realise that the electricity has to come from somewhere. So unless you happen to live in Norway or Canada, where much of the electricity is generated using hydro power, that electricity will be generated by burning fossil fuels. At this point, I'm sure that a number of readers will already be thinking that power stations are more efficient than the notoriously inefficient internal combustion engines which power today's cars. And without a doubt, this is true – large coal-fired power stations are about 33% efficient whereas internal combustion engines only manage about 17%. But, of course, the total efficiency of the electric vehicle is the efficiency of the power station multiplied by the efficiency of the power transmission (i.e. sub-stations etc.) multiplied by the efficiency of charging the batteries multiplied by the efficiency of the electric motor. In fact, the total efficiency of this power conversion chain is little different from that of the internal combustion engine so the only result of making all cars electric would be to move the pollution from the motorways and town centres to the coal fields where the power stations are located.

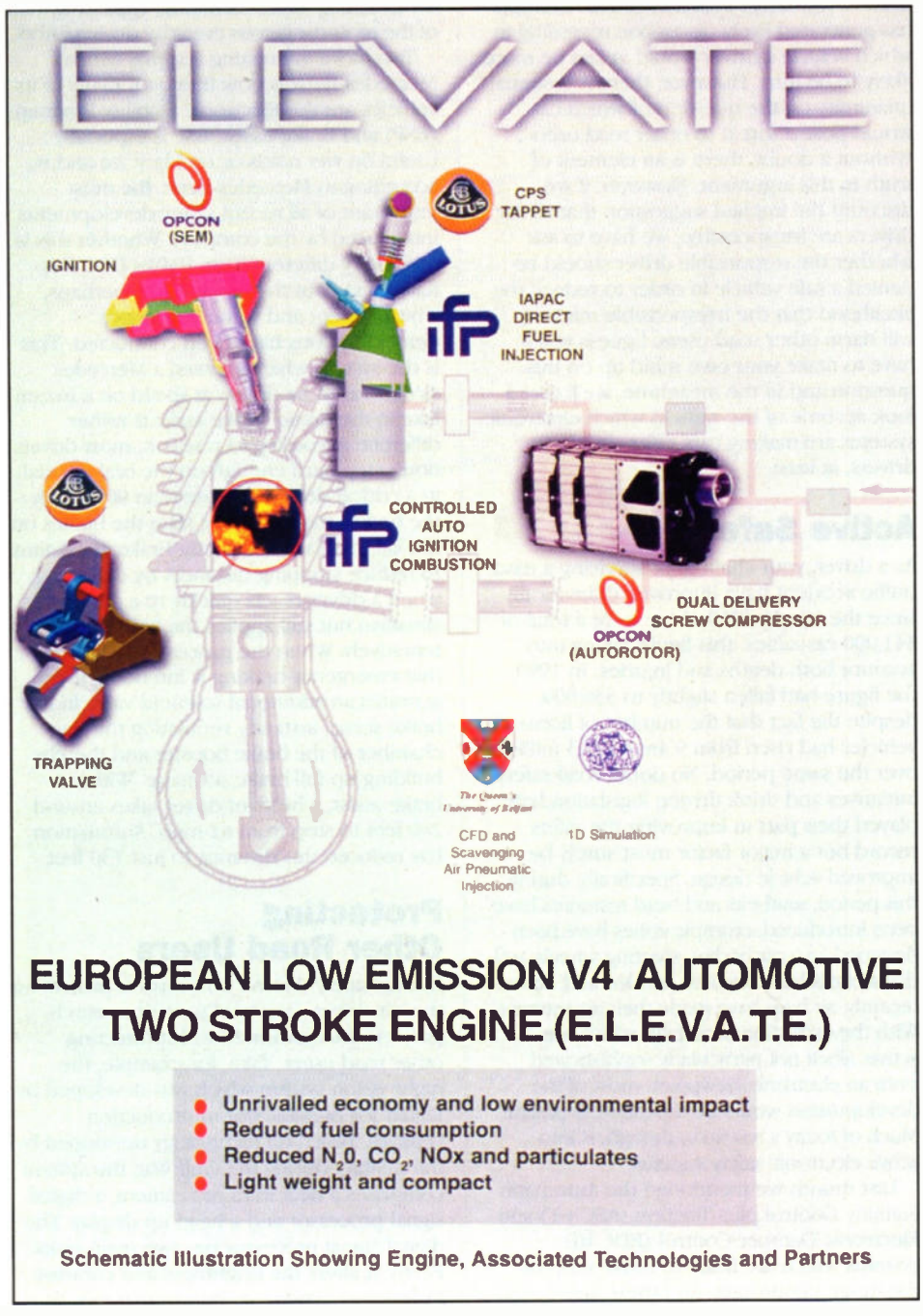
To be more accurate, this would be the case if the only change was to substitute a petrol engine for an electric motor. However, once you're using electric power, all sorts of exciting new possibilities come to the fore. For example, you can use regenerative braking in which the potential energy of the vehicle, rather than being wasted as heat in the brake pads, is turned back into electrical energy and used to re-charge the batteries. Unlike the conventional internal combustion engine which has to be ticking over even when the car isn't moving, an electric motor can be stopped and started as required. Clearly this will give significant gains in efficiency in congested city centres where vehicles are often driving only a few yards before stopping for fifteen or thirty seconds. But despite the undoubted advantages which electric vehicles could bring – so long as they're coupled with sophisticated electronic control systems – we really can't get away from the fact that electric cars have a very poor reputation when it comes to performance and range. Perhaps you might feel that motorists ought to sacrifice performance and convenience to do their bit to save the planet but, in reality, this isn't going to happen. Until such a time that improvements in battery technology allow electric cars to have bigger motors and achieve a greater range, electric vehicles aren't going to take the world by storm, and this, of course, is where the hybrid vehicle comes in. As described in our earlier series, various schemes are available, but the basic principle is that a petrol engine and an electric motor operate in concert so that the vehicle is able to enjoy the performance and range of a petrol car and the urban fuel efficiency associated with an electric car.

Internal Combustion Engines

Whether or not electric or hybrid vehicles do ever become mass market products remains to be seen. One thing's for sure, though, the internal combustion engine is going to remain dominant for some years yet so manufacturers are investing a lot of research effort into making them more environmentally friendly. One of Lotus' research projects is aimed at improving the efficiency of petrol engines in the environment we've already identified as being a particular strength of electric

vehicles – stop/start motoring. Once an internal combustion engine has stopped it can only be started using its electric starter motor so it really isn't sensible to stop the engine unless the vehicle is going to be stationery for a few minutes. So, although it would be quite possible to have an automated system which stops the engine if the vehicle is stationery for longer than some pre-set threshold and re-start it when the driver puts his foot on the throttle, efficiency would be lost due to over-use of the starter motor and the driver would loose the immediate response which he's used to. However, what is possible – in theory, at least – is to cut some of the cylinders when the engine is just ticking over. In fact, such an approach may yield benefits not only when the car is stationary but at any time the engine is operating below its maximum capacity. For example, cruising at 70mph on the level doesn't require a lot of power so this is another situation in which one or more cylinders could, perhaps, be closed down in order to provide an improvement in fuel efficiency. The tricky part, however, and this is where electronic control systems are necessary, is achieving an immediate and seamless changeover. If you're following a slow vehicle at 50mph and see an opportunity to overtake it, it's essential that extra power is made available as soon as you depress the throttle. And this means bringing extra cylinders back on-line without delay.

So far, we've just talked about emissions without considering just what these emissions actually are. If petrol was a pure hydrocarbon and if the combustion was totally efficient, the emissions would be carbon dioxide and water. Water is harmless but whereas carbon dioxide was, at one time, thought to be harmless, we now know that it is a 'greenhouse gas' which can cause global warming. However, if the combustion of hydrocarbons is inefficient, carbon monoxide will be produced and if the petrol contains impurities – as indeed it does – additional pollutants, mainly the oxides of nitrogen, will also be produced. The amounts of these emissions are small compared to the carbon dioxide and water but they are more harmful so in addition to reducing the total amount of emission, it's also important to control the composition of the exhaust gas to minimise the amount of the more harmful chemical compounds. As a cleaner fuel, compressed natural gas has been used in cars, especially on the continent, but a major disadvantage is that the fuel density is lower than that of petrol. In other words, unless you have a huge fuel tank, the driving range of the vehicle will be much reduced. So Lotus are working on a vehicle which can be powered from either petrol or natural gas. The philosophy is that for urban driving the car will run on natural gas to avoid producing noxious fumes in areas of high population, and for highway driving, the petrol engine is used to improve the range. And as with the cylinder deactivation, the challenge is to make the changeover such the driver is unaware of it. So, electronic sensors detect the driving style and thereby select the fuel accordingly and sophisticated control systems produce a seamless changeover.



Schematic Illustration Showing Engine, Associated Technologies and Partners

Cruise Control

If you drive at a constant speed you'll achieve a much better fuel efficiency than if you're constantly braking and accelerating – I guess that must be fairly obvious. So one method of using up less of our natural resources and reducing the likelihood of global warming is to try to drive at a constant speed. OK, I appreciate that this is often easier said than done on our congested roads but even when there's a clear road ahead, many drivers will find that their speed does, nevertheless, fluctuate somewhat. With cruise control – comparatively rare in the UK and Europe, except on luxury motors, but quite common in North America – a feedback control system keeps the car at a constant speed. In all honesty, this isn't promoted as an environmental feature, but as a convenience feature, and it's doubtful just how much fuel it does save. However, it does lead us onto other related innovations which could, conceivably, do their bit in making motoring more environmentally acceptable.

Before we get onto these state-of-the-art systems, however, let's touch on adaptive cruise control which is being developed by Jaguar and others. For whereas this is still aimed at making driving easier rather than making cars greener, it does provide a convenient stepping stone. I guess the main reason that cruise control is not especially popular in the UK is that our roads are too congested. When it's necessary to continually adjust the speed of the cruise control or to brake thereby disengaging it, it ends up being far more trouble than it's worth. With adaptive or autonomous cruise control, the driver still sets a target speed, but the aim of the system now changes from 'maintain a constant speed' to 'maintain a constant speed so long as that doesn't involve coming within a safe distance of the vehicle in front'. But in order to achieve this goal, the system may, on occasions, have to apply the brakes which, while making the system inherently safer,

certainly doesn't achieve our aim of making it more fuel efficient. The next step on is the intelligent highway, a concept which promises an improvement in safety, an improvement in fuel efficiency, an improvement in road capacity, and an improvement in comfort. Sounds too good to be true doesn't it?

Imagine that every car on the motorway is equipped with speed and distance sensors and that the throttle and brakes are under automatic control just as with adaptive cruise control. Imagine, in addition, that each car can communicate either with the vehicle in front and the vehicle behind or with road-side equipment. The possibilities are now staggering. Vehicles can travel, closely packed, without the risk of collision and without the need to constantly adjust their speed. Since all the cars are, effectively, linked together there is no concept of having to brake because the car in front has slowed down. All the cars in the convoy will travel at a constant speed and acceleration or deceleration would only take place when vehicles join or leave the convoy. Effectively, the vehicles would act like a train, the only difference being that the linkage is electronic rather than mechanical. In fact, the train analogy is a good one because, as with a train, advocates of the automated highway suggest that responsibility for steering will also be taken away from the driver. The cars would detect magnets fitted along the centre of the lane and control systems would ensure that the cars remain in the centre of their lanes. In fact, there would be very little for the driver to do on an automated highway, except to read the newspaper, to relax, and hopefully to be less tired when the time comes to leave the automated motorway and revert to manual driving.

Perhaps you think that this is all in the realm of science fiction but the feasibility of such a system has already been demonstrated. An 11 kilometre stretch of the Interstate 15, just south of San Diego in California was kitted out with roadside communication equipment and lane magnets and preliminary tests were conducted in August 1997. In one such demonstration, eight specially adapted cars joined the highway, accelerated to cruising speed and travelled at a constant speed while maintaining a separation of just four metres. The driver of one of the cars then communicated a desire to leave the automated lane, something which was achieved by splitting the convoy to allow him to leave and rejoining afterwards. The demonstration concluded by the convoy coming to a halt without breaking formation.

Road Safety Initiatives

The idea of an automated highway fills some people with dread and with some justification. I'd like to think that any such system would be designed to be fail-safe but, nevertheless, the possibility of a software bug occurring when you're travelling at 70mph just four metres from the car in front is something best not thought about. And as we mentioned last month, a number of people have expressed grave misgivings about systems designed to make cars safer. So before we look at safety features in any more detail, let's spend a while thinking about some of these philosophical questions.

The argument I presented last month was that if a system makes a car safer at a given speed, a tendency of some drivers will be to drive that vehicle faster. In other words, some people will always drive to the limit and the advantage of safety features will, therefore, be cancelled out. But according to some of the more radical road safety campaigners, safety initiatives are not just neutral in their effect, they can be positively detrimental. Or to be more specific, they are detrimental, not to car drivers, but to pedestrians and cyclists, the 'innocent' victims of motor accidents. Let me quote Robert Davis from his book Death on the Streets. 'Consider two fictional hypothetical vehicles at either end of a safety continuum. At one end... a hypothetical 'invulnerability vehicle' in which it is almost impossible for the driver to be hurt no matter how he drives. At the other end... a 'death trap vehicle' – one with, say, a sharp pointed steel spike positioned a few centimetres in front of the driver's forehead. This example has generated lively discussion regarding in which vehicle a driver would in fact be more likely to be hurt. However, there is essential unanimity on the question of which car would pose a threat to other road users'. Without a doubt, there is an element of truth in this argument. However, if we discount the implied suggestion that all car drivers are irresponsible, we have to ask whether the responsible driver should be denied a safe vehicle in order to reduce the likelihood that the irresponsible minority will harm other road users. I guess you'll have to make your own mind up on this question and in the meantime, we'll take a look at some of the ways in which electronic systems are making cars safer – to their drivers, at least.

Active Safety

As a driver, your chances of surviving a road traffic accident have improved dramatically since the 60s. In 1960, there were a total of 341,000 casualties, this figure taking into account both deaths and injuries. In 1990, the figure had fallen slightly to 336,000, despite the fact that the number of licensed vehicles had risen from 9.4m to 23.3 million over the same period. No doubt road safety initiatives and drink driving legislation have played their part in improving the safety record but a major factor must surely be improved vehicle design. Specifically, during this period, seatbelts and head restraints have been introduced, crumple zones have been designed into car bodies, steering wheels and dashboards have become padded and, more recently, air bags have made their appearance. With the exception of air bags which are active, albeit not particularly sophisticated from an electronic viewpoint, most of the developments would be described as passive. Much of today's research, though, is into active electronic safety systems.

Last month we mentioned the Automatic Stability Control plus Traction (ASC+T) and Electronic Damper Control (EDC III) systems which are fitted to BMW's top of the range saloon cars. And these are examples of systems which fill that middle ground between performance and safety-related features. In fact, ensuring that the wheels remain in firm contact with the road surface under various conditions is a key element in road safety. One of the first applications of microprocessors in cars was ABS in which skidding under hard braking was eliminated by controlling the application of the brakes on each of the wheels. This is now widespread but it's only the tip of the iceberg – much more sophisticated systems are on their way. Also on the BMW 750i is the Dynamic Stability Control (DSC II) which recognises lateral acceleration (i.e. cornering forces) and monitors wheel rotation speed, steering wheel movements and road speed to assess the risk of loosing grip with any of the four wheels. In the event that a potentially hazardous condition is detected, power output is reduced to such a level that the wheel is no longer in risk of loosing grip. In fact, DSC is also linked to the ABS system so brakes can also be applied to any of the wheels to keep the car stable, even if the driver brakes while cornering, apparently one of the most dangerous everyday driving errors.

Two more interesting systems which Mercedes-Benz is now fitting on many of its vehicles are the Electronic Stability Program (ESP) and Brake Assist. ESP is especially useful on wet roads or on black ice and is, according to Mercedes-Benz, the most important of all recent safety developments introduced by the company. Whether this is really very different from BMW's DSC II is hard to say but the emphasis is, perhaps, a bit different and some impressive demonstrations have been conducted. This is the system which allowed a Mercedes saloon car to be driven at speed on a frozen lake in the Arctic. Brake assist is rather different. According to research, most drivers don't step hard enough on the brake pedal in a critical situation. More than 90% apply the brakes too hesitantly, slam the brakes on too late or react incorrectly. Brake assist aims to reduce stopping distances by detecting when a driver reacts quickly to a dangerous situation but still applies the brakes too tentatively. When the processor concludes that emergency braking is intended, it activates an additional solenoid valve in the brake servo, instantly ventilating the rear chamber of the brake booster and thereby building up full brake pressure. Without brake assist, a hesitant driver takes around 240 feet to stop from 62 mph. Automation has reduced this distance to just 130 feet.

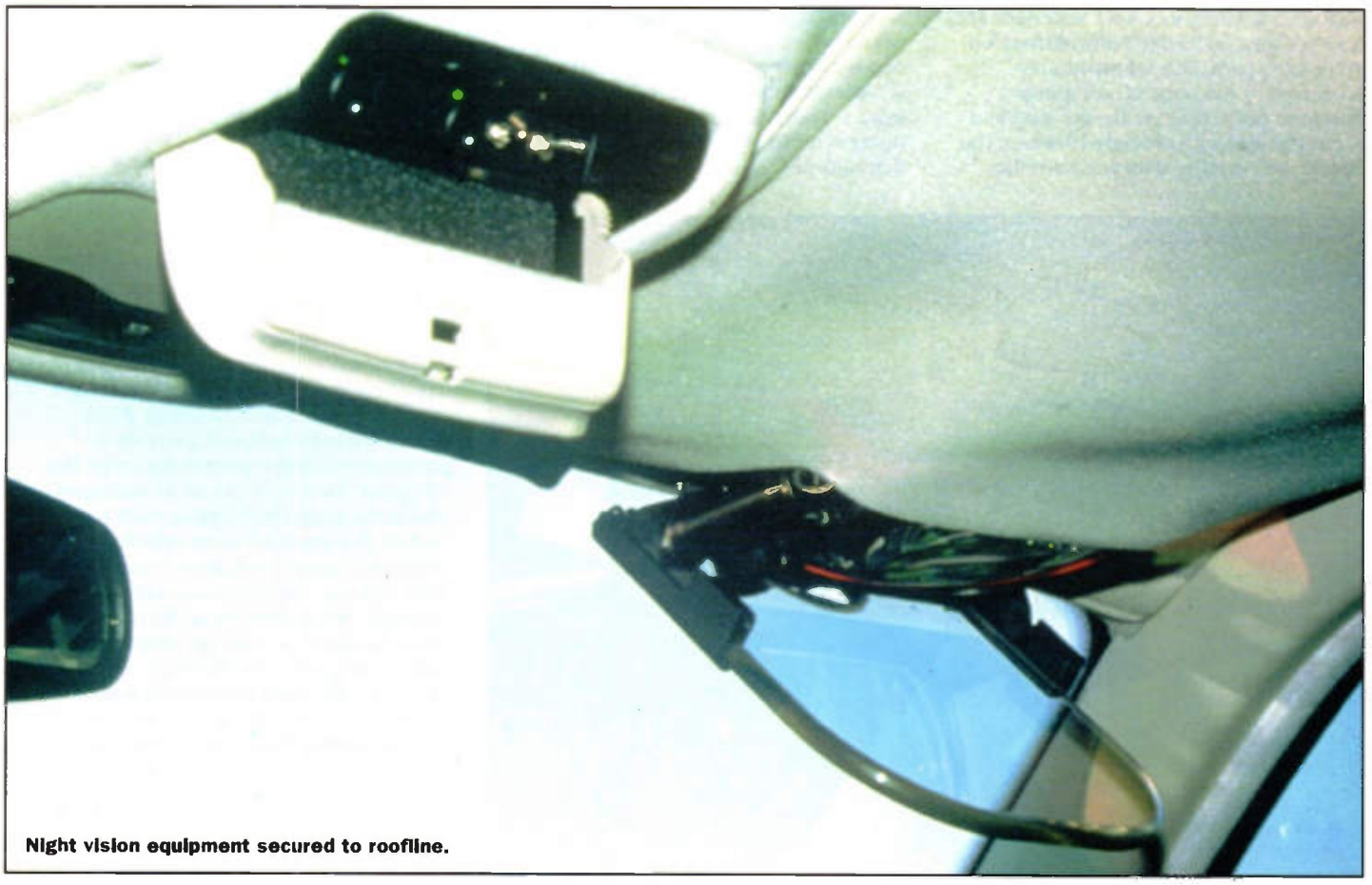
Protecting Other Road Users

But car safety doesn't only involve protecting the car driver – many of today's research projects are concerned with protecting other road users. Take, for example, the night vision system which was developed by Jaguar for possible use in production vehicles. Based on technology developed by the military during the Gulf War, the system comprises a near infra red camera, a digital signal processor and a head up display. The digital signal processor has two main tasks. Firstly, it alters the brightness and contrast in order to present an optimum image to

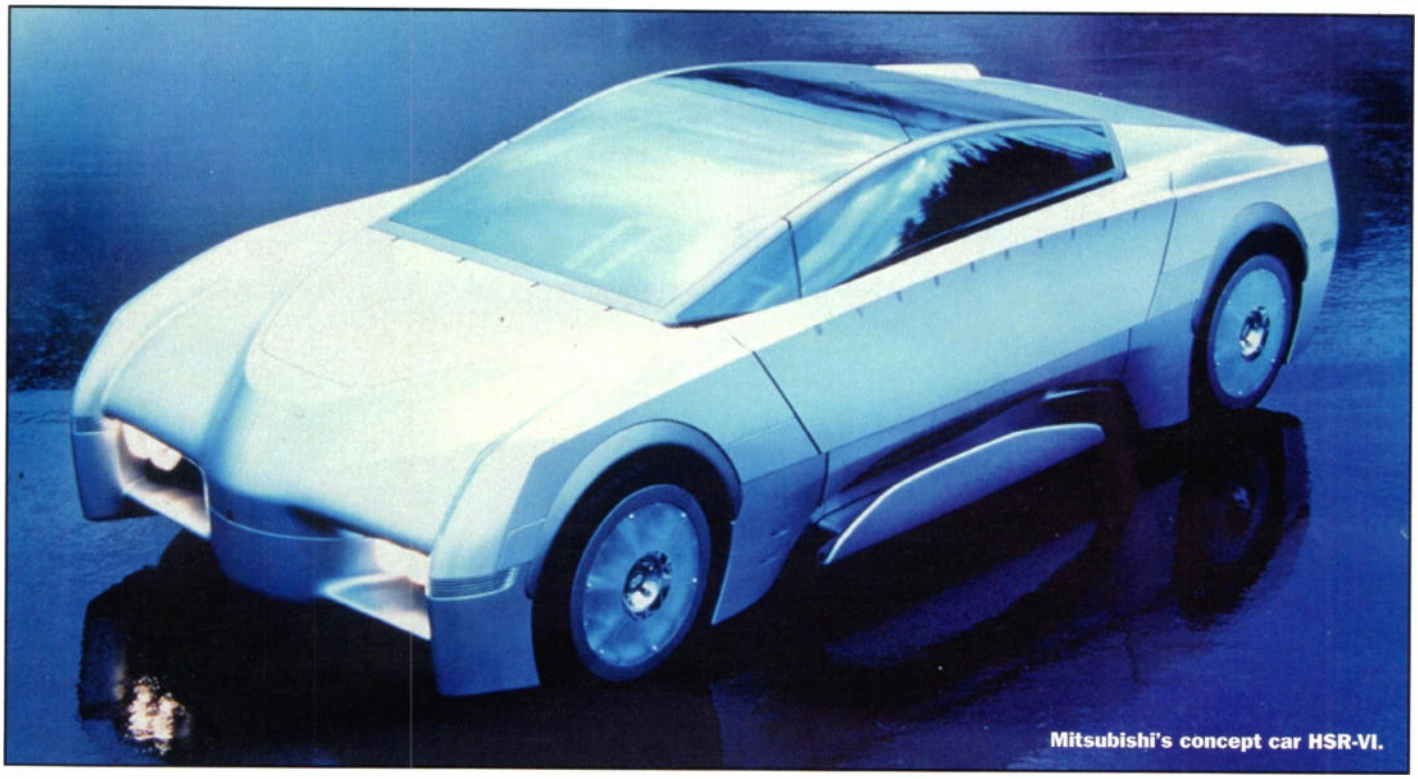
Night Vision system developed by Jaguar.

the driver. And secondly, it performs feature extraction so that lane markers, road edges, other vehicles, pedestrians and road signs are especially visible. Once processed, the image is passed to the head up display which causes it to be precisely overlaid with the actual view from the windscreen. In pedestrian detection trials from a moving vehicle in a dimly lit urban area, detection ranges were more than doubled. For elderly drivers, the improvement was even greater.

Making the driver aware of the environment in the vicinity of the vehicle is one of the key aims of Mitsubishi's concept car the HSR-VI. We'll come back to this innovative



Night vision equipment secured to roofline.



Mitsubishi's concept car HSR-VI.

car next month when we investigate in-car entertainment and periphery systems but for now we'll concentrate on some of its advanced safety features. HSR-VI has a so-called multi-eye system which is used to support the driver to improve safety. Two wide-range scanning laser radar units are mounted at the front of the vehicle and a further two are fitted at the rear. Stereo image cameras also face forward and backward and a further narrow beam laser radar unit faces forward. This combination of sensors monitors activity in the surrounding lanes, monitors road signs and lane markers, and detects any obstruction in the car's path. This information is processed by the onboard computer system to determine the danger level and warns the driver accordingly. However, the HSR-VI can do more than just warn the driver of impending danger. If the driver behaves illegally or irresponsibly, the autonomous avoidance systems will come into play. So if the driver fails to brake in traffic, passes a no-entry sign, exceeds a speed limit, fails to slow down when approaching red lights, a warning message will be displayed and the brakes will be applied accordingly. And if a collision looks likely, the driver will be warned and, if no preventative action is taken, the autonomous system will take control of the brakes, throttle and steering to prevent the accident. If the car can do all this, you would be excused for wondering why it needs a driver at all – surely a human driver is redundant. In fact, the HSR-VI does also feature a fully automatic mode in which the driver is totally superfluous but we'll leave that until next month.

The Tracker system in action.

Security

To bring this month's investigations to a close, let's briefly touch on security systems which, at first sight, might not seem to fit in with our theme of environmental and safety systems. However, when we bear in mind that a large proportion of car theft is associated with so-called joy riding – driving around town centres and estates at high speed with no regard for other road users – it becomes clear that security is an important element in road safety. But although electronics is a major contributory factor in improving vehicle security, a cautionary tale is appropriate here. Some of the early remotely-controlled locks and immobilises were a car thief's dream come true. Every time you press the button on a keyfob, a supposedly secret code is transmitted by UHF radio to the car. However, it is also transmitted to anyone in the vicinity with a suitable receiver. And in combination with programmable keyfobs, these receivers have been used to effect many car thefts. Of course, most of today's electronic locks operate using a pseudo-random sequence of codes so that just repeating the previously used code won't work. And this sort of system is, if the claims are to be believed, every bit as secure as the best conventional locks. But, of course, by including a bit of intelligence, electronic locks can be made even more secure. For example, some vehicles will attempt to protect you from forgetting to lock your car. The Toyota system, for example, will re-lock the doors if you open them but don't actually get into the car within thirty seconds. And if the worse comes to the worst and you car is stolen, electronics comes to the fore here too. The Tracker system, which can be fitted to most cars, is an RF 'bug' which suitably-equipped police cars can track to retrieve your vehicle. So if you're tempted to turn your hand to auto-theft, remember that big brother could be watching you!

THE WIRED MAN

An overview of this concept by Paul Freeman-Sear with information supplied by BT Labs.

The boys at Martelsham Heath BT Labs seem to think about anything these days. At one time they were ostensibly connected with communications research for any possible future development for BT, but now it seems the sky's the limit.

Mans desire to communicate easily and on the move, not just at a local level but at an international level is a very real one. Witness the explosion of all forms of electronic communication including mobile phones and the Internet in the last 40 years. So it seems this process will go on until communicating on the move with others anywhere on the globe will be as easy as talking to a person next to you.

There are those that have associated this rise in mass communications with an attainment to reaching a critical worldwide connectivity level – a level at which global consciousness is achieved. Without wishing to dwell on the more esoteric nature of this, the concept of a 'wired man' fit to communicate with the world, is intriguing.

Picture this if you will. In future, a man or woman can get up in the morning slip on some garments and be ready for the road fully equipped on their person with computer, personal organiser, worldwide communicator and all internet ready and all this without the current baggage of portables to weigh you down. The secret will be to absorb the electronics within your body or into your cloths. Sounds too far fetched! Give the lads at BT labs a few more years at it and the idea could turn in to reality. Within those initial steps to achieve such a thing, they are currently looking at the individual problems of size portability, display and power up requirements.

Here's an introductory statement from Professor Peter Cochrane, Head of Research at BT Laboratories.

"Almost by a process of technological osmosis an increasing percentage of the human race are gradually becoming cyborg."

"Around 20% of the functional parts of a human body can already be replaced. This includes the knee, hip, ankle and elbow joints, artificial hearts, ears, and skin, and shortly we will have; lungs, liver, pancreas and other vital organs as well. There are also now well over half of a million people walking around with electronics embedded inside them in the form of pacemakers and so on."

To that end, while many people now carry pagers, calculators, mobile phones and health monitors, researchers at BT Laboratories are now working on the BT Wired Man' – a study of the potential for combined communications to both the outside and inside of a human being.

Among the items being examined are pacemakers, electronic pain relief modules for the spine and knee, plus an anti-epilepsy unit that simultaneously fires pulses into the left and right hand lobes of the brain.

Each of these items needs electronic attention from time to time that necessitates a trip to a hospital where the memory bank of each unit can be downloaded and algorithms can be changed and modified and the health of the patient checked. In the future we might expect all this to be done via a mobile phone or some internal radio unit for example," explained Peter.

OK, so in order for wired man to become easily 'mobile' a few problems still have to be solved.

Who Needs a Keyboard

Many of us consider the qwerty keyboard to be a 'pain in the backside'. Not only is it cumbersome and a real strain for those that use it constantly but it's also speed limiting. If there was a top ten of bad decision makers, then the person who decided to rearrange the keyboard letters to slow typists down ought to rate high on this list. However the turning point is getting closer to the elimination of such devices. Speech recognition techniques have vastly improved and wired man might either voice info in by a lip mic or if you are self conscious about others thinking you are going mad by talking to yourself, maybe have a microphone in a gloved hand or fingertip touch keying. Other methods in the long term might be to 'think it in'. Yes, wired interfaces to the brain are just beginning to happen. If a keypad is required for major instructions, it is now possible, owing to conductive polymers being available to integrate touch pad contacts within the fabric of clothing.

In fact placing processor circuitry on to flexible substrates is also not far away.

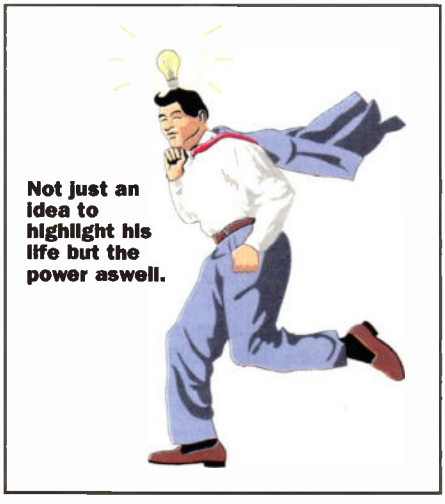
Information Recognition (Displays)

OK so where do you place a visual display on the body that is neither dangerous nor silly. Small displays could be placed on the back of a gloved hand, an arm, a visor or look down the barrel of a pen as in Smartquill (see page 20). Audio information comes in the form of an earpiece or piezo speakers in clothing or from speaker pressure pads on the skin surface. In fact as we know the under surface of the foot is very sensitive to pressure changes, we could potentially be trained to recognise patterns and could receive messages from our feet. In fact pressure pads placed anywhere on the body could have a dual function – one for information reception and secondly for body massage.

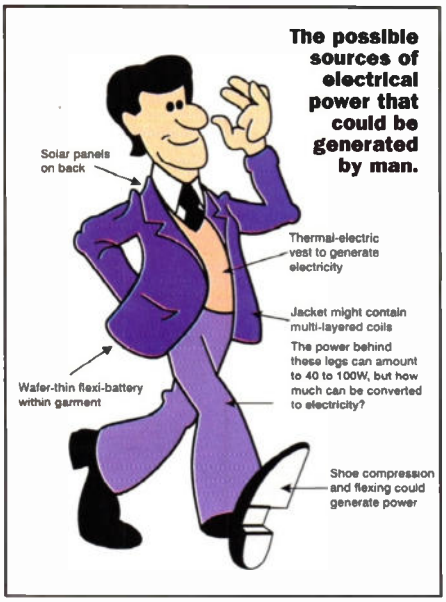
Further down the road there may be other ways of getting visual information direct into your brain, but that's another story.

Go Spread the Word

We all know about Smart cards and a few years ago I predicted that it would not be long before we might be carrying around with us a card the size of a credit card containing a lot of useful information not only for yourself but also to other interested parties like banks, insurance companies, inland revenue and database companies. Whatever convenient form it might be carried around on you, BT labs are looking at the idea that this sort of information could be stored in a computer on your arm or because of conductive polymers and other forms of wired clothing, sources of information could be distributed all around the body.



Not just an idea to highlight his life but the power aswell.



The possible sources of electrical power that could be generated by man.

The Power Behind the Vest

Communications for the Wired Man experiment are being supplied by various manufacturers and laboratories world-wide to augment those under research at BT Laboratories, but as Peter explained it is not just the communications technology itself that needs the Labs' research skills.

Peter says, "Providing power to this array of electronics is a major problem as we may not be able to rely on batteries alone," "To this end BT Laboratories is experimenting with a 'power vest' which has the potential in the future to be used to convert body heat to electricity, which when combined with other potential power sources generated from leg or arm movement may provide the answer to the power problem for the 'Wired Man'."

This is an interesting area. Those of us that work in dry warm work environments will know only too well of static build up on our bodies. There is probably enough static electrical energy to work a calculator! Generating electricity from moving limbs would probably derive from say piezo-electric effects from bending or inertial magnetic motion generating EMFs by flux linkage. Thermo electric generators could pick up some power perhaps from a power vest but it might have to rely on some new aspect of semiconductor junction temperature differences rather than any low output by conventional means. Some power be may gained from compression's and torsional twisting within shoes. Take the squeak out of your shoes and turn it into something useful! Another added bonus would be to pick up power from photovoltaic cells in the cloths. The technology is there on the latter. It may be that voltaic cells could be completely redesigned with electrodes reshaped and resized. Perhaps the large plate inter-electrode distances will become very small, say within the thickness of the garment, sandwiching the electrolyte in between! Which ever way you look at it, there could be certain health benefits if you had to go for a quick jog before you can talk to your mates in Australia, who might also be on the run! ELECTRONICS

A Smart Quill for an X-rated programme? Who knows?

THE SMART QUILL

Writing will never be the same again as another revolution starts here – by Paul Freeman-Sear.

Wouldn't it be great to have a pen that turns your handwriting into wordprocessed text in real time. Also, wouldn't it be nice to have a good visual display of an A4 page from within that pen. Now that would be one hell of a pen to write home about. Fortunately these ideas are now coming together as the lads at BT labs have done it again and as they say, it could cause 'the biggest revolution in handwriting since the invention of the pen' and 'when fully developed, it could put state of the art communications technology at your fingertips'.

Although it is only a prototype at this stage, BT has unveiled SmartQuill, a pen that can read hand written words. This computer in a pen has no keyboard but has spatial sensors to translate handwriting into typed text. They have made a special inkwell to slot the pen into to download the information to a PC.

Semiconductor accelerometers measure movement in two or three planes and an on-board Digital Signal Processor (DSP) converts it to ASCII characters. Rather like speech recognition software, the pen has so far notched up to 90% correct interpretation. At present most of the processing power to turn it into text is handled by a PC, but in the course of time as processing power increases and power consumption goes down, the circuitry will find its way into the pen itself. One variant of the pen is that one range might contain a micro display inside the barrel with a lens at the end. In order to view the screen the viewer holds the pen up to the eye. The idea behind this is that the average executive can view E-mail messages on the move.

Applications

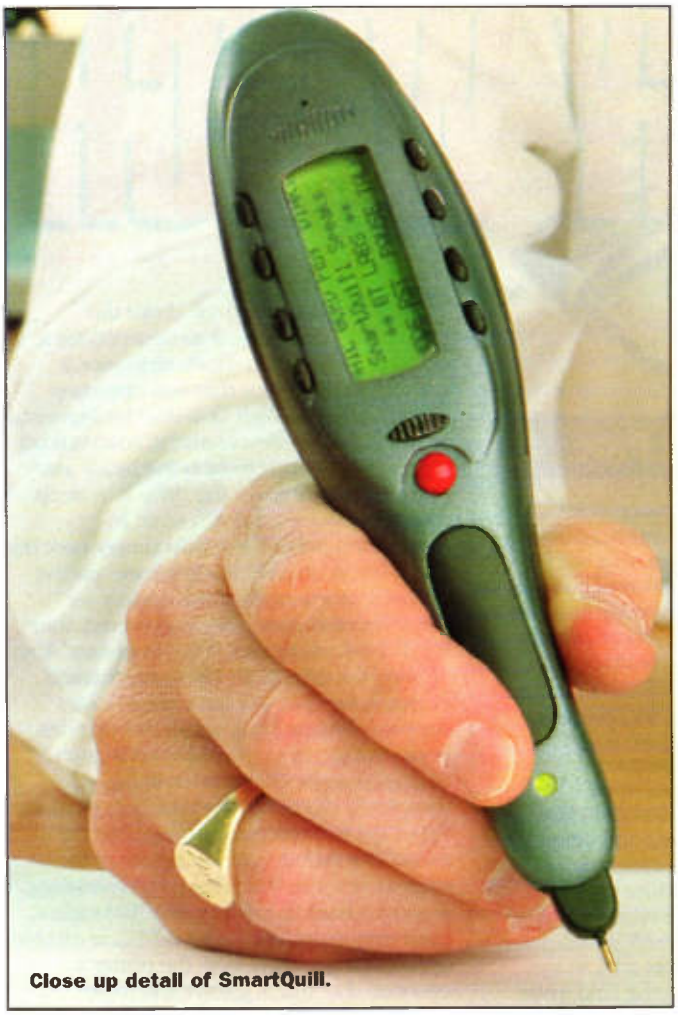
Eventually one should be able to write notes on paper and record them in the pen as text but at the moment just the nature of the pen strokes are stored. When back at base, the cursive script can be moved over to the PC to be processed. There is an on-board database of names and addresses and a diary. These can be accessed by writing out keywords with the pen. The information is then seen on a scrolling LCD display on the side of the pen. The scrolling action takes place by tilting the pen. If you are left handed the pen automatically detects a change of hand and inverts the scrolling display for you. They think of everything! It will also verify the owners signature. This could give rise to a whole variety of security applications. It could also be used as a calculator and pager.

As the sensing head principally works on an accelerating action the head is not orientation conscious, which means you can use it on a horizontal paper surface, a vertical surface or spell out words in the air. They have also put a tiny light in the end for insomniacs or those that might get inspirations at night and must write their thoughts down!

BT has filed a patent on the invention and is hoping a company will come forward perhaps in a joint venture to refine the project and bring a whole variety of pens from elementary to executive on to the marketplace.

TECHNICAL SPECIFICATION

4Mb of memory
Voice record and playback
LCD Display scrolls by tilting pen
Semiconductor accelerometers in sensing head
Powered by AAA battery
Lasts 25 hours
Auto power down with no movement



Close up detall of SmartQuill.

Dr Peter Cochrane using the SmartQuill.

TECHNOLOGY WATCH

IBM Microdrive.

with Martin Pipe

Way back in time, Hewlett-Packard introduced the Kittyhawk hard disk drive. There were two versions, one with a capacity of 20Mb and another of 40Mb. Nothing unusual about that, I hear you cry. But when it was announced, back in 1992, the Kittyhawk had roughly the same dimensions as a matchbox and was consequently hailed as a masterpiece of engineering. Unfortunately, it was somewhat ahead of its time. Only now are we beginning to see the type of 'pervasive computing' devices - wearable computers, PDAs, sub-notebook PCs and so on - that could take good practical advantage of the Kittyhawk's miniscule size. Back in the early 1990s, though, the primary drawbacks of the Kittyhawk were, limited applications apart, a high unit price and a non-standard interface. To the best of my knowledge, only one piece of kit - the obscure Dauphin DTR-1 notebook PC - was built around the Kittyhawk. In other words, there were probably more articles written about Kittyhawk than there were actual drives in use.

Today, practically all PC hard disk drives have form factors of either 3.5in (for desktop machines) or 2.5in (for notebooks). Next year, however, the ghost of Kittyhawk might make an appearance. In September, IBM announced the 'microdrive' - a hard disk drive with a platter roughly the same diameter as a pound coin, and an overall weight of 20 grams! The company, which has one of the biggest privately-funded research and development budgets anywhere in the world, plans to start shipping microdrives in the summer of 1999. The first two such devices, which have stated capacities of 170Mb and 340Mb, will be offered as OEM products to PDA and digital camera manufacturers. IBM have claimed that microdrive capacity will sell for around $1 per megabyte. Expensive compared to desktop PC equipment - you can now get 6.2Gb ATA drives for under £100 if you shop around - but they could revolutionise some product genres. No current PDA, for example, has a hard disk for storing data or applications - it's all buried within typically 4 or 8Mb of flash memory.

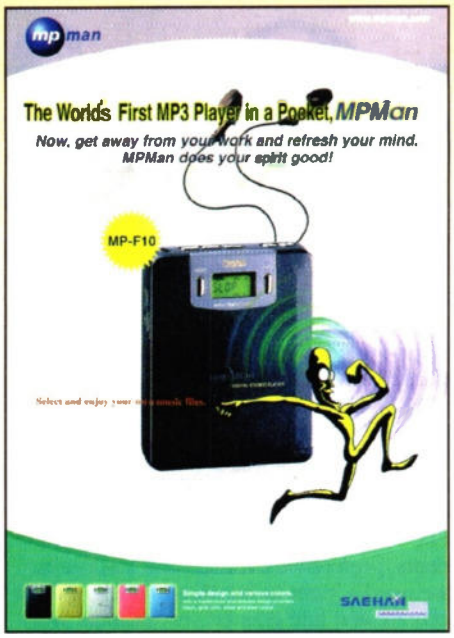
As a result, current PDA owners have to dump one application to fit another one on! Not an ideal situation, and one that will be somewhat less likely with 340Mb to play around with. The lifting of capacity constraints could also lead to some pretty nifty Windows CE apps. We could see usefully-detailed 'pocket' versions of Autoroute and travel guides, for example. Most digital cameras also rely on flash memory, although some expensive professional models store pics on a removable PCMCIA Type 3 hard disk. IBM claims Canon, Hitachi, Minolta and - ironically enough - Hewlett Packard are looking to integrate microdrives into future products. IBM is also encouraging GPS receiver makers to take up the microdrive. Specific geographical data could be transferred from a PC to the receiver's microdrive. Out in the field, your GPS-derived location could be displayed on a map, together with accurately-calculated directions that will help you reach a specified destination.

The microdrives will be offered as sealed CompactFlash cards, the interface of which is closely modelled on that of the standard ATA/IDE hard disk. CompactFlash cards, the primary patents of which are held by US company Sandisk, have the same 42mm x 36.4mm height and width. Type 1 CompactFlash cards, familiar to digital camera owners, are 3.3mm thick. The Type 1 products tend to be - as the name suggests - flash memory cards, ranging in capacity from 2Mb to 16Mb (Toshiba has, however, just announced a 32Mb card for mass production in 1999). Type 2 cards, meanwhile, have a thickness of 5mm. IBM's microdrives will be Type 2 cards. According to an IBM product manager, the microdrive will appear to the user as a 'very big' flash memory card - no special drivers will have to be written for devices with the required card slots. Unfortunately, the device will need to have a Type 2 CompactFlash slot. Few, if any, current devices have these. The 3.3mm Type 1 slots of current PDAs and digital cameras cannot physically accommodate Type 2 cards. Stand-alone Type 1 flash memory read/writers for desktop PCs already exist, primarily for digital photography enthusiasts. In time, we'll see Type 2-compliant models. In the PDA world, these will transfer data a hell of a lot faster than the serial link currently used to install applications and synchronise files. IBM reckons that some airlines could build small PDA-type computers, with Type 2 CompactFlash slots, into the back of aircraft seats. Executives would slip in their microdrives and resume work.

What else is there to say about the microdrive? Obviously, if its destined for a portable device then shock resistance is important. IBM claim that non-operating shocks can be as high as 1000g! Instrumental to this is an IBM development, 'load/unload technology', which retracts the heads away from the platter when the drive is in sleep mode or a powered-down state. In comparison, most hard disks simply park the heads on an unused 'landing zone' on the platter. Unfortunately, if the camera (or whatever) is dropped when powered, there is still a risk of damage and loss of data. After all, any disk drive is an electromechanical device. I, for one, wouldn't like to lose a once-in-a-lifetime photograph through disk drive damage - such considerations don't hold quite as much relevance in the completely electronic world of flash memory. Other key technologies employed by the microdrive include a development of the magnetoresistive head that is commonplace in today's hard disk drives. The IBM variant, giant magnetoresistive read (GMR), is capable of producing a signal from the platter's encoded data that is greater and more sharply-defined than that from previous read head designs. This helps bolster the recording density, claimed by IBM to be 5Gbit per sqaure inch (imagine what you could do with a 3.5in. desktop hard drive!).

Power comsumption is another crucial consideration, and the microdrive has been bestowed with low-power 3.3V semiconductors and an idle mode, which spins down the platter and retracts the heads after a specified shutdown period (similar technology forms part of the 'green' PC standard). In this idle mode, power consumption is quoted as 0.5W. Bringing the drive back to life shouldn't draw that much current - after all, the tiny platter (which spins at a standard 5400rpm) will have very little inertia. Unfortunately, the IBM specification doesn't tell you the power consumption of the drive when it's in use! It does tell you that there's a single platter, with either one or two recording surfaces (and the requisite number of heads) depending on the capacity. A tiny platter should aid the seek time - after all, the head actuator doesn't have to move far in order to move from track to track. This is quoted as 15ms, which is surprisingly slow. According to IBM, data transfer rates range from 34 to 49 megabits per second, presumably according to whether the data track is at the outer or the inner edge of the platter. Further details from **http://www.ibm.com/storage/.**

The biggest threat to the microdrive is, of course, the rather more robust non-volatile semiconductor memory. Toshiba **(http://www.toshiba.co.jp)** has just launched the TC58256FT, a TSOP-packaged 256Mbit flash-programmable 3.3V EEPROM with a one-off price of $75 to developers. The



volume price should, of course, be much lower when mass production starts in the spring of 1999. A pair of TC58256FTs could be arranged in a byte-wide configuration to yield 64Mb - a useful capacity for portable digital audio 'memory pads', portable computers and digital cameras. Eight, meanwhile, would yield a gigabyte - the size of a typical desktop PC hard disk not so long ago. Indeed, Toshiba specifically claims in its literature that the chip could be used to replace disk drives, and pose a real threat to IBM's development. Multiple chips can be 'stacked' on top of each other, resulting in extremely high capacities but with low PCB 'real estate' consumption. It's not just the packaging that's interesting. Toshiba used 0.25-micron design rule and shallow trench isolation technologies to shrink the new EEPROM chip to a mere 130 square millimetres. Interestingly, Toshiba is also building a single TC58256FT into a SmartMedia card. The 32 megabyte TC58256DC has a one-off price of $85, and is an ideal choice for the digital photographer with a busy agenda.

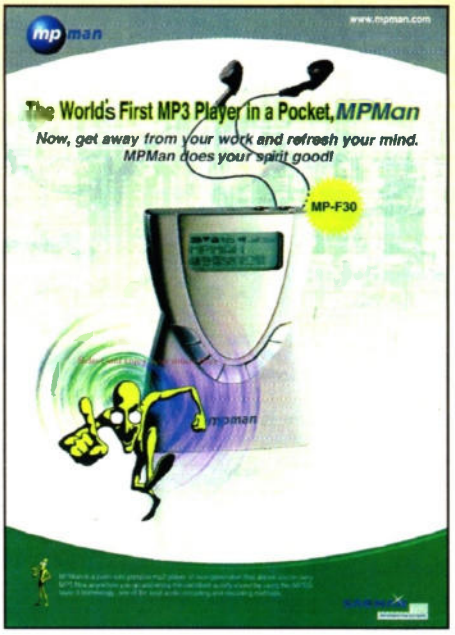
The ever-increasing sizes of flash memory

Music Vending Machine!

give rise to completely new applications. How about a completely solid-state personal stereo, for example? This already exists, at least if the website **(http://www.mpman.com)** is to be believed. The MPMan (a distortion of Sony's 'Walkman' trademark, perhaps?) is manufactured by a Korean company by the name of Saehan. Basically, you convert songs from CD (or .WAV file) to the highly-compressed MPEG 1 Layer 3 (MP3) audio format using your PC, and transfer them to the MPMan's flash memory using a parallel port cable (there's hence no version for Macs, because Apple's finest doesn't have a parallel port). An average track takes 45 seconds or so to transfer. Saehan's web site also describes the MPstation, a vending machine that dispenses MP3 songs to the MPMan. The MPStation is connected to a 'jukebox' server via ISDN. Saehan sees MPstations being placed in public locations, including shopping centres, airports, subways, record stores and internet cafes. MPMan users will select the songs they want transferred, and pay for them with coins (or perhaps e-cash?).

There are two versions of the MPMan, both of which are ergonomically modelled closely on the Walkman-style gadgets Saehan sees them replacing. One is a recorder player with in-built organiser, while the other is simply a player. Both models are offered with 32 or 64 megabytes of non-volatile flash memory. To give you some idea of the potential music capacity this offers, a 5 minute 30 second pop song, converted to a near-CD quality (96kbps) streaming MP3 file, occupies 3.8Mbytes. The tools required to produce MP3 files are, incidentally, linked from the Saehan site. Out of relevance, DIY MPEG audio was significantly covered in a previous edition of Electronics and Beyond. The obvious advantages of the MPMan concept stems from its lack of mechanics. No longer will 'skipping' or wow and flutter plague the early morning jogger! In addition, power consumption is excellent - Saehan claims that a single charge of the in-built NiMH battery will deliver between seven and nine hours playback. It's easy to select tracks - there's a display - and access times are far superior to any CD player.

Disadvantages? When you're sick and tired of the same old songs, there's not much you can do about it until you load in new ones. You certainly can't insert another CD or tape as you can with current personal stereos. Remember that the largest-capacity MPMan will only store an hour or so of music. This will, of course, change in the future if higher-capacity flash memory chips (such as the Toshiba device described earlier) are included. In addition, the MPstation is unlikely to be particularly popular unless you can transfer the songs back to your PC. That is, unless, the songs are very cheap and lend themselves to 'impulse' purchase. With distortion figures as high as 0.1%, I reckon that the analogue side of MPMan could do with a little extra development. No price for the MPMan has



been given - you have to e-mail Saehan for the current price - but I can see the playback-only unit selling for the same £100 as an upmarket Walkman. That is, of course, only if UK dealers start importing the things - Saehan invites queries from wholesalers and dealers via its website. You can also buy a MPMan directly from the company's website, although I would exercise caution here.

Dimensions:	42.8 x 36.4 x 5.0 mm
Capacities:	170/340 MB
Disks:	1
Data heads:	1/2
Seek time:	average 15 ms (typical read)
Media transfer rate:	34 - 49 Mbits/sec
Rotational speed:	4500 RPM
Power supply voltage:	3.3V
Weight:	20g
Interface:	CompactFlash Type 2
Key technologies:	IBM Enhanced Adaptive Battery Life Extender, GMR technology, load/unload technology

Table 1. Preliminary specifications - IBM 170 MB and 340 MB microdrives.

Architecture:	32 megabit x 8 (528 x 64k x 8; page size: 512 + 16 byte; block size: 16k + 512 byte)
Power source:	single 3.3V
Program time:	200ms
Erase time:	3ms
Access time:	10 microseconds (1st), 50 nanoseconds (serial)
Lead current	10mA
Program current:	10mA
Erase current:	10mA

Table 2. Toshiba TC58256DC specifications.

Memory:	32MB and 64MB
Size:	58mm(W) x 90mm(H) x 22.5mm(D)
Display:	Graphic Type LCD (8 characters/line x 2 lines)
Voice Recording:	4 minutes/MB
S/N Ratio:	70dB
Distortion:	0.01 to 0.1%
Max. Output:	5mW x 2 (headphone)
External jack:	Stereo headphone, line out, line/mic in
Power:	NI-MH 1500mAh Rechargeable Battery - one AA size

Table 3. Saehan MP-F30 MPMan recorder/player specifications.

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk. – Or look out for him online! His ICQ ID is: 15482544

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.

November 1998

24 to 25 Nov. Image Processing and Digital Document Management, Fielder Centre, University of Hertfordshire, Hatfield. Tel: (01727) 813 651.

25 Nov. Enterprise Networking for SMEs, Colloquium, Savoy Place, London, IEE. Tel: (0171) 240 1871.

25 Nov. Modern Methods of Detection for Buried Utility Services, Discussion Meeting at Savoy Place, London, IEE. Tel: (0171) 240 1871.

25 to 26 Nov. Developments For The Web, The Commonwealth Institute, Kensington, London. Tel: 01908 373311.

26 to 27 Nov. Practical Digital Signal Processing (DSP) for Engineers, London. Tel: (0181) 335 4014.

December 1998

1 to 3 Dec. Year 2000 Conference, Giga Information Group, Berlin. Tel: (01753) 831 731.

8 to 10 Dec. Online Information 98, National Hall & Olympia 2, London. Tel: (01865) 388000.

14 to 16 Dec. Second International Conference on Partial Discharge, IEE, Edinburgh. Tel: (0171) 240 1871.

March 1999

10 to 11 March. Softworld Accounting and Finance, Interactive Information Services, Grand Hall, Olympia, London. Tel: (0181) 541 5040.

24 to 25 March. Softworld for the Supply Chain, NEC, Birmingham. Tel: (0181) 541 5040.

31 Mar to 1 April. Conference on Antennas and Propagation, IEE, University of York. Tel: (0171) 240 1871.

May 1999

25 to 28 May. Ninth International Conference on Metering and Tariffs for Energy Supply International, IEE, Conference Centre, Birmingham. Tel: (0171) 240 1871.

June 1999

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

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

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

July 1999

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

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

September 1999

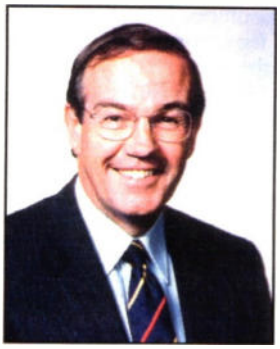
1 to 3 Sept. Ninth International Conference on Electrical Machines and Drives, Canterbury Christ Church College. Tel: (0171) 240 1871.

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

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

What's On?

Promises From a New IEE President



"You may believe that you are living in the 'Information Age' but you ain't seen nothing yet! The real information age is only just beginning. The next 50 years will be the most exciting society has ever seen."

This was the message given by Dr John Taylor OBE at the beginning of October in his Inaugural Address as President of the IEE, Europe's largest professional engineering society. Dr Taylor, who is Director of Hewlett-Packard Laboratories, Europe, was addressing an audience of over 400 senior industrialists, engineers and academics.

"The convergence of many different technologies and the interplay of business and social forces will produce something quite different from anything we have seen so far" said Dr Taylor. "ITEC – Information Technology, Electronics and Communications – is going to be the biggest single sector of the economy for at least the next 10 years. It will have a major, and often disruptive, effect on most other sectors."

The huge advances in information storage technology, reduced costs, the Internet and the ability to treat all media as digital data were highlighted by the President as the main drivers of the Information Age.

Rapid developments in the information infrastructure are already beginning to disrupt the way many established industries do their business, said Dr Taylor, publishing and the retail trade being two prime examples. It is estimated, for example, that within two years 20% of all new and used cars will be bought in the UK using the Internet.

The development of digital imaging and the ability to combine many different types of media in a single digital document promises both industry and individuals a wide range of exciting possibilities.

"There are hundreds of new uses of 'image as data' waiting to be invented and discovered" said John Taylor. "Imagine when there are hundreds of millions of cameras on the Internet, each with its own little Web site from which anyone authorised could pull an image whenever they wanted.

"I could check the weather anywhere in the world at a glance, or the traffic on the motorway on my route home. I could check that my car is still outside my house when I'm away. I could see whether my ageing mother is lying unconscious on the floor because she's not answering her phone."

Dr Taylor warned that the explosion of stored digital information would bring its own problems. "Over the next twenty years, almost everything ever written, composed, performed, painted, filmed or recorded will be put into digital form and will be accessible to anyone on the Internet. The rate at which we create new digital information is also going to explode." Dr Taylor went on to say. "We 'urgently' need to develop new information management and search technologies. Today's filing systems and search engines will leave us to drown in an ever-expanding flood of digital stuff. It will all be in there, or out there, somewhere, but our chances of being able to find it when we want to will diminish rapidly – as will our interest in doing so!"

The new IEE President ended his address with a warning that the developments ushered in by the Information Age will bring, and be used for, good and ill.

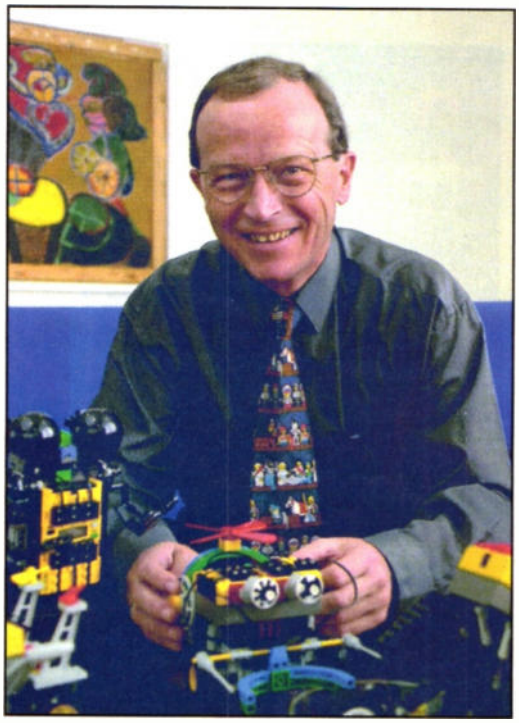
"An individual's life will be tracked with ever greater detail and precision – buying habits, movements, preferences, friends and associates. Might we need a 'right to fuzziness' which outlaws such accurate and fine-grained surveillance? Will the one smart card per individual be a bit too much? How will we be able to identify exactly what information is 'out there' on us as individuals, particularly as we can be sure that some of it will certainly be wrong? The consequences of that will be unpredictable, unpleasant and in many cases invisible."

He finished by saying. "We need to promote informed public debate about the future 'quality of life' implications of these technologies so that society can make informed choices and preparations."

Copies of Dr Taylor's Inaugural Address, 'Engineering the Information Age' are available from the IEE Web site at: **www.iee.org.uk/Lectures/inaug98.htm.**

Lego Announces New Era of Imagination

The LEGO Group has announced a series of global public awareness initiatives to vitalise children's own active imagination now and in the future. Coming at a time of increasing public concern over how the information age affects children, the new LEGO initiatives include the



launch of an international forum of experts to find new ways of promoting children's development and imagination, as well as other actions.

The initiatives announced by the LEGO Group come amidst a growing public debate about whether or not new technologies are helping children develop. "There are concerns that TV, point-and-shoot video games and even the Internet are hindering children's imaginative development, in all parts of society," says Dorothy Singer, professor of psychology at Yale University and co-author of the book The House of Make Believe: Children's Play and the Developing Imagination.

At a media event in London, the LEGO Group announced the founding of the Next Generation Forum; a global meeting point for the world's most advanced knowledge about children's development and imagination. Including international experts from the fields of education, research, the arts and business, a summit will be held annually beginning autumn 1999, to set a global agenda for children's development.

A smaller roundtable group will meet two times a year beginning in early 1999, to set the agenda for the summit. The roundtable group is being set up with the co-operation of Yale University professors Dorothy and Jerome Singer, founders of the Yale University Family Television Research and Consultant Centre and professor Mitchel Resnick of the Massachusetts Institute of Technology Media Laboratory. The 1999 summit will focus broadly on children's imagination. The members of the Next Generation Roundtable will be announced in the coming months.

Science Museum and Intel in £1.5m Collaboration Intel

Intel and the Science Museum in London have announced a collaboration embracing funding of the digital content gallery, due to open in year 2000. Intel has committed £1.5 million to the gallery, the UK's leading museum of science and technology.

The digital technology gallery will be part of the new Wellcome Wing, currently under construction. The wing will feature 10,000 square feet of gallery space and an IMAX 3D film theatre. Intel is also discussing with the Science Museum a proposal to enhance development of the Museum's Web site.

Announcing the collaboration, Sean Maloney, vice president of sales and marketing, Intel, said, "There are few places in the world that can explain technology as well as the Science Museum in London. Tomorrow's museums will extend into cyberspace and the Science Museum and the digital technology gallery will be in the lead".

Sir Neil Cossons, Director of the Science Museum, said, "The Science Museum is delighted that we will be working so closely with Intel in developing our Wellcome Wing digital technology gallery. As an industry and technology leader, Intel have a great contribution to make to a gallery which we hope will stimulate wide understanding and debate about the technology of today and tomorrow".

News of the collaboration follows Intel's biggest single corporate contribution to an art museum exhibition in the US, with an innovative collaboration at the Whitney Museum of American Art in New York. Intel is collaborating on The American Century: Art and Culture 1900-2000, a cultural and technological initiative that will greatly enhance the ways in which museum visitors, students and people in their homes experience and learn about works of art.

Internet Is Hackers' Dream Says Security Conference

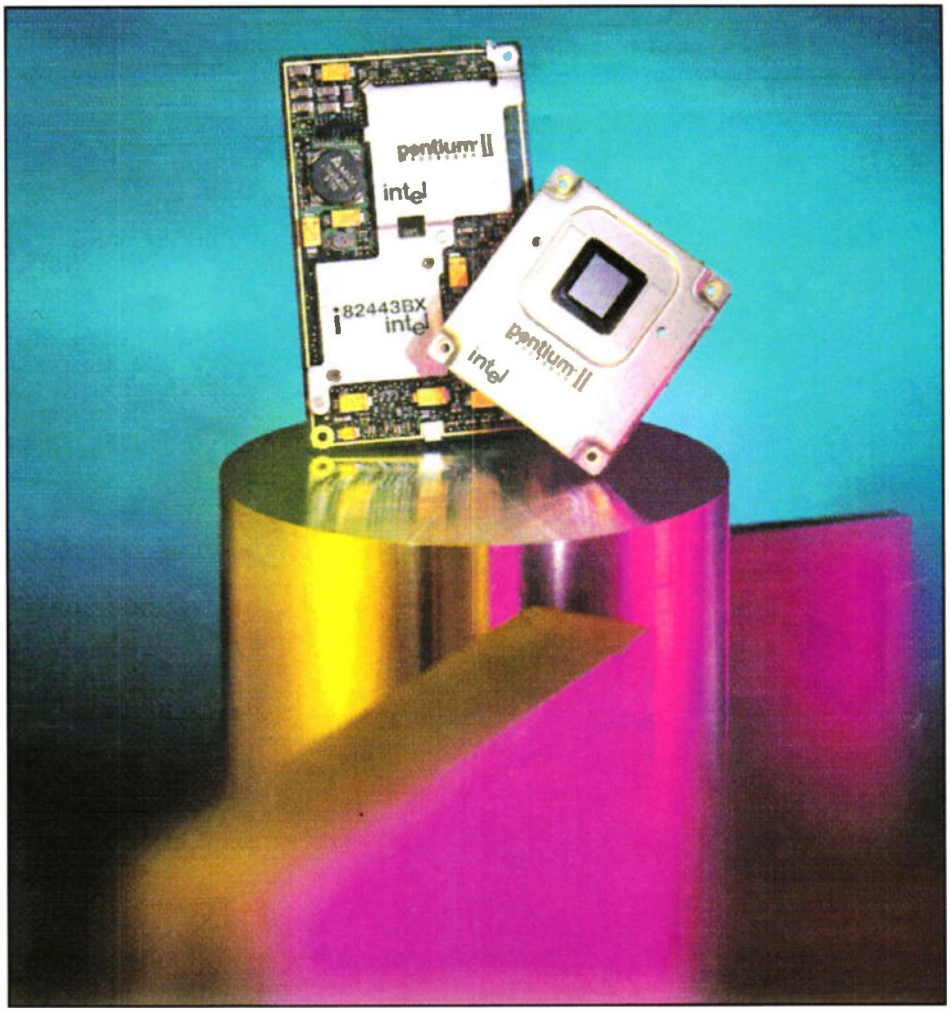
Around 90% of Web sites can be hacked and shut down within ten minutes, says Diligence, organiser of the UK's first independent IT conference on information security and corporate strategy.

Diligence illustrated the simplicity of e-mail forgery, Web site and network hacking, and virus infections at a live demonstration on October 28 at the Landmark Hotel, London.

"In the rush to get connected to the Internet, companies are ignoring the security implications and opening the door to the biggest single threat to their information security. Once a Web site has been hacked, it's usually a matter of hours before they can gain access to the entire IT system and everything it contains," says Harry Ram, director of communications for Diligence.

"Anderson Consulting believes the e-economy will overtake the traditional industrial economy by 2003 but the current farcical state of security means that it will provide even richer pickings for computer criminals unless companies start waking up to the dangers now," added Ham.

Nearly 70% of Fortune 1000 IT/security managers say their organisations were targets of information espionage in 1997 according to War Room Research. Only 12% reported break-ins to the police – primarily for fear of adverse publicity.



PSYCHO KINETIC BIO-FEEDBACK TRAINER & MOVEMENT DETECTOR

Photo 1. Complete Unit

PART 4

In part four, David Aldous gets down to construction.

This month we look at the mechanical layout and construction, and include the PCB foil and component overlay for the main board. Photographs of the main box and relative component position were reproduced in part two, issue 131.

Mechanical Construction

As stated in Part 2, the main electronics processing unit is built into a large size, standard, black plastic box. The sensing head is built into a smaller standard size plastic box. The sizes of both boxes are given in the appropriate drilling diagrams, and the part number/order code references in the appropriate parts lists. The two units may be physically plugged together to form a compact, self contained system for simple investigations or for setting up purposes, whilst for other investigations, the two may be linked via a 4m extension cable. NB: greater lengths than this are allowable, and intending constructors may wish to either make up their own choice of cable length or, alternatively, make up an additional extension cable. In the latter case, it is suggested that the cable be fitted with the appropriate 9-way D-connectors and shells to fit between the main processing unit and the free end of the main cable. This will allow suitable matching bail-locking retainers to be fitted to each connector, so as to prevent accidental disconnection during operation. Full details of cable assembly are given in the section on electrical assembly.

Marking Out

As the edges of the plastic boxes used, are curved, the best way to ensure an accurate datum line is to place a short (say) 6in/150mm metal ruler flat against the reference side of the box, with the end protruding above the top surface. If a second metal ruler is now placed with its measuring end butted up to the first ruler, accurate measurement is then possible. To avoid damaging the front panel, it is suggested that all marking be carried out with a 0.5 mm HB pump-action pencil. This allows marked lines

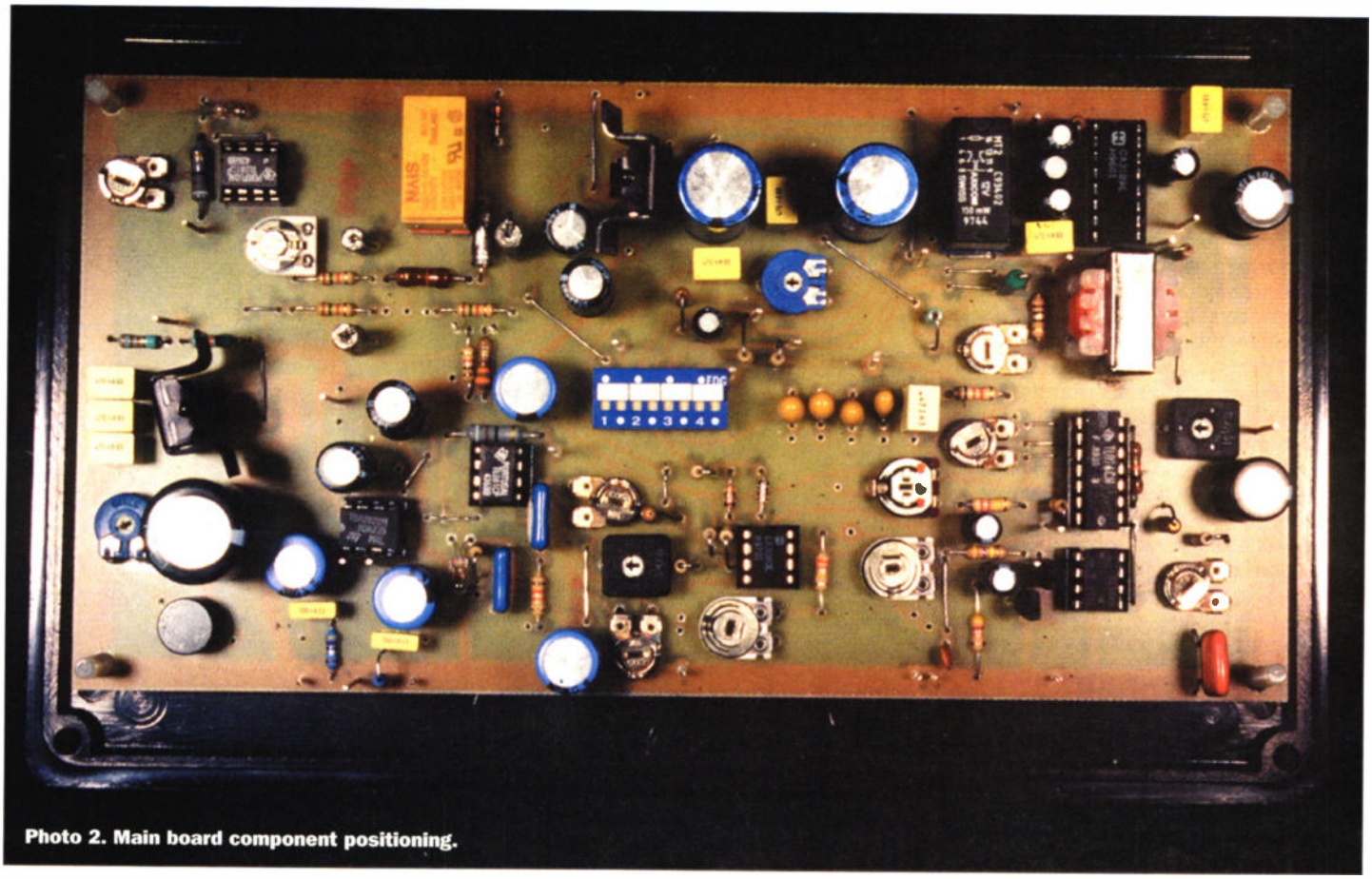
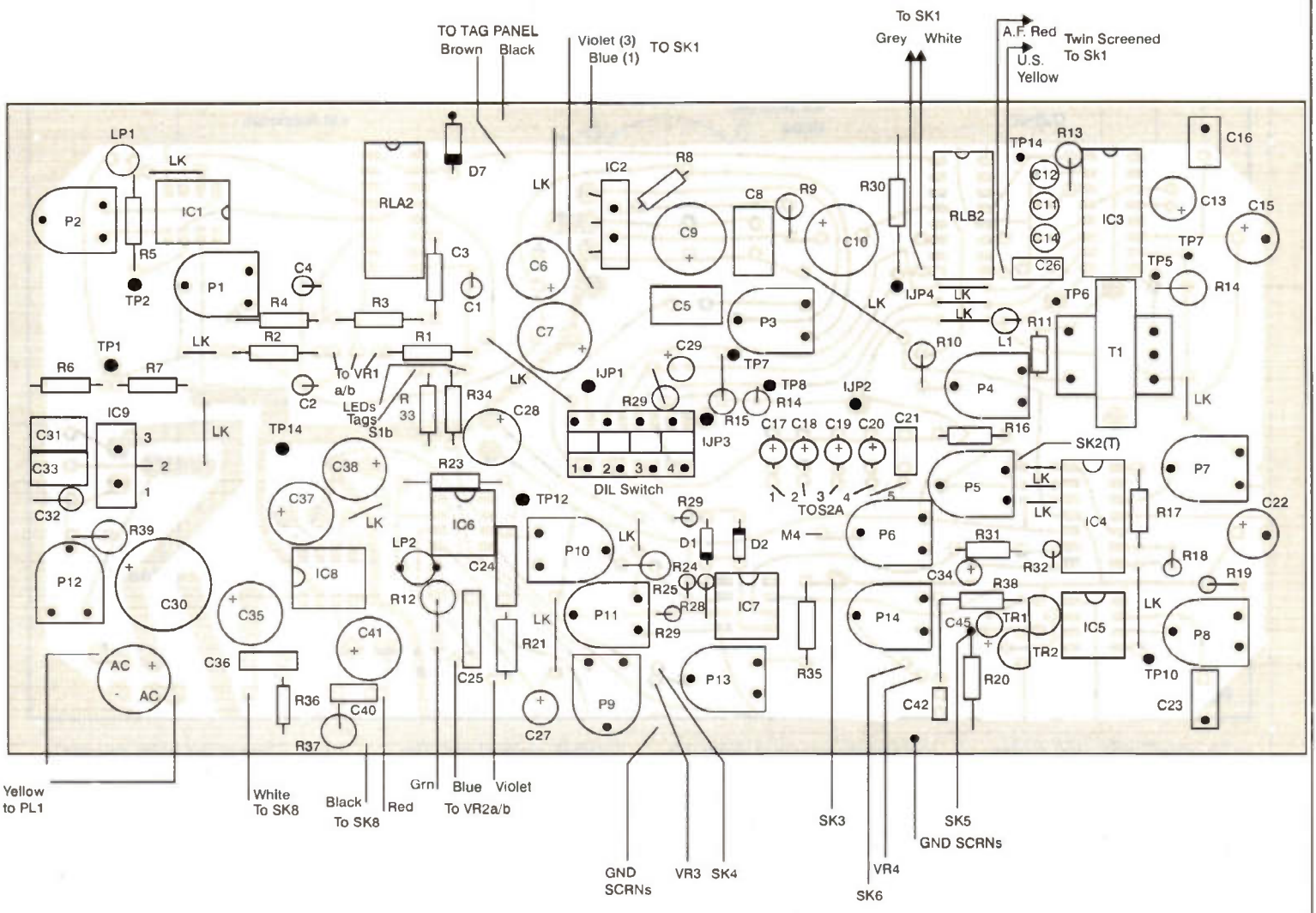
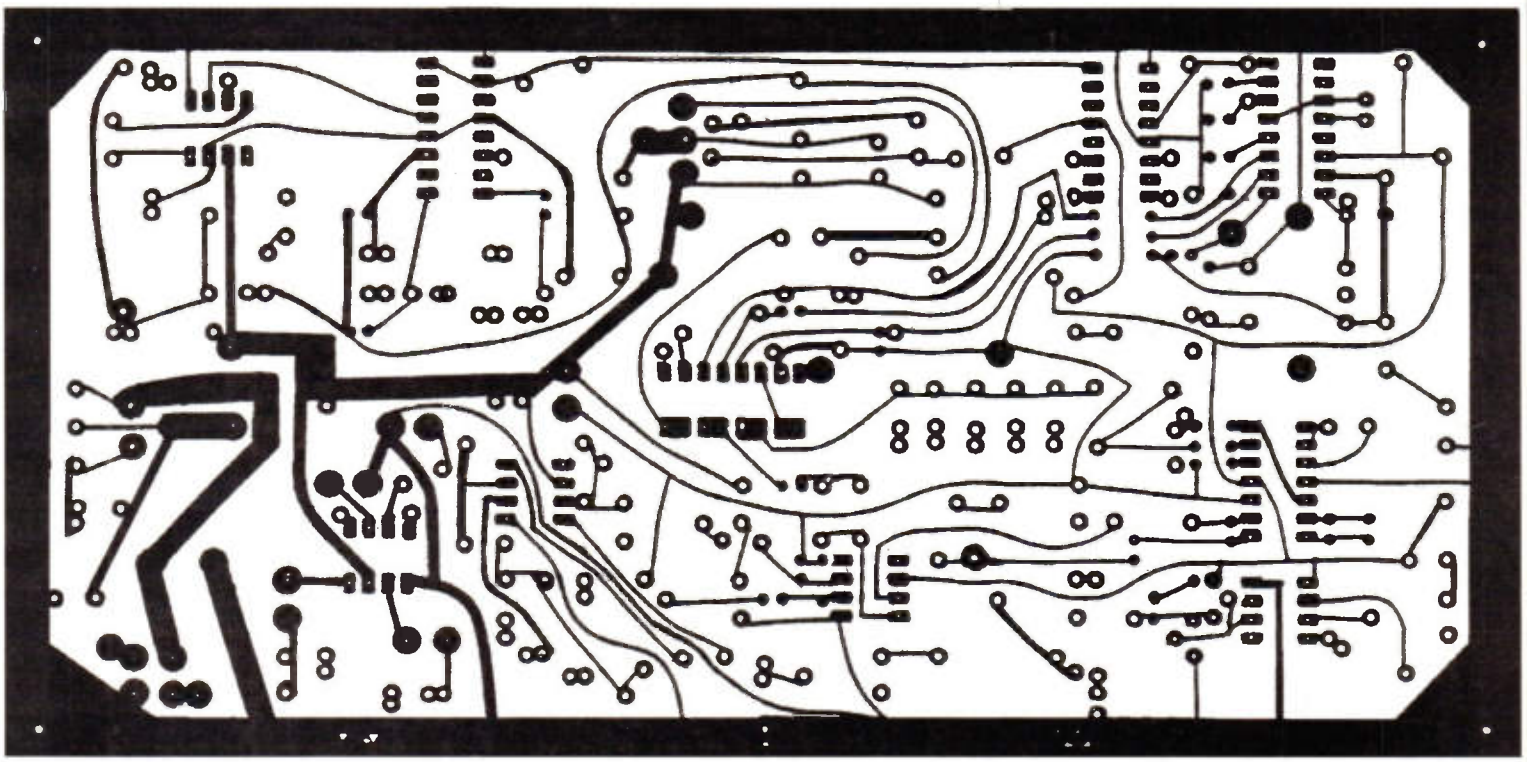


Photo 2. Main board component positioning.



Main board component overlay.



Main board. **Prototype version only**

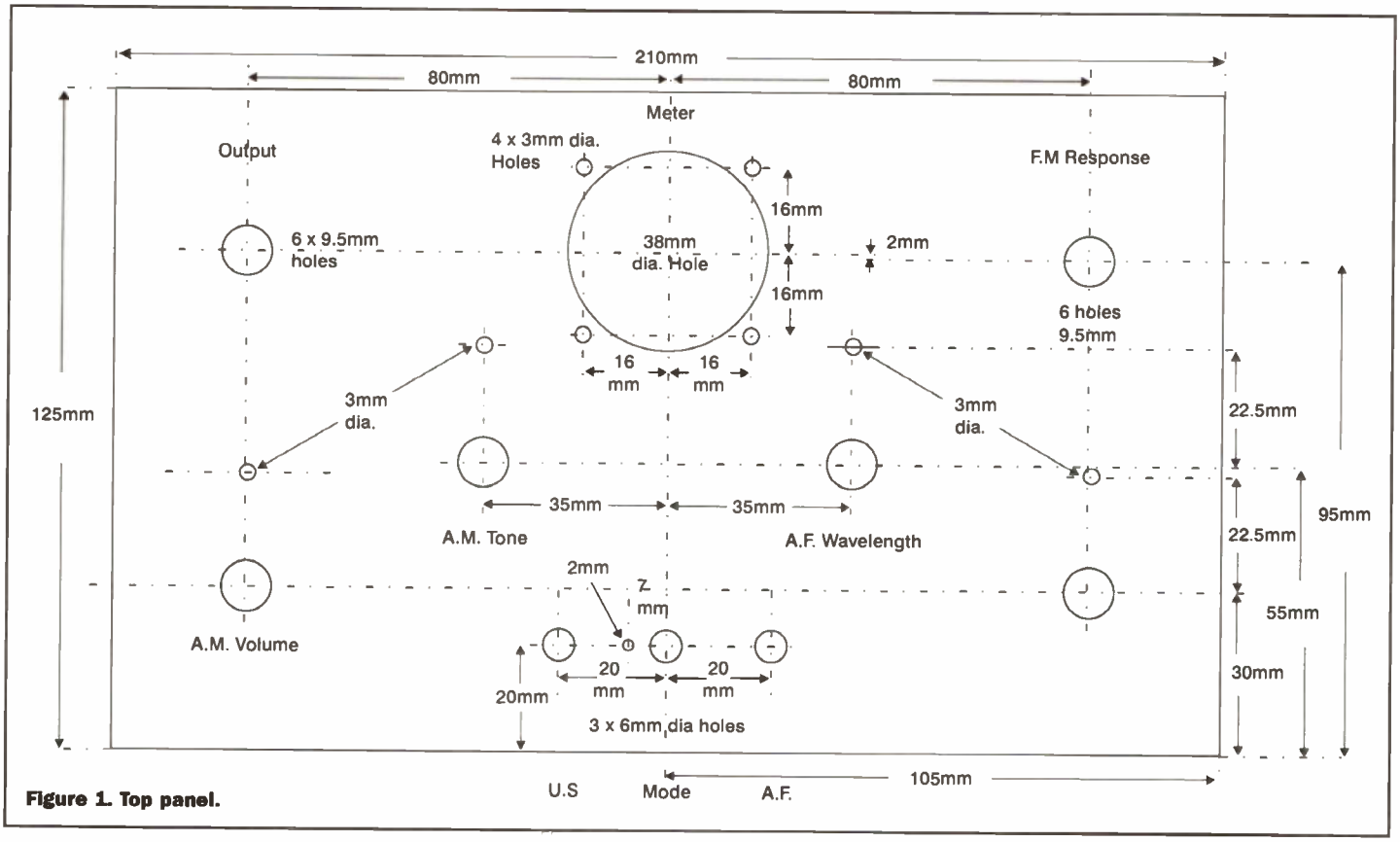


Figure 1. Top panel.

to be erased with a soft rubber once drilling and cutting is completed. The lines marked are rather feint, but careful observation under a good, angled, light source renders them more easily visible.

Marking, Drilling and Cutting Details

For the top panel on the main unit (see Figure 1), it is important to measure accurately from the datum lines indicated, in order to ensure correct relative placement of the meter and controls. The marking and drilling for the meter is particularly important, since the top side of the meter barrel is very close to one of the central stiffening rib base mounting bush supports.

The meter mounting holes require a large hole (38mm) and the meter barrel must be carefully marked out. The removal of such a large area of the panel can be a problem and several solutions are possible. One solution is to drill a series of closely spaced, small (say 3mm) holes, around the inside edge of the marked area and to then cut through the remaining material with a suitably shaped Stanley Knife blade, finishing off with a medium grade, half-round file to final size.

The smaller holes required for the meter mounting screws can be marked in one of two ways: (a) by direct measurement as shown or; (b) by placing the meter barrel into the hole and with the meter firmly pressed to the panel, gently rotate the meter back and forth over a few degrees. This accurately locates the radial hole positions. The exact centre line of each hole is determined by holding the

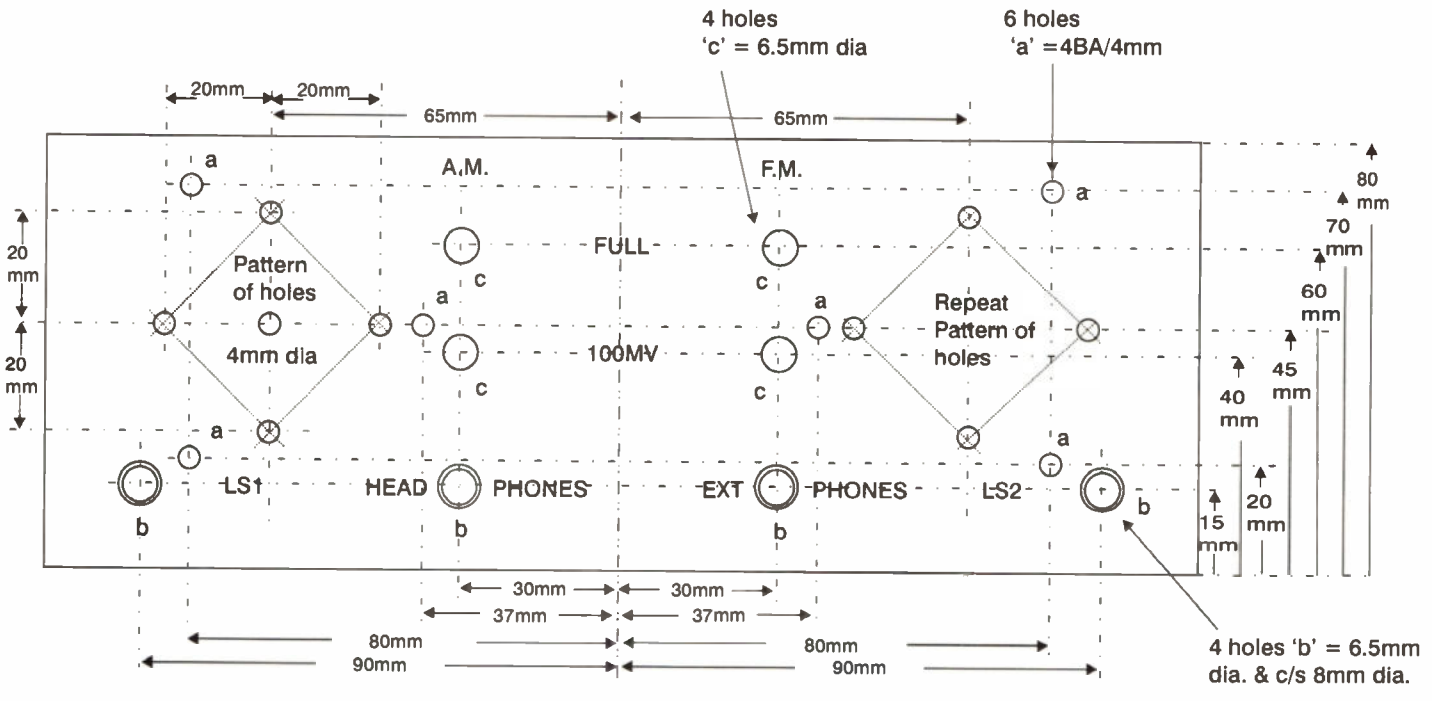


Figure 2. Back panel drilling details.

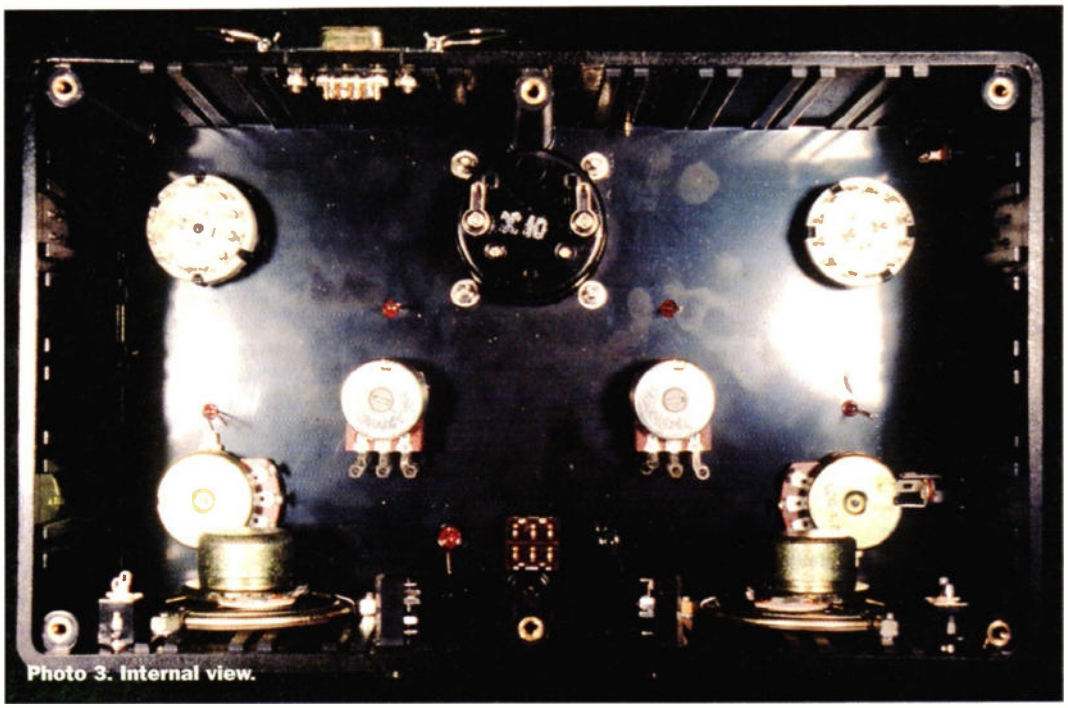


Photo 3. Internal view.

meter in the correct square relationship to the top edge of the panel and drawing short, radial marks, outward from each mounting screw with a 0.5mm HB pencil. If the meter is then removed, the marks can be extended to cross at the correct radial positions of each mounting bolt. The resulting centres are centre-popped and drilled out to 3mm.

For all other front panel mounting holes, after they are marked out, the next step is to pilot-drill all the holes with a 1.5 mm HSS drill. This can easily be done by hand with the aid of a suitable pin chuck drill holder, or with a small model makers power drill. A slow drill speed should be used to reduce the tendency to friction 'melting' of the hole edges. NB: The mounting holes for the two 5mm status LEDs may need opening out with a small round file or reamer to allow for the LED mounting bushes. The author actually used a set of hand-held reaming tools bought specifically for working on thin sheet metal and plastics, in order to cut panel holes to final size, and whilst these are the most useful tools for the job, they are however, quite expensive. A minimum size starting hole of 4mm is needed for these reamers. The current Maplin Catalogue lists a suitable small reaming tool (Page 1267, Maplin reference FG11M) suitable for most of the smaller panel holes and intending constructors might find it useful to purchase such a tool. However, no matter what method is adopted, great care must be taken not to rush the job.

All the smaller hole sizes should next be drilled out (or reamed) to final size. NB: In the case of the holes for the 3mm cursor LED's, the holes must also be countersunk by 2mm on the inside of the box, to accommodate the LED flange. The drill size to use here is 4mm, and very great care must be taken not to drill though the box. This is quite difficult to do by hand, but is best done either by simply holding the drill in a suitable pin chuck and drilling a little material out at a time, or preferably, if a pillar drill is available, by making use of the depth stop and taking great care to set this accurately to 2mm [Tip – if a pin chuck is not readily available, then a small panel knob with a shaft clamping screw will act as a makeshift drill holder/chuck]. After drilling and countersinking each hole, try the 3mm LEDs – they should be a tight push-fit. If so, then nothing more need be done. If loose, then a small amount of super glue can be used to fix them in place when ready for assembly.

The back panel (see Figure 2) is quite a complex area to mark-out and drill, since the internal stiffening ribs/PCB mounting slots have to be avoided as far as possible. This dictates the hole spacing to a great extent. Marking out is accomplished by using the bottom edge of the box (minus lid) as the datum edge and then relating the spacing of the drilling centres to a central, vertical line, drawn up the back of the box to the top edge. The most difficult part of this operation is the marking and drilling of the speaker grill hole patterns and is generated by nothing more than measurement and an ordinary small metal ruler. Try and avoid the temptation to drill these patterns by eye, since the internal stiffening ribs/PCB mounting slots can cause hole wandering, spoiling the appearance of the finished unit. The hole size adopted here is 4mm, although 5mm

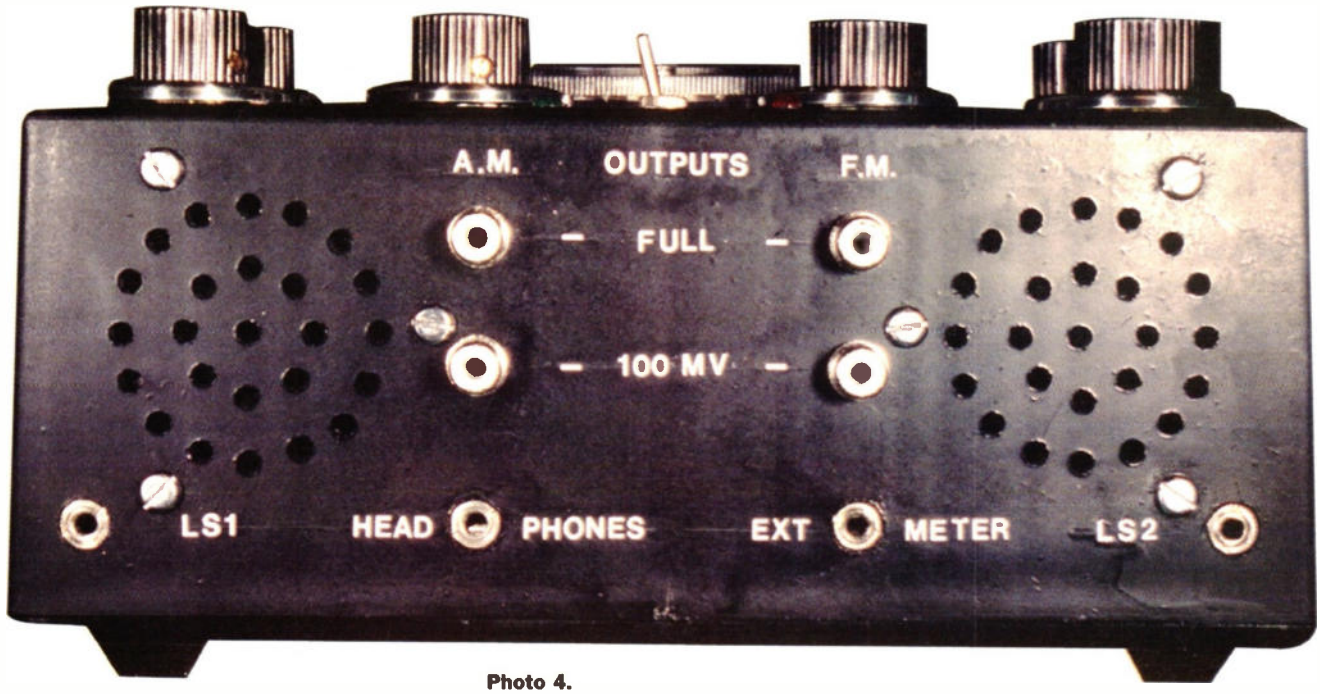


Photo 4.

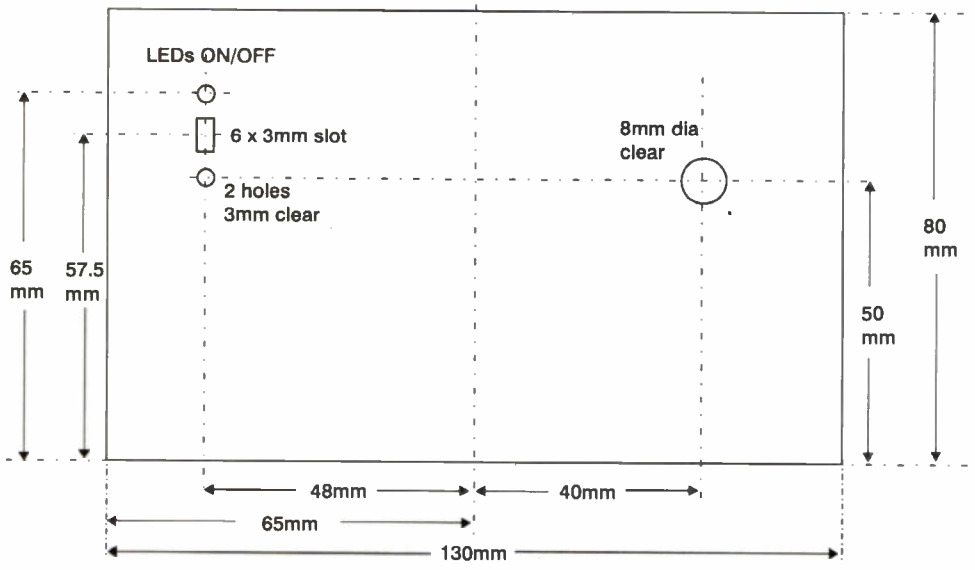


Figure 3. End panel.

could be used if preferred. The mounting of the small loudspeakers requires the use of three, 4mm holes, spaced at 120° around the pattern. The placing of these holes is critical in order to avoid fouling the internal structure of the box.

The jack socket holes are all 1/4in/6.5mm, but because of the thickness of the panel (4mm), they also have to be countersunk into the outer surface by 2mm, in order to allow tightening of the mounting ring. The countersinking needs to be 10mm in diameter. This is more difficult to achieve with the larger holes involved here, since any large drill has a tendency to 'pull' into (and through!) the work. A low drilling speed should also be used.

For the end panel (see Figure 3) the mounting hole for the power jack plug is quite straightforward to both mark and drill. A 1.5mm pilot hole is also employed here prior to final opening out to size. The slot for the LEDs On-Off switch is more critical, since this is next to one of the corner stiffening ribs/base mounting bush pillars, leaving little room for error. The marking is as shown. Two holes, each 3mm diameter are drilled within the marked area and then the slot is made oblong by use of a small, square, warding file. The two mounting screw holes are critical and are each 3mm diameter to accommodate the M2.5 mounting bolts.

The hole for the 9-way "D" connector on the forward panel (see Figure 4) is critically spaced above the bottom edge of the box. It is spaced in this manner so as to align with the corresponding 9-way D-connector on the head unit when both units are fitted with mounting feet. The 3mm holes accommodate the mounting bolts. Marking out of this hole is achieved by drawing the shape shown onto the box at the marked position, referenced to a line drawn up the side of the box and centred on one of the areas between stiffening ribs/PCB mounting slots. The unwanted material is removed by first drilling four, 1/4in/6.5mm holes near to the corners of the marked area, then simply cutting out the piece with a suitable Stanley Knife blade. Cleaning up the hole can be achieved by gently 'carving' away the remaining unwanted material. The holes for the two brass eyelet rings are drilled very carefully in the positions shown. This is because use is made of two of the main stiffening ribs/base mounting bush support pillars. The hole next to the outside edge can be drilled at a slight inward angle to ensure that the drill does not 'skate' off the corner of the box. Both holes are 1.5mm diameter and the brass eyelets then simply screw into these with a self-tapping action. The two holes at the opposite end of this panel are used to mount a small tag strip. The author used a cut-down section of a rather substantial tag panel, but so long as any strip used has at least five free tags, this part is not very critical. Marking and drilling of this set of holes is best left until last since the type and size of strip available will determine the exact hole spacing and final hole sizes required.

Next month we finish the mechanical construction at look at wiring, the sensing head and the parts list.

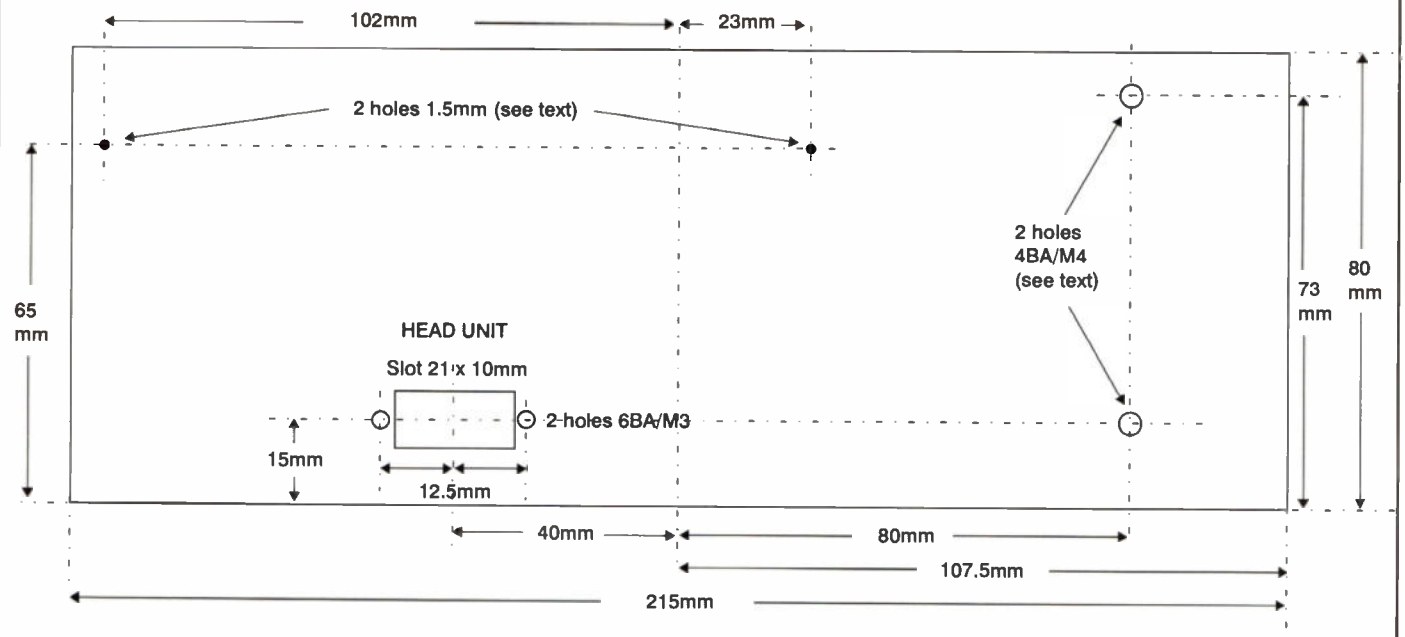


Figure 4. Forward panel.

LED TECHNOLOGY

Mike Bedford throws some light on the type and choice of LEDs.

"You can have whatever colour you like so long as its red, green or yellow". For many years this was the story of LEDs but after a couple of decades of relatively little change, recent product introductions have changed the LED market out of all recognition. No longer are you restricted to these three colours, now you can also buy blue LEDs, blue-green LEDs, and even white LEDs. And it's not just the range of colours which has improved dramatically – so has the light output available. Five years or so ago, the majority of LEDs had an intensity in the range 1-10mcd (milli-candela) – today, some of the high brightness LEDs boast an intensity of many candela – that's over a thousand times brighter. Traditionally, LEDs have been used as indicators but, of course, there's a limit to how bright a panel indictor needs to be. So this dramatic increase in intensity points to possible new applications – daylight indicators such as traffic lights and perhaps even lighting. So are we really going to have clusters of red LEDs in place of conventional brake lights? Are the days of tungsten filament bulbs and fluorescent tubes numbered – will LEDs take their place as the domestic light source the future? And the fact that blue LEDs are now available opens up some interesting possibilities too. Since LEDs are now available in each of the three primary colours, they could, perhaps, provide a competing technology to LCDs for flat screen displays. In this article we'll look at some of the more recent introductions in the world of LEDs with a view to investigating their suitability as replacements for conventional light bulbs and in flat screen displays.

This article isn't all about theory – some of what you can read about here you can put into practice today using products straight from the Maplin catalogue. OK, perhaps you won't feel inclined to buy the 921,600 LEDs you'd need to knock up a full colour VGA display but portable lighting is another matter entirely. My investigations into the possible use of LEDs for lighting has come about in connection with an interest in potholing, where long battery life, low weight and high reliability are important considerations. Perhaps you're not looking for a high tech caving lamp but many people do, nevertheless, have a need for portable lighting systems which offer these same characteristics. So whether you're interested in cycling, diving or camping or if you just want a small light-weight torch to keep in the car, this article may just give you some food for thought.

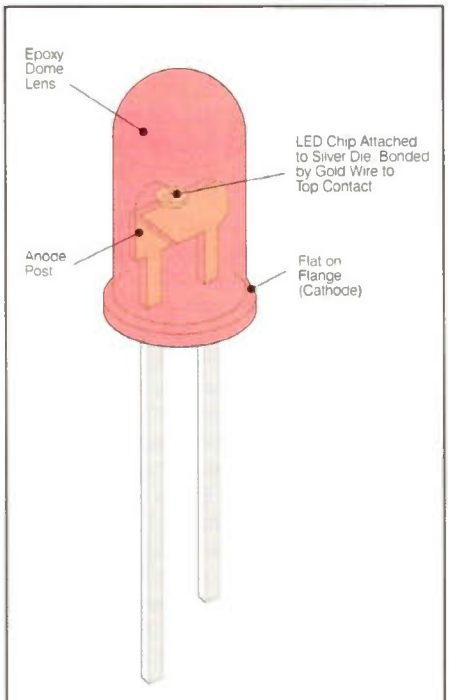
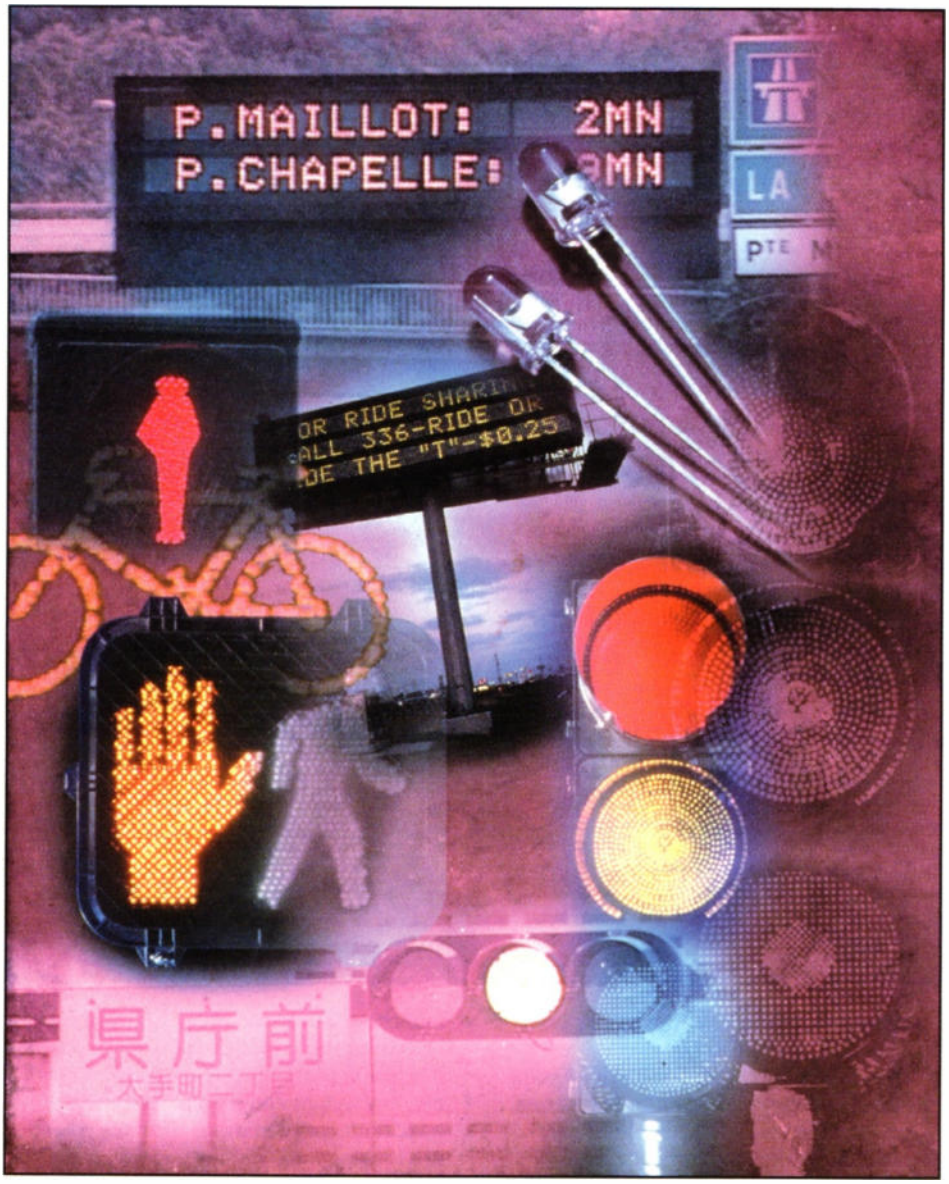


Figure 1. Basic LED construction.

LED Technology

Before we start to look at real world products, I thought it would be interesting to take a quick look at how LEDs are manufactured and how they work. The diagram shows the basic construction of an LED and, as you can see, most of what we think of as an LED is the transparent packaging which is formed into a lens. The most interesting part of the LED – essentially the actual LED itself, as opposed to the packaging – is the tiny chip which sits on the cathode post and of course, is also connected to the anode post. But the $64,000 question is how does this chip generate light when an electrical potential is applied to it.

The first thing to point out is that, as its name suggests, the LED or light emitting diode is a diode. Specifically, an LED is a semiconductor junction diode which consists of a p-n junction. In other words, a LED chip is an n-type semiconductor material – having a surfeit of electrons – at



one end, and p-type semiconductor material – having 'holes', or a deficiency of electrons – at the other end. Put very simply, an electric current will flow if the junction is forward biased with a sufficiently high potential difference. Under these conditions, electrons from the n-type semiconductor will move across the junction into the p-type material, and here they will combine with the holes. Since this involves the electron falling into a lower energy state, a photon of radiation is emitted, the frequency of which is proportional to the energy difference. In the case of LEDs, of course, this radiation takes the form of visible light or, perhaps, infra red. And by picking appropriate semiconductor materials, different frequencies, that is colours, can be produced. Materials with a small energy difference will produce low frequency radiation, in other words infra red or red. As the energy difference increases, orange, yellow, green and eventually blue light is produced. You will notice that LEDs are essentially monochromatic in nature or, in other words, they always produce light of a single frequency or colour. White light, on the other hand, is a mixture of colours so it would seem reasonable to assume that white LEDs are an impossibility. Surprisingly, therefore, you can now buy white LEDs – we'll see how this is achieved a bit later.

LED History

In the realm of transistors and ICs, silicon is doped by adding a small amount of impurity. Arsenic or phosphorous is used to produce n-type material whereas boron or aluminium is used to produce p-type material. But silicon isn't the only material which can be used as the starting point for semiconductors. Early transistors, for example, were made out of germanium and Gallium Arsenide (GaAs) is currently used in certain niche applications. The first LEDs, developed in the 60s, used the elements gallium, arsenic and phosphorous and were referred to as GaAsP devices. They produced 655nm red light and, by today's standards, were not very bright, producing about 1-10mcd (photometric units are described later). GaP red LEDs were found to offer a higher efficiency but, since the red light produced is at a wavelength of 700nm where the human eye is less sensitive, they don't look as bright. During the 70s, additional colours were developed, specifically GaP green, plus GaAsP orange, yellow, and high efficiency red, all of which are still in use today. In the 1980s, LEDs based on GaAlAs were developed. But although these were over ten times brighter than previous LEDs, there were some significant disadvantages. The only colour available was 660nm red and light output degradation was much worse than with competing technologies. The light output of a GaAlAs LED can reduce to 50% in 50,000 to 70,000 hours of operation.

So, by the late 80s, we had reasonably efficient red LEDs, albeit ones with poor light output degradation characteristics, plus relatively inefficient orange, yellow and green LEDs. The next step – and developments here are still underway with new and improved products regularly coming to the market – was the development of AlInGaP (Aluminium Indium Gallium Phosphorous) devices. These LEDs are bright, efficient, can readily by adapted to produce any colour from red through yellow to green, and light output degradation is slow. Blue LEDs first made their appearance some years ago but were dim and expensive so made little impact on the market. Recently, relatively efficient blue and green-blue LEDs based on GaN (Gallium Nitride) and SiC (Silicon Carbide) have been developed and prices are now starting to fall. Many of the super bright LEDs in the green to blue area of the spectrum are based on InGaN technology.

But what of the elusive white LED which I made reference to earlier? In theory, once red, green and blue LEDs are available, it would be possible to combine three chips in a single lens to give white light. This would be a similar principle to that employed in the tri-colour LEDs which contain a red and a green chips, either or both of which can be illuminated by selecting the appropriate polarity or using an alternating current. However, a different approach has been taken for white LEDs. A domestic fluorescent tube generates ultra violet light which is used to excite a mix of phosphors which glow in various colours to give the impression of white light. The white LED operates in a similar way except that, instead of generating ultra violet, the LED generates blue light to excite the phosphors. So, a so-called white LED is actually a GaN blue LED with a phosphor layer consisting of Yttrium, Aluminium and Garnet on the surface of the chip. Unlike all other LEDs which are essentially monochrome, the white LED has a broad spectrum, albeit one with a pronounced peak in the blue region corresponding to the frequency of the GaN chip which is used to excite the phosphors.

Are LEDs Really Efficient?

A common perception is that although LEDs are not nearly as bright as most other types of illumination, they are, at least, very efficient at turning electricity into light. The argument goes, therefore, that if and when sufficiently bright LEDs come along for use as lamps or, as an interim measure, if you construct a lamp containing a large number of LEDs, that lamp should be very efficient. Interestingly, this perception of high efficiency isn't backed up by the facts. Given time, it seems likely that LEDs will, in fact, exceed the efficiency of other forms of lighting but they're only just about starting to catch up.

And without a doubt, the traditional low intensity LEDs lagged far behind light sources such as fluorescent tubes and even the more efficient types of filament bulb. So let's take a look at some facts and figures to back up this assertion. Before we start, however, a few words on photometric units or, in other words, those units which are used to measure characteristics which, in everyday terms, we might be inclined to call brightness or intensity.

The most commonly quoted photometric unit you'll see related to LEDs is the candela. This is a measure of luminous intensity which is another way of saying that it represents how bright the LED will appear. Note, however, that this measure relates to the brightness in a particular direction so for a highly directional light source, the luminous intensity will be much greater in one direction than the others. In fact, all LEDs, and especially the high brightness versions, are directional, having an angle of illumination from around 60° down to less than 10° for some of the ultra-high brightness products. Clearly there will be a compromise between the angle of illumination and the luminous intensity – in theory it will always be possible to increase the luminous intensity by focusing the light into a narrower beam. For this reason, the luminous intensity is not a suitable figure for calculating a device's efficiency. Instead, we need to know the total light output of a device, not its intensity in a given direction. The technical term for this is luminous flux and this is measured in lumens. Therefore, a suitable measure of the efficiency of an opto-electric device is lumens per Watt. If you want to be able to determine the luminous flux of an LED, all you need to know is that the candela is defined as lumens per steradian (the SI measure of solid angle). So, if we assume a circular beam, the luminous flux in lumens is obtained by the multiplying luminous intensity in candela by 0.00024 times the square of the beam radius in degrees (this is accurate to within 2% for angles less than 60°).

Some Comparisons

OK, that's the theory out of the way so let's take a look at the efficiency of some common light sources so that we have something with which to compare the figures for LEDs. The most widespread form of lighting must surely be the tungsten filament bulb which, in its most basic form, has changed little for decades. The luminous efficacy of these light sources increases with the power. 3 lm/W is typical for low power torch bulbs and 17 lm/W for domestic 100W bulbs. More advanced variants of the tungsten filament bulb can improve efficiency at low power. For example, 2W krypton bulbs as used in some torches (and caving lamps) manage up to about 15lm/W compared to about 5 lm/W for a conventional torch bulb of the same power rating. However, they pay for this efficiency in terms of their lifetime which is measured only in tens of hours. If we turn our attention to fluorescent tubes, once again the efficiency increases with power.

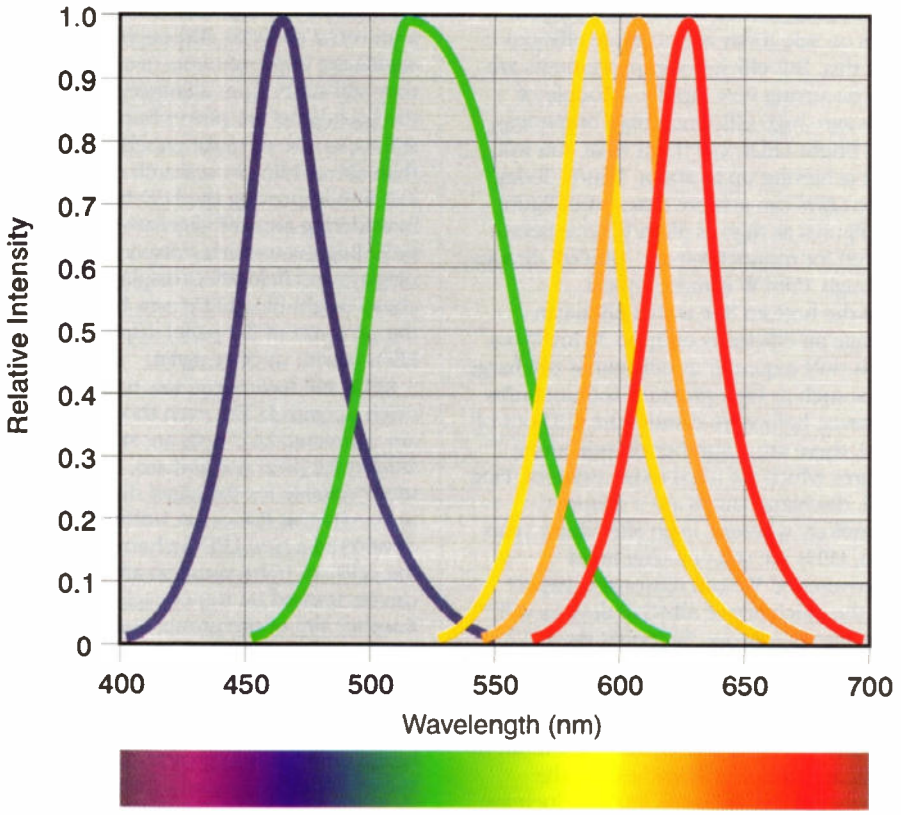


Figure 2. Typical spectrum for blue, green, yellow, orange and red LEDs.

The tiny 1W, 50mm tubes only achieve around 5lm/W but the compact tubes such as those intended as replacements for filament bulbs achieve about 50lm/W and full size tubes can boast an efficiency as high as 90lm/W. Discharge lamps are still more efficient – a 400W high pressure sodium lamp, for example, achieves 125lm/W.

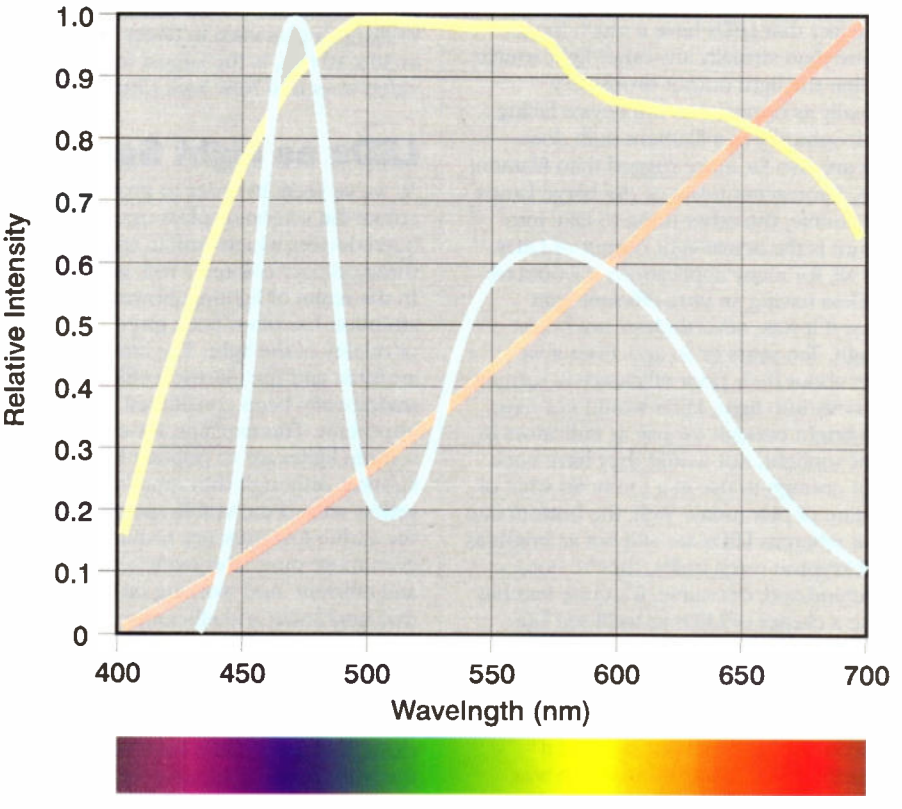


Figure 3. Three white light sources ~ yellow=sunlight pink=tungsten lamp blue=white light

So with that bit of background, let's look at the efficiency of an LED. In the early days, 0.01 lm/W was about the best which could be achieved, in fact, some of the standard LEDs on sale today are no more efficient than this. But efficiency improvements are now occurring very rapidly. A couple of years ago, high efficiency, high brightness, ultra bright LEDs, call them what you will, were achieving up to about 7 lm/W. Today, white LEDs can achieve this sort of figure and figures as high as 30lm/W have been quoted for monochromatic AlInGaP devices, although 15lm/W is more typical.

So the bottom line is that LEDs can manage an efficiency of up to 30 lm/W but this is only a quarter as efficient as discharge lamps such as high pressure sodium bulbs. However, before we dismiss the LED out of hand, there are a number of redeeming features which we need to be aware of. First of all, discharge lamps are a mature technology whereas, even after thirty years or so, LEDs are still enjoying rapid improvement. We can reasonably expect that the efficiency of AlInGaP devices will continue to improve. Secondly, the LEDs which we're looking at are low power devices which are suitable for portable battery powered equipment. A high brightness LED may dissipate just a tenth of a Watt and, as we've already seen, the efficiency of light sources tends to increase with power. As such, it is not exactly fair to compare a LED with a 400W sodium lamp. Lower power discharge bulbs aren't available so, if we're thinking in terms of portable equipment, we should really be comparing the LED with a low power krypton bulb which might have an efficiency figure of 15 – 20lm/W. And now, we can see that LEDs are already in this ball park with further improvements looking just over the horizon. And finally, we mustn't loose sight of the fact that LEDs have a much longer lifetime than virtually any other light source and that the light output drops very gradually as opposed to the device failing catastrophically as a filament bulb does. LEDs are also far more rugged than filament bulbs, fluorescent tubes or discharge lamps.

Of course, the other thing to take into account is the actual light output of LEDs. After all, for many applications it would be pointless having an ultra-efficient light source if it was, nevertheless, not bright enough. Ten years or so ago, even if we forget about their poor efficiency in turning electricity into light, LEDs would not have been bright enough for use as indicators in bright sunlight, nor would they have been bright enough to use in a torch. So what of the state of play today? Well, the bottom line is that whereas LEDs are still not as bright as small krypton torch bulbs, they're not too far behind and, of course, it's quite feasible to use a cluster of LEDs as we'll see later.

Display Technology

In the early 70s, there was much talk of forthcoming flat panel displays and it appeared that the only thing which was holding them back was the lack of a blue LED to supplement the red and green ones. Of course, the lack of a blue LED didn't hold up flat panel displays – a quite different technology based on liquid crystals was developed and this is now the de facto standard for laptop PCs. But the LCD is not a universal panacea. Although we've seen significant improvements over the years, they still suffer from a limited viewing angle, the back lights are power hungry, and it is still expensive to make panels much larger than about 14in. So research continues, not just into improving the LCD but also into a bewildering array of alternative technologies including micro-mirror displays, plasma displays and field effect displays. But with cheap bright blue LEDs now being available, the prospect of flat panel displays based on LEDs is with us once again.

LEDs still have some way to go in order to catch up with LCDs, even though LED sizes are shrinking, LCD cells are still much smaller for pixel use and are, therefore, more suitable for flat panel displays. But researchers at Princeton University have developed a new LED technology in which the cells are transparent so all three colours can be stacked on top of each other. Another aim of the group, apparently, is a single-colour roll-up LED newspaper. In the short term, however, it appears that flat panel displays based on LEDs will be niche products – the particular niche they're being aimed at is huge screens for use in sports stadia, at concerts, for advertising and such like. Here, the alternatives are video walls consisting of multiple CRTs or flat screens using filament bulbs with coloured filters. The latter type of screen is extremely power hungry – it's not unusual for the power consumption to run to many kilowatts. An LED display manufactured by Rainbow Vision is now taking pride of place in New York City's Times Square. The screen is capable of displaying live video feeds from satellite, broadcast, and the Internet as well as fixed media. The screen presents a brilliant display even in direct sunlight and, at 30 x 40 feet, is the largest full motion video screen in New York City.

LEDs as Light Sources

As we've seen, in order to produce full-colour flat screen displays using LEDs, we need devices which emit in each of the three primary colours – red, green and blue. In the realm of lighting, however, less attention has often been given to the colour or quality of the light. The amount of light available and the electrical efficiency has, traditionally, been considered the more important. This explains, for example, why sodium lights are so popular for street lighting. Although they emit largely in the yellow area of the visible spectrum – indeed the earlier low pressure sodium lights were even more monochromatic – they are bright and efficient. And working on the principle that brightness and efficiency are the only important factors, monochromatic LEDs were also pressed into service as portable light sources once they'd became sufficiently bright and efficient. For example, clusters of green LEDs have been used as the front lights on bicycles. However, using monochromatic light allows the eye virtually no perception of colour and some people have also argued that white light is needed for good perception of depth.

Diagram 4 is the CIE colour chart which was devised by the Commission Internationale de l'Eclairage in 1931. In theory, it shows the gamut of colours which can be seen by the human eye. The reason I say "in theory" of course, is that printing inks only allow some of these colours to be correctly reproduced so the diagram as printed here is, by necessity, only an approximation. Colours around the edge are pure colours whereas those in the middle are produced by mixing varying amounts of red green and blue. The numbers around the edge of the diagram correspond to the wavelength in nanometres. But just as printing inks can't represent all these colours, nor can the phosphors used in TV tubes. Points corresponding to TV red, TV green and TV blue are plotted and it's clear that a significant number of colours fall outside the triangle formed by joining up these three points. I guess the fact that we don't notice the lack of pure greens on TV pictures must say something about how well the human brain compensates for deficiencies. The points corresponding to red, green and blue LEDs are also shown and you'll notice that, if we forget about the so-called 'pure green LEDs', the situation is worse than with TV pictures – the available colours are noticeably deficient in the green part of the spectrum. However, you will notice that normal green LEDs are really a yellowish green and that white lies on the line joining this point to that for blue LEDs. In other words, it should be possible to produce a passable white light by mixing just blue and green devices in the correct proportions. For a flat screen display with good colour reproduction, on the other hand, it would be wise to use the newer pure green LEDs which – like blue LEDs – are based on GaN technology.

In view of the fact that white LEDs are now available, and that these have a broad, daylight-like spectrum, you might wonder why we're bothering to look at how white light can be mixed using monochromatic LEDs. Well, if your light source has room for just a single LED – as in a pocket torch, for example – then a white LED is your only solution. However, bear in mind that white LEDs achieve an efficiency of around 7lm/W whereas monochromatic LEDs are, at the best, three or four times more efficient. Therefore, if you can afford the space to use multiple LEDs, you can make a much brighter and more efficient light. I recently saw a prototype caving lamp which used a cluster of one red, three green and two blue LEDs. Given its low power consumption, it was very impressive indeed, and the light looked a pretty good white. If you're thinking of designing a LED-based torch,, however, you need to think carefully about the supply. Normal practice when using LEDs as panel indicators is to use a dropper resistor to limit the current which flows through a LED. However, the last thing you want in portable equipment is to waste power heating up a resistor. If you were to use a dropper resistor in series with a LED to operate it from four 1.5V AA cells, that dropper resistor could consume as much power as the LED and so the efficiency

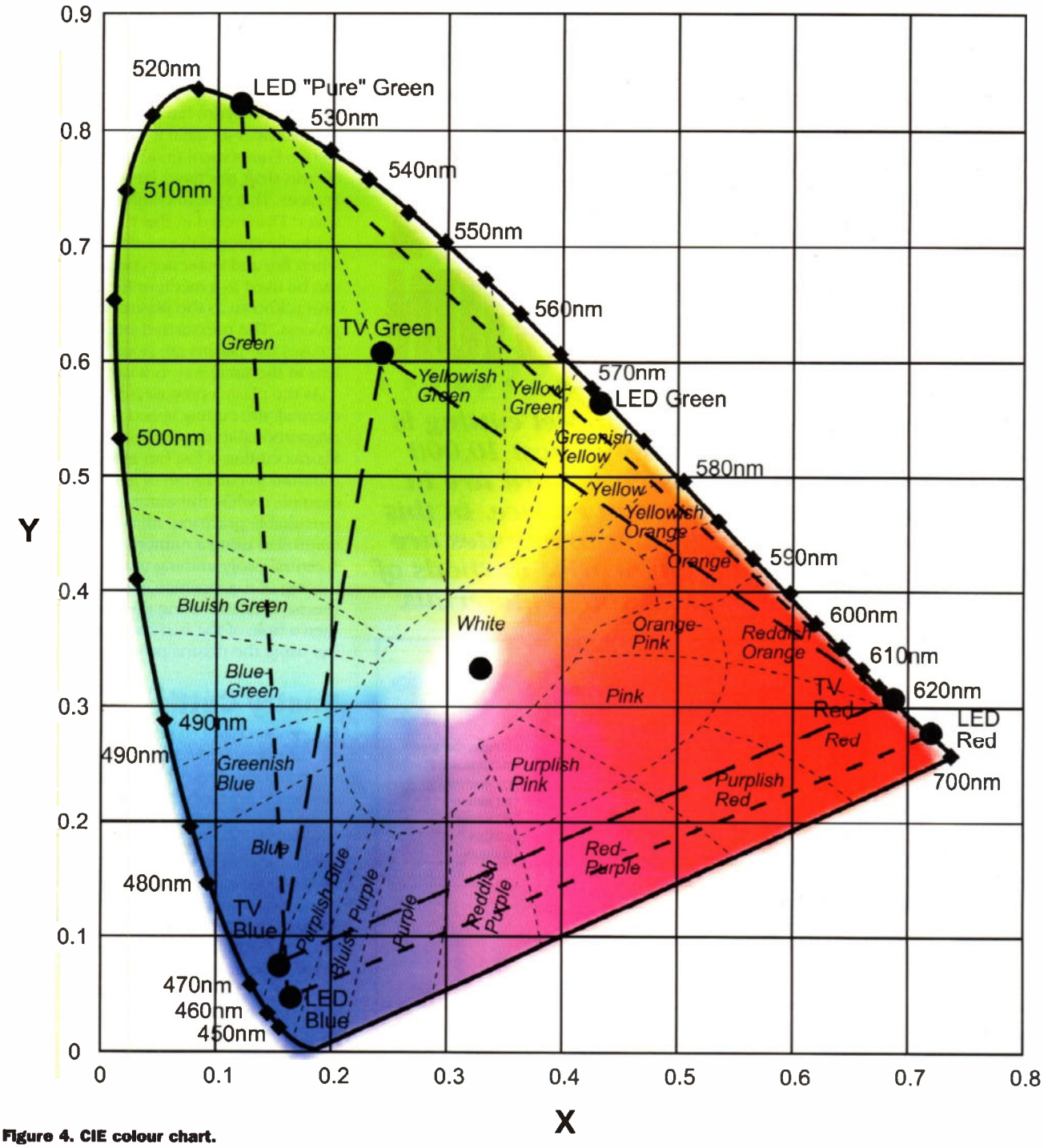


Figure 4. CIE colour chart.

would be halved. Of course, an alternative is to wire the LEDs in series strings, such that the voltage drop across each string is the same as the supply voltage. This way, you need no dropper resistors but another problem manifests itself. Since a LED will generate no light whatsoever if the forward voltage drops below some threshold, this configuration isn't tolerant of the supply voltage dropping as the batteries start to become exhausted. Unlike the case with filament bulbs, a LED torch constructed this way would tend to fail rapidly on old batteries with significant battery energy remaining unused. The obvious answer is to use a dc/dc power supply to give a constant voltage output from a fluctuating input voltage. The design of such a regulator is beyond the scope of this article but, hopefully, I've given you sufficient ideas to start experimenting with LEDs for lighting.

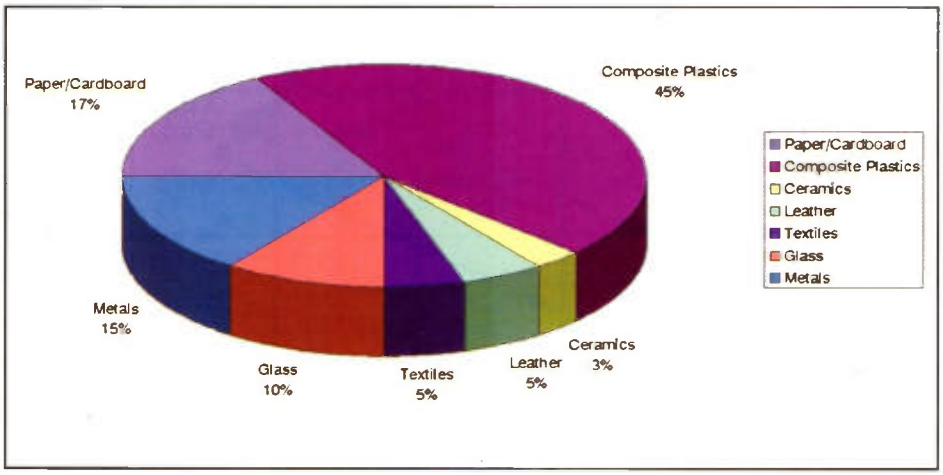
Terminology varies for LEDs suitable for this sort of application but if you're looking in the Maplin catalogue, concentrate on the Ultrabright and Extreme Brightness LEDs as opposed to the high brightness or super brightness types. Ultrabright and extreme brightness LEDs range from about 500mcd to 7cd, although these latter types are available only at a narrow viewing angle. Red, amber, yellow, green, blue and white LEDs are available at this sort of intensity.

Safety Issues

As one final comment, if you're going to be experimenting with high brightness LEDs, you'd be well advised to bear in mind the safety concerns which have been aired by some experts. Most people know not to look directly at lasers and whereas LEDs are not the same as laser diodes, they do share some important properties. What makes a laser dangerous to look at is that, despite the power usually being low, it does represent a high power per unit area of illumination. The same is true of LEDs. Although they may only be producing milliwatts of light, this light is produced from a tiny chip so if you stare directly at the LED, the light density landing on your retina could be much greater than if you were to stare at a conventional 100W bulb. And the other aspect in all this is that the risk increases with frequency. The maximum permissible exposure (in Watts per square metre) is several orders of magnitude lower for blue light than for red. None of this will affect you if you use a LED torch normally but it might just if you decide to shine it directly into your eyes. It could well be that there's nothing to worry about but it's surely better to be safe than sorry. ELECTRONICS

Jet Powered
WATER IS A CLEAN-CUT SOLUTION

The technology of high-pressure water-jet cutting is now widely used in industry, with almost 10,000 installations in service, of which one-third are in Europe and some 400 of those are in France. In this short article we look at how French companies are leading the way in developing innovative methods of using the power of water to cut through materials.



Above the Speed of Sound

The principle of water-jet cutting involves compressing water at 4,000 bars through a nozzle measuring just a few tenths of millimetres. The water flows out at 900 metres/second (between MAC II and MAC III). In the industrial materials sector, this type of cutting technology provides speed and precision in the controlled slicing, trimming, dressing and cutting operations involved on a wide range of materials of all thicknesses – everything from paper to wood and from rubber to plastics. By adding abrasive particles to the water-jet makes it possible to cut hard materials such as glass, ceramics, all ferrous and non-ferrous materials and alloys, elastomer and plastic composites.

Axiome, based in Western France, has been pioneering the use of water-cutting technology in Europe for ten years. A manufacturer of turnkey water-jet systems, the company conducts studies and produces X-Y tables for 2-D cutting, as well as robotic systems, which can also be used in high-frequency milling and high-pressure burring. In 3-D applications 90% are dedicated to the automotive industry. Axiome also manufactures VHP (Very High Pressure) systems and is a service provider for 2-D and 3-D sub-contracting.

French manufacturer Bourgogne-Hydro makes and fits machine pumps. The company is developing 'all-hydralic booster technology' which is able to reach 4,000 bars and with a water jet reaching a velocity of between 600 and 1,000m/sec (between MAC II and MAC III).

Fire & Water!

Bourgogne-Hydro has developed a mixed plasma/water-jet table in association with Electro-Equipement (a designer/manufacturer of twin-shaft machines based in western France). This system combines fire and water! Discovered in the 1950s, plasma has gradually entered the world of industry, and when fire and water are combined, water can be used as a medium for the plasma arc. This is known as the plasma/water-injection process. The pressurised jet of water focuses the plasma arc (ionized gas) on a lens in the same way as a ray of light.

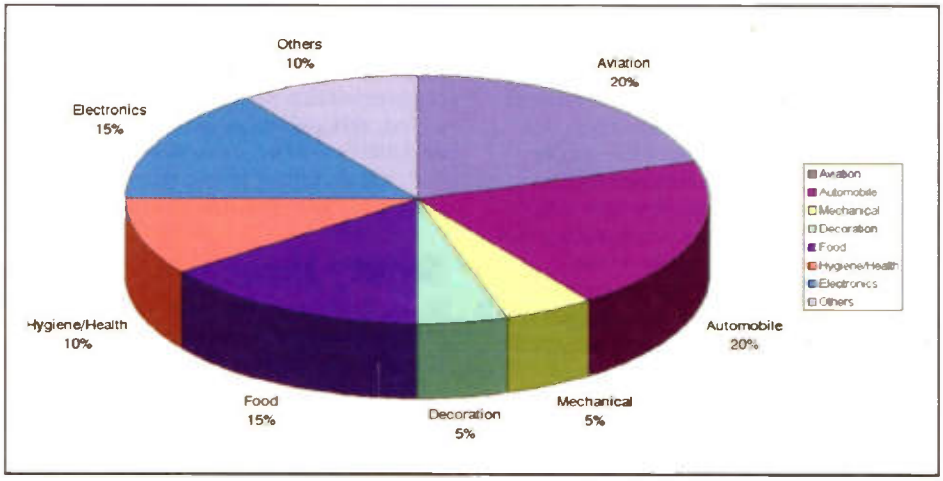
As the plasma process is primarily thermal, the cutting speed is inversely proportional to the thickness to be cut. Plasma cutting is fast but inaccurate (5m/min to cut 10mm of aluminium for example), while the water jet offers remarkable precision. All equipment is controlled using a numerical control system. A central programming unit controls remote loading of the machine, which then bores at precise locations using the water jet, and then a hole of the correct dimensions is cut out using the plasma process.

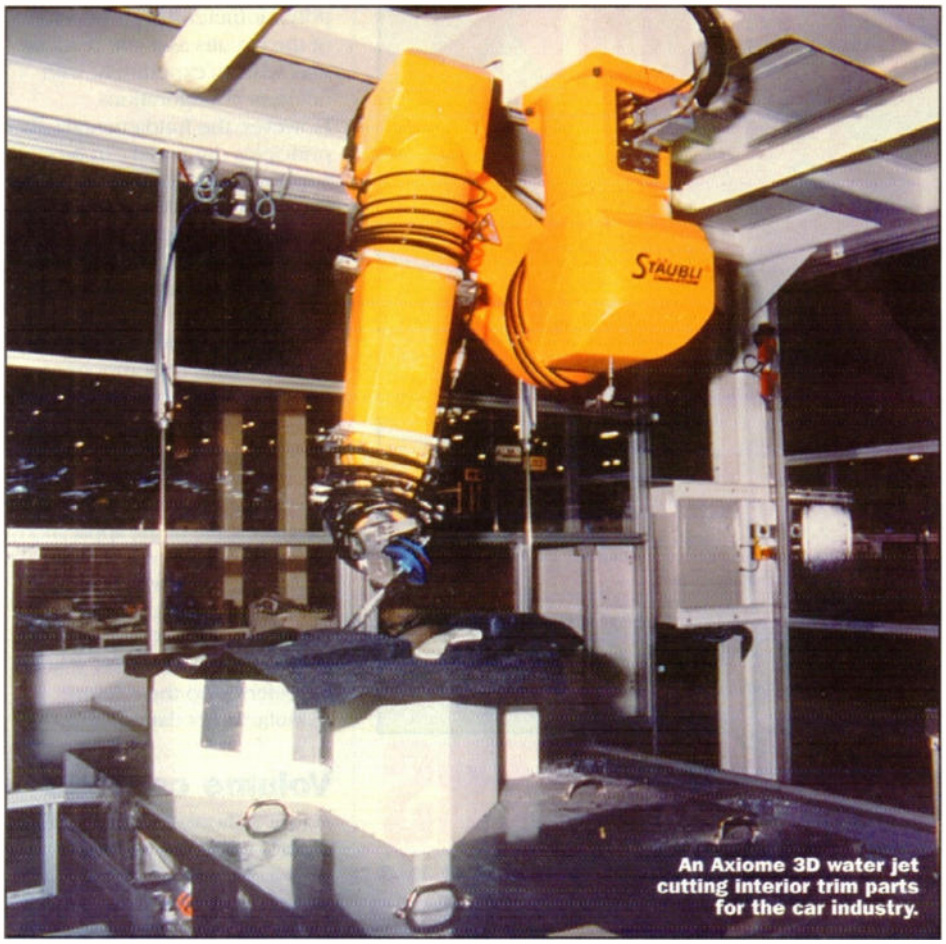
Pastry Cutting

Bourgogne Hydro has also designed a water jet-cutting system for the food industry, with the travel catering firm Servair as its first customer. A water jet is used to cut up the deep-frozen pastries served on-board aircraft. The application relies on a pressure generator coupled to a cutting table made by Toulouse-based firm Robolix. The compressor supplies water at a pressure of 3,000 bars. The water is conveyed to a synthetic diamond cutting laser-bored nozzle whose orifice measures a remarkable 0.2mm in diameter. The concentric film of water obtained (0.2mm over a height of 4cm), is used to cut pastries 35 mm high.

Servair currently produces 50,000 portions daily using this process, which guarantees the bacteriological quality since the water is only used once, and the weight (to the nearest gram) and dimensions of the portions.

Digital Control, also based in Toulouse, manufactures complete machines with very high-pressure pumps (4,000 bars), and PC-

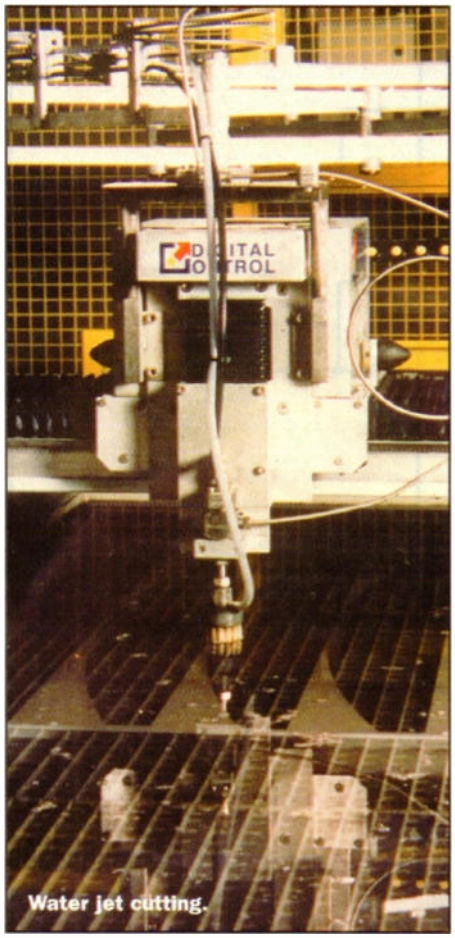


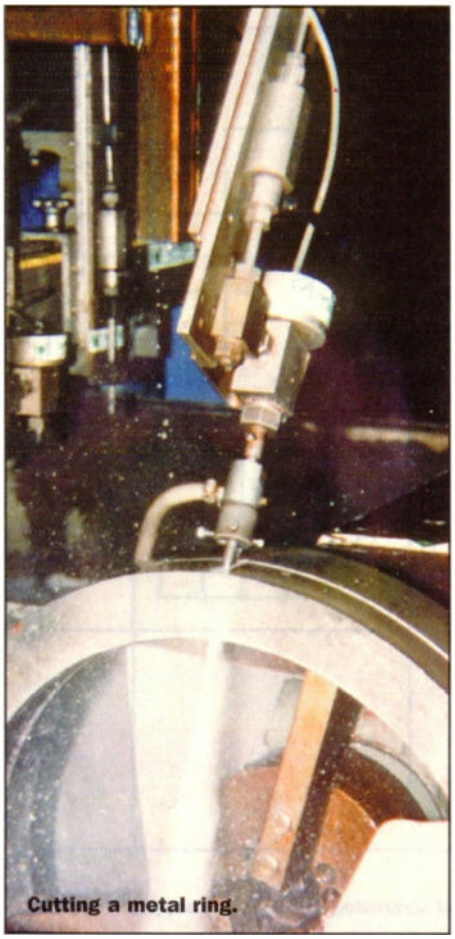


An Axiome 3D water jet cutting interior trim parts for the car industry.

controlled cutting tables, using pure or abrasive water. The company has almost 200 installations in Europe and worldwide. Through its ongoing research studies, it is able to offer expertise in a full range of cutting technologies (laser, plasma, water).

In the agro-food sector, a machine comprising of six nozzles, can process 50,000 items (such as cakes) a day. This system combines financial gain (reduction of losses) with a high-quality cutting process, making it possible to win market share with products sold in portions. Products are sliced neatly without heating (even crumbly pastry, pizza dough and cakes).


Water jet cutting.


Cutting a metal ring.

Other Materials

To treat leather and flexible materials, Digital Control has developed special machines for leather processing such as tanning, shoes, fine leather goods, clothes, furniture, saddlery etc.

Lectra-Systemes is one of the two world leaders in computer aided design and production solutions for the textile and leather processing industries. With Hydral 5000, a water jet cutting system designed specially for leather, Lectra Systemes offers a modular solution adaptable to an increase in the user's output. The field of cutting applications is broad: heterogeneous or sandwich materials, copper, aluminium and rubber parts. Between eight and ten layers can be cut at the same time without generating fibres.

AFMA Robots, a manufacturer based in the Touraine region, recently delivered a 3D laser robotised welding system to Aerospatiale. The system marks a first in machining and welding.

AFMA relied on the techniques developed some years ago for its S-axis gantry robots. Their rigid structure, which is designed to dampen vibrations, incorporates a range of technologies such as laser, water jet, machining spindles, non-destructive inspection. "These high-precision gantry robots are built on four pillars of pre-stressed reinforced concrete supporting the cross member, laser head assembly," explains Jean-Marc Le Blanc, company chairman.

Bomb Disposal

Sotradex, a French company specialising in providing solutions for bomb disposal, uses the cold water-jet cutting method. Hot cutting is impossible owing to the risks of explosion. Bombs are diffused by using water-jets to cut through their steel casing and recover the powder and detonator

Asbetos Removal

Studies are currently under way on a possible use of water jet technology to reduce risks for workers that remove asbestos from buildings. A sealed chamber to the exterior of the building would protect workers, while a water jet would rapidly cut the flocking away inside the building. The drops of water would stick to the asbestos dust, which would then be retrieved through a pipe and stored in sealed duplex bags.

Water-jet cutting clearly offers a host of advantages. Machined materials undergo no modification and the surfaces obtained are of excellent quality (no deformation, damage or dust). Moreover, this technology significantly improves working conditions by eliminating the nuisance caused by dust and waste.

For more information
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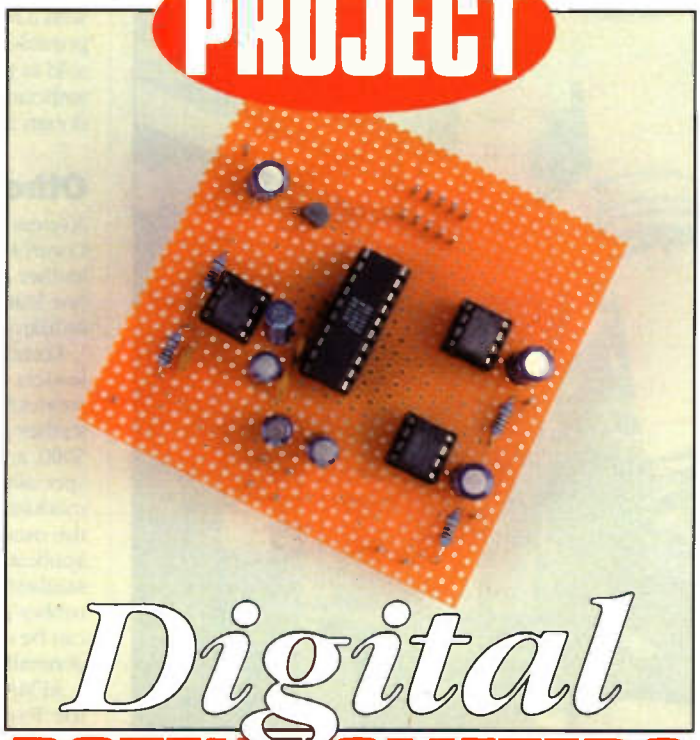
PROJECT



Digital POTENTIOMETERS PART 2

This month Gavin Cheeseman looks at circuits using dual digital potentiometers.

Last month, we covered the basic concepts behind digital potentiometers and looked at some circuit ideas based around a single digital potentiometer IC. This month we look at circuits using dual digital potentiometers.

As mentioned in part 1, a major use for digital potentiometer technology is in relation to audio processing and control. Typical examples of this are volume control and tone control. In most cases the audio signal is stereo and simultaneous control of left and right channels is required. There are various ways to achieve this but direct control of the audio signal using dual potentiometers is probably the most common, as it is effective and simple to implement.

Dual digital potentiometers that are ideally suited to audio applications are available providing the appropriate logarithmic response together with built in features for balance control and audio mute.

Practical circuits

The following circuits make use of the DS1802 IC from Dallas Semiconductors, available from Maplin. The same digital potentiometer IC is used in all of the circuits as some readers may wish to experiment with different configurations. However, the fundamental principles discussed can be applied to other similar devices. Parts lists are given at the end of the article to provide a starting point for constructors; however, as always it should be pointed out that it may be necessary to make modifications to the circuits or component values to suit specific applications. It has not been possible to cover all aspects of the operation of the device in this article as the main intention is to illustrate some of the applications of digital potentiometers at a practical level. For detailed information regarding the operation of the IC and associated specifications, readers are referred to the relevant manufacturers data sheets.

Volume controls

Figure 1 shows a simple volume control using the DS1802 device. As with all digital potentiometers the output is increased in a series of steps, in this case logarithmically. The circuit shown will operate from a split rail power supply of

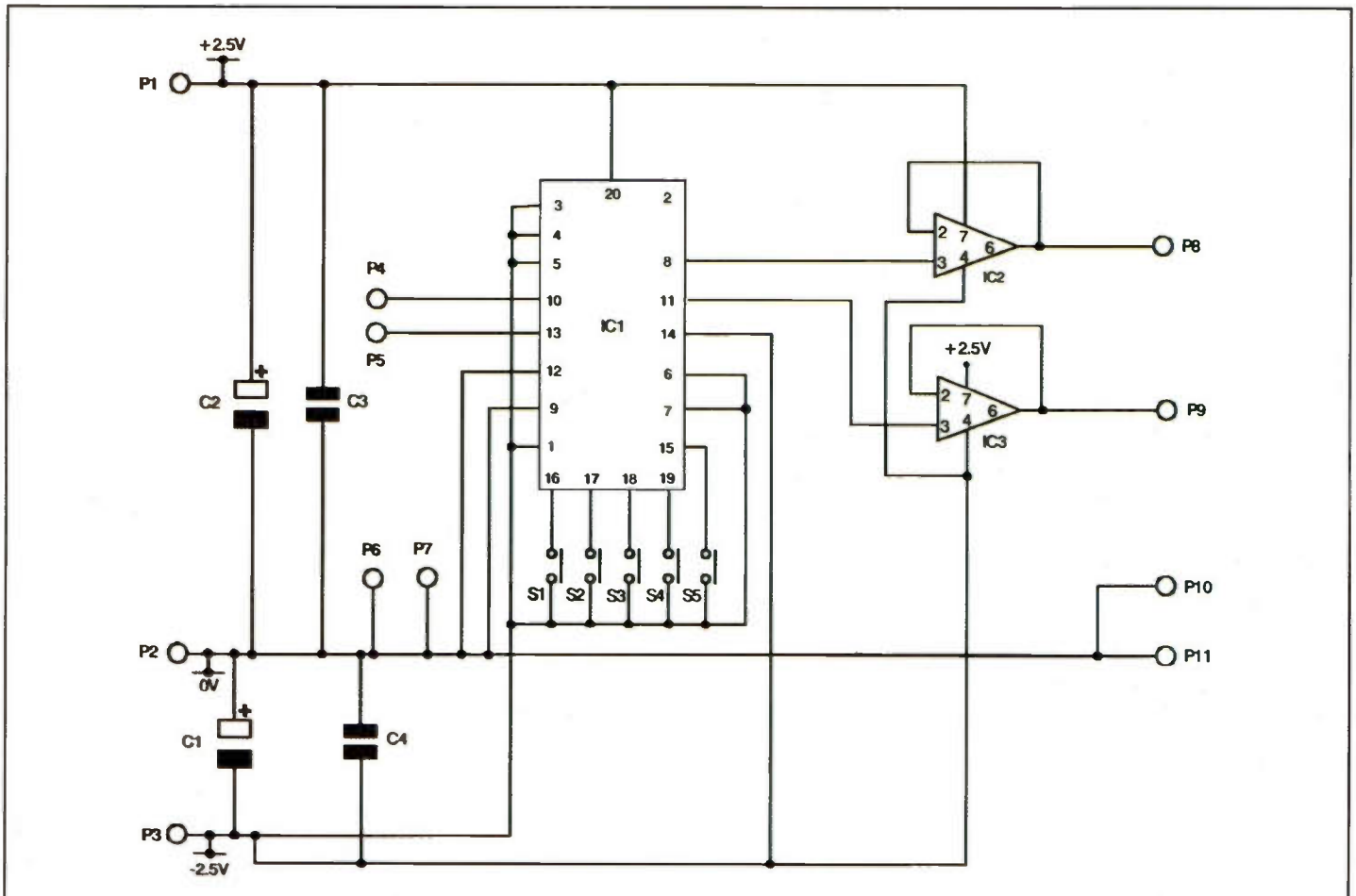


Figure 1. A simple stereo digital volume control operating from a split supply.

±2.5V which should be connected to terminals P1 (+V), P2 (0V) and P3 (-V). Capacitors C1 and C2 serve as bulk supply line de-coupling whereas C3 and C4 help to reduce high frequency noise on the supply rail. The input signal is applied between P4 and P6 (left channel) and P5 and P7 (right channel). It is recommended that the signal level is limited to 775mV rms. Higher signal levels may result in unwanted distortion and could possibly damage the digital potentiometer IC if absolute maximum ratings for the device are exceeded. Operational amplifiers IC2 and IC3 provide buffering at the output of the digital potentiometer IC. The buffered output is available between P8 and P10 (left channel) and P9 and P11 (right channel). Connection requirements are summarised in Figure 2. There may be a slight voltage offset at the output with reference to 0V but in many applications this does not present cause for concern. If voltage offset is a problem, the output can be coupled via a capacitor to remove the DC component. IC2 and IC3 may be omitted and the output taken directly from IC1 pins 8 and 11, if it is intended to drive a high impedance load (recommended >500k). Without IC2 and IC3, the circuit will operate from ±1.5V which is useful for battery powered circuits (for example 2 x AA cells). The operational state of IC1 is controlled using five push to make switches. The functionality of these is as follows:

S1 – Balance (right channel);
S2 – Balance (left channel);
S3 – Volume Down;
S4 – Volume Up;
S5 – Mute.

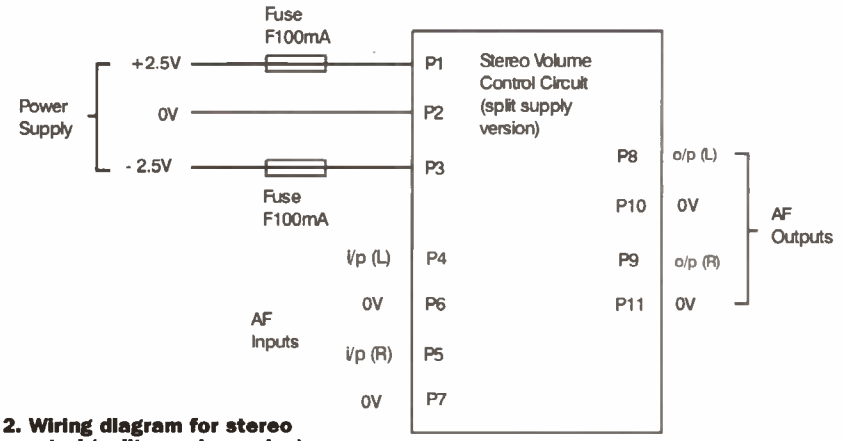


Figure 2. Wiring diagram for stereo volume control (split supply version).

The circuit shown uses the IC in stereo mode. When configured in this way the volume controls operate on both channels simultaneously. Momentarily pressing S4 will result in the volume of both channels increasing by one step whereas pressing S3 will reduce the volume. S5 mutes the output independent of the volume setting. The mute input effectively has a toggle action. Pressing S5 once results in the level of the output signal being attenuated such that it is for most purposes non-existent at the output. Pressing the switch once more will return the signal to its previous level.

The balance control switches, S1 and S2, control the balance of the left and right channel outputs. The level of each channel is effectively controlled with reference to the other. For example, pressing S1 will increase the level of the right channel if it is at a lower volume setting than the left channel. Once the volume setting of the right channel has reached a point where it is equivalent to that of the left

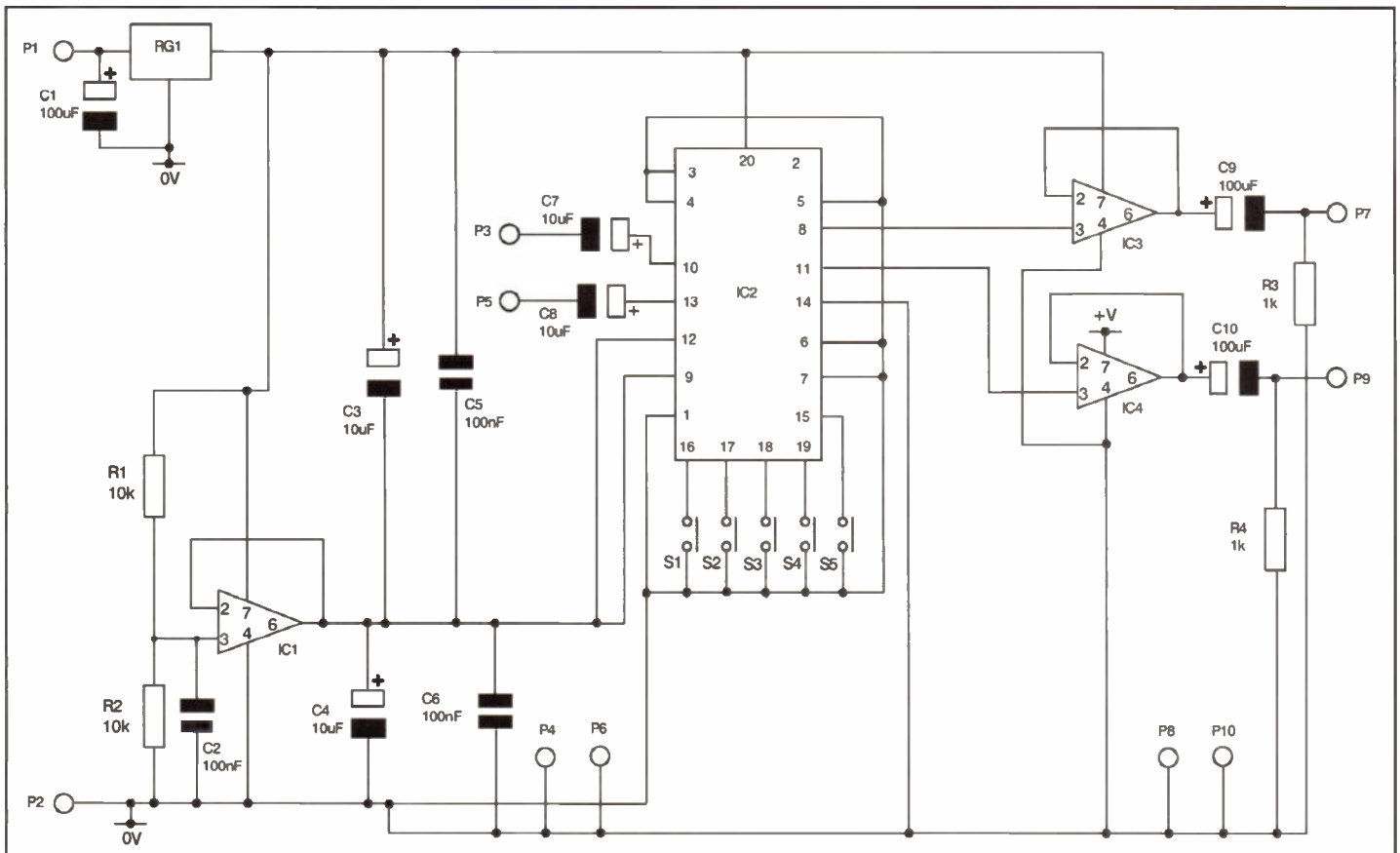


Figure 3. A simple stereo digital volume control operating from a single rail supply.

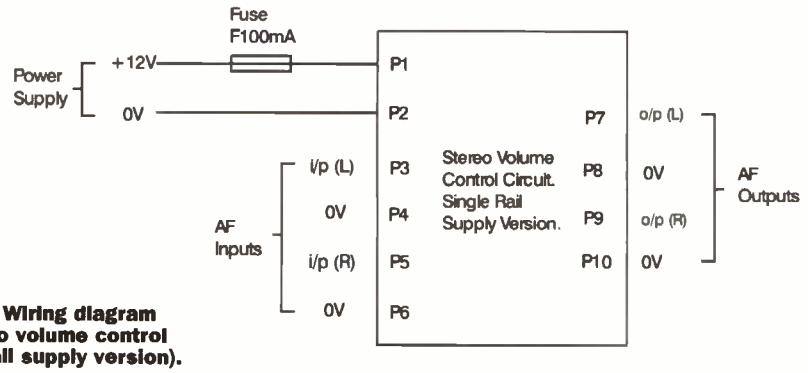


Figure 4. Wiring diagram for stereo volume control (single rail supply version).

channel, further operation of S1 will result in a reduction of the volume setting of the left channel. This sounds complicated but in practice operation of the balance control is very easy.

The circuit shown uses a split rail supply but this is not intended to imply that this is the only method of using the digital potentiometer IC. In fact for some applications the IC may be powered from a single rail supply without the need for any additional circuitry. The main criterion is that the voltages on any of the IC pins should not be allowed to exceed the maximum levels specified for the device by the manufacturer. Using a split rail power supply or appropriate biasing on the potentiometer pins of the IC helps larger input signals to be accommodated without the signal exceeding the specified ratings.

Figure 3 shows another stereo volume control circuit. This is quite similar to the previous circuit but is intended to operate from a single rail 12V supply connected between P1 (+V) and P2 (0V). Operational amplifier, IC1 is used to provide a centre reference rail for the digital potentiometer IC. This type of circuit has advantages over the use of a simple resistive divider as a relatively low impedance output is provided by the op-amp avoiding the need to use very low value resistors. It should be noted that only the potentiometer pins of IC2 are referenced to the centre rail. The control inputs of the digital potentiometer IC are referenced to 0V. The left channel input signal is applied between P3 (input) and P4 (0V) and the right channel input is connected between P5 (input) and P6 (0V). Outputs are taken from P7 (left) and P9 (right). Output 0V returns may be made P8 and P10. The necessary connections are illustrated in Figure 4. Capacitive coupling is used for the input and output signals and as a result the fact that the potentiometer terminals are biased at ½ supply voltage is transparent to the user.

Regulator, RG1 provides a stable 5V supply for the circuit. This is particularly important for IC2. Capacitor C1 helps to filter the input voltage to the regulator and C3 – C6 provide de-coupling for the 5V supply. C2 de-couples the ½ supply reference voltage produced by the potential divider comprising R1 and R2. The operation of switches S1 – S5 is as for the split rail supply volume control circuit described above.

Independent Control Mode

As mentioned, the circuits shown operate in the stereo mode such that the volume of both channels is controlled simultaneously by one set of switches. An alternative configuration allows two separate channels to be controlled independently. To set the circuit to this mode pin 7 of IC2 should be connected to +V and not to 0V. This configuration is illustrated in Figure 4. The connection must be made before power is applied to the circuit. The two channels have been designated left and right for descriptive purposes but are in fact two entirely independent channels and may carry totally unrelated audio signals. In this mode the operation of switches S1 – S5 is modified as follows:

S1 – Volume down left channel;
S2 – Volume up left channel;
S3 – Volume down right channel;
S4 – Volume up right channel;
S5 – Mute.

It should be noted that in the independent control mode, there is no balance control as this would be inappropriate.

Serial Interface

In addition to push button control, the DS1802 IC can also be operated using a 3 wire serial interface enabling the device to be controlled by a microprocessor. Control is achieved via pins 3, 4 and 5 of the IC which are normally grounded when push button configurations are used. For further information regarding this feature, readers are referred to the manufacturers data sheets.

Tone Controls

A further application for digital potentiometers is in tone control circuits. Tone controls are effectively variable filters. Basic tone controls can be produced using resistors and capacitors. An example of a simple treble control circuit is shown in Figure 5. Resistors R1 and R2 form a potential divider which attenuates the input signal. Using just the potential divider without any further components the level of attenuation remains relatively constant across a wide range of frequencies. However, the addition of C1 and VR1 changes the response of the circuit considerably. The effective AC resistance or more correctly reactance of the capacitor decreases as the signal frequency increases. Therefore C1 and VR1 allow some of the signal to bypass R1 and because the reactance of C1 is heavily frequency dependent, the overall response of the circuit is no longer flat. The attenuation of the circuit decreases with increasing signal frequency. The degree of increase is controlled by the setting of VR1. With VR1 set to maximum resistance, the effect of C1 is minimised and there is negligible increase in signal level at the output as the frequency is increased. Conversely, with VR1 at minimum resistance, the effect of C1 is much more pronounced. Under this condition, the level of the output signal increases considerably with frequency. Although the overall effect of the circuit is to attenuate the input signal, this attenuation can be reversed by amplification producing a treble boost characteristic.

A similar arrangement can be used to provide bass control. This is illustrated in Figure 6. The circuit formed by R1, R2 and C1 produces frequency dependent attenuation. At high frequencies the reactance of C1 is low and the attenuation of the circuit is at maximum, fundamentally determined by

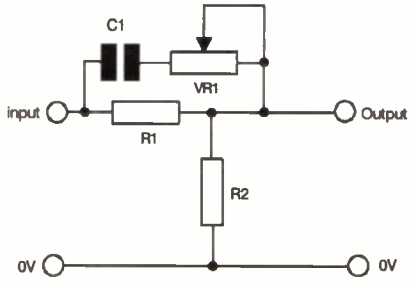


Figure 5. Simple passive treble control stage.

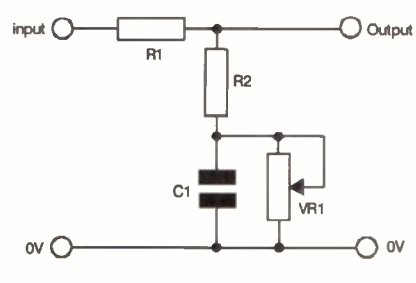


Figure 6. Simple passive bass control stage.

the values of R1 and R2 alone. At lower frequencies the reactance of C1 increases considerably such that it forms a significant part of the potential divider chain. As a result the output signal is considerably increased at low frequencies dependent on the value of C1. This is fine but effectively all we have is a low pass filter with fixed characteristics. To allow the level of bass to be varied, VR1 is connected across C1, forming a variable parallel resistance. When VR1 is set to maximum resistance, the effect on the circuit is negligible and the output signal level peaks at low frequencies. However, when VR1 is set to minimum resistance, C1 is effectively disabled and the attenuation of the circuit is once again, for all practical purposes, determined by R1 and R2, giving a flat response. As with the treble control described above, a boost effect may be achieved by further amplification of the signal.

The circuits shown are very simple and are intended to illustrate a basic principle. Values have not been shown as these will be determined based on individual applications. Practical tone controls can be considerably more complex in order to provide the required frequency response. Circuits of the type shown may be cascaded to provide modified response curves. This is where digital potentiometers can be useful as a large number of potentiometers can be controlled from the same point.

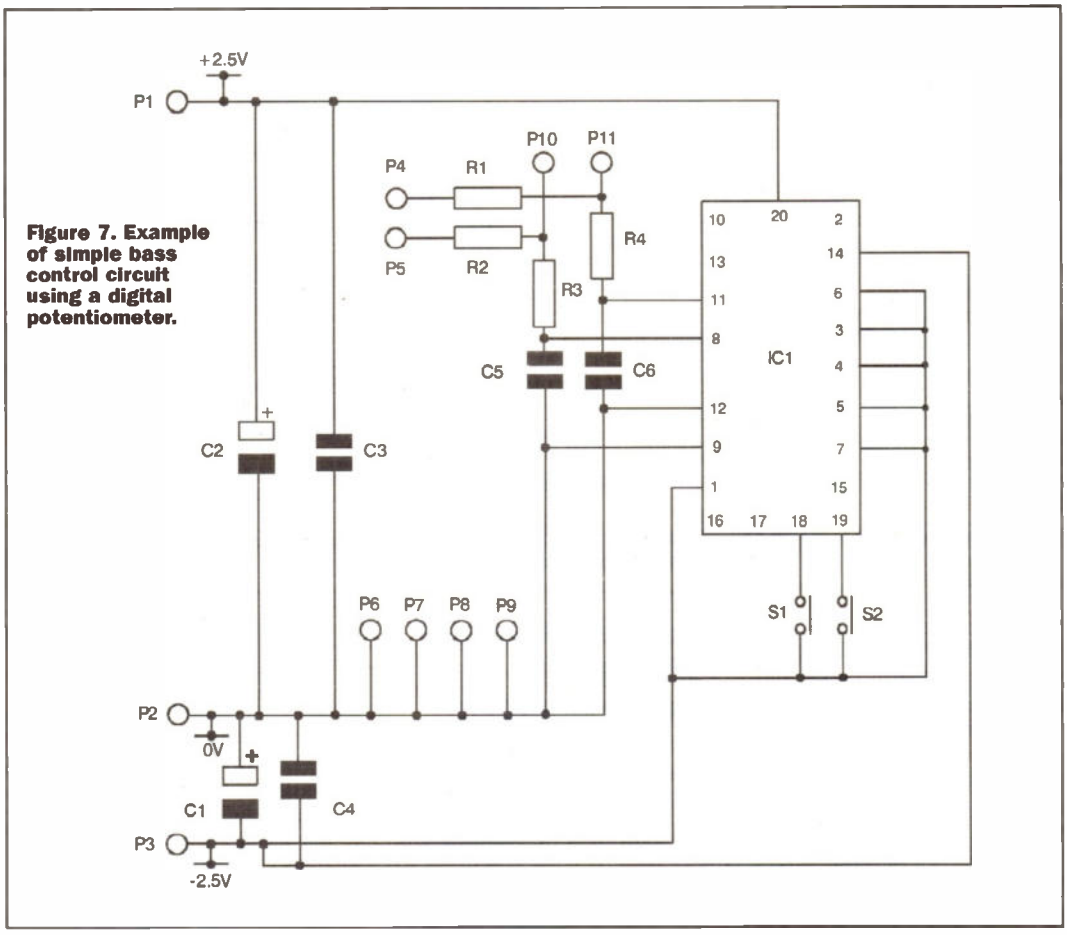


Figure 7. Example of simple bass control circuit using a digital potentiometer.

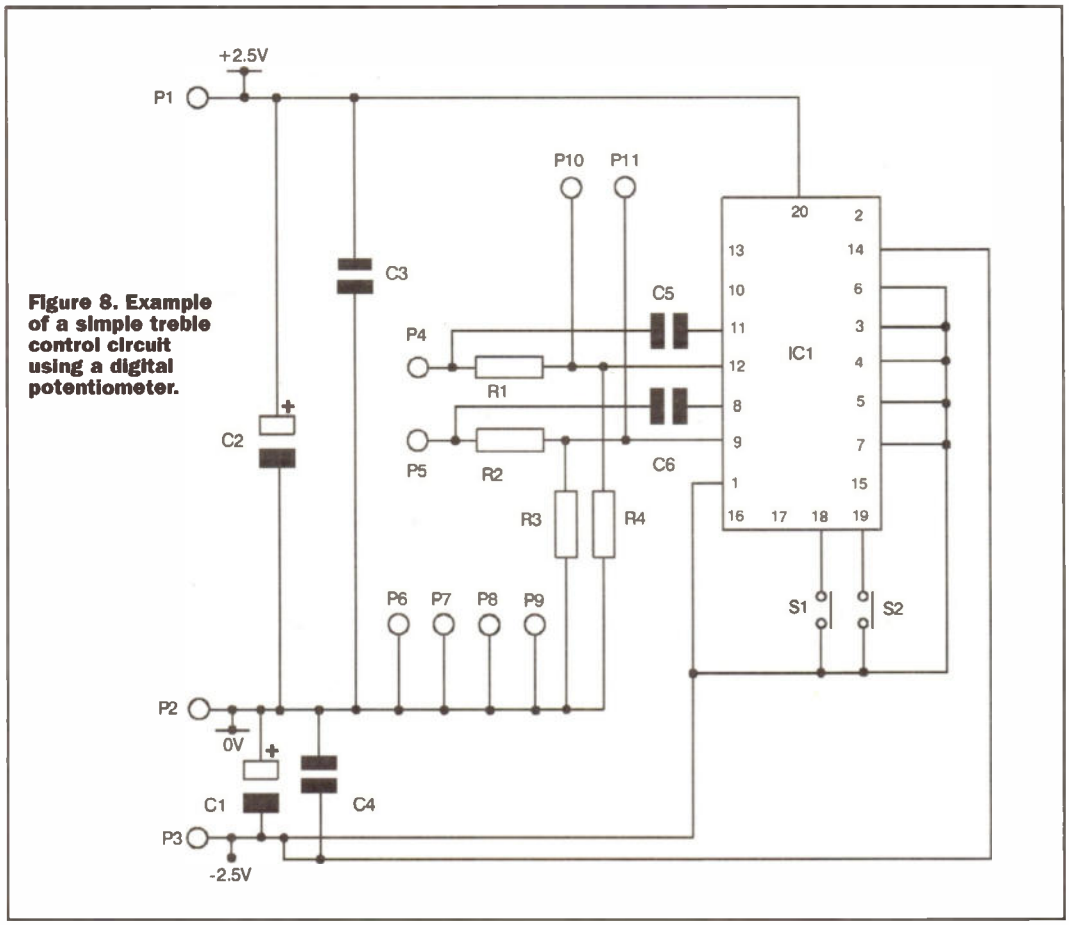


Figure 8. Example of a simple treble control circuit using a digital potentiometer.

Practical Tone Control Circuits

The following circuits illustrate how digital potentiometers can be used in tone control applications and are based on the principles discussed above. The circuits are intended to form a starting point and readers may wish to modify the values and configuration of filter components to suit there own applications.

Bass Control

Figure 7 shows a simple stereo bass control circuit using the DS1802 digital potentiometer IC. A very basic configuration is used to illustrate how the IC may be used in this application. The circuit shown operates from a split rail power supply connected to P1 (+V), P2 (0V) and P3 (-V). The same basic configuration can be used with a single rail supply so long as voltages on the potentiometer IC pins are maintained within the manufacturers specification. Suitable biasing arrangements can be used where necessary.

The input signals are applied on P4 (right channel) and P5 (left channel). Output signals are taken from P10 (left channel) and P11 right channel. Both inputs and outputs should be referenced to 0V (terminals P6 – P9). The response of the circuit is controlled using switches S1 and S2 and this affects both channels

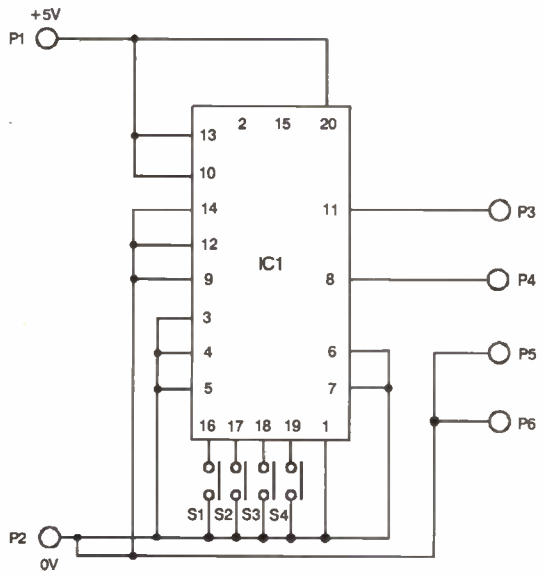


Figure 9. Using a digital potentiometer to control a DC voltage (4 switch version).

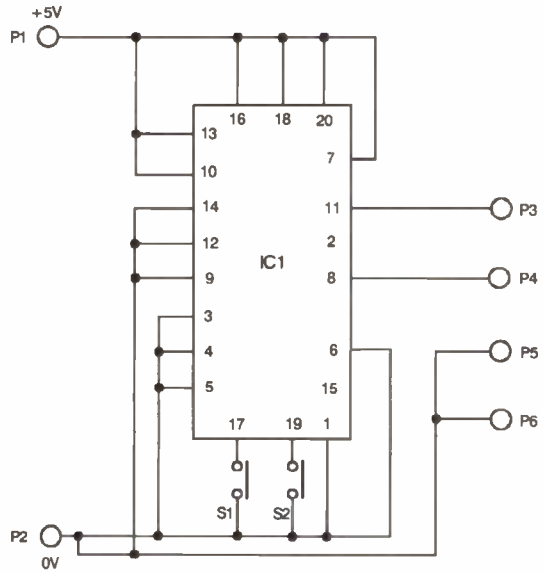


Figure 10. Using a digital potentiometer to control a DC voltage (2 switch version).

simultaneously. Closing S2 will result in a stepped increase in signal at low frequencies with high frequencies remaining substantially unaffected. Operation of S1 will reverse the process. Due to the nature of the circuit the output signal will be considerably attenuated when compared with the input signal. If necessary, the effect of this attenuation can be reversed by amplification of the input or output signal.

Treble Control

A simple digitally operated stereo treble control circuit is illustrated in Figure 8. Input and output pins are as for the bass control circuit described above and the same general comments apply. This time closing S1 will produce a stepped increase in output signal level at high frequencies whilst low frequencies remain largely unaffected. Conversely, operating S2 should reverse the process.

Variable Voltage Control

A digitally controlled variable voltage can be useful in a whole range of different applications. Push button control of the output voltage of a power supply is one of the more obvious examples. Other uses include gain setting of voltage controlled amplifiers and digitally controlled adjustment of voltage controlled filters and oscillators. Figure 9 shows a simple circuit that will produce two logarithmically stepped voltage outputs which may be controlled using push buttons. The power supply is connected between terminals P1 (+V) and P2 (0V). Two outputs are provided, one between P3 (o/p) and P4 (0V) and the other between P5 (o/p) and P6 (0V). If the IC is set up in stereo mode as shown in Figure 9 (IC1 pin 7 permanently connected to 0V) the output voltages will track each other closely. Alternatively the circuit may be set to provide two independently controlled outputs by permanently connecting IC1 pin 7 to +5V (and not to 0V). Please note: The current drain from output terminals P3 and P4 should not be allowed to exceed 1mA.

In the circuit of Figure 9 (stereo mode), the switches function as follows:

S1 – Balance (P3);
S2 – Balance (P4);
S3 – Voltage level down (P3 and P4);
S4 – Voltage level up (P3 and P4).

Balance control is included as the output voltage may be used to control amplifiers or filters in a stereo system.

If the circuit is set up to operate in independent mode, the function of the switches is modified as follows:

S1 – Voltage level down (P4);
S2 – Voltage level up (P4);
S3 – Voltage level down (P3);
S4 – Voltage level up (P3).

Remote Control of Digital Potentiometers

By their very nature, digital potentiometers are ideally suited to remote control applications. Exactly how this is implemented will depend on individual requirements. Infrared is a common transmission medium. You may wish to use a microprocessor based system allowing comprehensive control or it may be sufficient to use a simple system based on discrete components.

One feature of the DS1802 IC which could be useful when used with a simple remote control system, is the ability to control the device using a reduced number of switch inputs. An example of a circuit using the device in this way is shown in Figure 10. The circuit uses the independent control configuration. A single switch (as opposed to the usual two) is used to increase and decrease the volume level of each channel. If the switch is not pressed for a period of approximately 1 second, the direction of control is reversed. This method of control may also be used in the stereo mode, where one switch is used to set the volume level and the other is used to control the balance between the left and right channels. As mentioned, stereo mode is selected by disconnecting pin 7 of the IC from +V and connecting it to 0V. The connection must be made

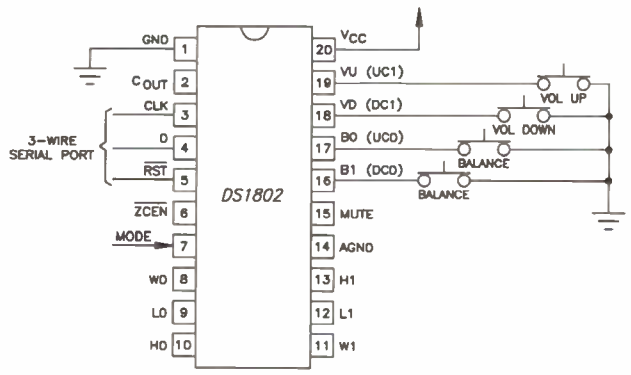


Figure 11. IC pinouts.

when the circuit is powered up. Pin 7 should always be connected to either +5V or 0V (-V for split supplies) and should not be allowed to float.

The switches in the circuit shown in Figure 10 (independent mode) operate as follows:

S1 – Output voltage P4 up/down;
S2 – Output voltage P3 up/down.

If the circuit is modified to operate in stereo mode the function of the switches will be:
S1 – Balance;
S2 – Output voltage (P3 and P4) up/down.

Of course, it is not essential to use physical push buttons with the contact closure inputs. Relays and electronic switching techniques can be used just as successfully as long as they are effectively open circuit in the off state. In this way, a simple infrared system providing just two switched (on/off) outputs can be used to provide remote control of stereo volume and balance. When using simple electronic switching, it is advantageous if the circuits are configured to operate from a single rail power supply. The control inputs are intended to be switched to IC ground (the most negative supply rail) and matters are simplified if the signal and digital 0V lines are at the same DC potential. Where isolated mechanical switches or relays are used, this does not present a problem. Under no circumstances should pin 1 and pin 14 of the DS1802 IC be connected to different DC levels.

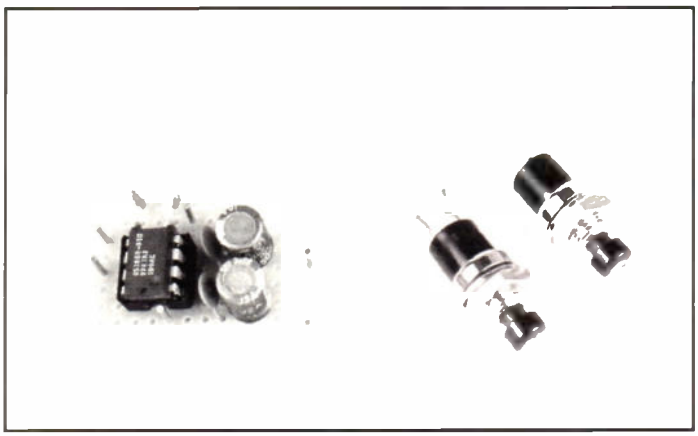
Circuit Construction and Safety

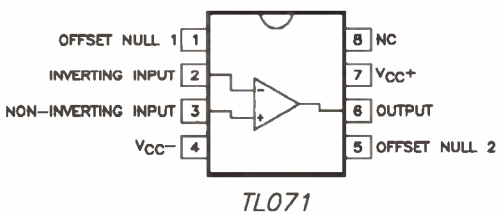
The circuits described may be constructed on PCB or matrix board. As with most audio circuits there are some layout considerations. Correct circuit layout is essential for low noise performance and different circuit configurations can give widely varying performance. Analogue and digital ground paths should be kept separate where possible meeting only at the point where the supply is connected to the circuit. Bulk de-coupling capacitors should be connected at this point. High frequency supply de-coupling (ceramic capacitors) should be connected as close to the relevant IC as possible. An attempt has been made to illustrate this on the circuit diagrams. It should be noted that for circuits which operate from a split power supply, the analogue and digital ground connections to the IC are actually made to the –V rail. The signal grounds are connected to 0V.

As always, it is recommended that DIL sockets are used for all ICs to prevent any possibility of damage during soldering and to simplify the changing of ICs if this becomes necessary. For safety reasons as well as for correct functionality, all polarised components such as IC's and electrolytic capacitors must be inserted observing the correct polarity. The polarity of radial electrolytic capacitors of the types specified is normally marked by a minus (-) symbol on the side of the component close to the negative lead.

As with the circuits described in part 1, most types of push to make switch can be used with the contact closure inputs. The switches specified should be suitable for general purpose use but there is no reason why other types may not be used if this is desirable.

Appropriate fuses should be connected in series with the power supply lines if the supplies are not suitably current limited or overcurrent protected. This helps to prevent damage to the circuit or supply under a fault condition. The current consumption of the circuits shown should be in the order of a few mA and few problems should be experienced if the circuits are correctly constructed. It is always advisable to monitor the power supply current when the circuit is first powered up, just in case there are any constructional errors. A multimeter set to the appropriate current range is useful for this purpose.





TL071

Pin out of TL071.

PARTS LIST FOR DIGITAL VOLUME CONTROL (FIGURE 1)

CAPACITORS			
C1, 2	Genelect 100uF 16V	2	AT40T
C3, 4	Minidisc 0.1uF 16V	2	YR75S
SEMICONDUCTORS			
IC1	DS1802	1	LE19V
IC2,3	TL071CN	2	RA67X
MISCELLANEOUS			
S1 – S5	Blk Push to Make Switch	5	ND91Y
P1 – P11	Pin 2145	11 pins	FL24B
	DIL Socket 8-Pin	2	BL17T
	DIL Socket 20-Pin	1	HQ77J

PARTS LIST FOR DIGITAL VOLUME CONTROL (SINGLE RAIL VERSION -FIGURE 3)

RESISTORS			
R1, 2	10k	2	M10K
CAPACITORS			
C1, 9, 10	Genelect 100uF 16V	3	AT40T
C2, 5, 6	Minidisc 0.1uF 16V	3	YR75S
C3, 4, 7, 8	Genelect 10uF 63V	4	AT77J
SEMICONDUCTORS			
IC1, 3, 4	TL071CN	3	RA67X
IC2	DS1802	1	LE19V
RG1	LM78L05ACZ	1	QL26D
MISCELLANEOUS			
S1 – S5	Blk Push to Make Switch	5	ND91Y
P1 – P10	Pin 2145	10 pins	FL24B
	DIL Socket 8-Pin	3	BL17T
	DIL Socket 20-Pin	1	HQ77J

PARTS LIST FOR SIMPLE BASS CONTROL AND TREBLE CONTROL CIRCUITS (FIGURES 7 AND 8)

RESISTORS			
R1, 2	10k	2	M10K
R3, 4	1k	2	M1K
CAPACITORS			
C1, 2	Genelect 100uF 16V	2	AT40T
C3, 4	Minidisc 0.1uF 16V	2	YR75S
C5, 6	Poly Layer 0.1	2	WW41U
SEMICONDUCTORS			
IC1	DS1802	1	LE19V
MISCELLANEOUS			
S1, 2	Blk Push to Make Switch	2	ND91Y
P1 – P11	Pin 2145	11 pins	FL24B
	DIL Socket 20-Pin	1	HQ77J

IBUS SERIAL PORT ADAPTOR

PART 7

Neil Johnson, of Cambridge Consultants Ltd, describes the latest addition to his IBUS expansion family.

Talking to the IBUS through a parallel port is all very well if you have a spare parallel port. If you don't, this project will enable you to talk to the IBUS through a serial port, opening up a wider range of applications for this useful PC expansion system.

Introduction

The IBUS (Interface BUS) was introduced way back in issue 119 of *Electronics & Beyond* with the Parallel Port Adaptor. Six months, five expansion modules and an application guide later, and a comprehensive, easily-expandable interface system has been created for the PC. In case you missed any of the previous projects, back issues are available from Maplin Electronics.

Up to now the only interface between the PC and the IBUS has been through a spare parallel port. While this is suitable for most people, including yours truly, there are situations where a parallel port is just not available.

For example, most PCs nowadays are built with only one parallel port, which is usually connected to a printer. It is also standard for there to be two serial ports – one serial port is used for the mouse, leaving one unused serial port. It would be far better to use this spare port to talk to the IBUS than constantly swapping cables over between the printer and the IBUS parallel port adaptor. If only there was some way to put this spare serial port into use.

A serial interface to the IBUS would broaden its range of applications. There are many computers and terminals in use which do not possess a usable parallel port (the Psion5 PDA, on which this is being typed, has only a serial port for external communications). Most computers can, with some simple programming, talk through their serial ports to the outside world.

This project presents an interface between the IBUS and a standard RS232-compatible serial port. It is based on a PICmicrocontroller, together with some additional interface logic.

Circuit Time

The circuit for this project, shown in Figure 1, consists of four main sections, each of which will be described below.

The first section is the serial interface, based on IC1. This converts the ±12V RS232 signal levels present at connector CN1 to and from the TTL-compatible logic signals needed by the rest of the circuit. The interface chip is an MAX233, and it includes all the circuitry necessary to generate ±10V to drive the RS232 signals, and buffers to translate the RS232 signals into TTL-compatible logic levels.

The second circuit module is based on IC2, a PIC microcontroller, together with its 4MHz crystal. To keep costs down the PIC performs all the operational functions of the circuit, including receiving and transmitting serial data (known as a 'soft UART' because the functionality of a UART is done entirely in software).

The third section is the IBUS interface. The complete IBUS interface timing and control is also handled by the PIC. The Address Buffer, IC3, and the Data Buffer, IC4, are both controlled by the PIC, and are both fed from the same 8-bit I/O port. The IBUS Read and Write signals are also generated by the PIC. As a safety measure IC5 protects the IBUS from both the Read and the Write signals being active at the same time. This might happen during reset, or if the software were to crash, and would cause a bus contention on the IBUS, resulting in possible severe damage to any connected bus interface circuits.

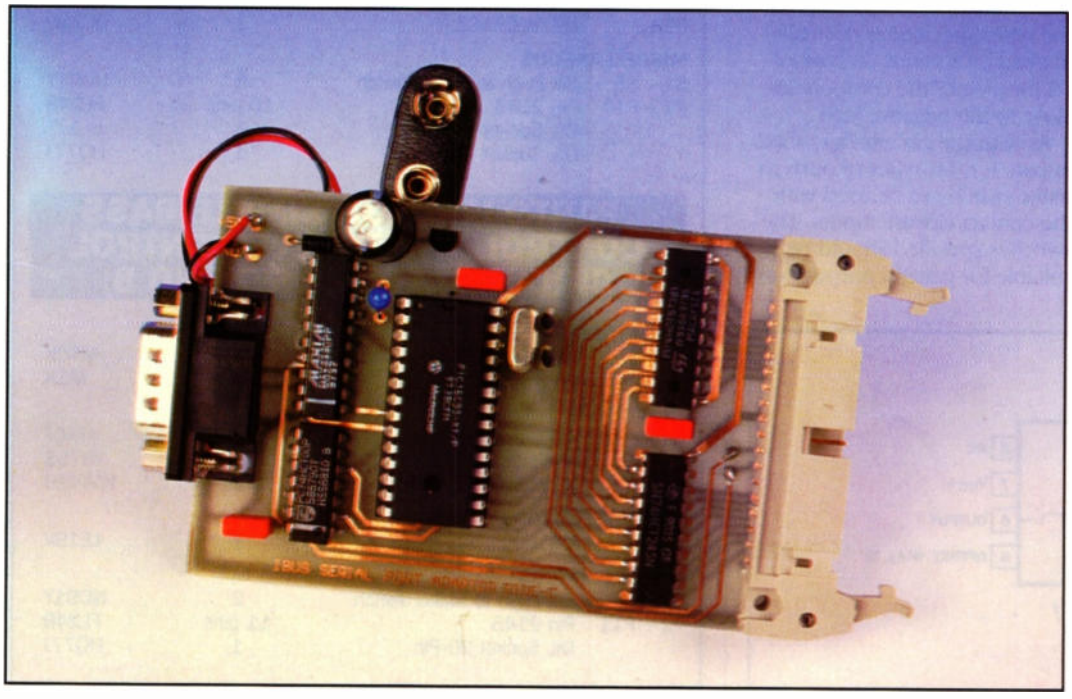
The final circuit section is the power supply. This is a simple DC supply, with IC6 regulating the incoming DC to the required +5V. Diode D1 protects the circuit from reverse voltages, while the various electrolytic and ceramic capacitors provide supply rail decoupling.

Take your PIC

The heart of this project is a PIC microcontroller. The PIC chosen for this project is the popular PIC16C55, which offers 22 I/O lines, 512 words of program memory, and 25 bytes of data memory. A block diagram of the internals of this chip is shown in Figure 2. It is based on a Harvard architecture, having separate program ROM and data RAM memories (it also has a separate, small, stack). This allows very simple instructions, and very fast execution times. From the 4MHz crystal it executes one instruction almost every microsecond – that's close to one million instructions per second! The three I/O ports (A, B and C) provide a controlled interface to the outside world, while the oscillator keeps the central processor ticking along. The counter/watchdog module provides additional facilities not used by this project.

The program memory is where the operating software is stored. For this project the software is designed to perform several important tasks:

1. receive and transmit serial characters (software UART)
2. command interpretation
3. IBUS interface
4. error handling



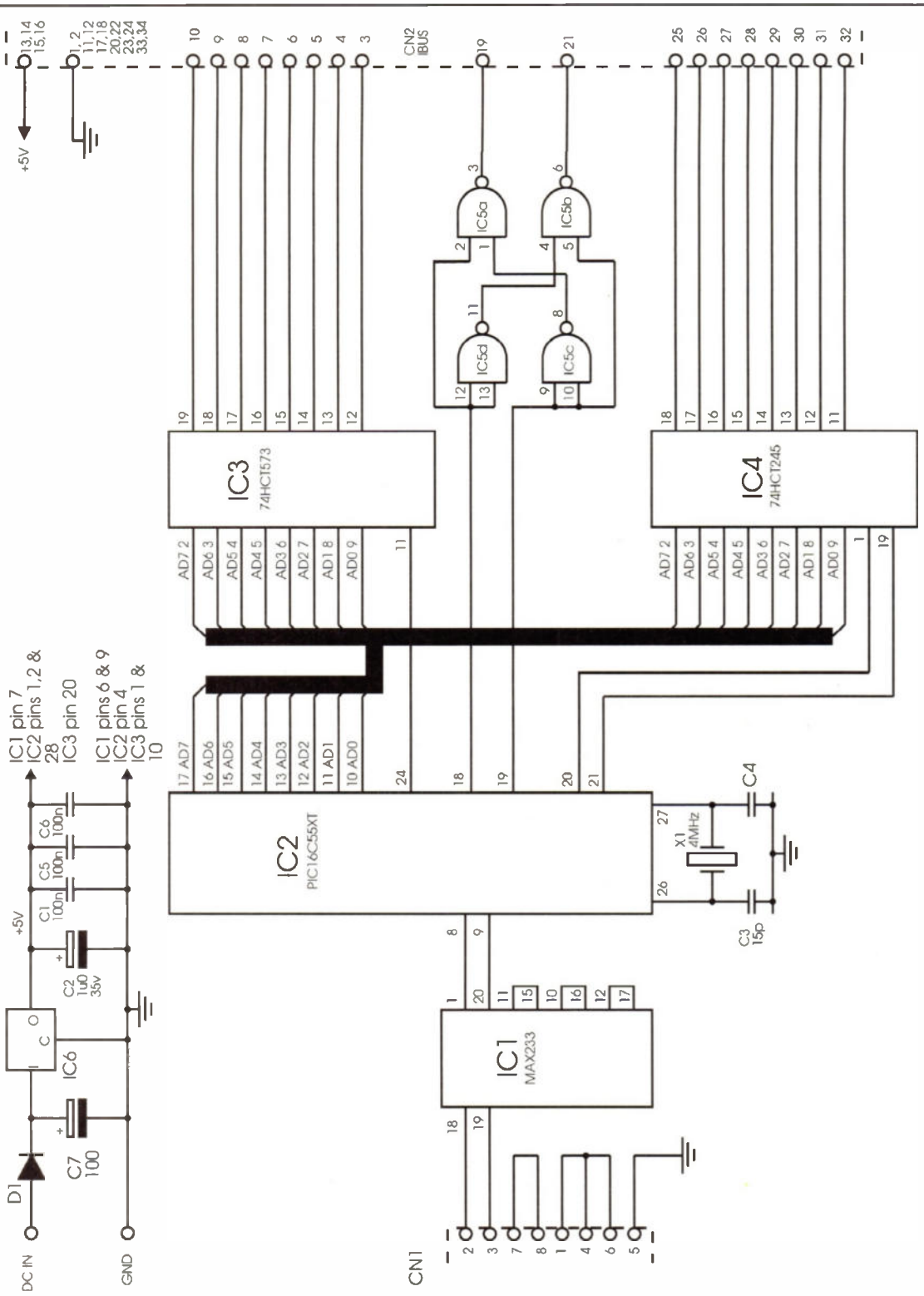


Figure 1. Serial Port Adaptor Circuit Diagram.

Figure 3 shows the basic operation of the software as a flow chart. The rectangular boxes indicate some processing operation, the diamond boxes show a decision stage, and the lines with arrows show the flow of execution, from the top downwards. A selection stage is shown by a diamond box followed by a number of annotated branches – if a match is found that particular branch is executed, otherwise the 'else' branch is executed.

The PIC has sufficient processing power available to be able to perform the actions of a UART itself. This keeps the cost down, reduces the number of components, and helps keep as much complexity in the software as possible. To receive a character, the software monitors the state of the receive line, looking for the falling edge of the start bit. Once this is found, the software uses a timing loop to wait for the middle of the next bit, whose value is consecutively stored to receive the entire eight data bits. Transmitting a character is not much more complex – set the transmit pin to the desired state and then wait for one 1-bit period. For the chosen data rate of 9,600 bauda 1-bit period is about 104μs.

Once characters have been received and decoded, they are then passed on to the command interpreter. This has the task of deciding what the controller wants to do – read from or write to the IBUS – and then processing any following address and, optionally, data parameters.

Once the address (and data for a write operation) is known and checked the PIC then performs an IBUS access cycle. This involves setting up the address latch and then either enabling the Read Strobe and examining the data bus, or putting some data on the Data Bus and toggling the Write Strobe.

At all stages in the processing of the commands the software is also checking for possible errors.

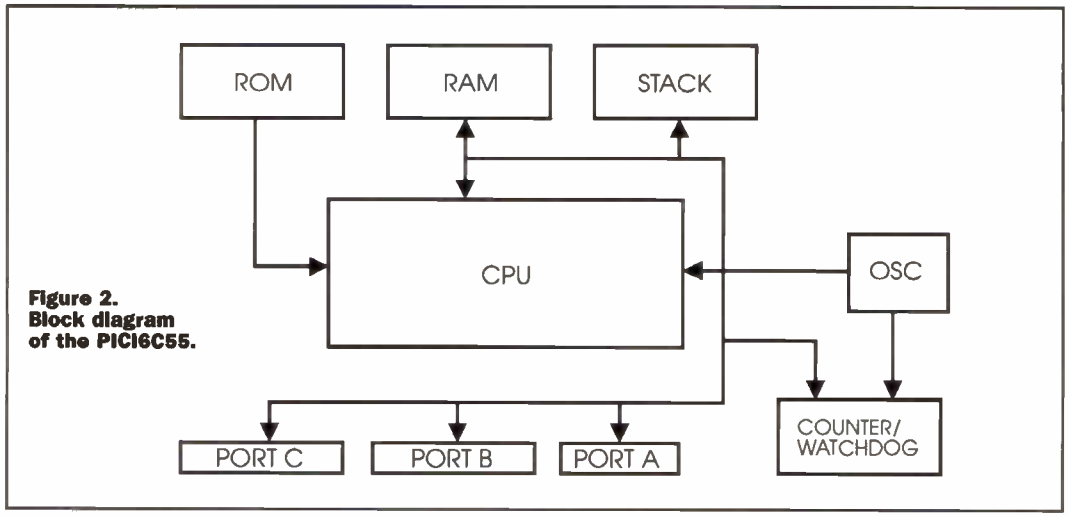


Figure 2. Block diagram of the PIC16C55.

In all cases if an error is found the software will not perform an IBUS access cycle, but instead will return to the top-most level of the command interpreter.

Command Syntax

This module understands two commands, one for read and one for write. In all cases the command is entered in UPPER case, while the numbers are entered in hexadecimal in either UPPER or lower case.

Read: R<addr>

This command reads the value from the IBUS location <addr>. The command returns the value of the data in hexadecimal. Example:

```
R12 (command sent by controller:
read from address H'12)
FF (result sent back by SPA:
result was H'FF)
```

Write: W<addr><data>

This command writes the byte <data> to the IBUS location <addr>. This command returns a 'W' as the result. Example:

```
W1234 (command sent by controller:
write H'34 to address H'12)
```

Construction Details

The PCB overlay is shown in Figure 4. All the components fit onto the PCB, including both the IBUS and the serial connectors. The only off-board connections are for the power supply.

This project uses a double-sided board, with some connections being made on the component side of the board. The board has been designed so that plated-through-hole (PTH) connections are not required. The only component-side solder connections are made to the ICs. I spent a long time deciding if a double-sided board really was the best way to design the board (increased complexity, two sides – twice the errors, etc) but, in the end, decided this was the simplest and most elegant solution.

Start with the two through-board links, located close to the IBUS connector. Then fit the IC packaged semiconductors. Note the correct orientation of the devices. For the simplest PCB layout some devices point upwards, while some are placed pointing down. Some of the IC pins have connections on the top-side of the board. These can be made with a fine soldering iron bit and a careful hand.

Complete the board with the remaining components (diode, regulator, capacitors and connectors), fitting the crystal last. It is recommended that PCB pins are used for the DC connection, mainly to protect the board from repeated soldering operations (the glue that holds the copper to the board eventually melts, and the pads fall off).

Finally, give the board a good clean with some solvent and a stiff brush. The recommended solvent for PCBs is iso-propyl alcohol (IPA), available from most good electrical suppliers. Some companies are now promoting other solvent-based cleaning fluids, usually supplied in aerosol cans, which can also be used for this task.

Testing

Before applying power to the board give it a thorough visual inspection, checking all solder joints for solder splashes or spills, and the orientation of

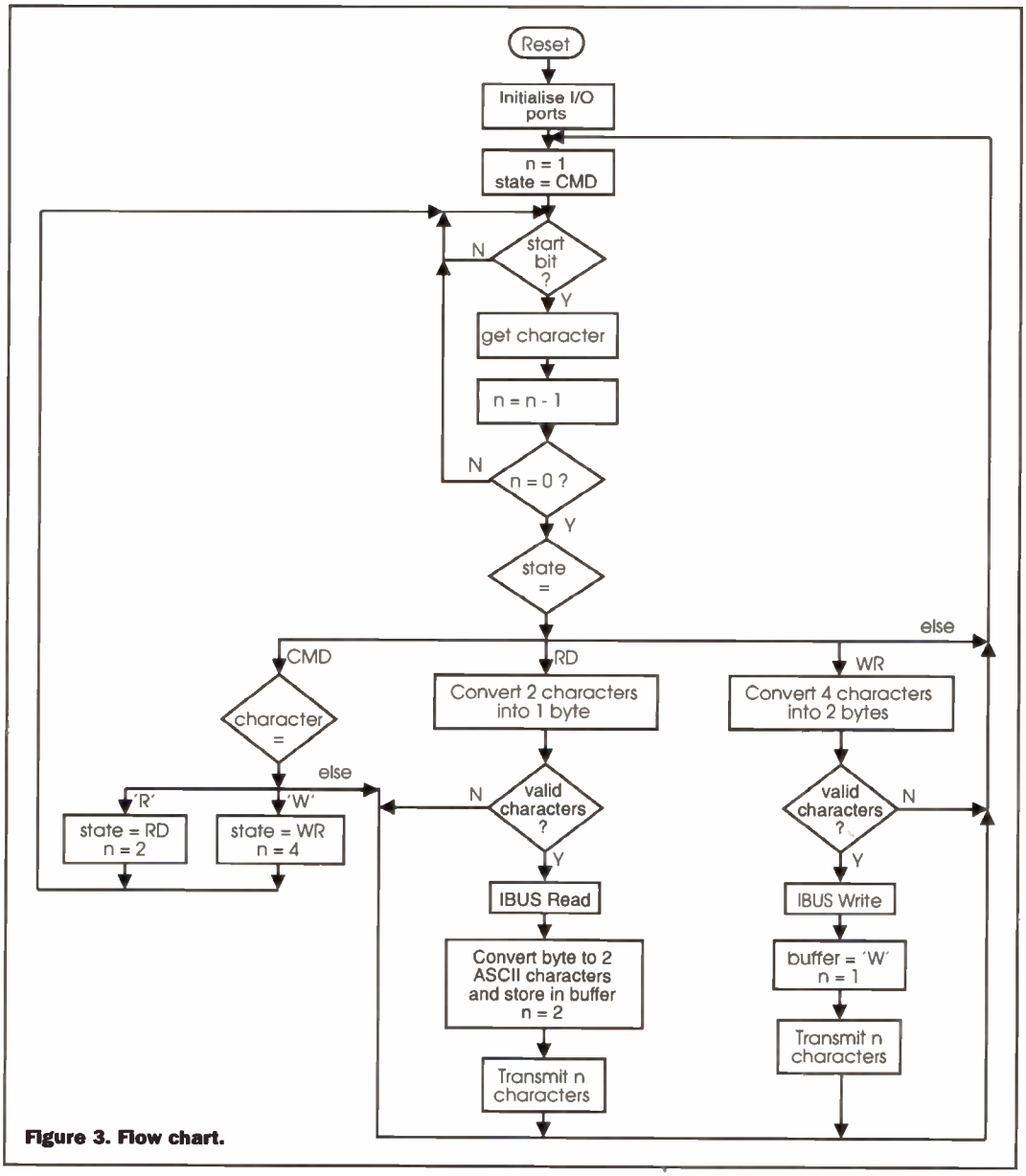


Figure 3. Flow chart.

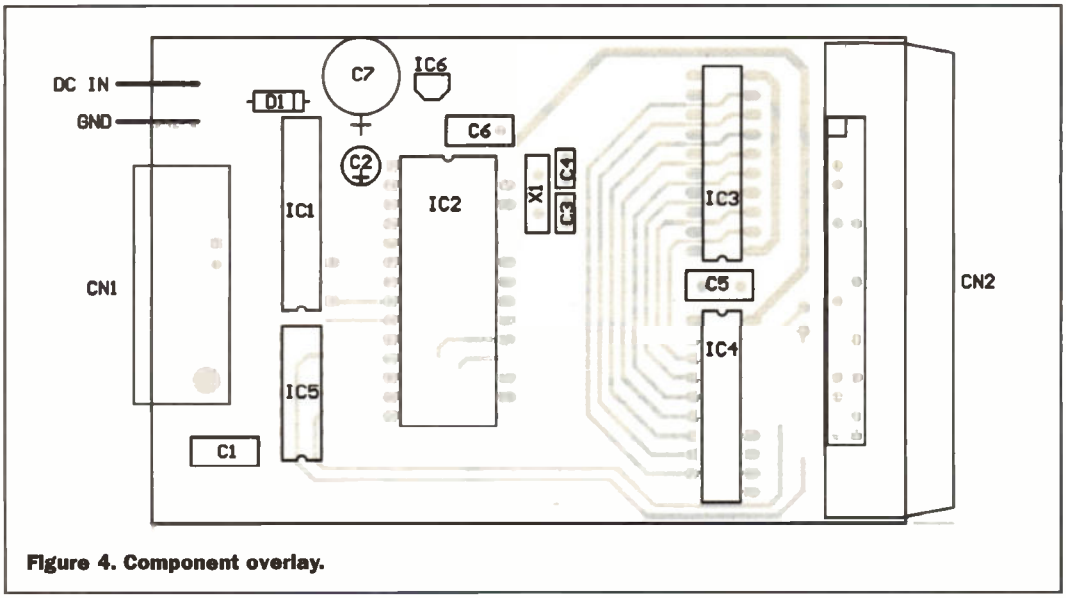


Figure 4. Component overlay.

polarised components.

If all is well connect the board to a DC supply of about 9V or greater (I use a basic 12V bench PSU). Switch on the power and check the board for any overheating components. These would most likely be the regulator or one of the ICs.

The next testing stage is to connect the unit to a simple terminal. This could be a dumb terminal (for example a DEC VT320) or a computer with a serial port and appropriate software. Connect the board to the serial port using a cable with the following connections:

SPA	9-pin	25-pin
1	1	8
2	3	2
3	2	3
4	4	20
5	5	7
6	6	6
7	7	4
8	8	5
9 not used		

Turn on the board and start the terminal. The SPA software does not perform a local echo, so you may want to enable this function on your terminal so you can see what you are sending. Send the command string "W0000" (a "W" followed by four zeroes) and check the unit responds with a 'W'. If not, check the connection between the terminal and the SPA.

The final testing stage requires an IBUS expansion module. Connect the module to the SPA with a length of 34-way ribbon cable and a couple of IDC connectors. The best module to use for testing is the Digital I/O module, published in issue 122 of *Electronics and Beyond*. This allows you to test both reading and writing data through the IBUS.

Write a value to the IBUS module and check the output matches the data sent to the module. Likewise, check the value read from the IBUS module matches the digital value fed into its inputs.

If all the tests have been successful you now have a useful addition to your IBUS system. This extra interface to the IBUS means wider applications, some of which are discussed below.

Applications

This module provides a standard RS232 interface to the IBUS. It uses a simple command language made up of ASCII characters to both read from and write to the IBUS. This simple interface means it should be relatively simple to connect any computer, terminal, modem or other control system to the IBUS.

For example, a system could be assembled for a remote monitoring or control application, Figure 5, consisting of a number of IBUS modules, the SPA, and either a small embedded computer, or a modem to talk to a remote computer over some long-distance communications channel. The modem used could be a traditional telephone modem, so you could periodically call your remote system to monitor or control its behaviour. Or you could use one of the many standard off-the-shelf RF radio modems, which is able to run at the required baud rate and can operate over considerable distances.

For special applications one can use a fibre-optic modem. These are useful where you require absolute electrical isolation between the control system and your computer, or where reasonable distances (up to a few kilometres) are required but telephone lines or radio signals are impractical. In a past life I have used such

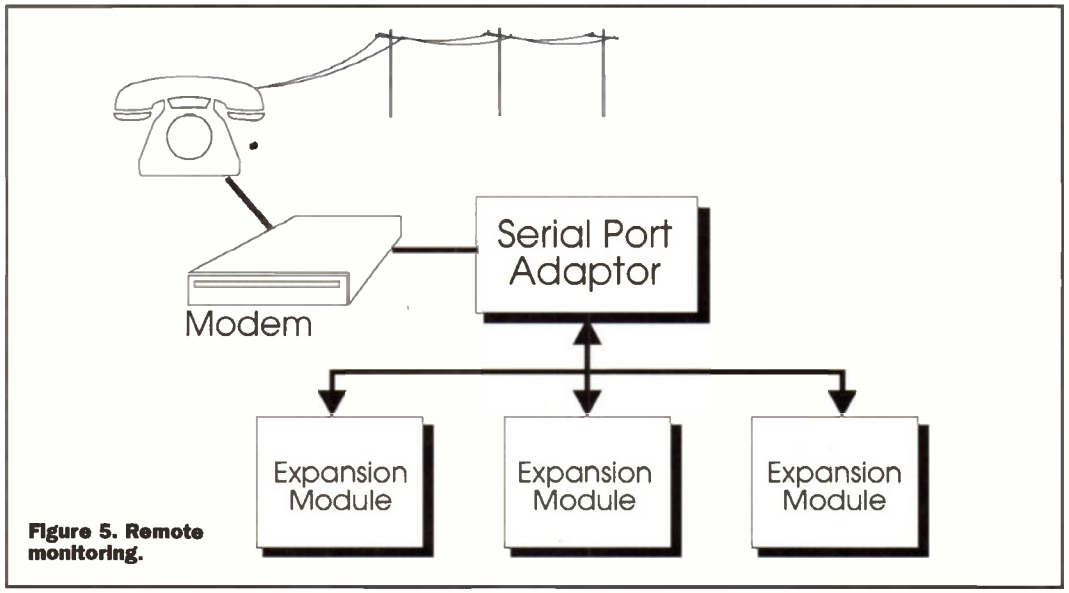


Figure 5. Remote monitoring.

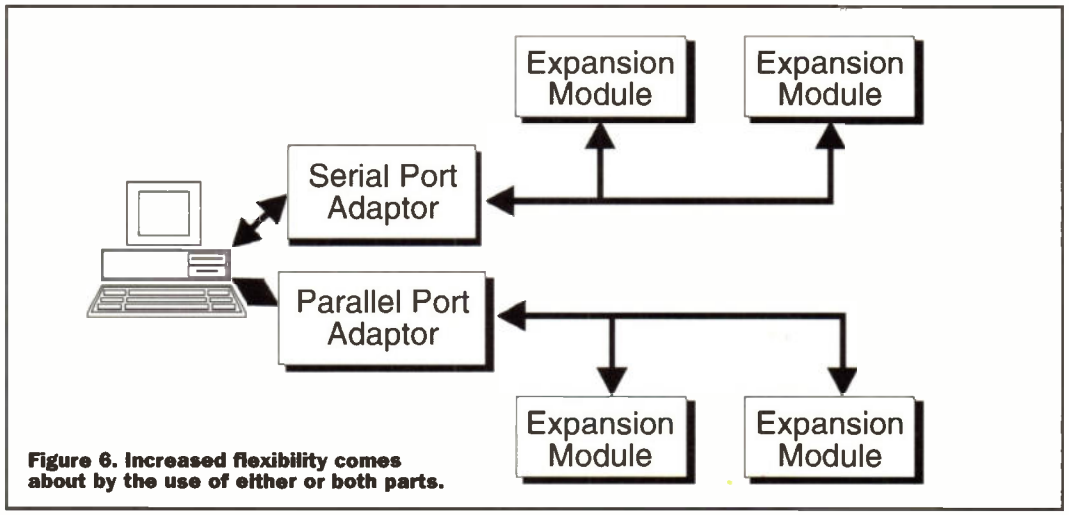
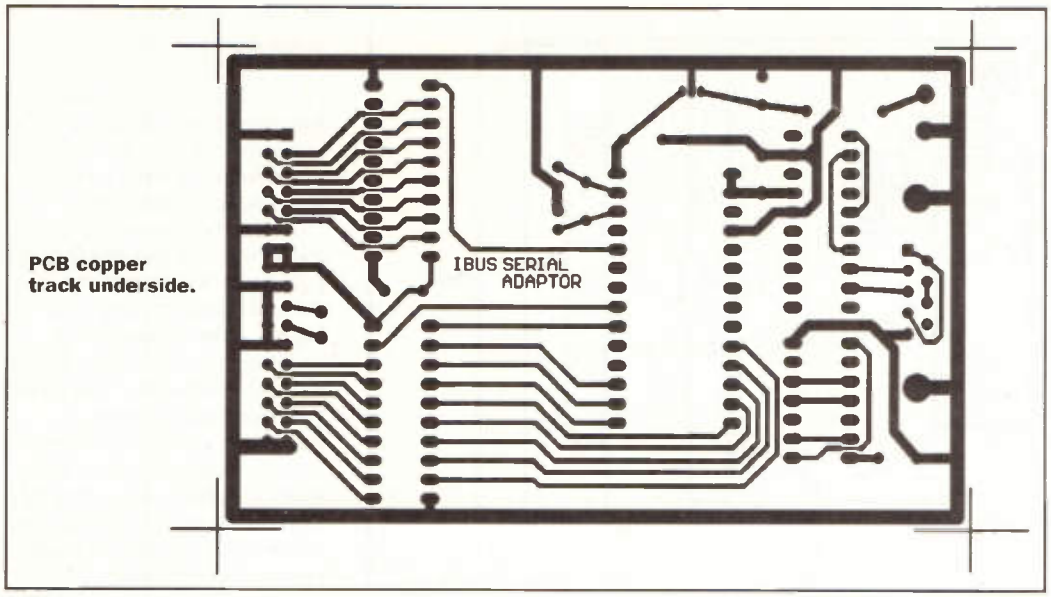
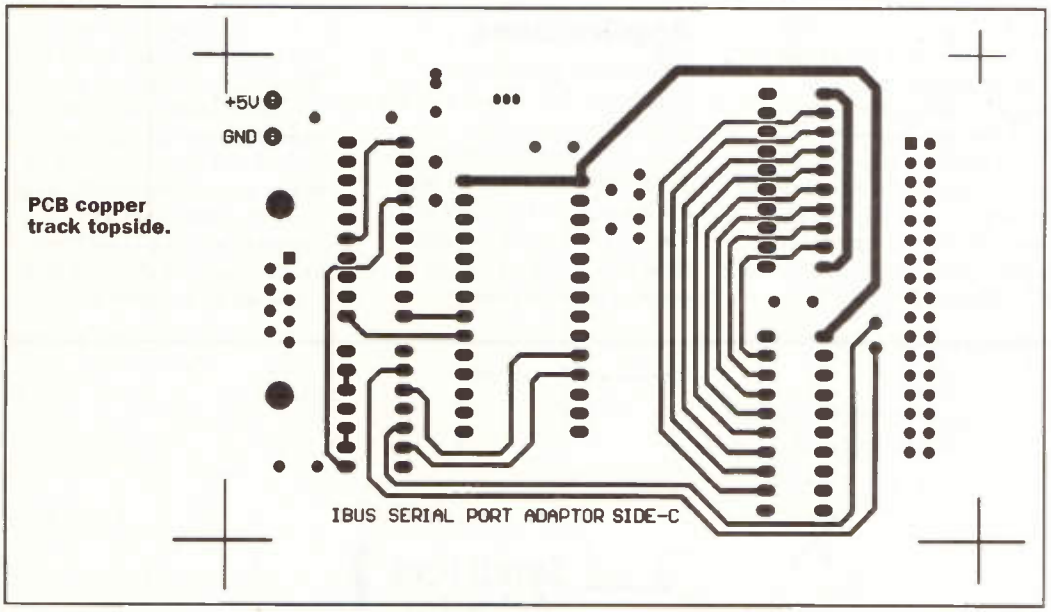


Figure 6. Increased flexibility comes about by the use of either or both parts.



PCB copper track underside.



PCB copper track topside.

devices for monitoring and control systems in an EMC test environment, where absolute electrical isolation was required between equipment on the inside and on the outside of the anechoic chamber.

Another, indirect, use for the SPA is to free-up a parallel port on the computer. There are now a number of interface devices which use the parallel port as a cheap, low-cost and simple PC interface (Figure 6). An example is the PICO range of analogue sample modules, which can turn a parallel port into a comprehensive oscilloscope or data logger. By moving the IBUS onto a serial port you can combine both systems into one, larger, monitoring and control system, while at the same time making a considerable saving over more complex and more expensive systems.

Taking this to the limit, if you found that one IBUS system was not enough to satisfy your needs, you could have an IBUS system on both the parallel port and on the serial port – a system capable of supporting up to 512 expansion modules! The sky well and truly is the limit.

Further Reading

If you want to know more about the PIC microcontrollers there are a number of excellent sources of information. First and foremost is the data available from the manufacturers, Microchip Technology Inc. Their website is at: **http://www.microchip.com** where you can find datasheets, application notes, and even free development software. If you don't have access to the World Wide Web you can still enjoy this wealth of knowledge with the Microchip data CD (order code DT75S). This contains the same material as is found on the website.

For a basic introduction to the PIC family you could start with one of the many beginners books. A good starters book is *A Beginner's Guide to the Microchip PIC*, order code AD31J. This describes their operation, assembly language, and simple applications, and includes a set of programs for writing your own PIC programs.

For the more adventurous there is the two-volume *PIC Cookbook* set (Volume 1 – order code DT76H, Volume 2 – order code VQ59P). These cover a wide range of example applications, and come complete with all the source code on the accompanying disks.

The datasheet for the MAX233 line driver/receiver is available from the manufacturer, Maxim, from their website: **http://www.maxim-ic.com.** Again, there is a large volume of data at this site, including datasheets, application notes and design guides for all of their products.

There are a number of books describing RS232 serial communications. One of the most comprehensive is *C Programmers Guide to Serial Communications* by Joe Campbell, published by SAMS Publishing. This book covers serial communications software in considerable depth, and is aimed at the advanced programmer.

For a description of the PC hardware behind the serial port connector "The Indispensable PC Hardware Book" by Hans-Peter Messmer has all of the details.

Acknowledgements

The author would like to express his thanks to Cambridge Consultants Ltd, Cambridge, for their help in providing development facilities for this project.

PROJECT PARTS LIST

CAPACITORS

C1, 5, 6	100nF ceramic	RA49D
C2	1µF, 25v tantalum bead	WW60Q
C3, 4	15pF ceramic	WX46A
C7	100µF 25v radial electrolytic	AT48C

SEMICONDUCTORS

IC1	MAX233	NR45Y
IC2	PIC16C55XT	AD38R
IC3	74HCT573	AE29G
IC4	74HCT245	UB68Y
IC5	74HCT00	AE20W
IC6	78L05 100mA regulator	AV02C
D1	1N4001	QL73Q

MISCELLANEOUS

X1	4MHz crystal	FY82D
CN1	9-way right-angle PCB D plug	FG66W
CN2	34-way right-angle IDC header	FA44X

IC sockets (optional), PCB, solder, wire, 2 PCB pins

The software accompanying this project, supplied on a 3½" disk, and a pre-programmed PIC16C55XT are available from the author at £10 each. Postage is £2.50 for the UK, £5 for everywhere else. Please send your order, with cheque or postal order payable to Neil Johnson, to:

Neil Johnson, IBUS Module, 2 Chapel Field, Dixter Road, NORTHIAM, East Sussex, TN31 6PQ, UK.

Software HINTS & TIPS

by Mike Bedford

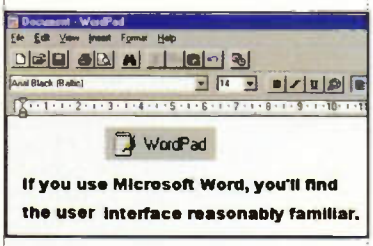
Computing on a shoestring is our topic this month as we investigate the applications bundled in with Windows 95.

Those who've just bought a top of the range 400MHz Pentium II PC with £1,000 worth of bundled software may find it hard to believe, but not everyone has access to the latest Microsoft Office Suite. Many of the cheaper offerings don't come with the office automation applications which are included with the big name PCs. So if you're hoping to start computing on a budget, your finances may only stretch to the hardware and operating system. The temptation, of course, is to try to find someone who can 'lend' you the CD for a word processor, spreadsheet and graphics package. But for those who are determined to keep on the right side of the law, there are alternatives. This month we'll take a look at those packages which come as part of the Windows 95 operating system.

But this doesn't apply only to people who can't afford to splash out on a fully inclusive PC. Perhaps you've just bought a new PC and you've decided to keep your old PC for the kids. The licences for most office automation applications only allow you to install the software on one PC (and perhaps also a laptop). Once again, the utilities bundled with Windows 95 offer a solution for those who want to stay legal.

WordPad

The first application we're going to look at is called



If you use Microsoft Word, you'll find the user interface reasonably familiar.

WordPad which is a simple word processor, rather like a cut-down version of Word. If you're hoping to produce sophisticated newsletters or the like then forget about this application. If, on the other hand, your primary reason for getting a PC is to do technical work such as electronic circuit simulation (using a public domain package) and your requirements for word processing are only basic, WordPad could well be what you need.

To start WordPad, press the start button, select applications, then accessories and you'll find the above icon. If you use Microsoft Word, you'll find the user interface reasonably familiar. It offers you basic control over fonts, colour, formatting, bullets, and it even allows you to import objects such as graphics. Notable features which are missing, however, are tables, multi-column text, equations, and even some of the paragraph formatting facilities such as space before and after. Clearly, though, blank lines can be used to achieve the same effect.

Of course, if you're intent on computing on a shoestring, you're probably considering shareware as an alternative. So why might you choose to use WordPad rather than a shareware word processor? I guess the main reason is that WordPad is totally and absolutely free. If you've got Windows 95 you've already got it. With a shareware program, on the other hand, you're duty bound to pay a registration fee to the author. Almost certainly this will buy you more facilities than those available with WordPad but it might not give you the compatibility with other word processors which you'll probably need. Like it or not, Microsoft file formats are an industry standard so if you want to share files with others, you need to have a word processor which will import and export in these formats. WordPad will import and export as plain ascii text, as Word (but only version 6) and as rtf. Beware, however, that if you import a file created in Word, edit it in WordPad and save it, you'll loose any of the formatting features which were present in the original file but which WordPad doesn't support.

Paint

Another useful application which is included with Windows 95 is paint. In fact, even if you have a full office automation suite on your PC, unless graphics is a major interest, this may be the only graphics package you have access to. As its name suggests, this is a paint package as opposed to a draw package. This means that it works at the level of pixels rather than at the level of objects like lines, boxes and text. That doesn't imply that you can't draw lines boxes and text – you can – but that the package will immediately convert them to pixels. The result of this is that the image cannot later be stretched without introducing "jaggies". It's also much harder to edit files afterwards. However, if you're happy to use the image at its original size and won't need to make frequent edits, Paint is perfectly usable.

To start Paint, press the start button, select applications, then accessories and you'll find the above icon. When the application starts you'll be presented with a blank sheet of paper on which you can start painting. Alternatively you can import graphic files in either .bmp or .pcx formats. As always, the best way to learn is by experimentation, but here are a few tips to get you started.

First of all, make sure that you start off with a piece of paper the right size for your intended purpose. Initially you'll be given a default piece of paper but if this is too large or too small, you can pick a different size in the attributes entry of the image menu. You can also choose between black & white and colour here.

The basic tools are displayed in the top left hand corner and are reproduced here. The best way to find out what they all do and the difference between the pencil and the brush, for example, is to try them out. Note also that as you select the various tools, the menu below the tools will change to reflect the options available for that tool. For example, the rectangle tool gives the option of an outline only, a filled rectangle only or a filled rectangle with an outline. The colours for outlines and fills are selected from the colour menu in the bottom left hand corner. The outline colour is selected using the left mouse button and the fill colour using the right mouse button.

Explorer

The one other application I'll mention is Microsoft Internet Explorer which, although not strictly speaking part of Windows 95, was probably installed on your PC nevertheless. You probably think of this as a Web browser as, indeed it is. However, it has a useful secondary purpose which fits in with the theme of this month's column.

You may have noticed one important drop-off in terms of the file formats supported by Paint. Files in the common jpeg format – very common on the Web, and more generally because of its good compression – cannot be imported. However, Internet Explorer can read jpeg files (not just from the Web – from you local disk too) and it can save a graphics file in the .bmp format. Since this is one of the two file formats which Paint does handle, Internet Explorer is useful as a file format conversion utility for jpeg files.

Tramway Grenoble Alsthom Zylberman

Reducing Crime ON PUBLIC TRANSPORT

Public transport operators want to provide their customers with a quality service that puts safety first. The need for innovative solutions which allow them to do this while at the same time reducing the number of employees needed on platforms and in the vehicles, has led to several French manufacturers to come up with interesting solutions to this problem.

Video Surveillance Systems

Paris-based Faiveley Transport produces train doors and railway safety systems. As a result of this company's in-depth expertise in safety and security matters, their latest product is a black box called Sirene. "With Sirene we want to eliminate vandalism and increase security on public transport," explains Marc Chocat, head of electronic products at Faiveley.

Sirene contains a complete video surveillance system, which uses between one and four small digital cameras (black and white or colour), and also includes recording equipment and an optional microphone. The Sirene system is installed in bus or rail carriages, and records what goes on inside without being seen by the passengers.

Sirene starts automatically when the vehicle is started up, and records from 4 to 280 hours of footage on a hard disk. But the footage is only examined after an incident has been reported. "Confidentiality is guaranteed in all incident-free situations," Marc Chocat stresses. "The recorded pictures can be accessed only from a single viewing station, which is kept locked".

In France, Sirene has already been installed by bus and tram companies in Orleans, Grenoble and Le Havre. In Britain, Connex and Chiltern Railways have installed the units in their long distance trains. These companies not only use Sirene to combat vandalism, but also to record track signaling. The recorded pictures could be used as evidence in any legal dispute over signaling.

Faiveley Transport has also revealed another innovative product. Named Vigil, it can be fitted in the cab of a train, underground train or tram, to provide the driver with real-time information about what is going on during the journey. It provides information about signals and operating data for the train, plus maintenance and diagnostic information. The operator can choose a split screen which shows all the pictures recorded by cameras within the vehicle at the same time. Faiveley Transport plans to give users the option of combining Vigil with Sirene so that the driver or guard will be able to look at all the pictures relating to any incident.

Sirene consists of 1-4 miniature cameras which can store several hours of pictures. The system works in a similar way to a black box on an aeroplane.

Totally Automatic Trains

Meteor the 14th Paris Metro line opened in October. It's a unique underground line as the trains are fully automatic and need no driver. The designer of the system, Matra Transport International, has solved the problem of passenger safety by calling on its expertise in railway computer systems. "We have installed a real-time video surveillance system in the trains," explains Philippe Hartheiser who is responsible for Matra's automatic systems. Two miniature digital cameras, positioned where passengers cannot see them, film the inside of each coach continuously. The pictures are transmitted to the central control unit where they appear on a screen. Supervisory staff are thus able to observe any incidents, and to intervene at the next station. "This is probably the first in-train continuous video surveillance system in the world," Mr Hartheiser claims.

Monitoring the Number of Passengers

City transport operators need to be able to manage the frequency of their services efficiently. French company GTI has installed sensors in the corridors of Lyons' underground network which enable it to monitor the volume of passengers at a much lower cost than any manual counting system. The results ensure that the right number of trains are running throughout the day.

Designed by Acorel, the device used in France's second city uses infrared radiation to detect passengers. "We have developed a method of seeing people in different positions, distinguishing them when they are crushed together and even identifying their direction of travel," says Serge Rizzi, head of Acorel. "The error ratio is no more than 2 or 3%." The data from the sensors is collected daily, using a portable terminal. The system is also being used in Reims, Dijon and Paris.

RATP, the Parisian public transport operator, is replacing its traditional counting system which uses a sensor-mat by the doors, giving out an electric signal when passengers stand on it. This mat has the disadvantage of being unable to distinguish between passengers getting on and those getting off. Nor does it work in the new buses, which have lowered floors.

Vigil's flat screen allows drivers to see what is going on inside their vehicle.

The operator is therefore adopting the Acorel counting system, with passive infrared sensors fitted within the door frames of buses. "By identifying peak periods and adjusting service frequency accordingly, we can provide the best possible service to our customers and make their journeys more pleasant," comments Didier Leclerc, who is responsible for RATP's new systems.

Points of Contact

For more information please contact Dan Ray at the French Technology Press Bureau 21-24 Grosvenor Place, London, SW1X 7TB, Tel: 0171 235 5330, Fax: 0171 235 2773

Solar ELECTRICITY

Not only does solar power produce very cheap electricity, but offers savings on carbon dioxide production. Douglas Clarkson explains.

Introduction

I have not received my letter in the post from Mr John Prescott. A letter that would ask me as a responsible but energy consuming citizen to begin to plan for a reduction in greenhouse gases for which I am responsible each year. Very approximately, some 2.5 tonnes of carbon dioxide from mains electricity, 3.5 tonnes for gas and 2.5 tonnes from travelling 20,000 miles per year by petrol driven car. These are in part the direct tally of being a consumer. Also, every product that is bought, every other service obtained is in turn releasing back into the atmosphere a bounty of carbon dioxide.

When was the start of the campaign? Has the campaign actually started? An awareness of the energy conflict facing us all is hard to keep a focus on. You have to be really thinking about it a lot to maintain a perspective of minimal energy living. The clamour of the marketplace is not about consuming less energy and reducing dependence on fossil fuels. Out of a 24 hour media day, mere seconds are set aside to open the mind to new possibilities of a lean burn society. Those who control the consumer society prefer it that way.

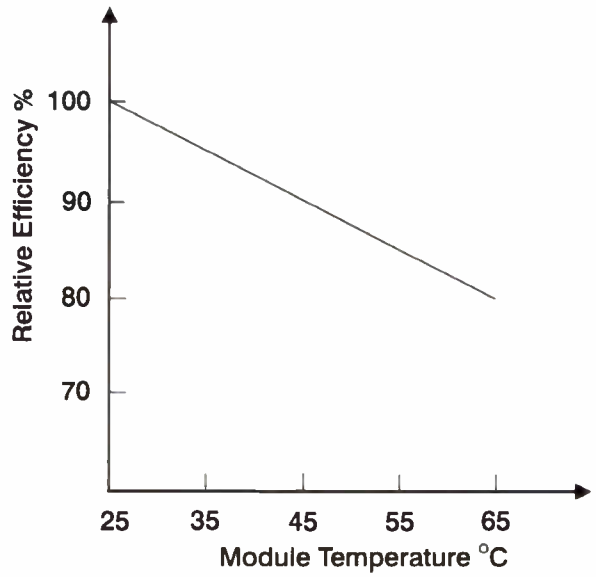


Figure 1. Fall off of efficiency with increased temperature of collector surface.

	Area (m^2)	Electricity kWh per year	Efficiency %
University of Northumbria (1995)	390	33,00	14.5
Flashglas Building (1993)	140	7,000	11.5
Schuco Building (1993)	155	8,200	12.0
Halle Stadtwerke (1994)	42	2500	13.0

Table 1. Early demonstration photovoltaic projects in Europe.

Remedies

The first instinctive approach is to translate to clean energy sources – not before time perhaps. All stops should indeed be taken out to make the transition. It is only in looking at the bigger picture, however, that some basic inferences can be observed. During the late 1970's I succeeded in installing a solar water heating system – exchanging heat into a domestic hot water tank which initially had been lagged with a rather paltry single insulating jacket. It was to dawn on me that the energy saving of insulating the tank from poor to excellent was of the same order of energy plus achieved from collecting from the entire 4.4 m^2 of solar collectors but with poor tank insulation.

If energy savings are required, then these have to be undertaken by a broad range of methods. To cover the landscape with myriads of windmills, litter the North Atlantic with an armada of wave power modules is not the final solution if the energy is wastefully utilised when it is distributed into the grid.

Having therefore migrated to that low energy refrigerator, installed cavity wall insulation, disabled the air conditioning in the car and been generally mindful of the larger perspective, then the question could be then asked – 'From where can I purchase my green energy?' My local electricity supply company has not contacted me to ask details of the portfolio of sources of power which I would want to draw from – in terms of coal, gas, nuclear and alternative sources where these are available – with the option perhaps of paying more for drawing from a non-polluting source.

I do not even know the current arrangement of energy mix with which I am supplied. Will this change with the impending further deregulation of the power industry? I would rather pay 10% more per year for a greener mix of supply than pay 10% less for the same predictable cocktail of carbon.

The Photovoltaic Potential

Some of the most interesting developments in new concepts about supplying energy come from the most unexpected areas. Earlier this year, BP Solar and Newcastle United football club announced plans to build the world's largest solar powered sports stadium. The 350kW solar project would be an integral part of a new 51,000 seater stadium at St. James's Park. This proposed development comes as part of Newcastle's

Material	Cost per square metre
Stainless steel	£170 – £200
Glass Wall system	£350 – £500
Stone	>£500
Photovoltaics	£700 – £1000

Table 2. Comparisons of cost of facade materials in office developments with current photovoltaic costs.

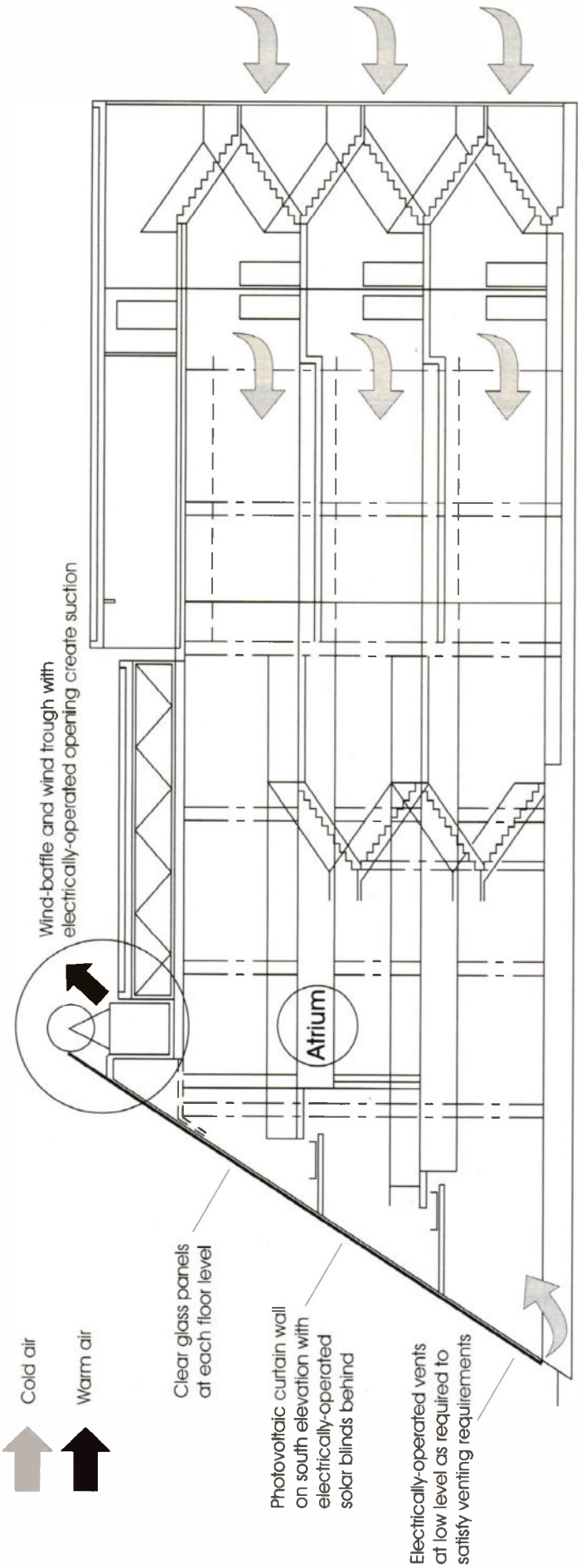


Figure 2. Cross section through Doxford building showing the slope of the solar facade and utilisation of solar energy for air circulation within building. (Courtesy Schuco International).

target of generating 1% of the city's electricity by solar energy by 2010. Total global production of solar photovoltaic arrays is currently around 120MW per year with BP Solar providing around 10% of this figure.

The significance of solar photovoltaic power, however, stems from its potential to be incorporated into the structure of buildings in general. It is estimated that the utilisation of energy in buildings accounts for 50% of the UK's carbon dioxide emissions – around 275 million tonnes. The increased use of computers and air conditioning has tended to introduce a rising trend of electricity demand from this sector which is expected to rise by 15% by the year 2000. However, one study carried out in 1992 estimated that by the year 2020 the UK could have installed 110GW at peak solar insolation.

The attraction in using photovoltaics on building structures relates to the relative ease of incorporating them into both existing buildings and new buildings, and also the good match between energy demand and energy availability. Up to two thirds of the UK's current electricity production could be generated by photovoltaics through wide deployment in homes and offices. While increasingly solar photovoltaics is being taken seriously abroad, in the USA, on the continent, in Japan, there has been much less uptake of the technology in the UK. While this position will ultimately change, and there is some evidence of this, it implies that the commercial edge in planning and installing systems could be captured by foreign companies.

Already outside the UK a significant numbers of companies are selling and installing solar photovoltaics as an off-the-peg product. Also, primarily considered at this stage as a manufacturing/building activity, this will also see the emergence of its attendant service sector as the maintainability of such systems also creates jobs. Major companies already engaged in this area in Europe include Ove Arup and Partners, Schuco and Flagsol – a subsidiary of Pilkingtons. The data in Table 1 relates primarily to European schemes that were in place up to 1995. Since then many more schemes have been developed on the continent.

Some Sunny Numbers

In the northern hemisphere, approximately 900kWh will fall on each square metre of surface. Even in the UK, it is possible to generate 75kWh of electricity per year from each installed square metre of solar panel vertically deployed in a due south orientation and with no shading. This can be increased to 100 units where the collector surface is tilted at 30°. With vertical orientation due west or due east, this would allow generation of around 50% of the output of a facade facing due south.

Many assessments estimate the savings of carbon dioxide produced by solar photovoltaic power production. Typical

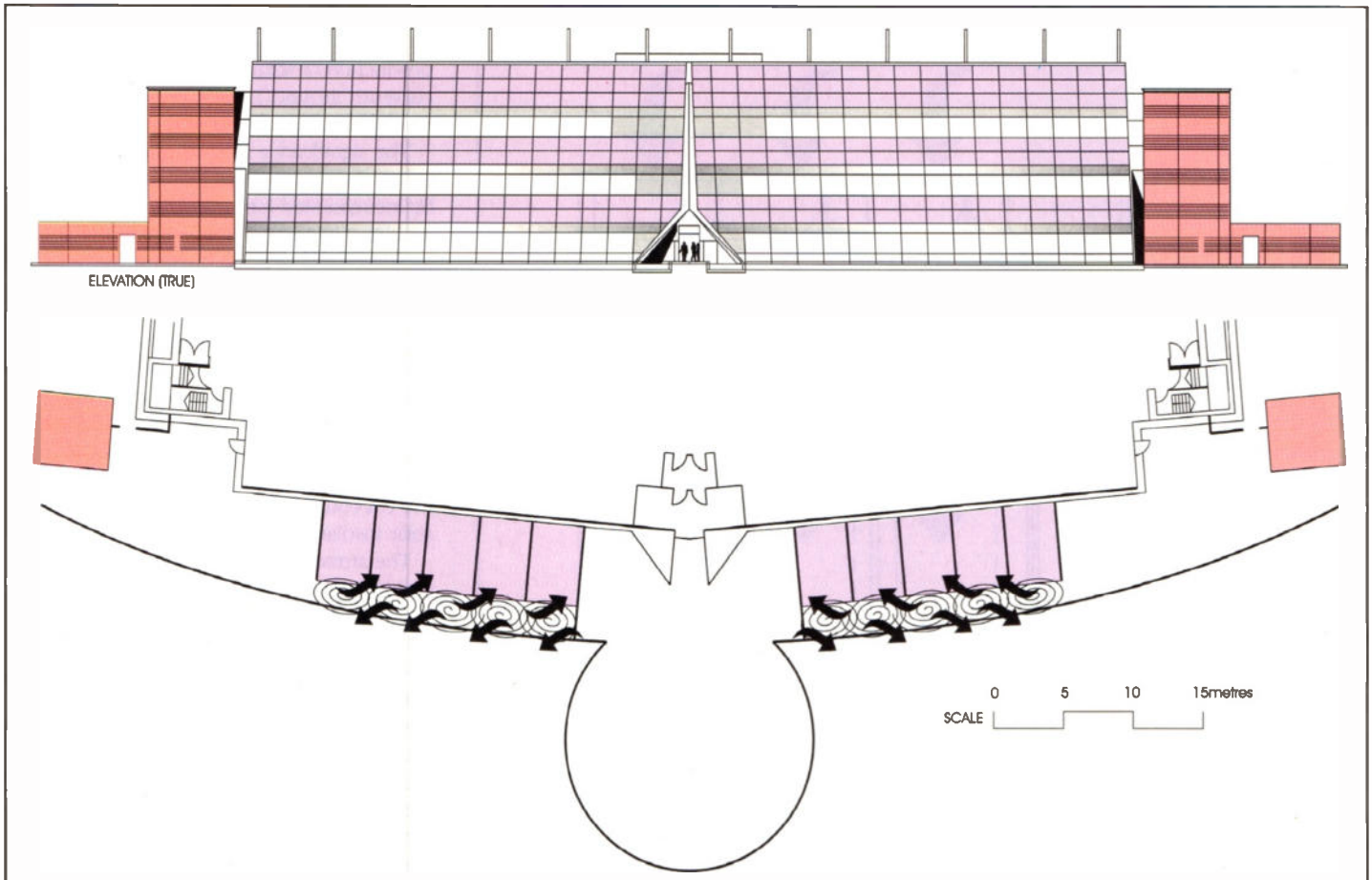


Figure 3. Vertical view of Doxford building showing line of orientation of solar facade (Courtesy Schuco International).

Status	Project	Output power kWp
Completed	Northumberland project	40
Completed	Ford Engine works, Bridgend	107
Completed	Solar Showcase, Birmingham	12
On site	New Campus, Nottingham University	63
On site	Bowater House Flats, West Bromwich	14
In design	Delabole Visitor Centre, Cornwall	65
In design	Newcastle United Football ground	350
In design	Peterborough Visitor centre	20
In design	Sunbury Office development	30

Table 3. Details of Photovoltaic Projects involving Ove Arup and Partners in the UK.

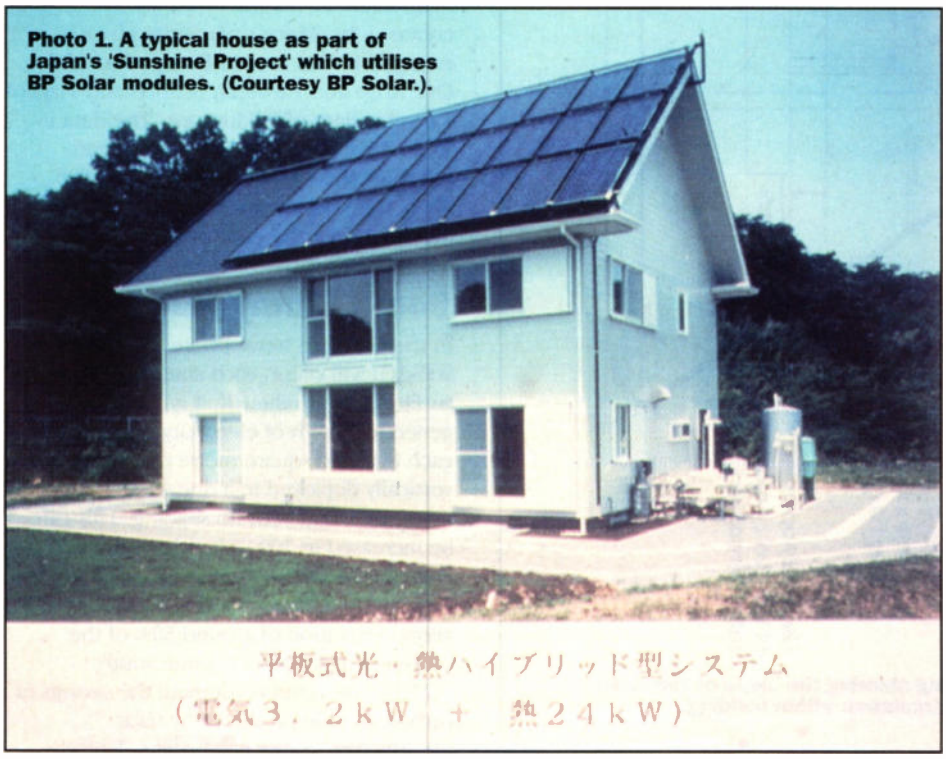


Photo 1. A typical house as part of Japan's 'Sunshine Project' which utilises BP Solar modules. (Courtesy BP Solar.).

figures equate to approximately 1kg of carbon dioxide per kWh, though the precise type of fossil fuel, conversion efficiency, transmission losses etc. from the power station into the distribution grid etc. all are factors to be considered. Some values as low as 0.6kg per kWh are quoted.

An important element of operation of photovoltaics is the requirement for cooling. With a basic temperature of 25°C, a 0.5% power reduction is typical with each 1°C temperature increase as indicated in Figure 1. Is this why the cool north of England climate is good for solar photovoltaic efficiencies? Thus bright sun coupled with high surface temperatures of 50°C to 60°C is not necessarily providing for optimum efficiency conditions. Indeed one of the challenges of photovoltaic implementations is what to do with the unwanted heat energy. Costs, which have to be considered, must be seen as transitional and be the subject of economies of production. Table 2 lists some details of facade material currently used in buildings as price per square metre.

Costs associated with the photovoltaic facades would include electrical connections and associated controls. The factors affecting the overall energy collection include the general orientation, angle to the horizontal and degree of shade from other structures. There is therefore significant effort directed towards increasing the efficiency of the energy capture process and also reduction of cost of photovoltaics to gain the competitive edge. The higher efficiency cells will require a smaller

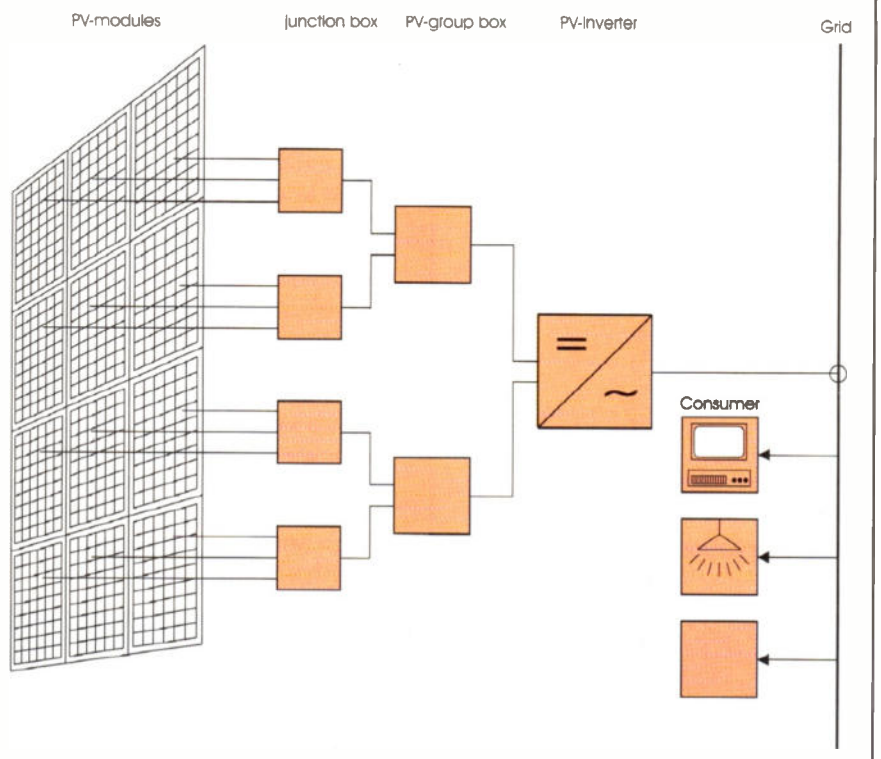


Figure 4. Typical connected structure of photovoltaic system (Courtesy Schuco International).

system is shown in Photo 1. Germany has recently committed considerable investment to solar photovoltaic power.

However, it would appear that generally the electric companies in the UK have misread the aspirations of the general public. In the USA, subscribers can choose to pay additional premiums for being supplied with 'notional' photovoltaic power through the local supply grid. In an article in the Detroit News, one subscriber is reported to be willing to pay an additional $474 per year to access 600W of solar power each month. There is also a waiting list of subscribers to 'take advantage' of such a facility. Could such a scenario happen in the UK? This is looked at in a later section.

In the USA, current costs of photovoltaics are between 30 and 40 cents per kWh – around three to four times more expensive than conventional utility power generation. In many situations, however, photovoltaic modules can supply power more economically in rural areas remote from power grids. New grid connections can attract a cost of $30,000 per mile. The goal of photovoltaic research is to optimise photovoltaic performance, efficiency, stability and cost – with target costs of 10 cents per kWh. It should be noted, however, that utility power costs vary widely across the USA.

collector area which in turn will require less infrastructure support on the building. BP Solar have been highly successful in manufacturing high efficiency photovoltaic panels with efficiencies of around 17%.

Currently, demand for solar photovoltaic modules is running ahead of supply. Increased manufacturing capacity is likely to come on stream over the next year. It would seem, however, that the more easier approach for cost reduction in the short term is a simple scaling up of production of existing processes. The increase in manufacturing capacity using new factories with state-of-the-art production techniques will probably see the cost come down a further 40% in a five year window.

Cost comparisons, however, are misleading. If the damage to health and the environment that arise from combustion of fossil fuels are considered, then the assessment would be different. Over 20,000 people are estimated to die each year from respiratory conditions triggered by atmospheric pollution associated with the burning of all classes of fossil fuels – including the internal combustion engine. The bottom line of our fuel bill could literally be someone else's final line.

Global Responses

While initiatives across the world with photovoltaics are providing the mechanism for interested members of the public to become involved and play their part – this is not yet what is taking place in the UK. Holland, for example, has plans to fund 100,000 solar houses by 2010. In Japan, the 'Sunshine project' aims to have solar panels installed on 70,000 homes by 2005. A typical

Month	Insolation kWh/m²/day	AC Output (kWh)	Inverter Efficiency %
January	0.29	150	77.9
February	1.97	1262	90.1
March	1.0	695	85.6
April	2.29	1658	90.3
May	2.88	2117	90.5
June	3.35	2294	90.4
July	3.03	1976	90.4
August	3.17	2320	90.3
September	2.27	1775	90.7
October	2.35	1794	90.5
November	1.72	1023	89.0
December	0.81	396	84.6
Annual	2.1	17460	88.3

Table 4. Summary of solar generation during 1996 of the Northumberland Building.

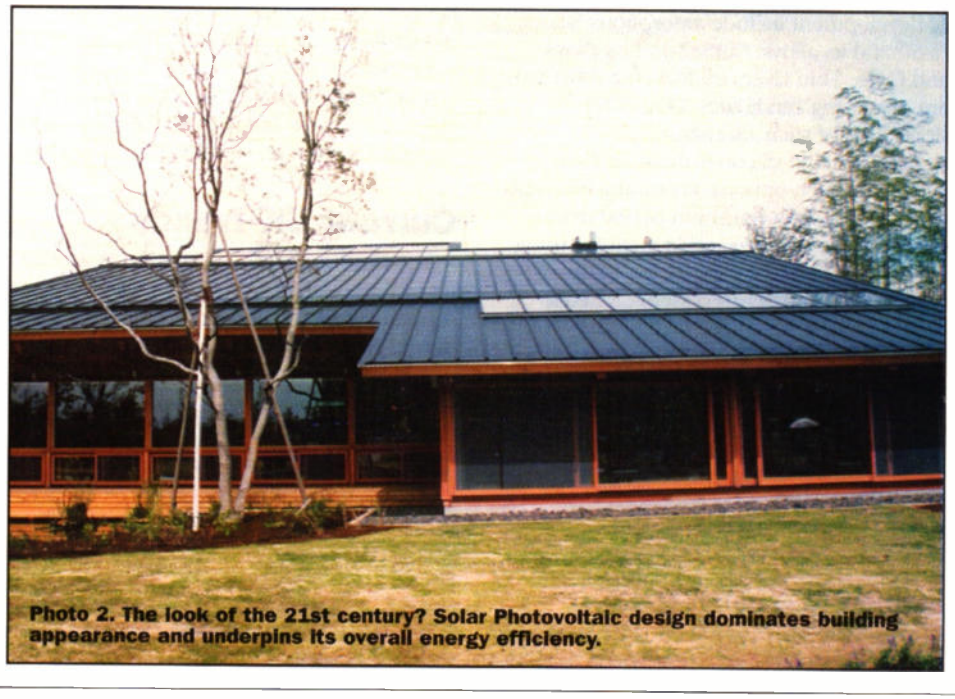


Photo 2. The look of the 21st century? Solar Photovoltaic design dominates building appearance and underpins its overall energy efficiency.

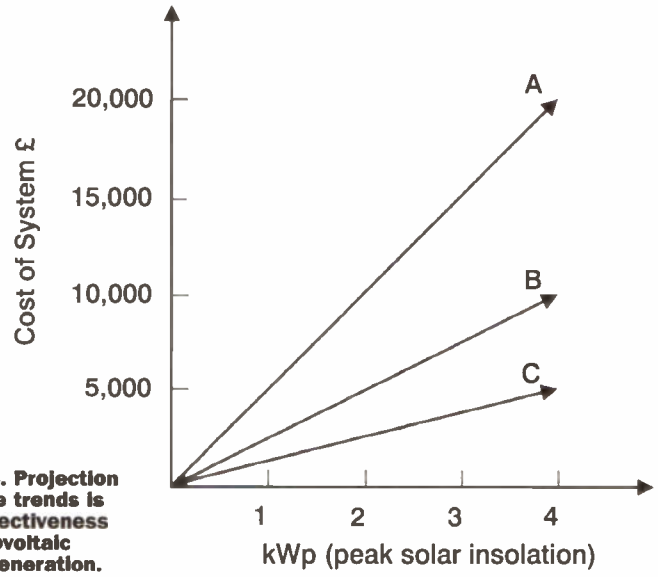


Figure 5. Projection of future trends is cost effectiveness of photovoltaic power generation.

incorporation of photovoltaics within buildings. Also, it tends to be the consulting engineers who can communicate effectively the concept of the utilisation of solar photovoltaics. The article in the recent Arup journal gives, for example, an excellent outline of the state of play. There does now appear to be a higher level of activity in this sector as indicated in Table 3 which outlines some current projects relating to PV installations in the UK undertaken by Ove Arup and Partners.

There is no doubt that over the ages buildings have been used as specific ways of creating an impression. Banks, for example, have been specifically designed to be provide a keynote of stability and continuity of commercial transaction. The image of good environmental credentials by means of environmental responsibility in building design would be a good way to maintain this ethos.

Political Prospects

The recent climate change meeting in Kyoto has finally set some practical goals which Europe has signed up to achieve in relation to stabilising and subsequently reducing carbon dioxide emission levels. In the UK, a government white paper on energy policy is expected to be published soon to include some positive indications for the photovoltaic industry with the expectation of an announcement of schemes to promote the use of photovoltaic technology. If, however, economies invest in cleaner energy sources, this is going to affect the nature of global trade – for energy efficient countries are going to be less likely to buy goods and services from countries which squander energy.

Research Trends

While the technique of monocrystalline silicon production is itself being refined, there has been interest for some time in developing technologies which would reduce cost of installed solar watt. Avenues of development include amorphous Silicon (a-Si) and its alloys, CuISe2 and its alloys and CdTe. Thin layers on low cost substrates are promising candidates. One of the drawbacks of such alternatives to monocrystalline silicon is the long term stability of such options. Promising materials will also require a transition period from initial research to large scale manufacturing production.

BP Solar has recently commissioned a manufacturing facility for CdTe in the USA which is achieving current efficiency levels of around 7% but with expectation that this will soon be raised to 9% and in the longer term 12% to 14%. Such technology is geared up very much to mass production techniques. In relation to this development, BP Solar had initially secured the patent rights to the CdTe technology that had been researched in California about 12 years ago. A pilot production system was subsequently developed in the UK which has since been translated into industrial production in the USA.

Photo 3. The Northumberland Building photovoltaic facade (Courtesy Newcastle Photovoltaics Applications Centre).

Still very much at the research stage, the field of thermovoltaics is seeking to use longer wavelengths of infra red for electrical conversion – using a range of heat sources. It may be possible to improve conversion efficiencies by additionally converting the as yet unused infra red wavelengths of sunlight.

Current UK Trends

In the UK there has been significant activity involving consulting companies such as Ove Arup and partners and Schuco International in relation to feasibility schemes for

An environmental building, incorporating solar photovoltaics will be seen in the future as a useful way of making a statement – a constant slogan as it were. Would staff in a building feel better in what they did knowing that the PC that they were working with was totally, or in part, drawing its power from the sun?

In an age where the image of an organisation is as ever an important facet of corporate success, banks, building societies and the like are actively planning to incorporate photovoltaics in their image for the 21st century.

Area (m^2)	Peak Power kW	Total kWh/yr	kWh cost	Total cost	Cost m^2	Notional customers
27.5	4	2750	0.32	22,000	800	1
250	36	25000	0.31	193,750	775	9
1000	144	100,000	0.26	650,000	650	36
5000	720	500,000	0.24	3,000,000	600	182
10000	1440	1,000,000	0.23	5,750,000	575	364

Table 5. Approximate costings of photovoltaic power and energy production factors for efficiency of 16% and 100kWh per square metre per year energy collection.

The Northumberland Building

The Northumberland Building is in effect a major on-going experiment which is providing vital data for optimising the photovoltaic schemes of the future. Data is extensively monitored at many points within the installed facility. Table 4 indicates data for a specific year, 1996.

There is considerable variation month to month through the year and also for specific months year by year.

The Doxford Project

One project being developed by Schuco International, relates to incorporating 70kW of solar photovoltaic energy in a building on the Doxford International Business Park in Sunderland. What makes this an interesting development is the fact that it is a speculative building development, with no pre-assigned purchaser.

The base energy requirement of the building of 85kWh/m²/year for its 4,600m² represents also a 'lean' energy building. Typically air conditioned buildings can require as much as 400kWh/m²/year. Such a project is characterised by an alteration in building design perspectives. Figure 2 indicates a section across the building. The photovoltaic array is incorporated into the facade of the building, with the panels facing approximately due south and inclined at 60° to the horizontal. The facade also includes some semi transparent modules to the back of which are attached electrically controlled blinds.

The vertical plan of the building is shown in Figure 3, indicating how the two sides of the facade are offset from each other by a few degrees. The overall design of the building is focused on the general reduction of requirement for air conditioning and controlled ventilation so that the solar facade compliments the other energy saving features within the building so that the solar facility makes a good contribution to the total energy need of the building. It is estimated that the building will provide around 30% of its energy requirement using its photovoltaic system. Presumably, also, after hours and at weekends in periods of good sunlight, the facility has the ability to export power to the grid. Compared to an air conditioned building with an energy demand of 400kWh/m²/year, the new building with solar facility will only require some 15% of this rated value – a saving of around 1500 tonnes of carbon dioxide per year relative to the energy guzzling building.

In such a project, therefore, in order to reduce carbon dioxide emissions, the photovoltaic facade is incorporated as part of a lower energy building requirement. Using design elements of the building, it is estimated will save £55,000 per year in power bills and reduce emission of 376 tonnes of carbon dioxide per year relative to the base line energy requirements of the 'lean energy' building. Assistance was obtained for the project from European Regional Development funds. The appearance of the project is quite different from its neighbouring buildings which have not been planned for solar conservation. As and when such designs are more common, the architecture of the world will subtly change, as was consequential with the invention of the passenger lift by Elisha Graves Otis at the end of the last century.

Figure 4 shows the typical connected structure of a photovoltaic system. Each individual module will comprise around 100 solar cells (Schuco system). To increase voltage, multiple rows of modules can be connected in series to form a chord. Also, current can be increased by connecting in parallel. The role of the PV distributor is to co-ordinate the inclusion/exclusion of chords. The connection pattern can, if required, be dynamically adjusted to optimise power efficiency levels. The PV relay rectifier completes the conversion to alternating current to drive the building's electrical demand or export to the grid if surplus power is being generated.

Models of Cost

Table 5 seeks to summarise some basic costing information in relation to photovoltaic systems with a basic 16% efficiency and with an ability to collect 100 kWh per year – indicating high quality efficient collectors. The cost per square metre of installation is approximately equally split between the cost of the actual photovoltaic modules and that of the balance of system costs. As the area of the installation increases, the cost per square metre is assumed to fall. A 'notional' domestic customer is assumed to require a peak supply of 4kW.

A large installation with 10,000 square metres could meet the yearly average needs of 364 customers with an annual demand of 2570kWh of electricity. This is in terms of overall energy demand averaged over the year, but peak demands in winter would probably not be able to be offset using such a facility.

If a notional 10% of an average customer's supply was purchased from the solar facility, this would resource the requirements of around 3500 average domestic clients. The additional annual cost of this electricity would be around £45.00 per year or less than £4.00 per month. For simplicity VAT has been ignored in these calculations. This model is acting to reduce the carbon dioxide emission of the set of supplies by a nominal amount per customer.

Such schemes would perhaps have an intermediate role in providing considerable momentum to lowering production costs and speed up the implementation of photovoltaic systems. As a business venture in its own right, it does not necessarily need to be a power company that implements the concept. This is a very oversimplified business analysis perhaps which ignores the cost of the money for the investment.

Alternatively a co-operative of 3500 customers could raise the finance by each providing £1643 – provided that a utility company would purchase all of the electricity produced by the facility. While it can be argued that it is really asking a lot for someone to spend £20,000 equipping a solar roof for a house, it is however, entirely within the financial means of increasing numbers of people. There could also be scope for cost reduction for a do-it-yourself installation. In the short term the priority is to increase production and reduce the cost of photovoltaics so that it becomes a more affordable attribute of building design. Figure 5 shows line A, where we are essentially now in the UK, line B where we could be in 3/4 years time and line C where we could be in 6/7 years time. The speed of the rate of transition of modes A to C will determine how soon photovoltaics will begin to take off and eventually begin to reduce our greenhouse gas emissions.

Summary

The impression is obtained, however, that for all the technological advances that have been made, they have all suffered from a lack of their control. Could the 21st century be about an age when common sense and a desire to live a more sustainable existence will gain the upper hand through some amazingly simple financial incentives? I do hope so. The question really is less about technology and more about 'doability'. An Englishman's house may be his castle but it is not yet the world's salvation.

Further Reading

Performance studies of the 39.5kWp Northumberland building photovoltic facade, NM Pearsall, KM Hynes and R Hill, Proceedings, Northsun, 97, Espoo, Finland, 1997

Energy Efficiency Office (1989-1992) Energy efficiency in offices: Good practice case studies, UK Department of Energy.

Points of Contact

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BP Solar, PO Box 191, Chertsey Road, Sunbury-on Thames, Middlesex, TW16 7XA, UK. Tel: 01932 779543, Fax: 01932 762533

Intersolar Group Ltd., 2 Cock Lane, High Wycombe, Bucks, HP13 7DE. Tel: 01494 452945, Fax: 01494 437045

Sandia National Laboratories, Photovoltaic Systems Divisions, PO Box 5800, Albuquerque, NM 87185-0753, USA.

RESEARCH NEWS

by Dr. Chris Lavers

Advances in Solar Energy Systems

With the increasing emphasis upon 'green technologies' within western industrialised nations, progress in the area of solar power has been welcomed by governments trying to comply with legislation on CO_2 emissions from traditional energy sources such as: coal, natural gas and oil. The UK government has only recently announced a new initiative to make more extensive use of renewable energy sources. However, it is fair to say that it is the developing industrial nations of the world – and at remote locations within those countries- that have the greatest benefits to be gained by the use of solar power.

Current photovoltaic cells absorb visible light within 2-3mm thick silicon wafers. Cell thickness is important as device efficiency falls off significantly if the cell is too thin. Silicon elements are made by doping the top layer n-type and the rear layer doped p-type. Metallisation to provide electrodes is applied to the two surfaces. Cell response as a function of solar wavelength is critical, most available materials usually have a very poor response between 450-600nm, which is where the solar spectrum is at its maximum. In addition amorphous silicon (a-Si) cuts off at only 700nm. In order to improve device responses multijunction cells are being developed with layers which are sensitive in selective parts of the solar spectrum. Researchers in Japan have developed a small multijunction of GInP/GaAs which has a very high efficiency.

Dr Chris Hebling and co-workers at the Fraunhofer Institute for Solar Energy Systems in Freiburg (FISE), Germany have developed a revolutionary fabrication process for solar cells which replaces conventional wet etching. Applying this dry solar cell technology conversion efficiencies of up to 11% have already been obtained. Cost-effective solar cells are prepared using low-cost graphite encapsulated substrates covered with conducting SiC. The graphite substrate acts as the base contact of the cell, while the encapsulation of the graphite with insulating SiC and SiO_2 /SiN/SiO_2 -layers creates thin-film solar cells on insulating substrates. Crystalline silicon thin-film solar cells on low-cost substrates are the most promising and challenging approach to reducing the costs of photovoltaic cells. The active silicon layer has to be deposited at high temperatures, the substrate and layers therefore have to withstand up to at least 1200°C. High temperature glasses are pure but very expensive; the most suitable substrates would be ceramics or graphite, which satisfy the demands for thermal and chemical resistivity as well as low-cost. However, problems arise from their porosity and the content of impurities, making conventional wet-processing difficult or even impossible. One way out of this problem is to encapsulate the substrate with one or more layers, e.g. oxides, nitrides or even silicon, serving as diffusion barriers and leading to a chemically tight and inert protective cover. The best way to avoid problems arising from porous substrates soaked with chemicals is to avoid any wet chemical treatment. At Fraunhofer, Christopher Hebling has developed dry-chemical technologies that use low temperature processing of crystalline thin-film solar cells on low-cost porous substrates.

Graphite substrates are encapsulated with insulating SiC to suppress diffusion of impurities out of the graphite. Next a conducting SiC-layer was deposited providing electrical contact to the graphite. A 40μm Si-layer is then deposited. The active silicon films are about 5-30μm thick. After a plasma cleaning step the emitter was formed by $POCl_3$ – diffusion at 820°C. Phosphorus glass is then etched by Reactive Ion Etching and a photolithographic mask applied. After etching samples are plasma treated. A double layer followed the p-type contact (see Figure 1). This simple design led to a confirmed world record efficiency for this type of device of 11% Figure 2, Figure 3 shows multiple cells on the same substrate (efficiency 9.3%) A ceramic system is also under construction. See Photo 1.

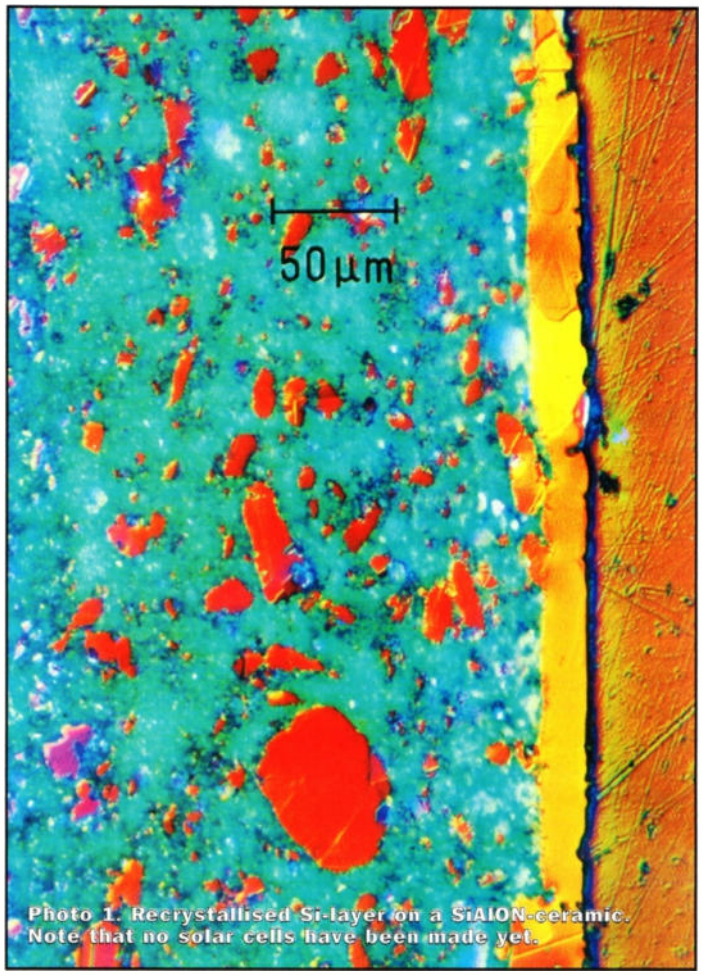

Photo 1. Recrystallised Si-layer on a SiAlON-ceramic. Note that no solar cells have been made yet.

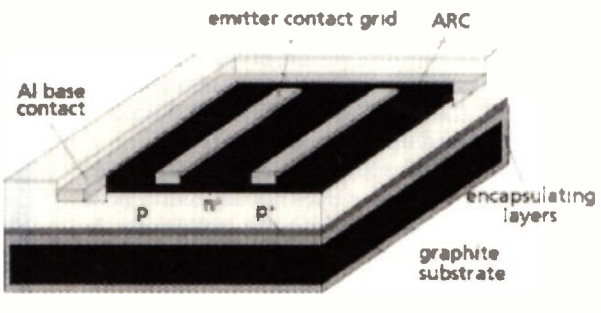

Figure 1. Structure of the thin-film solar cells on conducting graphite/SiC substrates.

Rapid advances in organic photosensitive materials also offer new device hopes. US chemists have just created a molecule that mimics nature's ability to convert light into a form of energy that plants can use to make sugars. In photosynthesis chlorophyll molecules link together to form large arrays of several hundred molecules. Within each chlorophyll molecule a large disc-shaped porphyrin group absorbs photons of light. Porphyrins are water-soluble nitrogen-containing pigments, consisting of four groups joined in a ring structure, occurring

Figure 2. Solar cell on SiC-coated graphite substrate, efficiency 11%.

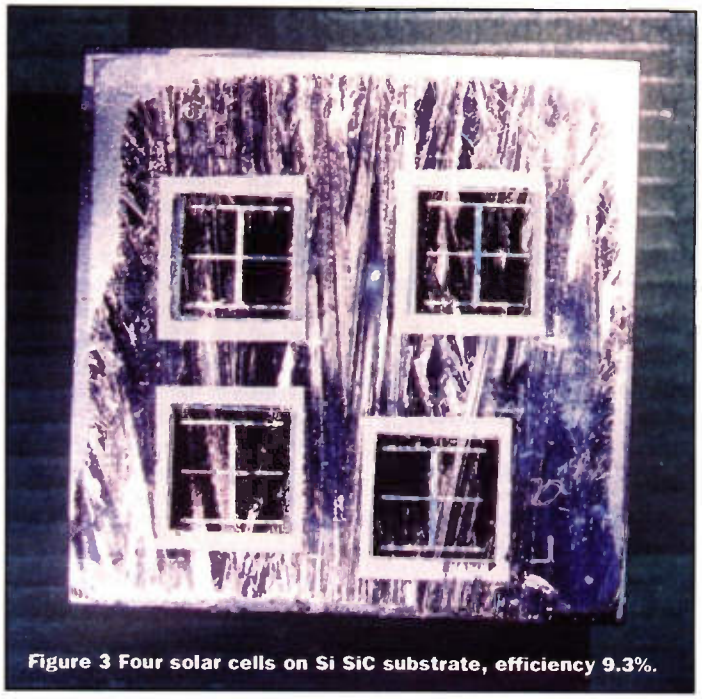

Figure 3 Four solar cells on Si SiC substrate, efficiency 9.3%.

widely in nature. Combinations of porphyrins with metal ions include chlorophyll and hemoglobin. As a consequence an electron is excited to a higher energy level, and the excitation energy will transfer molecule by molecule to the arrays' reaction site. At the reaction site the energy transported causes a final charge transfer process, producing sugar from carbon dioxide and water. Ken Suslick at the University of Illinois believes his synthetic organic based material may create photocells that are twice as efficient as present solar panels which are only about 15% efficient.

Further advances at FISE has lead to the development of a cooling system which uses heat from solar collectors. A prototype solar air-conditioning system suitable for office buildings in hot climatic zones has been built. In the first industrial demonstration project, solar cooling will be applied to provide air-conditioning for 350m² office area in Portugal. The new technology will improve working conditions and is beneficial to the global climate: there is no danger of coolants contaminating the earth's stratosphere and it reduces peak electricity demands over midday.

Ambient air is dried with a desiccant, and cools by water evaporation which is added to it. The drier the air before humidification, the better the whole process operates. As a desiccant the Freiburg scientists use silica gel, well-known for its water absorbing properties, and removes moisture from the air by accumulating water in its own molecular structure- until it is completely soaked like a wet sponge. The silica gel may be regenerated by heating, so that it can then adsorb water again.

The driving force for the solar air-conditioning unit is low-temperature heat from solar collectors at 80°C. Large storage tanks are not needed, because the solar energy supply and the cooling demand coincide. "We want to demonstrate that most of the air-conditioning for office buildings can be achieved with solar energy", explained Dr Hans-Martin Henning, the project leader at Fraunhofer. "In Mediterranean countries, these systems are already nearly economically viable today. Systems which cool in summer and use the heat released during

Figure 4. Light in the darkness- modelling the light pipes for an underground station at Potsdamer Platz in Berlin. Computer visualisation (commissioned by ITEG, Hallbermoos).

Picture Credits: Courtesy of Fraunhofer Institut Solare Energiesysteme.

drying for heating in winter are particularly attractive."

An office of Atecnic, an air-conditioning unit manufacturer near Lisbon, is to be renovated in the first industrial project. The FISE researchers have designed the system, while the Portuguese research institute, INETI, will be responsible for measurements and monitoring some 60m² of solar collectors sufficient to provide air-conditioning for the office area, and will also support heating in winter. The environmentally friendly technology is intended to replace electric-powered window air-conditioning units in the long term. The EU is subsidising the project with 40% of the costs.

Solar power is also able to provide relatively cheap seawater desalination in island communities such as the Canary Islands. A project just started in collaboration with Fraunhofer will trial a system to provide 1000 litres of fresh water per day. The aim of the project is to halve costs compared with other solar powered systems having similar daily capacities. Water prices of 25 ECU m^{-3} should be achieved. Physicist Matthias Rommel at FISE aims to achieve this by using a new polymer solar absorber. "For a collector to work well, first the absorber must absorb the highest possible amount of solar radiation, and then it must transfer the heat to the water. This demands a special coating, and good heat transport, compared to metals. Polymers usually suffer from two disadvantages: the selective coating cannot be applied easily and the thermal conductivity of polymers is about a thousand times lower. A new construction where water flows through the whole absorber unit overcomes this problem, and the problem of selective coating has been solved by a special sputtering process."

Fraunhofer is also helping with the revolutionary design of 21st Century lightpipe illumination for the new underground station at Potsdamer Platz in Berlin, see Figure 4. Lightpipe illumination may provide novel power saving measures within confined spaces.

Further solar powered device design is moving into the area of 'bionic' and biological devices. Recent research by Dr Devens Gust and colleagues at Arizona State University *(Nature vol 392. p479)* is on the threshold of developing simplified cells that convert light into biological energy. Gust has synthesised cellular factories which mimic the harvesting of solar energy by plants, a kind of 'bionic' photosynthetic power cell which combines biological and synthetic components. The cell uses light to make ATP, a high-energy compound all organisms use in respiration to fuel their metabolism. The system uses microscopic spheres made of oily membranes, which act as artificial cells. When illuminated, and with a simple chemical implanted in the membrane, an electric charge is created that pumps protons into the cells. Accumulating protons into the membrane creates a source of potential energy. Energetic protons escape from the cells, pass through a membrane converting energy into the building of ATP molecules. The artificial portion of the power cells is about 235 times smaller and simpler than its biological protein equivalent. Device size is also shrinking continuously with a Dutch team recently announcing that it has succeeded to make films of semi-conducting particles one molecule thick. Such films are being developed in order to design ultra-thin photovoltaic solar cells and light sensors. Arend Schouten and co-workers at Groningen University in Holland have made molecular films with water-soluble ends which bind to semi-conducting particles and thin films of semi-conducting particles which may be lifted onto a glass plate and sandwiched against another film. A semiconductor film made in this way may act as a photovoltaic cell. Such microscopic designer cells may have an important part in future solar energy device design for a wide-variety of device applications if light conversion efficiencies match up in practice with popular expectations.

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Space Station Lifeboat Flies Through First Test

The development of the X-38, a new spacecraft designed for use as the future International Space Station emergency crew return 'lifeboat', recently passed a major milestone with a successful first unpiloted flight test. The first X-38 atmospheric test vehicle was dropped from under the wing of NASA's B-52 aircraft at Dryden Flight Research Centre, Edwards Air Force Base, California, and completed its descent from 23,000 feet in 38 minutes.

"This was a real experimental flight test and the culmination of two years of hard work by a team from Johnson Space Centre and Dryden Flight Research Centre," X-38 project manager John Muratore said. "We had done everything we could to minimise the unknowns. But the real proof of the concept is a successful flight. We got one of those now, and we plan to do this about 20 more times over the next two years to prove we're ready to fly from space."

Atmospheric drop tests of the X-38 will continue using three increasingly complex test vehicles. The drop tests will increase to an altitude of 50,000 feet and include longer flight times for the craft prior to deployment of the descent parafoil (Photo 2). In 2000, an unpiloted space test vehicle is planned to be deployed from a Space Shuttle and descend to a landing. The X-38 crew return vehicle is targeted to begin operations aboard the International Space Station in 2003.

Once operational, the X-38 will become the first new human spacecraft designed to return humans from orbit and is being developed at a fraction of the cost of past human space vehicles. The primary application of the new spacecraft would be as an International Space Station 'lifeboat', but the project also aims at developing a version easily modified for other uses, such as a possible joint US and International human spacecraft that could be launched on expendable rockets as well as the Space Shuttle. The European space agency is co-operating with NASA in the current development work, supplying several components for the planned space test vehicle. The X-38 is being developed with a determined drive towards efficiency; the project takes advantage of available off-the-shelf parts already accounting for as much as 80% of the spacecraft's overall design systems.

Forthcoming Electronics and Electronics related conferences

A one day free Environmental Control and Monitoring Network seminar on Instrument Miniaturisation will take place on the 9th of December 1998 at UMIST, Manchester. For further details ring 0161 200 8908 or Fax 0161 236 0409.

CMMP '98, the Annual Physics Conference will be held at UMIST Manchester between the 21st-23rd of December 1998. For more information contact: The Institute of Physics, 76 Portland Place London or telephone 0171 470 4800.

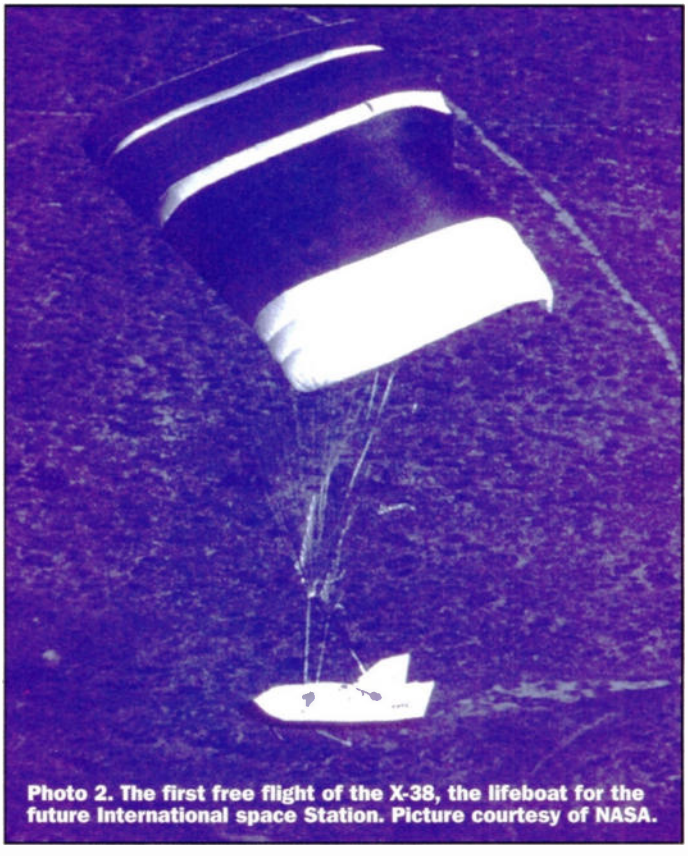


Photo 2. The first free flight of the X-38, the lifeboat for the future International space Station. Picture courtesy of NASA.

PROJECT

Red LED MESSAGE DISPLAY

PROJECT RATING 2

John Mosely constructs and evaluates this new Velleman Kit.

Maplin is now the sole U.K. distributor for Velleman Kits, and each month we will be looking at one of their kits. We gave away free in last months issue of *Electronics and Beyond*, a copy of their latest catalogue, and this month we will look at their Message Display Kit, model K5600R.

The Velleman LED Message Display features 12 independent characters, each arranged in a 7 x 5 LED matrix, and can be used to produce numerous visual effects – scrolling, blinking, rolling, panning etc. The speed of the effects is adjustable, and displays can be cascaded together to produce larger messages. The display is controlled by a pre-programmed PIC16C54A. Twelve output lines are used to drive the characters, via seven transistors (BC547B) for each character – every transistor drives a row of five LEDs. The circuit diagram is shown in Figure 1. The display requires a 12 to 28V DC supply, and there is an on-board 5V regulator that supplies the microprocessor. A 555 is used as a local oscillator, which is variable, to set the speed of the effects.

Velleman use only top quality components and that goes for the PCB, which in this kit is large! – 80 x 473mm. So do take care when handling the board not to damage it.

Although in theory there are spaces for 420 LEDs (7 x 5 x 12 characters), the kit is supplied with only 150 bright red LEDs. This was more than enough for the message chosen during construction, – *Maplin Plc* plus 'star' at either end – which resulted in just one blank character. The supplied manual shows the suggested numerous character LED configurations, and includes upper and lower case letters plus numerals, stars, arrows etc, plus double size bold characters for displays that will really stand-out. It is worth planning out your message beforehand using the blank LED layouts included in the manual for guidance. This will ensure that you know the total number of LEDs required, and if additional LEDs are needed then these can be bought from Maplin. The unit can be mounted either horizontally or vertically, so you can certainly be imaginative if you choose to construct more than one. Also, I would advise a message that you intend to live with, as changing the characters at a later date will be very difficult as you are required to place an LED or link in every position, and remember there are 420 of them!

Please do not be put off by this amount of soldering, as all it requires is a little patience, I took four nights working for about two to three hours per night to complete construction, and I believe that the end result was worth the effort.

SPECIFICATION

12 characters in a 5 x 7 LED array
Bright LEDs 60 to 80mcd
Reverse polarity protected
Powered from 12V to 28V DC 760mA supply
80 x 473mm dimensions
Adjustable speed of display
Pre-programmed microprocessor controlled effects
Vertical or horizontal position possible

Construction

Construction is very straight forward, and should commence with smaller items first. The resistors and diodes are supplied on a bandoleer that also includes many pieces of straight wire. This is not a mistake! You will need these for the many links that you will inevitably have to solder in – remember for every unused LED position requires a link. I would strongly urge all would-be constructors to retain all excess wire cut from resistors etc. to use as possible links.

Care should be taken at all times when placing components as there are a considerable number of them to solder in – 85 transistors, 103 resistors, 25 diodes, plus I would suggest, well over 100 LEDs, and a similar number, if not more, of wire links. It is easy to lose concentration when you are soldering such a large number of components, and an LED or diode can very easily be inserted the wrong way.

The two DIL ICs are supplied with suitable mounting sockets so that the last two components to be inserted are the ICs.

Next to the PIC DIL holder is a link which if left out will allow the display to go through its pre-programmed effects. If the link is inserted then the display is on permanently. You may prefer to fit a remote single-pole switch across this position to provide a choice if required.

Testing

The display requires a 12V to 28V 800mA supply, and I used a regulated variable mains adaptor (VN10L) set to 12V, which works perfectly well with the unit. If you were using considerably more LEDs then

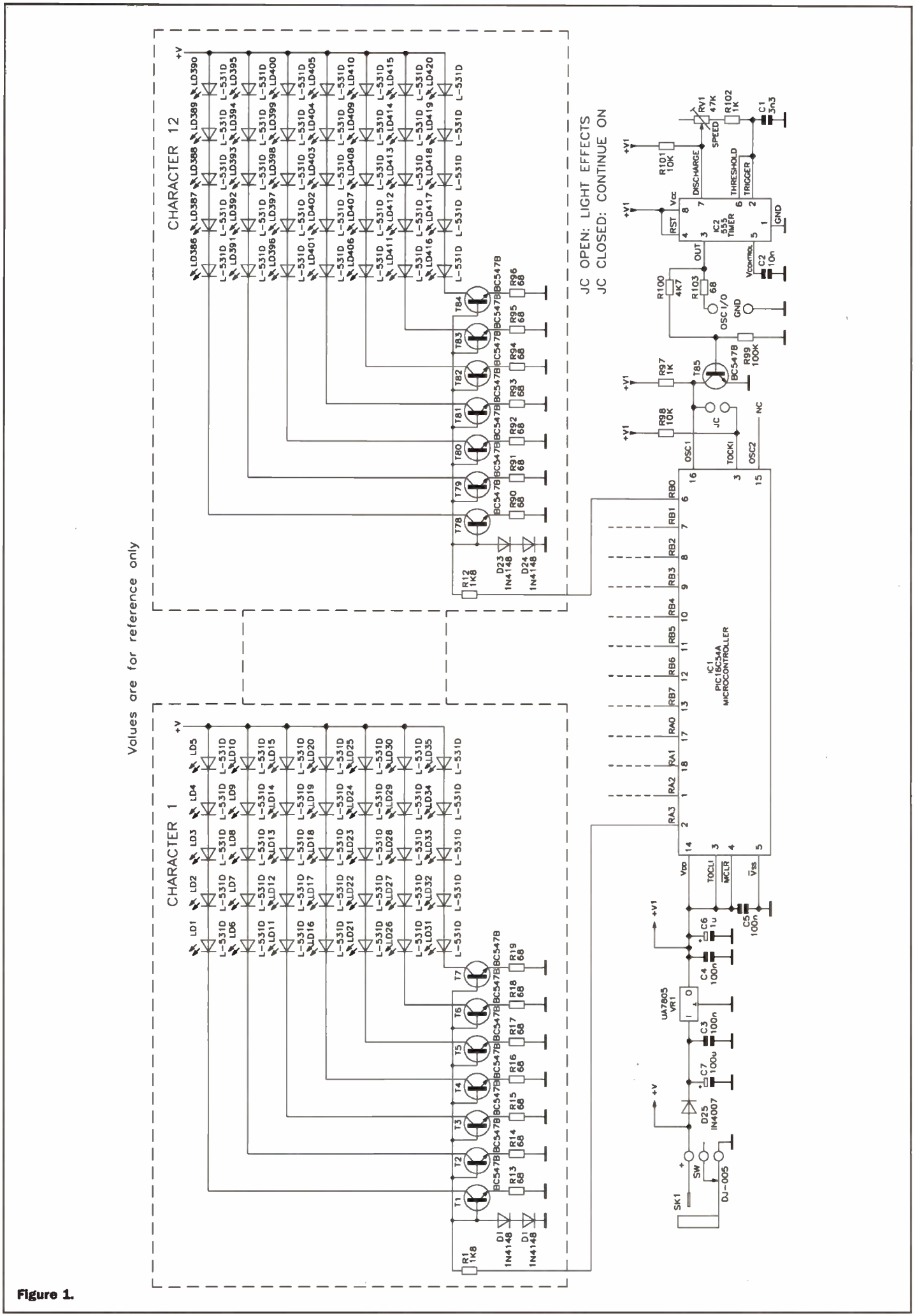

CHARACTER 12
CHARACTER 1
JC OPEN: LIGHT EFFECTS
JC CLOSED: CONTINUE ON
Values are for reference only
IC1
PIC16C54A
MICROCONTROLLER
IC2
555
TIMER
UA7805
VR1
SK1
SW
DJ-005
D25
IN4007
SPEED
DISCHARGE
THRESHOLD
TRIGGER
OSC1/O
JC
TOCKI
OSC1
OSC2
MCLR
Vcontrol
GND
NC

Figure 1.

JC93B might be a better choice rated at 12V 1.5A. These displays come with a reasonable length of connecting cable to allow the display to be mounted high, which is probably the most likely final position.

There is no setting up, and if you have left the link out by the PIC DIL holder then the display should work – if all is correct. I put two pieces of wire into this position which allowed me to twist them together to put the display on permanently. This will help to check that all the LEDs light up. If you are missing one, or a complete row, then check for dry joints and/or that all the LEDs are in the correct way round. The board legend is marked with the corresponding flat that is a feature of the supplied LED. This will help considerably with orientation. The transistors should all be inserted correctly as the legs are in a triangle shape and would be very difficult to insert wrong. If all is correct, then remove the link and sit back and watch your message.

A small preset pot on the right of the PCB adjusts the speed of the effects, and I personally preferred a slow rate. Next to this pot are points for providing oscillator input/output to synchronise more than one display. If it is intended that more than one display is used to produce a message, then one becomes a master and the others are slaved to it. The master is the only one fitted with IC2 the 555 timer, all the other boards have this timer IC left out.

The LEDs have a light output in the 60 to 80mcd range so produce a very bright visible display that can easily be seen in daylight, and in an office, shop or work room, the effects certainly catch the eye. As the display works from a 12V DC supply it can obviously be used from a car battery for use at outdoor sites for advertising such as mobile catering etc.

Conclusion

Although there was a lot of soldering involved it was certainly worth the effort. The display has been working for several days now and has worked faultlessly. The kit can also be bought with green LEDs, which leads to the possibility of having a large message display, made from two different coloured LED display panels. You could if you wish, alternate coloured characters within one display, and produce some interesting effects.

I was surprised at the cost of the kit, just £49.99 including VAT, which I believe to be excellent value. A special housing is available that includes a filter screen that will give the project a professional finish. ELECTRONICS

PROJECT PARTS LIST

RESISTORS (0.25W, unless otherwise stated)		
R1 – 12	1k8	12 off
R13 – 96,103	68R	84 off
R97,102	1k	1 off
R98,101	10k	2 off
R99	100k	1 off
R100	4k7	1 off
RV1	47k	1 off
CAPACITORS		
C1	3n3F	1 off
C2	10nF	1 off
C3,4,5	100nF	3 off
SEMICONDUCTORS		
D1 – 24	1N4148	24 off
D25	1N4001	1 off
T1 – 85	BC547	85 off
IC1	VK5600 Pre-programmed PIC16C54A	1 off
IC2	555 timer	1 off
VR1	7805 5V regulator	1 off
LD1 to LDxx	5mm Red LED	150 supplied
MISCELLANEOUS		
SK1	DC connector	1 off
	SPST Toggle Switch	If reqd FH97F

Order Codes

Red LED version	VY37S	£49.99
Green LED version	VY38R	£49.99
Housing	VY62S	£19.98
Additional red LEDs	CZ38R	51p (70mcd)
	UK19V	33p (150mcd)
Additional green LEDs	CX40T	40p (50mcd)
Power supply 12V 1.2A	VN10L	£13.99
Power Supply 12V 1.5A	JC93B	£22.99

REVIEW

iCU iMAC, i WANT 1

Apple's latest personal computer could be the apple of our eyes. Keith Brindley reviews it.

Apple has always been a significant force in personal computing. Its first mass-produced personal computer, the Apple II, led the field for several years, before its second mass-market machine, the Macintosh, took computing to new heights of usability. In 1985 though, Apple's original leader Steve Jobs was ousted in a boardroom coup and the situation changed. The ten following years of lacklustre management saw many of the Mac's advantages wain to PCs bundled with Windows. Few innovations – and certainly none the scale of the original Mac – came from the company. A rising financial crisis caused by three years of losses means the company was on the brink of collapse. The situation worsened so much that, this time last year, Apple was, for many observers, all but written off in the personal computing world.

But things change rapidly in this industry of personal computing and, by a strange quirk of fate, Steve Jobs has come back to lead Apple once again. In the year since, Apple is once again in profit, and new innovative developments point the way forward.

Take the iMac. A personal computer so powerful Apple claims it outperforms many ordinary PCs twice the price. A stylish translucent blue (Bondi blue, to be precise) and clear cabinet houses a high quality 15 inch monitor, small but adequate speakers with an enhanced stereo sound system, together with all the computer gubbins – no need for multiple monstrous beige boxes here. To cap it all there's a single handle to carry the whole kaboodle from room to room. Neat, cute, retro-styled, compact – call it what you will – you have to see the iMac to appreciate it. Almost everyone who sees one for the first time wants to touch it, to feel its texture, to operate its small but perfectly formed keyboard, to move its circular mouse. This is no ordinary computer.

Style, though isn't everything – PCs are a commodity item these days, and cost is a vital component. The iMac's street price of £999 will turn a few heads for sure because, while it's not the cheapest personal computer around, it's certainly one of the highest specified and performing machines in its range. Technically, at the heart of the iMac is a 233MHz G3 PowerPC microprocessor. While this doesn't have an operating cycle rate as high as the fastest Intel-based personal computers you have to remember that PowerPC processors are RISC-based

(reduced instruction set computing) devices, and Intel processors (of whatever category; Pentium, Pentium II, Celeron and so on) are CISC-based (complex instruction set computing) devices that are significantly less economical. As a result, a 233MHz G3 PowerPC is the equivalent of a significantly higher clocked Pentium. Apple, in its own tests, rates the iMac's chip as more than twice as fast as a 266MHz Pentium, saying it even outperforms 400MHz Pentiums in high-end PCs. Of course, technical tests aren't always applicable as there's a lot more to a computer than that. In the real world it usually all boils down to how the operating system works in combination with the hardware. In our test the iMac certainly flew past a 266MHz Pentium II running Windows 98, using similar applications and performing similar tasks. The iMac takes a step forward in connectivity, using only the universal serial bus (USB) present in most PCs available for the last year or so, which allows up to 127 USB devices to be connected to a single computer. Unlike those PCs though, the iMac shuns all other serial and parallel ports. This has a couple of implications. First, not many USB devices are yet available from third-party manufacturers — the notable exceptions being a few printers, scanners, digital cameras and external cartridge drive devices (more of which later). The second implication is that existing devices can't be used directly (although there are third-party USB-to-serial adaptors which allow existing products to be used with USB). Over the coming months there'll be many more USB devices on the market, driven by the iMac as well as other computer USB needs.

However, there is another omission from the iMac's design that might raise a few eyebrows — there is no floppy drive. Apple says that the floppy is dead, hence dropping it from the iMac merely proves it is a future-looking computer. People's requirements for external storage mean that floppies simply can't cope, and external cartridges are usually preferred. A product like Imation's SuperDisk drive (which is a USB device that holds 120Mb of data on a single cartridge — and can read and write a conventional floppy) fits the bill better than a mere floppy drive. Any software worth its salt these days is installed from CD-ROM, simply because the floppy doesn't hold enough data to make it a viable application medium. The iMac's network connectivity (an automatically sensed 10/100BaseT ethernet port, along with its 56K modem) means that files can be most rapidly be transmitted by wire, rendering the floppy pointless. Also, in the classroom or business, lack of a floppy insures against viruses from infected disks. But, be that as it may, most personal computer users still use a floppy for transferring occasional small files. So, while the floppy is definitely dying – which even the most die-hard floppy user has to admit – it's not yet quite dead and iMac users may find an external device like the SuperDisk a requirement for the time being. Lack of a floppy drive hasn't prevented the iMac selling mind you. In the first six weeks of its being on sale some 250,000 iMacs had been sold, and estimates of 1,000,000 iMacs sold by the year's end seem reachable, making it certainly their most successful machine, and – quite possibly, if sales continue in this vein – the world's best-selling personal computer ever.

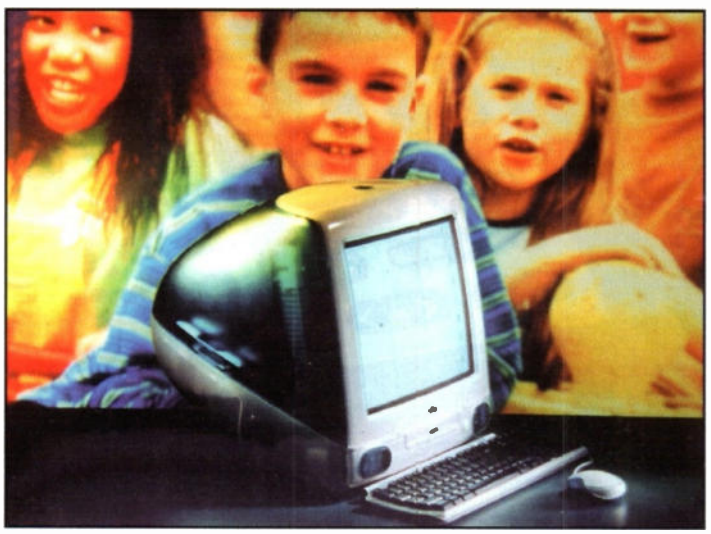
Using the iMac is a dream. When the iMac was launched the TV ad announced that there were three easy steps to the Internet. One – so the ad said – take the iMac out of its box. Two, plug it in. And three 'ha,ha' there is no step three! Using the iMac really is that simple. The MacOS Setup Assistant guides you through initial computer setup naming the iMac and linking it to any network and printer, automatically leading to the Internet Setup Assistant which does the same for your Internet connection. In our test, from turning the iMac on it took, quite literally, six minutes to surfing the Internet. In this process we connected the iMac to an existing Internet service provider account, but the Internet Setup Assistant process just as easily caters for new Internet users who can create and use a new Internet account with one of several Internet service providers.

The iMac is a Macintosh – albeit a highly stylish one – and the operating system is the standard MacOS. As such it's a cinch. It's bundled with significant software. For the serious user there's AppleWorks Office (formerly known as ClarisWorks Office), which provides all the word processing, spreadsheet, drawing and database facilities most users require. FaxSTF takes care of fax sending and reception through the iMac's internal 56K V90 modem. Kai's Photo Soap SE is included for touching up digital images. For Internet use there's a choice of Web browsers: Microsoft Internet Explorer or Netscape Navigator, while email is accomplished through Microsoft Outlook Express. All industrial products, and all very capable, with the result that – unless users have specific requirements – everything needed for general-purpose use is there, right out of the box.

No personal computer these days is complete without games, and the iMac has games for all the family. For youngsters there's Thinking Things and Sammy's Science House. For the serious gamer there's Nanosaurus and MDK. If you shop around you'll also find that many suppliers will bundle other software, particularly games, too.

There's no doubt that Apple's re-entry into the consumer market in the form of the iMac has already been successful. If anyone is looking out for a personal computer for home, business, or educational use, then the iMac must be considered. Its ease-of-use, quality, networkability, power, and simple style, cannot be ignored. Not looking out of place in the living-room, bedroom, study, reception, a business desk, or in the classroom or lecture-theatre, the iMac will fulfill most criteria.

Since the very first Macintosh computer in 1984, Macs have been turning heads. One of the most highly regarded magazines in the computer industry, Byte said a little while ago that the history of personal computing has been a race to keep up with Apple. The iMac proves that Apple's lead is not just historical. The iMac reviewed was kindly supplied by Xemplar, and educational purchasers (teachers, lecturers, students, parents) should contact the Xemplar sales department on 01223 724200 for details. Alternatively, the iMac is also available from any Apple reseller nationally (phone 0870 241 0212 for your nearest) or from Apple's own Apple Store (on the Web at **<www.apple.com/ukstore>** or by phone on 0800 783 4846).



Electronics in AGRICULTURE

PART 8

Crop Spraying

George Pickworth discusses the importance of droplet size.

Modern Crop Sprayers

By 1947 the basic principles of crop sprayers were well established and from then on improvements were essentially innovations. So, in this study we look at innovations which ultimately resulted in modern computer managed crop sprayers. Photo 12 & 13 Orchard sprayers will be discussed in part 9, the final part of this study.

The Sprayer Boom

The 'sharp' end of a sprayer is the nozzle. These are designed to deposit a film of chemical over the target weeds or pests as the case may be. The nozzles are obviously attached to the sprayer boom.

With early sprayers, the operator had to manually fold the booms, but with modern sprayers, this is done by electro/hydraulic operated rams controlled by the driver from a console in the cab; this facilitates working close to obstructions such as pylons or trees. Moreover, as the driver no longer has to leave the cab, contact with the sprayed crop is avoided.

As the spray leaves no visual indication on the crop, it has always been a problem for drivers to align the tip of the boom with the previously sprayed swath. Indeed, in 1945 the driver simply turned the sprayer on the headland as shown in Figure 9 and then followed the drill lines.

An important innovation around 1960 was the introduction of foam blob markers. The foam generators are attached to boom tips and as their name implies, periodically eject foam blobs; these persist long enough to provide markers for the following swath. See Figure 9.

Photo 12. HARDI PILOT™ display and control panel.

Tram Lines

Up to the 1960's cereal crops were generally sprayed once and this was to control weeds. Nowadays, cereal crops are sprayed several times; these include application of fertilizers, insecticides, fungicides and chemicals to restrict the length of the straw. So now it is the norm to create permanent tracks, known as tram-lines, which the driver follows during all spraying operations.

Tram lines, which are a conspicuous feature of corn fields, are generally created when the crop is sown by cutting off the seed flow to the relevant coulters. This technique allows a high degree of accuracy to be attained in setting out the tram lines. An alternative approach is to sow the crop overall and use the foam blob system for the first spraying, then follow the sprayer wheel marks for all subsequent sprayings.

Target Coverage

In 1945, the only practical way of ensuring a good target coverage was to mix the active chemical with vast amounts of water and literally wash the targets with a high volume of spray fluid using nozzles of the type shown in Figure 10. Total fluid application rates on cereal crops were therefore typically 1,000litres/hectare

Under good conditions, a 1945 'Bean' 500 gallon contract crop sprayer (Photo 10 last month), was quite capable of treating 50 ha/day. The logistics of collecting and transporting the large volume of water necessary to dilute the active chemical was therefore enormous. So, right from the pioneering days, attempts were made to reduce or even eliminate the water completely.

'Atomization'

Around 1946 trials were conducted with special nozzles which can be compared with a carburetor. See Figure 11. Concentrated chemical was fed by gravity into the venturi where it was broken up into droplets by an air flow which also projected the droplets to their targets.

Unfortunately, the original venturi type nozzles were not completely successful, one reason being that droplet size varied over a wide range, typically 50 to 500μm. The very small droplets were carried away by even a gentle breeze whilst the very large droplets, which accounted for much of the spray fluid often missed their target. See also Figure 12

However, the venturi system is inherently sound and forms the basis of several modern nozzles and is also the basis of some nozzles that produce droplets containing air bubbles more about these later.

Optimum Size

Droplet size is the principal factor in determining the volume of fluid necessary to give the required coverage of target pests or weeds. So, with a given volume of fluid, the smaller the droplets, theoretically the better the target coverage. See Figure 12. Indeed, where a reduction in the volume of applied spray fluid is the primary objective, the only way to achieve target coverage equivalent to higher volume sprays is to apply smaller droplets, but, as we will see, there is a limit to how far this process can, or needs be taken.

Photo 13. Knight wide boom air assisted sprayer (courtesy of Knight Farm Machinery Ltd.)

Applications

For any spraying job, there is an optimum droplet size. When applying liquid fertilizer for example, where a high degree of leaf coverage may not be necessary or even desirable, a reduced volume of fluid can still be used by making the droplets fewer but larger, i.e. more than 400μm diameter. Furthermore, such large droplets have appreciable momentum, so spraying can continue with wind speeds up to about 10m/sec. However, the maximum recommended wind speed for all spraying operations is 16km/h, i.e. 4.5m/sec.

Agrochemicals that are systemic i.e. where the active chemical is absorbed and translocated throughout the plant via the sap, (see also part 7, organo phosphorous) also do not require the target to be completely covered. Nonetheless, the better the coverage, generally, the better the result. So highly 'systemic' chemicals can also be applied with fairly large droplets, typically 300-400μm.

When applying selective herbicides to cereal crops, droplets 200-300μm diameter are about the optimum; these give good coverage of target weeds or pests with fluid application rates down to about 200-300l/ha. Moreover, the droplets of this size have sufficient momentum to penetrate the crop and allow spraying when wind speeds are up to about 4m/sec.

When Small Is Best

Some agrochemicals, which includes some fungicides and insecticides, require that the target plant or pest receives virtually complete coverage. So, other than to virtually 'wash' the targets with large volumes of fluid, a smaller volume of fluid can be applied as small droplets.

Unfortunately, droplets of less 200μm lack momentum to penetrate the crop and are highly susceptible to 'wind-drift'. Indeed, with conventional sprayers, work with very small droplets is limited to periods when wind speed is virtually zero. Later, we will look at innovations designed to overcome this drawback.

Changes

Limited changes in droplet size can be achieved with traditional type hydraulic nozzles by varying the pressure of the fluid. Major changes in droplet size are only feasible by changing the characteristics of the actual nozzle. Some sprayers have clusters of three nozzles each producing droplets within a limited band of sizes

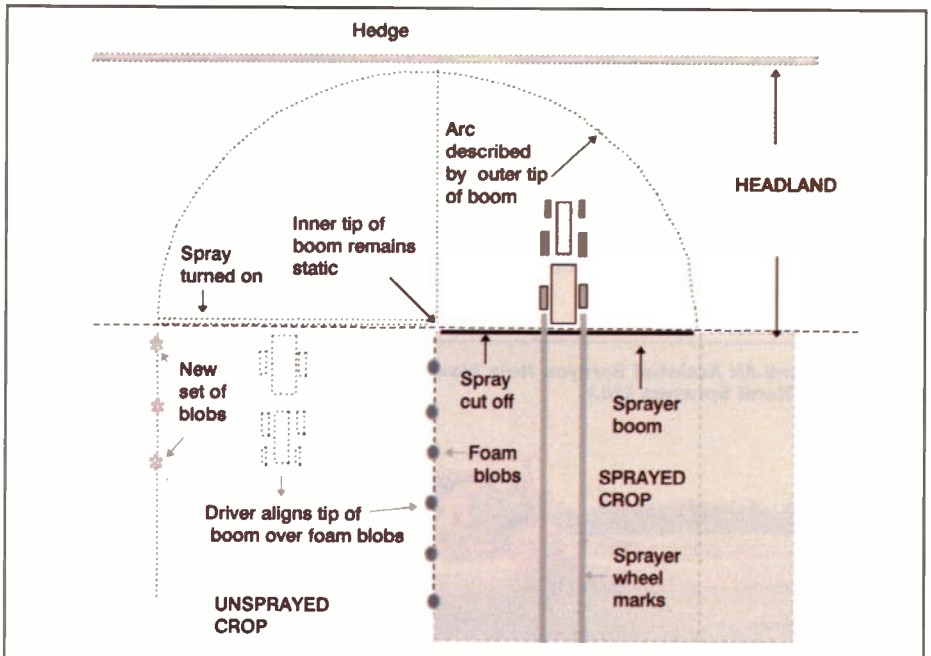


Figure 9. Aligning sprayer boom with the aid of foam blobs. Foam blob generators are fitted to the ends of the boom – the appropriate left/right generator is switched on as work progresses. Before the introduction of foam blobs, the driver followed the drill lines of the crop after making the turn. The headlands were last to be sprayed by driving around the perimeter of the field.

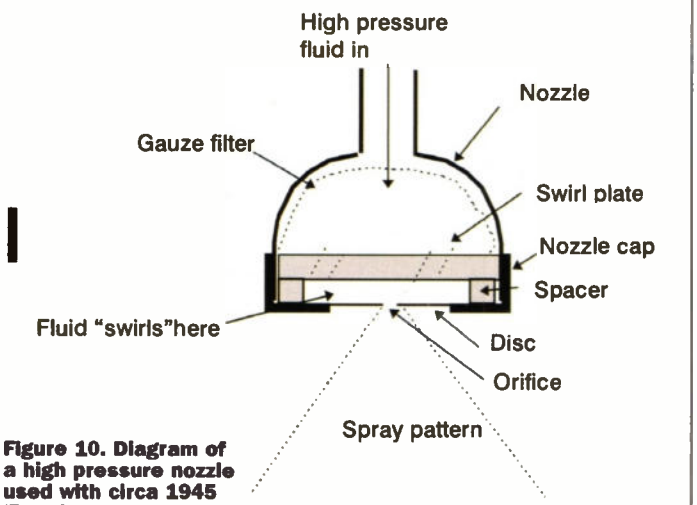


Figure 10. Diagram of a high pressure nozzle used with circa 1945 'Bean' sprayers.

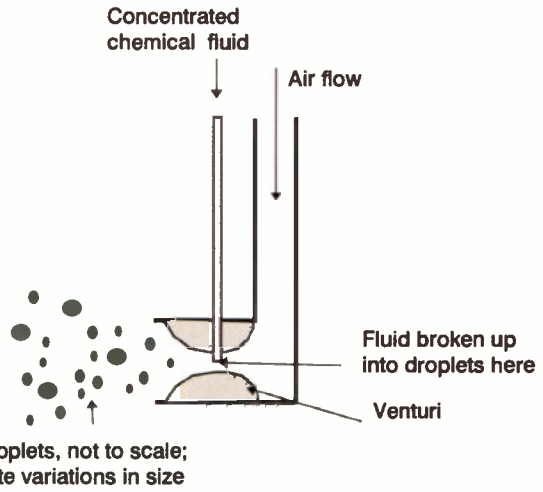


Figure 11. Diagram of a 1947 venturi type nozzle.

depending upon fluid pressure with the appropriate nozzle brought into service by simply rotating the cluster. With hydro/pneumatic nozzles, droplet size can be varied over a fairly wide range by varying air and fluid pressure. More about this later but first let us continue with simple hydraulic nozzles.

Electrostatic Charge

During the 1960's much interest was shown in a technique whereby the droplets were given an electric charge with polarity opposite to that of the plants or pests, so that the droplets were attracted to the target. The technique dramatically reduced wind drift and enabled very small droplets to be applied. Polarity of the charge seemed to be of little significance. See Figure 13

The sprayer was connected to one terminal of the high potential generator. The earthing electrode, a coulter, was attached to but insulated from the tractor, and connected to the second terminal of potential generator. With early systems, the compete tractor/sprayer was energized and insulated from the soil by the tractor tyres but this was not satisfactory. In later systems the sprayer was insulated from the tractor.

Although the system was effective, the generation of very high potentials presented both practical and operational problems. Today, the system is used only for certain specialized applications, but the concept is far from being dead.

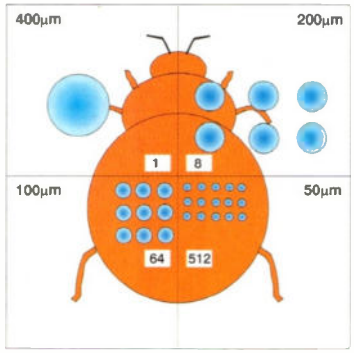


Figure 12. Diagram showing the coverage of target insect with a given volume of fluid and with droplets ranging in size from 50 to 400µm. Note that with 400µm droplets there is a good chance that the target might be missed completely.

Air Assisted

In more recent years it was found that if the nozzles produce fan shaped spray patterns, the droplets could be projected downwards into the crop by a curtain of air. Indeed, with medium size droplets, spraying could usually continue with wind speeds up to 8.0m/sec. i.e. about twice that possible with conventional sprayers. The HARDI TWIN™ SYSTEM, is a good example of this approach. Photo 14

However, the great advantage of the air curtain is that it greatly reduces the windrift problem when very small droplets are required. Moreover, application of very small droplets allows fluid application rates to be reduced to about 100l/ha or half that required to give an equivalent coverage with medium size droplets. Furthermore, by gently ruffling the plants, the air curtain significantly improves target coverage. See Figure 14. It was also found that by giving the air curtain a slight forward angle, it compensated for the forward travel of the sprayer thereby allowing higher operational speeds.

To carry the large volume of air, the air duct needs to start with a large diameter and taper towards the end of the boom. A substantial blower is also needed and is mounted on the actual sprayer boom, mechanical drive from the tractor or sprayer engine is impracticable, so an hydraulic motor, i.e. powered by the tractors hydraulic system, is used as shown in Photo 14.

Air Bubble System

With this technique, large droplets are produced but contain air bubbles. Being large, the droplets have sufficient momentum to penetrate dense crops and are obviously much less susceptible to wind drift. Obviously, by containing air bubbles they do not have the same momentum as 'solid' droplets.

Nonetheless, with the air bubble technique, many spraying jobs can continue with wind speeds up to 8.0m/sec. The droplets burst on impact with the target thereby greatly improving coverage and adhesion whilst economizing in fluid volume. There are two methods of producing droplets containing air bubbles, one is the venturi system already

Photo 14. Hardi Air Assisted Sprayer. Note blower at centre of boom (courtesy of Hardi Sprayers Ltd.)

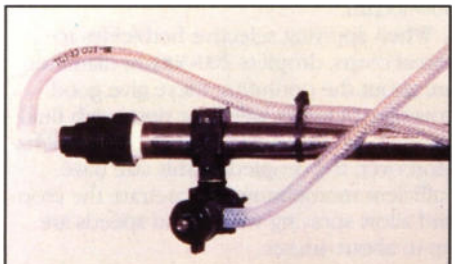


Photo 15. Knight AIR JETTM nozzle. Note small bore tube connected directly to nozzle that supplies compressed air. Compare with large diameter air duct of air curtain sprayer in Photo 13. (Courtesy of Knight Farm Machinery Ltd.)

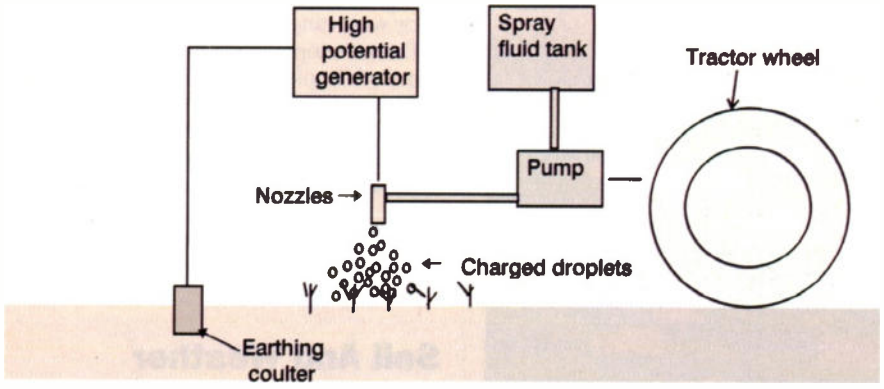


Figure 13. Diagram showing sprayer where droplets are given an electric charge.

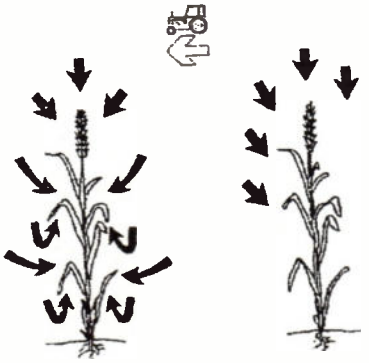


Figure 14. Diagram showing plants on left being ruffled by air curtain which improves target coverage.

mentioned, the other method and that adopted for the KNIGHT AIRJET™ system uses hydro/pneumatic nozzles. See Photo 15. With the AIRJET™ system the volume of air required to produce the bubbles is much less than with venturi or air curtain systems.

However, unlike the venturi or air curtain system, where the air current projects the droplets to their targets, the bubble droplets have to rely on their own momentum, (which as already mentioned is less than a 'solid' droplet) to penetrate the crop and to resist wind drift.

With the KNIGHT AIRJET™ system, the air is provided at a moderate pressure, typically 1.0bar, by a small compressor and is delivered to the nozzles via small bore tubes attached to sprayer boom. Fluid and air is mixed in the actual nozzle to produce the air bubbles within the droplets.

Speed Variations

So far, we have considered sprayers as having a constant discharge rate. Indeed, this remained the case until the development of computer managed sprayers. So, to ensure a constant application rate with early sprayers, forward speed had to be constant; this presented few problems on flat land but gave serious problems on undulating land. When ascending slopes, forward speed is reduced by the increased load on the propulsion engine. Forward speed is also reduced by wheel slip and this is of particular significance with tractors towing large sprayers. On the other hand, when descending slopes, the sprayer tends to overrun the engine so forward speed increases. The result is over application when ascending a slope and under application when descending.

Power Reserve

During my early days as a crop sprayer pioneer, the only practical method of maintaining a constant forward speed on undulating land was to employ tow tractors with adequate reserve of power; this usually meant employing sprayers with much less capacity than would be the case on flat land.

Nonetheless, even with adequate reserve of power, wheel slip with the tow tractor can significantly reduce forward speed. However, wheel slip is minimized when the sprayer is mounted on the actual tractor. See Photo 16 and 17

Variable Output

A more elegant approach to a constant application rate is to vary the fluid discharge rate in direct ratio to the sprayer's forward speed; this allows the sprayer operate in a lower gear and at lower speed when ascending slopes, thereby allowing a more economical engine to be used.

Nonetheless, with hydraulic nozzles of fixed dimensions and characteristics, the only practical way to vary output is to increase or reduce fluid pressure. Unfortunately, variations in fluid pressure can significantly effect droplet size, but with modern nozzles this effect is minimized.

With the HARDI TRONIC™ system, see

Photo 16. Knight tractor mounted sprayer (courtesy of Knight Farm Machinery Ltd.)

Photo 17. Knight self propelled sprayer (courtesy of Knight Farm Machinery Ltd.).

size and discharge rate is a product of the two pressures and can be varied over a fairly wide range.

Once the operator has chosen the required droplet size, by keying the relevant data into the computer, the system automatically maintains that droplet size even though the rate at which fluid is discharged varies in direct ratio to forward speed. A constant application rate and droplet size is therefore maintained over a fairly wide range of forward speeds. See Photo 19.

Soil And Weather

No matter how efficient the sprayer, it can only operate when soil and climatic conditions are suitable and this may last for only a very short period. In part 9, which concludes this study we look at how soil and meteorological data is collected by remote sensors and presented to the farmer on the office PC. The system can also automatically alerts farmers by mobile phone that conditions are suitable for spraying.

Photo 18 and Figure 16, a sensor on a sprayer wheel measures forward speed whilst the 'flowmeter' controls fluid flow to the nozzles. As the nozzle orifice presents a resistance to the fluid flow, changes in flow rate also change fluid pressure at the nozzles.

To avoid errors caused by tractor wheel slip, the sensor is installed on the sprayer wheel. With tractor mounted sprayers the sensor is fitted to the tractor's front wheel and with four wheel drive tractors, drive to the front wheels is wherever possible disengaged.

Radar speed measurement systems, which are well suited to many other cultural operations, have been found to give false readings when used with crop sprayers; the radar is upset by ruffling of the plants during a breeze.

The HARDI PILOT™ in Photo 12 is intended for use with their air assisted sprayers and in addition to having the features contained in HARDI TRONIC™ allows control of the angling of the air slot and nozzles. The screen graphically displays all operations and functions of the sprayer.

The Knight AIRMATIC™ controller in conjunction with their DELTA™ controller is used with their AIRJET™ system. The AIRMATIC™ controls air flow to the jet, typically 1.0bar whilst the DELTA™ controls fluid pressure, typically 4.0bars. Droplet

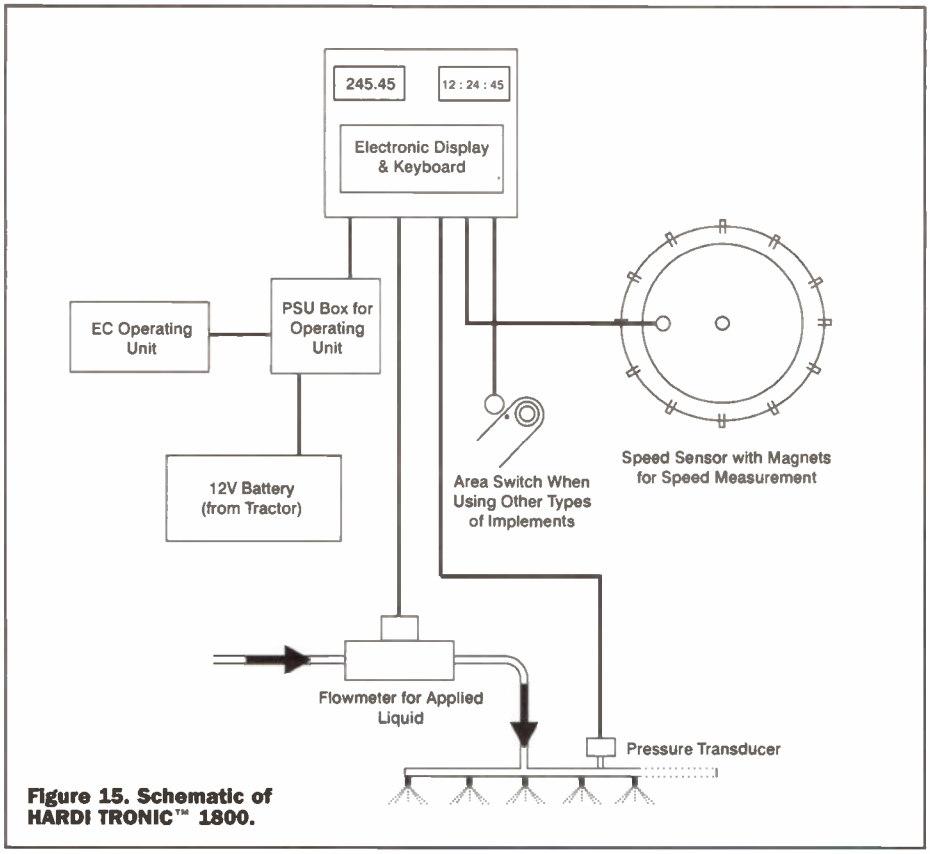
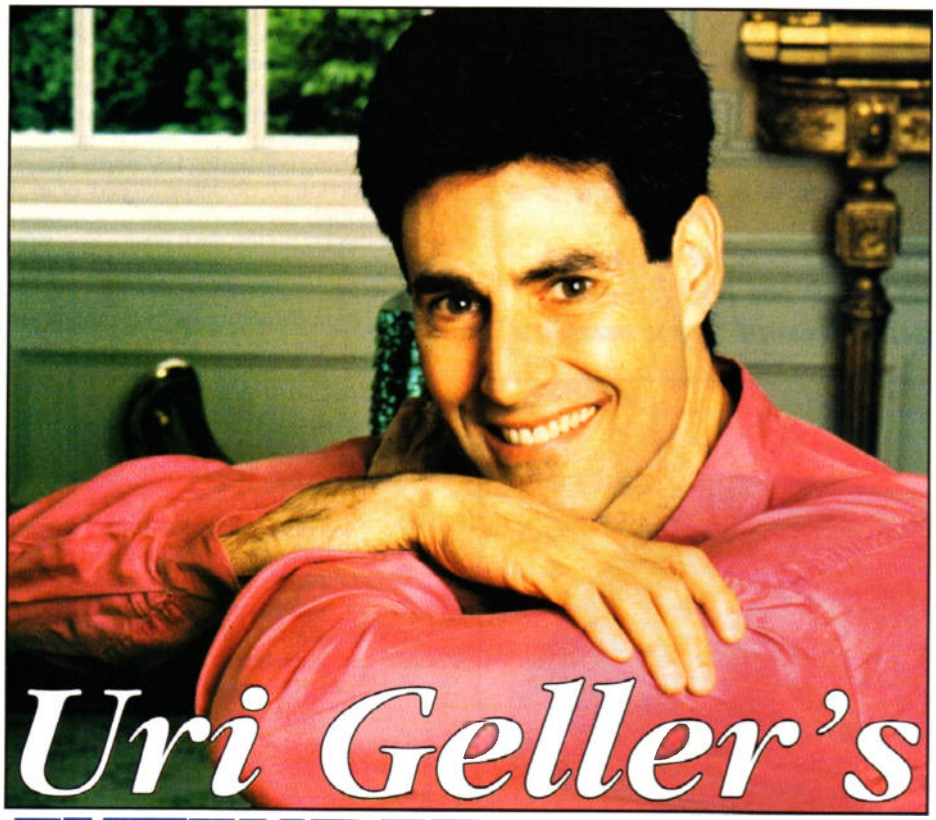


Figure 15. Schematic of HARDI TRONIC™ 1800.

Photo 18. HARDI TRONICTM control panel in cab – see also Figure 16 (courtesy of Hardi Sprayers Ltd.)

Photo 19. Knight AIRMATICTM controller. Used with air jet (bubble jet) system. Note display shows water pressure (spray fluid) and air pressure.



Uri Geller's EXTENDED REALITY

Psychokinesis At Princeton

Tucked away in a basement office suite on the campus of the prestigious Princeton University is the PEAR laboratory – that's the acronym for Princeton Engineering Anomalies Research. It sounds, pretty dull, yet what goes on in there is anything but dull. It is probably the most important research of its kind being done anywhere in the world today, and anybody who owns a computer or some other piece of microelectronics ought to know about it.

The man in charge of the PEAR lab, now nearing its 20th anniversary, is Robert G. Jahn, Dean of the engineering faculty, no less. A specialist in rocket propulsion and aerospace engineering in general, he has a solid record of work for NASA and the U.S. Department of Defense behind him. He now has an equally impressive record of research in a rather different area – the interaction between mind and matter, or what we usually call psychokinesis or PK for short. Yes, the PEAR lab is in fact a psychical research laboratory, although if it had been named as such it would probably not have lasted twenty days, let alone 20 years.

Jahn's reason for moving into this controversial area was, as he put it, "to identify those engineering devices, systems and processes most likely to display operator-related anomalies in their performance, and to illuminate the characteristics of such aberrations". In other words, he wanted to see if minds really can mess up machines.

Many people already think they can. There are those, luckily not too many of them, who seem to be able to make things break down just by being in the room with them. Scientists call this the Pauli Effect, named after the Nobel laureate Wolfgang Pauli who is said to have had an uncanny talent for causing mechanical disasters. In 1985, the sad story of a man named Peter Strickland appeared in the April issue of Computing with the Amstrad magazine. "If it involves a computer," he said, "you can almost guarantee it will malfunction if I'm around." The poor fellow couldn't even make a pocket calculator work properly, although his colleagues had no problems with the same machine. Once, he even managed to cause a computer-controlled textile machinery line to go haywire just by walking towards it.

One can only imagine what might happen if there was an outbreak of the Pauli Effect at, for instance, an air traffic control tower or a nuclear warhead storage facility.

Jahn and his colleagues are interested in far more subtle effects than those mentioned above, which may not be due to PK at all but to some still unknown kind of electrical emission from certain people. Their first experiments focused on two pieces of equipment – a random event generator (REG) and a wonderful contraption called a Random Mechanical Cascade. The REG was a conventional setup designed to convert a microelectronic noise source into a countable stream of positive and negative pulses. Volunteers were asked just to sit in front of the display screen and to do one of three things: increase the number of counts (PK+), decrease it (PK-) or do nothing at all (BL, or baseline).

The Cascade is a kind of enormous pinball machine. Measuring 10 feet by six, it contains, 9,000 small polystyrene balls which are released all at once from the top, tumbling down through an arrangement of 330 pegs to one of 19 collecting bins at the bottom. Normally, the balls arrange themselves into a neat Gaussian or bell curve, with the bins in the middle nearly full and those at the edges almost empty. Volunteers are asked to make more balls fall on either the left or the right side, or just to leave the cascade to do its own thing without mental interference.

Results of both kinds of experiment are intriguing. At first sight they do not seem very exciting, since there is less than one-percent difference between the PK+ and the PK- scores. But the point is: there should not be any difference at all.

The PEAR results may in fact be more interesting than they seem, although that is quite interesting enough. Jahn used whatever volunteers he could find, some of whom had several goes at the machines while others came only once or twice. Some were clearly better than others at remote-controlling, some being consistently successful, while others would regularly get results opposite to what they intended. Taken all together, though, the results are significant by an order of several thousands to one against chance. In any other branch of science, that would be considered pretty close to proof, especially since Jahn's work with random number generators has been repeated by about seventy other researchers in around eight hundred experiments. The odds against the overall results being due to chance have been estimated at a trillion to one. Who says there is no 'real' evidence for psychic powers?

So far, the PEAR group has been mainly interested in the effects that single individuals can have on a mechanical system that is supposed to be entirely random. Other researchers have recently taken things a stage further and looked for the influence of groups of people – up to a billion of them, in fact – on equipment similar to Jahn's. Their results are really strange, and I'm still not quite sure what they mean. I'll tell you about them next month.

Uri Geller's novel Ella is published by Headline Feature at £5.99, and his Little Book Of MindPower by Robson Books at £2.50, and Jonathon Margolis' Uri Geller Magician or Mystic? by Orion Books at £17.99. Visit his live website camera at **urigeller.com** and e-mail him at **urigeller@compuserve.com**

TRAVEL UPDATE

And now for some really useful travel news. A report by Paul Freeman-Sear on the latest developments in Digital Radio travel information.

To inspire designers and manufacturers, the BBC has commissioned London based design consultancy IDEO to come up with concepts for radio of the future to explore the potential of the medium. The model for a family radio proposes the following: options to save earlier programmes and download them later, on screen programme menus, icon dragging for tuning, and on-screen supplementary information such as sports scores or recording artist biographies.

When Digital radio gets a firm hold in our cars, receiving travel information will never be the same again thanks to the BBC. If all goes to plan, out will go the occasional messages about what's blocking which motorway and very often is of no relevance to you. Out would go localised electronic flagging via your RDS radio auto travel information. This is where you allow the local station to cut in with the travel news. The trouble is that very often you get a local presenter spouting on about this and that after the travel announcements. That is of course until an electronic flag returns you to the station you were listening to. Not an ideal situation!

With all that gone, think of the new potential situation where you the driver/listener has editorial control over what traffic information *you* want to listen to and when *you* want to listen to it, any time of day.

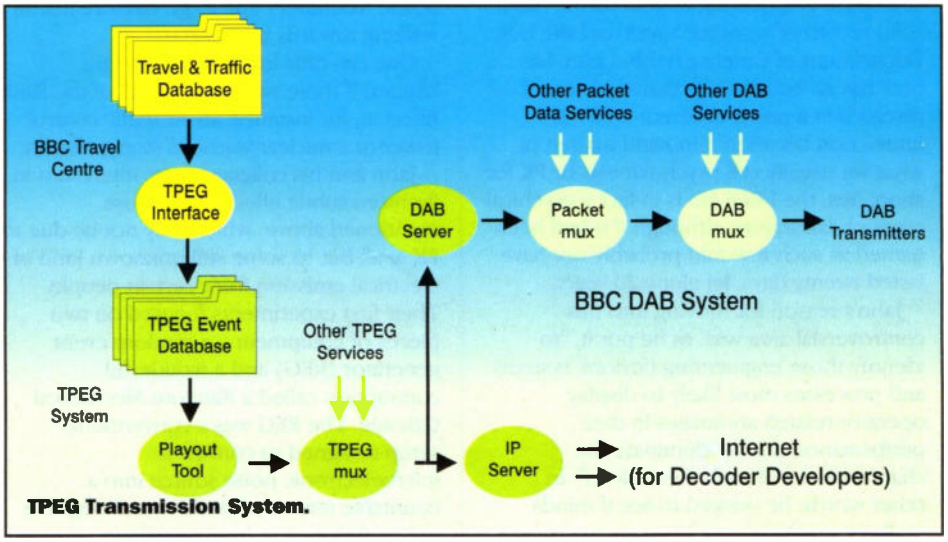
To that end, BBC Digital Radio has unveiled the world's first travel data service using a new data protocol called TPEG (Transport Protocol Experts Group) to fulfill that user need. This unique experiment will provide a continuous stream of travel data covering all situations known UK wide and it will enter your digital radio at 8kbits/sec. The information that is only relevant to you, i.e. the problems around where you are, can be filtered by a variety of means. This might be for instance supplied courtesy of your GPS navigation system which may or may not be resident in your radio set. The radio will know where you are and will broadcast traffic information for your immediate area. It would know you are on a motorway or which ever A road. An alternative to this might be, that given some key pad on the dashboard, you could input your own requirements, say announce all travel information that is happening within an 'x' mile radius of 'y' town. The radio would immediately respond with that information. As you might expect, this is a data stream and not a live voice so the information would appear perhaps in one of two forms. Either the on-board ROM would supply a speech string containing key words like 'M25 Junction 20 clockwise closed' or it might supply the information to a small visual display on the dash board. This would give the same message using on-board icons or symbols. The beauty is that the data stream can be interpreted by an appropriate ROM in a language you choose. It can also provide a running text display of the incident.

TPEG will exist as a very small separate stream of data running at 8Kbits./sec. This is significantly more data than exists with the current RDS data stream of 37 bits/sec. When BBC Digital begins its pilot in January 1999, it will enable manufacturers to use the coded information in varying formats. The first and most obvious being the integration into car navigation systems. The travel encoded information will contain the co-ordinates of longitude and latitude. This precise positioning will mean problem areas will be pinpointed exactly. Part of the TPEG transmission system will contain a section known as a playout tool. This is where the information has to be prioritised in order of importance. Scheduling algorithms will look at long term and short term events and arrange for them to be transmitted frequently or infrequently.

Early digital radio receivers for cars, and so far there are not that many out there, that cannot understand TPEG could have a box added. This would be left up to manufactures to develop. As TPEG is digital, it could be made available as an internet connection and could work with proprietary route planning software to give the best possible route without any holdups. As it is hoped that TPEG will be adopted as the standard protocol so all future digital radio and navigation systems should adopt it as standard. The BBC is working with other broadcasters who want to validate the protocol and make it a recognised standard.

Travel information will be provided by the BBC Travel Unit using their existing travel connections and real information will be provided during the six month trial. After that the BBC will go to public consultation and the system will then have to be approved by the government Department

The circular form of radio contains a large screen and is flanked by two speakers which could be moveable and connected to the receiver by infra red links or convenient cable.



TPEG Transmission System.

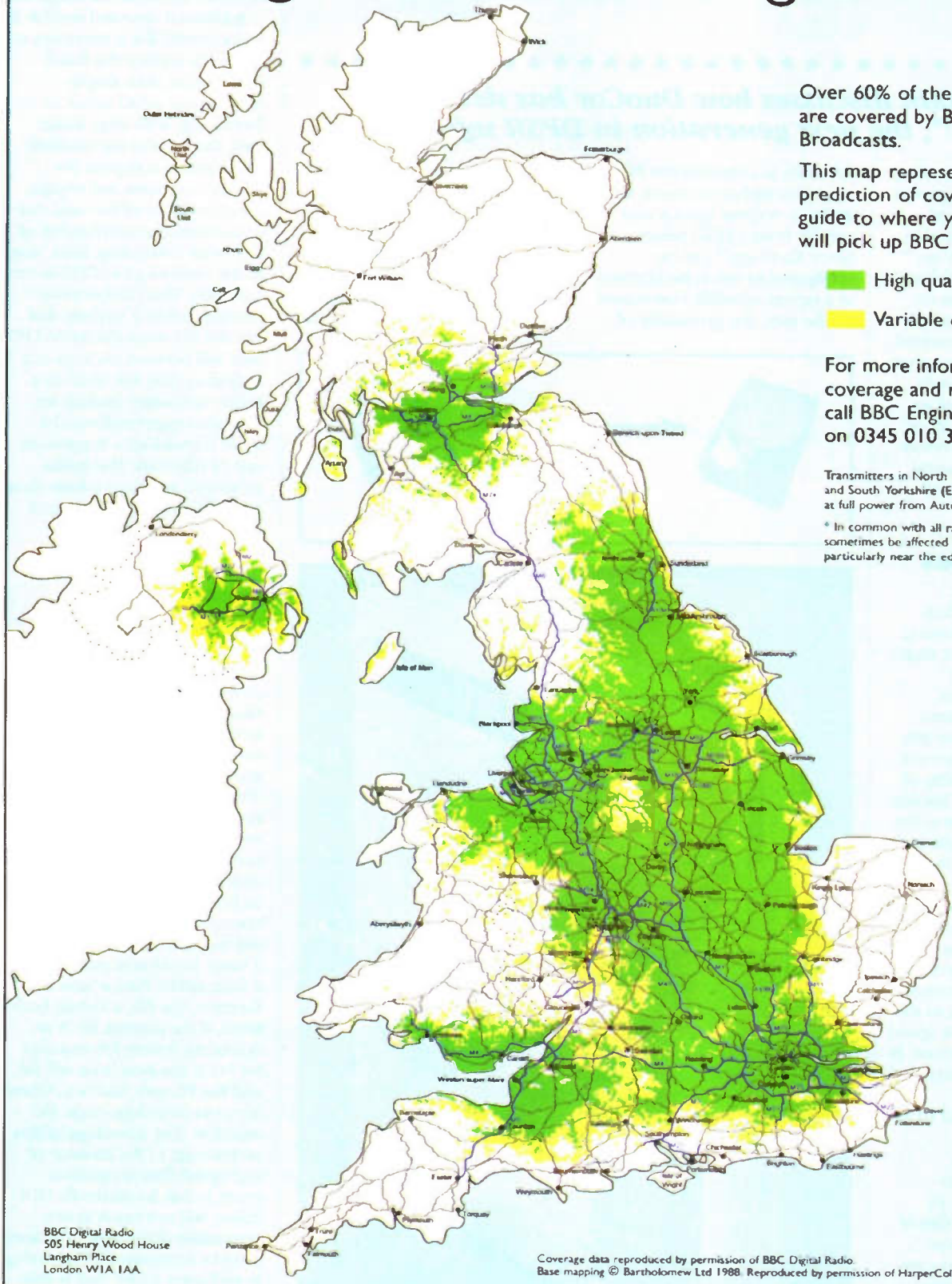
of Culture, Media & Sport.

After that, other pilot studies will be carried out for public transport, like rail and ferries etc. As this will be a publicly funded service anybody with the correct receiving equipment will have access to accurate travel information without payment. Where such specialist information might be required such as for road hauliers in getting freight efficiently from A to B, a premium-rate paid-for service might be set up by a third party. This information could be encrypted before being transmitted.

This travel information data stream is just one of a whole variety of possibilities available to us in the 'new' digital age. Using a now time-worn phrase - 'You ain't seen nothin' yet'.

ELECTRONICS

BBC Digital Radio Coverage in the UK



Over 60% of the UK population are covered by BBC Digital Radio Broadcasts.

This map represents a computer prediction of coverage and is a guide to where your Digital Radio will pick up BBC digital signals.

High quality coverage

Variable quality coverage*

For more information about coverage and reception please call BBC Engineering Information on 0345 010 313.

Transmitters in North London (Alexandra Palace) and South Yorkshire (Emley Moor) should be on air at full power from Autumn 1998.

* In common with all radio networks reception may sometimes be affected by local conditions, particularly near the edge of the shaded area

BBC Digital Radio
505 Henry Wood House
Langham Place
London W1A 1AA

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BBC Digital Radio

BBC Digital Coverage map.

The Next Generation IN DATA PRODUCTION/ SYSTEM RECOVERY - DPSR

Alan Whiskin discusses how DuoCor has developed XactCopy™, the next generation in DPSR software.

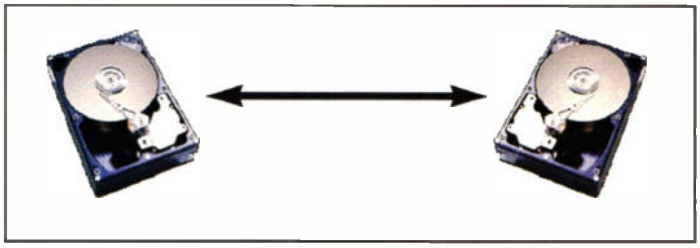
In the same way that mirroring and image files have improved on traditional, tape-based backup solutions for protection against HDD failure, XactCopy™ takes the next, giant step forward in securing the critical data on your PC. A thoroughly detailed solution that, once implemented, runs in the background, yet gives total control to the user when desired. Our DPSR technology advances the state of the art on both the hardware and software fronts, resulting in substantial improvements in speed and data security.

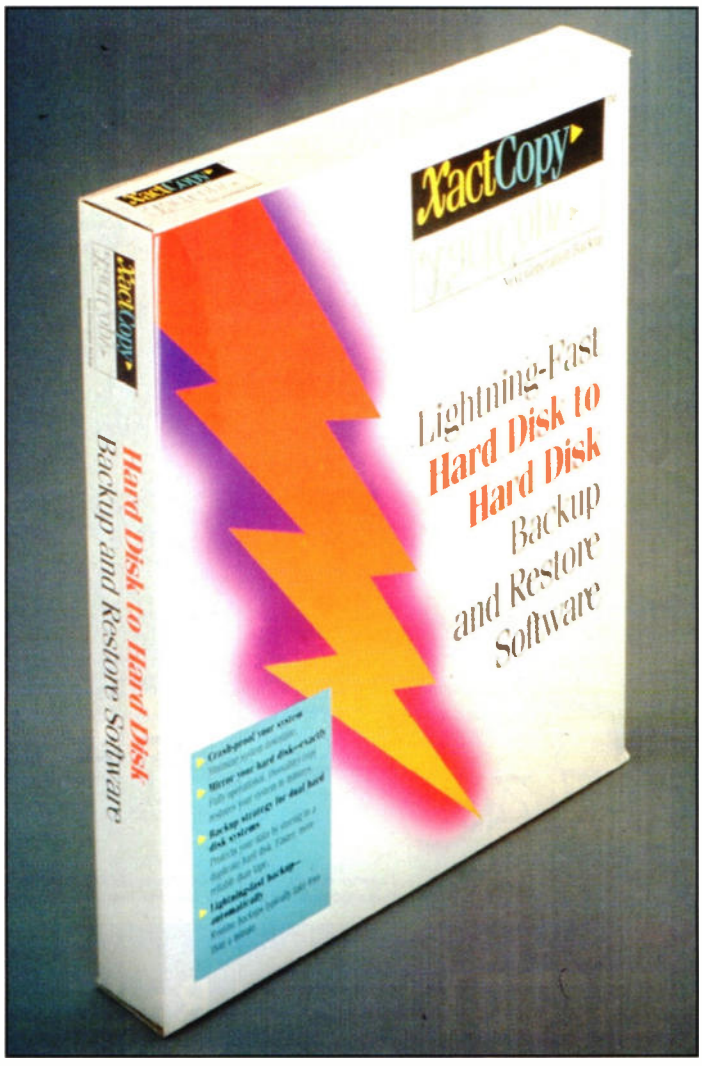
Tape Strategies

As anyone who has ever implemented a tape backup strategy can tell you, following the recommendations for multi-tape rotations of full and incremental backups is an expensive, tedious and time-consuming task. If you are able to find such a person, they will also tell you that probability of actually having a reliable backup in your tape library in the event of data loss or HDD failure and successfully completing the restore operation is 25%. Those few successful efforts that do occur often take many hours to complete due to the inherent speed limitations of tape media. The fact is that a tape strategy is rarely implemented, due to the limitations inherent in the speed and reliability of the medium. In addition, the discipline required is possessed by few.

By employing a second HDD as the backup medium, XactCopy™ achieves the creation of a 2GB backup volume in as little as 7 – 10 minutes at data transfer rate of up to 5MB/sce. Subsequent changed files only backups are completed in as little as one minute or less! The reliability of the HDD as a medium with near perfect data fidelity over the long term is well known. This combination of speed and reliability is a boon to the PC user who wishes to ensure the ability to recover quickly and reliably from a HDD failure. Since XactCopy™ can be configured to run in background at a pre-set schedule customized by the user, the probability of having a very up-to-date backup set is quite high!

Some recent advances in software employing image files or mirroring (hardware or software) have partially bridged the gap between tape strategies and the needs of today's PC user.





Images Files

By creating a compressed Image File and storing (archiving) it to a reliable medium such as a removable cartridge or a HDD partition, the PC user is able to recover from a HDD failure reliably, although at the expense of the time required to boot from a floppy disk and load the files necessary to restore the image file.

Additional time and trouble is encountered if it is necessary to physically replace the failed drive, rather than simply marking out a bad sector or re-formatting. With large image files, the need to use multiple cartridges to complete the backup operation will require the attendance of the user, not to mention the interruption of any other computing tasks, due to the need to go to DOS to run the utility. This cumbersome process makes it unlikely that any but the most disciplined PC user will perform backups at a frequency that will result in a highly up-to-date backup set. The advantage conferred by these technologies is primarily one of reliability. The media employed are more robust than tape. There is also a saving of time relative to tape, as the image files are created and restored more quickly than is possible with tape.

Mirroring

Mirroring, whether by hardware or software, used a second HDD and concurrent writing to both disks to create and maintain a redundant copy of the contents of the system disk. This method assures a very up-to-date backup, as all disk writing or file saving is concurrent to both disks. A major drawback to this technology, however is that a corrupted or cross-linked file will be present on both disks. If a 'save' function is executed by a user, rather than a 'save as' function, the file is lost on both disks. If the corrupt file is an operating system file required for boot, the next boot will fail, and the PC user had better have an up-to-date data image file available. The advantage of this technology, in the absence of corrupted files or operator error, is that an on-the-fly HDD failure will not result in any immediate down time. The user receives a message that 'mirroring is no longer active' and is able to continue working from the remaining functional drive in the system. The failed drive can be repaired or replaced when time becomes available.

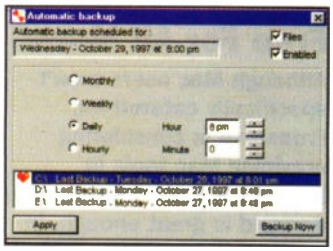
XactCopy™ DPSR

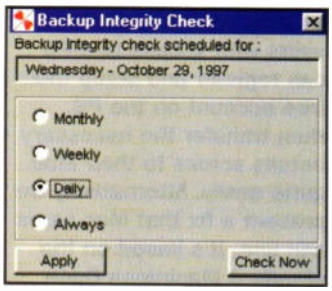
DuoCor's patent-pending XactCopy™ DPSR technology pulls it all together. The original strategic elements of the backup philosophy; full, incremental and differential backups, as well as the more modern elements of fault tolerance and hardware redundancy, operator error protection/recovery, system error detection/prevention and background operation in a multi-tasking environment are all embodied in one detailed solution. XactCopy™, when combined with a second HDD is a complete package that addresses the needs of the modern PC user who employs leading edge equipment and has several gigabytes of data to protect and secure.

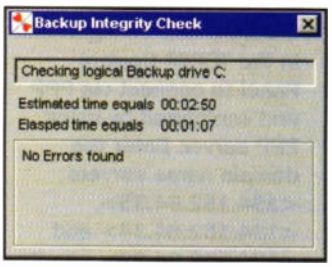
The breadth and depth of the XactCopy™ solution is the result of a highly detailed approach to designing the application, which focused on total data security as the design goal. The primary element of this design is the use of a second HDD as the backup medium, which is hidden from the operating system (OS). This design element accomplishes several objectives:

The OS is not subject to any drive letter conflicts resulting from the second C: drive because the OS cannot see the backup drive, only by XactCopy™. This means items such as shortcuts functions, operate correctly when running from a restored backup disk.

The backup disk is invisible to the OS. It cannot be accessed by the user from Windows®. This protects the data on the backup disk from operator error and file corruption in a way that mirroring cannot.







XactCopy™ does not have a delete function, only read/write functions, so that accidental deletions are not possible on the backup disk. In addition if a PC user has been lax in anti-virus protection XactCopy™ provides a barrier, under certain circumstances, to prevent the propagation of the virus to the backup disk.

In the event of a system drive failure, when the backup disk is unhidden from the OS, it is immediately bootable as the system drive. This results in recovery times of from one to five minutes from a system drive failure, less than one minute if optimal hardware configuration exists. Basically a PC with a crashed system disk can be up and running from the backup disk in the time it takes to reboot twice. The failed drive is then repaired or replaced when time becomes available.

Since the backup disk is hidden from the OS, XactCopy™ performs certain disk management and maintenance functions. These functions not only replace those performed by the Operating System, but also contribute greatly to the superior overall performance of XactCopy™ DPSR. The embedded maintenance functions of XactCopy™ are:

- **Verify** – Performed prior to the initial full backup, this is a non-destructive surface scan of the backup disk, which determines if there are any bad sectors present on the disk. If any are found, they are noted in the File Allocation Table (FAT) of the disk and data will be routed around the area during the writing process. This function can also be user selected at any time.
- **Check For Cross-Links** – The program checks for cross-linked files before all backup operations. On the initial full backup, the backup is aborted if a cross-link is found. On subsequent changed-files only backup operations, the cross-linked files are not backed up. In either case, XactCopy™ provides instructions to the user on how to remedy the situation in a way that is not possible using Scandisk® alone.
- **Integrity Check** – Performed after the initial full backup and after changed files only backup operations, at user selected intervals, this function monitors the integrity of the data on the backup disk to assure that the backup data is available when required.

When it becomes necessary to perform a 'restore' operation, these design elements and maintenance functions combine to assure that the backup disk contains data that is uncorrupted and ready to replace any bad data that may have developed on the system disk. Whether the need results from operator error or a system fault, the user simply selects the file, folder, complete partition or entire disk for restoration and initializes the process.

For the absolute maximum effectiveness of XactCopy™ as a DPSR tool, it is incumbent upon the user to schedule or manually perform backups in a way that reflects the pace of their work. Changed-files-only backup for a normal user will take about one minute or less, in a transparent and background mode with the user application still running and on-screen. The time and frequency selected for the automatic backups can be measured in minutes only if appropriate to the application.

Maintaining up-to-date back up files provides a high level of security to the user and is easy.

XactCopy is available from Maplin, in two versions:

Version	Order Code	Price
Windows 3.x/95 Version	LX65V	£115.15 including VAT
Windows NT (3.51 and 4.0)	LX66W	£346.62 including VAT

@Internet

Free For All PCs

We reported on a new free Internet service last month, and promised to keep readers posted. True to our word, here's more news on the service. Owned and run by Dixons, the high-street electrical retailer, the *Freeserve* Internet access system becomes the UK's first real free Internet service provider. There are other free services, but Freeserve is the first on a truly national basis. PC owners merely have to pop into a local Dixons, Currys, or PC World branch and pick up a copy of the Freeserve CD-ROM, which provides all the tools and programs needed to get signed on. You'll need to have a PC running at least Windows 95/98/NT and over 16Mb RAM, together with CD-ROM drive and modem of course.

The service is truly free, with free registration and subscription, along with unlimited email addresses and 5Mb of Web space for your own use. All that Freeserve requires is that you logon at least once a month to keep your account open. If the system detects you haven't logged on for the past month, the account will be deleted automatically.

Over the last month we've been trialling Freeserve quite a lot and can report it's generally a robust and easy to use system, although — in common with some other Internet services — it does tend to get a little bogged down at busy times. If you already have Internet access you can see its portal site at: <http://www.freeserve.co.uk>. No doubt this slightly sticky situation will improve as Dixons upgrades the service to cope with the demand — it appears that the free service is naturally very popular — but logging on at peak times is still a little tricky, with busy tones and unanswered dialups being quite common. Still, it's early days and we're sure that Freeserve will be an extremely viable service over the years to come.

While the service is free, potential users should understand that Freeserve charges a premium rate for technical help. Calls to its Technical Helpline (manned 24 hours a day, 7 days a week) are charged at £1 a minute. As a result it's in your own interest to sort your own problems out. In any case, there's not a lot to go wrong. Freeserve uses Microsoft's Internet Explorer as its default Web browser, and Microsoft Outlook Express as its email delivery system. Anyone familiar with these should find using Freeserve no different to most other Internet services. New users, on the other hand, might encounter several areas where help may be needed.

Free For All Macs

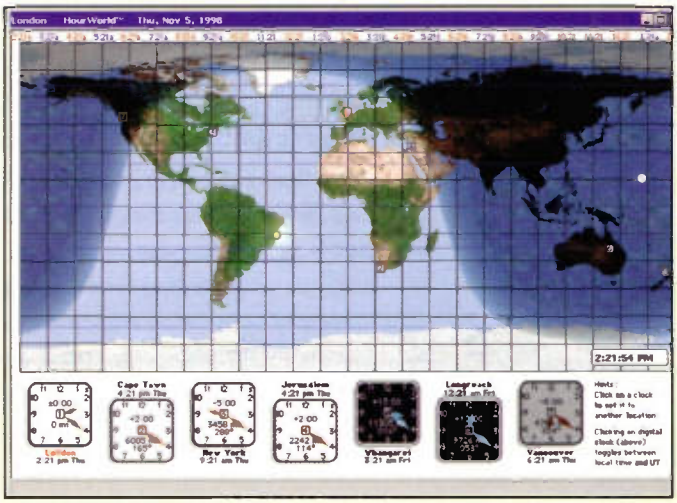
Although Mac users aren't specifically catered for, Freeserve is considering providing Mac tools in future releases if the demand is great enough. In the meantime Freeserve suggests that those Mac users with access to a PC can register and setup their free account on the PC, then transfer the necessary details across to their Mac quite easily. Alternatively we present a fix that Mac users can use. It's based on the standard Macintosh Open Transport Internet method.

1. Create a new configuration in the TCP/IP Control Panel to connect via PPP and configured by using PPP server. Enter the domain name servers <194.152.64.35>, <194.152.64.34> and <194.152.64.68> into its 'Name server addr:' field, save the configuration then quit.
2. Next, create a new configuration in the PPP or Remote Access Control Panel, enter the name 'freeservesignup', with a password 'signup' and telephone number '0845 079 6699'. Click Connect to log on.
3. In your Web browser enter the URL: <https://signup.freeserve.net/> (note that it's https - not just http) then go through the registration process. Once finished, make notes of your email address, your username and password, then disconnect PPP or Remote Access.
4. Now enter your username and password in PPP or Remote Access Control Panel and save the configuration.
5. Finally, in whatever email package you use enter your email address, your password, your POP3 account in the form <your_username.freeserve.co.uk@pop.freeserve.net>, and your smtp server <smtp.freeserve.net>

HourWorld

There's a nice little utility for Mac users, in the form of *HourWorld*. You can download it from <http://www.download.com>. It presents a view of the world, on which you can attach clocks displaying time at several cities around the world. Also on the world display is a shaded area representing the part of the world in darkness at that time.

While the basic program you can download is free, if you pay the shareware fees you get access to more complex versions. The HourWorld SVGA version for example has a large display option (800 by 600 pixels) with a total of 7 clocks, almanac printing for any location and date, by month or year, a phone call coordinator screen for planning phone calls or other events across multiple time zones, GPS functions, an editable database, editable locations, and access to the registered user portion of the HourWorld Website.



World Wide Words

In a move unprecedented in publishing history, a new dictionary has been published simultaneously both online as well as 'in print'. From the beginning of September, 450,000 members of AOL's UK Internet online service at **<www.aol.co.uk>** will have direct access to the New Oxford Dictionary of English, to search, check spellings, read daily featured words and phrases, and even take part in language debates.

Available exclusively on AOL, the New Oxford Dictionary of English will be based in the Learning Channel on the UK service. The Channel is designed as a comprehensive learning and reference source for all ages, abilities and interests.

The entire text of this completely new dictionary has been made available online. The use of clean, simple graphics makes the search facility on AOL simple to use and ensures fast access to hundreds of thousands of words online.

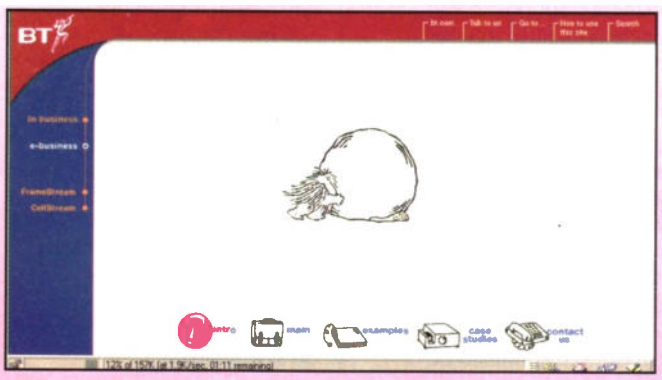
E-Business is on Agenda for UK Plc

According to research commissioned by BT at **<www.ebusiness.bt.com>**, nearly two thirds of UK's businesses are Techno-sceptics, companies that typically invest little money in IT and are wary of rushing to adopt new technologies. Although surprisingly, nearly a quarter of those Techno-sceptics say they will be selling more products and services electronically in five years time.

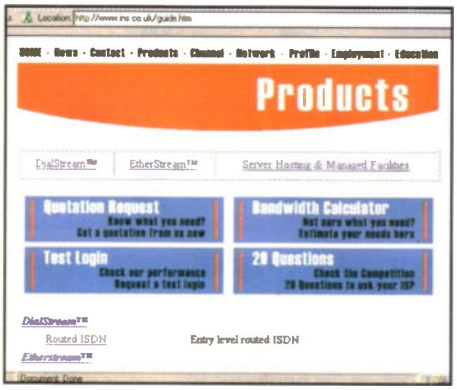
The findings warn that while UK Plc is cynical about conducting business electronically today, it is inevitable that business will be conducted electronically in the future and indeed essential if businesses are to remain competitive.

Overall, a total of 40% of UK's businesses said they had plans to conduct business electronically in the future. One in five believe they will be finding new recruits via the internet in the future and more than a quarter said they would be using videoconferencing to conduct business instead of travelling to meetings. Some 15 % also believe that in five years' time many employees will be working at home or away from the office on a regular basis.

The research reveals that although, in the future British business will be handled electronically, UK Plc falls into four distinct culture types that exist today, all of which are at different stages of E-business development.



Filtered Internet Access Stops Timewasters At Work



The Internet Network Services (INS) at **www.ins.co.uk,** launched a unique, network-level filtering service, Safenet. This protective network enables business customers to shield themselves from Web sites that they find inappropriate or offensive. With no distractions, no porn and no offensive material to worry about, Safenet can save a business considerable amounts of time and money.

The Safenet network supports the government's recent nationwide crackdown on 'cyber-porn'. Safenet automatically updates the system daily as new Web sites appear. Along with its own filters, the Safenet network incorporates Cyber Patrol software, a product developed by Microsystems, a division of The Learning Company. Cyber Patrol flags and prevents access to unwanted Web sites. In addition, Safenet can filter those sites that are specified by the customer.

With Internet Service Providers (ISPs) themselves under attack regarding censorship on the Internet, and one reputable company was recently prosecuted for failing to monitor the content of Web pages, more regulation of offensive material may be on the way. The European Union is funding a self regulatory regime aimed at filtering out illegal material on the Internet, and in the UK it is believed that the Department of Trade and Industry (DTI) is also planning a review on the removal of illegal material.

Subscribe Online for Free Cinema Screenings

The new 20th Century Fox Web site at **www.fox.co.uk** offers a complete guide to the company's upcoming and current movie and video releases. In addition to monthly online competitions for movie merchandise, visitors to the Web site can also subscribe online to free news updates and invitations to exclusive preview screenings of the latest movies.

Subscribers to the updates will be among the first to see the trailers and hear about local events for all new releases including the eagerly awaited Star Wars Episode I, due for release next year. The Web site has been designed to cater for all film fans and includes information on the smaller scale releases through Fox Searchlight as well as upcoming retail and rental video releases.

Internet Hit Squad To Hunt Down Hackers

Victims of cyber-crime can now hit back against hackers by setting a specialist hit squad on their trail. A new service from Internet security specialist CenturyCom at **www.centurycom.co.uk**, allows computer-based criminals to be traced back to their point of entry and beyond. Once located, these gaps can be secured to guard against future attacks.

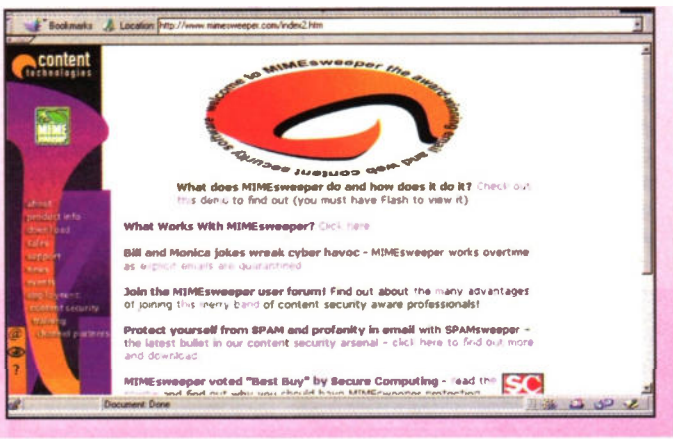
As soon as a company or individual is aware of a breach of security, they can call CenturyCom's 'Hacker Hotline' for assistance. The squad can then use various tracing techniques, such as examining the nature of attack and event logs, where they exist, to track the criminal's route back from the network or Web server.

Whilst most hackers cover their route by hacking into an unrelated PC and launching an attack from there, the majority of their route remains traceable. This means that, whilst few cyber-criminals leave themselves open to capture, their entry points can be located and blocked to prohibit future re-occurrences.

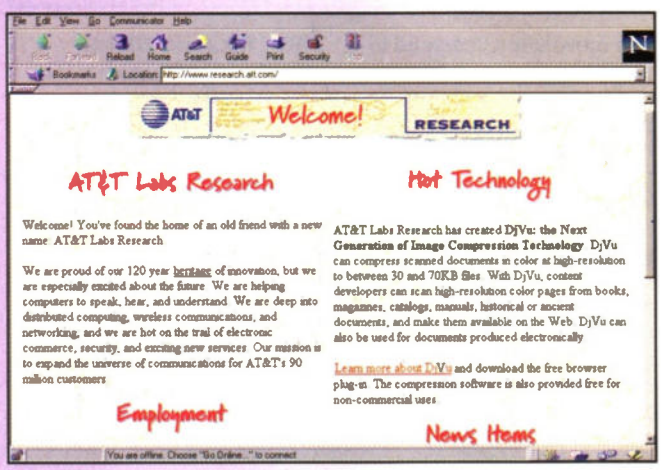
Content Technologies launches 'Spam Attack Pack'

Content Technologies is launching a dictionary of offensive and junk mail terms to allow users to avoid the potential legal and operational costs of junk mail. SPAMsweeper, available for free download from **www.mimesweeper.com**, comprises a comprehensive list of 'blocked' terms commonly found in unsolicited mail.

These include not only profane or offensive terms, but also phrases such as 'free gift', 'get rich', and 'remaining totally anonymous.' The dictionary also lists words commonly found in hoax viruses. The Spam Attack Pack will be updated every three months to accommodate new trends, such as Bill & Monica jokes, and known consumer scams and frauds.



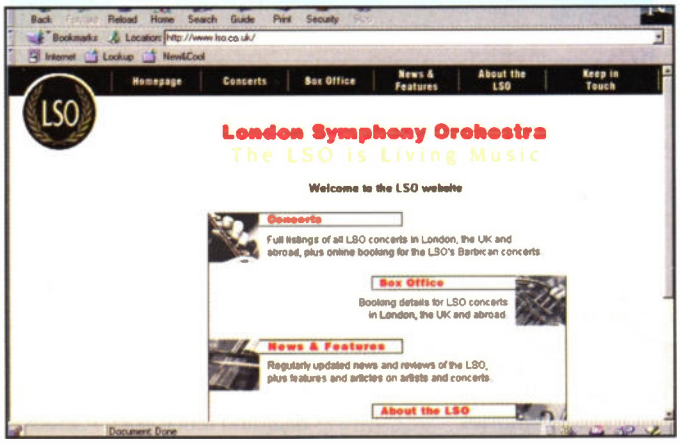
Fractal Models for Managing Internet Traffic



Researchers at AT&T Laboratory at **www.research.att.com** in the US are looking for new ways to manage networks that carry more data than voice traffic, and suggest the mathematics underlying so-called fractal behaviour could serve as a basis for more efficient models of data networks. In the case of data traffic, bursts of activity show up in approximately the same spiky pattern over a wide range of time scales - from milliseconds to minutes.

E-Commerce Empowers Sound of Music

At a glance there doesn't seem to be much to connect the London Symphony Orchestra and the rock musician, Manfred Mann. However, these two ends of the music spectrum have both turned to the same e-commerce software to add online sales facilities to their new Web sites. The package is Catalog from Actinic Software, a UK-based software house specialising in Internet business solutions. It will enable both sites to take secure orders from music enthusiasts all over the world.



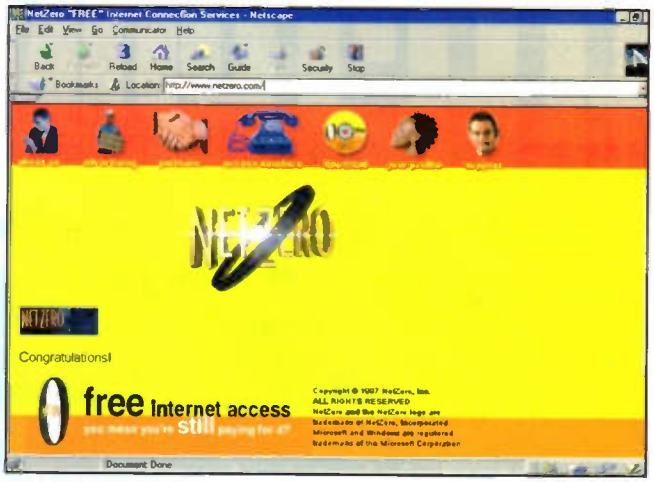
Manfred Mann used G-VIS Ltd to redesign his site under his own domain name at **<www.manfredmann.co.uk>**. This is part of his plan to promote the Summer European tour; the release of a new album 'Mann Alive'; and a programme of digitally remastered albums to be released in September

When the London Symphony Orchestra 1998/9 season opened on 23rd September 1998 tickets were available online for the first time, thanks to the new-look LSO Web site at **<www.lso.co.uk>**. The LSO promotes 85 concerts each year at its home in the Barbican Centre, which represents over 160,000 tickets on sale annually.

Interflora Takes Strain Out of Christmas

From December, Interflora's Christmas Collection is available from the company's Internet Web site at **www.interflora.co.uk.** Browse through the pictured range then order on-line quickly, easily and efficiently. Orders may be placed up to close of business on 22nd December for delivery before Christmas.

Another Try at Free Net Service



NetZero at **www.netzero.com**, is offering free Internet service to consumers, operating on an advertising-based business model. But the company isn't selling your typical banner ad, however. NetZero's banners can 'follow' users from site to site as they peruse the Web. The company says it's spent a year developing software that tracks users' habits, enabling advertisers to pinpoint their messages more efficiently.

Site Survey

The month's destinations

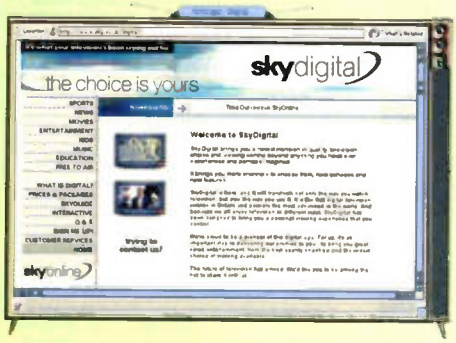
Digital television is a hot potato topic at the moment, with new channels popping up all over the place from one of the two current digital television broadcasters. Anyone considering buying a digital television, or at least a set-top box allowing you to receive digital channels on your existing television receiver, would do well to do a spot of research to find out what's what. Fortunately, everyone concerned appears to have a Website where you can find all the information you need. And before you say anything yes! we simply couldn't resist the window frames around the screenshots of these Websites.

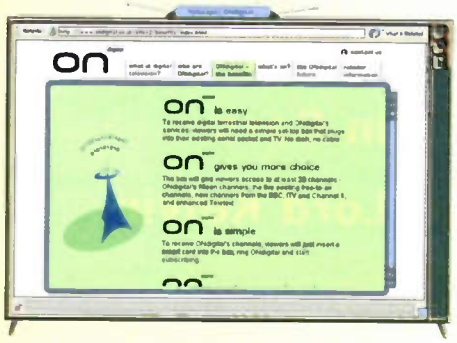
BskyB, of course, was the first digital television service to get up and running, and its Website at: **<http://www.sky.co.uk/digital>** is a good first stopping point.

Following hot on BskyB's heels is ONDigital's service, which got off the ground on 15 November. Check out its offerings at: **<http://www.ondigital.co.uk>**

While transmitting on both digital television broadcasting services, the BBC's digital channels are detailed on the beeb's Website, at: **<http://www.bbc.co.uk/digital>**. Here you can locate much more information too, for example about the roll-out program of channels and transmitters that will be affected.

Also, although cable television providers aren't expected to start digital television services until next year, Cable & Wireless gives a few details on its Website, at **<http://www.cwcom.co.uk>**





in the pipeline

ELECTRONICS and Beyond

Don't miss another great assortment of entertaining and easy-to-make projects and essential electronics information aimed at the novice constructor.

Issue 134 will be on sale Friday 1st January

PROJECTS

Model Racing Car Race Computer

Portable Geiger-Muller Counter

Guitar Pre-amplifier

Pyscho-Kinetic Bio-Feedback Trainer & Movement Detector

FEATURES

Flat Screens

Science & Language

Electronics in Cars

Life & Times of Lord Kelvin

Project Ratings

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

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

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

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

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

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

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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**.

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If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Service Dept. may be able to help. You can obtain help in several ways: ❶ Over the phone, telephone 0897 501353 between 9.00am and 5.30pm Monday to Saturday, except public holidays (calls charged at £1/min BT rates); ❷ By sending a facsimile, Fax (01702) 554001; ❸ Or by writing to Technical Services, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Services are unable to answer enquires relating to third-party products or components which are not stocked by Maplin.

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If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini-Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service return the complete kit to: Returns Department, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Enclose a cheque or Postal Order for the servicing cost (£24/hr min + parts) as indicated in the current Maplin Catalogue. If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost, plus parts. A kit building service is on offer for any of our kits. Please contact our customer service department for any pricing details.

ELECTRONICS and Beyond

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