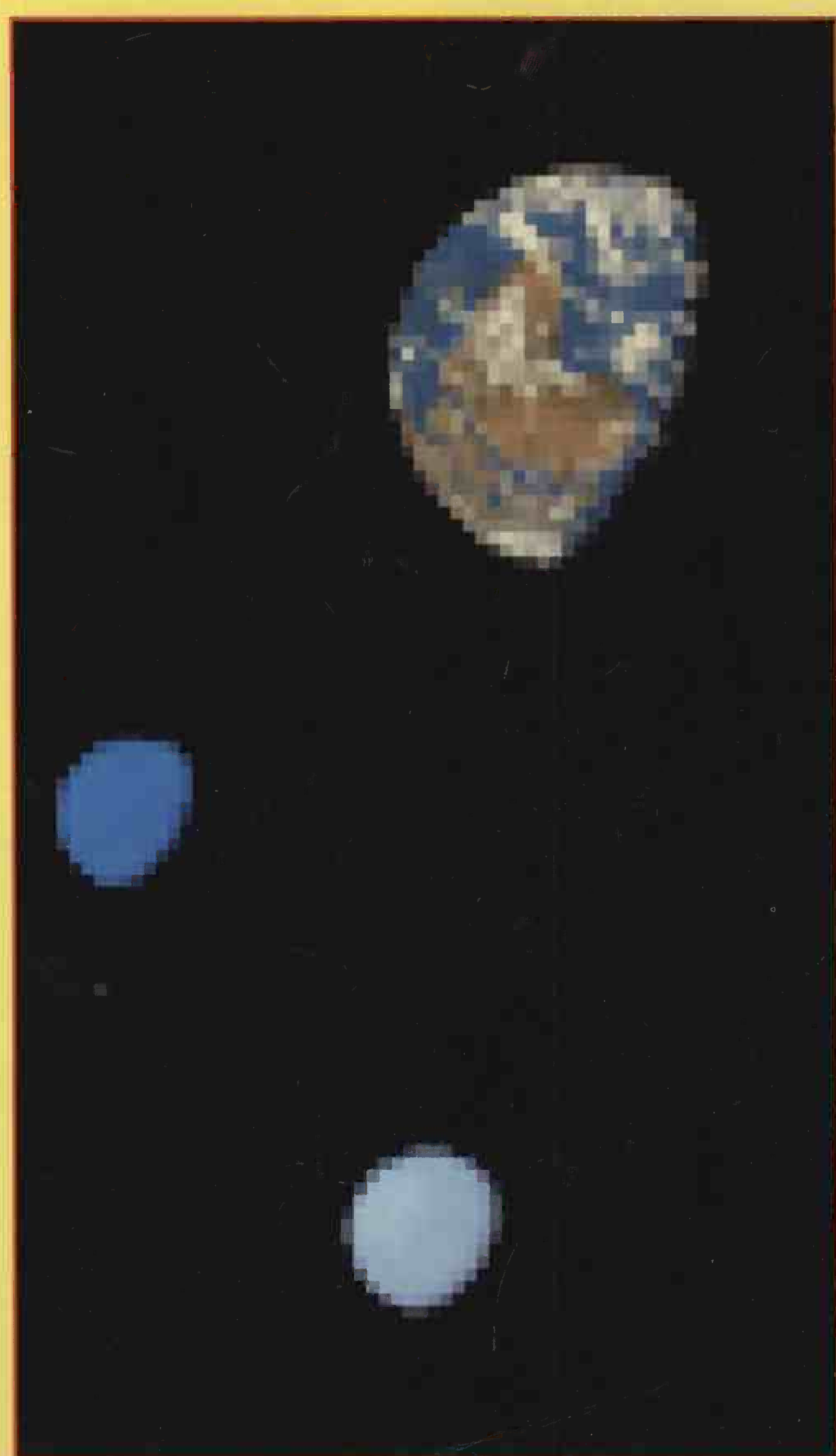
PRACTICAL

ELECTRONICS

August 1991 • £1.50

SCIENCE AND TECHNOLOGY



Electric Eyeballs
A close look at CCDs

Sony's New Mini-Disk
The end of DAT and DCC?

The Toshiba T1000LE
How portable is portable?

Bright Idea
8-Channel light controller

Serial Special
RS232 and all that

Memories...
Data storage

Getting Wired
Cables, cores, co-ax

How It Works
The multimeter

08
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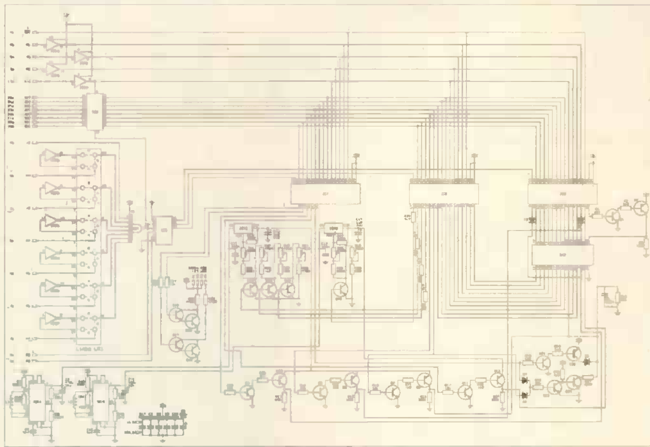
Finally... an exceptional PCB and Schematic CAD system for every electronics engineer!

BoardMaker 1 is a powerful software tool which provides a convenient and professional method of drawing your schematics and designing your printed circuit boards, in one remarkably easy to use package. Engineers worldwide have discovered that it provides an unparalleled price performance advantage over other PC- based systems.

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



Produce clear, professional schematics for inclusion in your technical documentation.

HIGHLIGHTS

Hardware:

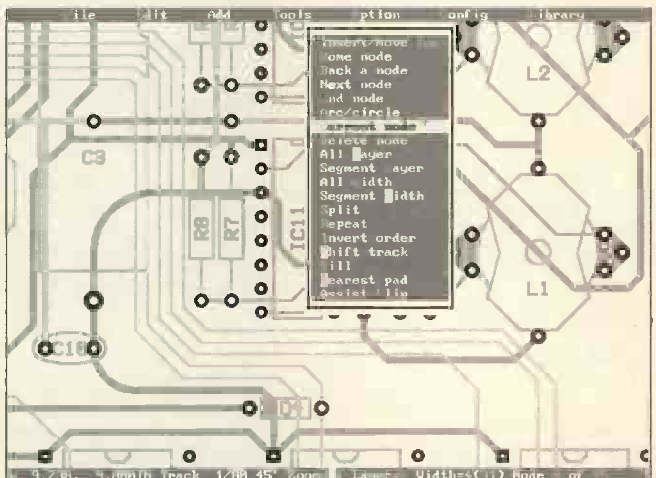
- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
- Microsoft or compatible mouse recommended.

Capabilities :

- Integrated PCB and schematic editor.
- 8 tracking layers, 2 silk screen layers.
- Maximum board or schematic size - 17 x 17 inches.
- 2000 components per layout. Symbols can be moved, rotated, repeated and mirrored.
- User definable symbol and macro library facilities including a symbol library editor.
- Graphical library browse facility.
- Design rule checking (DRC)- checks the clearances between items on the board.
- Real-time DRC display - when placing tracks you can see a continuous graphical display of the design rules set.
- Placement grid - Separate visible and snap grid - 7 placement grids in the range 2 thou to 0.1 inch.
- Auto via - vias are automatically placed when you switch layers - layer pairs can be assigned by the user.
- Blocks - groups of tracks, pads, symbols and text can be block manipulated using repeat, move, rotate and mirroring commands. Connectivity can be maintained if required.
- SMD - full surface mount components and facilities are catered for, including the use of the same SMD library symbols on both sides of the board.
- Circles - Arcs and circles up to the maximum board size can be drawn. These can be used to generate rounded track corners.
- Ground plane support - areas of copper can be filled to provide a ground plane or large copper area. This will automatically flow around any existing tracks and pads respecting design rules.

Output drivers :

- Dot matrix printer.
- Compensated laser printer.
- PostScript output.
- Penplotter driver (HPGL or DMPL).
- Photoplot (Gerber) output.
- NC (ASCII Excellon) drill output.



PCB layout editor provides full analogue, digital and surface mount support - ground and power planes (hatched or solid)- 45 degree, arced and any angle tracks.

£95 Despite its quality and performance, BoardMaker 1 only costs £95.00 + £5.00pp + VAT. Combine this with the 100% buy back discount if you upgrade to BoardMaker 2 or BoardRouter and your investment in Tsien products is assured.

Don't take our word for it. Call us today for a FREE demonstration disk and judge for yourself.

tsien

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

All trade marks acknowledged

This month...

After a month's break, How It Works is back with a look inside a multi-meter.

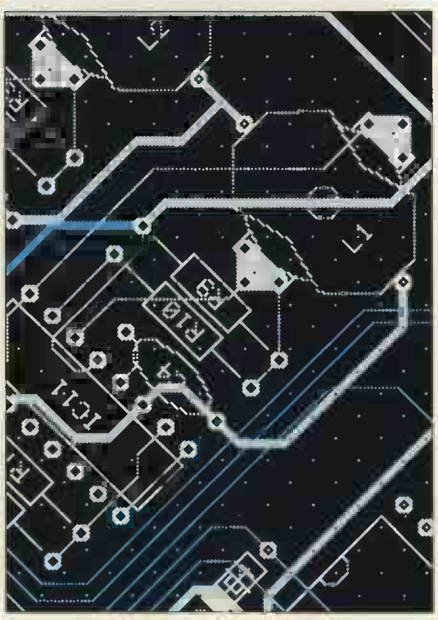
New to PE this month is a page devoted to integrated circuits, a new consumer electronics feature that takes an in-depth look at the latest technology to hit the shops and Practical Technology which examines some of the more interesting electronic productsavailable.

Due to a hiccup in production, the contents page last month stated that last month's edition of the PE Chronos was the last. Fortunately, it wasn't and it carries on this month with the first of the printed circuit boards.

Next month sees a couple of bonuses from PE, the first is a free 16 page Greenweld Summer Special Component Catalogue. The second is our special Seetrax competition. Five copies of the Ranger 1 PCB design software worth £200 plus add-on auto-router packages worth £100 will be on offer.

Kenn Garroch, Editor

Next month...



Summer holiday special... Win Seetrax Ranger CAD software worth £200. 5 copies are up for grabs and every unsuccessful entrant will get a demo disk. Only in PE's September issue.

Build It

Features

Regulars

Editor: Kenn Garroch Technical Editor: Andrew Armstrong Technical Illustrator: Derek Gooding Advertisement Manager David Bonner Production Manager: Richard Milner Production Assistant: Michael Sullivan Office Manager: Laura Esterman Office Secretary: Wendy Rhodes Publisher: Angelo Zgorelec • **Practical Electronics Intra House 193 Uxbridge Road London W12 9RA Tel: 081-743 8888 Fax: 081-743 3062 Telecom Gold: 87: SQQ567** • **Advertisements** The Publishers of PE take reasonable precautions to ensure that advertisements published in the magazine are genuine, but cannot take any responsibility in respect of statements or claims made by advertisers. The Publishers also cannot accept any liability in respect of goods not being delivered or not working properly. • Practical Electronics Is typeset at Intra Press on MacIntosh computers using Quark Xpress. Reproduction by Tetracolour Ltd. Printing by Andover Press, St Ives plc. Distribution by Seymour Press • **ISSN 0032-6372** •

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PRECISION

A **Talking Multitester**. Press a button on the probe and the meter will call out it's 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.

B **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.

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ALL THE ACTION
AS IT HAPPENS!

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Wavelengths

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

Ticking Off

On page 5 of the May issue of Practical Electronics you ask for comments. Here are some comments on page 5:

I am a long standing (25 years or more) reader of the magazine, which to this day I still find most interesting, but I am anxious that it has recently taken a turn for the worse. The answers given to readers' letters in the "Wavelengths" section this month I found quite unsettling. They were written in a didactic "Teacher knows best" style, and this case I fear that in many cases Teacher didn't know best. Some examples:

1. On your having been caught napping by Phillip J Turner on various points including the completely made up "MOS = Metal On Silicon" nonsense, I feel you should have simply thanked the reader, apologised, and shut up. Instead you grudgingly admit the correct definition (MOS = Metal Oxide Silicon), but then deliver a ludicrous and unwarranted lecture on the manufacture of semiconductors from oxides of iron, zinc, cobalt and nickel. I suspect you come from another planet if these are the materials from which your transistors and integrated circuits are commonly made. I believe MOS was first used as a prefix in the acronym "MOSFET", describing the construction of a new type of field effect transistor (distinguishing it from a JFET, junction type, and confirming it as an IGFET, Insulated Gate Type).

MOS here merely indicates the FET is made from a sandwich: Metal-Oxide-Silicon, (the oxide being one of silicon), so what's all this nonsense about cobalt and nickel oxides?

Have you ever heard of the saying "The customer is always right"? Not at PE it seems. May I add my voice to that of John Bilston and put in a plea for the "squiggle" version of the resistor? You are drawing the resistors for us, the readers, so why not draw them the way we like them? To me, the shape of the various elements in a circuit diagram provide what a drawing should provide: instant visual cues as to the form and function of the circuit. The symbols should be selected on the basis that the drawings should be easy for us to read, regardless of how easy they are for you to draw.

On that latter point your answer is not at all convincing to me: If you use a stencil (available in any drawing office) a "squiggle" is just as easy as a rectangle to draw, and if you are using a computer, then there is no difference at all in effort (unless the computer is as bloody-minded as yours seems to be!)

If you would like to see just how pleasing a decently drawn diagram can be why not look in your own magazine (current, May, issue) on page 17, and you'll see squiggles sufficiently suitable for Mr Bilson and me.

David M Parkins B Eng (Hons)
Greenbank Electronics
Birkenhead
Merseyside

Er...um....I suppose I could try being humble?

Last Of The Squiggles

I am currently in the process of taking a City and Guilds course in Electronics and would just like to add to the argument over squiggly resistors.

As far as I am aware, both symbols are quoted in the British Standard with the squiggle being used mainly in the USA. On my course we use the square block and I have been told that this is less prone to error and misunderstanding. I would like to place my vote behind the square block type.

A J Sanders
Cardiff
Wales

Unconstant

I have noticed a couple of inconsistencies in the July issue of PE. The first is that PE Chronos seems to have finished before it has really started. Was this a mistake or are you cutting it off in its prime?

The June issue of PE TEchniques section started off on an interesting question about humidifiers. The July edition didn't have anything at all, where's the rest of it?

Apart from this, I am enjoying your magazine, keep up the good work.

W Henson
Portsmouth

A slight misunderstanding nearly caused the untimely demise of the Chronos but, fortunately, as you can see from this issue, the saga continues. Apologies for the delay in the appearance of the second part of the humidifier, it finally made it in this month.

PCB Service

After phoning your magazine recently to try and get hold of a printed circuit board from you, I was distressed to hear that you no longer supply the printed circuit board service. Even though you wrote an article about making PCBs (is it really true that an editor of PE has never made one before?), I don't really fancy going to all that trouble myself, especially with some of the more complex ones.

Could you please please please bring back the PCB service? I could get up a petition, perhaps ask questions in The House, anything to get it back.

J Robinson
Manchester

In the true spirit of the present government, the PCB service has been privatised – look out for a Lys Electronics ad. With regards to my never having built a PCB, I'm afraid it is quite true though it was easier than I expected. ■

A roundup of the latest news and products. This month a logic simulator from Number 1 systems, a selection of Hi-Fi gear and the hotest new electronic camera from Kodak.

Tally Price Cut

The price of printing is falling lower and lower. In May, Mannesman Tally announced a reduction of 25% in the price of the MT753 to £749 and then knocked another £50 off to put its price at £699. This six page per minute (PPM) machine was launched last year as a portable with a footprint of less than A4 and Laserjet II emulation. An 80 sheet feeder is built in as is the battery pack which lasts for 80 sheets before it needs recharging. In June Mannesman Tally announced up to 28% off all its entry level printers. The MT904 4PPM laser printer is reduced from £949 to £699 until September, the MT82, 24-pin dot matrix is now available for £259 and the MT81, a 9-pin low end printer ,costs £119.

No. 1 Simulator

Faster than a speeding soldering iron, more accurate than a breadboard and handier than a copy of PE? Pulsar is a digital logic circuit simulator program from Number One Systems (makers of Easy PC PCB CAD) that aims to make electronic circuit design, fast easy and efficient.

Using a logic analyser type display, with readouts in binary, hexadecimal and octal, timing skews and glitches are displayed to a resolution of one picosecond.

Pulsar has a full component library for the CMOS 4000 and 74LS ranges and is capable of handling flip-flips, latches, monostables, tri-state and open collector gates. Other libraries are available as options and the user can add more by hand where the necessary details are available.

Apart from the video output, support is also supplied for dot-matrix and laser printers. Input can be either from the interactive netlist generator or the forthcoming schematic capture package, Analyser III.

Priced at £195 (£229.12 inc VAT) Pulsar is available from Number One Systems Ltd, harding Way, Somersham Road, St Ives, Huntingdon, Cambs, PE17 4WR, Tel. 0480 61778.

Dream Camera

A new electronic camera from Kodak looks set to revolutionise desktop published newspapers and journals. Obviously aimed at professional photographers, the Digital Camera System (DCS) is a pointer to a technology that could eventually be available for everyone. Designed as a new back for a Nikon F3, the digital camera operates in exactly the same way as a normal Nikon but produces 1280x1024 pixel images, in either colour or black and white. Up to six images can be stored in the camera's 8Mb memory with bursts of up to 2.5 frames a second being possible – a 32Mb buffer is also available allowing up to 24 images to be taken in one burst.

Once the pictures have been taken, they can be transferred to the digital storage unit (DSU) where they can be edited, stored, have captions added and be exported either by modem or SCSI to a Macintosh SE/30 or II – the most popular DTP machines around. Once there they can be edited as an electronic image using packages such as Adobe Photoshop and then put straight onto the page along with the text – no scanning needed.

The DSU is a portable unit which uses a hard disk drive to store up to 158 uncompressed (1.3Mb) or 600 compressed images. They can be viewed on the integral 4in monochrome LCD, deleted and annotated as necessary.

The camera "back" with its 21mm x 16mm high resolution imager uses 16 micron pixels and is approximately half the area of a 35mm frame. This means that a conventional 200mm lens becomes the equivalent of 400mm. Of the two versions available, the colour system allows images equivalent to film speeds of EI200, 400, 800 and 1600 – the monochrome also offers EI3200.

Due to be launched in the USA in August for around $20,000 , the system will be on sale in Europe next year for around £17,500. If it takes off, it will improve the speed with which pictures get into the news as well as their quality.

Get On Board

The latest version of the popular BoardMaker 2 computer aided design software from Tsien provides a number of new

features from top-down modification, new netlist interfaces, added schematic capture inputs, artwork output options. Priced at £295 the major new feature in version 2.4 is the top-down modification. When designing a PCB the usual starting point is the creation of a schematic. This can then be used to automatically design the actual board using files

Stereo TV

Now that NICAM digital stereo has established itself as a must for the TV enthusiast, television manufacturer Toshiba has announced a large screen set with the stereo circuit built in. The 2112DB is the first of a new range that features 30W music power (actually 2 x 10W RMS) in stereo, Fastext, on/off timer, twin SCARTs, a S-VHS connector, no signal power off, unified remote control and 50 channel tuning. The 59cm screen version has a manufacturer's retail price (MRP) of £619.99 and the 66cm version, £719.99.

that describe the various networks – a network is simply a collection of points that are connected together, for example, the supply rail or the ground lines. This netlist can be used by the computer program to assign connections to components and help design thew board. The top-down modification facility means that after a design is completed to the board level, changes to the schematic are automatically filtered down to the board design, modifying netlist files and time and date stamping the changes to provide an audit trail. The new component numbering system makes silk screen layer design easier since pin numbers are automatically tracked from the schematic to the final PCB.

Contact Tsien UK, Cambridge Research Laboratories, Huntingdon Road, Cambridge, CB3 0DJ, Tel 0223 277777

Happy Birthday

The British Amateur Electronics Club celebrated its 25th birthday in June and published its 100th newsletter.

As well as circuit ideas, features and special offers, the club also offers many cut price deals on components and magazines including a reduction on the subscription to PE at £16.20 Anyone wishing to get more information should contact H F Howard, BAEC, 41 Thingwall park, Fishponds,. Bristol BS16 2AJ

Micro-Brush

Originally designed for use in the dental profession, the Quick Stix from Dent-O-Care could prove useful to anyone who has to clean, glue, etch, paint or mop up in minute or hard to reach places. Made from thin flexible plastic which fines down to a point on which as a micro head composed of tiny non-linting fibres. Once bent, the thin neck is able reach any angle allowing great flexibility of use.

Quick Stix are available in boxes of 500 at a cost of £22+VAT (£25.85) from Dent-O-Care Ltd, 7 Cygnus Business Centre Dalmeyer Road, London, NW10 2XA, Tel. 081 459 7550

Events

The Second Grove Fuel Cell Symposium is to be held at the Royal Institution from 24-27 September 1991. Following on from the success of the Grove 150th Anniversary Symposium held two years ago, the event will cover advanced energy systems and environmental effects. Current progress in the technology will be reviewed in the power generation and transport markets.

William Grove invented the fuel cell in 1839 and later pioneering works was performed by Francis "Tom" Bacon. The Sir William Grove

Hi-Fi Power

For people who want that little extra bit of power from their Hi-Fis, the new MXF 900 stereo amplifier offers 460W RMS info a 4Ω load. Build around MOS-FET technology the unit offers DC loudspeaker protection, two second delay anti-thump circuitry, fan cooling, and VU meters, all in a rack mounting cabinet of 19in x143/4in. The price is £429.15 plus £12 delivery and is available from B K electronics, Unit 1/5, Comel Way, Southend-on-Sea, Essex SS2 6TR, Tel 0702 527572

Open Sounds

An innovative new speaker system is now available from Dali a Danish Hi-Fi company. The Skyline 2000 is a full-range hybrid ribbon/moving coil dipole system mounted in a stylish 1.6 metre tall case. Unlike other systems, dipole drive units are not boxed in but are open to the air in front and behind. The sound radiates equally at the front and rear but not at the sides. The resulting sound is supposed to be very natural but usually has problems with lower frequencies. To improve this aspect, the Skyline 2000 has very high power handling (200W continuous) with a 38cm moving coil woofer having a throw of over 2.5cm. This improves the bass response and the passive crossover provides a flat frequency response without introducing resonances. The mid range comes from two pre run-in 11.4 cm moving coil drive units and the tweeter is a transformer-less ribbon, 100cm long.

The cost is £1399.90 including VAT and the Skyline 2000 is available from dealers for Dali in the UK – Tel 0423 528537 for details.

Memorial Medal will be awarded to him for his work in this area.

For booking information contact K Russel, Elsevier Systems, 256 Banbury Road, Oxford, OX2 7DH, Tel. 0865 512242.

Free Symposia

The IEEIE will be holding the following events which are open to the public. No fee is payable and booking in advance is not required. Contact Continuing Professional Development Dept. IEEIE, Savoy Hill House, Savoy Hill, London WC2R 0BS Tel 071 836 3357 for details.

Automobile electronics – the next decade, 14th Oct 1991

Mobile radio communications – the technology options, 4th Nov 1991

Control of substances hazardous to health regulations 1988, 9th Dec 1991

Electronics in traffic control, 13th Jan 1992

Where is electronic servicing going, 10th Feb 1992

Alternative technologies and energy conservation, 30th Mar 1992

The automated home. 11th May 1992

Catalogues

STC Mercator's new catalogue covers a range of power chokes with inductances in the range 1.0μH to 15,000μH. The inductors are specially moulded to provide a combination of high current rating and small size with an operating temperature range from -55°C to +125°C.

For more information tel. 0493 844911

Fibre Finder

Fibre Express is a comprehensive catalogue of fibre optic components, cables, connectors and test equipment. It is available free from Honeywell Opto-electronics, contact Honeywell Control Systems, Optoelectronics Division, Zodiac House, Calleva Park, Aldermaston, Berks, RG7 4QU, Tel 0734 819511 ■

Hornby 00 OK

The new PolySwitch circuit from Raychem is being used in the latest model transformers from Hornby, makers of model trains sets and Scalextric for generations. The positive temperature coefficient devices are the fastest thermistors available and undergo a large, abrupt, change is resistance when an overcurrent or high temperature pass the trigger point.

When they trip, the devices limit any current to a very low value, protecting the following circuitry. There are no moving parts and an increased operating life is therefore to be expected.

More information can be obtained from Raychem, Faraday Rd, Dorcan, Swindon, Wilts, SN3 5HH, Tel 0793 482485

Silicon Valley

The latest from the VLSI fields, CMOS hedgerows and TTL cottages.

A/D convertors

The conversion speed of ADCs is on the increase. The latest chip from TRW and distributed by Ambar components features 40 million samples per second (MSPS) for an 8-bit conversion with a power consumption of 180mW. The device is aimed at applications such as digital TV, image scanners and multi-media.

Controllers

Optical disk drives are the next big improvement in storage technology, offering far greater capacity than the current floppy and hard disk media.

The CL-SM330/331 chip set from Cirrus Logic should help reduce system costs by lowering the chip count. Designed as a two-chip controller set, the devices are built to control 5.25in and 3.5in magneto-optical disk drives. Using an Intel 80188 processor, a complete drive sub-system built using the 330/331 pair would require a total of six chips with a SCSI 3Mb/s transfer rate. Complete compatibility with Continuous Composite Servo (CCS) standard for Re-writable Partial ROM (RPROM) and Write Once Read Many times (WORM) is fully supported. The current pricing is around $85 per chip set but once volume production starts, this should fall.

Contacts

Ambar, 17 Thame Park Road, Thame, Oxfordshire OX9 3XD, Tel 0844 261144
IDT Technology Europe, 21 The Crescent, Leatherhead, Surrey, KT22 8DY, Tel 0372 377375
Cirrus Logic, Tel 010 1 415 623 8300 (USA)
Burr-BrownPO Box 11400 Tucson AZ USA Tel 010 1 602 746 1111
Micro Call Tel 0844 261939
Microchip UK, Tel 0628 850303
Micron Technology, Boise, Idaho, USA

Clock drivers

The skew of a chip is the difference in propagation delay between the slowest and fastest outputs. In clock drivers, a skew of 3ns wastes up to 15% of a 50MHz (20ns) system's cycle. Two new chips claiming to be the fastest available, the IDT49FCT805 and 806, reduce this to 4%.

Each device has two banks of of five output clock drivers. The 1:5 input to output ratio reduces input loading which simplifies termination and reduces the total;chip count. All ten outputs are tri-state and controlled by one or two enable pins. The independent power and ground pins reduce the amount of internal noise and dynamic threshold shift caused by multiple outputs switching.

Filtering

The new DF1700 from Burr Brown is a dual channel digital filter which provides 8 times oversampling data for audio digital to analogue convertor. Oversampling converts the input data frequency to an output data frequency eight times greater by digital interpolation. The advantage of this is that low order analogue filters can be used after the DACs fed with the data to reduce filter phase non-linearities. The dual filters in the chip each consist of three cascaded two times oversampling finite impulse response filters (FIR). The output of the first FIR is two times oversampled by the second. The result is then two times oversampled again by a third FIR, further separating the desired analogue signal and sampling frequency. The device is compatible with Burr-Brown's PCM1700, PCM67 or two PCM63 digital audio DACs.

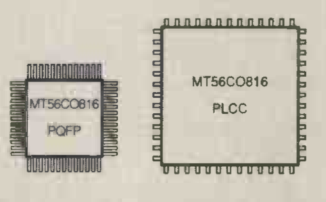
Memories

MicroCall recently launched a new family of 256 bit devices that combine the features of static RAM and EEPROM (Electrically Erasable Programmable Read Only Memory). The Xicor X24C44 and 45 are organised as 16x16 bits and the X22C10 and 11 as 64x4 bits. The chips are designed to be used as safety backup stores when power is removed from a circuit. In portable computers, this allows the use of an auto-resume feature allowing the system to be halted in mid-application and restarted safely. The EEPROM has an endurance of 1,000,000 cycles and a data retention time of 100 years.

With claims to be the fastest in the world, Microchip's 256k CMOS EPROM, the 27HC1616 offers 16kx16 storage at 45, 55, 70 and 90ns speeds with a 40ns version to be launched in the near future. Designed for use with 16-bit systems, the very low power consumption make them ideal for use with the latest microprocessors, especially the i386 and i486 where it eliminates the need for cache RAM since the EEPROM can be accessed directly.

Packaging

In an effort to cram more chips into a smaller board space, Micron Technology has announced the plastic quad flat package (PQFP). This has a footprint 40% smaller than the industry standard plastic leaderless chip carrier (PLCC). Used to package cache data SRAMs the 10mm PQFP is said to be the smallest in the industry.



This actual size illustration shows the PQFP on the left alongside its traditional counterpart.

Charges On The Move

Used in video cameras, fax machines, criuse missiles and fingerprint sensors, the CCD has become an important electronic device. Alan Williams takes charge of the explanations.

The charge coupled device (CCD) was invented in 1970 and has since found itself quite a number of applications. Some of these, such as astronomy and video cameras, are pretty well known. Others, such as facsimile machines, fingerprint sensors, aerial mapping and analogue delay lines are a little more obscure.

Developed at Bell Laboratories by Willard S. Boyle and George E. Smith, the CCD was based on concepts and technology being developed for bubble memories. The first patent was taken out in 1974 and early designs featured an array of 100 by 100 elements. Modern CCDs are commonly available with 512 by 512 elements and some experimental devices even stretch to 4096 by 4096. The advantages over conventional imaging techniques, such as photography and cathode ray tube video cameras, are that they are very small (the size of the average 24 pin DIL chip), very sensitive to low light levels, have virtually no picture distortion and are relatively cheap since they can be mass produced using standard silicon fabrication technology.

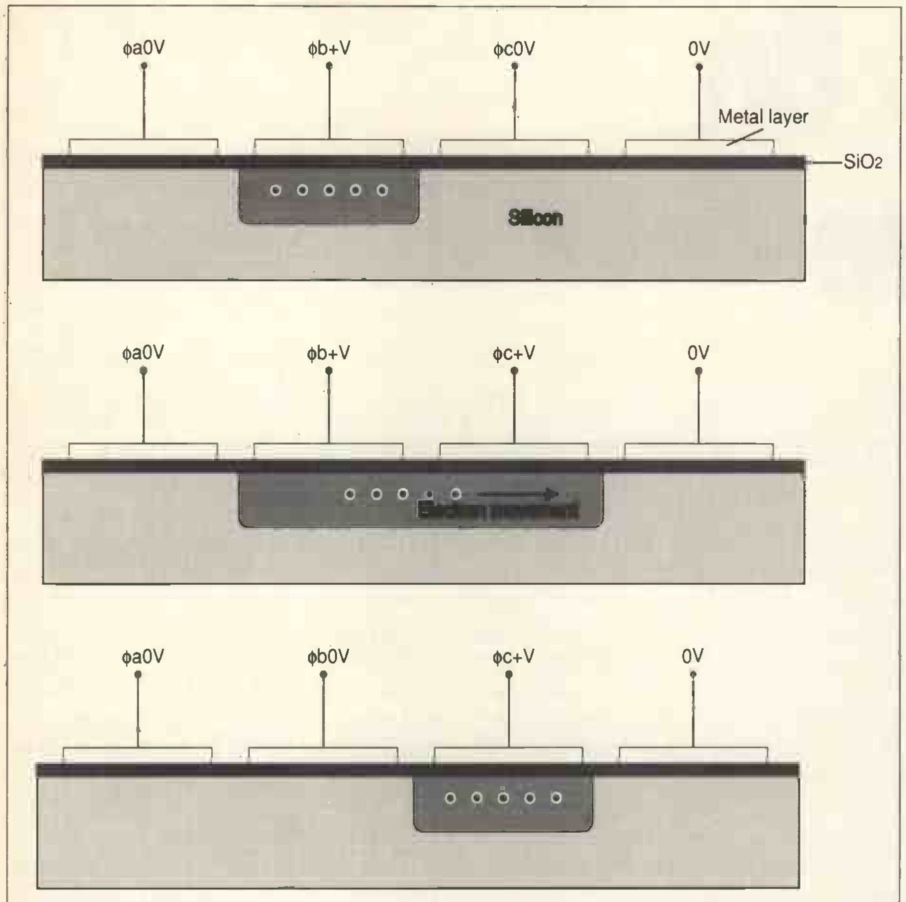
Pressing Charges

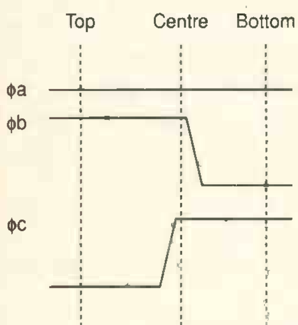
The CCD is a very simple device in its basic form. All it requires is a silicon block or substrate doped to be P-type material – holes being the majority charge carriers. On top of this is placed a thin layer of SiO_2 as insulation and above this an array of metal electrodes (Fig 1). Placing a voltage on one electrode with both of the adjacent electrodes at zero volts causes the area under the positive electrode to be swept clear of holes forming a depletion region, the positive charge repelling the positive holes. This area is like a well in which electrons can be held. The depth is dependent upon the value of the voltage on the plate above the area. If enough voltage is applied, the minority carriers, electrons in a P-type semiconductor, are drawn to the area under the electrode. The electrons simply stay in place with more being introduced by exposing the well area to light. Incoming photons create electron-hole pairs, the hole being driven out of the depletion region into the substrate.

The hand-held video camera is one of the main areas of CCD development.

Marching Orders

What makes the CCD special is the way in which the electrons can be extracted from the depletion regions and their numbers counted. On either side of of the electrode which maintains the cell are electrodes at zero potential relative to the substrate. By raising the potential on one of these electrodes, a larger area of depletion is formed and any electrons trapped under the centre electrode are able to move into the larger area. If the voltage on the first electrode is then reduced to zero volts, the electrons will be forced into the region under the second electrode. This movement is known as clocking and allows a whole line of charges to be marched across a piece of





silicon to an on-chip amplifier and then to an output or port.

At the output, the number of electrons from each well can be counted and the values stored. In an image sensor, the number of electrons in each well is dependent on the number of photons striking it. The more of these that turn up, the greater the number of electrons in the cell. Clocking the data out and displaying it results in an image. One drawback of this is that if too many electrons are put into a well, they overflow into adjacent wells. In image systems, this can be seen as blooming and smearing of the bright areas which, unlike older systems, does no damage. The other side of the coin is that their high sensitivity means that, with low noise amplifiers, it is almost possible to count the single photons.

Keep It Dark

One important feature of CCDs is the transfer efficiency. This defines how much of the original charge gets from one cell to the next. In most modern systems the efficiency is around 99.9% so that after 100 shifts or transfers, only 10% of the charge will have been lost. Another important factor is the lifetime of a well. When the surface electrode is clocked high the inversion layer formed sweeps the majority carriers out and attracts the minority carriers. The time taken to fill the well with these minority carriers from the substrate defines the well lifetime.

Yet another feature of CCDs that affects the number of electrons read from the system as it is clocked out is the dark current. Because the silicon block is above zero degrees Kelvin (-273°C) it is subject to thermal agitation and noise. This generates electrons in the semiconductor which, at worst, will fill up the wells reducing their lifetime and, at best, will add unwanted electrons to the data being stored in each well.

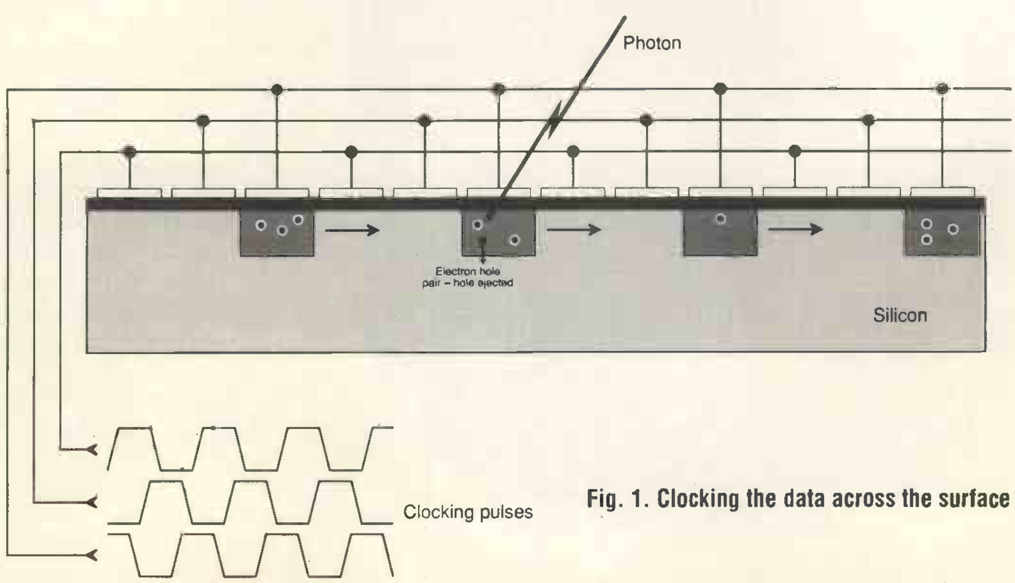


Fig. 1. Clocking the data across the surface of the CCD chip.

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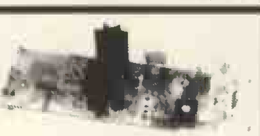

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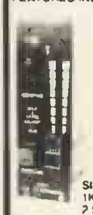

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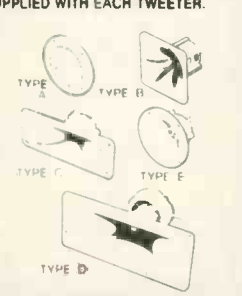

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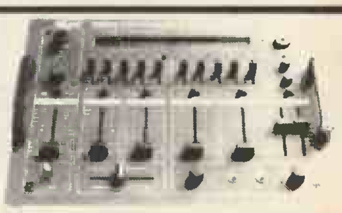

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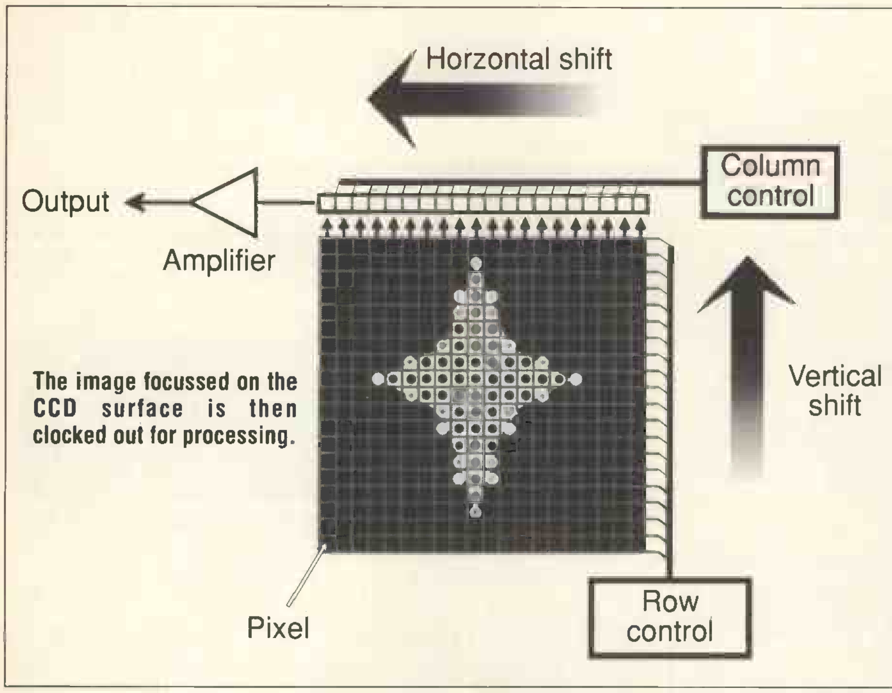


The image focussed on the CCD surface is then clocked out for processing.

Unfortunately, this dark current is generated at random so it can't easily be extracted at the output stage of the system. As the content of each well is moved on to the next, a number of dark current electrons will be added to it. In very large arrays, the electrons from each well may have to be moved quite a long way (up to 2000 shifts or more) with dark current being added at each clocking stage. This causes the final data to be almost completely but not quite inaccurate.

Two main solutions are possible. One is to lower the temperature of the silicon so that the thermal noise is reduced and the other is to clock the array at a higher speed. The first has the disadvantage of requiring large and expensive cooling systems, the second means that exposure times are reduced. In astronomy, the cooling technique tends to be used since longer exposure times are necessary and collecting an extra one or two photons may mean the difference between seeing a star and not.

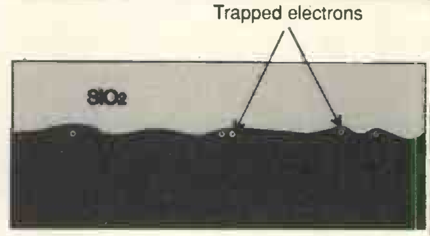
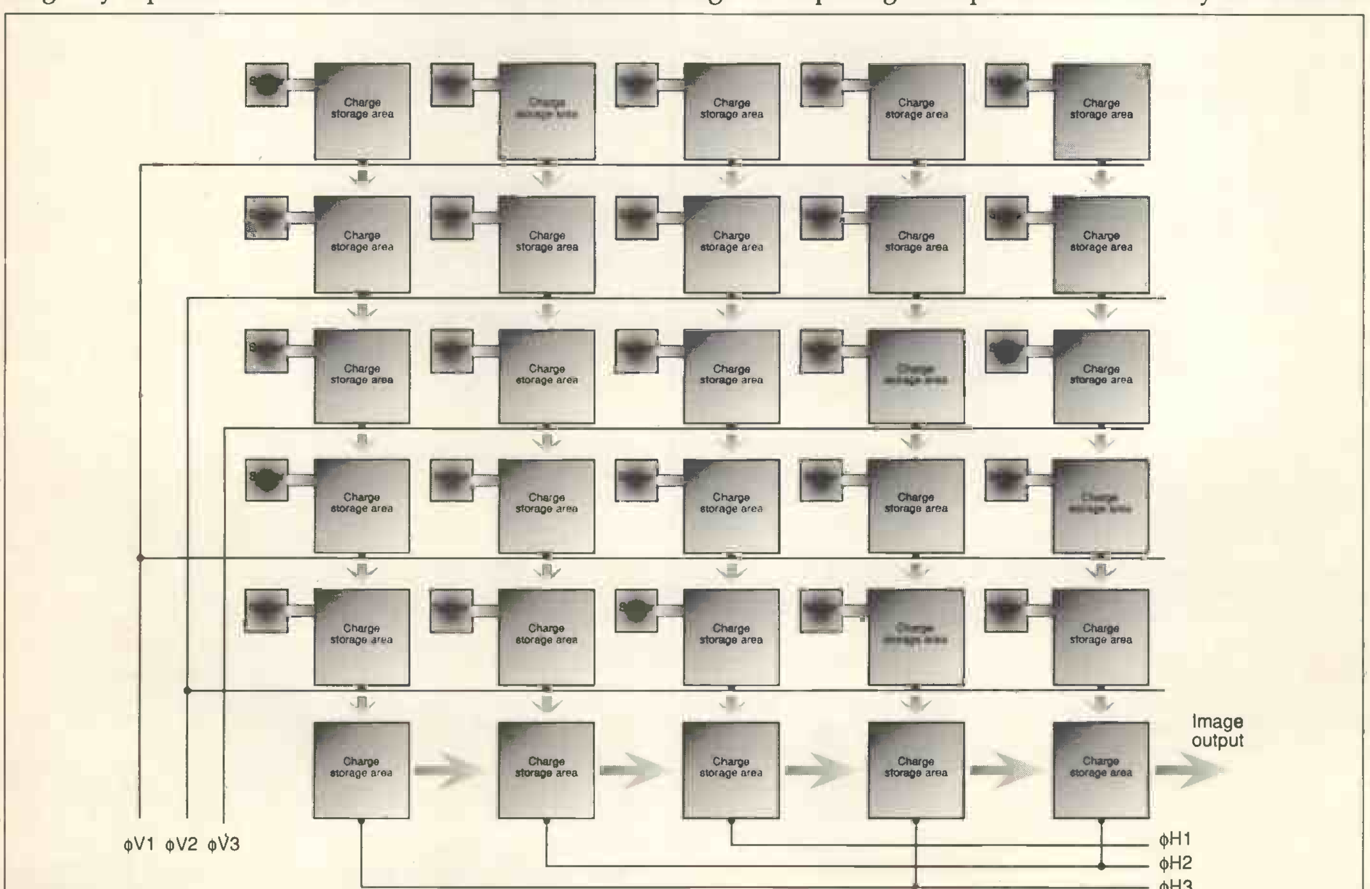


Fig. 2. Fabrication irregularities.

On The Surface

Two main types of fabrication are used to produce CCDs, surface channel (SCCD) and buried channel (BCCD). The channel is the area of the chip where the depletion region occurs and the electrons are stored. Unfortunately, SCCDs suffer from a lack of transfer efficiency due to the join between the silion substrate and the silicon dioxide insulating layer. This tends to be irregular and traps electrons as they are clocked



Interline transfer CCD imager.

across the chip. (Fig n). A solution is to use BCCD where the channel is held within the silicon layer, away from the surface join. All of the early designs were SCCDs because the charges could only be stored and manipulated near the surface of the silicon. The later development of BCCD proved to be a big step forward.

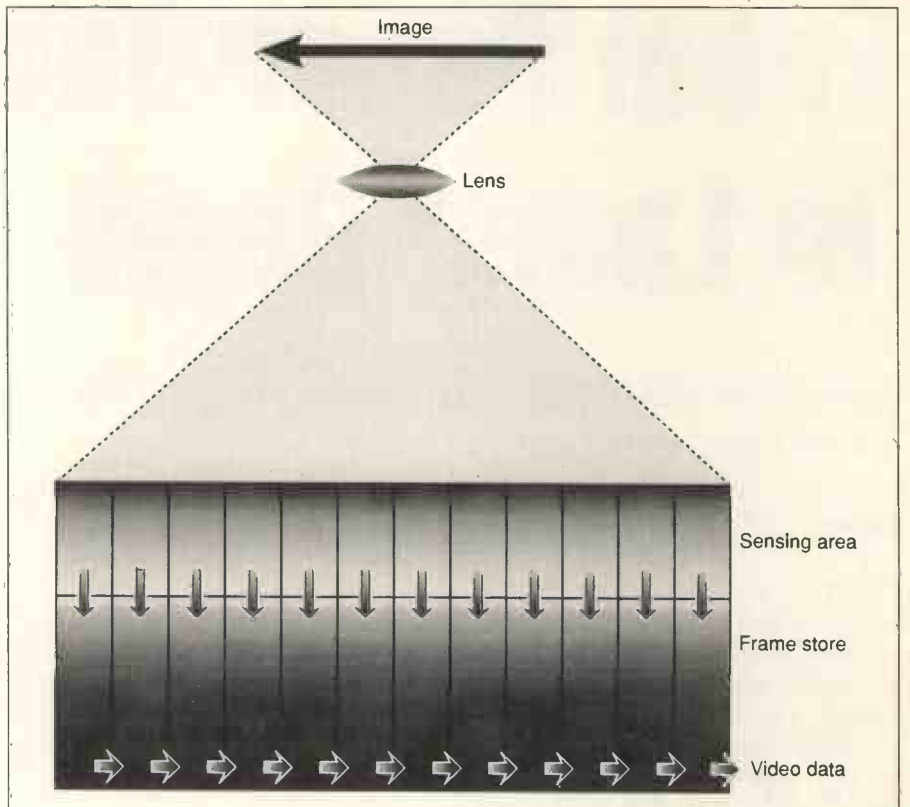
In The Frame

One way or another, the main uses for CCDs lie in the field of image sensing. They have the advantages of being small, robust and require relatively low voltages and power compared to the Vidicon tube type systems they have replaced. The wavelength response ranges from around 450nm to 1000nm with the image degrading at the higher end because infra red photons penetrate deeper into the substrate.

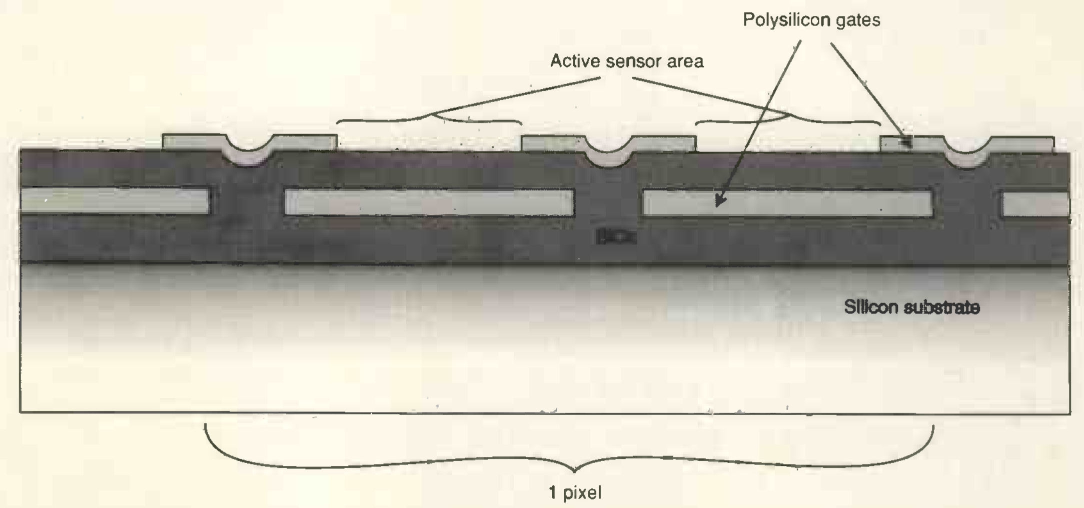
Image sensing CCDs fall into two categories, linear imaging devices (LID) and area imaging devices (AID). The first are used in systems that scan, for example, fax machines. A LID of up to 2048 pixels is used to scan the image on the paper as it is passed through the machine. The information is then coded and transmitted to the receiving system. Other systems that use LIDs are fingerprint sensors, aerial mappers and bar code readers.

The more familiar CCD is the AID used in most miniature video cameras and by pretty well all astronomers. It is a two dimensional array of sensors, each reading a pixel (picture element) of an image focussed on it. Because the image is sensed in one go, the array 'sees' the incident light and creates the relevant electrons in parallel. Because the clocking of the data off the chip takes a certain amount of time, a double buffering system has been developed to get the data through the system faster. In one way, which uses a BCCD, each sensor in the array has an associated charge store. When the exposure is complete, the electrons from each pixel are tranferred to its adjacent store allowing the next image to be formed on the sensors. During this exposure period the charge stores are clocked across the chip in parallel into a linear store which is then clocked off the chip via an amplifier to form the video data stream.

An alternative method uses two layers, the top of which is exposed to the image. After the exposure is complete, the electrons are transferred down to the next layer which operates as a normal CCD allowing the data to be clocked off the chip. ■



Frame transfer CCD imager.



Cross section of a typical polysilicon gate structure as used in CCD cameras.

From Paper Tape To Laser Beam

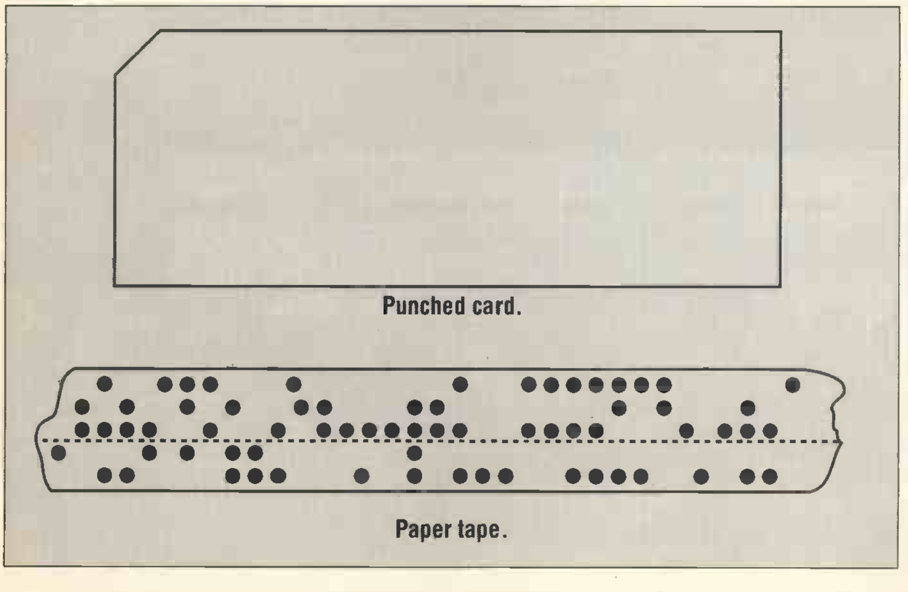
Anne Sutton climbs down the family tree of the disk drive finding that some of its ancesters were not so primitive after all.

The first digital storage device , the punched card, was invented in the 1800s to control weaving machines and player pianos. Made from stiff pieces of paper, specially positioned holes were used to switch parts of the machine on and off . By the end of the century they had become quite widespread and were used help analyse the data from the 1890 US census.

The next step from the punched card was the punched tape. This also stored data as holes but had the advantage of being faster to read – originally around 30 characters per second with mechanical systems and modern optical readers operating at 300 character per second or so, the system still being used in some places.

In 1945 a group of scientists led by John von Neumann, one of the fathers of the computer, reported that if a machine is to be able to deal with large computations, it must have a storage capacity of at least 1000 ten digit numbers. This was fifty times the capability of ENIAC (Electronic Numerical Integrator And Calculator), the world's first electronic computer designed in 1946.

The EDSAC (Electronic Delay Storage Automatic Calculator) built at Cambridge University in 1949 and the National Physical Laboratory's ACE Pilot, built in 1950 used the idea of a delay line to store information. The data in computer travels from place to place at the speed of light. Sound waves move much more slowly and it is possible to use it to store a train of bits. Converting the electrical pulses to sound pulses with a piezo electric crystal at one end of a tube of mercury and picking them up again at the other end, a delay of around 1000th of a second could be obtained. Once a train of pulses has been inserted, they can be fed around and around by using a pulse shaper and a feedback loop. The computer can read the store at any time and write to it by switching a new set of pulses in. Incredibly, this type of memory unit was still in use in 1970 in some electronic desk-top calculators.

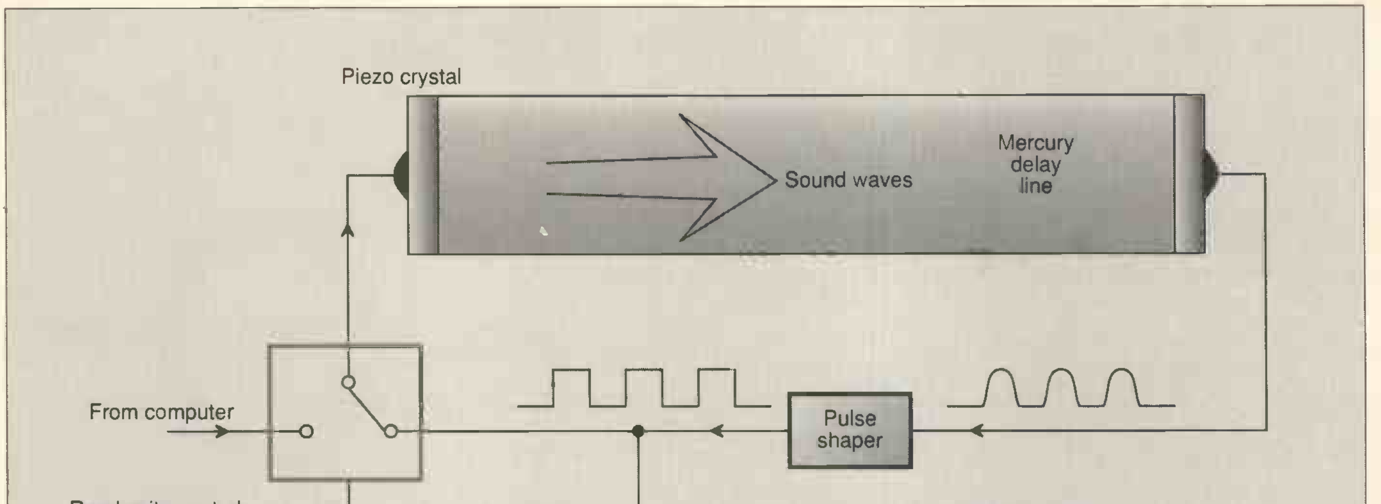


Punched card.

Paper tape.

Another early idea was the Williams tube which used a cathode ray tube's long persistence to store data in a grid or array format. This began the idea of random access – the ability to get at any part of the information in the store, without having to start at the beginning and read through to the end. The data was stored as small charged areas on the end of the tube. The data would be written and regenerated by the electron beam scanning across the face of the tube. By arranging for a charged area to be a one, a row of charges to be a word and a column of words to form the store, the data could be accessed in a random manner – the time taken for the electron beam of the CRT to scan any particular row being the same. Both the idea of random access and regeneration are still around in dynamic RAMs which have to have their information refreshed before it leaks away and are completely random access.

A form of storage that has also filtered through to modern systems, and is the direct ancestor to the floppy disk, is the magnetic drum. Invented in 1947 it consisted of a vertical spinning cylinder coated with a magnetic medium. A set of read/write heads were positioned up the side, each having its own track. The data could be written and read from each track at will and with a speed of around 2000 rpm, the access time would be about 15ms.



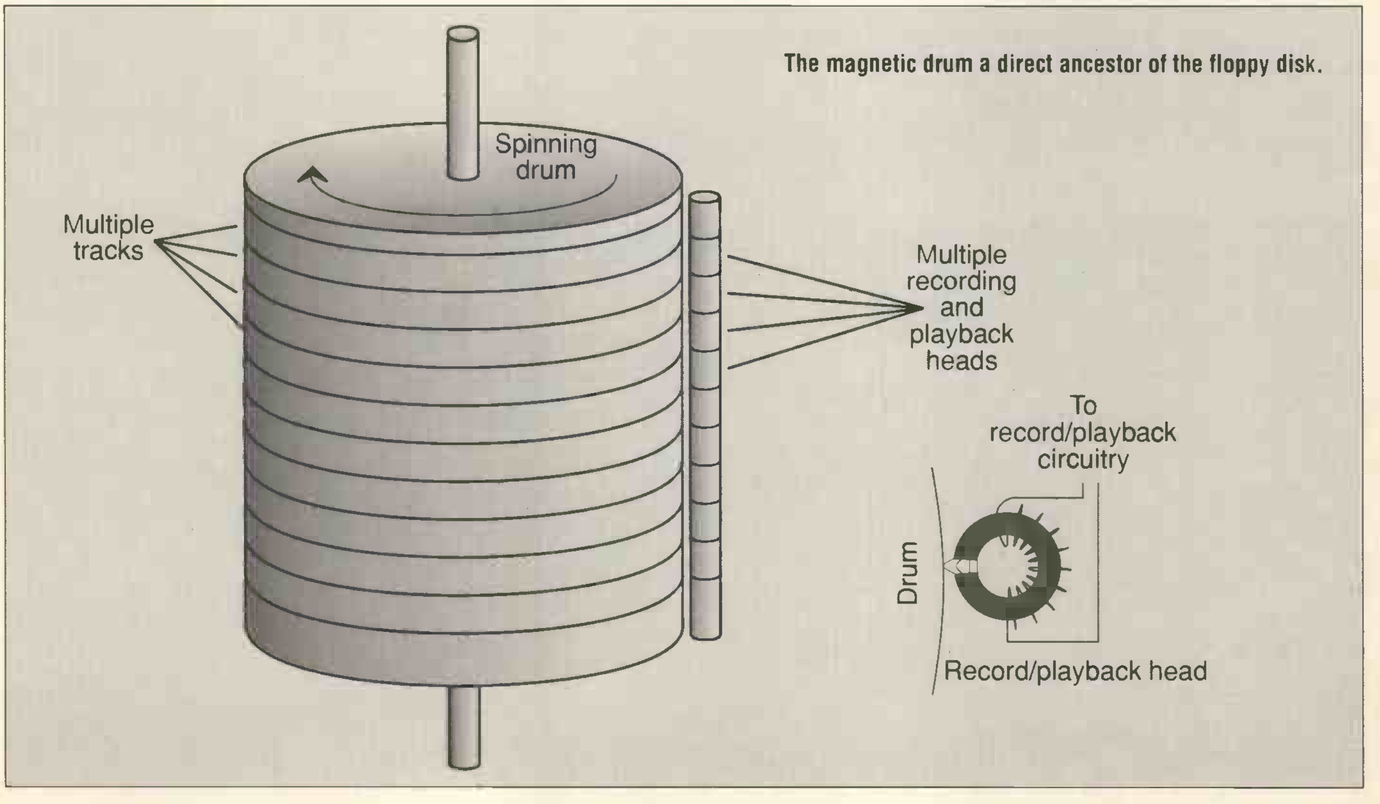
The operation of a delay line store.

The first high speed memory came in the form of a series of ferrite torroids or "cores" strung together on pieces of wire. When the current through the wire (known as the write wire) flows in one direction, the magnetic field induced in the core is in a corresponding direction. Reversing the current flow reverses the magnetic field. By using a large enough current, the ferrite is magnetised to saturation and the core remains magnetised when the current is switched off. The two directions can be regarded as on and off and are read by another wire, the sense wire. By placing the current which defines a zero on the write wire, any cores which are already zero remain that way. Any cores which are at one will flip over and become zero. This "flip" induces a small current in the sense wire telling the system that the core was in the one state. Unfortunately, this changes the one to a zero and the data must be re-written after the read – destructive reading. This works well for a single core and a complete memory can be built up from a number number of cores strung together in an array and placed in layers. Core memory formed an important storage medium from its invention in 1955 until the widespread use of integrated circuits in the mid to late 70s.

Off The Line

As computer developed from laboratory curiosities into machines that could do a serious days work, the need for mass storage increased. The on-line stores were used for the information being processed by the computer. Off-line stores where were all of the results and collated data were kept and the demand for

The magnetic drum a direct ancestor of the floppy disk.



At The Core

The trick to making an array of core memory devices is to use two write wires at right angles to each other. Each carries half the necessary current to magnetise the core. As one of the write wires passes through a core with half the write current, nothing happens. However, where the two wires cross, the full magnetic field is generated and the data is written.

The operation of a magnetic core depends on the magnetic hysteresis of the material used to make it. This has a very square loop as shown in Fig. a. To begin with, the magnetic field within the core is either at point 3 or point 1 defining a binary one or zero respectively. As the magnetising current is decreased from zero the magnetic field within the core eventually flips down to point 4 and as the current is reduced the field ends up at point 1 – binary zero. Increasing and then decreasing the current flips the core from point 1 to point 3 via point 2, writing a binary one.

A read-write cycle pulses half-write negative currents on the write wires that cross at the required core. The aim is to find, out via the sense wire, whether the core moves to point 4 from point 2 or point 1. The second part of the cycle pulses the half-write wires in the positive direction. If the core was at point 3 to begin with , this will send it back there via point 5. If the core was a zero, the first pulses will have caused it to flip, generating a current in the sense wire. In this case the inhibit wire is given a negative half-write pulse during the second phase of the read-write cycle. This counteracts vertical half-write pulses and the core only moves from point 1 to point 5 and back. This inhibit can't affect any unselected core since it only supplied a half-write pulse and doesn't coincide with others to make a full-write.

To create a memory, the cores are threaded into a square matrix, say 128x128. A number of these corresponding to the number of bits in a word are then stacked together to form a complete memory of 16384 words. Access times of as little as 500ns are possible but since the read occurs only during the first half of the cycle the re-write that must be performed to complete the process can take up to 6μs. It is up to the programmer to optimise the program to make best use of the core cycles to speed things up.

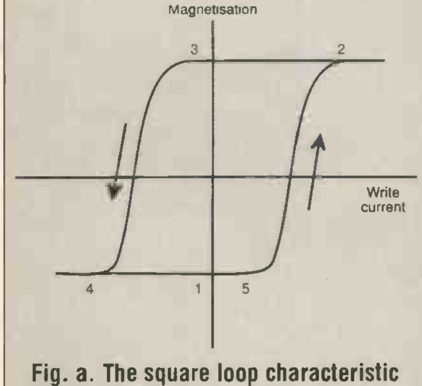
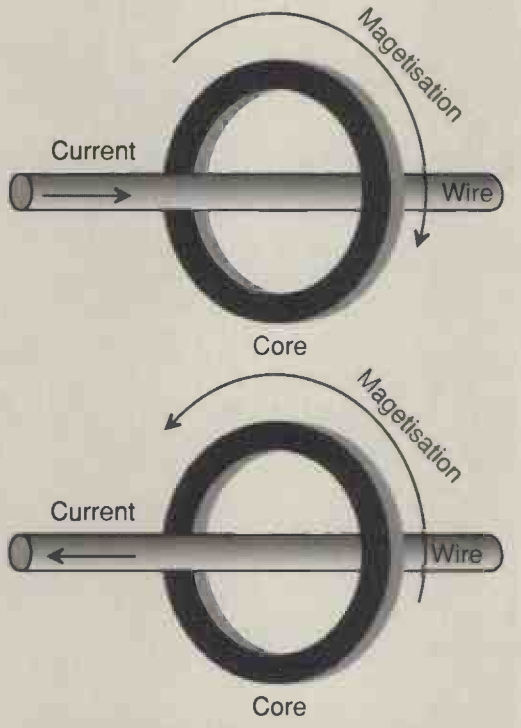
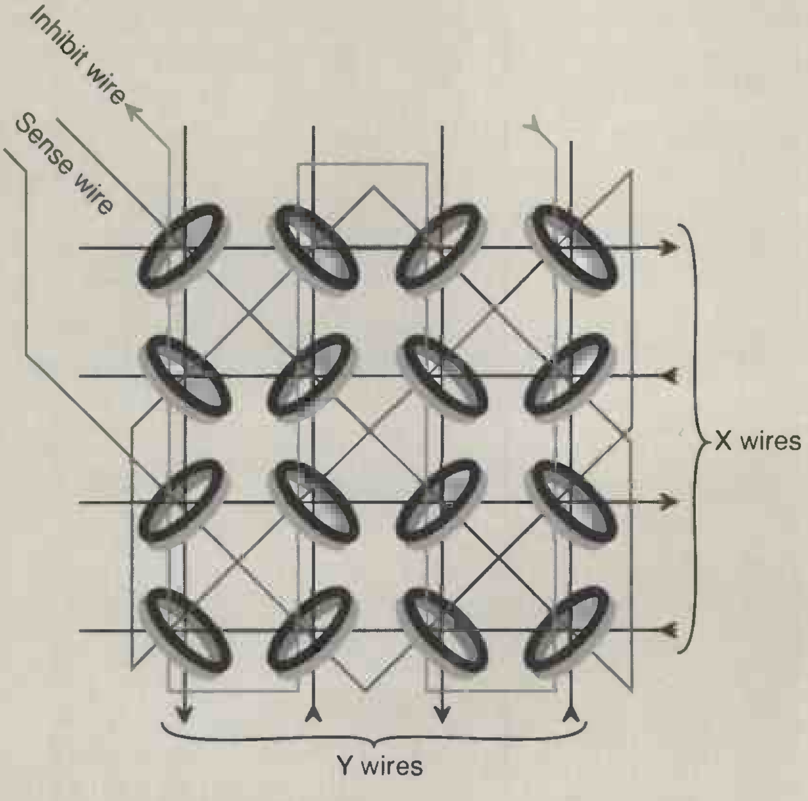


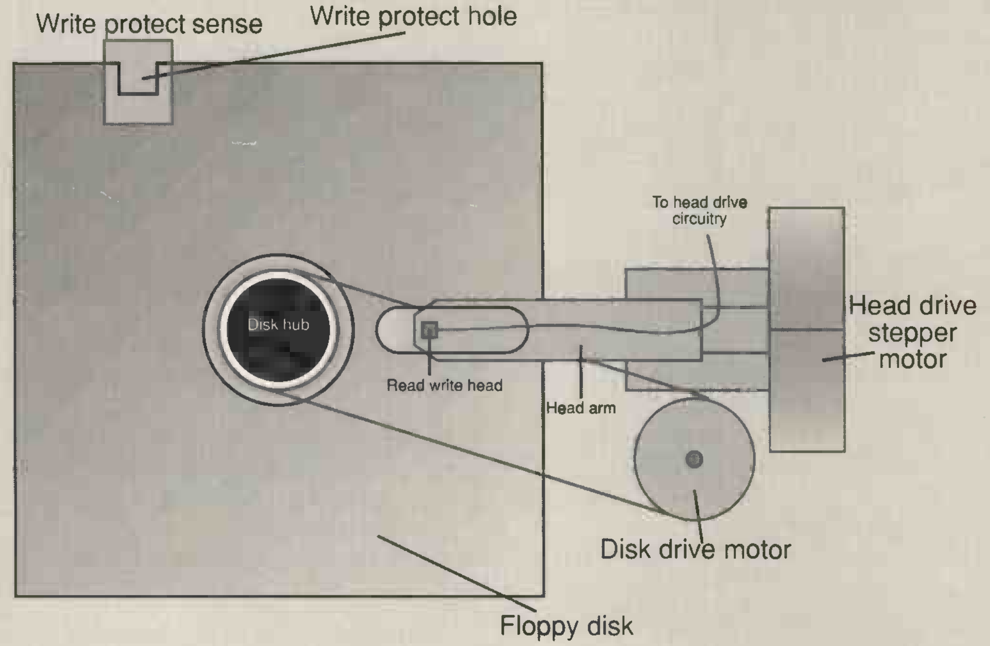
Fig. a. The square loop characteristic of a core.



The current flow in different directions creates opposite magnetic fields in the cores.



Magnetic cores strung together to make a memory array.



The floppy disk drive is the mainstay of all personal micro-computers.

bigger and faster systems was great from the very beginning.

The first high density mass store was the reel to reel tape recorder. Using a technology developed in the 1930, IBM developed its first digital system in 1945. By the 1950s plastic backed tape replaced the all metal systems and along with improved coding methods the tape became the major off-line storage medium. Generally, only four or five tapes could actually be hooked up to the computer at any one time. Others would be kept in cupboards and human operators would load them up when requested by the computer. This is a system that is still used in many large mainframe data processing companies though as the capacity of other mass storage systems increases, the tape changeovers become less and less.

The most obvious drawback with a tape is that it is not random access. To get at any section of it means winding through from one end. This makes it slow and inefficient. The solution was the invention of the hard disk drive. Based on the magnetic drum idea this originally consisted of solid circular platters about 1ft in diameter, coated with magnetic material on both upper and lower surfaces. Ten of these are assembled on a central shaft with the read/write heads passing between them, one for each surface. Using a stepper motor to move the head supports in and out, over 100 tracks could be defined on the disk surface. An added feature was that the arms could be retracted completely and the ten-pack of disks removed from the machine allowing them to be filed separately in the same way as tapes.

With the advent of the personal computer in the 70s, the need for a storage system rather smaller than the average washing machine became quite urgent. Many hobbyists turned to the compact cassette which still occupies its niche for the distribution of software – mainly computer games. Unfortunately, this had the same old disadvantages of all other tape systems, it was slow and not random access. In 1975, Shugart Associates invented the 8in floppy disk. These were rather large for the personal computer market so in 1976 the company brought out the SA400, a 5.25in floppy with 110kb storage capacity. This was the perfect size for personal computers and went on to become the industry standard. Indeed, it is still the standard, its capacity increased 10 fold. There are other sizes, the most common and the main competitor, being the 3.5in. Others such as 3in and 2in have not really taken off and all will one day be replaced by the new optical storage technology.

Using a laser beam to modify the structure of a disk and them read it back lead to the introduction of the WORM (Write Once Read Many times) drive in 1983. Current systems are able to store around 1Gb (10^9) and offer full random access plus traceable backups on a 5.25in disk. In the near future, fully read and writable optical disks should become available – they have already been announced for the audio market.. Also forming a link to the audio market are compact disk ROMs. These offer publishers the opportunity to sell large volumes of information on small, easy to access disks. These include dictionarys, encyclopedias, reference works, manuals, telephone directories, the list is getting longer every day.

The immediate future seems to lie with optical systems since they offer an increase in storage density by a factor of 1000. However, judging by the past demands of the computing community, the next increase will have to be by a factor of 1,000,000 which moves into the realms of such Sci-fi/current research ideas as molecular stores and 3D crystal memories. The stage where everybody can have every published work available at the press of a button is not too far off, the only problems will be making good use of it all and keeping it up to date. ■

Economy And The Electronics Industry

Depression, job cuts, mergers and takeovers, Tom Ivall looks at the state that the elctronics industry is in. Can it get worse?

A contract electronic engineer I know has been out of work for nine months now. None of the agencies he's been registered with can find anything for him. This wouldn't normally be a cause for alarm, if it weren't for the fact that, ever since leaving university with a degree in electronic engineering, he had been in continuous employment on contract work for some fifteen years.

Michael is in fact just one statistic in the steadily rising figures for existing and planned job cuts in the electronics industry. Among the big firms these range from 2000 or so at Ferranti to about 50,000 world-wide in the multinational Philips organisation. Other well known companies in the process of shedding labour are British Aerospace, GEC, Olivetti, Racal and Thorn EMI. Many smaller electronics firms, with just a few hundred employees, are also paring down their workforces.

"Well known companies in the process of shedding labour are British Aerospace, GEC, Olivetti, Racal and Thorn EMI"

The bulk of these job losses is made up of production and ancillary workers, but professional engineers in key activities like development or quality control are suffering as well.

The basic reason for this rising unemployment is a fall in demand for the products and services of the electronics industry. Companies are reducing their labour costs to save money and try and keep in the black while orders, outputs and profits are declining. But the fall in demand itself is explained by a combination of factors, not particularly linked to each other.

In the USA there has been an economic recession and in the UK we appear to be sinking into quite a deep one. The ending of the Cold War has resulted in governments cutting their expenditure on military electronics equipment. Changing patterns of computer utilisation in commerce and industry have hit the manufacturers of computer hardware. The intense competition worldwide has stepped up mergers and takeovers as companies try to make themselves bigger to secure more market share and all the other advantages of size.

Philips, being such a vast, multi-product, multinational company, is a case all on its own. Here the job cuts are being made to save money in the wake of a serious trading crisis. Several of the electronics businesses – notably computers, components and military equipment - have been doing badly and the results have been coming to light in the past nine months or so. Profits have slumped and business analysts predicted a substantial loss for the group in the last financial year.

Critics are saying that the Philips management should have seen the danger signals much earlier. But it seems they failed to do so because of a top-heavy, bureaucratic management organisation with an inadequate system of reporting and business forecasting. Now, under new chief executive Jan Timmer, a fundamental review of the whole group has taken place with the possibility of some of the less profitable businesses being sold off.

It's less clear whether there will be any job losses resulting from the new ownership of STC (Standard Telephones and Cables). Takeovers and mergers are often followed by pruning of labour in the acquired company.

STC Sell Off

Last year STC sold 80% of its computer subsidiary ICL (International Computers Limited) to Fujitsu of Japan for £743 million. (You may recall that ICL was the final repository of the original firms constituting the early British mainframe industry). This was followed in late 1990 by the agreed sale of the main body of STC to Northern Telecom of Canada for £1.9bn.

STC was formed as a British company in the 19th century when long-distance telegraph cables were the coming thing. In more recent times it has had a troubled financial history and for a while was largely controlled by the giant American ITT corporation. Now it has passed completely out of British ownership.

The Future Of Racal

Another well known British company in a state of some upheaval is Racal Electronics. Because of the popularity of the UK's cellphone service the firm's Vodafone subsidiary, Racal Telecom, has been doing extremely well. But Racal Electronics as a whole, despite holding 80% of Racal Telecom, only producing £97m pre-tax profits over the same period. This indicates, of course, that the remaining businesses – largely communications and military electronics manufacturing – have been doing rather badly.

At the time of writing there have been rumours of hostile takeover bids for the whole group (Cable and Wireless tried to acquire it a few years ago). Whether for this or some other reason, Racal are now in the process of splitting themselves up into several separately quoted companies, for example Racal Telecom and Chubb, the security business.

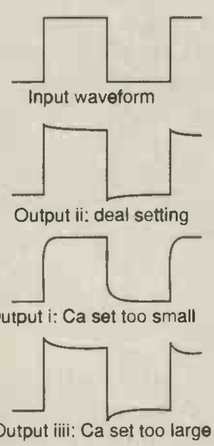
De-merging seems to be the order of the day, reversing the earlier strategy of mergers and takeovers by which the group built itself up to its present size. It seems likely that the remaining, badly performing manufacturing businesses – the tail-end of Racal Electronics – will now become the subject of a management buy-out.

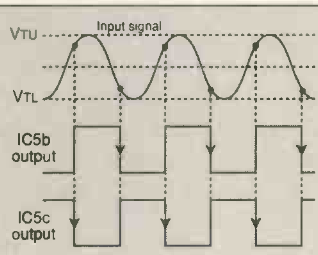
Meanwhile the economic recession in the UK is making life difficult for the companies developing and operating the latest digital mobile telephone systems. With falling demand they are having to consolidate and revise their plans for the future. Two of the four telepoint operators – Mercury Callpoint and BYPAS (Barclays Philips Shell) – have decided to merge. Although the PCN services are not yet in operation the development and setting-up costs are proving much higher than the three PCN consortia had originally estimated. Consequently, at the time of writing, it looks as though two of these consortia, Microtel and Unitel, are going to merge their businesses. It may well have happened by the time you read this.

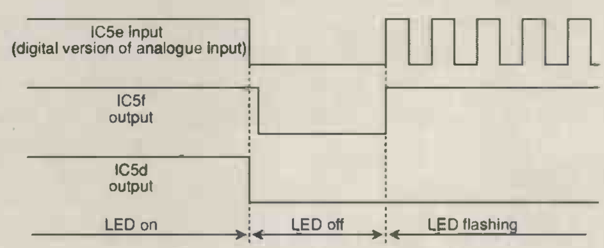
In consumer electronics, Ferguson report that unit sales of television sets and audio equipment have fallen and that the once booming camcorder market is now slowing down. ■

Dry Joints

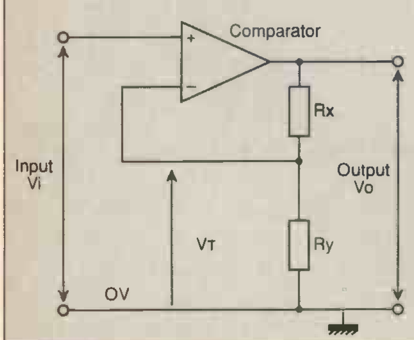
Due to production difficulties, a few of the diagrams in last month's PE Chronos project were a little dark, here they are again in a more readable form.

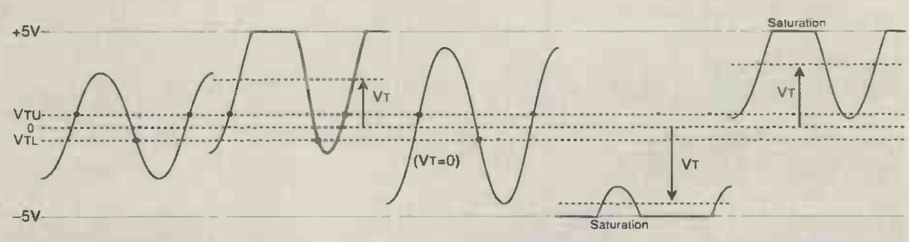






Clockwise from the left, Fig. 4, Fig. 7, Fig. 8, Fig. 10 and Fig. 6.





ODR indicator	Off	On	Off	On	On
Trig. indicator	Flashing	Flashing	Flashing	Off	On
Comments	Large signal correct triggering	Some signal, still triggering but trigger level has forced signal ODR (saturation occuring).	Correct triggering with very large signal, just within dynamic range.	Small signal within dynamic range, but forced ODR by excessive negative trigger level. No triggering.	Signal within dynamic range but excessive positive trigger level pushes it ODR and prevents triggering.

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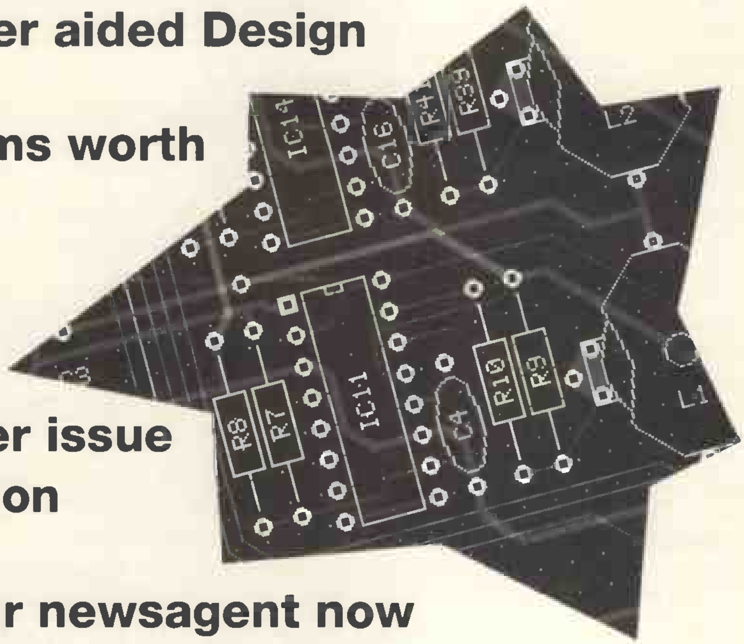

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New Product Developments

Ian Burley's new section aims to examine the latest products and technologies in the world of electronics. This month, the Sony Mini Disc, Bitstream, HDTV and Cable sting

Sony mini-disc player/recorder, prerecorded disc and blank recordable disc.

Sony vs The Cassette

It appears that Sony has been stung into action after the public unveiling of Philips' DCC (digital compact cassette) system earlier this year. Although DCC won't be ready for another year, it has confused the digital cassette tape market and many are now predicting that the role of Sony's DAT system as heir-apparent to the 27 year old compact cassette dynasty is doomed.

The best form of defence is attack and Sony's response has been to unveil a compact recordable magneto-optical (MO) audio disc called the Mini Disc or MD for short. A recordable disc was always going to be a milestone in the evolution of personal recording. After all, tape has a major disadvantage compared with disc media - it's serial; in other words it takes ages to search for individual tracks.

Like CD, MD will offer instant access to individual tracks and of course you will enjoy digital sound quality. MD's sampling rate is 44.1kHz - exactly the same as CD, though the data is compressed to just 20% of its original size in order to get 74 minutes of recording capacity in the diminutive 2.5" disc. That's roughly the same playback time of a standard 5" CD.

MO technology isn't that new. For several years now, MO drives have been used as very large capacity computer data storage devices instead of hard disc drives. The main disadvantage of MO drives is that they lag behind all-magnetic hard disc drive technology in terms of speed, but with single 5" capacities of 650 megabytes or even more, MO is a very convenient and compact medium.

An MO disc uses a combination of lasers and magnetic fields to write, read and over-write data from a disc. Like a magnetic disc, there are tracks of digital data arranged in sectors. Traditionally an MO drive uses a hot laser to loosen microscopic elements in the track which are then "flipped" or polarised by a magnetic field. Each polarised element represents a bit of data and can be read by a second cooler laser.

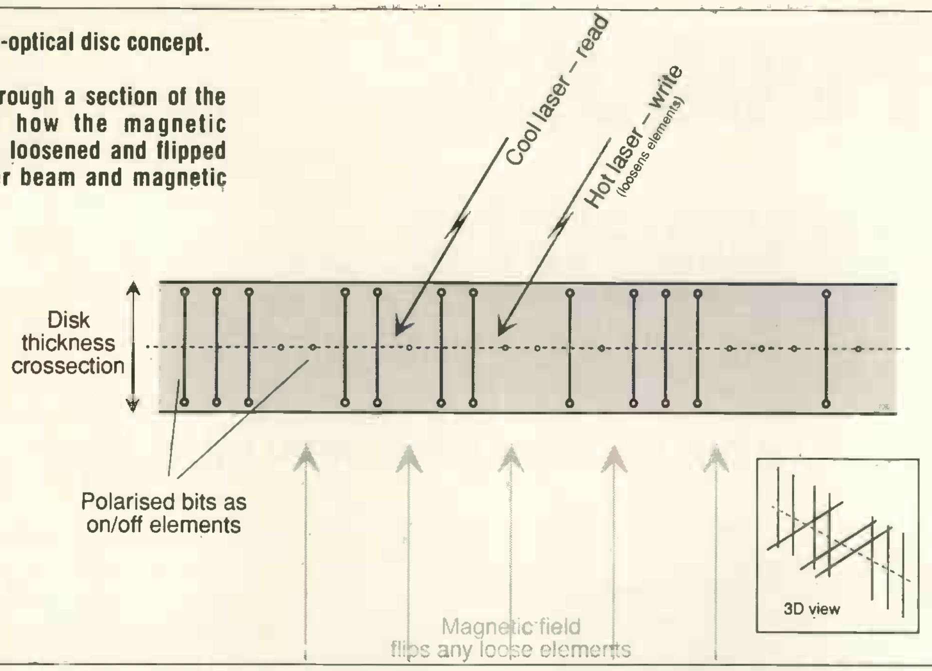
MD represents a new generation for MO technology as Sony has developed a single laser read/write head – which Sony likens to a vinyl record stylus by calling it a "pickup." Mini Discs have an improved magnetic substrate which requires just one third the magnetic field strength of conventional MO discs to enable data to be written. combined with a single read/write mechanism, the comparatively low power design means battery operated portability is a reality.

The same laser pickup can read discs manufactured in the same way as commercial CDs. This is very important to Sony if the music industry is to be persuaded to produce pre-recorded material on MD. Previously, MO discs were incompatible with CD read technology. A serial management copy system (SCMS) similar to that used in DAT players will be incorporated into MD players to prevent second generation copying of copyrighted software.

Sony wants MD to be a compact system which can be used on the move, in true WalkMan tradition. The old bugbear of portable CD systems, shock-induced track skipping, has apparently been eliminated in the MD system by buffering the data stream in an on-board 1Mbit memory chip. This holds about three seconds worth of

The magneto-optical disc concept.

This view through a section of the disc shows how the magnetic domains are loosened and flipped using a laser beam and magnetic field.



playback and provides plenty of time for a track to be re-read if the pickup was jogged.

The 5:1 digital audio compression system is called ATRAC, which stands for Adaptive TRansform Acoustic Coding. ATRAC appears to have some similarities to the PASC system used by Philips for DCC - which Philips stresses is a translation system, not a compression system. Unlike PASC's sub-band coding system, Sony's ATRAC is based on Fourier Transform mathematics. Like Philips' claims for DCC, Sony says there is no discernible quality loss after many generations of copying. Incidentally, Sony claims a frequency range of 5Hz-20kHz, negligible wow and flutter, and a 105dB dynamic range. This is technically superior to DCC, but the difference is probably not detectable by humans.

Sony's 2.5" disc cartridge looks much like a smaller version of the ubiquitous 3.5" computer floppy disc, complete with a sliding metal sleeve to protect the enclosed disc. It is remarkably compact and much smaller than today's audio cassettes, or tomorrow's DCC cassettes for that matter.

So how does MD fit into the future audio scene? Sony sees it as being complimentary to DAT, which can record several hours of music compared to MD's relatively modest 74 minutes. The latest news is that Sony is even grudgingly accepting that DCC won't go away and the firm is beginning to explore this lower-cost format before it's too late. MD looks like fitting in between DAT and DCC cost-wise. Sony UK reckons a blank Mini Disc will sell for around £10. Pre-recorded commercial discs shouldn't be much more expensive than today's CDs as they use the same manufacturing process. Compact WalkMan style MD players will sell for between £250 and £300.

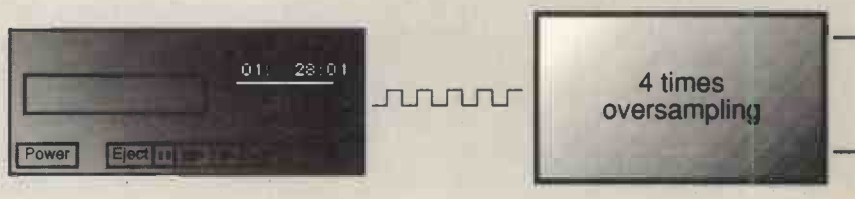
But this is all academic at present. You won't be able to buy a Mini Disc machine until the end of next year. Why has Sony prematurely revealed its MD project? Is it a coincidence that the announcement came two weeks before the big Summer Consumer Electronics Show (CES) in Chicago? Did DCC force Sony's hand? It's not easy to find a Sony representative to answer these questions! Still, the MD is a very welcome addition to the world of digital audio recording.

Is One-Bit CD Any Good?

It's approaching ten years since the compact disc was first introduced. The promise of "perfect" digital audio reproduction captured the public's imagination and it now looks like the vinyl record business is in serious decline because of the overwhelming success of CD. Obvious advantages of CD are fundamental when compared with old-fashioned records. There's no crackle from dust and static, no scratch-jumping and CDs play back the purest of recordings - free of distortion... or do they?

It's not disputed that CDs serve as highly detailed stores of musical information. However, the music is

Bitstream improves the quality of sound from a compact disc.



stored as digital data and the quality of your CD system hinges on how well that data is converted into sounds you can hear. It's not a simple case of throwing the stream of digital data at any old digital to analogue converter (DAC).

Sounds are stored on a CD in 16-bit words. Each word is a digitised sample of sound and 44,100 samples are made every second. If only the process was simply reversible, but unfortunately you can't just replay the samples back at 44.1kHz through a DAC. At that rate the resulting analogue signal would sound far from hi-fi - what were originally smooth waveforms before they were sampled would be reproduced in a very stepped way. The inaccuracies in the reproduced waveform translates as noise.

You could use analogue filters to get rid of the noise by smoothing out the waveforms, but this introduces other distortions like phase shifts which can be as undesirable as the as the noise. It's generally accepted that any smoothing of the data should be done in the digital stage.

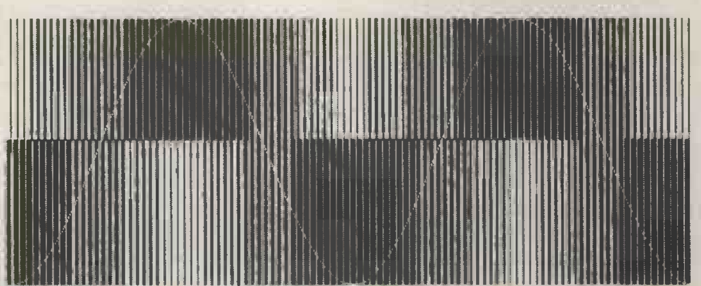
That's where over sampling comes in. In marketing terms, the more times over sampling and the more bits over sampled, the better. To a degree this is true as the data is effectively progressively smoothed. However the process is prone to errors, especially in low level signals, which can end up being reproduced as strange sounding harmonics. Loosely, what happens is that there is a fair chance that some bits in the 16 bit word presented to the 16-bit DAC will be wrong. If this happens to some bits,

The Philips CD850 Bitstream compact disc player.

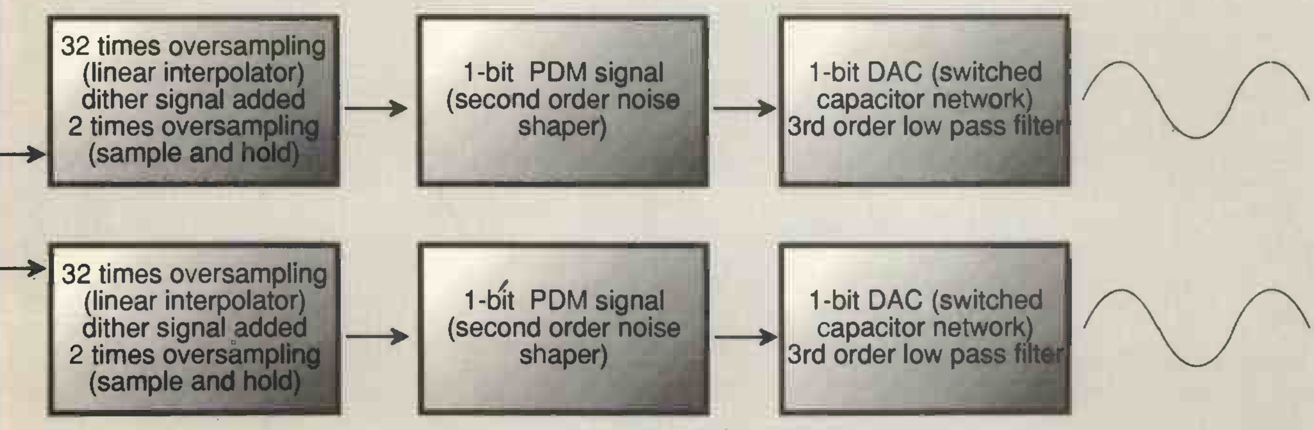
all you suffer is an error of one 65,536th of the overall sample, but if it's a very significant bit, that sample could be out by 50%, hence a glitch in the sound reproduction. On top of that, multi-bit DACs can be prone to glitches unless switching is performed in perfect unison. There are all sorts of tricks to get around this problem but they tend to be expensive and stretch the capacity of current LSI technology.

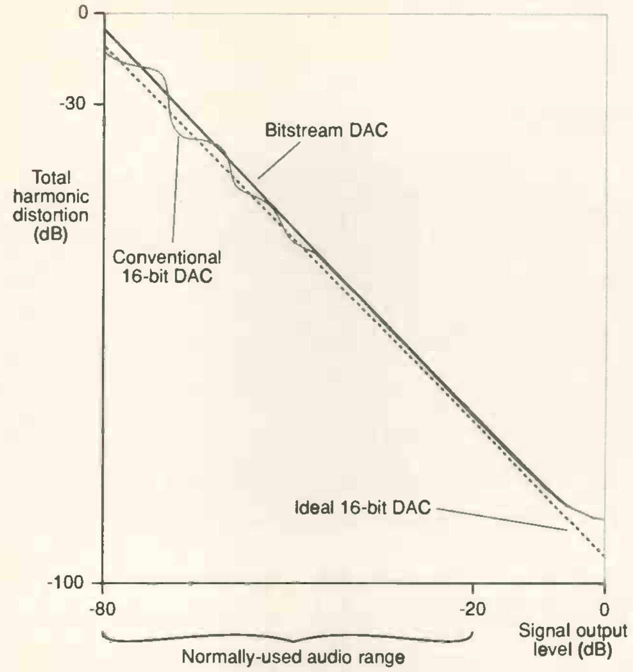
An alternative concept is to do away with a 16-bit DAC all together. Two rival methods now gaining popularity have done this and make do with a one-bit DAC. The two systems are Bitstream developed by Philips and MASH from Panasonic.

Philips uses a process known as Pulse Density Modulation (PDM) to convert the 44.1kHz 16-bit CD track samples into an extremely fast (11MHz) stream of binary data - the bit stream, from which the commercial name comes from. The ratio of the 1s and 0s in the bit stream determine the level of current being produced in time by



Above is a pulse density modulated sine wave with the original waveform superimposed.





A comparison between Bitstream, 16-bit DAC.

the system's simple one-bit DAC and hence the analogue signal. This will be free of any bit-wise glitches associated with 16-bit DACs and oversampling systems even though most of the sound shaping has been done in the digital stage.

Current Bitstream chips technology effectively oversamples by 256 times and the audio critics have generally been very pleased with the results. Panasonic's MASH system is similar to Bitstream in many respects, but uses a different algorithm for the single bit conversion. Unlike Philips, which has introduced Bitstream in its high-end CD players, MASH was first introduced in cheaper models and to many reviewers the advantages of MASH were masked by cheap associated circuitry.

The trend is definitely towards one-bit CD systems, so if you're thinking about buying a new CD player this specification will definitely be a consideration. Above all, however, it's how the player you choose actually sounds – no matter what DAC system it employs – which counts. However, it's more than likely that a one-bit CD players will be the favoured purchase.

HDTV News

While the US is nearing final testing stages to choose its high definition television (HDTV) standard, a recent conference in Cannes outlined just how far Europe is from choosing its own system.

In Europe, the argument is over whether we should be going for a full no-compromise HDTV system or an intermediate enhanced definition TV (EDTV) system like Pal Plus. The differences are between the EC Commission on broadcasting and industry-based Association of Commercial Television (ACTV). The EC is trying to support D2MAC, the satellite based HDTV system. Almost everybody else thinks that a terrestrial EDTV system would be more acceptable because it will remain compatible with existing television receivers. The new worries are that the EC may impose D2MAC on the industry in order to prevent its ultimate rejection.

Meanwhile in the US, four firms have formed a consortium and are bidding to be adopted by the FCC as providers of the official HDTV platform for the US – and, they hope, most of the rest of the world. The four are NHK, which has an analogue system already in limited Japanese use, Zenith/AT&T, ATVA (General Instruments and MIT) and finally, ATRC - the Advanced Compatible TV Consortium.

The ATRC is interesting in European terms as it is made up of two Euro-giants in the form of Thomson and Philips teamed up with NBC and Sarnoff Labs in the US. The ATRC is proposing an EDTV system even though the FCC has declared that full HDTV systems will be given priority in the evaluation stages. All the US systems are terrestrial and all but NHK's are digital systems.

Optimists in the US are saying that HDTV could start in the US by as early as June 1993. More realistically it will be 1995. Meanwhile, The BBC's head of engineering information has been recently quoted as saying that Pal Plus could be with us by 1995 as well.

Cable Sting

If you are privileged enough to have cable TV in your home, beware of strangers offering electronic mods to your receiver equipment which claim to by-pass subscription payment mechanisms.

Recently, 300 cable TV subscribers were nabbed in a sting operation which involved deliberately damaging tampered cable receivers by sending a high-powered signal down the line. The signal knocked out tampered sets while leaving genuine ones undamaged.

The so-called electronic bullet resulted in more than 300 guilty subscribers phoning up the cable TV firm to complain about the loss of service. They now face $100,000 law suits for pirating pay-TV channels they had accessed illegally. ■

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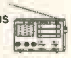

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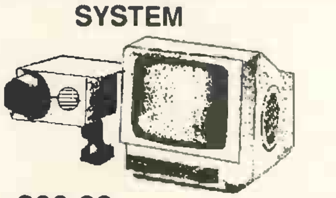
VIDEO AND AUDIO MONITORING SYSTEM



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FM BUG Built and tested superior 9v operation £14.00 ref 14P3

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As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8.

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12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10. MAINS POWER SUPPLY KIT £20.00 REF 20P33 READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4.

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600 WATT HEATERS Ideal for air or liquid, will not corrode, lasts for years. coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.

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Remote temperature probe for above unit £3.00 ref 3P60.

GEARBOX KITS Ideal for models etc. Contains 18 gears (2 of each size) 4x50mm axles and a powerful 9-12v motor. All the gears etc are push fit. £3.00 for complete kit ref 3P93.

ELECTRONIC TICKET MACHINES These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28.

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GAS POWERED SOLDERING IRON AND BLOW TORCH Top quality tool with interchangeable heads and metal body. Fully adjustable, runs on lighter gas. £10.00 ref 10P130

SMOKE ALARMS Ionization type 5 year warranty complete with battery only £5.00 ref 5P206

ANSWER MACHINES BT approved remote message playback, intergral push button phone, power supply and tape. Exceptional value at £45.00 ref 45P2

CAR IONIZER KIT Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33.

MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165.

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TELEPHONE AUTODIALLERS. These units, when triggered will automatically dial any telephone number. Originally made for alarm panels. BT approved. £12.00 ref 12P23 (please state telephone no req'd).

25 WATT STEREO AMPLIFIER c. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69 (Circuit dia included).

LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21.

MAINS FANS Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166.

POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2.

MINI RADIO MODULE Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716.

HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26.

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92, PACK OF 100 £30.00 REF 30P16

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.

FLOPPY DISCS. Pack of 15 3 1/2" DSDD £10.00 ref 10P88. Pack of 10 5 1/4" DSDD £5.00 ref 5P168.

SONIC CONTROLLED MOTOR One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827.

LCD DISPLAY. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.

ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.

100M REEL OF WHITE BELL WIRE figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107.

TRANSMITTER RECEIVER SYSTEM Originally made for nurse call systems they consist of a pendant style transmitter and a receiver with telescopic aerial 12v. 80 different channels. £12.00 ref 12P26

CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. nicely cased with built in battery operated light. Ideal bedside light etc! £4.00 each ref 4P82.

ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194.

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36.

ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181.

PC MODEMS 1200/75 baud modems designed to plug into a PC complete with manual but no software £18.00 ref 18P12

ASTEC SWITCHED MODE POWER SUPPLY 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39.

VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167.

CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292.

DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140.

PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135

POWERFUL SOLAR CELL 1AMP .45 VOLT only £5.00 ref 5P192 (other sizes avaliable in catalogue).

SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92.

LED PACK. 50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.

ULTRASONIC WIRELESS ALARM SYSTEM. Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6.

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18.

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62 or 2 sheets for £7.00 ref 7P22.

STRIP BOARD CUTTING TOOL £2.00 ref 2P352.

3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2

TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109.

TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.

BBC TRACKBALLS Once again in stock only £4.00 ref 4P86

CROSS OVER NETWORKS 8 ohm 3 way Japanese made units Excellent units avaliable at only £2.00 for a pair! ref 2P363

SPEAKER GRILLS set of 3 matching grills of different diameters. 2 packs for £2.00 (6 grills) ref 2P364

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91

4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365

TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366

COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57. Atari ST conversion kit £2.00 ref 2P362.

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205

5" X 3" 16 OHM SPEAKER 3 for £1.00!! ref CD213

ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207

PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10

2 MEG DISC DRIVES 3 1/2" disc drives made by Sony housed in a 5 1/4" frame 1.2 meg formatted. £66.00 ref 66P1.

CUSTOMER RETURNED 2 channel full function radio controlled cars only £8.00 ref 8P200

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries complete with hand charger and solar panel 14P200

CUSTOMER RETURNED TV/RADIO/CLOCK Made by Alba, may need attention good value at £28.00. ref 28P200 12 or 240v.

240 WATT RMS AMP KIT Stereo 30-0-30 psu required £40.00 ref 40P200

300 WATT RMS MONO AMP KIT £55.00 Psu required ref 55P200

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

ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc. £18.00 ref 18P200

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

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

TALKING CLOCK What more can we say?? £14.00 ref 14P200.

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How It Works...
The Multimeter

The essential instrument for anyone interested in electronics, its roots date back to the earliest days of physics.

Anyone who has had anything to do with electronics will have come across a multimeter. It is used to examine the properties of an electric circuit and generally supports three main measurement ranges, voltage, current and resistance. Some of the more modern designs also have additional functions such as continuity testing, capacitance and inductance measurement plus component checking for transistors and diodes. However, the basic model looks at Amps Volts and Ohms.

The meter's readout is provided by a galvanometer or ammeter. This is a device which dates back to the very first developments in electrical engineering. It consists of a coil of wire wound around a core of metal. Attached to this is a pointer which reads along a scale. This armature is placed inside a magnetic field so that when current flows through the coil, a force, or torque, is created that makes the armature turn. The more current passed through the coil, the more force is generated and the more the indicating needle moves according to Flemming's Rule. The turning force is resisted by a spring so that the indicator returns to zero when the current is switched off.

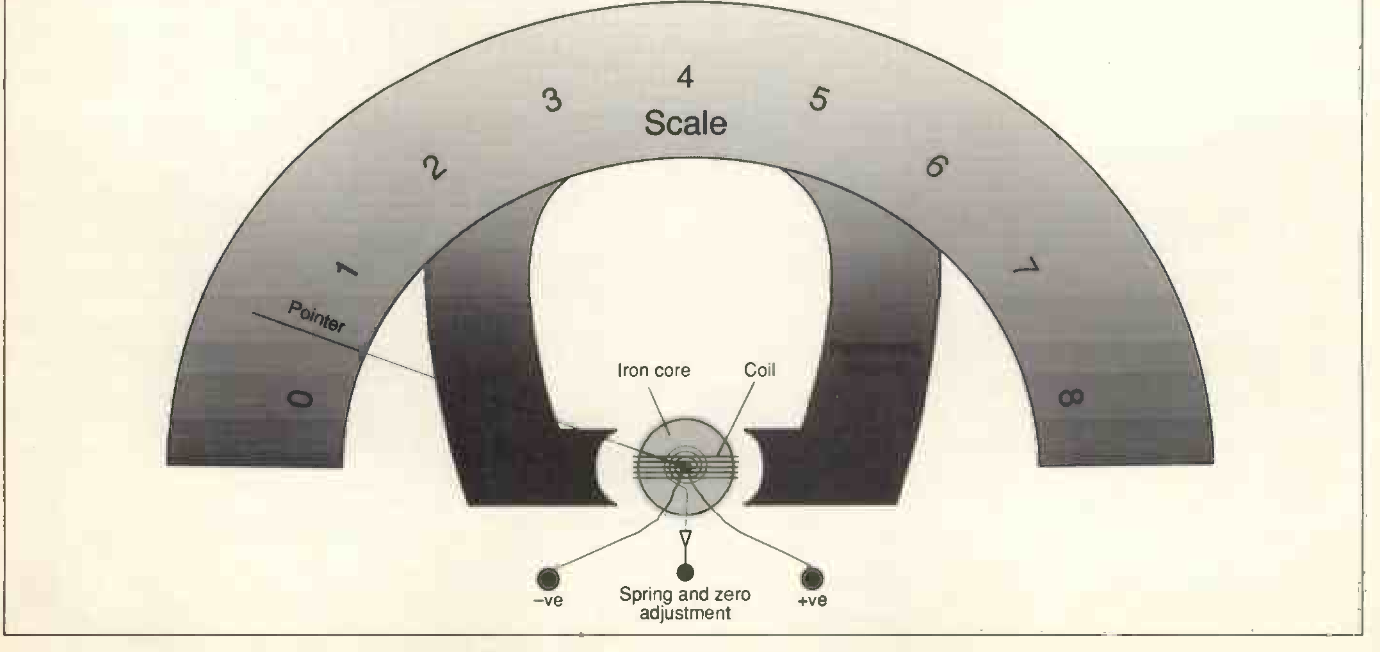
The basic ammeter therefore measures current as movement of its needle – the current being measured flows through the coil as though it were part of the circuit and the resistance of the coil is quite small. Different ranges are set by placing resistances in parallel with the coil.

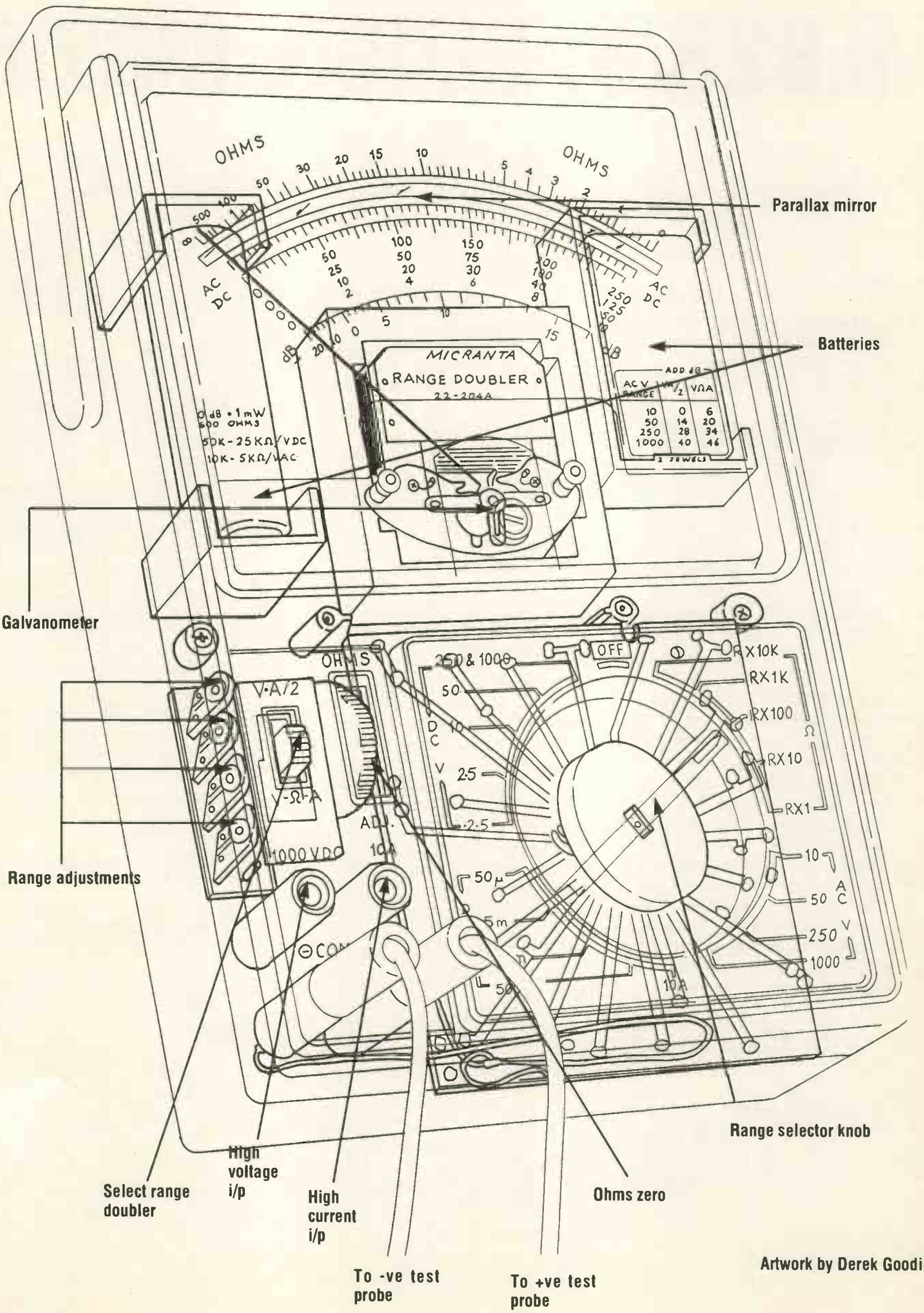
Voltage is measured by connecting a large resistance in series with the ammeter. When this arrangement is placed across a circuit, the voltage can be read as movement of the pointer.The different ranges are set by changing the values of the series resistors.

The measurement of resistance is simply a matter of applying a voltage to the circuit under test. The resulting current gives a direct measurement of the resistance of the circuit. ■

Fleming's Rule

If the thumb and the first and second fingers are extended at right angles to each other, with the thumb representing the direction of wire motion, the first finger representing the direction of magnetic lines of force (from the north to south poles) and the second finger representing the direction of current, then the left hand will give the correct relationships for a conductor in the armature of a motor or meter.





Artwork by Derek Gooding

Remote Control Chips... ML928/9, SL490, M375(

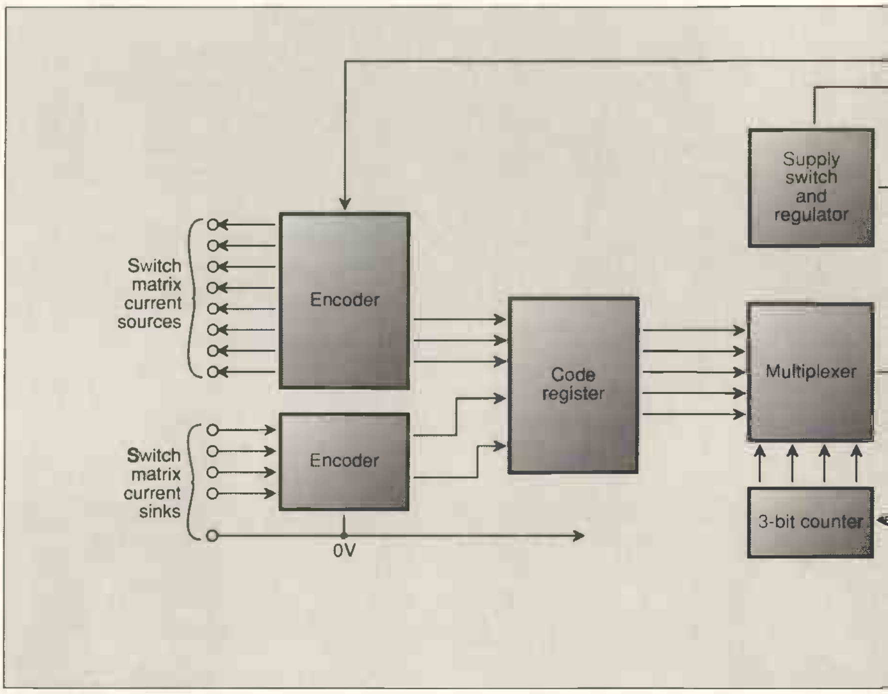
Back in the early days of electronics, remote control was something that required quite a lot of know how and complex circuitry. Nowadays, all that is needed are a few chips and a couple of discreet components.

The first chip set featured this month comprises two parts, the SL490 encoder/transmitter and the ML928/9 receiver/decoder. The second two are identical except that the first tresponds to codes 0 to 15 and the second 16 to 31. For systems that only require 16 codes, one chip can be used with the pair allowing access to all 32.

The input to the SL490 is an eight by four keyboard made up from single pole push switches – they are debounced by the SL490. Individual keypresses are coded up, transferred through an ultrasonic, infra-red, or other siutable link. At the other end, the ML928/9 receives the signals and decodes them into a 4-bit binary output. On both transmitter and receiver, the carrier for the data can be adjusted in frequency from 15Hz to 150kHz giving access to almost any transmission medium.

The data is transmitted using pulse position modulation (PPM) and the rate is selectable from 1 bit per second to 10k bits per second.

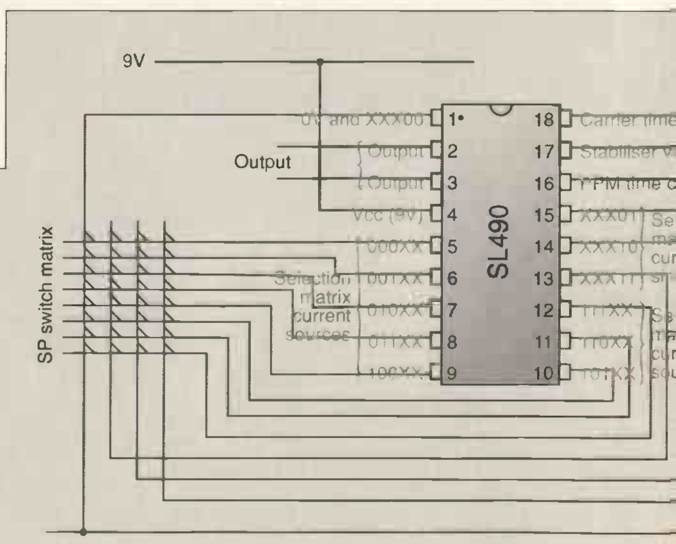
An unusual feature of the receiver is its negative logic. Instead of using 0V and +5V for logic 0 and 1, 0V and -12V are used respectively. This means that the supply voltage is negative and any input conditioning circuitry must give inverted pulses.

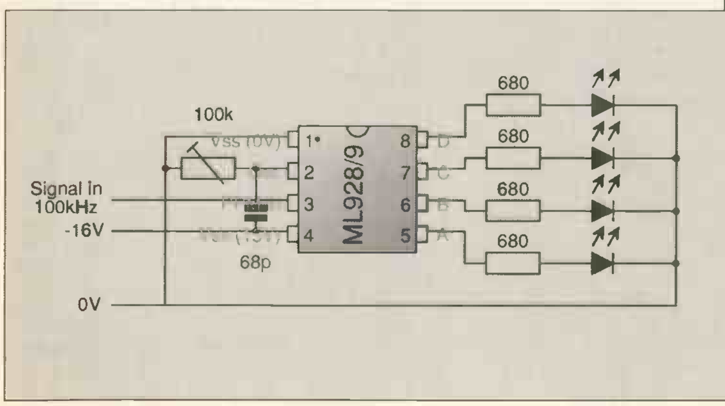


Single chip

The other featured chip is the UM3750 which is able to operate either as a transmitter or receiver. Instead of transmitting data the circuit simply attempts to find any chip with a corresponding code. Setting the input switches to a particular number causes a certain code to be transmitted. Only receivers with the same code will activate their receiver outputs. At first signt this would seem to be pretty useless. However, with some counting circuitry at each end of the link, 12-bit numbers transferred. The receiver is c through 4096 numbers and the re output used as a either to sto count or to latch it to other circui

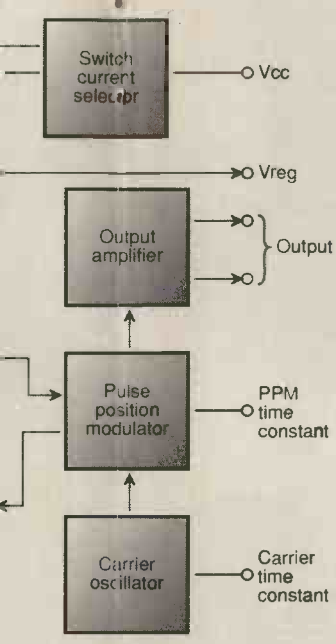
The only problem is one of since the receiver counts all 12 and compares them with the c code. It does this four times and valiud codes are received transmit/receive output at pin 1 low. The next valid code m

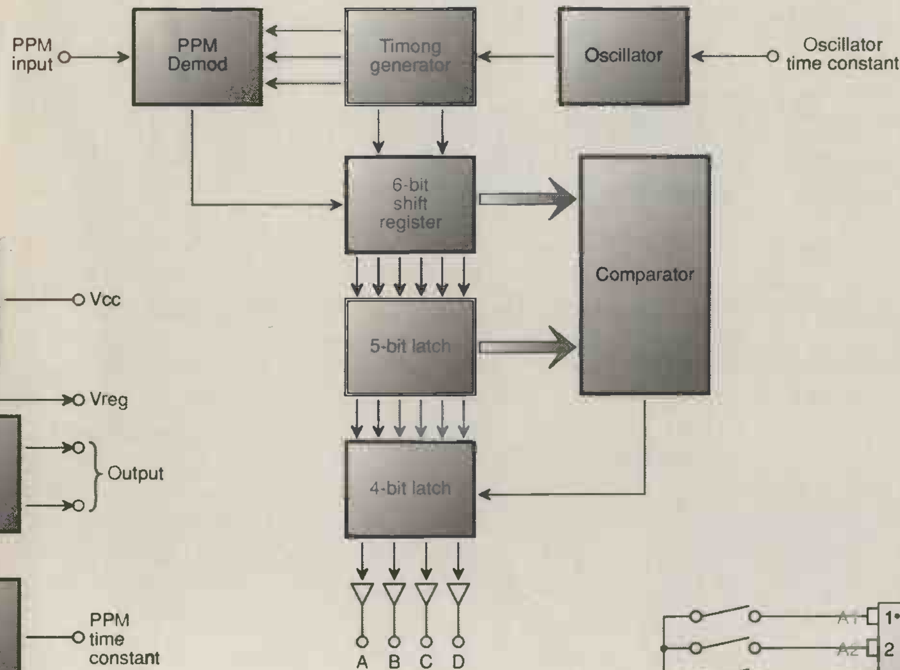


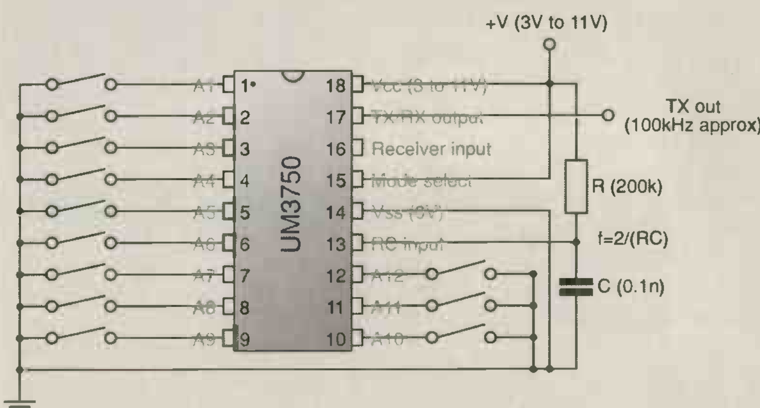


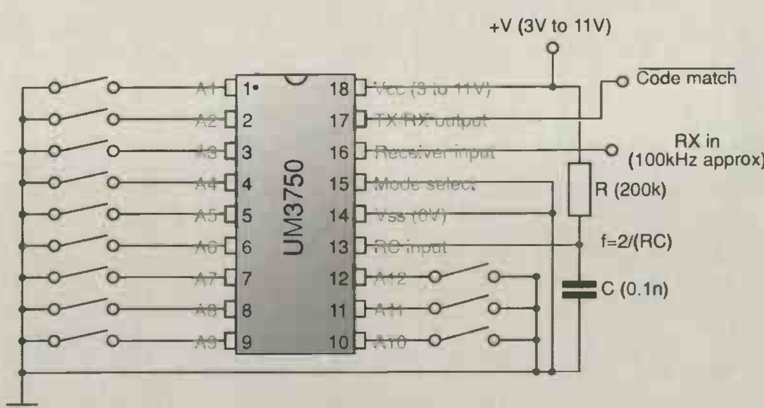
UM3750 Pin Functions

Pin	Function
1-12	A1-A12 Data select lines used to define the address of the encoder decoder chip pair. To set an address, puls the lines down to ground. They have built in pull up resistors.
13	R C Input defines the frequency with R ranging from 200k to 1.2M
14	Ground
15	Mode select, grounding this selects receiver mode and connecting it to Vcc, transmit mode.
16	Receiver input
17	TX/RX outputs signal in transmit mode and signals a correct code in receive mode
18	Vcc, the power supply, 3V to 11V









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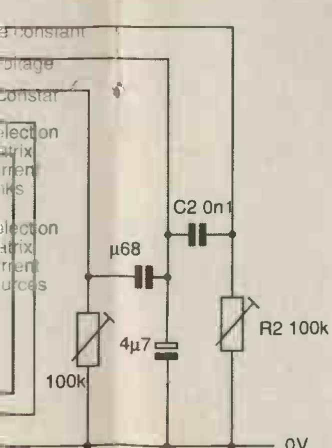
received within 128ms to keep the output low.

Another application of this circuit is when one transmitter has to talk to a number of independent receivers. Each of these has its own code number preset on the switch inputs and triggers its output when a valid code signal is received. As an example, this would allow a central handset to control a selection of household gadgets. ■



ML928/9 Pin Functions

Pin	Function
1	Vdd, -12V to -18V power supply
2	Time constant, the RC oair at the point defines the intrnal clock frequency from 15Hz to 150kHz. R can be from 25k to 200k with the frequency being given by f=1/(0.15RC).
3	Signal input, an amplified version of the signal from the SL490 is fed into here. This must conform the the negative logic format where "1" is -12V to -18V and "0" is 0V. The normal level is logic "1" with the data pulses to logic "0".
4	Vss, ground.
5-8	Four binary outputs using high power transistors.

SL490 Pin Functions

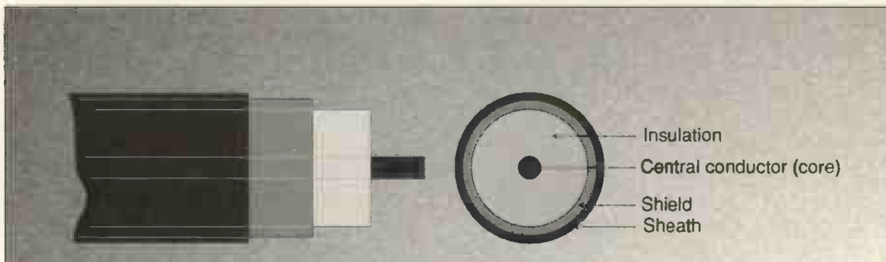
Pin	Function
1	Ground and keyboard column zero
2-3	Transmitted output from 1 to Vcc up to 5mA and 0Hz to 200Hz.
4	Vcc, 7V to 9.5V
5-12	Rows
13-15	Columns
16	Time constant for data set by 1.4C1R1
17	Stabilizer voltage from 4.3 to 4.9 volts.
18	Carrier time frequency given by 1/(C2R2)

Practical Components: Cables And Wires

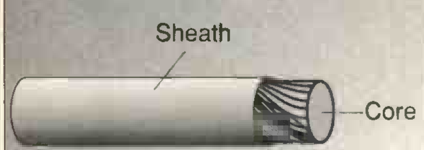
They may seem to be one of the simplest parts of any electronic circuit. But, a look through any electronics catalogue will show, there are quite a number of different types.

Without wires, there could be no electronics. They are used in every circuit to carry current from one place to another. The variety of uses for wires has led to a plethora of different types from simple hook up cable and enamelled wire to co-axial and ribbon.

A piece of cable consists of an electrical conductor, usually copper, surrounded by some form of insulation. If the copper core is solid then the wire tends to stay bent in any direction it is put into. Repeated bending will eventaully cause metal fatigue and the wire will break.



The construction of a coaxial cable.



The main elements of a cable.

To improve the flexibility, a number of cores can be used, the total diameter defining how much current the cable can carry. Cables that carry heavy currents, such as those used to power an electric cooker, are quite hefty, others, such as those used to transfer data from a silicon microchip to its input/output pins are very thin indeed.

The outer sheath of a cable is made from a variety of materials. The most common is PVC (Poly Vinyl Chloride) which is a good insulator, tough yet flexible and can be moulded very easily. Cables that have to carry high voltages might use an inner layer of polythene beneath a thicker layer of PVC. Wires that have to be crammed into very small spaces such as the windings on a transformer, are coated in enammel to make the sheath as thin as possible. ■

Cable Types

Coaxial
Acting as a waveguide, coaxial cables are used to convey high frequency signals from one point, say an aerial, to another, say a receiver or transmitter.

EHT
Extra high tension cables are used in high voltage systems up to around 25kV. The insulation is much thicker and better quality than normal cable.

Enamelled Copper
Transformer windings can consist of many turns of wire which must have as thin a sheath as possible, an enamel coating serves this function admirably.

Flexible
The flying leads used with test instruments must be as flexible as possible otherwise metal fatigue would probably cause them to break due to their constant movement. Flexible cable uses a large number of very thin wires as it core and a sheath of very flexible plastic.

Heat Shrink Sleeving
Where bare wires must be covered, heat shrink sleeves can be placed over them and when touched with a soldering iron or other hot object, shrink (by up to 50%) to form a tight fit around the wire, protecting it from accidental shorts.

High Current
Extra fibres in the core of the cable allow it to carry higher current. The formula H=RI2T defines the amount of heat (H) generated in a cable with respect to its resistance (R), the temperature (T) and the

square of the current (I). Making the cable thicker allows the extra heat being generated by the high current to be conducted and dissipated away as well as reducing the resistance.

Hook-up
Usually available in a number of colours, hook-up wire is used for interconnections between circuit boards and external components such as potentiometers, meters and displays.

Loudspeaker
When connecting speakers up to an amplifier, it is necessary to make the connections the right way around – otherwise the phase of the speakers may be wrong resulting in a loss of quality and volume. Loudspeaker wires come as pairs with a linked plastic sheath and marked so that one wire can be traced from end to end.

Low Noise
Using special sheathing methods it is possible to protect the signal carrying core from outside interference or noise. The sheath usually consists of polyethylene insulation surrounded by a layer semiconducting polyethylene and then the copper braided shield. All of this is covered with a layer of PVC (Ploy Vinyl Chloride) for strength.

Mains Cables
Used in household wiring these usually have three solid cores surrounded by a white PVC sheath. Known as twin and earth, two of the cables, the live and the neutral are covered with individual colour coded sheaths, red and black, with the earth being bare copper. Note that this is not the same as the cables used to connect equipment to the mains which uses three sheathed wires with the colour coding of brown for live, blue for neutral and green and yellow for earth.

Multi-core
Where connections require a number of wires to be taken from one place to another, a multi- core cable is used. These can be have from two to 40 colour coded individual cores and are usually shielded.

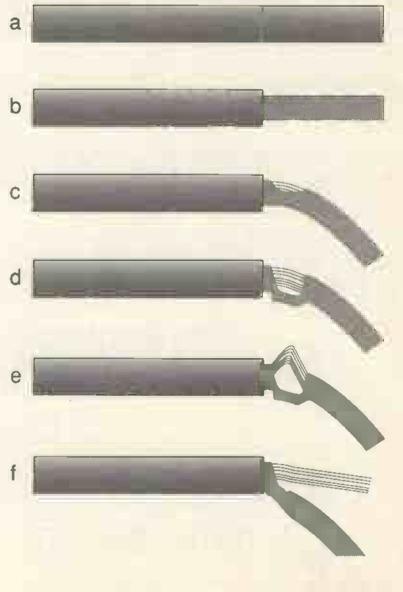
Ribbon
When connecting printed circuit boards together and especially in computer applications where a large number of connections must be made from one place to another, a ribbon cable is used. Instead of bundling all of the wires together inside an outer sheath, they are stuck together side by side to form a flat layer, hence the name ribbon. A number of different sizes are available from 2 to 50 way or more. Some are multi-coloured with others being plain apart from one key wire which has a stripe down it to make sure the polarity is maintained.

Screened
Screening is used to protect a sensitive signal from outside interference, for example, a microphone cable which is fed into an audio amplifier is very susceptible to 50Hz mains hum. The cable has a central core which is surrounded by insulation and then by a braid or flat tape which forms the screen or shield. Connecting the screen to ground effectively forms a Faraday Cage around the core, protecting it from outside electromagnetic influences.

Solid Core
Most cables use multiple cores to give them flexibility and reduce the metal fatigue incurred whilst bending. For connections that are not going to be moved once in place, for example on a printed circuit board solid core wire is ideal.

Telephone
Standard telephone connections use four or six core unscreened cable with individually colour coded sheaths.

Wire Wrapping
A way of constructing circuits, now quite rare, is to use components with long leads soldered onto chessboard like squares. The protruding leads are connected together to form the circuit with special wire and a wrapping tool. Normally the wire has a thin sheath which is easily removed by the wrapping tool when it winds the wire around the end of a component lead, allowing it to be soldered in place.



Baring A MultiCore

One of the first practical things most electrical and electroni engineers learn is how to bare a piece of wire. Some use their teeth, others resort to special tools. For most cables, the simplest way is to carefully cut around the sheath with a knife and then pull if off to reveal the core inderneath.

A useful technique for exposing the cores in a multi-way cable is illustrated above. First of all, the sheath is cut (a) down to the shield layer and removed (b). Next a screwdriver is inserted between the braids of the shield and an opening is made to expose the cores inside (c) – note that the shield is not cut at all. Bending the end down (d) and pulling the braid away reveals the core wires and inserting the screwdriver in the gap allows them to be pulled free of the shield (e) leaving the shield intact and the cores ready to be bared and soldered (f).

PE Chronos: The First Board

This month Tony Smith gets down to some construction work on the Chronos, starting with the input board.

The input board is double sided, having a ground plane and a component side to ensure good earthing for all nodes and connections at zero potential. Furthermore, the board is screwed to the front panel such that the circuits of both channels are neatly sandwiched between the ground plane and and the metal panel, effectively providing all around shielding.

Fixing the board to the front panel has the second advantage in that all connections between the board and the front panel controls are kept to a bare minimum. This simplifies construction and makes the layout neat and also eliminates cross talk and interference between the interconnecting wires. Note that the board is located well away from the mains transformers. This is essential to prevent mains pickup at the sensitive inputs.

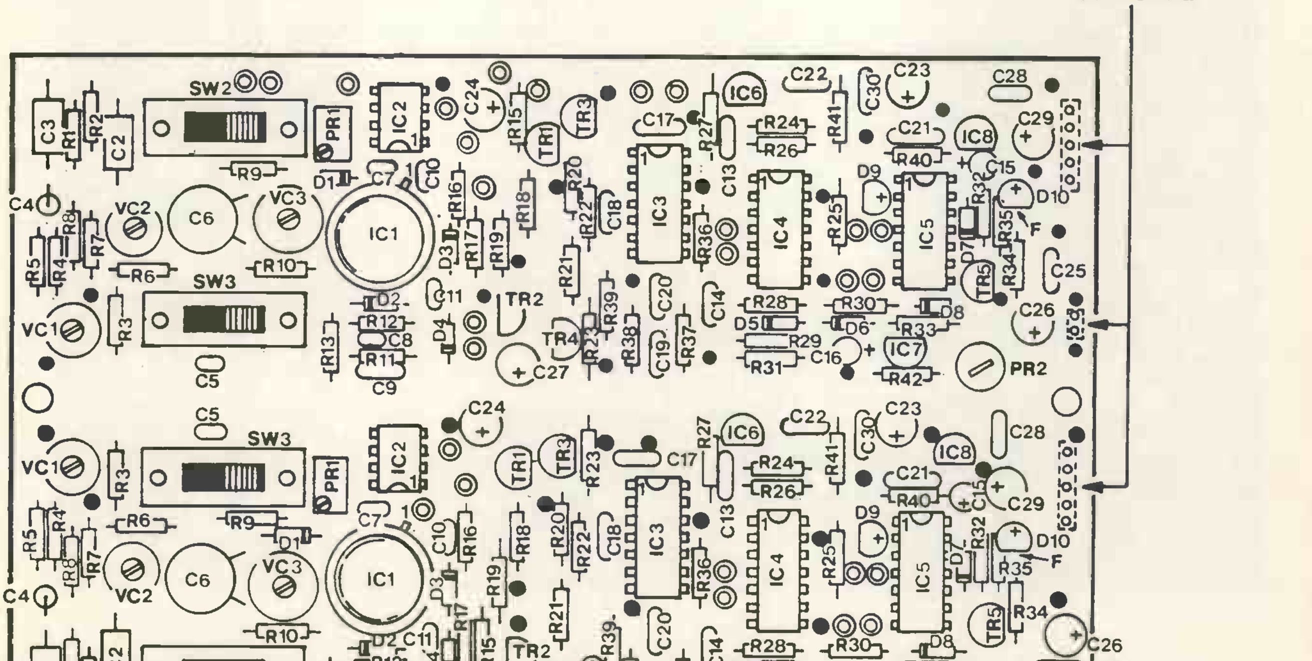
Construction of the board is straightforward and shouldn't pose any problems. However, there are two points which should be bourne in mind.

Firstly, several of the ICs used in the input circuits are sensitive to static discharge so care should be taken when handling them (the pins should not be touched and the soldering iron tip earthed). These precautions apply mainly to IC5 and IC1 which is rather expensive.

Since both input channels are accommodated on one board, the PCB is fairly densely populated. Because the board is screwed to the

FIG.28: Input Board, component layout.

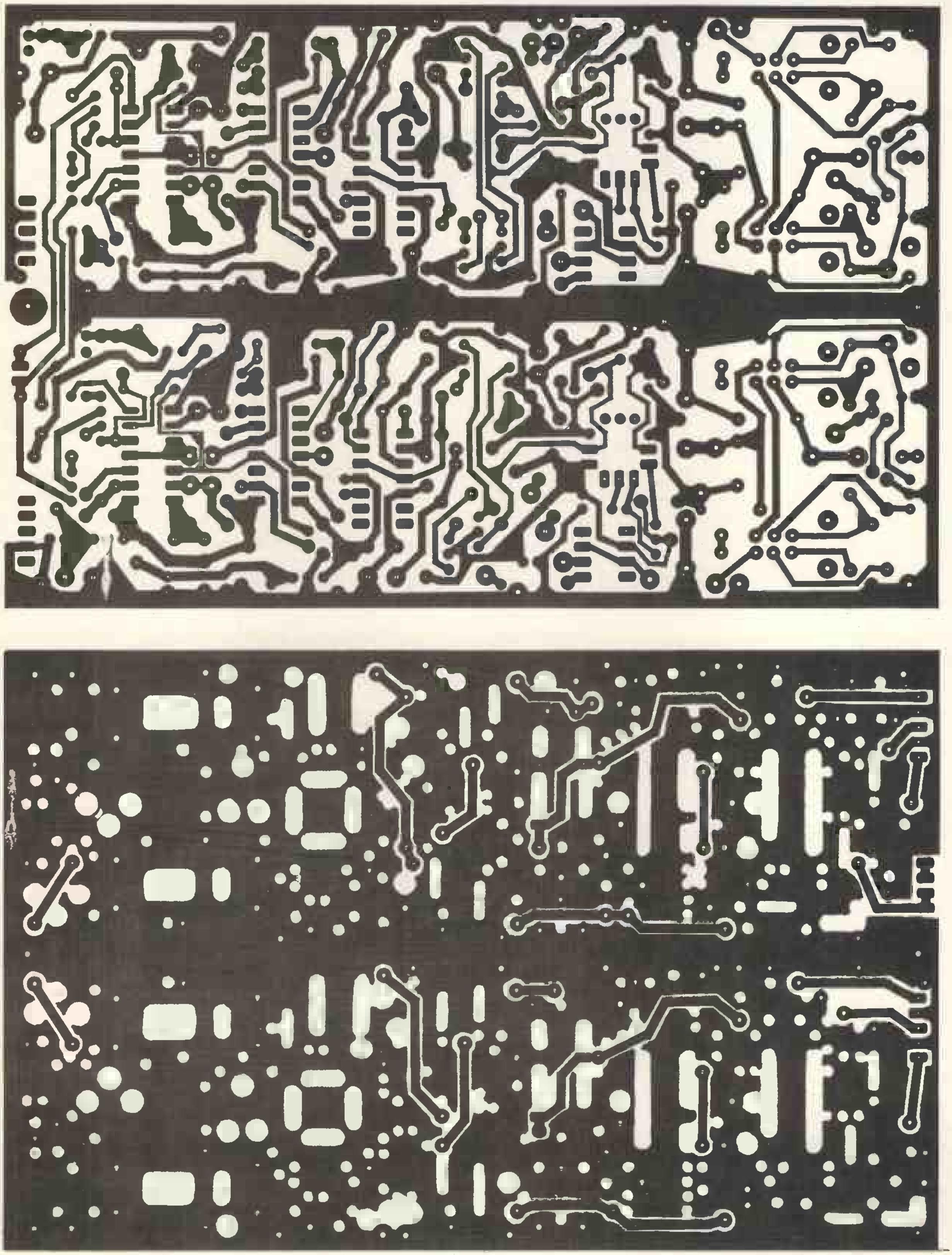
Connectors mounted on rear of board



● = link through board, (43).

◎ = Veropin connection.

Fig. 1. Input board component layout.



Input board PCB top and bottom.

front panel using 0.5in spacers, all components heights should be kept under this height.

Each input channel occupies one half of the board, the two halves being almost identical electrically and physically. They are kept separate to minimise crosstalk so there is no mixing of components and each half is considered a separate entity. The parts list is for one channel only so it is necessary to buy two of every component on the list.

Putting It Together.

The component layout for the input board is shown in Figs.1 and 2. Before inserting any components, make a thorough check of both sides of the PCB for shorts, broken tracks and so on. Next, begin construction by soldering the 43 through board links into place (remembering to solder both sides of the board).

Resistors and diodes come next and several leads are at zero potential so that they should be soldered to both sides of the board as shown in Fig. 3.

It is also convenient to bend certain resistor leads into small loops to act as test points during calibration – the main test nodes are at the junction of R9-R10, the high end of R12 and the junction with pin 11 of IC1 and the junction of R20-R21.

The next step is to solder all integrated circuits into place – sockets should not be used on the input board because of the height increase. Take care with he orientation and the anti-static precautions. Pins 3 and 8 of IC3, pin 10 of IC4 and pin 7 or IC5 should all be soldered to the ground plane as should the metal can of IC1 – take care not to use too much heat.

Follow the ICs with the capacitors keeping the leads as short as possible, especially the supply rail decouplers. If a large disk ceramic is used for C6, there is provision to lie it flat on the board. Also, C4 must be mounted on end, making the longer lead the 0V connection. Note that C7 and C8 should be inserted later when calibrating the board.

When the capacitors have all been soldered into place, insert the transistors and regulators. The variable capacitors and trimmer pots come next. If PR2 is used, it can be either a single or multiple turn type as preferred.

Note that PR1 should be inserted exactly as shown in Fig.1 such that its screw aligns with the access hole in the front panel. Almost all of the trimmer cap and pot leads are not at zero potential so take care that they don't short to the ground plane.

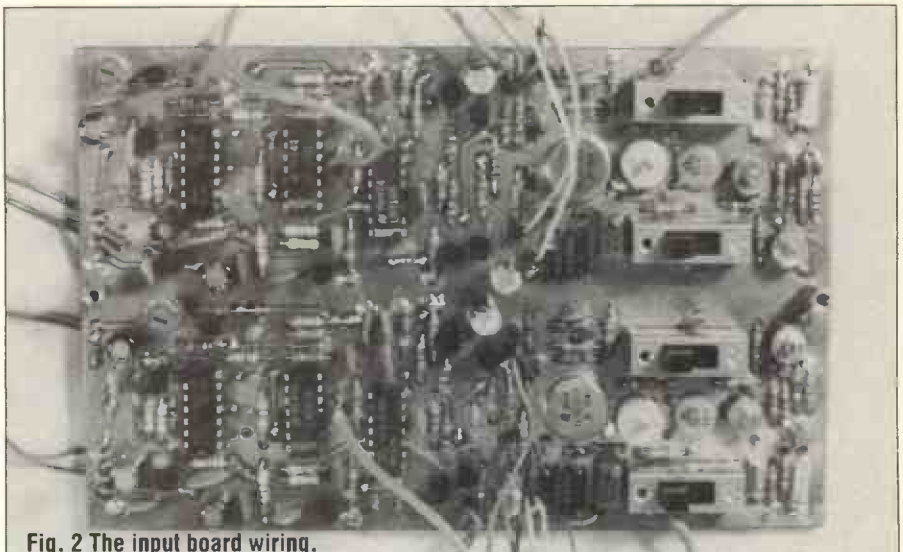


Fig. 2 The input board wiring.

Insert switches two and three and if they seem a little stiff, open up the PCB holes with a slightly larger drill bit.

Most of the front panel components are connected to the input board using veropin connections. Make sure that these pins are all less that 0.5in tall and that they don't short to ground unless they are meant to.

For test purposes, it is best to solder LEDs D9 and D10 directly onto the board although they will later be attached with short lengths of wire.

Finally, the ribbon cables (two 5-way and one 2-way) which link the input board to the main board should be inserted from the rear and soldered on the component side – they should be at least 14cm long.

Alternatively, if PCB connectors are used, they too must be be located on the rear of the board and soldered on the component side. Construction of the input board is now complete.

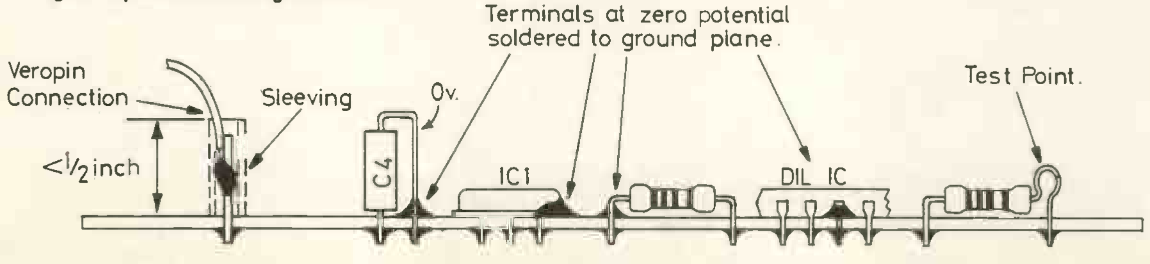
Panel Beating

The two mains transformers which power the PSU section of the main board are both bolted to the rear panel of the Chronos. All the dimensions in Fig.4 and Fig.5 are shown in mm.

Perhaps the simplest way to machine the rear panel is to locate the hole centres directly on the front panel using faint pencil marks. Note that the small holes labelled 'A' are for the transformers' fixing screws.Take care to check the sizes of the transformers before drilling so that the panel can be altered. The holes marked B, C and D are for the BNC connector (SK7, Ext clock), main fuse holder and mains input connector (SK11) respectively.

Marking the layout for the front panel is a little more difficult. First draw an actual size copy of Fig. 4 to use as a template. Next, place the template over the panel so that the edges match exactly and tape them together. Then, using a fine-tipped punch, transfer the hole centres and slot corners from the template to the panel. They can then be drilled out and the finished aluminium panel left shiny or sprayed with lacquer top cover up any accidental scratches. Once this has dried, the graphic symbols can be put on and the covered with fixative.

Fig. 3. Input board wiring details.



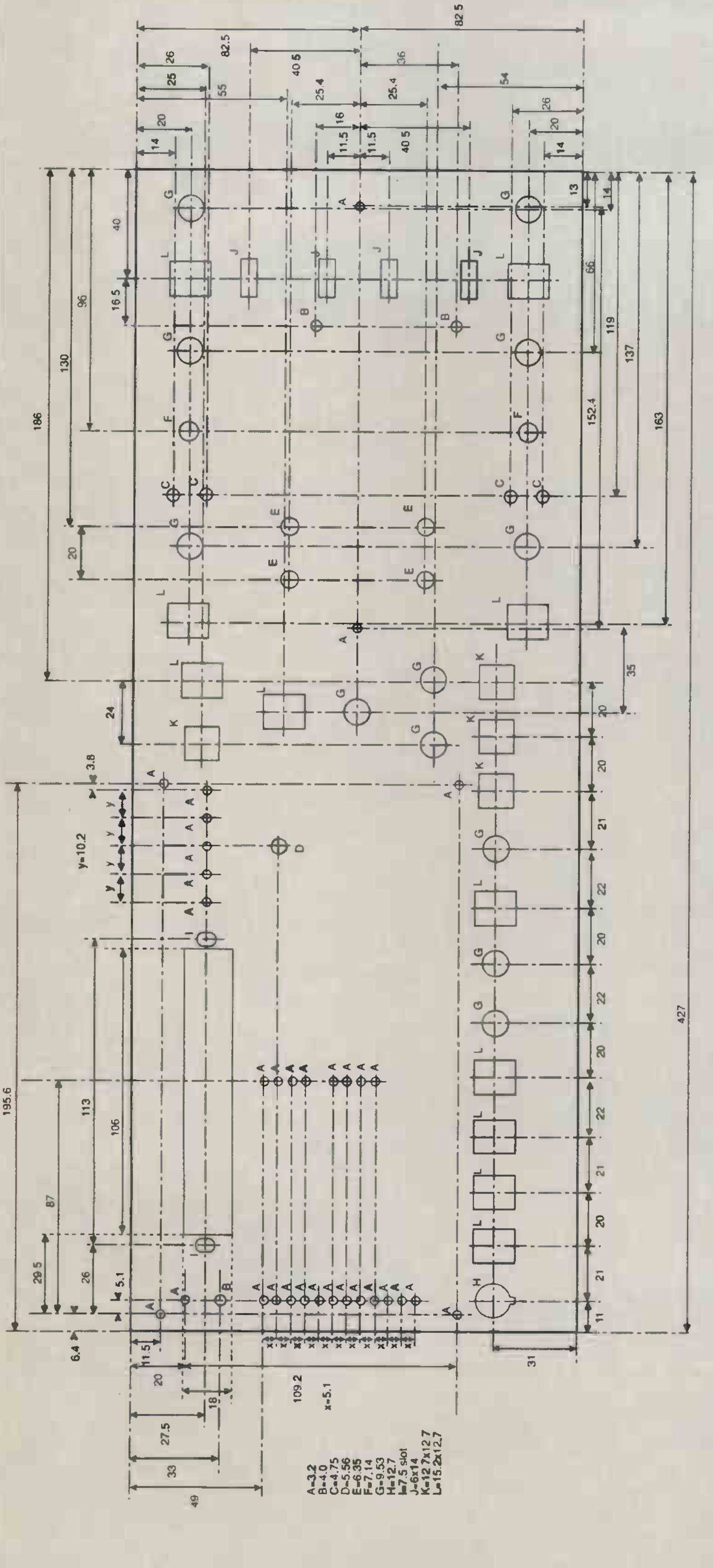


Fig. 31. Front panel holes.

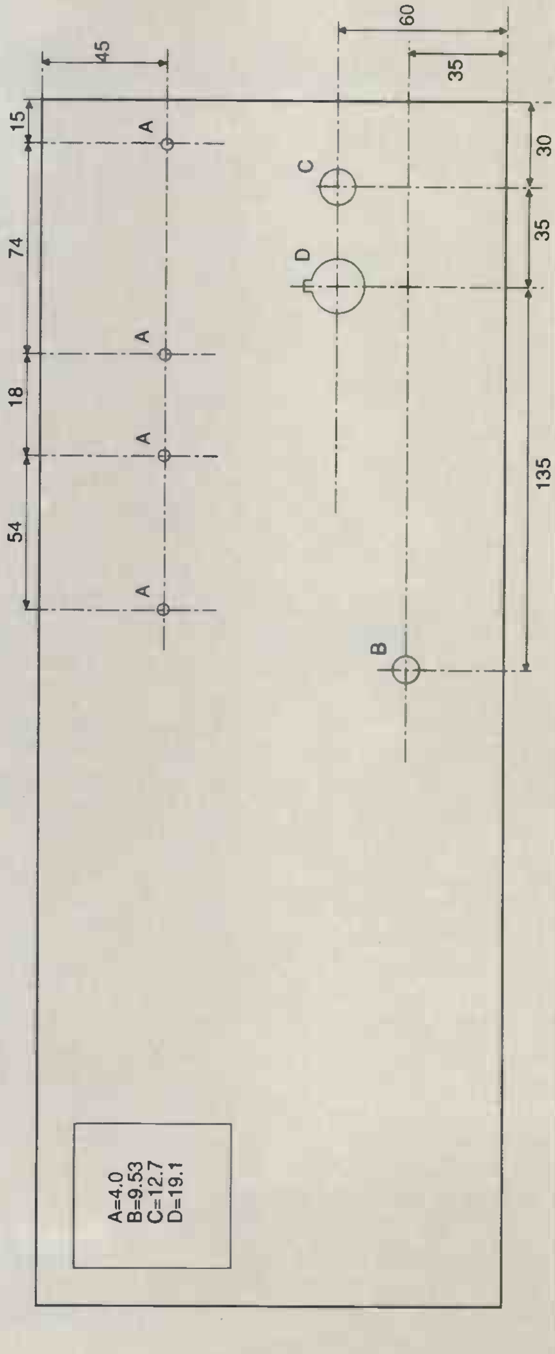


Fig. 32. Back panel holes.

Fig. 6. The back panel.

Transformers

The transformers should be bolted into place using three screws. The fourth is bolted to the 9V transformer near the panel edge and should be a little longer to accomodate the earth tags. Two earth wires about 6in long should be soldered to these tags. Next, fix the mains input connector (SK11) and fuseholder into place. The BNC connector for the external clock can also be fitted at this point.

General purpose insulated hook up wire with stranded core (16/0/2mm) should be used for all connections to the transformer primaries and secondaries. It's good practice to use brown wire for live connections, blue for neutral and other colours for the transformer secondaries.

Wiring the secondaries depends on the types of transformers used. Transformer T1 has dual 9V secondaries rated at 500mA, these should be connected in parallel. Alternatively a single 9V, 1A secondary can be used – see Fig.8.

If transformer T2 has dual 12V, 250mA secondaries, they should be connected together as shown to create a centre tap. Alternatively, a straightforward 12V-0-12V secondary can be used.

The wires to the secondaries of T1 should be a twisted pair at least 16in long. A twisted pair is recommended for neatness and, more importantly, to minimise the 50Hz electromagnetic field around the wires. The wires from the secondaries of T2 should also be twisted. Make sure a different coloured wire is used for the centre tap connection. The wires should be at least 15in long.

If the transformer primaries consist of dual 120V windings, they should be connected together as shown to create a single 0-240V winding. On the other hand, if the primaries are marked 0-120V-240V, make connections to the 0V and 240V terminals and ignore the 120V tap.

The two primaries are wired in parallel to the mains input. Take the neutral from the mains socket to one side of the T1 primary, then from here to the primary of T2.

The live terminal of the mains socket must go the first to the fuseholder – the fuseholder recommended has three terminals, two of which go to the same side of the fuse. Make sure that connections are made to each end of the fuse so that the live path is through the fuse.

From the fuseholder, take the live to the on/off switch (SW18) then back to the primaries of T1 an T2. The wires to the on/off switch should be a twisted pair, at least 14in long. The switch is only connected temporarily at the moment and should not yet be fixed into the front panel.

Keep all wiring on the rear panel as neat as possible, the two wires connecting the transformer primaries in parallel should also be a twisted pair. Good quality sleeving should be used on all connections (except earth), especially on the live terminals.

When making connections to T1, don't forget to wire the transient suppressor V1 across the primaries.

Finally, take one of the 6in earth wires and solder it to the earth terminal of the mains socket. The other earth wire will be connected later. There is no need at this point to fix connectors to the secondaries' wires as this can be done later when the wires have been trimmed to exact length.

The rear panel now needs little more attention. it can be tested when the input board is connected up. ■

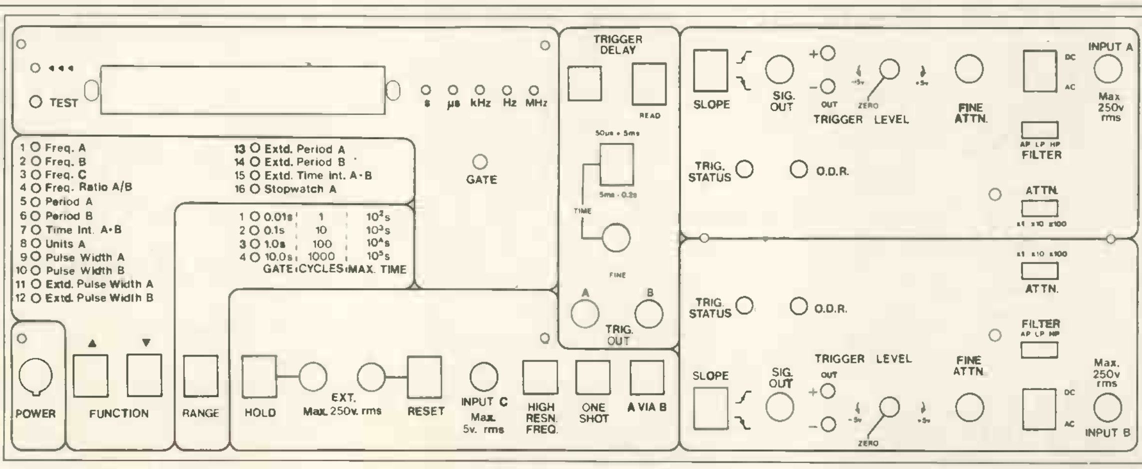


Fig. 7. The front panel graphics.

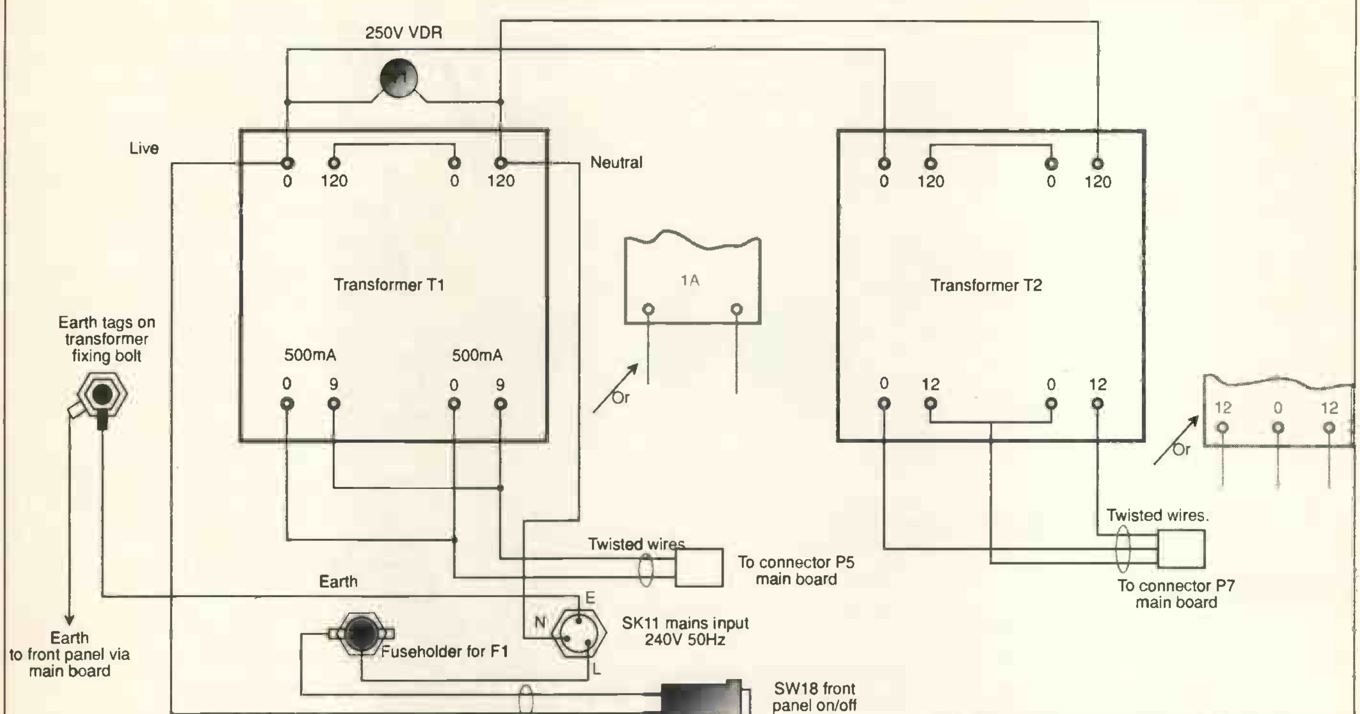


Fig. 8. The transformer connections.

Components

Resistors

R1	13k
R2	1M5
R3	1M0
R4	10k
R5,R15	200
R6,R10	910k
R7	110k
R8,R18,R19	2k2
R9	119k 0.6W
R11,R12,R22	3k6
R13	390
R14	10k 0.6W 5%
R16,R17	2k4
R20,R21	82 0.6W
R23	150
R24	4k7 5%
R25	1k5 5%
R26	820 5%
R27	180
R29	680
R30	620 5%
R31	1k8 5%
R32	360k 5%
R33	470k 5%
R34	47k 5%
R35	18k 5%
R36,R39	15k
R40	1M5 5%
R41	see text
R42	510 5%

Capacitors

C1	0µ1 630V DC or greater
C2,C3	220p 2.5% 630V DC
C4	820p 5%
C5	82p 5%
C6	56p 10% 250V rms
C7,C8	see text
C9,C22,C25,C28	0µ1
C10,C11,C13,C14,C17,C18,C19,C20,C30	10n
C12	10n 100V DC
C15	1µ0 10V tant
C16	1µ5 10V tant
C21	0µ22 min ceramic
C23,C26	22µ 25V sub min radial elect
C24,C27	22µ 16V sub min radial elect
C29	47µ 16V

Variable resistors

VR1	470 10% lin single turn pot
VR2	10k lin single turn pot with integral SPDT switch (SW4)
PR1	10k (3/8in square) 22-turn cermet preset
PR2	500 min cermet preset

Variable capacitors

VC1, VC2	2-22p Mullard Beehive trimmer 808 series
VC3	5-65p Mullard Beehive trimmer 808 series

Semicondutors

IC1	LH0032C
IC2	741C
IC3	LM319N
IC4	LM361N
IC5	74HCT14
IC6	78L08AC
IC7	79L05AC (or 79L08AC)
IC8	78L05AC
TR1,TR3,TR5	BC183L
TR2,TR4	BC213L
D1,D2,D5,D6	1N916
D3,D4,D7,D8	1N4148
D9	5mm red LED
D10	Flashing contiunuous 5mm red LED

Switches

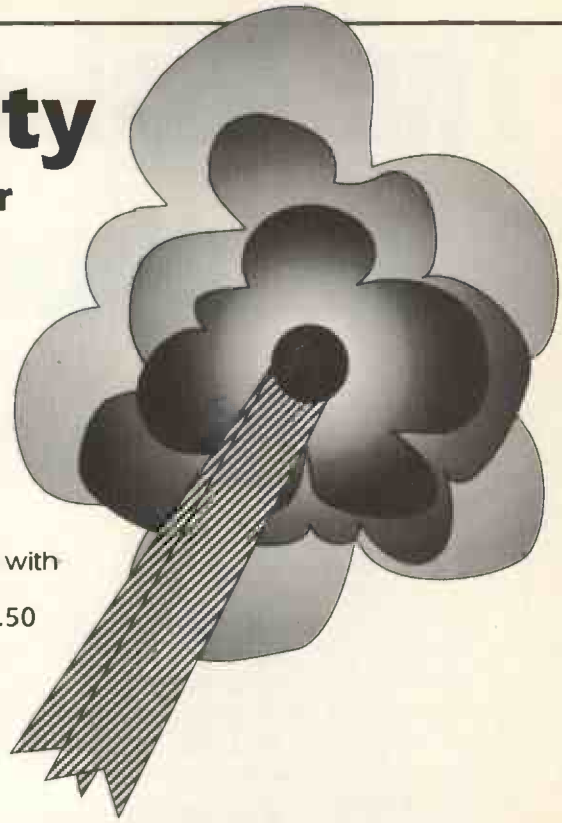
SW1,SW5	SPDT (single pole changeover)
SW2,SW3	Double pole three way PCB mounting slide switch
SW4	SPDT integral with VR2

Miscellaneous

SK1,SK4	50Ω BNC round chassis socket
SK2,SK3	Inslated socket 1mm 1 read 1 black

Power connectors (if used) 5 way x 2, 2 way x 1 (per board)
Ribbon cable 5 way x 2 and 2 way lengths
0.8mm through-board track links (43 perboard)
Small pin terminals 1mm types (36 per board)
Metal spacers 0.5 inch, 6BA threaded x 2
6BA screws chrome plated 0.5Inch x 2 unplated, 0.5 inch x 2
Potentiometer knobs, 4 per board
LED clips, 4 per board

Rewarding Loyalty



You can be a winner with our Reader Loyalty Bonus.

This month's top ten readers:

B. Hall of Bristol has £150 of the money spent with Maplin Electronic Components refunded.

S. Jones of Brighton who bought £150 worth of goods from Maplin Electronics.

Ben Wilcox of Scarborough receives £99.90 for buying goods from Tandy.

H. Palmer of London has the £84.95 he spent with Greenweld refunded.

D. Crome of West Kingsdown, Kent gets back the £51.04 he spent with Maplin Electronics.

P. Beardwood of Stockport traded with Bull Electrical and has £47.50 refunded.

Nicola Peck of Sheffield secures her £21.45 for purchasing goods from Suma Designs.

Robert Duncan of Chesseneuil, France claims his £19.84 which he spent with Greenweld.

G. Smart from Liverpool is reimbursed £18.95 for trading with Greenweld.

Peter Webster of London N7 has £17.50 repaid for his purchase from Cricklewood Electronic

The Toshiba T1000LE A Notebook Computer

Sarah Brook takes us through the pleasures and trials of one of Toshiba's most afforable notebook PCs.

Portables have been around for years, but few of them are actually comfortable to both carry around and use. The early versions weighing around 8kgs (15 pounds) were not really portable at all, but "luggable" and entirely unsuited to the mobile professional – unless they were professional weight lifters!

Then followed the first laptops, aimed at the mobile sales executive and frequent flier. But reduced weight also meant reduced speed and reduced keyboard space, so that the only sales executives who benefited from the technology were those with childsize hands and patient customers. Not to mention that high budgets were also needed to afford the considerable expensive of going portable.

Pocket portables were more affordable but even less efficient. Those that offered a qwerty keyboard could only be used by people with really tiny fingers.

The vision of a professional sauntering in and out of meetings with fully prepared statistics and written up notes remained an unfulfilled dream for all but the most affluent companies.

Enter the notebook PC. There are many coming onto the market now, with most manufacturers bringing out at least one. Toshiba probably have the best reputation in portables and the T1000LE is their most affordable version to date at £1,495 (plus VAT).

This machine is suitable for even petite professionals who will not have difficulty managing the 3.0 kg weight . It can be bought with an optional black nylon or leather carrying case with side pocket and, for those who do not take the office with them, the case itself is an alternative to a brief case.

The keyboard is full-sized and arranged for a normal adult hands. There are 84 keys, including 12 function keys and the numeric keys are integrated in the main keyboard. The keys are very responsive to light touch keystrokes, more so than many other manufacturer's machines.

Unfortunately, even Toshiba have not really managed to create a keyboard which is quiet enough to be used discreetly. As hard as one might try to stroke the keyboard lightly, there remains the inevitable "tapping" noise that is guaranteed to annoy colleagues, delegates or fellow travellers.

The screen display is sidelit to made LCD in grey/blue background with blue characters and has adjustable contrast and backlight brightness. Using a reasonably high resolution of 640 x 400 pixels, it is quite clear and easy to see. When used for a number of hours, however, the display is harder on the eyes than black and white or orange plasma displays. Also it is CGA, rather than VGA compatible. Toshiba do make a VGA portable, the T2000SX, but this is much more expensive at £3,395. At present there are other notebooks for the same price of £1495 which offer VGA but they are not as light in weight.

That said it copes adequately with spreadsheet graphics and for many people that is as as good a display as they will need.

If one needs to do anything more sophisticated, then a larger memory will be needed. The T1000LE comes with 1Mb RAM and a 20Mb hard disk. While this is vast improvement on the early portables, it is not generous by

The T1000LE is about the size of an A4 sheet and will easily fit into the average briefcase.

today's standards and an alternative model should be considered by people needing greater processing power. The memory is upgradable to 9Mb, but this is likely to be more expensive than buying an alternative model with more memory built in.

One feature that is useful, is the power maintenance. Batteries recharge automatically when it is used from a mains socket, giving 2 hours per charge – 4 hours in total with the optional extra picture, more than enough for most meetings. When the keyboard is not in use, the screen fades automatically to save energy, but does not disappear – as some portable screens do, which can be quite disconcerting or even dangerous as it is easy to forget the document was there and switch it off.

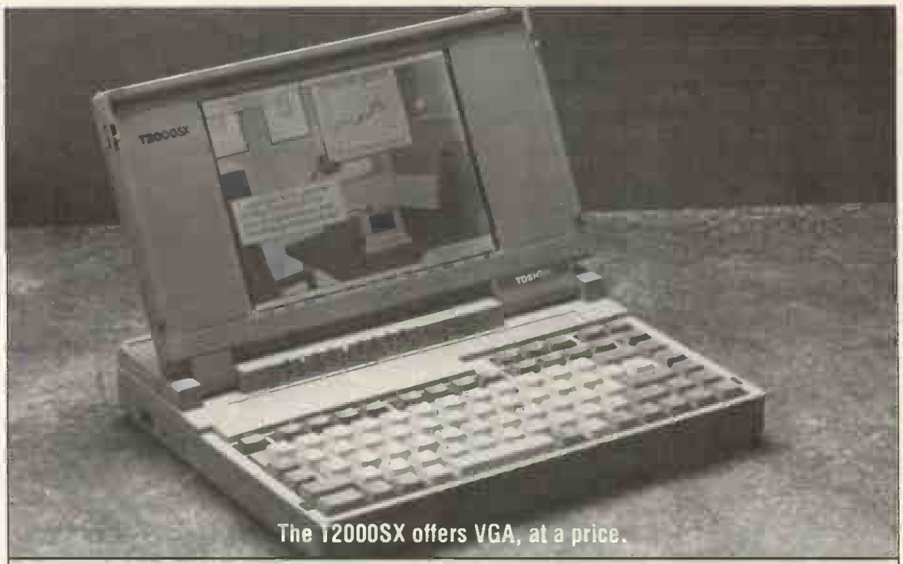
Also it is practically designed for travel. The power adapts itself to the local voltage and automatically switches from 100-240VAC. The international traveller, can also use the modem slot to link up to on-line information files.

Truly Portable

The Toshiba T1000LE is affordable and very useable. It doesn't offer the best value for money in that it doesn't have VGA screen compatibilty, nor much memory in the basic model. However, it does satisfy the needs of most notebook users – they are, after all, used to take notes when out of the office. It wouldn't replace a desktop computer and certainly not a Mac, but it is a useful and truly portable machine. And buyers probably do get some added value from the Toshiba quality of design. ■

Specifications

Processor	80C86 @9.54MHz
Memory	1Mb expandable to 9Mb
Hard disk	20Mb
Floppy disk	3.5in 1.44Mb/720kb
Display	640x400 LCD
Graphics adapter	CGA compatible
Keyboard	84 keys incl 12 function keys
Interfaces	25-pin Centronics, doubles as external floppy disk connector
Operating system	MS-DOS 3.3
Power Supply	Autosensing 100-240VAC
Battery	NiCd pack, lasts 2 hours per charge
Size	310x254x44mm
Weight	3kg

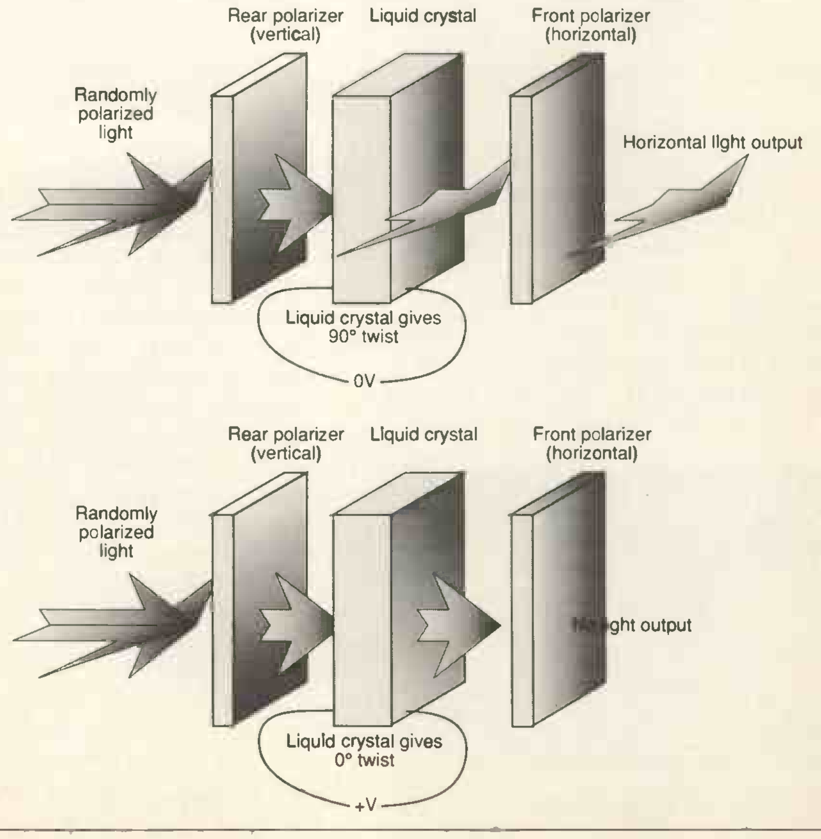


The T2000SX offers VGA, at a price.

LCDs

The technology that makes portable computers portable is the liquid crystal display. Its advantages are that is thin, light, requires low power and, recently, high resolution. The basic operation relies on the liquid crystal's ability to twist polarised light. The crystal itself is made up from long molecules that twist at right angles to the face of the display. When an electric charge is placed across the crystals the molecules untwist and allow the light through untwisted.

Randomly polarised light is passed through a vertical polarisor and then through the liquid crystal. When this twists the light through 90° a horizontal polarisation filter at the output allows it through. Putting a voltage across the crystal allows vertically polarised light through and the horizontal polarisor blocks it. In this way, pixels can be turned on and off under control of a microprocessor. By creating a matrix of LCD elements, each being individually addressable, a computer display can be created. The T1000LE display gets its randomly polarised light from the sides and uses a supertwist liquid crystal that rotates the light through multiples of 90°, the final amount being decided by the thickness of the crystal. This improves the contrast and widens the angle from which the screen can be seen.



A Closer Look At The Missing Link

The RS232C has been around for a long long time, longer than the microcomputer to which it has become an indispensible attachement. Gavin Moore explains.

Almost all micro-computers, printers, modems and terminals use RS232 and many people know it as one of the most frustrating things to wire up and get working.

RS232C was originally defined by the Electronic Industry Association as a standard way of linking terminals and other peripherals with computers. The definition only applies to the names and operations of the connection and the voltages used to send the signals. Any communications protocols are left up to the user and are the subject of other standards.

Making The Connection

The standard RS232 connector is the 25 way "D" and the signal names and functions for the various pins are shown in table 1. One source of confusion is the way in which the equipment at either end of the link is named. The Data Terminal Equipment (DTE) and Data Communications Equipment (DCE) were originally names for a terminal and a main computer respectively. The way to sort out which is which is simply to say that the equipment at "this" end is the DTE and the "other" end is the DCE. The main thing to remember is that the transmitter data and received data cannot run along the same wire so connecting the same pins to each other at each end will not work. The transmit from DTE must be connected to receive at DCE and vice versa. Unfortunately, almost all of the other signals apart from ground have non-standard uses and different manufacturers apply them in different ways. The simplest connection is shown in Fig. 1 and consists of three wires, transmit to receive at each end and the grounds connected together.

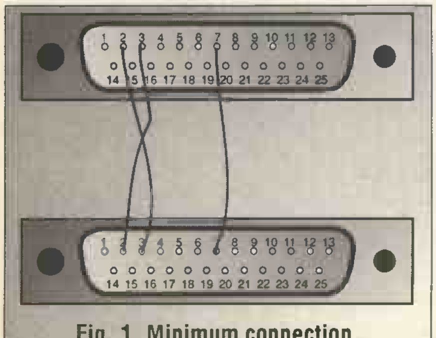


Fig. 1. Minimum connection.

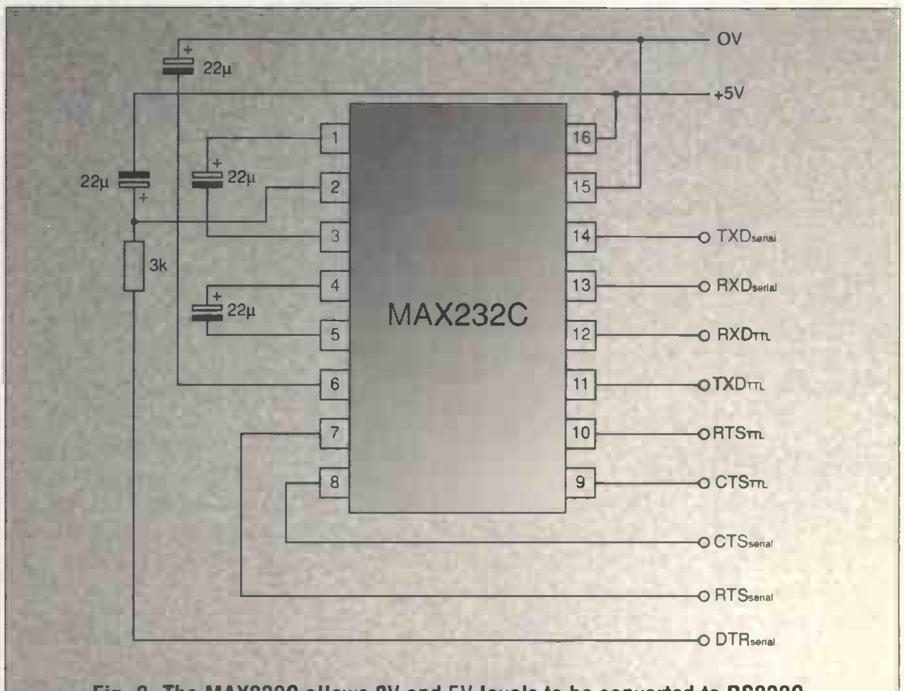


Fig. 2. The MAX232C allows 0V and 5V levels to be converted to RS232C.

Signal levels

Unlike the +5V and 0V common to other electronic communications systems, the RS232 uses negative voltage to define a one and a positive for a zero. These voltages is quite flexible and can be anywhere from ±3 to ±15 with ±12 being the norm. Since most electronic systems use TTL levels, conversion circuits are needed to interface to the correct voltages. A number of these, for example the MAX232C transmitter receiver which operates from a single +5V supply and incorporates a charge pump system to generate the negative voltages as required (Fig. 2).

There are two drawbacks to the RS232C standard. The first is that the theoretical distance over which it can be used reliably is about 15 meters. In practice however, it is possible to run up to 30 or 40 meters without too much trouble. The second problem is one of speed. The maximum data rate is about 20,000 bits per second – close

RS232C pin connections

Pin	Id	Name	Function
1	GND	Frame ground	Overall safety earth
2	TXD	Transmitted data	Data line out from DTE
3	RXD	Recieved data	Data line in from DCE
4	RTS	Request to send	Asserted by DTE when it wants to send data
5	CTS	Clear to send	Asserted by DCE when it has control of the link
6	DSR	Data set ready	Asserted by DCE when it is powered up and operating correctly
7	GND	Signal ground	The ground with which the data signals are referenced
8	DCD	Data carrier detect	Asserted by DCE when it is receiving a carrier over the link
9	NC	Reserved	
10	NC	Reserved	
11	NC	Unnassigned	
12	DCD2	Secondary data carrier detect	Same as DCD but for the second channel
13	CTS2	Secondary clear to send	Same as CTS but for the second channel.
14	TXD2	Secondary transmitted data	Same as TXD but for the second channel
15	TXC	Transmit clock	Used for synchronous communications, this signal comes from DTE and defines the data rate for the primary channel
16	RXD2	Secondary received data	Same as RXD but for the second channel
17	RXC	Receiver clock	As with the TXC, this is used for synchronous communications. However, it comes from the DCE.
18	NC	Unnasigned	
19	RTS2	Secondary request to send	Same as RTS but for the second channel
20	DTR	Data terminal ready	Asserted by the DTE when it is powered up and operating
21	SQD	Signal quality detect	Asserted by the DCE when the channel is okay
22	RI	Ring indicator	Asserted by the DCE when something on the channel is attempting to communicate with it.
23	DRS	Data rate select	Used to select the data rate of the DCE
24	ETC	External transmit clock	A transmitted data clock suppplied from DTE to DCE.
25	NC	Unnassigned	

to the standard rate of 19,200 which may sound fast but is actually rather slow. Again, the practice is a little different as it is quite possible to run up to 57,600 with few problems.

The Trouble With RS232

Connecting up a serial link is almost never as simple as it seems. Very occasionally it will work first time but usually an hour or so of fiddling, re-soldering and wire changing is needed. The best place to start is with the minimum connection (Fig. 1). If this doesn't work then one or both of the communications devices (computers, printers, modems and so on) probably think that nothing has been connected. The next step is to examine the CTS, RTS, DSR, DTR and, possibly, RI lines. One way to fool the system is to wire the signals back upon themselves so that, for example, a computer thinks it is on line when its DTR is connected to its CTS since the system at the other end of the wire might not have a DTR output. Another common scenario is to loop back RTS to CTS and connect DSR, DCD and DTR making the system think that any handshaking on the RTS, CTS lines is in progress and that the carrier is present and the remote system on-line when DTR is asserted. The rest of the link is a three wire system using TXD, RXD and GND (pin 7).

Because of the myriad of connecting possibilities, a few pieces of equipment can come in very handy. The first is a breakout box. This consists of a plug and socket, each of which is connected to a patch board. Any of the input connections can be wired to any of the output connections allowing guesses to be made to get the circuit working. It can either be made up from three 25 way D sockets and one plug as shown in Fig. 3 – two sockets are wired together pin for pin as are the other plug and socket. Once cased, it can be plugged into one piece of equipment and the cable plugged into the other side. Putting wires from one socket to the other allows the connection to be made up – note that it is not generally possible to "blow" the circuit by connecting outputs to outputs (+12 to -12) since the driving circuitry is usually protected against such happenings (on the other hand, it might not be so take care).

Another useful gadget is the gender bender. This is either two sockets or two plugs connected back to back and is useful in systems where the cable has a plug that needs to be a socket. Also available are loopback testers which route the signals directly back for test purposes (the breakout box can do this), the reverser which switches the transmit and receive lines over (swaps 2 for 3 and vice versa, also available from the breakout box) and various testers which have LEDs connected to the lines so that their states can be seen at a glance – this could be a minor modification of the breakout box using coloured LEDs, diodes and resistors to indicate the direction and polarity of the signals. ■

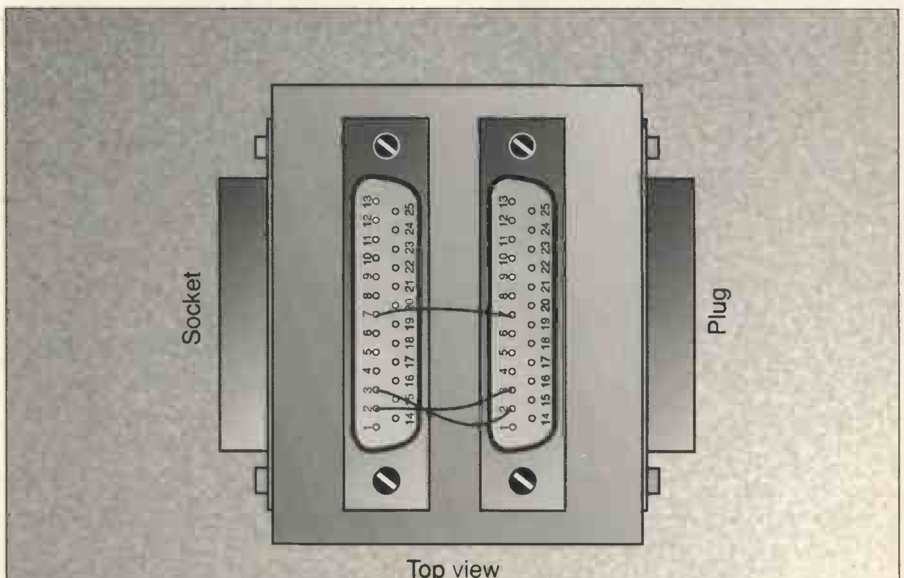


Fig. 3. A breakout box made up from three sockets and a plug.

Tripping The Light Fantastic

John Becker's latest gizmo will provide an astonishing light display that should find more uses than just art.

Light control units have more uses than mere entertainment. They also find applications in home security and mood setting. The Lux unit controls eight mains voltage lamps, each of which can be set to one of 32 brightness levels.

The brilliance of an AC powered lamp can be controlled by varying the point in the AC cycle at which it is switched on and off. Switching on early in the cycle results in a brighter light and late triggering dims it.

The switching is controlled by a triac which consists of two silicon controlled rectifiers (SCRs) connected in opposite directions. If a voltage is applied between the cathode and anode and the gate voltage is zero, no current will flow through the device. If the gate voltage is greater than a specific trigger level the current starts to flow. It continues to flow, even if the gate voltage is removed, until the anode voltage drops below a pre-determined level, at which point it stops. It will not flow again until the SCR is triggered again. Because of this a single SCR can be triggered into conducting only during one half of each AC cycle. Two back-to-back SCRs, or a triac, can be doubly triggered to conduct during both halves of the cycle.

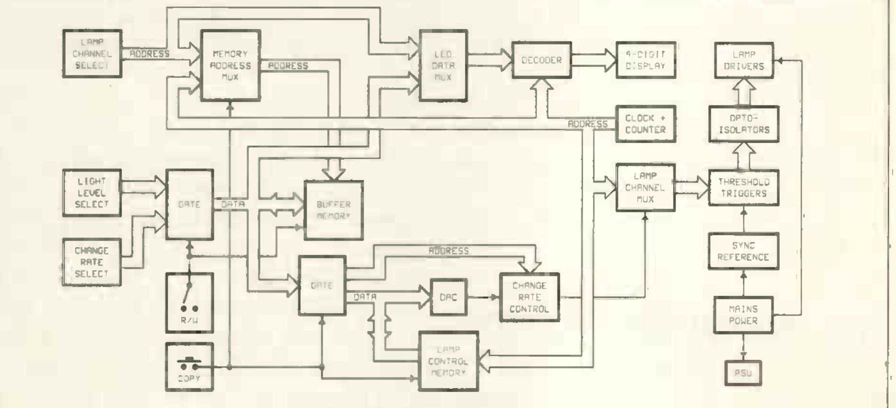


Fig. 1. Block diagram.

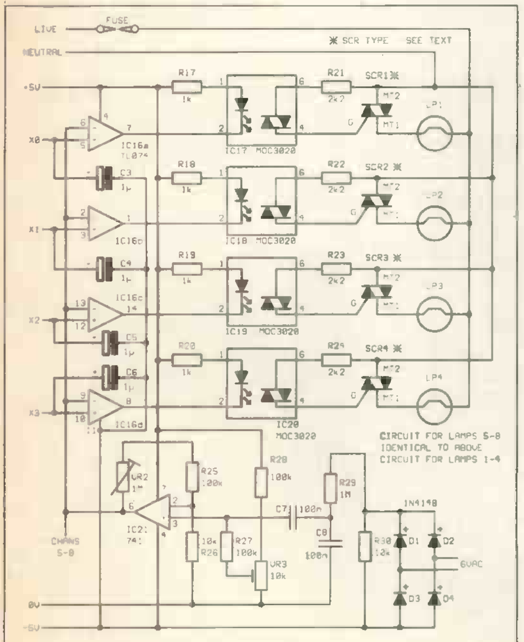


Fig. 2. Lamp driver circuit.

For this light controller, two triacs are used to control each lamp, as shown in Fig.2. Taking the control circuit for lamp LP1 for example, IC17 is an optically-isolated low current triac device with its gate under control of an internal LED. When the LED is turned on the triac conducts AC mains-derived pulses via R21 to the gate of the power triac SCR1 (even though they are triacs, they are referred to as SCRs).

The LED is controlled by the output of the comparator IC16a which in turn is controlled by the relative levels of a 100Hz signal on one input and a variable DC voltage on the other. R17 limits the current flowing through the LED. The 100Hz signal is generated by full-wave bridge rectification through D1-D4 of the 6VAC output from one of the PSU (power supply unit) transformer windings shown in Fig.7. The rectified output, schematically represented by the second waveform in Fig.3, is slightly delayed and smoothed by R29 and C8. Passing via C7, the resulting ripple voltage is amplified by IC21 and fed to the inverting inputs of all comparators. VR2 presets the amplitude gain and VR3 adjusts the basic DC bias level.

Each comparator's non-inverting input (X1, X2, etc.) is fed by a DC voltage at a level determined by the main logic control circuit. As the 100Hz signal sweeps up and down it crosses the reference levels on the non-inverting inputs of the comparators whose outputs are then triggered. By varying the reference levels, the comparators can be then triggered at different points of the mains-synchronised 100Hz waveform resulting in different lamp intensities. When changes to intensity are selected, the rate at which they are implemented is

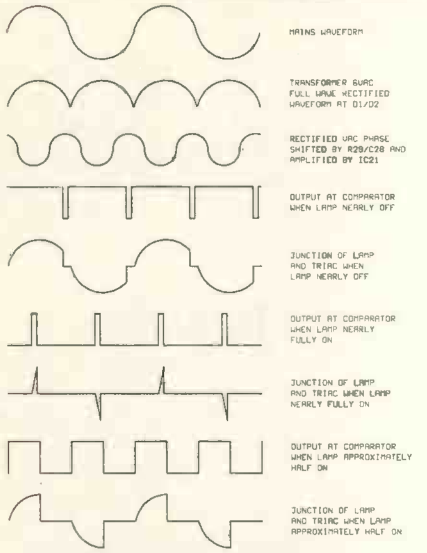


Fig. 3. Typical control waveforms.

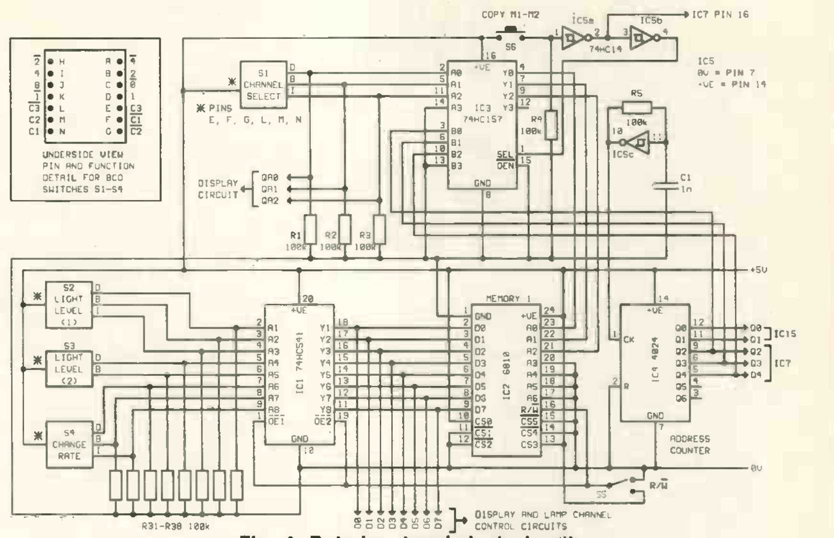


Fig. 4. Data input and clock circuit.

determined by the rate at which the capacitor (C3, C4, C5 etc.) charges or discharges via its chosen resistor path. This allows for lamp fade rates to be varied. Fig.3 shows the schematic representation of typical waveforms observed at the junction of a lamp and its triac relative to different trigger points. The lamp is on for the duration of the intermediate flat line portion (0V) of the relevant waveforms.

Setting The Codes

Binary coded decimal (BCD) switches are used to select the lamp channels and their intensities and rates of change, as shown in Fig.4. Only three of S1's four BCD outputs are used allowing any one of the eight channels to be selected.

The BCD number is passed via the multiplexed gate IC3 to become the address code for the buffer memory IC2. It is to here that intensity and change rate data is written prior to being copied into the main control memory. Two BCD switches, S2 and S3, are used to jointly select the intensity level. Unitary levels from 0 to 7 are selected by S2, and S3 selects decade levels from 0 to 3. Although it appears that non-linear decimal jumps occur from 07 to 10, 17 to 20 and 27 to 30, the control circuit sees the changes as linear binary progressions. The eight change rate factors are selected by BCD switch S4.

With S5 set for write mode, the 8-bit code generated by S2-S4 is gated via IC1's A0-A2 to Y0-Y2 paths to the data inputs of the buffer memory IC2. This records the intensity and change rate data as a single byte at the location addressed by S1. Switching S5 to read mode sets IC1 outputs to high impedance, preventing any further changes of S2-S4 from reaching IC2. S1, however, is still effective and the memory can be switched through each of the eight addresses enabling the stored data to be monitored on the LED display.

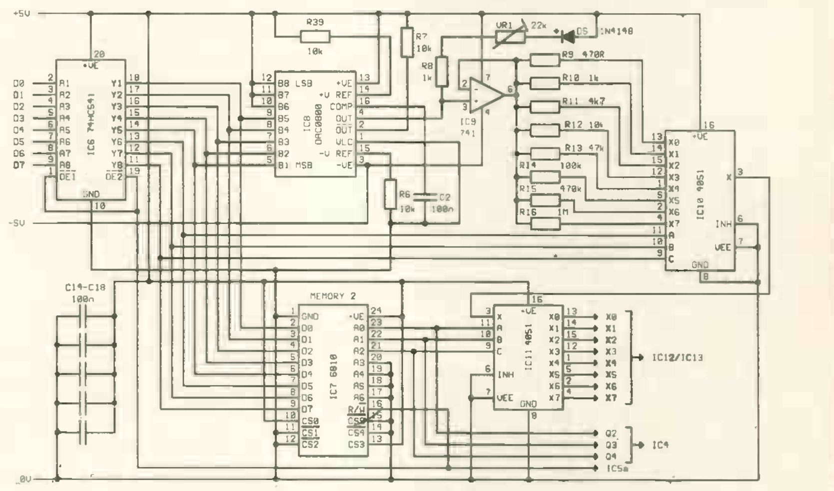


Fig. 5. Principal memory and output control circuit.

The Master Memory

Transfer of the buffer memory contents to the control memory is initiated by pressing S6 while S5 is in read mode. This takes the input

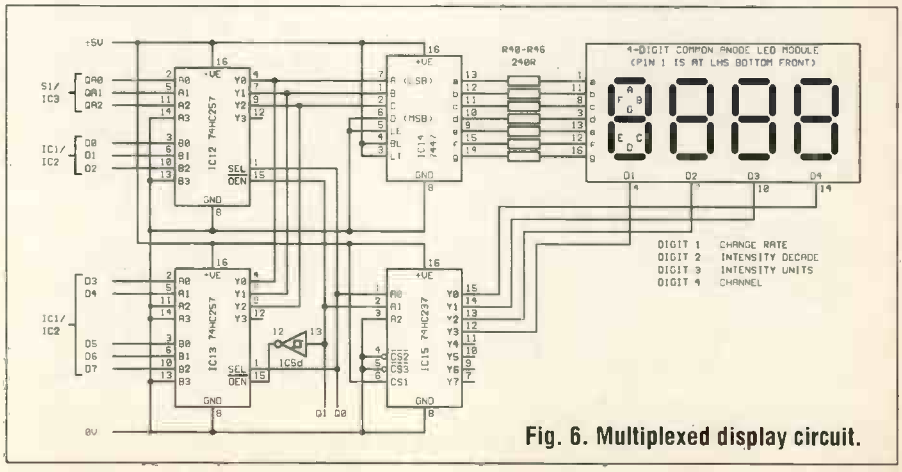


Fig. 6. Multiplexed display circuit.

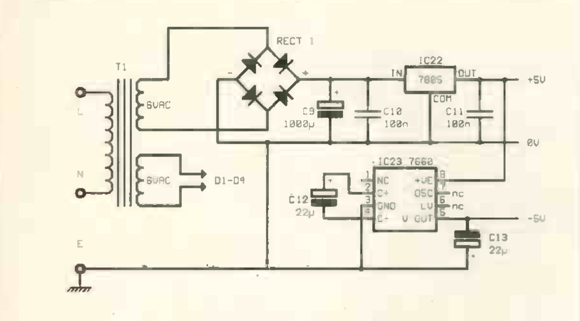


Fig. 7. Power supply circuit.

to IC5a high, forcing its inverting output low, setting memory IC7 in Fig.5 into write mode. The same level also opens gate IC6, coupling the data ports of IC2 to those of IC7. Simultaneously, IC5b inverts the output of IC5a causing IC3 to route paths B0-B2 to outputs Y0-Y2. These paths connect the Q2-Q4 outputs of binary counter IC4 to the A0-A2 address inputs of IC2. The counter is triggered by the clock generator formed around IC5c at the fixed rate set by R5 and C1. The same three counter outputs are also connected to address inputs A0-A2 of IC7 allowing IC2's contents to be copied synchronously. When S6 is released, IC3, IC6, and IC7 revert to their previous states.

Data lines D0-D4 of IC7, holding the lamp intensity factors, are also connected to the digital to analogue converter (DAC) IC8. Only the upper five data inputs of IC8 are actively used (B1-B5). The lowest three, B6-B8, are tied to the +5V line. This input combination maximises the DC output step level per bit while also providing an initial output bias level. IC6 has two current-related reference inputs which are tied to their respective logic levels by R6 and R39. The DAC's two differential output voltages are also current related. The inverse output voltage swing is governed by R7, while the non-inverse swing is a function of R8, VR1 and D5 in series. Only the latter output voltage is used to control the lamps. It is buffered by IC9 and fed equally via R9-R16 to the inputs of the 8-channel bidirectional analogue multiplexer IC10. Input to output routing selection is determined by the address code on pins 9-11. The code is set by the logic on IC7 data lines D5-D7 which hold the change rate factors. The output of IC10 is taken to IC11, a second 8-channel analogue multiplexer, which is used in the opposite direction to distribute the input level to any one of eight outputs. IC11's route controlling code corresponds to the lamp channel address supplied by outputs Q2-Q4 of counter IC4.

The counter continually cycles IC7 and IC11 through all eight addresses, routing the respective analogue voltages produced by the DAC to the correct lamp channels. Simultaneously, IC10 is addressed by the memory to route the voltage via the selected resistance path. Each output from IC11 is connected to a separate comparator, as seen in Fig.2. The rate at which the charge on the comparator's input capacitor will vary to match changes in channel control voltages is determined by the resistor value switched in by IC10. Since the clocked cycle rate is moderately high and the comparators have FET (field effect transistor) inputs, capacitor leakage between cycles is negligible.

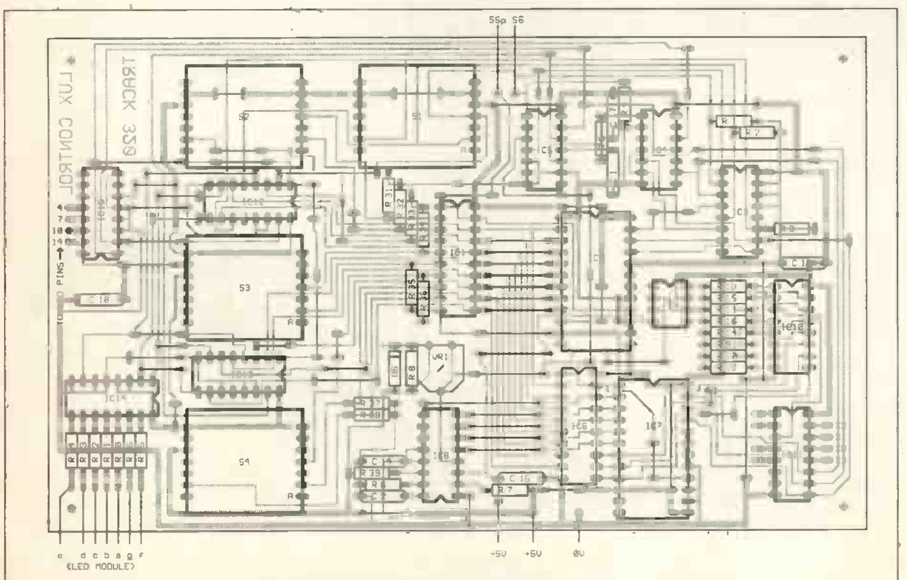


Fig. 8. Control board component layout.

Seeing The Light

Fig.6 shows the circuit which controls the channel data readout. Data is first split into four separate blocks, each relating to one display digit, by the two data selectors IC12 and IC13. Data is routed either along the A-Y or B-Y paths, depending on the logic level on pin 1. Channel address data is fed directly from S1 to IC12. Intensity and change rate data comes from the data lines connecting IC1 and IC2, allowing immediate switch values or recorded data values from IC2 to be displayed, depending on the read/write mode selected by S5. The Q0 and Q1 outputs of IC4 control the enabling and path selection of IC12 and IC13. Both have their path routings selected in tandem by the toggling of Q0. Their respective output enabling via pin 15, however, is alternated as a result of inverting the phase of the controlling Q1 signal via IC5d.

BCD data from the selected IC12/IC13 path is split by the open-collector decoder IC14 into seven segment-control lines. Within the multiplexed 4-digit display, the segment lines are jointly fed to each common-anode digit, which is also controlled by its own separate power line. IC15 supplies power to each of the digits in turn and its routing is synchronised with the IC12/IC13 path selection, using IC4's Q0 and Q1 outputs to set the appropriate Y0-Y3 output. The selection rate is fast enough to allow the digits to appear as though they are all active at the same time. Current through the segments is limited by R40-R46 whose values have been chosen to allow satisfactory brilliance while keeping the maximum current through IC14 and IC15 within bounds.

Going Live

The power supply control circuit is shown in Fig.7. It has a standard full wave bridge rectifying circuit

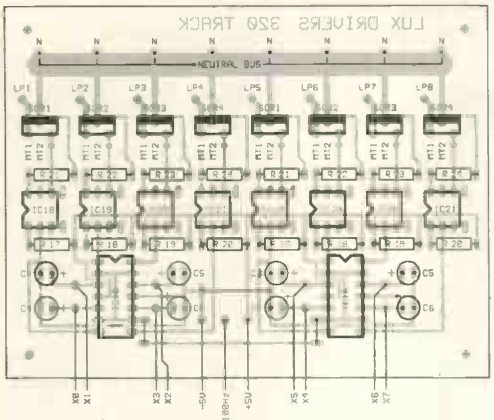


Fig. 9. Lamp driver board component layout.

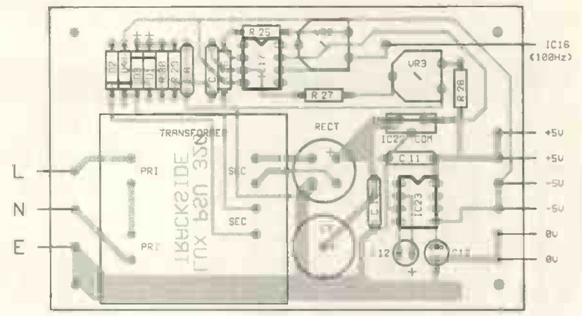


Fig. 10. Power supply board component layout.

followed by the +5V regulator IC22. IC23 is a DC voltage inverting chip, converting the positive supply to -5V.

Figs 8-13 show the PCB component and track layout details. Note that some of the link wires shown on the main PCB go under the ICs and switches so put them in first. DIL sockets should be used for all ICs.

Check out the PSU board first, making sure that no undesirable contact is made with the mains power connections, and that the DC outputs are at the correct voltages. Next check the control PCB by connecting it to the PSU and LED display but not to the lamp driver board. Establish that the switches perform the functions intended by observing the LED display and monitoring pin 6 of IC9 with a DC voltmeter. Adjust VR1 so that with S2 and S3 set to zero, IC9 produces an output voltage at or just above 0V. The maximum output voltage obtainable at the highest S2/S3 setting is approximately 4.4V, as limited by the inclusion of D5. Do not allow the minimum voltage set by VR1 to fall below -0.5V. Monitor the outputs of IC10 and IC11 at various settings of all switches, checking the correctness of output voltages. Be aware, though, that the resistance of the meter used will impose a load on the R9-R16 paths, possibly resulting in diminished voltage readings.

Connect up the lamp driver board, but do not yet connect it to the lamps or mains supply. Monitor the outputs of the comparators while, if possible, monitoring their inputs as well. With S4 at minimum setting, turn VR3's wiper to the 0V

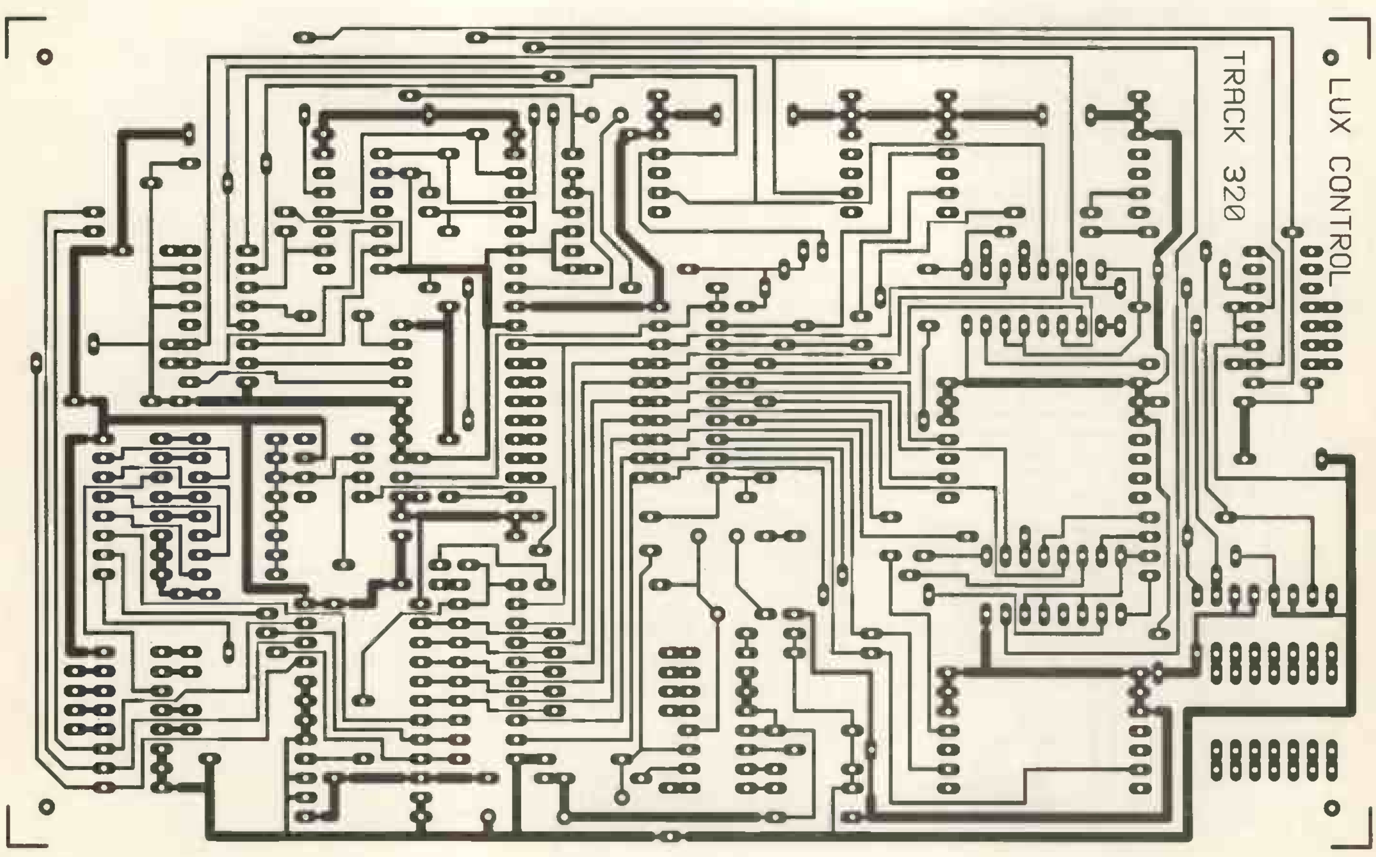


Fig. 11. Control PCB layout.

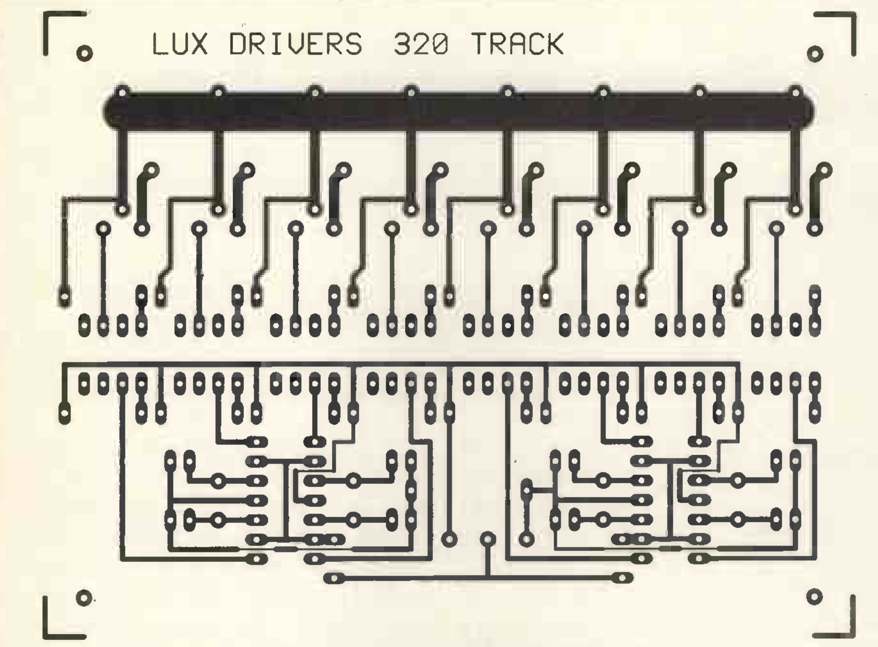


Fig. 12. Lamp driver PCB track layout.

end of its track and increase the gain controlling preset VR2 from zero resistance upwards until the monitored comparator output causes the meter needle to flicker at all settings of S2 and S3. (Close observation of the meter needle will be required since the comparator is being triggered at 100Hz.) Back off VR2 slightly until the flicker just ceases at extreme settings of the switches. If necessary, correct IC21's DC input bias by adjusting VR3 in order to linearise the 100Hz output swing. If an oscilloscope is used, the best settings of all presets can be more readily observed. Final adjustments can be done once the lamps are connected. The aim is to have the respective lamps just fully off and just fully on with S2/S3 set for levels 0 and 37 (LED readout figures).

When programming lamp control data, S2-S4 must all be switched to the required settings since all eight memory data lines are opened as inputs in the write mode. For S2-S4 changes to be acted upon immediately by all lamps, irrespective of the setting of S1, the buffer memory may (in effect) be bypassed by switching S5 to write mode and keeping S6 pressed.

Triacs rated at 3.5 amps were used in the test model. Controlling 150 watt lamps, no heat sinking of the triacs was necessary. Heat sinking may be required, however, if different triacs or lamp wattages are used. Ensure that the triacs are electrically isolated from the heat sinks, and also that they are correctly orientated on the PCB (pin configurations vary between types). Information on general heat sinking requirements can be found in the Heat Sink article in PE Feb 1988. Additionally note that it is preferable to bring the neutral line from each lamp back to the controller board to minimise the loading on the PCB track.

When working on or using the unit, it is imperative that strict attention be paid to mains safety. The unit, its case and the lamp housings must be earthed. Preferably use separate fuses for each lamp, plus one to protect the mains cable supplying the unit's PSU. A 1A fuse is adequate for the latter, the other fuses should have ratings suited to the lamp wattages. If you are in any doubt about the correctness of your mains wiring or fuse selection seek assistance from a qualified electrician. ■

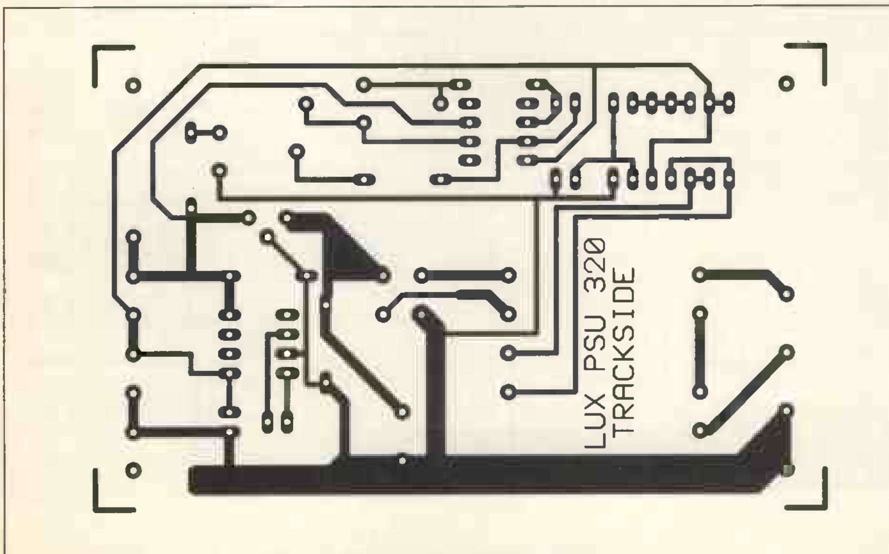


Fig. 13. Power supply PCB track layout.

COMPONENTS

R1-R5, R14, R25, R27, R28, R31-R38	100k
R6-R8, R12, R26, R30, R39	10k
R9	470R
R10, R17-R20	1k
R11	4k7
R13	47k
R15	470k
R16, R29	1M
R21-R24	2k2
R40-R46	240R
All 0.25W 5% carbon film	
CAPACITORS	
C1	1n polystyrene
C2, C7, C8, C10, C11, C14-C18	100n polyester
C3-C6	1µ 16V electrolytic
C9	1000µ 16V electrolytic
C12, C13	22µ 16V electrolytic
SEMICONDUCTORS	
D1-D5	1N4148
IC1, IC6	74HC541
IC2, IC7	6810
IC3	74HC157
IC4	4024
IC5	74HC14
IC8	DAC0800
IC9, IC21	741
IC10, IC11	4051
IC12, IC13	74HC257
IC14	7447
IC15	74HC237
IC16	TL084
IC17-IC20	MOC3020
IC22	7805
IC23	ICL7660
RECT1	50V 1A bridge rectifier
SCR1-SCR4	Triac (see text)
POTENTIOMETERS	
VR1	22k min horiz preset
VR2	1M min horiz preset
VR3	10k min horiz preset
SWITCHES	
S1-S4	PCB mounting BCD
S5	SPDT min toggle
S6	SP push-make

OIL IC SOCKETS
8 x 6-pin, 3 x 8-pin, 4 x 14-pin, 8 x 16-pin, 2 x 20-pin, 2 x 24-pin.

MISCELLANEOUS
4-digit common anode 7-segment LED display module, knobs x 4, PCB mounting mains transformer with two 6V 0.5A secondary windings, printed circuit boards, PCB supports x 12, case, lamps and fuses to suit.

Techniques

Andrew Armstrong comes up with the goods on ultrasonic humidity controllers.

Two months ago I started to answer a question from Mr Beal about electronic humidifiers and humidity controllers. After some thought and investigation, I believe I have a good solution to his problem.

He has provided me with further information about the greenhouses, including the important facts that the intended RH is 70%, with a temperature of 18°C at night and 21°C during the day. I had considered suggesting the use of heated evaporators to humidify the air, using the normal heating to supply the heat, and using a humidistat to control the supply of water. This idea is unlikely to work under the stated conditions, however, not least because the heat provided by sunlight will eliminate the need for heating altogether on some days.

Under the stated operating conditions, an ultrasonic humidifier is probably the most effective choice. A general scheme employing ultrasonic humidifiers is shown in Fig. 1. The water supply passes through a reverse osmosis plant, so it is sufficiently pure not to cause any problems. No sub-micron dust will be generated, and the humidifier itself will not scale up.

Air is blown through the system to distribute the water vapour, and incoming air is filtered to avoid filling the humidifier with dust too rapidly.

Ultrasonic humidifiers work best with a specified level of water covering the transducer, so the water level in the tank is regulated by a float switch controlling a solenoid valve on the water inlet. This gives more accurate control than a simple ball valve, and will maintain efficient operation.

Ultrasonic transducers can crack if they are energised in the absence of water so, should there be any likelihood of the system accidentally being run without a water supply, it may be advisable to incorporate a timer circuit to switch off the humidifiers if the water level falls below the float switch for any length of time.

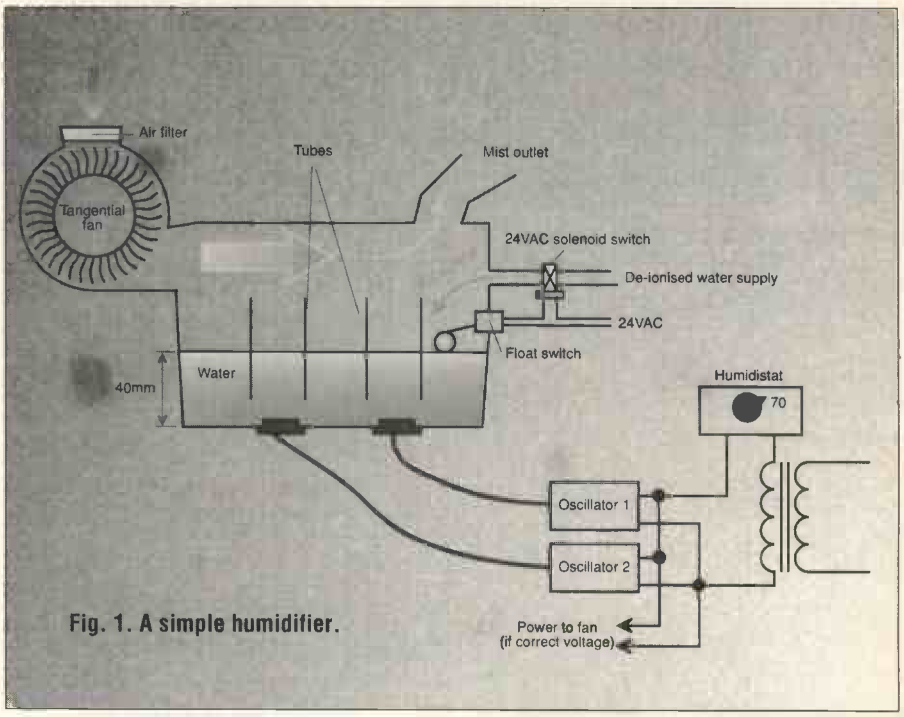


Fig. 1. A simple humidifier.

Nebulisers

The heart of the system is, of course, that part which vapourises the water, referred to as the nebuliser. This consists of a driving oscillator and a transducer, connected by a length of screened cable, or built as one module. A typical circuit of an oscillator is shown in Fig. 2. It uses the piezo-electric transducer as the frequency-determining element, and is powered by unsmoothed rectified dc. This is a low cost design, and it requires screening to avoid radiating interference.

The circuit is a simple oscillator with feedback from the midpoint of a series tuned circuit to the base via C6. The series tuned circuit, formed by L4 and C7, ensures that the resonator works at the correct frequency rather than at a harmonic. It also provides the necessary impedance transformation to give a loop gain of greater than unity. It is in the nature of a series tuned circuit that the voltage at the midpoint will be greater than that at the driving point, at frequencies near resonance. The impedance at the midpoint is, of course higher but this does not matter.

The emitter of Q1 drives high current into the low impedance of a tuned circuit, and the base, which has a higher impedance, receives a higher voltage drive signal. This same higher voltage signal is fed to the transducer, where most of the power goes to vapourise the water.

The power transistor, Q1, should have a breakdown voltage of at least 100V, a collector current rating of at least 3A, and a ft of at least 5MHz.

It is probably more practical to buy ready made nebulisers than to build them from scratch. The most expensive single item is the transducer, which should be definitely bought for the purpose: transducers for nebuliser use are supplied in a waterproof housing which is specifically designed to

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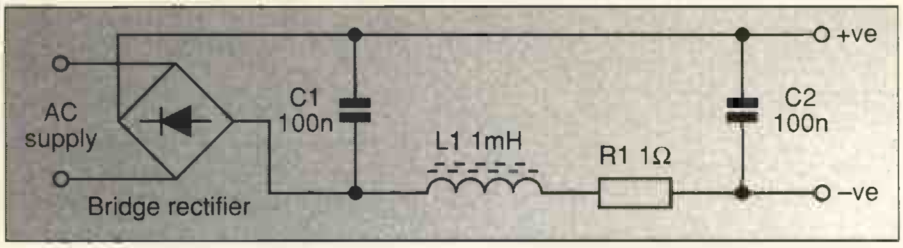


permit the transducer to be fitted to the bottom of the tank without leaks.

To maximise power transfer to the water, the face of the transducer should be angled at approximately 7 degrees to the horizontal, which is taken care of by the design of the housing. The depth of water above the transducer should be approximately 40mm (+5mm).

TDK make suitable nebulisers, but told me that they only supply in very large quantities. Their distributor, Regisbrook (0235 534909) may be able to supply the smaller quantities required. Failing this, they may at least be able to supply transducers, in which case it will be necessary to make oscillators for the circuit given here, and perhaps to experiment a little to achieve the best performance.

The TDK units are built in die cast heatsink cases which provide screening and heatsinking. It is necessary to build them, diecast boxes with extra heatsinks added. To minimise radiated interference, it would be best to feed in the power via feedthrough capacitors and to use, for example, a phono connector to feed the signal to the transducer.

Controller

A suitable humidistat can be constructed with very little trouble. Fig 3 shows a suitable design, using the Mullard sensor type 2322 691 90001 as mentioned in the first part of this project. The capacitance of this sensor depends on humidity, being 122pF +15% at 43%RH, and changing capacitance by 0.4pF +0.05pF/%RH. This gives typical figures of 117pF at 30%RH and 141pF at 90%RH, a suitable maximum range for a humidistat.

This design works on the principle of charge transfer. The humidity sensor capacitance is charged up to 5V, and then discharged into C9 at the oscillator frequency set by R14 and C10, which is approximately 70kHz. So long as IC1b is within its linear range, its inverting input remains very close to 0V, so that the capacitance of the sensor is fully discharged.

The effect of all this is to feed a small current into the inverting input of IC1b. A small negative current is also fed in, by transferring charge via C6. This capacitor is charged in one direction and then connected to the inverting input of IC1b in the reverse direction.

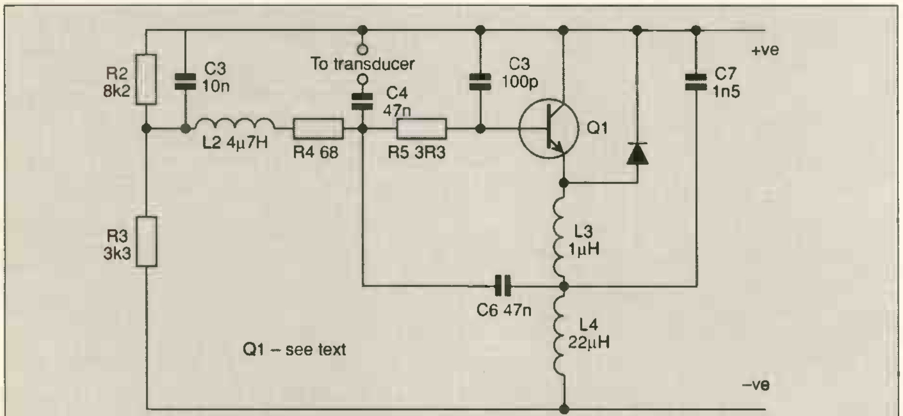


Fig. 2. Piezo crystal oscillator circuit.

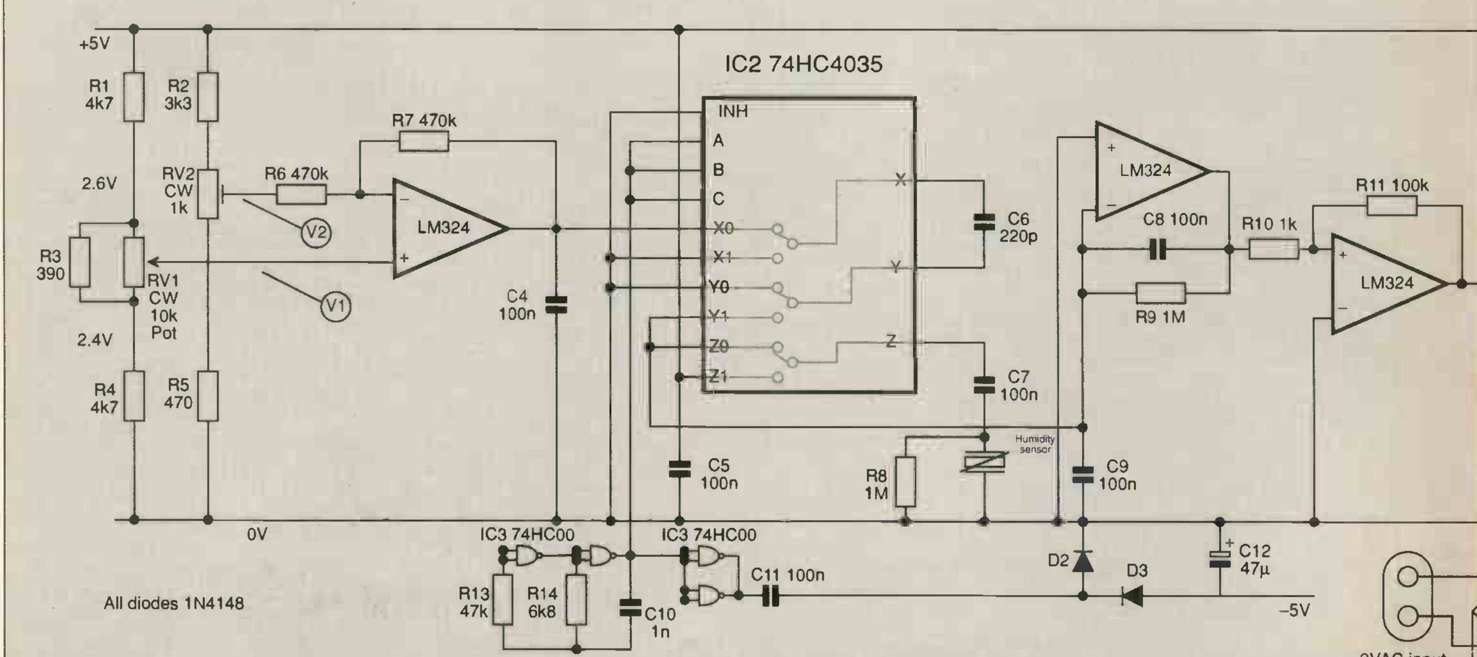


Fig. 3. Humidifier control circuit.

C6 has a higher capacitance than the highest value which the RH sensor can have, so that the negative and positive currents fed to the inverting input of IC1b will balance if C6 is charged to a lower voltage than that to which the humidity sensor is charged. For a completely nominal sensor, the voltages to charge C6 to balance the currents are: 2.66V for 30%RH and 3.19V for 90%RH.

The required charging voltage is provided by IC1a, whose output voltage is

Vout = (V1-V2) * 2

V1 is varied to adjust the setpoint of the humidistat, while V2 is adjusted to calibrate it.

The net effect of all this is that the output of IC1b is 0V when the setpoint exactly matches the RH. If the RH is too low, then the output of IC1b is positive, and if it is too high the output is negative. The output voltage variation with RH is calculated as follows:

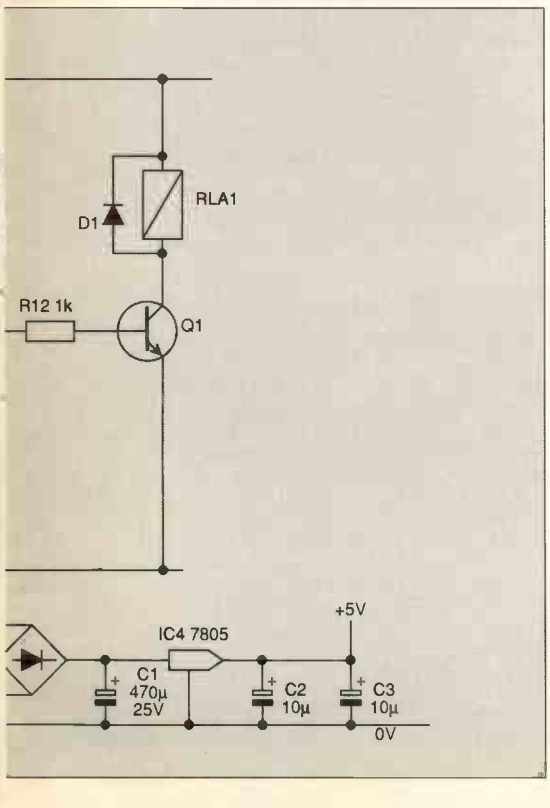
Extra charge transfer/%RH = 5V * 0.4pF = 2E-12C

Rate of charge transfer = 70E3 * 2E-12 per second = 0.14μA

Therefore output voltage change per %RH = 0.14μA * 1Mn = 0.14V

The hysteresis of the following comparator is approximately 160mV (because the outputs cannot swing very close to the supply rails), so a change of under 2%RH will cause the output relay to switch.

The interesting thing about this design is that variations in oscillator frequency or in power supply voltage will not affect the calibration, but will only affect the hysteresis.



Calibration

Ideally, one should calibrate the humidistat by using sealed containers at accurately controlled temperatures containing specified salt solutions. In practice, it would probably be acceptable to adjust the calibration potentiometer until the control pot causes the output to switch at approximately its mid-position, then install the humidistat and adjust until the humidity level is adequate.

This humidistat design has not been tested as it stands, but it is a variation on circuitry which I have used and which has proved dependable.

All the elements required for a humidification system have been shown here, in greater or lesser detail, and will work if applied intelligently. However, some filling in of detail and experiment will be required to make all the parts work properly together.

Battery Monitor

Occasionally I use a microphone in conjunction with an active balanced line driver to give clear sound when used a long way from the pa system. The battery lasts a long time, and tends to fail in use when I least expect it. Is there a design for a battery voltage warning system that will not take more current than it is worth?

Mr M Percival
Stoke Bishop,
Bristol

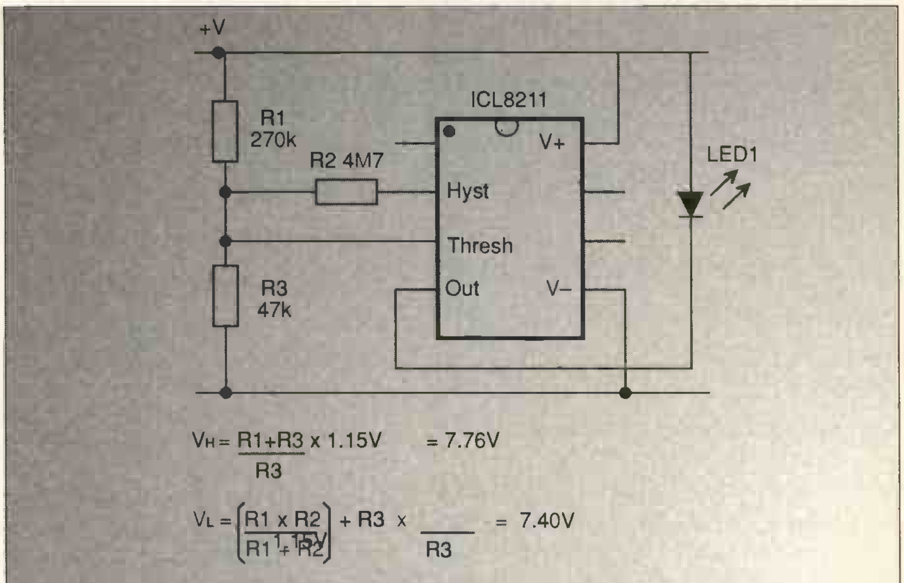


Fig. 4. Battery voltage warning system.

Yes there is. This is a problem I encountered in a similar situation, and the answer, shown in Fig. 4, has proved reliable for several years. The IC it uses, the ICL8211, is specifically designed for this purpose. It has a very low quiescent current consumption, so that almost all the current flow is through the divider chain (R1 and R3).

The ICL8211 switches on its output, sinking a current limited 7mA, if the voltage on the threshold terminal falls below the internal reference voltage (1.15V). An optional hysteresis output can be used to ensure clean switching.

The ICL8211 will work with as little as 6μA reference current, but higher accuracy can be achieved by using a higher current. The values shown in Fig 1 give a reference current of 1.15V/R3 = 24μA at the switching point. This should not add significantly to the battery load, and will give excellent accuracy.

The component values shown in Fig. 4 are suitable for a 9V battery supply, though the switching voltage might be slightly higher than is necessary. Other voltages can be calculated using the formulae supplied. ■

PRACTICAL
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What happened to Britain's lead in world technology? PE keeps on asking...

1966
The most interesting thing about looking back over the past issues of PE is seeing what the editor wrote (or sometimes ranted) about in his editorial. 25 years ago this month the subject was investment for the future and in particular, the space program. It seems that at this time, Britain and Europe were very interested in getting things into space. Unfortunately, it was becoming apparent that competing with the USA and USSR was going to be difficult both in terms of money and, as it turned out, political will. Worries about the "brain drain" were beginning to surface and there were calls for the government to do something. Remember, this was back in 1966 and history repeated itself in the seventies. With the current trend in financial cuts in the scientific arena, it looks as though it could all happen again.

1976
Ten years later it seemed that all was going reasonably well, as far as the editor Fred Bennet was concerned. The editorial observed the current Transatlantic race and the "236ft" collossus Club Mediterranée which was being taken across the Atlantic single handed. On board were all sorts of electronic goodies for the skipper: closed circuit TV for monitoring the sail positions, satellite navigation, radar, a radio weather map machine and visaibility warning devices. The ship was more a statement of the marriage of modern technology with that cheap renewable power source, the wind, than an entry in the race. It seems that fifteen years later, people are still making similar statements – with just as much effect.

1986
10 years on again saw an editorial that was decrying the current state of the educational system and its funding. The UK, having one been at the forefront of modern innovation and technology, was falling further and further behind. Electronics and its assciated technology was becoming a very important feature of everyday life. The editorial (by new editor Richard Barron) noted the complete lack of interest and understanding by most people in something that affected them daily. A MORI poll published at the bottom of the piece stated that "the most attractive applications of new technology are cordless and video telephone. Facsimile machines and word processors have much less appeal". Some of these are now taken for granted, though the video telephone is still nowhere to be seen. Perhaps if the populus were more educated? ■

Some Books To Begin With

This month's book reviews take a look at some new books that introduce the subjects of electronics and radio.

Aimed at the aspiring electronic technician, this book covers a lot of the basic coursework information needed for a City and Guilds Institute Course No. 224 in Electronics Servicing plus the equivalent BTEC course. It could also be used as a basic electronics introduction for anyone interested in the subject.

Starting off with an overview of the industry, a look at company structures, ensuing chapters cover safety at work, basic graphing methods and electrical units. They then get down to actual circuits,their construction and how to design practical printed circuit boards including soldering, various tools and some basic ideas about troubleshooting. All of this is kept at the basic level but serves as a good grounding in the ideas involved.

The chapter on amplifiers and oscillators uses real circuits to illustrate gain, buffering and the phase locked loop. The theory then takes a turn away from the practical and describes the operation of radio, modulation and sidebands for both AM and FM. The next few chapters looks at power sources including batteries, electromagnetism and its use in generators. Two odd chapters crop up at this point which are not really about electronics at all as they examine some basic principles of physics, light and sound waves. Binary numbers and logic, bring the subject back to the main stream with simple gates and truth tables. The final chapter takes a quick tour through a selection of common electronic systems from oscilloscopes and TV, to computers and tape recorders.

Volume 2, Part 1

By the same authors, volume 2, part one of this series continues where the first left off. It is a more technical book and expects quite a bit more knowledge from the reader. Beginning with a fairly comprehensive section on taking measurements from electronic circuits, it describes in detail, the operation of the basic semiconductor elements, the diode and transistor with a glance at integrated circuits. A wide selection of amplifier circuits are examined along with detailed descriptions of oscillator circuits.

Later chapters look at transfomers, transducers digital circuits and displays, basic microprocessors and computer hardware such as disk drives.

Both books are obviously written to be teaching works and supply a set of questions on each chapter (the answers being given at the back of the book). Together they form a good introduction to the subject of electronics and when accompanied by some practical work should enable the reader to gain a good basic working knowledge of the subject.

Servicing Electronic Systems
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Volume 2, part 1
Ian R Sinclair & Geffrey E Lewis
Avebury Technical
The Academic Publishing Group
Gower House
Croft Road
Aldershot
Hants
GU11 3HR
ISBN 1 85627 171 X
£9.95 and £11.95 respectively

On The Air

Amateur radio formed the basis for the development of the infant electronics industry back in 1905 when the first license was issued. Amateur Radio For Beginners seeks to increase interest in the subject among younger readers. Packed with photographs and illustrations of everything from the space shuttle to building a simple receiver, the book is perfect for the beginner.

After introducing the basic ideas, the author looks at how to get started either by buying a radio set or DIYing it and constructing a receiver from scratch – this includes full explanations about soldering, winding coils and what to do if it doesn't work.

The next few chapters describe how to go about obtaining a shortwave receiver. A few do's and don't are included here along with some good advice on where to look for a bargain.

If simply listening to other people on the air becomes boring, the book supplies full instructions on how to go about getting an amateur radio license. A complete glossary of terms is included as are details about call signs, QSL cards and morse code. It's the ideal present for someone looking for a new hobby.

Amateur Radio For Beginners
Victor Brand
Radio Society Of Great Britain
Cranbourne Road
Potters Bar
Herts.
EN63JE
ISBN 1 872309 06 2
Price £3.50

Compact Disks Information For All?

Barry Fox switches on his CD-ROM player and considers whether it is all too much trouble or whether it is going to be an essential tool.

Suddenly the more popular media are discovering multimedia. The fact that a 12 cm CD can store over 600 MBytes of data, equivalent to 600 million keystrokes on a typewriter, makes good gee whiz copy.

We are promised a new age of publishing, with a bookshelf of reference tomes, newspapers and encyclopaedias, all on a single disk – the same unit plays audio CDs, too.

The "domestic" systems have grown out of CD-ROM computer systems. Anyone who says that setting up and using a CD-ROM system is easy, has never tried it. Individual disks need "installing", like computer software. You get the system working for one disk and then other disks won't play. Or other programs, like a wordprocessing package, stop working. Some of the newspaper collection disks are not even indexed by topic, which makes them well nigh useless for research.

Pop-in And Play

The new domestic systems, Commodore's CDTV, and the rival CD-I from Philips, Sony and Matsushita, work on the "buy-and-play" principle. You buy the player, plug it into a monitor or TV set, pop in a disk, and play it. The player plays CD audio disks, too.

Now think about the practicalities. CDTV follows a policy now established for CD-ROM. The disk must be loaded into a protective caddy before loading into the player. Whereas CD Audio players have a tray which opens to take the disk, modern CD-ROM units and CDTV players have a

postage slot for a caddy. To play an audio disk on a CDTV player you have to take it out of its jewel box, put it in a caddy and post the caddy into the player. Afterwards you eject the caddy, take out the disk and put it pack in its jewel box.

Multimedia

CD ROM caddies, if you can find someone who sells them, cost 8 or 9 pounds each. They are far too expensive to use on a one-per-disk basis. In the real world people will not use a caddy system to play audio disks.

I also suspect that in the real world people will not use a multimedia system as an information sorce. Well would you switch on a player, switch on the Hi-Fi, switch on the TV set, take a disk out of its jewel box, put it in a caddy, post the caddy, start the program running and search out the information, when the same information is available from a book on the shelf?

BT's Phone Disk

I have knocked British Telecom a lot over the last year (and before that was knocking Mercury) so it is nice to be able to say something nice about BT technology. I am talking about Phone Disk, the CD-ROM which stores all the telephone numbers in the UK for search acceses.

Never mind that installing Phone Disk is a pain. The installation procedure tramples clumsily on existing PC configuration set ups. The inadequate manual does not clearly explain how to speed up searching by copying some files from CD ROM to hard disk. Every user has to registered and given a password. You need a new password to use the disk on another computer. Fortunately, help is at hand.

Paying The Price

The people on the Phone Disk Help Line know their stuff and really can help. Once running, Phone Disk is an incredibly powerful business tool. No large company switchboard should be without one. And in most uses will never use their system to play another disk. It is what the industry calls an "vertical" application.

But Phone Disk costs a blistering £2,200 for the four disks a year BT is producing. There were plans to make Phone Disk available on CDTV but BT's pricing policy knocked that on the head.

Of course, in the real world most people would not bother to fire up a CDTV system just to look up one telephone number. ■

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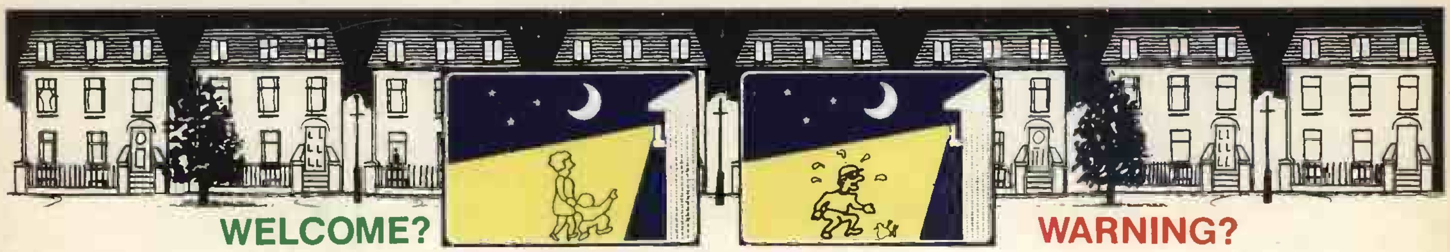
TEXAS	●	●	●	●	●	●	£5.99	£59.99
ARGOS	●	●	●	●	●	●	Not supplied	£46.99
PAYLESS	●	●	●	●	●	●	£7.59	£74.99
B&Q	●	●	●	●	●	●	£3.95	£79.99
MAPLIN	●	●	●	●	●		£3.75	£29.95

(Survey conducted on 21st February 1991)



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