AUGUST 1983

Hobby Electronics

AN ARGUS SPECIALIST PUBLICATION

Project Electronics For Everyone

85p

ZX81/Spectrum Programmable Joystick Controller

Protect Your Car Aerial With The...

HE Auto-Winder!

Novel Remote-Control Mains Power Switch

RAM Pack and Interface Board for the Jupiter ACE

AUGUST 1983
VOL 5 No 8

Hobby Electronics

PROJECTS

★ **PROGRAMMABLE JOYSTICK CONTROLLER** 11
Fun and games for the Spectrum, ZX81 and ACE.
★ **WHISTLE SWITCH** 36
Whistling in the dark?
★ **EXPANDING THE ACE** 42
Get this ACE RAM pack and I/O up your sleeve.
★ **AUTO-WINDER** 56
Retract your car radio aerial.
★ **READER'S PROJECT: ENLARGER TIMER** 60
Photographic Developments.

FEATURES

★ **ALL ABOUT ELECTRONICS PART 2** 20
Electromagnets and Ohm's Law.
FAMOUS NAMES 52
Concluding our longest-running series with Alexander Graham Bell.
★ **CAREERS IN ELECTRONICS PART 4** 47
Transmitting radio and television.

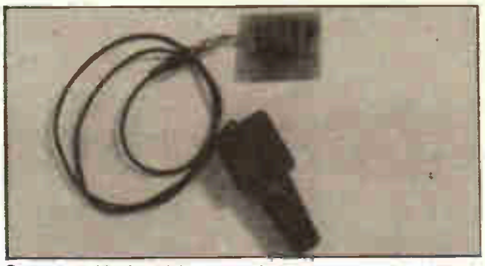
REGULARS

Monitor 6
What's On Next 18
HE Bookshelf 26
Points Of View 28
Forward Bias 31
Buylines 34
HE Subscriptions 40
Clever Dick 41
Reader Services 55
HE Backnumbers 62
PCB Service 63
PCB Printout 64

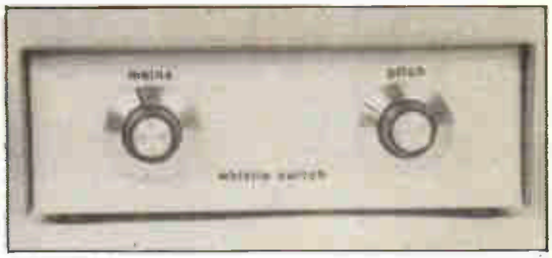
The Hobby 'Scope: *Once more we extend our apologies to readers awaiting the second part of this project. Due to unexpected technical and component supply problems beyond our control, it has had to be withdrawn again.*

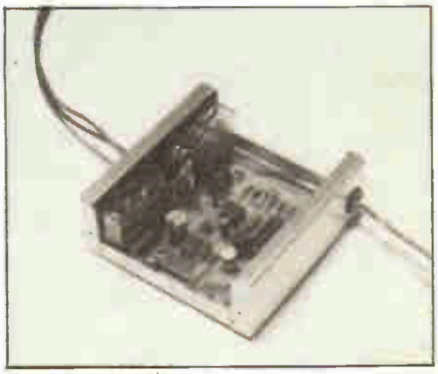
The final instalment of Components For Computing *has also had to be held over for a future issue.*

Editor: Ron Keeley
Assistant Editor: Helen Armstrong BA
Technical Illustrator: Jerry Fowler
Advertisement Manager: David Kitchener
Assistant Advertisement Manager: Joanne James
Managing Editor: Ron Harris BSc
Managing Director: T.J. Connell


Programmable Joystick — page 11

Ace Expansion Project — page 42


Whistle Switch — page 36


Auto-Winder for car radio aerials — page 56

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.
Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE, 01-437 1002. Telex No 8811896. Published by Argus Specialist Publications Ltd.
Origination by Ebony Typesetting, Trion House, 13 Dean Street, Liskeard, Cornwall PL14 4AB.
Distributed by S. M. Distribution Ltd, 16/18 Trinity Gardens, London SW9 8DX.
Printed by QB Ltd, Colchester. Covers printed by Alabaster Passmore.

Hobby Electronics

AUGUST 1983
VOL 5 No 8

PROJECTS

★ **PROGRAMMABLE JOYSTICK CONTROLLER** 11
Fun and games for the Spectrum, ZX81 and ACE.
★ **WHISTLE SWITCH** 36
Whistling in the dark?
★ **EXPANDING THE ACE** 42
Get this ACE RAM pack and I/O up your sleeve.
★ **AUTO-WINDER** 56
Retract your car radio aerial.
★ **READER'S PROJECT: ENLARGER TIMER** 60
Photographic Developments.

FEATURES

★ **ALL ABOUT ELECTRONICS PART 2** 20
Electromagnets and Ohm's Law.
FAMOUS NAMES 52
Concluding our longest-running series with Alexander Graham Bell.
★ **CAREERS IN ELECTRONICS PART 4** 47
Transmitting radio and television.

REGULARS

Monitor 6
What's On Next 18
HE Bookshelf 26
Points Of View 28
Forward Bias 31
Buylines 34
HE Subscriptions 40
Clever Dick 41
Reader Services 55
HE Backnumbers 62
PCB Service 63
PCB Printout 64

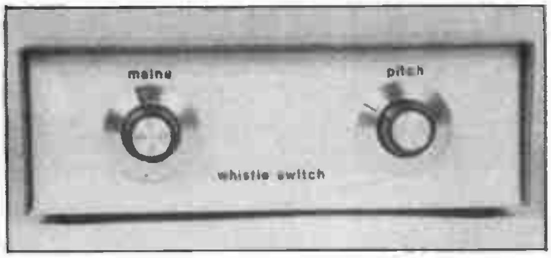
***The Hobby 'Scope:** Once more we extend our apologies to readers awaiting the second part of this project. Due to unexpected technical and component supply problems beyond our control, it has had to be withdrawn again.*

The final instalment of Components For Computing *has also had to be held over for a future issue.*

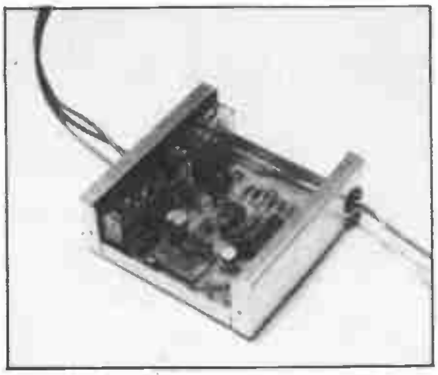
Editor: Ron Keeley
Assistant Editor: Helen Armstrong BA
Technical Illustrator: Jerry Fowler
Advertisement Manager: David Kitchener
Assistant Advertisement Manager: Joanne James
Managing Editor: Ron Harris BSc
Managing Director: T.J. Connell

Programmable Joystick — page 11

Ace Expansion Project — page 42



Whistle Switch — page 36



Auto-Winder for car radio aerials — page 56

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.
Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE, 01-437 1002. Telex No 8811896. Published by Argus Specialist Publications Ltd.
Origination by Ebony Typesetting, Trion House, 13 Dean Street, Liskeard, Cornwall PL14 4AB.
Distributed by S. M. Distribution Ltd, 16/18 Trinity Gardens, London SW9 8DX.
Printed by QB Ltd, Colchester. Covers printed by Alabaster Passmore.

MONITOR

Computer Data

A survey conducted by the **British Market Research Bureau** earlier this year, and published by **Gowling Marketing Services** of Liverpool, has produced some facts and figures which may be of interest to readers, although they are aimed primarily at companies marketing micros. The survey was conducted over 2000 households, which doesn't sound like a lot, but let's trust to the experience of the BMRB and see what they have come up with.

The picture that emerges is very much one of "A Portrait of the Micro Owner as a Young Man" and seems to be putting across the message that your proverbial 'computer society' is one which will grow up with the younger generation of users, rather than emerging fully fledged from the work done by industry and scientists — leaving aside that the one has only been made possible by the other.

The report shows that 4.9% of households, or about one in twenty, have a microcomputer — slightly under one million households in the UK. The most likely buyers are social groupings "AB, and C1", or, to put it another way, not only people with a certain amount of spending money to spare, but also people who have to ration 'non-essentials' (if you'll pardon the heresy!) fairly carefully.

"Males, *more particularly sons*" (our italics) "are the most likely users of the family home computer . . . Females appear to have little interest in computers." states the survey. (Significantly, the gels I know who actually like computing for its own sake work with mainframes, and think that micros are a waste of time!) The picture of earnestly struggling Dad being upstaged by Lad while Mum and Lass take no interest whatever rings true, doesn't it? Or does it? Any opinions?

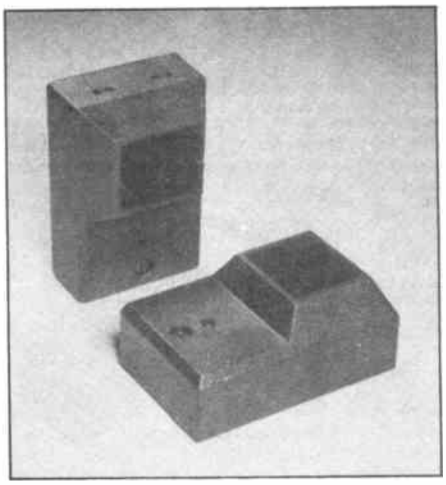
"People living in modern "middle price" owner occupied housing with young families, and those living in traditional high status suburbia" are also indentified as outstanding users of micros.

Unsurprisingly, the Sinclair ZX81 emerged as market leader with 43%, the Spectrum with 14% and the VIC20 with 12%. Also not totally surprising is that 40% of all micro sales were made in December, and 40% of all micros during the year were known to have been bought as gifts. These were mostly at the lower end of the price range.

Is it just a fad, like the Christmas puppy, which will soon be discarded, or is it a determined trend towards a micro in every home? Well, the marketing people certainly see it as a trend upwards. It looks as though Dad, not to mention Mum, had better start buttering up their BASIC before they come home one day and find they don't speak the same language as the electric cooker!

Another sign of the March of the Micros is the establishment, for the first time in the UK, of a Computer Trade Association to represent the retailers, distributors, software houses, manufacturers, consultants, and all who operate on the commercial side of computing. As with the Video Trade Association, their main reason for forming is to fight software piracy and the unauthorised lending and copying of copyright software. They also hope to establish a professional code of conduct to govern dealings both within the trade and between the trade and the public.

Among the members are Atari, Bug-Byte, Buffer, Micro Shop, Camputers, Grundy, Silversoft, Tandy and Virgin Games (who are handling the press side). Any enquiries about the CTA to **The Computer Trade Association, The Secretary, Nigel Buckhurst, 108 Margaret St., Coalville, Leicester LE6 2LX. Tel: (0530) 35566.**



Infra-Red Alert

Riscomp have announced an addition to their range of security modules and accessories: an infra-red system known as the IR 1470. The unit, which operates from a conventional supply, consists of a separate infra-red transmitter and receiver, and provides a modulated beam of infra-red light over distances of up to 50ft. In the event of the beam being interrupted, a relay in the receiver unit is energised. If this is connected to an appropriate warning device, it will sound an alarm. Both transmitter and receiver are housed in compact moulded enclosures and are easily mountable on most surfaces. An LED incorporated in the receiver indicates when the beam is lined up properly.

The system is British made and fully guaranteed, and is supplied with comprehensive data. It costs £25.60. Riscomp do a range of professional security modules, many of which are installable by anyone with adequate electrical and electronics knowledge. For futher information contact **Riscomp Ltd., 21 Duke St., Princes Risborough, Bucks HP17 0AT. Tel: (08444) 6326.**

A Word In Your VIC

SPT Electronics are marketing a versatile and low-priced software package for the VIC-20 and 64, by the highly descriptive name of Quick Brown Fox.

SPT boast that QBS offers more features than "industry standard" programs costing many times as much. Features include full editing, automatic reformating of whole texts, single-key command operations, compatibility with a wide variety of printers without complicated installation procedures, takes comparatively little memory space (and will run on the VIC-20's 5K without need for expansion) and — a unique feature — is apparently able to send and receive information from one computer

to another via built-in telecommunication facilities. This allows Fox systems to converse, and can work between QBS and some other systems as well.

The package costs £60 and, apart from converting the VICs into word processors, SPT see the system as the basis of a full professional letter-quality workstation for under £1000, a considerable reduction.

For more information contact **SPT Electronics Ltd., Tollesbury, Essex CM98SE. Tel: (0621) 868484.**

Get Miked Up

Sadelta Microphones, of Spain, have appointed **Telecomms,** of Portsmouth, as their sole UK distributors. To coincide with this, Sadelta have announced several new mikes in their range.

The Bravo O is a preamplifier compressor base microphone in a 'de-luxe' style housing with a normal/vox switch for amateur radio use. The maximum compression is 20dB. The Bravo 2 version has two VU meters for monitoring compression and preamp gain. The Bravo O is £29.95, the Bravo 2 is £39.95.

The HM-20 is a mobile hand-mike, designed for maximum comfort and ease of use. Sadelta claim that it can improve transmission in all frequency bands and modulation modes — mentioning DX and CB as good examples of 'worst conditions, peturbations and interference'! The HM-20 has four switching circuits and is adaptable to electronic and relay switch equipment, with a four wire cable which makes it compatable with all transceivers with three to seven pins. It has output level control on a revolving control switch in the thumb position.

The Sadelta Echo Master is a preamp desk mic with a built-in reverb 'echo chamber', for use with both radio and discos. Powered by an external 12V power supply, the Echo Master includes a VU meter for monitoring the modulation output, adjusted by a sliding pot. The price is £57.56.

Lastly, and most unusually, the LM-20 is a voice-operated microphone in two parts: a necklet with the actual mic on it, and a control box, connected to the necklet by a thin wire which can easily be connected or disconnected. The microphone is triggered by the sound of the operator's voice (with a slight delay in switching off — to allow the speaker to draw breath or pause!) — and its sensitivity is controlled by a setting on the control box. The control box also has red and green LEDs which light when the rig is transmitting or receiving, and a switch to deactivate the mic for normal conversation.

We don't have a price for this one or for the HM-20, but information can be had from the distributors, **Telecomms, 189 London Rd., North End, Portsmouth. Tel: (0705) 660036 and 882145.**

Breadboard Sighted!

The time draws near when a hobbyist's fancy lightly turns to thoughts of **BREADBOARD '83**. You have extra planning time this year, as the dates have (by popular demand) been moved nearer to Christmas; the 25th, 26th and 27th of November, to be precise.

This year's venue will be the plush, carpeted Cunard International Hotel at Hammersmith, right on the doorstep of the tube and bus services, and with easy access to the prime shopping areas of Kensington, Knightsbridge and Central London.

Features so far planned will include an extended programme of lectures, a bigger, better Computer Corner, Ham Radio Today's Action Centre, and a special package deal that will include rail travel, Breadboard ticket, bed and breakfast at a first class hotel, discount vouchers, etc. More details of this will follow.

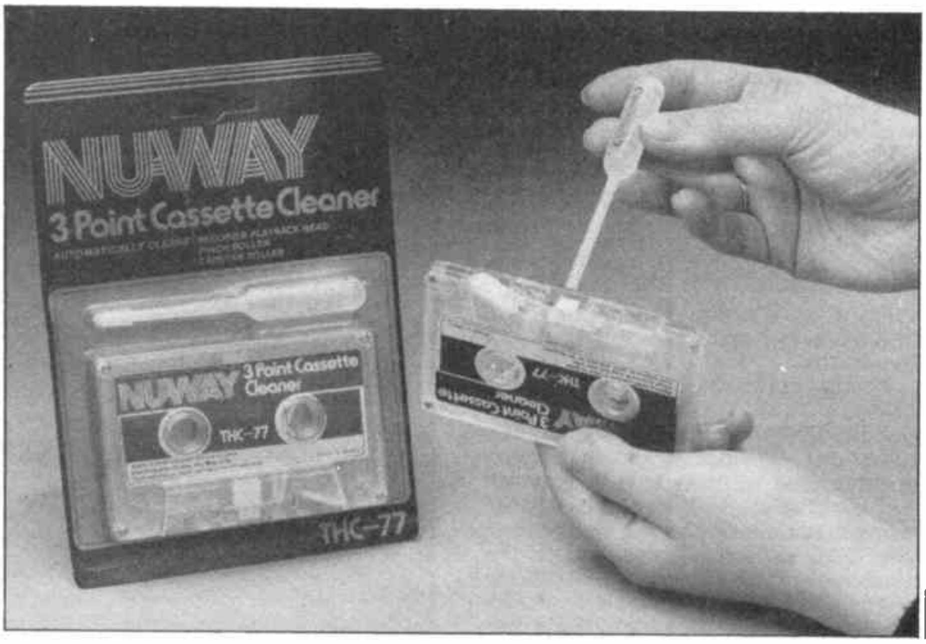
Specially for model railway enthusiasts is the Computer Controlled Railway Layout competition for a control system based on any microcomputer on a layout of not more than 6ft x 2ft x 6in. Get you entry forms by writing to **Peter Freebrey, Argus Specialist Publications, 145 Charing Cross Rd., London WC2H 0EE,** sending a small SAE.

Cassette Cleaner

Nu-Way Styli have produced a cleaning cassette for recorders. The difference between this cassette and many other 'cleaning cassettes' is that this one uses moving felt pads to clean the tape heads, and not an abrasive moving tape, and therefore causes far less wear and tear on the (expensive and troublesome to replace) tape heads.

The pack includes a cleaning lubricant, which is used to damp the two felt pads lightly. The cassette is then placed in the recorder and the recorder switched to 'play'. The pads move back and forth, cleaning the dirt and oxide not only from the record and playback heads but also the pinch and capstan rollers (dirty rollers can cause mistracking, which leads swiftly to the dreaded Magnetic Spaghetti which cheap or neglected cassette players love to feed on . . .) Once done, a pause of half a minute to let the cleaning fluid evaporate, and you're ready to roll again.

Regular cleaning like this (according to the instructions, of course) not only improves the sound quality but protects the player and the cassettes from damage. 90% of cassette player aggro is caused by dirt on the moving parts! So, if you can't clean the heads and whirly bits by hand, a cassette of this kind is the best option. It's especially useful for car players and other portables where the heads and rollers are hard to reach. The only recorders it may not do the job on are three-head machines — if you're lucky enough to have one!



MONITOR

The 3 Point Cassette Cleaner is made by **Nu-Way Styli Components Ltd., of 15 Haywood Ind. Park, Tameside Drive, Castle Bromwich B35 7BJ. Tel: 021 749 2240.** It costs £2.99 and is available from hifi retailers.

Mini Multitrack

Bandive Ltd. reckon that the cost of multitrack recording has been dramatically cut by the introduction of their Fostex X15 Tracker, which they call their 'musical sketch box'. This creature gives the impression, from the picture, of being a fairly meaty machine, but they claim that you can 'hold it in the palm of your hand', and at 3 x 11½ x 9in and 2.1kg, you could, too, if you happen to have fairly substantial hands.

The X15 is designed to run from an external AC adaptor (which is an optional extra) or a clip on battery pack (ditto), car battery or other battery.

All the essential features for taping and mixing for multitrack recording are in the X15, and all you need to add are microphones and headphones.

Tracks may be recorded indisidually, and monitoring for overdub is switched automatically. A built-in mixer, and tone control during record and playback allow skillful recordings to be made. Battery operation, remote punch-in, powerful headphone monitoring are among the features included.

Noise reduction is Dolby B; there are three positions on the input selector for mike, line or tape out signals going to the level control, equaliser facilities for input and output, gain and pan controls for each channel at overdub and mixdown, and plus or minus 15% pitch control for tuning and special effects.

For more information contact **Bandive Ltd., Brent View Rd., London NW9 7EL. Tel: 01 202 4155.**

New Spectrum Software

Oxford Computing Publishing have some new programs available for the ZX Spectrum.

Those currently available are a Machine Code Test Tool (with a version for the ZX81), including a character generator for the Spectrum version (£9.95), and Address Manager which will handle up to 1500 names or 400 full addresses on the 48K Spectrum (less on the 16K, obviously) and boasts the qualities of very high speed, super friendliness, multiple indexing and full-screen editing (£8.95) and "The Turk" chess program with six levels of difficulty and chess against the clock amongst its features (£8.95).

Later in the year other programs including Edit/Assembler, Financial Manager, VAT Manager and a Bridge Program will be released.

Having resolved certain problems with their GPO Box number, mail order turnaround at OCP is now usually 48 hours.

Information from **Oxford Computer Publishing Ltd., "Brimrod", 48 High St., Chalfont St. Peter, Buckinghamshire SL9 9QB. Tel: (0753) 888866.**

New Electronics Club

Newly formed is the **National Electronics Correspondence Club** — newly, that is, back at the end of April when first we heard of them just in time to miss the deadline for our July issue! According to their letter, the club has been set up with the express purpose of providing a communications link for all hobbyists who are remote from local electronics clubs — an excellent idea, and I'm sure they won't be turning away members of other electronics clubs who want to join, either.

Club features such as a bi-monthly newsletter with hints on project construction, topical features, circuit ideas, views and advertisements, plus special offers on equipment, are planned, and members will be free to correspond with the club and with other members for help and encouragement.

Membership will be £4.50 a year, and anyone interested should write to **Mr. E. Foley (Secretary), N.E.C.C., 95 Albert Rd., Levenshulme, Manchester M19 2FU,** enclosing 25p for information and application form (which will be refundable on membership). It would be nice to see this club flourish, as active hobby clubs are a benefit to everyone.

Sinclair Sound

Timedata are expanding their business to include add-ons for Sinclair computers, and the first product they have come up with is a tidy-looking sound box for use either with the ZX81 or the Spectrum, without the need for an adaptor.

The ZXM Sound Box is based on the 9812 three channel sound chip to give a wide range of programmable effects. The unit has a nine pin I/O socket which can be used with Atari and Commodore joysticks, and other Sinclair add-ons can be plugged into the back of the box. The built in amp and loudspeaker can also be used to boost the Spectrum's 'beep'.

The ZXM retails at £29.95 all inclusive. Order and enquiries to **Timedata Ltd., 16 Hemmells, High Rd., Laindon, Basildon, Essex SS15 6ED. Tel: (0268) 418121.**

Teach Yourself The Lot

Electroni-Kit, already well known for their popular Chip Shop kits, straight-forward construction kits with all the parts (even solder!) included, and simple no-prior-knowledge instructions

which even include a recommendation of which books to go on and read if you want to know more about electronics) are going about to make a whole new name for themselves distributing a new line in building-block, teach-yourself electronics and computing kits by **Denshi Block Mnfg. Co** and the **Gakken Co.**, of Japan.

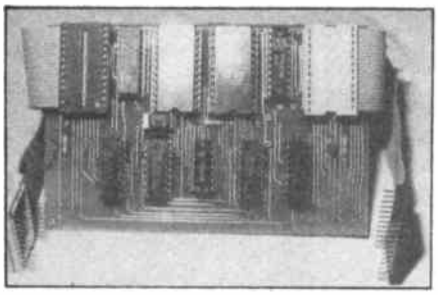
The FX-Computer is a contraption about the size of a substantial transistor radio. Within this battery-operated unit (no messing about with mains) is a series of interchangeable component blocks which enables scores of circuits to be built up without soldering or waste. The FX has two manuals, one for the electronic circuits, the second and longer containing 100 computer programs aimed at youngsters and complete beginners. The whole unit costs £69.95 plus £3.00 p&p, and the manuals are said to be excellent. A longer look at the FX-Computer will be appearing in HE in due course.

Along the same lines but somewhat smaller and less ambitious are the EX-System electronics construction kits, basically the same principle but with a lesser range of experiments. The kits range from the EX-15, with 15 projects to build, up to the EX-150, plus additional add-on sets. Prices range from £22 to £55.

For price lists and brochures, contact **Electroni-Kit Ltd., 388 John St., London EC1V 4NN. Tel: 01 278 0109.**

Shorts

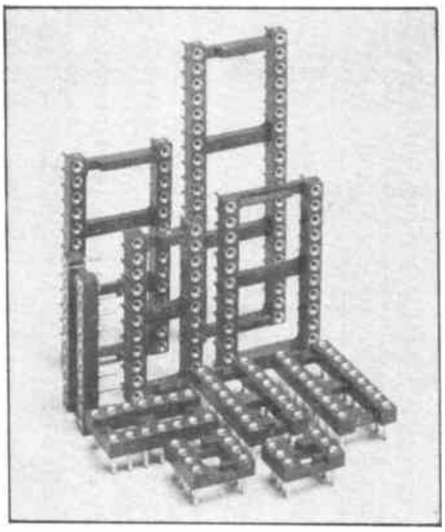
From J P Designs comes a multiplexed RAM card, Interface 84, which allows different microsystems to 'speak' to each other. Interface 85 plugs directly into 24 pin RAM or EPROM



sockets, via ribbon cable headers. A select switch allows onboard memory to be mapped on either microsystem. This feature gives the card the ability to alter the memory contents from the master microsystem, whilst acting as an EPROM on the developing system. This is particularly useful when software debugging 'dumb' controllers.

The internal static CMOS memory has a fast access time of less than 250nS, making the card usable with nearly all microsystems. Interface 84 comes fully tested complete with user notes at £49.95 plus VAT. Enquiries to **J P Designs, 37 Oyster Row, Cambridge, CB5 8LJ. Tel (0223) 522234.**

Possibly the world's lowest profile DIL IC sockets, the new **EMC 21,000 series**, available in 6 to 64 pin, 0.3, 0.4, or 0.6 in pitch options, allows the IC to sit only 2.92mm (0.115in) from the board. With the new funnel entry, short four finger style, Mini-Tulipe contact with bored out, closed-end, anti-wicking tail, this new range of stockets is suitable for manual or automatic IC loading and readily accepts both short and long IC legs.



Needing only standard layout 0.813mm (0.032in) PCB piercings and available in various gold/tin plating options, this new beryllium copper contact is rated for 1A but offers typical contact resistance of only 4.3mR. Capable of operating over a temperature range of –65°C to +175°C and utilising 94-VO rated glass reinforced polyester, the socket body is of an open frame design that will not twist, bend or soften during installation but still allows maximum cooling air flow plus easy cleaning and inspection and if you can follow that lot — ! — and want to know more, contact **EMC Interconnection Specialists, 50 London Rd., Sevenoaks, Kent. Tel: (0732) 460525.**

Made-to-measure dustcovers for video recorders can be ordered for £3.95 from **Helbri Products Ltd., 51 Birstwith Rd., Harrogate HG1 4QT Tel: (0423) 889704.** Please supply all dimensions (and make sure you leave room for switches sticking out beyond the line of the casing) including dimensions and location of the front panel clock so that a transparent window can be incorporated. Protection from dust prolongs videorecorder life in general, especially the expensive and fragile heads. Helbri do not say whether they make dust covers for other similar bits of equipment, but it is probably worth enquiring.

Elkan Electronics have announced their EASI-CALC 1251 program for the Sharp PC1251 pocket computer. Coupled with the CE125 printer-recorder this gives a "spreadsheet" with as many as 26 lines across and up to 100 rows deep, with over 200 "cells" or co-ordinates on the sheet. As well as being a problem-solving tool answering "What if . . . ?"-type questions, EASI-CALC 1251 can be a portable mini data base storing up to 100 names and phone numbers. The package consists of a data-quality micro-cassette tape and a twenty-page user's manual. No programming knowledge is needed.

EASI-CALC costs £14.95 from **Elkan Electronics, 11 Bury New Road, Prestwhich, Manchester M25 8JZ. Tel: 061 798 7613.**

Robotic arms producers **Colne Robotics** have produced a computer vision system costing only £395. Aimed at the educational market, the COLVIS system consists of a solid-state camera connected to a powerful microcomputer, which can extract and learn information from the image received from the camera. It can use parameters such as area, perimeter and centre of gravity to recognise the object in view, and deduce its position and orientation. It can be used with any microcomputer which has or can be fitted with an 8-bit bi-directional port.

Enquiries to **Colne Robotics Co. Ltd., Beaufort Rd., Off Richmond Rd., East Twickenham, Middx. TW1 2PQ. Tel: 01 892 8197.**

Namal Electronics have announced their ROMBLO 1248 EPROM blower for the Apple microcomputer. This device will program all common 24- and 28-pin EPROMS of type 2508, 2516, 2564, 2716, 2732 and 2764 or any pin compatible 5V EPROMS. The software is on-board, eliminating the need for disk drives.

The price is £95. Enquire to **Namal Associates Ltd., "Gatehouse", 25 Gwydir St., Cambridge CB1 2LG. Tel: (0223) 355404.**

Anybody wanting to sell or buy leisure goods in the south-east can contact **Leisure Line.** They are a telephone sales company who keep a register of goods on computer. They have expanded to include a listing of clubs, schools, organisations and private teachers involved in leisure pursuits. The service is free to those seeking information, charged to those advertising. Contact **Leisure Line Data Ltd., 238-246 King St., Hammersmith, London W6 0RF or phone 01 741 8301 9am to 9pm Monday to Friday.**

Dawne Instruments have also added a high standard multimeter, the Unigor 3n, to their range. It features 62 measuring ranges, costs £100, and is said to be the standard multimeter used by many professional European organisations. Special points mentioned by Dawne include single rotary switch for thirty-two measurement ranges, nearly 32k ohms/volt sensitivity, better than 0.5% accuracy, 0 to 500Rohms on the low range and 50MR on the highest, and a number of others.

More information from **Dawne Instruments and Electronics, Shields Rd., Bill Quay, Gateshead NE10 0RS. Tel: (0632) 695117.** HE

ZX81: Jupiter Ace: Spectrum

Programmable Joystick Controller

Paul Moody and Chris Lloyd

Set your fingers free! Banish keyboard cramp! Play action games as they were always meant to be played, with the HE Joystick Controller!

This project is a completely new idea in Joystick design because it is fully programmable and can be used with *any* games software for the ZX81, Spectrum or Jupiter Ace.

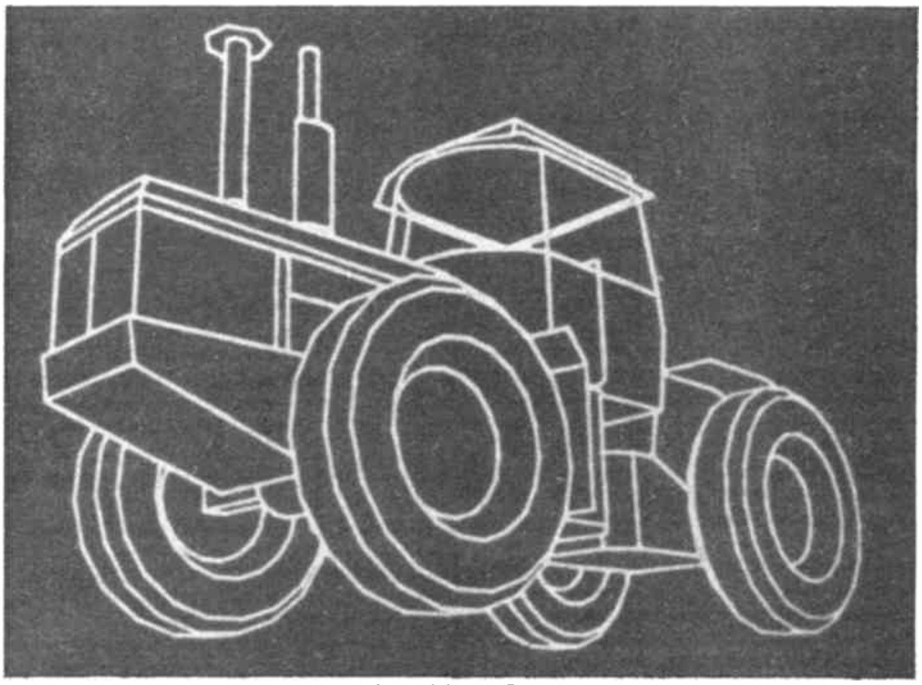
THE ZX81, Spectrum and Jupiter Ace keyboards are excellent for entering programs, but they are very difficult to use for playing any fast moving games. This is a great pity because there is a wide range of excellent games software written for the ZX81 and Spectrum. The Ace has perhaps been a little slower to catch on, but now that its versatility and speed are being appreciated, a number of good games have appeared for it.

The Joystick Controller described here can transform your computer from a toy into a true arcade style machine, and its unique design allows its use on *all* software. You won't need to buy software especially written for a joystick, because *all* your existing programs will work with it.

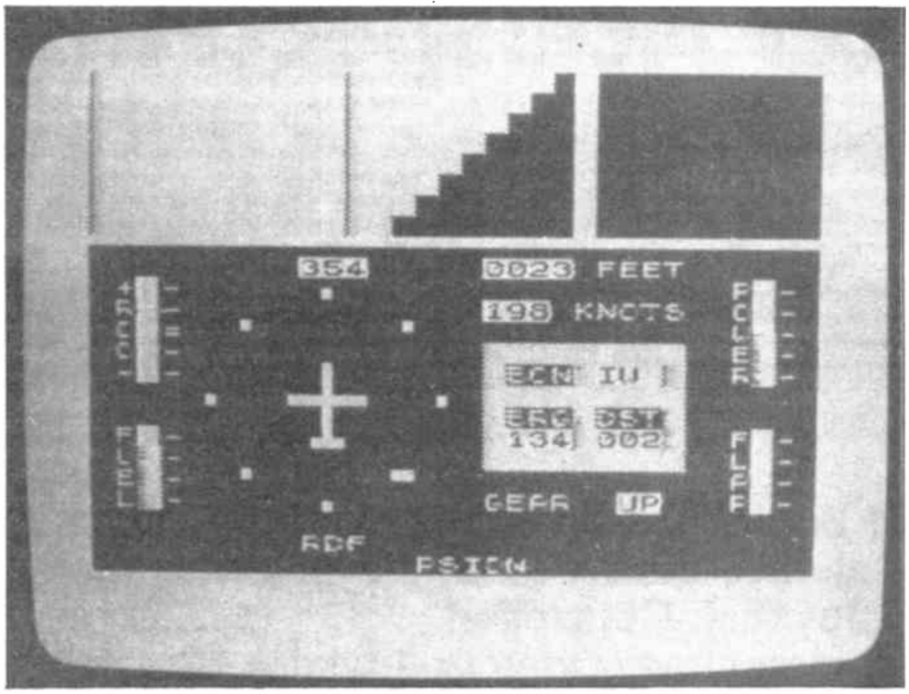
Basic Ideas

The way most joysticks work is to mimic the action of the keyboard, so that when the joystick is moved, the computer is fooled into believing that a key has been pressed. The problem that arises is simply this: which keys should the joystick mimic? One convention is to use the "arrow" keys — 5, 6, 7 and 8 for left, down, up and right, and 9 for fire. But unfortunately only a limited amount of software uses these keys — mainly because it is very awkward to use keys so close together. The result is that many people buy a joystick and then find that they can't use it on any of their old software, or that many programs that they would like to buy won't work with the joytick.

This article describes a completely



Although this drawing was produced by a Computer Aided Design package, similar 'sketches' could easily be made using the joystick and a simple drawing programme. The 'fire' buttons could also be used, for example to delete points back along the plotted track and, on the Spectrum, to change the foreground colour.



Some games, such as the flight simulator shown, use more than the six functions available on the joystick. However the keyboard can still be used for flaps, undercarriage etc provided the joystick controls are not operated simultaneously.

new idea in joystick design — the joystick is actually programmable and can mimic the action of *any* keys. To make things even easier for you, a program is included which remembers which games use which keys, so if you want to play a game that you've played before then you don't need to reprogram the joystick — simply give it the name of the program and it will do the rest.

To understand how the joystick works let's first take a look at the Sinclair keyboard.

The Keyboard

The keyboard consists of a five by eight grid of wires, with a key over each crossing point (**Figure 1**). When a key is pressed, it connects together the two wires passing beneath it. The keyboard is read, one row at a time, by taking each of the eight address lines low, in turn, leaving the other seven high. Say, for instance, that the computer wishes to read the row containing the letters "QWERT", then it sends A10 low with A8, 9, 11, 12, 13, 14, 15 all high. Now if none of the keys on that row are pressed, the outputs labeled KBD0-4 will all be at logic 1 — because they are all tied via resistors to +5 volts. But now consider what happens when key "W" is pressed: it connects A10 to KBD1, pulling KBD1 low and sending a logic 0 to the ULA (or to a tristate buffer in the case of the Ace, which has no ULA). So, by scanning through each row in turn the computer is able to build up a complete picture of the keyboard, and it does this every 1/50th of a second.

If you are wondering what those diodes are doing in the address lines, consider what would happen if they were not there and two keys in the same column were pressed at the same time; address lines would be shorted together and the computer would crash instantly!

Input/Output

But how does the CPU distinguish between reading the keyboard and reading memory? In both cases it puts out an address, but for reading the keyboard it sends out a low on $\overline{IORQ}$ instead of on $\overline{MREQ}$. This signal, combined with a low on A0, tells the ULA (or tristate buffer, in the case of the Ace) that it is reading the keyboard, and it transfers the values of KBD0-4 to the lower data lines, D0-4.

In A Nutshell . . .

To explain the operation of the Joystick Controller, we'll use the very simplifed (and highly schematic) circuit diagram of **Figure 2.** It consists of five basic blocks, plus a certain amount of control circuitry, represented here by a single two-input or gate.

The joystick itself is a simple array of six microswitches operated by the control lever; the output lines are connected to a +5V when one or more switches are closed.

An 8-into-3 line encoder operates on the CPU's address lines, A8 - A15, that are consecutively taken low during a Keyboard Read operation. The encoder simply reduces the number of address lines required for the memory by utilising the fact that only one of A8 to A15 will be low at any one time during a keyboard read. Since there are only eight possible states for A8-A15 at these times, only three lines ($2^3 = 8$) are needed to contain this information.

These three lines become the top three address lines to the Controller's Random Access Memory. The lower order address lines are derived from one of two sources, depending on whether the Controller is being programmed for use, or is in use. The address lines are selected by an electronic switch, operated by the CPU's Write Enable line, $\overline{WE}$.

When the controller is being programmed (this is further explained, later), $\overline{WE}$ is taken to logic 0 and the 'switches' are in the position shown, connecting the RAM's low-order address lines to the CPU's address lines. At the same time $\overline{WE}$ enables the RAM so that data can be written to it, and simultaneously connects the RAM's data lines to accept information from the CPU's data lines (this is actually done not by a switch as shown in Figure 2 — but this will be explained in a moment!).

Now the keyboard is not actually located at a single address; in fact any time A0 is low and an IN instruction has been issued (either by the CPU's Monitor program or by a user program — the Sinclair ULA can't tell the difference) the computer is performing a keyboard read operation. So, when programming the Controller, the keyboard is read by the program written for the purpose and the CPU will return, on data lines D0 - D4, a five-bit 'word' corresponding to whichever key has been pressed, if any. This data now has to be stored in the Controller RAM, and the location in RAM at which it is stored is determined by the CPU's address lines A1 - A7. This address is set up by a single number, entered as part of the set-up routine, which corresponds to a particular joystick position. What happens, in effect, is that the data corresponding to a particular key — 'Q', say, — is stored in the Controller RAM at a location which corresponds to a certain joystick position.

Now when a game is being played, the joystick output lines are connected to the RAM via the electronic switch (because $\overline{WE}$ is kept high).

Normally the ZX81 monitor performs a keyboard read about 50 times per second, and during these times both $\overline{IORQ}$ and A0 will be low, so the Controller RAM Chip Select pin will be enabled and data will be read from it, as well as from the keyboard. The RAM address, now depends on the physical joystick position, rather than a number representing it, and at that location will be found data corresponding to a particular keyboard letter!

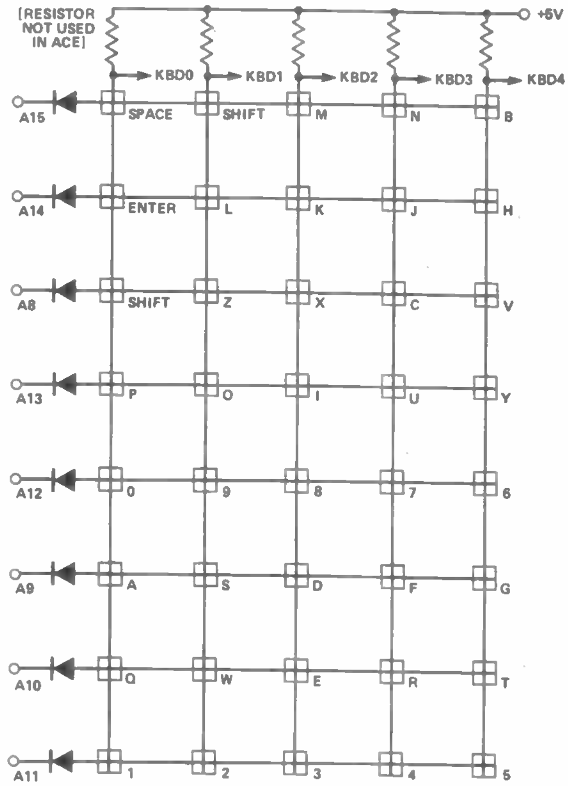


Figure 1. The keyboard circuit shown is typical of the ZX81, Spectrum and Ace, with minor variations between them. Each square over a pair of crossed wires represents a switch which, when closed, pulls a KBD line to logic 0 when the corresponding address line is at 0. The Monitor programme performs a keyboard scan about once every 20 milliseconds by consecutively pulling each address line to 0. The diodes prevent two address lines being shorted if two keys are pressed together. The keyboard is also scanned by an INKEY instruction in a user-programme.

As mentioned before, the RAM data lines are connected to the CPU's data lines by a 'switch' that is not really a switch. In fact 'it' is five high-power tri-state buffers, each bypassed by a resistor. When the buffer outputs are in a high impedance condition ('off') the resistors allow data to be written to the Controller RAM. However when the $\overline{WE}$ input is high the buffers are active (the 'switches' are then in the opposite position to that show in **Figure 2**) and they have sufficient 'muscle' to override the CPU data. Thus the computer receives data corresponding to the joystick position, rather than the actual keyboard data, whatever it may be. And, since the joystick position

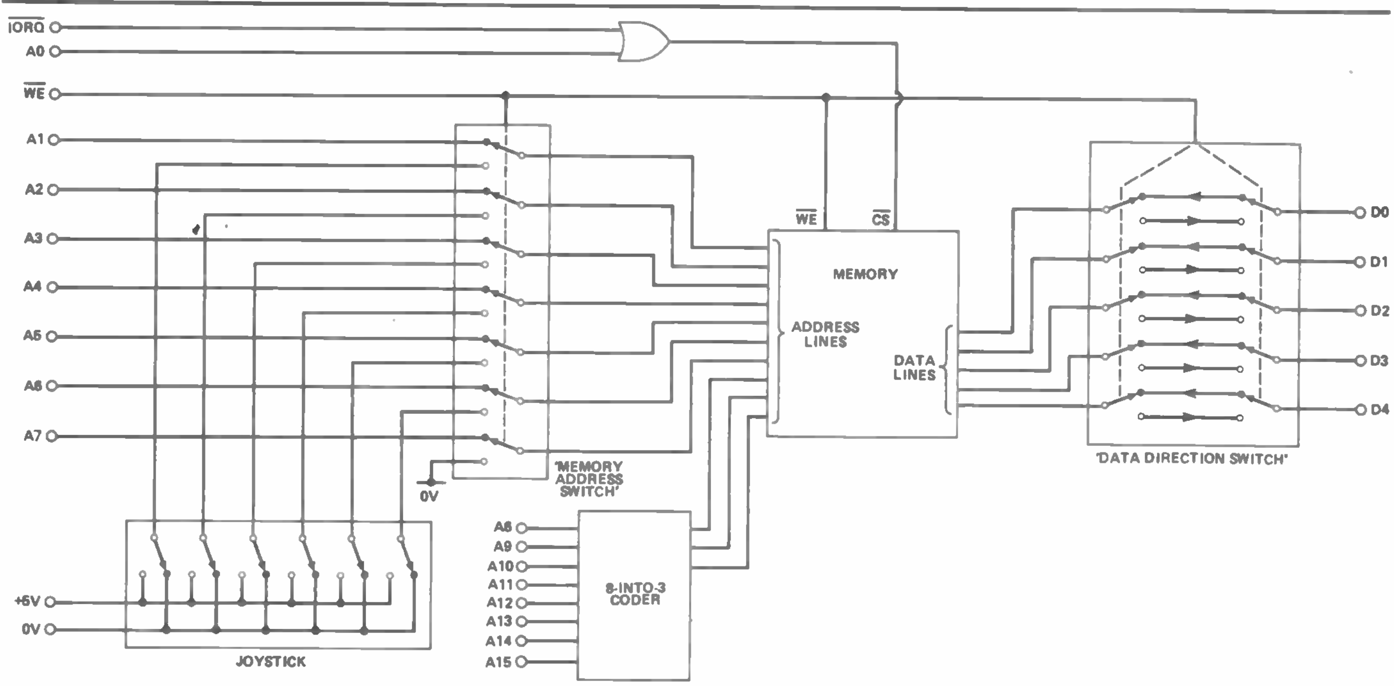


Figure 2. A highly representational block diagram of the Controller. When it is being programmed, the memory address lines are connected to the computer's address bus and data is accepted from the data bus, as shown. In use the "switches" are reversed; the joystick provides the addresses and previously programmed information is forced onto the data bus, overwriting information from the keyboard.

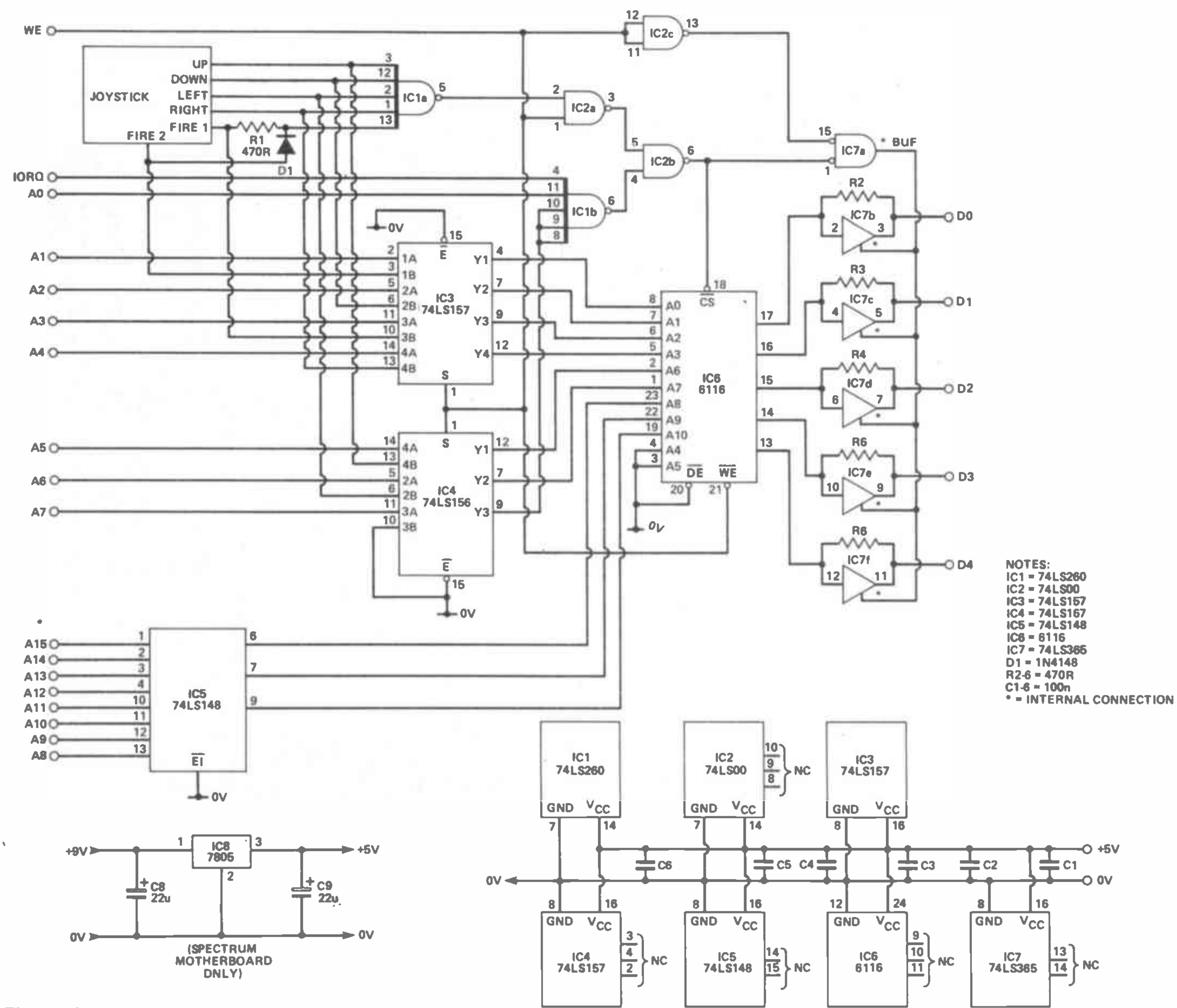


Figure 3. The full circuit of the Controller. ICs 3 and 4 are the "memory address switch" while IC7 controls the data direction.

has been set-up to correspond to a particular key, the computer receives the appropriate command — unless the Invaders have just bombed you out of the game!

The Complete Circuit

Figure 3 gives the complete circuit for the joystick interface. As before, A8 to A15 are encoded by 1C5 to give three address lines for the memory, IC6, a 6116 2K by 8-bit static CMOS RAM. IC3 and IC4 are 2-into-1 multiplexers connected as electronic switches — when SELECT (S) is at logic 0 the A inputs are connected to the outputs, and when at logic 1 the B inputs are selected.

First consider how the memory is programmed. To do this, an OUT command is given along with an address (on the ZX81 this command can only be given in machine code — there is no OUT command in ZX81 BASIC). The address must have both A0 and A7 low; A0 is always low for a keyboard read while A7 must be held low to avoid the Joystick memory being accidentally written to by the CPU when it gives control signals to the logic circuitry.

The OUT command sends both $\overline{IORQ}$ and $\overline{WE}$ low. Since $\overline{WE}$ is connected to the select line on the multiplexers IC3 and 4, the A inputs are selected, and in particular Y1 is connected to A7 and is thus at logic 0. This means that IC1a has all zero inputs and so gives out a logic 1. Then, since one of the inputs to IC2a is $\overline{WE}$, at logic 0, its output is at logic 1; therefore IC2b has both inputs at logic 1 and so it gives a 0 output. Thus IC6's $\overline{CS}$ pin is taken low, enabling the RAM. And, since the output of IC2c is a 1, BUF is 0 and the buffer outputs are open circuit, this allows data to be read into the memory from the data lines via R2 - R6.

Now consider what happens when the computer tries to read the keyboard. When the joystick is not being used it is important that the keyboard functions normally, and it is the function of IC1b to detect whether or not the joystick is being used. When the joystick is not being used, IC1b has all zero inputs and so gives a 1 output. D1 and R1 are included because IC1b has only five inputs while the joystick has six outputs; D1 and R1 form a hardware OR gate, thereby reducing the number of inputs to the IC1b. So, when the CPU tried to read the keyboard $\overline{IORQ}$ is 0 and $\overline{WE}$ is at 1; this, combined with the 1 from IC1b, gives a 0 on IC2a which gives a 1 at the output of IC2b. This takes the BUF line to 0 and the buffers are not selected, allowing the keyboard to be read normally.

When the joystick is being used, at least one of the inputs to IC1b is high and so its output is low, and this gives a 1 at the output of IC2a. Now, because $\overline{WE}$ is 1 during a keyboard read Y1 is connected to 1B and hence is at logic 0. Thus all the inputs to IC1a are 0 and so its output is at logic 1. Then the two 1 inputs at IC2b give a 0 output, selecting the memory, IC6. And, since IC2c is outputting a 0, BUF is at logic 1 and the output from the

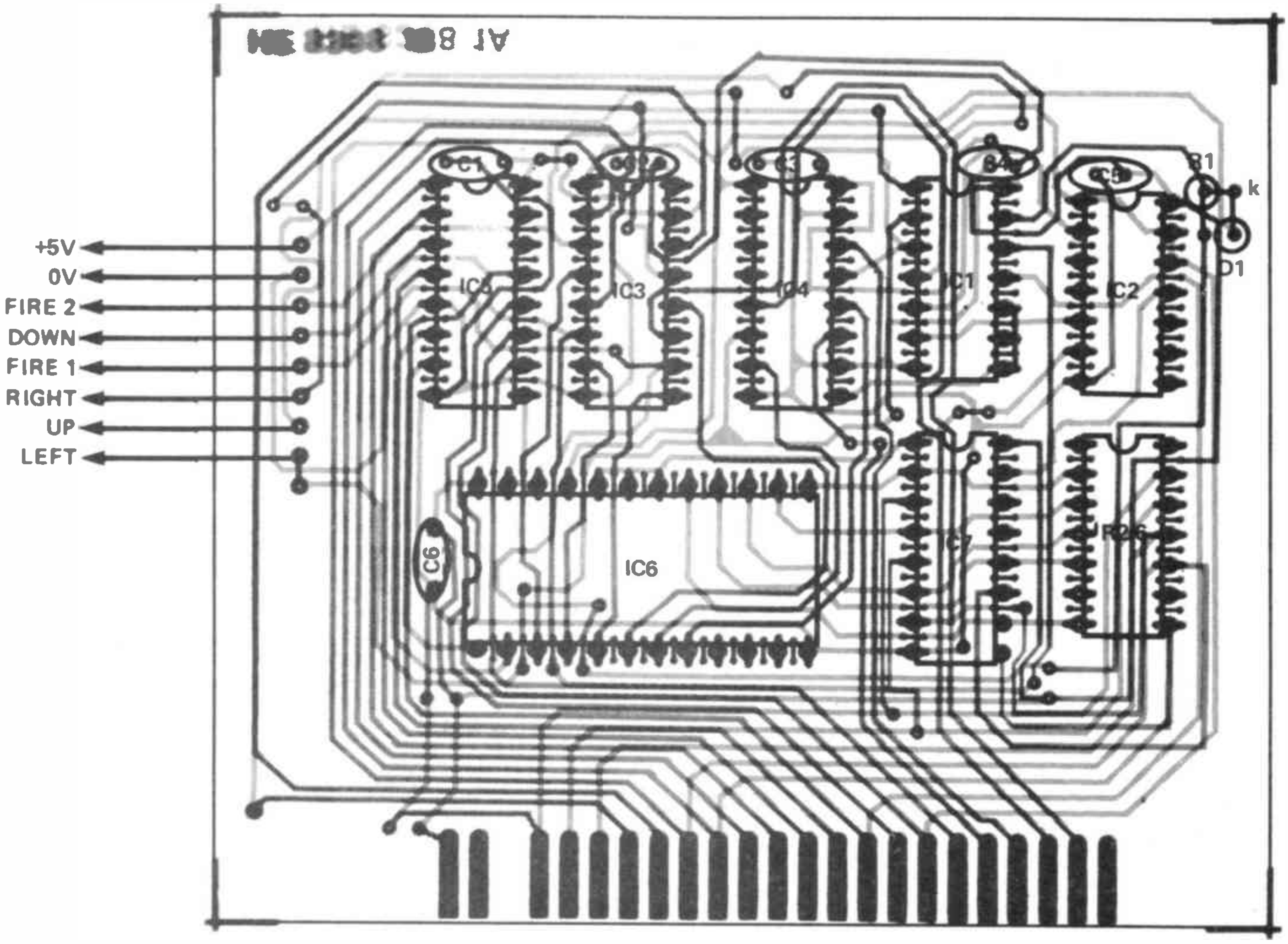


Figure 4. The component layout shown over the double-sided PCB patterns (the component-side tracks are in red). The Controller PCB plugs into a motherboard which carries the correct edge connector for whichever computer is being used. The Spectrum motherboard (not shown) also carries a 5V regulator circuit.

Parts List

RESISTORS

R1 – R6 .... 470R

CAPACITORS

C1 – C7 .... 100n disc ceramic

C8, C9 .... 22u 16V radial electro

SEMICONDUCTORS

IC1 .... 74LS260 dual 5-in NOR

IC2 .... 74LS00 quad 2-in NAND

IC3, 4 .... 74LS157 quad 2-in selector

IC5 .... 74LS148 8-into-3 decoder

IC6 .... 6116 2K x 8-bit CMOS static RAM

IC7 .... 74LS365 hex tri-state buffer

IC8 .... 7805 +5V regulator

MISCELLANEOUS

PCB; motherboard, wire, solder etc.

BUYLINES .... page 34

memory is buffered onto the data lines, overwriting the keyboard data.

Construction

The interface is built on two double sided PCBs. The main board plugs vertically into a smaller motherboard, which plugs into the edge connector; the main board is the same for the ZX81, Spectrum and Jupiter Ace, while the three motherboards are different. The ZX81 and Ace motherboards provide their own edge connectors so that rampacks may be plugged on, while the Spectrum motherboard has its own power supply — this is needed because the 48K Spectrum cannot supply enough current for the joystick interface. The interface actually needs very little power, but even the little that it does draw would be enough to make the Spectrum unreliable if the extra supply were not provided.

Construction of the main board is relatively easy — but take care with the 6116 memory. Since it is a CMOS IC it can be damaged quite easily by static charges. It has internal protection diodes which are effective up to about 4,000V, but since you can quite easily generate over 10,000V simply by walking on a nylon carpet you can destroy it simply by touching the pins! To avoid damage make sure that you don't remove the chip from its protective conductive foam until you are ready to use it, and earth yourself (eg by touching a water tap) before handling it.

Testing

When you have finished building the main board, plug it into the motherboard, plug the motherboard onto the computer edge connector and plug the joystick into the DIN socket in the main board. Now switch on the computer — it should behave normally. Now move the joystick into the UP position and try the keyboard. The keyboard should be completely inoperative, since it is being overruled by the joystick. Test the other joystick positions to make sure that the keyboard remains inoperative.

Software

Consider the BASIC program given in **Program 1** written for the Spectrum. It is a much simplified version of the complete joystick program, but it clearly demonstrates the ideas involved.

The program first accepts an input,

J, a number between 1 and 6, corresponding to the joystick position which is to be programmed — 1 corresponds to UP, 2 to DOWN, 3 to LEFT, 4 to RIGHT, 5 to FIRE 1, and 6 to FIRE 2. It then asks you to press a key, so that when the joystick is moved into the appropriate position *it will be as though that key has been pressed.* Say, for instance, that you enter 1 for the joystick position and then press "Q" for the key. Then, whenever the joystick is moved into the up position, the computer will believe that "Q" has been pressed.

Line 40 simply waits for you to press the key before entering the next section, a FOR/NEXT loop which reads the keyboard and then transfers the data to the joystick memory. The variable N counts through each row of the keyboard in turn; let's consider the case where J = 1 and it is the first time through the loop, when N = 8. Then the address, A in line 60 is equal to 65280 – 2↑J + 2, which in binary is 1,111 1110 0000 0010. This address has A0 = 0, which it must have for a keyboard read, and in addition the higher address lines (A8 to A15) are set to read the row SHIFT to V on the keyboard (see **Figure 1** again!). So, in line 70, "IN A" reads this line on the keyboard and "OUT A" transfers this to the joystick memory — and puts it into the memory location which has A1 = 1. So later,

PROGRAM 1

```
10 INPUT "Which joystick position?",
J
20 PAUSE 50
30 PRINT "Press the key
corresponding to this position — and
keep your finger on the key"
40 IF INKEY$ ="" THEN GOTO 40
50 For N = 8 TO 15
60 LET A = 65280 - 2↑N + 2↑J
70 OUT A, IN A
80 NEXT N
90 CLS
100 PRINT "Now take your finger off
the key"
110 IF INKEY$<>"" THEN GOTO 100
120 CLS
130 GOTO 10
```

when the computer tries to read this line of the keyboard and the joystick is in the up position, A1 will again be 1 (since it is coming from the joystick) and the joystick memory will output the data that had been transferred to it during the OUT operation. The counter N scans through the entire keyboard, making each of the address lines A8 to A15 low in turn, and transferring the keyboard data to the joystick. The overall result is that the joystick saves a copy of the keyboard which it will later output when the joystick is moved into the appropriate position.

This program seems to do everything we require, but it does suffer from two faults. The first problem is simply that it won't work with the BREAK key; as soon as this key is pressed the Sinclair BASIC monitor breaks out of the program and data is not transferred to the joystick. The only solution is to write the program in machine code, where it is safe from the BASIC monitor. The second problem is more difficult to cure. It arises whenever two or more functions are used on the joystick at the same time, for example when the joystick is moved into the UP position and FIRE button 1 is pressed. This sends both A1 and A5 high at the same time, but since the memory location this corresponds to has not been programmed, the joystick will not work. The answer is to rewrite the simple program, making it into two parts; the first part reads the keyboard, line by line, and saves the data for the second part which transfers the data to the joystick, filling up every memory location with the appropriate data. The software tape which is being supplied with the Joystick kit (see Buylines for details) actually contains three complete programs, one each for the ZX81, Spectrum and Ace. They are all very easy to use and are able to remember which keys are used by which programs, so you need only program the Joystick once for each game. **HE**

COMING SOON TO . . .

Hobby Electronics

CABLE AND SATELLITE TELEVISION

Going Up! Coming Down! All Change? Find out about the new directions in communications technology before they appear on the horizon — or under your feet!

TREMOLEKO GUITAR EFFECT

A small impressive unit, costing little but producing a truly amazing sound effect combining elements of tremolo and echo. This unique new effect for guitarists is exclusive to Hobby Electronics!

VARIABLE POWER SUPPLY

No matter how great your interest in electronics, two items of equipment are essential: one is a good multimeter, the other is a bench power supply.
This one is of the "cheap and cheerful" variety, but it provides a variable voltage between 3 and 30V, with current limiting at 1A1 less than 10mV ripple on the output.
For the price, could you ask for more?

GRIPOMETER

Amaze your friends, astound yourself . . . test the strength of your grip with the HE Gripometer. Can you light up the last LED, and make the tone climb to the top of the scale? Find out when you build this novel project!

NO-FUSS SOUND PRESSURE LEVEL METER

Calibrating this useful instrument for accurate sound pressure level readings is simplicity itself. The only test equipment needed is an audio signal generator and a voltmeter capable of measurements at frequencies of around 1kHz, say.
And if you don't already have them . . . you can build those too!

Please reserve ____ copies of the September issue of Hobby Electronics for

Name . . . .

Address . . . .

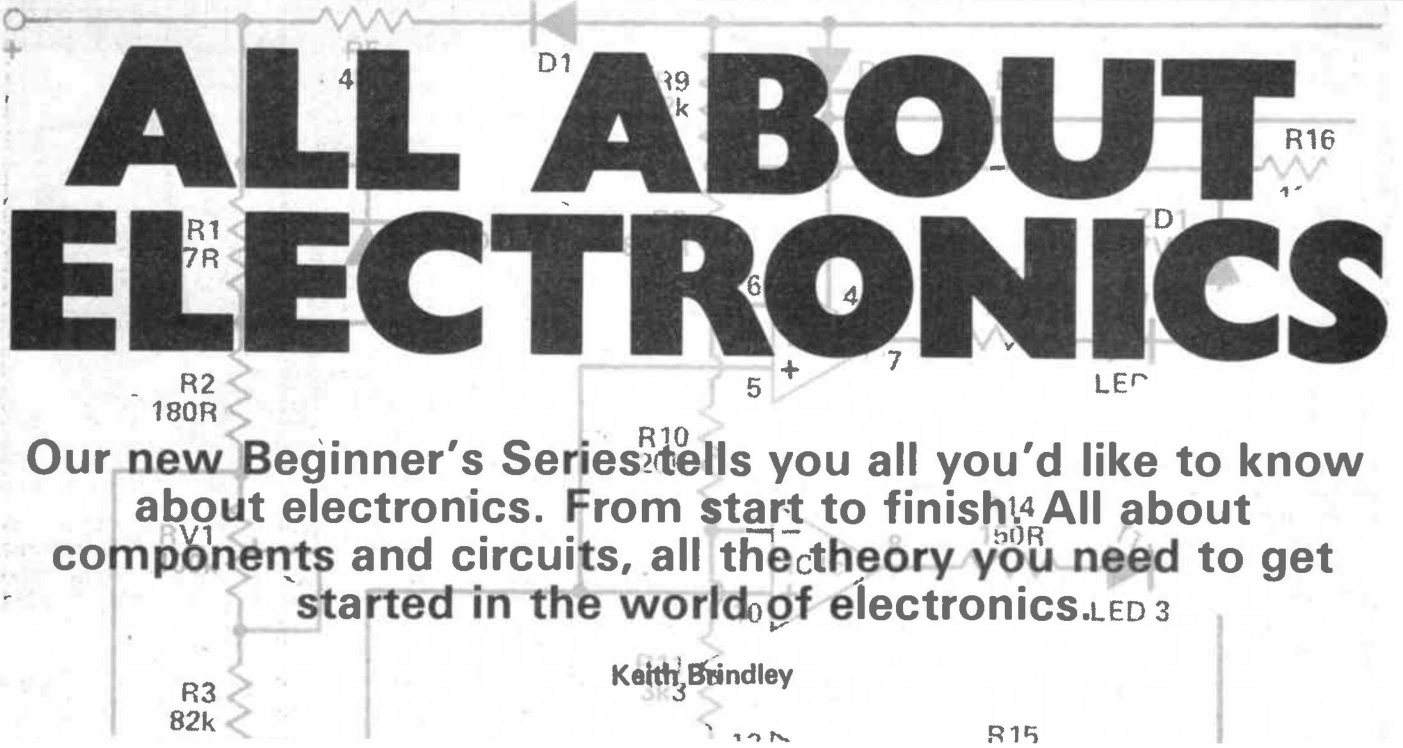
. . . .

. . . .

Hobby Electronics

September issue on sale at you newsagent from 12th August Place your order now!

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



ALL ABOUT ELECTRONICS

Our new 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

The Story So Far

Last month, we looked at electricity itself: what it is (a flow of electrons) and its three fundamental quantities (potential difference, current, resistance) which are tied together in a physical way defined by Ohm's Law. Put into mathematical formulae, Ohm's Law can be expressed by:

$$V = IR$$

$$I = V/R$$

$$R = V/I$$

So, if two of the quantities in any electronic circuit are known, the third can easily be calculated.

There are two main types of electricity: DC (direct current), where the potential difference, or voltage, remains constant — this is the sort of electricity which is obtained from a dry-cell battery — and AC (alternating current), where the potential difference alternates between two extremes. House electric systems are AC and here the voltage alternates between equal positive and negative amounts to give an overall voltage of 240V.

We saw that electricity need not always consist of large currents and large voltages, hence the need to divide the units of current (the ampere) and voltage (the volt) up into smaller parts, such as a microamp:

$$\text{ie, } 1 \times 10^{-6} = A$$

or, say, a millivolt:

$$\text{ie, } 1 \times 10^{-3} = V$$

Voltages and currents such as these are the sorts which we may find from such a device as a microphone which converts sound waves into electricity. We tend to call such voltages and currents *signals* — they *represent* the sound in an electrical way, just a traffic signals represent what to do next in a way which the motorist can understand. Now that we have seen exactly what electricity is, we're going to turn out attention to what electricity does. In other words, we are going to study the main *effects* of electricity.

Let There Be . . . Heat!

The first effect, observed every day when a light bulb is turned on is the creation of heat. Any conductor, if a high enough potential difference is applied across it, will conduct enough electricity to get warm. The thinner the conductor, the lower the potential difference it takes to heat it. What happens in a light bulb is that the conductor (known as the filament) is so thin that it doesn't take much electricity to heat it up. And it gets hot! So hot that it radiates enough energy to glow white hot — in other words, it gives off light.

Heat is also dissipated from the bar of a bar fire or a ring of an electric cooker, but here the electricity used only makes the bar or ring glow red hot — *even though more electricity is used and more heat is given off than with a light bulb filament.*

The reason for this generation of heat is connected with the very reason why electricity flows at all, ie, because the atoms of conductors allow their electrons reasonably free movement. The key phrase here is "reasonably free movement". No atom gives up its electrons without a struggle, however good a conductor it is and force (or energy) is always required to take the electron away from the atom. The potential difference applied across the conductor provides this energy by literally pulling the electrons out of orbit towards the positive side of the voltage source. When the electron jumps along to the next atom to take its place in 'orbit', some of that energy is then given off and is released as heat (**Figure 1**).

Thick And Thin

In a large mass of conducting material the effect of these small heat releases is to raise the temperature only by a small amount. In a thin conductor, however, the temperature obviously rises more dramatically with the same potential difference, even though the actual power released is identical. So, light bulbs are manufactured with a very thin filament so that only a small amount of power is used up or dissipated for the amount of light emitted.

Naturally, there is a mathematical relationship between the amount of electricity and the power dissipated as heat. It is summarised by a formula which can be used to calculate the power dissipated by any conductor with a voltage across it:

$$P = IV \text{ (measured in watts)}$$

So, for example, a potential difference of 100V across a conductor, with a current of 10A through it, would mean that the conductor will dissipate a power of:

$$100 \times 10 = 1000 \text{ watts} = 1\text{kW}$$
(ie, one kilowatt)

But, from Ohm's Law we know that $V = IR$ and $I = V/R$. So also: $P = I^2R = V^2/R$.

This means power is also dissipated by a *resistor* in a circuit, not just a conductor, and we can calculate the power dissipated by that resistor if we know its value and the value of the current through it, or the voltage across it. Enough said for now, but next month when the whole topic of resistance is discussed in depth, you'll see how the question of power plays an important rôle in our choice of resistor in a given electronic circuit.

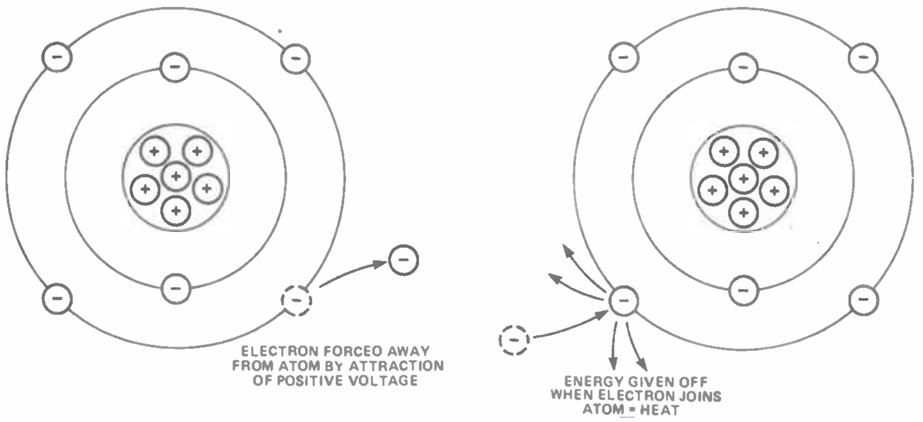


Figure 1. An electron can be forced away from its atom with the application of a voltage, but the energy used to force it away is released when the electron finds another atom with a missing electron.

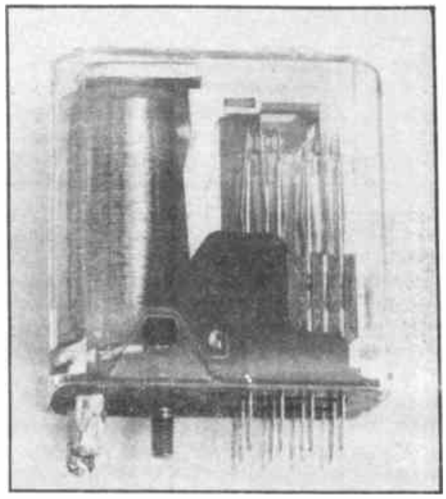


Figure 6. A relay can be used to switch currents (some relays have as many as 10 sets of switch contacts) upon application of a small current to pass through the coil.

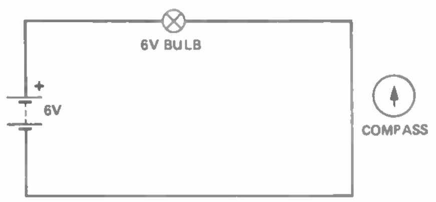


Figure 2. When the circuit is completed the needle of the compass will jump to a new position. As the circuit is disconnected the compass needle will once again point north.

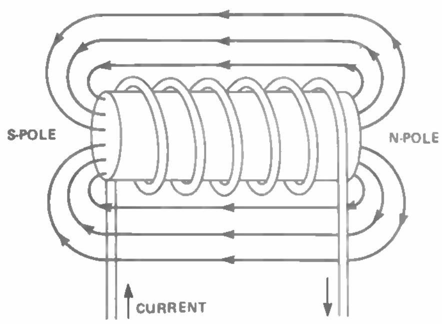


Figure 3. When current passes through a coil of wire, the electromagnetic field is stronger than that from a single length of wire. A north- and south-pole are generated.

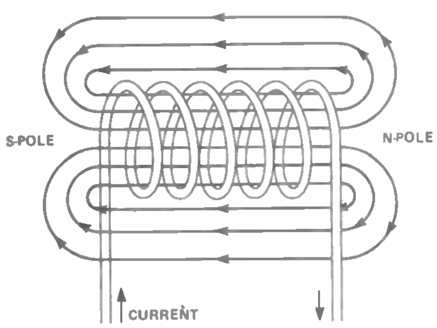


Figure 4. Winding the coil around a soft iron former concentrates the electromagnetic field.

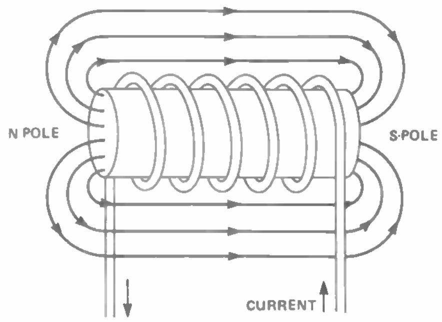


Figure 5. Reversing the direction of the electric current reverses the magnetic field.

Electromagnetism

The second effect of electricity we shall now look at is the magnetic field which is formed whenever a current is passed through a conductor. You can 'see' this magnetic field if you have a magnetic compass, a battery, a bulb and connecting wire. Simply position the compass close to the middle of the length of wire (**Figure 2**) and then connect the two ends of the wire to the battery. As you connect the circuit the compass needle will jump, then steady. Similarly, when you disconnect the wire, the needle of the compass will once again jump, then steady and point north.

This magnetic field is caused, like heat, by the energy electrons give off when jumping back to an atom. It is termed *electromagnetic* radiation to distinguish it from magnetic radiation from a permanent magnet (eg, bar-magnet, horseshoe-magnet) — electromagnetic radiation only occurs in a conductor when an electric current is flowing.

If you do the experiment in **Figure 2** you will see that the field generated is not a very powerful one. If might have caused the compass needle to move but it certainly would not have been strong enough to pick up a piece of metal, a pin for example. One way to increase the field should be obvious: increase the current. But there is a limit to how much current is available from a power source such as a battery. A better way to increase the magnetic field is to loop the wire into a coil, as in **Figure 3**. Each turn of the wire radiates its own field and the total effect is to create a magnet which is n times as strong as the single wire, where n is the number of loops in the coil.

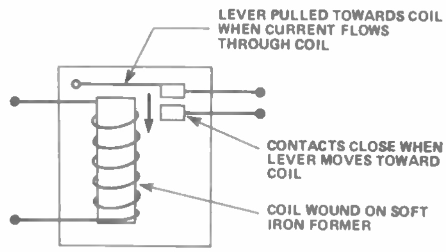


Figure 7. Inside a typical relay.

Loop The Loop

Another way to create a stronger magnetic field is to form this loop around a metal core (soft iron is best). The soft iron core (**Figure 4**) concentrates the field, producing a stronger electromagnet. **Figure 4** shows how the coil is now effectively a single magnet with the usual north (N) and south (S) poles. When the current flows as shown, ie, anti clockwise, the north pole is at the right hand end of the electromagnet. However, if the current flows clockwise as in **Figure 5** the poles reverse ends!

We have now seen the magnetic field which is generated around a conductor with a current flowing and the next question must be to ask, how can we use this effect? After all, an electromagnet is an electromagnet and by itself it must have only limited use. The most important use in the form is probably in a relay, an example of which is shown in **Figure 6**. Such a rely has an electromagnetic coil inside, which is operated by a specific voltage and ▶

current. When current flows through the coil it creates a field which pulls a lever towards it (**Figure 7**) activating switch mechanisms. The current to activate the coil is small but the current which is switched by the switch mechanism can be large and at a high voltage. So, for example a relay can be used to turn on and off a 240V mains-powered heater with only a 9V battery as in the circuit in **Figure 8**.

Undeniably though, electromagnetism doesn't seem to offer much until we consider the electromagnet in use alongside another, say a permanent magnet. If we remember the statement "like poles repel, opposites attract", then we can begin to understand the real usefulness of being able to switch magnetism, the force that pulls opposite poles together and pushes like poles apart, on and off at will.

Testing, Testing

The single conductor and compass experiment of **Figure 2** shows such a force making the needle of the compass (a permanent magnet) jump. Obviously, if we take our coil of wire formed around a soft iron core and pass a current through it, then put it beside a strong permanent magnet, the force between the two magnets will be a lot stronger. And, more important, because the strength of the electromagnetic field depends on the current through the coil, the force between the two magnets *depends on the current passed through the coil.*

This principle is used in the common test meters used everyday in electronics. **Figure 9** shows the basic part of a meter. The main items include a permanent magnet, a coil wound on a former, and a pointer attached to the coil. The coil is mounted on bearings so that it can rotate. The magnet's poles are shaped so that the field produced is radial and equal at all points on the coil. A coil-spring ensures the coil always returns to the same position when no current is passed.

When a current is passed through the coil, the electromagnetic field, interacting with the permanent magnetic field, forces the coil to rotate. When the force produced equals the force which the spring exerts against it an equilibrium is set up — in other words, the coil stops turning. The pointer therefore indicates on a scale the strength of the magnetic field produced by the coil and, because the field depends on the current through the coil, the position of the pointer on the scale is *an indication of the size of this current.*

For accurate measurements, all parts of a meter obviously need to be carefully designed and manufactured, but modern day meters can exhibit full-scale deflection (FSD), ie, the pointer goes from zero to maximum, when currents of only 1 uA or so are passed through the coil. A modern multimeter suitable for a selection of general-purpose test measurements in electronics is shown in **Figure 10**. This multimeter has a switch in order that

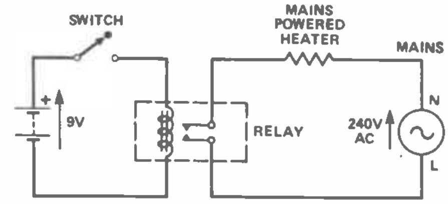


Figure 8. Showing how a relay and a 9V battery can turn a mains-powered heater on and off.

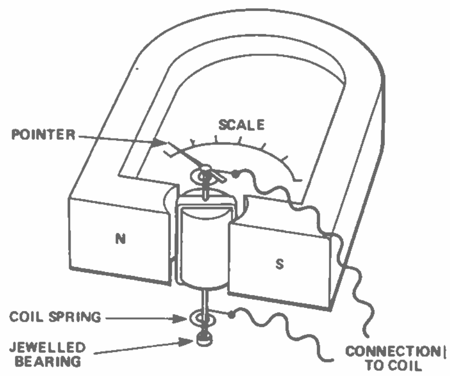


Figure 9. Inside a moving-coil meter.

the measurement range can be changed, so that larger currents can be measured. Also on the switch dial are locations so that voltage and resistance measurements can be taken, all with the same meter!

Now, how can this be done? How can we use the same meter to measure current, voltage and resistance at the flick of a switch? For the answer we must look at some circuits to understand exactly what we are measuring. Then we will see how to measure them.

Current

Figure 11a shows a circuit of a battery and a resistor. Battery voltage is 10V and the resistor has a value of 10k (ie, 10,000 ohms). So we can calculate, using one of the formulae associated with Ohm's Law, the current in the circuit:

$$I = \frac{V}{R} = \frac{10}{10{,}000} = 1 \cdot 10^{-3}\text{A} = 1\text{mA}$$

Figure 11b shows how we measure current. The meter must be part of the circuit — in this way the current actually passes through the meter coil. If the meter has FSD of 1mA then the pointer of the meter will be at its maximum position. If the meter had FSD of 10mA the pointer will be only 1/10th of the way across the scale.

But what happens if the meter has FSD of only 1uA? The pointer will try to go off the scale! The current going though the coil (1mA) is one thousand times greater than the current the coil was designed to withstand and it may "burn-out" ie, the heat generated by the current may actually be great enough to melt one or more of the loops of the coil. Once this occurs a break in the circuit

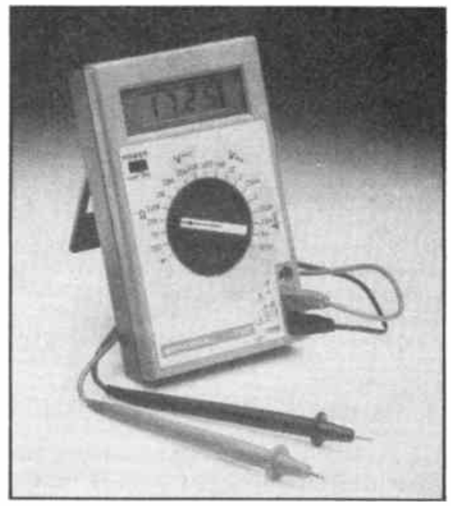


Figure 10. A typical digital multimeter with test probes.

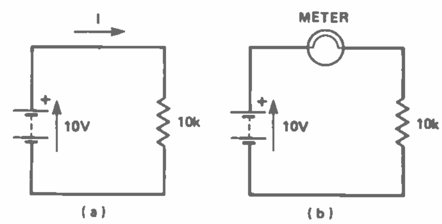


Figure 11a) Current flows when a resistor is connected to a battery b) measuring the current using a meter.

will be made and the meter is ruined. For this reason you must be very careful when using a test meter not to attempt to measure greater currents and voltages than the meter is switched to read at FSD. It is easy to adapt a meter with a very low FSD to measure currents of much greater value as shown in **Figure 12a**.

The meter can only be used to measure a maximum current of 1uA but the current in the circuit is 1uA (as **Figure 11a**). So to use this meter we need to sample only 1uA of the 1mA circuit current and bypass the meter with the other 999uA. We do this as in **Figure 12b** by putting a resistor, R2, in parallel with (ie, across) the meter. The resistance is calculated to allow 999uA through for every 1uA which the meter allows through.

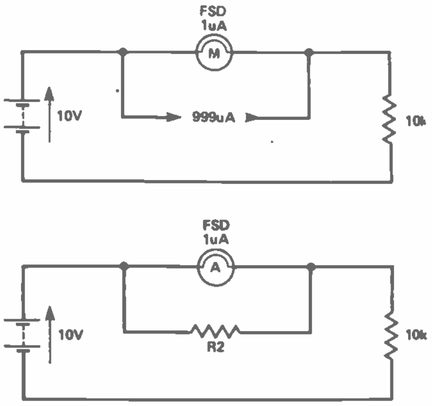
Now the voltage across the meter is the same as the voltage across the meter resistor (because they are joined at both ends — they are in parallel) whatever happens. So from Ohm's Law

$$IR\text{ (meter)} = V = IR\text{ (resistor)}$$

That is, the current though the meter coil multiplied by the coil resistance must equal the current through the resistor multiplied by its own resistance. We know that the current though the meter has to be 1/999 of the current though the resistor so

$$\frac{1}{999} \times R\text{ (coil)} = I \times R2$$

So, R2 = R/999 (coil). If the coil resistor



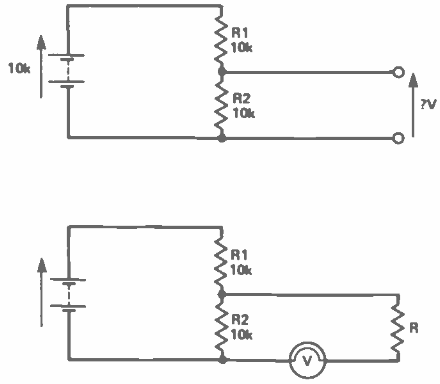


Figure 12 a) measuring a current which is larger than the FSD current of the meter — some of the current has to bypass the meter coil b) a shunt resistor (ie, in parallel) allows some current to bypass the coil

Figure 13 a) The voltage across a resistor b) measuring the voltage using a meter with a series resistor.

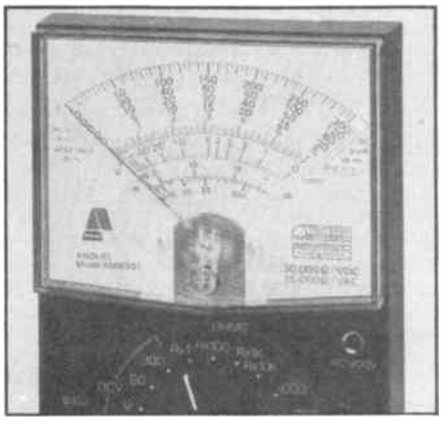
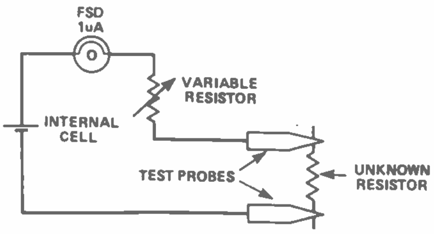


Figure 14. A typical analog multimeter scale. Note the reverse-reading resistance scale.

Figure 15. A typical use of a meter to measure an unknown resistance value.



is say 1k, then R2 = 1000/999 = IR. In this example we must put a resistance (which is 1/999 of the meter coil resistance) in parallel with the meter to let the meter which has FSD of 1uA measure up to 1mA. Other current values can be measured simply by putting another value of resistor, calculated as above, in parallel with the meter. All the switch does in a multimeter such as that of **Figure 10** is to connect in a different value resistor for every range of current to be measured.

Voltage

Voltage measurement is slightly different. The circuits in **Figure 13** show why. Say we went to find out the voltage across R2 in **Figure 13a**. We can calculate the voltage using Ohm's Law if we want, but in such a simple example it is possible to calculate the voltage by introspection. Look at the circuit: there are two equal resistors in the series (ie, in a line) across a source of 10V. So the mid-point of the resistor will have a voltage at the mid-point of the source voltage: 5V.

If we use the same meter as above, ie, with FSD of 1µA and a coil resistance of 1k, then we can calculate from Ohm's Law the current which will pass through the coil if the meter is simply placed across the resistor to measure 5V:

$$I = \frac{V}{R} = \frac{5}{1,000} = 5mA$$

(ie, 5000 times the FSD current!)

Obviously such a current will damage the meter, so we need to restrict the amount of current to be no greater than the meter's FSD current (1uA). When we measured large currents using the meter we connected a resistor in parallel to restrict the current flow through the coil. Things are different, however, when we want to measure a large voltage — *we add a resistor in series* (**Figure 13b**).

To calculate the value of this resistor we must remember that the aim is to restrict current flow through the meter to 1 A. So the total resistance of the meter coil to the added resistor must only pass 1 A of current. From Ohms Law therefore,

$$R\ (total) = \frac{V}{I} = \frac{5}{1x10^{-6}}$$

$$= 5 \times 10^6\ ohm = 5M\ (5\ Megohm)$$

The meter coil resistance is 1k so the added resistor should have a value of 4999000 ohms. It is not possible to manufacture a resistor to this sort of accuracy so in fact a resistor of 5M would be used. In a multimeter such as that in **Figure 10** different values of series resistors are switched in to measure different voltage ranges in the same way that different values of parallel resistors are switched in to measure current.

Resistance

Measurement of resistance is a lot different! A resistor is a passive device: unless a current is passed through it no voltage occurs to be measured and unless a voltage is applied across it no current can be measured, so a meter by itself will not be able to measure resistance. Any multimeter therefore has an internal battery cell to provide voltage and current. The current which passes through the resistor is given by Ohm's Law:

$$I = \frac{V}{R}$$

and the voltage is fixed by the voltage of the cell. So the current which flows is determined *by the value of the resistor being measured*. If we measure this current, using the meter as we've already seen, the position of the pointer will therefore indicate the value of the resistor.

An important point to note with a multimeter switched to measure resistance is that the current (therefore the pointer position) is *inversely proportional* to the resistance of the resistor being measured. In other words the meter appears to read backwards — the higher up the scale the pointer is, the lower the value of resistance. This also means that the scale is non-linear, ie, equal amounts of resistance are not equally spaced. An example of a typical multimeter scale is shown in **Figure 14**. You can see the linear scales of voltage and current and also the non-linear reverse scale of resistance. A typical resistance measuring circuit is shown in **Figure 15**. The main component to note is the variable resistor in the circuit which allows for varying voltages due to the cell discharging with time and use.

Using a resistance meter (or ohmeter) is a little bit different to a voltage meter (voltmeter) or current meter (ammeter) in that you first have to set the meter to read zero resistance on the scale, by adjusting the variable resistance when the ohmmeter probes are in good contact. This makes sure that at every resistance reading the varying voltage from the internal cell has been allowed for.

Safety First

An important characteristic of any meter is its sensitivity, ie, how far the pointer moves for a given current. It is normally expressed in ohms-per-volt (R/V). The more sensitive a meter is, the higher the R/V ratio will be. Any meter can be given such a rating by dividing its FSD current into one volt. For example a 1uA FSD gives:

sensitivity = 1V/1uA = 1×10^6 R/V

If you are going to purchase a multimeter for use in electronic

Table 1. Circuits symbols for this month's new components.

Table 2. Standard abbreviations for measurements and values used universally in electronics. It is important to distinguish between capital and lower case abbreviations, as they can mean different things.

Table 1

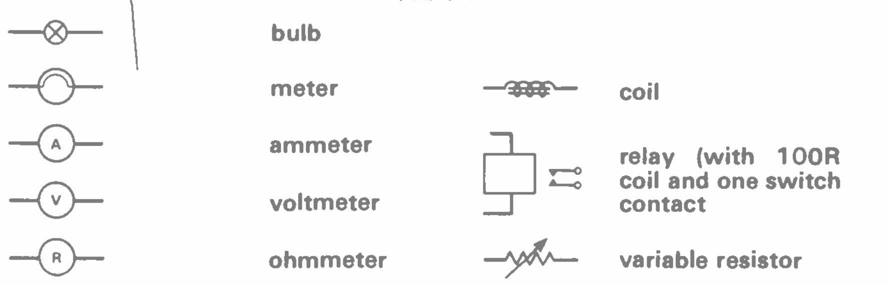


Table 2

DC	direct current
AC	alternating current
V	voltage/volts
I	current
R	resistance/ohms
A	amperes/amps
m	1×10^{-3} eg, one milliamp = 1mA
u	1×10^{-6} eg, one microvolt = 1uV
n	1×10^{-9} eg, one nanovolt = 1nV
p	1×10^{-12} eg, one picofarad = 1pF
k	1×10^{3} eg, one kilovolt = 1kV
M	1×10^{6} eg, one megohm = 1MR
P	power
W	watts

measurements, make sure you get one with as high a sensitivity as you can afford. Buy one with a sensitivity of at least 50,000 ohms/volts, preferably 100,000 ohms/volts.

The last thing to remember about multimeters is that there are a few rules you must follow which ensure the meter isn't damaged in any way:

- When you measure a current, voltage, or resistance which is unknown always measure it first on the highest range and step down range by range until you obtain a good measurement. This will make sure that the meter coil is not burned out by too large a current.
- The meter has to be polarised when taking DC voltage and current measurements ie, the negative terminal of the multimeter goes to the more negative side of the circuit and the positive terminal to the more positive side of the circuit. This prevents the meter pointer going in the reverse direction and being bent or damaged. AC measurements are different, however. A small circuit inside the multimeter converts AC to DC and always makes sure the coil turns in the right direction.
- Resistance measurements must not be taken with the resistor in circuit. A voltage may be present across the resistor when in circuit and too much current may flow through the coil due to this voltage and the coil may be damaged.

Finally, **Table 1** gives a list of the new circuit symbols we've met this month and **Table 2** lists some common abbreviations in electronics. Learn them well, you will see them time and time again. Next month, we will go deeper into the bits and pieces used in electronics — the components which go together into circuits — and show you how they work.

HE

Bookshelf

THE HE BOOKSHELF is the easiest way to build up your library of electronics books. Order today to have these top titles delivered DIRECT TO YOUR DOOR.

52 PROJECTS USING IC741 £1.25
More than 50 ways of using the ubiquitous IC741.

50 (FET) FIELD EFFECT TRANSISTOR PROJECTS £1.75
Contains a wide range of projects, all based on Field Effect Transistors.

COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS £1.75
Features many varied projects using numeral displays, counter and driver ICs.

RADIO CIRCUITS USING IC's £1.35
All you need to know about using IC's for AM or FM reception.

IC LM3900 PROJECTS £1.35
Provides the ground work for simple and more advanced uses of IC LM3900.

PRACTICAL CONSTRUCTION OF PRE-AMPS, TONE CONTROLS, FILTERS AND ATTENUATORS £1.45
Contains practical designs for use with home constructed equipment or commercial modules.

BEGINNERS GUIDE TO MICROPROCESSORS AND COMPUTING £1.75
Basic introduction to binary arithmetic, micro-processor operation and macine language programming.

IC 555 PROJECTS £1.95
The 555 timer users 'Bible'!

CHOOSING AND USING YOUR HI-FI £1.65
Concise information for all hi-fi enthusiasts.

ELECTRONIC GAMES £1.75
Amusing electronic games which can easily and inexpensively be constructed by the enthusiast.

ELECTRONIC HOUSEHOLD PROJECTS £1.75
Packed with circuits for projects that can be used in or around the home.

A MICROPROCESSOR PRIMER £1.75
A painless approach to understanding computers and computing

REMOTE CONTROL PROJECTS £1.95
Practical information about many applications of remote control.

ELECTRONIC MUSIC PROJECTS £1.75
Many practical circuits for less complex items of electronic music equipment.

ELECTRONIC TEST EQUIPMENT CONSTRUCTION £1.75
How to build and use a wide range of test equipment for the hobbyist.

POWER SUPPLY PROJECTS £1.75
Packed with circuits for building various kinds of power supply.

SINGLE IC PROJECTS £1.50
Easy to construct projects based around a single IC.

PRACTICAL COMPUTER EXPERIMENTS £1.75
Build and examine a number of basic computer circuit elements

ELECTRONIC PROJECTS USING SOLAR CELLS £1.95
A range of practical applications using silicon solar cells.

VMOS PROJECTS £1.95
Contains a number of varied and interesting projects using VMOS power FETs.

DIGITAL IC PROJECTS £1.95
Simple and advanced projects based on digital ICs.

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE £2.95
Find possible equivalents for a popular user-orientated selection of modern transistors.

HOW TO USE OP-AMPS £2.25
All you need to know about Op-Amps, a source book of circuits and design calculations.

AUDIO PROJECTS £1.95
Clear information on how to build pre amps, mixers, power amps, tone controls etc

To receive your books you have only to fill in the form below and send it, together with your payment, to the address stated.

Please allow up to 21 days for delivery. This offer applies only within the U.K. Prices may be subject to change without notice

SEND TO: HE BOOKSHELF, 513 London Road, Thornton Heath, Surrey CR4 6AR.

I am enclosing my Cheque/Postal Order/ for: (delete as necessary)

£..... (Made payable to A.S.P. Ltd)

VISA **OR Debit my Access/Barclaycard (delete as necessary)**

Please use BLOCK CAPITALS and include post codes.

Name (Mr/Mrs/Miss) ....
(delete accordingly)

Address ....

....

....

Signature .... **Date** ....

Books Required	Price
Add 75p p&p	0.75
Total Payment £	

POINTS OF VIEW

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

Calling Mr. Giggs

If there is a Mr. Giggs out there, who wanted a Heathkit manual for a C-3U R-C Bridge, please could he get in touch? We know somebody who has one.

Atari In The Islands

Dear Sirs,

I receive your very helpful magazine a little later than some of your readers but it is better than gold. In February's issue which has just arrived you comment about the hobbyists in remote corners of the country - well we here in the middle of the South Pacific are in a rather remote part of the world, so all we can get hold of in the way of news and information is even more valuable than to those who can buy magazines off the bookstall and whose public libraries are stacked with the latest books.

I teach Physics here - and computing, and when I was visiting Britain last year I bought myself an Atari 400. I explained to the supplier that I was going to a rather remote part of the world and would value keeping in touch. He promised all sorts of help - including the VAT back on my machine after I'd left the country. That is the last I've heard from him.

I am delighted with the capabilities of the 400, but had problems with the program recorder; I wrote to the supplier, and also Atari in the States. I heard back from the States saying I'd be having a reply to my problem - that was February 3rd, and I'm still stuck.

I have regular classes that I teach - imagine my frustration setting up programs the night before and finding that when the engineers at the power station have changed over from one generator to the other there has been a break in the power and I've lost everything - my hair which is already thin is going even faster!

My idea in teaching computing is to give a chance to young men and women to get "hands-on" experience which they would not, and do not get otherwise. I'm also experimenting with the use of the 400 as a multi-purpose piece of physics equipment which I hope will lead the way to teachers in other third-world countries 'discovering' the micro as a means of doing much more with little capital outlay. However I am very limited with no means of storing programs.

Just after I came back I encouraged a local electronic music shop owner to become an Atari stockist, he is all enthusiastic and has gone ahead, but we need outside help and advice beyond our own capabilities. I hope this letter may stir some.

Much as we enjoy the sunshine here we are also keen on keeping up with the latest technology.

Yours sincerely,
Rob Pattison,
Physics Dept.,
Lelean Memorial School,
Box 66,
Nausori,
Fiji.

PS. Our school is one of the only three with a computer in Fiji.

You seem to be doing a lot with a little, and good luck to you. It's a pity about dealers who take the 'out of sight, out of mind' line but I hope Atari either in the UK or the States (or both) will help you out with your problems. You may have to nag them .

I am ignoring our usual custom and printing Mr. Pattison's school address so that readers and teachers in similar situations can write to him and exchange ideas.

Mr. Pattison would also like to know whether there are any broadcast satellites that he could tune into with the right receiver in his part of the world (the Pacific Islands, for non-geographers!) In between coping with cyclones and hurricanes, that is. . .

In Search Of A Job

Dear Sirs,

I am a regular reader of HE and was very interested in your article on Careers in Electronics in May '83.

I am about to start the last term of a full-time TEC Higher Certificate in Electronics course I am taking at Liverpool Polytechnic, which I am advised I should successfully pass, so I am beginning to look around for appropriate employment. The few approaches I have so far made to local firms have been unsuccessful, some so strange to electronics as to assume I was looking for employment as an electrician's mate!

Anyway, I am writing to ask if you could advise me where I might obtain names and addresses of the major firms in the Electronics field, anywhere in the country, so that I can contact them regarding employment prospects. Any help you could give me would be very much appreciated.

Yours faithfully,
J. A. Richardson,
Middlesborough,
Cleveland.

Yes. Random approaches to firms, while they can turn up an unexpected gem of opportunity, very often result in blank stares and puzzlement.

To get the names and addresses of electronics firms, you need to consult professional magazines and trade papers advertising for posts (this is not to say you can only apply for the posts being advertised). Find the largest reference library you can and try to get hold of papers like *Electronics News* and *Electronics Weekly*. Ask the librarian for assistance in tracing electonics journals and also any trade directories which lists electronics firms. Also, don't forget the Yellow Pages phone directories.

This is the long, laborious, individual way of looking for an employer. The other one is to contact your local Educational Authority and ask to be put in touch with their Careers Office. Go and talk to them.

Doesn't your polytechnic have a technical library and/or a careers office.

In Search Of Electronics

Dear Editor,
HELP!!

I've spent many years in the software side of the computer industry, however, I've caught the BUG to know and learn more about th hardware element.

I want to be able to read and understand circuit diagrams upwards, because I want to build my own microcomputer. The principle application will be the knowledge I would have gained in actually building it.

The snag is, I don't want to go back to college, so I would like to know of home/correspondence courses and books available, no matter what the cost.

Can you PLEASE, PLEASE inform me of those bodies etc. that can help.

Yours in much need,
Richard Lanyon-Hogg,
Husbourne Crawley,
Beds.

Now *there* is an encouraging noise! Someone who wants to know how the things *work*. Stick with it — people who know about the innards as well as the outards (is there such a word as outards?? There is now . . .) of microcomputers are going to be in demand.

Bodies: Well first of all, there is HOBBY ELECTRONICS. We have just started a new series for beginners, *All*

About Electronics; going back a bit, Hobby has run *Into Electronics* (Nov '78 to June '79), *Into Digital Electronics* (Sept '80 to Jan '81), *Into Electronics Components* (Aug '81 to July '82) and *Into Electronics Construction* Feb '80 to July '80). All these articles are available from our Backnumbers service, £1.50 an issue.

Then there is the *British Amateur Electronics Club*. Contact **The Secretary, Mr. J. G. Margetts, 113 South Rd., Horndean, Hants PO8 0ER** for information.

Check out your local main library for information about part-time courses in electronics run by your local education authority.

For information on books, check out some of the publishers mentioned in *Look In The Book* (HE February '83) and write for their technical catalogues.

You could also try *Electronics, Its Easy*, the popular collection of reprints on basic electronics compiled by our sister magazine ETI and available for £4.95 from the same address as HE Bookshelf, viz. **513 London Rd., Thornton Heath, Croydon, Surrey CR4 6AR**, which has just been reprinted for the third time.

And you could always contact The Open University, Milton Keynes (right up your street — literally!) — and write to the Courses Information Department and ask what they have. You don't have to commit yourself to doing a degree, and can work entirely at home.

Correspondence courses are a bit outside our frame of reference, but you will find them advertising in many semi-pro electronics magazines, including ETI. One address plucked at random is the **British National Radio and Electronics School, Reading, Berks RG1 1BR**.

Keep and eye on MONITOR which sometimes features self-teaching kits, and electronics and computing clubs.

Build something! But start with a kit, if in doubt — you will have fewer variables to cope with. It's not as complicated as it looks.

Self-education is a convoluted process, full of mysteries. Get a decent multimeter, cultivate an elegant soldering technique, double-check for dry joints, have patience and keep reading Hobby Electronics — and you can't go far wrong . . .

Sine Errato

Dear Sir,
In the HE June '82, Ian Sinclair lets his poetic license run away with him: the sine wave is not so called because it is snake-like but because it is the plot of an actual sine wrt time. The Romans used 'sinus' to describe anything in the curvaceous department. Our 'sinusoid' is the plotting of another curve but just happens to be a curve in itself.

The curve in question is the arc, TQ, of a circle. TQ comes from drawing a tangent TS, a radius OT and a secant OS cutting the circumference at Q. P is the vertical projection (shadow) of Q on OT. To be fair, we don't measure TQ but its height, PQ – because its always harder to measure a curve, even with bits of string. Although 'sine' means a curve (like the sinus in your head), we already have another Latin word, 'arc'. In this context we have corrupted the translation of 'sine' to mean not the curve TQ but its straight height.

As you know, in engineering, navigation etc, useful ratios are:

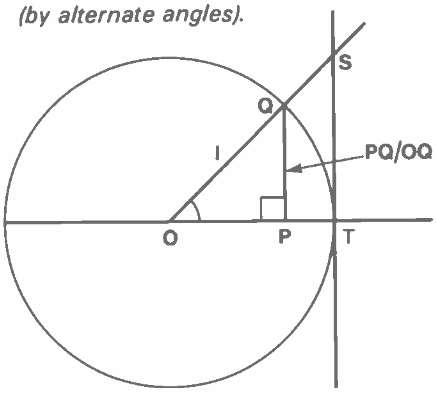
$$\text{sine unit}^{-1}\text{ radius} = \frac{PQ}{OQ}$$

$$\text{secant unit}^{-1}\text{radius} = \frac{OS}{OT} = \frac{OQ}{OP}$$

(by alternate angles) and

$$\text{tangent unit}^{-1}\text{ radius} = \frac{TS}{OT} = \frac{PQ}{OP}$$

(by alternate angles).



The unit circle as described in our letter.

The basis for simplifying these long names is to assume a unit circle to begin with. For any such right angled triangle POQ, you can always invent a unit circle with sine PQ/OQ and a radius of one unit (one yard, French loaf, yard per minute, etc.) Now 'sine per unit radius' equals numerically 'sine', since the radius is a unit. Ie, PQ/OQ over 1 equals PQ/OQ, which is why we say simply that the sine of POQ is PQ/OQ. Similarly secants, tangents and the co-functions. I'll leave you to work out the hyperbolics!!!
Yours faithfully,
Kathy Louise Saint-John Crostorry,
Machen,
Gwent.

Ian Sinclair replies:
"Thanks for the letter. Methinks the lady doth protest too much. The point I was making is that there has to be some reason for calling a ratio of two straight lines a sine, and the shape of the graph of sine (angle) plotted against angle is a good reason, just as the name of the tangent, (from tangere, to touch) must come from the appearance of a graph of tan(angle) plotted against angle."

Well, if you will take advice from a nation which tried to build circles out of straight lines, what can you expect? They spoke Latin too, and where are they now? And now we've got typesetters quoting ancient Greek at us. It's getting "out of hand" (ex digitas), if you ask me . . .

Meet Your Match

Dear Sir,
I have written to three of your advertisers, but none has been able to help me. Would it be possible for you to give me the name of a manufacturer or supplier for the following information?

I would like to obtain five matched pairs of 47uF capacitors or a pair of matched capacitors of the values of 47, 94, 141, 188 and 235 which must be 10-volt working.
Yours faithfully,
R Head.
Heanor,
Derbyshire.

Capacitors are not sold as matched pairs, nor are they available in any of the values you require except 47uF.

To match capacitors, you must have a reasonably large number of the nominal value and then measure the exact value, choosing the closest pair. You'll find our Digital Capacitance Meter, a project published in HE April '82, quite suitable for the job.

As for the odd values, you'll have to make them up by selecting the appropriate values and then correcting them in series or parallel as required.

Capacitor networks are the opposite of resistor networks. Two capacitors in series have the total value of:

$$Ct = \frac{C1C2}{C1+C2}$$

while capacitors in parellel are simply added together, re:

$$Ct = C1 + C2$$

So, to make up a capacitor of 95uF, you need 47 = 47uF. A 141uF capacitor is three 47uf in parallel and so on.

Microlog Transformer

Dear Sir or Madam,
After reading HE December '82, I am building (or trying to build!) an HE Microlog computer.

However, I have had considerable difficulties (apart from postage problems to Dubai) in obtaining a suitable transformer (3VA, 240V, 20-0-20). Please could your send me some information on possible buylines for the transformer (no reference to it was given in the Buylines section of HE) as my only other alternative is a multi-purpose transformer costing over £10.00.

Thank you.
Yours faithfully,
D. Horton-Szar,
Dubai,
UAE.

This is a fairly standard transformer, stocked by many companies who advertise in HE. Try Cricklewood Electronics. **HE**

FORWARD BIAS

Questions, answers and errata from readers and writers.

The **Soft Fuzz** project, published in Hobby Electronics last month, was originally designed as a two-step unit to which extra steps could be added at the constructor's whim, to experiment with different effects. The author has a few words (and numbers!) to add on the subject:

"From the explanations given in the Soft Fuzz article, it is a small step to design a feedback network to produce any required type of compression. First of all, you should draw a graph of the required characteristics. When you are satisfied with the shape of the graph, read from it the slopes (hence the gains needed), and the output voltages at which the slope of the graph changes.

Taking a two-step circuit as an example, suppose that you wanted the gain to be 1 for large signals. For smaller signals let us say that we want a gain of 13½ for outputs up to 1V2 and a gain of 5.2 from 1V2 to 2V.

First of all, since the final gain is to be 1, R13 must be the same value as R3 (3k3) — simple. Next, calculate for the gain of 5.2. For this, R11 + R12 + R13 must be equal to 5.2 x R3.

Therefore, since R13 = 1 x R3, R11 + R12 = 4.2 x R3 = 13k86.

Similarly, for the gain of 13.5, R1 + R2 + R11 + R12 + R13 must be equal to 13.5 x R3. Since R11 + R12 + R13 = 5.2 x R3, R1 + R2 = 13.2 - 5.2) x R3 = 27k39.

The next step is to calculate the ratios of the resistors. Since we know the total resistance of each pair, it is simple (with a calculator) to multiply the total value by the appropriate fraction, and then pick the nearest preferred value to the answer.

The best way to find the required ratios is to start with the lowest voltage breakpoint, 1V2. This is the charge from the highest gain to the intermediate gain, so resistors R1 and R2 are the ones concerned.

In order to switch to TR1 or TR2, a voltage of OV6 must be developed across R1. For a 1V2 breakpoint, this allows OV6 across all other resistors together. This means that R1 is half of the total resistance value, which is 13.5 x 3k3 = 44.55k =>R1 = 22k275 equals about 22k. Since R1 + R2 = 27k39, R2 should be 5k39, so pick the nearest preferred value: 5k6.

In order to make it simple to calculate R11 and R12, you can remove TR1, TR2, R1 and R2 from the calculation.

Once TR1 or TR2 has switched on, R1 and R2 have no further resistive effect on the feedback. The effect of the network is to subtract a voltage from that appearing across the rest of the feedback network. This voltage is:

$$\frac{(R1 + R2)}{R1} \times OV6 =$$

$$\frac{(22 + 5.6)}{22} \times OV6 = OV753$$

Therefore when the output reaches 2V, there will be 1V247 across the rest of the feedback network. The calculation is now carried out much as above: for OV6 across R11, R11 = OV6 x R11 + R12 + R13 (ie 17k16 => R11 = 8k256 — so choose the preferred value of 8k2.

To find the final resistor, R11 + R12 + R13 + 17k16 and R11 + R13 = 313 + 8.2 = 11.5 => R12 = 17.16 - 11.5 = 5k66, so choose the preferred value of 5k6.

That's it! All calculated!

With enough patience for tedious sums, this can be extended to many more stages.

Incidentally, if you happen to possess a 'scope and a triangle wave generator, and if you dislike sums, you could make up the circuit with resistor values chosen by "finger in the air" methods, display the performance on the scope, and modify the values until the performance pleases you."

Or — we suppose — you could attach it to an electric guitar and see what happens! Just remember to disconnect the power before you change any components, that's all . . .

COLLECTED BOOBS

Starting right here, Forward Bias is going to reprint all the official Hobby Electronics Errata Cards, going back to January 1979, for the benefit of those readers who are either struggling with a project which has some nameless disease, or who are thinking of embarking on an old Hobby project.

Photocopies of Errata Cards are still available on request with an SAE or International Reply Coupons, but regular readers will now have the chance to build up their own file.

Let's get started:

Flash Trigger
(HE January '79)

Figure 3: 'RV1' label on the right hand side of the board should read 'RV1 Wiper'.bng.

The **Parts List** should read:

R1, 2 .... 33k
R3-5 .... 330k
R6 .... 100k
R7 .... 470R

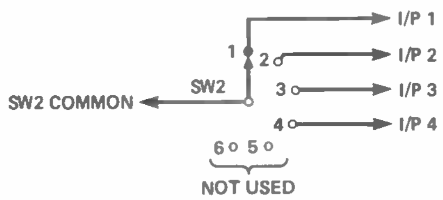
Also:

RV1 .... 50k linear

Some switch details were omitted. They are:

SW1 .... SPST On/Off
SW2 .... 2 pole 6 way rotary (only 1 pole 4 ways used)

SW2 should be connected as follows:



Drill Speed Controller
(HE June '79)

Figure 1: On the Circuit Diagram, the link shown shorting Q1 base and collector, and Q2 base and collector together is incorrect. The PCB and overlay give the correct version.

Starburst *(HE September '79)*

PCB Overlay: the OV and +9V notation should be swapped over. Also, reduce R7 - R11 to 15 - 18k for reliable switching.

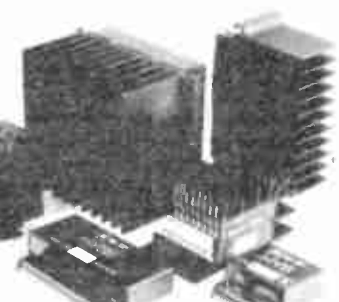
Recent Errata

HE Starburst (HE September '79) see *Projects From The Past*, Points of View HE May '83.
Big Ear (HE December '82) see *Ear Errata*, Points of View HE March '83.
Microlog (HE December '82) see *Microlog Mistake*, Points of View HE March '83, and *Microlog Errata*, Monitor and PCB Printout HE January '83.
HE Echo-Reverb (HE May '82) see *Designer On The Dole*, Points of View, HE December '82.

Past Project Progress

There is now a PCB available from our PCB service for the **Low Cost Alarm** (HE December '82) — see the PCB Printout, HE June '83.
The troublesome **Telephone Timer** (HE June/July '82) is being re-examined from the bottom up by our technical team (all of him), but the solution is not yet on schedule for publication and probably won't be for some time. The **Echo Reverb** (HE May '82 may also be coming in for scruitiny shortly. **HE**

GET BIG POWER



ILP Modular Amplifiers
the third generation

Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.

WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
[illegible]	[illegible]	4-8	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Protection: Full load line. Slew Rate 15v/μs. Risetime 5μs. S/N ratio 100db. Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity 500mV rms. Input Impedance 100K Ω. Damping factor 100Hz >400.

PRE AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
[illegible]	Mono pre amp	[illegible]	10mA	[illegible]
[illegible]	Stereo pre amp	[illegible]	20mA	[illegible]
[illegible]	Guitar pre amp	[illegible]	20mA	[illegible]
[illegible]	Stereo pre amp	[illegible]	20mA	[illegible]

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the B6 for modules HY6–HY13 £1.05 (inc. VAT) and the B66 for modules HY66–HY78 £1.29 (inc. VAT).

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D Typ at 1KHz	DISTORTION I.M.D 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc VAT
[illegible]	[illegible]	[illegible]	<[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	<[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	<[illegible]	<[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Protection: [illegible]
Slew rate: [illegible]
Frequency response (−3dB) 15Hz – [illegible]
Input impedance [illegible]

'NEW to ILP' In Car Entertainments

C15

Mono Power Booster Amplifier [illegible]

Very easy to use. [illegible]

Robust construction. **£9.14 (inc. VAT)**

Mounts anywhere in car. [illegible]

Output power maximum [illegible]
Frequency response [illegible] T.H.D. [illegible]
S/N ratio (DIN AUDIO) [illegible]
Input sensitivity and impedance [illegible] 8Ω
Size 95 x 48 x [illegible]

C1515

Stereo version of C15 **£17.19 (inc. VAT)**

Size 95 x 40 x 80. Weight 410 gms.

POWER SUPPLY UNITS [illegible]

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY248	£17.07

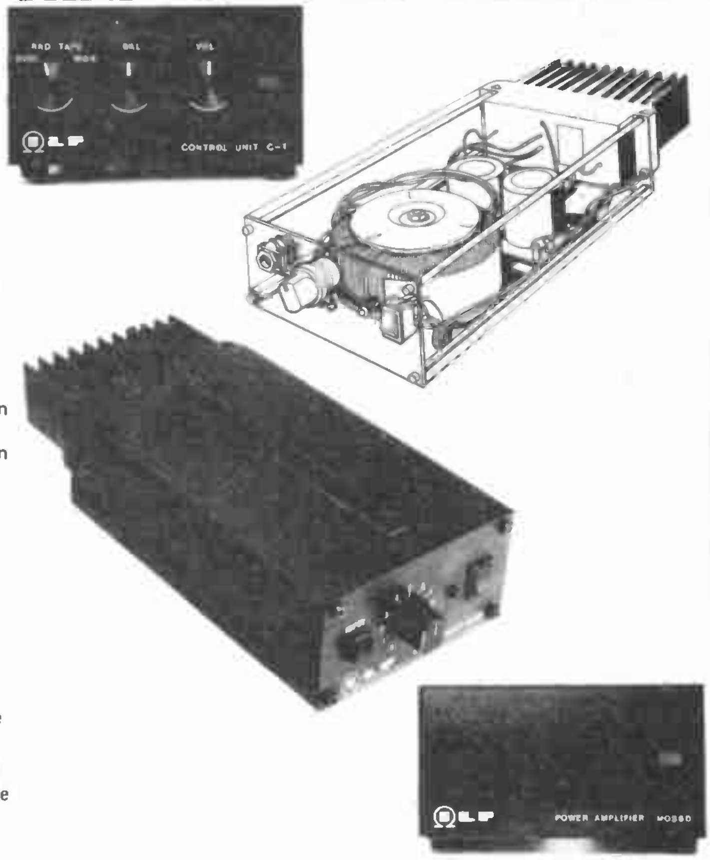
Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	[illegible]
PSU 53X	2 x MOS128	[illegible]
PSU 54X	1 x HY248	[illegible]
PSU 55X	1 x MOS248	[illegible]
PSU 71X	2 x HY244	[illegible]

Model Number	For Use With	Price inc. VAT
[illegible]	[illegible]	£22.54
[illegible]	[illegible]	£22.54
[illegible]	[illegible]	£24.22
[illegible]	[illegible]	£24.22

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V and "2" in place of X for 240V.

WITH A LOT OF HELP FROM ILP ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...



Unicase

Over the years ILP has been aware of the need for a complete packaging system for it's products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert 'O' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

TO ORDER USING OUR FREEPOST FACILITY

Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. if sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED

ILP ELECTRONICS LTD

Post to: ILP Electronics Ltd., Freepost 4, Graham Bell House, Roper Close, Canterbury CT2 7EP, Kent, England.
Telephone: (0227) 54778.
Technical: (0227) 64723.
Telex: 965780.

Please send me the following ____________

Total purchase price ____________

I enclose Cheque ☐ Postal Orders ☐ Int. Money Order ☐

Please debit my Access/Barclaycard No. ____________

Name ____________

Address ____________

____

Signature ____________

BUYLINES

Joystick Controller

A full set of parts and components for this project, including the PCB and a two-button joystick, is being supplied by **Cambridge Computing**, 1 Benson Street, Cambridge CB4 3QJ. A motherboard is provided as part of the package so don't forget to specify which computer (ZX81, Spectrum or Ace) you intend to use with it. An instruction sheet for assembling the Spectrum motherboard, which carries a 5V regulator, will be included where appropriate.

The cost of the kit is £26.00, including VAT, packaging and postage, and a cassette of joystick operating software for all three computers.

Expanding The Ace

Usually it's easy enough to locate a single supplier for all the components of a Hobby Electronics project, but not always! For this project you'll need to go to at least two suppliers for all the requisite bits and pieces.

For the semiconductors, try **Technomatic**, who stock a very large range of digital components. They can also supply the IC sockets which, while not essential, provide some flexibility when first completing the project.

The interface section of the project is connected to the real world via two 12-way inter-PCB plugs, and one of the few sources for these gadgets is **Ambit International**. Order them using Ambit's stock code numbers: 10-03012 for the plugs, 10-03003 for the cable shells and 10-03030 for the crimp terminals (don't forget that you need 24 of them). Ambit can also provide the ICs and the passive components, if you dont already have them.

Finally there is the PCB edge connector socket that plugs onto the Ace expansion port. Like the ZX81, the Ace uses a 23+23-way (double-sided) edge connector, but differs in that the polarising key is in position 23, at the extreme left of the expansion port as viewed from the rear (our numbering of the Ace port pins thus follows the convention established in the many volumes of literature on the ZX81 and Spectrum, where the pins are numbered from right to left as viewed from the rear).

Again, there are alternative sources of supply for the socket; **Technomatic** can supply a 25+25 way unpolarised socket which can easily be modified to place the polarising key in the correct position (if you state that the component is for this project and ask them nicely. Technomatic will do the modification for you).

Alternatively a 23+23-way socket with the key in position 23 is available from **Innovonics**, 147 Uplands Road, East Dulwich, London SE22 0DF.

Whistle Switch

A novel project, this, but one for which the imaginative constructor will find many uses!

The standard components — resistors, capacitors, most of the semiconductors — are all easily obtainable. Where there might be some problem is in finding the transformer, and the relay.

T1 is a sub-miniature 12-0-12V type, rated at 50mA per winding (1.2VA total) and, somewhat unusually, is not intended for printed circuit board mounting. The required type should measure about 30 x 27 x 25mm, and the fixing centres should be at 36mm to fit the holes marked out on the PCB. However if the exact type can't be had, it should be easy enough to drill the PCB to accept slightly wider fixing centres. Alternatively the transformer could be mounted off the board and wired into the appropriate PCB points (this will mean a bigger case, too).

The specified relay is an ultra-miniature mains relay with a single changeover contact rated at 10A; it is an unusual device, with unusual pin-outs and so it will be hard to find a substitute unless you're prepared to re-design the PCB tracks!

The alternative to modifying the project (a course we do not recommend, as it happens), is to contact **Magenta Electronics**, who have kindly arranged to stock exactly the type of relay and transformer required for the project.

The most important IC to find is the 567 tone decoder/PLL; it may be either an NE567 or an LM567 — they're equivalent, so it doesn't matter. Similarly a TL071 could be substituted for the specified 081, with some improvement in the noise performance, and any of the standard general purpose silicon PNP transistor types could be used in place of the BC109 — BC149, 319, 549 and so on.

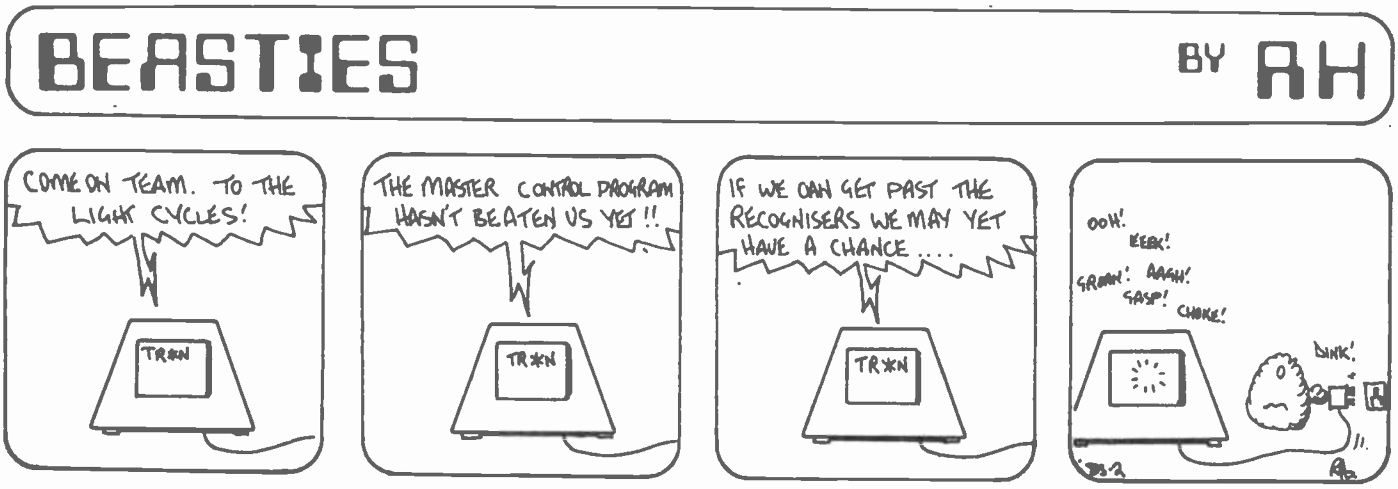
All these other bits and pieces are also available from **Magenta**, of course, and the cost of the project excluding case and PCB should be around £10.00. A Vero type GP3 case, which measures 180 x 110 x 55mm, is £2.28 and the price of the PCB can be found by looking at our PCB Service page.

Auto-Winder

No problems with this project — all the components are stock-standard and available from regular mail order companies such as **Rapid Electronics** in Colchester.

The relays are both 12VDC/160-240R coil types with contacts rated at 5 amps or better. If the relays and PCB are mounted in one case, it should measure approximately 4" x 4" x 1½" (101 x 101 x 64mm); if the relays are mounted separately the case for the PCB alone will need to be at least 4" x 2" x 1½" (101 x 50 x 64mm). Either way, use a metal case — folded or diecast aluminium — not plastic!

The cost of the Auto-Winder project ought to be under £10 including the relays but not the PCB or the metal box.



Just Whistle

R. A. Penfold

It won't fetch you a private taxi, fix you a long, cool cocktail or come running up with your tennis ball when you call it, but it *will* turn you household gadgets off and on, and doesn't require tactful handling or regular feeding!

The Whistle Switch unit is a novel form of remote control which enables an item of mains powered equipment to be switched on and off at will, simply by whistling the appropriate note! Although the system was designed originally for its novelty value, it is in fact a practical form of remote control and has the advantage over most other systems of not requiring a transmitter of some kind to activate the receiver. The unit could also be very useful to a disabled person, so it is not purely frivolous.

The maximum range that can be obtained depends on a number of factors such as the sensitivity of the microphone used, but a range of about 6 meters or so can be readily achieved using the prototype equipment, and this is more than adequate since the unit is only intended for the control of equipment in the same room as the user (like the popular infra-red and ultrasonic remote control systems). Using the specified relay the unit can control mains equipment having a power rating of up to 2400 watts.

Tone Decoder

The device at the heart of the Whistle Switch is an NE567 phase locked loop tone decoder. The block diagram of **Figure 1** shows the internal arrangement of this device plus the discrete components required in order to make it function correctly.

A fairly conventional phase locked loop circuit is formed by the phase comparator, amplifier, and current controlled oscillator (CCO). Most phase locked loops use a voltage controlled oscillator (VCO) rather than a CCO, but the basic method of operation is the same using either type. With no input signal the CCO receives a control current that sets its operating frequency at roughly the centre of its operating range. The values of R2 and C1 set this free running frequency.

If an input signal is applied to the circuit, and is at the same frequency and in phase with the signal from the CCO (in other words the two signals rise and fall in amplitude precisely in unison and with the same polarity) there is no change in the output signal from the phase comparator and the following amplifier stage. If the

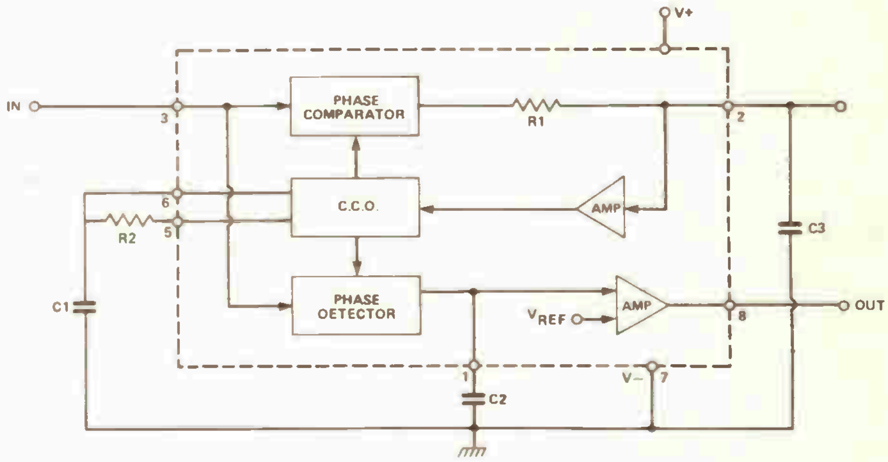
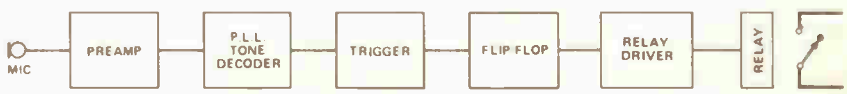


Figure 1. The block diagram, with internal units and components.

How It Works

Basically the unit is very straight forward, as can be seen from the block diagram. The output signal from the microphone is extremely small and is first amplified by a high gain preamplifier to produce a usable signal level. The signal is then fed to a phase locked loop (PLL) tone decoder, and this activates a switch if the input signal is within a fairly narrow band of frequencies. A trigger circuit plus some simple filtering are used to give a clean switching action as the input tone commences and finishes, so that multiple operation of the circuit and unreliable results are avoided.

If the trigger circuit was to be used to directly drive a relay or relay driver stage the relay would only be switched on while the input tone was present and this would be of limited practical use. A flip-flop is therefore used between the trigger and relay driver circuits so that each time a burst of tone is received at the input the relay changes state (ie if it is on, it switches off; or if it is off, it switches on). A set of relay contacts are used to control the load.



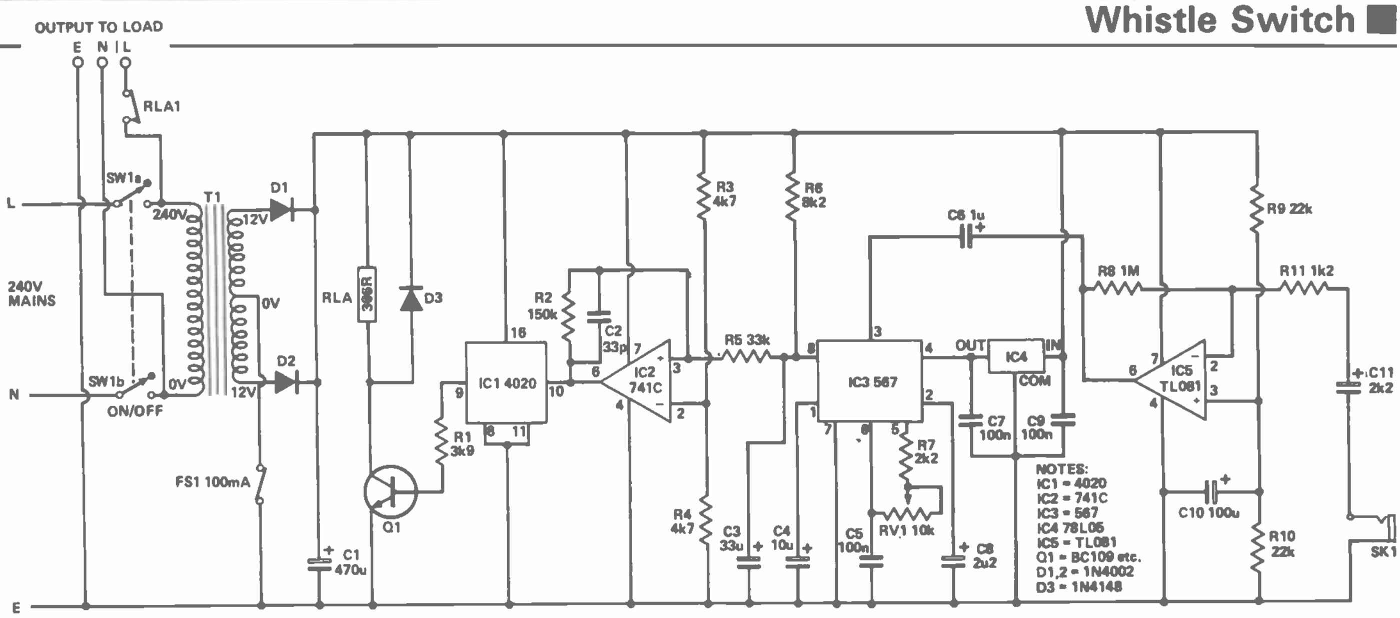


Figure 2. The circuit. SW1 disconnects the unit from the mains.

input signal is at a higher frequency than the CCO or leading it in phase, then the output voltage from the phase comparator increases slightly, and the amplified signal is fed to the CCO as an increased control current. This raises the operating frequency of the CCO so that it locks onto the frequency of the input signal and keeps in phase with it. Of course, this only happens if the input signal is reasonably close to the free running frequency of the CCO ie, within the locking range.

A similar thing happens if the input signal is at a slightly lower frequency than the CCO, but the output voltage from the phase comparator reduces as does the control current from the amplifier so that the operating frequency of the CCO reduces to match that of the input signal, and the CCO is locked in-phase with the input signal. The output from the phase comparator is actually a series of pulses, and the required control voltage for the amplifier is obtained by feeding these pulses to a lowpass filter which is comprised of R1 and C3. This simply gives an ouput voltage which is an average of the output potential from the phase comparator.

The CCO is used to operate an electronic switch, and it closes the switch on positive output half cycles and opens it on negative half cycles. The input signal is fed via this switch to a capacitor (C2), and if then the phase locked loop has achieved lock the input signal will only be connected to the capacitor during positive half cycles. This gives a strong positive charge on C2, producing a sufficiently large potential to activate the voltage comparator and switch on a transistor at the output of this circuit. If the input signal and CCO are not phased locked, the switch will sometimes conduct while the input is positive going, but it will conduct while the input is negative going as well, and just as often. This gives only a low charge on C2 since the positive and negative input signal tend to cancel out one another. The output transistor of the voltage comparator does not therefore switch on.

This may seem a rather complex way of doing things when compared to a filtering and level detection arrangement, which it is, but the complexity is in the NE567 integrated circuit and only four discrete components are needed (R1 is within the IC), R2 and the three capacitors are discrete components). Also, using conventional filtering it would be difficult to obtain a similar level of performance. This arrangement has good sensitivity to any signal within the locking range of the PLL, but signals outside the locking range cannot activate the circuit. This gives the circuit what is effectively an ideal frequency response for tone decoding applications, and provides virtually complete immunity against spurious operation.

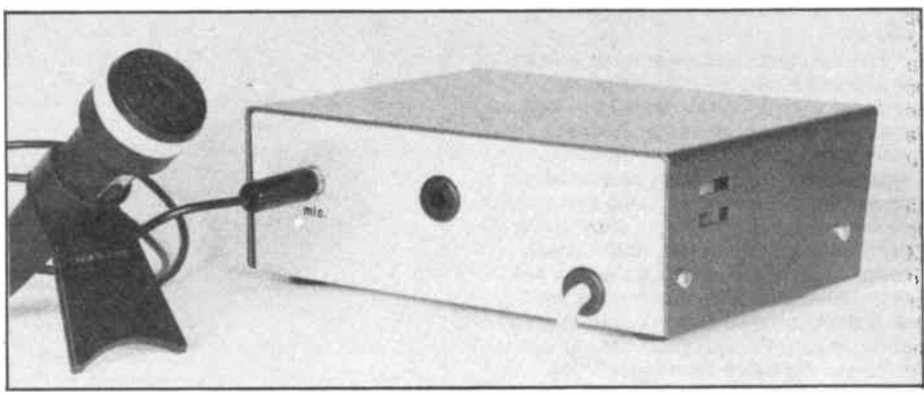
The Circuit

The full circuit diagram of the Whistle Switch appears in **Figure 2**. As the unit will be left running continuously and has a significant current consumption even when the relay is not switched on, it would be impractical to power the unit from batteries, and a simple unregulated mains power supply is therefore used. This uses push-pull fullwave rectification, and smoothing is provided by C1.

The preamplifier stage uses a BIFET operational amplifier, IC5, as a simple inverting amplifier having a voltage gain of nearly 60dB (1000 times). An output level of around 20 millivolts RMS is sufficient to drive the next stage of the circuit, and this obviously gives the unit a high degree of sensitivity. However, the preamplifier is designed for use with a low impedance dynamic (cassette type) microphone and the output level from one of these is usually no more than a few hundred microvolts even if the microphone is in quite close proximity to a loud sound. This high sensitivity is therefore essential in order to give the unit a good maximum operating range.

IC3 is the NE567 PLL tone decoder, and this is powered from the main supply lines via a 5 volt monolithic voltage regulator. This prevents the device from receiving an excessive supply voltage and also helps to avoid problems with the lock frequency range drifting. C5, R7, and RV1 control the centre frequency of the PLL, and using RV1 the centre frequency can be adjusted from about 700HZ to approximately 4kHZ. C8 is the lowpass filter capacitor and C4 is the charge storage capacitor in the output switching section of IC3.

Getting a system of this type to operate reliably is more difficult than it might at first appear, due to the fact that the input signal does not consist of perfectly gated tone bursts, and is likely to be contaminated with a



substantial amount of noise. The NE567 gives excellent noise immunity, and an R-C filter at the output (R6 plus C3) largely overcomes problems with the input signal starting and finishing less than instantly. IC2 is used as a trigger circuit having a substantial amount of hysteresis, and the 4020BE divide by two circuit also has a trigger circuit at its input. A combination of all these measures give the unit excellent reliability.

Q1 is the relay driver and this is fed from the output of the first binary counter stage of IC1 via current limiting resistor R1 (IC1 is a 14 stage binary counter, incidentally). A set of normally closed relay contacts are used to switch the "live" supply lead to the piece of (mains powered) controlled equipment. An on/off switch is included, and this can be used to disconnect both the Whistle Switch and the controlled equipment from both sides of the mains supply.

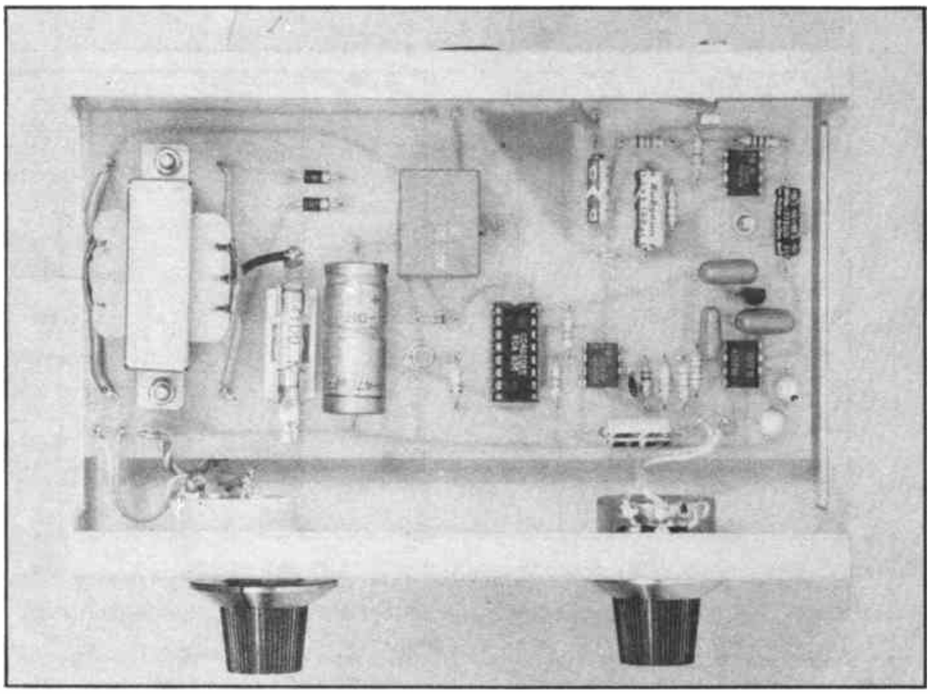
Construction

With the exception only of the controls and input sockets, the components are all mounted on a printed circuit board, as detailed in **Figure 3**. FS1 is mounted in a chassis mounting fuseholder which is bolted to the board. Similarly, T1 is not a printed circuit mounting component and must be bolted in place. It is advisable to use the specified relay since any other type would almost certainly necessitate a drastic redesign of the board before it could be used, and it might even be necessary to mount it off-board. Note that IC1 is a CMOS device and it should therefore be mounted in a (16 pin) DIL IC socket, and it should not be fitted into the socket until all the of the components have been mounted on the board. Handle this device as little as possible.

A case measuring about 150 by 100 by 50mm is suitable, but this represents about the smallest size that is capable of accomodating all the parts. SW1 and RV1 are mounted at opposite ends of the front panel (SW1 on the left — RV1 on the right), while SK1 is fitted at the left hand end of the rear panel (as viewed from the rear). The entrance hole for the mains lead is drilled low down at the opposite end of the rear panel and the exit hole for the mains ouput lead is drilled at roughly the centre of the panel. Both these holes should be fitted with grommets to protect the cables.

The printed circuit board is bolted to the base panel of the case and spacers about 12mm long are used so that the underside of the board is held well away from the metal casing. The final wiring-up is then completed. A short screened lead is used to connect SK1 to the printed circuit board. Be careful not to make an error when connecting the mains lead and SW1, and check this wiring carefully before switching on and testing the finished unit!

A low impedance dynamic



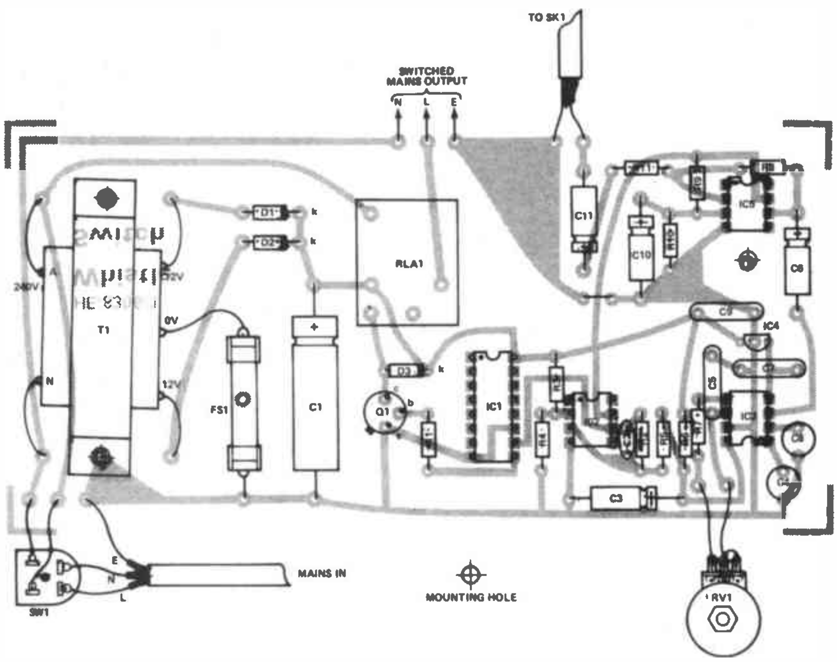


Figure 3. The PCB and components. T1 must be bolted down.

Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1 .... 3k9
R2 .... 150k
R3, 4 .... 4k7
R5 .... 33k
R6 .... 8k2
R7 .... 2k2
R8 .... 1MR
R9, 10 .... 22k
R11 .... 1k2

POTENTIOMETERS
RV1 .... 10k linear carbon

CAPACITORS
(All axial electrolytic except as noted)
C1 .... 470u 25V
C2 .... 33p ceramic plate
C3 .... 33u 16V
C4 .... 10u 25V radial electro
C5, 7, 9 .... 100n polyester
C6 .... 1u 63V
C8 .... 2u2 63V radial electro
C10 .... 100u 10V
C11 .... 2u2 63V

SEMICONDUCTORS
IC1 .... 4020BE 14-stage counter
IC2 .... 741C op-amp
IC3 .... NE567N tone decoder/PLL
IC4 .... 78L05 5V regulator
IC5 .... TL081 BIFET op-amp
Q1 .... BC109 etc.
D1, 2 .... 1N4002 rectifier diodes
D3 .... 1n4148 signal diode

MISCELLANEOUS
T1 .... 12-0-12 100mA secondary
FS1 .... 20mm 100mA quick-blow
SW1 .... two-pole rotary mains switch
RL1 .... 12V/400R coil see Buylines
SK1 .... 3.5mm socket
PCB; case, 150 x 100 x 50mm (see Buylines); 20mm chassis mount fuseholder; 2 x control knobs; 1 x 16-pin DIL socket; 6BA fixings, wire, solder etc.

BUYLINES .... page 34

microphone is connected to SK1 (inexpensive microphones of this type are readily available as replacements for cassette recorders). These often have a remote control switch and a moulded twin 2.5 plus 3.5mm jack plug (the 2.5mm plug connecting to the remote control switch). In this case it will either be necessary to change the plug for an ordinary 3.5mm type, or a "dummy" 2.5mm socket must be fitted at a suitable position on the rear panel.

RV1 can be adjusted to give operation at any practical frequency desired, and the correct setting can be found simply by whistling the desired operating note and adjusting RV1 from maximum to minimum resistance, but stopping when the relay switches on or off (it can assume either state at switch-on). It takes the unit a fraction of a second to operate, and RV1 should therefore be adjusted reasonably slowly so that it is not taken beyond the correct setting before the relay is activated.

The locking range of the phase locked loop is only plus and minus about 7%, and this gives excellent immunity to spurious triggering by general noise and household sounds, but it is also necessary to hit the right note with reasonable accuracy in order to operate the unit. However, this should not be difficult for anyone with a reasonable sense of pitch.

DURRANTS (ELECTRONIC COMPONENTS)
9 ST MARYS STREET, SHREWSBURY, SHROPSHIRE
TELEPHONE 61239

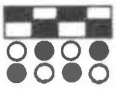
ALL PRICES INCLUDE V.A.T. add 40p P&P

Resistors ¼w 5% c/film all values 1p each (min 10); Resistors ½w 5% c/film all values 2p each (min 10); Capacitors (polyester) .001 MFD to .1 MFD 8p each; Capacitors (ceramic) 1pf to .047 MFD 6p each; Capacitor packs 100 polyester/ceramic £1.50; Resistor Packs 100 ¼/½ c/film 60p; Resistor/Capacitor Packs 100 mixed 90p; Bush Stereo Cassette Panel (new with diagram) £1.00; T.C.E. Stereo Decoder Panel (new) £1.00; Copper Clad Board 6¼" x 5½" 75p; Copper Clad Board 4" x 5½" 39p; Slide Switch D.P.D.T. (min type) 12p each 10 for £1.00; Reed Switch N/o contacts 15p each 10 for £1.20; M.E.S. Lampholders (screw down type) batten 10p each; Relays 24v coil 2 pole c/over 30p each; Holder for above 10p each; Connecting Wire Assorted Colours 50 mtrs 60p; Micro switch 10a contacts, lever type 35p; Micro Switch Burgess (Min Type) 20p; Bridge Rectifier 30v 350ma 25p each 5 for £1.00; Transistors BFR50 — BFY51 15p; ORP12 Light Dependant Resistor £1.20; Cassette Tape Counter Units 45p; Mains Filter 240v 15A £1.50; Terminal Blocks 12 way 25p; Stranded Connecting Wire: orange, brown or black 10 yds 20p; Heat Sink Compound 95p per tube; Soldering Irons 240v 25w £4.99; 100 mfd 63v Radial Capacitors 8p each 10 for 50p; 2.2 MFD 63v Axial Capacitors 5p each 10 for 40p; 100 Assorted Nuts and Bolts (B.A. & Metric) 25p

This is a sample of the many thousands of items in stock
Price lists 15p & 25p P&P

Elen Electronics —— DISCO

Tired of boring 3 & 4 channel lighting controllers. Then try our new 8 CHANNEL PATTERNMAKER for spotlights or lighting screens.



16 different sequential patterns including Catherine Wheel, Screen Writer, Checker & Light Train.

Kit comprices PCB & all components including 2K PROM & Monitor LEDs. Only £27.00 + VAT.

Hardware kit including case, 12 way socket & matching plug, mains lead etc. Only £9.50 + VAT.

Please add 60p P&P to order.

ELEN ELECTRONICS
Unit 9, Telford OP. Centre,
Halesfield 14, Telford, Shropshire
Tel: 0952 585897

Further details on request

LITESOLD

MINIATURE TOOL SETS AT MINIATURE PRICES

Ideal for work on optical and electronic equipment, instruments and models. Japanese made, top quality metric tools in hardened and tempered steel, with fitted plastic cases. Swivel-top, chromium-plated brass handles. Not to be confused with similar cheap non-Japanese sets.

SCREWDRIVER SET 113. 6 plain screwdrivers, blades 0.9, 1.2, 1.8, 2.3, 3.0 and 3.5mm. Price **£2.70.**

SOCKET SET 227. 5 socket spanners, 3.0, 3.5, 4.0, 4.5 and 5.0mm. Price **£2.80.**

CROSSPOINT/HEXAGON SET 305. 2 Japanese crosspoint screwdrivers, sizes 0 and 1. 3 Hex. key wrenches 1.5, 2.0 and 2.5mm. Price **£2.70.**

COMBINATION SET 228. 5 open spanners 4.0, 4.5, 5.0, 5.5 and 6.0mm. 5 socket spanners 3.0, 3.5, 4.0, 4.5 and 5.0mm. 2 crosspoint screwdrivers bit sizes 0 and 1. 3 screwdriver bits 1.5, 2.5 and 3.5mm. 3 Hex. keys 1.5, 2.0 and 2.5mm. 1 scriber. 1 swivel-top driver/holder.
Price **£4.83.** All prices include postage and 15% VAT.

Ring for Access/Barclaycard Sales or send remittance to:

Light Soldering Developments Limited, 97-99 Gloucester Road, Croydon, Surrey CR0 2DN. Tel: 01-689 0574.

Do you think that designing and understanding electronic circuits is beyond you?

We'd like to show you that you're wrong

The summer edition of Electronics Digest, *Gateway To Circuit Design,* provides a step-by-step introduction for the newcomer to the art of circuit design. Firstly, you'll be introduced to the commoner electronic components — but not in a passive way. Electronics is a practical subject, so *Gateway To Circuit Design* will enable you to build simple circuits for yourself, and take measurements on them (along the way learning how to use a multimeter). Once these introductions are over, *Gateway To Circuit Design* shows you what goes into the design of a wide range of electronic equipment — for audio, computing and electronic music, for instance.

Gateway To Electronics is an occasional popular series in Electronics Digest, published by Argus Specialist Publications. Previous issues in the series have concentrated on projects; now we'd like you to design your own!

At all good newsagents now or available by post from Electronics Digest, 513 London Road, Thornton Heath, Surrey.

£1.85

CLEVER DICK

Poor CD's in trouble, his brain all befuddled, Put him out of his muddle, by solving this puzzle.

Now here's a challenge for all crossword and puzzle fanatics. Let's have your answers then! All genuine and logical replies will be placed in a box and an answer selected by the fair hand of HE's editorial assistant. The reward? Oh, a binder . . . of course! The competition closes with the last entries received at the HE editorial office on 30th July 1983, and if no reasonable solution is submitted, the binder goes to the author, by default.

O Clever Dick!
My first belongs to us all, slave or free
My second concludes what is to be.
My third is initially placed by you second.
My fourth of all men is the end.
With my fifth may the answer be seen,
While my sixth lives and dies for its queen.
Solve this riddle and justice be done,
For my whole must be backed to be won.
Guy Inchbald,
Manchester.

PS Now at the last one further surprise:
I have no desire for your glittering prize!
A Spectrum cassette of the Hobbit would do,
But I doubt such a reward may be granted by you.

As for the Hobbit, you'd be amazed what the Wee Folk of the HE office can get up to. They'll be in touch.

Meanwhile, some people have strange ideas about what's witty and what's not . . .

Dear CD,
You wrote in the February issue of HE that you would award a Binder to the writer of the most witty letter: well, try this one.
I don't normally buy anything at Tandy (£1.19 for a 4011 IC is bad news), but I needed a piece of Vero-board like yesterday, so I risked it.
I went to the counter and asked if they had any Veroboard: "What board?" the man said, "I don't understand". So I pointed to a piece of perforated board and said "Like that but with copper strips across it". "Oh", he said, "If you can't see any we don't have any".
Tandy? Who needs them?
M. Bronze,
Corringham,
Essex.

OK. I tried it, but I don't see what's so funny. I can't believe you left the store in fits of laughter . . . did you? Prices like that are no joke!

It's not true, by the way, that I complain about hand-written letters. Of course I sometimes have to guess at words, which can be awkward!

Dear Clever Dick,
I think that it is appalling that a Hobby Electronics Binder costs £4.95. I'd rather the spend the money on components and I'm probably not the only one! (Hint, hint).
PS I'm only 13.
PPS Sorry about the spelling.
M. Myers,
Cheltenham,
Glos.
PPPS ACE mag.
PPPPS Please print this.

A request I cannot refuse (to print the letter that is — free binders are another matter entirely).
I agree that £4.95 is a lot of money, but if you only knew what it costs to produce them, the time and effort, the painstaking craftsmanship . . . oh alright, you win, you can have one. But if it doesn't arrive you can blame it on your handwriting!

Dear CD,
I have just made the Stall Thief project (May issue) but don't know how to connect it to the points in the car, which is a Renault 4. I have tried a few likely spots, with the engine running, on the outside of the distributor but only saw sparks and received a healthy shock. Please explain how and where they are connected.
Yours etc,
SC,
Hampstead.

First of all, I can't imagine why you bought a Renault — don't you know it's French? — and second, I find it difficult to believe that anyone would actually want to steal one. As for your problem (the Stall Thief, not the car) Figure 2 in the article shows that the device is connected across the distributor contact breaker. Not being a French Mechanic I can't do better than that. And since you regard a jolt from the ignition system as "healthy" you may as well continue to experiment with the engine running.
Personally, I prefer jogging.

In a recent issue, I referred a reader to HE's Book Service but apparently forgot to mention the price.

Dear Sirs,
In the May 1983 issue of Hobby Electronics magazine, in the Clever Dick feature, you make reference to a book on Long Distance Television Reception. Unfortunately no price was quoted.
I am interested in receiving two (2) copies of this book. Please advise price and delivery charge.
The most convenient way for me to make payment is by certified cheque in pesetas. I trust this is acceptable.
S. L. Watkins,
Malaga,
Spain.

Hmmmm. Long Distance Magazine Reception, eh? Not bad, not bad. My apologies to Mr. Watkins; the price is £1.95, and the order should refer to publication BP52. You should add £1 to the post and packaging charge and, if possible, make out the cheque in pounds, not pesetas.
As ever, I'm happy to try and answer any reasonable enquiry . . . but some questions simply leave me feeling blanque.

Dear Mr. Dicks,
I have only been interested in electronics for two months, now, so all this grovelling is quite new to me. Why do they do it? I would be inclined to send a cheque for £5 and ask for a binder.
P. Roberts,
Yeovil,
Somerset.
PS HE is the best mag out (I've only just realised what HE stands for).
PPS What are those cute cuddly looking balls that sometimes appear in your pages?

I'm inclined to agree — especially since my binders are being purveyed to the public (that's you) for only £4.25, including postage and packaging! I'll leave it to another reader to try to describe our 'Beastie' cartoon characters; words fail me! **HE**

Extending the ACE

HE's Input/Output board supplies the extra RAM the ACE needs to control HEBOT or similiar useful devices.

Mike Lord

If you are the proud owner of a Jupiter ACE then you will know that although it has 3K bytes of RAM fitted most of this is taken up by the screen and character set areas, leaving not a lot for your 'programs'. And you will probably know that FORTH was originally developed for control applications — like steering a telescope or guiding a robot — and may be interested in experimenting along these lines.

This project has been developed to help in both of these areas; by giving you an additional 2 or 4 bytes of RAM space, plus 8-bit input and output ports to control devices such as the HEBOT computer controlled robot.

Everything is on one printed circuit board which plugs onto the ACE's rear bus connector. If you don't want the I/O ports, then you can just build the RAM extension, or you could even leave out the RAM parts for the time being and just make the I/O ports.

The Credit

Figure 1 gives the complete circuit diagram of the add-on board. Looking at the RAM part first, this is provided by ICs 1, 2 and 3, ICs 1 and 2 are 6116 2K bytes CMOS static RAM chips, chosen because they are very easy to use — having no particular vices — and take very little power. These chips deal with a complete 8-bit byte at a time, the data being transferred into or out of the IC on the ACE's data bus lines D0-D7. Since each IC holds 2K (2048) bytes, eleven address inputs are needed to select a particular byte, and these come from the ACE's address bus lines A0-A10. To read data out of the chip, or to write new data in a 'low' pulse must be applied to the 'Output Enable' or 'Write Enable' inputs; these pulses are easily obtained from the ACE's

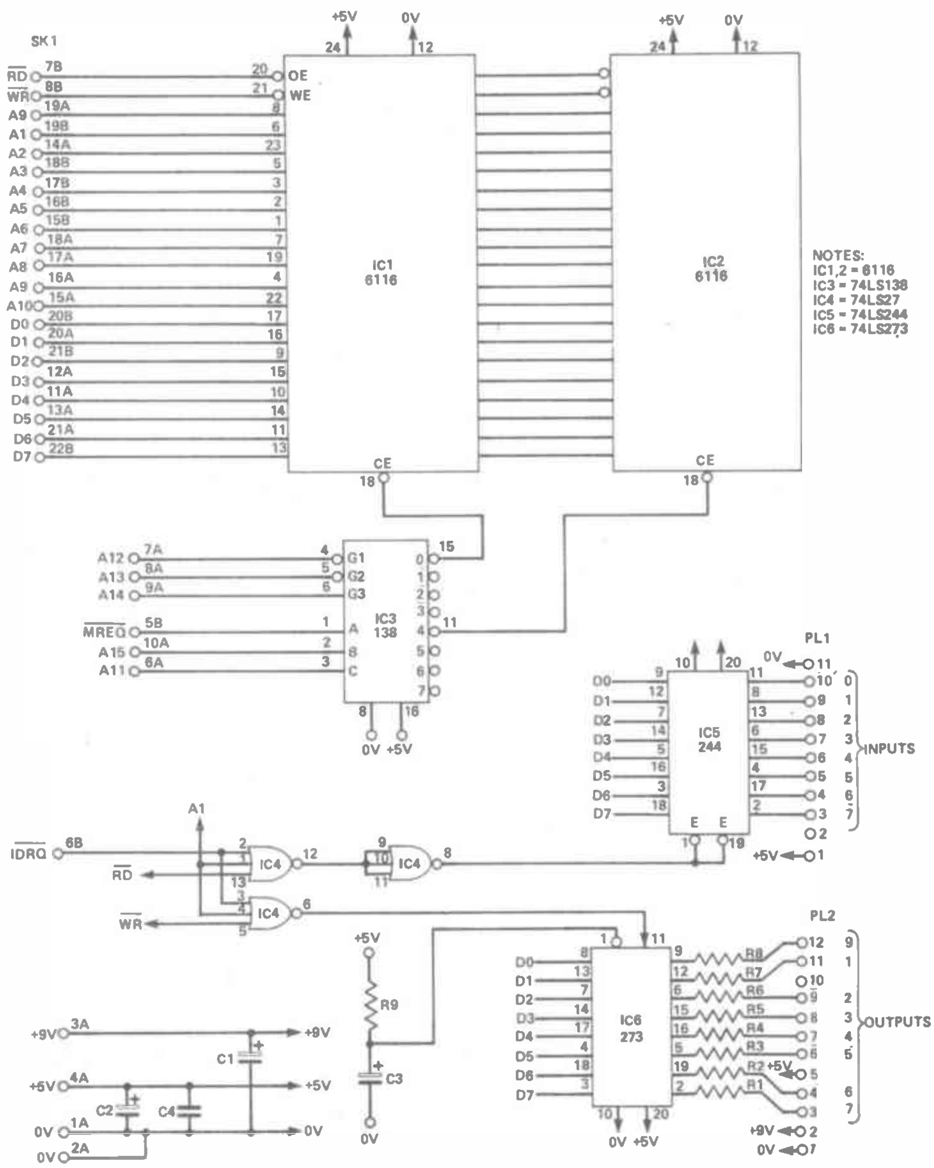


Figure 1. The complete circuit.

bus $\overline{RD}$ and $\overline{WR}$ lines. The other connections to the RAM chips are the OV and +5V supplies, and the $\overline{CE}$ (Chip Enable) input on pin 18, which must be low when data is being written to or read from the IC.

The $\overline{CE}$ inputs to the two RAM chips are provided by IC3, which ensures that ICs 1 and 2 are only enabled when the ACE wants to access memory at the appropriate addresses. IC3 is a 'one out of eight decoder' having eight outputs which normally give out a 'high' logic level. When the chip is enabled by low level signals on its G1 and G2 inputs and high level signal on its G3 input, then one of the eight outputs will go to a low level, which output depending on the signal applied to the chip's A, B & C select inputs.

These A, B, C and G inputs are connected to the five most significant address lines from the ACE and to the $\overline{MREQ}$ line, which goes low when the ACE wants to read from or write to a memory location (as opposed to an I/O location). The way they are connected results in IC1 being enabled whenever the address is in the range 4000-47FF (hex) and IC2 being enabled when the address is in the range 4800-4FFF. These addresses follow immediately after the addresses used by the RAM in the ACE itself, so that the new memory adds directly onto the existing directory and stack area.

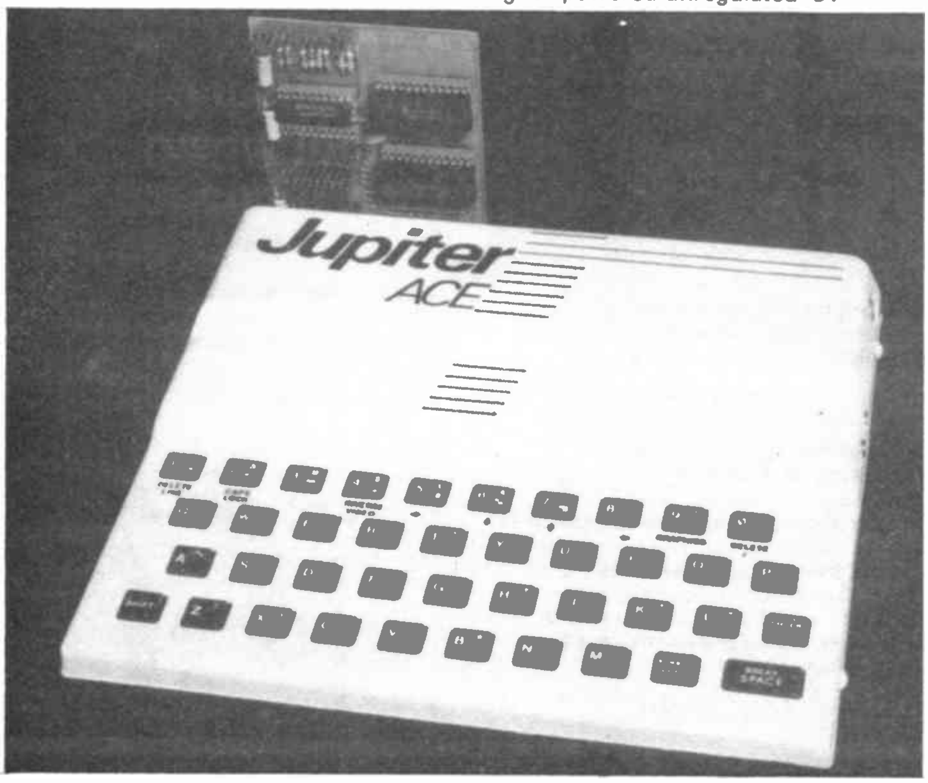
The I/O ports are provided by ICs 4, 5 and 6. IC5 is a simple 8-bit tri-state buffer which, whenever it is enabled by a low level signal on pins 1 and 19, transfers whatever signals are present on PL1 directly to the system data bus lines D0-D7. At other times the outputs of IC5 are in a high impedance state, so as to not affect the data bus.

IC6 is an 8-bit latch which, when clocked by a pulse on pin 11, grabs whatever information is on the data bus lines at that time and holds it until the next time it is clocked. The eight outputs are fed though the protective resistors R1-R8 to the board output plug PL2. These resistors have been put in to prevent damage to IC6, in case any of the board outputs are accidentally connected together or to +5V, but they do limit the available output signals and so their values should really be chosen to give as much protection as possible depending on exactly what the board is driving. If it is driving TTL loads, then R1-R8 should be between 100 to 330 ohms each, but higher values (around 1kR) can be used when the board is driving light loads such as those presented by the HEBOT control circuitry.

R9 and C3 reset IC6 so that all of its outputs are at low level when power is switched on.

IC4 is a triple 'positive NOR' gate which is used here to provide the enable and clock pulses to ICs 5 and 6. It gives a low level 'enable' pulse to IC5 whenever the ACE reads from an I/O location with address line A1 to '0', and gives a clock pulse to IC6 whenever the ACE writes to an I/O location with address line A1 at '0'.

The I/O connectors PL1 and 2 carry +5V as well as the input/output signals; this comes from the regulator inside the ACE and not more than about 100mA should be drawn. PL2 carries the +9V unstabilised line from the ACE's mains adaptor; again, not more than about 100mA should be drawn. If you look at **Figure 2**, you will see that the two holes on the board are labelled 'OV' and '+9V'. These let you connect an external higher-powered unregulated '9V' supply if the devices you are controlling need more power than can be provided by the ACE's mains adaptor, but note that if you do connect such an external supply then it will also be powering the ACE, and so *the ACE's own mains adaptor should not then be connected.*



Parts List

RESISTORS
(All ¼ watt 5% carbon)

R1-8	1kR (see text)	
R9	4k7	

CAPACITOR

C1, 2, 3	4u7 25V radial electro	
C4	100n ceramic	

SEMICONDUCTORS

IC1, 2	6116 2K static RAM	
IC3	74LS138 1-of-8 decoder	
IC4	74LS27 triple 3-input NOR	
IC5	75LS244 octal tri-state buffer	
IC6	74LS273 octal latch	

MISCELLANEOUS

SK1	edge connector see Buylines	
PL1, 2	12-way PCB plugs see Buylines	

1 x 14-way, 1 x 16 way, 2 x 20 way, 2 x 24 way IC sockets; PCB; wire, sleeving, solder etc.

BUYLINES .... **page 34**

Construction

The component layout is shown in **Figure 2**. A single sided printed circuit board has been used to keep the cost of the project down, but this has meant that 14 wire links have to be added, as shown, to complete all of the connections. These should be sleeved where there is a danger of accidental short circuits.

After fitting the links, the resistors R1-R9 should be soldered in place, followed by the IC sockets and then the capacitors. Note that the sockets used for ICs 3 and 4 *must* be low profile types.

The input and output connectors, PL1 and PL2, should be fitted so that their plastic mouldings are on the component side of the board with the short ends of the pins going though the board to be soldered on the track side. Two pins will have to be removed from PL1 and one from PL2, as only 10 and 11 holes respectively have been drilled in the board. The missing pins provide a polarising facility to reduce the chance of putting the mating sockets on wrongly.

The sockets to be used with the input/output plugs are purchased as empty 'shells', with loose contacts which are soldered onto the connecting wires then pushed into the shell so that they latch home.

SK1 is a 25+25 way, 0.1in pitch double sided edge connector with wire-wrap pins. If you can't get exactly the right type then buy a longer one and cut it down to the correct length. The pins should be removed from the third position from one end and a polarising key fitted in their place (if you can't find a suitable key in the shops, then one can easily be cut from a piece of thick plastic). This polarising key is most important, as it is the only thing that will prevent you from plugging the board in wrongly, with possibly disasterous consequences. SK1 should be fitted so that it is square onto the PCB, and spaced so that the body of the connector is about ¼in from the PCB. PCB.

If you want to build up the RAM part of the board then ICs 4, 5, 6 and R1-9 and also C1 & C3 and PL1, 2 need not be fitted. If you are starting small, then IC2 can be left out, resulting in only 2K extra bytes of RAM. On the other hand, if you are are only interested in the I/O circuits then leave out ICs 1, 2 & 3.

Testing It

Before plugging the board into the ACE, check it very carefully to make sure that the right components have been fitted the right way round and — most important — that solder splashes or excess solder on joints have not caused any short circuits between adjacent tracks. The areas that this type of fault is most likely to have occurred are where tracks pass between the pins of ICs 1, 2, 5 & 6.

Once you are certain that it won't damage anything, you can then try the ACE with the new board plugged in. Remember to switch off the power before plugging anything in or out! It should behave exactly as before except that if you had added RAM then entering:

```
15384 @
```

should print 18432, if you have added 2K, or 20480 if you have added 4K bytes, and you will now be able to enter much longer dictionaries.

If you have equipped the board with the I/O circuits then you can test these with a voltmeter and a wire link. First, check that the outputs on pins 3, 4, 6-11 of PL2 are all at less than 0V4. Then set them all to the high level by:

```
255 253 OUT
```

and they should then be between 3 and 5 volts. To check the input circuits, use:

```
253 IN
```

which will print 255 if all of the inputs on pins 3-10 of PL1 are open, and lesser values if any or all of these pins are connected to 0V.

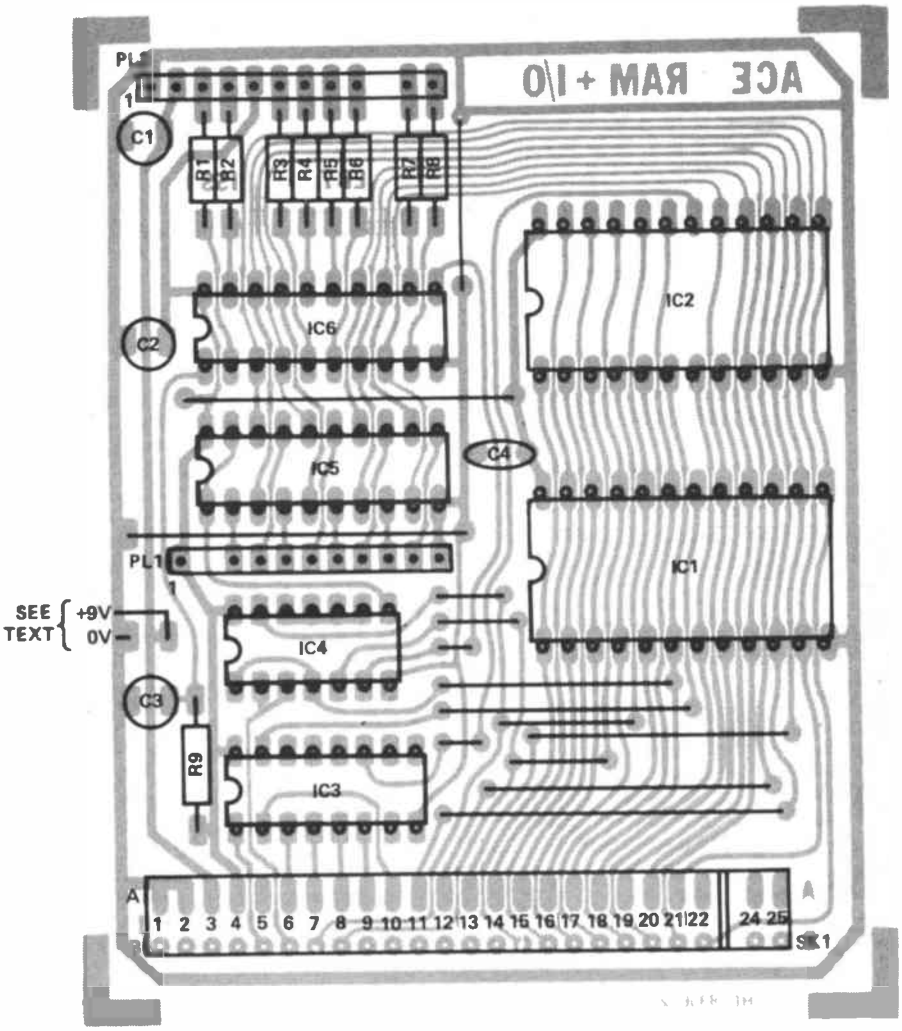


Figure 2. The PCB and components. Wire links are used to keep the board one-sided.

Using The I/O

Both the input and the output ports are at I/O address 253 (actually they will appear at many addresses because only address line A1 is looked at, but 253 is a convenient value to remember) and are accessed by using the ACE FORTH words IN and OUT. For example,

```
253 IN
```

will put on the stack a value corresponding to the logic levels on the eight input pins, while

```
253 OUT
```

will set the eight output pins according to the value on the top of the stack.

Both the input and the output are 8-bit binary values which you can translate to and from decimal with the aid of **Table 1**, so that — for example — to set bits 1 and 3 of the output port to the 'high' level (1) and the rest to 'low' (0) you could use:

```
10 253 OUT
```

It is worth noting that FORTH's OR word works on a bit by bit basis, so that we could have set output bits 1 and 3 to '1' by:

```
2 8 OR 253 OUT
```

And so does the AND word, which is very convenient when we want to examine the state of a particular input line;

```
253 IN 8 AND
```

leaves a value onto the stack which is zero only when input bit 3 is zero (bit 3 corresponding to decimal value 8).

TABLE 1

I/O Bit	Decimal Value
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128

Table 2

PL1		PL2	
1	+5V	1	0V
2	***	2	+9V
3	IP 7	3	OP 7
4	IP6	4	OP 6
5	IP 5	5	+5V
6	IP 4	6	OP 5
7	IP 3	7	OP 4
8	IP 2	8	OP 3
9	IP 1	9	OP 2
10	IP 0	10	***
11	OV	11	OP 1
12	***	12	OP 0

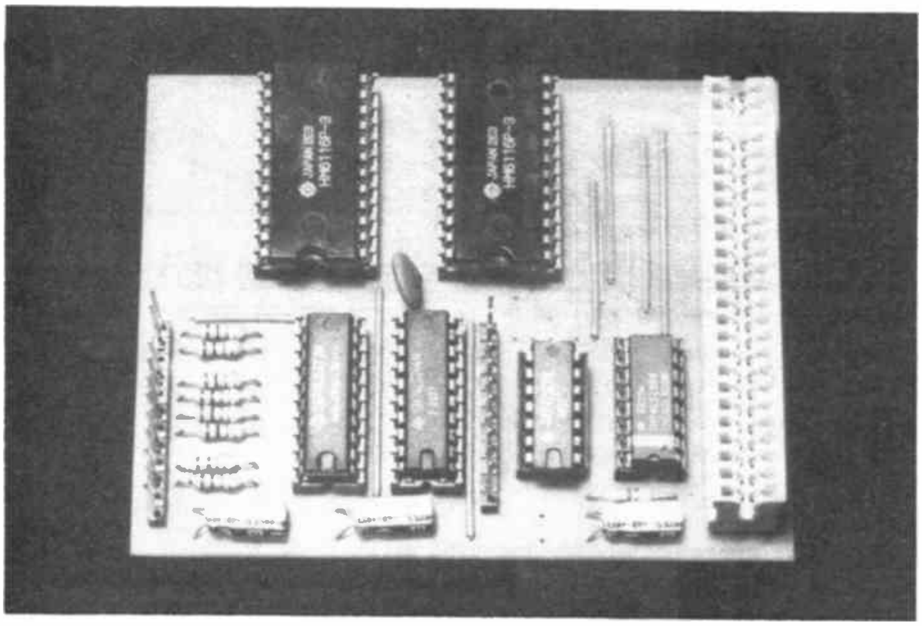
*** = pin removed for polarising

Table 3

HEBOT PCB	ACE I/O BOARD
RM1	PL2-11
RM2	PL2-10
RT	PL1-9
FT	PL1-8
LT	PL1-10
BT	PL1-7
P	PL2-6
OV	PL2-1
OV	PL1-11
+10V	PL2-2
H	PL2-4
T	PL2-3
LM2	PL2-8
LM1	PL2-9
L	PL2-7

Table 4

OUTPUT VALUE	CONTROL FUNCTION
0	HEBOT stopped, lights & beeper off.
5	Move forward.
6	Turn clockwise.
9	Turn anti-clockwise.
10	Move backwards.
16	Lamps on.
32	Pen solenoid on.
64	Low frequency beep.
192	High frequency beep.



Driving HEBOT

HEBOT (HE's computer controlled robot project published in the November 1982 issue) is an ideal vehicle for experimenting with the use of FORTH as a control language, using the input/output capabilities of this board.

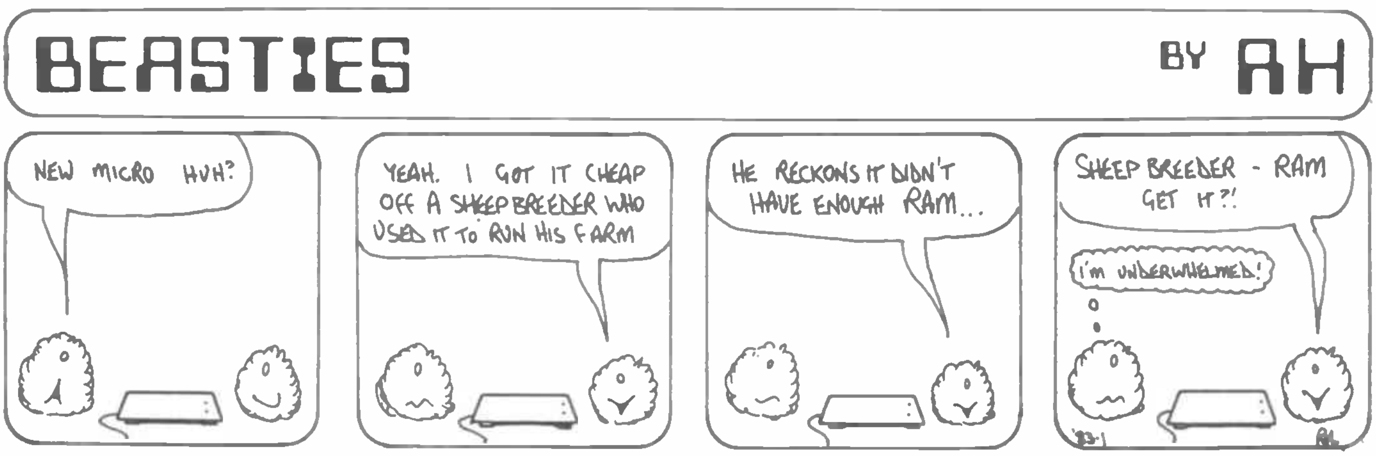
Eight output lines are needed to control the motors, speakers, lights and pen of HEBOT, and four input lines are used to monitor the touch sensors. These can be connected to PL1 and 2 as shown in **Table 2.** The ACE's mains adaptor will give just about enough power to drive HEBOT, as well as the ACE, as long as you don't want to operate the pen solenoid and avoid switching instantaneously from full forward to full reverse. If you want to operate the pen or thrash about at high speed then a more powerful supply should be connected as described earlier.

Table 3 shows the decimal values to be output to get HEBOT to perform as discussed earlier these can be combined by adding the values or by making use of the OR word. **Program 1** gives a simple program to make HEBOT move, beep and flash using keys W, E, S and 3 to control direction L to light the lamps and B OR H to beep. Pressing key Q will turn off HEBOT and end the program.

Program 1

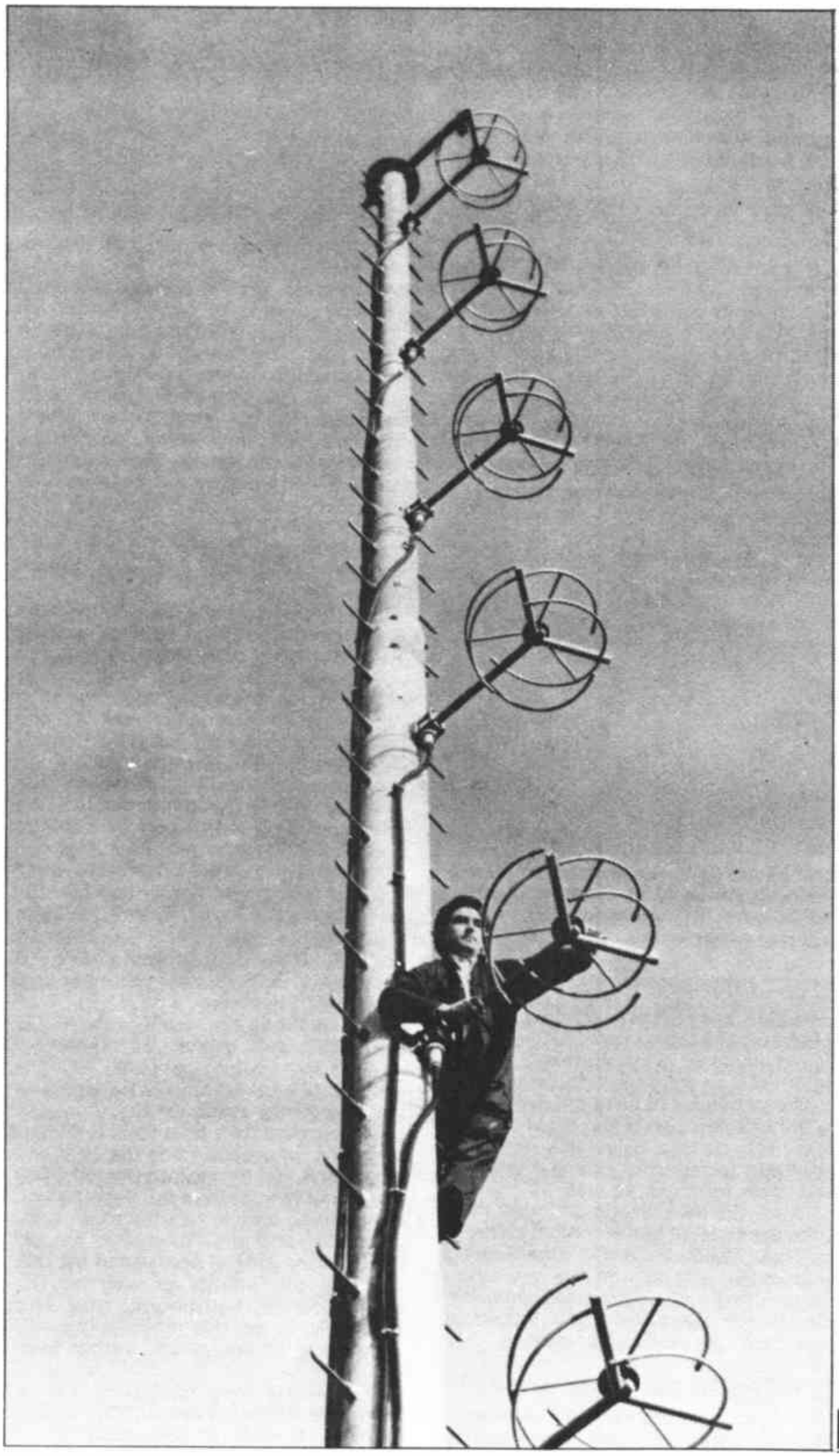
```
: MATCH 3 PICK = IF
  ROT DROP SWAP
  ELSE DROP
  THEN;

: GO BEGIN
  0 INKEY
  6 ASCII E MATCH
  9 ASCII W MATCH
  10 ASCII S MATCH
  5 ASCII 3 MATCH
  16 ASCII L MATCH
  64 ASCII B MATCH
  192 ASCII H MATCH
 SWAP 253 OUT
  ASCII 0 =
  UNTIL ;
```



CAREERS IN ELECTRONICS '83

Steady nerves, high standards of engineering achievement and no illusions about glamour are the basic requirements for getting into the broadcasting business.



Helen Armstrong

MANY CAREERS in electronics make highly specialised, even rarified, demands on the engineer, enabling him or her to work safely within a narrow field. In the world of broadcasting, this is far less likely to be true. Broadcasting is one of the most competitive of all industries. On the one hand, it feeds the constant public demand for new ideas and entertainment, calling for continual experimentation, even innovation, with new effects and equipment and, on the other hand, the media is enormously self-publicising by its very existence, attracting talent from many fields from all over the country. So competition to get in is fierce. To compensate for this possibly discouraging picture, broadcasting companies are less likely to be looking for the brilliant theoretician who cannot wire up a plug, and more likely to take the self-motivated enthusiast with reasonable qualifications and a proven personal interest in a relevant activity: amateur radio, sound recording or film-making, to take some obvious examples. The vivid — and possibly apocryphal — description of the ideal trainee engineer: "A third class degree who can get an outside broadcast truck out of a bog" may not tell the whole story, but it illustrates the kind of practical problem which a broadcast engineer may be faced with.

With the expansion of the telecommunications industry during the past decade, the need for a supply of able engineers and technicians has grown in fits and starts. The arrival of the video boom and new television companies like Channel 4 is currently opening up, by direct and indirect means, more opportunities in broadcasting in general than for some time, providing some of the most varied careers in engineering.

IBA And BBC

There are, as you might expect, a number of categories of technician and engineer employed in the industry. The two big transmitting organisations in the UK, the BBC (British Broadcasting Corporation) and the IBA (Independent Broadcasting Authority) have very similiar structures where engineers are concerned, except that with the BBC the studio and transmitter operations are contained in the same organisation, whereas with independent TV and radio, the IBA operates the transmission networks, while various private companies operate the studios.

In this month's issue, we are going to by-pass the studio side — which would partially tend to attract engineers perhaps with more creative yearnings, who want to work with cameras, sound and video equipment — and look at the engineering jobs on the transmission networks in the two broadcasting companies.

It is worth noting that the IBA, having a smaller number of jobs on offer, advertises its posts less widely than the BBC. While the BBC may advertise in specialist magazines, and also (naturally) in The Listener, as well as advertising for trainees through college and local authority careers offices, the IBA restricts its advertising, which therefore reaches the press more rarely.

Taking test measurements on a transmitter during on-the-job training.

Part of the IBA's Harman Engineering Training College, in Seaton, Devon, the centre of operations for their training programme.

In both cases however, if you know what sort of a job you are looking for, or would like to train for, and what kind of qualifications you have or hope to have, it can be helpful to send an application to the relevant part of the organisation. Don't rely on this, however — keep an eye open for specific jobs and courses and apply for these as well.

When the IBA needs trainees they circulate schools and technical colleges on the "Milk Round", interviewing prospective candidates on the spot. When they do advertise, amateur electronics magazines and the local press are two media they choose.

Getting In Training

The BBC puts its trainee engineers through a course which starts with a twelve week stint at their Engineering Training Centre at Wood Norton in Worcestershire and then continues on the job, depending on their specialisation. Training includes further stints at the training centre and, particularly in transmitter work, trainees will be moved round the country to some extent. Their specialist training for engineers is registered with the IEE and counts towards the qualification of Chartered Engineer and membership of the IEE. Trainees work towards attaining Engineer status within three years.

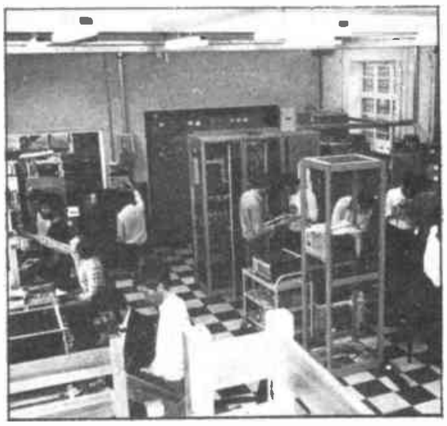
The IBA recruits one group of trainees every year, and to fill jobs as needed. Their training programme begins in June and takes in four stages over eighteen months. This begins with a nine-week induction course at the Harman Engineering Training College in Devon, and concentrates on broadcast engineering, especially the systems used by Independent television and radio. This is followed by a stay at one of their transmitting stations, and after that a full-time two-term polytechnic course. The last six months concentrates on Transmission Technology, again at the Harman college. The course concludes, if successful, with your appointment as a Broadcast Engineer.

Non-qualified engineers beginning at the BBC are known as Technical Assistants. Young people — this effectively includes anyone from college leaver age up to about thirty — can begin a career as a broadcast engineer by acting as assistants to the qualified engineers, and training on the job. They work chiefly at setting up, aligning and maintaining broadcast equipment, both in London and at various sites around the country. This of course can include work in the studio as well as the transmission equipment, but the emphasis is on the maintaining and developing of equipment, rather than operating it.

The basic requirements for a Technical Assistant are GCE 'O' levels, grade A, B or C, or CSE grade 1s, in English, Maths and Physics, as well as "A" level study (or the equivalent) in Maths and Physics. English, plus a TEC Certificate or Diploma, or a City and Guilds Part 1 in Telecommunications, or an ONC/OND in Electrical or Electronic Engineering can be considered. As well as this, a keen amateur interest in and knowledge of an electronic-based subject is effectively vital. The minimum age for appointment is 18, and normal hearing and colour vision are essential. For the Transmitter Department, especially, a driving license is an asset.

Qualified Opportunities

The BBC also takes on qualified engineers for a wide range of jobs. Transmitter Engineers are needed for the maintenance and operation of complete transmission stations around the country, including SHF link equipment, receivers, RF standards converters, stereo encoders, digital equipment for synchonisations and pulse code modulation signals, low and high voltage switching gear, generators, aerials, cooling systems, test equipment and the transmitters



An important factor in all broadcast work is learning to work as a team, as well as using individual initiative.

Constant monitoring of signals is the basis of transmission work.

themselves. There are opportunities to work on both analogue and digital, valve and transistor equipment. The work is usually based at transmitting stations often in isolated areas around the country and needs a fair amount of mobility from day to day.

There is a Research Department where new techniques and systems are developed for use by the whole organisation. The Radio Frequency Group deals with the business of transmitting from the stations to hcme receivers. The Transmission Group deals with long-distance transmission and signal coding of all sorts. In the Design Department the Transmission Group designs new equipment for transmitting, monitoring and controlling, and the Transmitter Capital Projects Department commissions and sets up new transmission links.

Communications engineers based in London or other main regional centres maintain the radio and TV links between studio and transmitters, and also international links, including satellite links at short notice — very demanding work.

As a qualified engineer, you will need to have at least a degree, an HND or HNC in electronics or electrical engineering, or physics or a City and Guilds Full Tech Certificate in Telecommunications or a TEC Higher Certificate or Diploma in Electronics or Telecommunications. For work on R&D or Capital Projects a first or good second class degree is needed.

One field of transmission engineering is experimental work with satellite transmissions. This is an outside broadcast transmitter/receiver.

An Expanding Business

The IBA's requirements for both trainees and engineers are very similar. They specify City and Guilds Full Tech, HNC or HTC or CNAA degree in Electrical or Electronic engineering as basic qualifications for trainee Broadcast Engineers, and recruit qualified engineers on an ad hoc basis.

Broadcast Engineers operate and maintain the IBA's 750-and-growing transmission stations; some are based at their four Regional Operations Centres, and are concerned with monitoring and operating transmission. The majority of Broadcast Engineers are based at one of the twenty-two maintenance bases and work as part of a Mobile Maintenance Team, visiting transmitters within a certain range. As well as signal measuring, repairs, maintenance and trouble-shooting, Broadcast Engineers are involved in setting up new transmitters at the rate of about one a week, countrywide; and the expansions brought about by Channel 4 and increasing local radio stations are both widening the scope of the services provided and bringing in new engineering techniques.

The central planning and control centre is at the Engineering Headquarters, Crawley Court, Winchester, where there are also sections dealing with new developments and experimental electronics, including digital work.

Getting In Touch

If you are interested in a career in broadcasting, then the first step is to write to the Personnel Officer of the organisation (or organisations!) that you would like to work for, stating your qualifications (or potential qualifications, if studying) and interests. The demand for engineers of the right calibre is high at the moment, and likely to remain so for a long while, so now is a good time to be planning towards a broadcasting career. All the broadcast companies, both those we have looked at here, and the television companies and independent video companies, can afford to choose candidates of the highest calibre and posts are usually filled by people holding more then the basic qualifications are kept to a level which any bright student of engineering can fulfil, to encourage enthusiastic people to apply, since the broadcasting organisations are looking for the right people, rather than for a sheaf of paper qualifications.

Both the BBC and the IBA produce booklets laying out the requirements — and rewards — for engineers which you should look at before making a speculative application, or if planning a course of study. The two addresses you need to know are:

Inside IBA's Television Transmission Laboratory, students learn how to operate equipment used at the transmitting stations.

The Personnel Officer,
The IBA,
Crawley Court,
Winchester,
Hants.

The Engineering Recruitment Officer,
BBC,
Broadcasting House,
London W1A 1AA

You can also look in the engineering and audio press, and consult your college careers office and local Education Authority careers office, where vacancies will be on file.

Our thanks to the BBC, IBA and Central London Careers Office for assistance with this feature. Pictures reproduced by kind permission of the BBC and IBA.

HE

VIDEO GAMES

ACCESS Atari
Aerial Splitter
Joysticks
Keyboards
Mains Adaptor
Paddles

ACCESS 3rd P
Extn Lead
Joysticks
Le Stick
Pointmaster
Quick Shot
Redball
Starfighter
Straight Stick
Trackball
Trigo Commd
Vid Command
Wicos
Zircon

ACCESS Misc
Video Storage
Units

ACTIVISION
Barnstorming
Boxing
Bridge
Chopper Cmd
Dolphin
Dragster
Enduro
Fishing Drby
Freeway
Grand Prix
Ice Hockey
Kaboom
Keystn Capers
Laser Blast
Megamania
Oink
Pitfall
Plaque Attack
River Raid
Robotank
Seaquest
Skiing
Sky Jinks
Spider Fighter
Stampede
Starmaster
Tennis

APOLLO
Lost Luggage
Racquetball
Shark Attack
Skeet Shoot
Space Cavern
Space Chase

ATARI
3-D tic tac toe
Adventure
Air/Sea Battle
Asteroids
Backgammon
Basic Math
Basic Progrm
Basketball
Basketball (r/s)
Berzerk
Bowling
Brain Games
Breakout
Casino
Centipede
Checkers
Chess
Circus
Codebreaker
Combat
Concentration
Defender
Demons/Diams
Dig Dug
Dodge'em
E.T.
Football/sccr
Fun with Nos
Galaxian
Golf
Gravitar
Hangman
Haunted Hse
Human Cann
Hunt & Score
Indy 500
Jungle Hunt
Kangaroo
Krull
Math G Prix
Maze Craze
Min Golf
Missile Cmnd
Ms Pac-Man
Night Driver
Olympics
Othello
Outlaw
Pac-Man
Phoenix
Pinball
Pole Postn
Raiders of L/A
Sky Diver
Slot Racers
Soccer
Space Invaders
Space War
Star Raiders
Street Racer
Superman

ATARI

ATARI VCS (2600) – THE NO 1 BRAND LEADER IN THE U.K.

ATARI: The Atari Video Computer System known as the Atari VCS or the 2600 has now become the T.V. game brand leader. In the U.K. there are over 700,000 owners of the VCS with access to a range of over 200 different plug in cartridges, each having a multitude of different variations and difficulty levels. Every system comes complete with the main console, two individual joystick controllers, a pair of paddle controllers, aerial splitter, mains adaptor and a 27 game Combat cartridge. It gives you bright crisp graphics, realistic sound effects and even specially designed circuits for the protection of your Television Set.

SECONDHAND GAMES: We currently have several secondhand Atari VCS units in stock which we are selling for only £49 (inc VAT). This price includes the Console, with Combat Cartridge and all the accessories, as well as a 12 month guarantee. We also have stocks of several secondhand cartridges many at half price (all with 12 months guarantee). We will normally buy back secondhand units and cartridges at one third of our standard price.

£49

EXTENSIVE CARTRIDGE RANGE: The Atari VCS is so popular that in addition to Atari's own cartridges, there are over 150 compatible cartridges, produced by at least a dozen different third party manufacturers. Silica Shop has one of the largest cartridge selections available in the U.K. Our range of over 200 titles (printed either side of this column), includes items in stock now, as well as many of the new releases for later in 1983.

SILICA ATARI CLUB: Silica Shop has over 20,000 Atari VCS club members registered on our computer. As a specialist company we are able to obtain advance information about new developments and send detailed catalogues to all of our club members, enabling them to evaluate new products before they buy. This is a totally FREE service, to receive your copies complete the coupon below.

SERVICE CENTRE: Atari International (UK) Inc has recently appointed Silica Shop as an authorised Atari Service Centre. This means that we can now service your Atari VCS or 400/800 (under guarantee if applicable), whether or not you purchased it from us.

VCS COMPUTER KEYBOARD: A keyboard will soon be launched to convert the VCS into a fully programmable home computer. For further details, join our club by completing the coupon below. We will then let you know when further information is available.

STARPATH SUPERCHARGER: The supercharger plugs into the cartridge socket of your VCS and expands its RAM almost 50 fold, from 128 to 6,272 bytes. This increased memory adds vivid high resolution graphics capabilities and significantly lengthens the game playing time. Supercharger has a range of multi-load games (at £19.45 each), these offer the facility to play a game in several distinct parts (great for adventures), the next section being loaded when you have completed the previous one, thus enhancing the game play. For further information please complete the coupon below.

£79

ATARI VCS CONSOLE- With Combat Cart & Accessories £68.70+VAT = £79.00

ATARI/Contd
Super Brkout
Surround
Swordquest E
Swordquest F
Tennis (rlept)
Vanguard
Volleyball (r/s)
Warlords
Yars Revenge

BOMB
Assault
Great Escape
Splendour
Wall Defender
Z-Tack

CBS (Coleco)
Blue Print
Carnival
Donkey Kong
Gorf
Mousetrap
Smurf
Solar Fox
Turbo
Venture
Wings
Wizard of Wor
Zaxxon

IMAGIC
Atlantis
Cosmic Ark
Demon Attack
Dem. Attack II
Dragonfire
Fire Fighter
No Escape
Riddle of Spx
Scuba
Starstorm
Star Voyager
Trick Shot
Zone

M-NETWORK
Advs of Tron
Air raiders
Burger Time
Comp Revenge
Frogs & Flies
Intnl Soccer
Lock 'n' Chase
Space Attack
Tron Ddly Dsc
Winter Olymp

PARKER
Action Force
Amidar

PARKER/Con
Emp Strks Bk
Frogger
Incredible Hulk
James Bnd 007
Jedi Arena
Lord of Rings
Popeye
Q-Bert
Reactor
Rtn of Jedi 1
Rtn of Jedi 2
Sky Skipper
Spiderman
Super Cobra
Tutankham

SPCTRVSION
Chall of Nexar
China Syndrme
Cross Force
Gangster Alley
Glactic Tactic
Mangia
Master Builder
Planet Patrol
Tape Worm

SUPERCHGER
Communst Mut
Dragonstmper
Escape from M
Fire Ball
Killer Satellite
Phaser Patrol
Suicide Mission

TELESYS
Coconuts
Cosmic Creeps
Demoltn Herby
Fast Food
Ram - It

TIGERVISION
Jawbreaker
King Kong
Marauder
Miner 2049er
Polaris
River Patrol
Threshold

ZIMAG
Cosmic Corridor
Dishaster
Immies & Aggs
I want my Mom
Pizza Chef
Quest for Gold
Tally Ho
Tanks no Tanks

ACCESSORIES

We stock a wide range of accessories for the Atari VCS and 400/800 personal computers. The same accessories can be used on the Commodore VIC range of computers. The Wico range can also be used with the Texas Instruments computers on purchasing a special adaptor. To give you an idea of the range available, just take a look at the following list:

Trackball by Wico

LE STICK: A mercury filled joystick specially made for one handed operation, with thumb fire button.

QUICK - SHOT: This joystick features a contoured handle grip, thumb trigger and optional base fire button. It is supplied with 4 sure foot suction grips.

STARFIGHTER: Neat and compact with a small direction stick. Metal interior for added strength.

VIDEO COMMAND: With a tapered handle, this joystick is for one handed use. It has a directional control which is similar to a jet fighter joystick.

WICO RED-BALL: An arcade type joystick with a red ball handle, it features 2 fire button locations, one at the base and one on the stick. It comes supplied with 4 grip pads for easier table top use.

WICO STRAIGHT - STICK: The main feature of this joystick is its arcade style, bat handle grip. It also has 2 fire buttons. Four grip pads included for table top use.

WICO TRACKBALL: A true arcade style trackball for use with your Atari or Commodore VIC. This product is designed to give arcade control in your living room.

12' EXTENSION LEAD: A 12' extension for Atari and Atari compatible joysticks for greater player freedom.

Wico Straight Stick with Stick Fire Button

MATTEL INTELLIVISION

MATTEL INTELLIVISION: The Mattel games unit is a most versatile T.V. game which offers 3-D graphics quality for only £98. Each cartridge comes with 2 overlays which fit over the unique hand controller giving easy directions for game play. Using the handset's control disc, objects can be moved accurately in 16 directions giving a realistic simulation of lifelike movement.

VOICE SYNTHESIS: The Intellivoice unit, price £49, is used with special cartridges where high quality synthesised male and female voices feature as part of the game play.

NEW MATTEL CARTRIDGE RELEASES: Why not complete the coupon below and join the Silica Mattel Owners Club and receive our FREE news bulletins and 16 page catalogues detailing new Mattel releases. There will soon be over ninety cartridges available for the Mattel, and a small selection from these is listed below:

MATTEL: Arctic Squares, Burger Time, Buzz Bombers, Chess, Cloudy Mountain, Loco Motion, Mission X, Mystic Castle, Sharp Shot, Solar Sailor, Space Shuttle, Vectron, Winter Olympics. ACTIVISION: Happy Trails, Pitfall, Stampede. C.B.S. Blue Print, Carnival, Donkey Kong, Gorf, Mousetrap, Smurf, Solar Fox, Turbo, Venture, Wizard of Wor, Zaxxon. IMAGIC. Beezer, Dracula, Ice Trek, Nova Blast, Safecracker, Swords & Serpents, Tropical Trouble, White Water. PARKER: James Bond 007, Lord of the Rings, Popeye, Q-Bert, Spiderman, Star Wars, Super Cobra, Tutankham.

COMPUTER KEYBOARD: In July/August 1983, Mattel will be launching their new £89, 49-key computer keyboard attachment called 'Lucky' which is fully programmable and has microsoft basic built in. It will transform your Master Component into a home computer. The adaptor also accepts a 6 note polyphonic music synthesiser and full size 49-key piano keyboard that will make learning music as easy as playing games.

£98

MATTEL CONSOLE £85.22 + VAT = £98.00

VIDEO GAME CLUB

In a fast moving market like video games, it is difficult to keep up to date with all the developments that take place. With new programmes and accessories being introduced at a fast rate by several different manufacturers, it is impossible to get all the information you require from one manufacturer alone. It is for this reason, that we have set up owners clubs for the more popular video games and home computers, to keep you fully up to date with what is going on with your particular machine. As far as we know, Silica Shop are the only company to offer such clubs, but that is not surprising since we are the specialists. We currently have FREE clubs for the Atari VCS, Atari 400/800 home computers, and Mattel Intellivision. Soon we will have clubs for Colecovision, Aquarius and Vectrex. So if you own one of these machines, fill in the coupon opposite, and we will enrol you FREE OF CHARGE in the club relevant to your computer or video game.

FREE LITERATURE

FREE LITERATURE – Please send me your FREE LITERATURE and catalogues on the following items:

OWNERS CLUB – I already own the following products, please enrol me in your FREE club:

Mr/Mrs/Miss: .... Initials: .... Surname: ....
Address: ....
....
....
....
Postcode: .... ZHE 0883

☎ 01-309 1111

SILICA SHOP

SILICA SHOP LIMITED, Dept ZHE 0883,
1-4 The Mews, Hatherley Road, Sidcup, Kent, DA14 4DX
Telephone: 01-309 1111 or 01-301 1111

FREE LITERATURE

Alexander Graham Bell

Ian Sinclair

Dooby Doo Doo Wop! Time to ring off with the most Famous Name of them all . . .

YES, of course you've heard of *him*, Bell of telephone fame and founder of the Bell Telephone Co., "Ma Bell" to millions of US citizens who take for granted a standard of telephone service that makes us as sick as a Buzby to think about. But did you know that the decibel is named after him, or that he invented the telephone as a deaf aid? Read on, and discover more about the life of this remarkable poineer.

Alexander Graham Bell was born in Edinburgh in 1847, to a family who had dedicated their lives to the service of the deaf and dumb — his father was the inventor of the hand signals which are still used to this day. His parents were established authorities in elocution and speech correction (what would they have made of CB?), and they did not send Alexander to school, preferring to draw on the considerable talents of the family for his education. The success of this education, unhindered by local authorities or social workers (not yet invented), gained Alexander his first job in 1864, as resident master at Weston House Academy, a small boarding school in Elgin, a cold grey town in the Highlands.

Devoted To The Deaf

In 1870, however, the whole Bell family decided to emigrate, like so many Scots before and since, in search of a better living in Canada, and they moved to Brentford, Ontario. Alexander found nothing to his taste there, and shifted again to Boston, Mass. in the USA, to open a small school, in 1872, for training teachers of the deaf, a topic in which he took a passionate interest.

He had very considerable success, and in a remarkably short time established a nationwide reputation for his methods of training teachers, particularly in the "hand alphabet" which his father had devised. This, incidentally, is a subject of controversy at the moment because it is no longer being taught, and the change is bitterly resented by many deaf people who feel that a valuable method of communication may be lost to future generations.

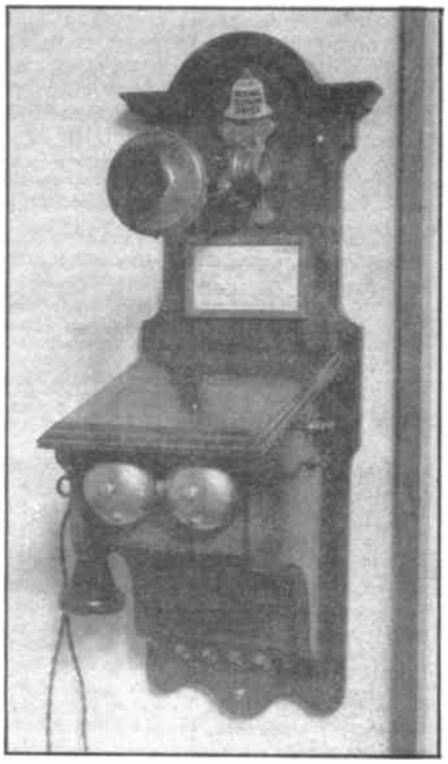
As a result of Bell's success, he was asked to incorporate his school into Boston University, and he became Boston's first Professor of Vocal Physiology in 1873. It was as a result of this achievement that he was able to find time for research, with all the facilities of a University now available to him.

Telegraphy Progress

He was fascinated by the development of Telegraphy, because it was a method of communfcation which was open to people with severe hearing or speech defects — in fact many deaf people were trained as telegraph operators in those days, just as the tradition of training blind people as piano tuners grew up. Bell's interest in the electric telegraph led to the invention, along with his excellent but lesser known assistant Thomas Watson, of many improvements in telegraph design, and to Bell's increasing involvement in, and knowledge of, electrical circuits. Gradually he conceived a system which would convert the sound waves of speech into electrical signals, and back again, with the purpose of allowing the deaf to hear what was being said some distance away. Curiously enough, another emigré, David Hughes, was working in Virginia along similar lines.

Bell's telephone system, after a few false starts, took the simple form of a carbon microphone, a battery, and an earpiece. The carbon microphone was until very recently still being used in telephones, particularly in this country; it is now being replaced by the electret microphone, the only device sufficiently sensitive, and with a large enough signal output, to take its place.

The carbon microphone principle (which is attributed to Hughes) goes thus: a thin flexible membrane or diaphragm of metal is held in an insulating cylinder which has a metal backplate, and the space between the diaphragm and the backplate is packed with granules of carbon. Carbon is a resistive material, and the resistance depends very much on how tightly the carbon particles are packed together. With this arrangement, pressing the diaphragm inwards considerably reduces the resistance between the diaphragm and the backplate; pulling the diaphragm outwards considerably increases the resistance. With a battery connected, the device becomes a



variable current generator, with the amount of current depending on the movement of the diagphragm.

A Toast To Carbon

When a sound wave hits the diaphragm, it causes the diaphragm to vibrate at the same frequency as the sound wave, and with an amplitude (amount of movement) which depends on the loudness of the sound. In this way, sound waves hitting the diaphragm cause waves of electric current in the circuit connected to the carbon microphone. The useful and remarkable thing about the carbon microphone is the size of the electrical signal that it generates, putting several volts across a load with several milliamps flowing. Until the development of electrets there was nothing that came anywhere near such an output, and the defects of the carbon microphone, such as its narrow bandwidth and the resonances which it caused, were not of great significance in telephone use.

Bell's receiver was electromagnetic, using the arrangement which, once again, has survived more than a hundred years. This uses a magnetised metal diaphragm held close to an electromagnet, usually of horseshoe shape. The varying currents transmitted by the microphone are sent through the electromagnet of the earpiece, and they cause the diaphragm to be magnetically attracted to an extent that depends on the amount of current. In this way, the current waves that flow in the circuit when someone speaks into the microphone are converted back to a sound by the action of the earpiece.

According to the notes that Bell made at the time, the first words spoken over a telephone circuit were "Come here, Watson, I want you . . . ". The fact that Watson heard them and rushed through to Bell's room was the start of something big. They took out a patent on their telephone system in 1876, and the invention was recognised by the confederation of the Volta Medal on Bell in 1880 by the French Government. By this time, the Bell Corporation was being set up to exploit the invention which in a few years was to change the habits of the whole world.

Enter The Decibel

Bell, at this stage, could have simply retired from active life, content to amass a fortune as President of one of the most important and rapidly-growing corporations in the US. It is typical of him that he did not, preferring to devote more time to research and to the twin ideals of developing his invention and of helping the deaf. His work on sound transmission soon highlighted a short-coming of measurement, that there was no scale of comparative loudness of sound.

From a large number of careful measurements, Bell found that the apparent loudness of a fixed frequency from a telephone receiver was proportional not to the electrical power but to the *logarithm* of the power, and so he proposed a unit for comparative loudness, the logarithm of the power ratio of two signals. This was widely adopted, and named the Bel in his honour, dropping the final "l" to avoid any confusion between unit and name.

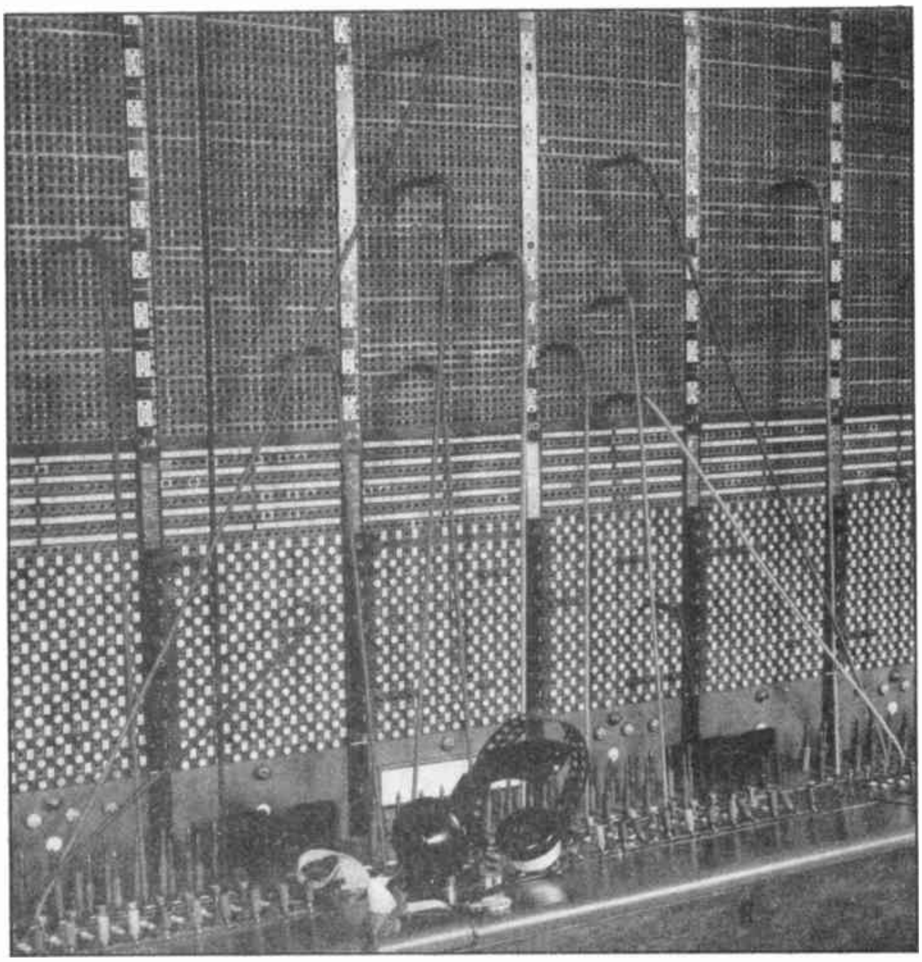
The Bel, however, is a larger unit, and just as we use microfarads instead of farads for measuring capacitance, it's more convenient to use tenths of a Bel, or "decibels", in place of Bels. Unfortunately the decibel is the most abused and least understood of all the units encountered in electronics.

Photos On The Phone . . .

Bell also worked on developments of the telephone system, as always, with a view to helping the deaf to communicate. One notable development, well ahead of its time, was the Photophone of 1880. This was a device to transmit photographic images over a telephone, a forerunner in many ways of the Photofax process and of slow-scan TV.

The principle was simple and ingenious. A transparency is fastened to a glass cylinder so that a light can be shone through transparency and glass on to a photocell (using selenium), which is inside the hollow cylinder. The cylinder is spun round, and the photocell is slowly moved from one end to the other, so that varying currents are generated in a circuit connected to the cell as varying amounts of light reach it through the transparency.

These currents could be transmitted over telephone lines, and at the receiver a photographic method was used to re-create the image. A piece of moist sensitised paper (the original sensitising chemical was potassium iodide) was then wrapped round a metal drum, which was the earth connection of the receiver. The signals from the transmitter were connected to a brush contact, which touched the moist paper as it revolved with the drum. The current flowing through the paper caused the chemcial to decompose, leaving a stain (iodine, when potassium iodide is used), and the amount of staining depends on the amount of current. Provided that the receiver drum is sychronised with the transmitter drum, the received image is a reasonably good reproduction of the transmitted one. An incidental advantage is that the picture size can be scaled up or down by making the receiving drum a different size from the transmitting drum.



. . . Letters Down The Line

The Photophone principle was developed into Photofax, and its descendents are still used. Bell followed it up with the Graphophone of 1887, designed to allow writing to be transmitted along telephone lines — and a large part of his receiver principle for this device can now be seen in the form of XY plotters for computers.

Bell died in 1922, the Grand Old Man of the telephone, and to the end a benefactor of the deaf, to whom he left much of the vast fortune he had accumulated. His other monument was the founding of the American Association to Promote Teaching of Speech to the Deaf, now known as the Alexander Graham Bell Association for the Deaf. This institute sponsors a great deal of research, much of it nowadays into electronics, resulting in a constantly improving service to the deaf. In many ways, I think that Bell would be more interested in this than in the whole telephone service if he could return to see it all.

Many, many thanks to Ian Sinclair for our longest-running series, and we hope our readers have enjoyed reading Famous Names as much as we have enjoyed running it.

HE

It's easy to complain about advertisements.

The Advertising Standards Authority.
If an advertisement is wrong, we're here to put it right.

A.S.A. Ltd., Brook House, Torrington Place, London WC1E 7HN.

TALK TO THE WHOLE WORLD

Study now for the

RADIO AMATEUR'S EXAMINATION

We have had 40 years successful experience in training men and women for the G.P.O. Transmitting licence.

FREE R.A.E. brochure without obligation from:–

British National Radio & Electronics School
READING, BERKS. RG1 1BR

Name ....

Address ....

HE/8/817 BLOCK CAPS PLEASE

Branime

TYPE 161B
DUAL POWER SUPPLY KIT

INCORPORATES A POSITIVE & A NEGATIVE REGULATED SUPPLY

BOTH ARE ISOLATED & ADJUSTABLE 1.3V TO 16V D.C.
Interconnect to give 2.6V to 32V or
−1.3V/0/+1.3V to −16V/0/+16V
Output current 1A at 16V to 0.35A at 1.3V
Ripple is less than 1mV

£25.99
inc. P & P and VAT

Built & Tested
£37.95 inc. P&P and VAT

Comprehensive design details with calculations are included so that the kit is an excercise in power supply design. The kit, which uses quality components, is complete with instructions. Case punched and stove enamelled in attractive blue and grey with a printed front panel to give a professional finish.
Excellent for the beginner, the experienced amateur and as a tutorial for schools and colleges.

SEND CHEQUE OR P.O. ALLOW 21 DAYS FOR DELIVERY

BRANIME MARKETING LTD DEPT. HE/8
BALTHANE IND. EST., BALLASALLA, ISLE OF MAN

EUROPA ELECTRONICS

Mail Order to 160 High Road, Willesden, London NW10 2PB
TEL: 01-907 1659

SEND FOR A FREE LIST OF OUR LARGE RANGE OF ITEMS
ALL DEVICES ARE NEW, FULL SPEC AND GUARANTEED

Post & Packing: Add 30p to all orders under £5.
VAT: All UK orders add 15% to total cost including p&p.

74LS SERIES

74LS00	11p	74L[illegible]	76p
74LS01	11p	74LS151	40p
74LS02	11p	74L[illegible]153	40p
74LS03	12p	74LS154	80p
74LS05	12p	74L[illegible]	30p
74LS06	12p	74L[illegible]156	38p
74LS07	12p	74LS157	25p
74LS08	12p	74L[illegible]158	30p
74LS09	12p	74L[illegible]160	38p
74LS10	12p	74LS161	38p
74LS11	13p	74L[illegible]162	38p
74LS12	12p	74LS163	38p
74LS13	15p	74L[illegible]164	40p
74LS14	25p	74L[illegible]	50p
74LS15	12p	74LS166	60p
74LS20	12p	74L[illegible]168	85p
74LS21	12p	74L[illegible]	85p
74LS22	12p	74L[illegible]170	70p
74LS26	12p	74L[illegible]	55p
74LS27	13p	74L[illegible]174	40p
74LS28	14p	74L[illegible]	40p
74LS30	12p	74LS181	90p
74LS32	13p	74L[illegible]	120p
74LS33	14p	74L[illegible]190	38p
74LS37	14p	74L[illegible]191	38p
74LS38	18p	74L[illegible]	38p
74LS40	12p	74L[illegible]	38p
74LS42	30p	74L[illegible]194	38p
74LS47	38p	74L[illegible]195	35p
74LS48	45p	74L[illegible]196	45p
74LS51	14p	74LS197	45p
74LS54	14p	74L[illegible]	50p
74LS55	14p	74L[illegible]240	58p
74L[illegible]	120p	74L[illegible]241	58p
74L[illegible]	18p	74L[illegible]	58p
74L[illegible]74	16p	74L[illegible]	58p
74L[illegible]75	18p	74LS244	58p
74L[illegible]76	17p	74L[illegible]	70p
74L[illegible]83	38p	74L[illegible]	50p
74LS85	48p	74L[illegible]248	55p
74L[illegible]	18p	74L[illegible]249	55p
74L[illegible]	22p	74L[illegible]251	35p
74L[illegible]	66p	74L[illegible]	35p
74L[illegible]	32p	74LS257	30p
74L[illegible]	40p	74L[illegible]	35p
74L[illegible]	50p	74L[illegible]	55p
74L[illegible]107	20p	74L[illegible]	20p
74L[illegible]109	27p	74L[illegible]	130p
74L[illegible]112	20p	74L[illegible]	20p
74L[illegible]113	20p	74L[illegible]	60p
74LS114	22p	74L[illegible]	225p
74L[illegible]	20p	74L[illegible]	30p
74L[illegible]	34p	74LS280	100p
74L[illegible]	60p	74L[illegible]	40p
74L[illegible]125	24p	74L[illegible]	140p
74LS12[illegible]	25p	74L[illegible]	140p
74L[illegible]	34p	74L[illegible]	27p
74LS133	30p	74LS365	27p
74L[illegible]	25p	74LS367	27p
74LS138	27p	74LS368	27p
74LS139	27p	74LS374	55p
74LS145	70p	74L[illegible]375	45p
74LS147	120p	74L[illegible]377	80p
		74L[illegible]78	60p
		74L[illegible]	45p
		74LS393	48p

TRANSISTORS

AD161	42p
AD162	42p
BC107	10p
BC10[illegible]	12p
BC109	10p
BC109C	12p
BC177	16p
BC17[illegible]	18p
BC17[illegible]	20p
BC18[illegible]	10p
BC18[illegible]	10p
BC184L	10p
BC[illegible]	10p
BC[illegible]	10p
BC214L	10p
BC547	17p
BC54[illegible]	12p
BC54[illegible]C	14p
BC[illegible]	15p
BC[illegible]7	15p
BC[illegible]	15p
BC[illegible]	15p
BFY50	23p
BFY51	23p
BFY52	23p
TIP[illegible]A	32p
TIP[illegible]A	35p
TIP31A	38p
TIP[illegible]A	38p
TIP[illegible]A	[illegible]
TIP[illegible]4A	74p
TIP41A	80p
TIP4[illegible]A	56p
T[illegible]	32p
[illegible]	45p
[illegible]	28p
[illegible]	26p
[illegible]	26p
[illegible]	26p
[illegible]	26p
[illegible]	48p
[illegible]	10p
[illegible]	10p
[illegible]	10p
[illegible]	10p
[illegible]	10p
[illegible]	10p
[illegible]	10p
[illegible]	10p
[illegible]	22p
[illegible]	18p
[illegible]	18p
[illegible]	18p
[illegible]	15p
[illegible]	30p
[illegible]	30p
[illegible]	38p

COMPUTER CHIPS

Z80A	320p
Z80ACTC	280p
Z80ADART	700p
Z80AP10	280p
Z80[illegible]10	810p
680[illegible]	225p
6821	100p
[illegible]	378p
6850	110p
685[illegible]	280p
6875	800p
80[illegible]	450p
8154	950p
8156	350p
8212	100p
8216	100p
82[illegible]	270p
8[illegible]50	880p
8253	380p
82[illegible]	258p
8259	400p

MEMORIES

[illegible]	120p
[illegible]	100p
2516	250p
2532	378p
[illegible]708	250p
2716	250p
273[illegible]	320p
4116 20	100p
4164 16	400p
4818 AP3	280p
5101	210p
6116P3	350p
74S188	150p
74[illegible]88	180p
74[illegible]	225p
[illegible]45474	400p

CRYSTALS

1MHZ	280p
[illegible]MHZ	225p
4MHZ	150p
[illegible]MHZ	190p
10[illegible]	118p
[illegible]MHZ	200p

LINEAR ICs

741	14p
748	38p
CA3019	80p
CA3046	70p
CA3048	220p
CA3059	285p
CA3060	280p
CA3080	72p
CA3[illegible]	48p
CA3130[illegible]	80p
CA3130T	110p
CA3140[illegible]	80p
CA3140E	50p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA[illegible]	300p
CA[illegible]40E	110p
CA3[illegible]00G	200p
LF347	150p
LF351	48p
LF[illegible]	85p
LF356	85p
LF[illegible]	85p
LF357	110p
LM301A	25p
LM[illegible]10	120p
LM311	70p
LM318	180p
LM[illegible]19	218p
LM324	30p
LM[illegible]24Z	80p
LM[illegible]	140p
LM339	80p
LM348	65p
LM380	75p
LM381[illegible]	145p
LM382	115p
LM[illegible]44	180p
LM[illegible]	90p
LM[illegible]	120p
LM[illegible]	95p
LM[illegible]	100p
LM[illegible]	50p
LM[illegible]N	85p
LM[illegible]11	125p
LM[illegible]914	250p
LM3915	280p
LM3916	250p
LM13600	110p
MC1310P	150p
MC1448	250p
MC1458	36p
MC1495L	350p
[illegible]1496	70p
MC3340[illegible]	120p
MC3403	65p
[illegible]431	140p
[illegible]544	180p
[illegible]555	10p
[illegible]556	45p
NE564	420p
NE565	120p
NE566	186p
NE567	140p
NE570	410p
NE571	400p
NE592	80p
NE5534P	110p
TBA810	95p
TBA820	80p
TL061CP	40p
TL0[illegible]2	60p
TL064	85p
TL071[illegible]81	25p
TL072[illegible]82	45p
TL074	100p
TL084	80p
TL094	200p
TL170	50p
TL4[illegible]0C	70p
ZN414	80p
ZN419C	180p
ZN4[illegible]	130p
ZN424[illegible]	130p

4000 CMOS

400	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	38p
4009	24p
4010	24p
4011	11p
401[illegible]	18p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
40[illegible]0	48p
40[illegible]1	40p
40[illegible]2	45p
4023	13p
4024	32p
40[illegible]5	13p
40[illegible]6	80p
4027	20p
4028	40p
4029	45p
4030	18p
4037	110p
4038	110p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	48p
4048	60p
4049	24p
4040	24p
4051	45p
4052	50p
4068	14p
40[illegible]	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	18p
4078	18p
4081	14p
4082	15p
4086	55p
40[illegible]	125p
4093	24p
4094	90p
40[illegible]5	78p
40[illegible]	70p
4501	28p
4502	60p
4503	46p
4504	78p
4508	38p
4507	35p
4510	45p
4511	45p
4512	86p
4518	40p
4520	50p
4521	80p
4526	60p
4527	80p
4528	50p
4532	70p
4583	80p
4584	38p
4585	75p
40085	60p
40097	50p
4010[illegible]	140p
40103	170p
40106	36p
40109	100p
40163	60p
40174	50p
4017[illegible]	50p
40193	60p

OPTO ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
OR[illegible]	120p	TIL78	58p

VOLTAGE REGULATORS (PLASTIC) TO220

78[illegible]	40p	790[illegible]	45p
7812	40p	791[illegible]	45p
7815	40p	7915	45p
7818	40p	7918	48p
7824	40p	7924	48p

7 SEGMENT DISPLAYS

DL704	118p	TIL321	99p
DL707	115p	TIL3[illegible]	99p

THYRISTORS

[illegible]A 400[illegible]	40p	C106D	38p
5A [illegible]	48p	TIC44	24p
8A 800[illegible]	80p	TIC45	26p
12A 400[illegible]	95p	TIC47	38p
BT106	150p	[illegible]06	32p
[illegible]T118	180p	[illegible]4	38p

LED inc clip

	3	5
Red	[illegible]0p	10p
Yellow	12p	14p
Green	12p	12p

ISOLATORS

ILD74	130p
ILQ74	240p
TIL11[illegible]	70p
TIL113	70p
TIL116	70p

TRIACS

3A 100V	48p	1[illegible]A/100V	78p
3A 400V	56p	12A/40[illegible]	82p
8A 100V	80p	12A/80[illegible]	135p
8A 400V	86p	16A/100[illegible]	103p
8A 800V	115p	16A 400V	106p

DIL SOCKETS

Pin	Low Prof	Wire Wrap
8	8p	25p
14	10p	35p
16	10p	40p
20	22p	50p
24	24p	65p
40	30p	100p

ELECTROLYTIC CAPACITORS
Axial & Radial Values [illegible]
63V 1 2.2 3.3 4.7 6.8 10 8p, 15 22 33 5p
40V 330 470 45p, 1000 48p, 2200 70p
25V 47 100 0p, 220 330 12p, 470 25p, 680 1000 34p, 2200 80p, 4700 92p
16V 470 14p, 1000 20p
10V 1000 18p, 2200 25p

POLYESTER CAPACITORS (Radial) 250v
10n 15n 22n 33n 47n 8p, 68n 100n 8p, [illegible] 10p, 470[illegible] 18p, 680n 20p, 1000n 25p

MYLAR FILM CAPACITORS (Radial) [illegible]00V
1n 1n5 2n2 3n3 4n7 6n8 10n 8p, 15n 22n 3[illegible]n 47n 0p

CERAMIC CAPACITORS 50v Radial Lead
22pf—47,000pf E12 Values 4p

TRANSFORMER
Mi[illegible]
Primary 240V
Second 6-0-6
9-0-9 12-0-12

PCB Mounting

[illegible]VA	200p
[illegible]VA	270p

Standard

[illegible]A	220p
1[illegible]VA	295p
24VA*	330p

* Also 24-0-24

DIODES

OA47	8p
OA[illegible]	9p
OA91	9p
OA200	9p
OA202	9p
1N914	4p
1N[illegible]16	7p
1N4148	4p
1N4001	5p
1N4004	6p
4007	7p

POTENTIOMETERS
Carbon track, 0.25W log & linear

5K 2M single gang	30p
5K 2M single gang D/P switch	7[illegible]
5K 2M dual gang stereo	[illegible]

PRESET POTENTIOMETERS
Horizontal & Vertical

0.1W 100R 1 Meg	7p
0.25W 100R 1 Meg	10[illegible]

RESISTORS 5% Carbon Film
E12 values

0.2[illegible]W 1R 5M	1p
0.5W 1R 5M	1.5p

SWITCHES
Slide 1A

DPDT	14p
DPDT c/off	15p

Sub-min Toggle

SPST on/off	54p
SP c/over	60p
DPDT	75p
DPDT [illegible]	[illegible]

Push Button

Push to Make	15p
Push to Break	25p

VEROBOARDS

	clad	plain
2½ x 3¾	73p	82p
2½ x 5	83[illegible]	—
3¾ x 3¾ 83p		
—		
3¾ x 5	95p	79p
3¾ x 17	325p	211p
4¾ x 18	425p	—
Pkt of 100 pins		50p
Spot face cutter		118p
Pin insertion tool		162p

BRIDGE RECIFIERS

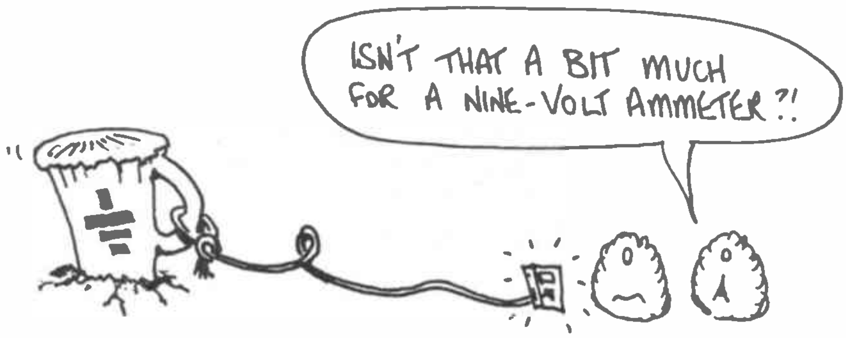
1A[illegible]	18p
1A100[illegible]	20p
1A400V	28p
2A100V	30p
2A400V	45p

ZENER DIODES
[illegible]
400mW 8p

Retail Shop: North Parade Electronics, Mollison Way, Edgware, Middlesex.

READERS' SERVICES

Feeling stumped? Looking for the right connection? It must be time to reach for HOBBY ELECTRONICS! Here's how . . .



Letters

While we are always happy to receive correspondence from readers, it is simply not possible for the editorial staff to reply to every letter. Because of staff limitations and the fact that producing the monthly editions of HE must take precedence, *we cannot even guarantee to answer letters accompanied by an SAE*. Hopefully this situation will prove temporary and we can shortly resume a full service to readers.

In the meantime, to reduce the amount of mail to which we attempt a reply, certain guidelines have had to be imposed:

● Letters from readers who have been unable to successfully build a Hobby project will receive first claim on our attention. But we urge readers to first make sure they understand the problem, and to read all parts of the article thoroughly: it is wasting our time (which is better spent ensuring that current projects are error free) to reply (to pick a common case) that the supplier of certain components is given in Buylines, on page 34.

● Many enquiries are concerned with drafting errors in circuit diagrams or component overlays; corrections for most errors have been published in subsequent issues, so please check your back numbers before writing to us — the information may already be in your hands.

● Where there is a definite problem, we ask that readers first try to solve the problem themselves: again, reading the article carefully will often resolve what appears to be a contradiction between, say a Veroboard layout and the circuit diagram.

● If it is necessary to write, please try to supply useful information: it is impossible to give constructive advice to the reader who says "My project doesn't work. Can you help?". The short answer, and the only one possible, is *no*!

● We would like to hear from any reader who has had difficulty with a Hobby project and who has come up with a solution, but we cannot advise when a project has been modified and fails to work: if you decide to make changes you will have to live with the consequences. Similarly, we are pleased to take readers suggestions for projects they would like to see in the magazine, or for modifications to improve a published project, but we cannot design circuits on request or re-design a project to suit the requirements of a single reader.

● We will try to answer any readers' questions on electronics in general, to suggest sources for components for old projects or to offer whatever advice we can when circumstances permit; however, we cannot advise on the purchase, use or modification of commercial equipment.

● We are unable to advise on the purchase of components in foreign countries; overseas readers are advised to read carefully the advertisements placed in HE by mail-order component suppliers and to write to them directly (this advice also applies to many UK readers wishing to obtain components for projects!).

● Unless specifically requested to the contrary, any letter to Hobby Electronics may be selected for publication in the magazine, including letters with an SAE if they are sufficiently interesting; in such a case a copy of the editorial comment will be returned to the reader prior to publication.

● Letters not accompanied by a stamped, self-addressed envelope may be selected for publication but will not receive a personal reply. We will attempt to reply to all enquiries backed by an SAE (if writing from outside the UK please include the correct number of International Reply Coupons, available from Post Offices) but we cannot guarantee a reply, nor can the publishers, Argus Specialist Publications, be held legally responsible for the accuracy of the information supplied.

Writing For HE

● Hobby Electronics' editor is continually looking for good projects, ideas for projects and designers to develop an idea into working project.

However unless you are already a seasoned contributor, it is unlikely that your first effort will reach the standard required for publication in the magazine. So if you have an idea or a design and you personally think it would be suitable as a Hobby project, write and tell us about it — and please include a telephone number (night or day, we're open all hours here) where you can be contacted.

Similarly if you are a designer, perhaps with time to develop someone else's ideas, please write or phone the editor!

Any Old Rope?

We will also undertake to publish any suitable but undeveloped ideas as experimental "Reader's Projects". The article will generally fill one page when published and should include a circuit diagram and description, parts list, component overlay (the projects should generally be on Veroboard) and some brief suggestions as to how the device might be constructed by the adventurous reader! A working prototype will not be needed, and the flat rate for Reader's Projects will be £20.

Simple circuits are also needed for publication as "Short Circuits"; no constructional information is needed, and contributors of "Shorts" will be rewarded with £10 per idea.

The Back-Log

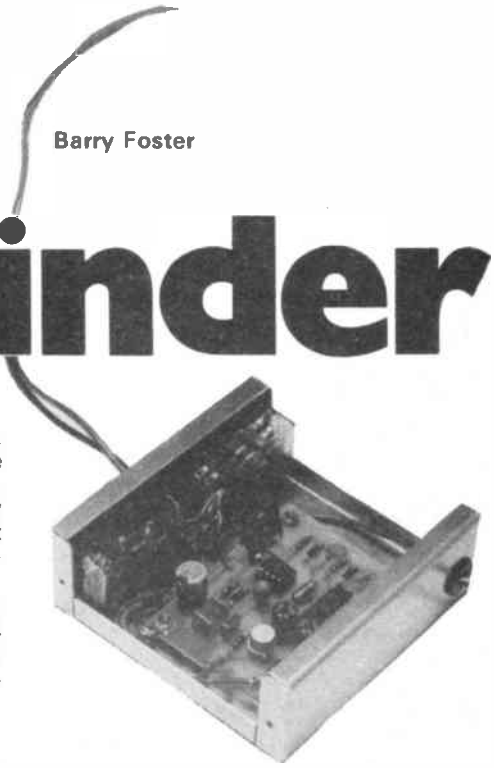
The above guidelines for writing to Hobby Electronics have had to be drawn up in response to the growing pile of yet un-answered letters from readers.

We apologise to all those still awaiting a reply; we are doing everything possible to clear the jam, but to enable us to do so in reasonable time we are retrospectively imposing the above restrictions on the type of enquiry with which we will deal. Therefore, any letter or question not relating to a Hobby Electronics project or a general electronics enquiry will be returned, with the SAE, to the reader. HE

The Automatic Car Wash has just eaten your Car Radio Aerial for the third time in six months. It's time you got wise to the

Barry Foster

Auto Winder



LIKE MOST THINGS, car aerials are not intended to last forever. Far from it, you'd be lucky if one stayed in its appointed place for 12 months, because as well as the perils of rust and accidental damage, car aerials seem to provide an irresistable attraction for some . . . people. So, a car aerial that can be wound up and down by an electric motor is worth those few extra pounds — unless you like the battered chic of the coat-hanger look, of course.

The problem with motorised aerials, though, is that you have to remember to wind the thing down when you leave the car. No problem, you'd say — but the one time you forget will be the night you'll lose it, won't you! The solution to all these problems, then, is to install an automatic car aerial motor, one that winds the aerial up when you turn the radio on and winds it down when the radio is switched off. You can buy such an item outright, of course, but why spend more than you have to? The HE Auto-Winder will do the trick, and impress your friends as well!

Up And Down Circuits

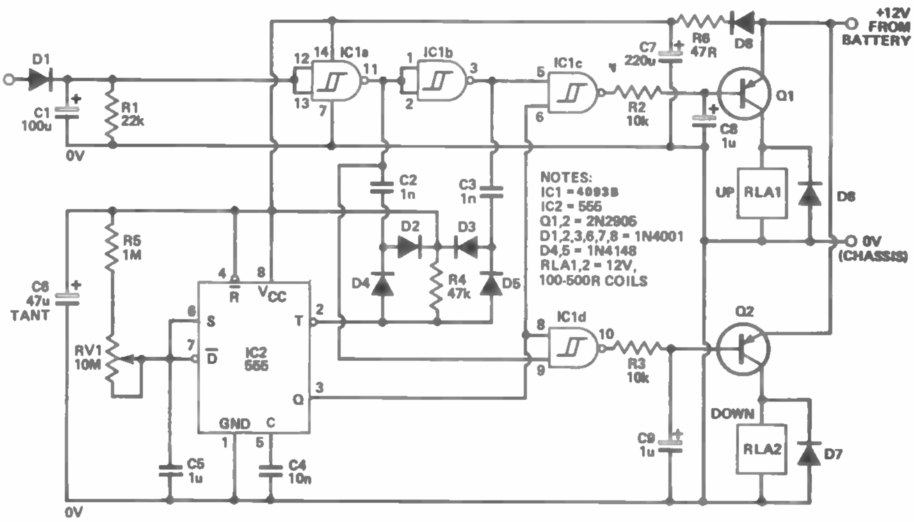
Since the Auto-Winder has to automatically wind the aerial either up or down, it has to respond to two different conditions in different ways. First, when the radio is switched on, it must wind the aerial up; then when the radio is turned off the aerial has to be retracted. All this is accomplished by a circuit which controls two relays to drive the motor in one direction or the other; a gating network turns on the appropriate relay while an adjustable timer sets the period for which the motor is driven.

The Auto-Winder circuit is permanently connected to the car's battery (the current consumption of the control circuitry is a matter of around eight milliamps and is hardly significant, especially when compared to the current drawn from the battery by the starter motor, say) and therefore will instantly respond when the radio is turned on or off.

The control input is taken from the on/off switch of the radio; when power is applied capacitor C1 rapidly charges up through the isolating diode D1, and when the voltage reaches the Schmitt trigger threshold of IC1a, its pin 11 will go low. Now C2 begins to charge through R4 and D4, pulling the trigger input of IC2 (a 555 timer) below 1/3 supply voltage and thus starting the timing period. C2 charges fairly rapidly, producing a low-going pulse approximately 120 microseconds wide, after which is charges up to the supply voltage; this leaves the trigger input at V+ so that it can respond to another low-going pulse.

IC2 is connected in a standard monostable configuration. Initially the Q output is low and the Discharge input, pin 7, is in a low impedance state,

Figure 1. The circuit, using a 555 timer and 4093B Schmitt trigger.



How It Works

The input to the unit comes from the car radio power supply, which provides a positive voltage on the input gate when the radio is switched on. The gate output is a negative pulse to the trigger generator; this produces trigger pulses to start the timer in two different situations: first, when the radio is switched on and then when the radio is switched off.

The timer sets the period for which the aerial motor is on, so that the aerial may be either completely extended or totally retracted.

The timer output is gated to either the Up or Down relay by another output from the trigger generator.

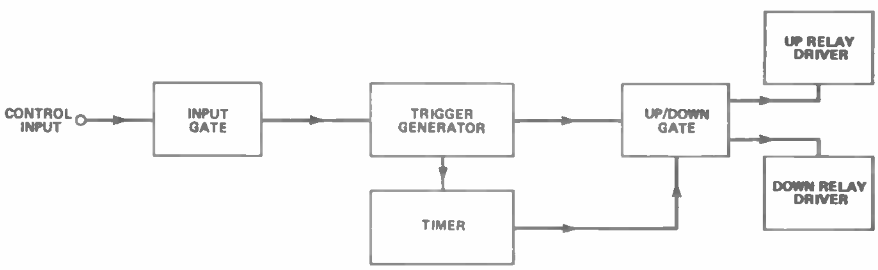
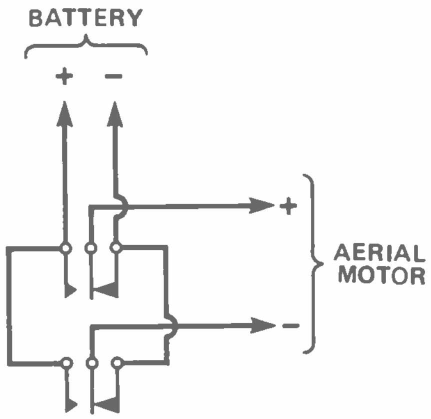
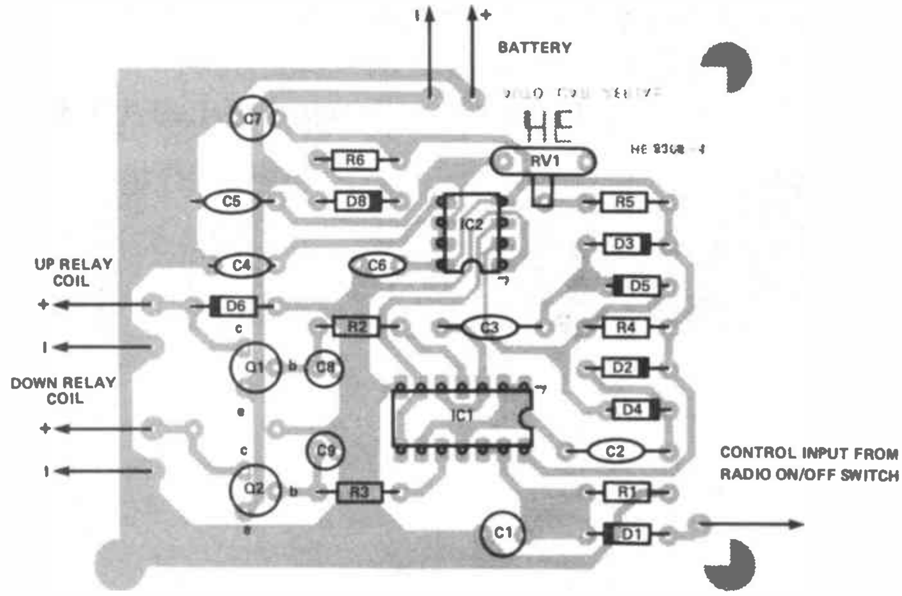


Figure 2. The PCB and components. Note that the relays are designed to be mounted away from the board.

Figure 3. Wiring for the relays. See over the page for suggestions on how to install the relay with the Auto Winder.





Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1 .... 22k
R2,3 .... 10k
R4 .... 47k
R5 .... 1MR
R6 .... 47R

POTENTIOMETERS
RV1 .... 10M vert. preset

CAPACITORS
C1 .... 100u 16V radial electo
C2,3 .... 1n polyester
C4 .... 10n metallised polyester
C5 .... 1u metallised polyester
C6 ....47u 16V tantalum bead
C7 .... 220u 16V radial electro
C8,9 .... 1u 16V radial electro

SEMICONDUCTORS
IC1 ....4093B quad 2-in Schmitt trigger NAND
IC2 .... 555 timer
Q1,2 .... 2N2905 PNP transistors
D1,2,3,6,7,8 .... 1N4001
D4,5 .... 1N4148

MISCELLANEOUS
RLA1,2............. see Buylines
Case (see buylines); PCB; wire, solder, nuts and bolts etc.

BUYLINES ....page 34

shorting out the timing capacitor C5. When the IC is triggered, Q goes high and pin 7 goes to a high impedance state. C5 then begins to charge via R5 and RV1 until the voltage on it reaches 2/3 of the supply; this is detected by the Sample or 'threshold' input, pin 6, and the output promptly changes to low. At the same time pin 7 switches to low impedance and C5 discharges to ground through the IC, in readiness for the next timing period. The charge rate of C5, and hence the monostable on-time, can be varied by adjusting RV1.

The Q output of IC1 is applied to gates IC1c and d; since the output from IC1a is low when the radio is switched on, the pin 9 output of IC1d is low, and so its output is high. However C9 was charged to near the supply voltage through the emitter-base junction of Q2 when the unit was first connected to the battery, so this high just ensures that the charge on C9 is maintained, keeping Q2 turned off.

However with a low on pin 11 of IC1a, the output of IC1b will be high, thus both inputs to IC1c are high and its output will go low. Now C8 will discharge into pin 4 and as soon as the voltage on the base drops to more than OV7 below the battery voltage, Q1 will turn on, activating RLA1 and driving the motor to wind the aerial up. The sequence of events when the radio is switched off is similar; the unit will not operate immediately however, because C1 will take some time to discharge through R1, thus maintaining a high on IC1a's inputs for about two seconds. This is to prevent the aerial shuttling up and down if it takes two or three attempts to start the motor! Eventually, though, C1 will discharge below the threshold voltage of the Schmitt trigger and the output of IC1a will go high, IC1b output goes low and IC1c output goes high. However C2 was previously charged through R4, D4, so now the voltage at the junction of C2, D2 and D4 goes rapidly to 2V+ but then discharges via D2 and R4.

Meanwhile C3 is charging up through R4 and D5, pulling the trigger input of IC1 below 1/3 V+ and so commencing another timing period. This time, though, IC1c has a low input and so its output is high, keeping Q1 and the up relay turned off. But IC1d has both inputs high, and therefore a low output, so C9 will now discharge into pin 10 of IC1d; when the voltage on the base drops more than OV7 below the battery voltage Q2 turns on RLA2, driving the aerial motor to wind the stick down.

Construction

The Auto-Winder is easily built on a single-sided PCB (see PCB Service page for a ready-made board or build your own using the pattern printed on page 64), following the overlay diagram **Figure 2**. No special precautions are needed beyond the usual handling restrictions applicable to CMOS integrated circuits and the correct orientation of polarised components such as electrolytic capacitors.

When the PCB has been assembled, temporarily connect the relays to the points indicated on the component overlay. The relays have not been mounted on the PCB to allow a wider selection of relay types and to allow more flexibility when it comes to installing the unit in the car. However, the relay contacts should be rated at at least 5A, preferably 10A, since the aerial motor will draw quite a lot of current when it starts up. Then connect a lead to the control input on the PCB and temporarily connect the power supply lines to a 12V battery or power supply (do not connect the aerial motor, yet) and test the unit by touching the control input lead to the positive terminal of the supply. Hold it there, and the Up relay should click on for a moment, then turn off. Remove the control lead from the positive terminal and after a short delay the Down relay should turn on, then release. You can now adjust RV1 to hold the relays on for ▶

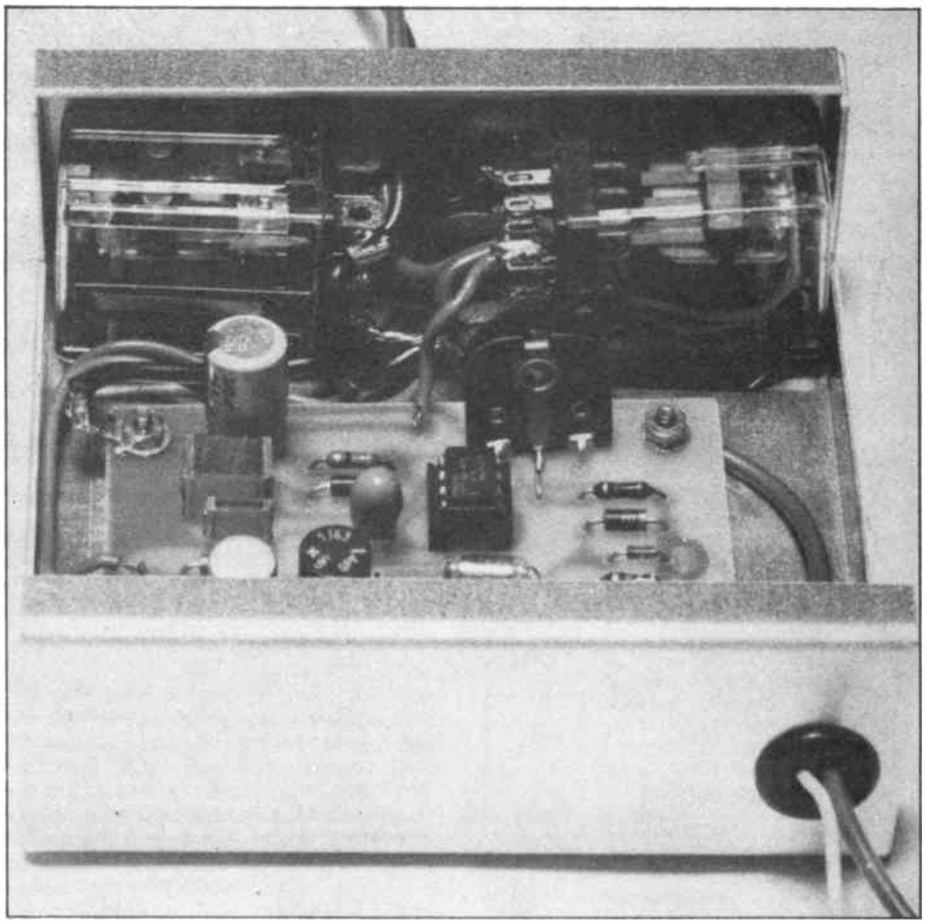
a time approximately equal to that required to wind the aerial up and down to its end-stops

Installation

Where and how you mount the Auto-Winder in the car is going to depend on the space available. The obvious spots are either under the dash or in the engine compartment; the preferred location is under the dash, away from the hot and oily engine.

The relays could be mounted with the PCB inside a metal case, as with the prototype, or separated from the control board; for example the PCB could be installed under the dash, close to the radio, with long leads to the relay coils and short leads again to the aerial motor. However if the relays are mounted with the PCB, be sure to wire them as shown in **Figure 3** before securing them inside the case with strips of double-sided tape.

Once the unit has been installed, all that remains is to make the final adjustment to RV1 so that the motor fully extends and retracts the aerial; then all you have to do is to remember to turn on the radio!



Our prototype was built in a no-frills, open-topped metal case for mounting in an inconspicuous place under the dashboard. The relays were mounted in the case with the PCB.

HE

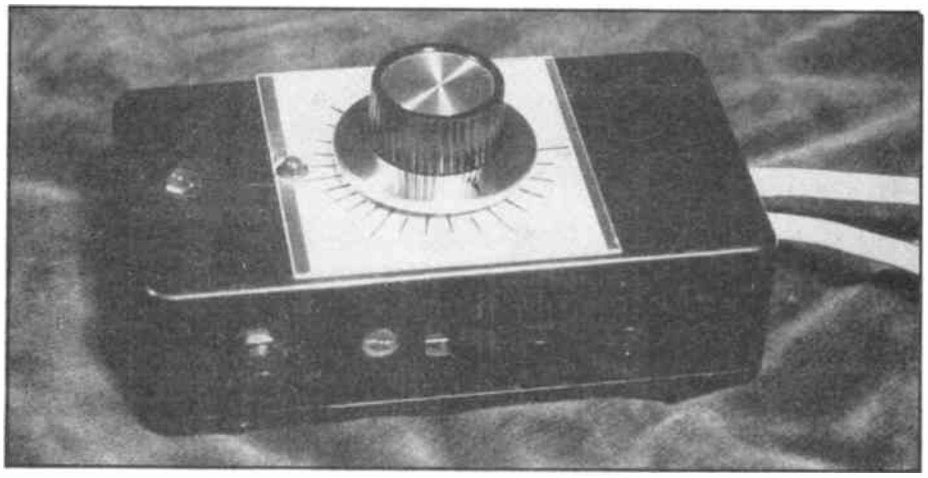
READER'S PROJECT

Simple, untested circuits straight from Hobby readers.

Enlarger Timer

A. Clegg

THIS CIRCUIT differs from most of those published in recent years inasmuch as neither a transformer nor a relay are employed. The preference here is for a lighter, more compact mains switching device — one that can be built for a fifth of the price asked in photographic shops — with an acceptable degree of accuracy and repeatability of the timing period.



The Circuit

The unit is powered from the mains, via a 13A plug fused at 3A, with the mains rectified directly by BR1; thyristor SCR1 provides the load switching and both these components can easily accommodate a 100W bulb.

The remainder of the circuit is powered from a 10V rail provided by dropping resistor R1, Zener diode ZD1 and smoothing capacitor C1. The dropping resistor should be rated at at least 3W for the value shown; it can be reduced, but to no lower than 10k, in which case it should be a 5W type, and the values of R3 and R6 should be decreased to 1kR.

The timing is provided by IC1, a 555. The timing period commences when SW2, a push-to-make momentary action switch, is operated. Then, pin 3 goes high and feeds the potential divider formed by R4, R5; the voltage from the divider switches on the SCR and thus the load. C4 and R7 are included as a precaution against self-latching of the SCR when a high wattage bulb is used but they may be omitted for a normal 60W bulb.

When pin 3 goes high at the start of the timing period, it also drives LED 2 to indicate 'time on', and commences to charge C2 via RV1, which therefore sets the timing period. When C2 charges up to 2/3 of the supply voltage, the timer pin 3 output will go low, causing the SCR to switch off and extinguish LED 2. C2 now discharges into pin 7 of IC1 and the green LED 1 comes on to indicate the timer is in the standby condition. The indicator LEDs are arranged to switch alternately to maintain a reasonably constant current through R1.

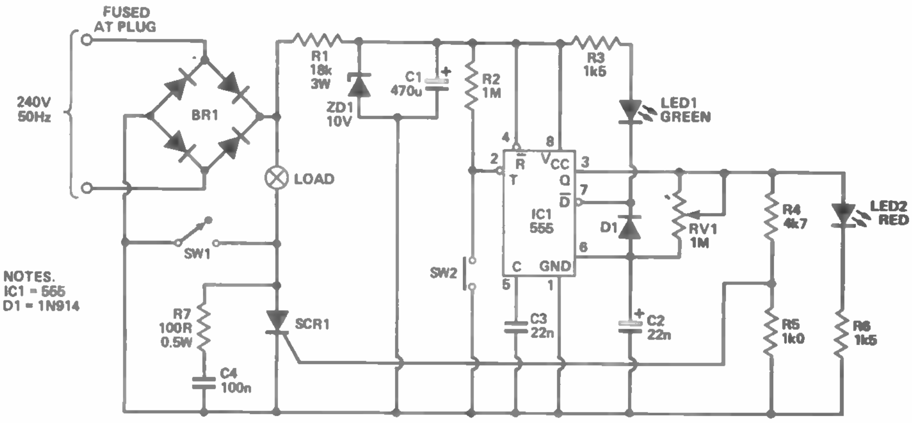


Figure 1. The circuit.

Parts List

RESISTORS
(All ¼ 5% carbon except as noted)
R1 .... 18k 3W (see text)
R2 .... 1MR
R3, 6 .... 1k5
R4 .... 4k7
R5 .... 1kR
R7 .... 100R 0W5

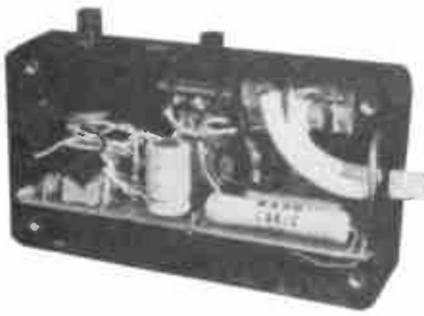
POTENTIOMETERS
RV1 .... 1MR 0W5 linear

CAPACITORS
C1 .... 470u 16V radial electro
C2 .... 22u 16V tantalum
C3 .... 22n radial polyester
C4 .... 100n 400V axial polyester

SEMICONDUCTORS
IC1 555
SCR1 .... C106 400V/4A SCR
BR1 .... WO-04 400V/1A diode
ZD1 .... BZX61C10V 10V 1W3 Zener
D1 .... 1N914
LED1 .... 0.2" green
LED2 .... 0.2" red

MISCELLANEOUS
SW1 .... 240V/1A mains rated slide or toggle
SWS2 .... push-to-make momentary action
Case (see text); PCB; mains flex or 'Figure 8'; control knob, wire solder etc.

BUYLINES .... **page 34**



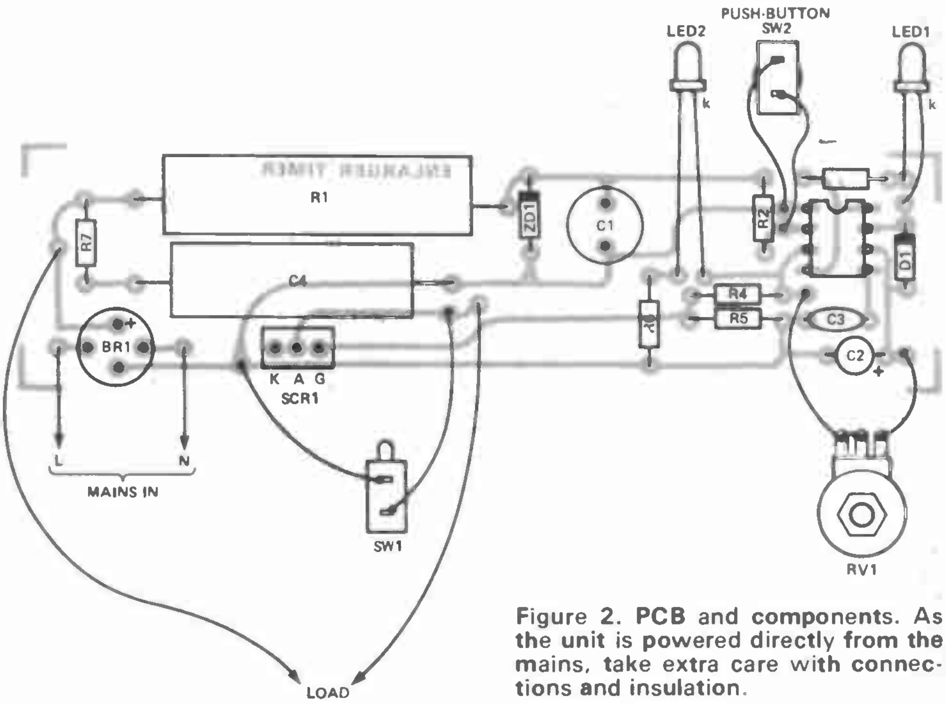


Figure 2. PCB and components. As the unit is powered directly from the mains, take extra care with connections and insulation.

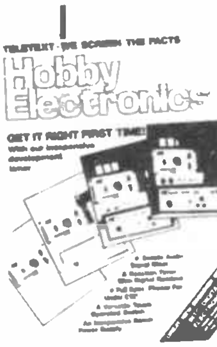
Construction

The circuit can be build on a PCB and housed in an ABS plastic case measuring 112 x 62 x 31mm. As the circuit is powered directly from the mains, without the isolation afforded by a transformer, *every care should be taken with all connections*, soldered or otherwise; a plastic enclosure should be used and the timing capacitor RV1 should have a plastic shaft and a plastic covered control knob. The input and output leads should be securely clamped inside the box to prevent the connections from being pulled apart. If light 'Figure 8' flex is used, tie a knot in the cables inside the box, beside the outlet holes.

An over-ride switch, SW1, is included for setting up the enlarger and a graduated scale can be drawn around the timing control knob. First sketch out the timing positions (0 to 30 seconds) on white card, then use rub-down lettering to mark the positions for 0, 10, 20 and 30 seconds. Finally, cover the card with a piece of thin clear plastic and secure it under the potentiometer with the hex locking nut. **HE**

Hobby Electronics cannot undertake to answer queries on Reader's Projects.

BACKNUMBERS



February 1980
Passion Meter, Win Indicator, Short Circuit Special, Kit Review Special, Into Electronics Construction Part 1.

May 1980
MiniClocks, 5080 Preamp, Model Railway Track Cleaner, 5080 Loudspeakers, Loudspeaker Crossover Design, Radio Controlled Model Survey.

June 1980
Microbe Radio Control System, Egg Timer, Two Watt Amplifier, Fog Horn, Short Circuits, LEDs and LED Displays.

July 1980
Sound-Operated Flash Trigger, 18+18 Car Stereo Booster, Hazard Flasher, Electronics in Photography, Electronic Espionage, Piezo Electricity.

August 1980
EquiTone Car Equaliser, Pass-The-Loop Game, Gaztec Gas Detector, OP-Amp Checker, In-Car Entertainment Survey, Introducing Microprocessors.

September 1980
MicroMixer, Reaction Tester, Guitar Phaser, Development Timer, Teletext Explained, Into Digital Electronics Part 1.

October 1980
Kitchen Timer, Tug 'o' War Game, Light Dimmer, Freezer Alarm, Intruder Alarm, Temperature-Controlled Soldering Iron.

January 1981
Car Rev-Counter, Bench Amplifier, Sound-Into-Light Converter, Chuffer, Electronic Games reviewed.

February 1981
Heartbeat Monitor, High-Impedance Voltmeter, Medium Wave Radio, Two-Tone Train Horn, Audio Signal Generator.

March 1981
Public Address Amplifier, Windscreen Wiper Controller, Bicycle Speedometer, Photographic Timer, Microcassettes.

April 1981
Pre-Amplifier Part 1, Super Siren, Guitar Tremolo, Russian Roulette Game, Doorbell Monitor, Anatomy of a Space Shuttle.

May 1981
Electronic Organ, Voice-Operated Switch, Infra-Red Controller, Pre-Amplifier Part 2, Audio Millivoltmeter.

June 1981
Power Amplifier Part 1, Continuity Checker, Envelope Generator, Early Radio, Gadgets, Games and Kits Supplement.

July 1981
Burglar Alarm, Doorbuzzer, Treble Booster, Electronic Aids for the Disabled, Power Amplifier Part 2.

August 1981
Electronic Ignition, Thermometer, Electronic Organ (final part), RPM Meter, Bench Power Supply, Radio Control Survey, Into Electronic Components Part 1.

All of the 1980 issues, except January and April, are still available together with the remaining issues from 1981.

All backnumbers cost £1.50 each. For those of you who only want copies of articles, we do offer a photocopying service. Each copy costs £1.50 and information as to its title and publication date should be given. Ordering backnumbers and photocopies could hardly be easier, just fill in the coupon, cut it out and send it to the appropriate address.

HOBBY ELECTRONICS BACKNUMBER ORDER FORM TO:

Hobby Electronics

513, London Road,
Thornton Heath,
Surrey, CR4 6AR
England.

Please send me the following items:

NAME ....

ADDRESS ....

....

....

....

Back issues .... at £1.50 each

I enclose £..........

Cheques and Postal Orders should be made payable to ASP Ltd.

HOBBY ELECTRONICS PHOTOCOPY ORDER FORM TO:

Hobby Electronics

145 Charing Cross Road,
London,
WC2H 0EE

Please send me the following items:

NAME ....

ADDRESS ....

....

....

Photocopies of .... in the

.... issue at £1.50 each

I enclose £..........

Cheques and Postal Orders should be made payable to ASP Ltd.

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.

NOW you can buy your PCBs direct from HE. All (non-copyright) PCBs will be available automatically from the HE PCB Service. Each board is produced from the same master as that used for the published design and so each will be a true copy, finished to a high standard.

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.

Board	Project	Price
June 81		
HE/8106/1	Envelope Generator	£1.87
HE/8106/2	Organ 2	£2.53
July 81		
HE/8107/1	Organ 3	£6.00
HE/8107/2	Organ 4	£6.00
HE/8107/3	Ultrasound Burglar Alarm	£2.53
August 81		
HE/8108/1	RPM Meter	£1.77
HE/8108/2	Thermometer	£1.67
September 81		
HE/8109/1	Power Pack	£1.69
HE/8109/2	Reaction Tester Game	£1.71
HE/8109/3	'Diana' Metal Detector	£3.31
October 81		
HE/8110/1	Combination Lock	£2.65
November 81		
HE/8111/1&2	Sound Torch (Set of Two)	£5.31
December 81		
HE/8112/1	Pedalboard Organ	£5.64
January 82		
HE/8201/1	Intelligent NiCad Charger	£2.83
February 82		
HE/8202/1	Relay Driver	£2.07
HE/8202/2	Mast-Head Amp	£1.08
March 82		
HE/8203/1	Digital Dice	£1.40
April 82		
HE/8204/1	Digital Capacitance Meter	£4.02
HE/8204/2	Dual Engine Driver	£3.27
HE/8204/3	Bike Alarm	£2.45
May 82		
HE/8205/1&2	Digital Thermometer (Set of Two)	£4.62
HE/8205/3	Echo-Reverb	£5.63
HE/8205/4	Cable Tracker	£1.85
June 82		
HE/8206/1	Power Supply Design	£2.48
HE/8206/2	Auto-Wah	£3.08
HE/8206/3	Auto Greenhouse Sprinkler	£3.45
HE/8206/4&5	Telephone Timer (Set of Two)	£6.50
July 82		
HE/8207/1	Tanover	£2.13
HE/8207/2	TVI Filter	£1.78
HE/8207/3	Computer PSU	£7.68
HE/8207/4	Solar Radio	£1.98
August 82		
HE/8208/1&2	Digital Millivoltmeter (Set of Two)	£4.34
HE/8208/3&4	Audio Analyser (Set of Two)	£11.55
September 82		
HE/8209/1&2	Signal lights	
	Main Module	£1.96
	Junction Module	£1.70
HE/8209/3	ZX Interface	£3.34
HE/8209/4	Slot Car Controller	£1.98
October 82		
HE/8210/1	Flash Point Alarm	£2.13
HE/8210/2	Negative Voltage Generator	£1.49
HE/8210/3	Squelch Unit	£2.52
November 82		
HE/8211/1	Pedometer/Odometer	£2.13
December 82		
HE/8212/1	Phase Four	£2.83
HE/8212/2	Microlog	£3.98
HE/8212/3&4	Tape/Slide (Set of Two)	£5.26
HE/8212/5	TV Amp	£5.70
HE/8212/6	Lofty	£2.61
HE/8212/7	Noise Gate	£3.60
HE/8212/8	Low Cost Alarm	£2.30
January 83		
HE/8301/1	Chip Probe	£1.82
HE/8301/2	Switched Mode Regulator	£1.96
February 83		
HE/8302/1	Incremental Timer	£7.13
HE/8302/2	DigiTester PSU	£6.70
March 83		
HE/8303/1	Loudspeaker Protector	£2.51
HE/8303/2	Overvolt Cutout	£2.25
April 83		
HE/8304/1	6502 EPROMMER	£7.18
HE/8304/2&3	Ducker	
	Main Board	£3.56
	Preamp Board	£2.31
HE/8304/4	Power Down	£2.10
May 83		
HE/8203/1	BBC Interface	£4.82
HE/8305/3	Stall Thief	£2.50
HE/8305/4	Auto-Test	£2.50
June 83		
HE/8306/1	Sinclair Sound Board	£2.80
HE/8306/2	CB Rap Latch	£1.65
HE/8306/3	Bat Light (Car battery monitor)	£2.25
HE/8306/4	Traffic Light Toy	£2.56
July 83		
HE/8307/1	Soft Fuzz	£2.77
August 83		
HE/8308/1	Whistle Switch	£4.40
HE/8308/2	Ace Interface	£352
HE/8308/3	Enlarger Timer	£292
HE8308/4	Auto-Winder	£298

PLACE an order for your PCBs using the form below (or a piece of plain paper if you prefer not to cut the magazine), then simply wait for your PCBs to drop through your letterbox, protected by a Jiffy bag.

HE PCB Service, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC2H 0EE

I enclose a cheque/Postal Order made payable to ASP Ltd, for the amount shown below Price.

OR

I wish to pay by Barclaycard. Please charge my account number

. . . .

VISA

OR

I wish to pay by Access. Please charge to my account number

. . . .

SIGNATURE . . . .

NAME . . . .
(BLOCK CAPITALS)

ADDRESS . . . .
(BLOCK CAPITALS)

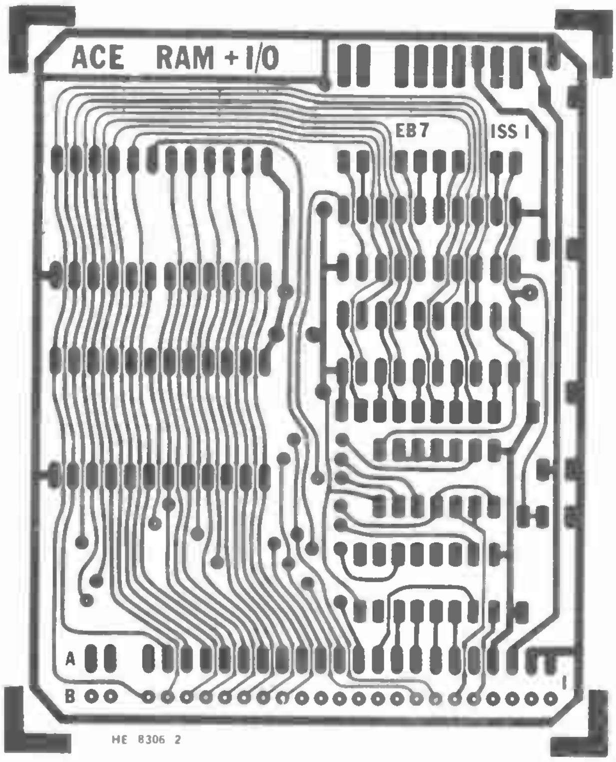
. . . .

. . . .

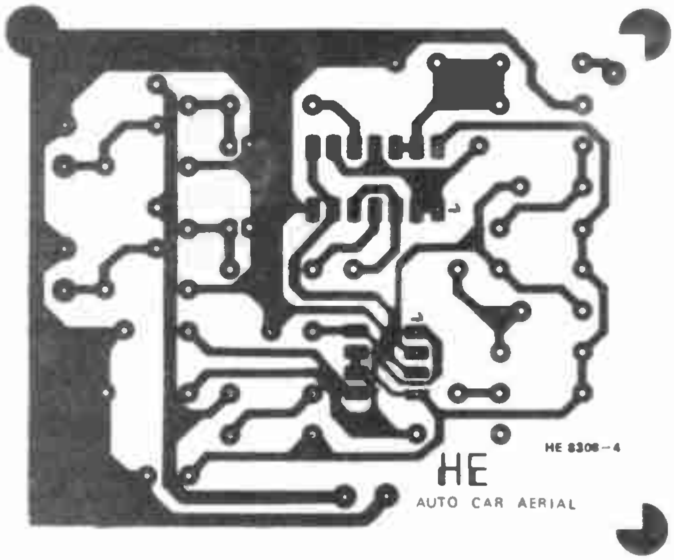
Please allow 21 days for delivery

Boards Required	Price
Add 45p p&p	0.45
Total Enclosed £	

PCB FOIL PATTERNS

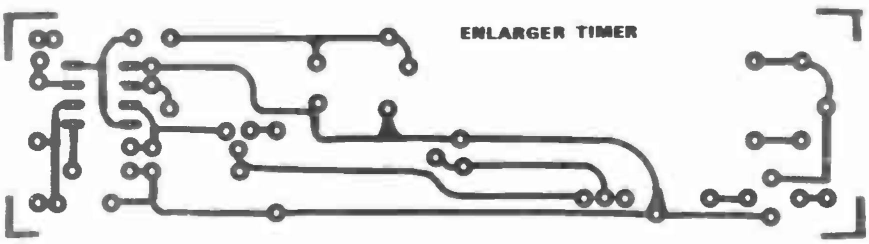


Above.
The ACE I/O board. Take care, before soldering in components, that the fine tracks have not fused together at any point, and that you have drilled out all the connection pads.

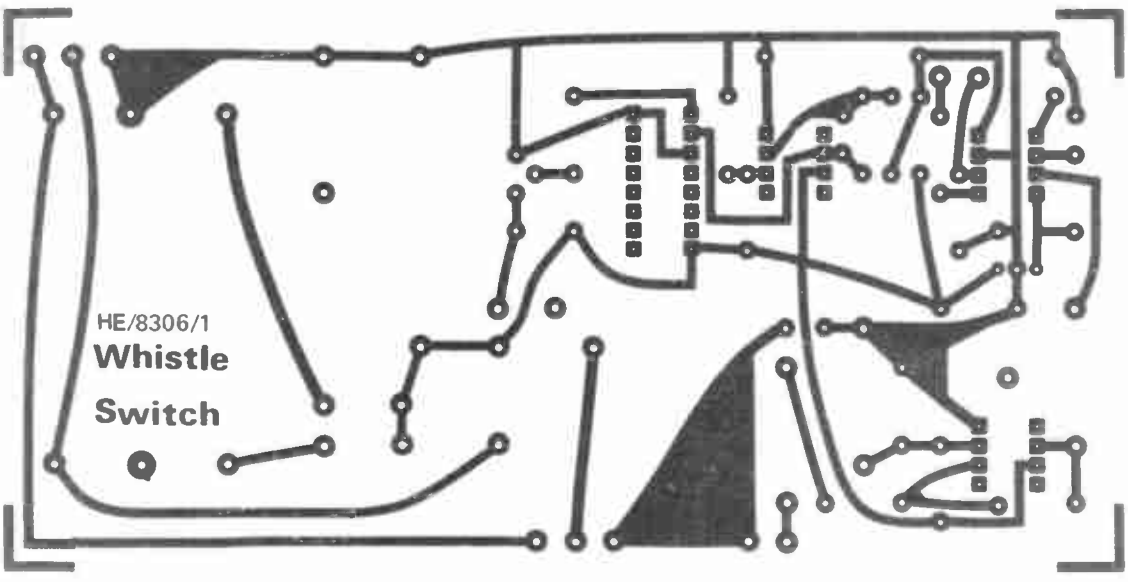


Above. The Auto Winder PCB foil.

Below. The Photographic Enlarger/Timer PCB.



Below. The HE Whistle Switch.



Lineage:
30p per word (minimum 15 words)
Semi-display £7.50 per single column centimetre
Ring for information on series bookings/discounts

All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request)

01-437 1002
EXT 282

Send your requirements to:
Julie Bates,
ASP Ltd.,
145 Charing Cross Road,
London WC2H 0EF

PLANS 'N DESIGN

AMAZING ELECTRONIC PLANS. Lasers, Superpowered Cutting Rifle, Pistol, Light Show, Ultrasonic Force Fields, Pocket Defence Weaponry, Giant Tesla, Satellite TV Pyrotechnics, 150 more projects. Catalogue £1 (refundable) — from Plancentre, Bromyard Road Industrial Estate, Ledbury HR8.

BOOKS & PUBLICATIONS

PARAPHYSICS JOURNAL (Russian translations). Psychotronics, Kirlianography, heliphonic music telekinetics. Computer software. SAE 4 x 9":— Paralab, Downton Wilts.

MACHINE CODE. If you are at all interested in learning more about this invaluable tool, then join the ZX machine code users club. Send £1.00 for trial issue of club magazine "Micro Arts" to: Toni Baker, 5 Dumergue Avenue, Queenborough, Kent ME11 5BT. Cheques payable to Micro Arts.

ALARMS

CENTURION ALARMS

We manufacture, you save £ £ £'s

Send s.a.e. or phone for our Free list of professional D.I.Y. Burglar Alarm Equipment and accessories.
Discount up to 20% off list prices, eg. Control Equipment from £15.98, Decoy Bell Boxes from £5.95 inc.

TRADE ENQUIRIES WELCOME
0484-21000
or 0484 35527 (24 hr. ans.)
CENTURION ALARMS (ETI)
265 Wakefield Road, Huddersfield HD5 9BE. W. Yorkshire
Access & Visa Orders Welcomed

BURGLAR ALARM EQUIPMENT. Please visit our 2,000 sq. ft. showrooms or write or phone for your free catalogue. C.W.A.S. Ltd. 100 Rooley Avenue, Bradford BD6 1DB. Telephone 0274-308920.

COMPONENTS

MAIDSTONE ELECTRONIC components shop. Thyronics Control System, 8 Sandling Road, Maidstone, Kent. Maidstone 675354.

WAVEBANDS

Auto Electronics,
103 Coventry Street,
Kidderminster
Tel: (0562) 2179

Brand new components by return post or ring with Access/Barclaycard number for same day despatch.
All manufacturers guaranteed new stock. All at most competitive prices. Catalogue available only 50p. All prices inclusive of VAT.

IN STOCK New telephone plugs and sockets also ZX81 plugs and spectrum plugs and wide range of burglar alarm equipment and all accessories for same plus large range of components. Shudehill Supply Co. Ltd., 53 Shudehill, Manchester 4. 061-834 1449.

KITS

ELECTRONIC kits for sale: Morse Practice £4.10, Dice £8.10. SAE for details. Bee Micro, 33 Bevendean Crescent, Brighton, E Sussex.

PRINTED CIRCUITS. Make your own simply, cheaply and quickly! Golden Fotolac light-sensitive lacquer — now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric chloride 55p. Clear acetate sheet for master 14p. Copper-clad fibreglass board, approx. 1mm thick £1.75 sq. ft. Post/packing 75p. White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall.

DIGITAL WATCH replacement parts, batteries, displays, backlights, etc. Also reports publications charts. S.A.E. for full list: Profords Copners Drive, Holmer Green, Bucks HP15 6SGE.

SOFTWARE GAMES

FANTASTIC 16K ZX81. Adventure £3. Fight monsters and collect as many treasures as possible. Only from Softbus, 6 Aston Mead, Salisbury, Wilts.

SOFTWARE APPLICATIONS

SPY CASSETTE. Amazing cassette will allow you to stop, list or copy any previously unstoppable tape. Includes two free utilities. State if for ZX81 or Spectrum. Send just £3. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

EQUIPMENT

AERIAL AMPLIFIERS Improve weak television reception. Price £6.70. S.A.E. for leaflets. Electronic Mailorder, Ramsbottom, Lancashire BL0 9AGH.

U.V. Light exposer unit for use in prep. of Photo-resist P.C.B's. Attractive wooden construction with exposer area of 250 x 150mm. Case 350x250x-95mm 240V operation. Only £37.00 p&p. Send cheque to V.E.P. Ltd., 5 Hewens Road, Uxbridge, UB10 0FR.

BURGLAR ALARM EQUIPMENT. Please visit our 2,000 sq. ft. showrooms or write or phone for your free catalogue. C.W.A.S. Ltd. 100 Rooley Avenue, Bradford BD6 1DB. Telephone 0274-308920.

FOR SALE

QUARTZ L.C.D. CLOCK. Only 1½" diameter. Sticks anywhere. Only £2.80. p&p 30p. Taits Mail Order, 31 Lime Grove, Addlestone, Surrey.

KIA RETURN AN AD No. 9 ... Quality 120 Watt Fibreglass. TO3 Poweramp Modules + Heatsinking, ... £7.95 + Advert 9 ... 8 Cunliffe Road, Ilkley.

WANTED

WANTED. Source of burglar alarm PCB's. Please send details of cost and type to Steve Lawton, Midland Works, Filey Ave, Royston, Barnsley, S. Yorks.

For all your classified needs contact Julie on **01-437-1002 Ext 282**

PROJECTS

BOXES
To House Your Project
Plastic 80mm x 62mm x 40mm 95p
100mm x 75mm x 40mm £1.15
120mm x 100mm x 45mm £1.30
Many other sizes in Aluminium and Plastic.
S.A.E. for lists. Price includes VAT. Add 30p p&p.
ELECTRONICS CENTRE
28 Station Road,
Dovercourt, Essex.

SERVICES

T-SHIRTS FOR SUMMER!
"I'm user friendly", "Have you seen my peripherals?" And many more. £3.25. White or blue. S. M. L.
One Per Cent Screens
12 Star Lane, Great Wakering, Essex.

TRANSISTORS

SPECIAL OFFER of unmarked transistors (each type of transistor supplied in separate, marked bag). BC338, BC237B, BC239B, BC115, BC173B, BC182B, BC238B. Only 50p for 10 (excluding VAT). Add 25p p&p. Access/Barclaycard accepted. Van Gelder Ltd, P.O. Box 10, Southend-on-Sea, SS2 6Q6.

CLASSIFIED ADVERTISEMENT — ORDER FORM

**Advertise nationally in these columns to over 100,000 readers for only 30p per word (minimum charge 15 words).
Simply print your message in the coupon and send with your cheque or postal order made payable to
Argus Specialist Publications Ltd to:**

CLASSIFIED DEPT., HOBBY ELECTRONICS

145 Charing Cross Rd., London WC2H 0EE. Telephone: 01-437 1002

Please indicate classification required.

Name ....

Address ....

....

Tel. No. (Day) ....

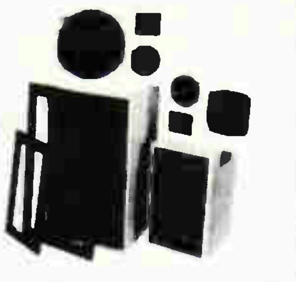
WE TAKE ACCESS AND BARCLAYCARD

Please place my advert in H.E. for ☐ months. Please indicate number of insertions required.

HE ADVERTISERS INDEX AUGUST 1983

A.D.Electronics	18
Ambit International	IFC
Audio Electronics	27
Bicc Vero	30
Bi-pak	30
B K Electronics	IBC
B.N.R.S	46,54
Branime Marketing	54
Circuit Board Components	30
Cricklewood	10
Dataplus Developements	61
Durrant Radio	45
Electronize Design	59
Elen Electronics	45
Europa Electronics	54
Hazzlewood Electronics	25
Hemmings Electronics	58
H.G Electronics	18
Horizon Electronics	39
ICS	61
ILP	32,33
Kelan Engineering	27
Litesold	45
Magenta Electronics	19
Parndon Electronics	39
Racom	18
Rapid Electronics	35
Brian J Reed	39
Sandwell Plant	18
Silica Shop	4,5,OBC
Sparkrite	51
S&R Brewster	25
Technomatic	17
T K Electronics	25
Thandar Electronics	50
Twyford Electronics	24

MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise **Mullard** woofer (8" or 5") with foam surround and aluminium voice coil. **Mullard 3" high power domed tweeter. B.K.E.** built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.

8" 40W system — recommended cabinet size 240 × 216 × 445mm
Price £14.90 each + £2.00 P & P.

5" 30W system — recommended cabinet size 160 × 175 × 295mm
Price £13.90 each + £1.50 P 8 P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.
8" system cabinet kit £8.00 each + £2.50 P & P.
5" system cabinet kit £7.00 each + £2.00 P & P.

OMP 80 LOUDSPEAKER

The very best in quality and value.

Ported tuned cabinet in hard-wearing black vynide with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz-20KHz; Size: 20in x 15in x 12in; Weight: 30 pounds.

Price: **£49.00 each**
£90 per pair
Carriage: £5 each £7 per pair

BK ELECTRONICS

Prompt Deliveries
VAT inclusive prices
Audio Equipment
Test Equipment
by
Thandar
and
Leader

STEREO CASSETTE TAPE DECK MODULE

Comprising of a top panel and tape mechanism coupled to a record play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.

Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1% **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5¼in × 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.

Price £26.70 + £2.50 postage and packing.

Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.50.

PANTEC

HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 5 x 46 x 14mm (9 volt) **Price: £7.99p**

DIGITAL THERMOMETER -9.9°C to +99.9°C. LED display. Complete with sensor. 70 x 70 mm (9 volt) **Price: £27.60p**

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled. professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) **Price: £12.49p**

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHZ Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22 mm 9/12 volt) **Price: £16.49** Transmitter 80 x 50 x 15 mm (9/12 volt) **Price £10.29** P&P All Kits +50p. S.A.E. for complete list.

3 watt FM Transmitter

LOUDSPEAKERS

THREE QUALITY POWER LOUDSPEAKERS (15", 12" and 8" See Photo) **Ideal for both Hi-Fi and Disco applications.** All units have attractive cast aluminium (ground finish) fixing escutcheons

Specification and Prices.

15" 100 watt R.M.S. Impedance 8 ohms 50 oz. magnet 2" aluminium voice coil Res Freq. 20 Hz. Freq Resp to 2.5KHz Sens 97dB. Price. £34.00 each + £3.00 P&P

12" 100 watt R.M.S. Impedance 8 ohms 50 oz magnet. 2" aluminium voice coil. Res Freq. 25Hz. Freq Resp. to 4 KHz. Sens 95dB. Price. £24.50 each + £3.00 P&P

8" 50 watt R.M.S. Impedance 8 ohms. 20 oz. magnet 1½" aluminium voice coil. Res Freq. 40Hz. Freq. Resp to 6 KHz. Sens 92dB Black Cone. Price: £9.50 each. Also available with black protective grille Price. £9.99 each P&P £1.50

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £22.00 + £3** carriage.

12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. **Price £22 + £3** carriage.

15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. **Price: £47 + £4** carriage.

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm

This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required

Price £31.35 each. £2.50 P&P

OMP POWER AMPLIFIER MODULE

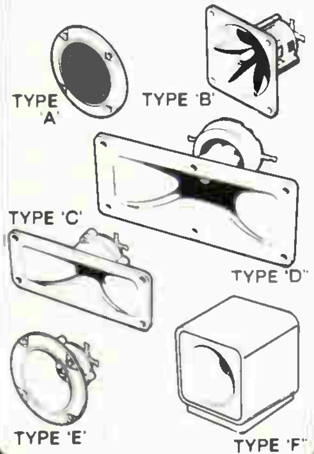
New model.
Improved specification

NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module **complete** with integral heat sink. toroidal transformer power supply and glass fibre p.c.b. assembly. Incorporates drive circuit to power a compatible LED Vu meter. New **improved** *specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.*

SPECIFICATION
Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16 ohms.
Frequency Response:— 15Hz - 30KHz -3dB.
T.H.D.:— 0.01%.
S.N.R. (Unweighted):— -118dB ±3.5dB
Sensitivity for Max Output:— 500mV @ 10K.
Size:— 360 x 115 x 72 mm
Price:— £31.99 + £2.00 P&P.
Vu Meter Price:— £7.00 + 50p P&P.

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series) **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers **Price £4.29 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.99 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.99 each.**

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos **Price £7.99 each.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.99 each.**

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each**

P&P 20p ea. (or SAE for Piezo leaflets).

HOME PROTECTION SYSTEM

Better to be **'Alarmed'** then terrified.

Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**

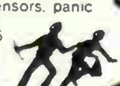
Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.

Indoor alarm — Electronic swept freq. siren. 104dB output.

Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE OVER £100 Usual price £228.85 — **B.K.E.'s BARGAIN PRICE £128.00** + £5.00 P&P.
S.A.E. for colour brochure.



SAFGAN DT-520 DUAL TRACE OSCILLOSCOPE. *New British model. 12 month guarantee.* 20 MHz Band Width. **Specification:** ★ CH1, CH2. 5mV/div-20V/div. ★ Time Base: 1 Sec/div-100ns/div ★ XY Facility: Matched XY inputs. ★ Trigger. Level control ± slope selection. ★ Auto, normal, TV Triggering ★ Z-Modulation. ★ CAL output 1V 1KHz. ★ Sweep output 0-9V ★ Graticule blue ruled 10 x 8 cm (5" C.R.T.) Very sharp trace. ★ Size. H235mm, W177mm, D360mm ★ Weight: 6.5 Kgs ★ Supply: 200-240 V. 40-60Hz ★ Price. £241.50 — FREE Securicor Delivery *Probes.* X1 £8.05. X1/X10 Switched £10.93.

FREE SECURICOR DELIVERY

B.K. ELECTRONICS

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX, SS2 6TR

★ SAE for current lists ★ Official orders welcome ★ All prices include VAT ★ Mail order only ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by prior appointment, please phone 0702 527572

100 FREE PROGRAMS

FROM SILICA SHOP — WITH EVERY PURCHASE OF AN

ATARI 400 800

ATARI

ATARI PRICES REDUCED!

We at Silica Shop are pleased to announce some fantastic reductions in the prices of the Atari 400 800 personal computers. We believe that the Atari at its new price will become the U.K.'s most popular personal computer and have therefore set up the Silica Atari Users Club. This club already has a library of over 500 programs and with your purchase of a 400 or 800 computer we will give you the first 100 free of charge. There are also over 350 professionally written games and utility programs, some are listed below. Complete the reply coupon and we'll send you full details. Alternatively give us a ring on 01-301 1111 or 01-309 1111.

ATARI 400 with 16K	**£149**
ATARI 400 with 48K	**£198**
ATARI 800 with 48K	**£299**

400/800 SOFTWARE & PERIPHERALS

Don't buy a T.V. game! Buy an Atari 400 personal computer and a game cartridge and that's all you'll need. Later on you can buy the Basic Programming cartridge (£35) and try your hand at programming using the easy to learn BASIC language. Or if you are interested in business applications, you can buy the Atari 800 + Disk Drive + Printer together with a selection of business packages.

Silica Shop have put together a full catalogue and price list giving details of all the peripherals as well as the extensive range of software that is now available for the Atari 400 800. The Atari is now one of the best supported personal computers. Send NOW for Silica Shop's catalogue and price list as well as details on our users club.

THE FOLLOWING IS JUST A SMALL SELECTION FROM THE RANGE OF ITEMS AVAILABLE:

ACCESSORIES
Cables
Cassettes
Diskettes
Joysticks
Le Stick Joystick
Misc Supplies
Paddles

ADVENTURE INT
Scott Adams Adv
No 1 Adventureland
No 2 Pirate Adv
No 3 Mission Imp
No 4 Voodoo Cast
No 5 The Count
No 6 Strange Ody
No 7 Mystery Fun
No 8 Pyramid of D
No 9 Ghost Town
No 10 Sav Island 1
No 11 Sav Island 2
No 12 Golden Voy
Angle Worms
Deflections
Galactic Empire
Galactic Trader
Lunar Lander
Mountain Shoot
Rearguard
Star Flite
Sunday Golf

AUTOMATED SIMULATIONS
Crush Crumble Cmp
Datestones of Ryn
Dragons Eye
Invasion Orion
Rescue at Rigel
Ricochet
Star Warrior
Temple of Apshai
Upper Reaches Aps

BOOKS
Basic Ref Manual
Compute Atari DOS
Compute Bk Atari
Compute Magazine
De Re Atari
DOS Utilities List
DOS2 Manual
Misc Atari Books
Op System Listing
Wiley Manual

BUSINESS
Calculator
Database Managemt
Decision Maker
Graph It
Invoicing
Librarian
Mort & Loan Anal
Nominal Ledger
Payroll
Personal Finl Mgmt
Purchase Ledger
Sales Ledger
Statistics 1
Stock Control
Telelink 1
Visicalc
Weekly Planner
Word Processor

CRYSTALWARE
Beneath The Pyram
Fantasyland 2041
Galactic Quest
House Of Usher
Sands Of Mars
Waterloo
World War III

DYNACOMP
Alpha Fighter
Chompelo
Crystals
Forest Fire
Intruder Alert
Monarch
Moonprobe
Moving Maze
Nominoes Jigsaw
Rings of The Emp
Space Tilt
Space Trap
Stud Poker
Triple Blockade

EDUCATION from APX
Algicalc
Atlas of Canada
Cubbyholes
Elementary Biology
Frogmaster
Hickory Dickory
Inst Comptg Dem
Lemonade
Letterman
Mapware
Maths-Tac Toe
Metric & Prob Solvg
Mugwump
Music Terms/Notatn
Musical Computer
My First Alphabet
Number Blast
Polycalc
Presidents Of U S
Quiz Master
Starware
Stereo 3D Graphics
Three R Math Sys
Video Math Flash
Wordmaker

EDUCATION from ATARI
Conv French
Conv German
Conv Italian
Conv Spanish
Energy Czar
European C & Caps
Hangman
Invit To Prog 1 2 3
Kingdom
Music Composer
Scram
States & Capitals
Touch Typing

EMI SOFTWARE
British Heritage
Cribbage Dominoes
Darts
European Scene Jig
Hickory Dickory
Humpty Dumpty
Jumbo Jet Lander
Snooker & Billiards
Submarine Commdr
Super Cubes & Tilt
Tournament Pool

ENTERTAINMENT from APX
Alien Egg
Anthill
Attank
Avalanche
Babel
Blackjack Casino
Block Buster
Block 'Em
Bumper Pool
Castle
Centurion
Checker King
Chinese Puzzle
Codecracker
Comedy Diskette
Dice Poker
Dog Daze
Domination
Downhill
Eastern Front
Galahad & Holy Grl
Graphics/Sound
Jax-O
Jukebox
Lookahead
Memory Match
Midas Touch
Minotaur
Outlaw/Howitzer
Preschool Games
Pro Bowling
Pushover
Rabbotz
Reversi II
Salmon Run
747 Landing Simul
Seven Card Stud
Sleazy Adventure
Solitaire
Space Chase
Space Trek
Sultans Palace
Tact Trek
Terry
Wizards Gold
Wizards Revenge

ENTERTAINMENT from ATARI
Asteroids
Basketball
Blackjack
Centipede
Chess
Entertainment Kit
Missile Command
Pac Man
Space Invaders
Star Raiders
Super Breakout
Video Easel

ON LINE SYSTEMS
Crossfire
Frogger
Jawbreaker
Mission Asteroid
Mouskattack
Threshold
Ulysses/Golden Fl
Wizard & Princess

PERIPHERALS
Centronics Printers
Disk Drive
Epson Printers
Program Recorder
RS232 Interface
Thermal Printer
16K Memory RAM
32K Memory RAM

PERSONAL INT from APX
Adv Music System
Banner Generator
Blackjack Tutor
Going To The Dogs
Keyboard Organ
Morse Code Tutor
Personal Fitness Prg
Player Piano
Sketchpad

PROGRAMMING AIDS from Atari
Assembler Editor
Dsembler (APX)
Microsoft Basic
Pascal (APX)
Pilot (Consumer)
Pilot (Educator)
Programming Kit

SANTA CRUZ
Basics of Animation
Bobs Business
Display Lists
Graphics Machine
Kids 1 & 2
Horizontal Scrolling
Master Memory Map
Mini Word Processor
Page Flipping
Player Missile Gr
Player Piano
Sounds
Vertical Scrolling

SILICA CLUB
Over 500 programs write for details

FOR FREE BROCHURES – TEL: 01-301 1111

SILICA SHOP LIMITED
Dept HE 08 83 1-4 The Mews, Hatherley Road, Sidcup, Kent DA14 4DX Telephone 01-301 1111 or 01-309 1111

SILICA SHOP

FREE LITERATURE

I am interested in purchasing an Atari 400/800 computer and would like to receive copies of your brochure and test reports as well as your price list covering all of the available Hardware and Software

Name ....

Address ....

....

....

Postcode ....

HE 8 83