Final issue – Collector's item

October 1992 £1.50

NEW PRACTICAL ELECTRONICS

SCIENCE AND TECHNOLOGY

28 years of electronics

Electronics In Cars
Boolean Logic
New Products
Build An Electronic Echo

Opinion

Barry Fox talks telephone connectors
Ian Burley discusses the future of telecommunications

This month...

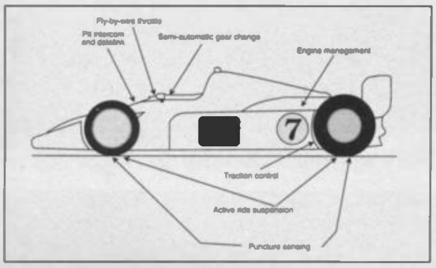
Practical electronics has been around since the birth of the electronics industry and has seen it grow from a minor engineering enterprise to its current world dominating position.

Unfortunately, times change and PE is now to merge with is sister magazine Everyday Electronics. John Becker, my predecessor and a long time contributor, takes a look back to when both magazines where run by the same company – page 12.

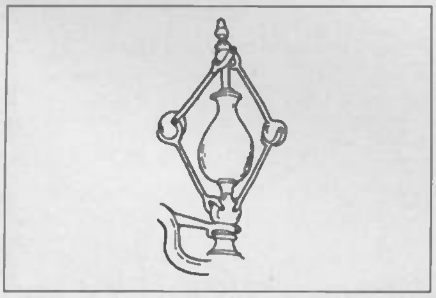
Another long time contributor, Derek Gooding presents an extravaganza of images looking at the development of automation technology – page 28.

On a more modern note, Ian Burley delves into the hi-tech world of motor racing to see how electronic technology built for the track is finding its way onto out roads – page 30.

Finally, I would like to take this opportunity to thank everyone who has contributed to PE over the years and helped me out over the past two years at the helm.



Racing electronics – page 30



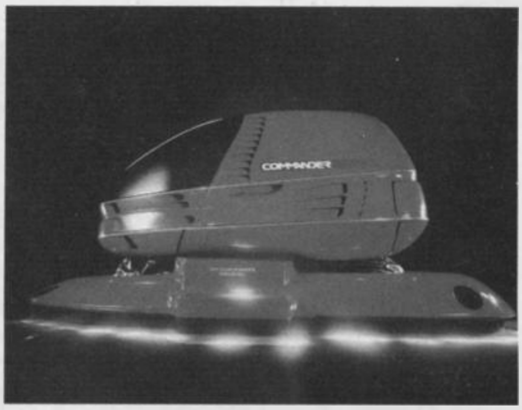
Early automation – page 28

Next month...

We join forces with Everyday Electronics so look out for the super bumper issue.

Cover illustration and design: Richard Milner

When we were 25 – page 12



The VR machine – page 17

Features

Time Change 12
John Becker looks back over PE's past

Background Logic 22
The workings of boolean algebra

Car Electronics 30
How electronic gadgets are taking over in cars

HELLO...Hello...hello 40
Build this super echo unit

Regulars

Innovations 4
Virtual reality, HDTV and Crystaleyes 3d-specs

Wavelengths 6
Your questions answered

Electronic Computing 5
A doubled DX-2, high quality printers plus Texas and Victor PCs

Barry Fox 10
Connecting US phones to UK services and vice versa

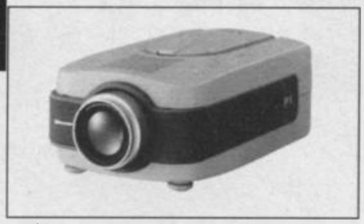
Ian Burley 11
This is the age of communications

New Product Developments 15
Modular PCs, flight simulators, and the ultimate mousetrap

Look Back 28
Two hundred years from steam engine to microchip

Techniques 45
The basics of bio-feedback

Taking a ride – page 18



Sharp LCD projector – page 17

Electronic book – page 19

Caught in a trap – page19

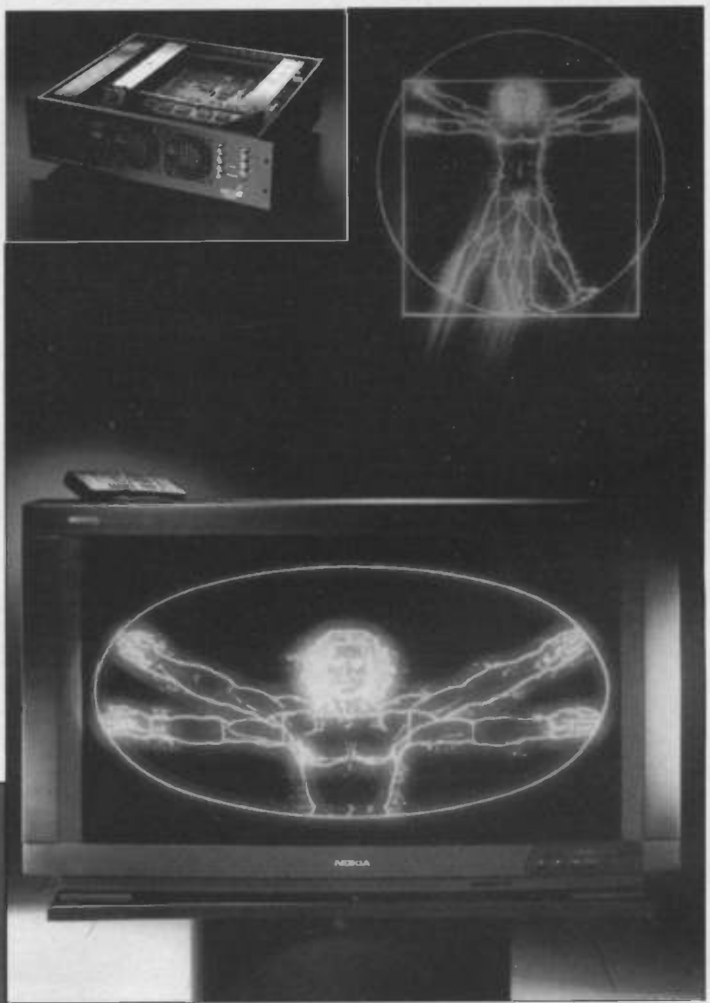
Editor: Kenn Garroch Advertisement Manager David Bonner Accounts Manager Martin Milner Additional photography by Carolyn Vaughn Publisher:Richard Milner Managing Director: Angelo Zgorelec • **Practical Electronics Intra House 193 Uxbridge Road London W12 9RA Tel: 081-743 8888 Fax: 081-743 3062 Telecom Gold: 87: SQQ567 CIX Care of PROGNOW • Advertisements** The Publishers of PE take reasonable precautions to ensure that advertisements published in the magazine are genuine, but cannot take any responsibility in respect of statements or claims made by advertisers. The Publishers also cannot accept any liability in respect of goods not being delivered or not working properly. • Practical Electronics is typeset and reproduced at Intra Press on Macintosh computers using Quark Xpress, Scan Xpert scanner and Adobe Photoshop. Advertising reproduction by Circle Rule Ltd. Printing by Andover Press, St Ives plc. Distribution by Seymour Press • **ISSN 0032-6372** •

Innovations

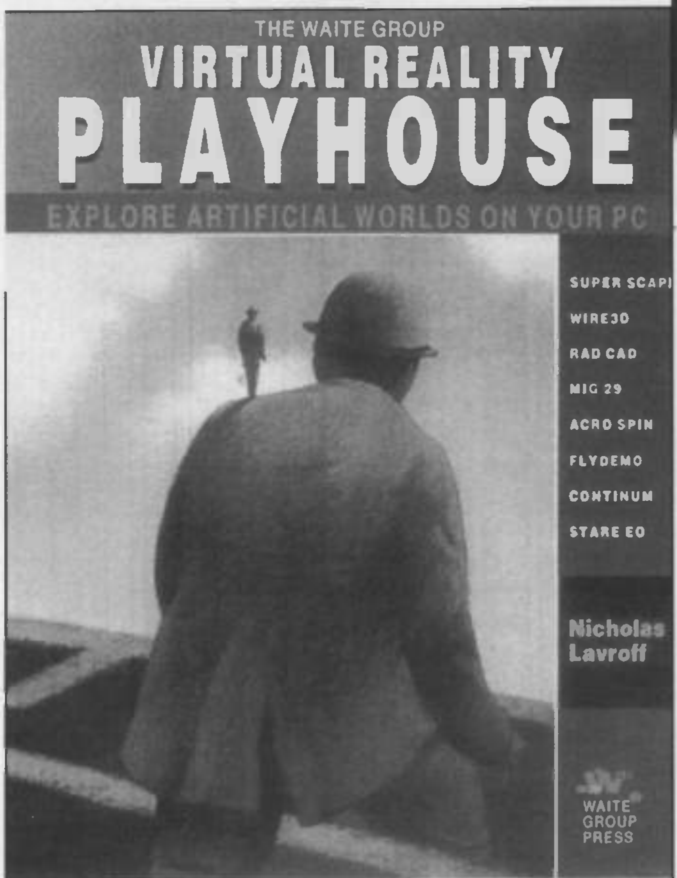
A round-up of the latest news in the technology arena

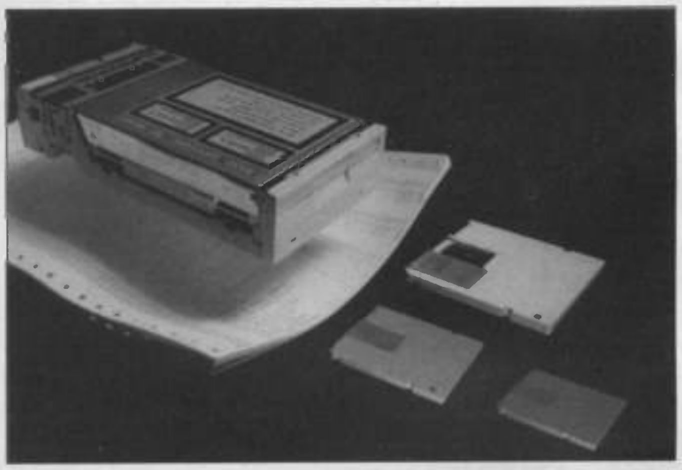
The Olympic Games were transmitted across Europe live in HD-MAC, a proposed high definition TV standard. Receiving it in the UK was Nokia with its HDTV Olympic Receiver – a 16:9 format 36in direct view (not projected as some others are), 1250 line TV.

Nokia's receiver has been designed especially for HD-MAC reception as well as all standard terrestrial broadcast formats including PAL, SECAM, NTSC and D2-MAC. It is also Nicam stereo compatible and has built in teletext functions. In a sense, this is the ultimate in TV sets and makes the common or garden 4:3 625 TV seem very old fashioned. Nokia also make a wide screen TV capable of receiving and displaying normal 625 line PAL TV pictures. This is seen as an in-between step to the next generation TV which the Olympic Receiver represents.



Nokia's HDTV with tuner box inset





The Sony half-height 3.5in optical disk above holds 128Mbytes, spins 3000 times per minute and a data transfer speed of 625kbytes per second and use Sony's magnetor optical storage technology.

Pick up any recent newspaper or magazine and you are likely to find an article about virtual reality (VR). This is a technology that can completely immerse you in a world that exists only inside a computer. Even the cinema is starting to get in on the act with films like Lawnmower Man.

On a more serious note, VR is beginning to be used in industry and medicine for training, visualisation and modelling work.

Virtual Reality Playhouse is an innovative book/disk package from Waite Group Press. It gives a complete history and overview of VR and is one of the first books on the subject. Included in the package is a disk and a pair of 3D specs that will allow readers to experience VR in practice. Programs include 3D wireframes that rotate out of the screen, a virtual city that can be explored and a jet fighter simulator.

For more information, contact Waite Group Press/Pitman Publishing, 128 Long Acre, London WC2E 9AN, tel 071 379 7383.

CITIZEN

ALWAYS A GOOD IDEA

DOT MATRIX & NOTEBOOK PRINTERS

Silica presents some great offers on the award winning range of high quality matrix printers from Citizen. Each Citizen printer is built in the UK to exacting standards, ensuring superb reliability and output. Our confidence in Citizen's quality is such that we are pleased to include a 2 year guarantee with every printer. Plus, if you buy a Citizen printer from us, we will give you the Silica Systems Printer Starter Kit (worth £29.38), *FREE OF CHARGE!*

FREE DELIVERY
Next Day - Anywhere in the UK mainland

FREE STARTER KIT
Worth £29.38 - With every Citizen printer from Silica.

2 YEAR WARRANTY
Silica offer a 2 year warranty (including the printer head) with every Citizen printer from Silica.

WINDOWS 3.0
Free Windows 3.0 driver. Included with the Silica Starter Kit.

FREE COLOUR KIT
With every Swift 9 and Swift 24e printer.

FREE HELPLINE
Technical support helpline open during office hours.

MADE IN THE UK
Citizen printers are manufactured to high standards.

9 PIN PRINTER

144 CPS — **80 COLUMN**

- Citizen 120D+ - 9 pin - 80 column
- 144cps Draft, 30cps NLQ
- 4K Printer Buffer + 2 Fonts
- Parallel Interface as Standard
- Graphics Resolution: 240×240dpi
- Epson and IBM Emulation
- Pull tractor & bottom feed
- FREE Silica Printer Starter Kit

RRP:	£199
STARTER KIT	£25
TOTAL RRP:	£224
SAVING	£95
SILICA PRICE:	£129

SERIAL INTERFACE OPTION
The 120D printer is available with a serial interface for £139+VAT Ref: PRI 2125 - £163.33 inc VAT

£129
+VAT=£151.58 ref: PRI 2120

9 PIN PRINTERS

192 CPS — **80 COLUMN**

- Citizen Swift 9 - 9 pin - 80 column
- 192cps Draft, 48cps NLQ
- 8K Printer Buffer + 3 Fonts
- Parallel Interface
- Graphics Resolution: 240×240dpi
- Epson and IBM Emulation
- FREE Colour Kit
- FREE Silica Printer Starter Kit

RRP:	£239
COLOUR KIT	£38
STARTER KIT	£25
TOTAL RRP:	£302
SAVING	£123
SILICA PRICE:	£179

£179
+VAT=£222.08 ref: PRI 2209

192 CPS — **136 COLUMN**

- Citizen Swift 9x - 9 pin - 136 column
- 192cps Draft, 48cps NLQ
- 8K Printer Buffer + 3 Fonts
- Parallel Interface
- Graphics Resolution: 240×240dpi
- Epson and IBM Emulation
- A3 landscape printing
- FREE Silica Printer Starter Kit

RRP:	£329
STARTER KIT	£25
TOTAL RRP:	£354
SAVING	£105
SILICA PRICE:	£249

£249
+VAT=£292.58 ref: PRI 2309

24 PIN PRINTERS

216 CPS — **80 COLUMN**

- Citizen Swift 24e - 24 pin - 80 column
- 216cps Draft, 72cps LQ
- 8K Printer Buffer + 6 Fonts
- Parallel Interface
- Graphics Resolution: 360×360dpi
- Epson, IBM & NEC P6+ Emulation
- FREE Colour Kit
- FREE Silica Printer Starter Kit

RRP:	£365
COLOUR KIT	£38
STARTER KIT	£25
TOTAL RRP:	£428
SAVING:	£169
SILICA PRICE:	£259

£259
+VAT=£304.33 ref: PRI 2534

192 CPS — **80 COLUMN**

- Citizen 224 - 24 pin - 80 column
- 192cps Draft, 64cps LQ
- 8K Printer Buffer + 2 Fonts
- Parallel Interface
- Graphics Resolution: 360×360dpi
- Epson and IBM Emulation
- Colour Option Available
- FREE Silica Printer Starter Kit

RRP:	£269
STARTER KIT	£25
TOTAL RRP:	£294
SAVING:	£95
SILICA PRICE:	£199

£199
+VAT=£233.83 ref: PRI 2484

NOTEBOOK PRINTER

64 CPS — **80 COLUMN**

- Citizen PN48 Notebook Printer
- Non-impact Printing On Plain Paper
- LASER QUALITY - 64cps
- 4K Printer Buffer + 2 Fonts
- Rear and Bottom Paper Loading
- Parallel Interface
- Graphics Resolution: 360×360dpi
- Epson, IBM, NEC P6 & Citizen Emulations
- Power: Mains, Battery or Car Adaptor
- FREE Silica Printer Starter Kit

RRP:	£325
STARTER KIT	£25
TOTAL RRP:	£350
SAVING	£101
SILICA PRICE:	£249

£249
+VAT=£292.58 ref: PRI 2100

24 PIN PRINTER

192 CPS — **136 COLUMN**

- Citizen Swift 24x - 24 pin - 136 column
- 192cps Draft, 64cps LQ
- 8K Printer Buffer + 4 Fonts
- Parallel Interface
- Graphics Resolution: 360×360dpi
- Epson, IBM and NEC P6 Emulation
- A3 landscape printing - FREE Colour Kit
- FREE Silica Printer Starter Kit

RRP:	£489
STARTER KIT	£25
TOTAL RRP:	£514
SAVING	£165
SILICA PRICE:	£349

£349
+VAT=£410.08 ref: PRI 2574

24 PIN PRINTER

GOLD AWARD
Best Budget Printer 1990
Micro Decision

144 CPS
80 COLUMN

- Citizen 124D - 24 pin - 80 col
- 144cps Draft, 48cps LQ
- 8K Printer Buffer + 2 Fonts
- Parallel Interface
- Graphics Res: 360×360dpi
- Epson and IBM Emulation
- FREE Silica Printer Starter Kit

RRP:	£249
STARTER KIT	£25
TOTAL RRP:	£274
SAVING:	£105
SILICA PRICE:	£169

£169
+VAT=£198.58 ref: PRI 2534

ACCESSORIES

SHEET FEEDERS			
PRA 1200	1200		£71.38
PRA 1215	124D/224 Sw9/24/24e		£88.70
PRA 1228	124D/224 Sw9/24/24e		£42.00
SERIAL INTERFACES			
PRA 1189	120D+		£56.45
PRA 1209	124D/224 Swift 9		£32.25
PRA 1709	Swift 24/24e		£26.38
32K MEMORY EXPN			
PRA 1753	124D/224 Swift 24/24e		£13.10
PRINTER STAND			
PRA 1242	124D/224 Sw9/24/24e		£24.03
PRA 1274	Swift 9x/24x		£30.66
ORIGINAL RIBBONS			
RIB 3520	120D/Swift 9 Black		£2.91
RIB 3949	Swift 9x Black		£7.15
RIB 3924	124D/224 Sw24/24e Black		£4.20
RIB 3936	Swift 9/24/24e Colour		£15.63
RIB 3248	PN48 Single Strike		£3.61
RIB 3348	PN48 Multi Strike		£3.61
COLOUR KITS			
PRA 1236	Swift 9/24/24e		£35.25
PRA 1240	Swift 9x/24x		£35.25
PN48 ACCESSORIES			
PRA 1148	PN48 Battery		£51.70
PRA 1155	PN48 Cable Extn		£ TBC
PRA 1162	PN48 Car Adaptor		£ TBC

All prices include VAT and Free delivery.

STARTER KIT

FREE!

Worth: £25 +VAT=£29.38

To get you up and running with your new printer from Silica:

- 3½" Disk - Amiga & ST Drivers
- 3½" Disk - Drivers for Windows 3
- 2 Metre Parallel Printer Cable
- 200 Sheets of Continuous Paper
- 100 Continuous Address Labels
- 5 Continuous Envelopes

If you already own a printer, and would like to buy a kit, you may order one (ref: KIT 5500) for £24.95 - £5 off RRP!

SILICA SYSTEMS OFFER YOU

- *FREE OVERNIGHT DELIVERY:* On all hardware orders shipped in the UK mainland.
- *TECHNICAL SUPPORT HELPLINE:* Team of technical experts at your service.
- *PRICE MATCH:* We normally match competitors on a "Same product - Same price" basis.
- *ESTABLISHED 12 YEARS:* Proven track record in professional computer sales.
- *BUSINESS + EDUCATION + GOVERNMENT:* Volume discounts available for large orders.
- *SHOWROOMS:* Demonstration and training facilities at our London & Sidcup branches.
- *THE FULL STOCK RANGE:* All of your requirements from one supplier.
- *FREE CATALOGUES:* Will be mailed to you with offers and software/peripheral details.
- *PAYMENT:* By cash, cheque and all major credit cards.

Before you decide when to buy your new printer, we suggest you think very carefully about WHERE you buy it. Consider what it will be like a few months after you have made your purchase, when you may require additional peripherals or software, or help and advice. And, will the company you buy from contact you with details of new products? At Silica Systems, we ensure that you will have nothing to worry about. We have been established for over 12 years and, with our unrivalled experience and expertise, we can now claim to meet our customers requirements with an understanding which is second to none. But don't just take our word for it. Complete and return the coupon now for our latest Free literature and begin to experience the "Silica Systems Service".

MAIL ORDER HOTLINE **081-309 1111**

SILICA SYSTEMS

MAIL ORDER: Order Lines Open:	Mon-Sat 9.00am-6.00pm	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX — No Late Night Opening	**Tel: 081-309 1111** Fax No: 081-308 0608
LONDON SHOP: Opening Hours:	Mon-Sat 9.30am-6.00pm	52 Tottenham Court Road, London, W1P 0BA — No Late Night Opening	**Tel: 071-580 4000** Fax No: 071-323 4737
LONDON SHOP: Opening Hours:	Mon-Sat 9.30am-6.00pm	Selfridges (1st Floor), Oxford Street, London, W1A 1AB — Late Night: Thursday until 8pm	**Tel: 071-629 1234** Extension: 3914
SIDCUP SHOP: Opening Hours:	Mon-Sat 9.00am-5.30pm	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX — Late Night: Friday until 7pm	**Tel: 081-302 8811** Fax No: 081-309 0017

To: Silica Systems, Dept PRNOW-1291-55, 1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX

PLEASE SEND A CITIZEN COLOUR CATALOGUE

Mr/Mrs/Ms: .... Initials: .... Surname: ....

Address: ....

....

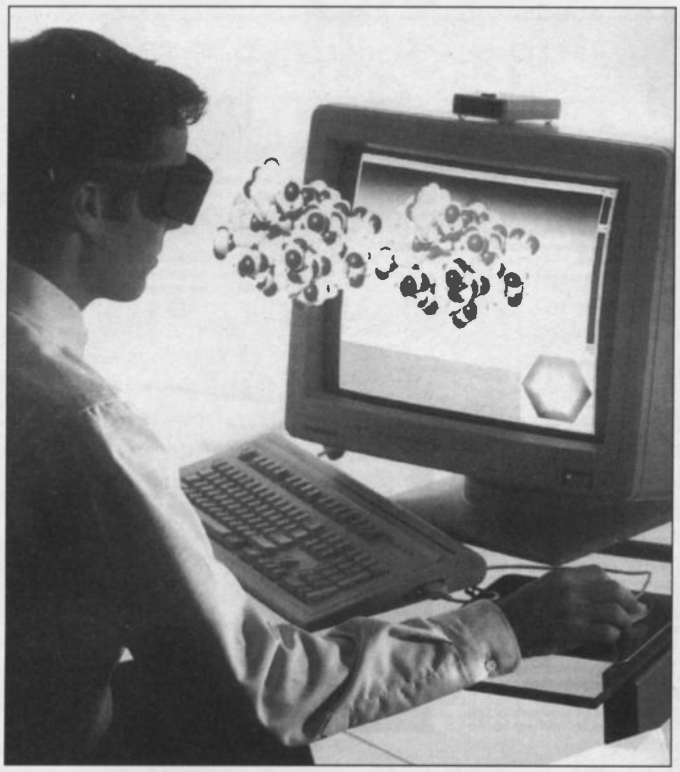
.... Postcode: ....

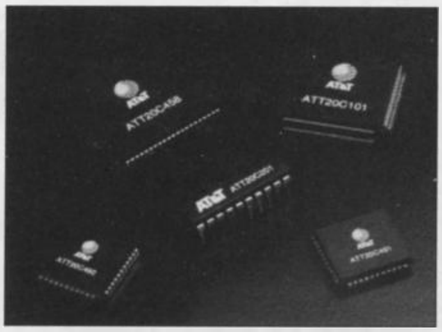
Tel (Home): .... Tel (Work): ....

Company Name (if applicable): ....

Which computer(s), if any, do you own? 55C

E&OE - Advertised prices and specifications may change - Please return the coupon for the latest information.





Designers of affordable, mass-market PCs and workstations can give their customers near photographic quality displays with AT&T Microelectronics' newest generation chip set.

The Crystaleyes viewing devices are electronic glasses, the lenses of which open and close alternately, exposing the left eye to a left image and the right eye to a right image at a rate of twice the normal vertical screen refresh rate. A flicker free image is delivered to the brain which combines the two images to produce a 3D effect. The glasses are synchronsed with the display and the computer via an infra-red link.

Computing News

The latest from Anthony Robertson

At last the IBM PC is catching up with Amigas, Apples and Ataris, quality sound can be provided with Audioport, an external audio adapter for laptop, desktop and notebook PCs.

Audioport now gives PC users a low-cost and simple way to add stereo, broadcast-quality, digital-audio functions to their application programs. Users can perform real-time, direct-to-disk recording and playback of sampled sound.

As easy as plugging in a printer, Audioport conveniently connects to the parallel printer port of any PC.

Super printer, super price

Texas - the way ahead?

Continued on page 8

Wavelengths

If you have any comments, suggestions, subjects you think shouled be aired, write to PE

Longer Lasting Lights

In these days of environmental awareness, I am keen to outfit my house with the new long lasting, low power lightbulbs, some of which I believe are produced by Thorn EMI. My problem is that I am having difficulty locating a source, and I want to get the best units available. Can you advise me on the various types available, and the price range?

P McNamara
Inverness

You might like to glance over Ian Burley's experiences with these long lasting bulbs in the September issue of Practical Electronics.

You should be able to buy compact flourescent bulbs from Woolworths and your local electricity showroom – although you may have to make enquiries with the shop assistants to get hold of them. They cost roughly £10 each which, although it may sound expensive, is not too bad when you consider that they use a quarter of the power of a normal incandescent bulb for the same light output and last up to eight times as long. They are, consequently, much better for the environment.

Answerphone Advice

I have an ansaphone at home, but it often records people who just put the phone down when they realise noboby's at home. Are there answerphones which do not record these nuisance calls, or which record the phone number of the person who hangs up, so I can ring them back and annoy them?

Brian Adams
Richmond

Unfortunately, BT doesn't provide any facilities for answerer's to know who is calling them – you might try contacting BT to see if they are ever hoping to do this. After all, they are supposed to be willing to listen to customers suggestions (or am I confusing them with a well known bank?). I don't know of any phones which get around this problem perhaps other readers can help?

Personal Organisers

I have noticed the proliferation of Electronic personal organisers in the high street shops recently. Is it worth getting one yet, or are the prices likely to drop, and the power of the units to increase, in a hurry? Also, which of these units would you recommend, and which are compatible with IBM PCs? I would be using it mainly as a diary and memo book, but I do travel occasionally so a world clock would be useful too.

T Jarvis
Sunderland

The is a wide selection of electronic organisers to choose and most offer the same functions. At the top end of the scale are machines which are basically micro-miniaturised PCs and will run MS-DOS compatible software – from manufactuers like Atari and Poqet. At the other are the simpler devices which provide basic calendar, notebook, address book, calculator, alarm functions – the Psion Organiser and Sharp IQ. The thing to bear in mind is that for alarm functions and basic names and addresses, a cheaper model will do fine. Do check out the method of changing batteries and make sure that there can never be any data lost druing this process – some Psion Organisers are troubled by this problem. Also take a look at what add-ons and upgrades are available. Will you want to attach it to a PC or do you want a simple spreadsheet? Other points are that it is almost impossible to take notes on any machine that is so small – especially if you have big fingers. Look out for QWERTY keyboards rather and ABCDEF type if you are a typist – it is hell trying to find keys that are not in the right place! Apart from this, choose whichever one takes your fancy.

On the increased power front, the latest offerring is, or will be, the Apple Newton (PE August) which looks set to make all other organisers redundant – we shall have to wait and see when it eventually appears.

Remote Controls

My brother has a remote control unit that works on both his TV and Video, using a switch to choose which is active. Is it possible to buy these, or are they only possible if the TV and Video are made by the same company?

T Jefferson
Cleveland

Many manufactuers now provide multi device remote controls. To operate with any machine you will probably need a remote control that can learn your machine's codes. There are a number of these around – try One For All II from Celtel (0256 474900).

FM Interference

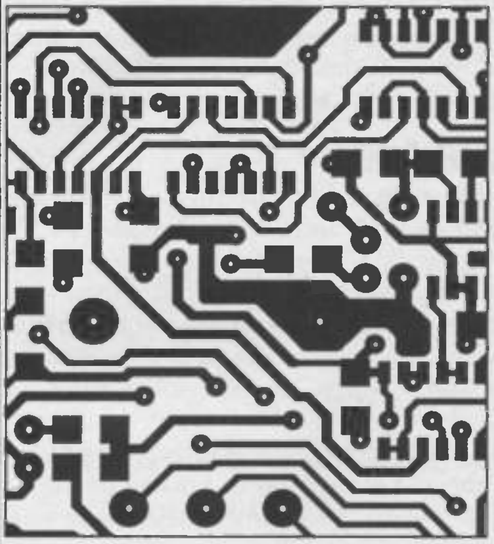
When my radio is tuned into FM stations I find that walking around the room causes interference, spoiling my enjoyment of the programmes. What causes this, and why is FM so touted as the best wavelength with such an obvious problem? This never used to happen with longwave.

Mrs Brady
Tooting

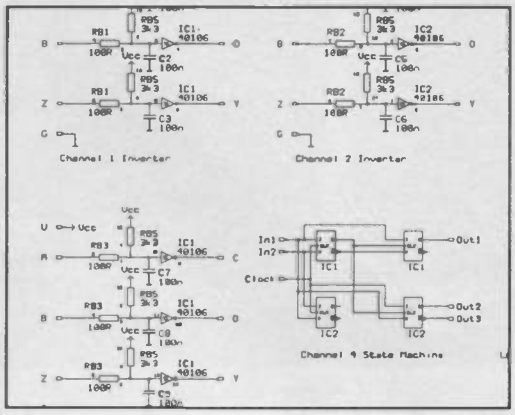
FM is better because you get a much higher bandwidth which allows a wider range of audio frequencies to be transmitted and hence, higher quality. What you really need is a better aerial so that you improve the signal strength of the radio station you're listening to.

EASY-PC PCB and Circuit Diagram CAD

Forget using tapes and lightbox! Create your Circuit Boards using CAD - like the professionals.



- Runs on PC/XT/AT etc. with Hercules, CGA, EGA or VGA display and many DOS emulations.
- Design Schematics Single and Double sided and Multilayer boards including Surface Mount.
- Standard output includes Dot Matrix / Laser / Inkjet Printer, Pen Plotter, Photo-plotter and N.C. Drill.
- Extremely powerful.
- Very easy to use.



EASY-PC

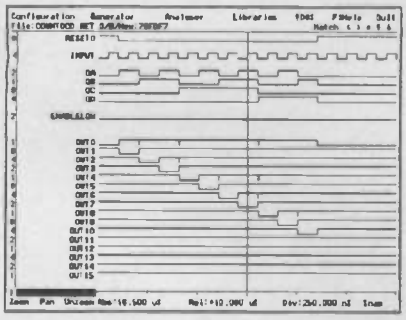
Technical support is free, for life!

Only £98.00!
Plus P&P+VAT

Over 13,000 Installations in 70 Countries Worldwide!

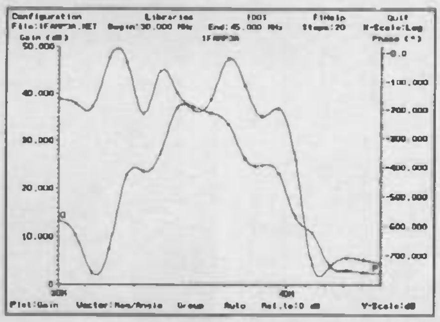
Options:-500 piece Surface Mount Symbol Library £48, 1000 piece Symbol Library £38, Gerber Import facility £98.

DIGITAL SIMULATION £195



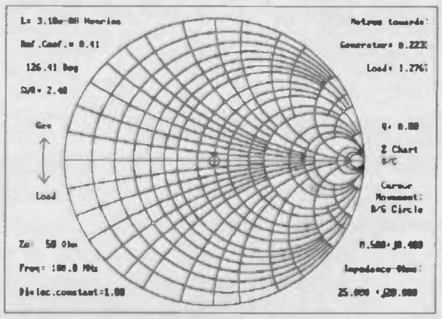
- At last! A full featured Digital Circuit Simulator for less than £1000!
- PULSAR allows you to test your designs without the need for expensive test equipment.
- Catch glitches down to a pico second per week!
- Includes 4000 Series CMOS and 74LS Libraries. 74HC/HCT libraries only £48.00 each.
- Runs on PC/XT/AT/286/386/486 with EGA or VGA.

ANALOGUE SIMULATION £195



- NEW powerful ANALYSER III has full graphical output.
- Handles R's,L's,C's, Bipolar Transistors, FET's, OP-amp's, Tapped and Untapped Transformers, and Microstrip and Co-axial Transmission Lines.
- Plots Input / Output Impedance, Gain, Phase & Group Delay.
- Covers 0.001 Hz to > 10GHz
- For PC/XT/AT/286/386/486 with EGA or VGA.
- Very fast computation.

SMITH CHART CAD £195



- Z-MATCH II simplifies RF matching and includes many more features than the standard Smith Chart.
- Handles transmission line transformers, stubs, discrete components, S Parameters etc.
- Supplied with many worked examples.
- Superbly easy to learn and use.
- Runs on IBM PC/XT/AT/386/486, CGA,EGA,VGA.
- Ideal for Education and Industry.

For full information, Write, Phone or Fax:-

Number One Systems Ltd. 1

- TECHNICAL SUPPORT FREE FOR LIFE!
- PROGRAMS NOT COPY PROTECTED.
- SPECIAL PRICES FOR EDUCATION.

REF: PE, HARDING WAY, ST.IVES, HUNTINGDON, CAMBS, ENGLAND, PE17 4WR.
Telephone: 0480 61778 (7 lines) Fax: 0480 494042
International: +44 -480-61778, Fax: +44-480-494042 ACCESS, AMEX, MASTERCARD, VISA Welcome.

Victor, high quality, low cost

Being an interrupt driven device it can live in the background, and does not interfere with the use of the printer. For further information regarding Antex or its products, please direct inquiries to: Antex Electronics Corp. 16100 S. Figueroa Street, Gardena, CA 90248 Tel: 010-310-532-309.

High Class OCE

OCE Printing systems have announced their new '6775' laser printer capable of document output at an impressive 23 pages per minute (ppm) . This figure almost equals the current price of this piece of hi-tech, at £29,000. Quality wise this futuristic new printer can provide 508 dots per inch (dpi) resolution. Kind of makes the standard 'office' 8 ppm printer seem lacking, doesn't it? For more information please contact OCE Printing Systems on 081-502-0038.

Texas Workstation

Now that the 80486SX chip is gaining new ground in the PC Power Wars, Texas Instruments have announced an 80486SX based design, which is claimed to provide higher specifications at a lower price than previous 80386DX based models. The TI486SX/20P costs around £2,000 and uses an Intel microprocessor to provide up to 20% more power than earlier models based on 80386DX architecture.

Fitted with 4Mb RAM expandable to 16Mb, onboard hard/floppy disk controller and integrated SuperVGA graphics capabilities and a choice of one or two 40Mb or 110Mb hard drive storage, this computer is more than a match for any PC software, users care to install on it. For more information please contact Texas Instruments Limited, on 0234-270111.

Price Victor

On the pricing front, Victor Technologies has made an aggressive move in the 486 market by introducing the XTRA, a 486SX micro tower series product, for only £1199, undercutting their industry opponents by hundreds of pounds This new computer which is manufactured at the Tandy-Victor factory in East Kilbride, can be delivered within 24 hours of order placement.

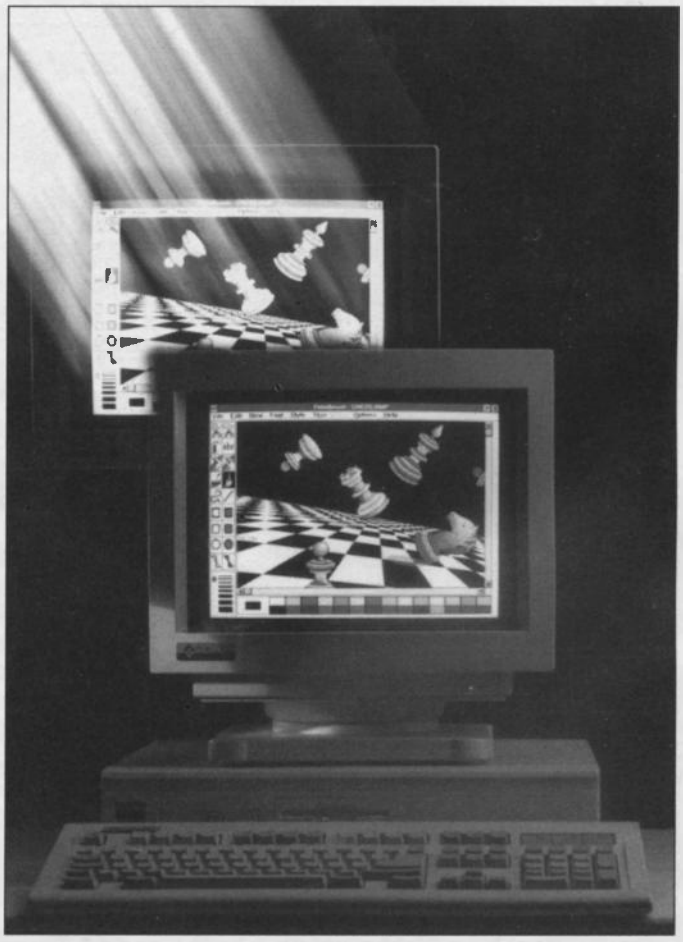
Like the Texas TI486SX/20P, the V486/MX XTRA is equipped with a 80486SX processor running at 20MHz, and a super VGA colour monitor. Storage facilities provided as standard are 4MB of RAM, expandable to 32MB, a 105MB hard disk drive, 8KB of CPU cache and a 1.44MB floppy disk drive. As in all Victor desktop products, MS-DOS 5.0 and Windows 3.1 are installed before despatch. For further information please contact: Duncan Seager, Victor Technologies, Tel: 081-897-6565.

Double Speed 486

The DX2 microprocessor is catching on it seems. Pericom Technology has introduced the 486DX2-50 which incorporates Intel's new clock-doubled CPU, providing 50MHz speed but at a lower cost than standard 50MHz systems. This 'big gun' among micro processors is only the first step of the ladder in terms of speed, late 1992/early 93 will see the availability of 100 Mhz designs.

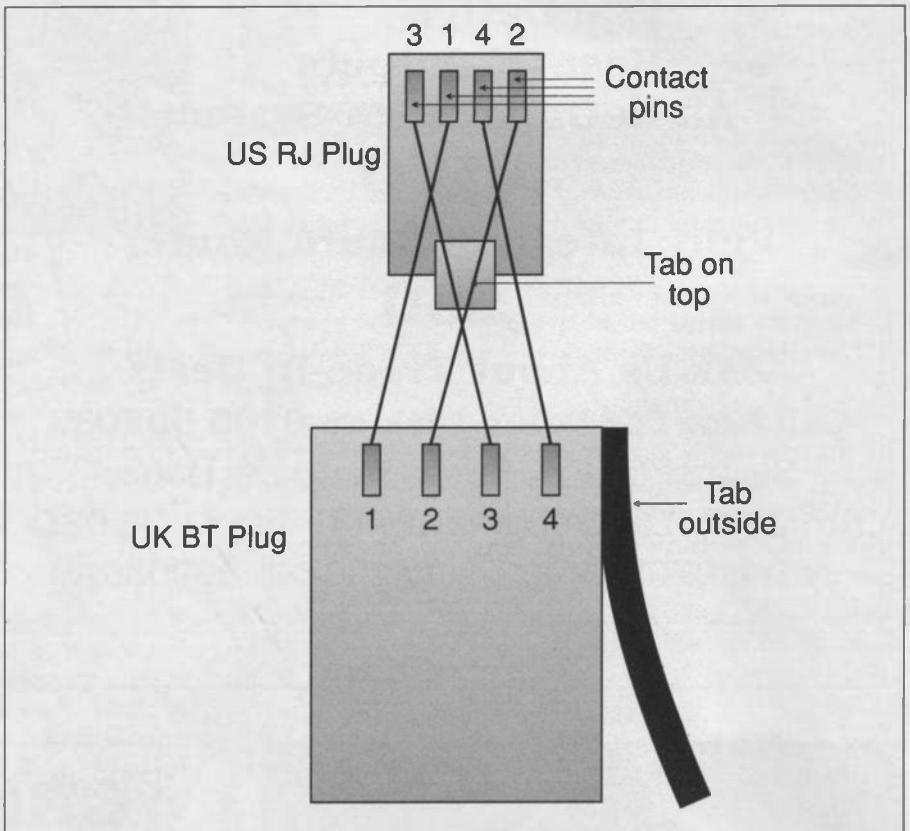
The 486DX2 chip operates internally at twice the clock speed of the rest of the system, which operates at its 'normal' speed. This significantly increases system performance, but the chip works with existing 25MHz motherboard designs, and does not substantially increase the price. In standard configuration the Pericom 486DX2-50 costs a reasonable £1404. Further information can be obtained from Pericom Technology plc on 0908-560022 ■

Pericom's double standard



Barry Fox

From the 70s to the 90s and the tale of a telephone socket.

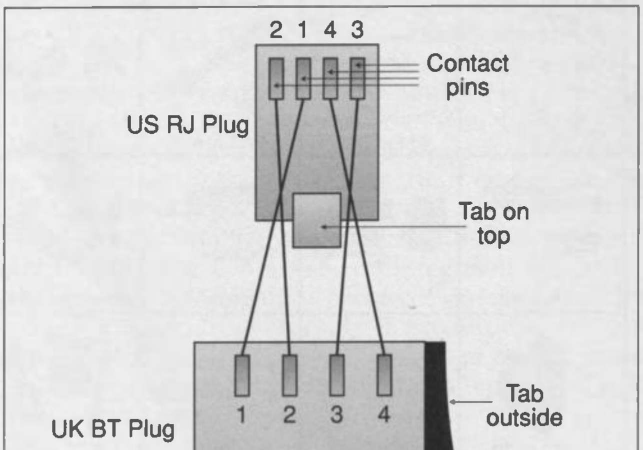


Another variant, outside to inside.

The box files on my shelf tell me that I started writing for Practical Electronics almost exactly twenty years ago. In those days I was still working witha firm of patent agents and wrote a monthly piece for PE called "Patents Review". In it I reported on the latest, and most interesting, patents on electronics which had been published by the British Patent Office.

For legal reasons (a professional ban on anything that could be construed as advertising) the Patents Review columns were not signed. Over the years I got pretty bored with electronic patents because the same old ideas seemed to be coming around again and again. So in the mid-80s we switched to "The Leading Edge", a signed column about new technology, future opportunities and missed opportunities.

Since the mid-70's I had also been writing another column, "For Your Entertainment", in what was previously PE's sister magazine, Everyday Electronics. For those same professional reasons, the first ten years of the EE columns had to be written under a pen-name, Adrian Hope.



Outside to inside, one variant suitable for connecting RJ equipment to BT lines

I enjoyed writing both columns, and when the two magazines went their own separate ways (after being sold off by IPC) the new owners let me carry on. I am grateful to a series of editors for giving me a free hand to follow whatever stories I found interesting. The plan now is for me to continue in the new merged magazine, still following stories that interest me and with the basic guiding principle that what gets written will hopefully be new or interesting or useful to at least some readers.

Take telephone wiring, for instance. There is a mess of non-standardization over telephone equipment connections and I know of no reliable source of helpful information. I also know alot of people who have been left wondering why their equipment stubbornly refuses to work. So for this last column I am putting down the fruits of a lot of hard work on testing many different leads bought from different sources round the world.

Most modern telephone equipment now comes with a socket for a North American RJ telephone plug. With a bit of luck the equipment comes boxed with a correctly wired connecting lead, which has an American RJ plug at one end and a BT standard telephone plug at the other. But what happens if you buy equipment abroad and need a UK lead, or try and buy extra leads of existing equipment? There is a better than 50% chance you will end up with no dial tone.

Comparing different cables can be a very confusing business. There is no reliable standard for colour coding

Continued on page 37

Ian Burley

It's for you...

The telephone industry is on the brink of technology-driven confusion and upheaval after decades of relative tranquillity. Arranging a new phone line won't simply be a case of getting BT in to do the job, instead there could be a baffling choice of phone companies and facilities.There will be greater customer choice and competition will drive prices down, but will it be all to much for the average customer and do these companies really have our best interests at heart?

Speaking about the disjointed development PC networking systems, the boss of Intel, the huge chip manufacturer, recently used the history of the telephone of as an example of how a united effort from the world's telephone companies had resulted in a stable and standardised global service. Pick up a phone today and, from the UK at least, you can direct dial to over two hundred countries. Buy a PC network and there is no guarantee it will talk to somebody else's. The analogy is that in the PC world you need literally dozens of different phones to keep in contact with everybody you need to.

Naturally the telephone industry has experienced its own turmoil regarding standardisation and compatibility as new technologies become available. However, most of these headaches ave been confined to the phone companies. We the customers only see the benefits in the form of digital exchanges and satellite links, etc. - which we quickly take for granted. The only inconvenience most of us have had to face in the last ten or so years has been the need to change to modern push-button phones and jack sockets.

But that's all set to change. Technology and the liberalisation of the telephone market are conspiring to make life very difficult for the consumer. First of all, should you stick with good old BT? Despite its multi-billion pound profits, BT is genuinely scared of the competition which is slowly but surely marshalling its forces. Cable TV companies have joined Mercury in offering alternatives to BT phone lines while other companies you might not readily associate with the telecomms industry like British Rail and the electricity distribution companies are exploring the possibility of competing directly with BT by providing long distance transmission lines.

There will also come a time when deciding on a new phone line will involved asking one's self whether a conventional line will be adequate or will a more advanced ISDN digital phone be necessary? Don't forget that video phones are just around the corner too.

Meanwhile, why have a physical phone line at all? Wireless communication is supposed to be tomorrow's solution - bring your phone with you wherever you go. Cellular radio phones have been around since the mid-1980s and there are over a million users in the UK despite their relatively high cost and occasionally over-saturated networks. As cellular sales tail off to business users, attention is turning to domestic users. Vodafone is set to launch a cut-price service for non-business users later this year with reduced off-peak calls and monthly tariffs. Some cellular air time providers, like Ford for example, are already offering similar deals.

There will also come a time when deciding on a new phone line will involved asking one's self whether a conventional line will be adequate or will a more advanced ISDN digital phone be necessary?

But cellular is old-hat, won't we all be using GSM or PCN digital mobile phones before the turn of the century? Or what about the Motorola Iridium mobile phone system with its proposed network of 77 low-flying satellites?

The emerging technologies offer potentially exciting possibilities, but frankly the future makes me more concerned than excited. Technology, it seems, can be too focussed - all the tricky problems get fixed and the simple ones get overlooked, like what does the customer really want?

Telepoint is a perfect example of how things can go very wrong. It offered an alternative to shabby and unreliable public phones in the form of a compact cordless phone you could use away from home. On the face of it, an excellent idea - especially as it was cheaper than cellular. Digital technology meant clearer sound and security from radio scanning snoopers. But right from the start telepoint operators decided against answering their critics, the most important of whom were would-be customers.

None of the service providers wanted to sell affordable handsets, they only wanted to sell profitable airtime. No affordable handsets meant no customers. Worse, the opportunity to add value to telepoint by promoting its use as a viable alternative to an ordinary cordless phone when at home was missed. Once again greedy eyes could see nothing but air-time revenue. Telepoint was criticised for not offering an incoming call facility but the industry's reaction was simply to say, sorry - that's not the business we're in, despite the fact that a limited incoming call facility was actually part of the telepoint specification.

There are signs that the industry is learning from its mistakes. The cellular phone industry is stupidly hampered by the fact that the unique ID numbers linked to each cellular phone number are burned into each phone. Changing phones is an expensive process requiring re-programming. Tomorrow's PCN and GSM phones will have smart cards meaning you can use anybody's phone simply by inserting your own card. It's simple little things like this which surely should have been considered right from the start. ■

Merging The Magazine

John Becker, PE's Editor from 1987-90, reflects on the merger with Everyday Electronics that will take place with the next issue of the magazine.

It was with mixed feelings that I received the news that PE is to merge with Everyday Electronics. On the one hand, I lay great store in the concepts of independence and tradition. On the other hand, I recognise that in times of recession, market forces often dictate that survival actions must be taken irrespective of sentiment. In the current climate of the economy in general, and of the hobbyist electronics market in particular, the merging of PE with EE makes commercial sense.

PE's 25th birthday party. From left to right, Sir Clive Sinclair, Angelo Zgorelec, John Becker

Common Origins

I have been associated with PE in various ways ever since its first issue in November 1964: as reader, as advertiser, as contributor, and as Editor. Naturally I feel sadness that after nearly 28 years PE is relinquishing its independence. However, the sadness is tempered by the manner in which PE's separate identity is being absorbed. What may not be known to some readers is that PE and EE both originated from the same stable and were for many years edited by the same Editors, first Fred Bennett and then Mike Kenward. It is Mike Kenward who now owns and edits EE, and so in a way, by merging with EE, PE is simply returning home after a few years separation.

In 1964, when PE was first published by IPC under the editorship of Fred Bennett, the hobbyist electronics market was entering its boom years. At the time, IPC's two principal electronics magazines were Wireless World and Practical Wireless. Incredible as it may seem now, there were then far more advertisers clamouring to reach the many thousands of readers of WW and PW than either magazine could realistically accept. To cater for this buoyant market, IPC introduced a third magazine, PE. Over the next few years, the market had expanded further and other publishers had responded to its commercial potential by introducing competitive magazines. Aware of the increasing expansion, IPC felt justified in adding a fourth hobbyist electronics title to its range and in 1971 introduced EE, also under the editorship of Fred Bennett.

Fred continued to edit both PE and EE until 1977 when IPC chose to transfer PE's offices from London down to Poole. Preferring not to move to Poole, Fred stayed in London to continue editing EE. Mike Kenward, who had first joined Fred's staff in 1968, was appointed as PE's new editor.

Recession And Takeover

The late 1970s, however, saw the start of what proved to be a decline in the hobbyist electronics market, triggered in particular by the introduction of the personal computer. Slowly, but irrevocably, readers of all the electronics magazines were seduced away from their soldering irons by the novelty of playing with computers. Then, from 1979, the Government's deflationary policies began to result in a rise in unemployment and in the extinction of many of the electronics companies who had been supplying the hobbyist market, trends which still continue. By the end of 1985, the continued spiral downwards of readership and advertisers resulted in IPC deciding to close both PE and EE. However, two people foresaw that although PE and EE were now commercially unviable for a large publishing company, they had great potential for small independent publishers. Those two people were Angelo Zgorelec, who had founded Personal Computer World, and Mike Kenward. At the beginning of 1986, Angelo bought PE and Mike bought EE.

Angelo initially had PE edited by Richard Barron, formerly an assistant editor on PE during the last few years of IPC-ownership. Mike did his own editing of EE, as he still does. I was invited to take over PE's editing in January 1987 and continued to edit it until November 1990, when I handed over the chair to Kenn Garroch.

We have all done our utmost to inspire readers to be interested in the many fascinating and important aspects of electronics, and to reverse the effects of the recession upon our market. Indeed, I recall a feeling of optimism at the time of PE's 25th Anniversary in November 1989. In my review of PE's history I said, "Electronics is again increasingly becoming a major source of leisuretime fulfilment ... the marketplace for retailers is again expanding, the stalls vacated by those who didn't withstand the storm are being filled by new companies. There is indeed a silver lining in this our Silver Anniversary year." These words of optimism were expressed at a time when there did seem a chance that the lengthy and devastating recession was coming to an end. Regrettably, three years on, we all know that there are still few tangible signs that this is so.

Despite the slump, I still maintain a feeling of optimism about the worthwhileness of electronics as a hobbyist pursuit

Consolidation

From my many years experience as a retailer, I know that those advertisers who so far have withstood the recession can only continue to do so if the ratio of sales value to advertising costs remains realistic. In boom times, advertisers would be likely to advertise in many magazines to promote the maximum readership awareness of their products. During times of recession, though, many advertisers can no longer afford to spread their adverts so widely across all the relevant magazines. When advertising revenue is spread thinly between the magazines, the merging of two which have much in common makes good sense. Such a merger brings most of the readers of both magazines into one forum, a forum which can be more effectively addressed by advertisers who are less stretched financially. By combining production costs and advertising revenue, the merged magazines can offer their jointly increased readership a much stronger publication which is more capable of continuing to provide a broad variety of high-class features and constructional projects.

Exploration

Despite the slump, I still maintain a feeling of optimism about the worthwhileness of electronics as a hobbyist pursuit. There is enormous satisfaction to be gained from making something for oneself, particularly in making something that works. Unlike some constructional hobbies, electronics offers opportunities for people of all abilities and ages to achieve success at many levels of sophistication. In addition, electronics is a hobby which can involve both brains and hands. It can be an intellectual challenge as much as a physical one. There is such a wide range of component varieties around now that there is practically nothing that cannot be achieved electronically once the idea has been conceived. Furthermore, one of the beauties of electronics is that once a few simple basics are understood, it can always be explored at higher and higher levels. Yet, if hobbyists don't want to go too high, they don't need to, and they can still achieve satisfaction.

Rôle Model

During its 28 year history, PE has encouraged hundreds of thousands, possibly millions, of people to become interested in electronics. Many readers, inspired by the pages of PE have gone on to make electronics their career, myself included. PE has kept readers informed about new developments in electronics and the allied technologies. It has educated people in the use of electronics and encouraged them to explore for themselves. It has published thousands of constructional ideas for readers to build, ranging from simple door buzzers to complex microprocessor controlled test equipment. Some of the published projects have been so revolutionary that their concepts have been taken up by industry.

The success of the role which PE has played over the years is a tribute to its two principal Editors, Fred Bennett and Mike Kenward. Tribute must also be paid to Angelo, who rescued PE when its was faced with closure by IPC. The title now returns to Mike who, through EE, has maintained similar ideals and objectives to those first established for PE.

As much as one would have preferred to retain the individual styles and traditions of two magazines which have been part of our electronics culture for many years, hopefully the merger of PE with EE should prove to be beneficial to the recession-hit hobbyist electronics market as a whole.

I now commend you to Mike's good hands. Best wishes to you all.

John Becker ■

High-spec Modular PCs Vie For The Limelight

Ian Burley looks at two new notebook computers, the ultimate flight simulator, an electronic book and a hi-tech mouse-trap.

In this month's column we have a varied collection of interesting items and to start off here's a look at a pair of very advanced notebook PCs from Elonex and CPW. Elonex is a fast-growing PC company based in North London and deals directly with its customers rather than via a dealer or distributor. The firm very modestly claims its latest product, the NB-425X modular notebook PC, is the "best notebook PC in the world." The UK-manufactured computer was designed in California by Oakleigh Systems with obvious influence from Apple's acclaimed PowerBook notebook Macintosh range. It has a footprint slightly smaller than an A4 sheet of paper and weighs a commendable 5.5lbs including its power supply unit and battery. Processor options range from a 25MHz 486SX to a full-blown 66MHz 486DX and if you start off with the entry– level chip you can simply upgrade later.

CPW's super fast laptop.

We all expect a choice of display on desktop PCs but notebooks and other portables rarely have that luxury but Elonex offers no less than four different flat panel screens for the NB-425X; two monochrome screens, a passive matrix colour screen and a top of the range colour active-matrix version. Once again it's possible to upgrade the screen if you decide you need a different one. The modular aspect of Elonex's new baby is nicely rounded off by a removable hard disk feature with capacity options from 40Mb up to 450Mb. There is a PCMCIA mini-card expansion slot and a desktop docking station will be an optional extra. If Elonex's claims of battery capacity of up to 18 hours are verified it will represent a breakthrough in notebook PC battery technology.

The reason why the NB-425X invites comparisons with Apple's PowerBook range is because of its distinctive 'cyclops' tracker ball mouse pointing device which occupies the centre of the computer's facia below the set-back keyboard. There's no doubt Elonex will generate a lot of interest with the NB-425X, especially as it has been promised an aggressive price when it makes its public debut at the Business Computing Show at Earls Court in September. Monochrome display prices start at £1000+VAT and £1500+VAT for colour systems.

Elonex: Tel.081 452 4444

CPW Computer Consultants must be very frustrated by Elonex's anouncement as it will inevitably have drawn attention away from their own power-packing high-spec. notebook, the 6.4lb EPS 486. This is a no-compromise machine sporting a 50MHz 486 processor, upgradable to the 586 when it arrives later this year, an active matrix colour screen plus a removable hard drive up to 200Mb in capacity which CPW claims will fit happily into a shirt pocket. An optional expansion box holds up to three full length 16-bit expansion cards. CPW will be again be vying with Elonex for attention at the Business Computing Show where th EPS 486 gets its formal launch.

CPW: Tel.071 922 8890

Portable video projector

I sometimes wonder whether the future for a fair proportion of the television market lies with video projectors. Sharp lends assistance to this hypothesis via its new and very small XV– P1 video projector which has just been released onto the Japanese market. Sharp was one of the first to produce an LCD-based video projector three years ago. The XV-P1 incorporates a single 3.6in

Take the Sensible Route!

BoardMaker is a powerful software tool which provides a convenient and fast method of designing printed circuit boards. Engineers worldwide have discovered that it provides an unparalleled price performance advantage over other PC-based and dedicated design systems by integrating sophisticated graphical editors and CAM outputs at an affordable price.

NEW VERSION

In the new version V2.40, full consideration has been given to allow designers to continue using their existing schematic capture package as a front end to BoardMaker. Even powerful facilities such as Top Down Modification, Component renumber and Back Annotation have been accomodated to provide overall design integrity between your schematic package and BoardMaker. Equally, powerful features are included to ensure that users who do not have schematic capture software can still take full advantage of BoardMaker's net capabilities.

BoardMaker V2.40 is a remarkable £295.00 (ex. carriage & VAT) and includes 3 months FREE software updates and full telephone technical support.

AUTOROUTER

BoardRouter is a new integrated gridless autoroute module which overcomes the limitations normally associated with autorouting. **YOU** specify the track width, via size and design rules for individual nets, BoardRouter then routes the board based on these settings in the same way you would route it yourself manually.

This ability allows you to autoroute mixed technology designs (SMD, analogue, digital, power switching etc)in **ONE PASS** while respecting **ALL** design rules.

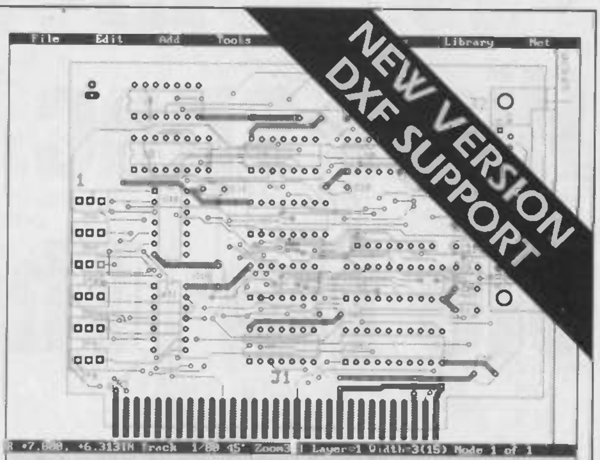
GRIDLESS ROUTING

No worrying about whether tracks will fit between pins. If the track widths and clearances allow, BoardRouter will automatically place 1, 2 or even 3 tracks between pins.

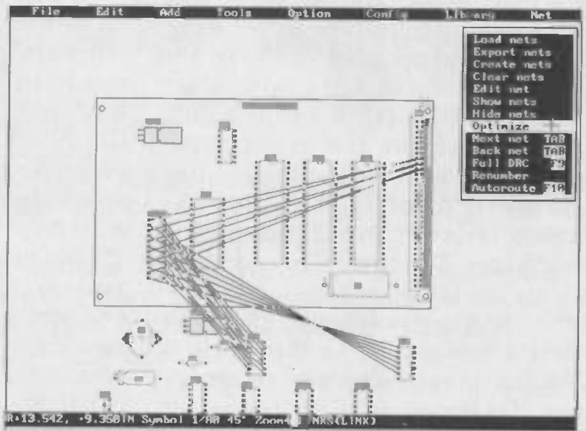
FULLY RE-ENTRANT

You can freely pre-route any tracks manually using BoardMaker prior to autorouting. Whilst autorouting you can pan and zoom to inspect the routes placed, interrupt it, manually modify the layout and resume autorouting.

BoardRouter is priced at £295.00, which includes 3 months FREE software updates and full telephone technical support. BoardMaker and BoardRouter can be bought together for only £495.00. (ex. carriage & VAT)



Full analogue, digital and SM support - ground and power planes - 45 degree, arced and any angle tracks with full net-based Design Rule Checking.



Optimized placement by displaying ratsnest per component. Lines indicate the unrouted nets.

HIGHLIGHTS

- Net list import from OrCAD, Schema etc.
- Graphical and manual netlist entry
- Top down modification for ECOs
- Forward and back annotation
- Component renumber
- Effortless manual routing
- Fully re-entrant gridless autorouting
- Simultaneously routes up to eight layers
- Powerful component placement tools
- Copper fill
- Curved tracks
- Extensive Design Rule Checking
- Full complement of CAM outputs
- Support and update service
- Reports generator
- Gerber, PostScript & DXF output
- Full SMD support

Don't just take our word for it. Call us today for a FREE Evaluation Pack and judge for yourself.

tsien

Tsien (UK) Limited
Cambridge Research Laboratories
181A Huntingdon Road
Cambridge CB3 0DJ **UK**
Tel 0223 277777
Fax 0223 277747

Access VISA

Sharp's portable LCD projector

100,386 pixel LCD projection panel instead of the more traditional trio of panels for each primary colour used in more bulky units. In fact Sharp says the XV–P1 is just one third the size of its conventional projectors. It weighs 4Kg and can produce a picture size from 30in at 1m distance to 60in at 2m. The PAL version has a horizontal picture resolution rated at 320 lines, which is greater than the reproduction capabilities of standard video recorders (approx 250 lines) though behind the 400 or so lines resolution possible with S-VHS or hi-band video and, of course, broadcast TV.

A compact 4kg unit you can easily move around seems like an entirely better prospect than some of the monster 30in plus TVs which have been gaining in popularity in recent years. Only the former would be at all practical in my tiny living room!

Sharp: Tel.061 205 2333

Affordable flight sim

If you're like me, you would give quite a lot to have a go in one of those full-size Rediffusion aircraft trainer simulators. The company has not been insensitive to these desires and has been in the arcade video-game slot-machine business for a while now. However, the latest Rediffusion simulator for mere mortals, called Commander, takes the arcade machine state of the art onto a new plane. For a start Commander is not a video game with a hydraulic seat attached, it has been designed from the ground up as a mini-version of the real thing. Three computers control the cockpit motion, audio/display and simulation. In fact the master control computer is a very ordinary Intel-286 based PC, but this communicates with a pair of much more powerful multi-processor cards featuring 8, 16-bit and full 32-bit ARM RISC processors which handle all the processor-intensive bits and pieces.

Commander is a virtual-reality machine. Its graphic displays are calculated in real time and are in full 3D. Software for the Commander system is being developed by LucasArts and though the launch machines feature a flight simulation scenario, new programs can be added and selected from an internal hard disk drive. A submarine simulation is already on the

Rediffusion's Commander.

Inside the Commander.

An example of the VR imagery.

drawing board. All games can be mode selectable from combat, training through to 'family entertainment' mode and there are ten skill levels.

Inside the simulator there are seats and controls for two people. A large 26in VGA FST monitor dominates and provides your view into the virtual scene. A smaller 12in monochrome monitor acts as a glass instrument display and a third colour monitor is provided for people outside to see how you're getting on. The hydraulically operated cockpit can generate 1g accelerative forces and tilts forwards, backwards, sideways and lifts vertically.

Commander simulators have just started shipping in the UK. If you've ever wanted your own Rediffusion flight simulator you will need a three phase power supply and about £45,000. A snip compared to the spare million or two you'd need for the grown up version.

Panasonic Book Player

A third manufacturer has joined Sanyo and Sony to produce its version of the so- called electronic book player originally developed by Sony. The 8cm CD-ROM electronic book standard has now been adopted by Panasonic and the KX-EBP1 is the result. It's similar in construction to the Sony player in that the mini-QWERTY keyboard forms the lid under which either a book CD ROM cartridge or a conventional 8cm audio CD fits. However, whereas the Sony unit is quite rectangular in profile, the Panasonic is more square. The unit weighs 830g including its battery pack and has dimensions of 150x53x127mm. Like both the Sanyo player and Sony's latest version (PE August 92) the Panasonic accepts both discs conforming to the original EB-G standard (text and graphics only) as well as the latest EB-XA (Text graphics and sound) standard. A back-lit 4.5in 256x200 pixel LCD is provided but you can also plug your KX-EBP1 into either a NTSC, PAL or Secam standard TV, or a composite video monitor.

The International Electronic Book Publishers Committee (IEBPC) now boasts 74 members and the selection of EB titles is growing steadily, mainly aimed at business and education users. A 16-bit V20 processor hides inside the device and with the promise of entertainment CD ROMs eventually. I can bet that you will soon be able to play Tetris on EB players! The KX-EBP1 is already shipping in Japan and availability here in the UK promised as of September with a price of around £400-£450.

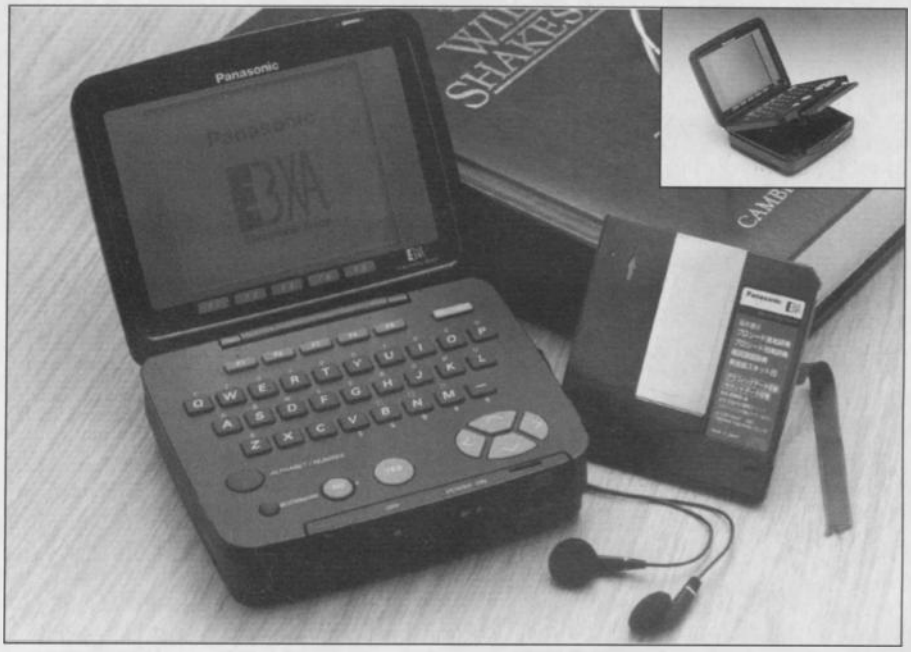
Panasonic UK: Tel.0344 853 912

Cheap Videoconferencing

Next we move onto videoconferencing, an expensive luxury most companies will have to wait many years for before it becomes affordable and widespread. At least that's what a lot of people shouldn't be thinking according to Mercury Communications. To spread the word that videoconferencing is affordable and accessible now, Mercury has set up four videoconferencing demonstration centres across the UK. Andy Gent, Mercury's business development manager for videoconferencing is aware that most people still think that the cheapest video conferencing systems cost in the region of £100,000 – which they did just a few years ago.

"We want our customers to know that Mercury can offer very high quality sound and picture quality systems from as little as £17,000 per site", Gent explains. He also adds that videoconferencing isn't expensive to run either. "A videoconference between London and Glasgow can cost less than 20p per minute based on Mercury's 2100 Premier service", he revealed. Compared to the cost and inconvenience of travelling to a meeting by train or air, Gent has an increasingly attractive point to make.

Several more demonstration centres are planned but in the mean time if you think you might have a use for videoconferencing you can book a demonstration by phoning Alison Faccenda on 0908 833 115.



The Panasonic electronic book – inset shows how it opens up to take a disc.

both of which must be triggered in order to be certain of a capture. The electronically controlled trap door snaps shut and then a master control unit is signalled. This responds by sounding a volume-adjustable alarm, flashes a light and then dials up a sequence of up to four radio pager numbers. Staff can then respond to their pagers and be sure that a particular trap has been successful. Poisoned bait is unnecessary and traps can be emptied promptly. The control unit even has a printed log to keep track of up to individual 200 traps. Rentokil hopes the system will be a success in places where gnawed wires and cables might be dangerous as well as the more obvious places one expects to find mice, where food is prepared for example.

IBM Hybrid Technology

For a complete change of subject, attention is now turned to the humble microchip and IBM's efforts to squeeze even more performance out of existing semiconductor technology. IBM research scientists are claiming to have more than doubled the performance of certain types of chip by integrating two different kinds of transistor on the same silicon. They have combined extremely fast bipolar transistors used in mainframe and supercomputer chips with CMOS (complementary metal oxide semiconductor) field effect transistors. The former are very fast but just as power hungry – supercomputers often require exotic refrigeration systems to keep bipolar components cool. CMOS on the other hand is a power efficient semiconductor type liberally used in more down to earth computers like PCs and video games, but CMOS logic is much slower than bipolar logic. IBM's aim is to optimise the design of its chips by increasing the performance of parts of the chip by using bipolar logic while retaining CMOS where speed isn't important. The net result should be chips which are still fast but less power hungry.

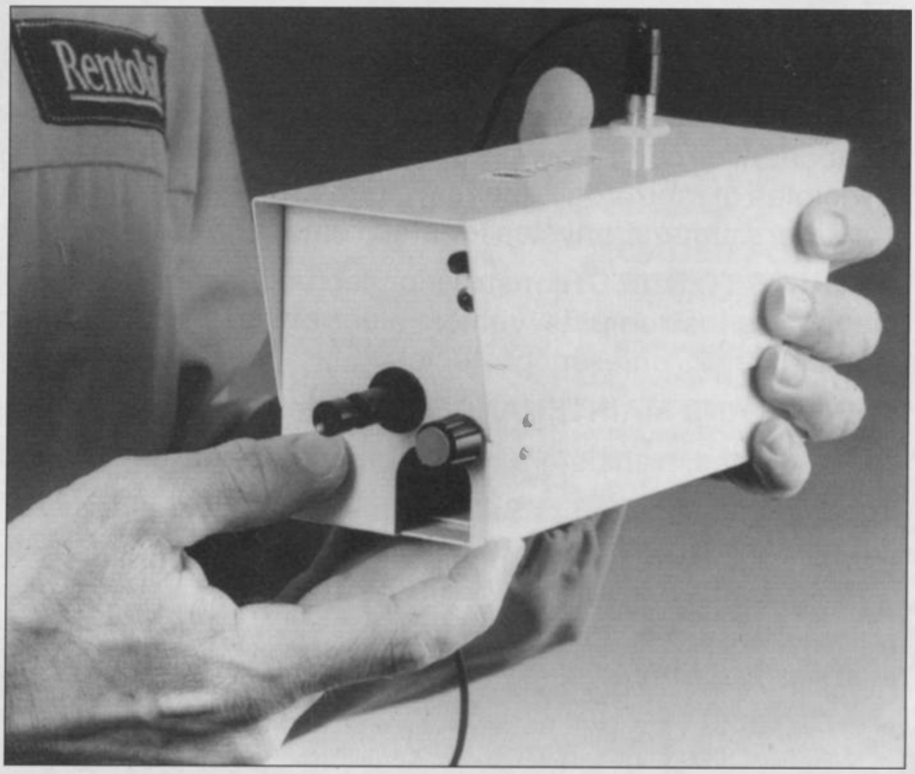
Mouse Alert

Most amusing item of the month, depending on whether you're a mouse lover or not, has to come from Rentokil. The renowned pest control organisation has developed Mouse Alert, which has to be one of the most sophisticated mouse traps ever. Rentokil's problem was not how to trap our little furry friends but to know conveniently which trap had attracted a guest. Modern methods of pest control can involve the distribution of a large number of traps which can be tiresome to check regularly. So Rentokil's Mouse Alert traps own up once they have been triggered. Each trap box has a pair of infra red beams,

Anti-forgery Machinery

Finally a bit of news from Canon. I couldn't work out whether this was a publicity stunt or not but it seems that Canon is so embarrassed by the ability of its colour laser photocopiers to fake bank notes that it has developed a gadget which can recognise bank note designs if anybody attempts to copy them. A library of several bank note designs is offered and attempted forgery results in a blank page coming out of the machine. ■

Is this the ultimate mousetrap?



Over 1,000 pages of well-organised and clearly explained information is brought to you by an expert editorial team whose combined experience ensures the widest coverage.

Regular supplements to this unique publication, each around 160 pages, mean that you will always be kept abreast of the latest developments from the UK, USA and Europe as they occur

ALL-IN-ONE AND EASY-TO-USE

A sturdy ring-binder allows you to use the manual on your workbench. The looseleaf format also means you can slot in the regular updates as they arrive – so all your information is there at a glance.

EXTENSIVE GLOSSARY

Should you come across a technical word, phrase or abbreviation you're not familiar with – simply turn to the glossary included in the manual and you'll find a comprehensive definition in plain English.

REGULAR UPDATES

Unlike a book or encyclopedia, the manual is a living work – continuously updated by new material. Recent or upcoming supplements include radio, superconductors, electric motors, basic electronic building blocks for beginners which can be joined together to construct elaborate circuits, filters, IBM PC and compatibles (including use of PC cards). Supplements are sent to you approximately every two months.

Each supplement contains approximately 160 pages – all for only £23.50 + £2.50 p&p. You can of course return any supplement which you feel is superfluous to your needs.

RESPONDING TO YOUR NEEDS

We are able to provide you with the most important and popular articles in our updating supplements. Our unique updating system is based on answers from readers request questionnaires. Through this service you are able to let us know exactly what information you require in your manual. You can also contact the editor directly in writing if you have a specific technical request or query relating to the manual.

ASSEMBLING ...

There's nothing to beat the satisfaction of creating your own project. From basic principles to circuit-building, the manual describes clearly, with appropriate diagrams, how to assemble radios, loudspeakers, amplifiers, micro-computers and measuring instruments.

The new revised edition of The Modern Electronics Manual contains practical, easy-to-follow instructions for building and programming your own computer. It shows you how to make fun gadgets such as a remote control door opener and a digital rev. counter for your car. It also tells you how to construct useful devices like test gear, security and baby alarms – plus – many more popular devices.

Wimborne Publishing Ltd., 6 Church St, Wimborne, Dorset BH21 1JH
Tel: 0202 881749 Fax: 0202 841692

THE MODERN ELECTRONICS MANUAL

New Revised Edition of Basic Work: Now contains over 1,000 pages of information.
Regular Updates: Approximately 160-page supplements of additional information which are forwarded to you immediately on publication. These are billed separately and can be discontinued at any time.
Presentation: Durable looseleaf system in large A4 format (197mm × 210mm)
Price of the Basic Work: £39.95 + £5.50 p&p (to include a recent supplement).

YES please send me on 10 days free approval **THE MODERN ELECTRONICS MANUAL**. If I decide to keep the manual, I shall then pay **only £39.95** plus £5.50 postage and packing at the end of the 10 days approval period. I shall also receive the appropriate Updating Supplements several times a year. These are billed separately and can be discontinued at any time.

FULL NAME ....
(PLEASE PRINT)

ADDRESS ....

....

.... POSTCODE ....

I AM OVER 18
SIGNATURE ....
(Parent or guardian must sign if under 18)

ORDER FORM
Simply complete and return the order form to the following address
The Modern Electronics Manual
Wimborne Publishing Ltd
6 Church Street
Wimborne Dorset BH21 1JH

OVERSEAS ORDERS: All overseas orders must be prepaid but are supplied under a money-back guarantee of satisfaction. If you are not entirely happy with the manual return it within a month for a refund of the purchase price (you do have to pay the postage). Add the following amounts to the price of the manual to cover postage:

EIRE **£10.50** (air mail only)
EUROPE (including C.I.S.) **£21.00** (air mail only)
MIDDLE EAST/FAR EAST/INDIA, AFRICA/SOUTH AFRICA, SOUTH AMERICA } **£20** surface, **£37** air
REST OF THE WORLD **£25** surface, **£31** air

Note surface mail can take around 8 weeks to some parts of the world. Each manual weighs about 4·5kg when packed.

All payments must be made in £'s Sterling payable to Wimborne Publishing Ltd. We accept Mastercard (Access) and Visa credit cards.

Getting To Grips With Logic

Kenn Garroch takes a quick tour around the concepts and electronics behind most modern computer and control systems.

Formalised logic has been with us since Aristotle and has been used on and off, to prove and disprove many ideas and concepts. However, it was not until the latter part of the last century that a chap named George Boole decided to make a formal study of two valued logic and set down some rules by which it operated. The development of Boolean logic paved the way for later developments in electronics that resulted in the digital computer.

Nowadays, Boolean logic is widely used in electronics from circuits that select the winner of a TV quiz game, to super, higher powered computers.

Basic Functions

At the heart of all Boolean logic lies three functions or operations, AND, OR and NOT. Each of these operates on a value or pair of values and produces a result. The values and results can have one of two states; true or false.

Taking the simplest operation first, the NOT or inverse function takes its input and produces the exact opposite. So a true becomes false and false becomes true.

AND and OR are slightly more complicated since they both take two inputs and produce a single output. The AND operation only produces a true output when both inputs are true. Any other inputs - both being false or only one being true - causes the output to be false. The OR operation produces a true output when either or both inputs are true but not when they are both false.

Unfortunately, logic operations are somewhat difficult to describe in English - or at least are a little long winded - and the best way to show how they work is through truth tables. These provide a graphical and hence visual format that reveals the workings of the logic at a glance. As can be seen from Fig. 1. the tables shows all of the possible inputs and all of the corresponding outputs. The three tables show NOT, AND and OR. It may seem redundant to specify all four possibilities for the two input functions but the idea of a truth table is to show rigorously the possible inputs.

Fig. 1. The three basic truth tables.

NOT

Input	Output
true	false
false	true

AND

Input 1	Input 2	Output
false	false	false
false	true	false
true	false	false
true	true	true

OR

Input 1	Input 2	Output
false	false	false
false	true	true
true	false	true
true	true	true

Notation

Once the basic ideas of the three root functions of Boolean logic are grasped, a way of formally writing them down is needed - in the same way that while arithmetic can be done in the head, there comes a point when it must be written down on paper using a standard notation. Fortunately, logic notation is similar to arithmetic or mathematical notation.

Fig. 2. Some other common functions.

NAND

Input 1	Input 2	Output
false	false	true
false	true	true
true	false	true
true	true	false

NOR

Input 1	Input 2	Output
false	false	true
false	true	false
true	false	false
true	true	false

EOR

Input 1	Input 2	Output
false	false	false
false	true	true
true	false	true
true	true	false

Input 1	Input 2	AND	NAND	OR	NOR	EOR
false	false	false	true	false	true	false
false	true	false	true	true	false	true
true	false	false	true	true	false	true
true	true	true	false	true	false	false

Fig. 3. Truth tables collected together – note common features of EOR and NAND/OR and AND/NOR

Variables can be given algebraic names as in maths - X and Y or A and B are quite acceptable - and can have one of two values, true or false. This allows all of the possible inputs to a function to be implied in one go. The variable can be either true or false and the operation or function can operate on either of these values to produce a set output.

The AND function between two variables A and B is written A.B and the OR function A+B. Functions that are inverted have a bar put over them as in $\overline{A}$. This allows complex functions to be written out and allows the development of more complex functions that the rather simple basic three.

Fig. 4. Creating EOR from NAND and OR and AND

A	B	AND	NAND	OR	NOR	EOR
false	false	false	true	false	true	false
false	true	false	true	true	false	true
true	false	false	true	true	false	true
true	true	true	false	true	false	false

$$(\overline{(A.B)} . (A+B))$$

NAND	OR	AND
true	false	false
true	true	true
true	true	true
false	true	false

Additional Functions

The most common complex (although they are not very) functions are known as NAND, NOR and EOR (aka XOR). The first two are simply formed by placing a not after the AND and OR operations and stand for NOT AND and NOT NOR respectively. In notational form, is A and B are the inputs, then the output is $\overline{(A.B)}$ for NAND and $\overline{(A+B)}$ for NOR. The EOR or exclusive OR is a little more complex and conforms to most peoples opinion of what OR should be. It is defined as producing a true output when only one of the inputs is true. If both are false or both are true then the output is false. The truth table for this along with those for NAND and NOR is given in Fig. 2. However, we need to be able to derive some method of combining the standard three gates to produce the correct result.

Writing all of our functions out in one table as in Fig. 3. gives some idea of which functions can be combined. The NAND function has the same three last terms and the OR function the same three first. Feeding these two outputs into and AND gives the same result as the EOR. Alternatively using a NOR and an AND in parallel and combining their outputs into a NOR also gives EOR.

The operation of the function can be written out as:

$(\overline{(A.B)} . (A+B))$

or

$\overline{((A+B).bar + (A.B))}$

and can be analysed via a truth table by evaluating all of the possible inputs A and B

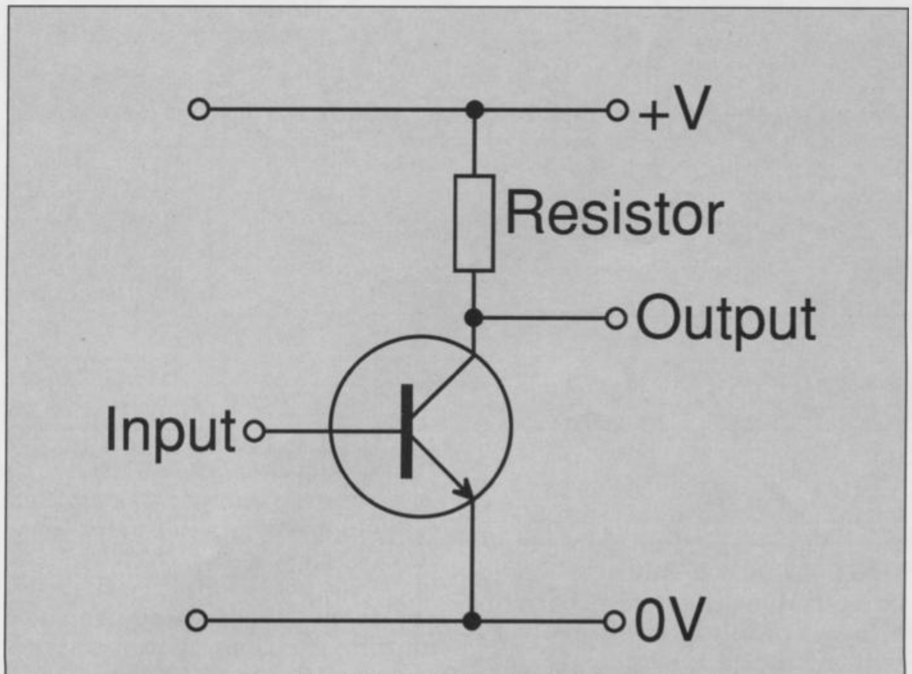


Fig. 5. A simple invertor circuit.

and writing these down as another column and then performing the next operation to get the result which is A EOR B (Fig. 4.) - usually denoted by A circle plus B.

Through The Gate...

So far, all of the discussion has been rather academic and revolved around dry statements of logic and truth tables. Putting the theory input practice is quite straight forward. The electronic circuits needed to generate the three basic logic functions are relatively simple.

The NOT functions can be made from a single transistor. When set up as shown in Fig. 5. connecting the base or input up to the +V makes the transistor conduct pulling the output towards the 0V and connecting the input to 0V turns the transistor off allowing the resistor to pull the output up to +V. Making +V true and 0V false gives an invertor. In practice, true and false are 1 and 0 and the voltages used are +5V for 1 and 0V for 0.

The AND and OR functions can most simply be generated by two diodes. In the AND gate both are connected the same way around via a resistor to the +V line as shown in Fig. 6. The output is taken from the junction of the diodes and the resistor. Taking both of the inputs to the diodes to +V results in the output being at about +V. Taking either or both of them to 0V pulls the output down to 0V - the standard operation of the AND gate. The OR is similar but the other way around as in Fig. 7.

In practice, it is better to feed the output of the standard AND and OR circuits into invertors to allow a transistor to provide more power to the output allowing more gates to be driven from it. This causes the AND and OR to become NAND and NOR and is one reason why these are the most easily fabricated basic gate designs.

A selection of gates in symbol form are shown in Fig. 8 and Fig. 9. shows how NAND and OR can be put together to form an EOR. When buying real chips to make up real circuits, it is inefficient to put only one gate per package and there are usually at least four, depending upon the number of inputs - it can be seen from the AND and OR circuit designs that by adding more diodes, more inputs can be made available and in truth table form, this just means more input possibilities - Fig. 10.

To The Silicon Valley

Since they were first invented, electronic logic chips have become faster, cheaper, smaller and better. Not content with simple function like AND, OR and NOT, manufacturers found that through large scale integration, very sophisticated functions could be implemented re each chip onto a piece of silicon. This led to the development of the 'logic family' where each chip pro-

Fig. 6. A simple AND gate.

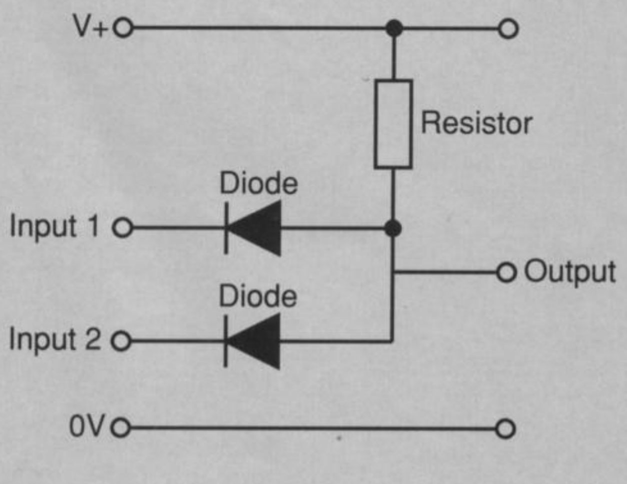
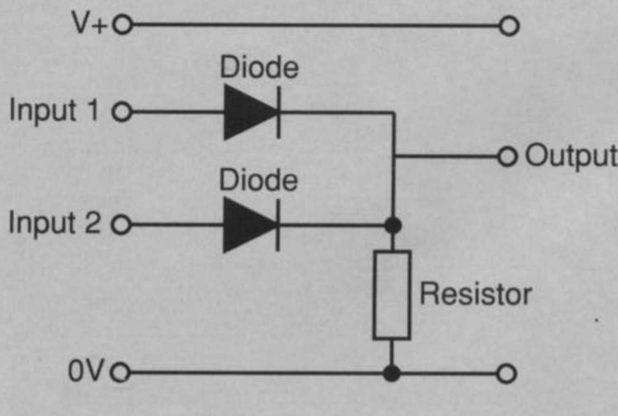


Fig. 7. A simple OR gate.



AMSTRAD PORTABLE PC'S FROM £149 (PPC1512SD). £179 (PPC1512DD). £179 (PPC1640SD). £209 (PPC1640DD). MODEMS £30 EXTRA. NO MANUALS OR PSU.

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7R.

MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable) Ideal for all sorts of precision timer applications etc. Now only £4.00 ref 4P151.

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29R

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42R

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual override facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. Now only £19.00 ref 19P29

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43R

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39R Suitable mains adaptor £5.00 ref 5P191R

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2R

MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12R

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AR

12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead **NOW ONLY £19.00!! REF 19P14R.**

CAR STEREO AND FM RADIO. Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £19.00 ref 19P30

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power ampl 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R, 4 x D's £9.00 ref 9P12R, 1 x PP3 £6.00 ref 6P35R

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32R.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104R. Bumper pack of 1,000 ties £14.00 ref 14P6R

GOT A CARAVAN OR BOAT?

NEW 80 PAGE FULL COLOUR LEISURE CATALOGUE

2,500 NEW LINES FREE WITH ORDER ON REQUEST

OR SEND £1.00

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1R

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd £5.00 ref 5P158R

FM BUG Built and tested superior 9v operation £14.00 ref 14P3R

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R.

ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3R.

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43R

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 5 tapes New low price £8.00 ref 8P181

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10R. MAINS POWER SUPPLY KIT £20.00 REF 20P33R READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4R.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17R. Larger transformer £12.00 ref 12P41R.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. New low bargain price only £2.00 ref B2P1

HIGH RESOLUTION 12" AMBER MONITOR 12v 1.5A Hercules compatible (TTL input) new and cased £22.00 ref 22P2R

VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4R

25 WATT STEREO AMPLIFIERc. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia Included).

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R, PACK OF 100 £30.00 REF 30P16R

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.

12V 19A TRANSFORMER. Ex equipment but otherwise ok. Our price £20.00

ULTRASONIC ALARM SYSTEM. Once again in stock these units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system £25.00 ref B25P1 additional detectors £11.00 ref B11P1

IBM AT KEYBOARDS Brand new 86 key keyboards £15.00 ref 15P612

AMSTRAD MP3

UHF/VHF TV RECEIVER/CONVERTER

CONVERTS COLOUR MONITOR INTO A TV!

£9.00

286 MOTHER BOARDS. Brand new and tested complete with technical manual. £49.00 ref A49P1

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated £6.00 ref 6P36R.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167R

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286R.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287R.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92R.

LED PACK. 50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52R

AMSTRAD 1640DD BASE UNITS

BRAND NEW AND CASED

TWO BUILT IN 5 1/4" DRIVES

MOTHER BOARD WITH 640K MEMORY

KEYBOARD AND MOUSE

MANUAL

OUR PRICE JUST

£79!!!!

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62R or 2 sheets for £7.00 ref 7P22R.

STRIP BOARD CUTTING TOOL. £2.00 ref 2P352R.

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91R

4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365R

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205R

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries complete with hand charger and solar panel 14P200R

PC STYLE POWER SUPPLY Made by AZTEC 110v or 240v input. +5 @ 15A, +12 @ 5A, -12 @ 5A, -5 @ .3A. Fully cased with fan, on/off switch, IEC inlet and standard PC flyleads. £15.00 ref F15P4

ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200

MODEMS FOR THREE POUNDS!!

Fully cased UK modems designed for dial up system (PSTN) no data or info but only £3.00 ref 3P145R

TELEPHONE HANDSETS

Bargain pack of 10 brand new handsets with mic and speaker only £3.00 ref 3P146R

DATA RECORDERS

Customer returned mains battery units built in mic ideal for Computer or general purpose audio use. Price is £4.00 ref 4P100R

SPECTRUM JOYSTICK INTERFACE

Plugs into 48K Spectrum to provide a standard Atari type joystick port. Our price £4.00 ref 4P101R

ATARI JOYSTICKS

Ok for use with the above interface, our price £4.00 ref 4P102R

BENCH POWER SUPPLIES

Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT TELEPHONE 0273 203500

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.

PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY

FAX 0273 23077

SPEAKER WIRE

Brown twin core insulated cable 100 feet for £2.00 REF 2P79R

DISC DRIVES

Customer returned units mixed capacities (up to 1.44M) We have not sorted these so you just get the next one on the shelf. Price is only £7.00 ref 7P1R (worth it even as a stripper)

MICROSCOPE 1200X MAGNIFICATION

Brand new complete with shrimp hatchery, shrimps, prepared slides, light etc. £29.00 ref J29P4.

LIGHT ALARM SYSTEM

Small cased alarms that monitor a narrow beam area for sudden changes in light level. Complete with siren that sounds for a preset time when unit is triggered. £7.00 ref J7P1

JOYBALLS

Back in stock popular Commodore/Atari equiv (replace standard joystick) £5.00 ref J5P8

720K 3 1/2" DISC DRIVE

Brand new units made by JVC complete with tech info just £19.00!! ref J19P2

CAR BATTERY CHARGER

Brand new units complete with panel meter and leads. 6 or 12v output £7.00 ref J7P2

CUSTOMER RETURNED SPECTRUM +2

Complete but sold as seen so may need attention £25.00 ref J25P1 or 2 for £40.00 ref J40P4

CUSTOMER RETURNED SPECTRUM +3

Complete but sold as seen so may need attention £25.00 ref J25P2 or 2 for £40.00 ref J40P5

HEX KEYBOARDS

Brand new units approx 5" x 3" only £1.00 each ref CD42R

PROJECT BOX

5 1/2" x 3 1/2" x 1" black ABS with screw on lid. £1.00 ref CD43R

SCART TO SCART LEADS

Bargain price leads at 2 for £3.00 ref 3P147R

SCART TO D TYPE LEADS

Standard Scart on one end, Hi density D type on the other. Pack of ten leads only £7.00 ref 7P2R

OZONE FRIENDLY LATEX

250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R

QUICK SHOTS

Standard Atari compatible hand controller (same as joysticks) our price is 2 for £2.00 ref 2P380R

VIEWDATA SYSTEMS

Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R

AC STEPDOWN CONVERTOR

Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin American output socket (suitable for resistive loads only) our price £2.00 ref 2P381R

CURLY CABLE

Extends from 8" to 6 feet! D connector on one end, spade connectors on the other ideal for joysticks etc (6 core) £1.00 each ref CD44R

COMPUTER JOYSTICK BARGAIN

Pack of 2 joysticks only £2.00 ref 2P382R

BUGGING TAPE RECORDER

Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record anything that was said. Price is £20.00 ref 20P3R

NEW SOLAR ENERGY KIT

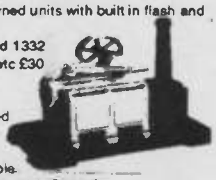
Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R

286 AT PC

286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included) Some metal work req'd phone for details.

35MM CAMERAS Customer returned units with built in flash and 28mm lens 2 for £8.00 ref 8P200

STEAM ENGINE Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200



TALKING CLOCK

LCD display, alarm, battery operated Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cock crowing! £14.00 ref 14P200.R

HANDHELD TONE DIALLERS

Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R

AMAZING TALKING COINBOX!

Fully programmable talking, lockable coinbox BT approved, retail price is £79 ours is just £29! ref J29P2.

ANSWER PHONES £15

Customer returned units with 2 faults one we tell you how to fix the other you do your self! £18 ref J18P2 or 4 for £60 ref J60P3 BT approved (retail price £79.95!! each)

COMMODORE 64 MICRODRIVE SYSTEM

Complete cased brand new drives with cartridge and software 10 times faster than tape machines works with any Commodore 64 setup. The original price for these was £49.00 but we can offer them to you at only £25.00! Ref 25P1R

90 WATT MAINS MOTORS Ex equipment but ok. Good general pupose unit £9.00 ref F9P1

HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt 4R speaker and a 2" 140R tweeter. If you want two of each plus 2 of our crossovers you can have the lot for £5.00 ref F5P2.

VIDEO TAPES E180 FIFTY TAPES FOR £70.00 REF F70P1

360K 5 1/4" Brand new drives white front. £20.00 Ref F20P1

EMERGENCY LIGHTING SYSTEM

Fully cased complete with 2 adjustable flood lights. All you need is a standard 6v lead acid battery. Our price is just £10 ref J10P29

AMSTRAD 464 COMPUTERS

Customer returned units complete with a monitor for just £35! These units are sold as faulty and are not returnable.

IN SUSSEX? CALL IN AND SEE US!

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

vided a useful building block function and all the chips coch family was the 74 series. These could be interconnected to create complex logic functions. The first such family was the TTL 7400 series where each chip identification number started of with the figures 74. The original TTL (transistor transistor logic) was power hungry and suffered from a number of drawbacks, not least being the limited 'fan out' or the limit to the number of gates or chip inputs that could be driven from a single output. The next big step forward was CMOS logic (Complementary Metal On Silicon) which had very low power consumption and high fan out. The drawback was that it was not as fast as TTL and was prone to damage from static electricity.

Since the early days of CMOS and TTL, things have come a long way. Chip manufacturers now produce high speed low power devices with high fan out and very few problems.

Without logic circuits, modern electronics would not exist. Fortunately, their operation and the theory of their design is relatively simple - perhaps a reason why they are so widely used. The development of the super fast microprocessor as a replacement for discrete logic chips makes a knowledge of how they work no less important that it was when designing with the chips themselves. ■

Fig. 8. Schematic symbols.

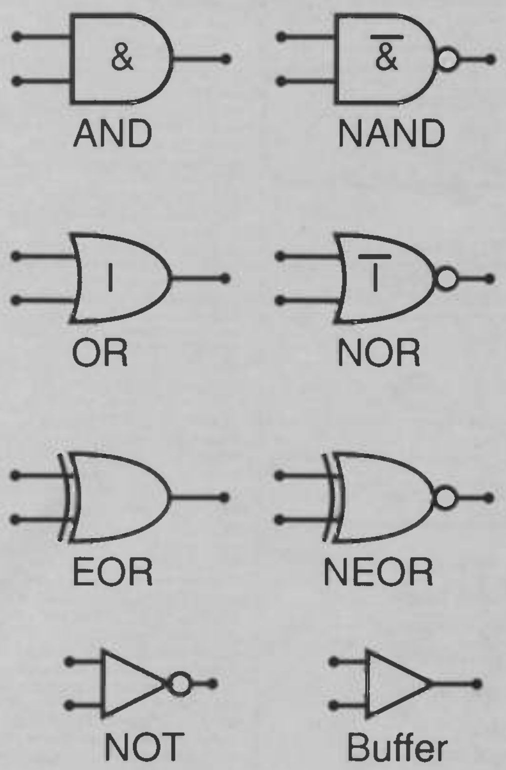


Fig. 9. Making an exclusive OR gate.

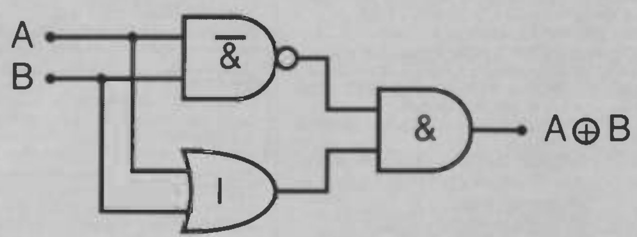
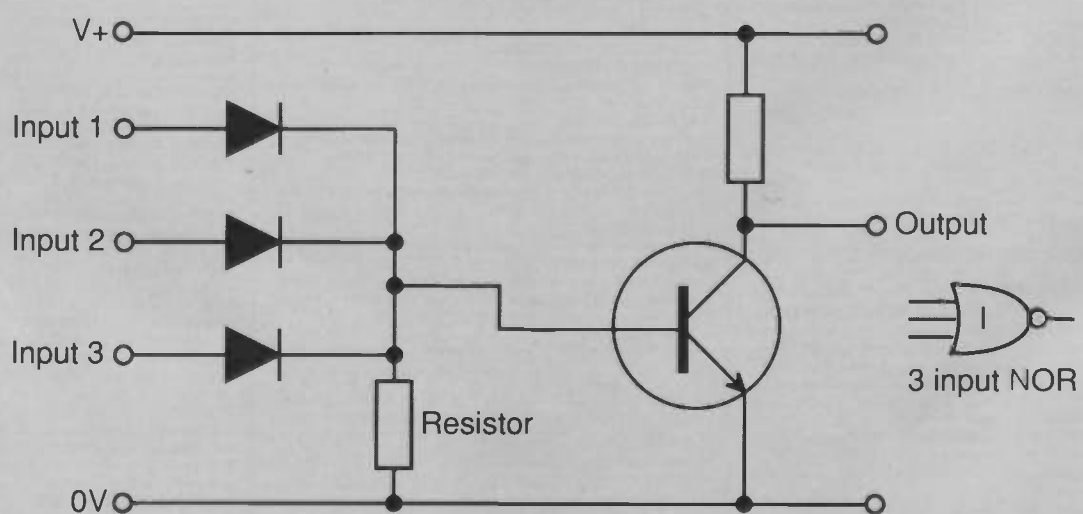
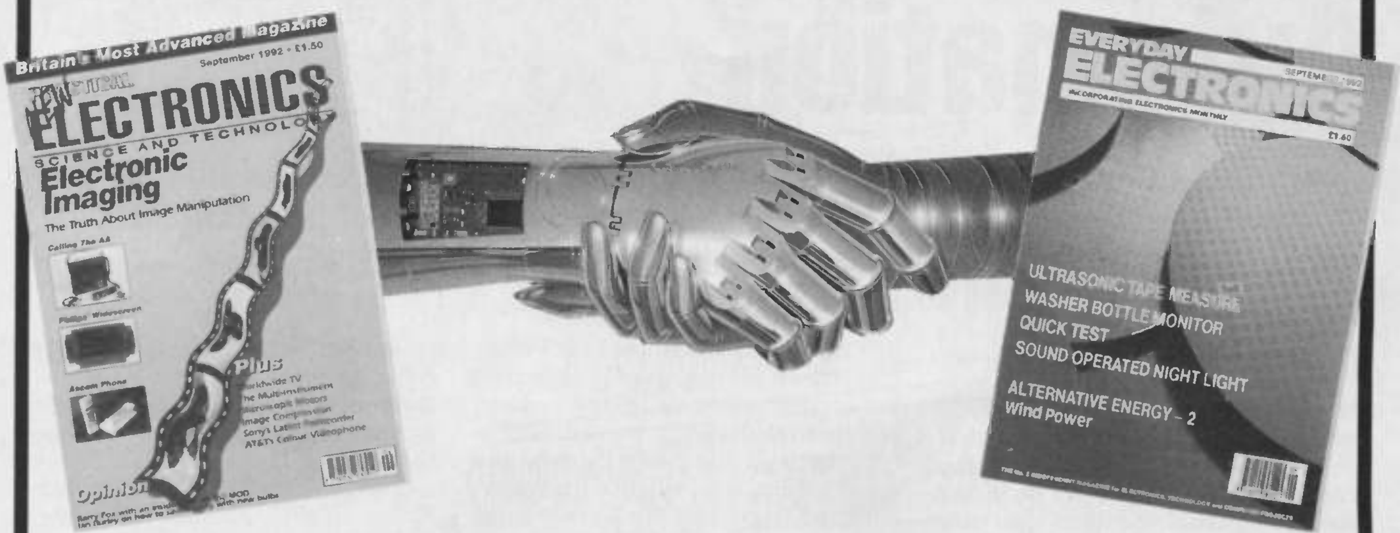


Fig. 10. A three Input gate.



GETTING IT TOGETHER

PRACTICAL ELECTRONICS EVERYDAY ELECTRONICS



From next months issue *Practical Electronics* and *Everyday Electronics* will merge together to give you the best possible electronics magazine.

The projects and features planned for the first combined issue of *Practical Electronics* with *Everyday Electronics* are:

MORE PAGES PROJECTS FEATURES SERIES

In fact more of just about everything you know and love in Practical Electronics

- ★ **TOMORROWS TECHNOLOGY**
- ★ **PERSONAL STEREO AMPLIFIER**
- ★ **REACTION TIMER**
- ★ **ALTIMETER**
- ★ **VIBRATION ALARM**

PLUS: **A new *Teach-In '93* series aimed at everyone interested in electronics and particularly at GCSE and "A" level students**

WHAT TO DO!

What do you need to do to get the combined magazine? Basically nothing at all except be patient and wait until the November issue appears on October 2. If you get a copy from your newsagent, watch out for the new combined logo on his shelves; if your newsagent delivers a copy or if you have a subscription you should find your copy on your doormat as usual.

It's going to be good – just wait and see!

FREE!

The November issue will also come with a **free 196 page** Greenweld Electronics catalogue banded to it (or a postage paid card to send for it if you are a subscriber).

Don't miss it – watch for Practical Electronics with Everyday Electronics around October 2, it will be selling fast!

A Century Of Automation

The quest for knowledge is as old as the human race. Derek Gooding takes a look at some of the developements that have resulted in our present day technology.

Computers, automation, feedback control, integrated systems, microprocessors, chips and Information Technology. Not too many years ago very few of these words existed but today millions around the world use them with ease and understanding. We are living through the later part of the 20th Century Industrial and Technological Revolution.

The invention of mine pumping technology and the skills of windmill builders came together to create a machine with a cylinder and piston, connected to a rocking timber beam high overhead to transmit power to pumps deep in the earth to help prevent the mine from flooding. The inventor, Thomas Newcomen, was a practical man with a deep concern for those who worked in those deep and dangerous mines where water seeped in so quickly after a heavy rain – a constant and potential danger. Steam from a simple boiler entered the cylinder beneath the piston and once full the supply was shut off by hand. Next a spray of cold water was sprayed into the steam filled cylinder, rapidly cooling the steam and condensing it back to water. Thus a partial vacuum was formed by the shrinking steam. The piston moved downwards due to the air pressure above the piston attemting to fill the vacuum. The beam above rocked on its central pivot and the pumps in the mine filled and brought the water to the surface.

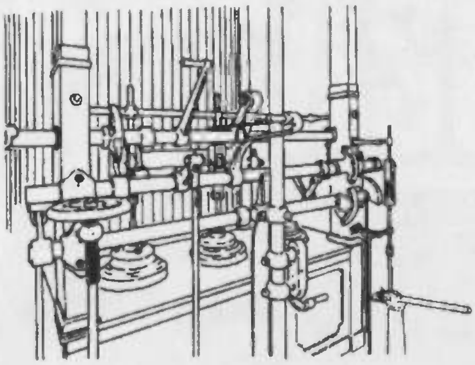
Newcomen's engines required constant attention. Every rocking action of the beam was under the control of the driver. He opened and closed the valves in a set sequence throughout his long shift. Fatigue, boredom and loss of concentration were all dangers for the driver to overcome. The solution? Automation. A simple pump and bucket proved to be the answer. Water from the bucket was drawn into the pump each time the engine moved its beam overhead and then, as the beam was allowed to rock back to the rest position, the small pump, now filled with water, emptied back into the bucket until enough movement had taken place to operate the timed restart of the engine by means of rods and levers connected to the timer known as a 'cateract'.

Some years later James Watt modified the design of Thomas Mead's 1783 invention, the centrifugal governor, as used on windmills, and instead modified it to add feedback control to beam engines with large flywheels. The flywheel's natural momentum, once turning, could be used to reduce the human involvement to a bare minimum. The speed of rotation, being directly proportional to the amount of steam available to the engine, meant that a rotary governor driven by the flywheel could be arranged to control the amount of steam available, to cause constant and preset speed of the wheel. Any increase in rotational speed would cause the governor to rotate faster and therefore the two heavy weights of the design would be thrown outwards and upwards as they turned, this simple action twisting the steam input control valve would obviously deprive the engine of power until the rate reduced enough to allow more steam to enter the cylinder. Thus a constant mean speed was maintained.

Mechanics are all around us. Even the invention of the Stowger telephone system in America around 1891 incorporated the "Watt" style governor into the dial pulsing rate of the dialled numbers. The action of pulling the dial around with the index finger provided a pause between digits transmitted. Releasing the dial allowed it to return at a fixed speed so that the switched pulses could be received at the exchange at the correct speed to drive the relays and make the correct connections to the number dialled. The first Stowger exchange in the U.K. was installed at Epsom in 1912. The last to operate in the London area was switched off on 28th July 1992 at Syapleford when it was replaced by an all electronic exchange.

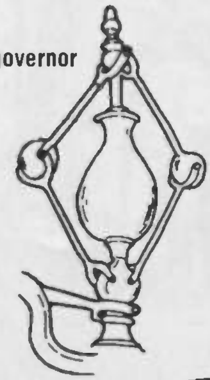
Thermionic valve discoveries led to the triode amplifier capable of sending telephone signals very long distances and from their introduction in the 1920's they were the mainstay of telecommunications. However, the transistor was soon to replace it and provided a smaller, less power hungrey alternative. Printed circuit boards did away with lots of jungle wiring. Transistors became more reliable, smaller and cheaper. Photography techniques and chemicals improved until very complex circuits and components could be reduced down to very small sizes and whole circuit reproduced in tiny areas on chips of silicon. Minaturised large scale integration of wiring and components on multi-layered semiconductor materials soon led to chips being taken for granted, but as with every previous invention, there is always something around the corner to superceed it... so what can the future promise us? From the day Practical Electronics Magazine first appeared I have enjoyed watching the advances, now, as it merges with Everyday Electronics I wish it well and having worked for so long for both titles I know many more amazing advances await us. Good luck. ■

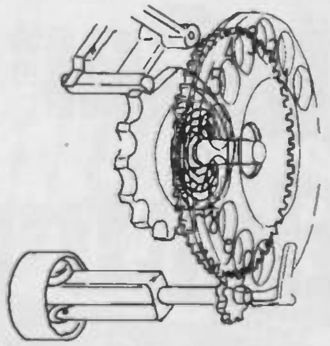
Derek Gooding is the Education Officer at Kew Bridge Steam Museum where technology from the past to developments towards the future are displayed and explained to schools and groups by appointment. The Steam Engine collection is the largest of its kind anywhere – and includes the largest working beam engine and the oldest working waterworks beam engine.



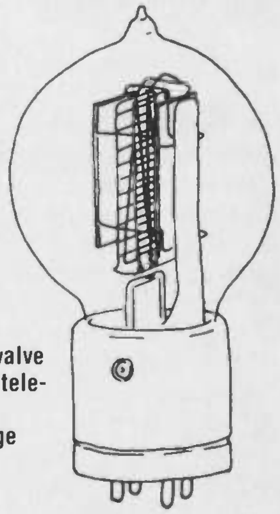
Cornish Bull steam engine

Pendulum governor

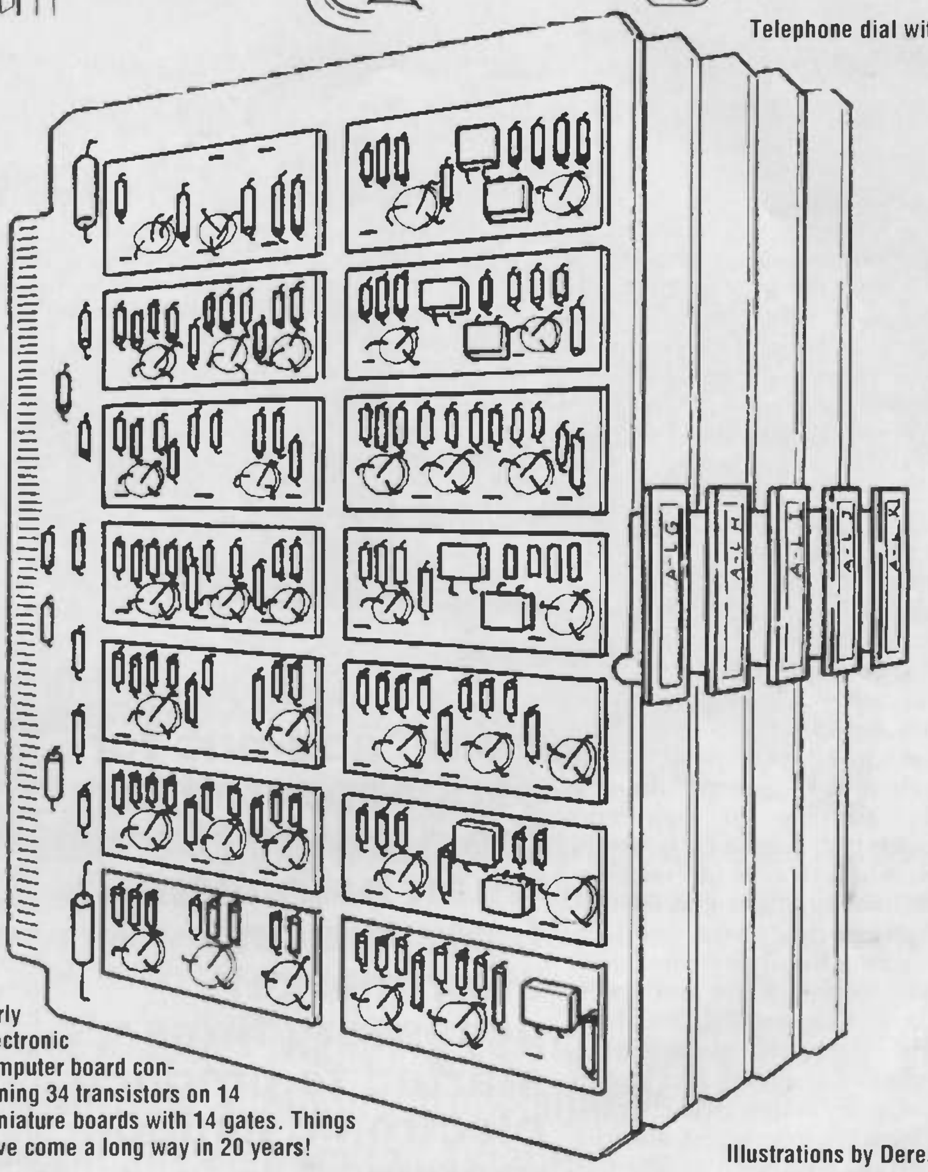




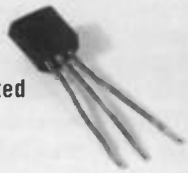
Telephone dial with governor



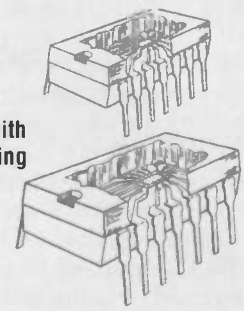
Triode valve used in telephone exchange



Early electronic computer board containing 34 transistors on 14 miniature boards with 14 gates. Things have come a long way in 20 years!



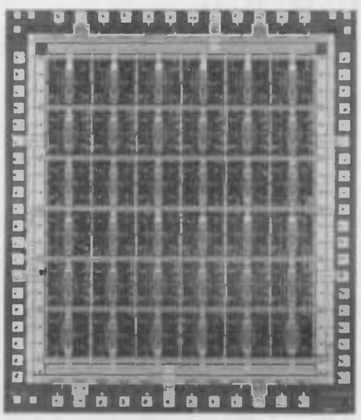
Encapsulated transistor



Chips with everything

Illustrations by Derek Gooding

BT chip design inspection



Plessy chip array

?

What of the future?

In-Car Electronics

Ian Burley dons his fire-proof suit, racing gloves and crash helmet to take a look at the electronic systems used in modern racing cars.

I doubt it would come as any surprise to regular PE readers to be informed that modern cars are stuffed with electronics. However, the range of uses electronics are applied to in the automotive industry is very extensive indeed. Exotic electronic systems contributed to Nigel Mansell's first world championship on the formula one race track this year, but there are some equally impressive electronics in many production cars as well.

The attraction of electronics to contemporary car designers is in control systems. Compared to the mechanical devices they have replaced or enhanced, electronic sensors and management systems are designed to endow far more accurate and speedy control of a whole variety of systems. Although the most obvious application of electronics in cars is in engine management and instrumentation, designers are fast approaching the 'fly by wire' analogy pioneered in the aerospace industry. Computer controlled systems exist to provide automatic transmission changing and torque distribution, active ride suspension, variable four-wheel steering and drive, and Saab is already experimenting with a an electronically controlled joystick to replace the steering wheel and throttle.

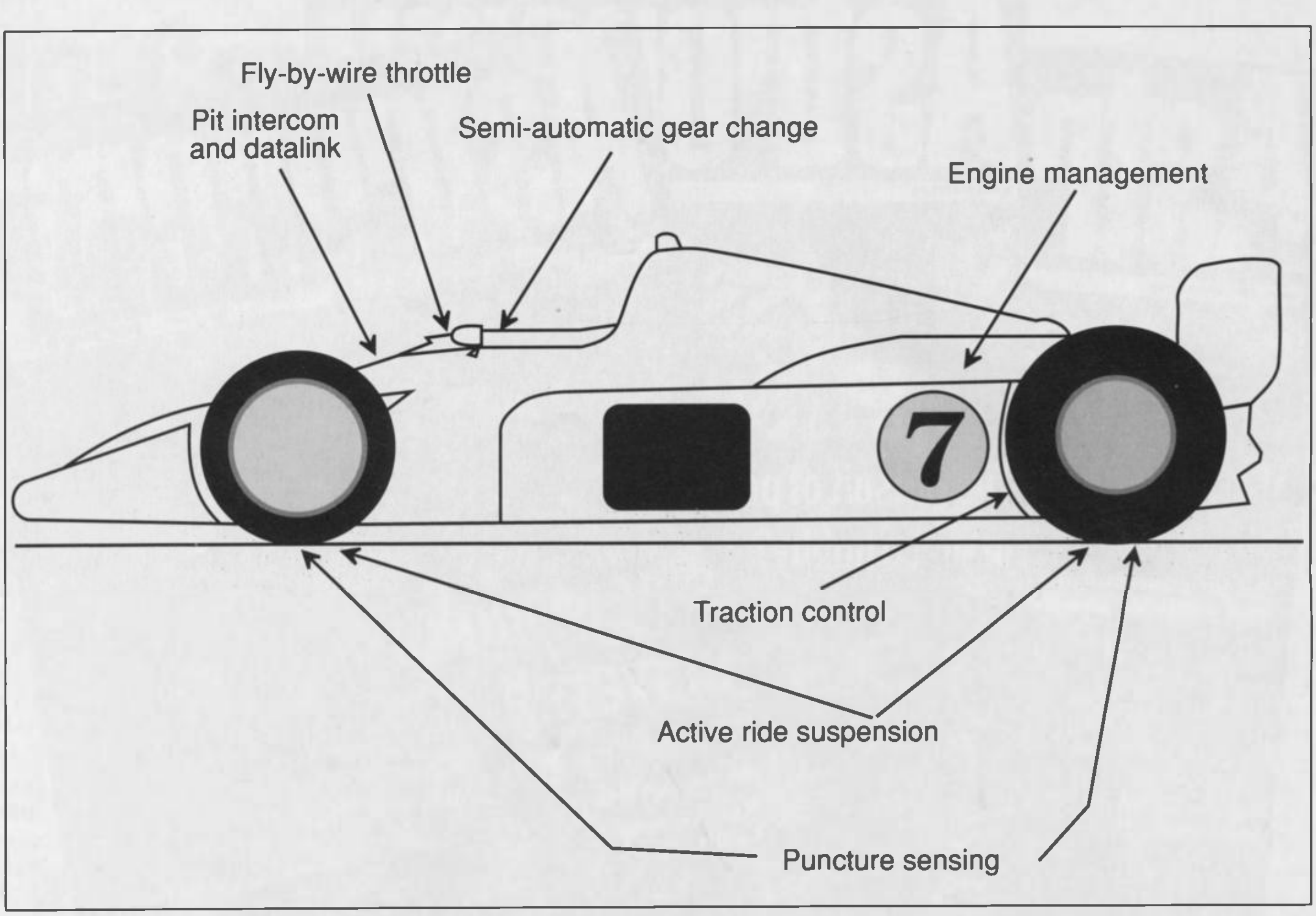
The first electronic add-ons for cars appeared in the early 1970s when both manufacturers and after-market accessory firms started to produce electronic ignition systems. These solved the perennial problem of worn contact breakers in the distributor. This small cam-driven switch had to operate under extreme voltages several thousand times a minute – once for every cylinder sparkplug ignition. Wear and accumulated debris meant regular cleaning and adjustment. The first electronic ignitions handled the high-voltage switching directly but retained the contact breaker for low-tension triggering and this meant a much longer life with less maintenance. However, one minor problem remained – the mechanical contact breaker could perform erratically at very high engine speeds. The ultimate solution was a contact-less or breaker-less ignition system with the high-tension electronic circuitry triggered by an optical or magnetic switch which completely replaced the old contact breaker. Better electronic designs also produced a stronger spark which translated into better cold starting and cleaner running, especially when fitted to old engines with worn distributor mechanisms.

"The first electronic add-ons for cars appeared in the early 1970s when both manufacturers and after-market accessory firms started to produce electronic ignition systems."

The early exploiters of electronic ignition could be found in the highly competitive world of motor racing. Mechanical ignition and fuel injection systems were quickly replaced by electronically controlled systems once the technology became available. The better high speed running offered by electronic ignition was complemented by improved fuel economy and power through accurate fuel metering and distribution with electronic fuel injection. Later this was to be essential for competition engines fitted with turbochargers.

A modern engine management system comprises a central microprocessor linked to several sensors at strategic parts of the engine. Typically there are sensors to monitor air intake flow, crankshaft position, fuel flow, ignition, manifold pressures and throttle position. Although engine management is mainly associated with electronic fuel injection, many modern carburettors are also electronically controlled. Some cars have a combustion knock sensor linked to the ignition system; if the fuel/air mixture pre-ignites it's probably because the ignition timing is too advanced. Prolonged pre-ignition, also known as pinking or knocking, can damage the piston and valves and is inefficient. The knock sensor informs the ignition system when this happens and instantly retards the ignition timing temporarily. Precise engine management is even more important for cars equipped with catalytic exhaust converters. A sensor in the exhaust system helps ensure that the engine is producing the right composition of exhaust gases which can be catalysed successfully.

Engine management controls the

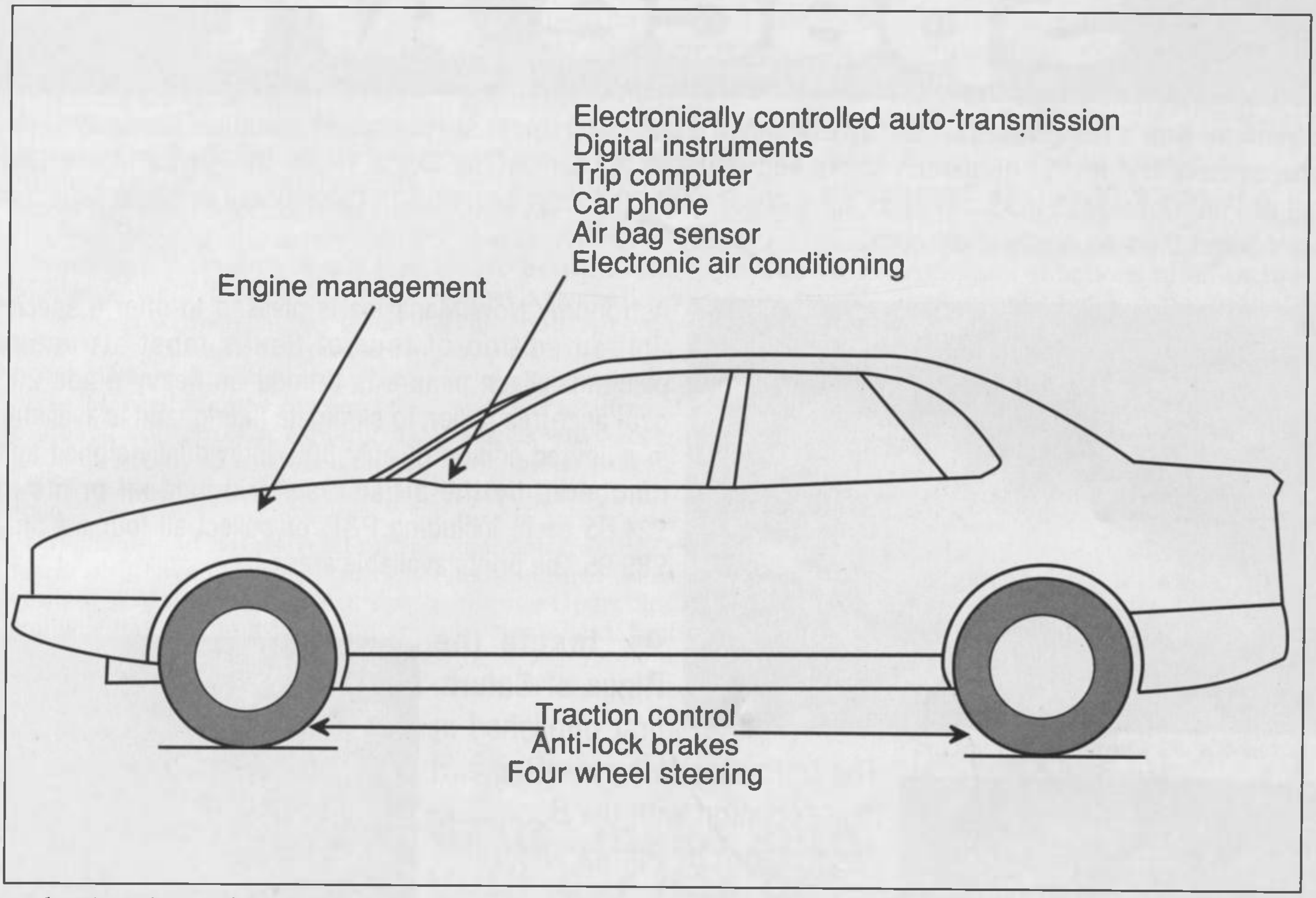


delivery of fuel to the engine and the timing of the ignition of each fuel charge. Advanced engine management systems can treat each cylinder individually – sometimes referred to as a multi-point system. The microprocessor in the engine management control unit refers to a pre-set database or 'map' which corresponds to optimum engine settings according to engine speed and load. Car manufacturers map their engines for a good compromise between economy and performance. However, third party companies quickly realised that by re-mapping the engine management unit quite a lot more power could be extracted. This has become known as 'chipping' as it often only requires the replacement of a few electronic components. Typically re-chipped engines offer 10-15% power improvement, or more if the engine is turbocharged. Chippers often claim that the power in turbocharged Ford Sierra Cosworth engines, for example, can almost be doubled. These cars have detuned track racing engines and besides replacing the engine management map, just a small adjustment to the turbocharger control unleashes the engine's true potential.

Oddly enough, engine mapping is potentially a big compromise – even for the car manufacturers. The engine performance map data is for perfectly running brand new engines. Like all computers, engine management systems are prone to that old adage – garbage in – garbage out so if an electronically managed engine starts to wear and change its operational characteristics, the management system could become seriously confused. This problem could be much worse with 'chipped' engines. Engine management systems are also vulnerable to faulty sensors. It's essential that sensor data is correct whether or not the engine is old, new or chipped. One faulty sensor could quite possibly cause the whole management system to shut down. This happened to my own car once when the crankshaft sensor was eventually found to have an intermittent fault.

The symptoms ranged between the engine completely dying to a simple misfire. Unfortunately, 90% of the time it ran perfectly. In the end the garage was able to wheel the car into the service bay while the engine was still running and showing a problem. It was then be plugged into a real-time diagnostic unit and the faulty sensor was immediately identified. That was six years ago and I'm glad to report that although the engines powering cars I have driven since then have become even more electronically complex, reliability has not been a problem. Engines of the future will almost certainly incorporate a degree of artificial intelligence to adapt to the engine's ageing, and even self-diagnose faults. The new McLaren F1 road-going super-car even has a modem link for remote diagnostics and adjustment via a convenient telephone line!

The better you can control the fuel and ignition the more power the engine can be allowed to develop, hence the association of fuel injection and engine management systems with sporty cars. However, in these energy conservation times, improved efficiency not only means more power but better economy. For example, a 1.4 litre Rover with the latest 16-valve K-series engine develops 95 horse power, four more than a 1.9 litre Triumph engine developed in the late 60s, and it is considerably more economical than its forbear to-boot. The Triumph engine, incidentally, was consid-



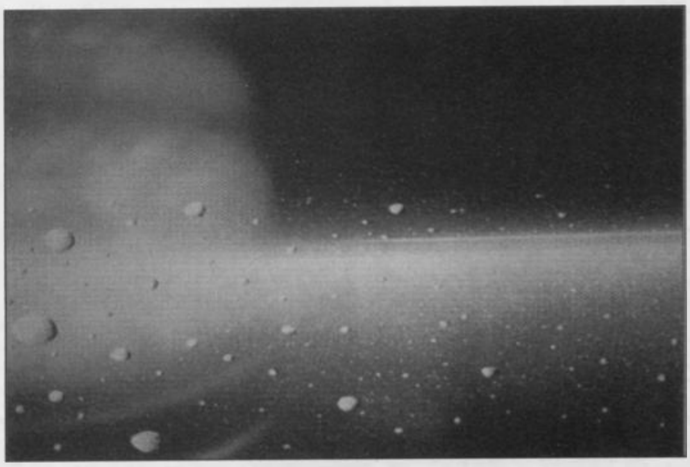
ered quite advanced for its time. It is no longer used by Austin Rover, but lives on as the basis for one of the world's most electronically managed engines at Saab. An experimental version of this engine is so tolerant of changes in combustion characteristics due to its management system that it will run happily on all sorts of weird fuels like alcohol and paraffin as well as normal petrol – without any external adjustments. Other smaller engines than the original Triumph can develop more than 50% greater power and yet exhibit no great fuel economy penalty. Much of the improved performance is down to better engine design, but tight control over the engine combustion provided by engine management systems has had a direct influence on the development of modern engines designs.

Electronic control is not restricted to engines. Several up-market executive cars now offer switchable suspension settings. These settings are governed by specially controlled valves in the suspension dampers. By tightening the valve you get a stiffer, more sporty handling set-up. If the chauffeur is at the wheel you can switch back to a softer and more comfortable ride which won't jog your view of the FT too much! Some cars like Citren's XM have electronically governed hydraulic suspension. The system is designed to prevent excessive pitching under acceleration and braking as well as to provide even more effective bump absorption. Adjustable ride height is offered as well, which keeps constant regardless of load. Back in the mid-80s Lotus built several road-going prototype sportscars with 'active' suspension. These cars had no mechanical springs at all. The car stayed off its bump stops through electronically controlled hydraulic pistons. The car's attitude was continuously monitored by a microprocessor and the suspension lowered or lifted accordingly. This happened in real time of course and the car didn't lean under hard cornering as a result, making it faster and supposedly safer as well. Lotus even ran the system for one season in Formula One, with mixed success – lack of reliability being the main problem. Active ride has since returned to Formula One and it has been the Williams team and Nigel Mansell who have exploited it successfully. This year's Williams car is widely regarded as having a crucial edge over the competition through active suspension which not only makes the car more comfortable to drive on bumpy surfaces, but ensures a constant ride height which is vital for aerodynamic performance. Several other teams are set to introduce rival systems.

Williams has also benefitted from other electronic advantages. Last year the Williams team followed Ferrari in introducing a semi-automatic gear change. Instead of operating a conventional gear lever and clutch, the driver only has to flick switch connected to an up or down shift lever conveniently sited on the steering wheel. The benefits include faster shifts and no need to take a hand off the steering at crucial moments. The McLaren team's system is rumoured to automatically shift gears up under acceleration which eliminates the potential inaccuracy of a driver guessing when the engine has reached peak speed for the next shift. In a Mclaren, the driver no longer has a direct mechanical connection with the

Space Art

Astronomy Now's Art Editor Paul Doherty is one of Britain's foremost space and astronomical illustrators. His pictures have featured in numerous books and regularly appear on The Sky at Night. Dr. Patrick Moore CBE said of Paul Doherty, *"Paul's paintings are without doubt the most beautiful and technically accurate, which is why I select them to illustrate my books."*

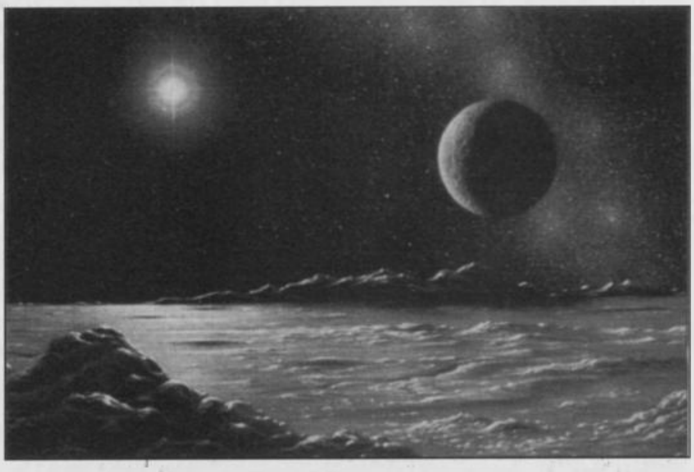


Astronomy Now Magazine is pleased to offer a special limited edition of four of Paul's most attractive paintings. Each picture is printed on heavy grade 200 gsm acid-free paper, to eliminate fading, and is available in a limited edition of only 300, individually signed and numbered by the artist. Select individual prints at £24.95 each, including P&P, or collect all four for only £89.95.The prints available are:

⬅ **Inside the Rings of Saturn**, first published in *The Unfolding Universe* (Rainbird in association with the Book Club Association) by Patrick Moore ☐

⬅ **Planetary System of Albireo**, first published in *Travellers in Space and Time* (St. Michael) by Patrick Moore ☐

➡ **Planet close to a Globular Cluster**, first published in *Travellers in Space and Time* (St. Michael) by Patrick Moore ☐



➡ **The Icy Surface of Pluto**, first published in the *George Philip Atlas of the Universe* by Mitchell Beasley ☐

To order, please tick the box in the caption of the print(s) you require and send a copy of this page to Space Art (PD), Intra Press, Intra House, 193 Uxbridge Road, London W12 9RA. Please enclose payment in the form of a cheque or PO made out to Intra Press. Don't forget to include your name and address.

Orders will be processed on a first-come, first-served basis. Please allow 28 days for delivery.

engine's throttle. Out has gone the throttle cable, to be replaced by an electronically controlled servo. In effect, the driver is almost reduced to advising the engine management system what to do leaving the electronics to make the final decisions. Some drivers are concerned that this will diminish the driver's skill contribution to the car's overall performance.

In the past, the reliability of electronic systems has been a problem – most publicly demonstrated when Nigel Mansell blamed his Ferrari's onboard computer for changing gears erratically all by its self at 200 MPH at the British Grand Prix in 1990.

Williams and now several other teams also have electronic traction control. This is the modern day equivalent of the limited slip differential. An electronic system checks for imbalance in the rotational speed of the driven wheels and alters the power feed to each wheel accordingly by adjusting a torque converter. It all sounds very simple, but the power loads involved reach around 800 horse power and adjustments must be made in milliseconds. Traction control is now available in some road cars – especially the four-wheel drive variety.

Staying with Formula One, most of the top teams enjoy real-time diagnostics whereby engine characteristics can be monitored via a radio link as the car performs on the track. It shouldn't be difficult to note when drivers aren't driving at their best! It's also suspected that some teams have the ability to change variables like the engine map data without having to bring the driver and car back to the pits.

Anti-lock braking systems are now increasingly common on road cars, though not yet in competition cars oddly enough. Braking control is at least one area where driver skill remains preferable to electronics, but for how long is anybody's guess. Anti-lock brake systems or ABS are usually electronically controlled but cheaper all-mechanical solutions are also available. Sensors detect when one or more wheels have locked up and the brakes are repeatedly disengaged and reapplied automatically in a pulsing motion. This retains some grip in a situation when the wheel would otherwise be sliding uncontrollably and unable to contribute to the directional control of the car. Advanced drivers are taught a similar method of extreme braking called cadence braking.

Four wheel steering (4WS) is another area where electronic control can sometimes be involved. With the more sophisticated examples of 4WS the steering relationship between the front and rear wheels can be different according to the road speed. At higher road speeds, like lane changing for example where only a slight turn of the wheel is required, the front and rear wheels will steer in the same direction, but at parking speeds or when turning a corner the rear wheels turn in an opposite direction to aid manoeuvrability. Some 4WS systems control the required steering attitude electronically. As previously mentioned, Saab is experimenting with a fly-by-wire joystick controlled steering system.

"Just make sure your car has battery and alternator up to the job of powering all these gizmos!"

Electronically controlled transmission has already been mentioned with regard to Formula One racing cars, but it's now not unusual to see electronically controlled automatic transmission in ordinary road cars. The more sophisticated systems are electronically linked to the engine management system in order to allow the engine and transmission to work more directly in concert. Switchable modes are also common whereby a 'sport' mode holds the transmission in a gear longer under hard acceleration, only changing up at a higher engine speed than usual. This is less economic on petrol consumption, but provides faster acceleration. All the driver has to do is punch a button to switch modes.

If you have an electronic control unit which monitors things like fuel flow, why not make use of that information and convert it into some meaningful figures like fuel consumption in miles per gallon on a dash-mounted display? Trip computers usually indicate average MPG, actual MPG, fuel used, and when hooked up to distance and speed information you can add an estimated time of arrival function, average speed, and so on. Other trip computer functions often include and exterior temperature indicator and a frost warning. LED or LCD vehicle maps to indicate doors which haven't fully closed or faulty lights are now becoming standard on up-market cars. Full digital instrumentation has dropped in and out of fashion. First introduced in the early 80s, digital instrumentation packs were unreliable and garish, plus drivers preferred the free-swinging needles on traditional analogue dials to low resolution LED/LCD segments. There was also some resentment to talking dashboards warning that the engine oil was low - even when it wasn't! Improvements in design and display electronics have inevitably seen a renaissance in digital instruments and there are useful security advantages in areas like 'electronic' odometers which can't be clocked. My car, a Rover 800-series has ordinary analogue main instruments but there are no less than five LCD panels to gaze at and goodness knows how many buttons to prod! The air conditioning unit even has a sensor to detect whether or not it's day time!

Electronics in cars is becoming boundless. Car radios are stuffed with some very complex chips providing crystal clear and interference free radio reception and radio data system (RDS) information. Car alarms are reaching almost absurd levels of sophistication to beat the thieves, from radio remote controlled locks which re-program their ID numbers every time they are operated to smart-card style electronic keys, without which the car is totally disabled. Then how about a radar detector to avoid the attentions of the local constabulary? Electric seats with memories, electronic puncture detectors, car phones, air bag triggers, electronics to tell you when the next service is due – the list goes on. Just make sure your car has battery and alternator up to the job of powering all these gizmos! ■

GoldStar

QUALITY, PROFESSIONAL PC's AT AFFORDABLE PRICES

EVERY PC COMES WITH:

1 YEAR ON-SITE WARRANTY
VGA GRAPHICS AS STANDARD
FREE UK DELIVERY

GoldStar is a key division of the Lucky GoldStar Group, one of the world's largest international corporations, employing over 100,000 people with a turnover approaching £14 billion. GoldStar, with their unrivalled resources and technical ability, have manufactured and labelled computers for many of the world's leading computer companies for over 30 years! In fact, other PCs you may have been considering, because they have a different brand "name" on the outside, may well be a GoldStar on the inside!

Silica Systems, an official GoldStar appointed dealer, are pleased to recommend this comprehensive range which combines the very latest technology with years of manufacturing experience. GoldStar's quality and reliability coupled with the Silica Systems service, provide you with the perfect PC solution for the home, business or education. From an entry level 286 desktop workstation to a powerful 486 EISA tower system, Silica and GoldStar have the answer, at an affordable price!

286 12MHz £399 + VAT

+£100 for VGA Mono Monitor
+£200 for VGA Colour Monitor

- *12.5MHz 286 (Landmark 17MHz)*
- *1Mb RAM (4Mb max on Motherboard)*
- *2Mb RAM on Plus Series*
- *EMS (LIM 4.0)*
- *42Mb, 130Mb or 210Mb IDE Hard Disk*
- *3½" or 5¼" Floppy Disk Drive*
- *3 Expansion Slots*
- *VGA (Paradise-1M) Graphics - 256K RAM*
- *Serial, Parallel & PS/2 Mouse Ports*
- *12 Months On-site Maintenance*
- *DOS 4.01, DOS Shell, GW BASIC, EMS 4.0, & Utility Software*
- *PLUS SERIES (from £599), Includes:*
  - *Dual Floppy Disk Drives*
  - *Mouse, Mouse Mat & Windows 3*
- *Price - £399+VAT without Hard Drive*

£499 GT212 WITH 42Mb HARD DRIVE

PLUS SERIES with GS1425 VGA Colour Monitor. Model Shown is GT212 286 12MHz

* All the GT212 PLUS SERIES models include 2Mb RAM as standard, so that they can run Windows 3.

Model	Processor	RAM Inc	Max RAM on Board	1 Year on Site	Expansion Slots	Landmark MHz	Co-Processor Socket	VGA Chips	VGA Video RAM	VGA 640x480	VGA 800x600	VGA 1024x768	No Hard Disk + Single Floppy 3½" or 5¼"	42Mb HD + Single Floppy 3½" or 5¼"	PLUS SERIES with Dual Floppy, Windows 3 & Mouse: 42Mb HD + Dual Floppies 3½" & 5¼"	PLUS SERIES: 130Mb HD + Dual Floppies 3½" & 5¼"	PLUS SERIES: 210Mb HD + Dual Floppies 3½" & 5¼"
GT 212	286 12MHz DESKTOP CASE	1 or 2 Mb	4 Mb	●	3 (2×16-bit 1×8-bit)	17 MHz	287-10	PARADISE	256K RAM	16 Colours	16 Colours	N/A	£399 +VAT= £468.83	£499 +VAT=£586.33	£599* +VAT=£703.83	£799* +VAT=£938.83	£1099* +VAT=£1291.33
GT 316	386SX 16MHz DESKTOP CASE	2 Mb	8 Mb	●	5 (4×16-bit 1×8-bit)	21 MHz	387SX-16	PARADISE	256K RAM	16 Colours	16 Colours	N/A	£599 +VAT=£703.83	£699 +VAT=£821.33	£799 +VAT=£938.83	£999 +VAT=£1173.83	£1299 +VAT=£1526.33
GS 318	386SX 20MHz DESKTOP CASE	2 Mb	8 Mb	●	5 (4×16-bit 1×8-bit)	25 MHz	387SX-20	PARADISE	512K RAM	256 Colours	256 Colours	16 Colours	£699 +VAT=£821.33	£799 +VAT=£938.83	£899 +VAT=£1056.33	£1099 +VAT=£1291.33	£1399 +VAT=£1643.83
GS 320	386DX 20MHz DESKTOP CASE - FULL SIZE	2 Mb	10 Mb	●	8 (5×16-bit 2×8, 1×32)	25 MHz	387DX-20	OAK	256K RAM	16 Colours	16 Colours	N/A	—	—	£899 +VAT=£1056.33	£1099 +VAT=£1291.33	£1399 +VAT=£1643.83
GS 347	386DX 25MHz DESKTOP CASE - 32K CACHE	4 Mb	8 Mb	●	5 (4×16-bit 1×8-bit)	40 MHz	386DX-25	PARADISE	256K RAM	16 Colours	16 Colours	N/A	—	—	£1399 +VAT=£1643.83	£1599 +VAT=£1878.83	£1899 +VAT=£2231.33
GS 335	386DX 33MHz TOWER SYSTEM - 64K CACHE	8 Mb	16 Mb	●	8 (6×16-bit 2×8-bit)	50 MHz	386DX-33	ATi Wonder+	512K RAM	256 Colours	256 Colours	16 Colours	—	—	—	£2099 +VAT=£2466.33	£2399 +VAT=£2818.83
GS 425	486DX 25MHz EISA TOWER SYSTEM - 8K CACHE	8 Mb	16 Mb	●	8 (8×EISA)	114 MHz	N/A	ATi Wonder+	512K RAM	256 Colours	256 Colours	16 Colours	—	—	—	£3499 +VAT=£4111.33	£3799 +VAT=£4463.83

14" VGA MONITORS

MODEL Nº	MONO/COLOUR	DOT PITCH	VGA 31.5KHz	S-VGA 35.2KHz	E-VGA 35.5KHz	1 Yr On-Site	Tilt & Swivel	EXC VAT	INC VAT
GS 1405	MONO	N/A	640×480	800×600	–	●	●	£100	£117.50
GS 1425	COLOUR	.39mm	640×480	–	–	●	●	£200	£235.00
GS 1430	COLOUR	.31mm	640×480	–	–	●	●	£230	£270.25
GS 1460	COLOUR	.28mm	640×480	800×600	1024×768	●	●	£250	£293.75

OPTIONS

DESCRIPTION	EXC VAT	INC VAT
1Mbx9-bit SIMM Memory Board	£50	£58.75
287 -12MHz Maths Co-Processor - For GT 212	£100	£117.50
387sx-16MHz Maths Co-Processor - For GT 316	£85	£99.88
387sx-20MHz Maths Co-Processor - For GS 318	£100	£117.50

OPTIONS

DESCRIPTION	EXC VAT	INC VAT
387dx-20MHz Maths Co-Processor - For GS 320	£150	£176.25
387dx-25MHz Maths Co-Processor - For GS 347	£150	£176.25
387dx-33MHz Maths Co-Processor - For GS 335	£160	£188.00
337Mb SCSI Hard Disk Drive - 10.7ms Access	£999	£1173.83

SILICA SYSTEMS OFFER YOU

- ***FREE OVERNIGHT DELIVERY:*** On all hardware orders shipped in the UK mainland.
- ***TECHNICAL SUPPORT HELPLINE:*** Team of technical experts at your service.
- ***PRICE MATCH:*** We normally match competitors on a "Same product - Same price" basis.
- ***ESTABLISHED 12 YEARS:*** Proven track record in professional computer sales.
- ***BUSINESS + EDUCATION + GOVERNMENT:*** Volume discounts available for large orders.
- ***SHOWROOMS:*** Demonstration and training facilities at our London & Sidcup branches.
- ***THE FULL STOCK RANGE:*** All of your requirements from one supplier.
- ***FREE CATALOGUES:*** Will be mailed to you with offers and software/peripheral details.
- ***PAYMENT:*** By cash, cheque, all major credit cards, or extended payment plan.

Before you decide when to buy your new GoldStar PC, we suggest you think very carefully about WHERE you buy it. Consider what it will be like a few months after you have made your purchase, when you may require additional peripherals or software, or help and advice. And, will the company you buy from contact you with details of new products? At Silica Systems, we ensure that you will have nothing to worry about. We have been established for over 12 years and, with our unrivalled experience and expertise, we can now claim to meet our customers requirements with an understanding which is second to none. But don't just take our word for it. Complete and return the coupon now for our latest Free literature and begin to experience the "Silica Systems Service".

MAIL ORDER HOTLINE 081-309 1111

SILICA SYSTEMS

MAIL ORDER: Order Lines Open: Mon-Sat 9.00am-6.00pm	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX	No Late Night Opening	Tel: 081-309 1111 Fax No: 081-308 0608
LONDON SHOP: Opening Hours: Mon-Sat 9.30am-6.00pm	52 Tottenham Court Road, London, W1P 0BA	No Late Night Opening	Tel: 071-580 4000 Fax No: 071-323 4737
LONDON SHOP: Opening Hours: Mon-Sat 9.30am-6.00pm	Selfridges (1st Floor), Oxford Street, London, W1A 1AB	Late Night: Thursday until 8pm	Tel: 071-629 1234 Extension: 3914
SIDCUP SHOP: Opening Hours: Mon-Sat 9.00am-5.30pm	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX	Late Night: Friday until 7pm	Tel: 081-302 8811 Fax No: 081-309 0017

To: Silica Systems, Dept PRNOW-1291-66, 1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX

PLEASE SEND ME A GOLDSTAR CATALOGUE

Mr/Mrs/Ms: .... Initials: .... Surname: ....

Address: ....

....

.... Postcode: ....

Tel (Home): .... Tel (Work): ....

Company Name (if applicable): ....

Which computer(s), if any, do you own? 66B

E&OE - Advertised prices and specifications may change - Please return the coupon for the latest information.

Continued from 10

either in the USA, UK or Far East, and certainly no international standard. Also, whereas the US RJ plug is designed to be transparent, and thus helpfully makes the core colours clearly visible, British Telecom's plug is unhelpfully opaque white. This usually makes it impossible to see the colour coding without first cutting off the plug.

The only sure way to check connections is electrically, with fine probes on the pins, and an audible signal to denote end to end contact. When you do this with enough leads, some simple guiding principles emerge from the confusion.

Both in the US and UK, there is provision for a six pin plug, but usually only four pins are used. Of these only two are essential for connection. In the USA, the "hot" pins are the two central pins, but in the UK the hot pins are the two outer pins. Whereas some leads preserve polarity end to end, others reverse it, on some or all pairs. But (in another context), BT engineers have confirmed to me that the polarity of connections is not important; and practice bears this out.

Clearly a lead which runs between a BT plug and an RJ plug to connect US equipment to a UK line, must route the outside "hot" pins of the BT plug to the inside "hot" pins of the RJ plug. Usually the outside pins of the RJ plug are also routed to the inside pins of the BT plug. Sketches 1 and 2 show the two main variations on this "outside to inside" theme, with and without symmetry of polarity.

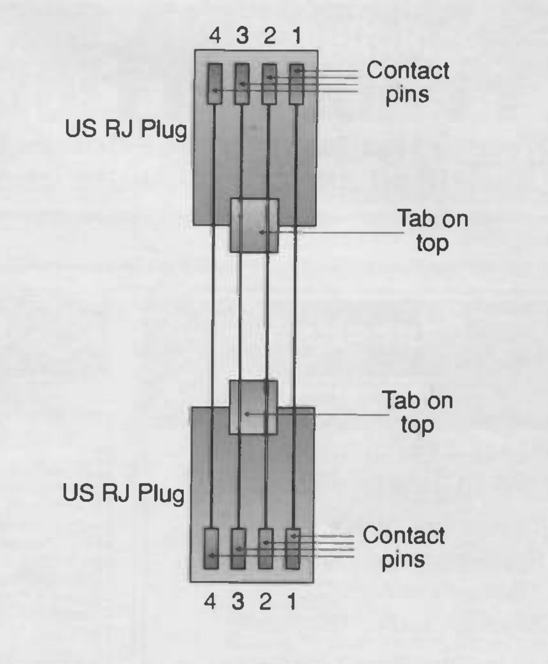
To confuse the unwary, some equipment which is fitted with RJ plugs, but designed for sale in the UK or Hong Kong (where they use BT plugs), makes the outside pins of the RJ plug "hot". So the connecting lead must route the outside pins of the BT plug to the outside pins of the RJ plug. Again, there are two variations on this "outside to outside" theme giving variations on polarity. See sketches 3 and 4.

Although there will usually be no working difference between types 1 and 2, and no difference between 3 and 4, there is absolutely no compatibility between types 1/2 and 3/4. If you use type 1/2 instead of 3/4, or vice versa, the there will be no dial tone.

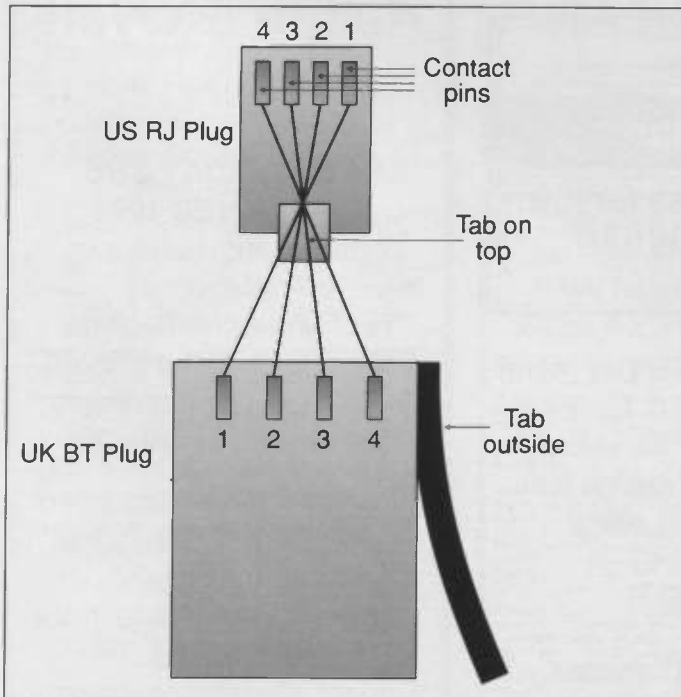
Shops do not identify these different types of lead by label and sales staff will seldom even know there is a difference.

There is a fifth type of lead, shown in sketch 5. This has two US RJ plugs back to back with mirror image wiring to provide a stright through connection.

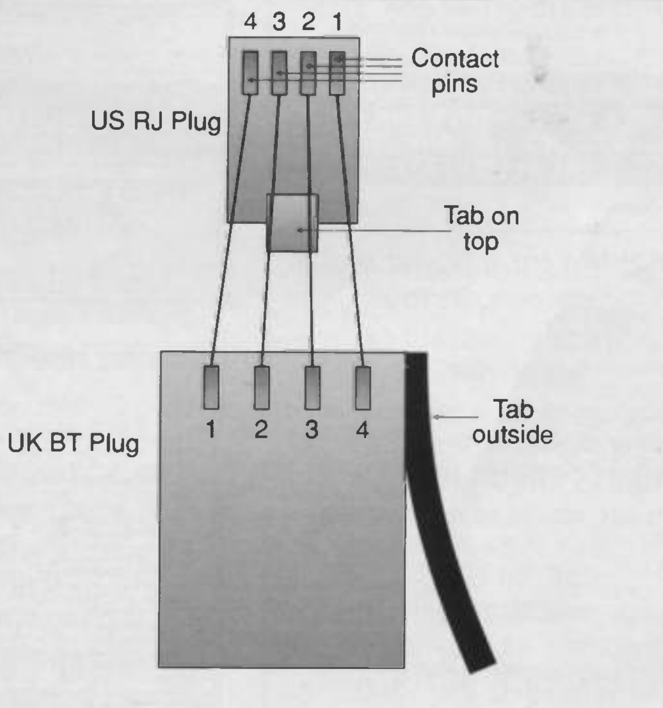
But beware. There are two types of this lead. One, usually short and coiled, connects the handset of a telephone to the main unit; the other, usually longer and straight, connects a phone to a wall socket. At first sight these leads look identical. But they are not. The RJ plugs on the handset lead are very slightly smaller than the RJ plugs on the wall socket lead. Although you can physically plug the small plug into the slightly larger wall or phone socket, it will not make a reliable electric connection. Shops often do not label or understand this difference either. ■



Mirror image gives straight through connection to and-from handset and main unit.



Outside to outside, inside to inside lead as supplied with some equipment sold on the UK market (eg Amstrad fax machine).



Outside to outside, inside to inside.

Practical Electronics Classifieds

Reach thousands of serious electronics enthusiasts with your message.
Classified advertisements can now be arranged by calling 0202-881749

Education

Start training now for the following courses.

- ❑ Telecomms Tech C&G 271
- ❑ Radio Amateur Licence C&G
- ❑ Microprocessor
- ❑ Introduction to Television

Send for our brochure - without obligation or telephone us on 06267 79398 (Ref: PE10/92)
Name...
...

Radio & Telecommunications Correspondence School,
12 Moor View Drive, Teignmouth,
Devon TQ14 9UN

BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT
AN EQUAL OPPORTUNITIES PROGRAMME
O.N.C. H.N.C. O.N.D.
Next Course Commences
21st September 1992
FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(DEPT. EE) 20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL 071-373 8721

Looking for a home study course, in the fundamentals of electronics?
Whether you are a beginner, or an old hand requiring a refresher, the **DIRECT PERSONAL LEARNING** course could be right for you.

Contact
K. Sparrow, Electronic Training Consultant, 11 Claydon Green, Whitchurch, BRISTOL Avon, BS14 0NG.
Tel: 0275 835669

Components

CATALOGUE £1.00 + 25 P&P

LEDs 3mm or 5mm red/green ....6p each. Yellow 11p each,
High intesity red,green or yellow 5mm 30p each
Cable ties 1p each £5.95/1,000 £49.50 per 10,000
Stepping motor 4 phase 12V 7.5' step 50 ohms £8.95
SAA1027 stepping motor driver chip £3.95
FM Transmitter kit good quality sound £8.60
High quality photo resist copper clad epoxy glass boards

Dimensions	single sided	double sided
3x4 inches	£ 0.95	£1.07
4x8 inches	£ 2.40	£2.68
6x12 inches	£ 5.37	-
12x12 inches	£10.66	-

Special Offers

Computer Grade Capacitors with screw terminals 38000µf 20V......... £2.50
87,000µf 10V £1.95, 68,000µf 15V £2.95, 10,000µf 16V....................£1.50
7 segment Common anode led display 12mm £0.45
LM2931AT5.0 Low drop out 5V regulator T0220 package........ ....£0.85
BS250 P channel MOSFET £0.45, BC559 transistor ....£3.95 per 100
74LS05 hex invertor £10.00 per 100, used 8748 Microcontroller £3.50
TV Main switcth 4A double pole with momentary contacts for remote control pack of 10 £3.95 box of 60 £19.95.
DC-DC converter Reliability model V12P5 12v in 5v 200ma out 300v input to output Isolation with data $4.95 each or pack of 10 ....£39.95
Hour counter (used) 7 digit mains 240V AC 50Hz £1.45
Resistor pack 2500 resistors 1/8-2W 50 different values.....................£8.95
Qwerty keyboard 58 key good quality switches new £5.00
Qwerty keyboard with serial output, no data £5.00

Wide range of CMOS TTL 74HC 74F Linear transistors kits
Rechargeable batteries, capacitor tools etc always in stock.
Please add 95p towards P&P - VAT Included

JPG Electronics 276 - 278 Chatsworth Road
Chesterfield S40 2BH
Access/Visa orders (0246) 211202. Callers welcome

We at
Practical Electronics
wish our readers
every success for the
Future

CAMBRIDGE COMPUTER SCIENCE LIMITED

LCD modules,.........16 char by 1: £4.00, 20 char by 2: £6.00, 40 char by 1: £8.00
5.25" Disk Drives, 80 Tk, DSDD ....£25.00 each
5.25" Disk Drives, 80 Tk, DSDD Used, No Wty ....£9.00 each
(The £9.00 drives are sold on a stricly 'as is' basis)
5.25" Disks, DSDD, 48tpi, boxes of 10 (free disk cleaner with 5 boxes).£3.00/box
Digital multimeter, 14 ranges, inc leads & manual..............................£10.00 each
Apricot Disk drive PSU 5V @ 2.5A, 12V @ 2A..............................£10.00 each
Disk Drive Data lead BBC Micro to Disk Drive(s)...Single £2.00 Dual £4.00 each
Disk Drive Power lead BBC Micro to Disk Drive(s) Single £2.00 Dual £4.00 each
8086 CPU chips ....£2.00 each
Z80A CPU, CTC, PIO £1.20 each; DMA £2.00..............................£4.50 all 4
27128 EPROMS (Ex equipment)..............................£1.20 each or £5.00/5
256K DRAM (Ex equipment)..............................£0.40 each
1MBit-10 DRAM (Ex equipment)..............................£1.40 each
256K Byte DRAM Modules, removed from equipment ....£6.00 each
16, 18 & 20 pin dil low profile IC sockets 0.3" wide £0.40/10 ....£3.00/100
22 & 24 pin dil low profile IC sockets 0.4" wide £0.40/10 ....£3.00/100
24, 28, 32, 40 & 48 pin dil low profile IC sockets 0.6" wide £0.40/10 .....£3.00/100
Circuit tester, finds faults in TTL & CMOS logic circuits, inc leads ....£8.00 each
Metal project boxes drilled & painted but unused 28 x 32.5 5cm..........£5.00 each
Used computer cards many useful components (large ones socketed)
Floppy disk card (NEC FDC chip) £1.00 Wini controller (WD HDC chip) £1.00 each
CPU card (8088, Z80 & EPROMS)..............................£3.00 each
Keyboards, full QWERTY, number pad and LCD ....£8.00 each
Desktop computer case with 200W mains PSU (used) ....£30.00 each

Prices include postage. Add 50p (plus VAT) to orders below £5.00
All items new unless stated. Add 17.5% VAT to all prices.
Send an SAE for our latest list or for more info.
Dept PE, 374 Milton Road, Cambridge, CB4 1SU
Tel: 0223 424602, 0831 430496 or 0831 430552 (Mail order only)

Auction

By Order Of The Secretary of State for the Home Department

CROWN
E II R

Sale by Auction of
RADIO AND ELECTRONIC TEST EQUIPMENT
including Hewlett Packard, Marconi,Racal, Bird, Telequipment, Farnell, Levell, etc; Signal Generators, Receivers, Amplifiers, Oscilloscopes, Power Meters, Recorders, Plotters, Power Supplies, Attenuators, etc:
by

Austin & Wyatt

on

WEDNESDAY 23rd SEPTEMBER 1992
commencing 10.30 a.m.
at the
Test and Investigation Laboratory, Government Buildings, London Road, Stanmore, Middlesex

Viewing arrangements and admission by Catalogue only giving full details, price £2 to include postage, from the Auctioneers, The Square, Bishops Waltham, Southampton SO3 1GG
Tel: 0489 893466

Miscellaneous

PTFE Low Friction material in 0.8mm sheet at 25p per square inch and 10mm thick blocks at £1.00 per square inch. SAE for details of Telescope Drive Systems and clocks. AWR Technology, 67 Thornbridge Road, Deal, Kent.

Study Electronics on the BBC Micro. An interactive approch to learning. Four program titles available. 'Introduction to Electronics Principles', 'Electronics Mathematics', 'Digital Techniques' and now 'Programming for Electronics'. Programs include theory, examples, self test questions, formulae, charts and circuit diagrams. User inputs and calculated outputs. £29.95 each + £2.00 P&P. Cheque or Postal Order to EPT Education Software, Pump House, Lockram Lane, Witham, Essex CM8 2BJ

Components

Schools

Surveillance

Surplus

Recycle your old projects and generate useful cash from spare components

Wanted: Back issues of Radio Constructor or Radio & Electronics Constructor 1970 onwards – must be in good condition. Tel: Chester (0244) 660637

Digital electronics tutorial software for IBM PC. Basics to Karnaugh maps. £5 only. Tel: 061 430 5208

Hornby Zero-1 design team members (1980-1984) please contact C Harris, 10 Patea PLace, Palmerston, North New Zealand. Tel: NZ 6 3561754. Information required Phase III

Two-tone steel panel boxes, white/grey, brand new beautiful finish, desk top with feet or can be wall-mounted. Illuninated push swith, LEDs and microphone. produced for Scantronic Homelink, but can be adapted for any project. Size 13" W, 11" D, 2" H, sloping fascia. Very attractive. Internal 12V sounder and connectors included. £3.00 each or £220 for 93 available. Also food used transformers (approc 100) £1.00 each, mostly 1A 15-20V AC out. 3 pin moulded plug (fused) with 2 metres 3 core 0.5mm flex, brand new £1.00 each. 2 pin plugs with 2 core flex 2m length, brand new, 50p each. All prices include carriage. Tel: Fab Security Systems Ltd, 0792 202718

DRAM. D-RAM 41256-15 60p each or £5.00 for 9. S-RAM 6116LP3 60p each. EPROM D2732D £1.00 each. Plug in relays 11-pin 240V/110V. £1.20 each. All items unused. Details (0273) 514465 (evenings)

Hewlett Packard Enthusiasts. HP9836 Computer to break for parts or repair. (Fault in memory section). O I R O #50 includes HP9111A graphics tablet, leads and software. More Info:- Crewkerne (0460) 73416 after 7:30pm

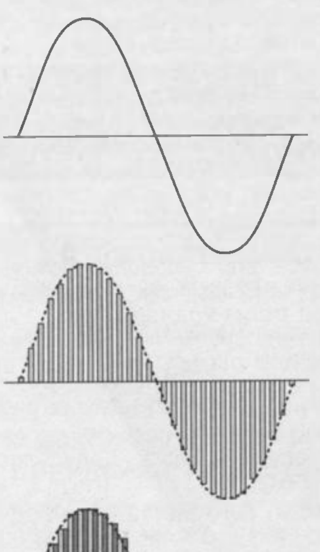
Echo And Reverb Effects Unit

A low-cost sound box for wierd and wonderful effects – crazy crescendo and raucous reverberation from M P Horsey.

Various devices are employed to enable sound reverberation or echo effects. These include multiple head tape recorders, metal springs and digital memory devices. Also of note are bucket brigade delay line integrated circuits. For example the TDA 1022 provides theoretical delays of up to 51 milliseconds. Unfortunately, the actual delay possible is very much less and a number of these ICs have to be cascaded together.

Another bucket brigade delay line IC is available which provides delays of three times longer. The IC is of the type TDA 1097. While a little more expensive, only two such ICs are required to provide reverberation and echo effects.

Fig. 1. Audio sampling.



A variety of sound effects can be obtained with this circuit. While designed for reverberation, the time delay can be sufficiently long to produce echo effects. In addition, the feedback may be increased to produced a crescendo effect – ideal for producing weird sounds.

Principle Of Operation

The TDA 1097 is a 1536 stage delay line. Each stage is a capacitor fabricated with associated circuitry within the IC. The audio (analogue) signal is divided into samples – as illustrated in Fig. 1. Each sample represents a precise voltage and is stored in the first capacitor C0. Between successive capacitors is an electronic switch which transfers the charge from one capacitor to the next. Thus, the sample is transferred along the capacitors, rather like water being passed from one bucket to the next as used in old fashioned methods of fire fighting – hence the name bucket brigade delay line.

The time taken for samples to travel from one end to the other depends upon the number of stages and the rate at which the electronic switches operate. In this IC, the number of switches is fixed at 1536. However, several ICs may be connected in series if required. The switching rate is determined by the clock pulse fed to pins 1 and 2. The frequency of this clock pulse may be from 5kHz to 100kHz. In practice, however, this frequency should be twice the maximum audio frequency required – look up Nyquist and Shannon theorems in a technical encyclopædia for more information.

The circuit described is intended for the human voice and a maximum audio frequency of 8kHz. The clock frequency is variable from about 12kHz upwards. At a clock frequency of 20kHz a delay of 38 milliseconds per IC is provided. Thus with two ICs a delay of up to 76 milliseconds is possible. Since the output is fed back into the IC, reverberation can continue for some time.

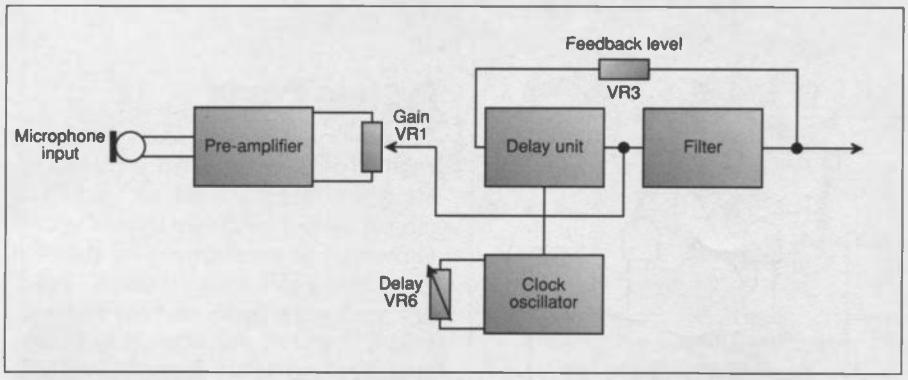
Electronic Filter

If electrical charges are to be passed from capacitor to capacitor it will be apparent that only alternate capacitors can actively hold the samples at any one time. The audio signal will, therefore, be split up as indicated in Fig. 1b. Filtering such a signal is difficult – and would result in only half the maximum possible audio frequency signal indicated above. This fragmented audio signal is taken from the main output pin 4. An output is also provided from the previous stage and the charges from this fill up the gaps as shown in Fig. 1c. Thus, if pins 4 and 6 are connected together, the combined output provides greater continuity of signal and simplified filtering.

This combined output is fed to an active filter comprising a 741 op-amp IC and associated resistors and capacitors. The effect of this circuit is to cut off all frequencies above 8kHz. Thus the bumpy wave of Fig. 1c. is reduced to smooth the audio wave similar to the input.

Circuit Arrangement

It is important to note that the circuit employs a positive earth



arrangement as shown in Fig. 4. This is unusual and may cause confusion to the unwary observer. The arrangement will not affect the way in which the circuit is connected to other equipment such as a power amplifier. The project consists of three main sections. These comprise the power supply, preamplifier, delay circuit and filter. A moving coil microphone may be connected to the input and the output is sufficient to drive a power amplifier in, say, a HiFi. Larger input signals could be applied at capacitor C6 if required.

Variable resistor VR1 acts as a microphone level control. VR3 controls the amount of feedback and hence the total reverberation time and VR6 controls the clock frequency and hence the length of time for which the audio signal is delayed in IC2 and IC3.

Microphone Amplifier

The high gain amplifier (Fig. 4.) based on a 741 IC increases the very low signal level produced by a moving coil microphone. The microphone signal is fed via DC blocking capacitor C1 to the non-inverting input of IC1. Resistors R1 and R2 hold this input at about -7V. The output from IC1 is fed back to the inverting input via R3, to reduce the gain to an acceptable level. The frequency range is set by C2, C3 and R4. The output passes via DC clocking capacitor C4 to VR1 – the microphone level control.

Delay And Filter Circuits

The amplified audio signal passes via R5 and C6 to the filter circuit comprising IC4 and associated components (described later). Part of the output from IC4 passes via VR3 and C9 to the input of the bucket brigade delay line IC2. The DC voltage at pin 3 is held at -7V by means of VR2 and R9. Capacitor C7 decouples the junction between VR2 and R9. Pin 5 of IC2 is connected to -15V: pin 8 to zero V and pin 7 to about -14V as set by the resistor chain R6, R7, VR2 and R8. The clock inputs are connected to pins 1 and 2.

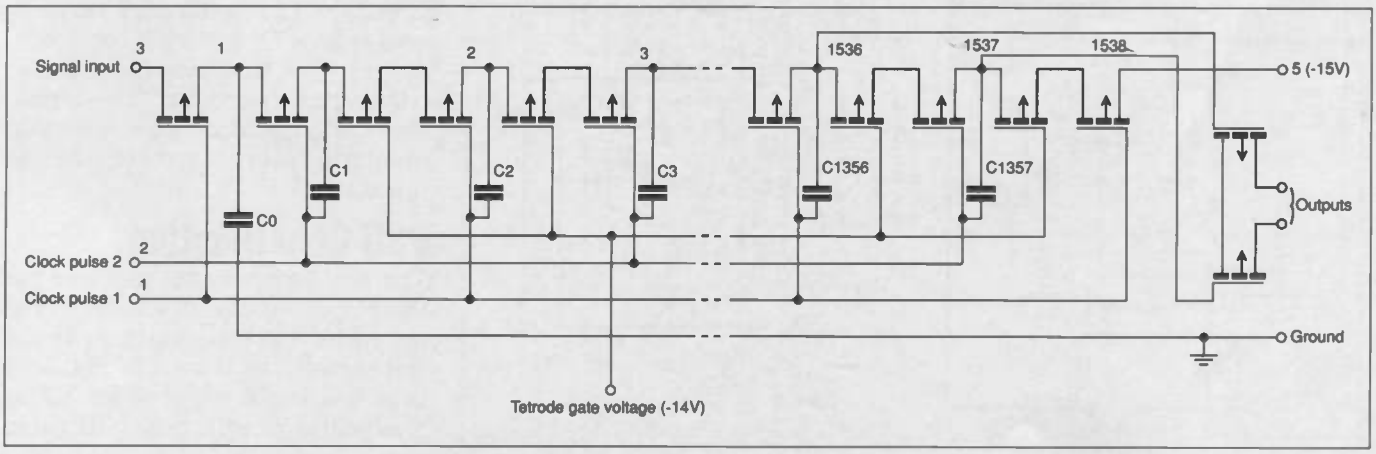
The delayed output from IC2 is taken from pins 4 and 6 and the signal is fed via DC blocking capacitor C8 into the next delay line IC3. This IC is connected in exactly the same way as IC2 except that the outputs are connected via preset VR4. This should be adjusted for minimum distortion and ensures that the two sets of outputs are equal.

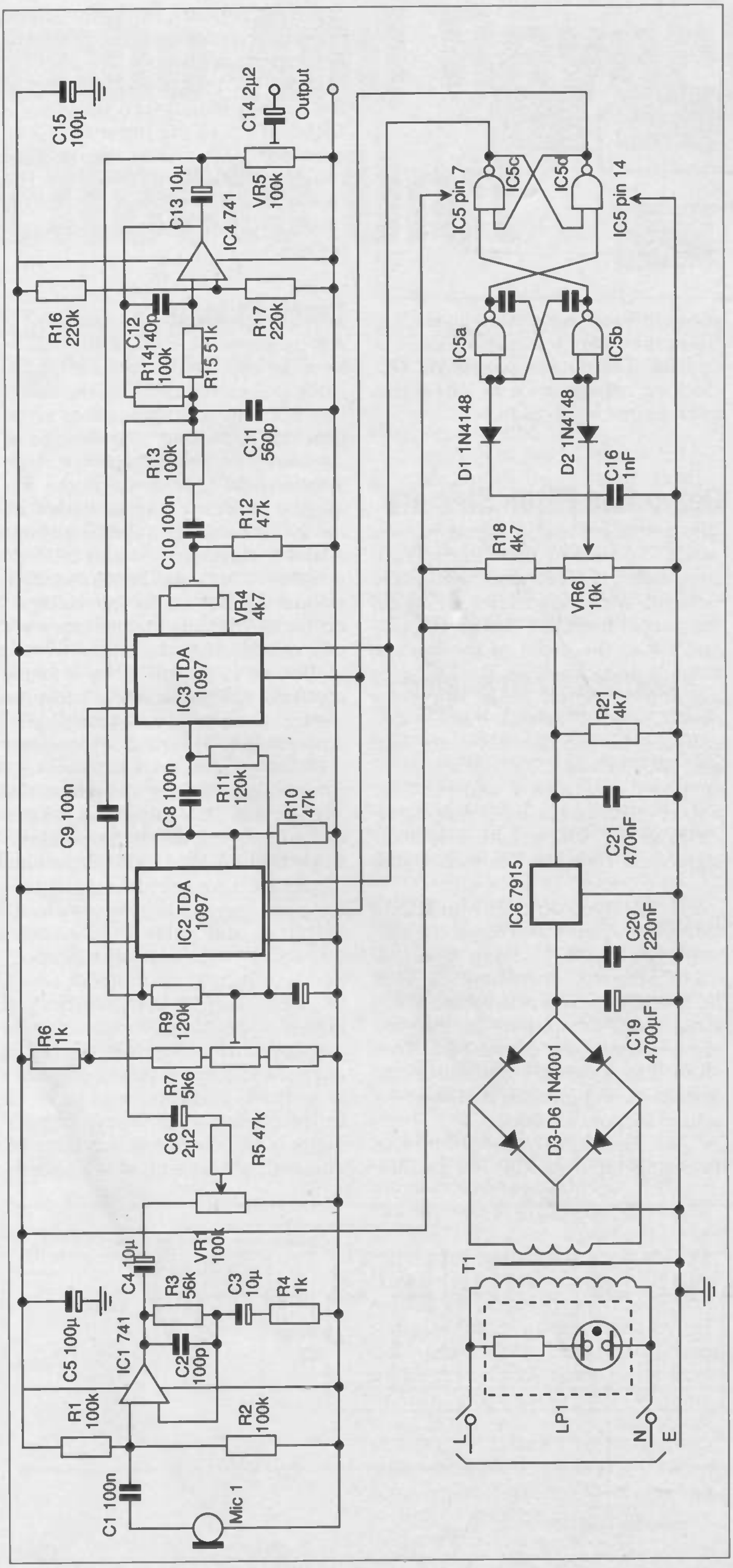
The signal now passes into the inverting input of IC4. The resistor capacitor network filters the signal so that frequencies above about 8kHz are cancelled out. Pin 3 is held at about -7V by R16 and R17. Part of the output from pin 6 travels via VR3 and C9 to the input of IC2 as previously described to complete the feedback loop. VR2 sets the feedback level and thus the lengths of time for which the signal reverberates.

Clock Cignals

An inexpensive CMOS 4011 IC is used to supply the two antiphase clock pulses required by the delay line ICs. The arrangement of resistors and capacitors and the use of all four gates provides a very clean symmetrical output wave, the frequency of which may be varied by means of a voltage applied to gates A and B via diodes D1 and D2. VR6 sets the voltage and hence the clock frequency. R18 limits the voltage , ensuring that the clock frequency cannot be increased too far.

Power is supplied by a fairly conventional arrangement comprising transformer T1 and four diodes. Smoothing is achieved by capacitor C19 with capacitors C20 ad C21 removing any tiny spikes on the supply. The -15V supply is provided by a negative voltage regulator IC6 which is a type 7915. Capacitors C5 and C15 provide additional decoupling for the microphone amplifier and delay filter circuits respectively. The components specified will supply up to about 60mA DC which is more than sufficient. A higher current transformer may be employed if the power supply is required to drive a power amplifier as well. No alteration need be made to the other power supply components is DC output is less than 1A although a heat sink will be neces-





sary for IC6.

Cutting Costs

The delay line ICs TDA 1097 are rather expensive and some constructors may prefer to build the circuit with one other than the two shown. It is recommended that the circuit be built with all the IC holders and wire links so that the second TDA 1097 may be added later. If only one delay line IC is used, leave out IC2 and C8 and take C9 to pin 3 of IC3 instead of IC2. The maximum delay is halved but quite interesting reverberation effects can still be obtained.

Mic Amp Construction

The microphone amplifier circuit is sensitive to electrical interference and it seemed prudent to construct is separately (Fig 5.) to allow for additional screening. As with all amplifiers, neatness of wiring is important to prevent the circuit from picking up electrical noise and feedback. Begin by breaking the tracks as shown. Then solder on the IC holders, wire links, resistors and small capacitors. Note that electrolytic capacitors must be connected with the correct polarity. Plug in the 741 IC the correct way around – no special handling precautions are required for this chip.

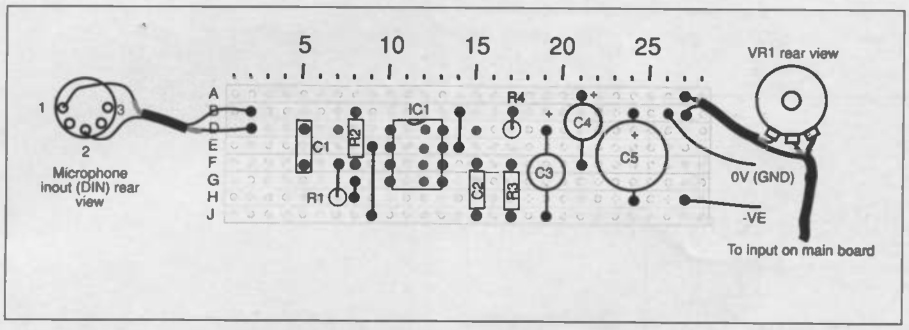
Screened cable should be used at the input and output. Note that the screen is connected to positive earth.

Testing

The microphone amplifier should be tested separately. Connect a suitable moving coil microphone and feed the amplifier output to the tape, tuner or Aux input of a power amplifier. The circuit may be powered from a 9V battery if required – don't forget that positive must be connected to ground. The signal obtained should be similar to that obtained from a tape recorder or tuner.

PSU Construction

The few components required for the power supply may be mounted on a piece of stripboard near the transformer as shown in Fig. 6. A heat sink is not required for IC6 as it is working well below its rated



current output. A 100mA minus 15V regulator may be available and can be used if preferred. There is little price advantage however. Make sure that the large electrolytic capacitor C19 is connected positive earth again. Note that track C is deliberately left unconnected.

The Main Circuit

The delay line filter and clock pulse generator are constructed on a single piece of stripboard as shown in Fig. 7.

Label the stripboard carefully and break the tracks where indicated, noting that the position of the break is critical in both directions. Sockets are essential for CMOS bucket brigade delay lines IC2, IC3 and CMOS IC5. It is wise to use a socket for IC 4 as well.

The sockets, wire links and components may be soldered in as usual noting the polarity of the diodes and electrolytic capacitors C6, C7, C13, C14 and C15. Screened cable should be employed to link VR2 with the circuit and the signal input and output. The screen must be connected to the 0V, IC4 should be inserted into its holder the correct way around but do not plug in the delay line ICs at this stage.

IC5 should be inserted into its socket noting that it is a CMOS IC and requires careful handling – see below.

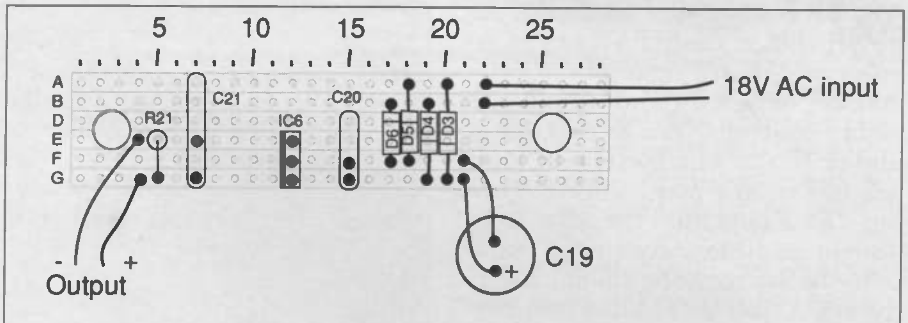
Mains Wiring

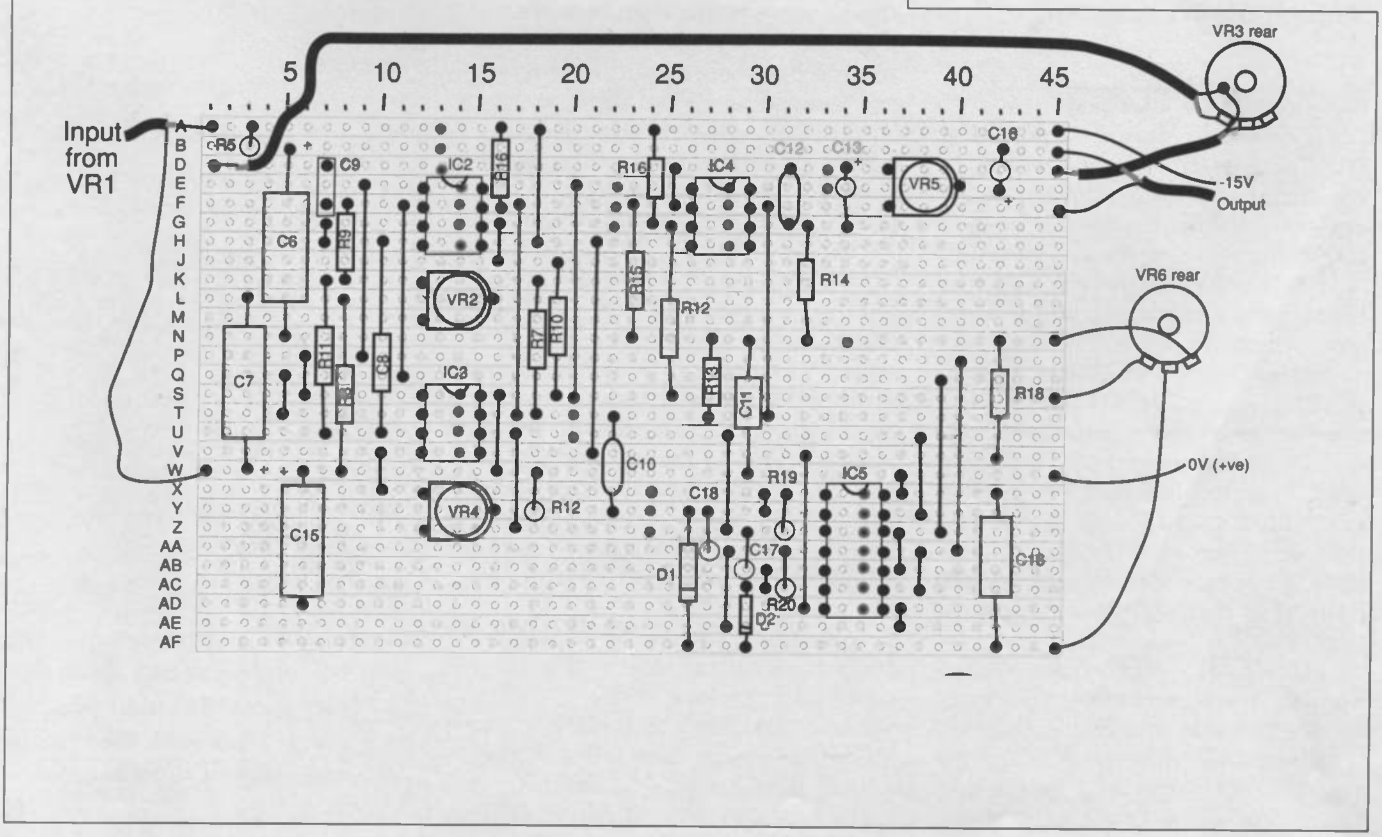
Keep all mains wiring as short as possible and away from the audio parts of the circuit. The mains earth lead should be connected to the metal core of the transformer and to the metal of the case. The earth connection should also be joined to the positive (0V) line of the power supply.

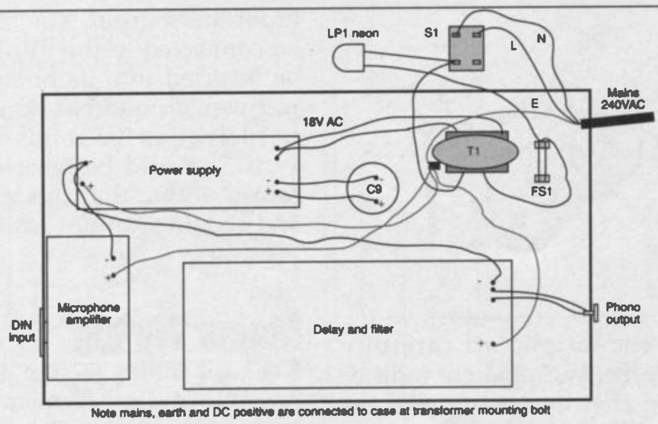
Connect the power supply to both the microphone amplifier and the delay/filter circuits. Connect a voltmeter across the power supply and switch on. Switch off immediately if the voltage appears to fall below 1.5V. The likely cause of this is a bridged pair of tracks or other short circuit – or either circuit connected with the wrong polarity.

If all is well, switch off and connect the microphone amplifier to the main circuit and the main circuit output to the power amplifier. Set VR1 and the presets to halfway.

Switch on the power supply and







Note mains, earth and DC positive are connected to case at transformer mounting bolt

speak into the microphone. The signal from the microphone amplifier should pass through the filter circuit and be heard from the power amplifier. No reverberation will occur as the delay line ICs have not yet been fitted. Adjust preset VR5 for good matching into the power amplifier and set VR1 for a reasonable microphone volume level.

The clock oscillator may be checked at this stage if an oscilloscope is available. Alternatively, a high impedance ear piece may be connected across CP1 and CP2. When VR6 us turned fully clockwise, maximum delay, minimum frequency, a high pitched sound should be heard.

If all is well, switch off and short circuit the power supply to ensure that the capacitors are discharged before fitting IC2 and IC3.

Handling Precautions

All CMOS ICs should be handled with care as the static electricity which appears on insulated materials – including the human body – can easily destroy an IC. The high cost of bucket brigade delay line ICs makes careful handling even more imperative.

Store the ICs in their original packaging material until the moment of insertion into their holders. Earth your hands by touching them to an earthed metal object (for example, the metal case of a power unit (plugged into the mains supply). Proper earthing straps are available from some component suppliers.

Place the IC packaging material against the destination socket to ensure that it is equally discharged.

Make sure that the ICs are the right way around and insert into the socket. Once fitted, other components in the circuit will protect it from electrostatic effects. This is providing no alterations are made. If any further soldering is required, first remove IC2 and IC3, taking the same precautions as before and return them to their protective packaging.

Final testing

The circuit may now be tested. Set reverberation control VR3 to minimum resistance (maximum feedback). Switch on and adjust the delay control (VR6) to maximum delay (Fully clockwise). A high pitched whistle may be heard. Turn up VR6 a little until the noise is no longer audible. Any sound made into the microphone should reverberate. Adjust VR3 so that reverberation decays rather than increases.

Adjust preset VR2 so that the voltage between its sliding contact and ground is -7V. In other words, connect the positive lead of the voltmeter to ground and touch the negative lead to the sliding contact of VR2 whilst adjusting VR2 for a 7V reading. Preset VR4 should be adjusted so that the two sets of signals from pins 4 and 6 of IC3 are equal. In the absence of an oscilloscope VR4 should be set to minimum distortion. Alternatively an oscilloscope may be used to monitor the signal at the sliding contact of VR4. Using a fairly high time base setting, the two sets of component frequencies should now be adjusted until the two heights are equal.

Assuming the earlier tests were successful, any failure at this stage suggests a mistake in the few components and links around IC2 and IC3. If necessary, check the voltage across pins 5 and 8 of each IC. A reading of 15V should be obtained.

Components

Resistors

R1, R2, R13, R14	100k
R3	56k
R4, R6	1k
R5, R10, R12	47k
R7	5k6
R8	3k9
R9	120k
R11	120k
R15	51k
R16, R17	220k
R18, R21	4k7
R19, R20	150k

Potentiometers

VR1	100k linear pot
VR2	4k7 preset
VR3	1M linear pot
VR4	4k7 preset
VR5	100k preset
VR6	10k linear pot

Capacitors

C1, C8, C10	100n polyester
C2	100p polyester
C3, C4, C7, C13	10μ polystyrene
C5, C15	100μ electrolytic
C6, C14	2μ2 electrolytic
C11	560p polystyrene
C12	140p polystyrene
C16	1n polystyrene
C17, C18	470p polystyrene
C19	4700μ electrolytic
C20	220n polyester
C21	470n polyester

Semiconductors

IC1, IC4	741 op-amp
IC2, IC3	TDA 1097 bucket brigade delay line
IC5	CMOS 4001B
IC6	7915 -15V power regulator
D1, D2	1N4148 diode
D3, D4, D5, D6	1N4001 diodes

Miscellaneous

T1	Mains transformer 18V (or 15V) 100mA secondary
LP1	Mains neon with integral resistor
S1	Mains toggle DPST switch
FS1	Fuseholder and 200mA fuse
Stripboards:	45 holes by 28 tracks (plus any extras for mounting holes), 29 holes by 8 tracks, 28 holes by 6 tracks, IC holders, DIN or jack socket (for microphone), phono socket (for output), knobs, mains cable, screened cable, connecting wire, grommets, screws, nylon nuts and bolts, metal case, wire and solder.

Connect the positive lead of the voltmeter to ground and check that pin 7 is at about -14V and pin 3 at about -7V. If all is well, the circuits may be fitted into a suitable case. ■

Techniques

Andrew Armstrong is on holiday Paul Chappell takes over this month.

This month's query is from Mr. F. Hinkley of Rochester, Kent, who would like to know the general principles of bio-feedback circuits. It's quite a tall order to cover such a wide area in the available space, but here goes.

The general principle of biofeedback is this: you can control the chosen aspect of your performance a darn sight better if you can see your progress and measure the results. Suppose you're trying to lose weight, for instance. You could just follow a diet and hope it's doing some good, but how much better it is to weigh yourself each day and see the results quantified. If your weight doesn't change you know the diet isn't working, so you adjust it. If it does change, the achievement of losing a few pounds may spur you on to even greater efforts. In principle a bathroom scales is a piece of biofeedback equipment.

A circuit that's well worth experimenting with is the skin resistance meter. The idea is that skin resistance is related to stress, with a higher resistance indicating a more relaxed state and a lower one showing tension. Skin resistance circuits have long been a staple of the electronics mags since they are easy and cheap to make and can give quite spectacular results. You could almost make do with a bench multimeter on resistance range, but because the resistance changes might amount to, say, a 1K change sitting on a basal resistance of 100K, the 1% movement of the needle could be a little hard to detect. Digital meters are not so satisfactory for bio-feedback since it takes a certain amount of mental processing to interpret the figures. The more direct the output, the better. Meter needles, bar displays, computer-generated images which change size or colour, or changes in pitch of a sound are all excellent ways of presenting the information.

Fig. 1 shows about the simplest skin resistance meter it's possible to make. The resistance sets the frequency of an audio oscillator. You listen to the tone produced through a crystal earpiece. The lower the pitch, the more relaxed you are. Q1 and Q2 can be any general purpose NPN transistor. The electrodes are the expensive part: they are each 2p. Literally. Solder a 2p coin to each input wire and tape one to each palm.

This simple circuit can show up some quite unexpected responses. Many people show a marked stress reaction at the noise of a passing lorry, although they'd insist otherwise. The act of telling a lie can give quite a strong stress response too, which is why a skin resistance circuit is always included in lie detector equipment.

The circuit can be improved by adding a simple frequency to voltage converter, offsetting the voltage due to basal resistance, and feeding the voltage from resistance changes to a meter movement or bar display. Fig. 2 shows a possible circuit. IC1 can be any general purpose op-amp and RV1 is adjusted periodically to bring the meter or bar back to centre scale. It's the changes you're interested in rather than the absolute value of skin resistance.

Pulse rate is another indication of stress level, and although probably not worth building for bio-feedback purposes alone a pulse rate meter can be a most useful aid for

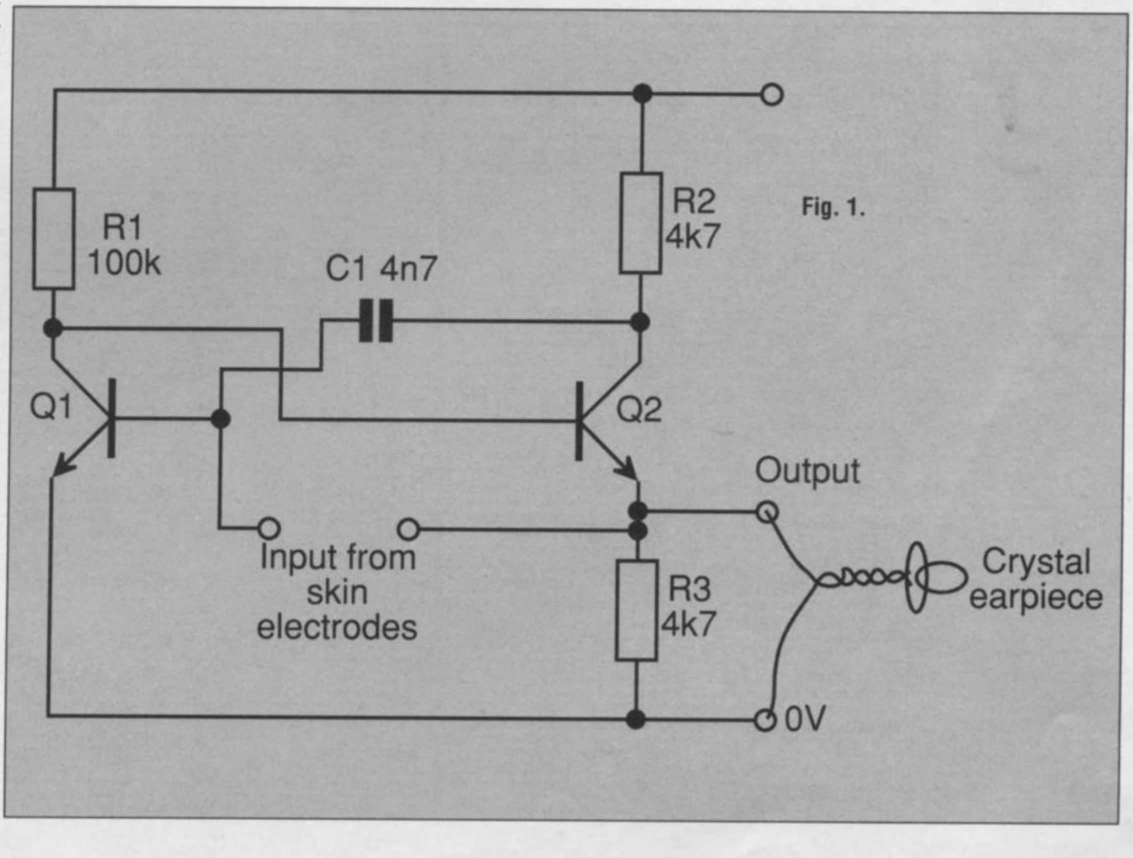
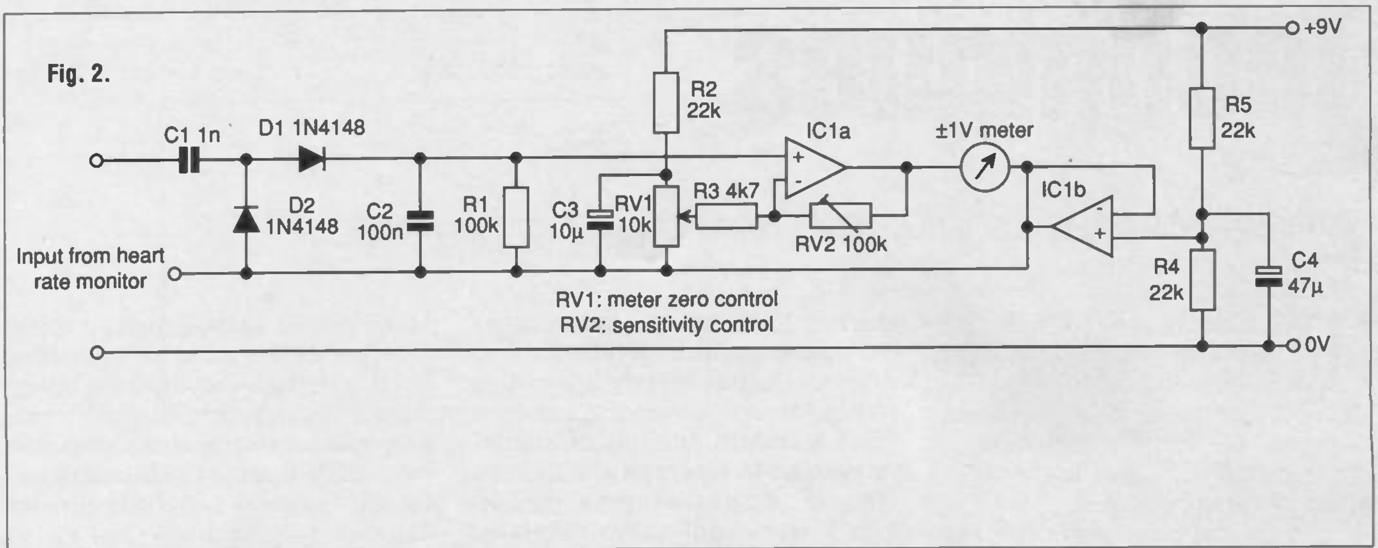


Fig. 1.

Fig. 2.



sports training too. There are two common ways of picking up a pulse signal from the body. One is to use an optical arrangement to shine light through the earlobe, for instance, and to detect the variations in light transmission as the blood pressure varies during each heart cycle. The performance of this type of circuit depends very much on the sensor, and for anyone ingenious enough to come up with a suitable mechanical arrangement to hold the source and detector in position, or with access to ready made sensors, it's the easiest way to do the job. The alternative is to detect the electrical activity of the heart directly, as shown in Fig. 3.

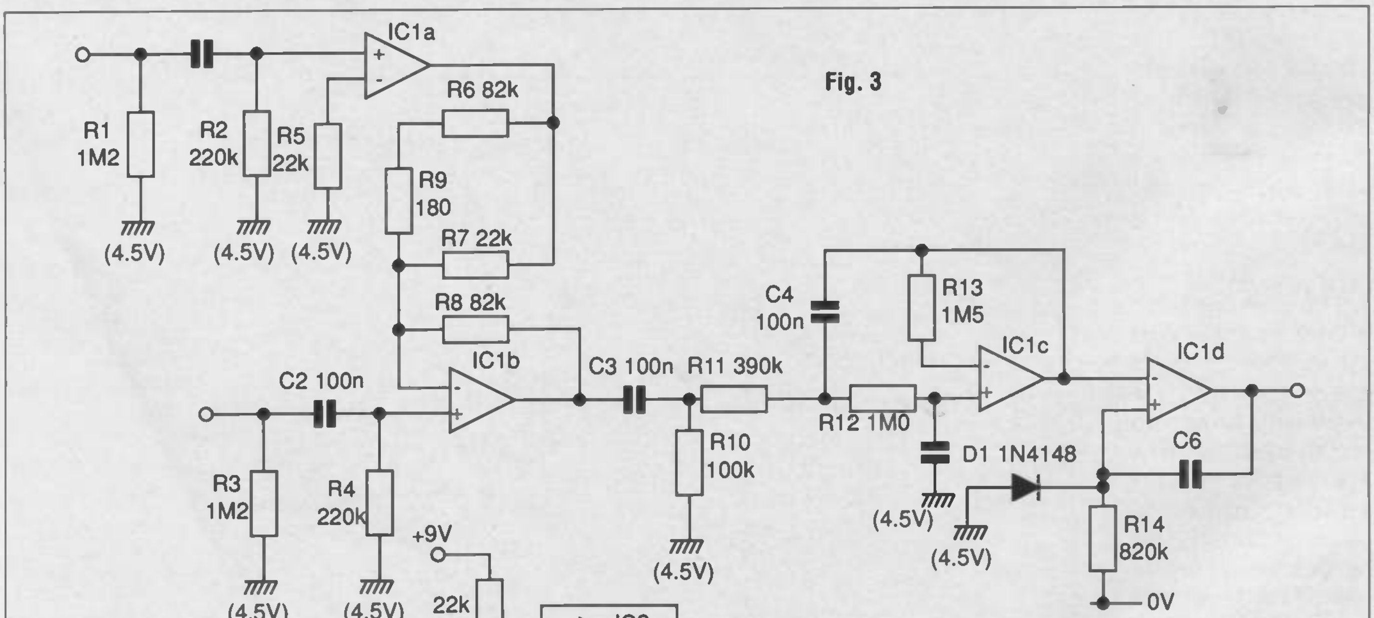
Once again you can use coins as the electrodes, either held in the hands or taped to your chest. If you can get hold of some proper ECG electrodes, so much the better. The circuit will work with cheap and nasty quad op-amps, but will benefit enormously if you use OP77s for IC1 and IC2 and a reasonable quality audio op-amp for IC3. IC1 and IC2 form a differential amplifier which helps to cancel out noise and mains hum while retaining the heart signal. IC3 and its associated components form a low pass filter with characteristics tailored for this application. IC4 turns the output of IC3 into a clean pulse train suitable for driving logic circuits.

The simplest way to use the output is to listen to it with a crystal earpiece. You'll hear a series of clicks at about one a second if you're fit as a fiddle, a little faster if you're a couch potato. Heart rate varies enormously and can easily increase by fifty percent with mild exercise. Stress and anxiety will also pop up the rate substantially.

The circuit of Fig. 2 can again be used to drive a meter or bar graph, although it will take longer to settle because of the lower frequency input. The values of C1 and C2 should be increased to 470n and 47µF respectively.

■

Fig. 3



OMP POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE (A4) S.A.E. 50p STAMPED FOR CATALOGUE ★

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS

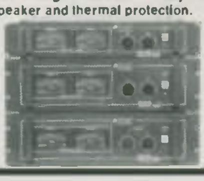
THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

FEATURES: ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.



SIZES:- MXF200 W19"xH3½" (2U)xD11"
MXF400 W19"xH5¼" (3U)xD12"
MXF600 W19"xH5¼" (3U)xD13"
MXF900 W19"xH5¼" (3U)xD14¾"

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH

OMP VARISPEED TURNTABLE CHASSIS

★ Manual arm ★ Steel chassis ★ Electronic speed control 33 & 45 R.P.M. ★ Vari pitch control ★ High torque servo driven DC motor ★ Transit screws ★ 12" die cast platter ★ Neon strobe ★ Calibrated balance weight ★ Removable head shell ★ ½" cartridge fixings ★ Cue lever★ 220/240V 50/60Hz ★ 390x305mm ★ Supplied with mounting cut-out template.

PRICE £61.30 + £3.70 P&P

OPTIONAL MAGNETIC CARTRIDGES **STANTON AL500MkII** PRICE £16.95 + 50P P&P **GOLDRING G950** PRICE £7.15 + 50P P&P

STEREO DISCO MIXER DJ6500

★ WITH ECHO ★

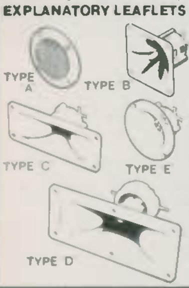
STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. MANY OUTSTANDING FEATURES:- Including Echo with repeat & speed control, DJ Mic with tone control & talk-over switch, 7 Channels with individual faders plus cross fade, Cue Headphone Monitor. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.

Price £134.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if two are put in series. FREE EXPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.



TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 + 50p P&P.

TYPE 'B' (KSN1005A) 3½" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.

TYPE 'C' (KSN1016A) 2"x5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.

TYPE 'D' (KSN1025A) 2"x6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.

LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.

OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

Made especially to suit today's need for compactness with high output sound levels, finished in hard wearing black vynide with protective corners, grille and carrying handle. Each unit incorporates a 12" driver plus high frequency horn for a full frequency range of 45Hz-20KHz. Both models are 8 Ohm impedance. Size: H20" x W15" x D12".

CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100WATTS (100dB) PRICE £163.50 PER PAIR
OMP 12-200WATTS (200dB) PRICE £214.55 PER PAIR

SPECIALIST CARRIER DEL. £12.50 PER PAIR

IN-CAR STEREO BOOSTER AMPS

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

ALL POWERS INTO 4 OHMS

Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

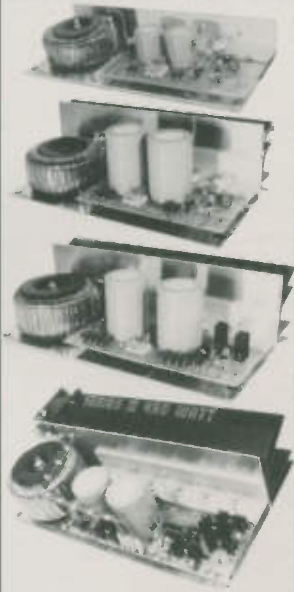
PRICES: 150W £49.99 250W £99.99 400W £109.95 P&P £2.00 EACH

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



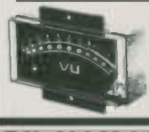
OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D.s (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control for very fast rise and decay times. Tough moulded plastic case, with acrylic tinted front. Size 84 x 27 x 45mm.
PRICE £8.70 + 50p P&P

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (50p STAMPED) FOR COMPLETE LIST.

P - From McKenzie Professional Series
S - From McKenzie Studio Series

McKENZIE:- INSTRUMENTS, P.A., DISCO, ETC

ALL McKENZIE UNITS 8 OHMS IMPEDANCE

8" 100 WATT P C8-100GP GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 80Hz, FREQ. RESP. TO 7KHz, SENS 96dB. PRICE £31.45 + £2.00 P&P
10" 100WATT S C10-100GP GUITAR, VOICE, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 72Hz, FREQ. RESP. TO 6KHz, SENS97dB. PRICE £38.89 + £2.50 P&P
10" 200WATT S C10-200GP GUITAR, KEYB'D, DISCO, EXCELLENT HIGH POWER MID.
RES. FREQ. 69Hz, FREQ. RESP. TO 5KHz. SENS 97dB. PRICE £53.21 + £2.50 P&P
12" 100WATT P C12-100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO.
RES.FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 98dB. PRICE £40.35 + £3.50 P&P
12" 100WATT P C12-100TC (TWIN CONE) HIGH POWER, WIDE RESPONSE, P.A., VOICE, DISCO.
RES. FREQ 45Hz, FREQ. RESP. TO 12KHz, SENS 97dB. PRICE £41.39 + £3.50 P&P
12" 200WATT S C12-200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A.
RES. FREQ. 45Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £71.91 + £3.50 P&P
12" 300WATT S C12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARDS, DISCO ETC.
RES. FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 100dB. PRICE £95.66 + £3.50 P&P
15" 100WATT P C15-100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS 98dB. PRICE £ 59.05 + £4.00 P&P
15" 200WATT P C15-200BS VERY HIGH POWER BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 3KHz, SENS 98dB. PRICE £80.57 + £4.00 P&P
15" 250WATT S C15-250BS VERY HIGH POWER BASS.
RES. FREQ. 39Hz, FREQ. RESP. TO 4KHz, SENS 99dB. PRICE £90.23 + £4.50 P&P
15" 400WATT S C15-400BS VERY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 4 KHz, SENS 100dB. PRICE £105.46 + £4.50 P&P
18" 500WATT S C18-500BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 27Hz, FREQ. RESP. TO 2KHz, SENS. 98dB. PRICE £174.97 + £5.00 P&P

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8" 50watt EB8-50 DUAL IMPEDENCE. TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P
10" 50WATT EB10-50 DUAL IMPEDENCE. TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P
10" 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P
12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P
6½" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P
8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. PRICE £12.99 + £1.50 P&P
10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

PHOTO: 3W FM TRANSMITTER

POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243