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Sony's Mini Disc

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

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

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

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

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

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

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

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This month...

Computer aided design doesn't only apply to creating circuit schematics and PCBs. A couple of other applications are looked into this month with reviews of Pulsar and Protolab. Both of these are circuit simulators, the first dealing with digital and the second with analogue circuits.

The interesting point about simulation of electronic circuits is that when computers become small enough and fast enough, there should be no need to create a circuit out of discreet components. Instead, a black box with the required inputs and outputs will do the job. Inside will be a microprocessor that runs a simulation of the circuit.

However, that's in the future, anyone interested in getting into CAD now should turn to page 53 (after reading this) and enter our Seetrax Ranger competition. There is over £1500 worth of CAD software to be won.

Kenn Garroch, Editor

Next month...

Surface mount devices; how, what, where and why plus a project that uses them. AM stereo radio. How it works: we look inside a radio. All in the next issue of Practical Electronics.

Build It

High Quality MOSCODE Amplifier.......................17
This valve based amp gives 100W of superb stereo Hi-Fi power.

PE Chronos.............................................37
This month, the main board is built and tested.

Features

Product Preview ........................................9
PE examines ACE, the latest in educational electronic software.

Technology In The Office ..............................11
James Carter looks into what is needed in a hi-tech office.

Pulsed Logic.............................................46
Sophisticated logic circuit simulation on a PC.

Digital Multi-Meters....................................43
Wanna buy a meter? Jason Summer examines 7 of the best.

Teach Yourself Electronics............................61
Protolab simulates a variety of simple circuits on a PC.

Regulars

Wavelengths..............................................5
Lasers and Sony’s Mini-disc, just some of the topics under discussion.

Innovations.............................................6
MS-DOS 5.0, ERS-1 and HDTV in the news this month.

Silicon Valley.........................................10
A round-up of interesting ICs from around the world.

New Product Developments..........................25
Ian Burley on Sony’s Mini-Disc and Samsung's security robots.

How It Works............................................30
What’s inside a video camera – Derek Gooding explains.

Data Sheet............................................32
Some CRT control circuits from National Semiconductor.

Practical Components.................................34
The Battery is vital to portable electronics.

Practical Technology.................................44
The fax machine, Kevin Jones on the Amstrad and Samsung.

Techniques.............................................57
Andrew Armstrong describes a fluorescent light dimmer.

Barry Fox.................................................63
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</tr>
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<tbody>
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<td>£79.99</td>
<td>£36.99</td>
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<tr>
<td>FILMNET DIGITAL STEREO AUDIO (NEEDED '92)</td>
<td>£125.00</td>
<td>£89.99</td>
</tr>
<tr>
<td>TELECLUB</td>
<td>£125.00</td>
<td>£79.99</td>
</tr>
<tr>
<td>CANAL PLUS/RAI INC. AUDIO (DISCRETE)</td>
<td>£155.65</td>
<td>£99.99</td>
</tr>
<tr>
<td>SECAM TO PAL CONVERTER (SECAM)</td>
<td>£99.99</td>
<td>£69.99</td>
</tr>
<tr>
<td>DUAL SECAM—RAI/CANAL PLUS (DISCRETE/SECAM)</td>
<td>£216.52</td>
<td>£149.99</td>
</tr>
<tr>
<td>RTL4 (DUTCH/ENGLISH)</td>
<td>£79.99</td>
<td>£39.99</td>
</tr>
<tr>
<td>STEREO MODULE</td>
<td>£99.99</td>
<td>£74.99</td>
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<td>VIDEO COMPANION XV2000 TO TUNER</td>
<td>£4.99</td>
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Wavelengths

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

With relation to the article by Mike Saunders in the November 1990 issue about lasers, I would like to know what happens if two lasers intersect. Is it possible to have two infrared lasers operating invisible beams and then make the intersection visible or, put another way, create a movable point of light in midair?

If this was possible, control of aircraft could be made threedimensional instead of the present flat radar screens. Each moving light point could be an aircraft and it would be simple to see its light point in relation to other aircraft, its height, distance from the runway, even its position on the runway.

Using pulsed lasers it may even be possible to code a selected lightpoint to identify a particular aircraft.

H G Hartog
Lower Hutt
New Zealand

After asking our in-house optical experts on Astronomy Now, it seems that because the are coherent, laser beams do interfere with each other when the intersect. Unfortunately, this has no visible manifestation at the point of intersection and can only be seen when the beams strike a surface.

As far as I know, light beams can’t be seen unless they reflect or something – all the eye sees are reflections.

Another way of looking at the whole idea is that if nobody has done this so far then it probably can’t be done (unless somebody knows better?).

Radio Request

I have noticed recently that you have introduced a regular page called how it works. Can I make a request for something to cover? I would like to know about the humble transistor radio, can you oblige?

T Smith
Royton
Lancs

We aim to be of service, look out over the next few months and your request should be granted.

Fuzzy Logic

In the August issue of PE I noticed that page 28 tried to show the improvement of HDTV over standard PAL. Was there a printing mistake or is there no difference? All of the pictures are rather blurred and have lines across them.

A James
Norwich
Norfolk

There is a definite difference between the original photographs but, alas, production problems cause interference, the result of which is the lines and blurring – sorry.

Bad Boards

The quality of the PCBs on page 38 of the August issue of PE left quite a lot to be desired. Is this the best you can do? I would have thought that with all of the latest technology, computer aided design and so forth, you would be able to produce perfect images.

P Williams
Colchester

The problem here was that the artwork came from the original masters provided by the author. Fortunately, you should be able to provide better boards from Lys Electronics (see the advert later in this issue).

Sony’s New Product

It was nice to see Ian Burley back with the New Product Developments replacement for Home Base. I like to keep track of what is new in the world of consumer electronics and your’s is the only magazine that, now, seems to be covering this on a regular basis.

What I would like to know is whether the magneto optical technology used in the Sony minidisc will be available for use with computers? It seems to me that this is the ideal media to store computer programs on. It is based on a digital system and appears to be small and quite rugged. The 74mins of music sampled at 44.1MHz should give 182 thousand mega words (at 16 bits per sample) or so – if my arithmetic is correct. This is a great deal larger than the average floppy or even the average hard disk.

A Henson
Stafford
Staffs.
The Latest DOS
MS-DOS 5, the latest version of Microsoft's well known PC operating system was announced recently. Previous upgrades went some way to removing the bugs and making things easier to operate but, version 5 is a complete overhaul. While attempting to retain backward compatibility many software packages work without a hitch. However, some have a few problems and some, apparently, don't run at all.

Among other features, a new DOS Shell has been provided to help anyone who doesn't like typing in long commands. This is basically a file management system like Xtreepro with the addition of context switching. It allows a number of applications to be started up at once and enables the user to move between them without exiting. Leaving one and moving to another is simply a matter of pressing a key - the current state of the program is saved to disk and the next program loaded in and activated.

Although this is rather slow it can be used to run say a wordprocessor, CAD system and, perhaps programming interpreter (such as the bundled Quick Basic) at the same time.

The other major improvement of DOS 5 over older versions is the improvement of memory management. If there is extended memory available on the machine various commands, a full screen editor to replace EDLIN and a QuickBasic interpreter. The upgrade pack is available from Microsoft (0734 500741) for £69.

ERS-1 Takes Off
The launch of the first European Remote Sensing Satellite, ERS-1 was originally planned for 3rd May 1991 but, due to various hardware problems was put back and back. It has now been re-scheduled to take off on 16th July from the European Spaceport in Kourou, French Guiana.

Fortunately, there was nothing actually wrong with the satellite itself, it was the third stage of the launcher that caused the problems. This has now passed its tests and should perform to specification during the launch.

ERS-1 is the largest satellite ever to be launched by ESA and it carries sophisticated sensing devices that will reveal any environmental problems both at sea, on the ice caps and on land. The synthetic aperture radar will be able to take high resolution pictures of strips of the earth's surface 100km wide as well as measure the direction and length of sea waves from 100 to 1000m.

The satellite, after going through exhaustive electrical tests, will be mounted on the launcher at the beginning of July ready for launch on the 16th.

Three days later, ESA will be celebrating the 10th birthday of Meteosat 2, the second in the series of European weather satellites launched a decade ago.

Originally designed to have an operational life of three years, Meteosat 2 is still active and will take its final image on 19th July 1991. Its operational life was actually only the seven years between taking over from Meteosat 1 and being replaced by Meteosat 3. Many people will have seen images from this spacecraft as it was used in TV weather forecasting throughout its life.

After taking its final picture, Meteosat 2 will be de-orbited allowing its position in the crowded geostationary orbit to be used by someone else.

Project VADIS
Project VADIS has just been announced as part of the Eureka programme for collaborative research. Aply code name Eureka 625, VADIS is an acronym for Video-Audio Digital Interactive System and aims to develop the
enabling technology to allow digital television with full 625 line resolution to be carried by bitstreams with speeds from 5 to 10 Mb/s. The project will be divided up into five main sections. The first job will be to define the range of applications to be considered by the VADIS project as well as the quality, data rates, video formats, security encryption and overall compatibility. Following this the algorithms necessary to compress the 216 Mb/s video and audio data by 20 to 40 times to achieve the target 5 to 10 Mb/s will be worked out.

The development of systems to multiplex video, audio and data into a single bitstream will follow on from the algorithm development until finally the hardware and software will be designed into VLSI chips to allow real applications to be created. After field trials are completed the eventual aim of the project will be to apply the technology in terrestrial and satellite broadcasting. An international partnership including most of the big names in telecommunications such as BT, the BBC, Olivetti, Philips, National Transcommunications, and Siemens, has an interest in the project which should see field trials underway by 1993.

**Up to 1250**

To cater for the transfer between current and HDTV systems, the EDTV 1000 upconvertor from National Transcommunications is designed to convert from 625 to 1250 lines.

The usual chicken and egg syndrome means that someone will have to produce an HDTV monitor before anyone transmits an HDTV signal or vice-versa. To overcome this and encourage the release of HDTV monitors, National Transcommunications have an interest in the project which should see field trials underway by 1993.

**Children On CAD**

Part of the fun of being a child is getting your hands and face covered in paint when "learning to become an artist". For the new child that fun has been replaced by electronics.

**RGB Interface**

Converting from RGB to composite video and UHF is now quite easy with the Wild Vision Chroma 100 and 150 series PAL coders. Many modern computers, Commodore Amiga, Atari ST, IBM PC to name but a few, output their colour video images in analogue RGB. The separation of the red, green and blue signals from the synchronisation improves the image by cutting down inter-channel interference - it also makes the video output circuitry of the computer somewhat simpler. Most computers use DACs to convert the numbers in memory into voltages that represent the colour shades on a monitor. The drawback is that RGB is generally incompatible with most TV and video equipment which uses a combined signal made up from red, green, blue colours plus the vertical and horizontal synchronisation information. Converting to composite video, as it is known, has, in the past, usually meant constructing some sort of special circuit.

The 100 series PAL coder takes 50 Hz RGB and outputs PAL encoded composite video for both direct and UHF operation. The Chroma 135 has one composite and one UHF output. The Chroma 150 outputs two composite signals, two RGB and one UHF and incorporates a colour bar test pattern.

Priced at £129 for the 135 and £185 for the 150.
**Innovations**

Yet another portable from Toshiba the 128GBSXe has a 386sx processor and a VGA display.

BT Gets Halfway

BT converts 15 telephone exchanges to digital operation every week and recently announced that it had converted half of the country.

Using the touch-tone dialling system the new exchanges offer much faster connect times plus a host of new facilities. Call diversion, call waiting, three way calling, repeat last call, call barring, charge advice, code calling and reminder call are just a few.

The trunk network which forms the backbone of the telephone system became all digital last year and was the first in the world to do so. It uses more than 1,500,000km of optical fibre allowing voice, data and images to be transmitted at high speed - it has another 10,000km added every week. The 3319th exchange, the halfway stage, was reached on 20th June this year when the Dean of St Paul’s Cathedral in the City of London officially closed the old mechanical exchange and opened the new digital one.

Petit Duo

Toshiba, well known for producing portable computers has just announced the launch of the “smallest printer on the market”. Citizen, known perhaps for its watches, has also launched the World’s smallest printer. According to the specs, they appear to be based around the same engine. Both machines have 24 dot matrix heads and can print on standard office stationary. The only difference seems to be in the sizes, the Toshiba measures 303x80x44mm and weighs 0.85kg whilst the Citizen is just 297x90x50 and weighs 1.17kg. The speeds, battery life and noise output appear to be just about the same as are the prices. The Toshiba Expresswriter 201 and the Citizen PN48 both cost £325.

No Tax

Back in July, PE reported that the new mobile telephone tax may apply to the telepoint phone. However, we can now confirm that this is definitely not the case.

The telepoint system is not classed as a mobile phone according to Roger Best MD of Phonepoint. Telepoint connects into the standard telephone network and does not make any use of radio frequencies set aside for mobile use.

The idea of the tax on mobile telephones was designed identify the mobile phone as a business perk. According to PhonePoint, the CT2 phone is a viable alternative for both residential and office communications, it costs less to operate and there is no comparison to mobile phones.

RSGB Mag

The Radio Society Of Great Britain announced the launch of a new bi-monthly full colour magazine. DIY Radio aims to introduce the fun of amateur radio to school children, housewives, disabled and senior citizens. Each edition will feature construction projects, equipment reviews, news stories, a wall poster, competitions and special offers.

The magazine is only available on subscription at £5 a year from DIY Radio, RSGB, Lambda House, Cranbourne Road, Potters Bar, Herts, EN6 3JE.

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Animated Electronic Circuits

A new piece of software from Labcentre Electronics may revolutionise the way in which the concepts of electronics are taught.

ACE, a forthcoming product from Labcentre is breaking new ground in terms of animated electronic educational software. Circuits are displayed in an animated form that shows the current flowing through the components, meeting resistances, charging capacitors and triggering transistors. As the national curriculum for England and Wales states:

"Pupils should understand the behaviour of a circuit and its components in terms of a model of charge flow"

ACE sets out to do just this. The topics that will be covered in the package include:

- Conductors and insulators
- Series and parallel circuits with bulbs and resistors
- Measuring voltage, current and resistance
- Fuses
- Variable resistors
- Current voltage characteristics
- Internal resistance
- Capacitors
- Diodes and rectification
- Basic transistor circuits

The operation of the software is fully mouse driven and allows the user to point to components such as switches and click them on and off. Current flow is displayed in the form of animated dots with the various potentials in the circuit shown in different colours with different dot spacings. At the bottom of the screen are tape-recorder-like controls which start the current flow, stop it, single step it and eject to the next project.

Designed mainly for use in schools either as an "electronic book" or "dynamic blackboard", the software will also be available for the hobbyist.

Unfortunately, there is a major drawback with the system in that it will only work with an IBM-PC 286 (AT) or higher with MCGA or VGA graphics, it also has to have a mouse. Not too many schools will have these to hand and, although the authors are confident that the software will do well, it remains to be seen if there are enough machines available to allow widespread use.

For more information contact:
Labcentre Electronics
14 Mariner's Drive
Bradford
BD9 4JT
Tel. 0274 542868
This month's trip down silicon valley examines a VGA LCD driver some new serial memory and high side power supply circuits.

Single Vision
The quest for the best personal notebook computer is driving the silicon industry to produce more compact and lower power chips. The latest is an LCD VGA controller from Cirrus Logic. The CL-GD6410 allows a complete VGA subsystem to be implemented using only five chips occupying less than four square inches.

On a monochrome system, the system provides 64 levels of grey and is capable of directly driving 512 colours using an active matrix LCD. In addition, the Simulscan feature enables the chip to drive an analogue CRT at the same time as the LCD.

The additional components required for a complete system are two DRAMs for the video memory, a clock synthesiser and, if a dual panel LCD is used, a 64k x 4 “frame accelerator” memory. The latter can be used to run a 70Hz refresh rate with an input clock of only 14MHz, comparable systems must use a 28MHz clock. The reduce rate allows lower power consumption as does the shutting down of circuitry associated with the CRT when it is not being used.

Serial Interchange
Being able to access memory in a serial fashion is nothing new. However, where most systems have used three or four wires, the Xicor serial EEPROM family uses two. The idea is to allow the same chip socket to be used by devices offering 1k, 2k, 4k, 8k or 16k of memory. The same two pins are used on every chip to communicate with the microprocessor so changing from chip to chip is just a matter of changing the software. The two wire communications protocol also frees up a couple of controller input/output ports to be used for something else. Currently available from Micro Call Ltd (0844 261939) are the X24C01A 1k byte EEPROM and the XA24C08 8k byte EEPROM.

Pump Up The Voltage
The new high-side power supply integrated circuits from Kudos Thame are able to produce regulated 11V output from a 5V power supply. The term high-side refers to positioning of a switch between the positive supply and the load – low side switching is the opposite, the switch goes between the load and the negative supply.

The MAX622 and MAX623 are ideal for providing the higher gate voltages required by low-cost N-channel MOSFET switches. The high-side aspect of the system avoids the requirement for costly P-channel MOSFETs, PNP transistors and logic level MOSFETs in switching and control applications where only low supply voltages are present.

The chips operate around charge pump convertors which eliminate switching regulators and the associated cost, size and EM (electro-magnetic) interference of inductors. The MAX622 requires only three inexpensive capacitors for a complete circuit while the MAX623 has them built in and needs no external components.

Able to operate from supply ranges from +3.5V to +16.5V and having a quiescent supply current of only 70µA, they are ideal for battery powered switching applications such as changing over from mains adaptors to internal batteries and battery load management. A useful facility is the power ready output which indicates that the high side supply has reached an operational level. For more information contact Kudos Thame on 0734 351010.
In The Beginning Was The Telephone

The modern office uses more technology than ever before. James Carter observes the current trends and looks at some of the latest gear.

Before the telephone the height of office technology was probably the fountain pen. The telephone revolutionised communications, especially business communications and forced the start of a technology race that started with the typewriter and has so far reached the personal computer.

Jack Of All Trades
The first computers were huge unreliable affairs built up from hundreds of valves and taking up whole rooms. To begin with they were mainly used by scientists for research purposes but, by 1951, the first business computer had been built. The Lyons Electronic Office or LEO was custom built by J Lyons & Company to run the payroll and by 1957 was producing the weekly payslips for 15,000 employees. This machine was a far cry from the sophisticated desktop machines that are now commonplace and it was not until the advent of large scale integrated circuits in the 1970s that the size revolution began.

When microprocessor based systems first appeared the maximum memory was around 64k with 8in disk drives using an Intel 8080 and the CP/M operating system. Things moved on to 5.25in disks and a Zilog Z80 microprocessor but the basic operation was still the same. Many of the early PC applications appeared at this stage. Wordprocessing took off with the infamous Wordstar and databases and spreadsheets started to become commonplace. However, until the increase in processing power enabled high resolution video screens to be catered for, graphics applications and games were quite rare and nothing compared to what is available nowadays.

Modern personal computers fall into three main categories, those built around the IBM PC architecture using the Intel 80x86 range of microprocessors, the Macintosh range, manufactured by Apple and the rest, Unix, Xenix, CPM, Sun workstations and so on.

The IBM PC compatible is the main workhorse of the small and medium sized office. The bottom of the range machines, known as the PC XT, use the Intel 8088 or 8086 microprocessor and have between 512kb and 640kb of memory. Disk storage is mainly on floppy disks though small hard disk drives capable of holding 10Mb to 20Mb are now cheap enough to be added on. These machines are generally used for wordprocessing, running small payroll and accounting systems and small spreadsheets. Unfortunately they are slow and have now been superceded by the IBM AT which comes with a hard disk drive as standard and an Intel 80286 (i286) microprocessor. Giving up to ten times the processing speed it is able to run reasonably sized databases and large spreadsheets. A limitation is the
i286's inability to run programs properly in areas of memory larger than 640kb.

One of the big advantages of the PC type machine is its expandability. By placing extra printed circuit boards or cards in the back, its capabilities can be considerably enhanced. Cards are available for a wide range of applications from high definition video displays and MIDI (Musical Instrument Digital Interface) controllers to extra hard disk drives and modems.

Most of the latest PCs use the i386 microprocessor which improves the processing speed dramatically and gives access to more memory.

At the top of the range are PCs using the latest Intel microprocessor, the i486. These are still in the minority but are finding applications in banking with large spreadsheets and other applications that require very high performance in a small desktop computer.

Although not as widely used as the PC, the Apple Macintosh range of computers has had a very large effect on the way in which software is presented to the user. The GUI or graphical user interface was pioneered by Apple in its early Macs. Instead of the command line interpreter and the dreaded A> prompt, windows, icons, a menus and a pointer (WIMP) are used to manipulate files and data. By setting standards for ways in which things are done, the time taken to learn a new application is dramatically decreased. In addition, the inhearently graphical nature of the machine means that it finds many applications in desktop publishing (DTP). The difference and rivalry between the Mac and the PC is such that dedicated users of either machine won’t even consider the other – Mac users are among the most evangelical of computer people.

The future of the office computer seems to be heading towards smaller and more powerful machines. Laptop computers offering the similar power to large desktop PCs are becoming common and they have the advantage that they can be folded up and put away when not in use instead of taking up a large chunk of desk space.

Getting It Out

The essential add-on or peripheral for the office computer is a printer. This provides a way to reproduce the results of an application in hard-copy form. In the early days, the quality was not considered too...
If you're serious about electronics... this is essential reading

Whether electronics is your profession or simply an absorbing hobby, these manuals are the definitive reference source.

The Electronics Repair Manual takes you from basic principles and theory through to the repair and maintenance of TV’s, radios, home computers... and much more.

Hobbiest or professional, you'll find a wealth of useful information clearly and concisely presented here. Information that is updated regularly by supplements of over 150 pages every two to three months.

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For anyone with a passion for how things work and how to build them the Modern Amateur Electronics Manual is a must. Page after page of projects to build and enjoy, ready to use PCB layouts, simple, precise instructions which are fully illustrated, offer hours upon hours of pleasure. And, like the Electronics Repair Manual, this book goes on growing, supplement by supplement, guaranteeing that it remains the finest reference work available.

As Mr. Lawson, Liverpool said: "As I am studying Electronics at Fleetwood Nautical College each and every supplement which I have received has been extremely beneficial. I would be lost without the manuals at my side. Thank you,"

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September 1991 Practical Electronics
important since printouts were only for payslips, account listings and so on. As wordprocessors developed the quality of printouts had to improve to compete with typewriters. The first high quality systems employed daisy wheels - a rimless spoked disk with a letter on the end of each spoke. Spinning the daisy wheel until the required spoke was in position and then using a solenoid to punch it onto the paper through a ribbon allowed print of the same quality as typewriters to be produced. The main drawbacks were speed and noise pollution - a daisy wheel printer in action sounds a bit like the start of a revolution.

The main competitor to the daisy wheel, the dot matrix printer, originally produced poor quality output since the characters were made up from a matrix of points and the resolution was only about 72 dots per inch (dpi) vertically and horizontally. This could be improved by overprinting characters so that the dots didn’t show too much but was still not as good as the noisy daisy. The major improvement for dot matrix printers came with the increase of the number of dot wires in the print head from 9 to 24, increasing the resolution to around 210 dpi. Unfortunately by this time, the laser printer had come to the fore and was falling in price offering 300 dpi at much higher speeds - up to 18 pages a minute - all very quietly. In addition they offered a selection of printing fonts allowing output that was almost indistinguishable from professional printed matter.

Most offices are now able to produce very high quality documents but are limited by the laser’s monochrome output.

Colour printers, though still expensive, are now available that give 300dpi resolution and 16.7 million colours in a box the same size as a laser printer and at only a quarter of the speed.

Computer Speak

Communications is what holds modern commerce together. Since its invention in 1876 by Alexander Graham Bell, the telephone has been the mainstay of business. It has evolved far beyond the wildest dreams of the early pioneers with its ability to reach pretty well anywhere on the globe in under a minute. Obviously there has to be a telephone at either end of the link but the system has now become so widespread that, in many countries it is taken for granted.

Apart from simple voice contact, the telephone is also used for the transfer of data and images. The modem (modulator demodulator) is the device which allowed high speed communications between computer to become commonplace. The facsimile or fax machine depends upon it for its operation.

The Fax uses a long CCD (charge coupled device) sensor positioned at right angles to the paper to scan
the image as it is moved past. The data is coded up either as ons and offs for black and white, or as a representation of the darkness of the image, and then pushed through a modem and converted into tones compatible with the telephone line. At the other end another fax pulls in the signals in through its modem and converts them back into an image using an electronic print head that generates marks on heat sensitive paper. A single page of A4 can be transmitted in under a minute allowing both text and images to be efficiently transferred from place to place.

The other main use for the modem is in communicating between computers. Until recently this was used mainly to send data from a host of satellite computers to a central system which could, for example, collate the days sales from around the country.

On a mainly amateur basis, the bulletin board has been around for some years. It provides a central computer upon which data can be stored and messages (E-Mail or electronic mail) left to be picked up by other computers as they ring in. This has developed into the on-line information service which provides data on everything from a synopsis of the days newspapers and stock market reports to multi-user interactive games such as MUD (Multi-User Dungeon). The other development has been the rise of the on-line conferencing system. Pioneered by Byte, the US computer magazine. The UK version, CIX, has conferences covering a wide range of subjects.

**Data Stores**

The next major innovation which will change the operation of the modern office is the CD-ROM. This provides a vast amount of data in a small compact unit. Although not widely used, disks containing the UK telephone directory and the Oxford English Dictionary provide quick access to vital data.

The main problem with CD ROM units is that there is no set way in which to access the data on the disk. Each tends to have its own programs to do this, some are good, others are pretty awful. Hopefully increased demand will force the manufacturers and publishers to get together to create a standard format.

**The End of The Office**

The increased capability and decreased price of office technology could eventually spell the end of travelling to work.

It is now quite possible to set up an office at home with all the essentials, computer, printer, fax, telephone and modem, all fitting on a single desktop.

Whether the advantages outweigh the disadvantages isn't known yet as working at home is still on a small scale. However, not having to commute to work every day definitely has its plus points.
Talking Multitester. Press a button on the probe and the meter will call out its reading in clear English. The reading is also shown on the units large, easy to read LCD display. Features autoranging, autopolarity, continuity sounder, diode-check and over-range indicators. Measures to 1000 VDC, 750 VAC, 300mA AC/DC, 30 megohms resistance. Requires 4 "AA" batteries.

Digital Multimeter. Full autorange or manual range control, selectable by a switch. Easy to read LCD display. Ideal for use in the field, lab, shop, bench or home. Fold-out stand allows you to adjust position for better visibility or to hang unit. Features continuity check, autopolarity, diode-check and low battery indicator. Measures to 1000 VDC, 750 VAC, 200 mA AC/DC, 20 megohms resistance. Requires 2 "AA" batteries.
Who Said The Valve Was Dead?

Jeff Macauley's high quality audio amplifier has been tested by the most discerning listeners we could find. The verdict? "Excellent".

What makes a good power amplifier? A simple enough question you may think but the answer depends on who you ask. There are many in the audio fraternity who would suggest that only valve amps posses good sound. Others believe that valve sound is a load of hokum and would point to solid state reliability and minuscule THD (Total Harmonic Distortion) figures. Yet others believe that any amp can be improved by stuffing the circuit with expensive components.

The first thing to realise is that an amplifier is a device which makes an enlarged copy of an input signal. To so this without violating the laws of physics the extra energy is supplied by a DC power supply. Obviously in order to produce a good copy the first requirement is that the power supply voltage should not vary with the changing signal level. This is a tall order and the reason why many people have expended a great deal of money on super power supplies. An easier and definitely cheaper method is to design the circuitry so that it ignores power supply variations. Properly done this is much more effective.

Another train of thought suggests that amplifiers should be designed with the minimum amount of components on the principle that the less circuitry there us, the less sound degradation there should be. This is the minimalist approach. Certainly it is quite possible to build equipment with very few components but Hi-fi, they are not. How good an amplifier is is determined by how closely he output resembles the input. Unfortunately most active devices are far from linear so to do a good job of copying a fairly complex circuit is required to compensate for any shortcomings.

A similar school of though suggests that negative feedback should be banned in audio design. Again, this would be okay if active devices were truly linear. Unfortunately, this is the real world and they're not. Furthermore, many feedbackless designs incorporate local negative feedback to linearise the individual devices.

In The Beginning

The starting point for any circuit is the engineering specification. The design objective was to supply 80W into 8Ω loads. At this point we can work out the required RMS (Root Mean Squared) from the relation: $V_{\text{RMS}} = \sqrt{PR}$ where P is the required power and R is the load resistance. This works out at just over 25VRMS. The peak to peak voltage is some 2.8 times greater at about 71V. Similarly the peak current requirement can be calculated at 4.5A. Obviously these are the bare minimum figures and any practical circuit will require extra margins to cope with stage saturation and power supply regulation.

These considerations set the parameters of the output devices which in turn set the driver stage specifications. It is customary, with power amp circuits to describe operation from the output stage backward. This convention has, presumably, come about because the output stage is the heart of an amplifier. Indeed the rest of the circuitry merely supports the output stage's critical rôle.

There are plenty of suitable power transistors that could have been used but for this circuit VFETs were chosen. When these were first introduced a few years back they were heralded as the successors to...
Anode
Grid
Heater
Cathode

Fig. 1. Triode schematic and typical operating curves.

bipolar transistors. They certainly have a lot going for them. For starters, they are immune to short circuits, have exceptionally high input impedance and tend to turn themselves off when they get hot. This latter feature is extremely significant. It means that the amount of heatsink required is determined solely by how hot you can tolerate the heatsink. Normal bipolar on the other hand will self-destruct unless elaborate precautions are taken to ensure that the temperature rise stays within strict limits.

Another advantage of the VFET is that its operation at low currents is far more linear than normal transistors leading to better crossover performance. In fact the only fly in the ointment is the large gate to source capacitances of these devices. These need to be charged and discharged with every signal cycle. However, by using the devices in the source follower mode this capacitance is effectively bootstrapped reducing drive requirement. Probably the only reason that we still use bipolar output stages at all is one of economics. VFETs, at present, cost about three times more than equivalent bipolar.

The devices chosen for the output stage are a complementary pair rated at 140V and 12A peak current. More than adequate.

In The Circuit
Starting at the output if the system, Q4 and Q5 are used in the source follower mode. Equivalent to the more familiar emitter follower configuration found in bipolar circuitry. Together they form a fully complementary output stage. The only additional components, R5 and R6 are included to ensure stability. Output signals are coupled to the speaker by C3. An important point here is the DC blocking action of this capacitor. Although a fault in the output stage is almost unheard of with these devices, it's still possible. If, for example, Q4 or Q5 were to become short circuited a directly coupled speaker would not last long enough for the plug to be pulled out. Speaker systems are very expensive compared to VFETs...

In order to drive the output stage properly, the driver circuit must be capable of charging and discharging the gate source capacitances whilst maintaining correct bias to avoid crossover distortion. For this reason the driver stage operates with 5mA of current.

The driver itself is a hybrid cascode comprising Q1 and V1. The first needs to have a high gain and low noise. The device used is actually half of a SSM2210 dual transistor per channel. This device features a noise voltage of only 0.7nV/√Hz and a guaranteed high current gain of 550 at 10μA collector current. The high gain means that the device makes an excellent voltage to current convertor. Note the absence of an emitter resistor. This is because the transistor is being used 'open loop'.

The only resistance in the circuit is the internal emitter resistance. In a silicon transistor this is equal to 26/IC where IC is in mA.

The series pass element is the valve V1. This needs to be a device of rather special qualities to accurately transmit the current.

The Cascode Amplifier
The cascode circuit first saw the light of day as an RF amplifier and has a substantially better response than the usual common emitter stage normally encountered as a voltage amplifier.

Fig. 2a shows both a common emitter amp with a simple cascode in 2b. Looking first at the common emitter stage, this acts as an efficient voltage amplifier but suffers from a couple of disadvantages. The major one is that the parasitic collector to base capacitance Cc allows high frequencies to find their way back to the base. This gives unwanted negative feedback at high frequencies and is known as the Miller effect. This gives premature curtailment of high frequency response.

From the point of view of an audio amplifier the overall performance of the common emitter stage is disappointing. Apart from the high frequency drop off, the input impedance...
MOSCODE Amplifier

is low and the distortion, especially at high output levels will be high. Output impedance is also quite high depending on the value of the collector load resistor.

Fig. 2b shows the basic cascode stage. This has two transistors connected in series. Q1 and Q2 are biased from the resistive divider R1, R2 and R3. C1 removes any AC signals from the base of Q2. Due to normal transistor action the emitter will sit at about 0.6V below the voltage applied to its base. It therefore provides a smooth DC level for Q1. Q1 is actually operating as an emitter follower. Signals across R4 will mirror input signals applied to the base both in amplitude and phase. Q1 has two functions. Firstly it converts the incoming signal into current variations to drive Q2 – it is a transconductance amplifier. Second, it provides a fairly high impedance to the input. Because the voltage at Q1’s collector is held constant by Q2’s emitter Miller feedback through the parasitic capacitance Cc cannot occur.

Q2 is operated in the common base mode. Current from Q1 appears across R5 as an output voltage. Because of the high drive impedance produced by Q1’s collector, the operation of this transistor is extremely linear. Again, the parasitic capacitance between the collector and base has no real effect because Q1 effectively earths signal voltages fed back to its base.

The cascode is a fair imitation of a perfect amplifying stage from the viewpoint of linearity. The HF response is also many times more linear than the common emitter stage.

signal provided by Q1.

At this stage it is as well to describe exactly why a valve is being used in the circuit at all. To start with, a transistor would have lost signals due to the base current since a transistor operates by current amplification. The base current will therefore vary during each signal cycle resulting in distortion. Using a suitable JFET instead of V1, would introduce the problem of source gate capacitance. Although the input impedance is low, most available devices would suffer from loss of top due to this capacitance shunting high frequencies to ground. Lastly, valves are very linear devices, more so than the majority of FETs and their characteristics are nearly constant from device to device – something that cannot be said of either transistors or FETs.

The valve is essentially the ideal device for this application. When used correctly the cathode current equals the anode current at all signal levels. Very low grid cathode current ensures that all the signals get to the output regardless of frequency. By using this hybrid configuration the best of all possible

Fig. 3. The main circuit.
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<thead>
<tr>
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<th>Issue</th>
<th>Board type</th>
<th>Size(wXh)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE Chronos</td>
<td>May-August 91</td>
<td>Input board, double-sided</td>
<td>160mm X 102mm</td>
<td>£19.56</td>
</tr>
<tr>
<td>PE Lux 3 Boards</td>
<td>August 91</td>
<td>Control, single sided</td>
<td>174mm X 105mm</td>
<td>£19.56</td>
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<tr>
<td>(Tripping the light fantastic)</td>
<td></td>
<td>Lamp driver, single sided</td>
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<tr>
<td>PE Chronos</td>
<td>September</td>
<td>Power supply, single sided</td>
<td>93mm X 59mm</td>
<td>£24.70</td>
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<tr>
<td></td>
<td></td>
<td>Double sided main board</td>
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<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
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<td>5mm Red &amp; Green LEDs</td>
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</tr>
<tr>
<td>5mm Yellow LEDs</td>
<td>0.08</td>
</tr>
<tr>
<td>1µF/50V Axial capacitors.</td>
<td>20 for 1.00</td>
</tr>
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<td>Atari 1MB Upgrade Kit</td>
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<td>1GHz Frequency Counter</td>
<td>83.60</td>
</tr>
<tr>
<td>Mini FM Wireless microphone</td>
<td>12.50</td>
</tr>
<tr>
<td>FM Wireless Microphone</td>
<td>16.49</td>
</tr>
</tbody>
</table>

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The Triode

The electronic age started in 1907 when an engineer name De Forest produced the world's first amplifying device, the triode. It had been known from Edison's experiments that a current flow could be produced between a heated filament and a metal plate inside an evacuated glass bulb when the plate was held at a positive potential compared to the filament. It was also observed that the current wouldn't flow when the plate was made negative with respect to the filament.

The reason for this rather puzzling state of affairs is that a heated filament in a vacuum ejects free electrons from its surface. A nearby positively charged plate will attract these so a current flows between them. Conversely, a negatively charged plate would repel these electrons and no current is able to flow.

worlds is obtained with very high linearity before feedback is applied.

The valve, an 6CA7, is an output pentode more normally encountered in the output stages of high power amps. Here, to improve the linearity of the circuit, the valve is being used as a triode.

This is achieved by connecting G3 to cathode and G2 to the anode. G1, which would normally be the input terminal is connected directly to ground. The consequence of this is that the cathode voltage is raised above ground by a few volts and this voltage acts as a low impedance stable supply for Q1.

Triode connection ensures that the anode and cathode currents are identical. It also alters the characteristics of the valve which become far more linear. The choice of the 6CA7 is deliberate in that it is one of the few valves on the market that can supply the high voltage swings necessary when operated from a low voltage source. Also, this allows the whole circuit to be directly coupled ensuring better transient response and no phase problems at the frequency extremes.

The performance graph of the valve is shown in Fig. 4. Note that the load line, the line which cuts the anode current/voltage to grid voltage lines, intersects the current axis at twice the quiescent value and the voltage axis at 95V. The limits of performance are indicated by the points at which this load line crosses Vg1=0V line.

The rest of the driver circuit consists of R4 and R3, connected in series. Here the simplicity of a VFET output circuit comes to the fore. Bias is set simply by the voltage drop across R4. Similarly there is no need for the usual small value resistors in series with the output devices to prevent crossover distortion.

Because we have open loop gain in the driver circuit it is possible to produce a very simple high quality amplifier by using shunt feedback. The output voltage at the source of Q4 and Q5 is applied to the voltage divider comprising R7 and R2. As a result the voltage at the output will rise until 0.6V is applied to Q1's base where it stabilises. By suitable choice of R7 and R2, the output is held at the correct voltage for maximum linear output voltage swings.

With a shunt feedback amplifier of this kind, the feedback reduces the input impedance seen at the base of Q1. As far as signals are concerned it's virtually at earth potential - which is why its called a virtual earth amplifier. The voltage gain is set by the ratio of R7 to R1.
C1 simply acts as a DC block for input signals while providing a short circuit at audio frequencies.

Having described the main amplifier circuitry in outline there are some practical aspects which also need attention. Because we are using a valve as one of the active elements it follows that it will be some seconds before this device switches on. It takes time for the heater to reach operating temperature and this has serious consequences for the speaker.

If no special precautions are taken, the full line voltage would find its way onto Q4’s gate. This would switch hard on and C3, be initially discharged, would pass an enormous current pulse to the speaker. With 100V on the line and an 8Ω load, theoretically a 12.5A pulse would be coupled into the speaker. This is obviously undesirable and some method must be devised to prevent it occurring.

The solution is to supply the line voltage to the driver stage gradually. This is the purpose of Q2, Q3 and the associated circuitry. At switch on C2 is discharged and appears as a short circuit between Q2’s emitter and Q3’s base. The voltage across it rises until prevented by Q3’s base and R8. The Q2 darlington pair emitter follower is supplied with base current by R10. As C2 charges, the voltage across R8 and at the emitter of Q2 rises gently. By the time this voltage has risen to near its final value it has reached its operating level.

One slow start circuit is required to power both channels. What isn’t apparent from the circuit diagram is the hidden function of the circuit. It operates as a super smooth supply for the driver circuitry and isolates the performance of the amplifier from the rest of the power supply. It has a performance comparable to a 317 regulator chip.

Turning to the other end of the circuit, the power supply. This falls naturally into two parts. T1 is the main transformer which, for reasons of compactness and low external magnetic field, is a toroidal component. The secondary voltage is full wave rectified by D1 and D4 and applied to the main smoothing capacitor C4.

T2 is a 6V secondary transformer rated at 4A and supplies the heater voltage for the valves. Each of these takes over one amp of current and
would be a logistical nightmare with regulated DC. Thankfully this is not required. There is no audible hum from the circuit using pure AC provided that the wiring diagram is properly followed. Note especially that one end of the heater circuit is connected to common earth.

Despite the fact that valve heaters are usually specified at 6.3VAC slightly underrunning them extends valve life and has little effect on performance.

**Building It**

Originally a low profile case was to be used with this project. However, getting a ready built case proved impossible. The custom case is made from 2mm aluminium sheet and sections of aluminium channel for the end and side pieces.

Fig. 5. shows the dimensions of the case panels together with the cutout positions. A 10 way PCB connector is used to connect the board, valve-holders and power supply.

Connect the output stage flying leads to the VFETs as shown and make sure that these power devices sit flush against the heatsink. Ensure that there is no electrical connection between the heatsink and the case.

A thin piece of screened lead is used to connect the cathode and grids to the board whilst the other wires are simply hookup cable. First order of business is to mount the board on the bottom panel of the case. Set this aside and complete the panel wiring. The heater wires are required to carry a considerable current continuously and so, 5A twin speaker wire are used. There is no need to twist these wires together, simply run them close to the chassis.

Having finished the panel wiring, check the work thoroughly and then connect the rest of the flying leads to the points shown apart from the line from the tagstrip to H14, and attach the PCB connectors.

**Setting Up**

Before testing the device it is as well to take a few safety precautions. First, put insulating tape across all mains connections including the primary of T2. Double check all the wiring and temporarily disconnect the earth wire from the main plug. Set the slider of PR1 at halfway.

Now connect a 100Ω resistor between the plus terminal of C4 and the drains of Q4/4A. Connect a multimeter, switched to a voltage range which will clearly show 100VDC, between ground and Q2's emitter.

Switch the circuit on. The voltage should gently rise to a maximum set by PR3. If this doesn't occur, or worse, the 100Ω starts to smoke, switch off immediately. You have a wiring fault. Assuming that all is well, slowly adjust PR1 or 95VDC. The voltage will continue to rise after any adjustment so it needs to be done slowly.

The valve heaters should begin to glow a few seconds after switch on. Measure the voltage at the sources of Q4/5 and the other channel Q4A/5A. This should measure around 55V. A couple of volts either way is of no consequence. Assuming all is well, remove the 100Ω resistor and replace it with a wire link and the amplifier is now functional. All that remains is to screw the case together and test it out with some music.

The sensitivity of the amplifier, for full output, is some 500mV. This can be easily obtained from almost any preamp. If you have a CD system, the amplifier can be used via a passive preamp – simply a potentiometer arranged as a potential divider will do. Any loudspeakers rated at 80W and up can be used with the amp including 4Ω types although the output level will be reduced.

**Components**

<table>
<thead>
<tr>
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</tr>
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<td>R10</td>
<td>150k</td>
</tr>
<tr>
<td>PR1*</td>
<td>10k horz preset min</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
<th></th>
</tr>
</thead>
<tbody>
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<td>C1</td>
<td>10µ/16V</td>
</tr>
<tr>
<td>C2*</td>
<td>100µ/100V</td>
</tr>
<tr>
<td>C3, C4*</td>
<td>4700µ/100V</td>
</tr>
<tr>
<td>C5*</td>
<td>100m/250V</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Active devices</th>
<th></th>
</tr>
</thead>
<tbody>
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<td>Q1</td>
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</tr>
<tr>
<td>Q2*</td>
<td>BD65C</td>
</tr>
<tr>
<td>Q3*</td>
<td>MPSA42</td>
</tr>
<tr>
<td>Q4</td>
<td>2SK135</td>
</tr>
<tr>
<td>Q5</td>
<td>2SJ50</td>
</tr>
<tr>
<td>V1</td>
<td>6CA7</td>
</tr>
<tr>
<td>D1, D2, D3, D4</td>
<td>1N5404</td>
</tr>
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<table>
<thead>
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<th>Miscellaneous</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T1*</td>
<td>240V/AC pnp, 35-0-35V sec 160VA</td>
</tr>
<tr>
<td>T2*</td>
<td>6-0-6V, 4A sec</td>
</tr>
<tr>
<td>2xOctal sockets</td>
<td></td>
</tr>
<tr>
<td>2x10mm grommets</td>
<td></td>
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* devices common to both channels.
Note that these are for one channel only.
Channel 2 components are indicated in the diagrams with an A suffix.

A full kit of parts can be obtained from: Hobtek, The Cottage, 8 Bartholomews, Brighton, East Sussex, BN1 1HG for £189+£5p&p.
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**Camb. Computer Sci** . . . . 54

Mendoscope………………….55

**Cirkit** . . . . . . . . . . 29

Morrison Micros…………….24

**Coles Harding** . . . . . . . .55

MOP……………………..51

**Cricklewood Elec** . . . . . .15

N R Bardwell………………….55

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National Coll of Tech…...15

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**Hi-Tech** . . . . . . . . . . 4

Stewart of Reading………..51

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**Intl. Corr. School** . . . . .60

Tandy……………………..16

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The Summer Consumer Electronics Show

Ian Burley touches the new Sony Mini-Disk, takes control with SIRCS II, examines the latest in multi-media all while dodging the security robots in Chicago.

The twice-yearly US Consumer Electronics Shows, which alternate between Las Vegas (winter) and Chicago (Summer), are a highlight of the electronics calendar. The latest show in Chicago certainly lived up to expectations. Among the notable new products this year was a first-look at the Sony Mini Disk (MD). Sony also previewed SIRCS II, its intelligent networking system for Hi-Fi and video units. Philips officially launched its domestic CD-I multimedia player, Sharp exhibited the first wall-hanging flat-panel LCD colour TVs and Samsung had a domestic robot on show, to name but a few of the attractions.

Sony pulled off the impressive feat of being the star of CES without actually having a show-floor exhibit. Instead, it rented a plush suite at a nearby hotel to show, in a more intimate atmosphere, its MD player alongside an improved version of last year’s star Sony CD innovation - the Data DiskMan electronic book.

Reading about the MD is one thing. Giving a working one (even a prototype) a shake while it is playing is another. The 1Mbit anti-skip buffer memory really works. In fact, it is possible to eject the 2.5in MO (magneto-optical) disk with perfect playback continuing for about three seconds afterwards. If the price is right when the MD goes on sale at the end of next year, joggers will be queuing up for one of Sony’s new babies. Unfortunately, we weren’t treated to a demonstration of the MD-player’s recording capabilities. Apparently the prototype isn’t quite ready to do that in public yet. However, playback quality from sample pre-recorded disks sounded fine.

The New CD-I player from Philips includes Bitstream CD Audio and Photo CD compatibility.
Meanwhile, Philip's show-stopper from the Winter CES in January, DCC (digital compact cassette) didn't make a big public showing this time. A futuristic Memorex ghetto-blaster mock-up based around a DCC player was the only show-floor evidence of DCC I spotted, however behind the scenes plenty of support emerged for DCC. Matsushita (Technics and Panasonic brands) now publicly admits it is the major Japanese backer of DCC. Even Sony has indicated it is seriously researching the possibility of producing DCC-based products even though this could be at the expense of its own DAT (digital audio tape) standard. The major German tape manufacturer, BASF as well as the Tandy Corporation were yet more big names to pledge support for DCC.

The future for personal digital audio is now becoming a bit less confused. DAT looks destined to be restricted to the big-spending hi-fi perfectionist as well as professional studios and even computer storage applications. MD will fit in the middle as a not exactly cheap recording medium at about a tenner for blank 74 minute MO disks, but will be attractive for its shock-proofing, compact dimensions and random track access features. DCC really does look like fulfilling Philips' strategy of replacing the venerable compact cassette as the everyday affordable digital recording medium.

Sony wasn't content to sit on its Mini Disk laurels at the show and followed up the MD marvel with an innovation we'll surely be seeing a lot more of in the future; intelligent and automatic interaction between hi-fi and video components. This is SIRCS II, the MkII Sony Infra Red Control System. SIRCS originally came about in the early 80s when Sony decided to standardise its infra-red remote controllers. This enabled a single remote to be used with several different units, say an amplifier, CD player and the TV or VCR. SIRCS II is a bit of a misnomer as the infra-red aspect takes a back seat to computer-style networking. At the heart of the system is a remarkably small custom IC developed by Sony to provide intelligent inter-component control.

A SIRCS II set up sees all your Sony Hi-Fi, video and TV components linked up by wires with 3.5mm stereo jack connectors. Insert a video into your VCR and not only will the VCR switch itself on, but it will alert the TV and even the Hi-Fi amplifier, if fitted. When you get bored with the video and press play on your CD remote. The Video section of the system will go to sleep - unless it's recording, in which case the TV will switch off but the VCR will remain unaffected. Audio tape sections have similar priorities when in record mode, so if you're recording off a radio tuner this will remain unaffected by the system being prompted to play your laser video disk. What's more, if you try to play, say your CD and there's no disk loaded, the TV will light up with a polite message informing you of the situation.

SIRCS II was demonstrated to a fascinated audience at the Sony hotel suite. Apparently, all Sony's up-market Hi-Fi will have SIRCS II capability as standard quite soon. Whether it's a genuine step forward in home automation or a rather sophisticated gimmick, remains to be seen. No doubt the Hi-Fi purists will reject it out of hand. Unfortunately, Sony isn't offering its SIRCS II technology to anybody else, so inter-make compatibility will be a problem when the competition eventually catches up. JVC exhibited a simpler intelligent components system for its VCR systems called AV Compulink and Bang and Olufsen has been selling an infra-red link system for its Hi-Fi components for some time, though this isn't nearly as advanced as Sony's. Although admitting that an extension of SIRCS II to other household appliances and even a personal computer was technically feasible, Sony won't be producing anything like this in the near future, if ever.
Enough of Sony and on to Samsung, the huge Korean electronics firm. Not usually noted for its innovation, Samsung surprised many at CES with its new domestic robot called Scout-About. This is a dome-shaped device weighing 16lbs and about ten inches high which scuttles about on wheels. It’s a bit like the top of a Dalek! Scout-Abouts aren’t designed to bring you your slippers or a cocktail, instead they’re seen as a robot replacement for the household pet come guard dog. A battery of sensors in the robot makes it a mobile fire and intruder detector. Scout-About can communicate with a static base-unit to call the police or fire service, if necessary, speaking in a pre-recorded digitised voice. The idea is that you position your Scout-About in the middle of a room, which it will patrol up to a radius of thirty feet. Scout-Abouts won’t fall over edges like stairs and another sensor prevents collisions with obstacles lower than 2 feet. Battery charge life is 50 hours and the unit can be used in a static position with an AC adaptor. At an estimated selling price of $1,000 (£625), the Samsung Scout-About is set to be a hot seller in US department stores this Christmas.

Philips has finally done it. Almost five years since its introduction and after countless delays, Compact Disk-Interactive (CD-I) has been launched as a consumer product at last – though in the States only. The European launch won’t be until Spring next year. Under Philips’ Magnavox brand name, the first consumer CD-I player will be on shop shelves in October for the recommended price of $1400 (£875). That’s considerably more expensive than Commodore’s rival CDTV system ($1000) which is based on Commodore Amiga computer internals. However, CD-I is technically superior and it has the backing of industry heavyweights like Matsushita and video-game leaders Nintendo. Those facts alone rated it as most likely to succeed according to many show-visitors. The fact that Nintendo has jumped onto the CD-I bandwagon was a great fillip for Philips if you’ll pardon the pun. Nintendo, which controls a multi-billion dollar video game empire, ditched a rival CD-multimedia development with Sony called Playstation by switching allegiance to CD-I. Another plus for CD-I is that Kodak’s Photo CD standard is to be added to the CD-I specification. CD-I full-screen motion picture video is not yet...
ready, which is partly why the European launch has been delayed, but upgrades will be available to initial CD-I buyers in the States hopefully early next year.

Commodore started shipping their CDTV system six months late in May. It has more software out now than Philips, but it will never be able to match the specially developed CD-I hardware for motion video playback quality. In fact some of Commodore's partial-screen motion video demonstrations at the show were decidedly grotty. After the show opened, Commodore announced that Kodak Photo CD compatibility would also be added to the CDTV spec. but this was soon countered by a statement from Kodak questioning if this was technically possible without a major hardware redesign of the CDTV. CES saw just the first of several major battles to come between CDTV and CD-I in the war to find a consumer multimedia victor...

NEC had a tiny corner of its video-game exhibit showing something far more interesting than any PC-Engine or TurboGrafx console. Here I stumbled across NEC's NID, which stands for New Interactive Display. Yes, this is another entrant in the CD ROM-based multimedia race but so far the only one to display a working full-screen motion video system destined for a consumer product and vastly superior looking to Intel's DVI (digital video interactive) full-screen video.

NID has an incredible 100:1 compression ratio using techniques similar to those of enhanced definition TV (Pal Plus for example). Only parts of the screen which change are digitally captured and portions of the screen which exhibit movement over a certain threshold are digitised in space-saving lower resolution - the human eye can't tell the difference. The result was very impressive, despite some odd colours produced by prototype hardware which was slightly damaged en route from Japan. NID will offer up to 72 minutes of continuous motion video at a resolution of 256x240 pixels as well as a stereo sound track. Exactly where NID will end up as a commercial product remains to be seen.

As for the rest of the show, JVC had a massive 36in diagonal 16:9 aspect ratio TV set, similar in appearance to a wide-screen HDTV. However, this was a decidedly below-average resolution standard 525 line NTSC tube. Why wide-screen? To get rid of the pillar box effect of cinemascope-style movies of course. In ordinary TV mode the spare picture space is used for viewing other channels simultaneously in miniature.

Sharp got the vote for the least taste award at CES. Apparently there is a sizeable market in Japan for its impressive range of ever larger active matrix colour LCD screens, used as wall hanging TVs. So what? To hang an LCD on the wall, you need to put it in a picture frame according to Sharp - and you should have seen some of the frames they're offering.

Panasonic might have at last solved the seemingly insurmountable problem of designing an infra-red remote control which even Mensa members can figure out how to use. Panasonic's Program Director dispenses with buttons and incorporates thumb-wheels instead. It's a brilliant idea and should have been thought of ages ago.

Finally, how about using the mains electricity wiring in your home as a telephone extension? The Utah-based firm, Phonex, has done just that. Using the mains for intercoms and even computer networks is old hat, but this is the first time I've seen a cordless phone extension system like this. The advantages are obvious: no excessive REN (ringer equivalence number) loading and a phone socket in every room. A mains extension cable becomes a phone extension! Range is said to be 1000 feet. The problem of neighbours listening in to your calls is apparently solved by an attenuator at the electricity meter. Future plans include a security encoded link and a UK version for BABT approval.
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Incoming light reaches the surface of the integrated stripe filter after passing through the automatic iris control lens (AIC), the colour temperature conversion filter (for artificial light or sunlight conditions variation) and finally through the crystal filter.

The white balance switch inserts a diffusion filter in the light path between the automatic iris control lens and the colour conversion filter to enable a computation of "white" diffused light in the available illumination.

The crystal filter helps to eliminate any false interference patterns when fine detail is viewed.

The stripe filter converts the incoming light into a 5MHz modulated signal containing the red and blue components and the green signal.

The pre-amp takes the pick-up tube signal (0.2µA to 0.3µA) and amplifies it for delivery to the signal processing circuits using a low output impedance and negative feedback low noise FET input amplifier with a "Percival" low noise circuit to improve the signal to noise ratio for the relatively high frequencies. Only the luminance (Y) signal passes through the 5MHz trap together with the mean value of red and blue signals (modulated). The Y signal passes to the 4MHz and the 0.7MHz low pass filters. The high frequency response \((Y_H)\) passes to the Y/chroma mix circuit and the low frequency (Y) signal to the R-YL and B-YL modulator circuitry.

The 5MHz band pass filter allows only the 5MHz frequency zone to pass to the 90° phase shift and 1H delay circuitry – inverting the 1H delayed modulated signal and adding it to the 90° delayed signal creates the Rc signal and subtracting the inverted 1H-delayed modulated signal from the 90° delay signal creates the Bc signal. The detector circuits provide the modulators with the R-YL and the B-YL signals to create the chrominance (chroma) signal by mixing.

The PAL signal composite is created by mixing the chroma signal with the luminance \((Y_H)\) signal.
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The demand for increased monitor resolution for use in Desktop Publishing, CAD and other graphics applications has lead National Semiconductor to develop some specialised video driver chips. Amongst them are the LH2426 and LM1201. The first is a triple 80MHz driver which can provide the red, green and blue signals directly to a cathode ray tube (CRT). The second is a wideband video amplifier which contains a brightness control and DC restoration voltage for the video signal.

Many modern computers provide analogue video output signals that allow access to a large range of colours or grey scale. These signals usually come from a digital to analogue convertor (DAC) controlled by a graphics processor within the computer. In the monitor these signals have to be amplified and conditioned from the 1V peak to peak (pp) of the computer to the 40Vpp needed to drive the cathode of the CRT.

The monitor's operation is split into two main sections, a low voltage video amplifier and a high voltage CRT driver. Each pixel of the display has to be energised by a varying amplitude pulse in a time that depends on the resolution. The higher the resolution, the shorter the pixel time and the wider the bandwidth needed. The popular monitor standards and resolutions are shown in table 1. These start at the basic 600x400 VGA PC and go up to the workstation 1280x1024 pixels. The corresponding pixel times for each system is also shown along with the overall rise and fall time for the video channels. There is no hard and fast rule for these times and they can vary between 1/3 and 1/2 of the pixel time depending on performance requirements.

A single complete channel is shown in Fig. 1 with independent adjustment for contrast and brightness included. For the latter, the voltage from the brightness control is sampled by the clamp comparator at the beginning of every line and the use of a feedback loop forces the DC voltage at the cathode to be at the level set by the black level adjust. The clamp comparator is controlled by the back porch pulse derived from the line sync pulse and occurs during the black level reference period of the video waveform.

**LH2426**
This chip contains three wide bandwidth, large signal amplifiers each designed for large voltage swings at high frequencies. The amplifiers work on a transconductance principle – an input current swing of ±4.38mA results in an output voltage swing of ±25V. Features include:
- Operation from an 80V power supply
- 80MHz bandwidth at 50Vpp swings.
- Rise fall time of less than 4ns.
- Output signal swing of 70V.
- Drives a CRT directly.

**LM1201**
Designed for use with high resolution RGB or monochrome monitor applications, this wideband video amplifier has a number of features that help reduce chip count. The chip contains a gated differential input black level clamp comparator for brightness control and an attenuator circuit for contrast control. The main features of the circuit are:
- 200MHz @-3dB wideband amplifier.
- Attenuator circuit for contrast control.

**Operational Ratings**

**LM1201**
- Supply voltage Vcc, Pins 10, 12, 15, to gnd pins 1, 7: 12V
- Max voltage at any input pin Vcc: 28mA
- Video output current: 1.56W
- Power dissipation: 5°C to 70°C
- Operating temperature range: 0°C to 70°C

**LH2426**
- Supply voltage: +80V
- Power dissipation: 10W
- Operating temperature range: -20°C to +90°C
## Monitor Standards

<table>
<thead>
<tr>
<th>System</th>
<th>Resolution</th>
<th>Chip set</th>
<th>Pixel time</th>
<th>Rise and fall time</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGA</td>
<td>640x480</td>
<td>LM1203+LM2416CT</td>
<td>42ns</td>
<td>21 - 14ns</td>
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<tr>
<td>Super VGA</td>
<td>800x600</td>
<td>LM1203+LM2416T</td>
<td>29ns</td>
<td>14.5 - 9.6ns</td>
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<tr>
<td>8514/A interlaced</td>
<td>1024x768</td>
<td>LM1203+LM2416T</td>
<td>22ns</td>
<td>11 - 7.3ns</td>
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<tr>
<td>PC-CAD non-interlaced</td>
<td>1024x768</td>
<td>LM1203+3xP43+LH2426</td>
<td>16ns</td>
<td>8 - 5.3ns</td>
</tr>
<tr>
<td>Work Station</td>
<td>1024x1024</td>
<td>LH2440, LH2422</td>
<td>14ns</td>
<td>7 - 4.6</td>
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<tr>
<td>Work Station</td>
<td>1280x1024</td>
<td>LH2440A, LH2424, LH3424</td>
<td>12ns</td>
<td>6 - 4ns</td>
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<tr>
<td>Work Station</td>
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<td>LM1203+3xP43+LH2426</td>
<td>9.8ns</td>
<td>4.3 - 3.3ns</td>
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<tr>
<td>Work Station</td>
<td>1024x1024</td>
<td>LH2440, LH2422</td>
<td>14ns</td>
<td>7 - 4.6</td>
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<tr>
<td>Work Station</td>
<td>1280x1024</td>
<td>LH2440A, LH2424, LH3424</td>
<td>12ns</td>
<td>6 - 4ns</td>
</tr>
</tbody>
</table>

P43 is a process 43 transistor 2N5770 or PN2564

Table 1.

---

- Externally gated comparator for brightness control.
- Provisions for external gain and peaking of video amplifier.
- Video input voltage reference.
- Low impedance output driver.

Also available is the LM1203, a triple version of the 1201, which is designed for use with resolutions up to 1024 x 768 and RGB.

---

Fig. 1.

- AC gain adjust
- Black level adjust
- Brightness adjust
- Black porch clamp input
- Contrast control 10k
- Brightness control
- Output stage
- LM2426
- LM1201

---

September 1991 Practical Electronics 33
Practical Components.
The Battery

Batteries are an indispensable part, necessary to all portable electronic equipment. This month's components looks at the variety available.

Invented around 200 years ago, the battery has become a vital part of modern mobile electronics. The first battery was a stack of zinc and silver coins separated by discs of paper soaked in brine. It was invented by Alessandro Volta who eventually gave his name to the unit of electromotive force, the Volt.

Batteries come in two main types, primary and secondary. The first are one-shot and an irreversible chemical reaction produces the energy. These are the most common types but are gradually being replaced by secondary or rechargeable cells. The most commonly used of these are lead acid and nickel cadmium.

Another device that can be classed as a battery is the solar cell. This makes use of the photo-electric effect in a semiconductor. When the junction of two differently doped pieces of semiconductor have light shone on them, electrons are liberated causing a small voltage to be generated. Solar cells have to be placed in series and parallel to provide energy in workable quantities.

Elements Of A Battery
A battery is made up from a series of cells connected in either series or parallel to increase the resulting voltage or current. The main features are:

- The electrodes, the anode and cathode, which also form the electrical contacts
- The electrolyte which allows the movement of electrons from cathode to anode and aids the chemical reaction
- The case, which may be sealed to prevent leakage or open to allow gases to escape

Recharging
The most popular rechargeable batteries are on the lead acid and nickel cadmium types. The first are used mainly in cars and are generally quite bulky. NiCd's, on the other hand, offer direct replacements for all of the standard sizes used in modern portable electronic equipment.

Charging up a NiCd is not simply a matter of connecting it up to a source of power. A constant current source must be used giving 45mA at the correct cell voltage of around 1.45V. For a faster charge, 150mA current can be used but this reduces the discharge time - the longer it takes to charge a battery, the longer it lasts.
Batteries

Standard battery sizes.

<table>
<thead>
<tr>
<th>Battery Type</th>
<th>Size</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>UM5</td>
<td>1.5V</td>
</tr>
<tr>
<td>Lady</td>
<td></td>
<td>1.5V</td>
</tr>
<tr>
<td>HP16</td>
<td>AAA</td>
<td>1.5V</td>
</tr>
<tr>
<td>HP7</td>
<td>AA</td>
<td>1.5V</td>
</tr>
<tr>
<td>HP11</td>
<td>C</td>
<td>1.5V</td>
</tr>
<tr>
<td>HP2</td>
<td>UM1</td>
<td>1.5V</td>
</tr>
<tr>
<td>D</td>
<td>UM2</td>
<td>1.5V</td>
</tr>
<tr>
<td>C</td>
<td>UM3</td>
<td>1.5V</td>
</tr>
<tr>
<td>PP3, Neda</td>
<td></td>
<td>1.5V</td>
</tr>
<tr>
<td>E-Block, 1604</td>
<td>006P, 6F22</td>
<td>1.5V</td>
</tr>
</tbody>
</table>

Battery types

Zinc carbon or Leclanché cell.
Commonly found in torches, transistor radios and other relatively short term applications, the zinc carbon cell cannot be recharged. It has a zinc cathode and a carbon anode with an electrolyte of ammonium chloride paste. A depolariser of manganese dioxide is distributed around the anode and mixed with powdered carbon (graphite) prevents the build up of hydrogen gas. Another name for this type of cell is a dry cell and it produces a voltage of about 1.5 volts.

The Daniell Cell
This has a zinc cathode and a copper anode. These were placed in a jar with a porous pot barrier in the middle. The cathode side was filled with sulphuric acid and the anode with copper sulphate and the electrodes inserted. This operates as follows:

At the cathode a zinc atom gives up two electrons as it enters the cathode electrolyte as a zinc ion Zn²⁺. This gives the cathode compartment extra charge plus two. To compensate for this two hydroxide ions (OH⁻) with a charge of plus one each pass through the porous separator into the anode compartment. This allows a copper ion to accept two electrons from the anode and deposit itself on the anode as a copper atom. The electrons are made available at the anode because of the external circuit through the load to the cathode.

Lead Acid
Most cars have a battery of this type to turn the starter motor to get the engine going. It is made up from two electrodes of lead, one of which is coated in lead IV oxide, dipped into an electrolyte of sulphuric acid. The output voltage from each cell is around 2V so six cells are connected in series to get a 12V car battery with about 90Ahrs capacity – it can supply 1A for 90 hours or 90A in one hour. Three cells are put together to make a 6V motorcycle battery.

Nickel Cadmium
NiCd batteries are the mainstay of the modern portable rechargeable battery industry. Available in all the popular sizes, a single cell gives out roughly the same voltage as a zinc carbon cell, 1.25V.

Alkaline
Similar to zinc carbon batteries, alkaline cells offer much longer life at higher current drains. Other advantages are longer shelf life, constant output voltage and protection against leakage.

Mercuric Oxide
Usually found in cameras and hearing aids, these offer an output voltage of 1.35V in a very compact package.

Lithium
Made from lithium manganese these cells have an output voltage of 3V and will last for very long periods at low currents. Applications include battery backup for low power CMOS RAM memories.
As above but with fitted 4 to 1 inline reduction box (800mm) and located nylon bolt & bracket drive bolt £40.00 & £28.00.

SINCLAIR CS WHEELS 1/3 or 1/6 including boxed tyre and tube. Wheel 27mm or 15mm diameter. Centre bore 15 mm £6.00 & £6.00, 16 mm £6.00 & £6.00.

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10 BAND COMMUNICATIONS RECEIVER.

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AMSTRAD BARGAIN.

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ASTEC SWITCHED MODE POWER SUPPLY. £300 for complete kit ref 3P140.

DIod. forge plugs into a plug in to stop! £3.00 each ref 3P137.

RF ALARM PANELS. 2 zone cased keypad entry, entry exit time delay. £10.00 Ref 10P145.
This month Tony Smith looks at the main board of his universal counter timer with details on how to put it together and test it.

Fig. 1 shows a photograph of the completed main board, the component overlay is illustrated in Fig. 2. Begin construction by inserting the through board links and rather than installing them all together, it is a good idea to do them in blocks of 15 to 20 – remember to solder both sides of the board.

Insert the diodes and resistors next, again, soldering leads on both sides of the board. Note that there is a choice between the standard crystal oscillator or a ready built DIL oscillator module to act as the Chronos' timebase. Until the choice is made, all relevant components, XTAL1, R79, R80, R81, C57, C58, C59, C60 and VC4 can be omitted. There is also a choice to be made about C50 and C68 so these should be left out for the moment as well.

Solder all the IC sockets into place and then insert the small capacitors. There are several tantalums and a small electrolytic all of which are polarised and must be inserted the right way around.

It is important to solder several capacitors on both sides of the board, C32, C33, C38, C39, C46, C53 and C56. Many capacitors – particularly disk ceramics – are supplied with pre-shaped leads. These kinks should be straightened out before the device is inserted since they add unwanted inductance which can be troublesome, especially where decouplers are concerned.

Next, insert the larger components such as fuseclips, bridge rectifiers, connector plugs and veropins.

Wherever polarised connectors are used in the Chronos, take care that they are inserted so as to match the polarity of their corresponding connectors on the other boards. If this is done correctly, there can be no chance of twisting the interconnecting cables which might otherwise cause considerable circuit damage.

The 5V regulator, IC33, should now be fixed into place and the heatsink seated before bolting it to the board.

Finally, solder in the six large electrolytics into place (C81, C82, C84, C85, C86 and C87). This concludes construction of the main board. Note that the component leads should be cropped right back so as prevent short circuits.

Power Supply

The next step is to connect the transformer secondaries to the main board as in Fig. 3. Temporarily place the rear perpendicularly to the top edge of the main board and locate the panel such that the ext. clock BNC socket is directly above the ext. clock input pins marked Ø. There is no need to assemble the rest of the case as yet.

Now, take the wires from both transformer secondaries along the rear panel and bend them out at right angles to the panels so that they pass over the PSU section of the main board. Then, bend them perpendicularly downwards to the relevant connectors and cut to length.

Next, attach the connector sockets to their wires. It is not important which way round the wires from the 9V transformer go, but the centre-tap wire from the 12V transformer must be connected to the innermost terminal (not the centre terminal) of the three-way connector which attaches to the plug P7 (the other wires can go to either of the other two pins).

Insert the anti-surge fuses F2, F3 and F4 on the main board (See Fig. 2) and also the anti-surge fuse F1 in the rear fuseholder and connect the transformer plugs P5 and P7.

The PSU section of the main board is shown in Fig. 4. Transformer T1 provides power for the entire digital circuitry of the
for an auxiliary +5V output to around 400mA. However, provision for current taken by the 5V sections is by R143 and C81 to provide an unregulated DC supply (nominally +10V) for the 78L05AV, +5V regulators on the input board. The output of IC33 is a stabilised 5V wave rectified by BR1 whose output is smoothed by C82 and C83 such as to supply each input channel with unregulated DC voltages of ±14V. These are then stabilised by the regulators on the input board, with each rail taking no more than 100mA. Thus, a combined capacity of around 200mA max for the positive and negative supply currents is easily catered for by the 250mA fuses and secondary windings.

The 250V VDR (V1) is fixed across the main supply line to provide the Chronos with protection against excessive mains-bound transients. Under normal conditions, the resistance of V1 is very high and has no effect on the circuit at all. However, should a transient spike greater than the 250V clamping voltage of V1 appear on the lines, the resistance of V1 drops dramatically shunting the transient and absorbing the energy. If a series of excessive transients should appear the fuse F1 is likely to be blown providing protection against further damage.

Testing The PSU

Connect mains power to the main input socket and turn on S18. WARNING: MAINS VOLTAGES CAN BE LETHAL. Take care not to touch any live terminals on the rear panel. Note that no ICs should be inserted yet or the input board connected up via plugs P8, P9 and P10.
With the main board resting on a non-conductive surface, use an oscilloscope to check the voltage at the output of the 7805 regulator. Ensure that the voltage is in the range 4.75V to 5.25V and that there is no ripple present. If there is ripple present check that C82 is soldered into place correctly. If there is no voltage at all, check connections from T1 secondaries through BR1 and F2. If the 7805 is getting very hot, look for a short through BR1 and F2. If the 7805 is OK, test the +5V supply should be available at connectors P6, P9 and P11, and also at the veropins directly to the left of P11.

Next, use the scope to check the voltages output at plugs P8 and P10 (the probe ground lead should be connected to zero volts when making all voltage checks). Fig. 3 shows the nominal on-load voltages at P8 and P10. However, as the input board is not yet connected, the no-load voltages should be in the region of +20V, +11V and -20V respectively. There should be negligible ripple voltage on all of these outputs. If there is ripple, check the RC smoothing filter associated with the particular output. If there is no voltage present, trace connections from the transformer through to the outputs.

**Calibrating The Input**

If the PSU section is in order, the input board can be set up and tested. All connections are shown in Fig. 5. The front panel components are connected to the input board using insulated hook-up wire and flexible co-ax.

For the moment it is only necessary to connect VR1 (fine attenu), VR2 (trig level) and S4 (zero trig level) to each input channel. Also, connect R14 to the common terminal of S4. Don't forget to connect the co-ax screens to the relevant terminals as shown in the figure. Before connecting VR1 and VR2, it is best to cut their spindles to the required length. I found the best way to do this is to locate the pots in the front panel, then cut this length off the spindle.

The connections to VR1 and VR2 are shown as though looking at them from the rear such that the direction of clockwise rotation is as shown. It is important to make the connections correctly so that the attenuation caused by VR1 increases with clockwise motion and the trigger level is varied rom negative to positive with clockwise rotation of VR2.

Note, also, that Fig. 5 shows S4 in its zeroed position (on both channels). To determine which terminals are which, rotate VR2 fully anticlockwise such that the switch 'clicks' and use an ohmmeter to find the closed contacts. One of them is the common terminal which must be connected to R14 whilst the other is the ground connection that will also be connected later to SK3. If the connections to S4 are mistakenly swapped around the trigger level becomes zero over the entire span of VR2.

The input board is now ready for testing. Whilst conducting the tests, try not to flex the connections any more than necessary. Remember, also, to test and calibrate both channels.

An oscilloscope with 10MHz
bandwidth is required to carry out the calibration. A non-attenuated probe and a probe with x10 attenuation should also be available. Sine and squarewave generators are required, the first being variable from 50Hz to 500kHz with an amplitude range from 500mV to 5V peak to peak (pp). The squarewave generator should range from 10kHz to 10MHz with amplitude from 500mV to 5V.

A high impedance DVM will also be needed for some of the checks. Before starting the tests, temporarily solder a small capacitor in C7 position (both channels). A 10pF ceramic should be adequate to stop IC1 breaking into spurious oscillation.

### Supply Rail Checks

Connect the three ribbon cables to the main board and switch the mains power on. Initially check that none of the ICs, transistors or regulators is getting very hot. If any of the leads from the squarewave generator as short as possible to the high end of R12. If the scope is used here select the most sensitive range and DC couple the input from a non-attenuated probe.

Now, adjust PR1 to bring the op-amp output to zero. It is essential that S4 is zeroed during this procedure or the trigger offset will also appear at the op-amp output.

Remove the link wire from the input pins such that the input is open circuit. The aim is to find the best combination of C7 and C8 to give optimum op-amp compensation.

The procedure is to couple a 500mV squarewave directly to pin 6 of the op-amp (the junction of R9 and R10). Then at a frequency of 10MHz, observe the op-amp output on the scope and compare it with the input signal.

The aim is to choose the capacitors such that the output is a replica of the input but with ten times the amplitude. It is important that the input signal be as rectangular as possible. It is also essential to use x10 attenuated probes when comparing the signals or else the input capacitance of the scope will cause distortion. Keep the leads from the squarewave generator as short as possible to reduce ringing and connect the ground leads as close as possible to IC1.

---

Figure 4: Power supply circuit.

Figure 5: Connections to the input board.
It is possible to use the clock of the Chronos' timebase for the squarewave. This is a 5V 10MHz signal available at the pin 2 of IC36 on the main board. The signal must first be attenuated to 500mV before feeding it to the op-amp as shown in Fig. 6. The attenuated signal should be fed to the op-amp using a very short length of coax as shown. Remove the resistive divider when the test is completed.

Further Compensation.
The next thing to select is the optimum compensation for the network by trimming VC3. With S2 and S3 still set to AP and x1, DC couple a 500mV 10kHz squarewave to the channel input. Once again, compare the input signal with the op-amp output using unattenuated leads.

Now, carefully adjust VC3 such that the op-amp output is the same as the input. When all the beehive trimmer caps have been adjusted, don't be tempted to apply any kind of sealing compound as this can change the capacitance.

Select x10 attenuation (S3 centre position) and DC couple a 50V, 10kHz squarewave to the channel input - S2 is still set to AP. Use non-attenuated probes to compare this signal with that as the op-amp output. Adjust VC2 to make the signals identical. The same should be done with the x100 attenuation by adjusting VC1.

On The Trigger
Use a short wire link to ground the channel input, select AP filter and x1 attenuation and use a DVM or scope with non-attenuated probe to monitor the output of IC1. With S4 zeroed, the output should be zero. Turn VR2 slightly clockwise so that the switch just clicks and the output voltage should jump to a value in the region of +5V to +6V. Gradually turning VR2 clockwise will cause this voltage to drop, go through zero and end up at -5 to -6V.

For different values of trigger level offset at IC1 output, check that the voltage at the signal monitor output (junction of R20-R21) is the same. Remove the ground link from the input and repeat for the other channel.

Filter Performance
Select zero trigger level and x1 attenuation. AC couple a 500mV peak to peak sinewave to the channel input and select a low pass filter. Keeping the input amplitude constant, vary the frequency in half decade steps from 1kHz up to 500kHz, the amplitude should have fallen to around 500mV peak to peak (PP).

Now select high pass filtering and with the same 500mV input, vary the frequency from 100kHz down to 50Hz. At 10kHz and above, the amplitude at the output of IC1 should be around 4.5V pp. At 1kHz the signal should be down to 3.2V and at 100Hz down to 450mV.

With the trigger level still zero and attenuation still at x1, select all pass filtering and AC couple a 500mV pp sinewave to the channel input. For decade frequency steps from 10Hz to 1MHz or greater check that the signal output from the buffer (junction of R20 and R21) is an undistorted sinewave with 5Vpp amplitude.

If the waveform is distorted, check the signal paths from IC1 and the transistors. If only half the wave is distorted suspect TR2 and TR3 otherwise try TR1 and TR4.

With zero trigger level, x1 attenuation and all pass filtering, ensure that VR1 is set to minimum attenuation (fully anti-clockwise) and set frequency of 500mV input sinewave to about 200Hz. Observe the output of IC1 on a scope this should be a 5Vpp sinewave swinging symmetrically around 0V. The trigger LED should be flashing and the ODR detector LED off.

Now rotate VR2 slightly clockwise so that the switch just clicks. The signal at IC1's output is forced fully positive with the peaks being clipped at around +7V. Because the signal is above the trigger window, the trigger LED should be continuously on. Also, the signal clipping resulting from op-amp saturation is caused by the large trigger level pushing the signal outside the dynamic range.

Slowly turn VR2 clockwise and the clipping of the positive peaks should grow less and eventually disappear. At this point the ODR LED goes out.

Continue turning VR2 clockwise. As the negative peaks pass through zero, the trigger LED should begin to flash. Eventually, as the signal is taken more negative, the positive peaks will fall below zero such that triggering ceases. As the signal is taken fully negative it will be clipped at around -7V.

Set VR2 to its centre position and observe the output from IC5b (pin 4 IC5). This should be a squarewave in phase with the sinewave. Now rotate VR2 clockwise, the duty cycle of the square wave should reduce correspondingly.

Final Test
The last test is with the filters set to AP with x1 attenuation selected. Couple a 200Hz 500mV sinewave to the channel input and set the trigger level to zero. Using a non-attenuated probe, observe the signal on pin 4 of IC4. It should be around 3.5Vpp. Slowly rotate VR1 clockwise so that the amplitude decreases. Eventually there will come a point where the signal is too small to cross the Schmitt trigger thresholds and the trigger LED will stop flashing. The positive and negative peaks of the signal at this point should correspond to the upper and lower threshold voltages respectively - ±70mV give or take a few mV.

If the values are different by more than 30mV then check the level shifting network around R27 to R31 and D5 and D6.

After all of this, check the connections to the board to see that they are still firm after all that flexing around.
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This month’s top ten readers:

P Jones of London NW6 has £150 of the money spent with Cricklewood Electronics refunded.

A Morris of Birmingham who bought £150 worth of goods from Panrix Electronics.

J Singh of Ealing receives £112.95 for buying goods from Tandy.

K Pongs of Tring has the £68.22 he spent with Greenweld refunded.

AR Tizzard-Largs of Ayrshire gets back the £67.40 he spent with Maplin.

CR Rounce from Doncaster is reimbursed £13.33 for trading with Maplin.

J Singh of Ealing receives £112.95 for buying goods from Tandy.

CR Rounce from Doncaster is reimbursed £13.33 for trading with Maplin.

R Aldridge of Ramsgate has £4.27 repaid for his purchase from Tandy.

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September 1991 Practical Electronics 43
The Facsimile Machine
What Are The Fax?

Kevin Jones looks at the technology that enables pictures to be sent down the phone. Now that the prices are falling, are they for everyone?

The facsimile machine or fax looks as though it will soon replace the portable phone as "the latest gadget". Prices are now falling to the point where machines can be purchased not only by businesses as standard office equipment but also by individuals for home use.

The advantage of fax over telephone is not just the ability to send pictures to your friends. It also means that messages can be left when they are out and letters can be sent in the evenings at cheap rates to be read first thing next morning. In addition, an A4 page of text can be sent in under 30sec or so – try reading out a page of text at this speed. Yet another plus is that the machine can be used as a photocopier. The only real drawback at the moment is that not everyone has one.

Until recently the problem of having a fax at home was the requirement for two telephone lines. Fortunately, the use of a fax/telephone/answerphone or a switch box means that now, systems can be run on a single line. For anyone thinking of purchasing a fax and who doesn't already have an answerphone, the combined option is the best. A machine which incorporates all of the latest telecommunications gear in one box such as the Amstrad FX9600AT, although not cheap, provides a neat solution.

Voice Or Tone

For anyone who already owns an answerphone, the switchbox is the way to go. This gadget that connects directly to the telephone line and provides two outputs, one for the telephone/answerphone and one for the fax. When a call is received, the box answers the phone and sends out its own ringing tone while it attempts to work out whether the call is from a person or a fax. When they dial up a number, fax machines send out tones for the answering machine to lock onto. The switch box, on hearing these flicks the call through to the fax machine which answers the call and receives the fax. If no tones are heard then the call is switched through to the telephone or answerphone. Most of the time this works very well, but, unfortunately, some foreign telephone voice calls seem to put tones on the line which the switch box mistakes for fax tones. In this case, the handset on the fax (if it has one) can be used to receive the voice call or the switch box can be manually made to operate with the phone. Of course, this is of no use to an answerphone.

The opposite problem also occurs occasionally and a series of bleeps can be heard on picking up the phone or on the answerphone. The reason for the switch box misunderstanding the signals is not clear though it doesn't happen very often.

Having both fax and answerphone in one box is not the

Specifications

Samsung SF1000 Personal Fax
Compatibility: CCITT group 2 and 3
Speed: 9600/7200/4800/2400 bps
Resolution 3.85 lines per mm (normal) or 7.7 lines per mm (fine)
Scanning method: CCD image sensor
Grey scale: 16 levels
Printer output: thermal
Document size 216mm wide
Paper roll length: 30m
Power: 220-240VAC
Dimensions 330x254x107 (WDH)
Weight 8.8lbs
All fax machines use roughly the same hardware and transmission/reception methods. The CCITT standards for sending fax data down a telephone line are G2 and G3. The difference between the two is one of speed and reliability. G3 runs faster than G2 but G2 is more reliable. For noisy telephone lines, G2 is the route to take, however, complaining to BT about line noise is also a possibility. Most modern machines support both standards and have modems that operate from 9600 bits per second (bps) downwards - a fallback technique uses the lower speeds if data is being lost during transmission.

When an image is being sent, it is slowly fed through the machine and scanned by a long strip CCD sensor. In normal or fine modes, the data is in the form of ones and zeros defining where the black or dark areas of the image are. This data is then coded up, usually using a variable length code where the more frequent numbers use shorter word lengths and hence transmit more quickly. A consequence of this is that more complex areas of the image tend to be sent more slowly - this is noticeable when a fax machine gets past the white space and onto the text. As well as transmitting and receiving images as normal or fine resolution, a photographic option converts the brightness of a pixel into a value from 0 to 15, known as a grey scale. This allows much better resolution of photographic images at the expense of a decrease in speed.

At the receiving end, the fax will have set itself up to the correct speed and resolution when first contacted. The ensuing information will then be decoded and printed out onto heat sensitive paper. This normally comes on a single roll and on some machines is cut to size at the end of each transmitted sheet and on others simply left for the user to tear off.

The Amstrad FX9600AT personal fax and answering machine.

Specifications
Amstrad FX9600AT Personal Fax and answering machine
Fax
Compatibility: CCITT group 3
Speed: 9600/7200/4800/2400 bps
Resolution: 3.65 lines per mm (normal) and 7.7 lines per mm (fine)
Scanning method: CCD image sensor
Grey scale: 16 levels with two styles
Printer output: thermal
Document size: 216mm
Paper roll length: 30m
Automatic paper cutter
10 page document feeder
Power: 220-240VAC
Dimensions: 380x340x128 (WDH)
Weight: 6.75kg
Answering machine
Outgoing message: 16s max
Incoming messages: stored on C30 micro-cassette
Automatic Fax/phone switching

Perfect solution either. On receiving a call, the machine plays its voice message. If, when this has finished, some tones are heard, the system enters fax mode. Otherwise, a voice message is taken. Unfortunately, when sending a fax, hearing a voice at the other end of the line instead of the expected bleeps usually means a wrong number. In the case of an "intelligent" fax/answering phone, it's just a matter of waiting out the voice message before sending the fax -- as long as you know.

Simple Or Sophisticated
There are a wide selection of fax machines available. The bottom end of the range is represented by the Samsung SF1000 personal fax. This operates with the normal G3 or G2 standards and is able to send and receive, standard, fine or photographic (grey scale) images. It has its own telephone handset with 10 memories for regularly used numbers plus a manual redial. On the minus side, it is only able to take one sheet of paper at a time though multiple sheets can be transmitted if they are fed in by hand. There is also no paper cutter so the received sheets must be torn off at the end of a message.

The other big problem encountered when setting it up. To save money there is no message display screen. This means that options such as identification codes printed on the message, whether to default to G2, how many rings should occur before answering and so on, must all be set up by pressing the start and stop buttons in a defined sequence. The results can then be checked by printing them out.

At the other end of the market is the Amstrad FX9600AT which incorporates an answering machine, auto redial, 20 memories, built in parallel interface allowing connection to a computer which can then send faxes and use the thermal printer for output. This is a more complex machine with a large number of facilities. The provision of a computer interface will appeal to users with PCs since text can be sent directly from a wordprocessed document directly to someone else's fax, saving both time and paper.

The fax machine appears to have reached its peak technologically. All that remains is for the price to fall a little more and most people will wonder how they managed without it.
Counting The Pulses

Pulsar is Number 1 Systems' latest piece of computer aided design software aimed at making logic circuit design and testing easier. Kenn Garroch checks it over.

In the bad old days, designing and building digital electronic circuits was a complicated affair that required an in depth knowledge of techniques such as state machines and transition tables.

After designing a circuit and "proving" that it works on paper, the only way to make sure it works is to solder some silicon. An alternative, just released for the IBM PC, is Pulsar. This digital logic simulator allows a circuit to be checked out to the stage where it should work in reality. Digital circuits can be put through their paces with all inputs and outputs being available for scrutiny. A knowledge of digital systems is still necessary although Pulsar could be used in conjunction with some textbooks to learn all about the subject.

Running Under A GUI

Pulsar comes on both 3.5in and 5.25in disks. Installation is straightforward and from inserting the floppy to getting the thing running takes only five minutes or so. A PCXT/AT with at least 512kb of RAM, a hard disk and either an EGA or VGA graphics card is the minimum system needed to run Pulsar. A mouse is also a pretty handy accessory to have available although it is possible to use the software via the cursor keys.

The whole package operates through a GUI (Graphical User Interface) complete with pull down menus and button clicking. In general these menus are easy to navigate and each has a help section at the bottom. Unfortunately, the help comments usually run to repeating what is already obvious and a more in-depth help system would have been a good idea. The manual is of some use in this area but it doesn't really have a reference section so trolling through it from end to end is usually the only way to find out about something.

Gray Code Simulation

Circuits are set up in Pulsar by taking predefined components or modules and assigning their inputs and outputs to each other. To do this properly it is necessary to draw up a design with a pencil and paper...
before even going near the editor—a fully graphical schematic editor would have made life a great deal easier. Users of Easy PC will find that they can output netlists directly into the system making the operation a lot easier. Others will have to suffer and do it by hand.

The program has four main sections, the analyser, circuit create/modify, a generator definer and the component/module library manager.

As an example, to set up the gray code circuit shown in Fig. 1, each of the nodes of the circuit is given a name and each component is given the corresponding node names at its connections. A component not shown in the diagram is the PSU or power supply. This provides two outputs, one is assigned to "1" and one to "0". These can then be used in the rest of the circuit to tie inputs high and low as necessary.

Having completed the definition, the next step is to load up the circuit into the analyser. However, before starting any analysis a couple of external generator inputs need to be defined. The "clock" input is taken straight from a standard 1kHz signal provided with the system and the "reset" input defined especially for the test.

The generator definer allows almost any input signal to be set up by specifying the high, low and time for each step. The reset signal is simply a short high level followed by a 10 second low, long enough to prove the circuit.

Building Black Boxes

Back in the analyser, the generators are attached and the simulation run producing the outputs shown in Fig. 2. Outputs Q1 and Q0 give the gray code as shown in the truth table.

The main requirement for designing a circuit is to put it down on paper and name the nodes and components. The libraries cover virtually all the standard CMOS 4000 range, the 74LS range and a set of system components. Simply entering the name gets the component from the library complete with connection definitions. A drawback with the system is that there is no facility to browse the libraries to see what is available—in graphical form preferably.

Once a circuit is proven it can be set up as a module which is, in effect, a black box with defined inputs and outputs. Modules are held in libraries and can be used in future circuits. This idea allows sections of a circuit to be designed and checked out and then connected together to form more complex systems.

When the simulation has been run all of the relevant waveforms are displayed on the screen. These can be shifted up and down the screen and grouped to make them easier to read. The controls allow zooming in on the display and panning.

The Package

The manual supplied with the software could be better. It takes the user on a "grand tour" of the software. This is quite long as there is an awful lot to see. Unfortunately, there is very little in the way of reference material. The index is reasonable and the appendices show all of the components held in the libraries.

Pulsar is a pretty sophisticated piece of software. It can cope with complex circuits and although it looks complicated at first sight, it is not hard to get to know and use. Anyone who wants to do a lot of digital design or who is interested in learning a lot about digital circuits might be interested. However, at £195 it may be priced beyond anyone who is not going to get a great deal of use from it.
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Measuring Up
Digital Multi-Meters

The number of DMMs available is on the increase. They now offer larger displays, more functions and lower prices than ever before. Jason Sumner examines a selection of seven.

It seems that the days of the analogue multi-meter are just about over. The DMM (Digital Multi-Meter) has now come to the fore offering more facilities at a lower cost and in a more robust and compact case.

The three main functions supported by DMMs are Amps, Volts and Ohms (Ω) measuring current, voltage and resistance. Other options becoming common are diode and continuity test, with the latter usually providing eyes-free operation by means of a sounder.

In general, all the meter displays are the same (see right). The main section is the 3 (plus a fraction) digits used for the main readout. The fraction is usually half a digit in the form of a 1 giving a maximum count of 1999. Some meters offer three quarters of a digit in the form of a 3 allowing counts up to 3999. All types normally allow two to three decimal places of accuracy if the correct range is selected.

Some instruments offer a semi-analogue display in the form of a bar graph across the bottom of the readout. Other indications may be the units, the current function, the polarity of the signal and whether the battery is due to be replaced.

Since many DMMs offer pretty much the same basic facilities, any additional options should be taken into account when selecting between different makes and models.

This meter is unusual for a hand held DMM in that its on/off switch is separate from the range selection dial. The only drawback with this is that it is possible to turn the meter on while it is on an unsuitable scale – for example, when connected up to measure volts and switching on with the ohms range selected.

Other features include a memory which remembers the last two digits of the current reading. These are then subtracted from the next reading to allow measurement of voltage or current deviation. The hold button keeps the display static until released and DC/AC/Ω/Lo switch allows measurement of AC or DC voltage and current or low and high resistance.

The only real problem with the DMM735 is that due to the colouring of the case (shades of brown) it could easily get lost when put down.

Specifications

<table>
<thead>
<tr>
<th>735 DMM</th>
<th>3.5 digits, 1999 count</th>
<th>Auto/manual range selection</th>
<th>Overrange indication</th>
<th>Sampling 2Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low battery indicator</td>
<td>3.75 digit display</td>
<td>VAC</td>
<td>VDC</td>
<td>MkΩ</td>
</tr>
<tr>
<td>Negative</td>
<td>Functions</td>
<td>Suplementry polarity indication</td>
<td>Analogue display</td>
<td></td>
</tr>
<tr>
<td>717</td>
<td>0 - 1000VDC Auto</td>
<td>0 - 750VAC Auto</td>
<td>0 - 10ADC Auto</td>
<td>0 - 10AAC Auto</td>
</tr>
<tr>
<td>0 - 2MΩ Auto</td>
<td>Global Specialities, Rackery Lane, Llay Wrexham, Clwyd, LL12 0PB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

September 1991 Practical Electronics 49
the first striking thing about the TM357 is that the on/off switch is very small. It is also separate from the function selector dial and so suffers from the same problem as the DMM 735. The display is rather basic and only shows the reading and low battery warning. All ranging must be performed by the user and there is no indication of the scale of the display – it is difficult to tell between kΩ or Ω for example. The overrange indication is a static 1 on the display; making it flash would have made operation easier.

Leaving the meter on just seems to drain the battery as there is no auto-shut off. On the plus side, the instrument is relatively cheap and has a built in prop-up stand on the

Offering a large display (75x30mm) the TM3487B also has a few functions not normally found on a DMM. The most obvious is that it is able to measure frequencies. It also has a horizontal bar graph display which gives a semi-analogue average display of the reading. The relative option allows signals to be compared and the max/min the instantaneous maximum and minimum peak values. All ranging is done automatically with the units shown on the display.

On the minus side, when the display is viewed at shallow angles, various elements of the display appear to be activate when they are off and there is no auto-shut down to save the battery. The manual is not particularly informative and the prop-up stand seemed particularly flimsy.

O

Obviously designed to be carried around in the pocket this meter is about as simple as they come. One control dial selects the function with any ranging taken care of automatically. No current measurement is supported and the probes are quite small, especially for those of us with banana fingers. The batteries are similar to those used in cameras and getting them in and out requires a very small screwdriver and some fiddling. However, they have an operational life of approximately 70 hours continuous use so they won’t need to be changed too often. On the other hand, since there isn’t an automatic switch off the batteries will eventually go flat if the meter is
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September 1991 Practical Electronics 51
Possibly the only drawback with this meter is the fact that it doesn't support current measurement. The casing has a very solid feel and looks as though it could take quite a lot of hammer. The display supports analogue as well as the standard 3.75 digits.

The touch hold facility allows eyes-free measurements to be taken. When in this mode the probes can be placed on the circuit and when the instrument beeps, the measurement is held until another is made. As with other devices there is no auto-shut off though battery life is rated at 1600 hours.

As a basic DMM the 70 has a professional air and is supported worldwide by Philips in Europe and Fluke in the States.

Specifications
Philips/Fluke 70 series II
Display 3.75 digits 3200 count
Auto/manual range selection
Overrange indication
Sampling rate unknown
Low battery indicator
Battery type 9V NEDA
Size 166x28x75
Weight 300g
Comes with battery test leads and manual
Price £59 (£69.33 inc VAT)
0 – 1000VDC 5 ranges
0 – 300mVDC 2 ranges
0 – 750VAC 4 ranges
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Harlow, Essex

Being brightly coloured, small and solid feeling, the TM5135B gives the impression of being good value. It only provides the basic functions for amps, volts and ohms plus a diode check but, for the price, these are all that can be expected.

On the back of the case is a fold out stand which props the meter up forty five degrees. On the front, the power switch is incorporated into the function selector dial – it isn't easy to switch the meter onto a low value range while measuring a high value since the ranges either side of off are 1000VDC or 750VAC.

The display is quite small but large enough to be readable under most conditions.

The TM175 from Cirkit is a pretty high spec meter for the price. The only problems are the separate power switch, the lack of autoranging and the small display. Apart from this, it offers a number of functions not found on the other meters in this review, capacitor and transistor measurement. There are sockets for both types of component built into the bright yellow case.

A built in stand provides either a prop or a hanger for ease of operation. An interesting display option is the up/down indication for logic testing. Whether this makes testing easier than reading the voltages 5V and 0V, it is difficult to say, it depends on what you are used to.

Specifications
Cirkit TM5315B
Display 3.5 digits 1999 count
Manual range selection
Overrange indication
Sampling rate 3Hz
Low battery indicator
Battery type 9V NEDA
Size 128x72x33mm (LWH)
Weight 200g
Comes with test leads and manual
Price £19.99 inc VAT
0 – 1000VDC 5 ranges
0 – 750VAC 5 ranges
0 – 10ADC 4 ranges
0 – 2000MΩ 7 ranges
0 – 15MHz 5 ranges
0 – 20µF 5 ranges
Transistor and diodes test built in

Specifications
Cirkit TM175
Display 3.5 digits 1999 count
Manual range selection
Overrange indication
Sampling rate 3Hz
Low battery indicator
Battery type 9V NEDA
Size 160x84x38 (LWH)
Weight 250g
Comes with test leads and manual
Price £57.96 inc VAT
0 – 1000VDC 5 ranges
0 – 750VAC 5 ranges
0 – 10ADC 4 ranges
0 – 2000MΩ 7 ranges
0 – 15MHz 5 ranges
0 – 20µF 5 ranges
Transistor and diodes test built in

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   b Single Metal Diode
   c Semiconductor Micro Device

2 What does an autorouter do?
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   b places the components automatically
   c does all the soldering

3 What are the track on a PCB made from?
   a Aluminium
   b Copper
   c Iron

Please tick the appropriate boxes:
1 a [ ] 2 a [ ] 3 a [ ]
   b [ ]   b [ ]   b [ ]
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56 Practical Electronics September 1991
Has PE published a fluorescent light dimmer circuit? I would like to dim the lighting in our kitchen/diner. I could replace the fluorescent lighting with incandescent, but I prefer fluorescent light for cooking. Ordinary light dimmers will not work, so is there a practical way to dim fluorescents?

William Jones
Barnsley
Yorks

It is more difficult to dim fluorescent lights, but it can be done.

Ordinary light dimmers will not work for two main reasons. The first reason is that the current in a fluorescent tube is limited by a series inductor, so that the current is significantly out of phase with the voltage. Conventional lamp dimmers, which derive timing information to phase trigger the triac from the voltage across the triac, receive a waveform to derive phase control information from which depends on the trigger point in the previous half cycle. The best result which is usually obtained by trying to dim a fluorescent with an ordinary dimmer is that the lamp flickers visibly near full brightness, and flashes or switches off at slightly lower brightness.

The second difficulty is that, in order to strike, a fluorescent tube requires its heaters to be energised. The normal method, illustrated in Fig. 1, is to use a starter, which switches on to conduct briefly when there is a high voltage across the tube. This draws current through the heaters, which begin to glow red. The starter then switches off, normally at a point in the mains cycle at which current is flowing in the inductor (because the current lags the voltage significantly). When the starter switches off, the current flowing in the inductor causes a sharp rise of voltage across the tube, which ionises the gas inside and illuminates the lamp. While the gas in the tube is ionised, there is a relatively low voltage across it, and the starter does not conduct.

So long as the gas remains ionised, the heaters are not required. If too little current flows, or if the current is interrupted for too long, the ionisation fades and the tube ceases to conduct or emit light. However, if the heaters are kept energised, conduction continues down to a lower current, and starts more easily. So one step towards dimming a fluorescent light is to energise the heaters continuously, as illustrated in Fig. 2.

The second necessary step to fluorescent light dimming is to derive phase information from a source which does not depend on
The load current. A simple method of doing this is also illustrated in Fig. 2.

The triggering current for the triac is drawn directly from the mains live, rather than from MT2 of the triac. This ensures that the trigger point is accurately phase-related to the mains waveform, rather than to the load current.

The drawback of this design is that the phase shift components are energised all the time, rather than only until the triggering point of the triac. This necessitates the use of higher powered components than would otherwise be required, and may be considered a disadvantage. However, this design has the advantage of simplicity and consequent reliability.

The two-stage phase shift network used in this design minimises hysteresis effects. A single stage phase shift network tends to give the effect, at least on incandescent lamps, that the brightness control must be advanced to a medium setting before the lamp will illuminate at all. The brightness can then be reduced to a lower setting if desired.

The reason for hysteresis is that when the diac fires it discharges the capacitor. The discharged capacitor will charge to a higher voltage on the next mains half cycle than it would have had it been left charged to the opposite polarity. Thus, firing on one half cycle promotes firing earlier on the next, and firing can be maintained at voltages too low to initiate it.

A more complicated but more precise approach is to use the circuit of Fig. 3. In this circuit, timing is derived not from the mains waveform as a whole, but from the zero crossings. Triac triggering is precisely controlled, and hysteresis is eliminated.

In this design, Q1 generates timing pulses derived from the unsmoothed rectified output from the mains transformer. Q1 only switches off very close to the zero crossings of the ac waveform, generating a short pulse which resets the ramp generator.

The ramp generator uses a Norton opamp. This type of opamp gives a voltage output in response to current inputs rather than, as with conventional opamps, voltage. The inputs of a Norton opamp have the voltage characteristic of diodes with the cathode to the negative supply rail. The reset pulse, therefore, raises the inverting input of IC1A to 0.6V, and resets the charge on the capacitor so that the output falls to OV. When the reset pulse disappears, the output ramps up to keep the charging current of C2 equal to the current flowing through R4 and RV1. The calculation relating to this is shown by the diagram.

To generate triac firing information, the ramp waveform is added to a direct current derived from the brightness potentiometer. The component values are calculated so that the comparator will switch on and then remain on if RV2 is fully clockwise, but will switch off for part of the time if RV2 is turned down slightly. When RV2 is set at zero, the peak of the ramp waveform should be just insufficient to switch the comparator. When the circuit has been built, RV2 should be set at zero, and then RV1 should be adjusted so that the triac just does not fire. It may be easier to test this function using an incandescent lamp as the load.

The triac suggested for this purpose is the TIC206M, a 500V 4A device. It might be thought that a 400V device would do, but with a highly inductive load being switched, the waveform could ring to a higher voltage under some circumstances. Other similar triacs would also be suitable, but the TIC206 is suggested because it has proved itself reliable in similar applications.
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This month’s 25 years looks at reed switches, early Karaoke and Woodpeckers.

September 1966

It seems that European disharmony is nothing new. 25 years ago, PE had a small article on the subject of which system should be used for colour TV. At the time, only B&W was available though people were looking forward to seeing their favorite TV programs in colour. Both Italy and France wanted to use the SECAM IV system while the British were dead set on PAL. At the time it was rumoured that the British television Industry was already committed to designing and producing PAL receivers.

Also in this issue was a feature on reed switches. At the time they were quite new and apart from providing simple switching in the presence of a magnetic field, they can also be used as a magnetic or electronic bistable. The trick is to use a small bias magnet that keeps the contacts in their current state. A larger field is then used to oppose or assist this magnet and open or close the switch.

1976

Karaoke appears to have been developed or at least patented back in 1976. The Sony Corporation of Japan applied for a patent on a device that artificially improves the sungers voice to make it resemble the sound of a voice recorded in a professional studio. The idea being that the would be vocalists could then join in with records in their own homes. Both delay and vibrato (frequency modulation) are added to the voice before blending it to the recording. This has had the real singers voice removed or diminished by cancelling the same sounds that occur on both stereo channels.

1981

This year saw the beginning of the electronic music revolution with the Casio 202 professional keyboard. Featured in the news section, this instrument was an upgrade of the successful 201. Featuring 8-note polyphony and a 49 note keyboard, the instrument cost a mere £275.

1986

Whatever happened to the Woodpecker? The signals emanating from Riga in the Soviet Union were described in a fascinating article in this issue. Apparently transmitted between 4.5MHz and 30MHz, this ‘chattering modulation was given the knickname woodpecker. Now that the cold war is over, is it still there? Can we finally get the answer as to what it was all about?
Circuit modelling techniques have more uses than just designing electronic circuits. They can also be used in education as Ben Howard found out with Protolab.

The basics of electronics deal with resistors, capacitors, inductors and voltage sources. Learning about them is really a matter of assimilating the various rules/laws and techniques and applying them. Protolab from Global Specialities is designed to aid in the comprehension of basic circuits and give lessons in their basic use.

The work area is a prototype board on which components can be placed and connected together. All operations are mouse and menu based and, unfortunately, there are no short cuts via the keyboard – the software doesn’t work at all without a mouse which is rather a pity. Putting a component, say a resistor, onto the board means quite a lot of clicking and mouse movement and there is great scope for improvement. Having positioned a component, various values and options can be set up – resistors for example have a value in ohms a wattage and a material such as carbon or wire-wound.

After a little practice, setting up circuits becomes relatively easy and experimentation can get underway. Testing a circuit means connecting up one of the various instruments, voltmeter, ammeter, oscilloscope, or wattmeter, to it after switching on the power. This is derived from a number of possible sources from batteries to AC current generators. The frequency of the latter can be set up to 2MHz with a wide range of voltages.

On applying the power, the rather informative message, “calculating twiddle your thumbs...” comes up. Fortunately, the test was performed on a PC with a 386-33 microprocessor so it only took a short while to examine the circuit. On slower machines the wait could be rather longer and, perhaps, quite tedious.

The manual supplied with the package is a large A4 folder with all of the instructions and a selection of experiments. One problem with this is that every time a page was turned, the ring binders spring open and pages begin to fall out. Apart from this, the quality is rather poor but readable.

Protolab provides a way to play around with simple electronic circuits. However, the omission of transistors gives it a rather limited scope although it is not too highly priced it has a rather outdated feel to the user interface which could use a lot of improvement such as colour and a keyboard alternative to the mouse.

Protolab
Price: £49.95 ex VAT
Global Specialties
Rackery Lane, Llay
Wrexham, Clwyd
LL12 0PB, Tel. 0978 853920

September 1991 Practical Electronics 61
Barry Fox

Videos In The Rain

Barry looks ahead to a future where it will no longer be necessary to hire videos.

It is now clearly on the cards that by the mid-1990s the satellite industry will be doing to the video rental business just what the video rental business did to the cinema industry ten years ago.

In the 70s local cinema management was sloppy. Customers had to queue in the rain, often with no advice given on whether they were likely to get in. Once inside they suffered dirty seats, rotten sound and poor projection of old prints. The management seemed more interested in selling hot dogs and popcorn than screening entertainment.

As the video rental business boomed, with literally tens of thousands of outlets across the country hiring films for a pound or so a night, people who wanted to see films stayed at home instead of going to the cinema. Cineplex closed and the rental business got stronger. In many towns the only way to watch a film was to hire a video or travel to a city centre.

With nearly three-quarters of all homes in Britain now having a VCR, around a million people a day have been hiring videos.

But now the cinemas are striking back, with American-style multi-screen complexes that treat films and customers with respect. A big screen with Dolby surround sound makes the cinema an experience.

The video rental business is hurting. But it will hurt a lot more as the satellite channels get stronger.

No More Programming

The key factor, which the video rental business has so far overlooked, is the use of PDC on satellite movie channels.

PDC, programme delivery control, is a very clever way of letting viewers set their VCR timers without ever needing to know how to set a timer. To cut a long story short, a conventional teletext signal will contain control codes which switch a modified VCR on when a selected programme begins and switch it off again at the end. A primitive PDC system is already in use in Germany, Austria and Switzerland. Britain has adopted an improved system which looks like becoming the standard for all Europe. It is known as Format 2, although obviously a catchy name is needed. "Startext" is mooted.

Simply Press The Button

Channel 4 is pushing PDC, because the station already uses teletext signals to control its programme distribution round Britain. It is a small step for Channel 4 now to start broadcasting the PDC codes for home use. Channel 4 will start PDC coding this autumn and already Philips has promised VCRs with PDC circuitry. Other manufacturers, including the Japanese, have said they will follow. Although the BBC and ITV networks have agreed to the PDC standard, they have not yet committed to providing a PDC service. But the BBC already has plans to automate its distribution network, along the lines pioneered by Channel 4, by 1993.

The real breakthrough could come if BSkyB starts using PDC on Astra. This looks very likely. BSkyB recently started using Fastext, which adds colour page codes at the bottom of the teletext screen.

PDC, or Startext, is natural progression. And PDC would seal the fate of the video rental business.

In the simplest form of PDC, a new VCR will display a page of programme listings. A button on the VCR's remote control moves a cursor over the screen so that the viewer can select a programme. Pressing another button then sets the timer to record that programme. But the VCR does not actually start until it receives another code which is transmitted as the programme begins. So a VCR set to tape a film at 10pm on Monday, will sit idle until 10.30pm on Monday, or Tuesday, or next month if, for some reason, transmission is delayed.

This is only half the PDC story. When the TV station transmits trailers of programmes to come, it can bury PDC codes inside the signal. All the viewer need do is press a single button on the remote control to set the timer to tape the trailed programme. There is no need to display a teletext page on screen.

So when BSkyB trails a dozen movies, all the viewer need do to tape them is press the remote control button while the trailer is playing. The VCR will then spring to life the first time that movie is transmitted.

This completely changes the rules of the subscription TV game. The satellite movie channels already broadcast scrambled movies twenty-four hours a day. With pay-per-view access control (which advanced scrambling systems already allow) these channels can transmit movies which would otherwise only be available on rental or in the cinema. Viewers will set their recorders to tape these movies while they are out or asleep, by using the PDC push button.

When this system is up and running, who will want to go out in the rain to the local video library and find that all copies of the film you want to see are out on loan?
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<td>Z2091</td>
<td>Red</td>
<td>5mm</td>
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<td>Hiton LTV823A</td>
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<td>Z2092</td>
<td>Green</td>
<td>5mm</td>
<td>std</td>
<td>-</td>
<td>13.5</td>
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<td>Yellow</td>
<td>5mm</td>
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<td>3mm</td>
<td>min</td>
<td>MLR527</td>
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<td>Z2098</td>
<td>Red</td>
<td>7x 2.55</td>
<td>Rect</td>
<td>Sensor elec SE8511D</td>
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<td>Z2055</td>
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<td>5mm</td>
<td>Rect*</td>
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<td>Z2056</td>
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<td>Z2097</td>
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<td>5 x 2</td>
<td>Rect</td>
<td>GMV57123</td>
<td>29</td>
<td>12</td>
<td>0.038</td>
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10k + mix of any of the above

Price: £0.02
100k + mix £0.016

7-SEG LED CLEARANCE!

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<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>CC/CA</th>
<th>Shape</th>
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<td>CA</td>
<td>RH</td>
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<td>CA</td>
<td>LH</td>
<td>£2.00</td>
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ALL THE SAME PRICE: 20p each

ANY 10 £1.60 100 £10.00

BULK OFFERS

BIB Accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
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<tbody>
<tr>
<td>BBC68 Computer terminal maintenance kit</td>
<td>£2.95</td>
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<td>Box of 10</td>
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<td>Box of 100</td>
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<tr>
<td>BBC61 Liquid static eliminator</td>
<td>£1.00</td>
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<tr>
<td>Box of 50</td>
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<tr>
<td>BZ914 1 Watt Amp Panels</td>
<td>£1.50</td>
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<tr>
<td>Box of 128</td>
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<tr>
<td>BZ1532 10 Channel C8 Switches</td>
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<tr>
<td>Box of 100</td>
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<tr>
<td>BZ4132 Firing Speed Adjuster</td>
<td>£1.00</td>
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<td>Box of 200</td>
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<tr>
<td>Speakers</td>
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<tr>
<td>BZ8750 Full 30 x 30 x 3mm speaker</td>
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<td>Box of 1000</td>
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<td>Panels</td>
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<tr>
<td>BZ1815 27C255 Panel</td>
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<td>BZ4071 Catalogue price £1.85</td>
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<td>Switch Mode PSU</td>
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<td>BZ680 Catalogue price £3.00</td>
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<td>Spectrum Connector</td>
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<td>BZ4130 Catalogue price £1.00</td>
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<td>CEE22 Connector</td>
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<td>BZ1794 Fixed switched mains inlet</td>
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<tr>
<td>PS1750 Mains Spindle</td>
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<td>Panel Clearance</td>
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<tr>
<td>BX541 20g of assorted populated PCB s, Ad P/C</td>
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<tr>
<td>FM Aerials</td>
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<tr>
<td>BX361 Ribbon aerial</td>
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<td>Wheels</td>
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<tr>
<td>Type A from Catalogue, 100mm dia x 17mm wide</td>
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<td>Reed Switches</td>
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<tr>
<td>DT6202 Heavy duty single pole switch with 47mm long body</td>
<td>£8</td>
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<td>DRA250 As above, but gold plated tags</td>
<td>£10</td>
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<td>Box of 100</td>
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<td>PL11 Printed 11pin add-on relay bases</td>
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<tr>
<td>RMS33-1A Top quality illuminated key switches</td>
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<tr>
<td>Single pole reed switch and fitted mini 5V bi-pin T1 lamp</td>
<td>£8</td>
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<tr>
<td>Box of 50</td>
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<tr>
<td>BZ577 1k edgeglow pot with switch, as used on small radios,</td>
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<td>Bag of 500</td>
<td>£15</td>
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<tr>
<td>BZ576 2.1mm power plug, chassis mounted. Normally 10p</td>
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<td>Bag of 500</td>
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<tr>
<td>BZ9298 470p, 18p Mullard can 50mm long x 25.4mm dia</td>
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<td>Box of 100</td>
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<tr>
<td>BZ9289 150x50 25V computer cans. 105mm long x 51mm dia</td>
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<td>Box of 49</td>
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<tr>
<td>Box of 50</td>
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<tr>
<td>BZ4138 Microselects. In our catalogue at £2.00.</td>
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<td>Box of 100</td>
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<tr>
<td>BZ4136 3-50W salt water lamp. 6000K. 150mm dia x 30mm</td>
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<tr>
<td>Box of 50</td>
<td>£25</td>
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<tr>
<td>BZ4135 Headphones - mini &quot;Stethoscope&quot; complete with 2 stereo jackplugs, Hinged headbands. 8R. Normally £1.75.</td>
<td></td>
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<tr>
<td>Box of 40</td>
<td>£25</td>
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</tbody>
</table>

BULK LED's

NEON INDICATORS

A parcel of IMO Neon indicators and various other lamps has just been delivered and offers the hobbyist a selection of top quality components at rock-bottom prices! Why are they so cheap? They're all for 110/120V! However, that's no problem because with every indicator we supply a suitable resistor for mains operation.

Type A - Panel mounting 33 x 15mm with 0.25" tags. Clip fix, requires 25 x 12.5mm cut-out.

Z1899 Green

Price: (Any mix) 5 for £1
100 + 0.10 1k + 0.06

Type B - Panel mounting 35.5 x 26.5mm with 0.25" tags. Clip fix, requires 30 x 22.5mm cut-out.

Z1901 Red
Z1902 Green
Z1903 Amber
Z1904 White

Price: (Any mix) 5 for £1
100 + 0.10 1k + 0.06

Type C - Small round face 10mm dia. Clip fix, requires 9mm dia hole.

Z1910 Green
Z1911 Amber
Z1912 White

Price: (Any mix) 5 for £1
100 + 0.10 1k + 0.06

Type D - Large round face 13.5mm dia. Clip fix, requires 12.5mm dia hole.

Z1913 Red
Z1914 Green
Z1915 Amber
Z1916 White

Price: (Any mix) 5 for £1
100 + 0.10 1k + 0.06

Type E - Small square face 10.5mm. Clip fix, requires 9.5mm dia hole.

Z1917 Red
Z1918 Green
Z1919 Amber
Z1920 White

Price: (Any mix) 5 for £1
100 + 0.10 1k + 0.06

Type F - Large square face 13.5mm. Clip fix, requires 12.5mm dia hole.

Z1923 Red
Z1924 Green
Z1925 Amber
Z1926 White

Price: (Any mix) 5 for £1
100 + 0.10 1k + 0.06

For more information, call us at 0703 236363 for our catalogue price list.
BATTERY BONANZA!!

LEAD-ACID + NICADS AT UNBEATABLE PRICES

EX-POLICE BATTES

Z4150 Ex mobile radio battery 10 x 63 x 23mm case (sometimes damaged) contains 8 AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rated 1.2V 600mA.

Price £3.00

SALE PRICE £2.00

Z4149 As above but 84 x 66 x 33mm. There are again 8 cells but they are longer than AA size, being 73mm long. Each cell rated 1.25V 900mA.

Price £3.50

SALE PRICE £3.00

Sealed lead acid batteries

Z9818 YUASA NP6-12. 12V 6Ah sealed lead acid battery. These have been regularly trickle charged whilst in store. Size 150 x 95 x 55mm. List price £28.00.

Prices £14.95 10 + £11.20

SALE PRICE £12.50 10 + £9.00

Z9820 YUASA sealed lead acid battery NP9-6 6V 10Ah. Size 150 x 95 x 50mm. List £18.00.

Our low price £10.00 10 + £8.00

Nicads

21951 Varta 'Memopac' PCB Nicad 8.4V 100mAh. Although new, these batteries are not in pristine condition, so are offered at way below normal costs. Size 41.26.14mm.

Price £1.50

SALE PRICE £1.00

Z1830 Saft 40 RF310 backup Nicad battery PC mounting on 70 x 22.5mm centres. Rated 3.6V 10mAh (20mA). Overall size 76.28 x 8mm.

Price £2.00

SALE PRICE £1.50

Z1829 Nicad 25mm dia 34mm long rated 4.8V 500mA. PC mounting tags.

Price £2.00

SALE PRICE £1.50

AAA Nicads by Sanyo

SUPERDEAL PRICE!! These superb quality batteries are rated 1.2V 200mAh, and may be charged at 20mA or quick-charged at 60mA. Normally costing around £1.50 each, we can offer these at the SUPERDEAL prices below:

Z2117 AAA Nicad £1.00

10 + 0.75 100 + 0.60

3M COMPUTER DISKS

New boxed full spec 3M disks at low, low cost. All prices in this box include VAT @ 15%.

<table>
<thead>
<tr>
<th>Per</th>
<th>Box</th>
<th>10</th>
<th>Boxes</th>
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<tbody>
<tr>
<td>3.5&quot; DSDD</td>
<td>£9.30</td>
<td>£83</td>
<td>5.1/4&quot; DSDD</td>
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<tr>
<td>3.5&quot; DSHD</td>
<td>£19.30</td>
<td>£171</td>
<td>5.1/4&quot; DSHD</td>
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</table>

AAA Nicads by Sanyo

SUPERDEAL PRICE!! These superb quality batteries are rated 1.2V 200mAh, and may be charged at 20mA or quick-charged at 60mA. Normally costing around £1.50 each, we can offer these at the SUPERDEAL prices below:

Z2117 AAA Nicad £1.00

25 + 0.75 100 + 0.60

4% VAT

MINIMUM ORDER VALUE £12 + £3 POSTAGE/PACKING PER ORDER
PACKS - PACKS - PACKS

Many of the Packs listed will be increased in price when our new catalogue comes out later in the year - so take this last golden opportunity to stock up at never again prices!!

Please note most packs are calculated by weight: quantities quoted are approximate, but we do try to ensure contents are at least the number specified.

### SEMICONDUCTORS

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Price/100 (GBP)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>K538 Diode Pack - untested small signal diodes like IN4148 etc at a price never before seen!!</td>
<td>2.50</td>
<td><strong>£1.50</strong></td>
</tr>
<tr>
<td>K547 Zener Diodes. Glass and plastic, 250mW to 5W ranging from 3V to 180V. All readily identifiable, with list supplied.</td>
<td>0.00</td>
<td><strong>£1.00</strong></td>
</tr>
<tr>
<td>K709 Bridge Rectifiers. Another superb value pack - could include anything from 1/2 A, 25V to 1000V, plastic and metal.</td>
<td>20 for £5.95</td>
<td><strong>£4.00</strong></td>
</tr>
<tr>
<td>K710 SCR's &amp; TRIACS. Big mixture could include all types from TO92 plastic up to D05 stud mounting with a chance of everything in between! 25V to 1000V, 100mA to tens of amps. Marvellous value.</td>
<td>25 for £4.95</td>
<td><strong>£3.00</strong></td>
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<tr>
<td>K708 Voltage Regulators. This is an excellent pack, made up from a huge variety of the +ve, -ve, fixed and variable regulators of the +ve, -ve, fixed and variable regulators</td>
<td>20 for £6.95</td>
<td><strong>£5.00</strong></td>
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### RESISTORS

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<th>Product Description</th>
<th>Price/100 (GBP)</th>
<th>Price</th>
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<tbody>
<tr>
<td>K517 Transistor pack. 50 assorted full spec. marked plastic devices PNP NPN RF AF. Type numbers include BC114, 117, 172, 182, 183, 198, 239, 251, 254, 255, 320, BF198, 255, 394, 2N3904 etc. etc. Retail cost £7.00 + Special low price</td>
<td>0.00</td>
<td><strong>£1.50</strong></td>
</tr>
<tr>
<td>K575 Plastic Power pack. Mainly TO126 and TO220 transistors, SCRs, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP and BD types.</td>
<td>50/7.50</td>
<td><strong>£1.50</strong></td>
</tr>
<tr>
<td>K576 Mixed pack of TO220 and 4 pin power components with data and pinouts. Types may include: 2N7004/5/6/14, IRF820/710/720/820, IRF520/6620, VNN0012 etc.</td>
<td>25/£8.00</td>
<td><strong>£4.50</strong></td>
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### CAPACITORS

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<th>Price</th>
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<tbody>
<tr>
<td>K518 Surface mount FETs including SM versions of 2N4340/1, 4392, 4857, 5486/60/1, also 2N7001/2 etc. Big variety at a low price!</td>
<td>0.00</td>
<td><strong>£1.00</strong></td>
</tr>
<tr>
<td>K536 74 Series Pack. 'On board' chips for you to desolder - containing many LS and other types. Good mix.</td>
<td>50/£4.00</td>
<td><strong>£2.50</strong></td>
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<tr>
<td>K536A Bonanza pack of 74 series chips on panels. 200 chips, may include L, LS, HC, HCT etc.</td>
<td>100/£4.00</td>
<td><strong>£2.50</strong></td>
</tr>
<tr>
<td>K544 Mullard Polyester Caps. An amazing range of values from a few pF to 0.1µF. Mostly computer grade, some ready cropped to exact sizes.</td>
<td>25/£2.75</td>
<td><strong>£1.25</strong></td>
</tr>
<tr>
<td>K544A Polystyrene Caps. An amazing range of values from 0.01 to 1µF at voltages from 63 to 1000V.</td>
<td>100/£4.00</td>
<td><strong>£2.00</strong></td>
</tr>
<tr>
<td>K510 200 Disc Ceramic Caps. Wide range of values and voltages from a few pF to 2.2pF, 3V to 3kV.</td>
<td>100/£4.00</td>
<td><strong>£2.00</strong></td>
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</tbody>
</table>

### CREDIT CARD HOTLINE: 0703 236363

**MINIMUM ORDER VALUE £12 + £3 POSTAGE/PACKING PER ORDER**
K531 Precision Resistor Pack - High quality, close tolerance R's with an extremely varied selection of values mostly ±1% and ±1/2% tolerances from 0.1% to 2% - ideal for meters, test gear etc.

Price... 250/ £3.00

SALE

PRICE... £1.50

K572 Resistor Networks - Both SIl and DIL in here, from 6 to 16 pin. Plenty of popular values like 1k, 4.7k and 10k, and a good sprinkling of many other values.

Pack of 100... £4.50

SALE

PRICE... £3.00

K503 100 Wirewound Resistors. From 1W to 12W, with a good range of values.

Price... £2.00

SALE

PRICE... £1.50

K525 Preset Pack. Big, big variety of types and sizes - sub-min, min and std, MP, slider, multturn and cermets are all included. Wide range of values from 2R to 5M. 100 assorted.

Price... £6.75

SALE

PRICE... £5.00

K505 20 Assorted Potentiometers. All types including single, ganged, rotary and slider.

Price... £1.70

SALE

PRICE... £1.20

OPTO

K530 LED Pack. Not only round but many shaped LEDs in this pack in red, yellow, green, orange and clear. Fantastic mix.

Price... 100/ £5.95

SALE

PRICE... £3.95

K806 LED Pack Contains only Red LED's - round, square, rectangular etc, from 3mm to 7 x 2.5mm.

Price... 100/ £5.00

SALE

PRICE... £3.00

K524 Opto Pack. A variety of single point and 7 segment LEDs (incl dual types) of various colours and sizes, opto isolators, numicators, multi digi gas discharge displays, photo transistors, infra red emitters and receivers.

Price... 25 asstd/ £3.95

SALE

PRICE... £2.50

K801 Seven seg LED pack. Big variety of sizes in this pack. May include Red and Green, also overflow/ polarity displays, single/ double digit, also 7/ 8/ 9 digit magnified displays. Sizes from 0.11" to 0.8". 20 pieces for just...

Price... £3.95

SALE

PRICE... £2.50

K804 Lamp Pack. A superb quality pack containing a wide variety of small lamps. Many different types - wire ended, bi-pin, slide, MBC, MES, LES, TL, wedge, minilam etc in voltages from 2.0V to 220V. Most are marked with voltage/ current.

Pack of 50... £4.00

SALE

PRICE... £2.50

SWITCHES AND RELAYS

W4700 Push Button Banks. An assortment of latching and independent switches on banks from 2 to 7 way. DPCO to GPCO. A total of at least 100 switches.

Price... 100/ £6.50

SALE

PRICE... £3.50

K587 A selection of toggle switches, mainly... from page 122 of our 1990 Catalogue. Includes single pole to 4 pole sub min and min. Pack of 50, £30 at cat prices.

Price... £14.95

SALE

PRICE... £9.95

K520 Switch Pack. 20 different assorted switches - rocker, slide, push, rotary, toggle, micro etc. Amazing value!

Price... £2.00

SALE

PRICE... £1.50

K542 Reed relays. Mostly DIL, single pole & double pole also some changeover, these are manufacturers rejects, but a good proportion work. 5V-50V coils 50 assorted.

Price... £3.30

SALE

PRICE... £1.50

K659 Reed Switch Pack. A selection of about 15 types of Reed switch from submin 12mm long to 5A rated 50mm long, mostly form A (make), few form C (changeover).

Pack of 30... £2.75

SALE

PRICE... £1.75


Price... £2.00

SALE

PRICE... £1.75

PLASTIC/ SLEEVING

K534 Sleevings - we've now accumulated enough sleeving to offer this very popular pack again. A terrific variety of types sizes and colours form 1-20mm bore, 0.0" from 2-24mm. Lengths from 10mm to 76mm. Well over 25 different types, including PVC, rubber, silicone etc.

Price... 200/ £2.00

SALE

PRICE... £1.75

K564 PCB Stand-offs. A mixture of 8 different styles and sizes from 4.75 to 12.7mm high.

Price... 100/ £2.40

SALE

PRICE... £1.50

K565 Miniature PCB Supports in Nylon. 6 different styles and sizes from 6.35 to 13.24mm high.

Price... 100/ £2.20

SALE

PRICE... £1.20

K533 Silicon Rubber Sleeves. 20mm long, 2mm bore, 1mm wall.

Price... 100/ 50p

SALE

PRICE... 40p

CONNECTORS

K557 Terminal Blocks. In all shapes and sizes, solder and screw from single way to 12 way in many different current ratings.

Price... 20/ £2.40

SALE

PRICE... £2.00

K803 PCB headers pack with/ without ears, straight and right angle from 10-64 way.

Pack of 20... £5.50

SALE

PRICE... £3.00

K802 Pack of DIN41612 connectors. These popular PCB connectors come as 32/ 64/ 96 way. Both plugs and sockets, some with pins missing. Normally costing £1-£3 each.

Pack of 25... £8.00

SALE

PRICE... £5.00

MOTOR + GEAR PACK

K579 This pack contains 10 assorted battery powered motors (mostly 3V) + 90 gears etc, 16 - 60mm dia + worms and shafts. Amazing value.

Price... £7.95

SALE

PRICE... £6.95

Are you a Bargain List Subscriber? If not, fill in the Order Form on Page 13 and become one - then you won't miss the Bargains!!

MINIMUM ORDER VALUE £12 + £3 POSTAGE/PACKING PER ORDER
GREENWELD SUMMER SALE LIST
CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

PACKS - PACKS - PACKS - PACKS

HARDWARE

K553 2BA screw mix. Mostly steel, few brass/nylon etc, cheesehead and countersunk, mainly in lengths from 3-38mm. Excellent selection.
Price ........................................ 100/£2.50
SALE PRICE .................................. £2.00

K551 6BA/ 8BA screw mix. Again an amazing mixture of lengths from 3-38mm. Nearly all cheesehead and countersunk in steel.
Price ........................................ 200/£4.00
SALE PRICE .................................. £2.00

K811 6BA screws. Nearly all pan head pozi in plated steel. Lengths to 16mm.
Pack of 100 ................................ £1.50
SALE PRICE .................................. £1.20

K805 M2 screws. Good mix, this. Cheesehead, c/s, pan, mostly pozi, few slot. Lengths to 12mm. All steel with various plating.
Price ........................................ £1.80
SALE PRICE .................................. £1.50

K806 M2.5 screws. Various heads - mostly pan and c/s pozi. All plated steel. Lengths to 10mm.
Pack of 100 ................................ £1.50
SALE PRICE .................................. £1.20

K807 M3 screws. Good selection of sizes including a few brass. Most heads. Lengths to 35mm.
Pack of 100 ................................ £1.50
SALE PRICE .................................. £1.20

K808 M4 screws. Huge variety! Pan, c/s, cheese, set, slot, pozi. From 4-50mm long. All steel, plated, black/hi-tensile.
Pack of 100 ................................ £1.60
SALE PRICE .................................. £1.30

K809 M5 screws. As above.
Pack of 100 ................................ £2.00
SALE PRICE .................................. £1.60

K820 Large bolts and set screws. Could weigh as much as 150g each (up to 16mm dia x 90mm long). Practically all are steel. Many different heads.
Parcel weighing 6kg ................................ £10.00
SALE PRICE .................................. £8.00

K616 Large washers 16mm and over (up to 30mm). Internal dia 8.5-17mm. Mostly plain steel, some shapenproof.
Pack of 200 ................................ £2.00
SALE PRICE .................................. £1.60

K817 Small washers. Big variety including shapenproof, spring and plain. A few brass and non-metal. 5-16mm OD, 2.4-8mm ID.
Pack of 500 ................................ £2.00
SALE PRICE .................................. £1.60

K599 Captive, shapenproof and locking nuts in sizes from 2BA to 6BA, mostly alloy.
Price per pack of 100 ................. £3.20
SALE PRICE .................................. £2.00

K598 Solder tags. Good variety of sizes from 3-11.5mm ID. Includes some small crimp types. Most are double ended. Great value.
Price ........................................ 200/£4.00
SALE PRICE .................................. £2.00

K527 Hardware Pack. This has a large variety of PK (caps) and self tapper screws from 2 x 11/2" up to 8 x 1 ½’’ also washers, some BA, metric and Whit. Screws plus other miscellaneous brackets, captive nuts and bits and pieces. 1kg (up to 1000 pieces).
Price ........................................ 1kg/£4.00
SALE PRICE .................................. £2.50

K535 Spring Pack. Approx 100 assorted compression, extension and torsion springs up to 22mm diameter and 30mm long.
Price ........................................ £1.70
SALE PRICE .................................. £1.00

K814 Roll pins in a variety of sizes from 1.7mm-dia 8-29mm long. Some are a little rusty.
Pack of 100 ................................ £2.00
SALE PRICE .................................. £1.60

K815 Pillars and stand-offs. This includes conventional threaded pillars and standoffs, also unusual shaped types too, up to 60mm long. Mostly steel, some alloy and non-metal. Nearly all M3/6BA or larger.
Pack of 50 ................................ £2.00
SALE PRICE .................................. £1.30

K555 Fuses. A marvellous selection of 15, 20, 25 and 32mm fuses both cartridge and wire ended in quickblow and antisurge varieties. May be anything from 32mA to 50A!!
Price ........................................ 100/ £3.95
SALE PRICE .................................. £2.50

K574 Wire link pack. A wide range of sizes from 3mm to 50mm for use with Breadboards or PCBs. Some are bare. A few are not preformed.
Price per pack of 250 .................. £1.00

K561 Coils and Chokes. Pot cores, IF cans, open wound coils, chokes, etc from a few p/u upwards in a wide variety of sizes and values.
Prices ........................................ 50/ £2.80
SALE PRICE .................................. £2.00

K573 Pack of assorted TOKO RCL coils, mainly in 10 x 30mm screened cans.
Price ........................................ 100/ £6.00
SALE PRICE .................................. £3.00

K541 Printed Circuit Boards. A wide variety of high quality printed circuit boards including audio, RF, digital etc all covered in components - resistors, capacitors, transistors, ICs, LEDs, switches etc, etc. A big pack of 2kg.
Price ........................................ Only £7.00
SALE PRICE .................................. £4.00

K712 Crystals. Mostly HC60 and HC18U in a wide variety of frequencies from a few hundred kilohertz to many megahertz and the odd crystal oscillator module or two.
Price ........................................ 20 for £4.95
SALE PRICE .................................. £4.00

K713 Fuseholders. Panel and chassis mounting from a basic clip to high current enclosed types for 15, 20 and 32mm fuses.
Price for pack of 50 ..................... £4.00
SALE PRICE .................................. £3.00

Transducer/ Sounder Parcel
Remains of STC sounder on P120 of 1991 transducer/ sounder.
A parcel of 10 assorted.
Price ........................................ £6.00
SALE PRICE .................................. £6.00

Power Supply Parcel
K586 This one's an absolute gem! Contains a selection of conventional and switch mode power supplies, including AA12531, Z4215, Z4311 + 7 others!! A parcel of 10 originally selling for £40+
Price per pack of 50 .................. £15.00
SALE PRICE .................................. £15.00

PHOTOGRAPHIC

K716 Odds and ends of Flash units, dedicated Flash Modules, Lens converters, incomplete cameras (at least 3).
Excellent value at ................................ £10

MINIMUM ORDER VALUE £12 + £3 POSTAGE/ PACKING PER ORDER
THE POW - POW -

ONLY £6.95 each
100 + £3.50 + VAT 1000 + £2.80 + VAT

Z660 Astec switched mode PSU type AA7271.
This small PCB, just 50 x 50mm will accept 8-14V input and give a stable 5V dc at up to 2A output. The 6 transistor circuit provides current overload protection, thermal cut-out and excellent filtering. Offered at a remarkably low price.

Price.................................................. £5.00
SALE PRICE........................................... £3.00

* 3½ digit 8mm LCD display
* Fully autoranging
* Display hold facility
* Diode and continuity test
* Probe styling
* Automatic polarity and zero
* Protective carrying case

A £34.95 AUTORANGING MULTIMETER
(1991 Catalogue)
LESS THAN ½ PRICE !!
YOURS FOR JUST

ASTEC Model AA12531
Switch Mode Power Supply

Input: 115/ 230V ac 50/ 60Hz
Outputs: V1 + 5V 5A
         V2 + 12V 0.15A
Size: 160 x 104 x 45mm

Partially enclosed panel with fixing holes in steel case on 120 x 125mm centres. Inputs and Outputs are on colour coded leads, there is also an EEC socket on a flying lead.

CONVERSION KIT GIVES TWO EXTRA OUTPUTS!
Max Current from each output: +5V(6A); +12V(2A); -12V(200mA);
-5V(2.5A);
Note: Max Total Wattage is 40W - eg +12V(2A); -5V(1.5A);
-12V(200mA); -5V(20mA etc.
Complete Kit of parts + Instructions K725
Instructions only K726

£3.50
£1.00

Over the years, we've had many different switch mode power supplies, but this latest unit is without doubt one of the finest we've ever seen! Made by Astec, it is a totally enclosed steel cased unit measuring 175 x 136 x 65mm, which has incorporated in it a switched and fused IEC mains inlet.
Inside, the PCB is 160 x 80mm with output pins fitted on one end. A connector to these pins to extend the outputs to the exterior of the case is provided.

Specification:
Model Number: BM41012
Input: 115/230V, 50/60Hz
Outputs: +5V 3.75A
         +12V 1.5A
         -12V 0.4A
Total Wattage: 65W
Prices................................... £12.95

Order Code
DM1360
AC volts .................. 0-2-20-200-500 Vac ± 2.3%
DC volts .................. 0-200m-2-20-200-500 Vdc ± 1.3%
Resistance .................. 0-200k-20k-2M-20MΩ ± 2%
Dims .................. 133 x 29 x 17mm

A £34.95 AUTORANGING MULTIMETER
(1991 Catalogue)
LESS THAN ½ PRICE !!
YOURS FOR JUST

£16

MINIMUM ORDER VALUE £12 + £3 POSTAGE/PACKING PER ORDER
## Switch Mode PSU's

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
<th>Sale Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z8887</td>
<td>Made by STC, 160 x 100mm panel is attached to an aluminium chassis. 165 x 102 x 65mm and has a single 5V 6A output. Supplied with connection details.</td>
<td>-</td>
<td>£4.95</td>
<td>£4.95 100+ 3.00</td>
</tr>
<tr>
<td>Z8888</td>
<td>A larger version of the above, PCB 220 x 100mm and chassis 225 x 102 x 65mm providing a single 5V 10A output. Supplied with connection details.</td>
<td>-</td>
<td>£8.95</td>
<td>£7.95 100+ 4.50</td>
</tr>
<tr>
<td>Z8890</td>
<td>DC - DC Converter Boards. These panels 220 x 195 require 50V DC input for a 5V 19.5A output. Inputs and outputs on DIN41612 connector. These brand new panels made by STZ are now being offered at just:</td>
<td>-</td>
<td>£7.95</td>
<td>£6.95 100+ 3.20</td>
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</table>

## Constant Voltage Transformers

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
<th>Sale Price</th>
</tr>
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<tbody>
<tr>
<td>GR75107</td>
<td>2kVA</td>
<td></td>
<td>£3.45</td>
<td>£2.50</td>
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<tr>
<td>GR75108</td>
<td>1kVA</td>
<td></td>
<td>£1.75</td>
<td>£1.00</td>
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</table>

## High Power Inverters

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
<th>Sale Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z8802</td>
<td>Battery charger unit. 2 part vacuum formed black plastic case 570 x 215 x 165mm with room for 10 x 2.6AH 6V sealed lead acid batteries. Inside is a neat PSU - RS toroidal transformer 207- 95. 120/240V primary 0-4, 0-8 secondarily, each at 10A. There is a bridge rectifier and smoothing cap. The output is taken to a PCB 510 x 45mm containing 10 identical charging circuits. Each has a TIP31A, 741, IN4002 and couple of Rs, and a 3 pin connector.</td>
<td>-</td>
<td>£8.00</td>
<td>£8.00 each</td>
</tr>
</tbody>
</table>

## STC POWER SUPPLIES

These are extremely well made linear power supplies by STC (series 15) offering exceptional value for money. Chassis size 124 x 100 x 41mm. Input voltage can be 100, 120, 220, 230, 240V. There is over-voltage protection on both models.

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
<th>Sale Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z8998</td>
<td>Type 15AAA. Output 5V/ 3A. STC price in 1987 £43.99.</td>
<td>-</td>
<td>£8.00</td>
<td>£8.00</td>
</tr>
<tr>
<td>Z8999</td>
<td>Type 15AAB. Output 15V/0.5A twice STC price in 1987 £60.09.</td>
<td>-</td>
<td>£10.00</td>
<td>£10.00</td>
</tr>
<tr>
<td>Z8915</td>
<td>Type 15AAC. Output ± 15V/0.5A. STC price in 1987 was £60.38.</td>
<td>-</td>
<td>£10.00</td>
<td>£10.00</td>
</tr>
<tr>
<td>Z8916</td>
<td>Type 15AAH. Output 15V/1A with OVP. STC price £43.99.</td>
<td>-</td>
<td>£10.00</td>
<td>£10.00</td>
</tr>
<tr>
<td>Z8917</td>
<td>Type 15AAJ. Output 15V/1A. STC price £41.69.</td>
<td>-</td>
<td>£10.00</td>
<td>£10.00</td>
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</tbody>
</table>

## Oric Power Supply

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
<th>Sale Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z4208</td>
<td>Moulded plastic case with built in 13A plug. Output 9V dc at 600mA delivered to 2m lead with 2.5mm power plug.</td>
<td>-</td>
<td>£3.50</td>
<td>£2.50</td>
</tr>
<tr>
<td>Z425</td>
<td>Siliconix mains input, 4.5V dc 100mA output to 3.5mm jack plug on 2m lead. Built-in continental 3-pin plug. Size 62 x 48 x 35mm.</td>
<td>-</td>
<td>£2.00</td>
<td>£1.20</td>
</tr>
</tbody>
</table>

## Model Railway Control & Switching Unit

This ready built versatile piece of equipment allows:

- Full forward and reverse control of trains using regulated and smoothed supply (1.5A). Requires 3 components (supplied) to be soldered into panel.
- Relay control of 5 separate circuits. (10A change over contacts, ideal for points operation).
- Powering of auxiliary equipment - 2 separate 5V 1A outputs.
- Connections, both input and output are by screw terminals which are clipped onto the on-board pins.

The five 12V relays are controlled by transistor circuits which require only 5V 30mA, supplied by the on board power supply. Supplied uncased with circuit and wiring diagram. (SAE for free copy.)

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z8897</td>
<td></td>
<td></td>
<td>£3.50</td>
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</tbody>
</table>

## Minimum Order Value

Minimum Order Value £12 + £3 POSTAGE/PACKING PER ORDER.
**Power Supply Capacitors**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Voltage</th>
<th>Ripple</th>
<th>Mfd'</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z4343</td>
<td>220µF</td>
<td>40V</td>
<td>2.7A</td>
<td>45/26</td>
<td>2.12</td>
</tr>
<tr>
<td>Z4344</td>
<td>470µF</td>
<td>63V</td>
<td>4.4A</td>
<td>50/36</td>
<td>3.77</td>
</tr>
<tr>
<td>Z4345</td>
<td>10,000µF</td>
<td>40V</td>
<td>4.8A</td>
<td>56/41</td>
<td>3.89</td>
</tr>
<tr>
<td>Z4346</td>
<td>15,000µF</td>
<td>25V</td>
<td>5.5A</td>
<td>56/41</td>
<td>3.96</td>
</tr>
</tbody>
</table>

**Prices:**
- Z4343 $0.20 per 25
- Z4344 $0.50 per 100
- Z4345 $0.50 per 100
- Z4346 $0.50 per 100

**SALE**
50% off

*All these have screw terminals except those marked.*

**Resistors**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Voltage</th>
<th>Mfd'</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z1877</td>
<td>CR1 9W</td>
<td>6 for £1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z1878</td>
<td>CR2 9W</td>
<td>6 for £1</td>
<td></td>
<td></td>
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</tbody>
</table>

Both available in boxes of 250 = £15 per box.

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Voltage</th>
<th>Mfd'</th>
<th>Price</th>
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<tbody>
<tr>
<td>Z1873</td>
<td>10R 22W</td>
<td>All at the same price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z1876</td>
<td>185 ±15W</td>
<td>£100/£3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z2873</td>
<td>2R2 22W</td>
<td>£100/£3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z28102</td>
<td>56R 5W</td>
<td>All available in boxes of 1000 = £15 per box.</td>
<td></td>
<td></td>
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</tbody>
</table>

**SALE**
50% off

**Capacitor Clearance**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Voltage</th>
<th>Mfd'</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z4004</td>
<td>100 350µF</td>
<td>Nova 48 ±3%</td>
<td>£1.00</td>
<td>0.60</td>
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<tr>
<td>Z4005</td>
<td>220 400µF</td>
<td>Nova 54 ±2%</td>
<td>£2.50</td>
<td>1.50</td>
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<tr>
<td>Z4006</td>
<td>470 400µF</td>
<td>Nova 54 ±1%</td>
<td>£3.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Z4007</td>
<td>800 400µF</td>
<td>Nova 56 ±1%</td>
<td>£3.00</td>
<td>2.00</td>
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<tr>
<td>Z4008</td>
<td>2200 160µF</td>
<td>Nova 45 ±1%</td>
<td>£2.00</td>
<td>1.20</td>
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<tr>
<td>Z4009</td>
<td>2200 250µF</td>
<td>LCR 118 ±4%</td>
<td>£3.00</td>
<td>2.00</td>
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<tr>
<td>Z4010</td>
<td>4700 16µF</td>
<td>LCR 45 ±2%</td>
<td>£0.75</td>
<td>0.45</td>
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<tr>
<td>Z4011</td>
<td>10000 25µF</td>
<td>LCR 65 ±3%</td>
<td>£0.50</td>
<td>0.25</td>
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<tr>
<td>Z4012</td>
<td>33000 15µF</td>
<td>LCR 35 ±3%</td>
<td>£1.00</td>
<td>0.60</td>
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<tr>
<td>Z4013</td>
<td>3900 63µF</td>
<td>Nova 115 ±1%</td>
<td>£1.20</td>
<td>0.75</td>
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<tr>
<td>Z4014</td>
<td>4600 50µF</td>
<td>Nova 84 ±2%</td>
<td>£1.50</td>
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<td>Z4015</td>
<td>10000 63µF</td>
<td>Nova 10 ±1%</td>
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<tr>
<td>Z4016</td>
<td>10000 25µF</td>
<td>Nova 54 ±2%</td>
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<tr>
<td>Z4017</td>
<td>10000 85µF</td>
<td>IR 65 ±4%</td>
<td>£3.00</td>
<td>2.00</td>
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<tr>
<td>Z4018</td>
<td>15000 63µF</td>
<td>Nova 115 ±1%</td>
<td>£2.50</td>
<td>1.50</td>
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</table>

**SALE**
50% off

**DIL Socket Delights!**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>per 100</th>
<th>Price</th>
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<tbody>
<tr>
<td>YV</td>
<td>220µF 10V</td>
<td>£3.00</td>
<td>0.05</td>
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<tr>
<td>KB</td>
<td>470µF 25V AX</td>
<td>£3.00</td>
<td>0.05</td>
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<tr>
<td>KB</td>
<td>470µF 16V AX</td>
<td>£3.00</td>
<td>0.05</td>
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<tr>
<td>KB</td>
<td>10µF 16V R</td>
<td>£3.00</td>
<td>0.05</td>
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<td>KB</td>
<td>220µF 16V R</td>
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<tr>
<td>KB</td>
<td>100µF 25V R</td>
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**DIL Socket Delights!**

<table>
<thead>
<tr>
<th>Code</th>
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<th>per 100</th>
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<tr>
<td>ST 8</td>
<td>£2.25</td>
<td>0.015</td>
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<tr>
<td>CS 14</td>
<td>£3.00</td>
<td>0.020</td>
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<tr>
<td>ST 16</td>
<td>£3.75</td>
<td>0.025</td>
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<td>ST 18</td>
<td>£3.75</td>
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<td>CS 20</td>
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<td>ST 24</td>
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<tr>
<td>ST 40</td>
<td>£9.00</td>
<td>0.060</td>
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</tr>
</tbody>
</table>

**SALE**
75% OFF

**Resistor Stock Clearance**

*One million assorted resistors for just £300 + VAT + Carr (That's 3p/100)*

**Audio Amplifier Panels**

**1W Amplifier - mono**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Voltage</th>
<th>Mfd'</th>
<th>Price</th>
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<tr>
<td>Z414</td>
<td>20µF 1000V</td>
<td>£10.00</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

*2xTBA820M and dual volume control.*

**SALE**

- £0.75 each
- 10 + 0.50: 25 + 0.40: 100 + 0.32

**Tape Deck**

**CB Aerial Eliminator**

**Memorex Tape**

*Originally sold at £7.95.*

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z4001</td>
<td>680ft</td>
<td>£5.00</td>
</tr>
</tbody>
</table>

*2 for £1.00*
VIESTEL II

Total Communication for Deaf People

Specification
- Dimensions: 34cm x 45cm x 13.7cm
- Weight: 4.5kg
- Full 'QWERTY' keyboard plus 'function' keys for ease of use.
- 40 character screen which displays your messages clearly, clearly and quietly.
- Text editor for preparing recording and storing information.
- Memory for up to 9,500 characters.
- Auto-answering capability for receiving calls even when you are not there.
- Auto-dialling capability for sending messages during cheap rate telephone periods.
- Real time clock.
- Personal telephone directory for storing your most commonly used numbers.
- Calculator.
- Printer interface for connection to a printer.
- Telecom Gold, or BKU mail box, function key.
- VIESTEL II runs from mains with battery back-up so memory is retained even when VIESTEL II is turned off.
- For connection your only requirements are a power point and a British Telecom jack plug socket.

Options:
- Printer

These units are new and boxed, but because the company who manufactured them has gone bankrupt they are offered without guarantee. There is a comprehensive 143 page instruction manual provided. These units originally sold for over £500.

Our Bargain Basement Price £150
Sale Price £75

If you want to look through the manual first, send £12 (£10 deposit + £2 post): £10 refunded on its return.

SEMICONDUCTORS - If you're seriously into Semi's, ask for our Bulk Buyers list - Diodes, Transistors, IC's etc, all at knockout prices!!

Dynamic RAM Modules
Z1985 Dynamic 256k RAM modules SIMM, 8 x 41256-12 with room for 9th chip. Similar to types costing £100
Our low price £25.00, just £10.00 each

Sale Price £7.50

Z1818 Dynamic RAM modules by NEC type MC141256A8A-12. These SIPs are on panels. 118mm x 77mm and have 8 x 41256 RAMs, giving 256k of memory. Similar to
Their price £35.00.
Our price £30.00

Sale Price £7.50

Bridge Rectifiers

ZMB20A 25A 200V
BY120 25A 50V
S44120 4A 200V

Price £1.00

Speech Chip Bargain

The SP1026 is probably the best known speech chip available.

Our special low price £25.00

1992 Catalogue - Yes we know we’re only half way through 1991, but if you want to be first with the Bargains, you can place an advance order now - just add it to your order where indicated. This will be sent to you on publication 1st October, 1991.
### Dual Sheet Feeder

**Z8837 Exxon Dual Sheet Feeder Z200**
- Overall dimensions: 395 x 210 x 285mm.
- Brand new and containing some very high class electronics.
- Although of little practical use as it stands, it makes a great break down unit.
- Contains:
  - 3 x 12V 36R 7.5° stepper motors by Airpax and associated gear trains drive belt etc.
  - 2 x 12V Solenoids
  - 2 x 12V Electronic buzzer
  - 1 x 12V 36R 7.5° stepper motors by Airpax and associated gear trains drive belt etc.
- **Price**: £12.50

### Dragon Interface

**Z99 Dragon Interface**
- Case 116 x 62 x 28mm with 2 x 9 pin D Plugs, 2 leads with 5 pin DIN plug.
- Inside is a PCB with 4 transistors and 20 resistors.
- **Box of 50**
- **Price**: £20.00

### Krazy Keyboard Klearance

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Dimensions</th>
<th>Features</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z8842</td>
<td>Tatung VT410 keyboard</td>
<td>85 keys</td>
<td>Separate numeric keypad, circuit has 2 or 3 broken keys</td>
<td>£5.00</td>
</tr>
<tr>
<td>Z8848</td>
<td>Keyboard by Cherry</td>
<td>104 keys</td>
<td>All normal keys fitted, chips on board: L5373 x 2, LS374, LM3086 x 2, LS138 x 3, LS374, LS08, 6805</td>
<td>£4.00</td>
</tr>
<tr>
<td>Z8862</td>
<td>Keyboard from Liberater Computer</td>
<td>278 x 124mm</td>
<td>62 keys, some of these have been used, output to 20 way connector</td>
<td>£6.00</td>
</tr>
<tr>
<td>Z4116</td>
<td>24 way (8 x 3) membrane keypad</td>
<td>24 x 24mm area</td>
<td>Large 200 x 128mm area, self adhesive</td>
<td>£1.00</td>
</tr>
<tr>
<td>Z4363</td>
<td>Membrane keyboard 225 x 84mm</td>
<td>11 keys</td>
<td>Output (common bus) on 12 way ribbon cable</td>
<td>60p</td>
</tr>
<tr>
<td>Z4383</td>
<td>Membrane keyboard 225 x 84mm with 11 keys</td>
<td>95 x 70mm</td>
<td>Output (common bus) on 12 way ribbon cable</td>
<td>40p</td>
</tr>
</tbody>
</table>

### Books

**K585** From page 104 of the 1990 Catalogue plus others not listed, a selection of computer books. Will include 'Sensing & control for the BBC' and 'Go Forth'. A pack of 10 books, originally retailing for £50.
- **SALE PRICE**: £6.00

**Sensing and Control Projects for the BBC by T Nutns**
- Shows how 'ANALOGUE IN' and the 'USER PORT' sockets can be interfaced to the real world.
- Fully explained projects in non technical language.
- No soldering required.
- Original price: £5.95.
- **SALE PRICE**: £2.00

**'Go Forth' by Paul Kall**
- An introduction to Forth Language.
- It's as easy to use as BASIC, but is much faster.
- This book is a complete foundation course in Forth programming, and contains a number of complete programs.
- Original price: £8.95.
- **SALE PRICE**: £2.00
Send your order to:

GREENWELD ELECTRONIC COMPONENTS
27 Park Road, Southampton, SO1 3TB
(A different postcode is correctly shown on reply paid envelopes)

Customer No: Date:
Name:
Address:
Post code

OFFICE USE ORDER CODE QTY No of Pcks Description Price £ p

Z9999 Bargain List Subscription Service Our next 6 Lists with reply paid envelope UK/BFPO 2.00 O/SEAS 4.00

Z0000 1991 132 page Catalogue UK/BFPO 1.50 O/SEAS 3.00

C1992 1992 Catalogue - sent on publication, 1st Oct 1991 UK/BFPO 2.00 O/SEAS 4.00

IMPORTANT: Please fill in the following information. Thank you

1. Did you receive this SALE supplement (Tick all that apply):
☐ with your previous order ☐ As a Bargain list Subscriber ☐ Unsolicited
☐ with Everyday Electronics ☐ with Practical Electronics ☐ with Elektor
☐ with Television ☐ Other (Please state how)

2. Please let us know if you want this order:
☐ Sent as soon as possible with a credit note for any parts out of stock;
☐ Sent as soon as possible with any out of stock items to follow. (only if value over £10);
☐ Held for expected deliveries for up to ______ days (state how long);
☐ Other (please specify) ________________________________________

3. Have you ordered from us before? YES ☐ NO ☐ Are you already a Bargain List Subscriber? YES ☐ NO ☐

4. Please tick method of payment: Cheque ☐ PO ☐ Cash ☐ Credit Card ☐ Other ☐
Credit Card No (Visa/Access/Connect): ____________________________
Ex Date: ____________________________

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Signed by: ____________________________

Date: ____________________________
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Listed below by page number are our **SALE PRICES** for all goods listed in our 1991 catalogue, our 1991 Spring Supplement and Bargain List 68:

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| Pages 4-14 | 10% off |
| Pages 15-23 | 10% off |
| Pages 20-31 | 10% off |
| Pages 36-42 | 5% off |
| Pages 49-88 | 10% off |
| Pages 94-97 | 10% off |
| Pages 102-105 | 10% off |

### 1991 SPRING SUPPLEMENT

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| Pages 13-18 | All ½ price |

| Page 19 | All ½ price except BYW20 |
| Page 20 | All ½ price except EBY20 |

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| Page 28 | Z22997 40% |
| Page 29 | Z612 25% |
| Page 29 | Z4035 25% |
| Page 30 | Z4090 25% |

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**Page 110**
All ½ price except Z4190

**Page 111**
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**Pages 112-113**
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**Page 114**
All ½ price

**Page 115**
All ½ price

**Page 116**
All ½ price

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All ½ price except 5A regs

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| £4.00
| £6.00 Rest 25% off

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See Pages 8 & 9 of this supplement

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All ½ price

**Page 121**
All ½ price

**Page 122**
All ½ price

**Page 123**
All ½ price

**Page 124**
All ½ price

**Page 125**
All ½ price except 5A regs

**Page 126-26**
25% off

**Page 131**
See Page 6 of this cat for switch packs

**Page 132-68**
See Page 16 of this supplement.

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### BARGAIN LIST 68

| Page 2 | 25% off |
| Page 3-4 | 25% off |
| Page 5 | 25% off |
| Page 7 | 25% off |
| Page 8 | 25% off |
| Page 11 | 50% off |
| Page 12 | All ½ price |
| Page 13 | All ½ price |
| Page 14 | All ½ price |
| Page 15 | Except 1 million R's |
| Page 16 | Except 5A packs |
| Page 17 | Except Bulk LED's |

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### BBC 'B' SOFTWARE - FINAL CLEARANCE

This has been cluttering up our stores for far too long - now being sold at not much more than the media value.  (SAE for more information, colour leaflet).

**Micro Maestro** - Comprises 5½" disk + computer tape; 16 page handbook; C60 stereo cassette with backing tune of popular tracks like 'Ghostbusters', 'Charlottis of Fire', and 'Superman'.

Original Price £17.95

**SALE PRICE**

£2.00

**Music Master** - Comprises microphone to attach to recorder + processing device; 5½" disk; 12 page handbook

Original Price £52.78

**SALE PRICE**

£4.00

**Mupados Recorder Tutor** - Comprises 5½" disk; 38 page large format spiral bound handbook; C90 stereo cassette with 82 tunes.

Original Price £30.94

**SALE PRICE**

£2.50

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**HITACHI SCOPES**

**ON ALL MODELS!**

| V212 | £385 |
| V223 | £545 |
| V522 | £730 |
| V209 | £860 |

**SALE PRICE**

| £346.50 |
| £490.50 |
| £657.00 |
| £774.00 |

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**MINIMUM ORDER VALUE £12 + £3 POSTAGE/PACKING PER ORDER**

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**GREENWELD**

**CREDIT CARD HOTLINE: (0703) 236363**  **FAX: (0703) 236307**
Acoustic Couplers

- Z23183 Black
- Z23200 Red
- Z23201 Blue
- Z23199 Black

Current price is around 60p. Now fine point cartridges are essentially complete.

Stationery products

Pentel Rolling Writers. These fine point cartridges are essentially complete pens without an outer casing, so can be used as they are. Current price is around 60p. Now look at our prices! (State 2nd choice.)

Modem Panels

Another parcel of parcels from Dovtly. These are all believed to have come from discontinued units and as far as is known are not faulty. However, please note some have missing chips or boards are cut to prevent re-use. They are therefore being sold for their component value only, not as working units.

Instrument Fans

- Z5005 Excellent quality instrument fan by Toyo. Model TF2220A. 230V AC. 92.5mm x 25.5mm deep. Silent operation. List around £19.50.
- Our price £6.00
- SALE PRICE £4.00

- 25 + £3.00
- 100 + £2.40

- Modem Panels
- Another parcel of parcels from Dovtly. These are all believed to have come from discontinued units and as far as is known are not faulty. However, please note some have missing chips or boards are cut to prevent re-use. They are therefore being sold for their component value only, not as working units.

- Map Light
- "JIMMY" the electronic football game of skill

- SALE
- Both £2.00

- Summer Sale List 15

- CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

- GREENWELD

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- Both £2.00

- Summer Sale List 15

- CREDIT CARD HOTLINE: (0703) 236363 FAX: (0703) 236307

- GREENWELD
CAMERA CLEARANCE

Job lot of 'returns' just arrived, offering the amateur photographer a bargain buy in 110 & 35mm cameras. We've been asked not to mention the manufacturer's name, but it's well known for its equipment and available in all photographic and chemist shops (Boots) etc. There are a number of different models, but to simplify matters we've grouped them into 3 main types:

(a) 110mm manual;
(b) 110mm motor driven;
(c) 35mm manual.

All are complete and intact and look OK, so the faults (if any) are probably minor. Because they're so cheap, you can afford to buy 2 or 3 - we're sure you'll be delighted with the value we're offering! - but please do remember these are returns and are sold without guarantee.

**Z5028 110mm Manual models include 110LF and 110TF, many have built in flash (our choice).**

**Prices**

- £3.50 ea
- 5 for £14.00

**Z5029 110mm Motor driven. Models include 110IF.**

**Prices**

- £4.00 ea
- 5 for £16.00

**Z5030 35mm Manual. Models include 35HL, 806, 35CT, DL10, DL7. Most have built in flash (our choice).**

**Prices**

- £4.50 ea
- 5 for £18.00

**Z5032 Broken cameras. These have parts missing. A parcel of 6 assorted, all 35mm including manual, motor driven, autofocus, twin lens types.**

**Price**

- £15.00

HIGH QUALITY SLIMLINE

LOGIC PROBE/ PULSER

Top quality slim (18mm dia) precision instrument for troubleshooting and analysis of logic circuits. It works as a level detector, pulse detector and pulse stretcher. It is circuit powered, has LED indicators and comes with additional probe lead and clip, and instruction sheet. An excellent addition to your Test Gear at an unrepeatable price. We have purchased all available supplies and can offer this superb instrument for around half the normal selling cost.

**Order Code M625**

**ONLY £10.00**

**Extraordinary Easiwire Offer!!!**

The easy to use no-soldering wiring tool which makes construction of small electronic projects so simple!

All included in the kit are: Wiring pen, Utility tool, Punched wiring board, Self adhesive sheet, Spring loaded terminals and jacks, Spare spool of wire, Excellent instruction book. Catalogue price £15.00

**SALE PRICE**

**£5.00**

MINIMUM ORDER VALUE £12 + £3 POSTAGE/ PACKING PER ORDER
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**Over 9000 Installations in 50 Countries Worldwide!**

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- Not copy protected.

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**PULSAR**

**£195**

- At last! A full featured Digital Circuit Simulator for less than £1000!
- Pulsar allows you to test your designs without the need for expensive test equipment.
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- Includes 4000 Series CMOS and 74LS Libraries
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- Not Copy protected.

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**Z-MATCH II**

**£195**

- Z-MATCH II simplifies RF matching and includes many more features than the standard Smith Chart.
- Handles transmission line transformers, stubs, discrete components, S Parameters etc.
- Supplied with many worked examples.
- Superbly easy to learn and use.
- Runs on IBM PC/XT/AT/386/486, CGA,EVA,VGA.
- Not Copy protected.

### Options:

- 1000 piece Symbol Library £38, Gerber Import facility £98

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