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Product Reviews

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The portable Macintosh

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Van Gogh on a VCR

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What's New

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BoardMaker 1 is exceptionally easy to use - its sensible user interface allows you to use the cursor keys, mouse or direct keyboard commands to start designing a PCB or schematic within about half an hour of opening the box.

HIGHLIGHTS

Hardware:

- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
- Microsoft or compatible mouse recommended.

Capabilities :

- Integrated PCB and schematic editor.
- 8 tracking layers, 2 silk screen layers.
- Maximum board or schematic size - 17 x 17 inches.
- 2000 components per layout. Symbols can be moved, rotated, repeated and mirrored.
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- Graphical library browse facility.
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- Placement grid - Separate visible and snap grid - 7 placement grids in the range 2 thou to 0.1 inch.
- Auto via - vias are automatically placed when you switch layers - layer pairs can be assigned by the user.
- Blocks - groups of tracks, pads, symbols and text can be block manipulated using repeat, move, rotate and mirroring commands. Connectivity can be maintained if required.
- SMD - full surface mount components and facilities are catered for, including the use of the same SMD library symbols on both sides of the board.
- Circles - Arcs and circles up to the maximum board size can be drawn. These can be used to generate rounded track corners.
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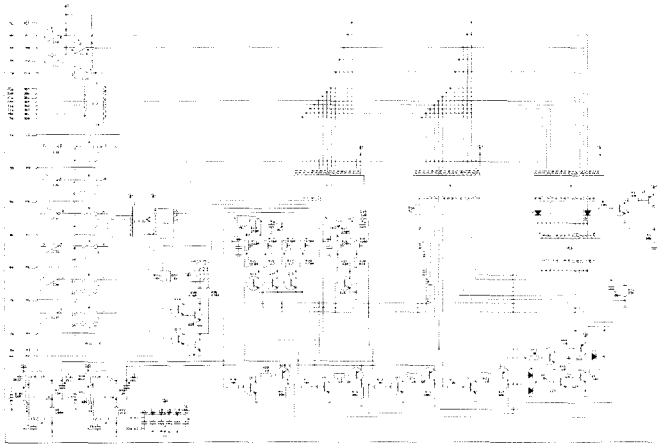
- Dot matrix printer.
- Compensated laser printer.
- PostScript output.
- Penplotter driver (HPGL or DMPL).
- Photoplot (Gerber) output.
- NC (ASCII Excellon) drill output.



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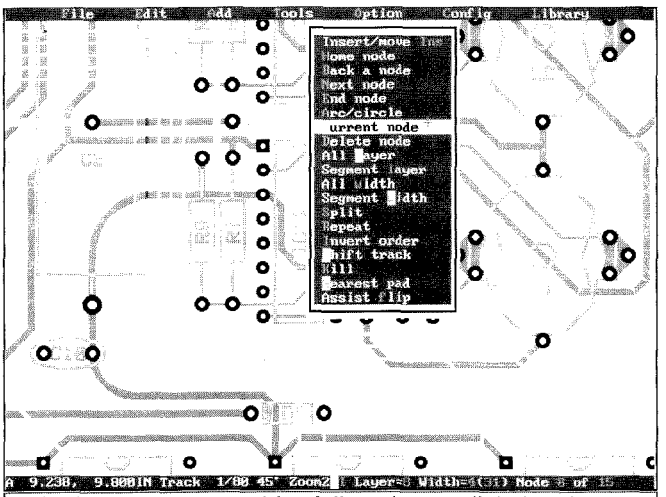

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This month...

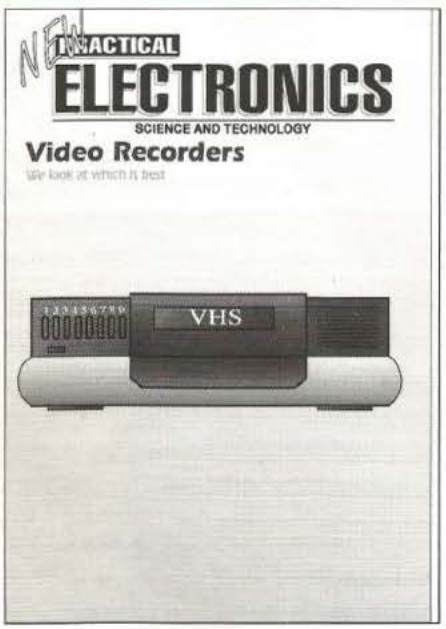
In last month's issue I mentioned that I would rather like a laptop Macintosh computer. At the time, the machine was just a rumour and phoning Apple had produced a resounding "no comment". Days after the magazine was sent to be printed, a press release arrived on my desk from Apple announcing the launch of three new laptop computers – just in time to miss the deadline. Fortunately, Apple were kind enough to let me play with the new PowerBook 140 for a few days – the full review can be seen on page 10.

Also in last month's issue we featured the Joint European Torus. As everyone will know now, they achieved a fusion reaction that produced 2MW of power on 9th Nov 1991 and are looking forward to continuing their research up until 1996.

Here at PE we try to keep you in touch with all of the latest technology.

Kenn Garroch, Editor

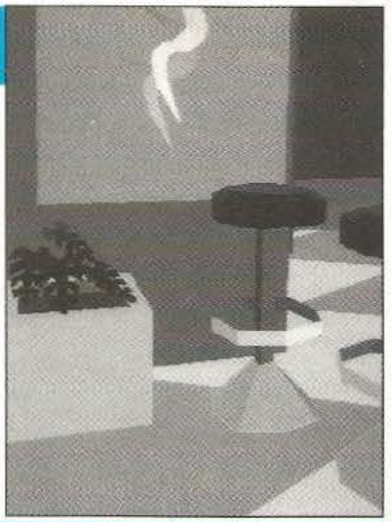
Next month...



PE looks at the best of the VCRs, CAD, 3D sound, games machines, how a camera flash works plus all of the regulars.

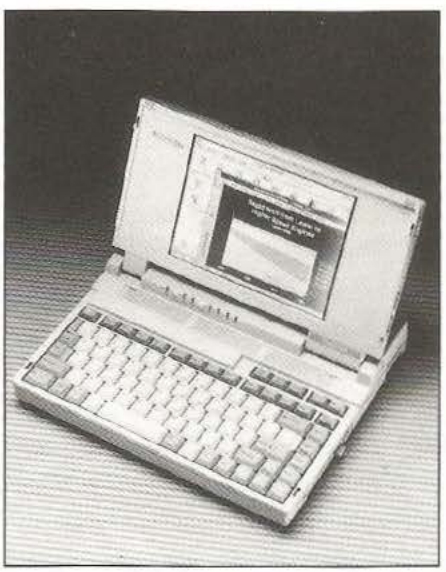
Out On 5 December

Features



Reviews

Regulars



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Wavelengths

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

Subjective Speakers

Your review of the Canon S-50 speakers in December's PE proved to be a little confusing. The two diagrams at the top of page 39 purporting to show how the speakers work was rather unfair. Normal speakers spread their sound far more than is shown and it is difficult to see how the S-50s offer any advantage. It would have been nice to have seen a more in-depth analysis of their operation showing their physical and audio characteristics. As it was, the article was subjective from beginning to end.

W M Partridge
Hemel Hempstead
Herts

It would have been nice to do an in-depth test but, unfortunately, we don't have the facilities. In defence of the review, sound reproduction from a HiFi system is rather a subjective matter so examining them in that way is fair – I have actually heard the S-50s myself and I must admit that they do sound different – Ed.

Flat Presentation

I read with interest the letters about Sharp's' monstrously framed flat screen TVs, and I would like to add my comments.

Any new technology needs to be presented in a way that makes it appeal to the general public. After seeing the frames in question (last month's PE page 5), I can't help thinking that Sharp have gone about it the wrong way. A wall hanging TV screen is something of a mistake in any case as most TVs sit noisily in the corner on their own stand. Any technology that wants to replace them will have to look like them, at least to begin with. To hang a TV on the wall would require it to be placed at about waist height or lower, just where it could get knocked or smashed. Any higher and we would have cricked necks trying to watch it. As they stand, the wall hanging TVs a la Sharp, are only good for displaying art – perhaps computer art.

The upshot of all this is that new technologies have to be designed and presented in a way that makes them immediately recognisable as to their function. If this is not done they will never take off.

M Mathews
Bolton
Lancs

Scanning Data

Last month you featured an article about image scanners "Putting you in the picture". In the main it was quite interesting but I would be grateful if you could answer a couple of questions.

Firstly, the picture you used as an example was obviously an etching and so was quite grainy. Is the reproduction as good on normal photographs?

Second, on page 36 you gave a sequence of images showing the difference in quality at different resolutions which were to be viewed clockwise. Even looking closely, the only one that stands out is that which was scanned with 16 grey levels. Which of the others is which, or are they all the same?

Thirdly, you don't really specify which scanner you used and where you can get it from.

Aside from the above, it looks as though you may have succeeded in proving that scanners can replace traditional methods of reproduction, for black and white at least. Will you be looking into colour scanners at any point?

Andy Marshall
Hampstead
London

In answer to your first question, the pictures on pages 5 (Wavelengths) and 44 were scanned from black and white photographs – the first also appeared in PE September 91 on page 28.

The pictures on page 36 start at the top left and move across the top row with the 600dpi image being at the start of the second row – it is virtually impossible to distinguish between the 150, 300 and 600dpi images.

The scanner used was the Panasonic FX-RS307 and should be available through Panasonic dealers or though Panasonic at Panasonic House, Willoughby Road, Bracknell, Berks, RG12 4FP.

Hopefully, quality colour scanners will become relatively cheap in the near future in which case, we will get one in a put it through its paces.

JET Mistake

Thank you for an interesting article about fusion reactors and JET in your December issue. One small point is that your artists seems to think that there are two protons in Tritium and not two neutrons.

P J Cherry
Littlehampton
Sussex

You're quite correct. My thanks to everyone else who pointed it out. ■

Errata

A number of errors crept into last months issue of the magazine, especially on pages 30 and 31, Electronics Goes Under The Hammer.
William Crookes was bestowed with the Order of Merit in 1910, not the Mint as stated.

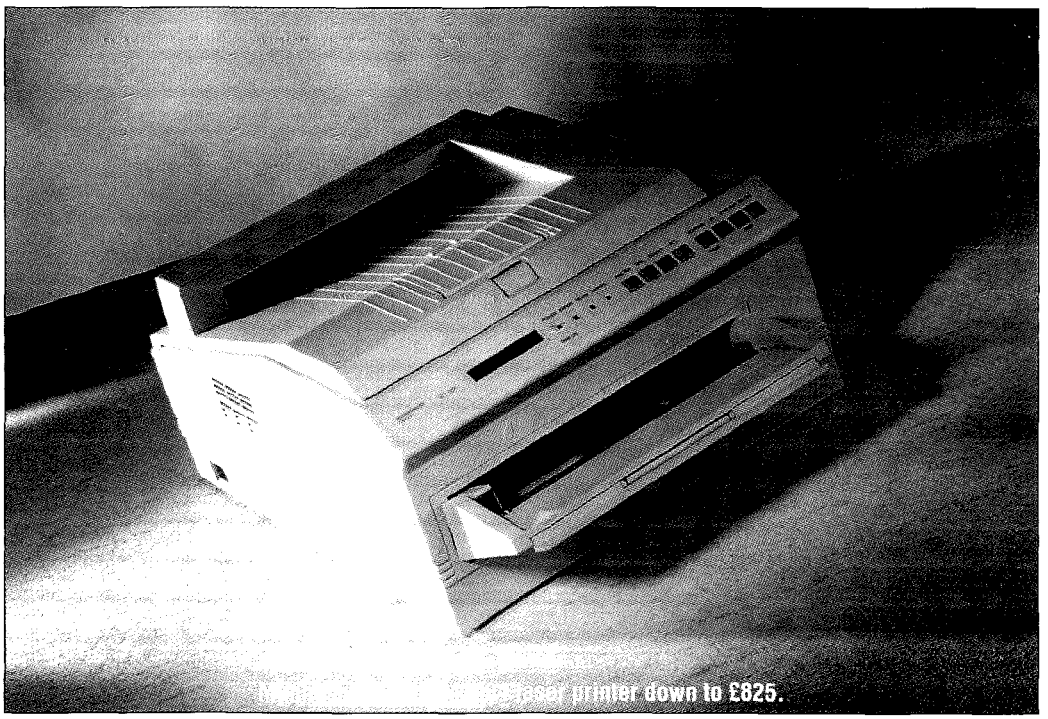
On page 48, the circuit diagram for the headphone amplifier had Q1 inverted laterally , the emitter should be connected to R1 and not the collector. In addition, the cathode of the valve should have been connected to the HT supply.

Innovations

This month, JET produces 2MW of power, Toshiba and Mannesman Tally cut their prices

Price Slash

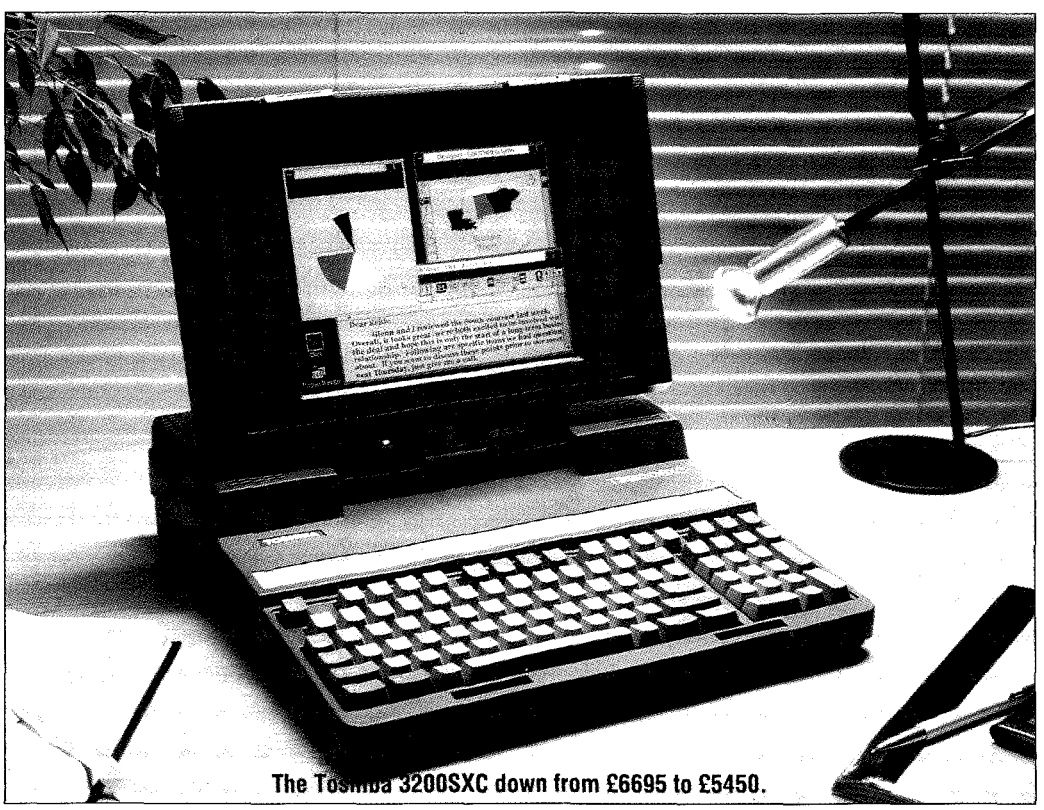
Signalling the rapid decline of the 24pin dot-matrix printer market, Mannesman Tally has announced that it will be cutting the price of its bottom of the range 4 page per minute MT904 laser printer. Originally priced at £999 when it was launched in April, this has been dropped to £825 to allow MT to take a larger share of the laser printer market.



The MT904 laser printer down to £825.

Toshiba Down

Also in the price cutting competition is Toshiba. It is knocking up to 30% of its range of portable PCs, printers and accessories. Hoping to start a Christmas rush on its products, Toshiba will drop its prices on Nov 4 bringing, for example, the T1000LE portable (reviewed in PE August 91) down from £1495 to £999 and the T2000SX/20 from £2650 to £1499. The bottom of the range, the T1000SE now costs a mere £525. It looks as though laptop computers are finally reaching prices where they are affordable.



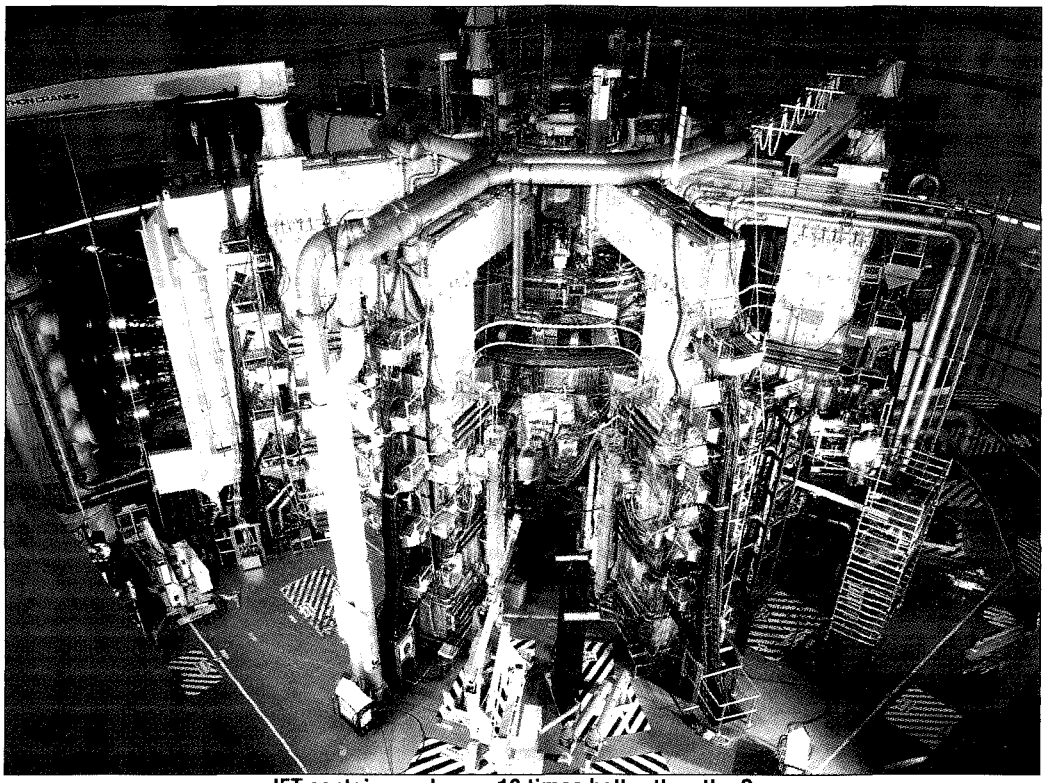
The Toshiba 3200SXC down from £6695 to £5450.

JET Generates

At 7.44pm on Saturday 9 November 1991, JET, the European experimental fusion reactor based at Culham near Oxford, announced that it had produced a significant amount of energy from a fusion reaction. Between 1,500,000 and 2,000,000 Watts of power were generated using deuterium and tritium fuels held in a magnetic containment vessel.

This is the first time these two particular fuels have been used. Previous experiments have used only the non-radioactive deuterium (an isotope of hydrogen with two neutrons instead of one). Starting with low concentrations of tritium (another isotope of hydrogen with three neutrons), JET is aiming to move up to a full power system using a 50/50 (D/T) fuel mix by 1996.

The next step for the project is to get



JET contains a plasma 10 times hotter than the Sun

confirmation of funding from the EC to keep the experiment open until 1996. With the successful demonstration of a fusion reaction, there is now a good chance that the project will get the required funding.

When the project finishes in 1996, an experimental reactor ITER capable of generating 1000 mega Watts of power will be constructed. If experiments with this work well then commercial reactors could be a reality within 30 years.

More information about the Joint European Torus can be found in the December issue of Practical Electronics.

Kiss FM Goes 3D

Regular listeners to Kiss FM, a London based independent radio station, will have heard the new 3D sound system recently introduced. The effect of BASE (Bedini Audio Spacial Environment) sound processing technology is to allow the brain of a listener to receive more of the source information in a way that enhances the sound.

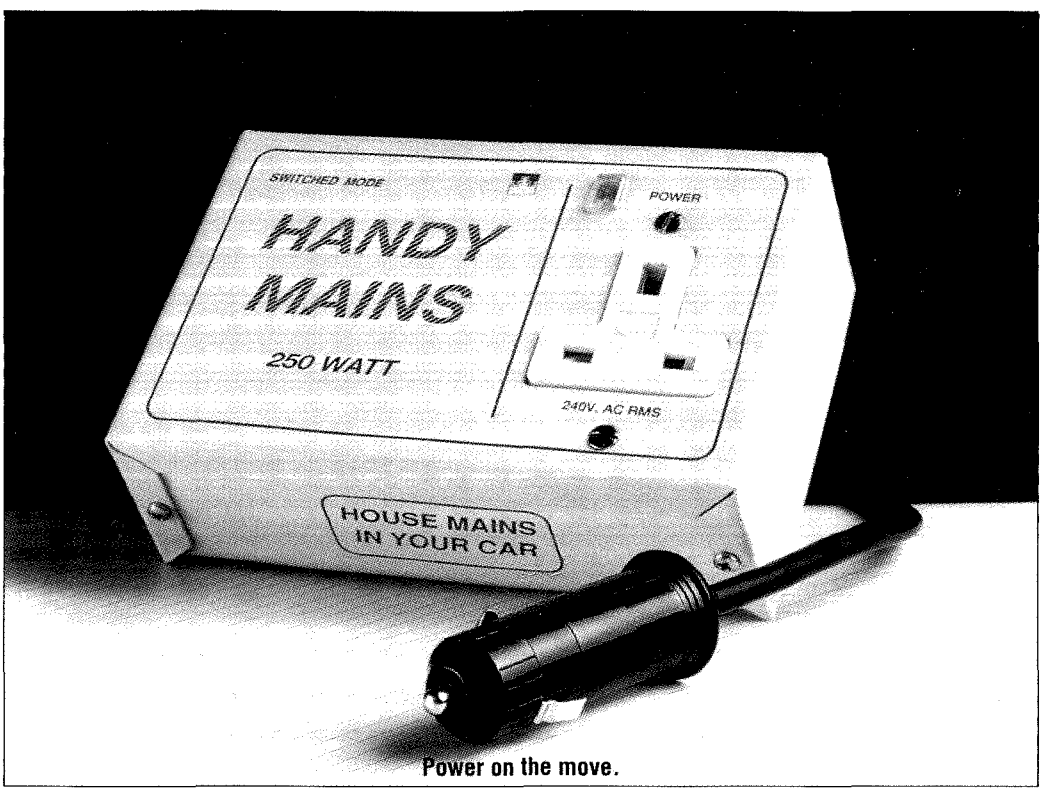
BASE is normally used at the mixing or recording stage and once the sound has been encoded, it can be transferred to CD, DAT, cassette LP and so on, without loosing the added effect. The main result of this effect is to add an "out of speaker" and "height" dimension to the sound.

As well as being used on Kiss FM, BASE was used in the films Star Trek V and The Hunt For Red October. The advantage of the system over other techniques is that no extra equipment is required at the reproduction stage. An ideal application would be in stereo TV where the separation between the speakers is limited.

For more information contact Sound BASE Ltd, Watford Court, Throgmorton St, London EC2N 2AT, Tel 071 256 8716

Battery Mains

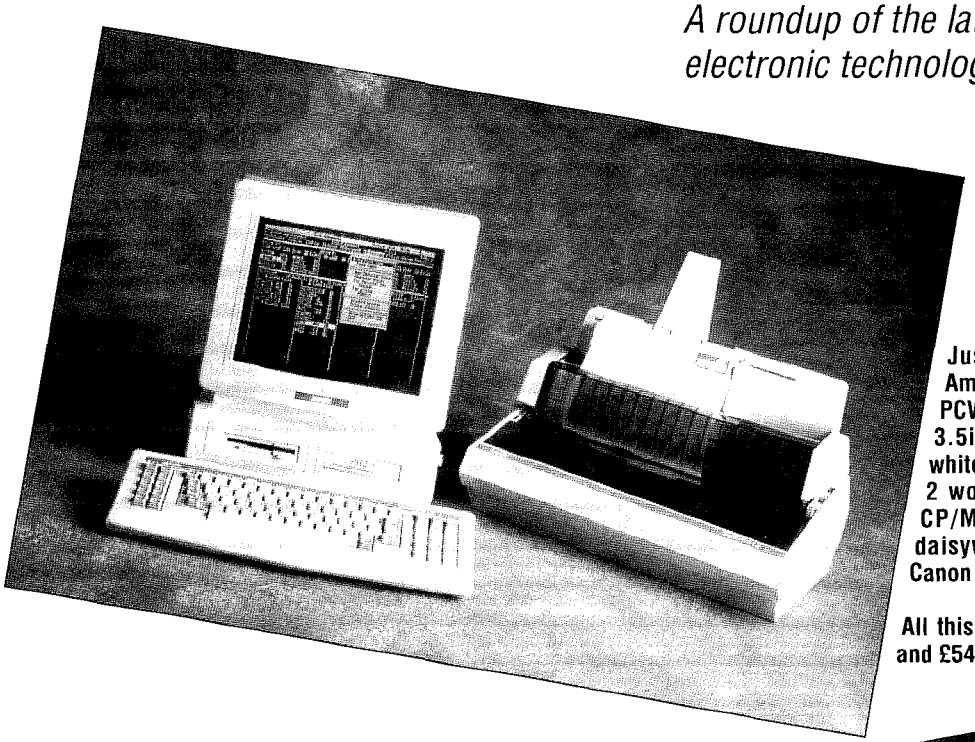
The Handy Mains unit is a power inverter that allows up to 200W continuous power at 220V to be drawn from a car battery. This could provide power for a TV, fax, electric drill and so on, even a vacuum cleaner. The basic model is priced at £59.95 with a Super model providing more start up power, more continuous power, thermal overload protection and an audible warning when the battery is running low, costing £89.95. For details contact Switched Mode Ltd, Unit 2, The Markham Centre, Station Road, Theale, Berks, RG7 4P
R. Tel. 0734 302113 ■



Power on the move.

What's New

A roundup of the latest in computers, video and electronic technology.



Just when you thought they were obsolete, Amstrad has improved and revamped its range of PCW computers. The 9512+ comes with a built in 3.5in 720k floppy disk drive, 512k RAM, paper white monitor, daisywheel printer, and Locoscript 2 wordprocessing software, all running under CP/M Plus. Another option is to swap the daisywheel for the, more up to date and faster, Canon BJ010e bubble jet printer.

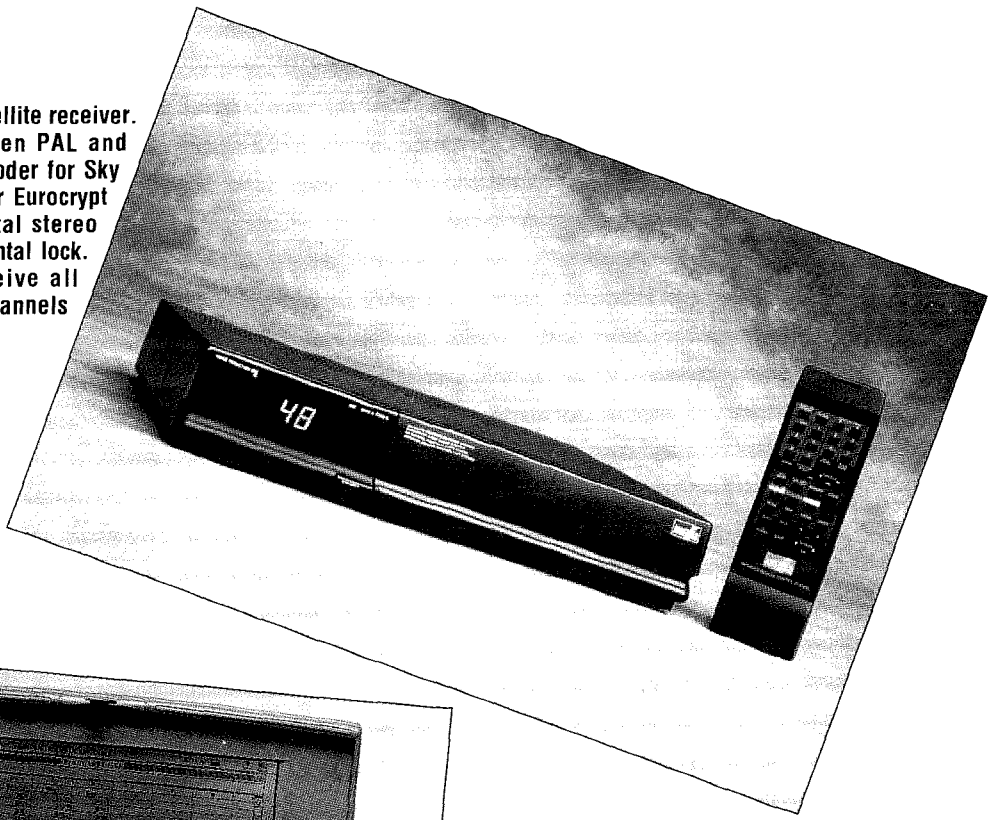
All this costs £449 (£527.58 inc VAT) with the daisy and £549 (£645 inc VAT) with the bubbles.

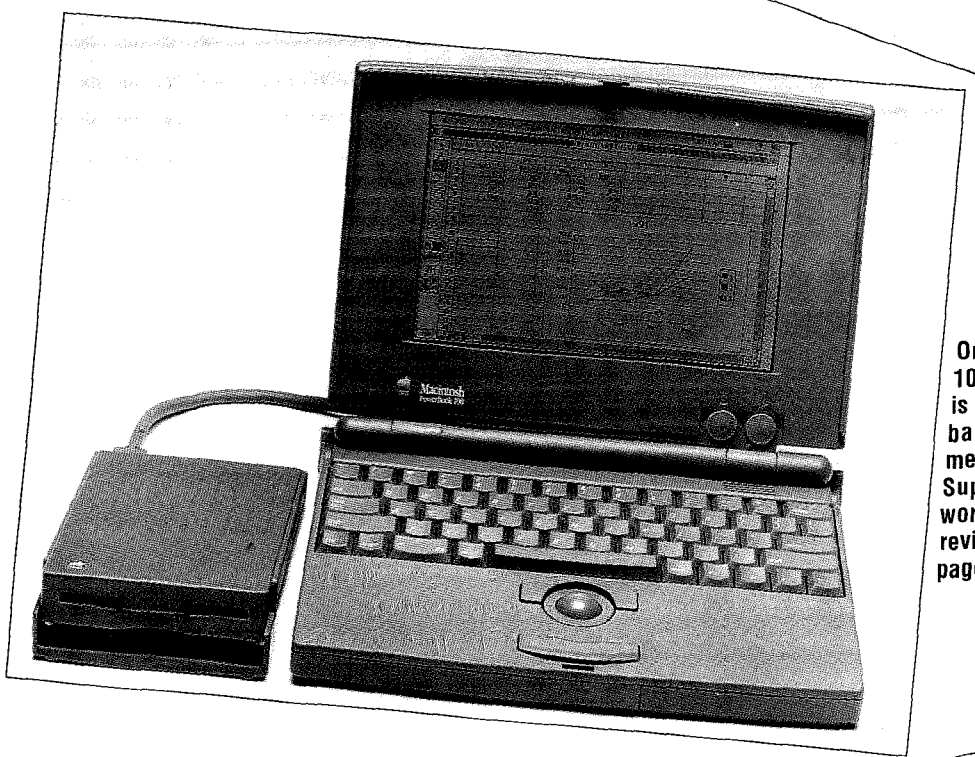
Another new computer range from Amstrad is the Series 5. This features two basic machines, the PC5086 and the PC5286. The first is based around an 8086 microprocessor running at 8MHz with 640kb of memory plus a single 720kb 3.5in floppy disk drive and a VGA monitor – in other words a basic PCXT. Additions to this include an extra floppy drive and a 40Mb hard drive.

The PC5286 is based around an 80286 microprocessor with 1Mb or RAM, VGA, mouse and a single floppy disk drive making it a cut down PCAT. An optional 40Mb hard disk is available for those who need the extra space.

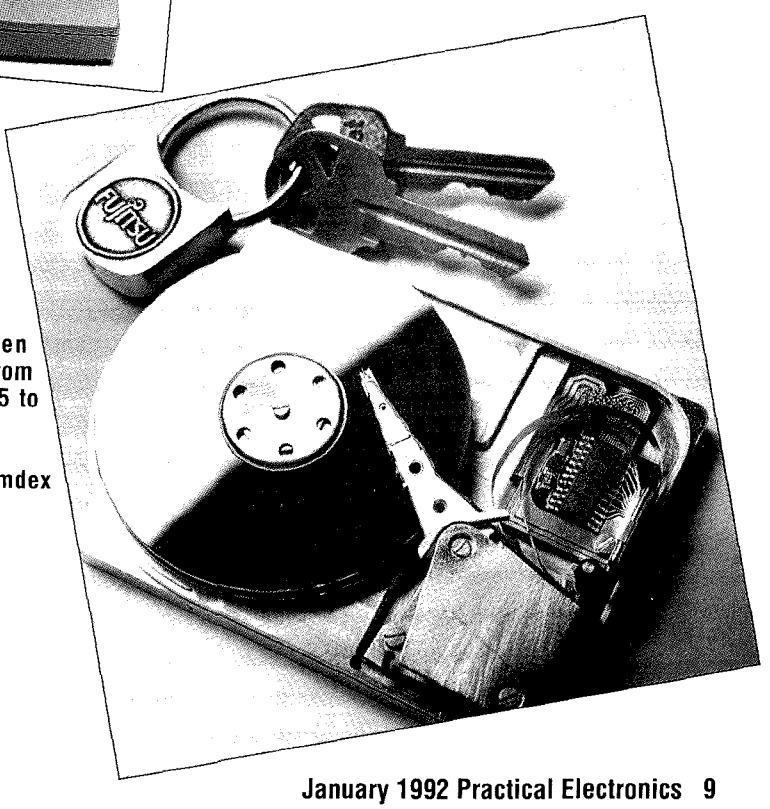
Prices range from £399 (£469 inc VAT) for the PC5086 and ££999 (£1174 inc VAT) for the top of the range PC5286. A special version of the PC5286 is available at £899 (£1056) that adds a games pack including two external speakers, a sound card and analogue joystick plus three computer games, Links, F15 Strike Eagle and Prince Of Persia.

Also from Amstrad is the new SRD600 satellite receiver. This offers automatic switching between PAL and D2MAC, two separate dish inputs, a decoder for Sky Movie channel, an integrated decoder for Eurocrypt signals, 99 channel capacity, HiFi digital stereo sound, infra-red remote control and parental lock. This system should allow you to receive all current and future European satellite channels well into the next century.





Only recently announced, the Apple PowerBook 100 offers all of the power of an Apple Macintosh is a laptop/notebook computer. The built in tracker ball replaces the mouse and with 2 or 4Mb of memory. a built in 20 or 40Mb hard disk and triple Supertwist LCD display, it looks set to take the world of portable computing by storm. For a full review of this and the other models in the range see page 10 of this issue.



Set to make portable computer even smaller, this 2.5in hard disk drive from Fujitsu offers storage capacities of 45 to 90Mb in a low high package.

For even smaller drives, see the Comdex show report on page 25.

Apple's New Babies

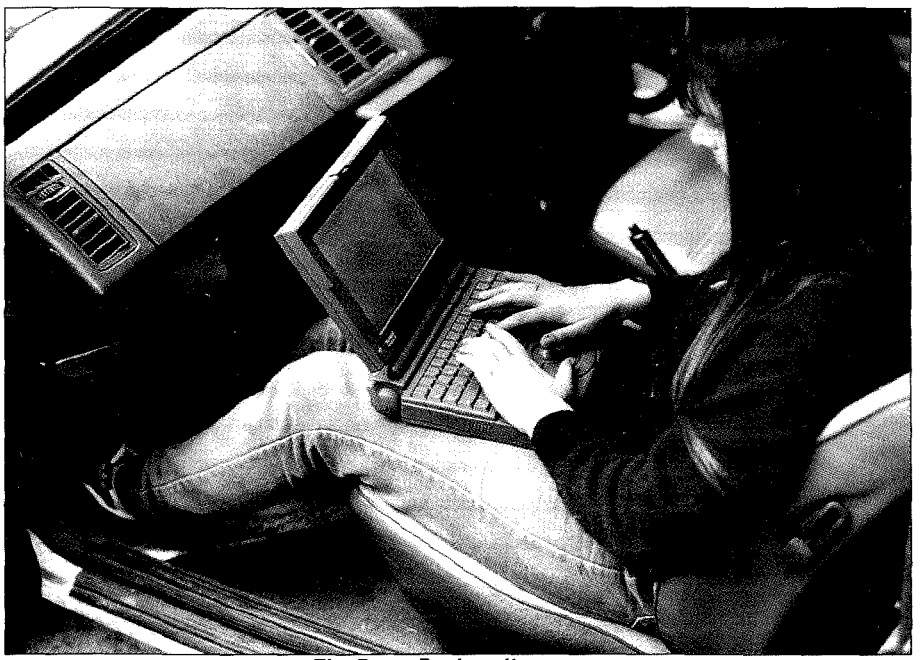
Kenn Garroch gets to play with the new Apple PowerBook and likes what he sees.

In the December issue of PE one of my Christmas wishes was to have a portable Macintosh computer. About three days after the magazine was finished, Apple announced three new notebook portable machines and, on phoning and asking, agreed to lend me one for evaluation purposes.

At the bottom of the range is the PowerBook 100 which measures 8.5x11x1.8in and weighs 1.5lb, the smallest and lightest in the range. It comes with either 2Mb or 4Mb of memory and a 20Mb internal hard disk drive. On the software side, a full implementation of the new system 7 is included running on a 16MHz 68000 microprocessor. This allows all existing Apple Mac software to be run at about the same speed as on a Mac plus or perhaps SE. Built in interfaces allow the machine to be hooked up to an external disk drive, a Mac Localtalk network or other computers via a serial link (RS232 compatible).

The PowerBook 140 is the mid-range system that offers all of the functions of the 100 but adds an internal 3.5in floppy "Superdrive" able to read IBM PC disks as well as Mac formats – useful for transferring data between the Mac and a PC. The processor is upgraded to a 16Mhz 68030 offering processing power equivalent to a Mac IIcx. It weighs 6.8lb and measures 9.3x11.25x2.25in and can have a 40Mb hard disk instead of the usual 20Mb version.

The top of the range is the 170. The microprocessor speed is increased to 25Mz and a 68882 maths co-processor is added. Instead of the backlit supertwist LCDs used in the 100 and 140, an active matrix LCD provides faster screen updates and better visibility under more varied light conditions. 4Mb of RAM is standard as is a 40Mb hard disk. The processing power of this machine is better than many of the high end Macs currently in use for electronic publishing (DTP).



The PowerBook on the move.

What's In The Box

A brief look at the portable computer market will help to put the new PowerBooks into some sort of context. Laptop or notebook computers running of the IBM-PC type have been available for a few years now and recently, virtually every manufacturer of desktop PCs also has been adding a laptop to its range of machines. The latest of these sport Intel 386 microprocessors and colour LCD displays offering all of the functionality of a top of the range business machine in a package roughly the size of an A4 sheet of paper and about 1.5in thick. The only company not to offer such a machine has, up until now, been Apple. With the launch of the PowerBook series, all of this has changed and it looks like Apple has jumped to the top of the market in terms of laptop capabilities, speed, functionality and style.

Tracker Balls

The first noticeable thing about the PowerBook computers is their keyboard layout. Instead of taking up the whole of the top of the computer, it is confined to the top half with the tracker ball dominating the lower. A big problem with portable computers has always been, what to do with the mouse? A number of solutions have been tried but the integral tracker ball is the best so far. The two empty areas on either side of the ball serve as rests of the hands – very useful when travelling on a bumpy train as they also allow the computer to be held stationary.

Using the ball is not as easy as a normal mouse and takes a bit of getting used to. Positioning is not as accurate as a mouse because there is no stable surface to push against and when clicking the buttons (above and below the ball), the ball tends to move putting the cursor in the wrong place.

The keyboard is a little squishy but is very quiet – a big advantage in a laptop as clicking and clacking away in meetings can be very off-putting for the speakers and embarrassing for the users.

When not in use on a knee, the powerbook has two sturdy click out legs to give the keyboard a better angle for typing.

Battery Mains

As a test of the batteries and mains power of the PowerBook 140, it was connected to the mains adaptor and put to sleep overnight. The battery level indicator then showed a full charge. Leaving the machine running just on batteries gave 2.75 hours of operation before an alert message popped up advising me that the machine was running on reserve power and that it should be connected to the mains as soon as possible. Ignoring this and continuing work produced another message 25mins later to the effect that the machine should be plugged into the mains adaptor immediately! Operation of the disk at this point produced a slightly flickering screen but another 10mins of operation were possible before the final message came up saying that the machine would be shutting down in 10secs, "Good Night" and off it went. Leaving it a while longer and then plugging in the mains adaptor and pressing a key brought the PowerBook back to life just where it left off with no data loss. This came to around 3 hours and 20 minutes, pretty good for a portable with a hard disk drive.

On Screen

On the whole, the screen display of the 140 is very good. It is just that bit larger than a standard Mac Plus/Classic/SE type screen and allows a document plus a couple of desk accessories (calculator, battery power, clock and so on) to be displayed at once. Unfortunately, because standard triple supertwist LCDs are used, the update time is rather slow and anything that moves around the screen at speed, such as the mouse, tends to smear. The drawback with this is that small pointers tend to "get lost" – the normal method of finding the pointer or cursor on a Mac is to whizz the mouse around and the movement on the screen catches the eye. With an LCD, this doesn't work too well and the eye has to hunt around to locate it.

The viewing angle of the LCDs is reasonable although the screen can really only be seen by one person at a time. The backlighting works well but when turned off, the screen cannot be seen at all. It would have been nice to have had a rear reflector so that the light could be turned off to save battery power.

Presumably the 170 with its active matrix LCD reacts much more quickly and, although it consumes more power, will give a superior display.

System 7

All PowerBooks come with the latest version of the Mac operating system, System 7. This is a full graphical user interface (GUI) and provides all of the functions expected of a Mac. It is easy to use, easy to learn and generally intuitive (unlike most of its look-a-likes). The 4Mb of memory allows two or possibly three applications to be run at once (though not usually multi-tasking) and a virtual memory system allows applications of virtually any size – depending upon the amount of disk space available. A RAM disk is also possible allowing the use of the hard disk and its motor to be cut to a minimum.

One good feature of the machine is its protectiveness. Unlike standard Macs, which can lose a lot of work if the power is removed at an inopportune moment, the PowerBook with its battery keeps everything current even when the power is off. The machine can be shut down and restarted in the normal way. However, as the hidden restart button on the back proves, this is not the way to run a portable. Instead, the sleep function is activated when the machine is not being used. Switching back on again is simply a matter of pressing a key on the keyboard. Operations continue where they left off although there is a lull of two or three seconds after the machine comes on and before anything happens.

Power Supplies

One of the most important aspects of a portable computer is the battery power system. On the Powerbooks, two systems are used. The 100 uses a sealed lead-acid battery that gives from two to four hours use and the 140 and 170 have NiCd batteries that provide two to three hours.

To help conserve the batteries there are a number of power saving levels, the first of which is that sections of the hardware are put to sleep when they are not being used. At the next level, the hard disk drive shuts itself down after a preset time, coming back on only when it is needed. At the top level, the whole computer switches off after a user defined delay. Pressing a key on the keyboard brings it back to life at the position where it left off. Of all of these, the most annoying is the hard disk drive switching off. The way in which the Mac's operating system runs is that sections program code are brought in from the disk when they are needed – especially for rarely used alerts and sampled sounds. This means that there is a delay of about three seconds which the disk runs up to speed before any transfer can take place. It would have been nice to have had a small indicator somewhere on the screen to say that this was happening. The disk drive is so quiet that there is no way of telling why the machine has suddenly stopped.

Otherwise, the battery operation and mains supplies are faultless, especially the warnings about power shortages – see box.

With the PowerBook range of laptop portable computers, Apple has entered the notebook market in a serious fashion. In the main, the operation of the machines is on par with their equivalent desktop counterparts. A little thought could have been given to the casings which, although sturdy enough, were a little clumsy to carry. This is made more of a problem by the fact that they cost a minimum of £1375 for the 100 model and over £3000 for the 170 – not something to drop. Indeed, this is the main problem with the machines, although they offer a fantastic amount of computing power for such small portable systems, they are quite highly priced and, more than ever, I'd like one for Christmas. ■

Specifications

PowerBook 100 2Mb RAM, 20Mb hard disk drive £1375 (bottom of the range)
PowerBook 140 4Mb RAM, 40Mb hard disk drive £2195 (mid range)
PowerBook 170 4Mb RAM, 40Mb hard disk drive £3150 (top of the range)
There are a number of alternatives within this with various other configurations of memory and disk systems. Also available are internal modems, extra rechargeable batteries and an external disk drive for the model 100.
For more information dial 100 and ask for Freephone Apple.

Silicon Valley... A Faster Microchip

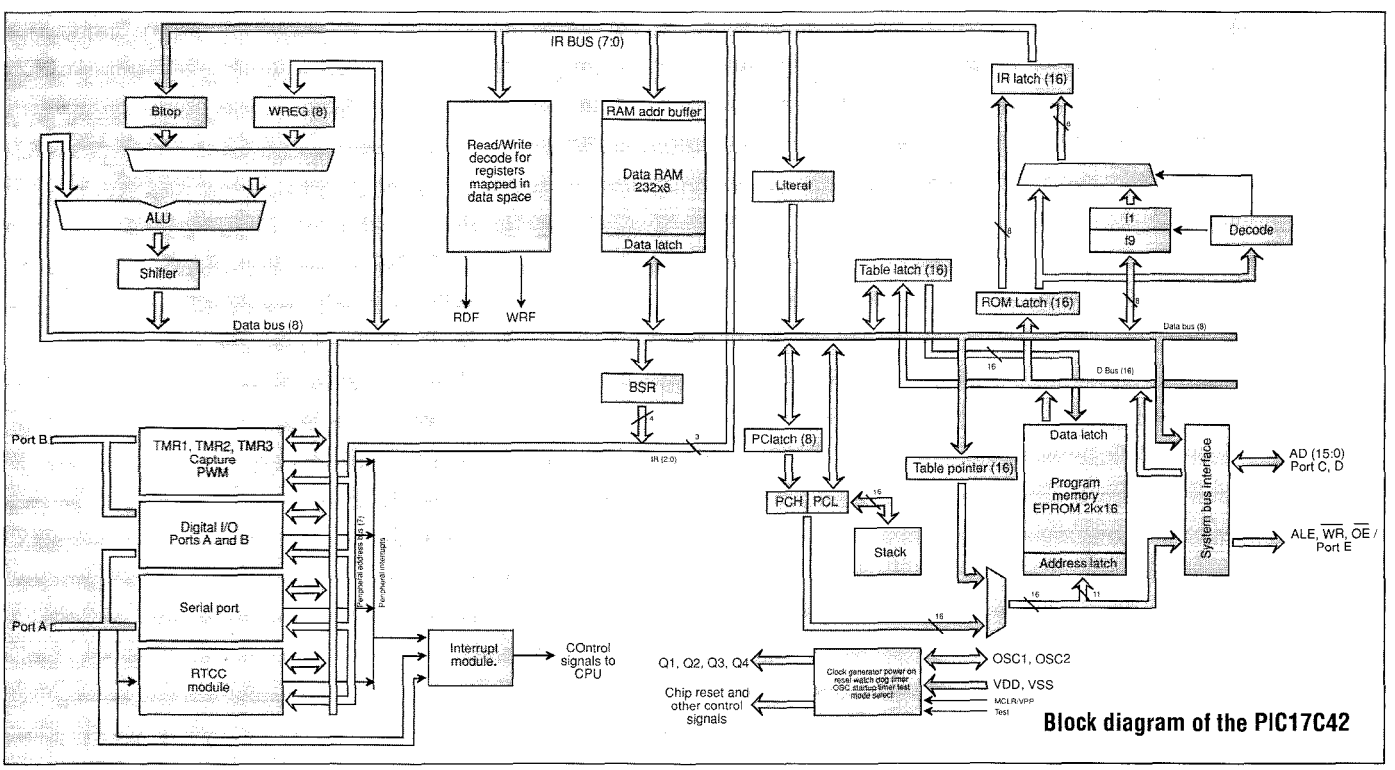
The latest micro-controller from Microchip is an 8-bit RISC running at 16MHz. Kenn Garroch takes a quick look at its innards.

Microchip has just announced the release of its latest 8-bit RISC micro-controller, designed specifically for complex real-time embedded-control applications. Its processing power and throughput is several times faster than most other 8-bit micro-controllers, the main competition being from the Hitachi H-8 series which is currently more expensive at around £10 – £20 each, in volume, compared to less than £5 for the PIC17C42.

Aimed at the automotive, industrial, office automation and telecom markets, the PIC17C42 uses a 16-bit single word, single cycle, 8-bit data-word reduced instruction set (RISC) architecture. It includes a built-in 2k x 16-bit EPROM program memory, 232 x 8 general purpose and 48 special function registers in static RAM (SRAM). There are 11 external/internal interrupts, 33 user configurable I/O pins, three 16-bit counter/timers and two high-speed pulse width modulation (PWM) outputs (15.6kHz conversions at 10-bit resolution) a full featured universal asynchronous receiver transmitter (USART) serial communications system running at 260kHz with a chip clock speed of 16MHz. Future devices are planned to have a clock speeds of 25MHz and 33MHz.

The use of a RISC system allows the controller to run at high speed since each of the 55 instructions occupies a single 16-bit word that executes in a single cycle. The use of a pipeline to read instructions in and process them simultaneously also contributes to a speed-up of performance. The only two-cycle instructions are used in branches and table look-up – the branches, GOTO, CALL and so on, require an extra fetch for the branch addresses.

To help the development process with the new controller, Microchip has also introduced the PICMaster-17. This is a PC-based MSDOS development system that runs under Windows 3 and provides assembler software, an in-circuit-emulator and EPROM programmer. Real-time trace data can be captured and displayed without halting the emulation. The PICMaster can be used with all current and future Microchip 8-bit controllers simply by changing a device personality card and an emulator control pod. ■



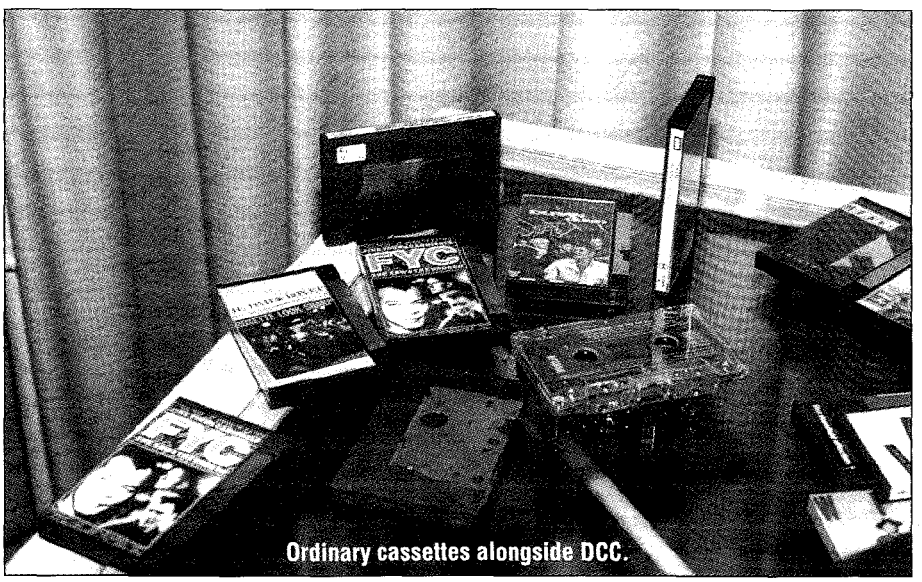
Block diagram of the PIC17C42

1991 A Year In Consumer Electronics

Ian Burley looks back over the old year to see what was new, what was good, what succeeded and if any of it has a future.

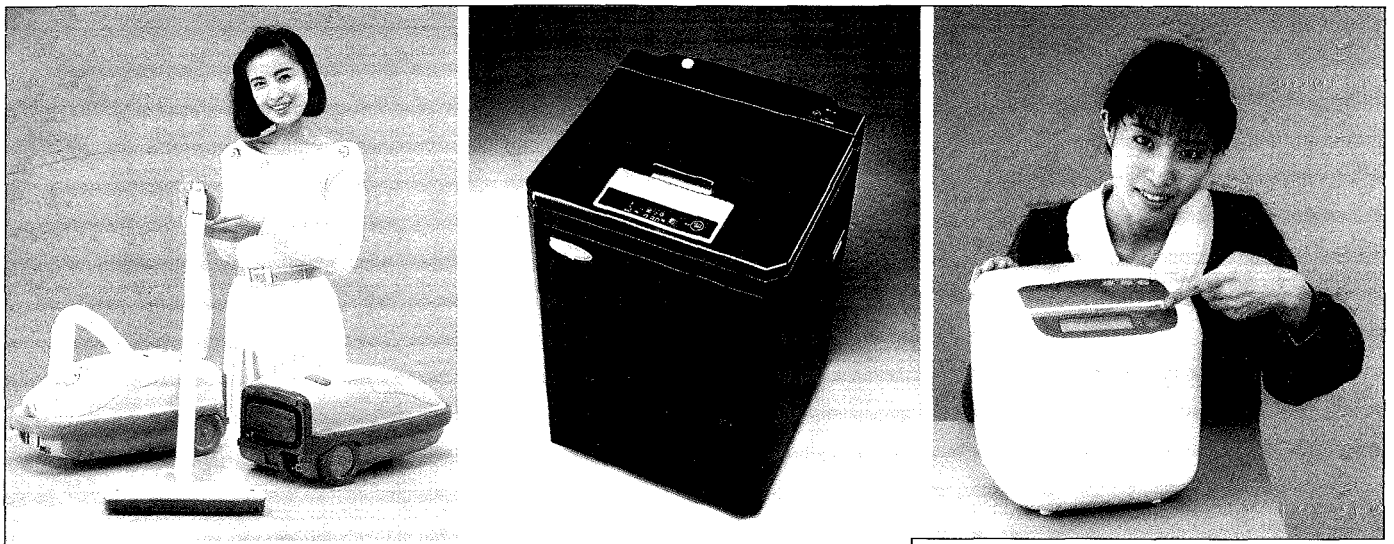
As ever it has been a very interesting year in the world of new electronics products. It's not easy to pick out all the highlights but for me, several new product developments, announcements and arrivals spring readily to mind; Digital Compact Cassette, Mini Disc, CDTV, CD-I, HDTV, fuzzy logic, Dolby S, and more...

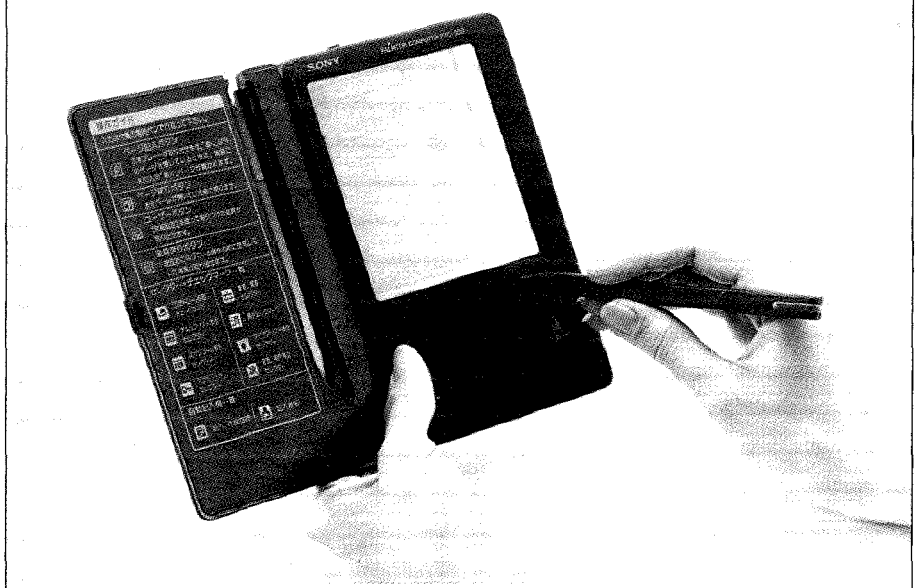
The year started off with a bang; Philips started to turn the screw on Sony's long beleaguered DAT (digital audio tape) standard by stealing the show at the big Consumer Electronics Show (CES) in Las Vegas with an ingenious alternative. For the first time the general public was getting wind of an Philips' new digital audio cassette standard which was cheaper than DAT and could even play the billions of original analogue compact music cassettes already owned the world over. This was Digital Compact Cassette, or DCC. Sound processing directly modelled on the characteristics of human hearing enabled Philips to promise the prospect of 90-120 minutes of near-CD quality listening on a new ruggedised cassette tape which borrowed design points from both video cassettes and PC floppy discs. Crucial backing from Matsushita, the giant Japanese electronics group whose brand names include Panasonic and Technics, and Tandy in the US provided the foundation for Philips' eventual triumph in establishing DCC as the new digital heir to the music cassette throne. Despite initial flustered protestations that DAT would not be threatened by DCC, Sony later licensed Philips' DCC technology and DAT was suddenly a has-been in the consumer market.


Ordinary cassettes alongside DCC.

Sony's Digital Audio Disc.

Sony wasn't going to admit total defeat, however, and the second digital audio technology bombshell of the year arrived with the announcement of Mini Disc (MD). I have personally been waiting extraordinarily patiently for a random access CD-quality recording medium – a recordable compact disc in other words. Sony's MD system is just that. At the summer CES event in Chicago, Sony showed that it too could

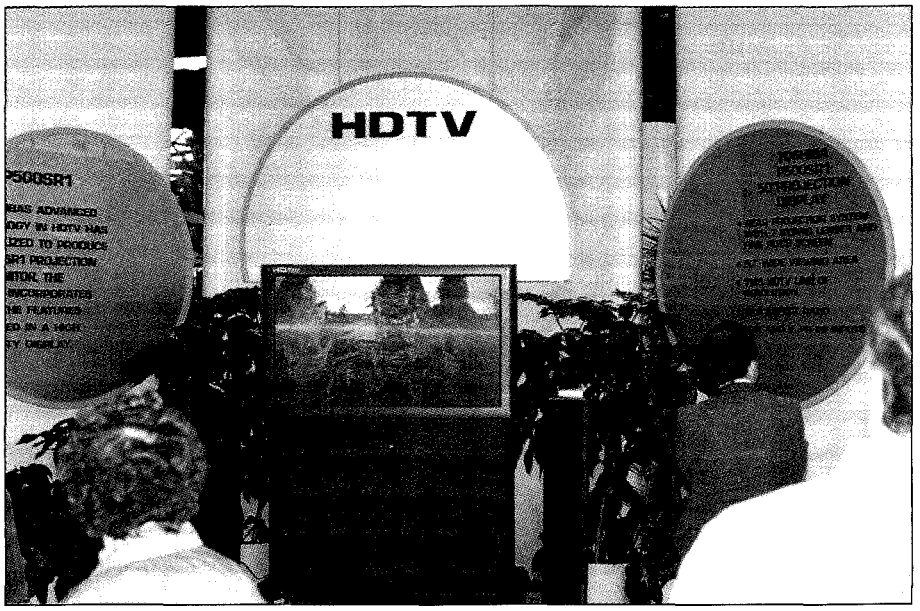




All of these products incorporate fuzzy logic and all come from Japan.

match Philips' ingenuity. Using a tiny 2.5in disc and hybrid magneto optical (MO) read/write heads combined with a space-efficient digital encoding technique not a million miles from the one Philips uses for DCC. Sony showed a CD player you could slip into a shirt pocket and go jogging for 74 minutes without any interruption to listening. It seemed apparent that Sony had been forced to show its hand. The prototypes we saw in Chicago were very early developments and recording demonstrations were not possible. However, like DCC, I was impressed by the sound quality of pre-recorded material auditioned. Hifi perfectionists might be able to claim detected imperfections in the music, but for myself and I suspect millions of others, the audio quality and stability of DCC and MD players will be perceived as a quantum leap from existing analogue audio cassettes. The Sony versus Philips struggle ended amicably, too, with Philips following Sony's example and licensing its rival's technology. Back on the analogue front, Dolby's S-level noise reduction system entered production a little over a year after it had been announced, but it's not likely it will become a household term like Dolby B; digital systems have seen to that.

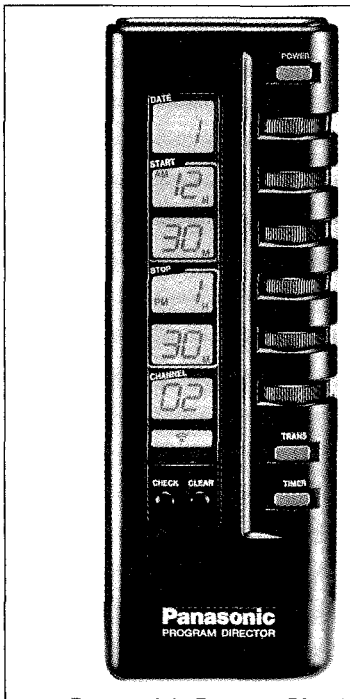
1990 was supposed to have been the year of Multimedia. The idea of combining audio, visual and textual information in a structured form on ordinary compact discs to provide interactive multimedia databases is certainly here to stay. A lot of things happened in the multimedia world this year, but the industry is still far from mature. Commodore



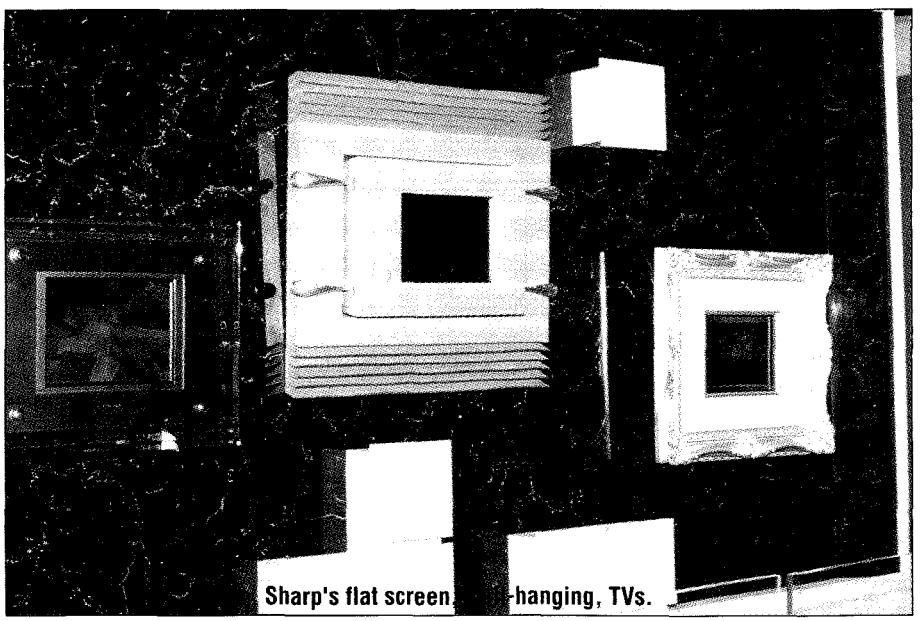
admitted its schedule of introducing CDTV (Commodore Dynamic Total Vision) by Christmas 1990 was hopelessly optimistic. A year after CDTV was first announced in a blaze of self-indulgent glory, it was re-launched and the first production machines were shipped during the summer. Personally, I think Commodore is trying to do too much with CDTV on a hardware platform (a stripped down Amiga personal computer) which was never designed for the job. CDTV's main rival is CD-I, or Compact Disc Interactive, invented by Philips back in 1986 and once again being co-developed by Matsushita, Sony and Tandy among others. CD-I was nearly written off a while back as deadline after deadline was missed. CD-I was what the inventors of the term vapour-ware had in mind! At last in 1991 the first consumer CD-I machines hit the shops in the US, albeit without long-promised full-screen motion video. We're told that machines will accept chip-upgrades next year when the motion video chip-sets go into production. European is expected to get full-spec machines with motion video sometime before the summer of '92. Kodak also announced that CD-I machines would be capable of displaying still images from its Photo CD discs. CDTV has had the advantage of beating CD-I to the market place, but sales are not exactly boiling over. CD-I is undoubtedly superior on the technical side and has the backing of major consumer electronics manufacturers. 1992 will be make or break for both systems.

Meanwhile the PC industry got its multimedia act together and invented the MPC (multimedia PC) standard based around an extended version Microsoft's Windows graphical user interface, CD ROM and an add-in stereo sound extension.

The battle for supremacy in high definition TV (HDTV) generated much discussion this year. In the US, moves to establish an HDTV standard were accelerated, with final test trials of the half dozen or so proposals scheduled for early in 1992. The impressive looking, but rather elderly Japanese HDTV system went live this year, but in Japan only and for just a few hours a day. Most still can't afford the exorbitant costs of a HDTV set. In Europe there has been an almighty scrap between the European Commission, TV manufacturers and the broadcasters. The EC wants to impose on the industry HD-MAC, the satellite broadcast high definition system which manufacturers like Philips and Thomson have invested heavily in. Broadcasters are very worried that established standard resolution wide screen format TV, D2-MAC, will be damaged by the EC proposals. Then there's PAl Plus, which aims to use extremely sophisticated signal processing at the broadcasting end to preserve compatibility with existing television sets but offer a wide-screen option. Perhaps 1992 will see



Panasonic's Program Director.



Sharp's flat screen, [illegible]-hanging, TVs.

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Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range..... £23.95

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1500m range £16.45

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Transmits a continous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation £22.95

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As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m £35.95

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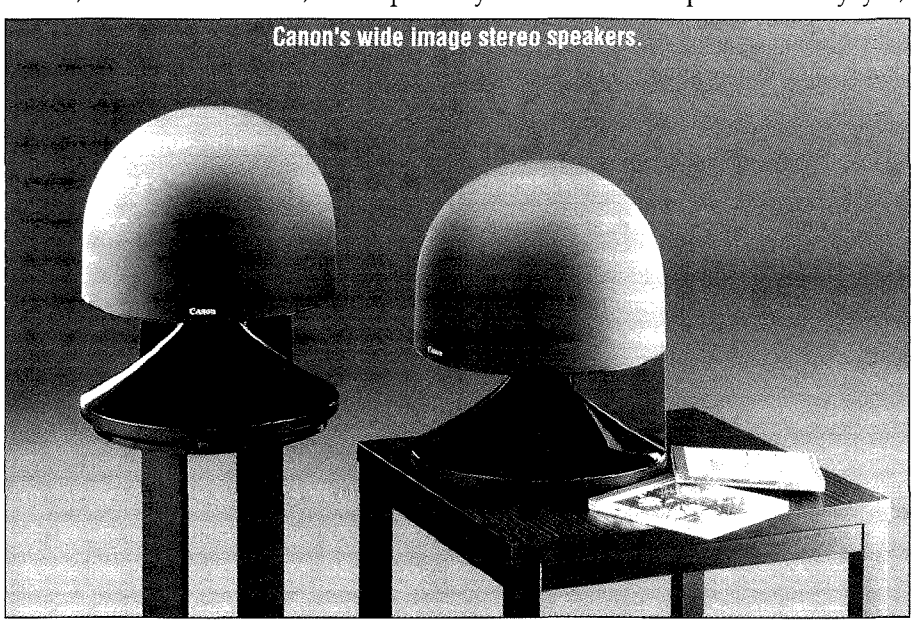
Commodore's CDTV.

all these arguments resolved.

I'll not forget in a hurry the advances in LCD colour screen technology this year. Elsewhere in this issue we look at the latest notebook PCs which now sport colour LCD screens. We're getting ever closer to the goal of dumping the veteran cathode ray tube and replacing it with flat panel LCD screens. Toshiba has exhibited a very attractive 10" portable colour TV which is a mere three inches or so thick. Sharp is also working hard to perfect active-matric colour screen technology for domestic TVs.

In October we looked at what appears to be a big trend in Japan; fuzzy logic. If a household appliance has practically any form of user-adjustment, you can bet some Japanese engineer is trying graft fuzzy logic onto it. Washing machines, elevators, vacuum cleaners, camcorders, microwave ovens, industrial robots, even pen plotters computer CAD systems now use fuzzy logic technology to enhance their operation. The Japanese government has just announced it is to pour hundreds of millions of dollars into a long-term project to develop super-fast neural computing mainframes featuring fuzzy logic operating systems. Experts are convinced the products of this research will make today's so-called fifth-generation supercomputers look pretty feeble. It's also expected that these "sixth-generation" computers will have a relatively high degree of intelligence hard-wired into them, making operations like object recognition and abstract problem solving far easier than via traditional digital computing methods.

After fuzzy logic vacuum cleaners, what about neuro-fuzzy robots to do the vacuuming for you? That's not quite a reality yet, but Samsung in South Korea has at last produced an affordable (almost) domestic robot which does more than just prance around emitting horrid digitised noises. Launched at the Summer CES show in Chicago, the Samsung ScoutAbout works as a robot intruder and fire alarm system with the ability to alert fire or police services.



Canon's wide image stereo speakers.

Other developments in 1991 which come to mind include Canon's surreal-looking wide-stereo image S-50 speakers. They work but Canon's engineers are not quite sure why. Back to Sony and SIRCS II - the promise of HiFi and AV equipment intelligently linked up in a simple network. Switch on your CD player and the amp springs to life as well. Then switch on your VCR and if you're not playing a CD the amp switches to the VCR input and the CD powers down. Apparently Sony envisaged SIRCS II as a way of alleviating pressure on AV/HiFi sales people from customers querying exactly how to use their newly purchased electronic marvels. Panasonic gets my vote for a device which solves one of the biggest problems in contemporary consumer electronics – how to work the VCR remote control timer recording programmer. Panasonic's Program Director does away with buttons and introduces stunningly simple to use thumb-wheels.

There isn't actually enough room to list even a decent fraction of the positive happenings in consumer electronics technology this year. But to bring the optimists down to earth with a bump, here's a quick reminder of how things can go sadly wrong. Two technologies I've had high hopes for have been practically laid to rest this year. Keyline, the artificial-intelligence portable teleshopping terminal which was to have pioneered the use of electronic money stored in smart cards, went deadly quiet in 1991. This was also the year that three out of the four DTI licensed Telepoint digital cordless phone service operators folded. The fourth (Hutchison Rabbit) still breathes but has yet start its service.

At least the good news far outweighed the disappointments. Let's hope it stays that way in 1992. ■

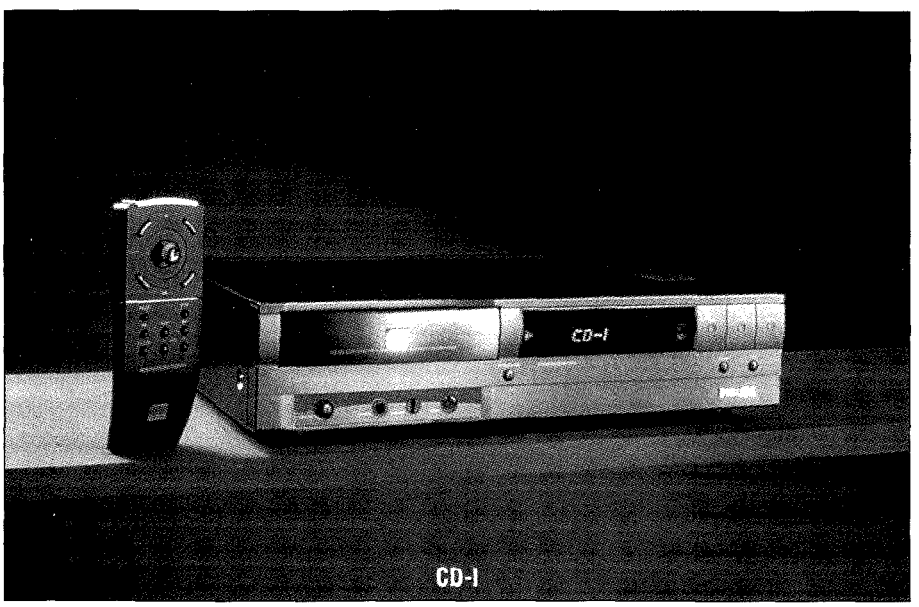
Multimedia – What's All The Fuss?

If you believe all the hype and the buzzwords, multimedia is the technology of the nineties.Julie Saunders checks it out.

Multimedia has been receiving a great deal of hype over the past six months or so. It has its own magazine, there was a recent show at Earls Court devoted to the latest happenings in the area and it has been heralded as a technology set to revolutionise the world of publishing.

Trying to attach a short definition to multimedia is not all that easy. At one end of the spectrum it is an interactive television system and at the other a way of creating new worlds.

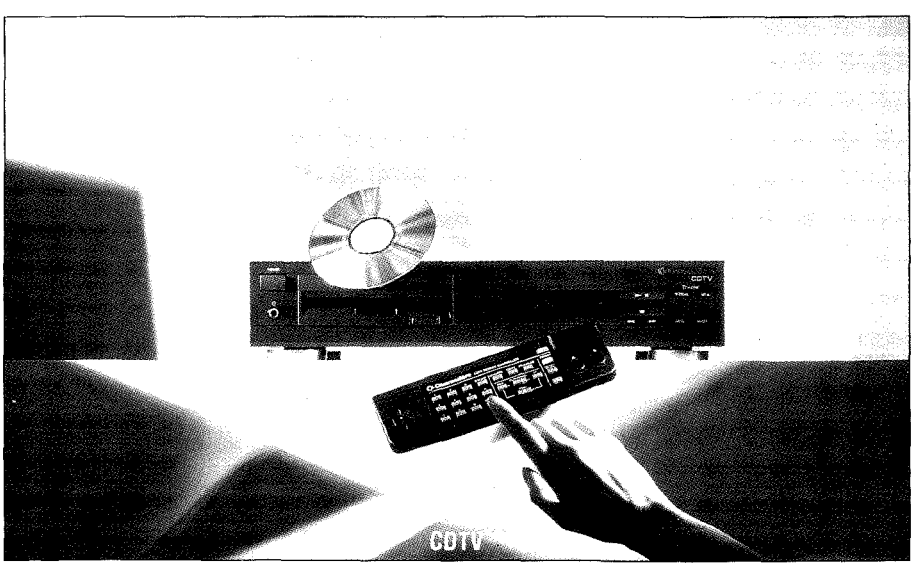
Possibly the best simple description is that multimedia is a combination of sound, vision and computers. The fact that there are a number of ways in which these can be integrated gives some idea of the variety of which multimedia is capable.



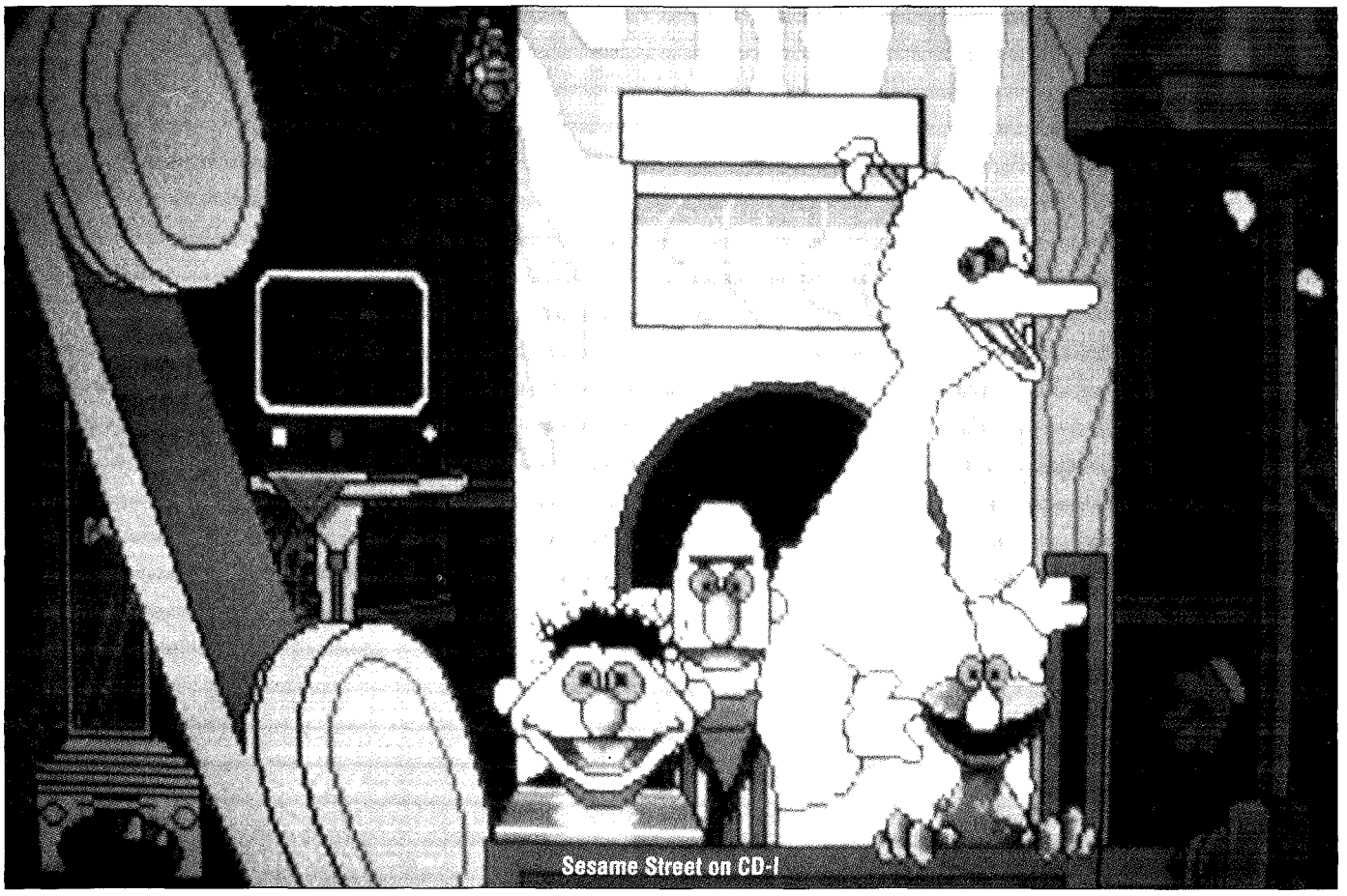
CD-I

The Hardware

The roots of multimedia probably lie with the invention of the laser disc and the personal computer. Using one to control the other meant that images could be selected at random from the disc and text overlaid from the from the computer to create captions and menus. One of the first systems to use this technology was Domesday Project,which linked a BBC Micro to a Laser Disc player, holding information about the UK in map, text and video form. To get at the information, a tracker ball was used to position a pointer on a map of Britain. Clicking a button zoomed into the map showing finer and finer detail until the town, city or village level was reached. At this point still photos and selected information from the area were available. Like its 900 year old predecessor, the whole thing was a snapshot of the country though, in a more easily accessible format.



At the base of modern multimedia are CD-ROMs – compact disc read only memories. CDs use laser beams to scan small pits on the spinning disc which hold digital information this can be music, text, images or instructions to a computer. Because laser beams can be made to track very fine points, a large amount of data, around 650Mbytes or 150,000 pages of text, can be stored and with the disc being relatively small, access



Sesame Street on CD-I

times are relatively quick. CD-ROMs are now widely used as a publishing medium with dictionaries, newspapers, workshop manuals and the Complete Works Of Shakespeare, to name but a few, all available in this electronic form.

The next step up from simple text publishing is to supply pictures. CDs are able to cope with stills but the old adage that a 'picture says a thousand words' is rather wide of the mark for moving images. The amount of data required for 25 seconds worth would completely fill the average CD. A way around this problem is to compress the data, usually by examining which portions of each image actually change from frame to frame and only recording the changes. The drawback with this is that it either slows the whole system or requires a vast amount of computer processing power.

Two commercial systems that use CDs are Compact Disc Interactive, or CD-I, from Philips and Commodore Dynamic Total Vision, or CDTV, from Commodore. Both of these use standard CDs containing a mixture of text, graphics and compressed still video in conjunction with a computer system that allows the user to interact with the data. As yet moving images can only be provided by the controlling computers graphics animation capabilities – in the case of the CDTV, the Commodore Amiga at its heart is able to provide high revolution moving graphics images as well as high quality digitised sound.

Among titles already available for CDTV are Time Table Of History which covers the American past and Music Maker, the ultimate in electronic jukeboxes. Other titles are becoming available as the market grows.

Another aspect of multimedia, first announced by Kodak and more recently by Philips, is a facility to allow 35mm photographs to be transferred to CD for later viewing on TV or personal computer. The Kodak Photo CD system takes colour transparencies and digitally

Multimedia What does it all mean?

Multimedia was the latest computer buzzword a year ago. For six months you couldn't open a copy of MacUser without reading a product announcement or an article. Now it's got into the general vocabulary. So what is multimedia?

Multimedia means digitising information from many sources – text, pictures, video, music – and recording it on a computer system where it can be manipulated and recombined. The computer press spent six months telling us this would change our lives, then gave up; MacUser admitted a huge proportion of their readers just weren't interested. What went wrong?

Don't believe the hype!

There are two basic problems with multimedia. First; you need a lot of expensive high-power computer equipment to make it work. Digitising video and sound and replaying it in real time is beyond current PCs because of the huge resources required in processor speed, display capability and memory storage. A single scanned image can use up over 10Mb of hard disk. Can you imagine how much space you need for a 20 minute video? Second; what would we do with all that capability, if we had it? Things like animated dancing memos and on-screen World Cup while you enter data sound great. But who's got time to assemble those memos, when a simple written note will do, and what will your boss think about your typing speed and accuracy?

Today the world, tomorrow the solar system...Multimedia for the rest of us...

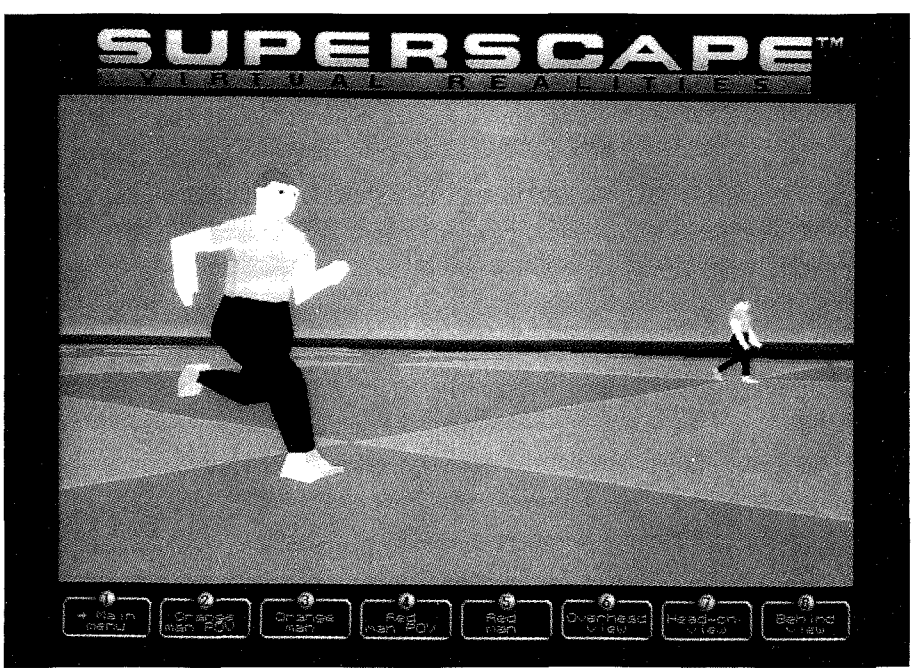
Of course multimedia isn't totally useless. In fact it's been around for longer than you might imagine. Video games using laser disks are one example, karaoke is another. It's also driven progress in the technologies of image compression and data handling, and this is already spinning off benefits in the computer world. But until the Sparc-alike is the standard pocket computer, with a simple graphic interface and easy-to-learn software, multimedia will remain the tool of professionals with a real need for it and the ability to commit the necessary resources.

Richard Milner
Production Manager of PE

scans them at 3000x2000 resolution for storage on a CD. All the user needs is a Kodak Photo CD player and a TV or a CD ROM XA and a personal computer.

In Training

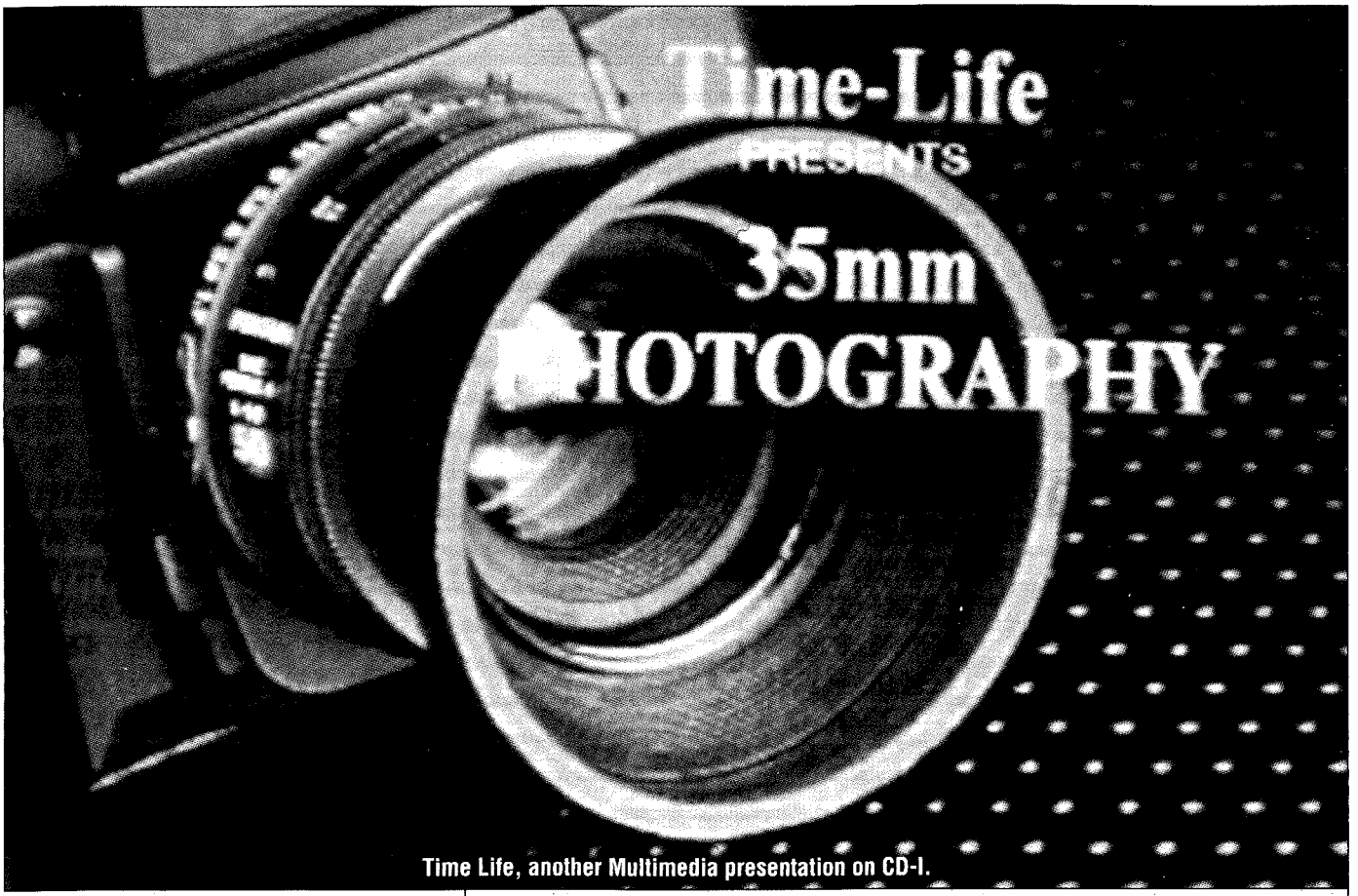
One of the main uses of multimedia is in interactive training. The user can be put into certain situations or supplied with information in visual form that teaches them how to react. Language learning is popular, as is management training – there are even programs that teach you how to cope with stress. At the moment, many of these systems rely on moving images and are not really compatible with current CD technology – they run from the larger laser discs. However, as capacity increases, they will move to the smaller CD and will probably become a standard method of tuition.



New Worlds

The aspect of multimedia which has generate most comment is virtual reality, also known as cyberspace. This uses the modelling capabilities of the computer to create a digital world which can be seen and touched. Viewing is by means of a small pair of LCD screens mounted in front of the user's eyes. The images supplied by the computer to each of these give rise to a three dimensional view. Adding a pair of headphones supplies 3D sound and special feedback gloves allow physical interaction. Early versions of these gloves simply used strain gauges to sense the movement of the fingers. The latest versions use ultrasonic or radio signalling to sense the position of the glove in space and, as well as tracking the movement of the fingers, supply feedback via hydraulic 'fingers' – cyberspace is now solid.

Building a virtual reality world involves a great deal of hard work. Objects are built up from points grouped together to form polygons, which can be filled to give the appearance of solidity. By determining the angle of the lighting on a scene, the colours of the polygons can be altered to make them look real. Since each of the points has to be defined individually in space, a lot of work is involved. Increasing the amount of information increases the quality of the image. For example, a virtually real room could have chairs, tables, a telephone, pens, pencils and so on. Increasing the detail would put numbers on the telephone buttons and a make on the pencil. In theory, the ultimate virtual reality would be a model of the whole world with detail down to the litter on the streets. The main



Time Life, another Multimedia presentation on CD-I.

drawback would be keeping it up to date as things move around. On the other hand, exploring it would be enormous fun.

Advanced virtual reality systems have actually been around for years in the form of flight simulators. Allowing pilots to make mistakes on a mock-up of an aircraft rather than the real thing not only saves lives and money, it also trains them in the correct reactions to emergency situations. All that is required is a cabin mounted on hydraulic rams which allow it to be moved around, giving the pilot the feeling of a bumpy ride. The graphics and animated runways plus other air-traffic all add to the reality. The main problem with scaling down such environments is the processing power needed to create the images and the cost of a system that allows the user to feel the effects of what is happening. Visitors to amusement arcades will now be quite aware that a simulation of driving in a grand prix or flying a jet fighter into battle are now experiences available to everyone. Although the graphics are generated by computer, this is nonetheless a variation on the cyberspace concept and multi media. ■

Buzz Words

Apart from a new technology, multimedia has spawned a large amount of jargon. The following table gives a taste for the subject:

AVI	Audio Video Interleave – Microsoft multimedia. Microsoft were the original authors of the operating used on IBM PC type computers
BIMA	British Interactive Media Association
CD	Compact Disc – a plastic disc upon which large amounts of digital information can be stored
CD-I	Compact Disc Interactive – Philips' multimedia machine
CD-ROM	Compact Disc Read Only Memory – uses a CD to store digital information in a form which cannot be read
CD-ROM XA	CD-ROM with extended architecture – a PC based system that interleaves sound and vision as a parallel stream allowing sound always to be linked to motion
CDTV	Commodore Dynamic Total Vision – Commodore's multimedia machines which has an Amiga 500 at its heart
DVI	Digital Vision Interactive – Intel's multimedia system. EMC European Multimedia Centre
Hercules	Monochrome graphics adaptor for IBM PC compatibles
Hypertext	an interactive database system that connects information via graphics and uses a mouse pointer to select data.
ITDG	Interactive technology Development Group
JPEG	Joint Photographics Experts Group – an International Standards Organisation (ISO) committee working on compression standards for still video
MPEG	Moving Picture Experts Group – an International Standards Organisation (ISO) committee working on compression standards for moving video
PhotoCD	a system to store 35mm photographs on CDs
POI	Point Of Information – a multimedia system used to give information to customers
Quicktime	Apple's multimedia
VGA	Video Graphics Array – computer display system for IBM PC compatible machines offering high resolution and multi colour
SVGA	Super VGA – the next step up from VGA

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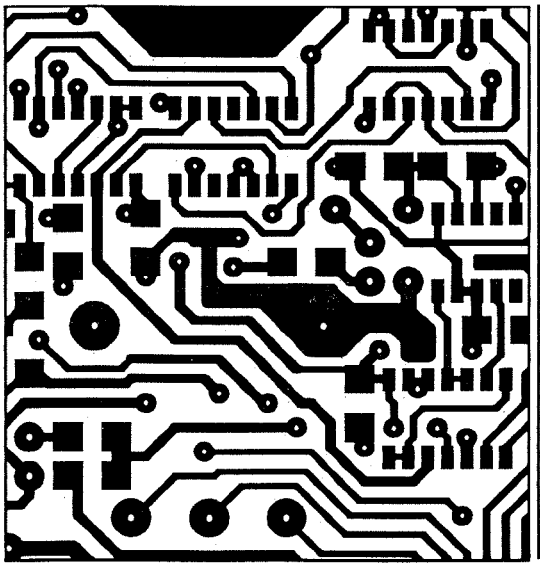

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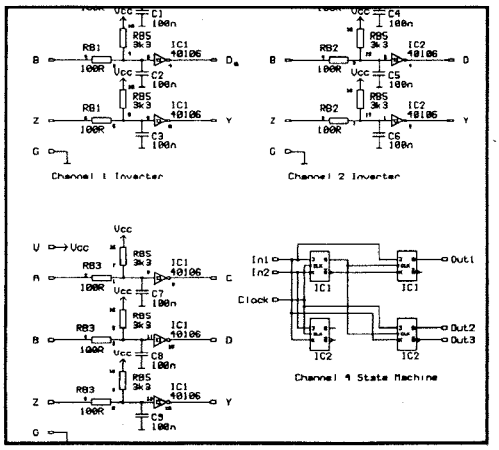

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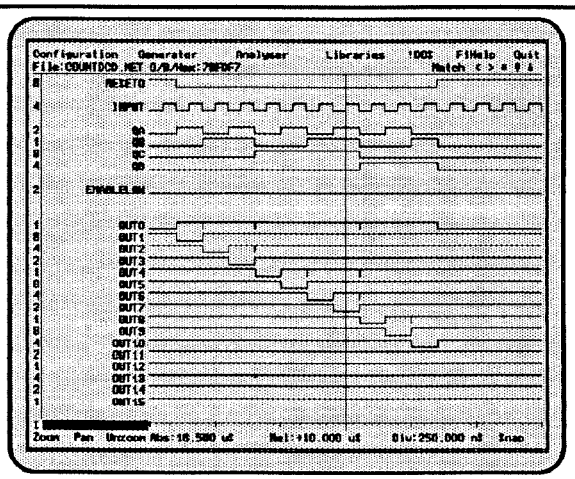

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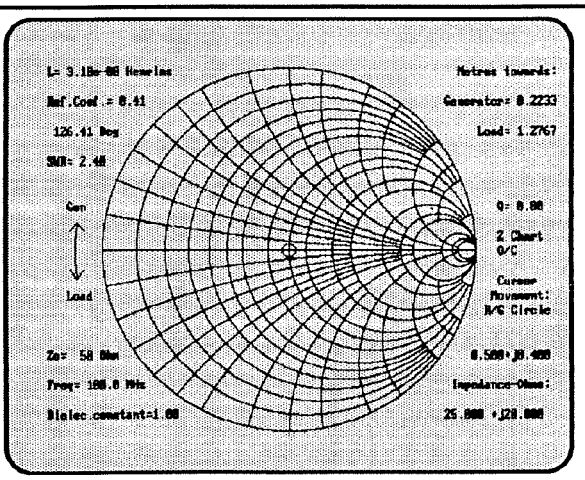

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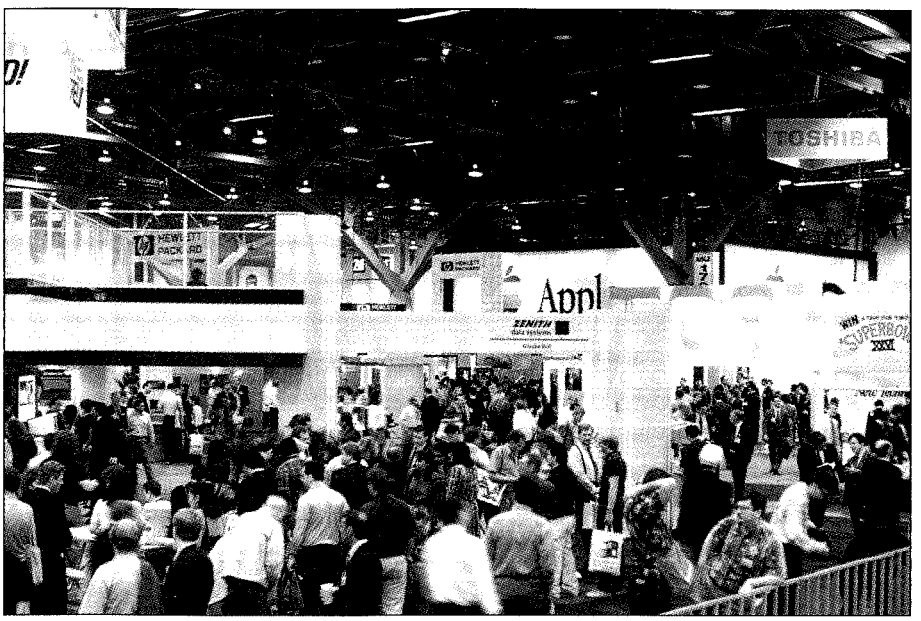
Cramming 21Mb Into A 3.5in Floppy Disk

This month Ian Burley visits Comdex Fall in the USA and discovers a computer world about to be invaded by colour LCD computers, pen computers and floptical disks.

Comdex is a massive trade-only show and convention for the personal computing industry held twice-yearly, and Comdex Fall 91 had no less than 1900 firms from all over the world, exhibiting on 3,000 stands. Most of the big names attend and there are usually lots of new technology developments to see. Here are a few which caught my eye:

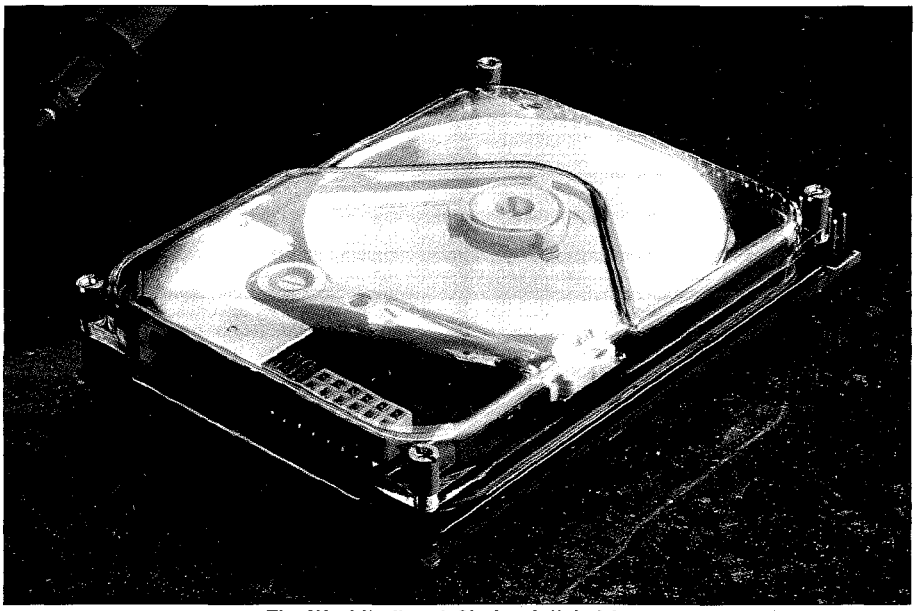


Comdex features all the big names.

Floptical

For the first time the new hybrid magnetic and optical floppy disc standard, Floptical, exhibited in force at a Comdex. Key members of the Floptical lobby are magnetic media giants 3M and Maxell. What they're pushing is an affordable floppy disk with a data capacity of at least 21Mb - thirty times greater than a 720K floppy for example! Hybrid technology is used, combining high density magnetic data storage and optical registration. Importantly, the Floptical standard, which is 3.5in, is downwards compatible with 720K and 1.44Mb PC floppy disks. Floptical is not magneto-optical (MO) like IBM's new high capacity read/write optical disc, for example. There's more on those later. Instead, the optical aspect of Floptical is for accurately registering the high-density magnetic read/write head over extremely narrow tracks. Standard 3.5in disks usually work at 135 tracks per inch density. Floptical crams 1250 tracks per inch of media width. Optical registration of the head is accomplished by an LED sensor which lines up with tiny pitted grooves , rather like a vinyl record, adjacent to each track - although unlike a record the tracks are not spiral. The optical grooves are indelible and so unaffected by magnetically encoded data changes. The drive mechanism has a pair of read/write heads, one for conventional standard capacity double or quad density disks plus one for the super-high density Floptical disks. Standard 3.5in drive mechanisms are now available to the trade for as little as $30. A Floptical drive will cost ten times that, but it is still an attractive alternative. Maxell and 3M say that when the disks start shipping later in 1992 they will be attractively priced, with Mb/$ costs well below

Maxell re-writable Magneto Optical Disk



The World's first 1.8in hard disk drive.

standard floppies. There is also talk of enhancing the technology further and eventually releasing an 80Mb floppy.

Floptical is undoubtedly attractive, but there is one ingredient for success still to be found - IBM's endorsement. Currently, IBM is backing the relatively puny 2.88Mb 3.5in floppy standard established earlier in 1991. At the other end of the removable disk storage media scale there is IBM's 128Mb MO standard. Logically Floptical fills a gap, but the future for Floptical won't be rosy unless IBM decides the gap needs filling.

Tiny Hard Disks

Just a few years ago the 3.5in hard disk was an amazing feat of miniaturisation. It made the original 10Mb 5.25in 'compact' hard disk supplied with the first IBM PCs ten years ago look elephantine. In 1991 we were just getting used to 2.5in hard disks with area dimensions not much bigger than a credit card – and disk capacities of up to 80Mb as well. Comdex saw the introduction of the 1.8in hard disk from Integral Peripherals in Boulder, Colorado. The firm hopes its microscopic new devices will be a hit in the fast growing notebook market as they exhibit very low power consumption as well as being petite. The 20Mb 'Mustang' version with its controller PCB relocated off the drive case is just 10mm thick. The other dimensions are just 3x2in. A twin platter and slightly thicker 40Mb 'Stingray' will be introduced soon.

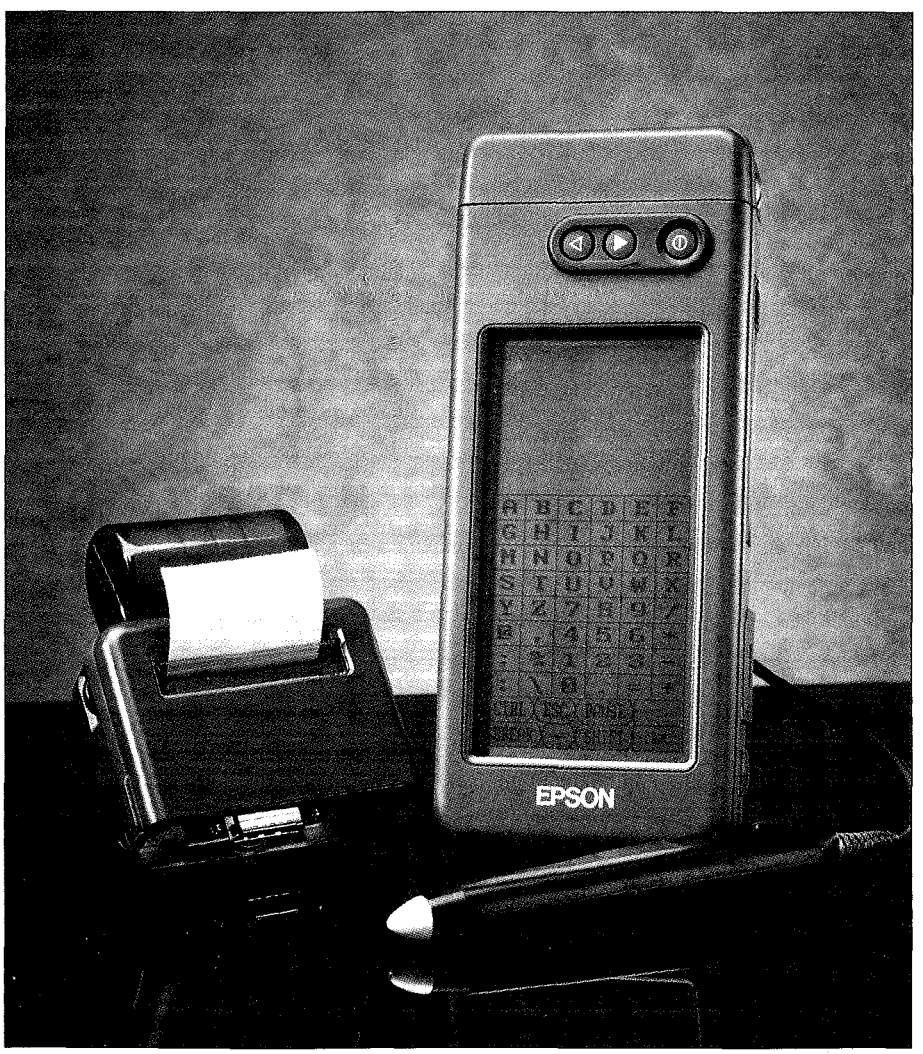
Pen Power

If you are unlucky enough to be booked by a policeman in San José, California, there's a reasonable chance the officer won't jot your details into a ticket pad but instead scribble directly onto the LCD screen of a GRiDPAD keyboardless portable PC. The San José police force is the largest in Silicon Valley – where else would you find high-tech constables?

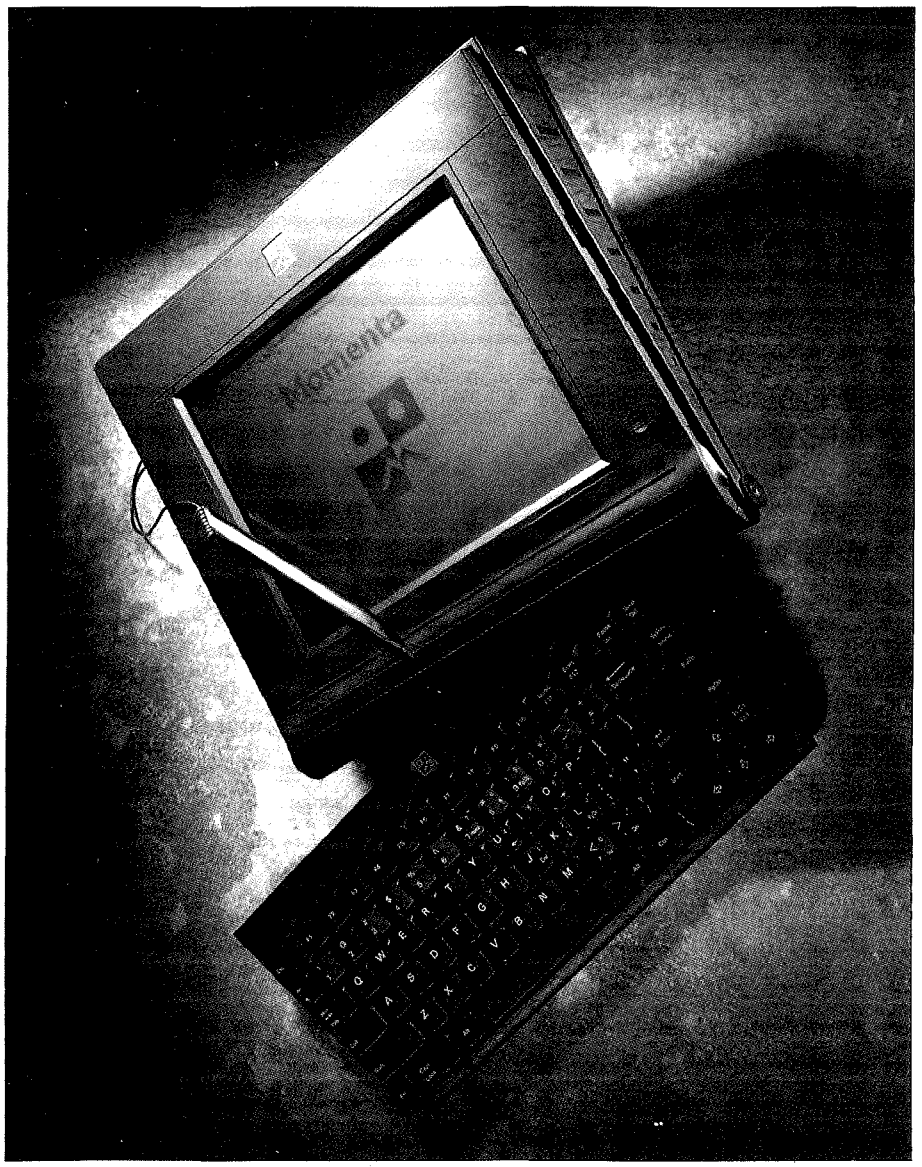
Comdex was a veritable keyboardless computing showcase. While Go Corporation with its PenPoint operating system and Microsoft (Pen Windows) prepare to battle it out on the software side, there were plenty of hardware developers showing their pen-compatible wares.

Samsung, NCR (now owned by US telecomms giant AT&T), IBM, Momenta, Microslate, Epson, Trigem and GRiD among others exhibited working PCs without keyboards. Actually, that's not strictly true as several have connectors for conventional keyboards should the user so desire and the Momenta makes a virtue of its compact optional keyboard.

Most of these next-generation computers rely on a pen or stylus being used directly on a sensitive LCD screen for inputting numbers or text and selecting menu



Epson's EHT-20 features a touchscreen LCD.



Momenta, yet another pen based system.

functions. The primary advantage over the current trend in miniaturised computing, notebook PCs, is that unlike a notebook with its keyboard, you can hold a pen PC and 'write' onto it conveniently on the go - walking around a warehouse or at the scene of an accident for example.

Some pen-input computers are finger compatible as well. Philips didn't show a machine, but it announced a pen or finger compatible LCD display system which is also sensitive to how much pressure is being applied. The system is called PAID or Philips Advanced Interactive Display. Visualise a drawing program which make lines thicker the harder you press, for example.

The huge Korean industrial conglomerate, Hyundai, was due to exhibit a pen computer but it failed to materialise due to technical problems. This highlights how early in the development phase pen computing is. GRiD and Microslate have been shipping their hardware for a while now, but pen computing in general isn't set to take off in earnest until about the time of the next Comdex Fall. By then some useful operating systems will be available and the hardware will be more stable. Advanced handwriting deciphering algorithms will also benefit from even more powerful CPU chips later in 1992. IBM even showed a colour LCD pen computer currently being evaluated for use on the New York Stock Exchange.

For many, the pen is far more intuitive than either a keyboard or mouse. Quite soon I expect to see peripherals for deskbound computers to provide pen/finger input instead of the traditional mouse. Personally I'd rather speak to my PC rather than poke it around with a finger, but useful voice recognition is a year or two away yet.

If you prefer a pen or stylus, Wacom Technology's cordless pen input device could be the answer. The device uses no batteries and relies on electromagnetic 'resonance' technology developed by the firm. Basically the pen's position is determined by the screen radio signals being resonated by a coil in the pen. I can't see tethered pens having a long shelf life so Wacom has a good head start in what will undoubtedly be a very busy niche of the emerging pen computing industry.

Most of the pen computers shown were full size devices designed to show a whole page of A4 text. Indeed, some were positively bulky. Epson was an exception; it's EHT-20 hand-held could be just the first of a flood of similar pocketable touch-screen personal computers, or palm-tops. The Epson, a 10MHz 8088 DOS-compatible also accepts finger input. JEIDA (PC Card) credit-card sized non-volatile memory cartridges are used for storage. Epson sees its palmtop as a hard-working pocket computer in the same mould as Psion's Organiser II, of which half a million are now used in industrial and retail applications.

In 1992 we can expect a major advance in palm-top computing with the much rumoured Apple machine which will almost certainly use British ARM RISC processor technology originally developed by Acorn Computers in Cambridge. A lot of people are going to be forgetting about keyboards in 1992!

Low Power CPUs

There is a big battle raging in the PC chip world. Intel's dominance of the PC with its 386 chip range is under serious threat from both Advanced Micro Devices (AMD) and Chips & Technologies, both of whom have developed cheaper and faster 386 clones. AMD has also produced a special version of the 386SX which not only runs 25% faster at 25MHz than Intel's version but requires just 3.3V to operate instead of 5V – very attractive for battery-hungry notebook PC makers. Intel's answer is a special version of the 386SX chip, the SL with special power saving functions built in – basically the chip stops

when it is not needed to save precious milliamps. Over at C&T, better known for its PC support chips, not only has the firm joined AMD in producing a range of 386 clones, but at the other end of the scale it has produced a single-chip PC; just a single square package IC containing an 8088 processor (PC/XT compatible), memory management, interfacing and I/O support. All you need to do is add memory.

Colour Screens

The history books will note Comdex Fall 1991 for the arrival of colour LCD notebook PCs. This has provided a second chance for the passive-matrix colour LCD which was rapidly losing out in favour of the sharper, faster, brighter but much more expensive and power hungry thin film transistor (TFT) active-matrix colour LCD technology.

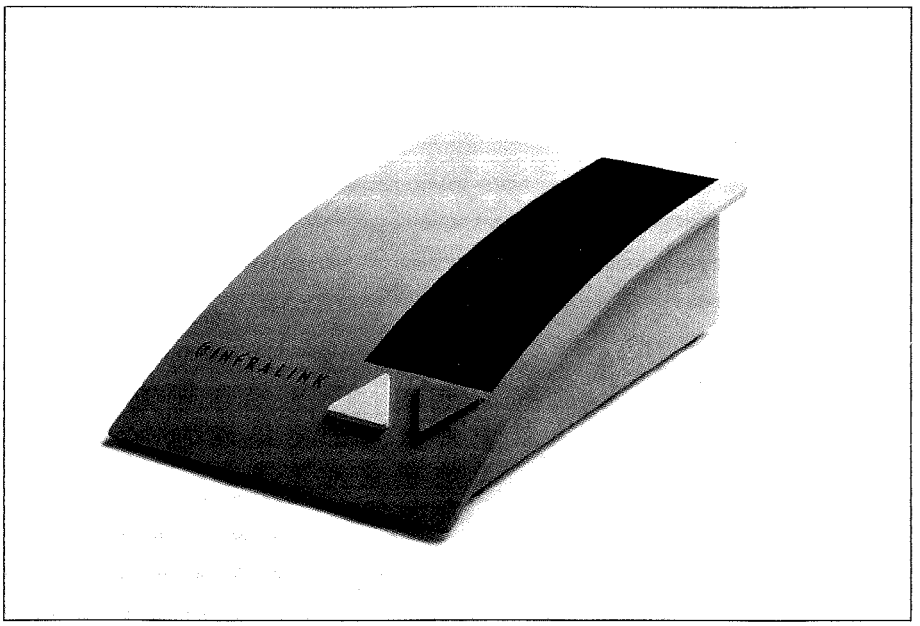
Only two firms, Sharp and Epson were spotted showing active-matrix colour screen notebook PCs. Sharp's display was up to the usual incredible standards offered by active-matrix technology, but nobody on the Sharp stand would admit how long, or not so long as the case might be, the colour notebook's battery life compared with a conventional mono notebook.

Epson was much more candid as their active matrix screen, developed by subsidiary Seiko Epson, actually had some new features. Active matrix it is, says Epson, but TFT it is not. Instead Epson calls its new colour screen technology metal-insulator-metal, or MIM. Advantages over TFT technology include higher production yields due to less assembly stages, so it's cheaper to make and lower in power consumption. The screen, to my eye at least, wasn't quite as brilliant as the Sharp TFT example, but certainly miles better than any of the passive matrix screens around. We should be hearing more about MIM screen technology.

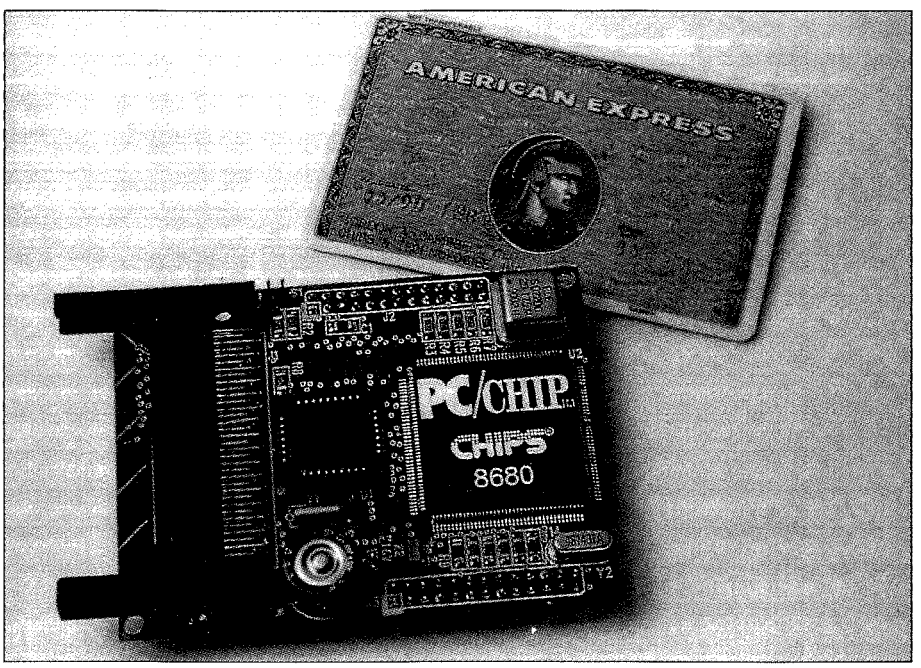
Battery Developments

Like Toshiba and a couple of other notebook PC makers, Epson now offers Nickel-Hydride rechargeable batteries instead of the traditional Nickel-Cadmium type. Over NiCd, Nickel-Hydride doesn't suffer from recharge capacity reduction or 'memory' problems and has a higher charge density. Most 386 notebook computers claim about 3 hours of continuous use in typical conditions with NiCd batteries. Epson, by combining the new low power Intel 386SL CPU with Nickel Hydride batteries, claims continuous use of up to 8 hours or a week in 'sleep' mode between recharges.

Also catching the attention at Comdex was a new infra-red local area networking system from a firm called Infralink – just imagine – no messy cables! The transceiver units are very neatly styled as well. As mentioned earlier, MO technology is gaining ground, especially after IBM introduced a 128Mb removable 3.5in cartridge earlier in 1991. Maxell and Epson both introduced 128Mb 3.5in MO devices at Comdex and JVC even showed a dinky 2.5in 40Mb MO disc. Finally there's just time to mention a new drafting plotter made by the Japanese firm Mutoh. Yes, that versatile of tecnhologies, fuzzy logic (PE October 91), has made its way into computer peripherals. Fuzzy processing is used to choose the best vectors to be drawn first in order to speed up the drawing process. ■



Infra-red LAN system in a stylish box.



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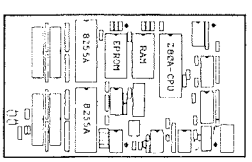

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A star feature is that no special or custom chips (ie PALs, ULAs, ASICs etc) are used — and thus there are no secrets. The Z80A is the fastest and best established of all the 8-bit microprocessors — possibly the cheapest too!

Although no serial interface is included, it is easy for a Z80A to waggle one bit up or down at the appropriate rate — the cost is a few pence worth of code in the program: why buy hardware when software will do?

Applications already identified include: Magnetic Card reader, mini printer interface, printer buffer, push button keypad, LCD alphanumeric panel interface, 40-zone security interface for auto sending of security alarms, code converter (eg IBM PC keyboard codes to regular ASCII), real time clock (with plug in module), automatic horticultural irrigation controller.

By disabling the on-board Z80A-CPU this card will plug into our Interak 1 CP/M Plus disk-based development system, so if you don't fancy hand-assembling Z80 machine code you don't have to!

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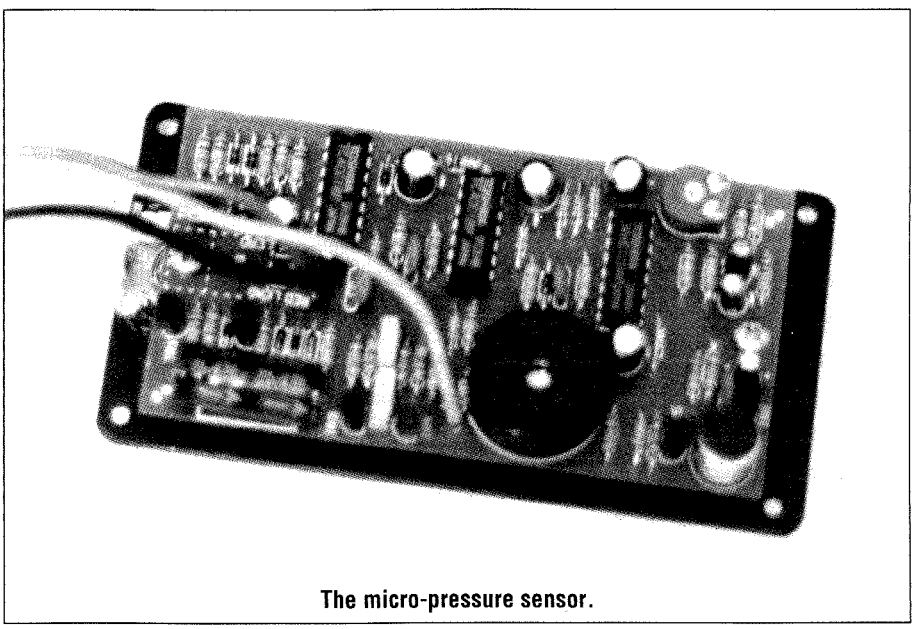
Combating The Deathriders

Car burglar alarms are sadly becoming a necessity for most car owners. Karl Hastings takes a look at a system available in kit form.

With car thefts on the rise and Death-riders on the rage, the need for some sort of car protection is becoming vital.

A number of systems are available, some simple, other sophisticated. Most of those that have to be fitted professionally are expensive, leaving a lot of scope for the DIY enthusiast.

One supplier of car alarm kits is Electronize Design, which markets a range of systems that can be connected up in a variety of ways to form a customised alarm system suitable for both a particular car and a particular cost.



The micro-pressure sensor.

Aspects Of A Car Alarm

The main function of a car alarm is to stop anyone tampering with the vehicle. At the first sign of trouble, it sets off an alarm, either the horn, a special siren, or some other sort of deterrent. Hopefully, this will attract attention to the car and make a thief think twice before going any further. Unfortunately, some systems can quite easily be set off accidentally. Sometimes this can just be a gust of wind rocking the car or it may be someone letting off a firework nearby – another likely situation is somebody with a shopping trolley accidentally knocking the car. Usually, alarms set off in this way are faulty or they are too sensitive and need adjusting

Intruder Sensors

When it comes to sensing an intruder, a number of methods are available. A simple method is to hook into the cars electrical system and detect any voltage changes. These will occur when a door is opened and the courtesy light comes on – since the system is battery powered the small dip in voltage cause by the light activating is easily detected. This type of system is known as a "volt drop detector".

An alternative, yet still relatively simple, system uses a pressure sensor. Most modern cars are fairly air-tight and when a door is opened, there will be a sharp, short, drop in the internal air pressure. Alternatively, if someone tries to break a window, the pressure sensor will react to the small pressure change. The micro-pressure sensor is the system used in the Electronize alarm covered in this review; its main drawback is when using it with older cars. These tend not to be very airtight.

The more sophisticated alarm systems use infra-red movement sensors. These ignore all happenings outside the vehicle but as soon as someone starts moving around inside, the alarm is set off.

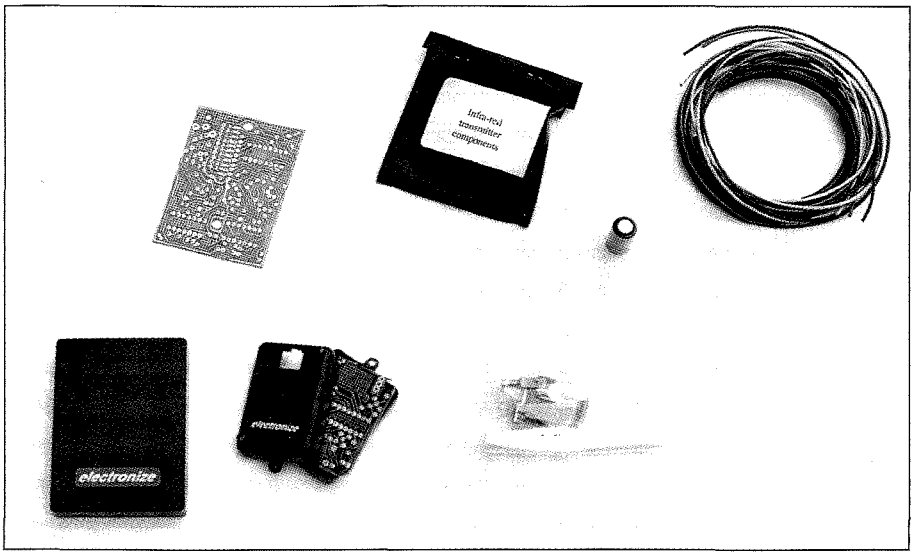
Which alarm is ideal for the car depends on the type of car available. The best thing is to analyse how the sensing system works and make sure that this will work in your particular car. For example, a micro-pressure alarm will not be all that good in an open top sports car, neither will the infra-red detector. On the other hand, cars that don't have courtesy lights won't work with volt-drop systems.

In Control

Having fitted an alarm, there have to be ways of activating and de-activating it. Again, a simple way is possible. This connects into the ignition circuit. When the key is off, there is usually no power in the car's system and the alarm is active. Turning the key, turns on the power and deactivates the alarm. The problem with this system is

that there must be a delay between the alarm being set off and the siren sounding to let the owner open the door, put the keys in the ignition and turn it on. This would give plenty time for a thief to remove something from the car and be running away – the owner then returns to the car to find the alarm sounding and goods gone.

The solution is to be able to activate and deactivate the alarm from outside the car. A small infra-red transmitter which sends a coded pulse to a receiver on the dash of the car which, in turn, signals to the alarm sensor unit to turn off is the normal approach.



The components.

A Real System

The Electronize system looked at here consists of a micro-pressure sensor plus infra-red transmitter and receiver. All three units came in kit form, though they are available ready made, and in this case the only need is to be fitted.

The kits comprise almost everything required to build the items: components, circuit boards, cases and even solder. Unfortunately, one of them had a component missing – it is best to check everything before starting any construction. To complete the construction, all that is needed are a soldering iron, some small wire clippers and a small cross head screwdriver.

The Instructions

The instruction leaflets are adequate for the construction but a little thin on installation advice. All of the components are listed along with details on how to recognise them – including the resistor colour codes – so beginners should have no trouble. There are step by step instructions on how to solder and the order in which the board should be put together. Altogether, the construction was very straightforward, all component positions are on the board and a picture of the assembled board is supplied to show where everything should go.

Fitting

Building the three items takes about four hours in total, with time off for cups of tea and diagram scrutiny. The next step is to fit them to the car. In the case of the micro-pressure sensor, the instructions try to cover every eventuality and all possible car wiring systems. It helps to have some sort of meter or voltage trace – a 12V bulb attached to a crocodile clip at one and and a sharp probe at the other perhaps. Most cars hide their ignition switch systems well out of harm's way and dissecting parts of the steering column or dashboard can take a bit of thought – it is not always easy to see how they were put together in the first place. Tracing out the correct wires is easy if a workshop manual is handy, otherwise it is a matter or tracing incoming and outgoing voltages to the switch. The instructions don't really cover this in a lot of detail but most amateur electronic engineers should have little trouble.

Once wired in and tested, the sensor can be attached firmly to the car and the infra-red remote control set up. The in-car unit attaches to the top of the dashboard in plain view of the outside world. The transmitter attaches to a key ring and, although not extremely small, is rounded in shape so it shouldn't wear out too many pocket linings.

Before completely assembling the remote control, the code number must be set up. This is the same in both the transmitter and receiver. All that is required is to make or leave open a set of links on the printed circuit board. There are 59,046 possible combinations so the chances of anyone else having the same code are fairly remote. An advantage of Electronize's marketing system is that extra key-fob transmitters can be purchased and set to the same code if more than one person needs to use the car.

In Use

Most of the time, the alarm seemed to work – the car hasn't been broken into recently – although a little adjustment was needed to get it to react well to the door opening.

The system was used to activate the horn which was loud enough to deter anybody. For those who want to personalise things a little, or who have quiet horns, a siren might be a useful alternative. These can be a little more distinctive making it easier to distinguish at a distance which car has had its alarm triggered.

In the end, whether to go for a ready made system or do-it-yourself comes down to the difference in price and whether you want to get your hands dirty. In either case, it has to be fitted to the car so some sort of electronic fiddling will be necessary. ■

Specifications

IR transmitter

Kit	Assembled
£13.95	£17.95

IR receiver

£21.35	£26.55

Micro-pressure trigger £10.95
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Available from Electronize Design
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Sutton Coldfield, B74 4DQ
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How It Works... The Answerphone

The number of telephone answering machines in use is growing daily. Richard Topping describes the basic operation of this ubiquitous device.

One of the biggest areas of growth in the telecommunications market after the privatisation of British Telecom has probably been in the area of answerphones.

The capabilities of telephone answering machines varies quite a lot. Usually, the more expensive machines have better facilities and "you pays yer money and takes yer choice". The machine shown in the drawing opposite offers functions found on most machines and is a good general example.

Operation

When the phone rings, the answering machine allows three or four rings to pass by before picking up the line. This allows the user to answer the phone if they are nearby. If no-one picks up the receiver then the machine plays its outgoing message. In cases, this is recorded by the user and resides at the beginning of the incoming message tape. An alternative it to use a voice synthesiser to generate a message – in the example machine, this can be one of four messages that can include the telephone number of the answering machine is on and a divert telephone number.

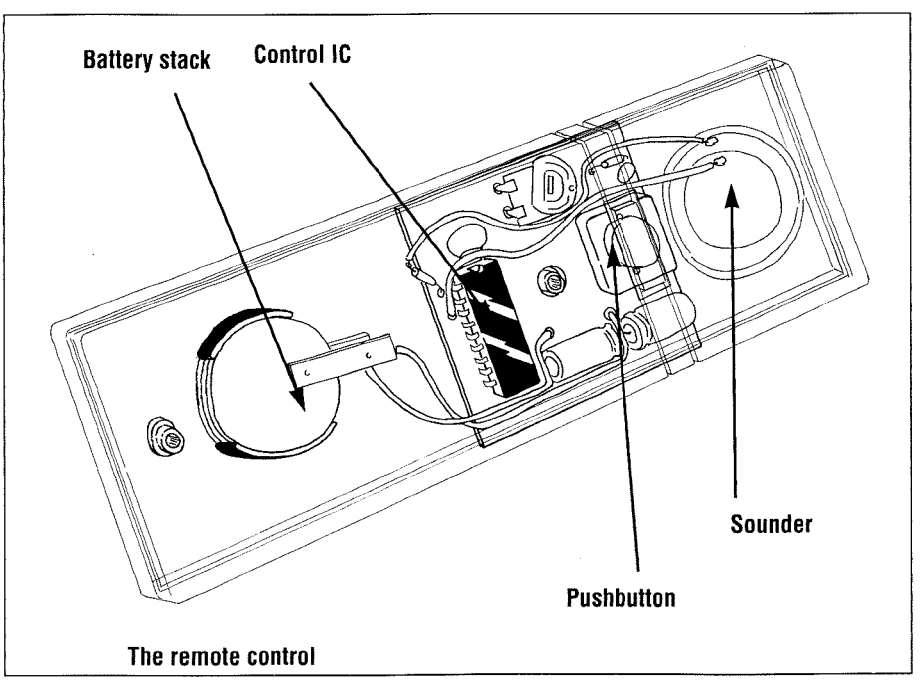
After the message has gone out to the caller, a number of beeps are transmitted that tell the caller when to start speaking. After the message has been recorded, the answer machines increments its incoming call counter and displays the number on a readout. Most systems limit the length of a message so that the tape does not become full too quickly. In more sophisticated machines, this can be set to a predetermined period, in a basic model, messages can be of any length up to the end of the tape – great for people who like to talk to answerphones.

After a number of calls have been recorded, playing them back is simply a matter of pressing one button. In some machines, the synthesised voice is used in conjunction with a built in clock to record the time each message arrived. Other machines just play the messages to the end of the tape and beep a couple of times. At this point the user presses the replay button again and the tape is rewound and the message counter set to zero.

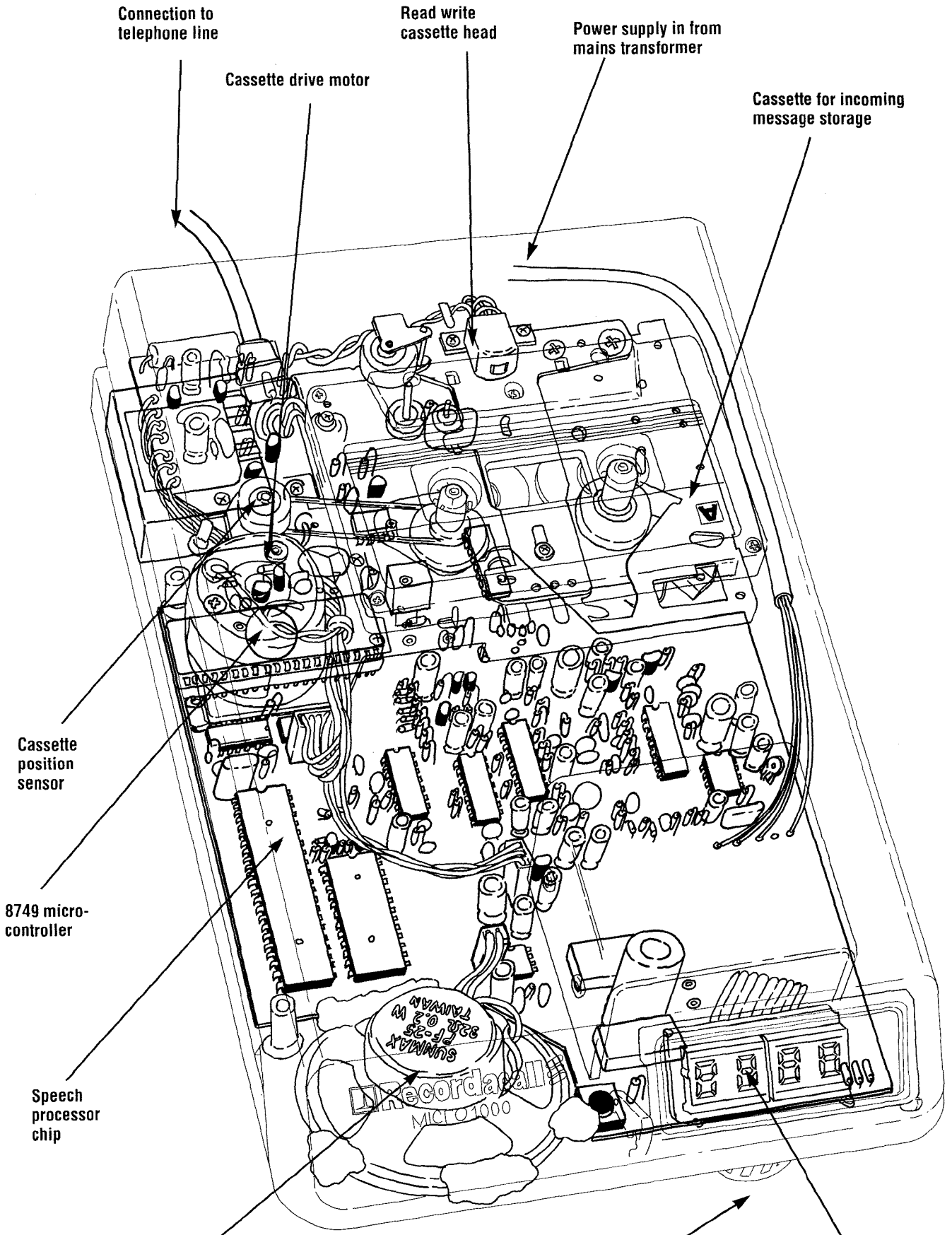
A remote control facility allows the user to play back any recorded messages from a remote location. By ringing up the answerphone and using a touch-tone handset to play a code number to the machine, a number of commands can be executed. These range from simply playing back the calls to selecting individual calls and recording new outgoing messages.

The Future

Telephone answering machines are becoming more and more sophisticated and the latest are completely solid state. A digital sampling system records the outgoing and incoming messages into a RAM (RAndom Access Memory) or to a computer disk. Callers who have touch-tome phones can ask for diversion numbers or pass messages along. As soon as computers are able to understand general speech reliably, answering machines should become intelligent enough to answer questions an take specific messages for particular people. ■



The remote control



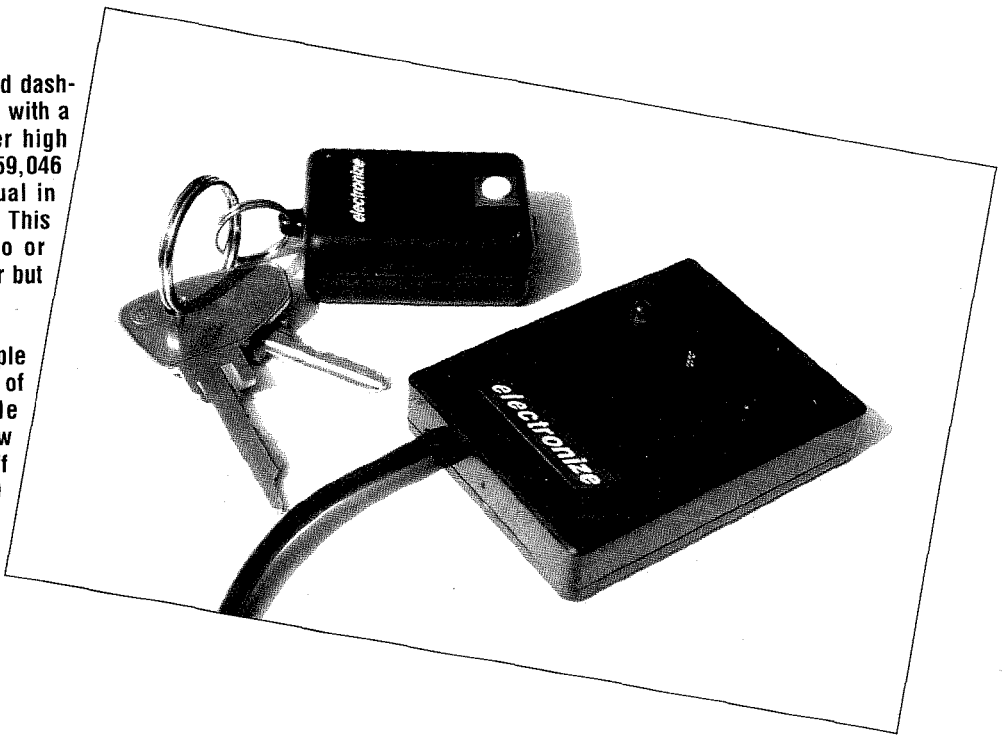
Artwork by Derek Gooding

Competition

Win A Car Burglar Alarm

The Electronize keyring transmitter and dash-top receiver when used in conjunction with a micro-pressure sensitive alarm offer high security for your car. With a range of 59,046 possible codes, the system is unusual in that the user can set the code used. This had obvious advantages where two or more people want to use the same car but don't always want to swap keyrings.

The transmitter uses high power multiple pulse infra-red system to give a range of up to five metres. The low profile receiver is designed to sit in full view on top of the dash board. To warn off intruders, a high intensity red LED flashes continuously when the system is armed and a green LED flashes once the correct code switches off the alarm.



To win a Micro-pressure alarm plus infra-red transmitter and dash-top receiver simply answer the following questions:

1 The frequency of infra-red radiation ranges from approximately:
a 10^{12}Hz to 10^{14}Hz b 10^{6}Hz to 1010^{8}Hz c 10^{20}Hz to 10^{24}Hz

2 The maximum speed for cars not on the motorway in the UK is:
a 50mph b 60mph c 70mph

3 Most modern cars connect which side of the battery to earth:
a positive b negative c neutral

✂.....

Please tick the appropriate boxes:

1	a	❑	2	a	❑	3	a	❑
	b	❑		c	❑		c	❑
	c	❑		c	❑		c	❑

Fill in your name and address
Name .....
Address.....
Town .....
County .....
Post Code .....
I subscribe to PE❑
Send your entry to:
PE Alarm Competition, Intra Press, Intra House, 193 Uxbridge Road, London W12 9RA
The competition ends on 1 Feb 1992. The first five entries pulled out of the hat will receive prizes. The judge's decision is final and no correspondence will be entered into.

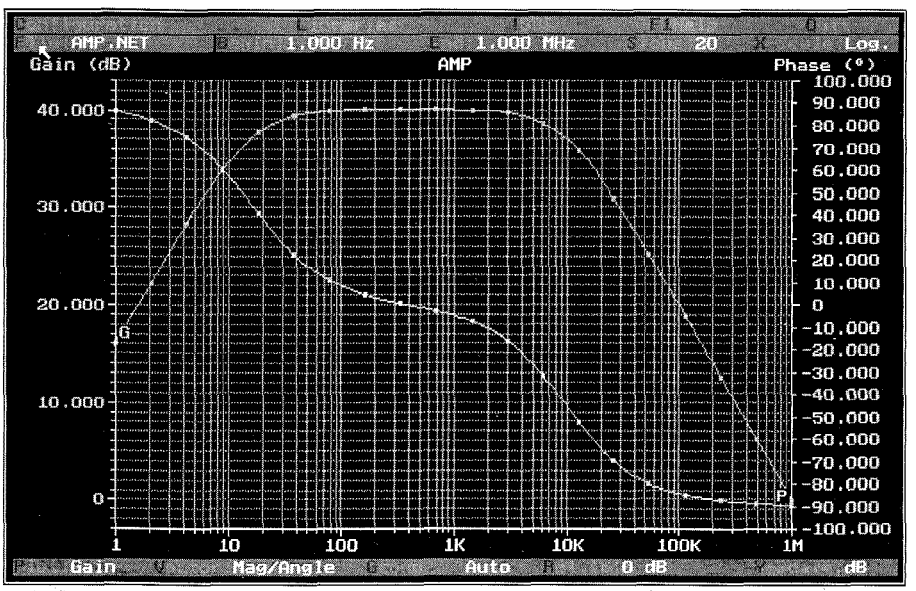
Looking At It Linearly

Alan Smith loads up Number One Systems' new linear circuit analysis program and finds a new way of designing circuits.

Number One Systems, famous for its PCB and digital circuit CAD systems has extended its range to include a sophisticated analogue circuit simulator, Analyser 3, an upgrade of its existing Analyser 1 and 2 systems.

All electronic circuits can be treated as black boxes with input and output connections. Some form of signal is fed into the system which performs an operation producing an output signal. For digital circuits, this is more or less all there is to it. However, analogue circuits have other characteristics such as input and output impedance and phase change as well as the change in gain with amplitude.

Supplied on a 3.5in or 5.25in disk, installing Analyser 3 could have been made easier. Although it is acceptable to assume some knowledge of the operation of a PC from someone who is going to analyse a circuit, it isn't difficult to write an install program or batch file. As it stands, the user has to create a directory on the hard disk and copy all of the necessary files across before getting started.

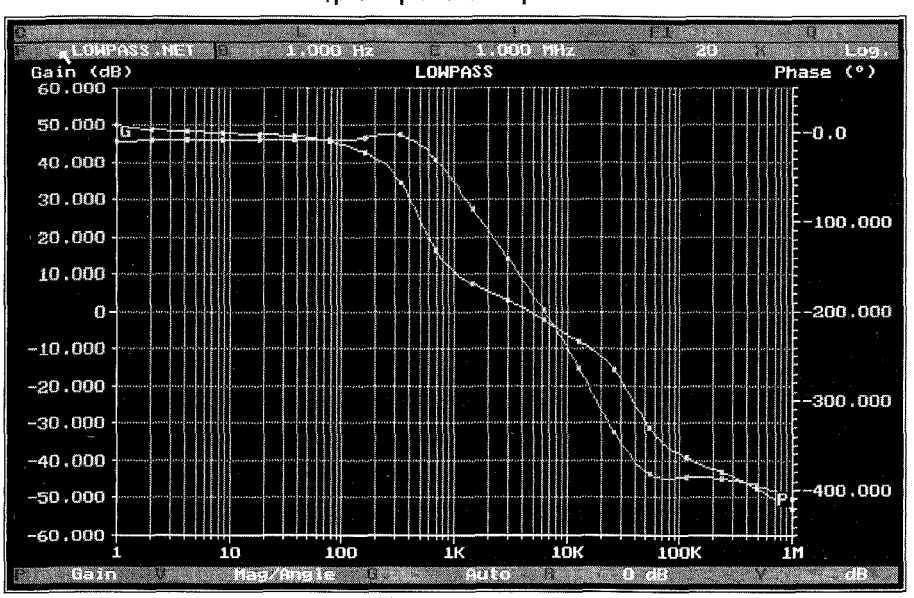


gain/phase plot of an amplifier network.

On starting the system up, the user is presented with a blank graph and a selection of menus. The system runs under a Graphical User Interface (GUI) – windows and mouse pointer – but could do with a little tweaking to make it a bit more intuitive. As it stands, the manual is needed to figure out what menu does what and what to do next.

All circuits are held in a network list format which defines the components as modules. Each has an input and an output and can be linked up with other components to form circuits. Setting this up is rather an involved affair and the circuit must be drawn up and labelled before it can be entered. The user interface is purely text based and it would have been nice to be able to design circuits with a graphical CAD system. However, the netlist file format is given so it should be possible to interface it to CAD systems such as Easy PC.

Gain/phase plot of a lowpass filter.



Built in primitives

Resistance with parasitic capacitance
Pure resistor
Capacitor
Inductor
Bipolar transistor
Field effect transistor
Operational amplifier
Transformer
Tapped transformer
Transmission line
Strip line (Micro Strip)

Device library

ZTX239, ZTX313, ZTX450, BF240, 2N918, 2N5179 bipolar transistors
BF245A, BF256A FETs
LF351, LF356, LF357, LM202, LM741, LM748, TL080 op-amps

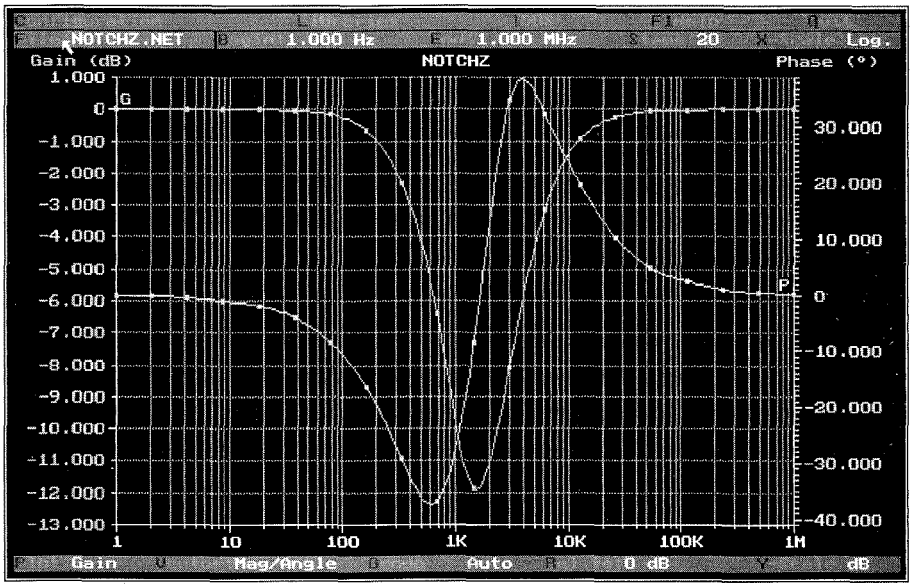
Once deigned, components and modules can be added to libraries and combined to make more complex modules.

There are four basic plots that can be made for a circuit, gain, input and output impedences and group delay. All of these are plotted against the frequency of the input signal which can range from 0.001 to 999GHz. An analysis consists of testing the circuit at a range of frequencies in a specified number of steps. It can be viewed in graphical form or as a table of results, either of which can be printed out. Some example displays are shown in the Figs. On the machine used for the test, an admittedly fast 386 PC running at 33MHz, the analyses ran very quickly. On a 286 they might take a little longer

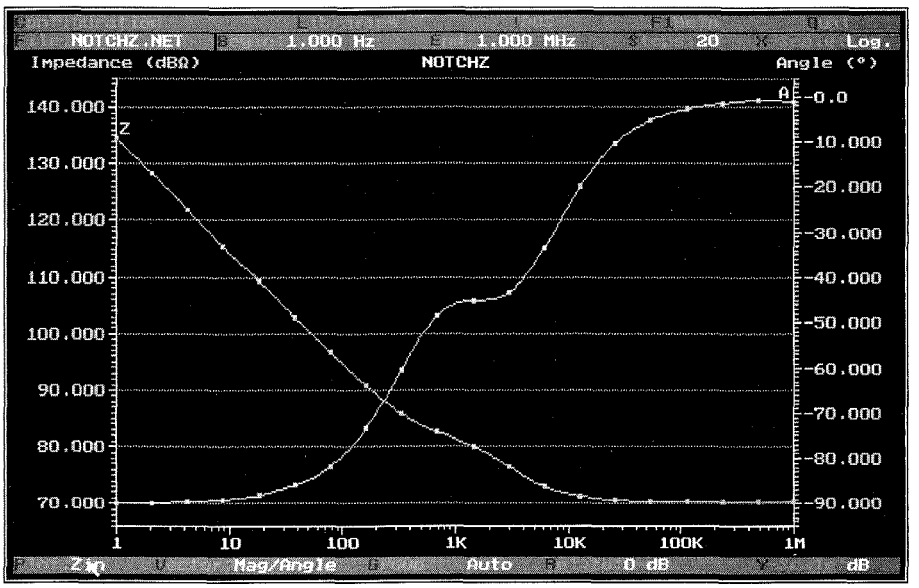
The manual takes the user through the operation of the system in the form of a "Grand Tour", introducing each new section in turn. The drawback with this method is that new users can't play around with the system and look up the relevant bits in the manual when necessary. More of a reference would have been nice.

Analyser 3 provides a relatively easy to use way of analysing circuits before committing solder to copper. It could be used by beginners to understand how to analogue circuits work although extra tuition in the form of a circuit analysis book would also be necessary.

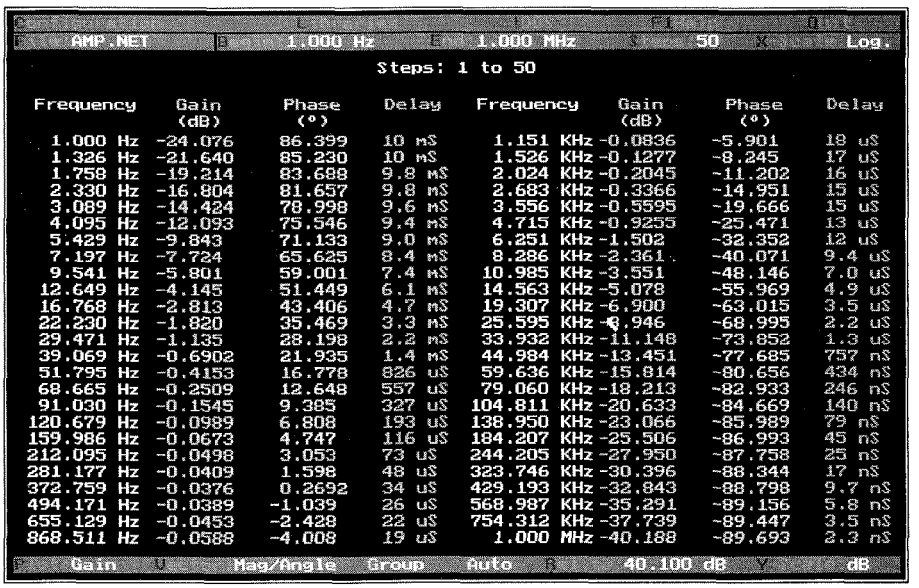
At £195 plus VAT, it is probably a good buy for anyone interested in designing or analysing complex analogue circuitry. ■



Gain/phase plot of notch filter.



Input impedance for notch filter.



Frequency	Gain (dB)	Phase (°)	Delay	Frequency	Gain (dB)	Phase (°)	Delay
1.000 Hz	-24.076	86.399	10 mS	1.151 KHz	-0.0836	-5.901	18 uS
1.326 Hz	-21.640	85.230	10 mS	1.526 KHz	-0.1277	-8.245	17 uS
1.758 Hz	-19.214	83.688	9.8 mS	2.024 KHz	-0.2045	-11.202	16 uS
2.330 Hz	-16.804	81.657	9.8 mS	2.683 KHz	-0.3366	-14.951	15 uS
3.089 Hz	-14.424	78.998	9.6 mS	3.556 KHz	-0.5595	-19.666	15 uS
4.095 Hz	-12.093	75.546	9.4 mS	4.715 KHz	-0.9255	-25.471	13 uS
5.429 Hz	-9.843	71.133	9.0 mS	6.251 KHz	-1.502	-32.352	12 uS
7.197 Hz	-7.724	65.625	8.4 mS	8.286 KHz	-2.361	-40.071	9.4 uS
9.541 Hz	-5.801	59.001	7.4 mS	10.985 KHz	-3.551	-48.146	7.0 uS
12.649 Hz	-4.145	51.449	6.1 mS	14.563 KHz	-5.078	-55.969	4.9 uS
16.768 Hz	-2.813	43.406	4.7 mS	19.307 KHz	-6.900	-63.015	3.5 uS
22.230 Hz	-1.820	35.469	3.3 mS	25.595 KHz	-9.946	-68.995	2.2 uS
29.471 Hz	-1.135	28.198	2.2 mS	33.932 KHz	-11.148	-73.852	1.3 uS
39.069 Hz	-0.6902	21.935	1.4 mS	44.984 KHz	-13.451	-77.685	757 nS
51.795 Hz	-0.4153	16.778	826 uS	59.636 KHz	-15.814	-80.656	434 nS
68.665 Hz	-0.2509	12.648	557 uS	79.060 KHz	-18.213	-82.933	246 nS
91.030 Hz	-0.1545	9.385	327 uS	104.811 KHz	-20.633	-84.669	140 nS
120.679 Hz	-0.0989	6.808	193 uS	138.950 KHz	-23.066	-85.989	79 nS
159.986 Hz	-0.0673	4.747	116 uS	184.207 KHz	-25.506	-86.993	45 nS
212.095 Hz	-0.0498	3.053	73 uS	244.205 KHz	-27.950	-87.758	25 nS
281.177 Hz	-0.0409	1.598	48 uS	323.746 KHz	-30.396	-88.344	17 nS
372.759 Hz	-0.0376	0.2692	34 uS	429.193 KHz	-32.843	-88.798	9.7 nS
494.171 Hz	-0.0389	-1.039	26 uS	568.987 KHz	-35.291	-89.156	5.8 nS
655.129 Hz	-0.0453	-2.428	22 uS	754.312 KHz	-37.739	-89.447	3.5 nS
868.511 Hz	-0.0588	-4.008	19 uS	1.000 MHz	-40.188	-89.693	2.3 nS

Gain/phase table for notch filter.

Van Gogh Meets The Video Recorder

Easy computer graphics for the masses? Laura Esterman connects up the Vtech Video Painter to her VCR and finds out.

Designed for the creative couch potato, this product consists of a graphics tablet which hooks up to a video tape player and allows the user to draw pictures onto his or her television screen. With Video Painter you can draw lines and shapes, colour them in, paste ready-made graphics and do limited animation.

Main Features

There are twelve colours to work with and you can draw over one of the pre-set backdrops or create your own. Using a pen-shaped stylus, you select one of the drawing tools, which are divided into eight different options: drawing, fills, erasing, expand/magnify, copy, move, pre-drawn graphics and animation. Many of these options are subdivided to include choice of line thickness, fill pattern, lettering text and a zoom feature. Most of the commands reacted in the same way as those on a computer graphics package, however I was frustrated by the undo feature; this erased not only the last command, but every one in the option last selected. The animation, too, is restricted to simple pre-set movements of the graphics provided.

Hooking Up

Connecting the unit to my video recorder was slightly difficult. It isn't that it's complicated – you merely have to plug the lead into your VCR's "video in" socket – it's just that with the variety of connectors made by different video manufacturers, you may need to obtain an adaptor to fit your particular model.

Vtech's Video Painter, computer graphics for all.

Video Artistry

The system reacts best to manipulations of the pre-set designs, as drawing freehand is often compromised by the poor resolution on the drawing tablet. Unfortunately, there is no way to import images into the system; imagine the possibilities of being able to personalise a video tape on your screen..The system also comes equipped with a game, but this is so simple I quickly moved onto the main object of creating pictures. It is possible to save your creations by recording them on your VCR, however there is no way, obviously, to print them out. I also found some of the colours showed up better on the screen than others did, and the cursor seemed to jump a bit when I had finished drawing a line or took the stylus off the drawing pad. The entire picture jumped and went erratic when the colour white was selected – I'm not sure if this was my VCR or the Video Painter, but if the fault was on my system, it reacted skittishly with it. Still, despite the drawbacks, it was fun to let loose my artistic tendencies and interact with the television screen rather than just stare at it. ■

Specs Box

Vtech Video Painter

Price £79.99

Available from all good toy shops around the UK.

Vtech stockists can place orders directly with the company.

Contact Vtech on 0235 555545

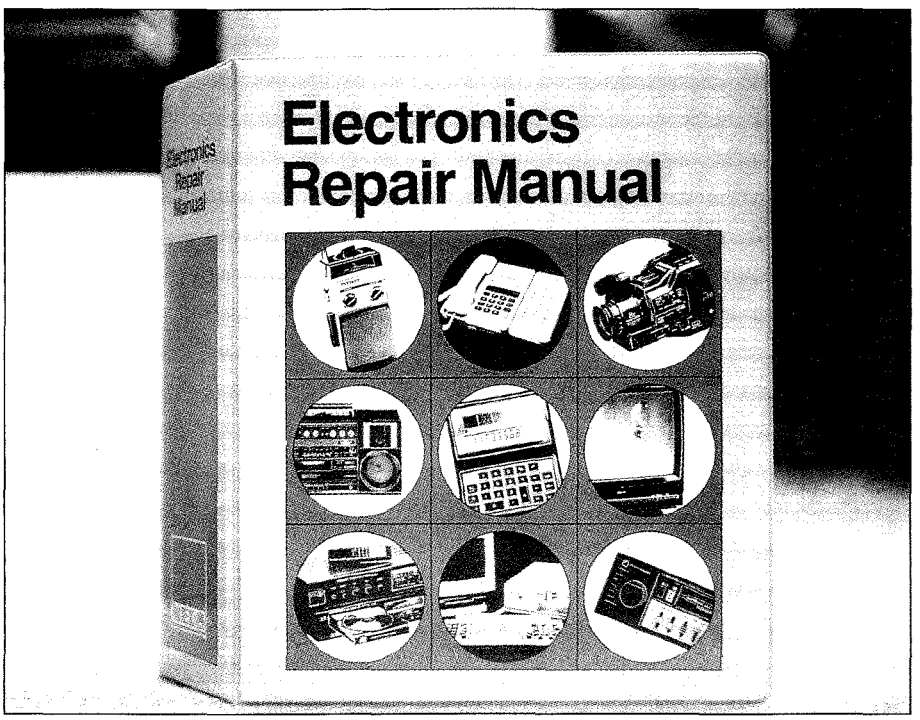
How To Repair Electronic Equipment

Bruce Godstone opens the pages of the Electronics Repair Manual to find a huge amount of information on a wide range of subjects.

Most pieces of electronic equipment have labels on the bottom that say "no user serviceable parts inside". In reality, this is rarely true and most things can be repaired with a little knowledge and the right approach. The Weka Electronics Repair Manual attempts to provide the information and experience for the would-be repair technician enabling them to tackle just about anything. Some knowledge of electronics is assumed so beginners will need to learn some of the basics before they can get started.

The manual itself is a huge tome that consists of 13 chapters covering a variety of topics all printed in a large friendly type face. It is aimed mainly at the amateur, although a number of comments from the authors do give the impression that a professional repair workshop could be set up using the manual as a basis. Unfortunately, life is rarely this simple and a good grounding in electronics is essential as well.

After the contents and index, the first part of the book consists of a sort of "all you wanted to know about electronics and never dared ask". Following a short introduction and a brief section on safety and first aid for electric shock, a wide selection of abbreviations, symbols and quantities are covered. The next section looks at electronic components, in detail. Because these are the main cause of trouble in electronic equipment, this section has been made quite exhaustive. A large amount of information is given on manufacturers specifications and codings – useful for identifying a replacement of a broken part.



After looking at what tools will be needed, the manual gets onto the nitty-gritty of fault finding techniques. Oddly this is a relatively short chapter – this could be because there really isn't all that much to say on the subject. Finding a fault is a matter of the correct approach. The first thing is to understand what the equipment should do, then find out what it doesn't do anymore and what happened to make it faulty. The next step is a matter of tracking the fault down.

The final eight chapters examine specific items of equipment and cover them in varying amounts of detail. There is a lot of stuff about HiFi amps, radio receivers and home computers, but rather less on video recorders, compact disc players and camcorders. What makes this section of the manual interesting is not that it helps much with repairing equipment directly, but that it gives a good description of how the equipment and its subsystems operate (or would if they didn't need repairing).

One of the main selling points of the manual is that regular updates on equipment and technology are supplied. This should mean that the rather thin sections on the more modern equipment will fill up as more data and experience becomes available. In the end, this is what should make the manual a valuable reference tool. ■

Electronics Repair Manual
WEKA Publishing
Freepost
The Forum
74/80 Campden Street
London NW1 1YW
Tel. 071 388 8400
Price £44.95+£5.50 p&p

Practical Technology... PC Graphics Cards

High quality graphics are a must for the latest IBM PC compatible computers. Eric Dunstan examines the current standard, VGA and its successor, SVGA.

One of the oddities about modern computers, especially IBM PC compatibles, is that they are sold without monitors. Some dealers may offer one type of display, others may offer something else entirely. The main point of all this is that a basic PC, whether XT or AT or even 386, is an expandable system and the monitor is an add-on.

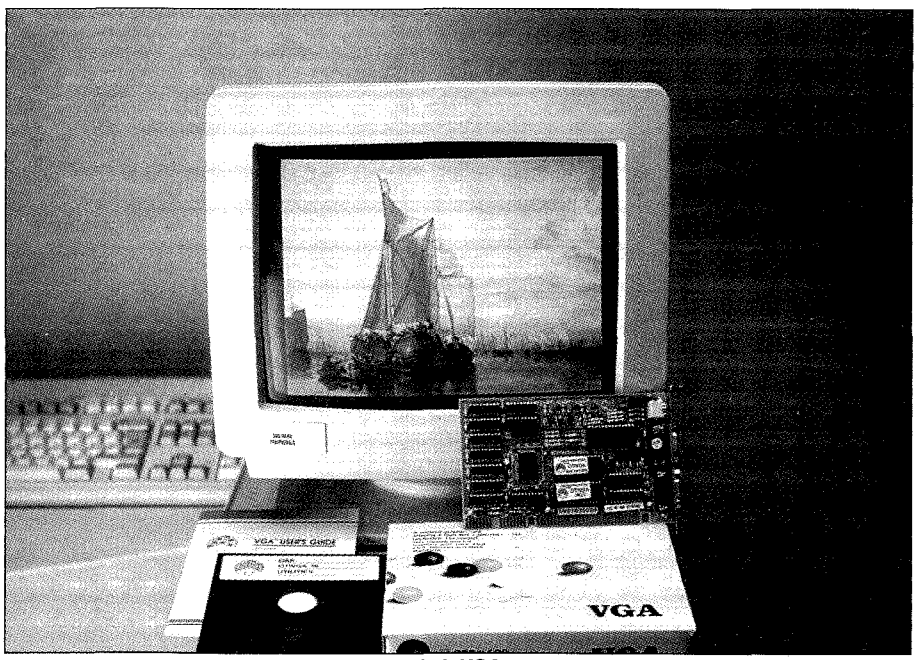
Slotting In

In the back of the PC are a number of expansion slots – usually six. One of these is set aside for the printer port, another for the serial port and one perhaps for a hard disk. One of the spare ones must also be set aside for the monitor or display card. These come in a wide variety of types and capabilities from the simple MDA or monochrome display adaptor, to the SVGA, or super video graphics array.

Many machines come with Hercules boards fitted, as this is a cheap system that allows monochrome text and graphics to be displayed on a relatively low cost and low quality monitor.

Unfortunately, most of the latest software uses high resolution graphics and colour that requires at least a VGA card. This means that most cheap PCs bought over the past few years will have to be upgraded with a new card and monitor – with some software, the old card and monitor can be used at the same time as the new one; some CAD packages allow text to be displayed on the older display adaptor.

Upgrading is not all that difficult as IBM style systems are made to have cards added. It is simply matter of opening the machine, slotting in the card, closing up and switching on. The operating system and software take care of any details and the change in quality is dramatic.



Oak VGA

What is VGA

The basic VGA card supports medium resolution graphics at resolutions up to 800x600 pixels. Unfortunately, it can only display 16 colours at once in this mode and to get 256, a lower resolution of 320x200 pixels must be used. The hardware that achieves this is not particularly complicated and most modern designs have virtually all of their functions integrated onto a single chip. The main external component is the memory required to hold the graphics data. Unlike the display systems used on machines like the Commodore Amiga, Atari ST and Acorn Archimedes, the video memory is not strictly part of the main computer memory. Instead it is supplied separately on the video card.

Three types of video monitors can be driven from VGA, analogue, digital and monochrome. The first allows virtually any colour to be displayed by placing the correct mix of voltages on its red, green and blue input lines. Since the voltages on the lines can be continuously various between 0 and 1V and infinite number of colours can be displayed. In practice, this is limited by the graphics card resolution. The video data held in the graphics card memory is pushed through a DAC (Digital to Analogue Convertor) to drive the colour lines. The number

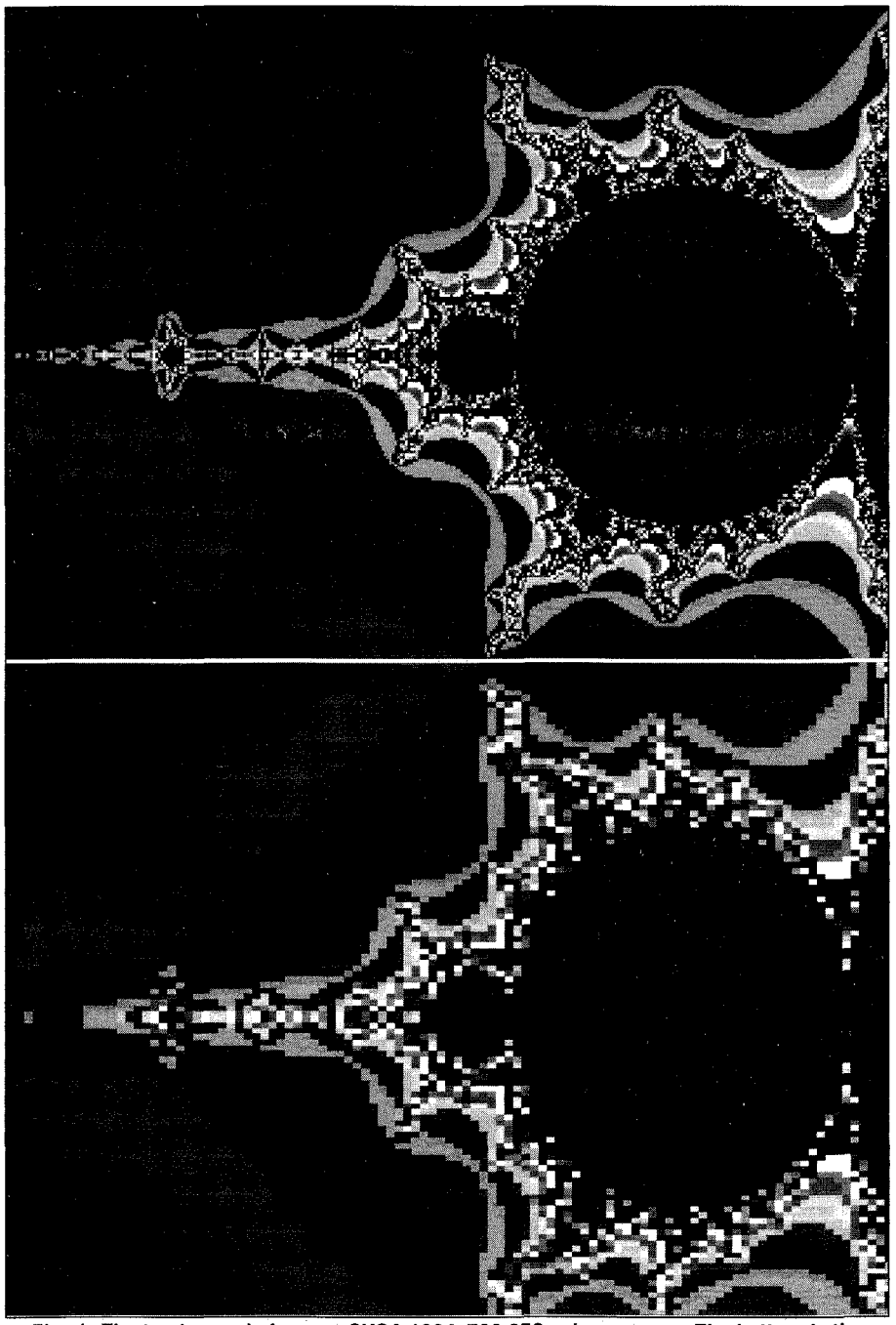


Fig. 1. The top image is from an SVGA 1024x768 256 colour screen. The bottom is the 320x200 by 256 colours of VGA.

of possible colours displayed is determined by the number of bits the DAC can convert – 4-bits gives 16 colours and 8-bits 256 colours.

A digital monitor also has red, green and blue inputs but each has only two states, on or off. Used on their own this would allow only eight colours to be displayed. However, associated with each is an intensity control so the number of colours is squared to 64. The limitation on colours is imposed by the monitor and not the display card.

Monochrome systems are usually digital in form and have two input pins, one for the video information and one for intensity. The first defines whether a particular should be on or off and the second, the brightness of the pixel. This sort of system greatly limits the output of a VGA card and would not normally be used. An alternative form of monochrome is the grey scales possible with a single colour analogue monitor. In this situation, the red, green and blue outputs of the card are combined to form a single intensity signal which allows a number of shades of grey to be viewed.

The final point to be made about the monitor is the synchronisation. This normally comes in the form of a horizontal pulse that tells the monitor when to start a new line of the image, and the vertical pulse, which starts a new scan – the image is a raster scan composed of horizontal lines scanned from left to right and stacked vertically. The frequency of the synchronisation signals has two main effects. The higher this is, the better the resolution of the image since more dots or pixels can be shown. Also, increasing the refresh rate of the screen reduces the amount of flicker seen by the eye, making it much easier to work with.

All of the above comments apply mainly to VGA. However, a new standard that has more or less taken over in the past year or so is super VGA (SVGA) or enhanced VGA (EVGA). This increases the maximum screen resolution to 1023x768 and the number of colours displayed at the same time to 256 – the difference in quality can be seen in Fig. 1. A number of configurations are possible with different amounts of on-card memory. At 256k the system performs in much the same way as a standard VGA. Moving up to 512k increases the screen resolution to 1024x768 but only 16 colours. At 1M the full 1024x768 pixel resolution with 256 colours is possible.

The Next Step

There are a number of systems that are better than SVGA. Some workstations offer 2034x1024 pixels and even 1280x1024. However, these are quite a bit more expensive and require fast memory and sophisticated monitors. They are mainly used for computer aided design where good screen resolution is a requirement. ■

Specs Box

The video cards used in this feature were supplied by Southern Peripherals.

For more information contact
Southern Peripherals
17 c London Street
Basingstoke
Hampshire
RG21 1NT
Tel. 0256 819221

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

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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. £6.00 ref 6P18R

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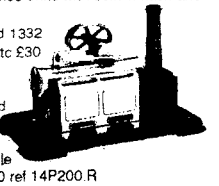

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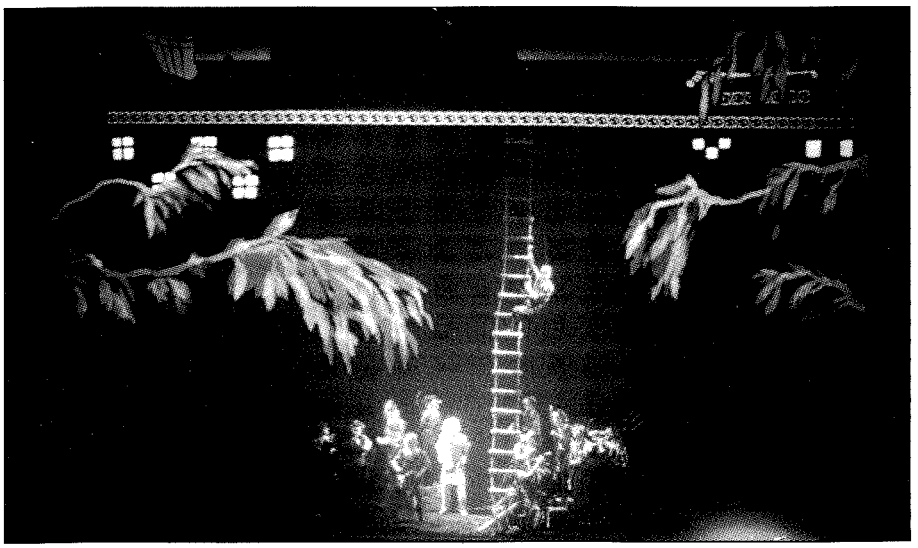
PE Goes To The Theatre

The Hunting Of The Snark is a multimedia extravaganza. To see if all that technology spells good entertainment we sent Fiona Gammie to see it.



It is not every day you are invited to the "ultimate high-tech multi-media fantasy adventure" and I thought I had better go along and find out what it was all about. *The Hunting of the Snark* is the brainchild of Mike "Remember you're a Womble" Batt and is no ordinary West End musical.

A vast array of 144 projectors (no I didn't count) create wonderful moving images from seagulls and waves to flowers that grow so incredibly high. They are controlled by six computers and this means quite complex animation sequences can be run from the roof to the stalls throughout the performance.

As the credits rolled, I was not sure if I had gone into the Odeon down the road but then the front row of the orchestra started dancing and I guessed I was in the right place.

The story line is a touch tenuous. A motley crew take to the high seas in search of a snark, a weird creature that found fame in Lewis Carroll's nonsense poems. The action takes place on various moving levels against a backdrop created by the high tech animation.

When it comes down to it, you can use technology to create the slickest production in town, but does it make a good show? Perhaps a psychedelic experience would be more apt. Nevertheless I was sufficiently inspired to dust off my lacrosse stick this weekend and go snark hunting...

Fiona Gammie

The Hunting Of The Snark is on at the Prince Edward Theatre, Old Compton Street, London W1. Call 071 836 3464 for booking details.

Back To The Books

Diode, Transistor and FET circuits Manual
R M Marston
Price £12.95
Publisher Newnes
ISBN 0-7506-0228-7

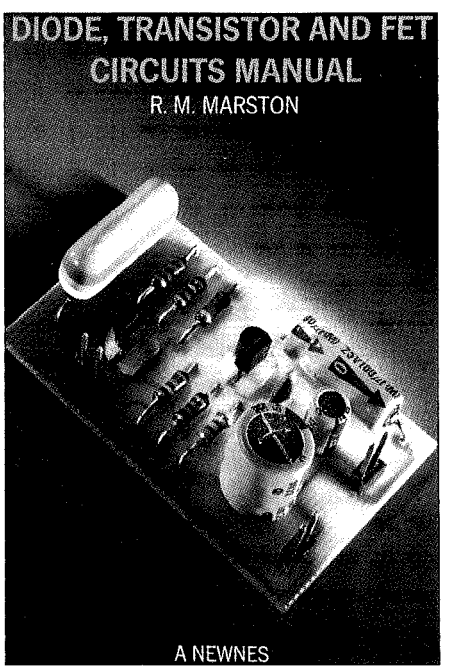
If you want to know anything about circuits that involve diodes, transistors or FETs, you need look no further. Starting off with diode circuits, there are more of these than you might think, it moves on to cover the basic principles of transistors, amplifiers, waveform generators and FETs.

Apart from the more everyday circuits, this collection includes some quite obscure ones such as current mirrors and lie detectors.

The FET section of the book looks more at the construction and characteristics of the various types available than actual circuits. There are a few of these, lamp controllers and touch switches. However, many others are simply versions of the transistor circuits shown previously.

The book is aimed at people who know something about electronics and are able to build a project from the circuit diagram, beginners should start with something simpler first.

Kenn Garroch ■



The Future Of Semiconductors

Atom sized switches, superconducting logic and ultra-fast logic all feature in Ian Poole's analysis of the latest developments in semiconductors.

Super-conducting integrated circuits are set to revolutionise the electronics industry in the next few years. This has been indicated by the fact that Hypress Inc in Elmsford New York have just fabricated a 4-bit shift register which has been tested up to 9.6 GHz and only dissipated 40μWatts. In fact the upper frequency limit was not that of the chip, but the test system, and it is expected that it will operate at frequencies significantly higher than this. Furthermore, computer simulations have indicated that these techniques should be capable of operation up to 25 GHz or more.

The superconducting logic is based on the Josephson Junction. It uses a relatively wide geometry of around 3.0μm in contrast to Gallium Arsenide (GaAs) devices for the same frequency which require 0.5μm. The structure is fabricated using a ten layer thin film deposition process. A Josephson tunnel junction uses a 10Å barrier in a vertically stacked structure.

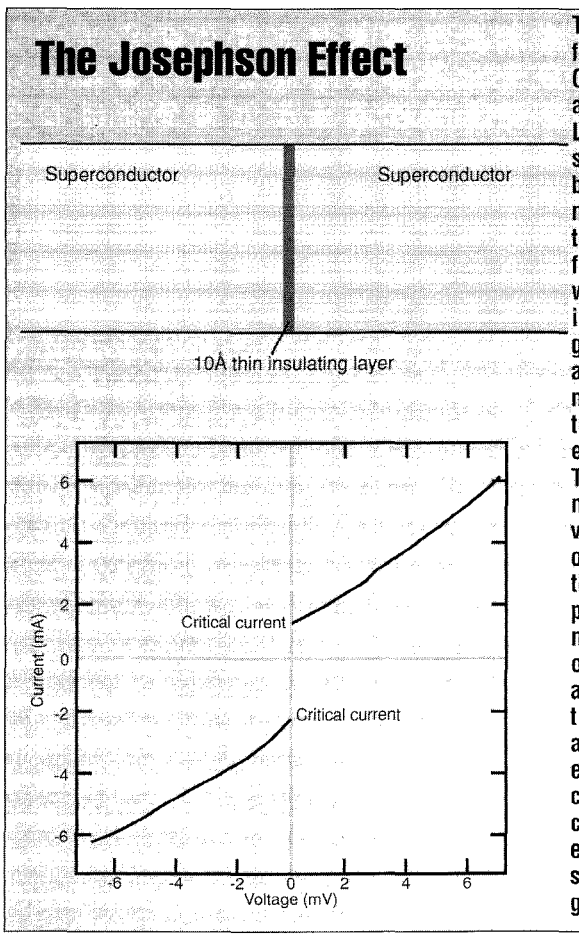
The fabrication process uses a very low temperature of 150°C. This means that it will work with almost any flat substrate. In turn this allows for it to be combined with standard Silicon (Si) and GaAs technologies for interfacing to other circuits.

In view of the difficulties and cost of maintaining the super-conducting temperatures, it is not intended that these ICs would be used as stand alone chips. Instead the idea is that these first chips are used only as proving grounds for much larger systems. Eventually it is hoped that super-conducting logic systems will be combined with a suitable interface so that they can communicate with standard circuitry.

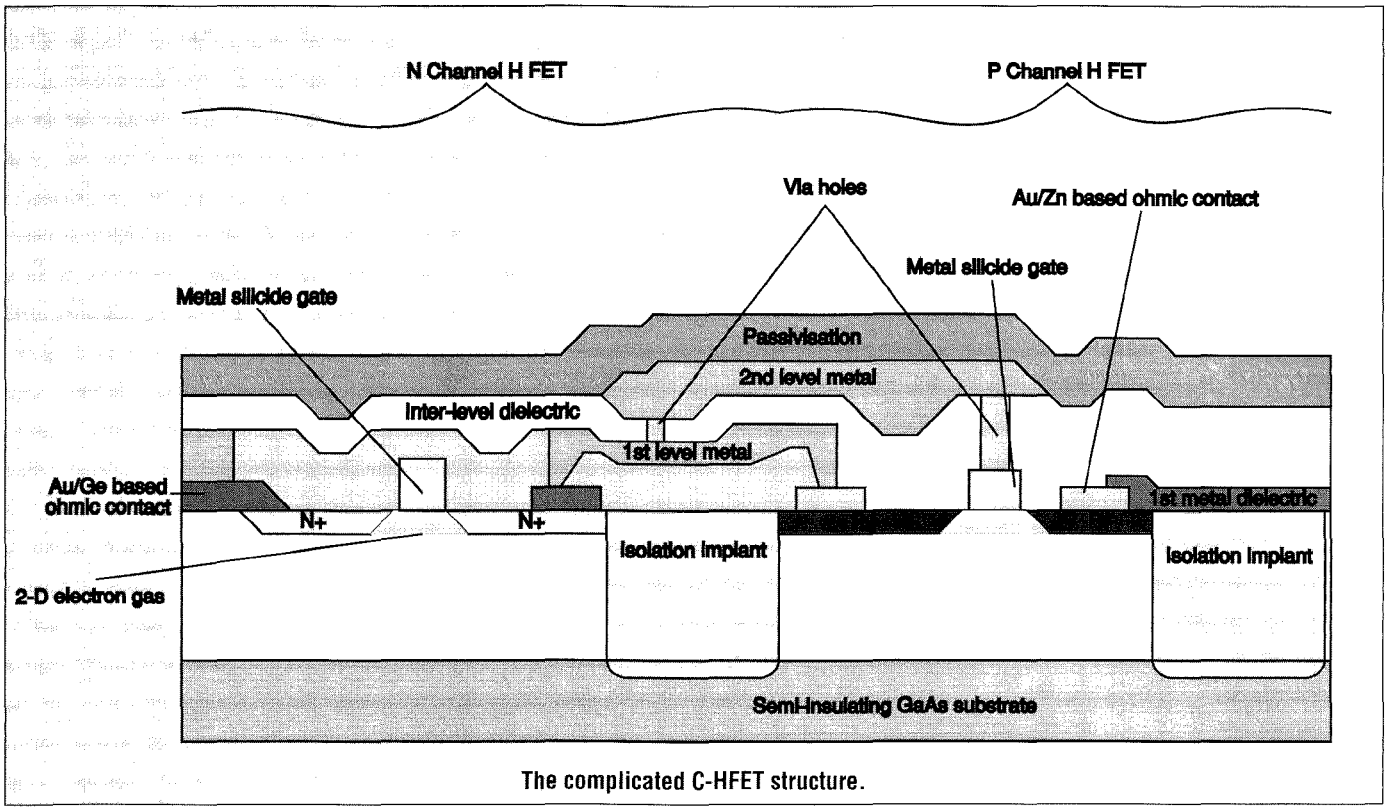
Initially it is hoped that it will be possible to fabricate a number of items including correlators running at 10 GHz for military radar systems. Other ideas include logic which can be included into very high speed processors and ADCs (Analogue to Digital Convertors). These items would find uses in digital signal processors for radio communication, detection and radar systems. With faster chips it will be possible to achieve far more than is currently possible.

Another aim which is further into the future is to build a complete processor. With current estimates a multi-IC unit using 16 superconducting chips would have 1000 times the processing power of a VAX11/780, a sizable mini-computer, and yet the active circuitry would consume less than a watt.

Even though this seems a long way off some high density fabrication has already taken place. Shift registers up to 700 bits long have been fabricated to prove that



The Josephson Effect was forecast by Brian Josephson at Cambridge University in 1962 and verified in 1963 at Bell Labs. When two superconductors are separated by a very thin layer of insulating material – 10Å or so in thickness (top-left) – a current flows from one to the other when the voltage between them is zero. This is shown by the graph (bottom-left). Below or above the critical current, normal single electron tunnelling ensures the currents either side of the zero point. The jump from positive to negative and vice versa as the voltage hits zero is due to pairs of electrons tunnelling through the insulator. The tunnelling is possible because quantum mechanics defines the position of an electron as a probability and for thin insulating layers, this can straddle the layer allowing the electron to be either side. The change in conduction at the critical current allows the Josephson effect to be used as a high speed switch and hence in logic gates.



The complicated C-HFET structure.

the necessary processes can be achieved. However, as yet the chips have not been tested at high speed. When this happens the way will be opened for dramatic improvements in data processing techniques.

High Speed ICs

A breakthrough in low power GaAs ICs has recently been achieved at the Honeywell Research Centre at Minneapolis. This is particularly important because GaAs offers a much higher frequency capability than Silicon. Up until now the problem with this technology has been its high power consumption. In turn this has limited the level of integration which has been possible because of the problem of removing excess heat from the chip. With the introduction of the new low powered ICs the level of integration for gallium arsenide is set to rise, and with it the frequency limits for large scale integration (LSI) chips.

It has long been accepted that complementary circuits like those in CMOS chips are the key to low power consumption. This has spurred the development of a CMOS like structure for gallium arsenide devices. However this is not easy and has led to the use of a new structure called a complementary HFET (C-HFET). Essentially it is based upon a heterojunction field effect transistor which is configured to give the complementary feature required by IC designers.

The first departure from normal is that the chips do not consist of bulk GaAs. Instead they achieve much better performance by using an aluminium GaAs / indium (In) GaAs structure. Like CMOS, this new structure only draws current as the circuit changes state. This means that power consumption is vastly reduced and integration levels can rise.

In addition to achieving its primary aim there have been a number of other advantages. One is that it can be run over a very wide range of temperatures. At one extreme it can operate in liquid nitrogen which makes it ideal for interfacing with superconducting logic. At the other extreme it has been shown to tolerate 200°C which means that it is ideal for using in extremely harsh environments.

To achieve this new structure it has been necessary to use a process known as molecular beam epitaxial deposition (MBE). This enables the creation of very precise areas for the heterostructure on top of a buffer region of bulk gallium arsenide. This introduces very stringent alignment problems in the lithographic stages and to overcome this, a self aligned 1μm metal silicide gate structure is used.

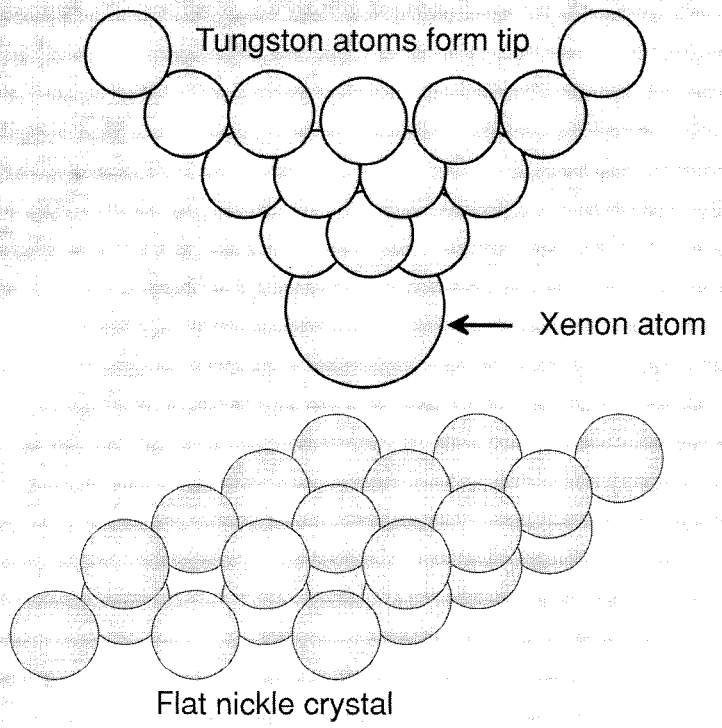
Although the development of this process is still in its early stages of development a 4k bit static RAM has been fabricated. This was shown to have an access time of 4 nS and only dissipated 100 mW – a fifth of that used by a standard GaAs memory of the same size.

Future developments of this structure include reducing the size of the gate to about 0.3μm. This would permit the frequency of operation to be raised even further, as well as the level of integration. However, despite these early hopes a spokesman said that there is still a considerable amount of work to be done before these chips are commercially viable.

Atom Sized Switches

A considerable amount of work is being undertaken around the world to pack more into an IC. To do this chips are being made larger to accommodate more circuitry and in parallel with this work individual components on the chips are being made smaller. Currently, transistor dimensions of around 0.5μm are the smallest which can be made, but it is expected that this will be reduced by about half at the turn of the century, with final reductions to about 0.1μm.

In order to reduce dimensions



Atom sized switch structure.

further than this, radically new approaches are needed. One of these may have actually began with some work which has been started at IBM's Research Centre in California. Here some experiments have shown how the movement of a single atom can produce a switch.

In these experiments a single atom of Xenon was successfully moved between two electrodes spaced apart by a few atom diameters. The effect was monitored by looking at the change in tunnelling current flowing between the two electrodes as the position of the atom changed. As two distinct states were noted this could be equated to the two levels of a digital switch.

Obtaining the effect was not easy. It required a temperature of -269°C and a very specialised tunnelling scanning microscope. One electrode was the tungsten tip of the microscope whilst the other was made from a nickel crystal. In fact the shape of the tungsten tip compared with the flat nickel crystal was critical for the operation of the device.

The switch was operated by applying a short voltage pulse across the electrodes. This caused the Xenon atom to jump across the gap from one electrode to the other causing the tunnelling current to change. This could just be detected.

To return the switch back to its original state the voltage pulse was reversed. Both the Xenon atom and the current returned to their original state.

In view of its revolutionary nature the switch is only in its very early stages of development and it is not clear if it can be made on a commercial basis. One reason for this is that no process currently exists for making the device outside a laboratory experimental set up. Even so, it is expected that this research will have a major impact on future generations of miniaturised devices in the not too distant future. Looking further ahead it may be possible that atomic switches could be made viable enough to become as common as today's logic families. ■

Glossary

4 bit shift register
A logic device that holds bits of information is parallel but can move them sideways under external control.

Josephson Junction
See page 45

GaAs devices
As an alternative to the usual Silicon semiconductor, GaAs or Gallium Arsenide can be used to make integrated circuits that operate at higher speeds. They are also more expensive.

Substrate
The base layer of an integrated circuit (IC) upon which other layers can be placed.

ADCs
Analogue to Digital Convertors are integrated circuits that convert voltage levels into digital numbers.

Bulk gallium arsenide
A large number of ICs can be made on one disc shaped piece of semiconductor, either Si or GaAs. This is then broken up to form the individual chips. Each disc is cut from a long bar of the material which is made in bulk.

Aluminium gallium arsenide / indium gallium arsenide structure
By combining different elements with basic semiconductor materials, they can be made to act in different ways. Indium and Al are added as impurities in a technique known as doping.

Super-conducting logic
By reducing the temperature of the logic ICs, quantum effects such as tunnelling can be used to perform logic functions. The loss of resistance in a superconductor also helps decrease the power required as superconductors have no resistance.

1Å (angstrom) is equal to 10^{-10} m

Automatic Greenhouse Watering System

Owen Bishop's digitally controlled watering system checks the temperature, time of day and soil moisture to make sure your plants are kept in the best possible condition.

Plants consist of about 90% water, so it follows that providing a regular supply is a vital to keep them alive. Unfortunately, the rush of a modern lifestyle means that making sure the plants get the water they deserve is not always possible. The solution is an automatic, electronic watering system which can also provide an extra dose of water if the plants begin to dry out unexpectedly. For those who do not wish to install an elaborate irrigation system, the moisture sensing section of the circuit can be built separately to be used as a simple battery powered indicator for testing the soil in individual pots.

Different people have different ideas about when and how they should water their plants. Different plants have different ideas on when and how they should be watered. This project attempts to cater for all. The system is completely automatic and allows the water to be controlled in a number of ways including overhead sprinklers and mats. It takes its water supply either from tanks or from the mains.

The electronics is designed to operate on small electric water pumps or valves with the mechanics of actually distributing the water being left to the reader's preferences.

Fig. 1. shows the main elements of the system. The monitor relies on three sensors feeding information into a logic unit which decides when to supply water. The logic will never disturb the neighbours by turning on the water at night and it will never risk damage to the pump or valves by trying to turn on the water in frosty conditions.

The light sensor determines whether it is night or day, or rather, when there is a change from one to the other. This provides the information the logic needs if the system has been switched to operate under one of its first three modes:

Mode A: water at dusk.
Mode B: water at dawn.
Mode C: water at dusk and dawn.

Although these will suit most situations, the system also provides two rather more plant orientated modes:

Mode D: water during the day whenever the soil is dry.
Mode E: water during the day whenever the soil is dry, provided that the greenhouse is not too hot.

These modes rely on the soil moisture sensor, the light sensor and the temperature sensor. The sixth mode is intended for plants that require continuously humid conditions and is best for spray nozzles:

Mode F: spray for short periods intermittently throughout the day.

The system as published allows only one mode of operation at any one time but there should be no

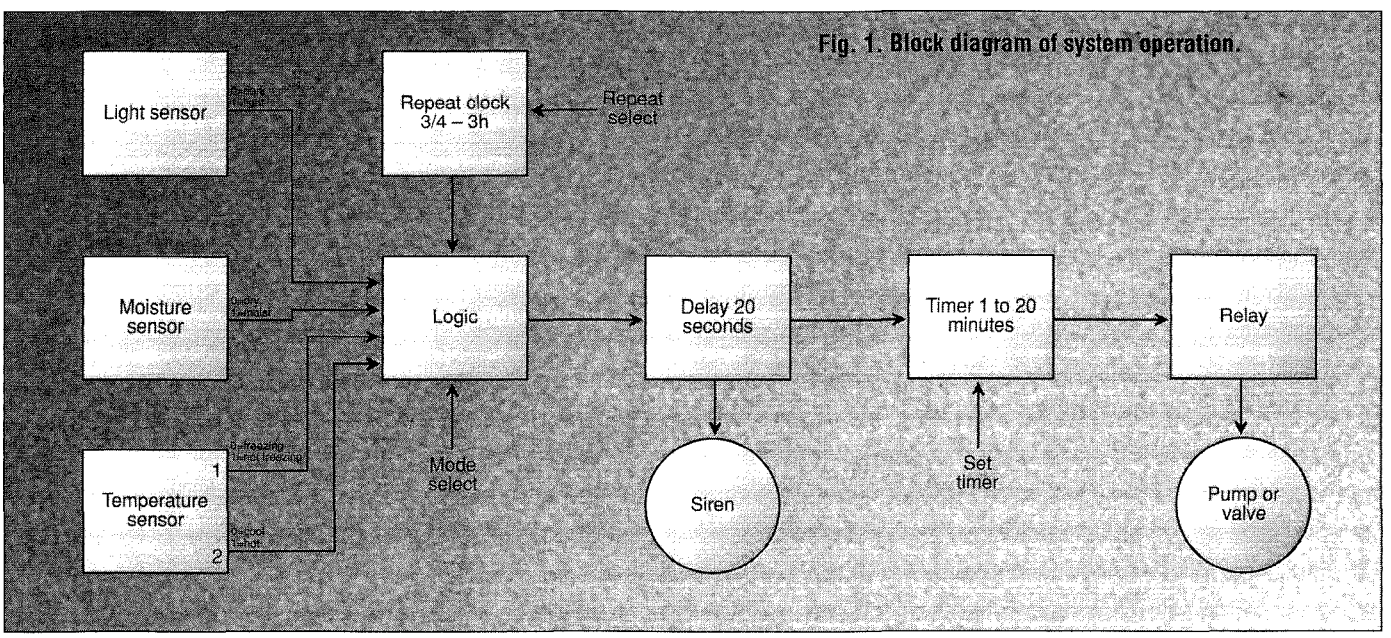


Fig. 1. Block diagram of system operation.

difficulty in expanding it to allow for quite different modes to be used in different parts of the greenhouse. In a multiple system, the basic sensors and logic circuit control two or more sets of delay, timer and relay circuits.

Construction

The circuit is assembled on a single PCB (printed circuit board) as in Figs. 7 and 8. The off-board components are mounted on the lid or panel of the enclosure (Fig. 9). Begin with the sensor systems, testing each one as it is completed. The light-sensing circuit may be tested with R1,VR1 and the yellow LED (D1) temporarily connected. The LED goes on when R1 is shielded from the light and off when it is exposed. Remember the low frequency filtering and allow about 10 seconds for the circuit to respond to changes in intensity.

The moisture sensing circuit is tested by attaching a pair of test leads to the soil probe terminal on the board and to the 0V line. Temporarily connect D3 and VR2 to this circuit. The voltage at IC3 pin 3 is approximately 1.1V when the probe leads are not connected to each other. The output of IC3 is low (0-2V) and the LED is on. Connecting the probe leads, either by touching them together or pushing them into moist soil causes the voltage at pin 3 to rise by an amount varying with the resistance between the probe leads. If the voltage rises above that set by VR2, the output of the IC rises almost to +12V and D3 goes out.

In the temperature sensing circuit, check that the voltage at pins 3 and 5 of IC5a are correct:

V=(Temp+273)/100

Adjust VR3 so that the voltage at its wiper is about 2.87 V. If the room temperature is greater than 5C the output at pin 1 is high. Set the voltage at the wiper of VR4 to correspond with a temperature of about 2C above room temperature. The output at pin 7 of IC5 is low, but goes high if IC4 is placed between a finger and thumb to warm it up.

Install IC10 and check its operation. Adjust VR5 until the voltage at pin 5 rises and falls once every 21 seconds. This gives the required timings at pins 1 to 3.

Check the delay timer IC11 by connecting the buzzer. Temporarily connect pin 6 to +12V using a flying

Circuit Details

The light sensor is a light-dependent resistor (R1 shown in Fig. 2). Under dark conditions its resistance rises, raising the voltage at the junction between R1 and VR1. The rising or falling voltage is sent to a low-pass filter, consisting of R2, R3, C1 and C2. Their high resistance and capacitance result in a very low cut-off frequency, at about 0.08Hz. The effect of this is that only very slow changes of voltage pass through the filter. As day becomes night or night becomes day, the voltage received by IC1a falls or rises steadily. By contrast, rapid changes of light, such as those caused by people wandering around, are filtered out and ignored.

The NAND gate of IC1a has Schmitt trigger inputs. Because of these, the output of this changes state only for major swings of input voltage. Smaller changes, such as might be caused by the transitory cloud obscuring the sun, are ignored. Thus the output of this gate, which is the inverse of its input, is high by day and low by night. The Schmitt trigger has a sharp response so the change is almost instantaneous. VR1 can be varied to set the exact light level at which the change occurs. The output of IC1a, inverted by IC1b, is used to drive an LED (light emitting diode). This comes on in the dark and is off during the daylight.

A special water sensing IC (integrated circuit) is used to monitor the dampness of the soil (Fig. 3). This generates a signal of about 6Hz which passes through C4 to pin 10. However, if there is a conductive pathway between pin 10 and 0V, the signal strength falls appreciably. Pin 10 is connected to one metal rod of the probe inserted in the pot of soil or compost. The other rod is connected to the 0V rail. The conductivity of the soil depends mainly on its moisture content. The damper the soil, the weaker the signal picked up by pin 10. In dry

Fig. 2. Light-sensing circuit.

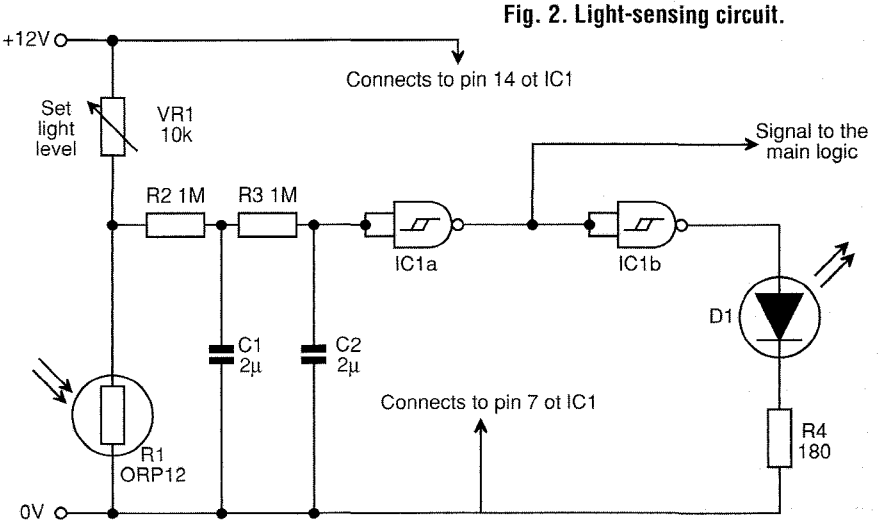
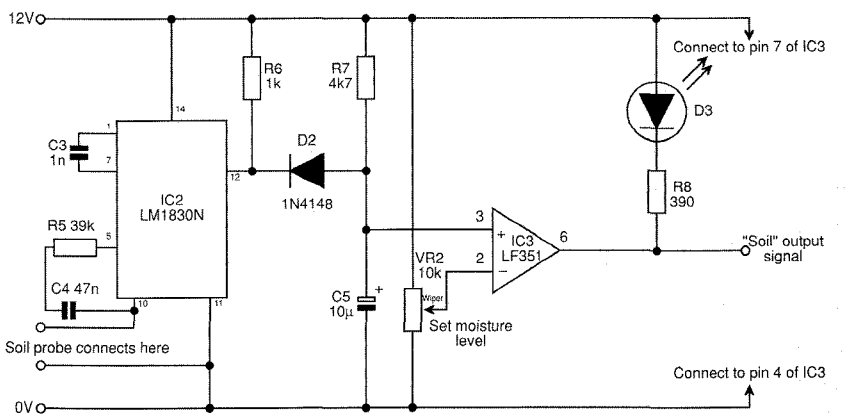


Fig. 3. Moisture sensing circuit.



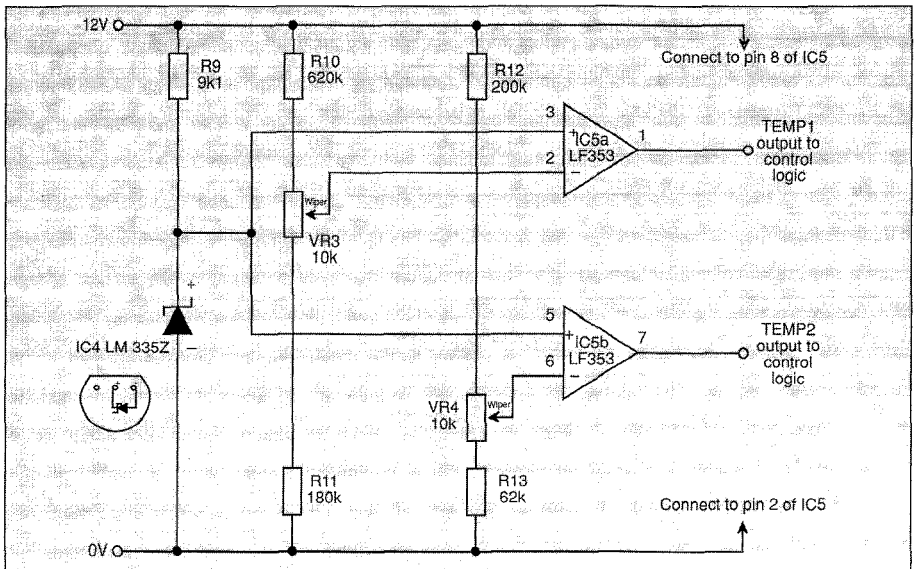


Fig. 4. Temperature sensing circuit.

soil, the signal is received at full strength. A detector in the IC produces an alternating voltage at pin 12, the average level of which is proportional to the level of the signal reaching pin 10. D1 rectifies this signal. The amount of current drawn from C5 during the negative swings of the signal depends upon the signal amplitude. If the soil is damp, signal amplitude is low and the current passing through R7 is able to maintain a reasonable charge on C5. If the soil is dry, signal amplitude is high and a greater current is drawn from C5. The voltage across C5 is low.

The varying voltage level across C5 is converted to a logical low or high by IC3, wired as a comparator. Output is high when soil is damp and low when it is dry. VR2 sets the moisture level at which the output changes. D3 indicates the current state, being off when the soil is damp and on when it is dry.

The fact that the signal to the probe is alternating is important because direct current (DC) would cause the metal probes to corrode by electrolysis – this still occurs but the effect is reversed when the voltage is reversed.

The temperature sensor (IC4 in Fig. 4.) is a band-gap device with a voltage output which is proportional to the absolute temperature. The output voltage, at the junction between R8 and IC4 is 0.01V per Kelvin. Thus the output is 2.73V at 273K, equivalent to 0° on the Celsius scale. To find its output at other temperatures simply add 273 to the temperature in Celsius and divide by 100 to find the output in volts. There are two comparators in the temperature sensing circuits. IC5a detects low temperatures and its output (TEMP1) goes low when the temperature is near to freezing. This is done by setting VR3 so that the voltage at its wiper is a little above 2.73V, say 2.80V. IC5b detects excessively high temperatures. For example, it could be set to detect temperatures in excess of 30°C by setting VR4 to supply 3.03V to pin 6. The comparator outputs are high for temperatures above the set levels. TEMP1 can be set in the range -5°C to 5°C; TEMP2 can be set in the range 5°C to 40°C.

Fig. 5. shows how the logic uses the information supplied by the sensors:

Mode A: IC6a and IC6b generate a high-going pulse when the output of the light sensor falls from high to low.

Mode B: IC6b and IC6d generate a high-going pulse when the output of the light sensor rises from low to high.

Mode C: IC7a and IC7b perform the OR operation on the pulses of modes A and B thus reproducing a high pulse at dawn and dusk.

lead, then briefly connect it to 0V and back to +12V again. The siren sounds for about 10 seconds. Now add VR6 to this circuit. Repeat the test and note that the relay operates at the instant the siren ceases to sound. The relay may operate when the power is first applied. If this happens, turn VR6 to give minimum time, then wait until the relay is released before testing.

Finally, insert the logic ICs (IC6-IC9) in their sockets. Use a test lead to temporarily connect one of the terminals S2A to S2F to the terminal S2. Run through the various combinations of the inputs for each mode of operation. Check that the circuit is triggered by the required combination of events for each mode, but is not triggered when it should not be. To avoid undue noise at this stage it is a good idea to disconnect the buzzer and rely on measuring the voltage output at pin 5 of IC11 to confirm that the logic is working correctly. When testing modes D and E, turn S2 to the 0.75h position (IC10, pin 21) then turn it to the INSTANT position to trigger the pulse generator. This makes it unnecessary to wait each time for the clock output to go high.

The PCB has provision for a number of terminal pins on the 0V and 12V rails to provide return paths for various off-board connections. However, it simplifies the wiring if these returns are made in the off-board wiring instead as in Fig. 9.

There are various ways of constructing the soil moisture probe. The simplest is to use a two-pin plug. A better result is obtained with a probe made from two brass or stainless steel rods about 50mm long, 3mm in diameter, mounted parallel to each other and spaced about 20mm apart. They can be held in two holes bored in a block

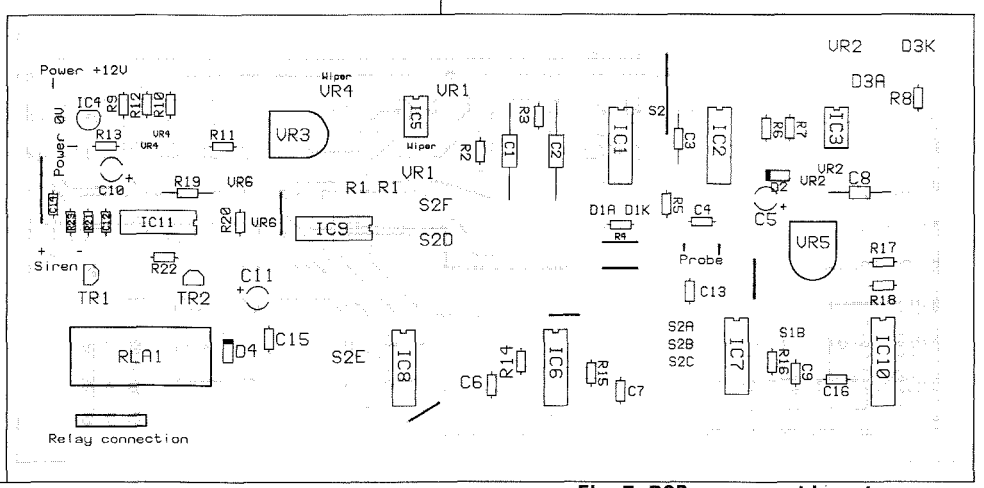


Fig. 7. PCB component layout

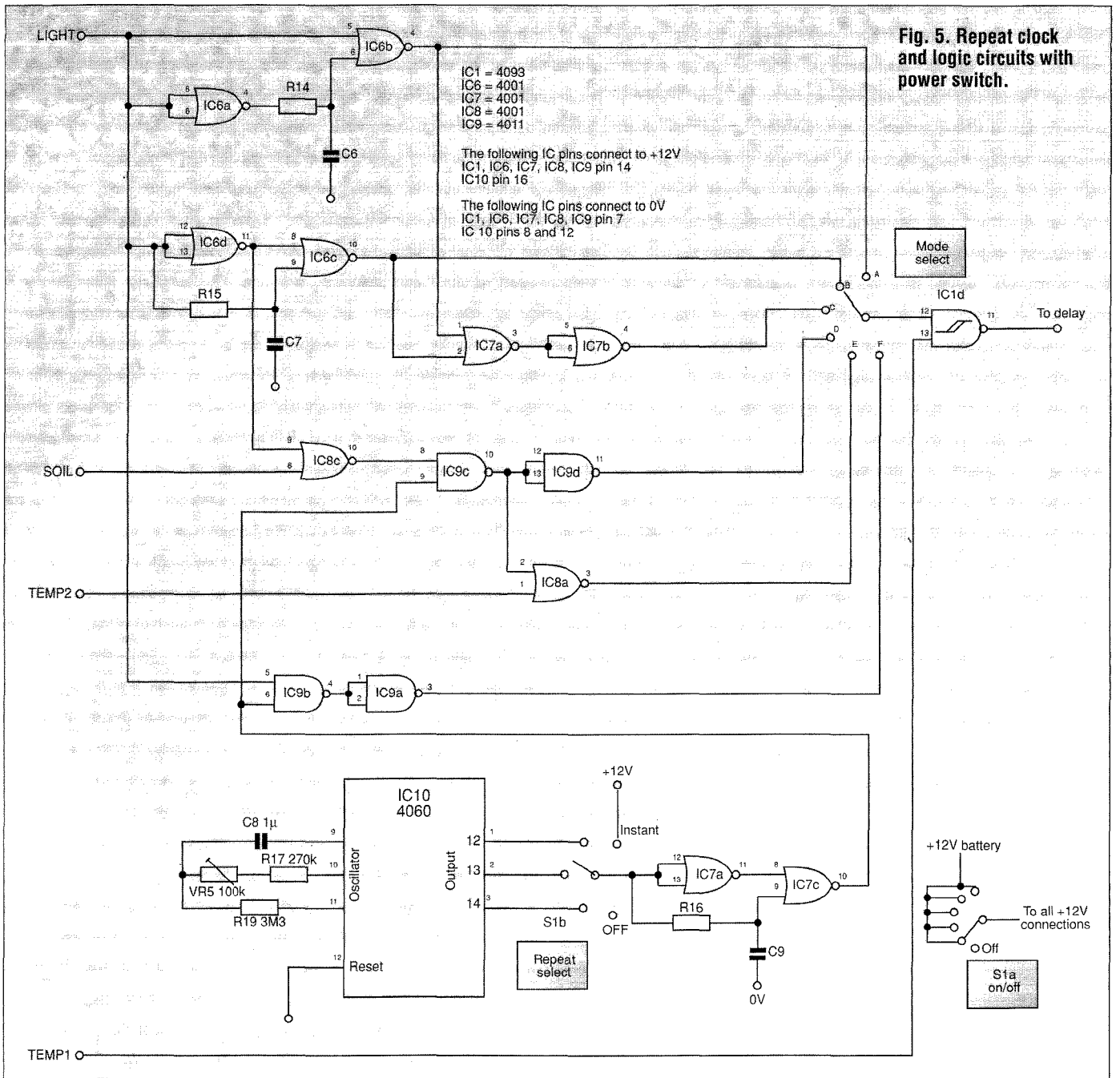


Fig. 5. Repeat clock and logic circuits with power switch.

of plastic. The block must not be too large as this might prevent the water from reaching the soil immediately below the block.

Installing the system

The unit is mounted where it is not likely to have water sprayed or dripped on it. It should be sheltered from direct sunlight so as to avoid overheating of the temperature sensor. The light sensor R1 is mounted where it receives full daylight and is not unduly subject to shading from trees or other fixed objects. A lead from R1 runs to sockets SKT1–SKT2 on the front panel of the unit.

The soil probe is connected by a lead to sockets SKT3 and SKT4 on

Mode D: this depends on the action of the repeat clock IC10. The oscillator of IC10 runs at 1.5Hz and this frequency is divided by 2^{12}, 2^{13} and 2^{14} to give square waves repeating by 0.75h, 1.5h and 3h intervals. One of these signals is selected by S3b. The pulse generator produces a high pulse every time the output from IC10 rises. The action of IC8c, IC9c and IC9d is to produce a high pulse whenever the repeat clock pulse arrives, provided that it is daytime (LIGHT is high) and that the soil is dry (SOIL is low).

Mode C: the output from IC9c (a low pulse coincident with the repeat clock, provided it is daytime and the soil is dry) is NORed with the TEMP2 output to prevent watering if the greenhouse temperature is excessive. A high pulse is produced by IC9a if the temperature is suitable.

Mode F: IC9a and IC9b produce a high pulse every time the repeat clock pulses, provided it is daytime. The repetition rate of the clock is selected by the setting of S3, which also acts as a power ON/OFF switch. S3 also has a fifth position. INSTANT. This triggers the system to water the plants immediately, irrespective of the clock state. Watering lasts for a single period of 1 to 30mins, according to the setting of the timer.

The high-going pulse produced as above is selected by S2 and passed to a NAND gate IC1d. Provided that TEMP1 is high (no risk

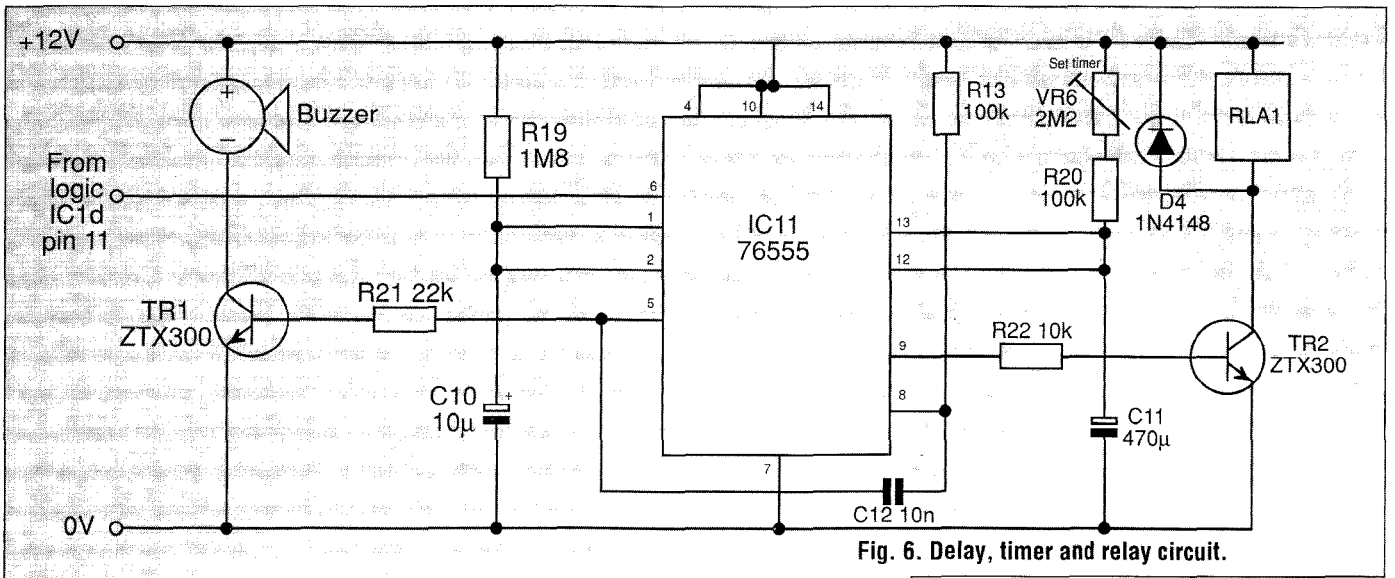


Fig. 6. Delay, timer and relay circuit.

of freezing) this pulse appears as a low at the output of the gate and goes to the delay circuit.

The delay circuit consists of one of the timers in the 7556 dual timer package. This is wired as a monostable (Fig. 6.). When it is triggered by the low pulse from the logic circuit, its output (Pin 5) goes high for about 20s. The high output turns TR1 on and causes the solid-state siren (buzzer) to sound. This warns that a deluge is imminent. The output of the first timer (pin 3) is connected to the trigger input (pin 8) of the second timer by way of capacitor C12. Normally the trigger input is held high by R23 but when, at the end of the 20s delay, the output of the first timer goes low, a low pulse is transmitted to the trigger input of the second timer. This is also wired as a monostable but with a period which can be varied from one minute to about 20 minutes by setting VR6. The high output from the second timer turns off TR2 and the coil of the relay is activated.

The relay is used to turn on one or more electrically-powered water pumps or valves. Small pumps are available that operate on a 12VDC supply so these can be powered from the same supply as the monitor circuit. However, they require a considerable current (usually about 2A) and will quickly drain a normal battery system. It is better for the power for the circuitry and pump to be provided either from a lead-acid battery or a mains powered 12VDC unit. This must be rated to supply 2A or more, but the supply need not be the front panel. The probe is inserted in a pot of soil or compost. Whether or not the pot also contains a plant is optional. The pot is located in what is regarded as a typical part of the greenhouse. It should receive average sunlight, average ventilation and an average amount of water when the system switches on. Probably several trials will be needed to find the most suitable location.

Obviously a single watering regime cannot possible suit all the plants in the greenhouse. Much can be done by placing the plants so that those which need most water receive the most when the system is running, while those which need the least are at the extreme of the watered area. ■

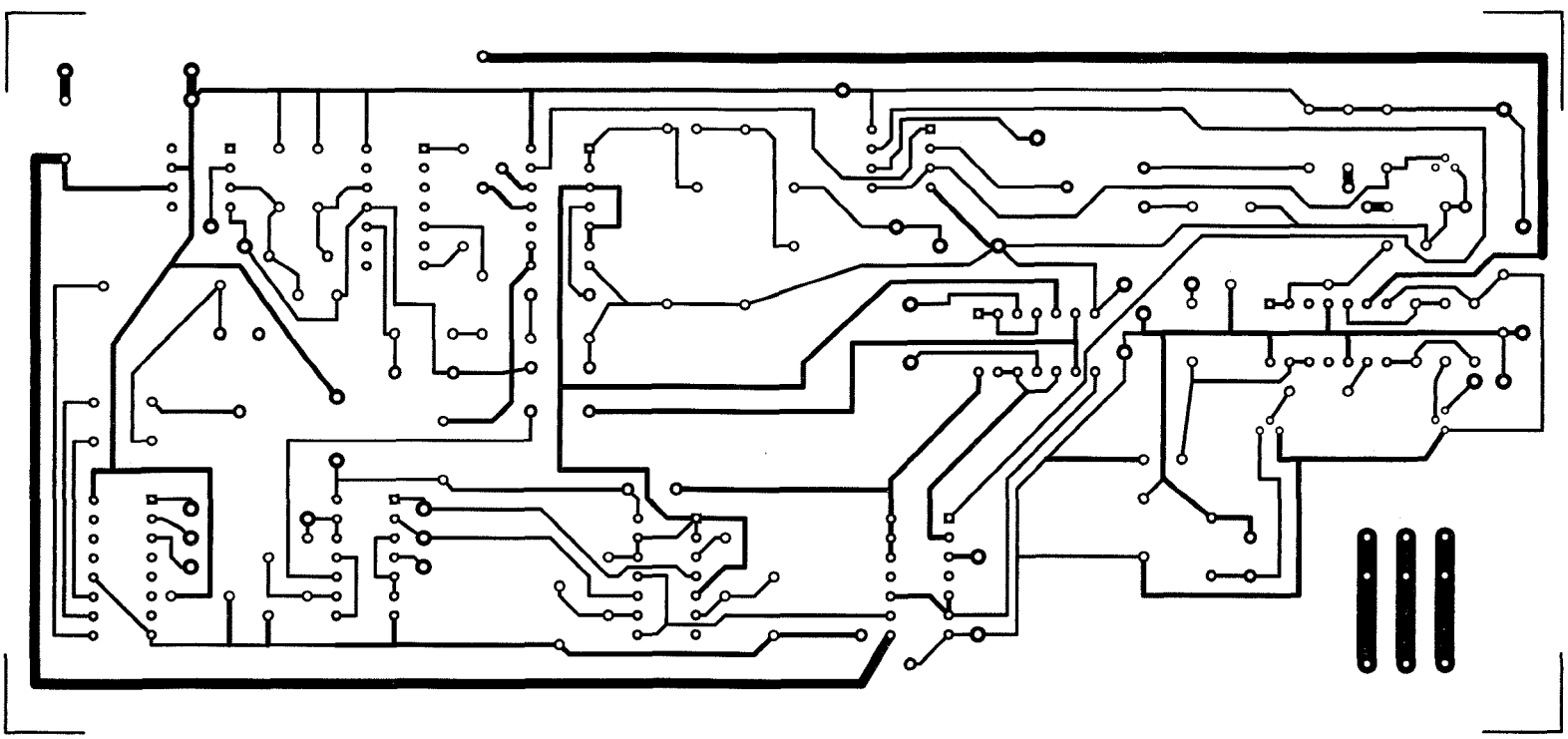


Fig. 8. PCB tracks from copper side.

regulated. The length of time a battery will last depends mainly on the time a pump will be running. For example, using a 2A pump and watering for 15 minutes once per day requires 0.5AH – half an amp each hour. A lead-acid battery such as used in the average car has 15AH and will last for one month without recharging. On-demand watering (Modes D and E) requires more or less than this depending on such factors as the season, the type of plants and whether or not the greenhouse has summer shading.

Electronically controlled water valves are available for use with a +12V DC supply and their requirements are similar to those for water pumps. If mains-powered valves are to be used, appropriate precautions must be taken when wiring up and installing the circuit, particularly to avoid water entering the enclosure – this is really a job for a qualified electrician.

The circuit itself requires just over 100mA at 12V DC. In order to avoid possible interference caused by the switching on of the pump or solenoid in a valve, it is recommended that the circuit has its own power supply. If a mains supply is available in the greenhouse, the best source of power is a 12VDC mains adaptor; this should have a regulated output and a type rated at 300mA is very suitable. If the mains is not available, a lead-acid battery of 1.9AH capacity will power the system continuously for 19 days. As a separate unit, intermittently used,the moisture sensing circuit can be run on a 9V PP3 battery.

Components

Resistors, all carbon or metal film, 0.25W, 5%, except where stated.

R1	ORP12 light dependent resistor
R2, R3	1M
R4	180
R5	39k
R6	1k
R7	4k7
R8	390
R9	9k1
R10	620k
R11	180k
R12	200k
R13	62k
R14,R15,R16,R22	10k
R17	270k
R18	3M3
R19	1M8
R20,R23	100k
R21	22k
VR1, VR2, VR4	10k carbon pot
VR3	10k horizontal preset
VR5	100k horizontal preset
VR6	2M2 carbon pot

Capacitors

C1, C2	2µ polyester
C3	1n polystyrene
C4	47n polystyrene
C5	10µ tantalum
C6, C7, C9	10n polyester
C8	1µ polyester
C10	10µ electrolytic 16V radial leads
C11	470µ electrolytic 16V radial leads
C12, C13, C14, C15	100n polyester

Semiconductors

D1	light emitting diode, 5mm yellow
D2, D4	1N4148 signal diode
D3	light emitting diode 5mm green
TR1, TR2	ZTX300 NPN transistor

Integrated circuits

IC1	4093 CMOS quad 2 input NAND with Schmitt inputs
IC2	LM1830F fluid level detector
IC3	LF351 single JFET op-amp
IC4	LM335Z precision temperature sensor
IC5	LF353 dual JFET op-amp
IC6, IC7, IC8	4001 CMOS quad two input NOR gate
IC9	4011 CMOS quad two input NAND gate
IC10	4060 CMOS 14-stage binary ripple counter with internal oscillator
IC11	7556 CMOS dual timer

Miscellaneous

RLA1 12VDC miniature relay with change-over contacts rated to withstand a minimum of 2A DC or mains voltage.
S1, S2 rotary switch, 2 pole, 6-way knobs for S1, S2 and the potentiometers
12V solid state audible warning device (siren, electronic buzzer)
Plastic enclosure approximately 220mmx150mmx60mm or larger
DIL IC sockets, 8-pin (2 off), 14-pin (7 off), 16-pin (1 off)
panel mounting sockets with plugs (4 off)
printed circuit board
1mm terminal pins
plastic self-adhesive PCB mounting strip about 100mm long (2 off)
Lead-acid cells or other power supply – see text
connecting wire, solder, materials for making probe.

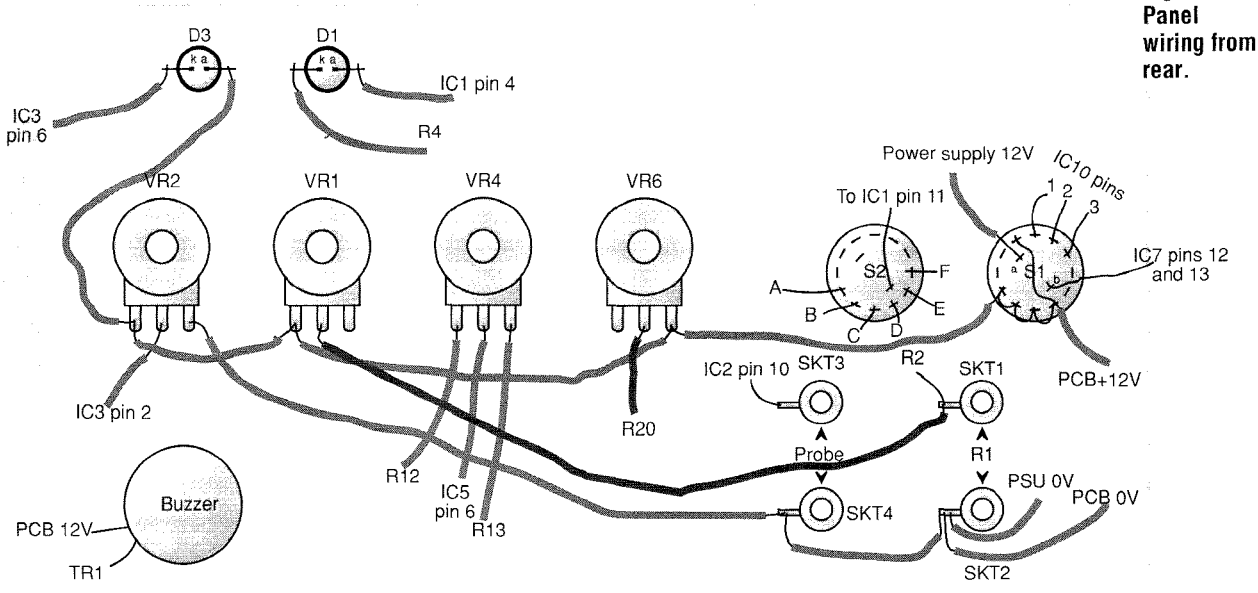


Fig. 9. Panel wiring from rear.

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Techniques

Andrew explains how to fix a cassette recorder with a Swiss army knife and some vodka .

This Techniques column, like last month's, has a seasonal bias. B.Robertson of Swindon writes to say that he is intending to take his Walkman on a ski trip with him this winter. "The chalets normally provide some sort of radio/cassette player for our entertainment," he continues, "but the cassette mechanism has often not been cleaned for so long that it chews up tapes and cannot be put right. How can I use my cassette player to play tapes through the radio set?"

I know just what you mean - I have ended up mending the cassette player in a chalet with a Swiss army knife myself. Trying to clean the pinchwheel with vodka (and trying to avoid making it sticky) after removing the chewed pieces of tape is the worst part.

Coupling

There are two obvious approaches to this question. First of all, you can buy a coupling unit which looks like a cassette with a lead issuing forth from it and which is designed to feed a signal into the stereo tape head of a cassette player. The normal use for these coupling units is to play a CD Walkman through a car stereo, but it should play an ordinary Walkman through a radio cassette player unless the head itself has been damaged.

If you don't want to spend the money on one of these units, and/or if you fancy a novel approach to the problem, you could use the signal from the Walkman to modulate an oscillator somewhere in the FM frequency band and tune the radio to pick up this signal. The circuit shown in Fig. 1 is the simplest I have seen which will do this job.

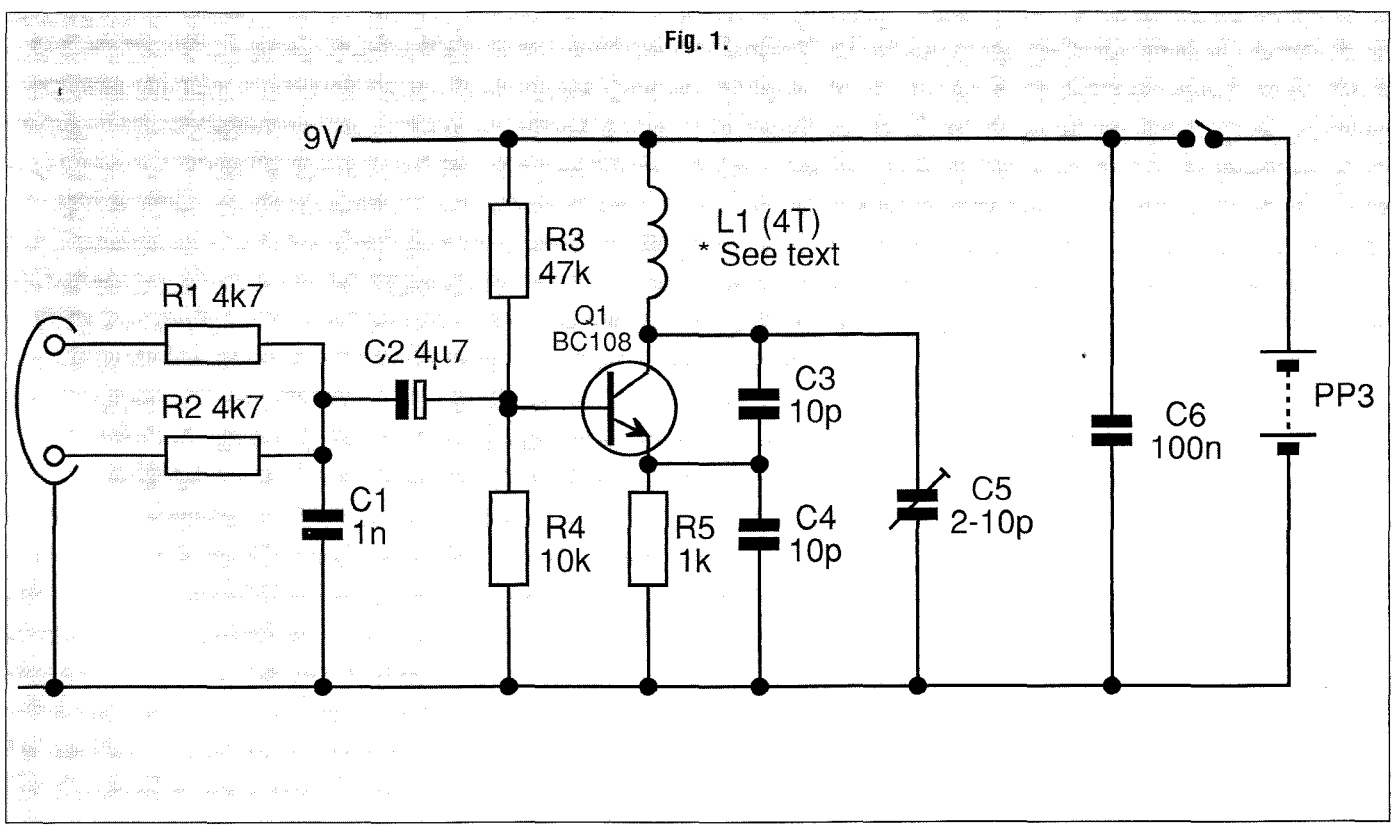
From an RF point of view, both of the power supply rails are at ground potential, and the base of Q1 is decoupled to ground via C1. The RF part of the circuit then reduces to a transistor with a parallel tuned circuit as its collector load, and feedback from collector to emitter, roughly impedance matched by C3 and C4.

The base of the transistor is not decoupled from the point of view of audio frequencies, and the stereo audio signal from the Walkman is converted to mono by R1 and R2 and used to modulate the base voltage. This varies the operating point of the transistor enough to cause the frequency to wobble in time with the sound, producing a frequency-modulated signal. There is also a small amount of amplitude modulation, but this does not usually have any significant effect.

Linearity

Different transistors work in different ways in this circuit. BC182s produce a fair amount of amplitude modulation, with very

Fig. 1.



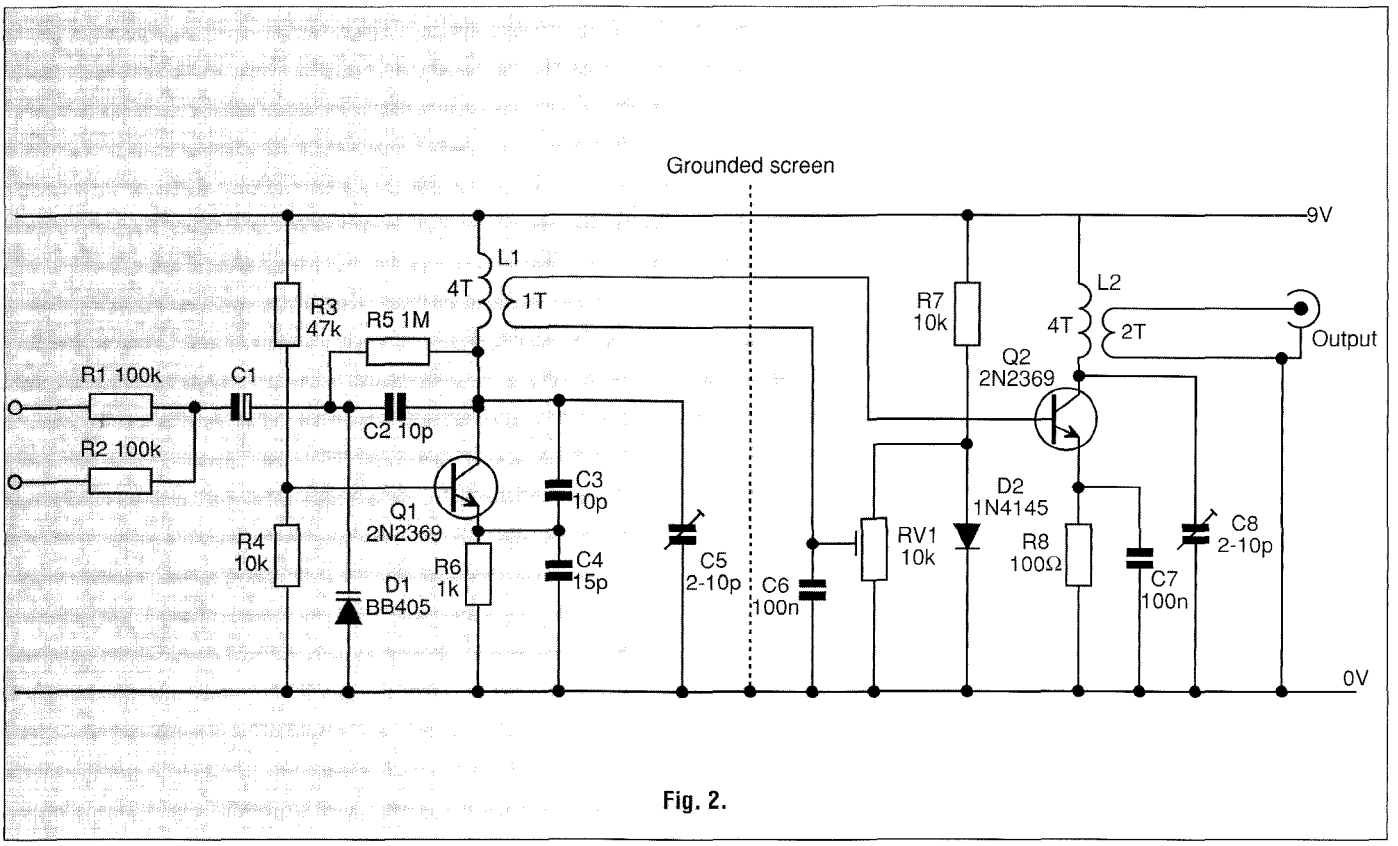


Fig. 2.

little frequency variation, which makes the signal rather distorted. BC108s always seem to work reasonably in this circuit, with some samples giving virtually no amplitude modulation and seemingly linear frequency variations. Some samples of 2N2369 work well, but not all work well enough. To get a good quality signal, some experiment is necessary.

If this oscillator is placed near the FM radio, it will be able to be picked up at a good strength. Strictly, this would possibly constitute an illegal transmission, though if a BC108 is used the range is very short indeed. If a 2N2369 is used, the range could be 10 yards or more, depending on the physical dimensions of L1, which influence how effective an aerial the coil forms.

If one wished to avoid any possibility of an illegal transmission, the obvious answer would be to reduce the power still further and connect the output straight to the radio. Unfortunately, it is very difficult to make this work in practice, because if the power is reduced too far, the oscillator tends to stop. In addition, connecting the output of the oscillator to anything alters its frequency. To get around these problems, the circuit of Fig.2 may be used. If this is built in a screened box, then the only signal coming out is from the low-power buffer stage. This output can be directly connected to other things, for example, to the aerial of an FM radio, without affecting the frequency of the oscillator.

The oscillator stage itself is like that of Fig. 1, but the modulation is done in a more conventional manner, using a varicap diode. This gives good quality sound regardless of what type of transistor is used.

A small amount of signal is coupled to the next stage via a 1 turn secondary winding on L1. The output of the second stage is adjusted by varying its bias with RV1. In order to provide just the output level needed to feed to an fm tuner, the potentiometer will probably need to be advanced only a fraction of a turn above the 0V end. Indeed, if it were turned up far the power output (and battery consumption) of the stage would increase and it would become a transmitter with quite a respectable range if an aerial were connected.

To tune the output stage, RV1 should be adjusted to produce a current of about 1 to 2 milliamps in Q2 - which may be verified by measuring 100 to 200 millivolts across R8. A few centimetres of wire should be connected as a temporary aerial, and a radio should be tuned to the radiated frequency. The aerial of the radio should be retracted, and it should be placed at a range of several feet. RV1 should then be turned down until reception becomes noisy, and C8 should be adjusted for maximum signal.

The power should now be reduced to the minimum level required, in order to prolong battery life.

If a very small circuit is required, because of luggage restrictions, the circuits could probably be made to run on a single 3V lithium cell (or at most two in series) if the transistors were re-biassed. For example, in Fig. 1 R3 would be reduced to 8k2, and R5 would be reduced to 680n

Inductors

Some experiment may be required to find the best design for the inductor. An experimental circuit used 4 turns of 0.2mm wire solenoid wound on a piece of 5mm diameter Pyrex rod, superglued into place. This resulted in a stable oscillator which has been used successfully to play my walkman through my car radio, demonstrating its stability against temperature changes and mechanical shock. ■

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Continued from page 62

until now been regarded as spare. But of course they are not really spare. They are used to connect VCRs, satellite tuners and computer video games to TV sets. Inevitably, powerful Channel 5 transmissions will cause interference where frequencies clash.

A clause in the Broadcasting Act 1990 requires the Ch. 5 franchise winner to pay for whatever re-tuning, modification or replacement of equipment is necessary. Obviously this would kill Ch. 5. So another clause, which the Home Office slipped in quietly, says that people who erect the modified aerials (different frequency range and different polarisation) which will be necessary to receive Ch 5 will forfeit their free cure for interference.

The ITC has now published a technical report (cost £500 + VAT) by National Transcommuniations Ltd (formerly the IBA Labs at Winchester) on the likely extent of re-tuning. The press has been shown a synopsis. NTL estimates that by 1994, when Ch. 5 starts broadcasting, there will be anything between 4 and 8 million VCRs which need re-tuning. But it assumes that half of their owners will have forfeited their rights.

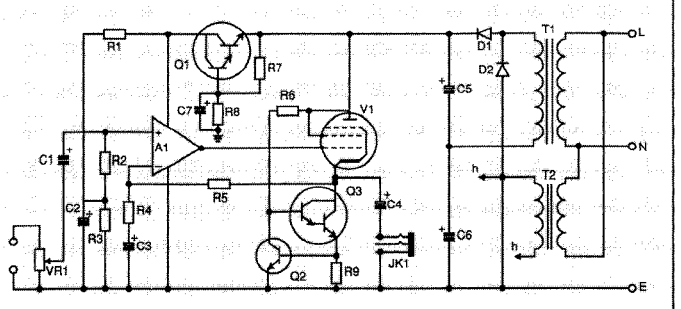
The report largely ignores satellite receivers and video games. The ITC plays the omission down. But there is now a resurgence of interest in video games. Witness Nintendo fever. There are already 1.5 million satellite dishes in the UK with sales at around 70,000 a month.

The report also ducks the issue of how much technical assistance will cost.

Of course not all equipment will be at risk, but by 1994 there could easily be 10 million pieces of equipment suffering interference. Common sense tells that once the word gets around, people will claim any free help they need – or think they need – before erecting a new aerial and starting to watch Ch. 5. This will bankrupt the franchise. 5.

Beware those who blandly say that retuning is easy. Anyone who has juggled a daisy chain of tuned RF connections knows otherwise. By 1994, when Ch. 5 switches on and triggers nationwide interference, no engineer will make a house call for less than £50. No broadcaster will be able to afford the bill, and no service facility will be able to make all the calls immediately.

Personally I do not care if someone is daft enough to bid for the Ch. 5 franchise and goes bust. But I do care about the electronic mess they will have caused. ■



Last month's headphone amplifier circuit diagram had a slight mistake in it. Thanks to those readers who pointed it out.

The Valve HT supply was not shown connected.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Barry Fox

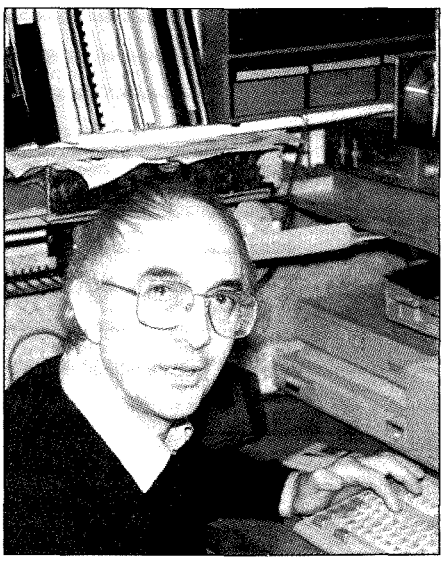
Not The Best Way To Make Money From TV

Barry examines the current trend of selling franchises in the TV industry. With ITV already gone, will Channel 5 and Teletext face the same problems?

It would be hard to find anyone who thinks the new procedure for granting commercial TV franchises is fair, sensible and of advantage to anybody, except the Treasury. Bidders for what was ITV, and will now be known as Channel 3, had to say how much they will pay the government for a franchise. Unless there are "exceptional circumstances", the highest bidder won.

Taking A Chance

The blindingly obvious risk is that the highest bidder will run out of money and either go bankrupt or inflict viewers with cut-price programmes, bought in from abroad. The lower bidders with more money to spend on better programmes will never get the chance to prove their promises. The bidding process has had an unsettling effect on the existing ITV stations who do not know whether they will still be broadcasting after the end of 1992. Witness how pitifully little the ITV companies have done to exploit Nicam stereo.



All we can do now is watch the Channel 3 system fail painfully and publicly – like the poll tax – and wait for the government to find a way of changing the system without too much loss of face.

In the meanwhile there are two more franchise pantomimes to go through.

> Personally I do not care if someone is daft enough to bid for the Channel 5 franchise and goes bust.

Teletext Trouble

In November the Independent Television Commission will start selling off the commercial TV teletext services to the highest bidder. The current licenses for Oracle's services on ITV and Channel 4, expire at the end of 1992. The new licences will be granted by April 1992. As with the Channel 3 licences the Broadcasting Act 1990 lets the ITC accept a lower tender only under "exceptional circumstances".

On 9 September the ITC published its draft licence for teletext, asking for comments by 7 October. Obviously this made it impossible for monthly specialist magazines to advise readers in time – these are the magazines most likely to read the small print and spot the technical restriction which will adversely affect all viewers in the 7 million homes which now have a teletext TV set.

Current teletext services use up to 12 picture lines in the vertical blanking interval (which make up the black borders at top and bottom of the TV picture) to carry the digital data for around 250 pages of information. The ITC plans to licence only 7.5 lines. The remainder will be sold off for other uses, such as closed user group data services where encrypted data is available only to paying subscribers.

Oracle currently uses 11 lines for ITV and 12 for Channel 4. It estimates that a reduction to 7-line working would mean a loss of 100 pages of text. If the same number of pages are transmitted, it will take longer for them to appear on screen. Either way viewers will then only get part of the service they have grown to expect.

Who Wants Channel 5?

In January the ITC will advertise the franchise for Channel 5, Britain's fifth TV channel. The winning bidder will broadcast to over 70% of the UK, using frequencies (mainly UHF channel numbers 35 and 37) which have

Continued on page 60

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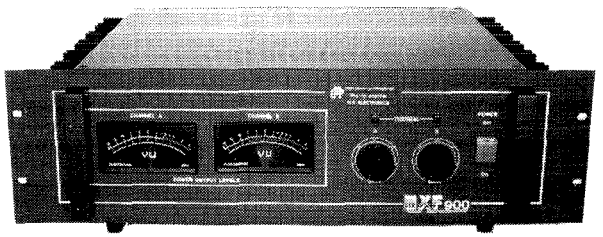

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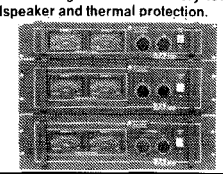

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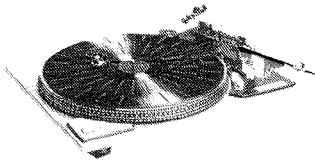

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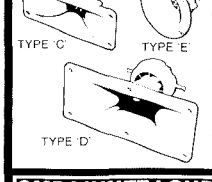

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Made especially to suit today's need for compactness with high output sound levels, finished in hard wearing black vynide with protective corners, grille and carrying handle. Each unit incorporates a 12" **driver plus high frequency horn for a full 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

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

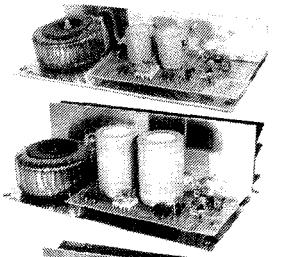
THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono
ALL POWERS INTO 4 OHMS
Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

OMP MOS-FET POWER AMPLIFIER MODULES

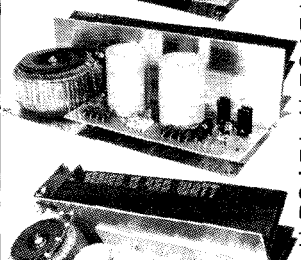
SUPPLIED READY BUILT AND TESTED.

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.

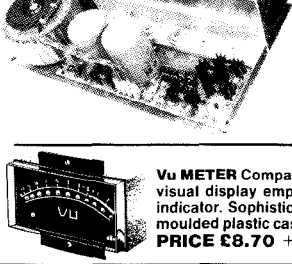
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



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

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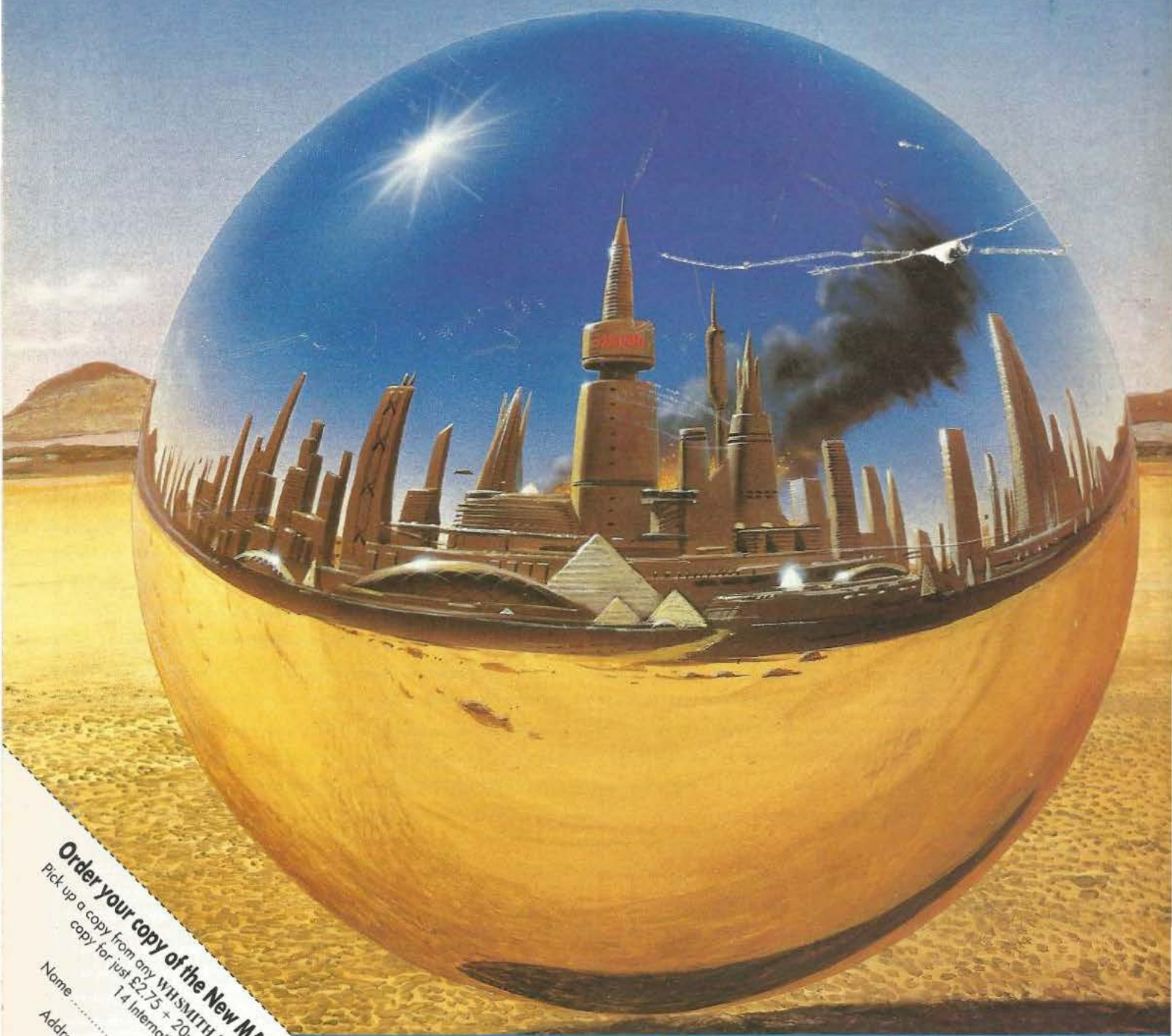
1992 BUYER'S GUIDE TO ELECTRONIC COMPONENTS

Maplin



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