AN ARGUS SPECIALIST PUBLICATION
JULY 1984

Hobby Electronics

Project Electronics For Everyone

90p

SOFT OPTIONS

Computers on Television...

Entertainment or Education?

Easy Projects

Car Map Light Dimmer

Positive/Negative Reading DC Voltmeter

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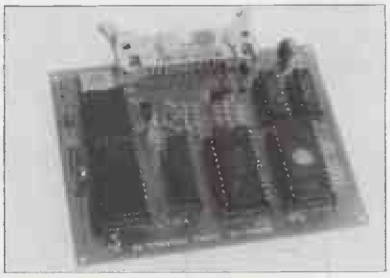

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				1-9	10-49
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Semiconductors

Linear IC's

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LM308CN	DIL version	61-03081	0.65
LM311CN	Popular comparator	61-00311	0.46
LM324	Low power quad op amp	61-03240	0.67
LM339N	Low power quad comparator	61-03390	0.68
LM346	Programmable quad op amp	61-00346	3.72
LF347	Quad Bi-FET op amp	61-00347	1.82
LM348	Quad 741 type op amp	61-03480	1.26
LF351	Bi-FET op amp	61-03510	0.49
LF353	Dual version of LF351	61-03530	0.76
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NE556N	Dual version of the 555	61-05560	0.50
uA741CN	DIL low cost op amp	61-07411	0.22
uA747CN	Dual 741 op amp	61-07470	0.70
uA748CN	741 with external frequency comp	61-04780	0.40
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ULN2283	1W max. 3-12V power amp	61-02283	1.00
MC3357	Low power NBFM IF system and detector	61-03357	2.85
ULN3859	Low current dual conversion NBFM IF and detector	61-03859	2.95
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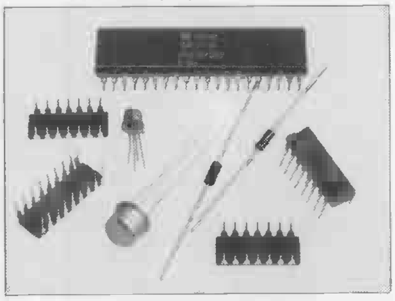
HA12017	83dB S/N phono preamp 0.001% THD	61-12017	0.80
MC14412	300 baud MODEM controller (Eduro/US specs)	61-14412	6.85



Microprocessor & Memories

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6116-3	16K (2kx8) CMOS RAM 200nS	26-36116	6.68
Z6132-6	32K (4kx8) quasi RAM 350nS	26-06132	15.00
4116-2	16K (16kx1) 150nS	26-24116	1.59
2764	64K (8kx8) 450nS	26-02764	9.50
2732	32K (4kx8) 450nS	26-02732	5.70

Voltage Regulators

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7812	12V 1A positive	27-78122	0.40
7815	15V 1A positive	27-78152	0.40
7905	5V 1A negative	27-79052	0.49
7912	12V 1A negative	27-79122	0.49
7915	15V 1A negative	27-79152	0.49

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BC212	General purpose	58-00212	0.10
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BC238	Plastic BC108	58-00238	0.08
BC239	Plastic BC109	58-00239	0.08
BC307	Complement to BC237	58-00307	0.08
BC308	Complement to BC238	58-00308	0.08
BC309	Complement to BC239	58-00309	0.08
BC327	Driver/power stage	58-00327	0.13
BC337	Driver/power stage	58-00337	0.13
MPSA13	NPN Darlington	58-04013	0.30
MPSA63	PNP Complement to MPSA13	58-04063	0.30
J310	JFET for HF-VHF	59-02310	0.69
J176	JFET analogue switch	59-02176	0.65
3SK51	Dual gate MOSFET-VHF amp	60-04051	0.60
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TIP32A	Complement to TIP31A	58-15032	0.35
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IN4002	Rectifier diode	12-40026	0.07
IN4148	General purpose silicon	12-41486	0.05

Silicon Controlled Rectifiers

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C106DI	400V 4.0A	52-00106	0.70
C122DI	400V 8.0A	52-00122	1.45

3mm Diameter LEDs

V178P	Red	15-01780	0.15
V179P	Green	15-01790	0.16
V180P	Yellow	15-01800	0.18

5mm Diameter LEDs

CQY40L	Red	15-10400	0.12
CQY72L	Green	15-10720	0.15
CQY74L	Yellow	15-10740	0.15

Infra-Red LEDs

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R F Components

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200 North Service Road, Brentwood, Essex, CM14 4SG; 53 Burrfields Road, Portsmouth, Hampshire, PO3 5EB; Park Lane, Broxbourne, Hertfordshire, EN10 7NQ.

To: Cirkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire.
I enclose 80p. Please send me your latest catalogue and 3×£1 discount vouchers!
If you have any enquiries please telephone us on Hoddesdon (0992) 444111.

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HE7

Hobby Electronics
JULY 1984
Vol. 6 No. 7

PROJECTS

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SPECIAL

REGULARS


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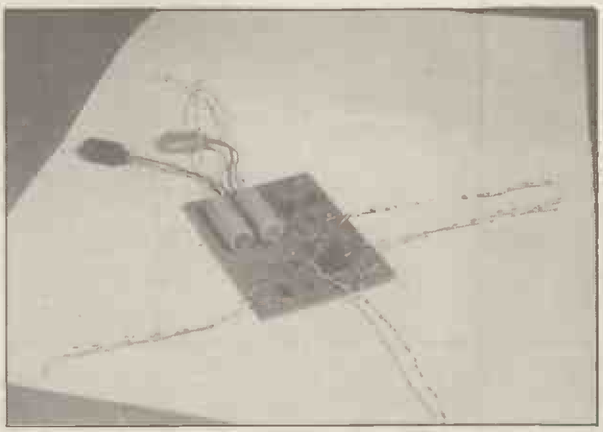
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Editor: Ron Keeley
Deputy Editor: Helen P. Armstrong BA
Technical Editorial Assistant: Terry Johnson
Technical Illustrator: Jerry Fowler
Advertising Manager: Joanne James
Copy Control: Lynn Collis
Managing Editor: *Ron Harris BSc*
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MONITOR

Clip That Chip

OK Industries' "Chip Clips" allow safe testing of ICs without stressing or displacing the chips as do some conventional "Clothespin" type test clips, claim the company. Built-in moulded separators eliminate short circuits, and units to fit 8, 14, 16, 24-28, 36-40 and 64 pin ICs are available.

OK's range of **stripping tools** can handle insulated wires up to 6mm. The SP series includes the SP01, which is made of fibreglass reinforced polyamide for lightness, which can take 0.5 to 2.5mm round and flat cable and employs a single action. The SP02 Mini Stripper is a pocket tool with a cutter for conductors from 0.08 to 1.0mm.

The SP03 is dual purpose for standard electrical cable as well as light gauge electronic cable up to 4 or even 6mm, automatically adjusting to cable area to avoid damage. All the tools have a typical cutter life of around 100,000 cuts.

The 784 is automatic and adjusts itself for wire and cable up to 6mm. The 787 removes insulation on cables up to 45mm wide and 0.1 to 0.75mm thick, with a stripping length of up to 7mm.

Industrial **cleaners** now available from OK include Technosolve degreaser and cleaner for metals and most plastics, Technolube for an antistatic coating on most materials, including precision moving parts, and Oilube is an oil-based lubricant for use where silicone lubricants are unsuitable.

All of these come as aerosols.

Further information from **OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. Tel: (0703) 619841.**

New Shop

Microrange Electronics is a company working from Stratford in East London whose main line is PCB manufacture, making up small runs of electronic equipment and manufacturing 19in rack cases. They also retail components direct to the public at their shop, including panel meters and component boxes. A price list should be available by the time you read this, and the address to visit/call is **Unit 258, Stratford Workshops, Burford Rd., London E15 2SP. Tel: 01-536 1415.**

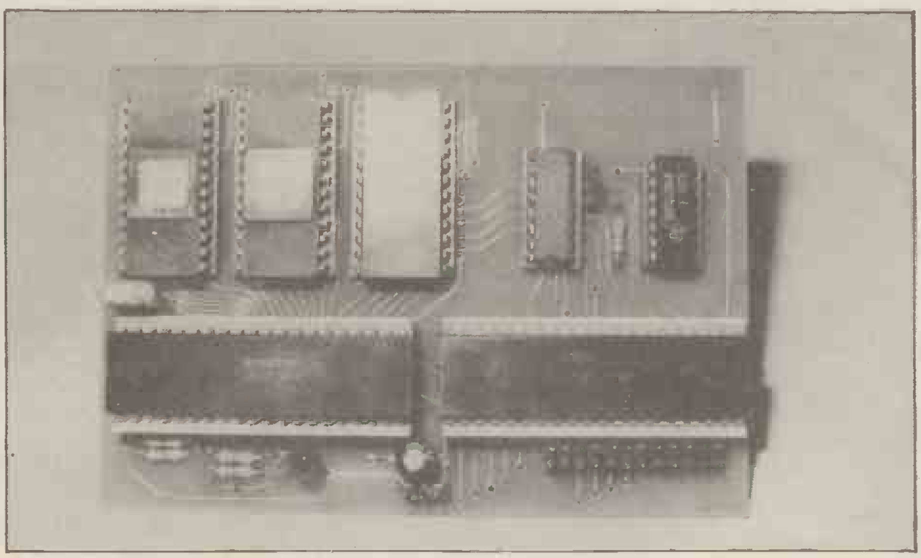
Control Board

"Control 68" is a new low cost **micro controller** from **J. P. Designs** designed to give small 'stand alone' terminals intelligence and flexibility. This compact 75x100mm PCB needs a +5V supply, and uses the 6802 microprocessor running at 4MHZ, 2KB of user RAM, up to 8KB of EPROM decoding, and 16TTL compatible Input/Output lines. On-board links allow 2716 or 2732 EPROM type devices to be used. PIO interrupts are serviced for quick I/O response time.

Applications extend into educational and experimental spheres, providing an opportunity to become familiar with the 6802 microprocessor.

The card, which can be easily programmed, is supplied with full user notes and circuit diagram at £49.95 + VAT.

Enquiries to **J. P. Designs, 37 Oyster Row, Cambridge CB5 8LJ. Tel: (0223) 32234.**



New Name

Roxburgh Suppressors are coping with increased demand by moving offices and adopting a new trading name: **RSL, Haywood Way, Ivyhouse Lane, Hastings, E. Sussex TN35 4PL.** A catalogue of all RSL standard filters is available from the Sales Office at that address. This division of RSL is also known as Stotron.

Soft Toolkit

In response to the growing demand for 'useful' software, **Timedata** are pleased to announce TT-S, a powerful and sophisticated Spectrum **programmers' toolkit**. TT-S contains five utility programs which were written for their own use by Timedata's development programmers to make the job of program writing as painless as possible; 'gamma', a relocatable BASIC extension giving new keywords with syntax checking, including TRACE, FIND, AUTO, as well as intelligent RENUMBER and MOVE commands; 'screens', a high-resolution drawing program with proper 'fill' and text print facilities; 'udg', (!) a powerful aid when creating user defined graphics characters; 'tape', which reads and displays the contents of tape file headers and

'ram' a thorough RAM test program.

All five programs can be used with 16K or 48K Spectrum, with or without Interface 1 and Microdrives. 'gamma' can also be used with most types of printer interface. TT-S is supplied with a comprehensive 28-page manual and can be obtained from leading computer shops or direct from Timedata at £7.95 inc. VAT and carriage.

Orders and enquiries to **Timedata Ltd., 16 Hemmells, High Rd., Laindon, Basildon, Essex SS15 6ED. Tel: (0268) 418121.**

Peripherals On Show

A show of interest to every micro owner is projected for The Barbican in London during the 13-16th September. This is the **What Peripheral Show**, and we gather that this means what it says: the exhibition organisers are inviting dealers and manufacturers in every kind of perhipheral from stationery to disc drives.

Trade enquiries to **Computer Marketplace (Exhibitions) Ltd., 20 Orange St., London WC2H 7ED.** An extensive advertising campaign is promised nearer the date with full details for visitors.

Fast Recorder

Ikon Computer Products have come up with a high-speed **cassette data recorder**, now available for Dragon micros, with versions for the BBC, Oric, Electron, Commodore, Nascom and Tandy following in subsequent months.

The Ultra-drive has a read/write speed of 1200 characters a second (ten times faster as an ordinary domestic cassette recorder), with a capacity of about 200K per cassette.

The Ultra-Drive is completely automatic, and is based on the Philips mini digital cassette recorder. It is available from **Ikon Computer Products, Kiln Lake, Laugharne, Dyfed SA33 4QE. Tel: (099421) 515.** The price is £79.95, plus £3.45 p&p. Cables, operating system, interface, a microcassette, and VAT are all included in the price.

Have A Byte Of Serial

A **serial controller** with 4K byte buffer memory and communication via an RS232 is available as a peripheral device to the Velleman microprocessor-controlled **EPROM programmer**. In kit form the EPROM programmer and serial controller are both available from **Electronic & Computer Workshop** of Chelmsford.

The EPROM programmer is a microprocessor-based stand-alone unit complete with power supply, housing and test socket. Requiring no personality model, once built it will test, verify, copy and program the following EPROMs: 2716 (Intel or second source); TMS2526 (Texas Instruments); 2732 (Intel or second source); 2732A (HMOS version of Intel). An adaptor socket for IC 2532 is also available.

The programmer has a twenty-four key pad which includes hexadecimal keyboard and function keys, twelve address LEDs, four function LEDs (error, prog, OK and size) and two hexadecimal displays. The serial controller acts as a peripheral device to the EPROM programmer allowing serial datalogging from any computer, mini or microcomputer system.

Three **power supplies** in kit form are now available. The Velleman 1A power supply has an adjustable voltage from 1V2 to 35V, a typical line regulation of 0.01%, load regulation of 0.1%, 100% electrical burn-in and 180dB ripple rejection.

The Velleman 5-14VDC/1A series as a power supply for Velleman kits needing a PSU of that power rating. Input voltage is 6-16V/1A.

The Pantec stabilized power supply kit no. 3 is a professional power supply able to feed transmitters, receivers, stereos and car radios, and the high degree of stabilization and regulation make it suitable for lab. use.

A full auto ranging DMM, the Pan 2101, is currently available. This has input impedance of 10MR AC/DC, auto ranges from 200mV-1000VDC, 21600-VAC, resistance 200-2000kR, and lower power resistance from 2kR to 2000kR. AC/DC current measurement is from 200mA to 10A and all ranges except 10A are protected up to 250VAC/VDC. The Pan 2101 costs £79.90 plus £1.00 p&p/VAT.

Enquiries to **Electronic & Computer Workshop Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 262149.**

Mind The Step

A new two-part **hand-held case**, with a 24° sloping display panel, designed to incorporate a range of LCDs together with bezels, a PP3 battery compartment with removable cover, has been launched by **Boss Industrial Mouldings**.

Moulded as standard in easily drilled and punched black, grey and brown ABS this new BIM 2900 case measures, 165 x 24.5 mm and tapers from 87mm at the sloping display panel end to 82.5mm where hand held.

Having recessed fixing holes under the base to accept the supplied feet, four internal PCB mounting bosses within the lid key area, plus two more bosses within the sloping display sections, this case can be used in a wide range of hand held meter, controller and thermometer type applications.

Enquiries to **Boss Industrial Moulding, James Carter Rd., Mildenhall, Suffolk IP28 7DE. Tel: (0638) 716101.**

MONITOR

Soldering On

A new **soldering unit** from **Litesold** combines the features of their ETC-4B unit with CALPLUG temperature selection, and the ETC-4C unit with digital temperature display. Called (not surprisingly) the ETC-4D, the new unit gives instantly variable, but interference-proof temperature selection by means of seven colour coded CALPLUGS, which are available for selected temperatures from 210° to 400°C.

The operating temperature of the iron can be constantly monitored during use by an LCD on the front of the unit which is operated by a thermocouple sensor inside the iron bit. Proportional band temperature control ensures rapid heating and eliminates swing. Idling temperatures are held around ±1°C, and spiking, RFI, static and magnetic interference are totally avoided.

The plug-in iron is interchangeable for all ETC-4 units, and a choice of bits in sixteen shapes and sizes is available. Enquiries to **Light Soldering Developments Ltd., Spencer Place, 97/99 Gloucester Rd., Croydon, CR0 2DN. Tel. 01 689 0574.**

PSU Kit

A new triple output **bench power supply** from **Grenson Electronics**, retailing at £99, is available in kit form at £59, all inclusive.

The BPU-4's three outputs are 3 to 8V at 2A5, 8 to 16V at 0A5 and -8 to -16V at 0A5. The 8 to 16V supply lines are tracking outputs providing a true +/- supply across that range.

The outputs are highly stabilized with an output change of less than 0.05% of a 10% input change, and less than 0.10% output change from zero to a full load. Ripple is better than 0.05% p-p. All outputs are protected against long term overloads, shorts and the injection of external voltages.

Information and data sheet from **Grenson Electronics Ltd., High March, Daventry, Northants NN11 4HQ. Tel. (0327) 705521.**

Getting Heavy

A heavy-duty cassette recorder for the BBC, Acorn and other home micros has been developed jointly by **Bell & Howell**, and **Leasalink Viewdata**, and designated the **Bell & Howell/LVL 317CX**.

This machine is based on a recorder designed specifically for schools and is built to particularly robust specifications, with facilities not always found on cassette recorders, such as an internal electret microphone (as well as an external socket), headphone sockets and a socket for remote control of the drive motor by the computer.

As well as fast forward and rewind, there is cue and review so that playback can begin as soon as the required portion of tape has been located (as found on most video recorders, and personal stereos, come to that). Operation is from either mains or batteries.

Load and Save connections to the BBC computer are via an IEC/DIN input/output socket and a 2.5mm jack for computer-controlled load and start. For computers such as the ZX Spectrum, the signal is taken from one of the ¼in headphone sockets, from which up to 40V is available.

The 3179CX costs £39.95 (RRP inc. VAT). A specification sheet is available. Enquiries to **Bell & Howell, Alperton House, Bridgewater Rd., Wembley, Middx HA0 1EG Tel: 01 902 8812.**

Carry On

Two new products are announced by the Kings Lynn firm of **Maxview**, suppliers of TV aerials to the "itinerant market" of caravan, yacht and HGV users.

The Cara **aerial amplifier**, 4½ x 2¾ in, has integral brackets to allow it to be bolted permanently at an appropriate position between a caravan television receiver and the incoming aerial lead, and covers the whole of the UK television and VHF radio spectrum from 40 to 900MHz. There is provision for either 12V or 24V operation to render it suitable for the supply voltages generally available on land vehicles and marine craft. The required voltage is selected by means of a switch on the top of the unit. Supplied with the amplifier is a generous length of coaxial cable terminated at each end with a standard-TV-type plug to interconnect amplifier with television receiver. A power lead to pick up the DC supply is also included in the kit.

A **Weatherproof TV Aerial Socket** is designed to be secured as a permanent fitment to the exterior of a vehicle or marine craft. The downlead from the aerial is plugged in to the coaxial socket contained within a small (2 x 2in) plastic box with a weatherproof snap hinge lid. Extending from the rear of the box is a three-metre coaxial cable which is passed through a hole drilled in the side of the vehicle and so to the television. When the vehicle moves on to another site the external aerial is unplugged from this weatherproof socket and, preferably, dismantled for safety in transit. At the next stop the aerial may be re-erected and the downlead plugged in once more to the Maxview weatherproof socket.

The Cara amplifier is listed at £13.50 and the Weatherproof Aerial Socket Assembly at £4.95, both including VAT. Although these products have a special appeal in the mobile market they have

applications in the domestic enviornment as well.

Enquiries to **Maxview Aerials Ltd., Maxview Works, Setchy, Kings Lynn, Norfolk PE33 0AT.**

Painting The Town Live

Electrolube have introduced a silver **conductive paint** which can be used on wide range of materials, including plastic, paper, wood textiles, glass and ceramics, and metal. The paint can be applied by brush, dip spray or even a pencil and takes about ten minutes to dry, giving a thin, flexible film of high conductivity. Some of the possible uses which Electrolube list are the design and repair of PCBs, repairing rear screen heater tracks, screening plastic cases against HF fields, earthing strips, connection with non-solderable surfaces, etc., etc. — anywhere where an electrical connection is needed which can't be provided by solder or a cable.

Details of stockists, etc. can be obtained from **Electrolube Ltd., Blakes Rd., Wargrave, Berkshire RG10 8AW. Tel: (073 522) 3014.** We don't have a price for this SPG, but it's never a cheap commodity, so we advise against attempting to lay out entire PCBs with it.

Modular Burglar System

Battery operated modular burglar alarms are easy to fit and offer a simple solution to the problem of warning family or neighbours if doors or windows are forced open. A new system on the market uses plugs and sockets for main wiring connections, making it simple to install. This system also eliminates problems with lost keys as it is push-button controlled using a secret code which can be altered if necessary.

Pulling out the plugs or the wiring activates the alarm.

Battery operation provides a safeguard against thieves cutting the power supply and allows the system to be left active when the occupier is away on holiday and has switched off his electricity at the mains. The basic kit comes complete with wiring and will protect four doors or windows, making it ideal for flats or high risk isolated areas such as garages or workshops. It includes a 100 dB siren which stops and resets after three minutes. Further reed switches and wiring and extra sirens, each with its own battery, can be plugged into the system, allowing it to be extended on a modular basis. The ground floor of the average three-bedroom house could be protected for well under £50, including a siren in a neighbour's house.

Further details from **Semiconductor Supplies International, Dawson House, 128/130 Carshalton Rd., Sutton, Surrey SM1 4RS. Tel: 01 643 1126.** The Starter Kit costs £29 inc. VAT and p&p.

One In The Eye

The **Optical Information Council** want hobbyists and DIYers to take better care of their eyes, and accordingly have circulated some recommendations for better eye care to us.

In the case of electronics construction, the hazards boil down to flying debris inadvertantly caused by exploding triacs, unpredictable solder-suckers, or stubborn component leads (resistance to the clipping short of). The trouble with these is that, unless you choose to wear eye-protectors all the time, they are unpredictable occurences. Fallout from cutting operations, particularly cutting faced chipboard or metal with a power-saw, is more predictable. Wearing even a cheap pair of plastic protective specs can avoid such tedious operations as twenty-five minutes trying to remove a slap of chip from your eye with a piece of wet tissue or worse.

The OIC recommends plastic lenses instead of glass for spectacle wearers when doing DIY, as glass can splinter. Preferred are industrial-standard polycarbonate lenses, which can be obtained both as simple eye-defenders and also as prescription lenses, and are said to be virtually unbreakable.

More information, and leaflets on various eyecare subjects, are available from Celia Hewitt at the **Optical Information Council, Walter House, 418 Strand, London WC2R 0PB. Tel: 01 836 2323.**

Go Forth And Multitask

Users who want **FORTH** for their **BBC Micros** will now find it on a 16K EPROM type 27128 from **Skywave Software**, going under the name of Multi-FORTH 83. This version of FORTH has been specially written for the BBC.

The EPROM can be plugged into the micro's sideways ROM area so that it has a higher priority than the BASIC ROM. It is multi-tasking, so that the user can have several FORTH programs on the go at once; compatible with the MOS so that the Disc Directory and other DFS commands can be used, and MOS commands can be used from within the FORTH, capable of maintaining files of more than 32K which can be stored on disc alongside non-FORTH files; vectored so that the more poweful features can be user-redefined; extensively documented, and with a number of other special features.

Multi-FORTH 83 costs £40 plus p&p and VAT from **Skywave Software, 73 Curzon Rd., Boscombe, Bournemouth BH1 4PW. Tel: (0202) 302385.**

BBC Second Processor

Upgrade Technology in conjunction with Rade Systems Ltd. have produced a new second **Z80 processor** the BBC Models A and B. Connecting via the serial port of the BBC, the unit has its own integral power supply and floppy disc controller, making it independent of the micro's own systems. The unit supports the true CP/M or Turbo DOS and the disc controller will handle two drives taking 3in, 5in or 8in discs, single or double sided and density, forty or eighty track.

The unit also allows up to three RADE add on boards to be plugged in. Units include a RAM expansion to 256K, adding serial, parallel or IEEE interfaces, hard disc storage or stereo sound synthesis.

The unit will sell at £299 + VAT under the name of "Upgrade" through a network of dealers. Enquiries to **Upgrade Technology, 290a High Rd., London NW10 2EU. Tel: 01 451 4414.**

JVC Course

JVC (UK) Ltd. are now running an in-house course to train a small number of students as service engineers for the video and hifi industry. It is expected that the trainees, once qualified, will be working at retail outlet level as after-sales technicians, and with this in mind some students are being partly funded by retailers.

The scheme is being set up as a joint venture with the Manpower Services Commission and is hoped to be the first in a series of schemes whereby prospective employers take an initiate in training people to service the trade, especially in specialised consumer area such as video and hifi.

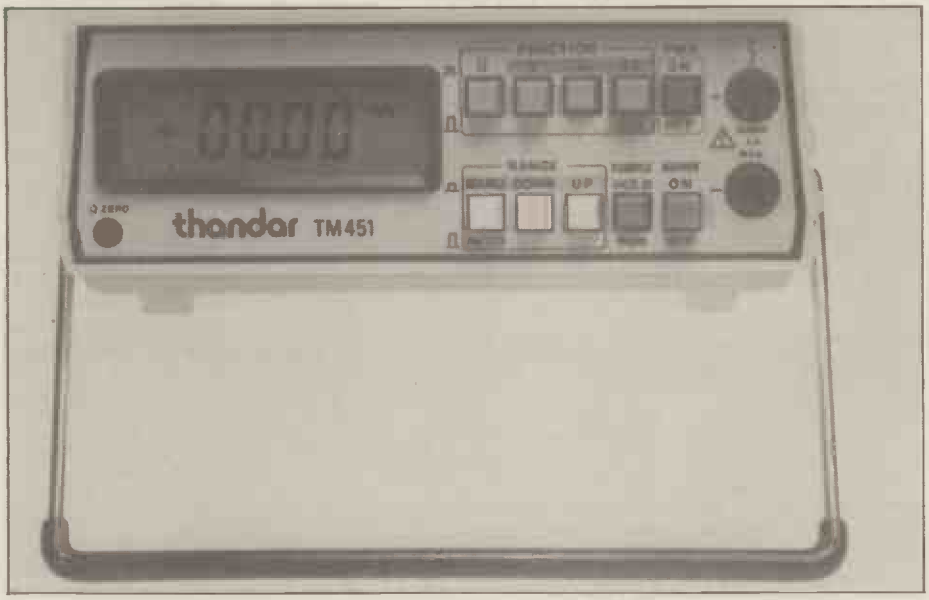
Which can only be a good thing if it raises the number and standard of after-sales service engineers.

4½ Digit LCD

The latest addition to the low cost instrumentation range of **Thandar Electronics** is the 4½ digit liquid crystal display digit multimeter. This bench/ portable instrument has a basic accuracy of 0.03% and features full auto bench/portable instrument has a basic accuracy of 0.03% and features full auto and manual ranging as standard. It has full measurement capability of DC and AC voltage, DC and AC current plus resistance and diode check in twenty-one ranges over five modes. A sample hold facility is also provided as is a continuity buzzer which also indicates over-range conditions in a different tone.

The TM451 is powered by a standard 9V PP3 battery, or via a mains adaptor as required. Battery life is considerable due to the CMOS LS1 technology incorporated. The TM451 is supplied complete with battery and probes at a price of £160 plus VAT.

For further details please contact **Thandar Electronics Ltd., London Rd., St. Ives, Huntingdon, Cambs PE17 4HJ. Tel: (0480) 64646.**



I/O Bureau

A warning to home computer owners, especially those doing a bit of programming or reviewing on the side, has come from the **Insurance Ombudsman Bureau**, a body set up four years ago by a group of major insurance companies to investigate queries and complaints from policyholders.

The two points which concern home owners are: are you adequately covered? and is your household insurance valid for your computer equipment if you are using it for business?

If you buy a computer and any amount of software or add-on equipment, check that the amount on your insurance policy is increased to cover it. Likewise, check with your insurers whether your policy covers your equipment if you are using it for any commercial purpose, or whether you need to have it insured separately under a commercial policy. Insurance companies are legitimately entitled not to pay up if the terms of a policy are not met by the householder, and lack of cover, or the wrong type of cover, are two of the commonest reasons for refusal to meet a claim in full or partially.

Read the small print! On a good policy it is there to explain, not mislead. If in doubt, talk to your insurance office or broker on the phone and then write to them confirming your understanding of the information they have given you. Then you have something in writing if there are any queries later.

Organ Intervals

The **Electronic Organ Constuctors Society**, which is a non-profit making society which aims to promote the design and construction of organs and other electronic instruments by amateurs, tell us that their September meeting will be on September 8th, and will be on the subject of Amplifiers And Speakers; another meeting on November 17th will be on the theme of PCB Manufacture And UV Box Construction.

The EOCS publishes five magazines a year for members, and holds five meetings a year in the London area. Enquiries to the **Publicity Secretary, Mr. P. Vickery, 5 Cringle Avenue, Southbourne, Bournemouth, BH6 4HX.** Their magazine is always full of specific practical advice and circuits.

What's In A Name?

National Panasonic (UK) Ltd. have announced that, from April 1984 they will change their name to Panasonic UK Ltd. The practical upshot of this is that all radio and hifi equipment currently identified by the name "National" will gradually be altered to read "Panasonic" this year, and the National Name will vanish from Europe altogether. National owners need need not be concerned if their brand name is no longer in the shops — it doesn't mean that the manufacturers have ceased trading. The parent manufacturing company, Matsushita Electric in Japan, are unifying all their products under the Panasonic name.

New from Panasonic is the RQ-8100 program cassette recorder, specifically designed for use with personal computers. The recorder connects by remote jack, and can be stopped and started from the computer keyboard. Data accumulation is at a rate of 1200bits/s and storage is 500KB on a C60 cassette. A phase selector corrects errors while loading commercial software, and monitor capability confirms signal transmission during loading and saving. Cue and review can be used to locate programs on the tape.

Running from mains (an AC adaptor is optional) or four R6 batteries, the RQ-8100's RRP is £44.50 from the usual outlets.

So Much Hot Air

A range of hot air nozzles for special applications, possibly the first to be available in the UK, are being supplied by **Steinel (UK) Ltd.**, as well as a range of nozzles for glue guns.

The four nozzles for the Steinel hot Air gun comprise a fan-shaped air flow nozzle for flat surfaces, a concentrated flow for spot temperatures, one for concentrating hot air flow for the soldering of pipes, and, possibly of most interest to hobbyists a paint-stripping nozzle which directs hot air flow, for instance, onto a window frame and away from the glass.

Hot air guns of various kinds seem to be taking over from more lethal methods of paint-stripping like caustics and blowtorches. The first person to adapt one to provide a home flow-soldering technique will be on to a good thing. Eagerly, we wait . . .

The Steinel Hot-Air Gun is designed for professional use, but Steindel say that it is ideal for enthusiasts and hobbyists. There are two models, a single-speed, 500° model and a dual-speed model giving a choice of 300° and 500°, as well as two speeds of airflow. For enquiries about the Hot-Air Gun and other tools and test equipment, contact **Steinel UK Ltd., 17 Reddicap Trading Estate, Sutton Coldfield, West Midlands B75 8BU. Tel: 021 378 2820.**

Clamp, Clip

A. Levermore & Co. are stocking miniature, USA-made Vice-Grip locking pliers. The two models, one with a long nose and the other with a rounded beak, are said to "crimp, clamp, clip, snip, grip and lock tight just like their big brothers." I forsee a rash on enquiries from hairdressers around the country . . .

The pocket-size pliers are only 4in long and will be available from specialist retail outlets. Enquiries to **A. Levermore & Co. Ltd., 24 Endeavour Way, Wimbledon Park, London SW19 8UH. Tel: 01 946 9882.**

Redefine Your Personal Space

Timedata Ltd. have produced a new software package for the Spectrum, called "HI-T" (piece of cake, ay?), which gives the lucky user up to 32 lines of 64 characters each, user input to any part of the screen without disturbing other data, print windows, where printing and scrolling can be confined to any rectangular area out of the screen, offset printing (figures can be moved up or down by one to five pixels) and redefinable print comma spacing, for flexible tabulation.

HI-T has the same standard character set as the Spectrum, and HI-T and standard characters can be mixed on the same screen. The program can be used on a 16K or 48K machine with or without microdrives, and costs £5.95 all inclusive.

Enquiries and orders to **Timedata Ltd., 16 Hemmells, High Rd., Laindon, Basildon, Essex SS15 6ED. Tel: (0268) 418121.**

A Controlled Charge

A new development in the control of **battery charging** by **S & W Battery Charging Systems** has been launched. The Sentinel controller is a four terminal encapsulated electronic plug-in module designed to control AC current and voltage to safe battery charging levels. The controller is simply inserted between the AC supply and the battery, and will allow whatever current is required to keep the battery in prime condition to pass without over or under-charge, reducing maintenance and energy waste.

The Sentinel may be incorporated as original equipment or added later to an existing system. It cannot, claim S & W, be incorrectly installed, and is designed to give users the full battery life that the manufacturer intended.

Enquiries to **S & W Battery Charging Systems Ltd., Nailsea Trading Estate, Southfield Rd., Nailsea, Bristol. Tel: (0272) 855161.**

Shoot Out

A **test instrument** for trouble-shooting printed circuit boards is now available from **Antron Electronics Ltd.** The T1200 isolates faults down to component level. On an unpowered an AC test voltage can be selected across a pair of hand held test probes and, by plotting the current/voltage characteristics of a component in-circuit, will display the resulting impedance signature on the unit's built-in CRT. Each range is current limited and safe to use on devices including diodes, transistors, voltage regulators, op amps, integrated circuits and many passive devices.

The T1200 also has a curve tracing facility for transistors and FETs, while its comparator feature allows the user to work on a PCB without a detailed knowledge of the circuit's action.

This rugged, portable unit weighs 2.5Kg and measures 252x 262x60mm. More information from **Antron Electronics Ltd., Hamilton House, 39 Kings Rd., Haslemere, Surrey GU27 2QA. Tel: (0428) 54541.**

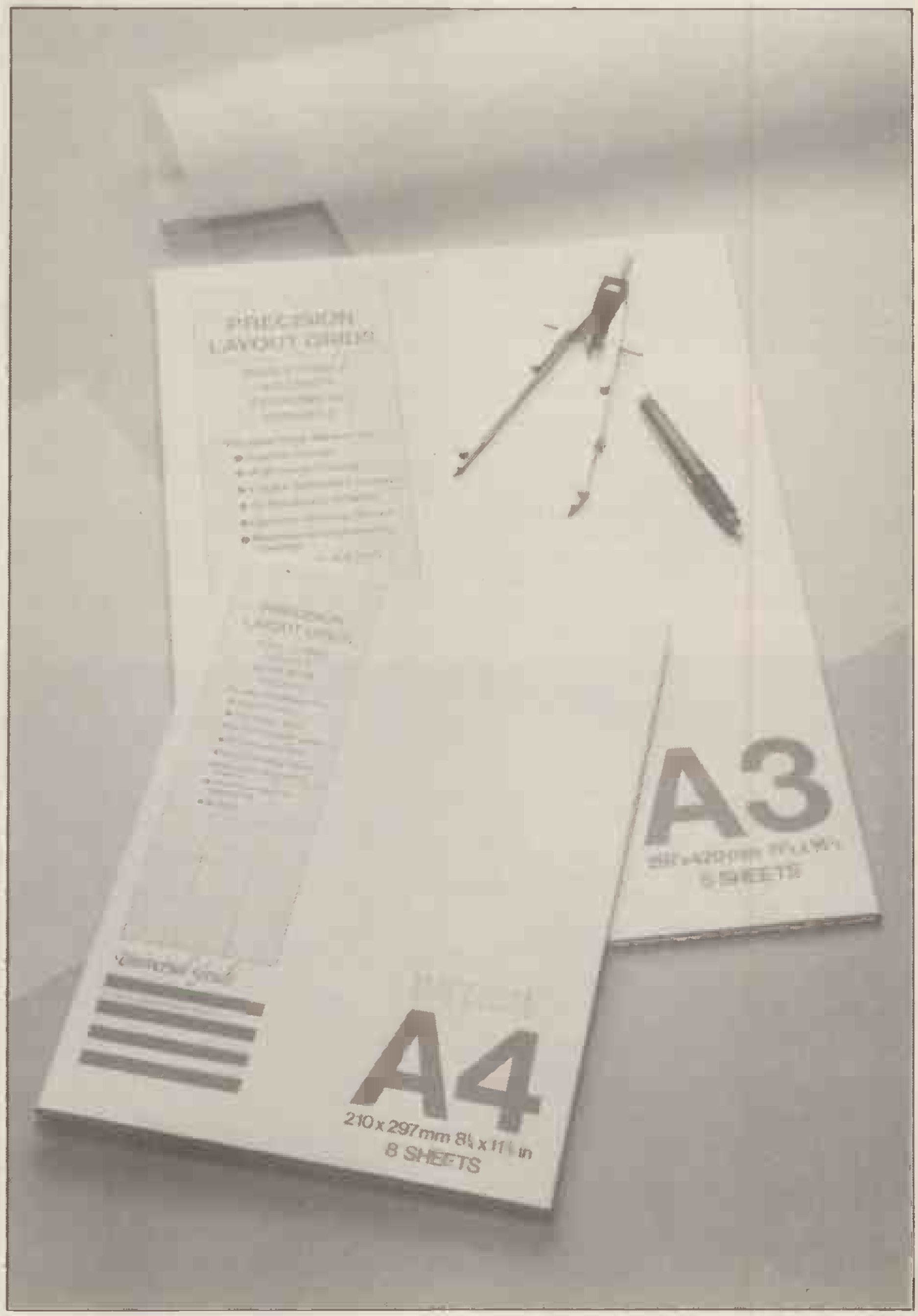
On The Matt

Quicker tape and pad application during PCB design is one of the benefits claimed by **Universal Grids** for their precision **layout grids**.

The grid material, made from stable matt polyester film with camera-invisible blue grid rulings in either imperial or metric rulings, allows greater accuracy than unruled or less stable bases, and this is especially important where reduction or enlargement is involved.

The material also doubles as drafting film for technical drawing, with the same advantages.

For a leaflet and stockists' list, contact **Universal (Electronics) Grids Ltd., PO Box 3, Liskeard, Cornwall PL14 6YZ. Tel: (0579) 20878.**



MONITOR

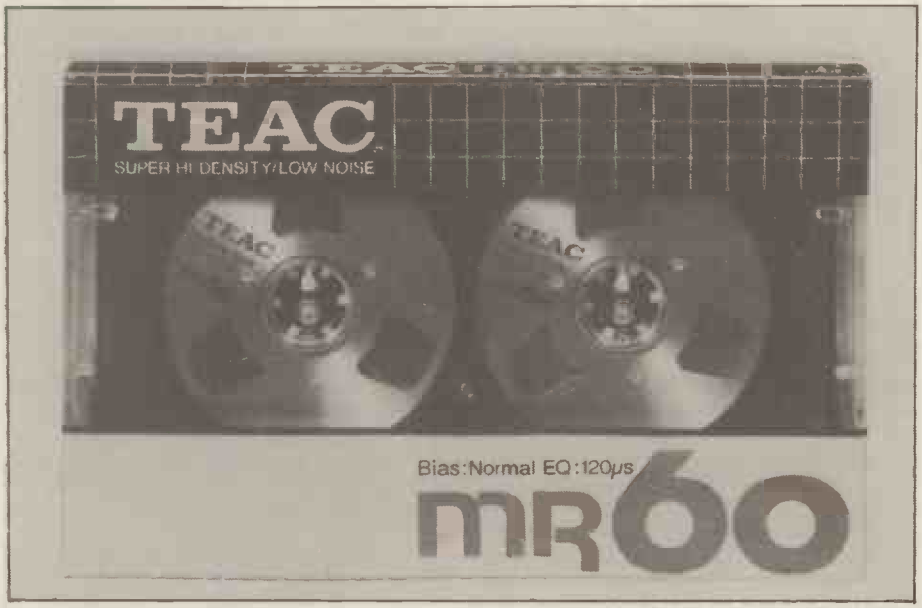
Three-Way Strip

New products from **OK Industries: co-ax wire strippers**, revolved around the cable, mak two- or three-layered strips. The cutting blades will removed dielectric, braid and external insulation either simultaneously or in any combination, by changing the blade "cassettes" which are colour coded for quick identification.

A PCB track repair kit comes in three packages, economy, standard and de luxe. The kits include master frames with tracks, fingers, pads, elbows and flatpack pads, eyelets and funnelets plus setting tools. The standard and de-luxe kits have epoxy, flux, cleaner, spatulas, abrasive sticks, tweezers, clamps and knives as well as other items. The de-luxe version even includes a soldering iron and a range of pliers. All the separate items can be purchased alone.

Speaking of de-luxe, for the constructor who is looking for the best in desoldering comfort, OK's electric desoldering iron offers one-hand desoldering, combining heat and suction in one. The vacuum chamber removes for cleaning, and replacement tip are available with 1.5mm and 1.77mm hole diameters. Versions for 115 or 230VAC 50/60Hz are offered.

For further information refer to **OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. Tel: (0703) 619841.**



The Reel Thing?

TEAC, best known for their tape recorders, is moving into the **cassette** tape market with two 'models'.

The MR60 is a 'reel to reel' type cassette, ie the tape within the chassis runs on two small metal spools. "Looks great — what more could you say?" say the company. Quite a lot, I dare say — the tape itself is Type 1 (Fe) rather than one of the fussier grades of tape, and the tapes are sixty minutes long.

The MDX Series of tapes come in C90, C60 and C46 lengths. TEAC claim that this series, which uses a newly developed metal powder with an advanced binder to provide a denser and more even distribution, has "broken the major objection with metal — price". We have not actually been quoted retail prices, but there is one to keep an eye open for, doubtless.

Further enquiries to **TEAC, Harmon (Audio) UK Ltd., Mill St., Slough, Berks SL2 5DD.**

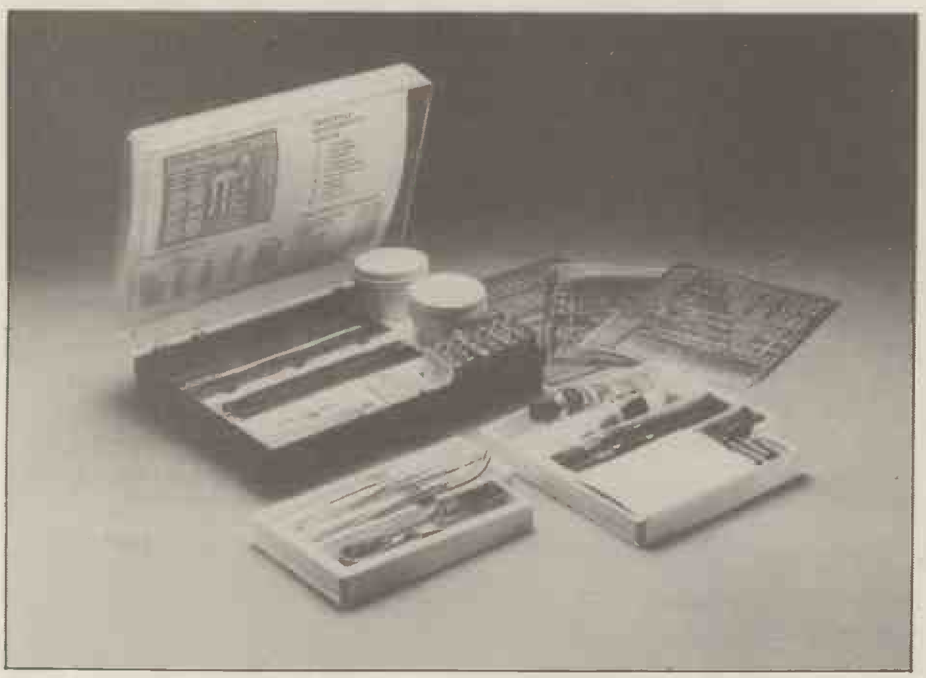
abx Discs

A so-far little known system in hifi is the dbx-enclosed **analogue disc system**, which boasts that it is the only analogue-recorded format that can reproduce the full dynamics of digital recordings. Unlike digital discs, dbx discs can be played on an ordinary stereo system, with the addition of a special dbx decoder unit.

A list of new additions to the dbx records and tapes catalogue has just come in, and includes records from the Bee Gees, Joe Cocker, Joe Jackson and Jeffery Osborne, as well as several cassettes by various pop, jazz and classical artists. The list overall is fairly restricted, with about forty rock/pop titles available, and rather more in the classical department, as well as jazz, easy listening and other titles.

Anybody interested should contact **Harman (Audio) UK Ltd., Mill St., Slough, Berks SL2 5DD. Tel: (0753) 76911.**

HE



Map Light Dimmer

A guiding light can be too bright, even in the darkest night. But not with the help of this simple in-car gadget.

A. Armstrong

LEADING, as I do, an excessively busy life, I sometimes find myself needing to work on writing in the car while someone else drives. For this purpose the maplight in the car is invaluable. However, though it is designed not to dazzle the driver, on a dark road it can still be a nuisance.

A much dimmer light would be suitable to check a neatly drawn circuit diagram, or to see the calculator. As I was part way through a much larger project and wished to make the best progress possible, I resolved to fit a dimmer to the maplight to enable me to use it all the time with out the danger of distracting the driver.

Those who know me have often remarked on my extreme dislike of electronic components getting "finger lickin" hot, so at least for these cognoscenti (*that's Italian for Smart Alec – Ed.*) it is no surprise that instead of using a hefty variable resistor, and maybe melting the plastic dashboard, I used an electronic controller.

The Principles Of Operation

The principle of operation of the circuit relies on persistence of eye vision. The lamp is switched on and off too fast for the eye to detect with a variable mark to space ratio which can be adjusted to control the brightness.

In fact the switching rate is high enough that the filament does not cool down much between cycles — the lamp just dims slightly between cycles rather than going off altogether.

This particular system dissipates little power, since with the switch ON almost all the power is transferred to the lamp, while with the switch OFF no power is drawn. The little power that is dissipated is due to the voltage drop in the switching device, switching losses, and the power used to run the circuit.

Of these effects, the greatest is voltage drop in the switching device.

The Circuit

Starting from the output, the switching device chosen is a VMOS FET, type VN46AF. A VMOS FET does not require a continuous current supply to maintain conduction, so the power consumption of the rest of the circuit can be reasonably low. Also, in most circumstances, a power FET is less destructible than a power transistor.

The particular device chosen has a maximum ON resistance of 3 ohms, so with the load to be used, a six watt lamp, the maximum voltage drop would be about 1V5 in the ON state.

This would result in a power dissipation of 0W75 maximum — well within the capabilities of the device without a heatsink. Most devices will do better than this — the prototype was measured at 0V8 drop in the ON state.

Surge Current

A lamp load exhibits a large surge current when switched on from cold. This is because the cold resistance of the filament is much larger than its hot resistance.

This surge current can be up to five times the steady running current.

This does not pose a problem to this circuit, because the fairly high switching speed keeps the lamp filament at an almost constant temperature so there is not a new surge each cycle.

The resistive nature of the FET prevents damage at the initial switch on, and reduces the thermal shock to

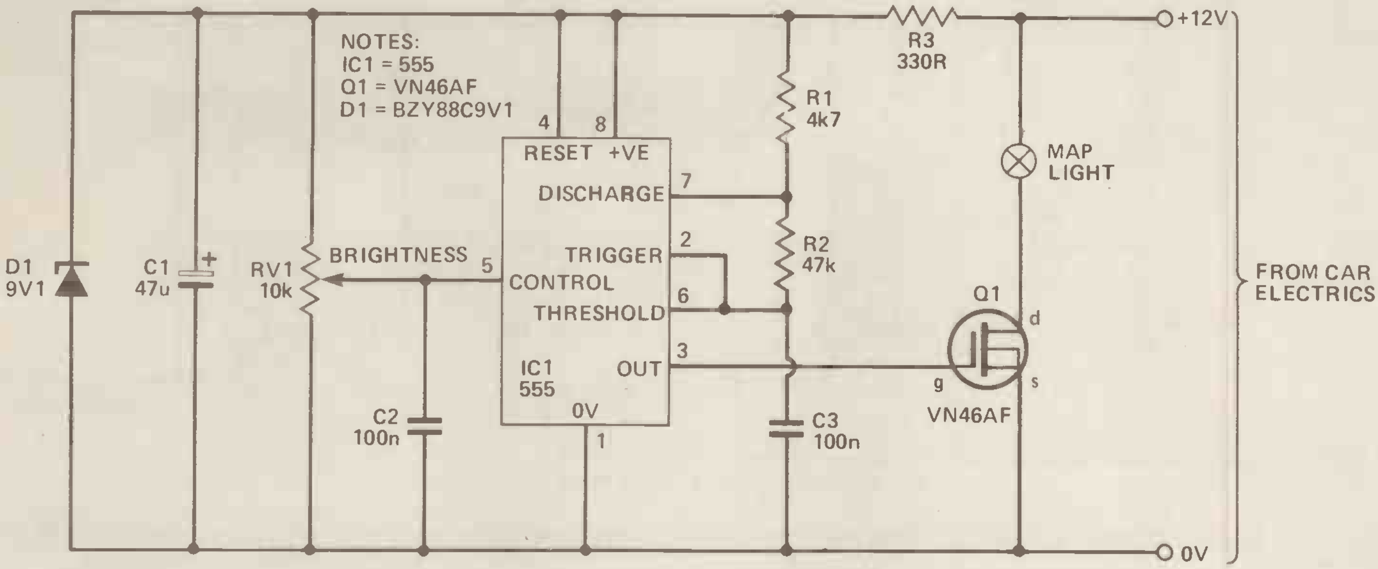


Figure 1. The circuit. The dimming is obtained by a rapid switching of the lamp, controlled by the 555 timer.

the filament by preventing such a heavy surge of current as would otherwise occur.

Timer

The IC which controls the switching is the well known 555 timer, which is intended for monostable or oscillator applications.

Its main internal functions comprise a flip-flop, and two comparators, which can set the flip-flop (and hence the output) into either state. The comparators switch at one third and two thirds of the supply voltage, but this can be modified by the control voltage input, and thus in this application can change the mark to space ratio.

It can in fact be varied from full on to completely off — through being on for two thirds of the time seems to be a typical setting required.

Gate Turn-on

The FET used requires less than 0V8 on its gate to guarantee to turn off — no problem for the 555 IC which is guaranteed to pull down to 0V25.

It also requires about 10V to reach its three ohm ON resistance, which is slightly more of a problem, since the

555 is not specified to get to closer to its positive supply than two volts. A ten volt Zener supply is used, so the worst case FET ON gate voltage is eight volts.

This in fact poses no problems — the worst case ON voltage drop would not exceed two volts, and it would be surprising if in practice any units built were anywhere near that voltage.

Other Uses

This project can of course be used to dim other lamps than maplights. It could form a very good way of prolonging the life of torch batteries if full brightness is not always needed.

In this kind of application the Zener could normally be ommitted, and a wire link substituted for R3. If, in a low voltage torch, the voltage drop in the FET is too great, then a second FET can be connected in parallel, due to the resistive nature of and positive temperature coefficient of the device.

WARNING: this is not true of bipolar transistors, e.g. 2N3055.

Experimentors Circuit

There is also another possible use for which this circuit can be adapted; — "dim dip" for car headlights.

Apparently someone has realised that encouraging everyone to drive around with their headlights on all th time at night defeats it own object of improving road safety, since the effect of being dazzled easily makes up for reduced change of anyone failing to notice a vehicle.

In order to achieve the aim of improving road safety, cars made from 1986 onwards will be fitted (I think)

Parts List

RESISTORS
(All ¼W 5% carbon)
R1 .... 4k7
R2 .... 47k
R3 .... 330R

POTENTIOMETER
RV1 .... 10k
linear pot

CAPACITOR
C1 .... 47u
16V radial electro
C2, 3 .... 100n
polyester or ceramic

SEMICONDUCTORS
IC1 555
timer
Q1 .... VN46AF
VMOS field effect transistor

ZD1 .... BZY88C9V1
9VI 400mW Zener

MISCELLANEOUS
Printed circuit board; maplight; knob; connectors; case if required; wire etc.

BUYLINES .... page 26

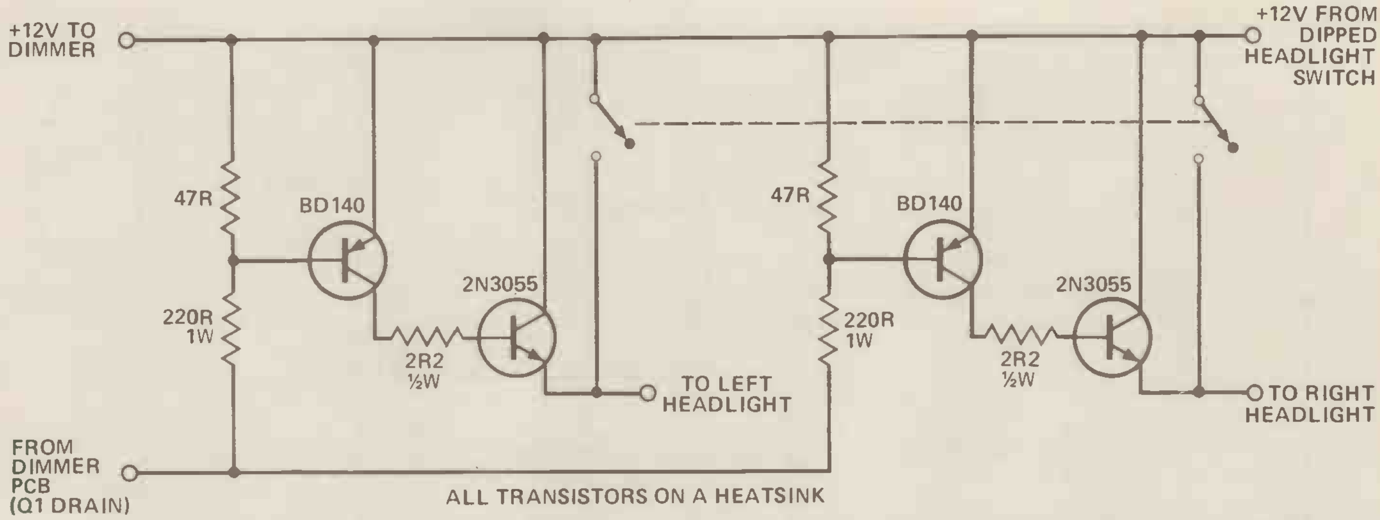


Figure 2. An experimentor's circuit for those wishing to try other applications for the circuit, including possible headlight dimming.

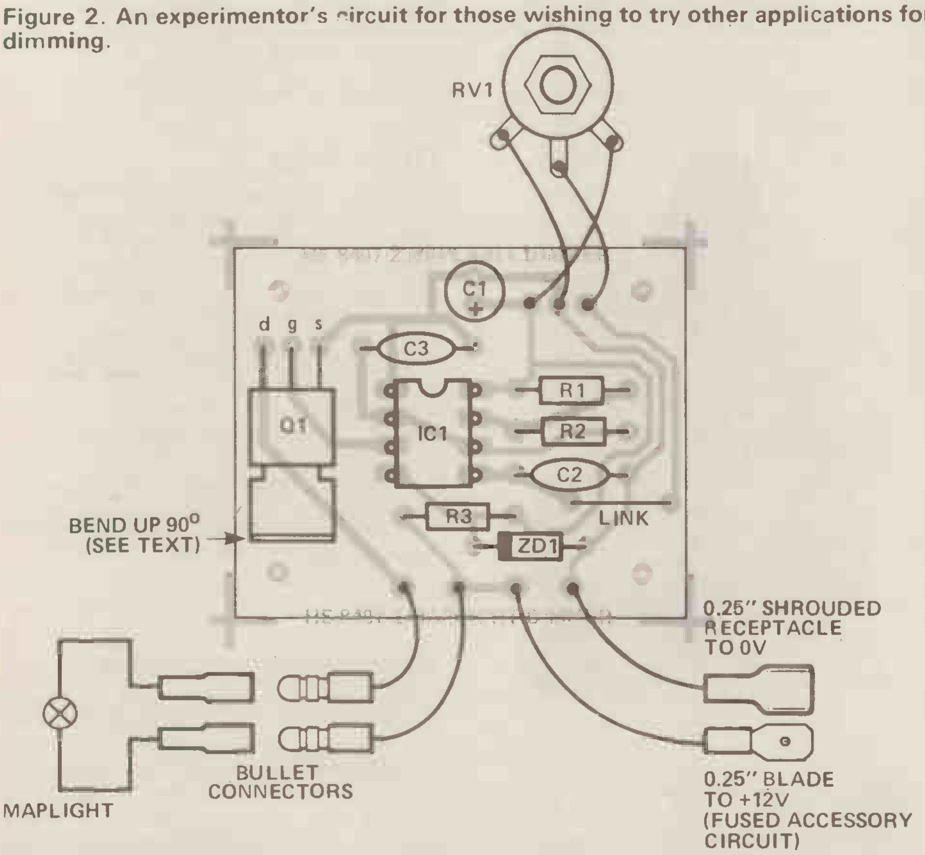
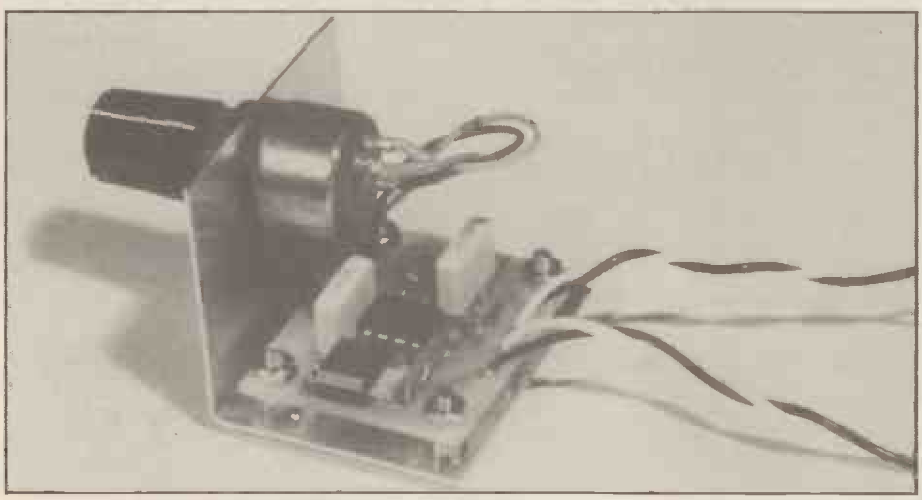


Figure 3. The PCB layout. Apart from the normal anti-static precautions, the only point to note is the careful bending-up of the heatsink tab on Q1.



with something which can dim the headlights if required, in the dip position.

Seemingly, this circuit with a more powerful output stage would carry out this function, though without further information as to the exact lighting regulations one cannot be absolutely certain. For those who wish to experiment with this, a suggested output stage is shown in **Figure 2.**

The output stage shown should be wired up on a heatsink, and care taken to avoid the insulated connections to avoid the risk of failure.

Construction

The construction of the Map Light on the PCB is quite straightforward, there are only two points to note. One is that to save space there is not enough room for the heatsink tab of Q1 to clear one of the fixing bolts. This means that the tab has to be bent as shown in **Figure 3.**

Carry out this operation very carefully, with the pliers near the plastic body of the FET.

The other point is that as Q1 is a MOS device, care should be taken not to "zap" it with static.

Continue to connect up the unit as shown, taking care that the polarity of the power connections is correct. It is recommended that a suitable selection of blade and bullet connectors be used, with female for supply and male for ground, to prevent misconnection.

Testing

Switch on. If the lamp will not light at all, at any setting of RV1, then suspect a broken connection. If it will not dim, check the power supply polarity, and check that Q1 is installed the right way round.

As part of its internal structure, most VMOS FETS have an internal diode between drain and source. This means that the device conducts all the time if the power is reversed.

You should now have a working dim maplight (for a dim navigator).

Happy driving!

HE

COMING SOON TO . . .

Hobby Electronics

INFRA-RED LINK

A very simple and compact IR link kit which can be used for remote control projects, burglar alarms etc. The sensitivity of the receiver can be adjusted to suit different applications as required.

TEMPERATURE CONTROLLED SWITCH

Thermistor-controlled switching device to operate any mains equipment drawing up to 5A. The design is straightforward, but has a choice of accurately adjustable ranges.

AUDIO FUNCTION GENERATOR

This waveform generator can be used for amplifier tests, digital modules, switching circuits etc, and it can be built into existing test equipment or housed in its own case. The generator provides square, sine and triangular waves, and has a wide frequency range with good stability throughout.

CIRKIT PROJECTS

Three highly functional projects designed by CirKit for their Electronic Construction Kit range, published exclusively in Hobby Electronics.

THE NEXT MOVE IN MICROS

We take a first look at the new micro which many are saying will dramatically change the face of the micro market, the all-inclusive Amstrad CPC464. With a built-in cassette recorder (or disk drive) and a choice of monitors, this "computing centre" may set the pattern for consumer computers for the future. Or will it?

DIGITAL TEST SET

The HE Digitester has a 5V power supply, a six-frequency pulser, and a three-state logic level indicator. An indispensible piece of digital test equipment for under a tenner.

SOFT OPTIONS

This month Soft Options looks at the 'pop' face of computing: computer games. Are they time-wasting trivia, or a genuine computing challenge? If you can't ignore them, how can you make use of them?
Also, Soft Options talks to a software company who have already found their answer to some of these questions, as well as others, and are providing unusually refreshing results. Plus news, views, reviews.

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August issue on sale at your newsagent from 13th July. Place your order now!

Although these articles are being prepared for the next issue, circumstances may alter the final content.

Hifi Control Amplifier

The second in an occasional series of hifi amplifier building blocks, the hifi control amp features an unusually wide choice of tone controls, and a circuit designed to the highest audio standards.

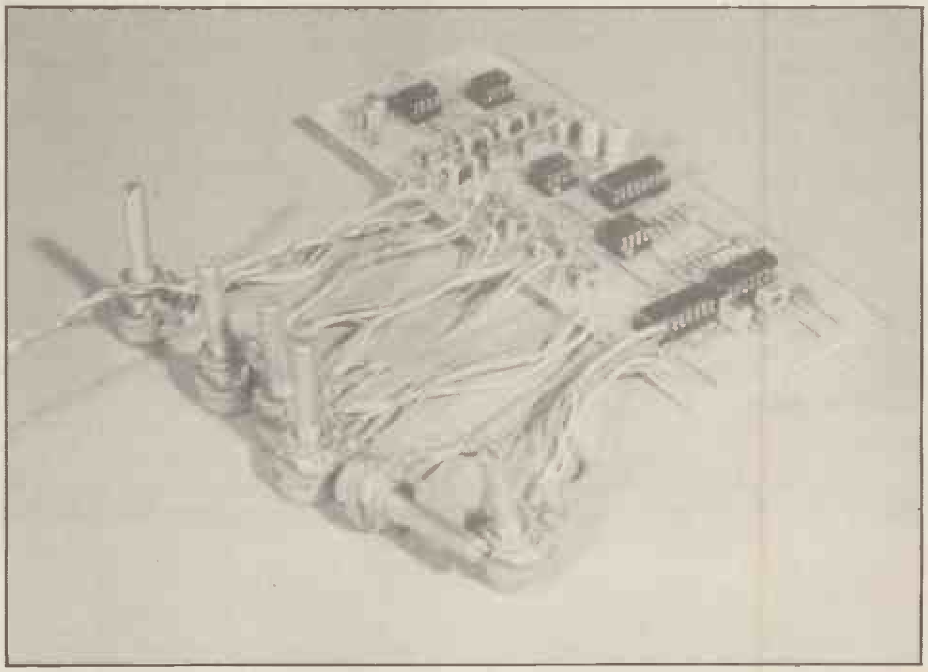
Andrew Armstrong

THIS project, which is designed to run from the hifi power supply published some months earlier, (HE February '84) is intended to be used as a building block from which the reader can construct preamplifiers, complete amplifiers, etc.

The output signal is suitable to feed into any normal power amplifier, be it a Quad 405 or a pair of power amplifier modules built from the pages of this magazine, and a separate output is provided to drive a headphone amplifier.

No input switch is shown in this project. However, with the addition of a simple selector switch, it could be used as a complete preamplifier with the qualification that there is no disc input. It would be suitable for tape, tuner, or laser disc player inputs.

The circuitry is designed throughout for minimum distortion and low noise, so this particular project is suitable even for those with extremely discerning ears.



Tone Controls

Some of the controls are slightly unusual. For example, as well as the conventional Baxandall bass and treble controls, a middle (presence) control is provided.

This permits the words of a song to be made more audible when the control is turned up or, when it is turned down, tailors the frequency response for listening at very low volumes, when the ear would normally lose touch with the extremes of bass and treble before the middle ranges.

Insensitive Ear

This characteristic of the ear is not limited to variations in the perceived loudness of extremes of bass and treble. In fact, as shown in the graphical representation of the ear's response known as the "Fletcher-Munsen curves", the threshold of pain is lower at the extremes of frequency. Thus the dynamic range of the ear is reduced outside the frequency band required most for intelligible speech.

In some forms of deafness, the threshold of audibility in the middle frequency band most required for there is little range between a sound which is too quiet to be heard, and one so loud as to cause pain.

A project making use of this information is already a gleam in the designers eye.

Stereo And Filter

A stereo width control has also been incorporated. This would be an advantage when listening on headphones, when the stereo effect of most records can be a little extreme, or, alternatively, when listening on speakers which are too close together, or listening to records which sound almost like mono.

The effective stereo width can be enhanced by advancing the control, thus providing an improved sound quality.

A second order low pass filter is provided as a scratch or hiss filter, suitable for example, for use with FM stations where the signal strength is not as high as required for noise free stereo reception. The filter is a conventional circuit, but is switched by analogue gates, allowing electronic control to be used.

A slightly unusual feature in this area is that the balance control is incorporated into the filter circuitry. Another feature of the project is that the output to the power amplifier can be muted by switching an analogue gate. This would permit the use of headphones while the speakers are conveniently muted.

The Circuit In Brief

Referring to the block diagram shown in **Figure 1**:

The signal is fed first of all into the volume control. For this reason, *all* the components used must be chosen for low noise level, since at low volume control settings the entire noise of the preamplifier will still be fed to the power amplifier. This means that large input signals can be handled without overload.

An alternative position for the volume control is provided, for use in situations where the input signal levels from different sources are known to be similar.

The buffer stage following the volume control may be chosen at the time of construction to have some gain, to permit the use of low level signal sources, or to provide an extra high level output should the power amplifier chosen require it.

The output of this buffer feeds into the low impedance of the input of the middle control, which in turn feeds into the fairly low input impedance of the Baxandall bass and treble control.

Filter

Following the tone controls is the switched low pass filter. Since the balance control is included with the filter, and since this control is often required to adjust for unequal strengths of signal in the left and right channels, the width control had to come after, rather than before, this part of the circuit.

The output from the width control is available to feed to a headphone amplifier, and a separate buffered output is provided to feed the power amplifier. This output is buffered, because, in order to achieve the minimum distortion due to non-linearities in an analogue gate, it is desirable to feed the output of the gate into a high impedance, and no guarantee can be made about the input impedance of the power amplifier chosen to be used with this project.

The Circuit In Detail

First, a note on the component numbering. In the left hand channel, component numbers start with "1" eg; R1, R2. In the right hand channel however, component numbers start with a "101". Thus, R1 and R101 have equivalent circuit functions in the left and right channels respectively.

For the sake of clarity only the left hand channel is shown in **Figure 2**, and component numbers in this channel are referred to in all descriptions.

The chosen value for the volume control, 47k, is quite a usual impedance value to find on an input. This value, with the coupling capacitor used, gives a low frequency roll off to -3dB at about 15Hz. This should not cause any audible effect.

Input Buffer

The buffer stage following the volume control is required in order to feed the low input impedance of the middle control. It is not possible to have a very high impedance at the input of this control without having extremely high impedances and possible noise pickup at points in this stage.

The input buffer has resistors laid out on the PCB to enable gain to be set, though of course the best signal to noise ratio will be obtained from the circuit if sufficient signal can be provided to the volume control so that unity gain can be used. In this case, R1 should be omitted and R2 should be replaced with a wire link.

Buffer Gain

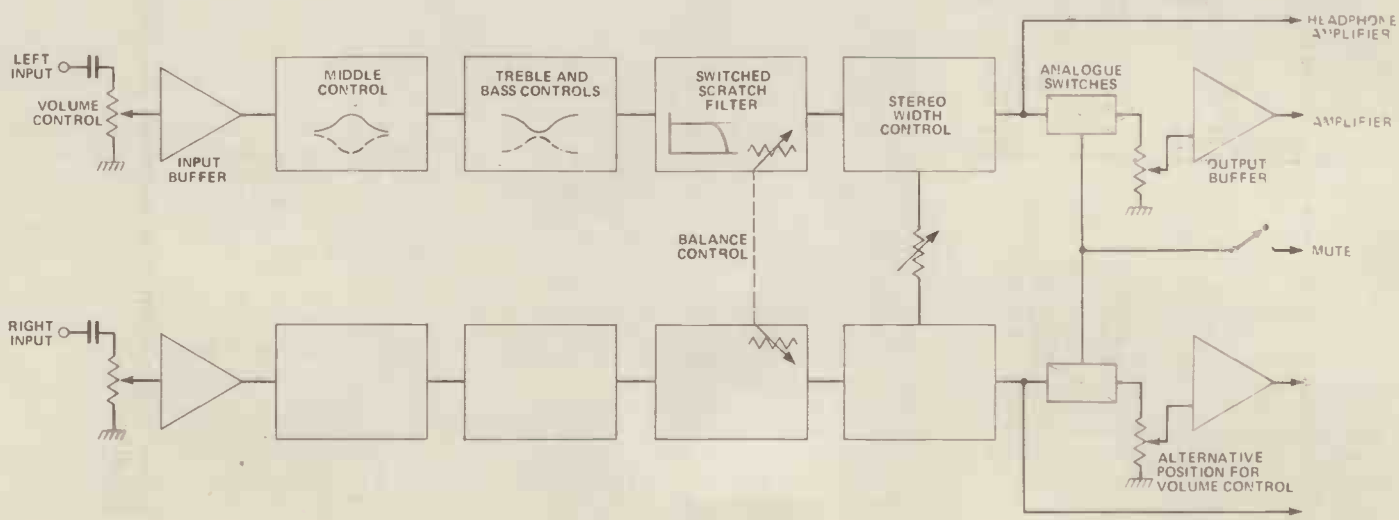
If gain is required in the input buffer stage, this can be calculated as:

$$\text{gain} = R1 + R2 \div R2$$

If a very high gain is used, the signal to noise ratio will be degraded, and op-amp distortion may become a significant factor. If IC1 is required to have a significant gain, ie input signal levels are very low, the use of a 5532 is recommended, as this is an exceptionally low noise device. In this case the use of metal oxide resistors around this op-amp is also suggested. For most applications, the LF353 or TL082 are sufficiently low noise devices.

Should there be any difficulty in obtaining the LF347 Quad FET op-

Figure 1. The block diagram, showing details of the left hand channel. An alternative volume control position is shown so that the control amplifier can be adapated for different requirements/power amps if required.



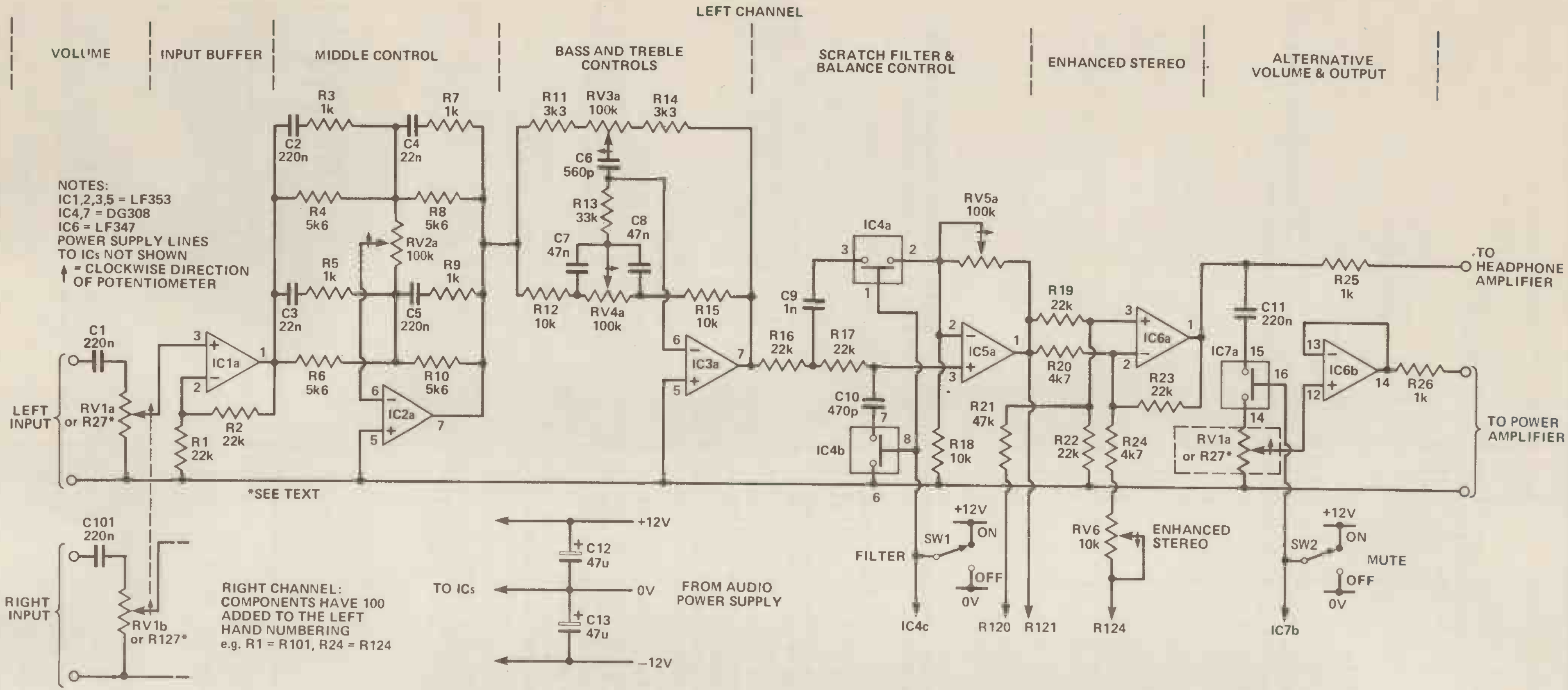


Figure 2a (above). This shows the left hand channel of the hifi control amplifier, with connections to the right hand channel indicated. Details of the connections in the stereo width control (enhanced stereo) section are shown in Figure 2b to avoid any confusion.

The alternative volume control section, far right, allows different methods of constructing the volume control according to the power amplifier to be used, and the final use to which the control amp is to be put.

An audio power supply suitable for use with this amplifier and other Hobby projects was published in HE February '84, and the Headphone Amplifier module will make its appearance in a month or two.

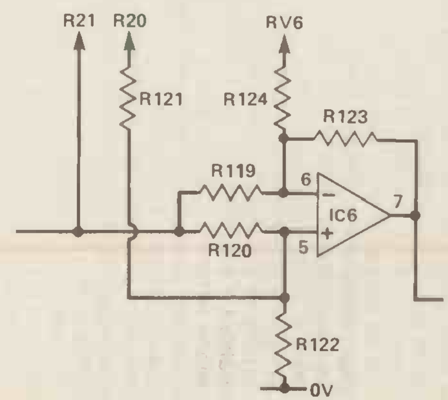


Figure 2. (far right). This illustrates the complex signal interconnections in the stereo width enlarger stage of the amplifier.

amp, the LM324 can be used at the expense of a tiny increase in distortion. Gains in excess of five should be avoided.

The middle control can provide a voltage gain or attenuation of approximately 5.6 over the middle range of frequencies. It achieves this by having two feedback networks connected in reverse, and a pot, RV2 which can vary the proportions of negative feedback the op-amp actually receives from either network.

The range of frequency responses available from this is illustrated in **Figure 3**.

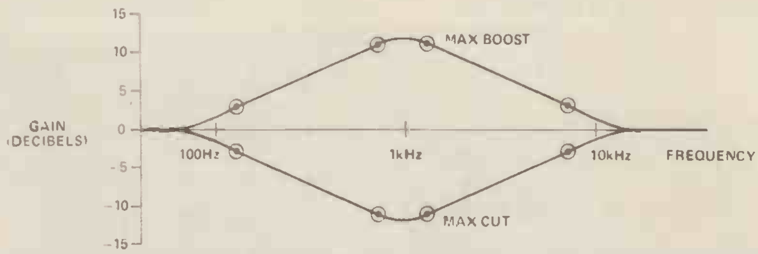


Figure 3. This diagram shows the boost and cut over the middle range of frequencies given by the middle tone control of the amplifier.

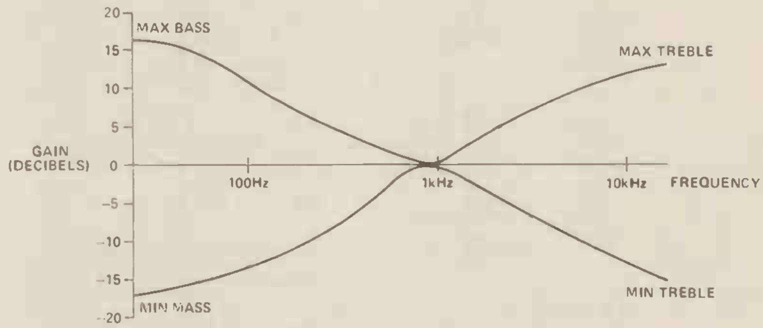


Figure 4. This diagram shows the boost and cut available over the bass and treble frequencies by the conventional Baxandall bass/treble tone controls.

Level Response

The frequency at which the response would start rising with the control in the middle boost position is set by C2 and R4, and is about 130Hz. The frequency at which the response starts to level off is set by C2 and R3 and is approximately 723Hz.

The response starts to fall at the frequency set by C4 and R8, and is about 1.3kHz while the frequency at which it starts to flatten off again, ie back to unity again, is 5.6 times this, at 7.224kHz.

Middle Control Frequency Response

This frequency response diagram was drawn up by plotting just the points ringed. This is a simple method to obtain a close approximation to the frequency response of an RC circuit. To show how it is done, take as an example the maximum boost condition.

At very low frequencies, the impedances of capacitors C2 and C4 are much higher than resistances R4 and R8, so these resistors are the dominant factor in determining the gain, which is therefore unity.

The frequency at which the impedance of C2 equals that of R4 is said to be the first breakpoint, ie the frequency a which the change in response becomes noticeable. At first glance, it would seem that the gain would be almost two, with only R3 reducing it slightly below this point.

The signal passing through C2 is in quadrature (90 degree phase shift), so the effect of R3 is less than might be imagined, but the signals via C2 and R4 add vectorially thus producing a gain of 2 rather than two. (2 corresponds to about 3dB.)

The next breakpoint, involving C2 and R3, is calculated in a similar manner. The only difference here is that this breakpoint is at a gain of 3dB less than the maximum that could occur if C2 were shorted. Similar reasoning applies to the rest of the graphical representation of the frequency response.

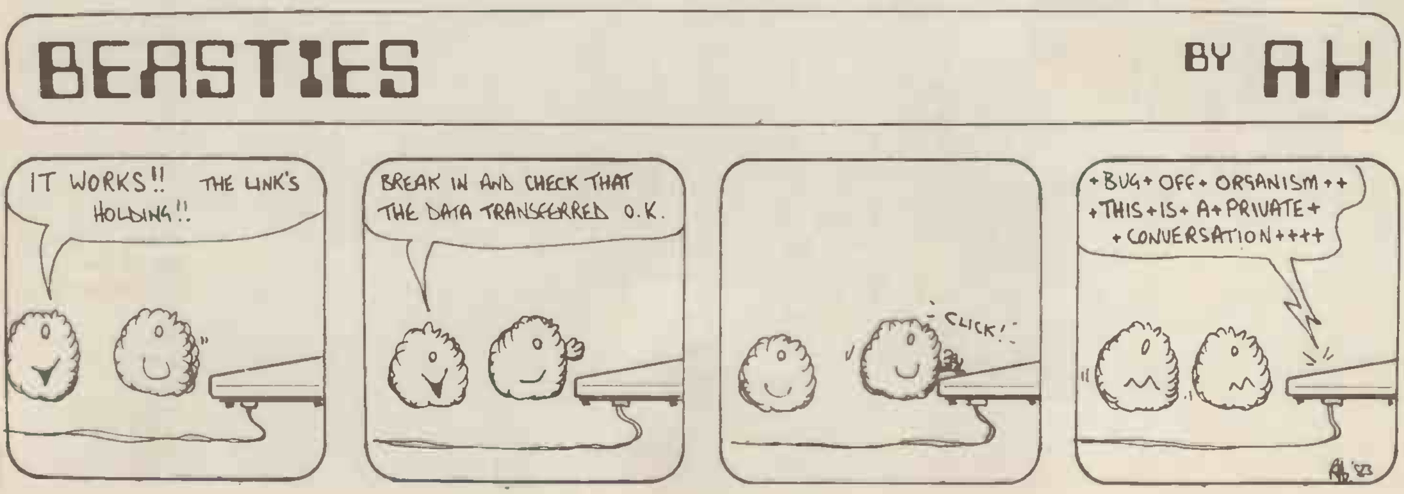
The frequency scale is logarithmic, since this is a reasonable representation of the way the ear perceives different frequencies.

This kind of technique, making use of reasonable approximations, is widely used in electronics to avoid the necessity for equations which will not conveniently fit on the paper (or in the brain of the designer).

Tone Controls

The next stage of the circuit is the Baxandall tone control. This is conventional in design and typical characteristics available from it are shown in **Figure 4**.

About 15dB of boost or cut is available from these controls at the extremes of frequency. Put quite simply, RV3 adjusts the amount of negative feedback or alternatively signal input at high frequencies, and RV4 performs a similar adjustment at



low frequencies. Thus a boost or cut at treble or bass can be provided.

Scratch Filter

The next stage of the circuit is the low pass filter for reducing the sound of scratches on the record or hiss on FM reception.

The form of the filter used is known as "voltage controlled voltage source", (a standard form). To realise this particular filter form, a non-inverting unity gain buffer with a low output impedance is required. In order to serve as a balance control as well, this circuit is also required to have an adjustable amount of gain.

To meet these seemingly conflicting needs, the signal on the inverting input of the op-amp is used as the unity gain output. So long as the op-amp does not clip, and is not asked to produce enormous amounts of gain, the signal on this inverting input will faithfully reproduce the signal imposed on the non-inverting input, but at a much lower impedance.

The filter roll off frequency is set by R16, R17, C9, and C10. In order to obtain the optimum shape of filter response, ie maximally flat, the value of C10 should be double the value of C9. This gives a damping factor of 0.7071.

Balance Control

The controllable gain in this circuit is used to provide the balance control function. Each channel, left and right, is connected to one half of a dual ganged pot RV5, in such a way that when the resistance on the left hand channel increases, the resistance on the right hand channel decreases.

When the pot is in its centre position, the gain of this stage is 1.5 in each channel. With the control in either extreme position, the gain of one of the channels is reduced to one, while the gain of the other is increased to two.

Thus, this balance control cannot direct all the sound to one loudspeaker or the other, but it does provide a useful range of balance adjustment, over the ranges of imbalance liable to be encountered in practice.

Should a wider range of control be required, the circuit should be set to give a higher gain by reducing R18 and of course R118.

The capacitors in the filter part of this circuit may be switched out by switching off the analogue gates in series with them. In this case, no filtering action takes place, and the stage is simply a buffer and balance control.

Width Control

The following stage is the width or stereo enhanced control. The functioning of this is at first sight rather complicated, but the principle on which it works is straightforward. What it actually does is subtract a portion of the left hand channel from the right hand channel, and vice versa.

This subtraction is carried out by adding some of the input of one channel into the non-inverting input of the other. The action of the circuit, overall, is inverting, so the output of the left channel op-amp is the left input signal inverted plus a proportion of the (non-inverted) right input signal.

This therefore gives an output on which is superimposed a proportion of the other channel of the stereo, but inverted. This fools the ear into perceiving the loudspeakers as being farther apart than they really are.

Fine, but what happens if you prefer the sound the way it was on the record, you may ask. To allow this, a proportion of non-inverted signal is *subtracted*, by means of a resistance between the inverting inputs of each channel. This relies on the same aspect of op-amp functioning as the filters, namely that the signal on the inverting input of the op-amp accurately reproduces that imposed on the non-inverting input, assuming that the op-amp is operating on a linear mode.

The proportion of non-inverted signal subtracted can be varied by adjustment of RV6, either to leave the effective stereo width wider than standard, or to adjust it through an unaltered condition, almost to mono. This may be slightly difficult to understand at first, but the circuit used is possibly the simplest and cheapest means to produce this effect.

The width control feeds the headphone amplifier output, via a resistor, whose value may be chosen to limit the maximum headphone volume is non-destructive level.

Output

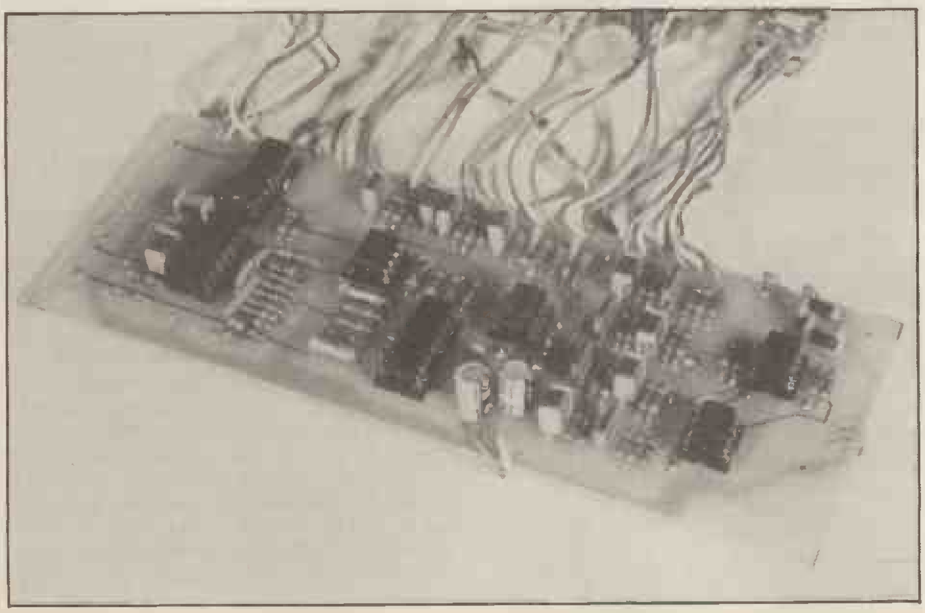
The width control also feeds, via a capacitor, the analogue gate used to mute the loudspeaker output. This analogue gate feeds to the second possible volume control position, and the wiper of the volume control feeds the output buffer. Since the signal is coupled via a capacitor, any offset built up in the rest of the circuit will not be transferred to the output.

The 1k resistor in series with the power amplifier output reduces the likelihood of damage being caused if voltages are fed back into the output, due, for example, to a severe amplifier fault.

Construction

This is a moderately complicated project, so it is strongly recommended that the printed circuit board should be used, rather than a Veroboard layout. It is also preferable, if possible to use a temperature controlled soldering iron. (No, I don't represent a company that makes them.)

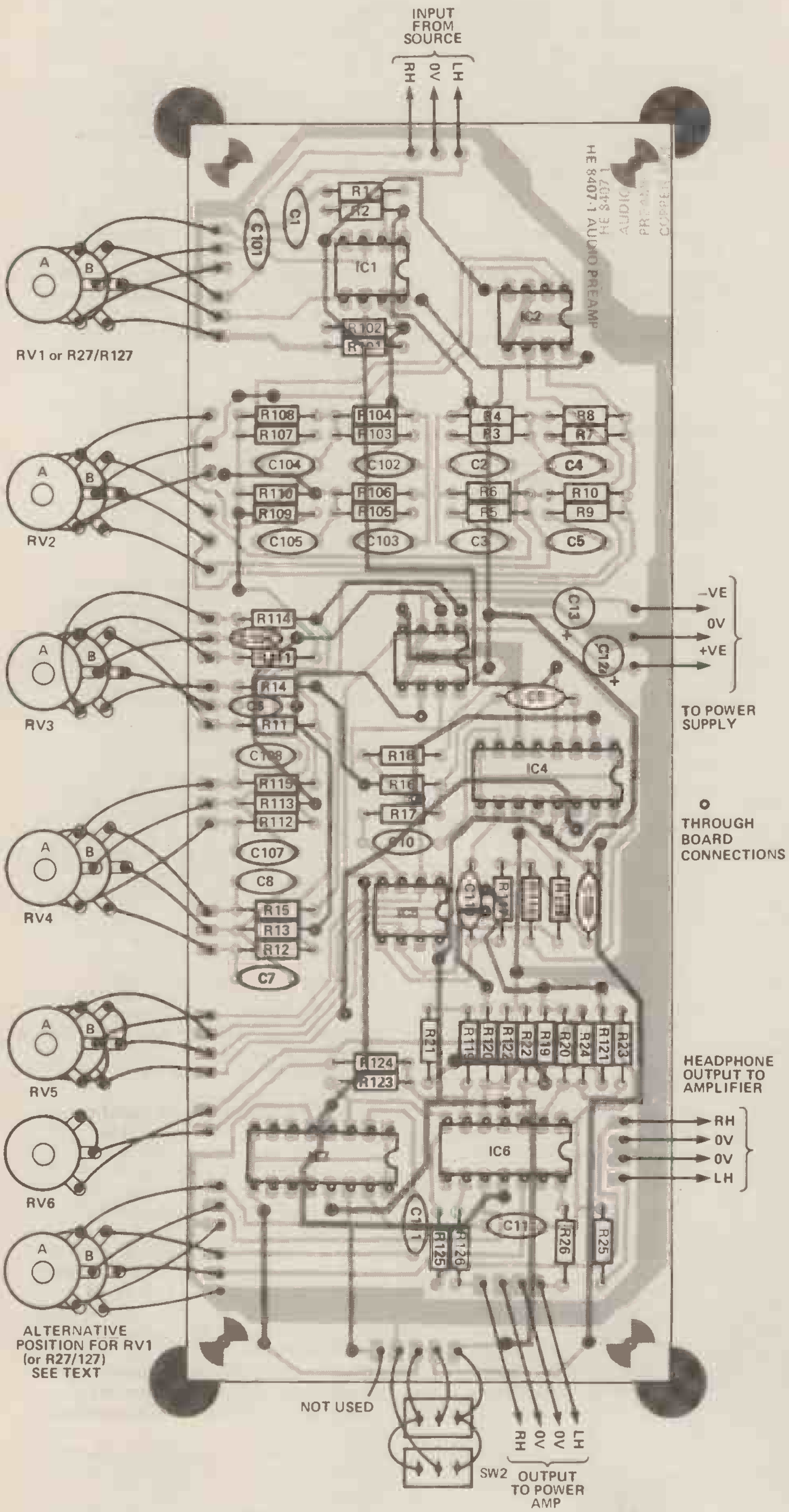
The use of such an iron can avoid hours of annoyance finding the one bad joint preventing the project from working.



Volume Control

When the PCB is assembled, it is first necessary to decide which of the alternative volume control positions to use.

If the preamplifier is intended to form part of a permanent or semi-permanent system, then it is a practical proposition to use potential dividers or extra buffers with gain on the inputs to adjust them all to the same signal level.



Parts List

Left hand channel numbers given only

RESISTORS
All ¼W 5% carbon
R1, 2, 16, 17, 19, 22, 23 .... 22k
R3, 5, 7, 9, 25, 26 .... 1k0
R4, 6, 8, 10 .... 5k6
R11, 14 .... 3k3
R12, 15, 18 .... 10k
R13 .... 33k
R20, 24 .... 4k7
R21, 27 .... 47k
Two of each of the above is required for stereo.

POTENTIOMETERS
RV1 .... 47k dual gang log
RV2, 3, 4 .... 100k dual gang lin
RV5 .... 10k dual gang lin
RV6 .... 10k single gang lin
One of each is required for stereo.

CAPACITORS
C1, 2, 5, 11 .... 220n polyester
C3, 4 .... 22n polyester
C6 .... 560p ceramic plate
C7, 8 .... 47n polyester
C9 .... 1n polystyrene
C10 .... 470p polystyrene
Two of each required for stereo.
C12, 13 .... 47u 16V radial electro

SEMICONDUCTORS
IC1, 2, 3, 5 .... LF353 dual J-FET op-amp (4 off)
IC4, 7 .... DG308 quad analogue switch (2 off)
IC6 .... LF347 quad J-FET op-amp (1 off)

MISCELLANEOUS
SW1, 2 .... SPDT min toggle
Double sided printed circuit board; IC sockets; screened cable; Audio Supply Power Module (see text); wire; solder etc.

BUYLINES .... **page 26**

Figure 5. Thje PCB layout. This is a moderately complicated double-sided board. Detailed instructions are given in the text, but we will note here the authors point that it is preferable to insert the pin-throughs, marked by small rings on the overlay, before placing the components, followed by the IC sockets if you wish to use them. Otherwise, construction is straightforward. The photo opposite will act as a guide — there are one or two minor differencies, as the photo was taken at the penultimate prototype stage.

This project has a double sided printed circuit board, **Figure 5**, and connections must be made from top and bottom in various places. In some places this is done by top soldering a resistor lead, but in many places (marked on the overlay), the connection should be made using track pins, or failing that, pieces of tinned copper wire (ie clipped resistor lead).

Owing to the difficult positioning of some of the pin-throughs, these should be inserted first.

No top soldering of ICs is needed, so that sockets may be used if desired. If sockets are to be used, these may be inserted first to help locate the rest of the components. Otherwise, it is better to insert the resistors first and the ICs last, as in normal procedure.

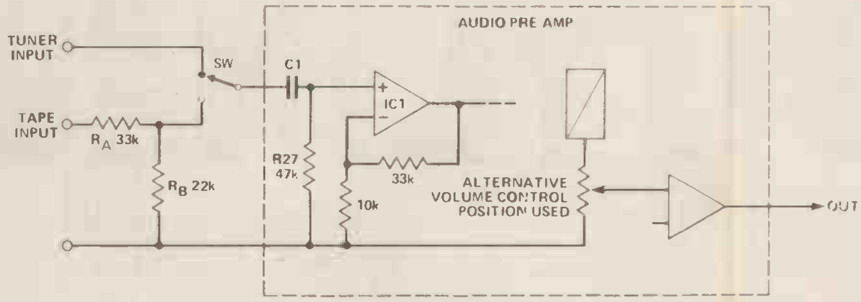


Figure 6. One possible application of the control amp: using the alternative volume control position, for recording say from a VCR and radio tuner at the same time.

Headphone Amp

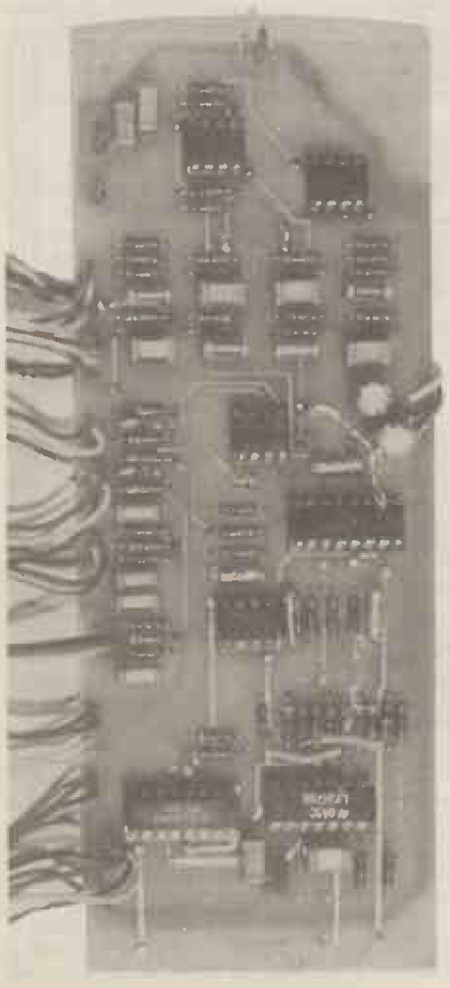
In this case, better performances will be available with the volume control at the output of the circuit. This also means that the master volume control does not affect the headphone volume which can then remain set at the required level as the loudspeaker volume is adjusted. A signal level of about three volts peak to peak is a reasonable level to aim for.

If on the other hand, the preamplifier is to be used with a varying selection of signal sources, it is probably better to use the volume control at the beginning of the circuit, in order to avoid the possibility of the circuit overloading on a strong signal source.

Whichever volume control position is not used should have a fixed resistor of the value of the volume control inserted, and the non-inverting input of the op-amp should be connected to the upper end of the resistor.

Once the volume control has been connected, all the other controls should be wired up, as shown. The power supply lead should be soldered to the pads on the PCB, and ideally a Molex connector should be used at the other end to connect to the power supply unit.

Take care to connect the power supply leads correctly, since the power supply unit's connections do not all correspond to connections on the preamplifier unit.



Testing

The preamplifier should now be ready to test.

First of all, in order to avoid damage to the power amplifier or speakers, switch on and check each op-amp output to make sure that there is no significant offset. If there is then suspect a solder blob shorting an input.

Assuming there are no problems then set the volume to minimum, and connect a signal source, eg tuner and a power amplifier. Slowly advance the volume until the sound is at a suitable level, and then test all the other controls to make sure they work in the right direction.

Assuming all is well so far, the unit can be built into a case and the knobs fitted. The one control requiring special attention is the width control. In order to find the "normal" position, feed a signal into one channel only, and adjust the width control so that the signal is audible only on the channel it is fed into. Carry out the test in reverse to make sure there is no significant difference in the required control positions. Centre the knob. The preamp is now ready to use.

Should it by any chance not work, a good way to isolate the area of the trouble is to connect a probe, consisting of a capacitor feeding a volume control, to the power amplifier. Use this probe to check for the presence of signal on each op-amp output from the input onwards, and where the signal disappears or becomes distorted the fault is not far away.

Further Notes

There are two associated projects which are more than merely a gleam in the designers eye. The next item under consideration is a matching headphone amplifier with enough power to drive a small pair of loudspeakers for low level monitoring if required.

To follow this, an input switching system is already on the drawing board. It is intended to provide adequate facilities to cope with the many recording and replay devices now available, and will have control of recording signal sources separate from listening selection.

Thus, for example, one could record onto the soundtrack of the video recorder from the radio while listening to an LP. **Figure 6** shows just one simple application of the pre-amp. Here IC1 is used with its gain set by the 10k and 33k resistors. The alternative volume control position is used, as the input signals are so low as not to need the attenuation of a volume control. Resistors Ra and Rb are used to attenuate the tape signal so that the volume levels for both the inputs are similar. The values for Ra and Rb should be determined by experiment as should the amount of gain required.

All this and more in future issues of HE!

HE

BUYLINES

Maplight Dimmer

A components list for the experimenters circuit is not given in this article as a few of the components depend on the wattage rating of the load, ie. the lights used in your car.

No case is specified as the housing depends on your own ideas. A small plastic case about 3" x 3" x 1½" will take the printed circuit board quite comfortably if desired.

If not already fitted to your car, a maplight can be purchased in almost any car accessory place. There are some maplights which have an internal switch, and this may be used with slight changes to the circuit to switch off the 12V supply to the dimmer.

The one possible difficult item is the VN46AF. This can be obtained from Rapid Electronics.

Estimated cost for this project is £2.50 excluding the maplight and PCB. The PCB is available from our PCB Service.

± DC Voltmeter

No real buying problem here. The most expensive item is the panel meter, and it is advisable to shop around for this item. A 50-0-50uA meter *is* generally available although it is not widely advertised.

Our advice here is to collect a few catalogues (as we are currently doing!).

A metal case is advisable, as the circuit is rather sensitive and will be more stable if it is screened. Cost is approximately £5.00, and this excludes the panel meter and case.

Audio Pre-Amp Module

First the cost. We estimate this to be about £16 and this excludes the PCB and the power supply mentioned in the article. The most expensive item here is the double sided printed circuit board, and because of its complexity it is not advisable to make your own.

The LF . . . ICs are common enough to be found most everywhere, whereas the DG308 analogue switches are not. The author has suggested they can be obtained from a number of sources but we have been unable so far to find anywhere except **RS Components**.

Your best bet here is to order the ICs through your local component shop, or alternatively you can try: **S & R Brewster, 86-88 Union Street, Plymouth, Devon. Tel: 0752 665011**. The RS order number is 303-551.

No case description or size has been given, as the case will depend on how many modules you wish to include. For those who intend to use the Pre-amp "as is", a small ali box with lid large enough to take the controls, the PCB and the power supply will suffice for the time being.

HE

SOFT OPTIONS

Editorial

It is now official. The home computer industry has failed to achieve useful objectives and this could "seriously affect future growth of the market". A Gallup poll says so, and we all know what jolly useful things opinion polls are.

This one is based on research among "middle-class parents who have observed little educational benefit from home computers bought for their children", and the study says, "We know that what actually happens is the child, usually a boy, ends up using it solely for playing games" instead of doing homework on it, or learning to program.

There follows an interesting section on statistics: so many machines bought at a cost per unit of under £170 (why don't they just say Spectrums and be done with it?); numbers bought at Christmas; total in UK, etc; then the really good bit, where the document sets out its thoroughly researched conclusion:

"We have now potentially 2.5 million homes in which the parents are realising, perhaps only now, the error of their decision."

Lest you feel this is all too arbitrary to be taken seriously, I must say that I read about it in the Times; and at least one software house has mentioned the poll in its recent publicity handout, which indicates that it's well on the way to passing from the realms of opinion into established fact.

I wonder if Christopher's parents know how disillusioned they are? Christopher is ten, and when he and a friend came in from bob-a-jobbing during the Easter holidays, they tried to work out the finances of their endeavours on the calculator. They failed.

So they sat down and wrote a short program so that the home computer could do it for them. The program worked.

And I must remember to explain to Mike that his nine year old is not really interested in doing maths with his computer — he must just be playing games on it, because that's what the survey says. As for Hazel, Kate, Josephine, Nicholas, et al, their interest is a mere micro-illusion. The people of Gallup *know* .

What nonsense it all is! Of course there are a number of disillusioned people around. New technologies are susceptible to impulse buying by consumers who subsequently discover it's not what they expected.

Someone I know fell for the advertising hype surrounding the latest hi-fi system during the seventies boom, only to discover for the first time that he was deaf in one ear and couldn't benefit from its highly balanced twin-speaker, ultra-fidelity capacity.

And doubtless the home-micro industry has suffered similar casualties.

Nevertheless, I suspect the computer business will survive these devastating findings. After all, even in this day and age, not everybody either can, or wants to, drive a car, but nobody's predicting bankruptcy for the Ford Corporation.

Contents

Editor: *Ron Keeley*
Associate Editor: *Mary Sargent BA*
News Editor: *Helen Armstrong BA*

Computers On Camera

Too many people are bewildered by computers, even frightened of them, says the Saturday Show's computer expert. That's why, although their job is to entertain a young audience, they aim to enlighten as well. If parents benefit as well as kids, so much the better . . .

by **Helen Armstrong**

Glitter, spangles, music and laughter. These are not the usual surroundings for a computer, you might think, but to the team on ITV's popular children's magazine programme, the Saturday Show, they are at least as natural as the classroom or the family TV set. While computers are not yet endowed with the glamour of a pop star or a formula one racer, presenter Tommy Boyd and producer Glyn Edwards felt strongly that the microcomputer's technocratic image could be brought down to earth to provide entertainment and practical information for their young audience.

This conviction led to the show's researcher, Robin Eastwood, to track down computer journalist Chris Palmer to act as the show's consultant on all matters computerate. An expert at the age of 20, Chris was a member of the young computer generation, while being experienced enough to take a broad view of the subject. Chris resents being called a whizz-kid. As he points out, the real "whizz-kids" are around 14 — or younger — falling into the age bracket of the Saturday Show's audience.

But the computer corner is not aimed at the elite of the youngsters to whom programming a computer seems to be as natural as talking. They are concerned with the other 98 percent, the ones who are curious, or who haven't yet seen enough to be curious, or who have seen just enough to be intimidated, baffled or bored stiff by the whole idea. Perhaps unsurprisingly, the germ of the curiosity which the show's staff detected had arisen from what must be the most glamorous aspect of computing to most teenagers. No, not space invaders, but the wealth and fame achieved by the invader's inventors, the freelance program writers, sometimes only 15 or 16 years old.

The production team became aware of this interest after a spate of news items in 1983. As a result, they asked Chris at first to organise a couple of general-intrerest items on computers. These were a success, and Chris was asked to supervise a regular computer slot, thereafter known as Interface. The task, as he saw it, was to present micro-computers to the school-age audience without preaching only to the converted. To do

"We have done some pretty revolutionary things" says

Chris. "We were the first to transmit an actual computer program, live on the air, so that people could record it in their homes, take it to a computer, and run it. All they needed was a tape recorder, or a video recorder."

Not that this first in computing and broadcasting was trouble-free. The program broadcast was a game for the Spectrum, and viewers were invited to send the solution to the game to the programme. When no response came, the team checked a recording of their own broadcast, and found that electrical noise from the studio had destroyed the program as it was sent out. They re-broadcast it in a subsequent programme, and presto! three hundred replies arrived. The over-the-air software was a success, showing how computer data could be sent simultaneously to every home in the country and stored for future use.

This is just one example of Chris's policy of taking ordinary domestic microcomputers and doing unusual things with them. Computer graphics are inviting because they can be altered in colour and form to suit the user, and can be printed out — in different coloured versions — and kept. A computer-controlled robot, too, went down well, not least because it showed the experts having their own problems as the little robot stubbornly refused to do as it was told.

Definitely for the initiated was the show's competition, co-sponsored by Commodore, to write a program. The response, amounting to several hundred programs, was remarkably good, especially as this could only include youngsters already owning and programming their computers. "It took us two weeks to work through them all" recalls Chris.

During his time working with computers, Chris has been impressed by the unusual relationship between humans — especially, but not exclusively, youngsters — and their computers, which seems to exceed the intimacy between some male persons (typically) and their motor vehicles.

"They talk to them" explains Chris. "And, unlike any other piece of machinery, the computer answers back. I'm not talking about speech synthesisers, although that could come! But BASIC, or any computer code, is a complete language which can pass information about what is going on inside the computer, in response to instructions from the user. A language like BASIC is not so very different from standard English."

The complete absorption in the computer experienced by some users is not merely because they can converse with them. "Kids want to have fun" says Chris, "and once they know how to use it, the computer offers almost infinite fun and amusement. It engages their sense of fantasy. It can be their plane, their space ship, their jungle, their games board. It's a window into another world." It's the software which is important to them. It's malleable and intangible, like magic. Once they have learned to write and modify their own software, they can conjure up whatever scenario they want."

This special relationship with computers has, apparently, both positive and negative results. Shy people are often drawn out by their enthusiasm and become communicative, but others become so absorbed that they are only concerned with their machines and other enthusiasts, giving rise to the little clusters of "computer buffs" who huddle together talking an incomprehensible jargon.

Fortunately this excess mystique will become a thing of the past, as more people

Let's not get too serious. This is a Saturday morning variety show, and everyone's in it to have some fun. Presenter Tommy Boyd, in his Saturday Best, prepares to count in a competitor on Up For Grabs.

become acquainted with how they actually work. "Many parents find them scary" says Chris. "They've heard that the computer is the most powerful tool ever invented, something that can take over the world. On a more practical level, they are afraid that the computer will replace them in some way. Then they see that their kids can control computers almost naturally. They're afraid that their kids are more knowledgeable than they are, and terribly different. This happens when the kids are very young, and it worries the parents. But all that is happening is that children pick up new languages faster than adults, and learning computing is learning a new language.

"Computers very rarely get used for practical applications in peoples' homes. How many people do you know who actually keep their accounts on a computer? That tends to be limited to the salesmen's schpiel. They mostly get used for playing games. Interested kids gradually get bored with playing games, buy some add-ons and start programming. They start by writing their own simple games, they read the manual, and gradually find out just what the machine can do.

But Chris is keen to promote the very realistic view that learning how to program is not the only route to understanding computers. Far from it: programming is a specialised task. Most computer users don't need any knowledge of programming at all: the software is already witten and packaged. The majority of professional users don't even have contact with the software.

But I wonder, does the sight of Chris's computer complex, roped together with cables and not always responding on cue, contribute anything to the confidence of the uninitiated child, let alone its parents? Chris reiterates that children want to be entertained, they like a challenge, and they want to know that they can get their hands on these pieces of machinery and do things with them, that it doesn't matter if they don't always get results first time. Once they know that they can experiment, that they can make mistakes without breaking anything, and that the results are there as they hunt for them, the barriers are down.

The next step is to get "hands on" the machinery. Inspired by the traditional "grab a gobstopper" seaside game, Chris devised "Up for Grabs". Like the original game, this involved one mechanical grabbing arm, operated by remote control, which the players use to fish for prizes. The difference was that the player in this case could be five hundred miles away.

The motorised arm would be controlled by a computer in the television studio, but would be connected via another computer to a joystick controller in the home of a volunteer viewer somewhere around the country. The signals would be passed from the viewer's living room, to the television studio in Birmingham, down the telephoe lines. The player would watch the robot arm on television, live as it happened, and attempt to manipulate it to collect a trophy from the array of prizes.

However, linking the joystick to the robot arms — not originally designed to be joystick controlled — and feeding the real-time signals from the distant joystick via the telephone to the television studio so that the player could see what was happening needed a completely new piece of software, which Chris wrote himself. As it was experimental software, he designed it so that he could recompile the program in the morning before the show began, using PET speed compiler software, if he saw a way of improving it.

The robot arm itself, Armdroid I, was contributed by Colne Robotics, who also made some modifications to it to make it easier to control. In the studio, the arm was given an orange livery with fluorescent green grabs, the better to tone in with the show's sparkly decor, mounted on a revolving rostrum, and it was ready to go. Meanwhile, the computer corner's Man On The Spot, Simon Rockman, was standing by to travel to a distant place, armed with joystick, modem and computer, to set up the controls needed to operate the arm.

"We had a good response to this" says Chris. "We would probably have had an even better response if we had made it clear that the kids didn't have to have their own computer, or the right sort of computer. We provided all the equipment. It would be impossible if we had to adapt a whole lot of different set-ups." Chris prefers to work with the Commodore 64, which he knows well and finds excellent for control work. On the strength of this, Commodore provided a modem and other equipment for Up For Grabs.

Once everything is linked up, making the grab is not as easy as A-B-C. Real-time machine control by telephone is not a commonplace requirement, and ordinary modem links are not designed to encode and decode signals quickly enough for a mechanical gadget to respond smoothly.

"The Rick Wakeman of the computer keyboard" – Mr. Palmer co-ordinates micro, modem and a string of back-up systems to put a viewer in charge of the Armdroid.

The movements of the arm are more complex than the normal up-down-left-right-fire of joystick commands, giving the player a different set of responses to become accustomed to before the game. Chris got around this last factor, largely, by organising the control software so that the arm mirrored the movement of the joystick as much as possible — but there was still the grab to manipulate. Nonetheless the movements of the arm occasionally appeared eccentric to say the least. And the player had exactly one minute and twenty seconds to grab the prize. A minute is a long time on television.

Watching the robot arm perform live, the catch in the grab become apparent — literally. Chris contacts the player of the week by telephone and puts him in touch with the arm. As the countdown begins, he stands by with a spare joystick — they even have an "understudy" player standing by in case of line failure — and calls instructions to the player. The arm begins to move, in response to the joystick on the other side of the country. It moves uncertainly at first, peering around. Then it begins to home on one of the packages. The player can only follow its progress via the television. On the TV screen, the robot's grab is clearly linked up to a prize, but seen from another angle, it's a good six inches to the left. The player can't see this. "Right, go right" calls Chris. Eventually the player of the week manages to lift one prize away and drag off another, blundering into a few more on the way. "This is the best one we've had so far" Chris enthuses. "Usually they just knock them over. We give them all the help we can, but the two-dimensional TV picture doesn't give enough information. There's no parallax to guide them. We stopped using the rotating rostrum after the first couple of attempts."

Nevertheless the studio audience are cheering the arm, apparently moving of its own accord. The player is up in North Wales, and is the last contestant. The experiment has run its course, the series is ending, and when it returns there will be something different but, if Chris has his way, no less experimental.

What about the entrants, I asked. Computer freaks tend to be male. Are they all boys? "Mostly, but we've had about twenty per cent girls replying, which isn't bad." I asked why he thought girls seemed less interested in computing than boys. He gave the opinion that they weren't encouraged enough, and that they wanted to see something useful that they could do with computers. He does not see cookery software as an answer.

Chris doesn't see the Saturday Show's computer corner as overtly educational. "It's a Saturday morning kids' programme, we don't want to be seen as directly trying to educate the kids. But we try to educate them subtly." So why attempt to educate at all? "There are a lot of people who are very confused about computers. Any hints and tips they can get are a help.

Chris also has his views on educational aspects of computers, especially about teaching computeracy. The computer as a window on a magic world where anything is possible is a view which has impressed him. "Educational programs can encourge kids to play, and therefore to learn" he says — reinforcing a view which is developing here at Soft Options. "You can get their attention by playing up the fantasy element; when they get the questions right, especially. This is primarily for younger kids. The older ones are better at just

Tommy Boyd demonstrates the "parallax problem": the two-dimensional TV screen gives a flattened view of the arm and its targets, so that it is very hard to judge where the arm is pointing.

working through the examples, using the computer as a personal teacher. There isn't a great deal of this happening yet."

"Schools don't have enough machines. A school tends to have "a computer". You need one per child. That's a purely an economic problem."

How does he rate software as opposed to textbooks as the educational medium?

"That's hard to say, but good software could be easier to index because the computer can search very quickly through the material. There's not much software of that kind."

As to teaching computing, he doesn't like to see too much on the school curriculum, believing that formal teaching can put youngsters off programming, which they often teach themselves out of enthusiasm. He thinks they should be told to "go away and play with the computers" to see what they can get out of them.

"What should be done" he says "Is to teach people how to use computers, instead of how to program, which is specialised. The time would be better spent in teaching them how to extract information from a database, how to use the system, how to use the power of computers to access information. This is what is meant by Information Technology. I think that the teaching of computing is being formalised in the wrong direction."

Talking after the show to Tommy Boyd — who refers to Chris as "the new Barnes Wallace" — I learned another angle of the Saturday Show's involvement with computers. According to Tommy, both he and the show's producer, Glyn Edwards, are "converted computerites". Tommy's father was a computer engineer on the juggernaut-sized mainframe computers of the fifties "where you had to work all week to get the thing ready to operate for two hours on a Saturday, and it could do less than a Spectrum" — these machines didn't capture his imagination. Microcomputers did, however. "They looked like fun and they are fun" he says. "I play with my computer." Tommy reckons that youngsters presented with computers start off by playing with them, and gradually progress to writing programs. He claims that he can't write programs himself — the furthest he has got is around 100 lines — because he doesn't have the large amount of free time needed to become familiar with the art. "After doing about ninety-six hours in one week, you begin to develop a relationship with the computer" he says.

Having begun with a game that mimicked an old-fashioned seaside game, Tommy would now like to move on to something futuristic "With fantastic visuals, like a videodisc game — say finding the way out of a maze". The next series of the Saturday Show will have a new producer, Graham Mole, and a new set of attractions including, we hope, another contribution to the cause of making the home computer so familiar that "techno-fear" is in the forgotten past.

Soft Talk

This month's reviews have been written by primary and secondary teachers, and by parents with children of the ages catered for by the particular programs on test.

Words, Words, Words

(A.S.K. Software)
BBC Computer
Recommended for ages 5 to 8
Price: £9.95

Reviewed by **Roger Battley**

The program comes on a cassette together with a small, twelve page booklet. This is wholly adequate documentation, and the quality of the paper and layout are designed to give the impression from the outset that no effort has been spared to create a good, usable program.

And this initial impression proved to be extremely accurate; a good, usable program is precisely what A.S.K. have produced.

It is aimed at the 5 to 8 year age group, with the degree of assistance decreasing for the older child.

The booklet is divided into sections, one of which gives a very full explanation on how to load the program and cope with possible problems.

This sort of information is always welcome, both to home users and to harrassed teachers working under pressure in classrooms, and it is a pity more programs are not as well introduced as this one.

Another indication that A.S.K. knows what it is doing lies in the educational notes, which give some helpful hints, probably for the home user rather than the teacher, who could very easily introduce the program as part of the class activities.

The particular point which impressed me concerned upper and lower case letters. Displayed letters are always in lower case, regardless of whether the CAPS lock is on or off, and this, as the handbook points out, could cause confusion because the letters on the keyboard are upper case.

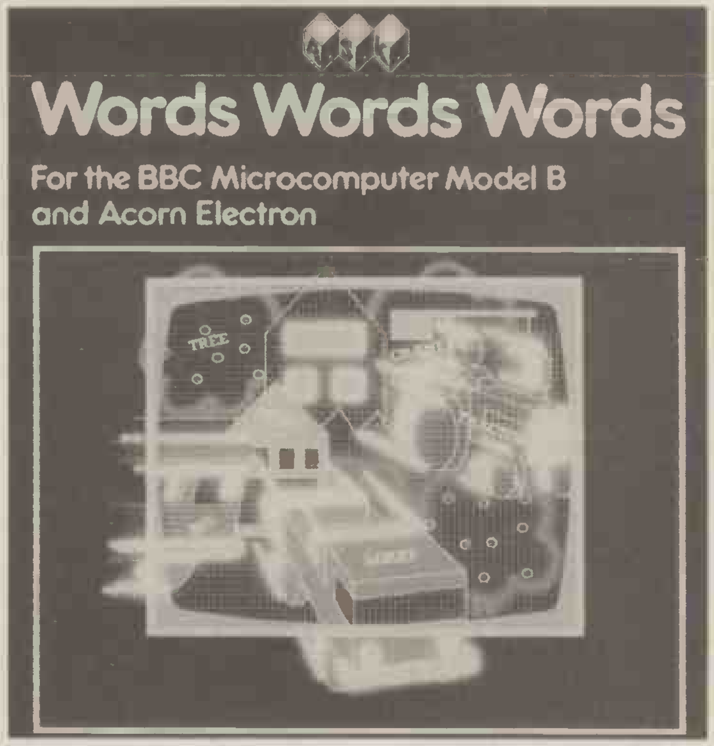
The booklet suggests using stickers printed with lower case letters when younger children are using the program, which indicates that the writer really has thought about computers vis a vis children.

Perhaps some enterprising manufacturer might consider offering a lower case keyboard for use in infant and primary schools.

At the end of the booklet, a list of words used in the program is given, with alternatives in some cses.

For example, a drawing of a bus can be identified either as such, or as a coach.

I found one error, when the word "ant" was not listed, but since my daughter was able to



identify it and the computer accepted her input, that is hardly significant.

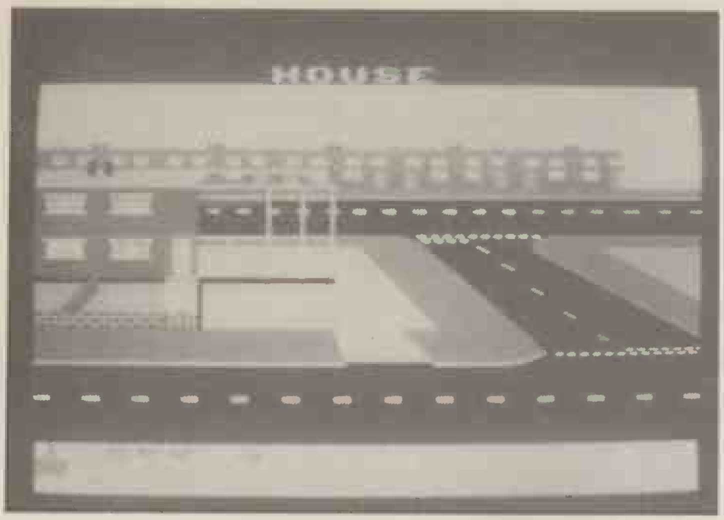
As for the program itself, this has been equally well thought out. Since I consistently forget to rewind a tape after loading, the fact that this one was recorded on both sides prejudiced me in its favour.

I also felt that it was very thoughtful of them to print clearly on the cassette the time needed to load the program. If a teacher knows it will take 4 minutes 25 seconds to load, it helps with lesson planning. And as it happened I had no difficulties with loading, at all.

The object of the program is to build up a scenario by correctly spelling the names of things drawn by the computer. The really captivating aspect is that when the game has been successfully completed, the finished picture is animated as a reward. The children who played the game enjoyed this very much.

A menu gives a choice of eight places which can be visited during the "writing" of the picture story. You can visit them in any order, with the limitation that the castle always leads to the end of the program.

The "sound track" volume is adjustable and it is worth doing this before you select the



first loction; this is done by typing in the name of the scene required.

Once the location is chosen, a series of objects such are presented for identification and their names must be correctly spelt.

Two attempts at each answer are allowed, and if the word is properly spelt the object is re-drawn as part of the scene to be built up.

If the answer is wrong, the computer gives the right one, but the object is not included in the finished picture.

When the picture is fully complete, the animation starts.

A duck swims across a pond, a car drives into its garage, a balloon floats away and bursts or a girl posts a letter.

The animation was sufficiently well done to hold my seven year old daughter's attention even after several demonstrations of the same sequence, and it certainly encouraged her to try other locations to see what would happen.

The final venue is a suitable castle scene and involves a ghost and a wise (BBC?) old owl, which were particularly enjoyed by my children.

The program ends by generating most of the characters featured along the way, and moving them slowly and randomly around the screen. This, in itself, the children found entertaining as they "spotted" the different creatures.

In my opinion, this is a most successful program, and could well be used with successive classes in schools. The words it uses formed a good basic vocabulary of object names likely to be frequently encountered, and the program worked well on a black and white screen. In colour, however, it really came to life.

Did I have any criticisms? At the risk of being petty, I felt that some of the sounds produced by the objects, when animated, could have been more realistic.

The duck for example, spoke a language entirely unducklike to the conniseur of quackish, but this seemed to worry me more than it worried the children.

I would like to see, as a future development of this program, possibly on disc, a facility for creating characters and scenes oneself, and so expanding the word list to make a highly useful program even better.

Having nit-picked, I must now say that I can thoroughly recommend *Words, Words Words* for use in any primary school and I am equally sure that parents using it for children at home would be pleased with it.

A.S.K. programs are available mail order from A.S.K., at London House, 68 Richmond Road, London SW15, or from the same high street outlets as Acornsoft, who are marketing their software priced £9.95.

Pathfinder

(Widgit Software)
16/48K Spectrum
Price: £5.95
Reviewed by **Gerald Lockyer**

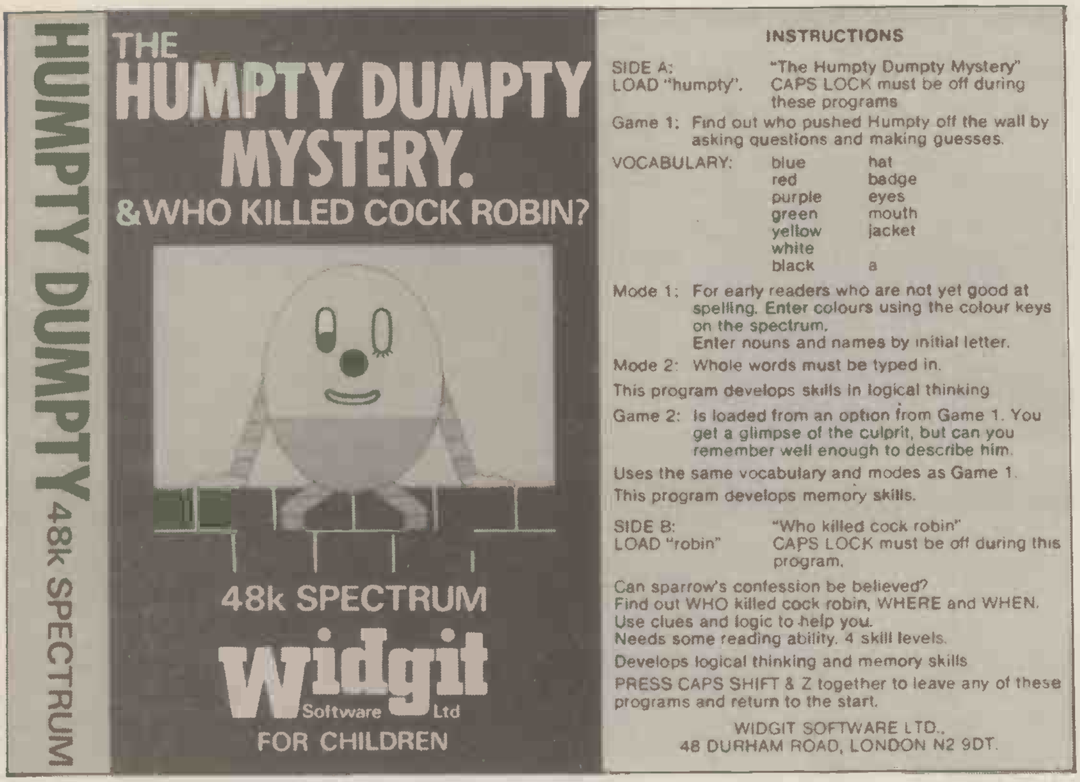
Pathfinder is an attractive set of four programs appropriate for infants or pre-school children. The instructions tell us that the programs are intended to "help children think in spatial terms and plan moves ahead", and I think they will succeed.

They also demonstrate some important computing concepts for beginners, such as automatic execution of a list of instructions. The programs are quick to load, can be listed and will run on either the 16K or 48K Spectrum.

In the first program,*Rabbit,* four cursor control keys move a rabbit through a maze. The maze is created by a random procedure at the start of each turn, and takes a few seconds.

The final maze always, miraculously, allows for only one pathway through it! However, since even the blind alleys are paved with carrots, which the rabbit systematically chomps as he advances he'll probably want to eat the lot before leaving.

Kangaroo is also a maze game, with the added attraction that a sequence of moves can be entered before they are executed. If, for example, you enter 5 followed by 1 and then press G for GO, the programmed kangaroo jumps five squares up and one along — unless he hits a wall, due to a miscalculation.



You have the option of entering and executing one move at a time, or of plotting his entire route in advance. All the moves are clearly listed beside the maze for checking, and are flagged as they are executed.

In the third program, *Picnic,* the grid is still present but without maze partitions. The task here is to steer a monster round four sites, so that it may pick up fruit.

The game calls for foresight and planning skill, since the monster must not cross its own trail, and the player has the option of giving up and restarting with the same layout, which is friendly.
The final program, *Frogs,* tests similar skills, with more sites to visit and with obstacles to avoid. The frog must cross a pond, picking up as many as possible of his six friends on the way, whilst avoiding water lilies and his own trail.

Judged purely as games, all four programs share a weakness: there are no prizes for speed or success, and I think this might discourage some children who need such motivation. The one special reward promised for a fully pre-programmed kangaroo was merely a series of hot flushes as he retraced his path. **Adult supervision** is needed, both to get the children started and to applaud their skill. This puts the emphasis on fostering parent teacher involvement, a good component of software for early learning.

The programs are robust and very simple to use, employing a minimal set of keys, and are distinguished by imaginative screen designs and motifs, which use cheerful, well-contracted colours.

On the whole, *Pathfinder* is a skillfully designed package, well suited to its aim and at a price which makes it a very real alternative to toys and books.

The Humpty Dumpty Mystery

(Widgit Software)
16/48K Spectrum
Price: £6.25
Reviewed by **Audrey Verdin**

The tape consists of three games, each involving at least two skill levels. The Humpty Dumpty game has two response modes: single key or the typing in of whole words, which constitute a challenge for older children.

The first game is the "Humpty Dumpty Mystery" itself.
Humpty Dumpty has been pushed off his wall with malice aforethought, by one of the King's Men, and the players must determine the culprit by a series of questions designed to establish the colour of his hat, badge, eyes, mouth and jacket.

If it is established that the felon's hat is not red, for example, then pictures of all red-hatted suspects are removed from the screen. An informed guess is possible, when the field has been sufficiently narrowed.

This is a game for one player, similar to the board game, *Guess Who,* by Milton Bradley. Young children found it difficult to sort out the men's names in the initial line-up of twelve suspects, since there are no spaces between them and they are written in capital letters.

However, they enjoyed the pictures and loved it when Humpty Dumpty winked at them when they had solved the mystery. From a learning point of view, the value of the game lies in teaching children to recognise sets, and evolve a logical strategy in questioning.

Game Two involves identifying the unfortunate Egg's attacker by dint of remembering his colour scheme, briefly glimpsed as he gloats over his villainy. Questions and answers develop a description of the man and points are awarded for accuracy.

The younger children found that the mechanics of this game easier, and it is a very good program for developing visual memory and visual discrimination, which are essential skills in learning to read.

The third game is *Who Killed Cock Robin,* which uses logic in the same way as *Mastermind* by Invicta. Sparrow has confessed to the dastardly deed, but we are invited to query his guilt.

Detective work is required to discover the murderer, the time of the crime and where it was carried out.

There are four skill levels, and from three to six suspects, times and locations may be selected. The answers are determined by logical deduction and the occasional clue, if requested. The clues themselves need to be approached logically.

The program uses good graphics, is well presented and provides an interesting exercise in logical thinking. It is advertised as "One of a range of programs for pre-school and primary aged children", but the children at the lower end of the age range play the games intuitively rather than logically, and do not easily develop a systematic approach until they are about seven.
There is no doubt that these programs represent a step in the right direction. Widgit have produced a truly educational tape, in the best sense of the word. It is entertaining, attractive and appeals to a wide age range. At £6.25, it represents excellent value for money and is the sort of package needed in primary schools.

It will be also give pleasure and value to children using it at home.

All Fingers Go

(Micro Trust Software)
BBC Model B
Price £14.95

Reviewed by **Roger Battley**

All Fingers Go (Ultra Fast Touch Typing) from the National Extension College comes in a moulded plastic case which holds the instruction booklet and two cassettes. The booklet gives an introduction to the programs, together with a summary of the commands available to the user.

It also gives instructions on loading and running the tape, and the warning that if you have the disc interface fitted, you must first reset the page to &E00.

This being done, the tape loaded first time, every time. A colour set is an advantage when using this program, and there is a facility for altering the colours originally programmed. This has its own sub-menu and the function keys are used to change the settings.

It is worth adapting the colour to suit your own prejudices and to find the particular combinations which show best if you are using a black and white set.

There is a "beep" used to signal a typing error, but the volume of this is adjustable to suit your mood, your state of nerves or the time of day ("You musn't disturb the children while they're sleeping").

As a confirmed beeperphobe, I was grateful for this very thoughtful touch!

The program, when loaded, displays a menu from which you make your lesson selection. The screen display is split, with the keyboard layout of the micro in the lower half and the instructions in the upper. The pictured keyboard has the outline of a pair of hands over the keys and this is used to show the correct finger needed for each key.

These phantom appendages hover over what we-in-the-learning-to-touch-type business quickly come to recognise as the "home keys", a base from which to make all moves to the rest of the keys.

The first program is an introduction to the keys, and subsequent lessons followed in a similar format to lesson 1.

At first, the keys to be struck change colour on the screen, which assists indentification. The same sequence of letters is then presented as a line to be copied, and the screen fingers move to the next key as you hit the right ones, but there is no colour change.

Each line has to be typed three times before you may move one.

In the second part of the program, you have the same letter sequence, but must now type with no errors before you progress.

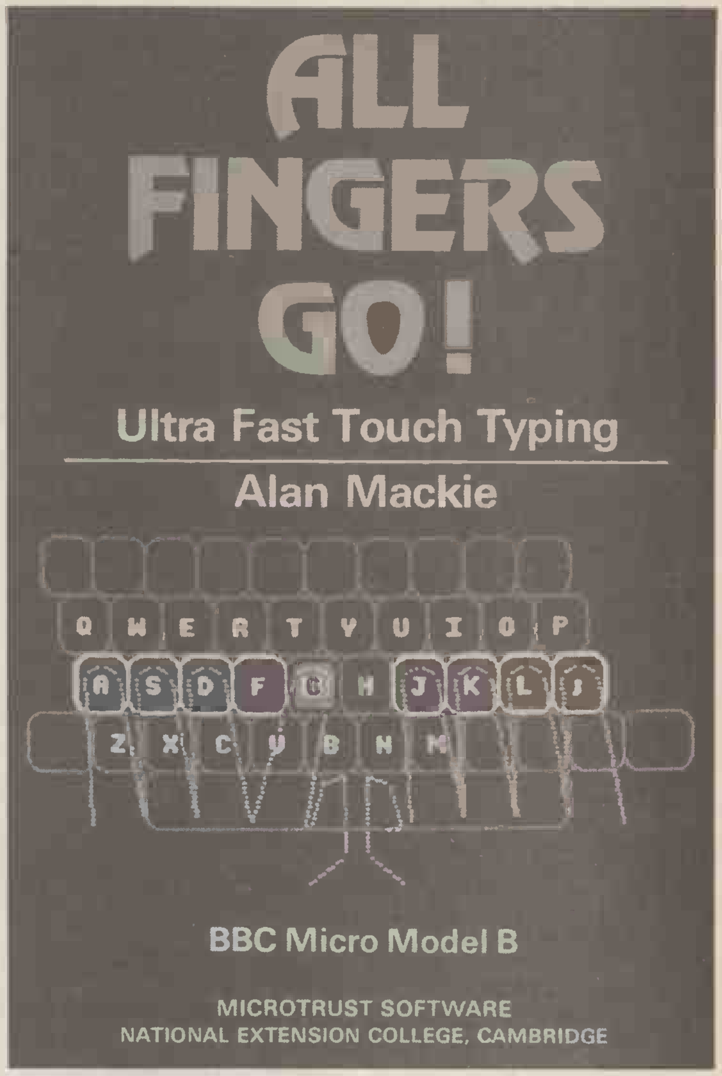
As your fingers leave the home keys, the diagrammatic digits also move, indicating which finger to use and where the key you need is located. it quickly becomes fairly easy to type the right keys by following the screen fingers, and not looking at the keyboard.

With each ensuing lesson, new keys are introduced, and by lesson seventeen, you will have used every key, always assuming that you haven't indulged in any short-cuts, otherwise called cheating!

There are eighteen lessons in all, which take you through all the processes of learning to type.

Each lesson begins with a menu detailing additional features useful to the particular lesson. Lessons are loaded separately and if you leave one uncompleted, you can return to the point at which you left off.
You can also check progress and obtain a speed and error analysis for each letter typed.

In later exercises, the sentances are automatically adapted so that words you have found difficult occur frequently, which ensures that you get the necessary practice.



The features found in each lesson are very concisely listed in the handbook.

The program has been written with the beginner in mind. The emphasis throughout is on accuracy, not speed, whilst the division into eighteen lessons enables the more advanced student to join the program at a level appropriate to his standard.

I am very much a two-fingered typist at the moment, but the early lessons have conviced me that touch typing is within the reach of the patient and self-disciplined user. The program has a very friendly approach which helps make a painstaking process as painless as possible.

It might have been useful to have a printout facility so that the speed and error analyses could have been saved and compared with subsequent attempts, but this is a very minor point of contention.

If you need or wish to learn basic keyboard skill, including correct fingering and the like, then this program should prove invaluable. I certainly have no hesitation in recommending it, and if you feel the initial cost is high, I can only say that the more one uses it (and practice in plenty pays dividends), the better the investment becomes.

Just one other thing. Does anyone where I can get a program teaching patience and self-discipline?

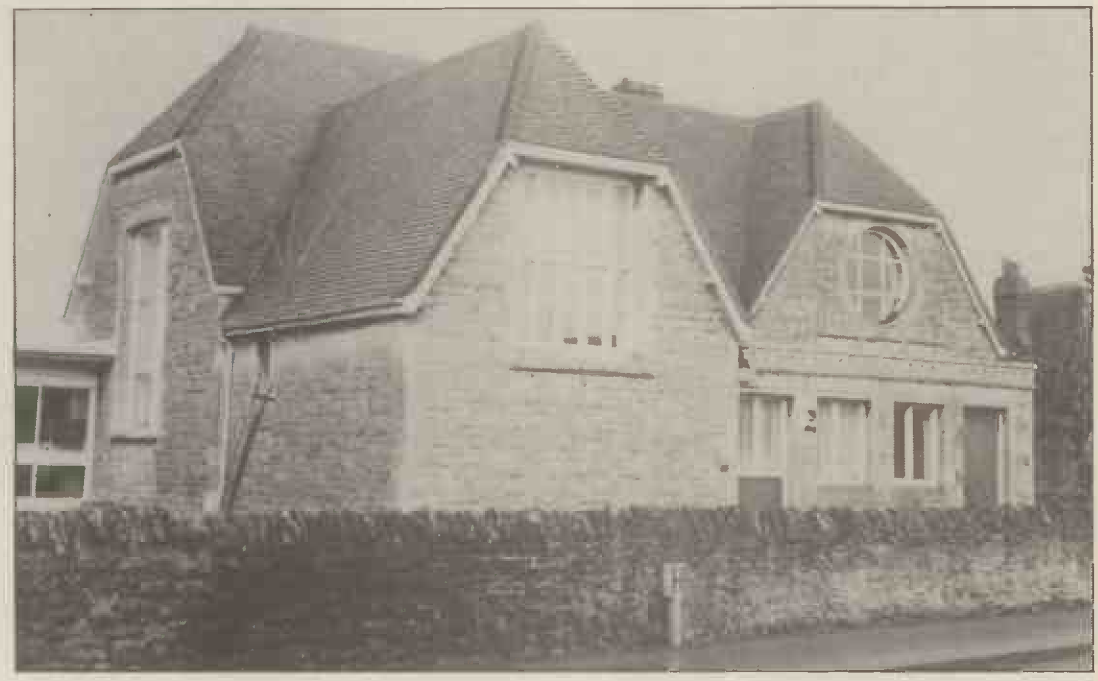
All Fingers Go is available from computer departments in W. H. Smith's or by mail order from Microtrust Software.

Microtrust Software,
National Extension College,
18, Brooklands Avenue,
Cambridge, CB2 2HN
0223-316644

Stanford-In-The-Vale

There are enormous practical difficulties in introducing computers into schools, but two teachers in rural Oxfordshire managed it with energy, enthusiasm, and the active assistance of a Parent's Association.

by Mary Sargent



Stanford-in-the-vale is a small rural village with a few shops, a garage, a village green and a primary school which boasts 142 pupils between the ages of five and 11 years, and five members of staff.

It is not a wealthy community and the school buildings reflect that fact. But if the buildings are out of date and in need of renovation, the standard of education being dispensed within the grey stone walls is emphatically of the 1980s, for Standford-in-the-Vale is in the process of achieving what many larger and more sophisticated establishments only aspire to in theory.

With only one RML 480Z and a couple of Sinclair ZX machines, the school has produced such a degree of computer literacy among the children that the difficulty it now faces is, what to do next?

But how has this odd situation come about? The first thing that must be said is that it could not have happened without two specific factors: one is Terry Rothwell, who has been at the school for 17 years, first as deputy head and for the last six years as headmaster; the other is Bob Loader, who met up with mainframe computers as a physicist at the government research establishment at Harwell and decided to take his enthusiasm and expertise into education in 1968.

He arrived at the school in 1971, and when Sinclair launched his first computer, the two men together set about harnessing the micro-revolution for the children's benefit with an impressive dedication.

They started with a ZX 80 bought from school funds, and without active understanding or support from either Stanford or the County Education Authority.

"One could see straight away," says Terry Rothwell, "that computers were coming in so quickly. They had such a lot to offer education if education could take advantage of it, not only in basic learning skills but in the interactive programs, making children more aware. When we first started we were basically thinking in terms of children being aware of computers, so that they would not be frightened of them. This was to be their future. I could see it coming into so many fields, credit card systems, paying in shops — it's all there in an embryo form. In education, whilst we are trying to educate them for the present world, we must also educate them for the future they will be living in."

Initially, Mr. Rothwell used his status as a familiar and trusted figure in the community to persuade parents that his ideas should be given a chance. Today, no such persuasion is necessary. He has the active help of a Parents' Association which now raises around £1,000 a year, which is largely used to supplement the hard and software support for the RML system, partially funded by the Government's MEP scheme.

As further proof of the success of the school's computing enterprise, some twenty of the older children now have their own microcomputers at home. In an area where money is not in vast supply, that sort of domestic expenditure is a clear indication that the Stanford parents still have faith in the headmaster's vision.

It is just as well, for the school faces two major problems. The first is hardware.

"I'm very pleased with our computer. My only criticism of RLM, indeed of all these firms, apart from Sinclair, is that they're all trying to make their fortunes in one year. The basic cost of the 480Z with a monitor and so on is around

£800. These sorts of figures are way beyond any normal primary school.

As teachers, we're delighted to know that the RML network exists, but there's no way in the present economic climate that anybody's going to be able to afford one. I feel that schools should be leading the way as regards equipment and not be behind homes. Take colour televisions. 80% of my children had colour television before the school had one! It should be the other way round, but inadequate funding is a part of our lives.

With one RML and a couple of Spectrums in the school, interaction between children is inevitably encouraged.

I'm not criticising Oxfordshire. They've done theii whack as far as they're able to in the sense of the government scheme, but we really need about five government schemes. And the other aspect of this problem is that, whilst Sinclair's prices are steadily coming down, Acorn's BBC machine and others have actually gone up! As a non-business man that doesn't make sense to me."

The second major problem the school has to contend with is a lack of good software. A lot of the programs are maths based, since these are the easiest type of program to write, but the need at primary level is for introductory programs in English, Remedial Reading and other subjects in which the primary teacher feels confident.

Mr. Rothwell believes that a teacher should be able to say, "This is what I want to do and I would like some programs to supplement the work and teaching I am doing." There is no doubt in his mind that the teachers must be dominant in deciding the content of the software.

It is not an area for the computer experts or the commercial firms and he is depressed about the lack of liason between the software houses and in-service teachers.

He feels that four years ago, the Government should have set up a team of 50 people to write educational software to specific briefings, which would have afforded some kind of basis for educational development, but he admits there is no easy solution to the problem.

A good teacher cannot always define why he operates in a particular way, and therefore may well not be able to communicate to a third party precisely what he needs in the software line, or why.

As far as Stanford itself is concerned, there is one member of staff who can partially mitigate that particular problem. Bob Loader has just spent some 300 hours writing a program, usable on either the 480Z or the secondary schools' 380Z, which demonstrates factorisation in a colourful and graphic form infinitely superior to many of the commerical programs available.

It is an unrealistic amount of time on top of a teacher's already demanding work-load and in any event, few teachers could work to Mr. Loader's exceptionally high programming standards. His personal commitment to computing in the school is total, but he is no fanatic.

Uninterruped use of a computer at home allows more concentrated activity.

"I'm cautiously optimistic about the future. We have a problem with the number of machines available and what software is available. I don't know what the limits are as to how far you can go with computing in schools. It's like so many other things, television for example.

It's a novelty to begin with and then later on the children become insensitive to outside stimulus. When we have television programmes, I enjoy them sometimes more than the children do. They watch television and immediately it's finished, sometimes before the end, they want to go on to something else. And I think the same thing will happen with the computer if we're not very careful.

In some ways, you can never win. If the programs become more attractive, then children may become blind to software which is less colourful but has a lot in it. But we've just got to wait and see."

This problem equates with a dilemma familiar to many teachers — if a reading book is designed with colourful cartoons and speech bubbles, is the child better motivated to read or seduced in to merely enjoying the presentation and avoiding the learning process?

At the moment, as Terry Rothwell says, "There's no doubt about the terrific motivation from the children," but they agree that, in Bob Loader's words, "It's got to be handled in the right sort

Some participants in a co-operative session lose interest occasionally!

of way, and it varies from time to time as to how you're going to use it."

Because Stanford was the first primary school in the area to show interest in computing, there has never been any question of facilities being delayed or withheld. What the County has been able to offer under the MEP scheme, it has offered, and Messrs Rothwell and Loader have done the rest with funds and support from the Parents association.

"We're better off as a small village school than a large comprehensive. Even though we only have one computer, it's much more available to all the children than in a comprehensive, where there are still only one or two machines and many more children.

We're using it as a tool for education, not to teach programming. In a secondary school they're trying to prepare children for examinations in computer studies and so on. We haven't got that problem."

"And if she presses these keys it plays Rhapsody In Blue".

But what of the future? The men agree that they are not interested in forcing programming into pupils. If individual children decide to pursue that angle, that is a bonus, but as a subject for the classroom, it is outside the scope of primary education.

Terry Rothwell believes that a future based on half-day schooling, with children working from home using computers as electronic books would be a very poor substitute for the personal contact and interaction which happens at school between teacher and child and between the children themselves. He is hopeful that that particular vision will founder on the built-in social factor of the need most parent have for their children to be out of the house from nine to four.

So where does education in general and Stanford in particular look for future developments?

Terry Rothwell is sure that robotics provides an immediate answer. But like every other aspect it must be handled with care. The latest in technology is not automatically the best in all situations.

"Floor turtles, I think, are exaggerated. In our situation, you can achieve the same attitudes and thinking with Big Trak. At Primary school level, floor turtles are too precise.

To have a Turtle drawing you a little triangle, that doesn't mean anything to the children. To have a Big Trak going through some chairs, now that's a different situation completely. Turtle is absolutely superb for older children, a possible development for my older children, 11 year olds. Big Trak — best toy out.

But the things which are going to come in over the next few years are the robots. No doubt about it. Tandy have a superb little robot at £30 and I can see great potential there in a primary school situation . . ."

It would appear that Stanford-in-the-Vale has little cause to worry about developments in its own village school coming to a halt for lack of ideas, but how does Mr. Rothwell see the situation in education as a whole?

"If it hadn't been for teachers moving along with Sinclair, who was the one who broke the market open in education, I really don't see that we would ever have had any movement from the top, particularly in primary schools.

What we really need in the educational world is for some of the passion and the drama which is found on the arts side of teaching to be applied to computing. We need a sense of urgency and enthusiasm, not clinical detachment and scientific caution."

The underlying drive and rationale of both men's commitment to the micro-revolution in schools is perhaps best summed up in Bob Loader's assesment of the computer's usefulness to children.

"It's got an immediate appeal and gets an immediate response. The important thing is it carries a person on, whoever they are, a child or an adult, and I think it is universal in that it applies to all ages and all abilities. It has this ability to draw you on to the next step. I find this myself with programming — you don't want to stop. It is so enjoyable to get on a bit further.

I don't think it's good to fix any limits on it at the moment. We don't know enough yet to say, don't use a computer for this or that. You've got to be very open about it and use it when you feel it's the thing to use."

There is little doubt that the school in Stanford-in-the-Vale not only feels it is the thing to use, but is using it in a very effective way.

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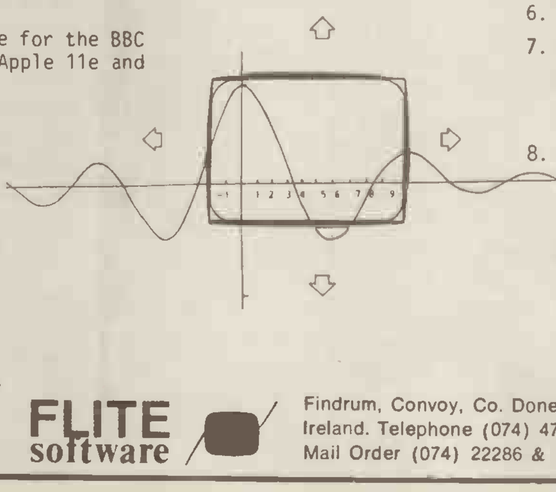

Cartesian is fun to use, which should go a long way towards ensuring that it *is* used, and it is both powerful and flexible enough to be of real benefit to any serious student of mathematics.

-Hobby Electronics

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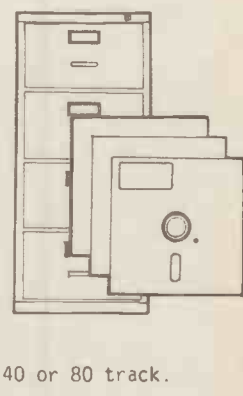

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Tandberg TCCR 530 Computer-Programmable Cassette Recorder

Soft Options looks at a computer-controlled cassette recorder designed to make waves in computer assisted learning.

Reviewed by **Margaret Curtis**

The Tandberg TCCR, is capable of being used, on its own, as a high-quality conventional tape recorder and, in conjunction with a micro with RS232 interface, as a highly sophisticated computer-controlled machine.

It has its own internal micro computer which performs a variety of tasks like winding and speed control, scanning its own keyboard, computing the *linear* tape counter values and displaying the results on seven-segment LED digits, and communicating with the host computer.

What this all means to the user is that the machine is capable of winding the tape at high speed, forwards or backwards, and stopping precisely at a predetermined point.

The motor is controlled to such an extent that gradual acceleration and deceleration is possible and the usual abrupt stop/start action of a standard recorder is prevented. Tape slippage is thus avoided and precise positioning of the record/playback head on any part of the tape is possible.

The overall effect is to give the ordinary cassette the appearance of being randomly-accessed, although of course the mechanics of the situation are such that it is merely being wound backwards and forwards with a high degree of precision.

The operation is very quiet and providing that there is something on the computer screen to hold the user's attention, the time taken to wind through a C60 cassette is not noticed.

The "something" on the computer screen is what the Tandberg system is all about. You could use the recorder as a very efficient storage medium for your computer programs, your data banks or (dare it be said) for your favourite arcade game, but that would be under-using the capabilities of the machine. The Tandberg is an interactive system. Together with the controlling computer it provides the facility to have audio material linked with text and graphics displayed on the computer monitor.

After loading a program from the TCCR530, the computer instructs it to present the first sequence of audio material. At the end of the sequence control passes back to the computer which presents a commentary or question to test the student's understanding.

The student's response might be an input on the computer keyboard or a spoken phrase or sentence to the cassette. This will trigger off an appropriate reaction, leading either to repetition of one or more sequences, or to the next section of material.

All the techniques of computer-based learning may be applied, involving tutorial, practice, testing, simulation etc, and the computer can be programmed to collect and analyse student performance and print out appropriate records.

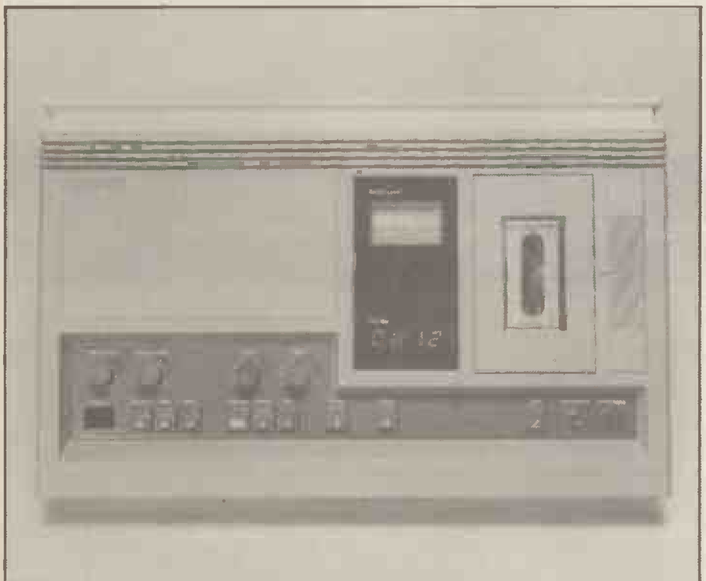
Some examples of possible uses are . . .

In the Language Laboratory: the computer could disply a sentence and switch the TCCR530 into record mode while the student reads the sentence aloud. A variety of features could be developed including comprisons of the student's pronounciation with a pre-recorded version provided by the teacher.

Problem solving (question and answer exercises): one of the limitations of these activities in a conventional computer-aided learning situtation is the restricted amount of material which can be displayed on the monitor. It is sometimes necessary to erase the student's input in order to explain why it was wrong.

With the TCCR530 it is possible to maintain necessary information on the computer monitor, wind on the tape in the TCCR530 in a pre-determined position and play an explanation of the student's error, with some reassuring messages that encourge someone who is making the same mistake time and time again to try a different approach.

Music Tuition: music lessons might be adapted to the system, with the possibility of playing extracts from, for example, actual orchestral performances, whilst explaining about the work or the instruments in text, graphics and manuscript form on the computer monitor. The micro's own sound capability could also be used to illustrate, simply, certain musical phrases, or they could be included on the cassette tape. The computer software which allows these complex tasks is provided by an "authoring package", and the creation of multiple-choice branching programs is made quick and efficient with their use. However, there is much that can be achieved solely by using BASIC.



The Tandberg has a command language which is well explained in the manual, and which is easy to use. The manual contains hints on preparing programs and, best of all, a short example of a BASIC program showing how to send commands to the TCCR530. The complete set of commands will not be described here but a typical sequence is shown in *Table 1*.

Table 1

RF	Rewind fast — make sure the tape is fully rewound and the tape counter zeroed.
GTO122	Wind tape until counter reads 0122.
PL TO+002	Play the tape until 2 seconds of silence are detected and stop.
	(*computer, then displays relevent material, poses questions etc*).
RT	Read tape counter (xxxx) into computer so that it can be used later if necessary.
	(*Suppose user's input was a "wrong answer"*)
GT1441	Tape forward to position 1441.
PL TO+004	Play tape until 4 seconds of silence detected, then stop. While the tape was finding 1441 the monitor could have explained the error and the audio information from the tape could have been supplementary detail. (*Then, while waiting for user response maybe just any keypress . . .*)
GTxxx	Go back to the stored location where the user error was detected, and continue.

To provide greatest flexibility in use, the logic functions of the computer-TCCR530 interface are software defined. As a result the operating instruction manual can initially appear a rather daunting document to those of us unfamiliar with electronics.

However, the Tandberg staff will be able to advise on cables, connections, and various parameter settings to cover the limited number of situations that the TCCR530 is likely to meet in any one educational environment.

The review model was connected to a BBC Model B computer, and worked very well.

A demonstration program was provided, in which the user took the role of a novice leading seaman/yatchsperson about to be instructed on the practice and proper way to give an International Distress Signal in the event of the vessel capsizing! If you have always associated controlled tape-recorders with language labs and "la plume de ma tante" then obviously you must think again.

In fact the TCCR530 has been designed to cope with many applications other than computer-based learning, and some of these applications could also be used in schools and colleges.

For instance, it can be used to record data from a computer - monitored experiment, with the computer reading analouge values (temperature, pressure, velocity etc) and converting them to digital information which would be downloade to tape whenever the computers's memory began to fill up.

With the addition of a simple unit, it could be synchonised with a slide projector and be used either to give a straight forward slide presentation with musical and spoken sound track or, with a back-projection box, an audio-visual learning program — which brings us back to interactive systems again.

To make the TCCR530/Computer configuration really useful either software-plus-audio packages should be available (and this, as far as we know, is not presently the case), or, perhaps more importantly, an authoring package which will enable the naive user to create his or her own course material easily.

Such authoring packages are just becoming available and it is hoped to review one of them in the future issue.

With a school interested in audio-visual teaching techniques, and with departments actually creating source material (slides and tapes) as part of their own courses, it would not be difficult to envisage that sufficient computer-assisted learning material could be generated in a co-ordinated effort across several departments to justify the cost of this very excellent machine.

Two versions of the Tandberg TCCR 530 are available from Tandberg. The single channel version is priced at £425.53, while the dual channel model is £473.57. Prices to educational establishments are substantially lower.

Tandberg Limited,
Revie Road, Elland Road,
Leeds,
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0532-774 844

FORWARD BIAS

Questions, answers and errata from readers and writers.

Conductance Meter
(HE June '84)

A small miscalculation: in the text on page 25, we state that 5n/mhos is the equivalent of 50MR. This should read 200MR.

Mains Touch Switch
(HE May '84)

In **Figure 4**, on page 15, the transistor Q1 has been omitted from the component layout.

See the details below.

Additionally, the component just to the right of C4, which is unlabelled, is D2.

We are unable to show the position of the missing resistor in a diagram this month, but will send a copy of the revised diagram to anyone requesting it.

COLLECTED BOOBS

Continuing excerpts from the Hobby Electronics Errata Box

Windscreen Wiper Controller
(HE March '81)

In **Figure 2**, *the Veroboard tracks between the IC pins should be cut, ie at D11, E11, F11 and G11.*

Pre-Amplifier *(HE April '81)*

In **Figure 4**, SW2 out-lead should be connected to the top of RV1, not the bottom. C7 can be increased to 100u to reduce 'thumps'.

Super Siren Project
(HE April '81)

In the **Parts List**, C2, 3 and 4 should be 10u not 10n, and C5 should be 100u, not 100n.

Russian Roulette
(HE April '81)

In **Figure 1**, pin 1 on IC2 should be pin 3.

In **Figure 2**, make sure that SW2 is a 'biased up' switch (ie momentary action). Break connections on PCB to pin 1 and connect to pin 3.

HE

ALL ABOUT ELECTRONICS

Our Beginner's Series tells you all you'd like to know about electronics. From start to finish. All about components and circuits, all the theory you need to get started in the world of electronics.

Keith Brindley

THROUGHOUT this series of All About Electronics, we have studied various aspects of electronics. First, we looked at the individual hardware items which collectively make up the family of electronic components fundamental to all electronic circuits: resistors, capacitors, inductors — passive components — and the active semiconductor components, transistors, operational amplifiers, logic gates etc.

Using these components we were able to understand and learn how to use the basic laws of electronics, and see how the components can be combined to produce electronic circuits. We saw how transistors, resistors and capacitors may be connected to produce amplifiers, flip-flops, filters, counters etc. — all circuits which are the building blocks of electronic systems.

Next, building-block circuits were combined to give an appreciation of the theory behind the two main concepts of electronics: analogue and digital systems. We looked at telecommunications, and how many telephone speech channels are multiplexed onto single trunks. Generally, in this analogue example, frequency division multiplexing is used to combine the many speech channels, each of which is single sideband modulated to a higher frequency. Then we looked at microprocessors and computer architecture to see how complex problems must be broken up into many basic and simple digital operations which the central processing unit of a computer performs sequentially.

We may summarise what we have observed, in **Figure 1**, with a "family tree" of topics, showing how the relationships between areas of study define their position in the family.

A Vs. D

Throughout the series, the concepts of analogue and digital electronics have been shown as separate, and with little or no overlap. The basic difference between circuits is the way individual components are used. In analogue circuits, for example, transistors are operated in their linear regime, ie, they smoothly control the flow of current through them. In digital circuits on the other hand, transistors are merely turned on or off, switching the current from maximum to minimum.

However, this is not always the case. There are many instances where analogue and digital circuits join together in one system. We did see an example of such an analogue and digital system when we considered time division multiplexing of telephone speech channels in telecommunications systems. In a TDM system each channel is regularly sampled, and valves or codes corresponding to the sampled signal are transmitted. In this way values or codes of many different speech control signals are transmitted

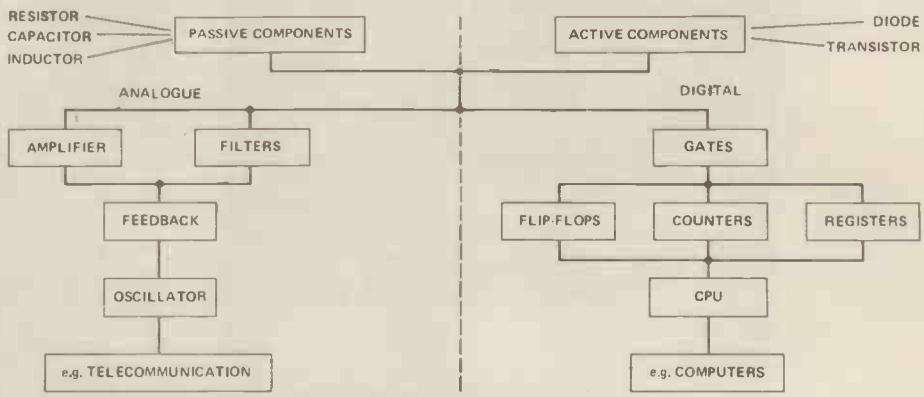


Figure 1. A 'family tree' of topics in electronics, all of which have been covered in past instalments of *All About Electronics*.

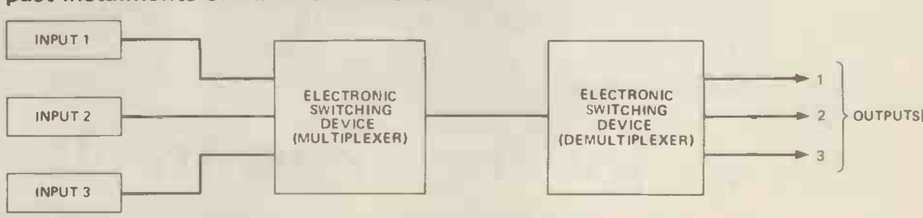


Figure 2. The principle of Time Division Multiplexing.

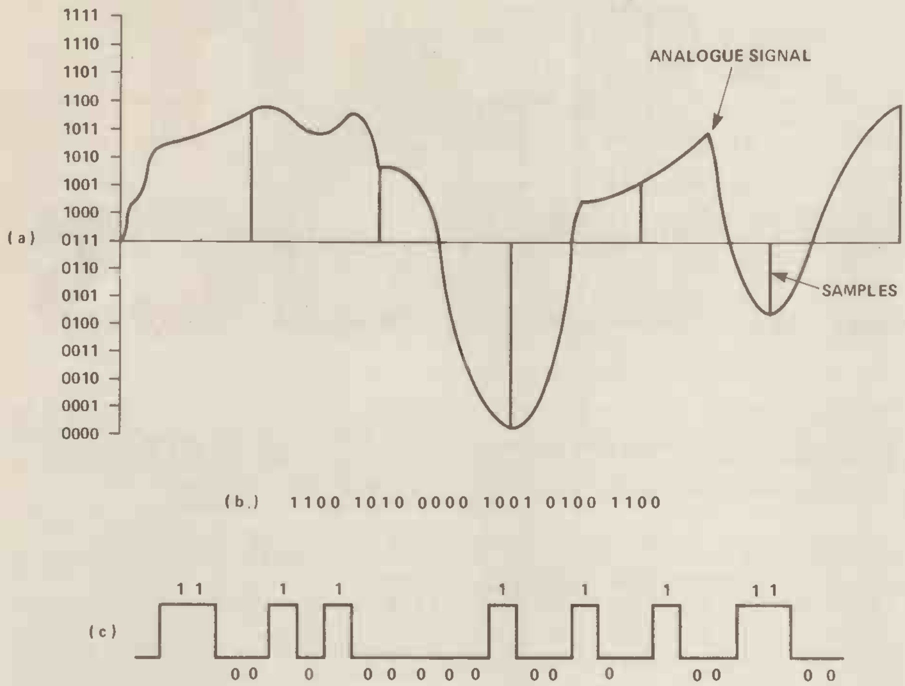
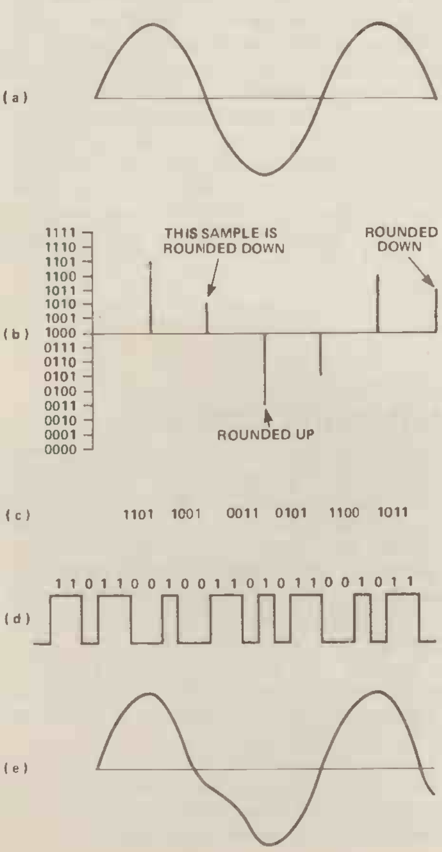


Figure 3. Pulse code modulations on an analogue signal, showing sampling and analogue-to-digital conversion.

Figure 4. The stages in digitising and recreating an analogue signal:
- **a) The signal.**
- **b) Six samples taken from the signal.**
- **c) The rounded digital codewords.**
- **d) The digital signal.**
- **e) The recreated analogue signal with distortion due to quantization errors.**



over single telephone trunks. The principle of TDM systems is repeated in Figure 2.

In the national telephone network, the time division multiplexed signals are transmitted as a pulse code modulated signal, ie each sample value is converted to a corresponding binary number before transmission. **Figure 3** shows an example where a possible analogue signal is sampled, each sample value is converted to a four-bit binary number, and each binary number is combined to form a single, pulse code modulated, digital signal.

This example shows two things which I want to consider now. First, the rate at which the digital signal must be transmitted — the bit rate — depends primarily on the original analogue signal. The important factor concerning the analogue signal is its maximum frequency, f max. If, say, the analogue signal is a typical speech channel signal which contains a variety of frequency components in the range of 200Hz to 4kHz then we can define f max as 4kHz. We know from the sampling theorem the samples must be taken at a rate of twice f max ie at 8000 samples per second, and so the bit rate of the four-bit digital signal is four times this — 32kbits s^{-1} — just to transmit a single speech channel signal. Every such speech channel analogue signal requires the same bit rate so, if eight similar speech channel signals, are to be pulse code modulated, time division multiplexed onto a single trunk, a bit rate of at least 256kbits s^{-1} is required.

What Do You Quant?

Second, this analogue-to-digital conversion relies on the fact that a digital signal consisting of discrete steps can adequately represent a continuous analogue signal. The four-bit digital signal of this example only has 2^4 = sixteen discrete steps, known as quantization steps so, inevitably, in the conversion of an analogue signal to a four-bit digital signal some rounding-up or rounding-down of the continuous signal to match the sixteen quantization steps must occur. **Figure 4a** shows an analogue signal which is to be sampled six times (**Figure 4b**) and the sample values converted to corresponding four-bit digital words by rounding-up or rounding-down to the nearest quantization step (**Figure 4c**). The digital signal corresponding to the analogue signal is shown in **Figure 4d**, and the eventual analogue signal, after conversion back from digital-to-analogue, is shown in **Figure 4e**. The distortion due to the discrete quantization steps is clearly seen, and is classed as an error — quantization error — which in this example is one part in fifteen (because there are fifteen quantization intervals between the sixteen quantization steps). As a percentage, the quantization error is 6.67% of the full output and if the output voltage range is say, 10V, the quantization error voltage is 0V67.

Quantization error will fall as the number of bits in the digital word increases, so an eight-bit digital codeword range will introduce a quantization error of only one part in 255, a mere 0.04% of full output. Using a larger number of bits per codeword obviously increases the minimum bit rate required to transmit the analogue information in a digital way, but greater accuracy and less distortion is the result. Eight-bit codewords are adequate for low-quality transmissions of analogue signals such as telephone speech signals but even the associated low quantization error of eight-bit codewords can be detected in the transmission of high quality music (for example, high fidelity reproduction) and frequently twelve-bit, fourteen-bit and sixteen-bit codewords are used. We will see an example later.

The circuits used to convert analogue signals into digital codewords and digital codewords into analogue signals are known as analogue-to-digital convertors (ADCs) and digital-to-analogue convertors (DACs). Often the principles used in DACs are also used in ADCs, so we'll look at DACs first.

Digital To Analogue

One of the simplest types of DACs is shown in **Figure 5**. It is based on a binary weighted resistor network, in which the resistor connected to the most significant bit of the applied codeword can have any suitable value, R. The resistor connected to the next most significant bit has the value of 2R, the next — 4R etc. In this way, the voltage produced at the output of the resistor network is proportional to the digital codeword applied to the input.

Although this DAC is simple and theoretically can be used to convert

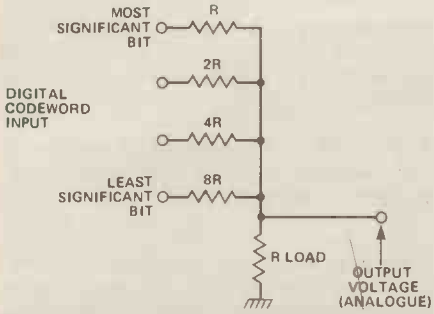


Figure 5. A binary weighted resistor network. This forms the basis of one of the simplest types of DAC.

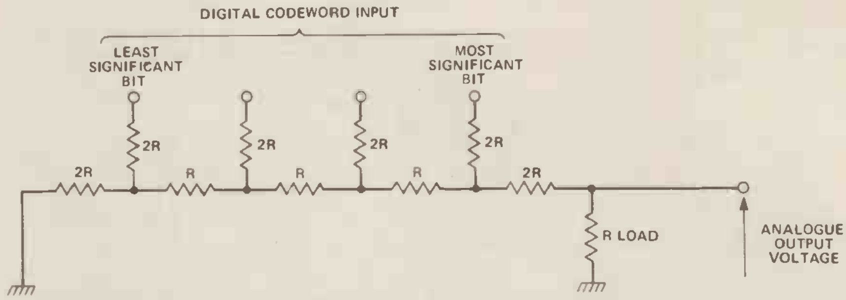


Figure 6. The R-2R resistor ladder type of DAC network.

digital codewords of any number of bits into an analogue signal, it does have one disadvantage — the doubling of resistor value for every bit means that a wide range of accurate value resistors will be required for anything other than conversion of digital codewords with less than, say, six bits.

Another type of DAC is based on the circuit of **Figure 6** which is an R-2R resistor ladder network. In this DAC only two values of resistor are used and digital codewords of any number of bits length may be converted, simply by extending the ladder.

Output voltages of both of these circuits may be amplified by suitable amplifiers; buffering the circuit and increasing the analogue voltage range to any desired level.

Analogue To Digital

Most DACs rely on one of the two principles outlined here. ADCs, on the other hand, can rely on a number of principles and tend to be much more complex. Two of the more common types of ADC are shown in **Figures 7** and **8**. The first type, a successive approximation convertor uses a DAC (of either variety previously discussed) in the circuit. A comparator compares the output is high. If the analogue voltage is input voltage. If the analogue input voltage is greater than the output voltage of the DAC the comparator output is high. If the analouge voltage is low. The logic block in the successive approximation converter decodes the logic states of the comparator and instructs the four bit register to act as follows:

- assume that the four-bit register is initially zeroed ie all bits are set to logic 0. The applied analogue input voltage must be greater than the DAC output so the comparator output is high. This sets the most significant bit of the four-bit register to logic 1. This is known as the first approximation.
- if the analogue input voltage is still greater than the DAC output the logic block sets the most significant bit of the four-bit register to logic one, in a second approximation. A third and fourth approximation are then undertaken.
- if after any approximation the analogue input voltage is less than the DAC output, the output of the comparator is logic 0 and the logic block resets the previous set bit of the register to logic 0, and sets the next most significant bit to logic 1.

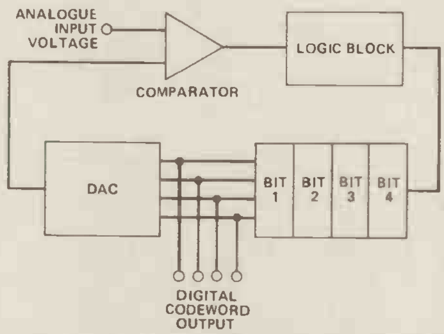


Figure 7. The successive approximation type of ADC.

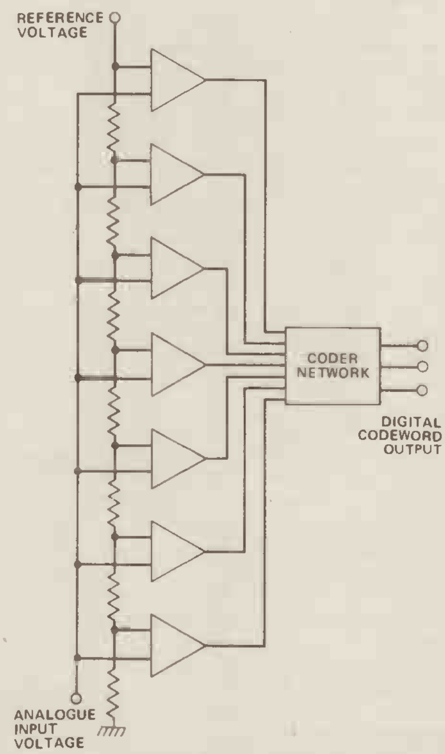


Figure 8. The parallel, or flash ADC which uses 2^n–1 comparators.

In this way four successive approximations of the applied analogue input voltage at each sample value are undertaken in the analogue-to-digital conversion process to four-bit digital codewords. If six-bit codewords are required a six-bit register should be used and the conversion process takes six approximations; eight-bit codewords take eight approximations, etc.

Successive approximation ADCs are ideal for conversion of low frequency analogue signals such as telephone speech channels, but the finite conversion time does not allow their use with high frequency analogue signals, say, radar frequency signals — because there is just not enough time between samples to fit in the required number of approximations. An alternative type of ADC, known as the parallel converter, is often used in such situations. Its basis is shown in **Figure 8** and consists of a bank of comparators, each of which compares the applied voltage with a reference voltage. The reference voltage for each comparator is different and is generated by the bank of resistors in the potential divider chain. The analogue voltage may be converted to digital codewords of any number of bits simply by using sufficient comparators and resistors — but here's the crunch.

The circuit shown would convert an analogue voltage to a three-bit digital codeword and uses seven (ie 2^3 –1) comparators. An eight-bit parallel converter, which is the minimum required for reasonable quality, would need 2^8 –1, that is 255 comparators! Such conveters are relatively expensive, but nevertheless are regularly used because of their fast conversion times. Parallel converters are, in fact, so fast and can be used to convert analogue signals of such high frequency that they are often referred to a flash converters.

MOD And DEMod

Many electronic systems use ADCs and DACs and their use is becoming more and more common with time. The reason for this lies in the fact that the advent of small cheap computers has led to an enormous increase in digital systems, which need to be interfaced somehow to the 'outside world'. All signals in the 'outside world' are naturally of an analogue form, so anywhere a digital system requires an analogue intput or output, an ADC or DAC must be used.

A form of ADC/DAC combination called a modem is often used where it is required to connect two digital system over a single telephone-type channel.

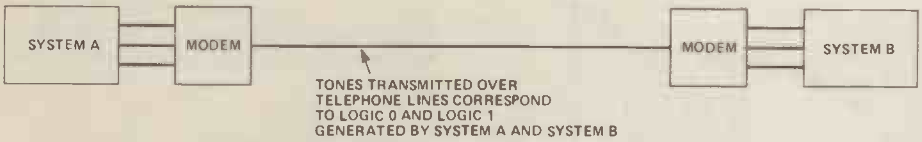


Figure 9. The use of a modem at each end of a telephone line allows digital systems to communicate in an analogue fashion.

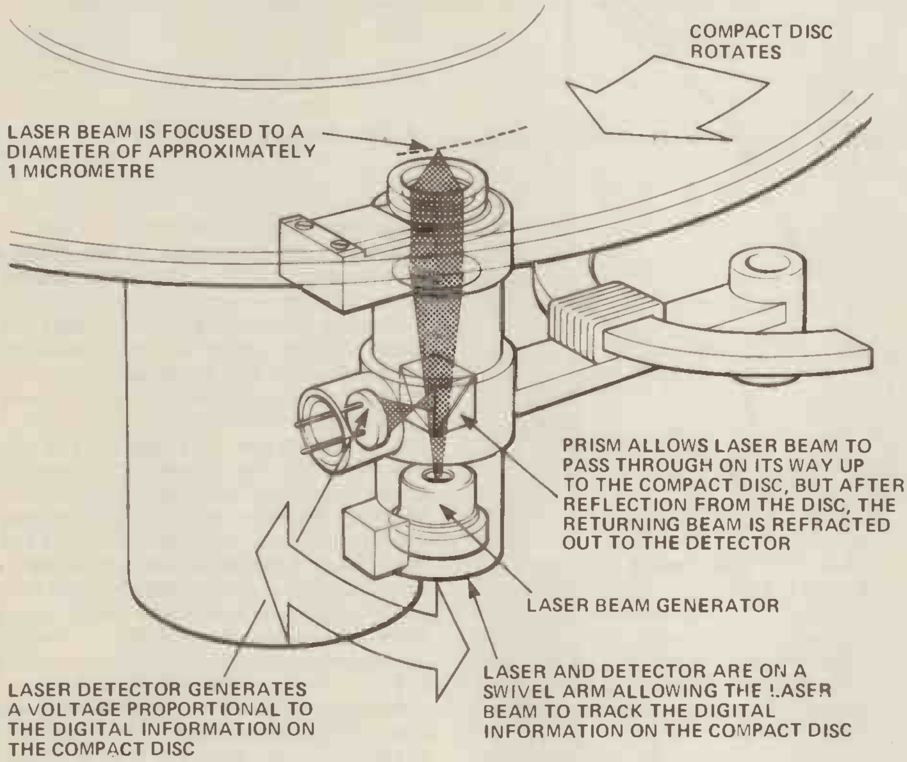
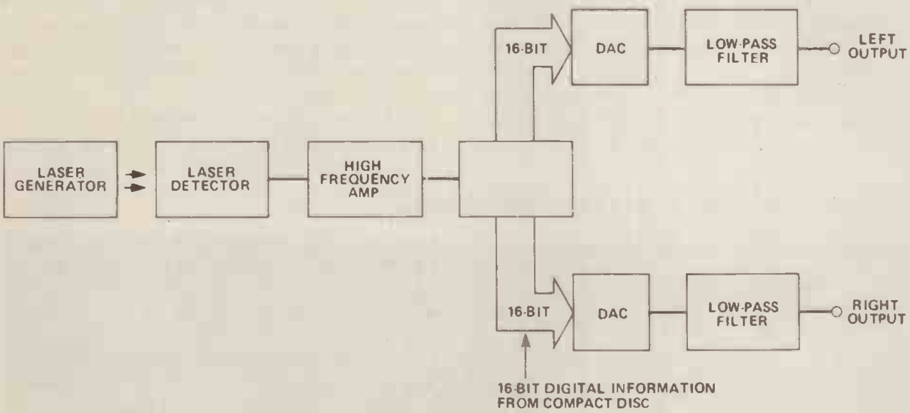


Figure 10. A low-power laser tracks the bottom surface of a digitally recorded compact disc.

The basis of such a modem connection is shown in **Figure 9**. "Modem" is an abbreviation for modular/demodulator, and this gives a clue to its operation. When one digital system, say System A, wishes to transmit information to System B, the digital codewords are broken down into individual bits, and information corresponding to each bit is sent over the telephone line. Being binary, a bit is either logic 0 or logic 1 and so it is a simple job for the modem to modulate a tone onto the telephone line, of one or two frequencies, depending on the bit. At the other end of the telephone line, System B's modem demodulates each tone received into a digital bit.

Modems are two-way communication devices and, whenever System A is not transmitting data to System B, System B can transmit data to System A. Thus, a single analogue telephone line may be used for two-way digital communication.

Integration and hybridization of ADCs and DACs has meant that what used to be quite complex and expensive circuits are now comparatively cheap. They are in fact becoming so cheap and readily available that they are now being used in areas of electronics which were previously considered to be the domain of analogue. One of the best examples of the invasion of analogue/digital conversion into analogue system is the compact disc high fidelity audio players recently developed and introduced. The compact discs such players play are small (4½in) plastic discs with digital information corresponding to analogue music information recorded onto them.



Bits Of Music

At the recording studios, ADCs convert the analogue music into 16-bit digital codewords which, at the compact disc factory, are transposed onto the disc.

A laser pickup, shown in **Figure 10** tracks the disc and picks-up the digital information, ready for conversion back to the analogue signal which may then be amplified to drive loudspeakers in the usual way. The laser is a low-voltage, semiconductor device, which radiates infra-red light of a single frequency.

The lens focuses the laser beam to a width of about 1 micrometre, within the disc. Reflected light from the disc

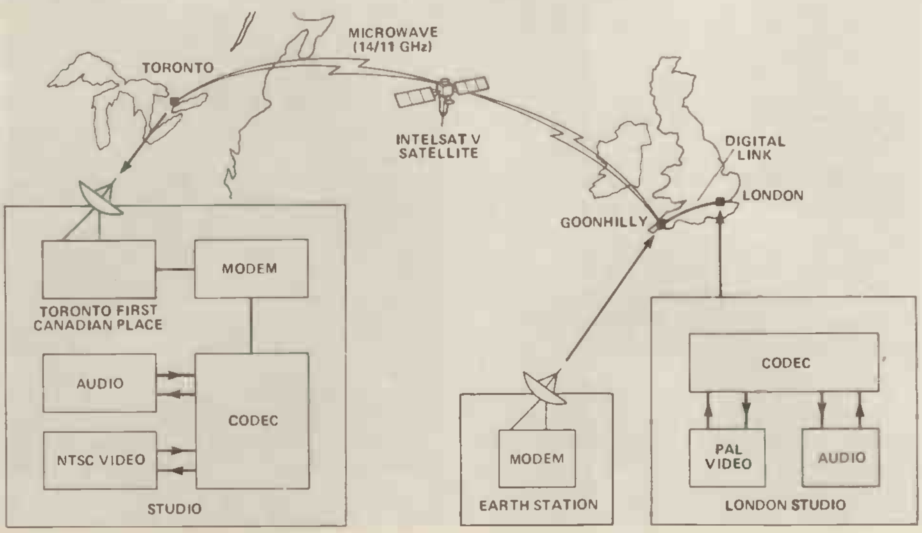


Figure 11. A block diagram of the main sections of a compact disc player.

Figure 12. A "block diagram" of British Telecom's new conference television system (see overleaf).

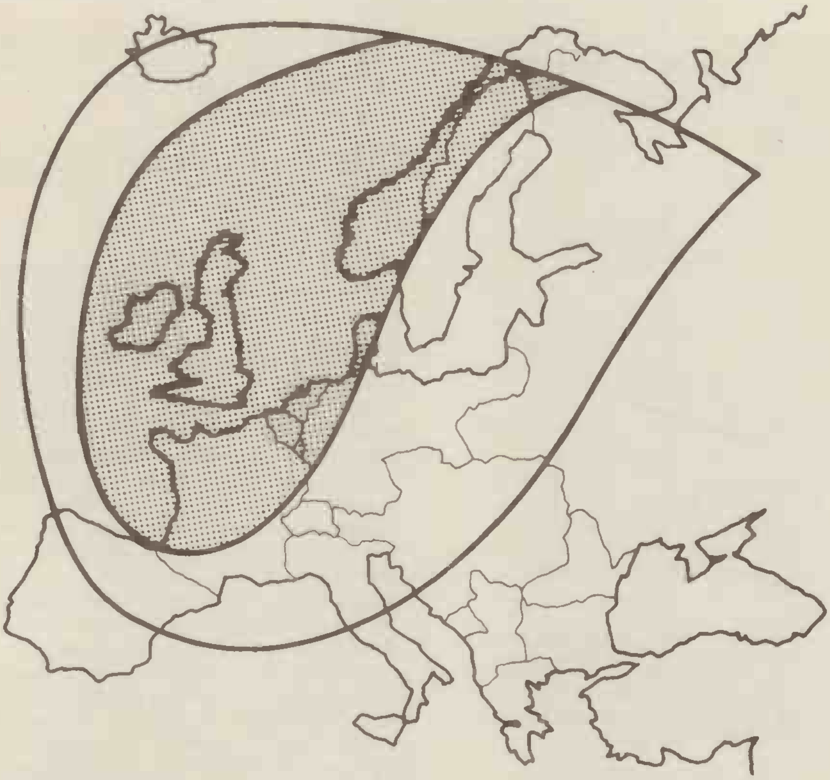


Figure 13. Footprint of the Direct Broadcast Satellite Service, which will be launched as a new television system.

passes back through the lens, back towards the laser source, but is refracted onwards by the prism so that it falls on the infra-red detector. This output voltage of the detector, after suitable amplification, and processing forms the digital input to the DAC. A block diagram of the basic parts of compact disc player are shown in Figure 11.

Although, currently, these players and the discs themselves are quite expensive (they are about the same sort of price as top-of-the-range record player decks and supercut LP records) they do, according to the specifications, produce sound of a much higher quality than their analogue counterparts, with added advantage that the compact discs are not easily damaged.

Digitisation of audio frequency analogue signals is not the only type of analogue-to-digital conversion currently in progress. British Telecom has recently announced details of its new transatlantic colour video conferencing service between the UK and Canada, in which customers in both countries can see and hear each other over a high-speed digital transmission link (Figure 12). The service is the first of its kind, and further services, with links to the USA, are in progress.

A special kind of ADC, named a codec, (coder/decoder) converts the analogue video and audio information into serial digital information, ie a string of bits. Simultaneously the codec compresses the original picture signal so that a reduced transmission capacity is required.

A Bit Above Us

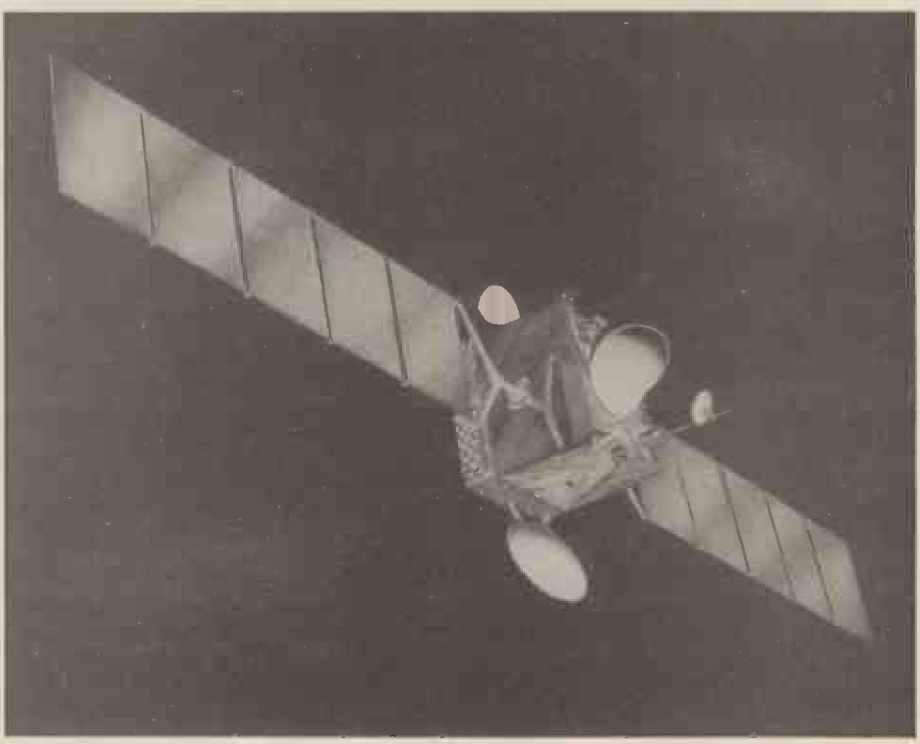
Of course, satellite television communications will not be restricted to only businessmen's conferences in the future. Within the next two or three years, a satellite, similar to that used for BT's transatlantic video conferencing service, will be used to relay broadcast television pictures across the UK. In fact, the satellite's footprint (ie the area of the earth's surface it covers — shown in Figure 13) will cover parts of western Europe, too. The satellite will be geostationary, ie it traverses its orbit once every twenty-four hours, and thus appears to be fixed in position when viewed from the ground. You can observe its position in the sky — although you will not see the satellite because it will be 22,300 miles up! — if you check the position of the sun at three o'clock in the afternoon (British summer time) in mid-October. At this time the sun is directly in line with the satellite's position. The aerial required to receive the satellite's transmissions may be sited at any point which is not in shadow at this time, and must point accurately at the satellite.

The satellite service, called Direct Broadcasting by Satellite (DBS), will be more effective than the existing broadcast television service and will be receivable at most if not all homes within the UK. The existing transmitter network, by comparison, only covers about 90% of homes.

Five television channels will be broadcast by the satellite within the range 11.7 to 12.1GHz (GHz = 1 x 10^{12}Hz). At these sorts of frequencies the conventional television aerial is not usable and a parabolic dish-type aerial must be used the diameter of this dish is about 60 to 90cm to provide good reception, and obviously, to point accurately at the geostationary satellite the dish must be solidly sited.

Existing television receivers may be fitted with converter-circuits allowing reception of the DBS television transmissions. Picture quality in this case will, however, be no better than that at present. New television receivers, specifically for DBS reception will, on the other hand, produce a much improved picture quality. This is because the DBS system will use a

An artist's impression of a DBX-type satellite.



British Aerospace Photograph.

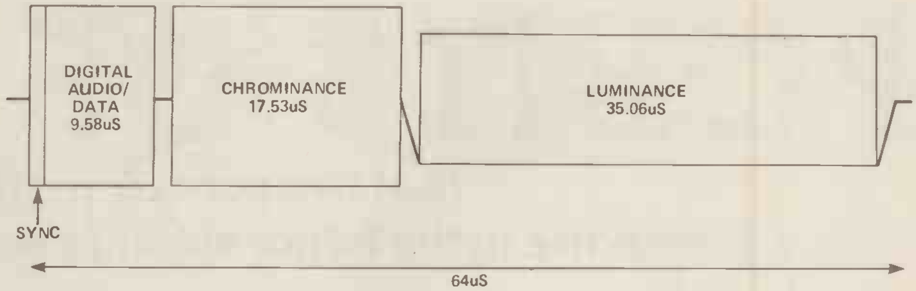


Figure 14. The contents of a C-MAC type Time Division Multiplexed Signal to be used in the DBS television service.

different method of transmission than the existing PAL colour system which we saw last month. DBS transmissions, in fact, are an ideal example of how digital and analogue concepts can be combined within a communications system. We shall look at DBS transmissions in detail.

DBS transmissions will be based on a colour picture system known as C-MAC (an acronym for C-type sound, Multiplexed Analogue Component). Three types of possible sound transmission within the DBS channels have been considered, all using digitised audio information:

- **A-type**, in which the audio signals are all carried on a sub-carrier within the channel. This (apart from the fact that digitised audio signals will be used in DBS) is similar in principle to the existing PAL television broadcasts, in which a sub-carrier, 6MHz above the vision carrier, carries the audio transmission.

- **B-type**, in which the audio signals are transmitted during television line synchronisation pulses.

- **C-type**, (the chosen type) in which the audio signals directly modulate the same radio frequency carrier modulated by the vision signals. DBS transmissions of C-type allow a maximum of eight digital high-fidelity sound channels. Two of these will be used for stereo sound transmissions with the television picture, the remainder may be used for other music transmissions or perhaps data transmissions.

Time-division multiplexing of sound and vision signals (a digitising process) will be used, the 64us time slot between television lines sync pulses being divided up as shown in **Figure 14**. Chrominance (colour) and luminance (brightness) signals are transmitted as analogue signals and, unlike the existing PAL colour systems where chrominance is transmitted merely as an extension of the luminance signal, a completely separate chrominance component is multiplexed and transmitted in the DBS signal. This separate transmission of the chrominance component is one of the main reasons why a DBS television receiver will produce pictures of much higher quality than those of PAL receivers.

More A Than D

It is interesting to note the fact that the authorities have opted for analogue transmission of the chrominance and luminance signal. This is mainly because of the fact that digital transmission of an analogue signal takes up much more of the transmission channel capacity than does the analogue signal itself. We saw this in our earlier example of pulse code modulated telephone speech channels where an analogue signal of 200 to 400kHz requires a bit rate of 64Kbits per second for adequate quality. This doesn't, of course, matter if an unlimited amount of transmission channel is available, as in the telephone system where extra cables can be laid as and were required. In a broadcast radio system, on the other hand, the transmission channel *is* limited. The satellite only has a defined frequency range in which to transmit, and few frequencies in the whole radio spectrum are not already used for radio transmissions of some description. Because of this, broadcast television chrominance and luminance signals are likely always to be transmitted as analogue signals.

Eventually, of course, even though transmitted signals may always be analogue, we can suppose that all of the circuits within television receivers will be digital, with a high degree of integration into IC form. A move has already begun in that area with at least one digital TV receiver being marketed in Europe. At this time however, such digital television receivers are expensive, although the trend towards cheaper and cheaper digital circuits will obviously close the price gap between digital and analogue television.

An End To It All

So, where does all this leave us? How will our electronic future (because it will be, undoubtedly, electronic) affect us? And where do we go from now?

Well, one sure fact is that there will be a great use of computers. As more and more components and facilities are reduced in size and built into single ICs, the more these ICs will be used in the most unlikely of places. The telephone system which we have considered in detail is an ideal example. For years, since their introduction, telephone sets have remained virtually unaltered apart from minor aesthetic changes. Within only a few years, however, every telephone set in the country is likely to have its own microprocessor inside it. Voice signals will be converted within the telephone to digital codewords which will be passed down the digital trunks to the exchange.

In short, digital circuits will be found in almost every gadget, tool, toy, entertainment etc. available, with appropriate analogue-to-digital and digital-to-analogue convertors acting as interfaces between them and us. Fortunately, no matter how clever these digital circuits are, they have to interface with the analogue world — mainly us.

Thankfully, we can't be digitised, (*we're working on it – Ed.*) so there is always the hope that analogue will survive the onslaught of digital. I have to go, my batteries are running down. Goodb. . . . .
Click.

The staff and readers of Hobby Electronics would like to thank Keith Brindley for a series which has taken us from the first principles of electronics through to an appreciation of some of its most complex applications. We will be starting a new and very special series on electronics for beginners in the autumn, so watch out for that round about October.

POINTS OF VIEW

Feel like sounding off?
Then write to the Editor stating your Point of View!

What A Melter

Dear Sir,
Re your comments on Woods Metal in your May issue. I would suggest to you that the Low Melt Solder used for Model Rail White Metal Loco Kits. It melts easily in water which is almost boiling. Use a spoon dipped in the water at the same time. I enclose a piece for your perusal. Any model rail shop which sells Loco Kits will supply. Try **W&H (Models) Ltd., 14 New Cavendish St., London W1 (01-837 5551)** *or* **Hobby Time, 5 Ravenswood Crescent, West Wickham, Kent (01-777 3510).** *The cost is about 75p to £1, this should be more than enough for Mr. Simmonds.*
I hope this will help.
Yours sincerely,
H. J. Woodman,
Brighton,
Sussex.

We carried out the following experiment on the nugget of whitish-grey metal which Mr. Woodman enclosed:

Equipment: one kettle; one teaspoon; four or five plastic coffee cups (beaker style); one plastic "swizzle stick" of type provided with hot drinks dispensers; kitchen sink; water.

The water was placed in the kettle and the kettle powered up. In the meanwhile, three of the plastic beakers were stacked one inside the other (to prevent the application of boiling water from eating a hole through to the experimenter's hand) and the sample of metal placed in or on the teaspoon.

When the boiling water was ready, the top beaker of the triple stack was filled with the water. The teaspoon bowl was then floated as deeply into the boiling water as possible without actually admitting the water to the teaspoon: (note to experimenters: hold onto the teaspoon at this point). Within about twenty seconds, the metal had begun to liquify at its extremities, and before a minute was up it was completely liquid.

At this point, the metal was poured from the teaspoon into the fourth (separate) beaker and encouraged to cool by holding beneath a stream of cold water. When the initial crystallisation was observed, the plastic swizzle stick was implanted in the cooling metal and held upright until the metal set hard. The plastic beaker (that is, the one with the metal in it) was inverted at this point, and it was observed that the swizzle stick did not fall out of the beaker.

From this we deduced that the Low Melt Solder would do the job of Woods Metal adequately. In fact, after taking expert advice, we decided that it probably *was* Woods Metal, under another name, or at least a very similar substance.

On a more serious note, we had better point out that this is not ordinarly low melt solder. It is very unusual for any metal to melt below the boiling point of water, as happened here — a fact borne out by astonishment of other members of the company who happened to drop into the kitchen during the experiment. This astonishment also lends point to the scarcity of Woods Metal, which most had heard of but few had ever seen.

However, Woods Metal is still the prescribed method of mounting crystals in some radio sets, we are very grateful to Mr. Woodman for his timely information.

Back Issues

Dear Sirs,
Having just read your July '82 issue, I was very interested in the HE Microtrainer, as a first computer project, but I noticed it as a second part and now wish to obtain the first part in the June '82 issue. Could you please give me details of ordering your back numbers?
Yours,
R. I. Powis,
Swanscombe,
Kent.

Now that our Backnumbers department has moved and settled down, we are running a new Backissues advert, with all the details. You will find it in most issues, possibly even in this one; if not, then the next one.

Electronics By Computer

Dear Sir,
Would it be possible to incorporate in your excellent magazine a series of computer programs to show:
(1) How with moving graphics Ohms Law works, how current flows in a circuit.
(2) Resistors and capacitors, in series and parallel.
(3) Set number of questions requiring an input answer, and if the answer is wrong, a routine that will explain the question/answer in detail.
In fact, a program on the whole aspect of Electronics.
I am sure, because of my conversations with people of all ages, especially young hobbyists, that this would be a very popular series. There are thousands of people with computers in their homes, that with a well-written series of programs could be given the chance to see how this otherwise invisible force works.
Why not be the first to give them this chance?
Yours truly,
F. J. Chappell,
Hayes,
Middx.

We ourselves are unable to devote the attention needed to write a really good educational electronics package (which is not as simple as it might look), but we are aware that programs are soon to appear which cover this general subject area. If you keep an eye on *Soft Options*, you should see some of these mentioned before long, and we hope there will be programs that we can recommend.

Solid Inducements

Dear Editor,
I am writing several letters to your mag - well, three to be exact. One is to your backnumbers section for a photocopy of the Dig Freq Counter project - please could you let me know if there are any faults with the diagrams or project (misprints, of course). SAE enclosed.
Excuse the slight sarcasm there! You produce a very good mag. I've stayed with it for three years now and will continue to do so. Your mag is generally simple enough for beginners, and some excellent projects for the not-so-beginners. I've

designed my own frequency meter (digital) so I want to see what HE's looks like.

A suggestion for projects: what about more test equipment? Your capacitance meter (April 1982) was good. To make mine more accurate I added a third digit.

A question: I have a problem with ETI project (Soldering Iron page 24 May 1981). As your mags are affiliated and you have the same address, could you let me know who to write to, or be so kind as to give me some help. My 20-0-20 transformer and 1A bridge rectifier blows up. The only substitution I have made is the toroidal core which I used a standard core of about 2x2x1¼in.

I also read and experimented with your Switched Mode PSU, but how do I work out the inductance of a core, given its size?
Yours,
Dave Van Rooyen,
Queensburgh,
S. Africa.

First off, yes, there was an error in the DFC project: C1 was listed as ceramic; it should read carbonate.

Like you, we are always keen on test equipment projects. They are not the easiest of projects, though, because of the problem of alignment and calibration. Almost always, you need test equiment to calibrate test equipment! Accuracy is a problem, because very reliable and precise instruments are always complicated and expensive, both factors which put them beyond the range of the average constructor.

That said, we remain dedicated to the idea of producing cheap, reasonably accurate and useful test equipment, and in fact we have one or two such projects lined up for the near future. And of course, if anyone happens to have a circuit for a spectrum analyser costing around **£20** we'd love to hear from them. . . .

You can't work out the inductance of a core. A core has no inductance. It may even have no substance, as it can be empty air. You can work out the inductance of a coil, but the maths used are tedious and involved. In their simplest form they look something like this:

$$L \triangleq \frac{urAT^2}{1}$$

where L is the length of the coil, A is the cross sectional area of the coil, T is number of turns and u is the permeability of the former (which must be calculated separately). 1 is the answer. For further information, consult the **Coil Design And Construction** Manual by **B. B. Babani**, £1.95 from **Bernard Babani (publishing) Ltd., The Grampians, Shepherds Bush Rd., London W6 7NF.**

We can't offer any help with the ETI project, I'm afraid. The gentleman to talk to is Phil Walker, Project Editor, ETI, at this address. Just don't tell him where you got his name from!

Telephone Hang-Up

Dear Sir,
I'm a student of electronics and I practice different electronics circuits by designing some myself; with the help of guide books, magazines and sometimes with the help of seniors. Recently, I designed a circuit to record a telephone conversation. This circuit proved to work alright, except the fact that the telephone line is blocked when the system is attached to the line, so that dialling of a number is not possible.

Could you please help me by suggesting some circuit diagrams which could perform the telephone recording with the help of an ordinary cassette player such that the recording takes place only when the speech is made, with no effect on the performance of the telephone. It is also intended that such a device could be attachable to the live wires of the telephone line in any place before the set, and unexposed.

I would be very much thankful for this act of assistance and kindness.
Yours truly,
M. Arshad H. Alvi,
Riyadh,
Saudi Arabia.

We're always glad to be of assistance, and happy to be kind, but we regret that in this case we can't help you. First, we haven't got the time or the manpower to design circuits for everyone who would like them, so we make it as fair as possible by not designing any at all. This is especially fair to Terry, who already has a full-time job designing and testing circuits for Hobby.

Additionally, in this country it is highly illegal to attach to the telephone lines any device which has not been strictly approved by British Telecom. I suspect it is also highly illegal to record telephone conversations without the knowledge of the parties concerned, at least without the proper authorisation, which isn't usually granted to popular magazines. At any rate, we have no experience in this specialised field.

(On the otherhand, what could provide more security and privacy than a device which phone calls being made? Mr. Alvi may be onto something here . . .).

It's Dead Again

Dear Sir,
I have recently come into contact with a publication of yours called Into Electronics Plus, published by HE in the summer of 1979, priced £1. I am most interested in obtaining a copy of this publication as it appears to be by far the best book on basic electronics from an introductory point of view.

I would therefore be very interested in your being able to tell me if it is still in print and its current price.
Yours faithfully,
D. T. Ellis,
Saltash,
Cornwall.

Sorry to disappoint you. IEP has been out of print for a number of years, although it was a popular publication in its time. Our other reprints collection, **Electronics — It's Easy**, has also now succumbed to recession economics and gone o/p after several years' popular run.

The department which deals with all our special publications is now in the process of arranging refunds for those people who have ordered EIE during the time when they were still deciding whether or not to revive it. This is not to say that it will never return in the future. If it does, this is where you will read about it.

Scope For A 'Scope

Dear Sir,
I have bought your magazine for about four months now and find it a very good publication.

Recently, I have noticed an advert for an oscilloscope kit that uses an ordinary TV set, and wondered if you have tried this type of project; alternatively, are there any plans for HE to publish such a project?

The reason I ask is that I have recently acquired the parts for your digital thermometer, and I noticed in the plans that an oscilloscope is useful, and thought that it may be a handy tool for the future. As you may have guessed, a commercial-type scope is beyond my budget.
Yours faithfully,
P. Humphries,
Newcastle-upon-Tyne.

Indeed, we have tried several times to produce an oscilloscope for the hobbyist. Our last attempt ground to a halt, fortunately before we got to the stage of issuing a parts list, when the author declined to continue the project.

However, a reasonably cheap oscilloscope project (one that uses an ordinary black and white TV set) is on line for another of our magazines, **Digital and Micro Electronics**, and will appear when we have tied up all the loose ends — possibly beginning with D&ME 5 later in the summer. I suggest that you check that out when it appears on your newsstands and see if it will fulfill your requirements. **H**

SHORT CIRCUITS

Circuit ideas from Hobby Electronics readers.

Hobby Electronics cannot undertake to answer queries on Short Circuits.

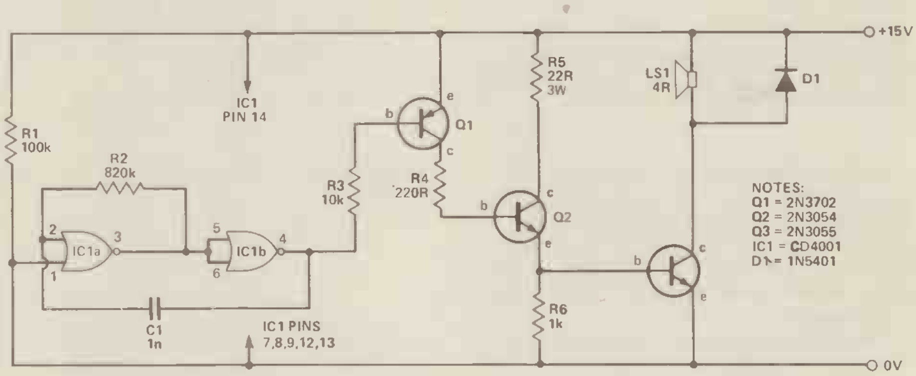
18W Alarm Generator

An oscillator design to cause the maximum alarm.

THIS CIRCUIT is a logical development of the Morse Oscillator circuit. It uses the same basic design but has a power amplifier connected to provide a louder output suitable for use in say, burglar alarm systems.

The oscillator section consisting of IC1, has already been described and need not be gone into here. The important point to note is that the morse key has been removed and pin 1 is permanently connected to the negative supply.

The first transistor, Q1 is used as a buffer instead of the extra gate used in the previous design, as the output of the gate is insufficient to drive the power transistor. The buffer transistor then drives the pre-driver Q2, which in turn drives the output device Q3.



The alarm can be used in any situation and will provide a good loud output whenever the supply connection is made. Because of the high power, Q3 will dissipate a large amount of heat and so should ideally be mounted on a small heatsink. Similarly, it is advisable to use heatsinks for the other two transistors.

Mark Stone,
Essex.

Morse Oscillator

A one-IC circuit for morse code practice.

THE SIMPLE circuit here uses just one IC as the active component to produce an audio signal suitable for budding radio operators to get some morse code practice. The circuit uses a CMOS IC connected in a rather unusual manner to that normally found around digital IC's. The individual gates of the IC are in fact used as inverting amplifiers with their inputs connected together to produce the inverting effect.

The circuit operates in the following manner.

Assume for the moment that the morse key is made and pin 1 is connected to ground. Without going into the why's and wherefore's, pin 1 is effectively connected to pin 2, (take our word for this — please!).

When the supply is first made the output of one of the gates will go high. Due to the varying characteristics of each gate it is impossible to say which one will go high first. Assume for the moment it is gate IC1a output which goes high with IC1b output low.

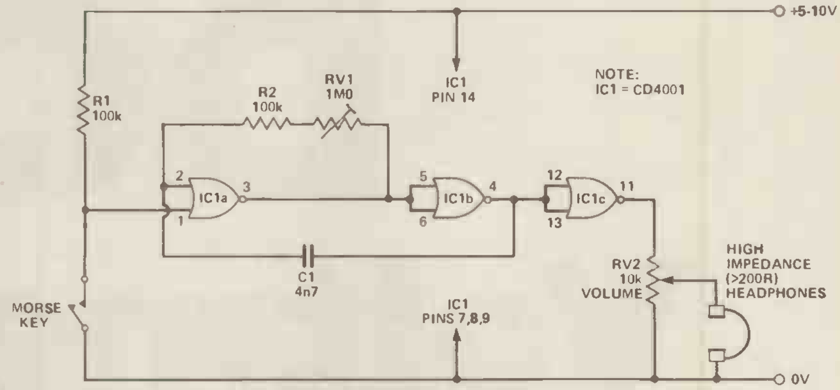
The capacitor now charges up from the high level of the output of IC1a via R2 and RV1. After a time which is determined by time constant of the capacitor and two resistors, the voltage across the capacitor will reach the transfer voltage of IC1a. This results in the output of IC1a going low thus causing the input of IC1b also to go low. This changes the previously low output of IC1b to high. At this time the capacitor discharges into the invertors as the capacitor is effectively reverse-connected. That is, previously, the right-hand end had a (logical) low, and the left-hand end had a high (via the resistors).

Once discharged the next cycle begins.

Now the capacitor beings to charge up from the negative supply via the two resistors, which are now effectively connected to the negative supply by virtue of the fact that the input of IC1b is low. As the capacitor charges up, the voltage at the input of IC1a will gradually fall, and after a time the transfer voltage of the gate will be reached. When this voltage is reached, the input will become low causing the output to go high — this in turn causes the output of IC1b to go low.

The capacitor is now once again reverse connected and begins to discharge through the invertors. The circuit operation then returns to the beginning with the capacitor charging up from the high output of IC1a.

The circuit thus continually oscillates producing a square wave output from both the outputs of the gates. All this takes place far quicker than it takes to explain!



The remainder of the circuit consists of IC1c used in this design as a buffer to feed the signal to the volume control and headphones. The preset is used to vary the frequency. The circuit is simple to construct and can be built on a small piece of Veroboard. Any supply can be used in the range 5-10 volts, but note the frequency changes as the voltage changes. To provide a good audio output it is essential to use high impedance headphones, and those with an impedance of greater than 200R will work very well.

Mark Stone, Essex.

Protected PSU

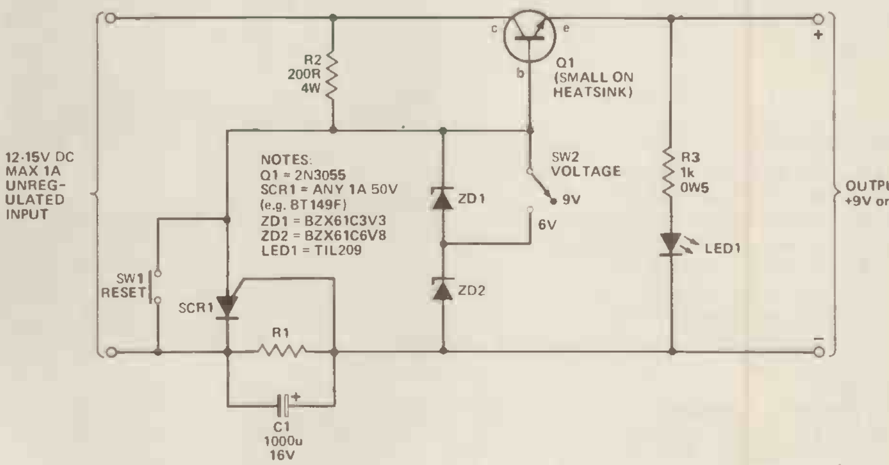
A short circuit which avoids short circuits.

THE PROTECTED PSU is conventional in design, using Q1 with its base tied to each of the Zener voltages to provide the regulated outputs of 6 and 9 volts. The circuit differs in respect to the short circuit protection components consisting of SCR1, R1 and C1.

When a short circuit occurs, the current passing through R1 increases to such a point that the gate turn on voltage of the thyristor is exceeded. Once this point has been exceeded the thyristor turns on, and in so doing, pulls the base of Q1 to ground, effectively turning the transistor off. With the transistor turned off, the external short circuit is effectively removed from the regulating circuit. However, becuse the thyristor is still turned on the current from the unregulated supply will still flow.

It in fact flows through the thyristor via R2, hence the need for a large power rating for this resistor. Because the regulating transistor is now turned off, there will be no supply to the LED, which of course goes out. This provides the user with an indication that a short circuit has occured and must be rectified immediately.

Once the short circuit has been removed, the circuit may be reset by pressing SW1. This puts a short across the thyristor which thus turns off. With the thyristor turned off the circuit returns to normal operation. The large value capacitor, C1 is included to prevent spurious operation



of the thyristor in the case of the large (but short) surge currents that may occur when the power supply is connected to circuits with a large capacitance across its own supply lines.

The value of R1 is calculated from the equation:

$$\text{Value of R1} = \frac{\text{gate trigger voltage (VG)}}{\text{required cut-out current}}$$

The value of VG can be found from the data sheet of the particular device you are using. So for example if you are using the example given in the circuit then the calculation is:

$$\text{Value of R1} = \frac{0V8}{800mA} = 1\text{ ohm}$$

Note that, for this particular circuit the maximum cut-out current that you can safely use is one amp. Although any current value smaller than this is quite safe. It is not possible to use a variable potentiometer instead of R1 as the values encounted are very small, and in most cases the value of R1 needs to be made up from lengths of enamelled copper wire.

Paul Mulvey, Ireland.

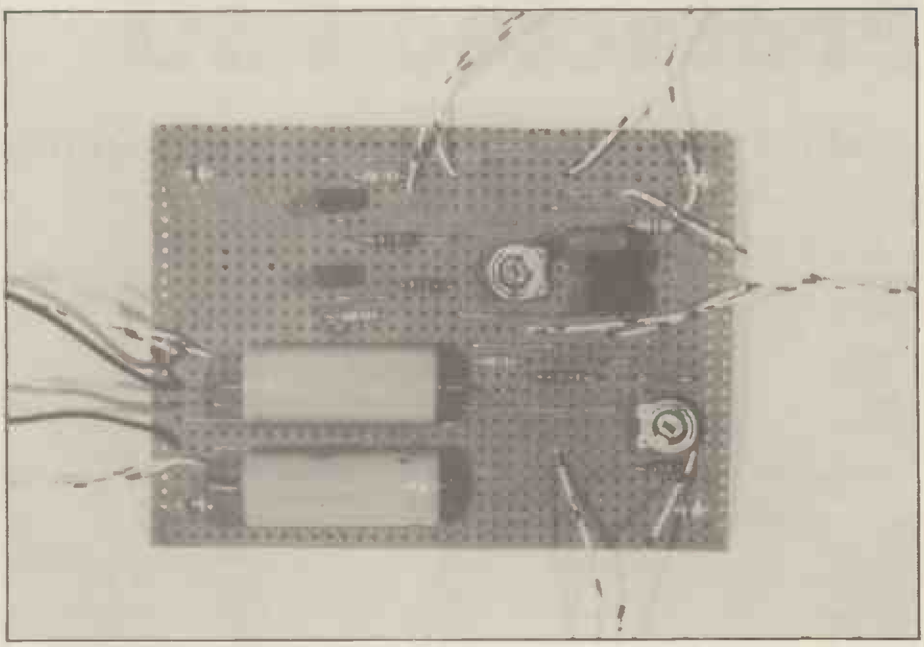
DC Voltmeter

A large ranges for a low cost: this voltmeter uses a centre-zero meter to give readings from plus/minus 500V to plus/minus 5mV, as well as unusually good protection against overload.

J. E. Aman

HERE is the experimentors' answer to DC voltage metering. An accurate, easily read, very high impedance meter that costs only a couple of pounds more than the meter movement.

We choose a centre zero meter not only for the great convenience it provides but also because with this design it's virtually impossible to destruct it.



The Circuit

As you can see from Figure 1, a FET input op-amp is used as an impedance transformer and we have switched the feedback resistors in an unusual way to virtually eliminate zero null adjustment and to give the meter a truly wide range of voltage reading, from plus and minus 500 volts to plus and minus five millivolts.

All this selective switching is done with a simple one pole six way rotary switch. Resistor, R10 sufficiently protects the meter movement from overload, as the maximum output of the op-amp is probably around ±8V when driven from nine volt batteries, only about 100uA maximum could be pushed through the meter. Since this is only twice the full scale current no other meter protection is needed.

The feedback resistors should be high tolerance precision resistors as these values effect the accuracy of the meter.

Op Amp

With negative feedback applied by R2-7 to IC1, the output will try to keep both inputs, pins two and three at the same voltage. Since the non-inverting input, pin three is connected directly to earth (the reference voltage), the inverting input, pin two, assumes a "virtual earth".

Any voltage introduced across the input sockets tend to upset this balance and the output voltage will change proportionally according to the value of this input voltage. By varying the value of the feedback resistors, we can achieve any voltage gain we want within the limits of the IC and the power supply rails.

For the higher ranges, 500, 50 and 5 volts, no voltage gain is required, and the combination of R1 and R2-4 attenuates the input voltage and provides gains of less than unity.

For the lower ranges, 0V5, 50mV and 5mV, voltage gain is required, and R1 together with R5-7 and the voltage divider network R8/9 provides gain greater than unity according to the selected range.

The zero null adjustment of IC1 could have been made accessible externally to the case. However this is not really necessary as once it has been set it is rarely adjusted. The circuit also includes a low battery warning indicator which lights an LED when sufficient volts have disappeared from the batteries.

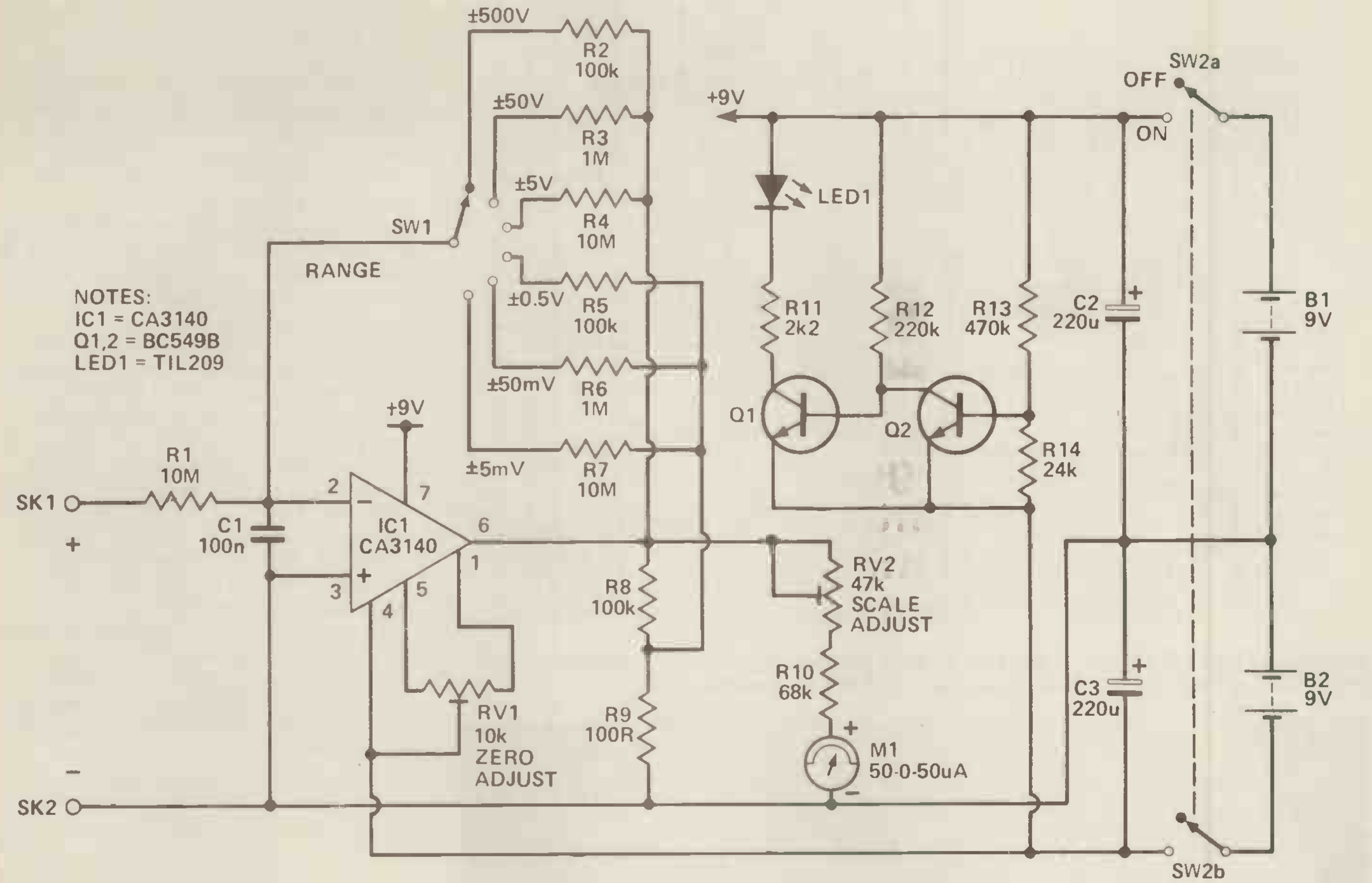


Figure 1. The circuit. All the switching is done via the six-pole switch SW1, while R10 protects the meter from overload. The red LED1 is a low battery warning indicator.

Low Volts

With fresh batteries the low battery circuit usually has 18 volts across it. This gives approximately 0V9 at the base of Q2. This transistor thus turns on, and in so doing pulls the base of Q1 down to ground. The LED thus does not light.

When the supply voltage drops to say, 9V, the voltage on the base of Q2 falls to approximately 0V4, Q2 thus switches off. As it does so, the base of Q1 is no longer tied to ground and the voltage on the lower end of R12 presents sufficient voltage on the base of this transistor to turn it on. Thus the LED lights and gives an indication that the battery voltage is too low for reliable operation.

It is often found that digital meters are marvellously accurate and easy to use. However, their sample rates at times can be less than optimum and they give no indication of any small brief surges which might occur. These criticisms seem minute but there are many situations where the addition of an analogue meter to one's workshop can be of greatest advantage.

Parts List

RESISTORS
(All ¼W 5% carbon except where stated)

- R1, 4, 7 .... 10M 1% metal film
- R2, 5, 8 .... 100k 1% metal film
- R3, 6 .... 1M 1% metal film
- R9 .... 100R 1% metal film
- R10 .... 68k
- R11 .... 2k2
- R12 .... 220k
- R13 .... 470k
- R14 .... 24k

POTENTIOMETERS

- RV1 .... 10k horiz preset
- RV2 .... 47k horiz preset

CAPACITORS

- C1 .... 100n polyester
- C2, 3 .... 220u 25V axial electro

SEMICONDUCTORS

- IC1 .... CA3140 CMOS op-amp
- Q1, 2 .... BC549B NPN silicon
- LED1 .... TIL209 red LED

MISCELLANEOUS

- M1 .... 50-0-50uA centre zero panel meter
- B1, 2 .... 9V PP3 batteries
- SW1 .... 1 pole 6 way rotary switch
- SW2 .... DPDT min toggle
- SK1, 2 .... 4mm socket

Veroboard; metal case; control knob; battery connectos; IC socket; test leads; connecting wire, etc.

BUYLINES .... **page 26**

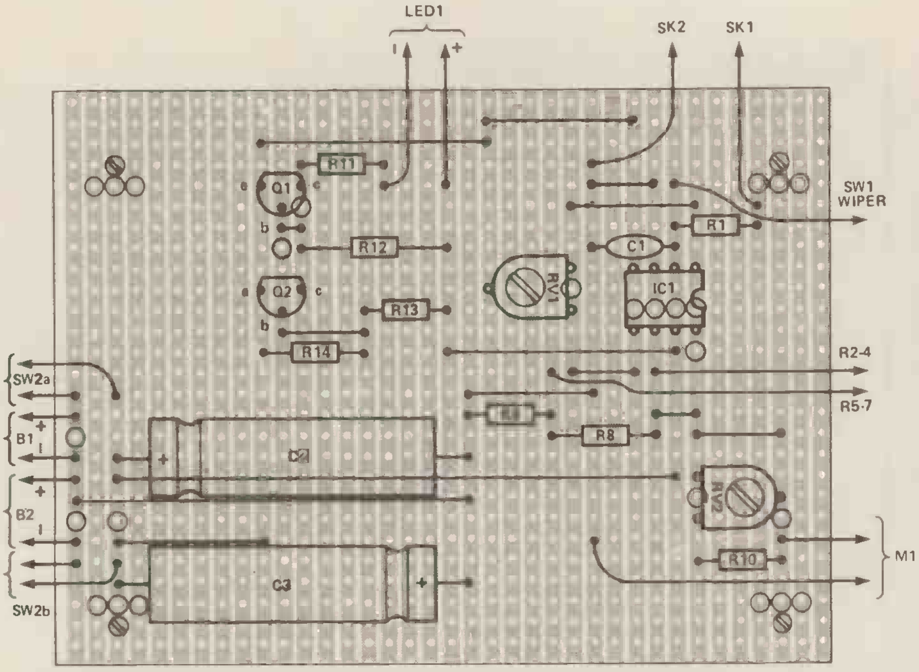


Figure 2. The PCB layout. If the CA 3140 is used, an IC socket is recommended. Note that resistors 2 to 7 are mounted on SW1 — see Figure 3.

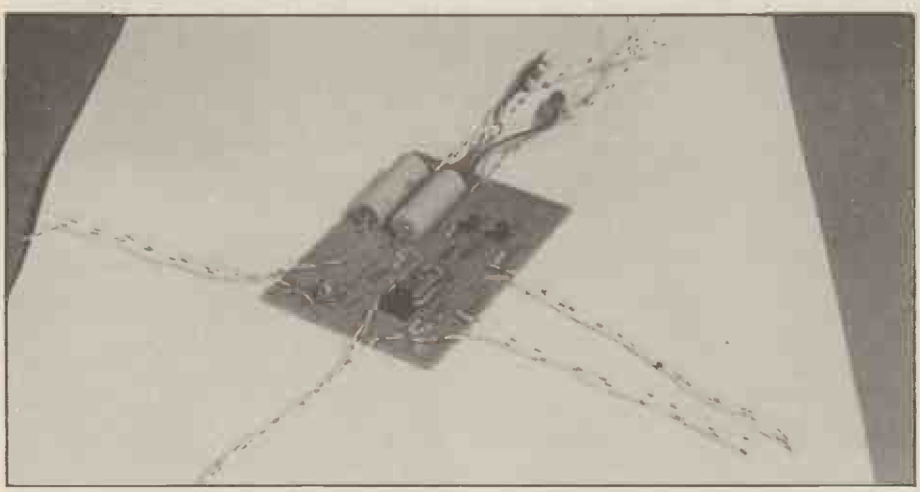
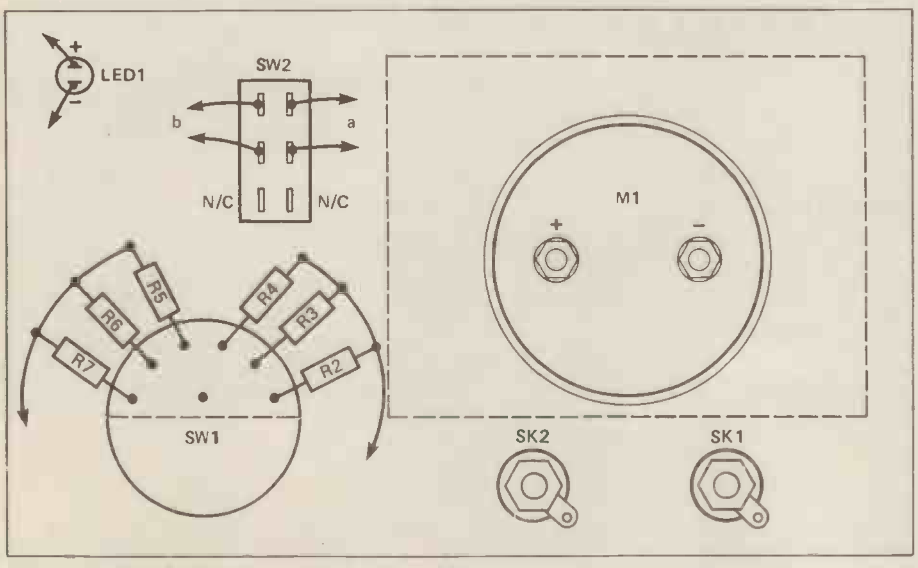


Figure 3. A recommended layout for the front panel (seen from inside). R2-7 are shown "flattened out" for clarity, but would normally be mounted perpendicular to SW1.



Construction

The construction of the Voltmeter is very simple and easily built on Veroboard. The feedback resistors, R2-7 are mounted on the switch and this eliminates the requirement of a large number of connecting wires to and from the board.

The actual Veroboard layout is shown in **Figure 2**.

An IC socket is recommended for IC1 as this particular IC is sensitive to static. However, if a TL061 is used, this is not so sensitive and does not really require a socket.

A recomended front panel layout is shown in **Figure 3**, and this shows the reverse side. Notice how the resistors on the range switch have been shown opened out for clarity. In practice, they are usually mounted horizontally to the switch.

Figure 4 shows a meter scale if the recommended type of meter cannot be obtained. Remember though that whatever type of meter is used, it must be a centre zero type.

The scale is drawn full size and may be cut out or traced and stuck on the meter's existing scale. The scale should be suitable for most meters, but if not, the proportions can easily be gauged.

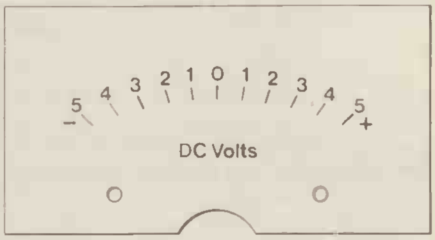


Figure 4. Cut out, or photocopy, this meter scale if you cannot obtain a suitable centre-zero meter.

Calibration

Connect the sockets together and adjust RV1 for a zero reading. Remember that this is a centre zero reading.

Select the 0V5 range and connect a known voltage source between 0V1 and 0V5. Next, adjust RV2 for the correct reading on M1 according to the applied voltage. As a check, reverse the test leads and see if a corresponding reading only this time negative shows on the meter.

As a final check, apply known voltages of the correct value and check the other ranges. They should, within reason be accurate if precision resistors are used. Because of the wide tolerance (comparitively speaking) of the ten megohm resistors, slightly more inaccuracy may be noticed on these ranges than others. **HE**

All About Batteries

HE takes the lid off — or at least, a slice out of the humble battery, and gets direct to the source of the power

Keith Brindley

EVERYONE KNOWS what a battery is: it's one of those little tubes you bung inside your tranny radio, torch or cassette player so that you can have light and music wherever you go.

But aren't they expensive? And why are some of them even more expensive than others? And is it really true what they say about this sort lasting twice as long as that sort, and does it really matter what sort of battery you put inside your torch because you use the torch so rarely the batteries are always flat anyway?

Well, this article aims, to dispel all the myths surrounding batteries with some hard scientific facts and figures which will allow you to choose between the different types and prices available.

First, a battery isn't "one of those little tubes" — one of those little tubes is a cell. Strictly speaking a battery in the electrical sense of the word is a collection of a number of cells. Four of the most common cells are shown in **Figures 1, 2, 3** and **4**, along with approximate sizes.

Figure 1 shows an AAA-size cell, about 44.5mm high and 10.5mm in diameter. Figure 2, AA-size, is about 50mm high and 14mm in diameter, and is one of the most popular sizes for small torches and radios, personal stereos, etc.

Although there may be many different types and makes of these cell sizes (and each different manufacturer may produce two, three or more varieties of each cell size) we are going to classify them here as AAA-size, AA-size, C-size and D-size in ascending order. We'll see later that many more cell sizes are avilable.

Cells In Series

One of the most popular size of battery — note the word, battery — is the PP3-size, shown in **Figure 5**. The PP3-size *is* an actual "battery" because its consists of six small cells in series with the case, as shown in **Figure 6**. Each cell is rated at 1V5, so the PP-3 size battery is rated at 9V. Other batteries in the PP-range are the PP1, PP6, PP9 etc. which are all constructed in similar ways.

Figure 3 shows a C-size cell, about 49mm in height and 25mm in diameter. Figure 4 shows a D-size cell, about 60mm high and 33.2 in diameter. This is the popular size for larger portable appliances, which may use from two to eight of them, typically.

But let's not forget another common battery, the car battery, which also consists of six cells in series, the difference being that they are a completely different type of cell, rated at 2V, so that the battery is rated at 12V. There's something else different about a car battery. It stores a substantial amount of electricity (far more than the cells and batteries we have looked at), enough to start a car. Once the engine is running, however, the generator or alternator gradually recharges, ie replenishes, the battery.

The car battery allows this recharge of electricity because it is constructed in a form we know as secondary cells. A secondary cell is any cell which allows recharge. The cells above, the AAA-size, AA-size, C-size, D-size, and all the PP-sizes are generally constructed of primary cells and cannot be recharged. We have used the word 'generally' because ranges of secondary rechargeable cells of these sizes are available, known as nickel-cadmium ("Nicad") cells.

Figure 5 shows a PP3-size battery, well known because of its hobby applications. The PP3 is a true "battery", made up of a set of cells, unlike the preceding four examples.

In a following article we will look closely at the secondary cells and batteries of Nicad and car types, but this article will concentrate purely on the primary types available, how they are made, how they work, and their main uses.

How Does A Basic Cell Work?

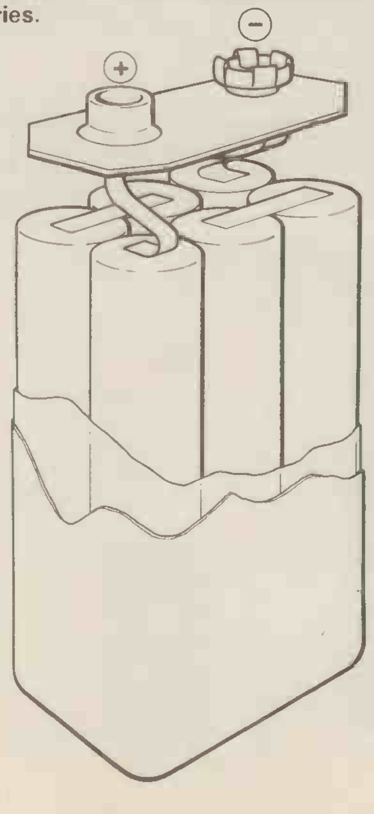
Essentially an electric cell is formed by inserting two conducting electrodes into a substance known as an electrolyte, as shown in **Figure 7**. One electrode, called the anode, is usually made of metal; the other, the cathode, is generally a metallic oxide material.

Metal oxides are formed when metal atoms combine with oxygen. A very common form of metal oxide, iron oxide, commonly known as rust, forms on iron or its derivatives when exposed to air. We all know too well the problems which rusting can create in car bodies, due to this combination of iron and oxygen. Most metals oxidise, and when a metal oxide is used in a cell it is used in a constructive way — unlike destructive rust.

The electrolyte can be made of a number of different materials, specially chosen for use with the particular electrodes in the cell. Different cells with different electrodes require different eletrolytes. Whatever substance the electrolyte is, it is an electrical conductor which conducts in a special way, which we shall look at now.

A metal used for an anode is always chosen because it has a much higher affinity for oxygen than does the metal (which is oxidised) of the cathode. Thus, if the anode and the cathode were mixed together the anode would take away the oxygen from the metal oxide cathode, leaving the cathode's metal behind. In this case we say the anode has been oxidised and the cathode has been reduced.

Figure 6. A possible internal construction for a PP3 battery, showing how six 1V5 cells are connected in series.



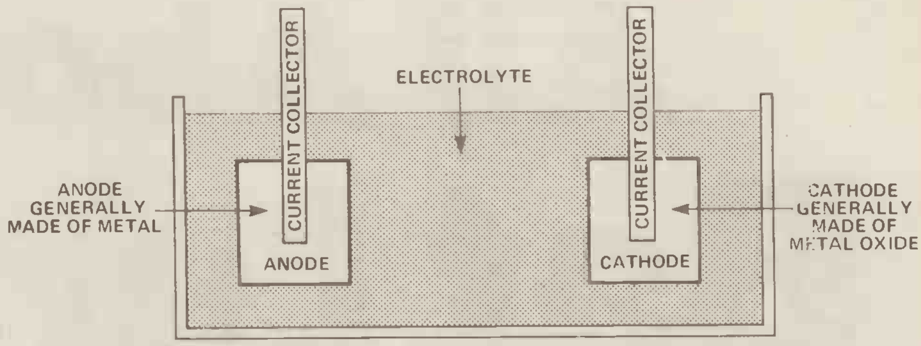


Figure 7. A basic cell, showing anode, cathode, and electrolyte.

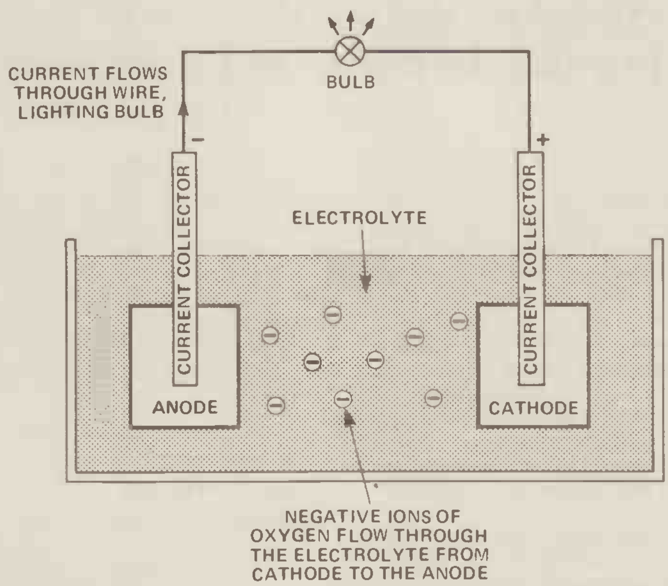


Figure 8. A basic cell in operation, in this case used to illuminate an electric light bulb.

Electrolytes are the special substances which allow this 'mixing' of anode and cathode to take place — without the necessity of the anode and the cathode touching. Under certain conditions the electrolyte contains particles of oxygen (charged with electrons) which originate at the cathode and move over to the anode, so that the cathode is reduced and the anode oxidised. These conditions do not, however, occur if the cell is as in **Figure 7**, although we say they have the potential. (This, incidentally is how the word potential, meaning voltage, is derived). In order for the charged oxygen particles to combine with the metal of the anode, each particle has to give up its electron charge. And in order for the oxygen particles to leave the cathode and enter the electrolyte they must gain a charge.

We can use this potential if we connect an electric circuit to the terminals on the anode and cathode, as shown in **Figure 8**. In this way the electrons, give off by the combination of charged oxygen particles with the anode, can flow from the anode into the circuit, through the bulb (causing it to light up) and back to the cathode where they can charge more oxygen particles. This stream of electrons, an electric current, will flow in a connected circuit for as long as the cathode has oxygen particles, or until the anode has been fully oxidised. At this point, we say the cell is discharged.

The charged particles flowing through the electrolyte are called ions. They can be of many varieties — not just oxygen — depending on the cell and the electrolyte used, but the principle is the same.

Different electrolytes, and different anodes and cathodes, produce cells of varying cost and performances. We'll look at the different parameters of all cells which are of most importance so that we may compare the different types as we meet them.

Voltage And Resistance

The potential voltage output of a cell is known as its electromotive force (EMF). The exact figure (usually around 1V5) depends particularly on the nature of the anode and cathode and the electrolyte, but also depends on the temperature and age of the cell. For a fresh cell, the EMF is usually slightly higher than its rated EMF, say about 1V6, falling to a lower figure, say 1V2, when old and discharged.

This variation in cell voltage, although

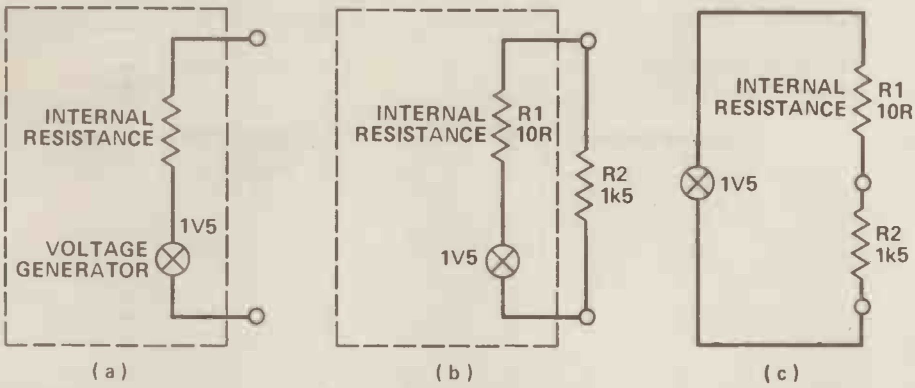


Figure 9a, b and c show the equivalent circuit (to Figure 8) of a 1V5 cell, showing internal resistance. For details see text.

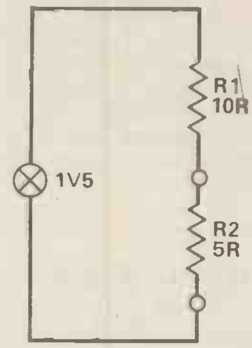


Figure 10. This shows how internal resistance affects operation in high current applications.

important, if often not critical because many electronic circuits do not need a fixed and steady voltage to operate.

Much more important, however, is a cell's internal resistance. This is the effective resistance within the cell itself, caused by the very structure and materials used. It cannot be eliminated, but may be very low depending on the type of cell.

We can look at the effects of internal resistance if we consider the diagram in **Figure 9a** which we may imagine to be the equivalent circuit of a cell. It consists of a voltage generator together with a series resistance: the voltage generator represents the potential EMF of the anode/cathode/electrolyte combination while the resistance represents the internal cell resistance.

Figure 9b shows a cell, with a voltage generator of 1V5 and an internal series resistor R1, of value 10R, connected to a resistor which represents a circuit with an overall resistance of 1k5. A current will flow which you may have expected to be (from Ohm's law).

$$I = \frac{1V5}{1500} = 1 \text{ mA}$$

However, the series internal resistance has an effect on the current and must be taken into account. The circuit has been redrawn in **Figure 9c** where we can see that the two resistors form a voltage divider network. Thus the voltage across the connected resistor (which we had previously taken to be 1V5) is

$$VR2 = \frac{R2}{R1 + R2} \times 1.5$$

$$= \frac{1500}{10 + 1500} \times 1.5$$

$$= 1V49$$

slightly lower than we thought. And the current through the connected resistor is

$$I = \frac{1V49}{1500} = 0.99\text{mA}$$

also slightly lower. The lower voltage and current is not, fortunately, sufficient to affect operation.

Let us now look however, at the circuit in **Figure 10** where the connected circuit has an overall resistance of 5R. As before, we might expect the current to be

$$I = \frac{1.5}{5} = 300 \text{ mA}$$

However, due to the cell's internal resistance, the voltage actually across the connected resistor is

$$VR2 = \frac{5}{10 + 5} \times 1V5 = 0V5$$

and the actual current is

$$I = \frac{0V5}{5} = 10\text{mA}$$

The significantly lower voltage and current will be sufficient to seriously affect operation of the connected circuit.

Not only does a cell's internal resistance reduce the potential current which may be delivered by the cell, but it also wastes energy. In the above example, the voltage dropped across the internal resistance, ie, 1V5 — 0V5 = 1V. causes a power dissipation of

$$P = \frac{V}{R} = \frac{1}{10} = 0W1$$

to be lost as heat from the internal resistance. The cell will get warm, which increases the internal resistance which, in turn, increases the voltage drop, thus increasing the power thus increasing the voltage drop etc in a vicious circle. In the worst case the connected circuit will not have enough current to work at all, and even if it does, the wasted energy will reduce the time the cell would otherwise be able to supply current.

So, as we see, internal resistance of a cell becomes more important the greater the current required from the cell. By reducing the value of the internal resistance the effect is lessened, but can never actually be eliminated.

Power For Hours

One of the last cell characteristics which we need to study before moving on to cell types is cell capacity, ie the amount of electricity which a cell actually holds. This is often specified as the amount of current which a cell can supply for a given period of time. For example, a cell may have a capacity of 1000 milliampere-hours (mAh). This means that (ignoring internal resistance) the cell may provide 1000mA of current for one hour, or 100mA of current for ten hours, or 20mA for fifty hours etc.

But, describing a cell's current capacity in terms of mAh alone does not define the cell's total capability. Somewhere along the line we need to consider a cell's voltage as part of its capacity. This is easily done by multiplying the cell's current capacity in mAh by its voltage. So, if our example cell's voltage is 1V5 it has a total energy capacity in milliwatt-hours (mWh) of

$$1000 \times 1V5 = 1500\text{mWh}$$

Zinc Carbon Cell

The existing zinc carbon cells available are all based on the original cell developed by the French engineer Georges Leclanché in 1866. It was assembled in a glass jar inside which was the cathode in the form of manganese dioxide paste, contained in a porous pot. The pot was surrounded with an ammonium chloride electrolyte solution, into which the zinc anode stood. A connection was made to the manganese dioxide cathode with a carbon rod. Modern zinc carbon cells have come a long way since the days of the Leclanché cell, known as a wet cell because of the electrolyte solution.

The outside can of the modern dry cell is made of zinc metal and forms the anode. Just inside of the zinc is a thin lining which separates the anode from the cathode and is saturated with electrolyte. The electrolyte is a mixture of ammonium chloride and zinc chloride, which is slightly acidic. The cathode of manganese dioxide is mixed with carbon powder and electrolyte to form a paste and inside this is inserted the carbon rod, which acts as a current collector. Various bits of paper are used for isolation and a thin plastic film covers the outside jacket.

By varying the electrolyte mixture, different types of zinc carbon cells can be made, suitable for different applications. For example an electrolyte of zinc chloride alone produces a cell with a lower internal resistance and is therefore more suited to heavier duty applictions. A higher quality blend of manganese dioxide cathode produces the same effect.

Alkaline Manganese Cell

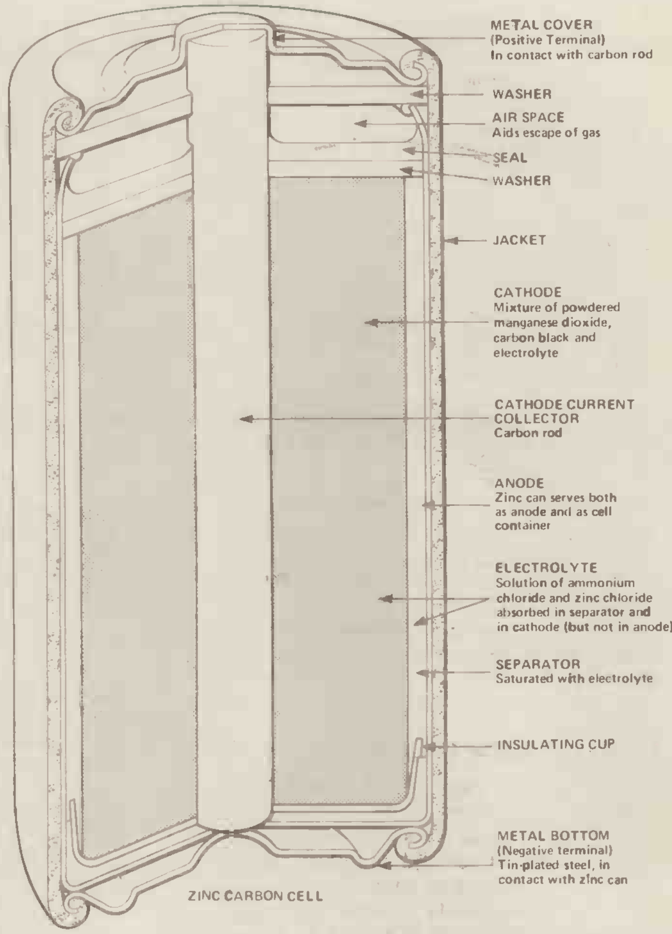
In the alkaline manganese cell, the anode and cathode materials, zinc and manganese dioxide, are the same as in the zinc carbon cell. The anode, however, consists of powdered zinc which allows the formation of a large surface area, formed into a paste with the electrolyte.

The manganese dioxide cathode of alkaline manganese cells is made from a much purer form of material known as electrolytic manganese dioxide, produced synthetically to have a much greater oxygen content. A solution of potassium hydroxide, an alkaline (hence the name) which is highly conductive, is used as the electrolyte. The use of this electrolyte, and the higher quality anode and cathode materials, results in a heavy duty, high quality cell with a reasonably low internal resistance and high energy capacity.

When compared with the construction of a zinc carbon cell the alkaline manganese cell (**Figure 12**) is 'inside-out', because the anode is on the inside and the cathode on the outside. A steel container is used which, unlike the zinc container of the zinc carbon cell, does not take part in the chemical process of producing current, so does not tend to perforate in use. It also provides a stronger and more leak-proof container. A metal central current collector — the nail — is in direct contact with the anode.

Cell EMF, because the same metal and oxide are used as anode and cathode, is the same as that of a zinc carbon cell — nominally 1V5.

Figure 11. The internal construction of a zinc carbon cell (see previous page).



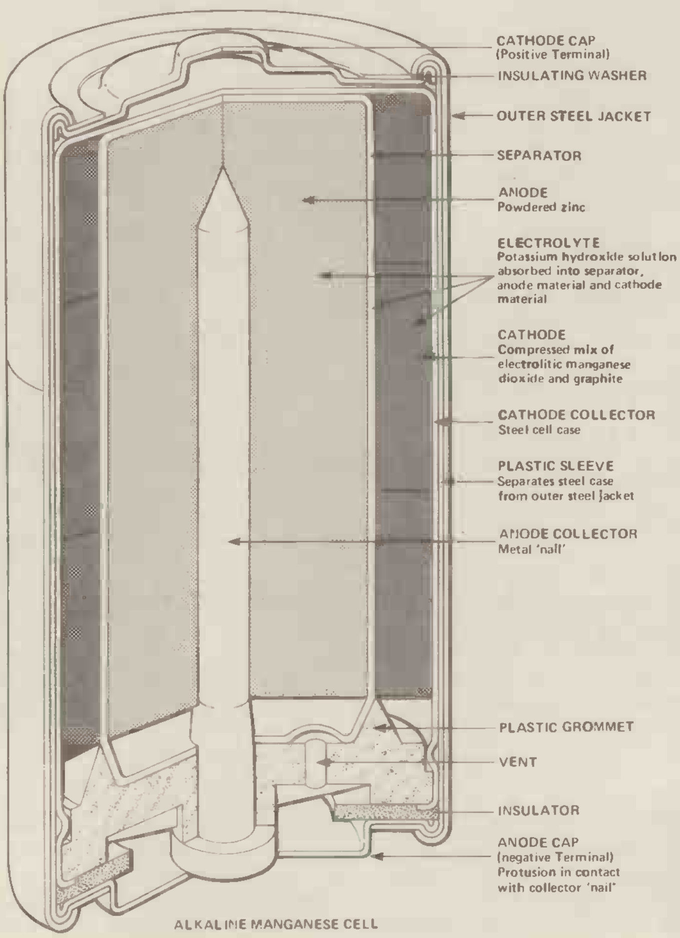


Figure 12. The internal construction of an alkaline manganese cell.

Button Cells

Some of the smallest and lightest cells, measured against capacity, are the button cells used to provide power in digital watches, hearing aids, calculators and photographic equipment. A number of different types are available and we shall consider the main types.

The mercury cell, shown in **Figure 13**, has an aqueous solution of potassium hydroxide as electrolyte. The inner surface of the cell's top is copper, which is electrochemically compatible with zinc, so wasteful corrosion is minimised. The cell is of a nickel-plated steel which is highly resistant to electrolyte corrosion.

Mercuric oxide, a material with a high oxygen content is the cathode which, although expensive, offers many advantages due to the possibility of a high ratio of energy to weight and

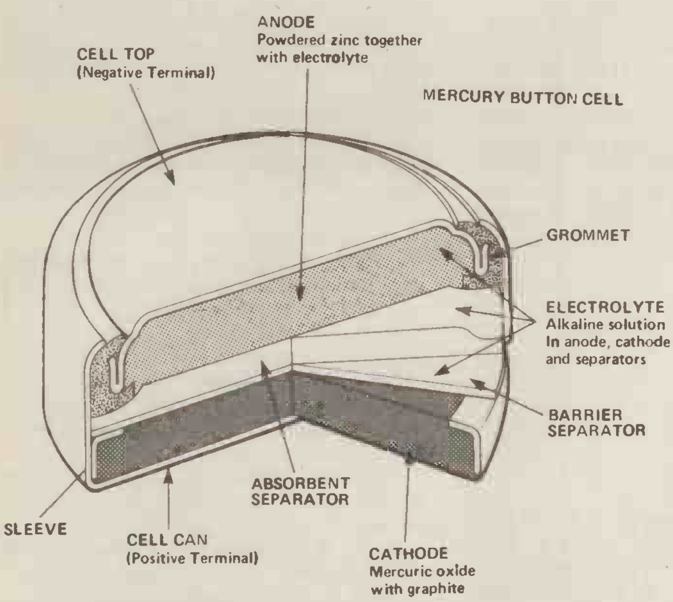


Figure 13. The construction of a mercury button cell. The silver button cell, and the zinc cell, are of similar construction.

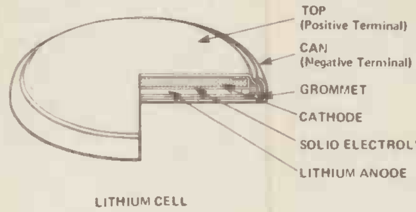


Figure 14. The construction of a lithium button cell.

volume. Nominal cell voltage is 1V35, and internal resistance is very stable and low.

Silver Oxide Cell

Another button cell cathode substance, silver oxide, is used in very similar cell construction to produce a cell with a higher nominal voltage of about 1V55. Internal resistance is again low and the cell is thus ideally suited for high current rates in applications such as devices with LED displays etc.

The combination of a high ratio of energy to weight and volume, excellent sealing, and long storage life (like the mercury cell) make the silver oxide button cell an ideal choice where space is at a premium. Silver oxide is, however, a very expensive substance.

Zinc Air Cell

The zinc air cell has a similar construction and appearance to silver oxide and mercury cells with the addition of air access holes in the base.

Oxygen, from the air around the cell is used to oxidise a zinc powder plus alkaline electrolyte anode, through a synthetic membrane. The fact that the oxygen particles are taken from the air, and not from a cathode means that more space inside the cell may be used to contain the anode, so the cell has nearly twice the electrical capacity of mercury and silver oxide cells.

Zinc air cells can have an exceptionally long storage life if they are sealed before shipment, with a sealing tab which prevents air from reaching the inside of the cell. The tab is removed immediately prior to use.

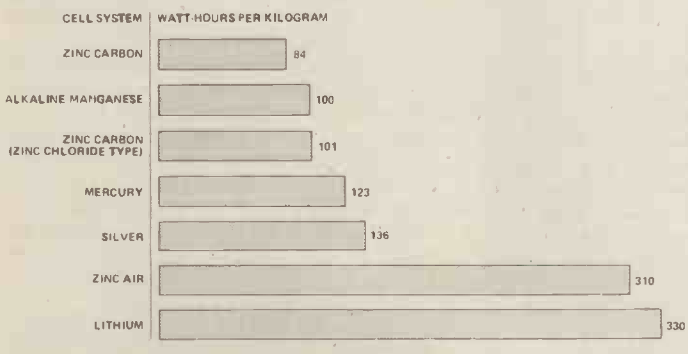


Figure 15. A graph showing a comparison of the capacities of various cell types with regard to their weight.

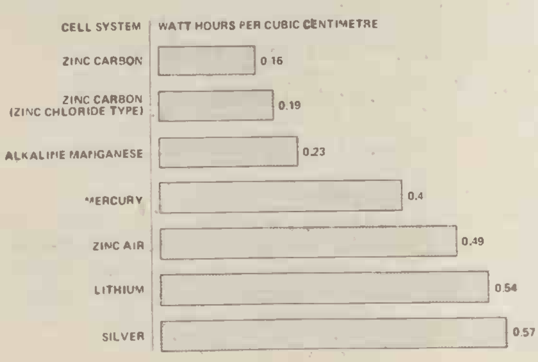


Figure 16. A graph showing a comparison of the capacities of various cell types with regard to their volume.

Size and number of air holes can determine the amount of air access and thus cells may be manufactured for specific application. For example, in an application where a large current is required, large and plentiful air holes are needed. An application of low current drain but long life, on the other hand will require a limited number of small holes.

Nominal cell voltage is 1V45.

Lithium Cells

The construction of a lithium-manganese dioxide cell is shown in **Figure 14**. It is similar to that of other button cells but with a lithium anode together with a manganese dioxide cathode.

Lithium is a highly reactive metal and this makes it an attractive material to use as a cell anode but this also makes it a most tricky material to deal with. Lithium must be handled and fabricated in an airless, moisture free environment.

This higher reactivity allows a cell of greater nominal voltage to be made — up to 3V6 ideal for use in heavy-duty higher-voltage requirements.

Many different electrolytes can be used within a lithium cell, producing cells with various specifications. One system used a solid electrolyte which is very stable but has a high internal resistance thus can only supply low currents, and has a nominal voltage of only 1V9.

Another electrolyte used in lithium cells is sulphur dioxide in liquid form, which allows a cell voltage of 3V. Yet another electrolyte, thionyl chloride, also a liquid, gives a cell with a nominal voltage of 3V6. These higher cell voltages are possible because the electrolytes act as combined electrolyte cathode materials to create higher potentials.

All types of lithium cells with liquid electrolyte allows a much lower internal resistance to be obtained and so can provide much higher currents.

Comparing The Different Cells

We have seen enough now to make a qualified judgement on the performance of the various cell-types and we shall make this judgement in terms of weight, size and finally performance of the two main types of cells — zinc carbon and alkaline manganese. **Figure**

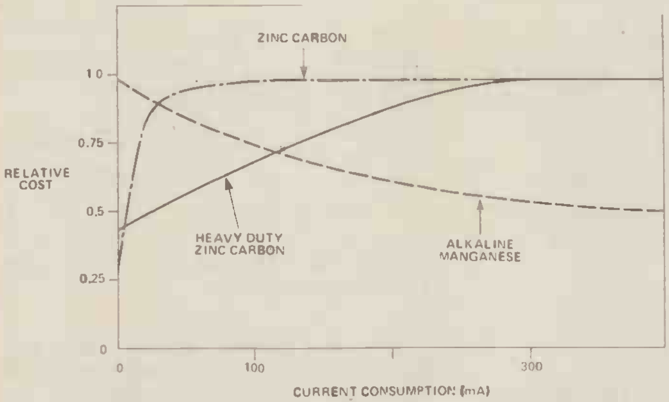


Figure 17. An interesting graph showing the relative costs of alkaline manganese, zinc carbon and heavy duty zinc carbon cells as a function of their current consumption.

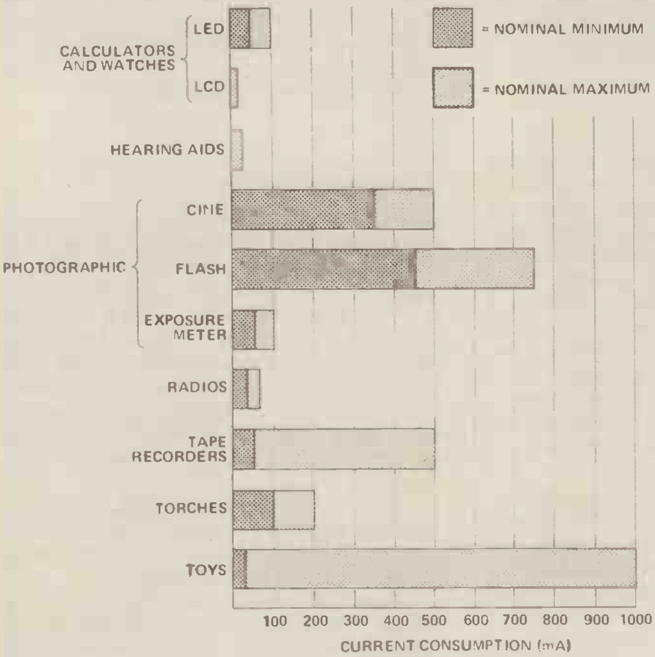


Figure 18. This graph shows the current consumption of some typical battery-powered devices. Typically, the more heat that is generated (as in the photographic flash) and the more moving parts the device has (as in the drive mechanism of a cine or tape recorder) the more expensive it is to run.

Zinc air cells (see previous page). Batteries tend to decay if they are stored for a long time without use. Zinc air cells are sealed until use, which gives them very long storage time. The seal is broken by pulling the tabs shown in the picture.

15 shows a block chart comparing the seven types of cell we have looked at, with regard to weight. The exceptionally lightweight characteristics of zinc air and lithium cells are obvious.

A block chart showing cell-types against volume, however, shown in **Figure 16**, is more evenly spread with silver cells giving the best performance in terms of physical size.

But the most important comparison we can make, and also the one which is very different to accurately undertake, is in terms of efficiency regarding cost per unit time. The difficulty arises because of the wide variety of retail prices between cells at different retail outlets. Nevertheless, the following gives a reasonable guidance.

Generally speaking, the button cell varieties are used in specific situations, in which other types of cell are not useable. Little point is therefore gained by including them in an efficiency survey. The three cell-types of importance, therefore, are the zinc carbon, the heavy duty zinc carbon and the alkaline manganese, which are all produced in similar ranges of size and are thus interchangeable. The question to be asked, then, must be, it is better to use zinc carbon or heavy duty zinc carbon or alkaline manganese cells in any specific application? **Figure 17** shows a graph of relative cost of cells against supplied current and illustrates that at fairly high current rates (about 100 mA or more) alkaline manganese cells are most cost effective.

However, below this figure heavy duty zinc carbon cells become a more viable form of portable power source.

Finally at low current levels, less than 20 mA or so, or even ordinary zinc carbon cells compare favourably with alkaline manganese cells.

Obviously, alkaline manganese cells are superior in terms of contained power and quality — the zinc case of the zinc carbon cell enters into the electrochemical reaction and the cell may leak its acid contents; the alkaline manganese cell's steel case should not leak. In all situations an alkaline manganese cell will outlast a zinc carbon cell, ie it will provide the same amount of current for a longer period of time. But in low current, or medium-intermittant current applications, they might not be the economically sensible choice.

Figure 18 shows a chart of battery-powered devices along with typical minimum and maxium current consumptions. You may find this of interest if you wish to know which type of cell is most economic for your battery-powered devices.

References

Use has been made in this article of the following booklets: *Modern Portable Electricity* (issued by the Every Ready Company (Great Britain) Ltd.); *Packaged Power* (issued by Duracell International Inc.).

HE PCB SERVICE

Ready made PCBs For Readers!

PRINTED CIRCUIT BOARDS (PCBs) for HE projects have often represented an obstacle for our readers. Some of you, no doubt, make your own but our PCB Service saves you the trouble.

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Apart from the PCBs for this month's projects, we are making available some of the popular designs from earlier issues. See below for details. *Please note that only boards for projects listed below are available*: if it isn't listed we can't supply it.

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HE/8206/4&5	Telephone Timer (Set of two)	£7.48
July 82		
HE/8207/1	Tanover	£2.45
HE/8207/2	TVI Filter	£2.05
HE/8207/3	Computer PSU	£8.83
HE/8207/4	Solar Radio	£2.28
August 82		
HE/8208/1&2	Digital Millivoltmeter (Set of two)	£4.99
HE/8208/3&4	Audio-Analyser (Set of two)	£13.28
September 82		
HE/8209/1&2	Signal lights	
	Main Module	£2.25
	Junction Module	£1.96
HE/8209/3	ZX Interface	£3.84
HE/8209/4	Slot Car Controller	£2.28
October 82		
HE/8210/1	Flash Point Alarm	£2.45
HE/8210/2	Negative Voltage Generator	£1.71
HE/8210/3	Squelch Unit	£2.90
November 82		
HE/8211/1	Pedometer/ Odometer	£2.45
December 82		
HE/8212/1	Phase Four	£3.25
HE/8212/2	Microlog~~	£4.58
HE/8212/3&4	Tape/Slide (Set of Two)	£6.05
HE/8212/5	TV Amp	£6.56
HE/8212/6	Lofty	£3.00
HE/8212/7	Noise Gate	£4.14
HE/8212/8	Low Cost Alarm	£2.65
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HE/8301/2	Switched Mode Regulator	£2.25
February 83		
HE/8302/1	Incremental Timer	£8.20
HE/8302/2	DigiTester PSU	£7.71
March 83		
HE/8303/1	Loudspeaker Protector	£2.89
HE/8303/2	Overvolt Cutout	£2.59
April 83		
HE/8304/1	6502 EPROMMER	£8.26
HE/8304/2&3	Ducker	
	Main Board	£4.09
	Preamp Board	£2.66
HE/8304/4	Power Down	£2.42
May 83		
HE/8203/1	BBC Interface	£5.54
HE/8305/3	Stall Thief	£2.88
HE/8305/4	Auto-Test	£2.88
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HE/8306/1	Sinclair Sound Board	£3.22
HE/8306/2	CB Rap Latch	£1.90
HE/8306/3	Bat Light (Car battery monitor)	£2.59
HE/8306/4	Traffic Light Toy	£2.94
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HE/8307/1	Soft Fuzz	£3.19
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HE/8308/1	Whistle Switch	£5.06
HE/8308/2	Ace Interface	£4.05
HE/8308/3	Enlarger Timer	£3.36
HE/8308/4	Auto-Winder	£3.43
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HE/8309/2	SPL Meter	£4.85
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HE/8310/2	Audio Level Meter	£3.55
HE/8310/3	High Voltage Meter	£3.99
November 83		
HE/8311/1	Wiper Delay	£3.22
HE/8311/2	Light Delay	£3.21
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HE/8312/1	Damp Meter	£3.32
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HE/8312/3	Light Meter	£3.63
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HE/8405/2	Touch Switch	£3.11
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HE/8406/1	ZX81 Tape	£3.81
HE/8406/2	Mains Intercom	£3.78
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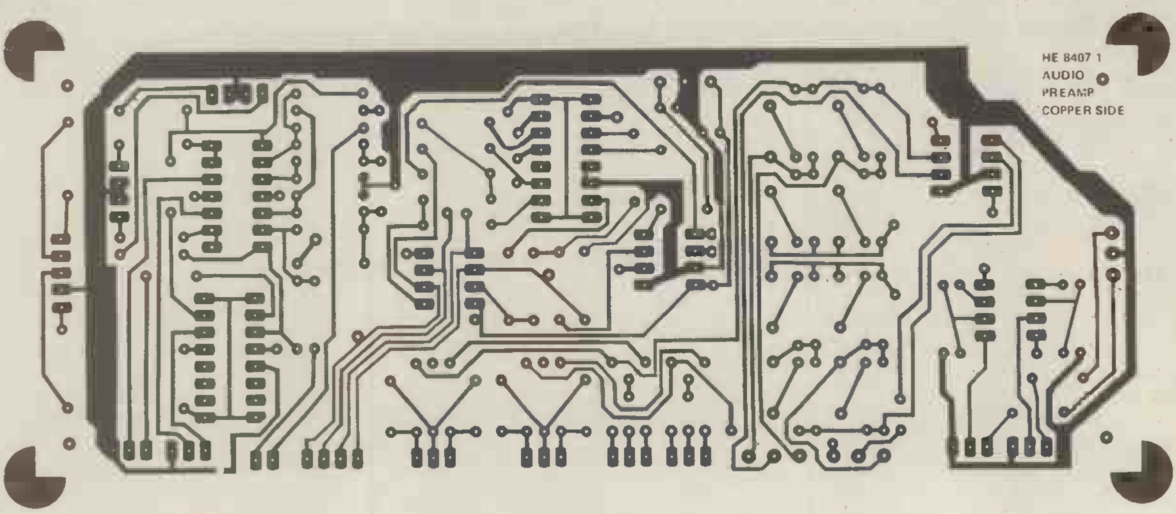

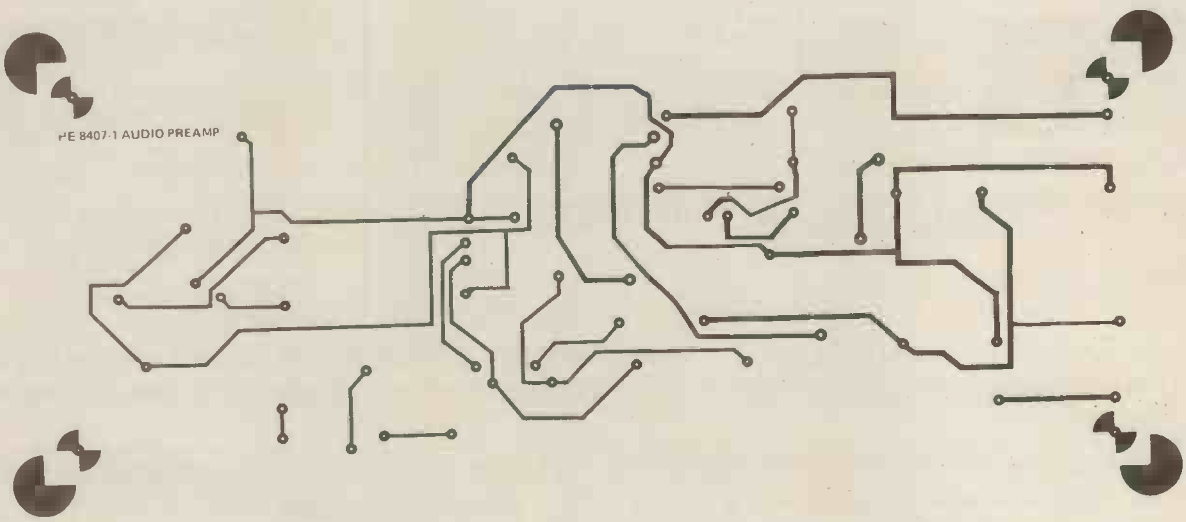

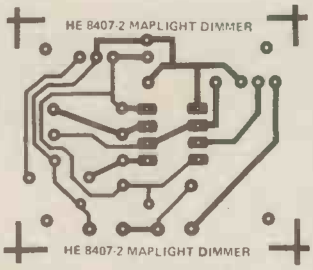

Above: The two foil patterns required for the Audio Amplifier. Ignore the fancy compass-like circles, these are only needed for registration purposes and are not likely to be needed for the home constructor.

Left: The foil pattern for the Map Light Dimmer. This is a simple board and can be made easily using for example a Dalo pen.

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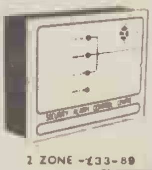

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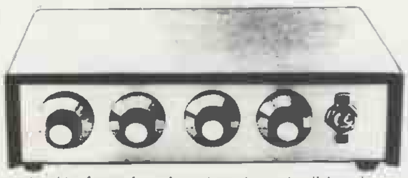

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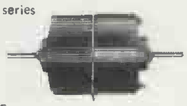

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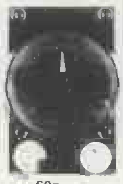

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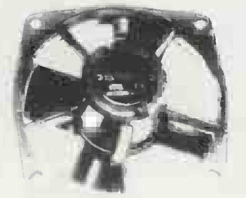

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4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

LIGHTING & POWER CABLES

Made by Volex to BRITISH STANDARD SPECIFICATIONS

P.V.C. sheathed outer-copper clad conductors

1.5mm flat twin	100	metres	£4.50
1.5mm flat 3 core	8E	metres	£11.00
6mm flat 3 core		metres	£54.00
16mm flat twin	8E	metres	£115.00

MINIATURE WAFER SWITCHES

2 pole, 2 way — 4 pole, 2 way — 3 pole, 3 way — 4 pole, 3 way — 2 pole, 4 way — 3 pole, 4 way — 2 pole, 6 way — 1 pole, 12 way.
All at 25p each or 10 for £2.00

OTHER TYPES IN STOCK — PLEASE ENQUIRE

BLEEP TONE These work off 12v and have an unusual and pleasant bleep. 69p each.

CONNECTING WIRE PACK 96 lengths of connecting wire, each 1 metre long and differently colour coded, a must for those difficult interconnecting jobs. 85p the lot.

RED LEDS 10 for 69p. 100 for £5.75. 1000 for £52.

IN LINE SIMMERSTAT Ideal heat controller for soldering iron and many other hand-held appliances. £2.30. 10 for £17.25.

VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are without case but we can supply a plastic case - £1.75 or metal case - £2.95. Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — a complete mains operated kit, case included.

£11.95 plus £2.00 post.

OTHER POPULAR PROJECTS

Short Wave Set — covers all the short wave bands using plug-in coils. Kit complete	£14.50
R C Bridge Kit	£9.95
3 Channel Sound to Light — with fully prepared metal case.	£14.95
Ditto — made up	£25.00
Big Ear, listen through walls	£9.50
Robot controller — receiver/transmitter	£9.50
Ignition kit — helps starting, saves petrol, improves performance	£13.95
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch — fools friends and enemies alike	£1.95
3 — 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Light Chaser — three modes	£17.50
Mullard Unilex HiFi stereo amplifier with speakers	£16.75
Radio stethoscope — fault finding aid	£4.80
Mug stop — emits piercing squark	£2.50
Morse Trainer — complete with key	£2.99
Drill control kit	£3.95
Drill control kit — made up	£6.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
FM receiver kit — for surveillance of normal FM	£3.50
Seat Belt reminder	£3.00
Car Starter Charger Kit	£15.50
Soil heater for plants and seeds	£16.50
Insulation Tester — electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio — receives Medium Wave	£2.95
Mixer Pre-amp — disco special with case	£16.00
Aerial Rotator — mains operated	£29.50
Aerial direction indicator	£5.50
40 watt amp — hifi 20hz — 20kHz	£9.50
Microvolt multiplier — measure very low currents with ordinary multitester	£3.95
Pure Sine Wave Generator	£5.75
Linear Power output meter	£11.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50
Stereo Bass Booster, most items	£8.95

ALS

BI-PAK BARGAINS

MINIATURE TOOLS FOR HOBBYISTS

Miniature round nose side cutters – insulated handles 4½inch length. Order No: Y043.

Miniature long nose pliers – insulated handles 5½inch length. Order No: YD44

Miniature bend nose pliers – insulated handles 5½inch length. Order No: YD45.

Miniature end nippers – insulated handles 4½inch length. Order No: YD46.

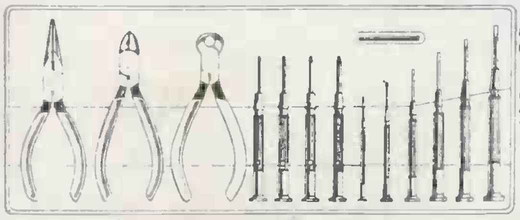
Miniature snipe nose pliers with side cutter and serrated jaws – insulated handles 5inch length. Order No: Y042.

ALL AT £1.25 each

FLEXEY DRIVER
A flexible shaft screwdriver for those awkward to get at screws. Overall length 8½inch. Order No: FS-1 Flat blade 4mm FS-2 Cross point no. 1
£1.75 each.

GRIP-DRIVER
8inch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places.
Order No: SD-1 Flat blade 4mm SO-2 Cross point no 0. £95p each.

13 PIECE TOOL KIT AND CASE



13-piece tool set housed in attractive moulded plastic case with clear sliding cover ● 1 off 5" snipe nose "radio" pliers with side cutters ● 1 off 4½" side cutters ● 1 off 4½" end cutters ● 2 off hex. "Allen" key drivers 2mm and 2.5mm; 2 off cross-point "Phillips" drivers No. 0 and No. 1 (with tommy bar) ● 6 off precision screwdrivers. Sizes from 1mm to 3.5mm ●

ONLY £7.50 DRDER No. VP102

PRECISION JEWELLERS' TOOLS

Rustproof, Tempered Handles and Blades. Chrome Plated Handles. Swivel Heads for use on Precision Work.

5T21 SCREWDRIVER SET
6 precision screwdrivers in hinged plastic case. Sizes – 0.8, 1.4, 2, 2.4, 2.9 and 3.8mm £1.75

5T31 NUT DRIVER SET
5 precision nut drivers in hinged plastic case. With turning rod. Sizes – 3, 3.5, 4, 4.5 and 5mm £1.75

5T41 TOOL SET
5 precision instruments in hinged plastic case. Crosspoint (Philips) screwdrivers – H0 and H1 Hex key wrenches. Sizes – 1.5, 2 and 2.5mm £1.75

5T51 WRENCH SET
5 precision wrenches in hinged plastic case. Sizes – 4, 4.5, 5, 5.5 and 6mm £1.75

MULTITESTER

1,000 opv including test leads & Battery
AC volts - 0-15-150-500-1,000
DC volts - 0-15-150-500-1,000
DC currents - 0 -1ma-150ma
Resistance - 0 -25 K ohms 100 K ohms
Dims - 90 × 61 × 30mm
O/No. 1322 OUR PRICE £6.50 ONLY

BRAND NEW LCD DISPLAY MULTITESTER

RE 188m
LCD 10 MEGOHM INPUT IMPEDANCE
•3½ digit •16 ranges plus hFE test facility for PNP and NPN transistors •Auto zero, auto polarity •Single-handed, pushbutton operation •Over range indication •12.5mm (½-inch) large LCD readout •Diode check •Fast circuit protection •Test leads, battery and instructions included

Max indication	1999 or –1999
Polarity indication	Negative only Positive readings appear without + sign
Input Impedance	10 Megohms
Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	–5°C to 50°C
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155x88x31mm

RANGES
DC Voltage 0-200mV
0-2-20-200-1000V. Acc. 0.8%
AC Voltage 0-200-1000V
Acc. 1.2% DC Current 0-200uA
0-2-20-200mA, 0-10A Acc. 1.2%
Resistance 0-2-20-200K ohms
0-2 Megohms. Acc. 1%
BI-PAK VERY LOWEST PRICE
£45.00 each
Leather Case for 188m £2.50 EACH

SIGNAL INJECTOR

Simple push button operation. Oscillates at 700 – 1k Hz with harmonics to 30MHz. 1.4V p/p output. Impedance 10kΩ. Ideal for trouble shooting with audio equipment. One "AA" penlight battery supplied. O/No VP96 £2.50

LOGIC PROBE

Automatic levelling. White LED indication. Minimum width of measuring pulse 30 millisecs. Maximum input frequency 10M Hz.
Input impedance: 100kΩ
Power consumption: 40mA maximum
Power supply: 4.5 – 18 V d.c.
ORDER No. VP97 £10.50

CURRENT/POL CHECKER

Heavy duty test prods with built-in indicators for testing polarity: indicates whether a.c. or d.c. 3.5V to 400V. O/No. VP98 £2.50

TESTER

Universal tester with ceramic buzzer. Tests diodes, transistors, resistors, capacitors and continuity. One "AA" penlight battery included.
Test current: Max 2μA
Test voltage: 1.2V
Response range: 100MΩ
Max voltage: 500V
Internal resistance: 390kΩ £5.00
Length: 135mm O/No. VP99

CIRCUIT TESTER

D.C. continuity tester for circuit checking on all low voltage equipment and components. Diode checking also possible. Takes two AA batteries. 90cm lead has crocodile clip. Body length 145mm. O/No. VP100 75p

ELECTRONIC SIREN 12v DC

Red plastic case with adjustable fixing bracket. Emits high-pitched wailing note of varying pitch - 100 cycles per minute. Dims - 90mm (dia.) 60mm (depth). Power - 12v DC. O/P 90dBA 1m type.
Our Price: £5.50 O/No. VP79

TAPE RECORDER SWITCH

Unit to control motor of tape recorder. 1.8m cord and 2.5mm plug attached. On/Off switch. Dims: 55 × 20 × 20mm. O/No. VP 127 £1.00

POWER SUPPLY OUR PRICE £4.25

Power supply fits directly into 13 amp socket Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug Input – 240V AC 50HZ. Output – 3, 4, 5, 6, 7.5, 9 & 12V DC Rating – 300 ma VP109.

RATCHET SCREWDRIVER KIT

Comprises 2 standard screwdriver blades 5 & 7mm size, 2 cross point size 4 & 6. 1 Ratchet handle. 5-in-1 Kit £1.45 each. O/No 329B

ELECT & PIEZO BUZZERS

PIEZO
Miniature round piezo-electronic buzzer. White plastic. Low consumption.
Frequency: 4kHz approx.
Output: 70dB (A) @ 1, typ.
Power: 12Vd.c. 4mA
Dims: 22 (dia.) × 11.5mm.
Fixing Centres 26.5mm.
O/No VP 107
95p

PIEZO
Piezo buzzer. White plastic 90mm leads. For use on a.c mains.
Frequency 3.5kHz approx.
Output: 85dB (A) @ 1m typ
Power: 240Va.c. 5mA
Dims: 32 (dia.) × 14mm
Fixing centres: 38mm
O/No. VP 108
£1.15

ELECTRONIC
Miniature electronic buzzers Solid state Ivory plastic 150 leads. Frequency 500 Hz approx
Dims 22 × 16 × 15mm.
Output 82dB (A) @ 1m typ
Fixing centres. 26mm
3V 25mA: O/No. VP 82 — 6V 25mA: VP 83
9V 25mA: O/No. VP 84 — 12V 25mA: VP 86
80p each

SUB-BOX

A neat swivelling disc provides close tolerance substitution resistors of 36 preferred values from 5ohms to 1Kohm. Simply fix clips into circuit and swivel until optimum result is achieved.
O/No. VP 112 £4.75

MINIATURE VICE

Miniature plastic and metal vice with strong suction base for portability. Single action to secure or release suction. Plastic jaws with rubber pads 20mm wide, open out to 40mm. Dims: 85 × 65 × 60mm approx.
FANTASTIC VALUE
O/No. VP 95 ONLY £1.60

LEARN A LINGO!

PILLOW SPEAKER

Slim under pillow unit. 8ohms 2" speaker. 1.5m lead with 3.5mm mono jack plug. Black. Dims: 65 (dia.) ×17mm.
O/No. VP 88 £1.25

METRIC & BRITISH MEASURES

Steel tapes in sturdy ABs plastic case. Silk wrist strap. These yellow coated convex tapes have inch and metric graduations. Automatic push-button return.
2m long × 13mm wide O/No VP 89 £1.00
3m long × 13mm wide O/No. VP 90 £1.50
5m long × 16mm wide. O/No. VP 91 £2.00

BATTERY TESTER

Tests all types of battery including standard, NICAD, Alkaline etc Takes all standard sizes including 6V lantern batteries and watch/hearing aid cells. Also tests fuses and lamps by means of internal 9V (PP3) battery. Can also be used to recharge NICAD batteries by means of external 3-12Vd.c power supply (not included)
Full instructions provided. Dims 185 × 103 × 30mm
O/No VP 101 £7.00 (approx.)

FM MONITOR

FM monitor for 2 metre band. All metal. Attached earphone PL259/SO239 connectors 144MHz 10W maximum Dims: (Body) 55 × 30 × 23mm
O/No VP 120 £4.20

DUMMY LOAD

50 ohms 30W.
UHF co-axial plug fitting (PL259).
O/No VP 121 £5.20

PICK-UP COIL

Large telephone pick-up coil for high sensitivity. Suction pad to stick to telephone 90cm lead to 3.5 jack plug Connects direct to cassette recorder Dims 32 (dia.) × 17mm (body) 36mm (dia.) sucker.
O/No VP 87 £1.00

SPEAKER PROTECTOR

Limits voltage to speaker or to the permissible max., by automatically introducing a resistor in series with speakers. When excessive voltage is reduced the unit resets itself. Electronic voltage-sensing relay circuit. Spring terminals. Cut-off level adjustable from 10W-120W. Full instructions included. Dims: 85 × 74 × 25mm.
O/No. VP 118 £9.95

ANTENNA SWITCH 2 and 3 WAY

Co-axial switch for one transceiver to two antennae or one antenna to two transceivers. Dims: 86 × 55 × 32mm (Body).
O/No. VP 113 £4.50
As above but 3-way.
O.No. VP 114 £4.75

HIGH PASS FILTER/SUPRESSOR

CB/TV. High pass filter. Reduces unwanted signals picked up by antenna. Dims: 45 × 25 × 17mm
O/No. VP 115 45p

LOW PASS FILTER

Designed to reduce harmonics on the VHS and TV band. Cut-off frequency: 30MHz. V.S.W.R.: Less than 1.2 to 1. Insertion loss: –0.2dB @ 27MHz. Impedance: 50 ohms. Dims: 80 × 55 × 40mm.
O/No. VP116 £2.75

ANTENNA COUPLER

Transceiver/car radio antenna coupler. With co-axial cables. One co-axial terminates in antenna plug and the other in PL259 plug. Dims: 67 × 46 × 30mm.
O/No. VP 117 £2.00

DC-DC POWER SUPPLY

DC to DC adaptor. Plugs into car cigar lighter aperture. Output 3, 4.5, 6, 7.5, 9, 12V @ 800mA. Has universal output spider plug, also 9V battery snap and polarity reversing facility.
O/No. VP 119 £2.45

BI-PAK

Send your orders to Dept HE7 BI-PAK PO BOX 6 WARE, HERTS
SHOP AT 3 BALDOCK ST. WARE, HERTS
TERMS CASH WITH ORDER, SAME DAY DESPATCH, ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL. (0920) 3182, GIRO 388 7006
ADD 15% VAT AND 75p PER ORDER POSTAGE AND PACKING

Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods normally sent 2nd Class Mail
Remember you must add VAT at 15% to your Total order.
Postage add 75p per Total order.