AN ARGUS SPECIALIST PUBLICATION

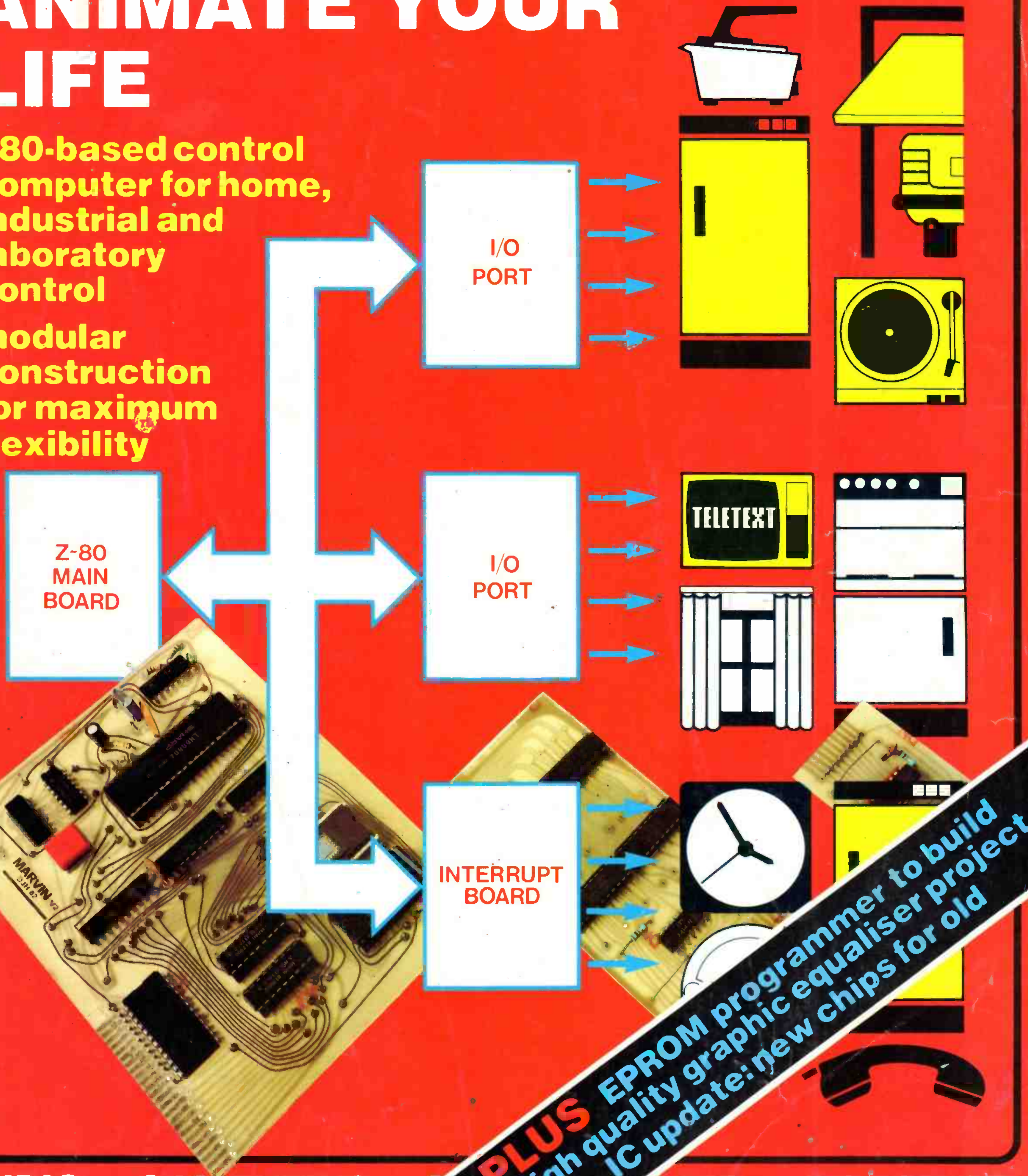
electronics today INTERNATIONAL

AUGUST 1983 85p

ANIMATE YOUR LIFE

Z80-based control computer for home, industrial and laboratory control

modular construction for maximum flexibility



PLUS EPROM programmer to build
High quality graphic equaliser project
IC update: new chips for old

..AUDIO....COMPUTING... ...ADIO....ROBOTICS..

Star sounds**
Star quality**
Star features**

Free SECURICOR DELIVERY on all orders over £100 (UK mainland only) Add just £2.50 on lower price orders

BIG NEWS ABOUT OUR LATEST ADVANCES IN ROBOTICS SEE INSIDE BACK COVER

DJ90 Stereo Mixer — this is a really versatile new mixer that enables the constructor DJ to produce a professional performance every time. There are two stereo inputs for magnetic cartridges, a stereo auxiliary input and mike input. Other 'plus' features are auto-panning for fast or slow slider controls, multi-mixing, ducking, interrupt, input modulation, in short everything . . . the whole works — AND — under £100 complete! Complete kit **£97.50** + VAT

TRANSCENDENT 2000 — Although only a 3 octave keyboard the '2000' features the same design ingenuity, careful engineering and quality components of its larger brethren. The kit is well within the scope of the first time builder — buy it, build it — play it! You will know you have made the right choice.
Complete kit **£165.00** + VAT

SALES COUNTER Collect your order from the factory. Open 9-12/1-4.30 Mon-Thurs. Easy parking, no waiting

This versatile modular mixer, featured as a constructional article in Practical Electronics can be built up to a maximum of 24 inputs, 4 outputs and an auxiliary channel. Each input channel has Mic and Line inputs, variable gain, bass and treble controls and a parametric middle frequency equalizer. There are send and return jacks, auxiliary, pan and fader controls and output and group switching. The output channels have PPM displays and record and studio outputs. The auxiliary channel also has a PPM display and there is a headphone monitor jack and a built-in talk-back microphone. The mixer modules plug into base units each of which takes up to 6 channels. To eliminate hum, the power supply is in a separate cabinet.

KIT PRICES

Input channel	£19.90	Base unit and wooden front	£27.50
Output channel	£18.50	Pair of mahogany end cheeks	£12.50
Auxiliary channel	£22.50	Power Supply and cabinet	£19.50
Blank Panel	£3.00		

All prices are VAT exclusive

Digital Delay Line — With its ability to give delay times from 1.6 mSecs to up to 1.6 secs. Many powerful effects including phasing, flangine, A.D.T., chorus, echo &

vibrato are obtained. The basic kit is extended in 400 mS steps up to 1.6 secs. Simply by adding more parts to the PCB. Compare with units costing over £1,000!
Complete kit (400 mS delay)
£130 + VAT
Parts for extra 400 mS delay
£9.50 + VAT

Free Soldering Practise Kit on request with your first kit — useful tips, well illustrated.

TRANSCENDENT POLYSYNTH — A four octave polyphonic synthesiser with outstanding design characteristics and versatility and performance to match.
Complete kit **£275.00** plus VAT (single voice)
Extra voice (up to three more) **£42.00** plus VAT

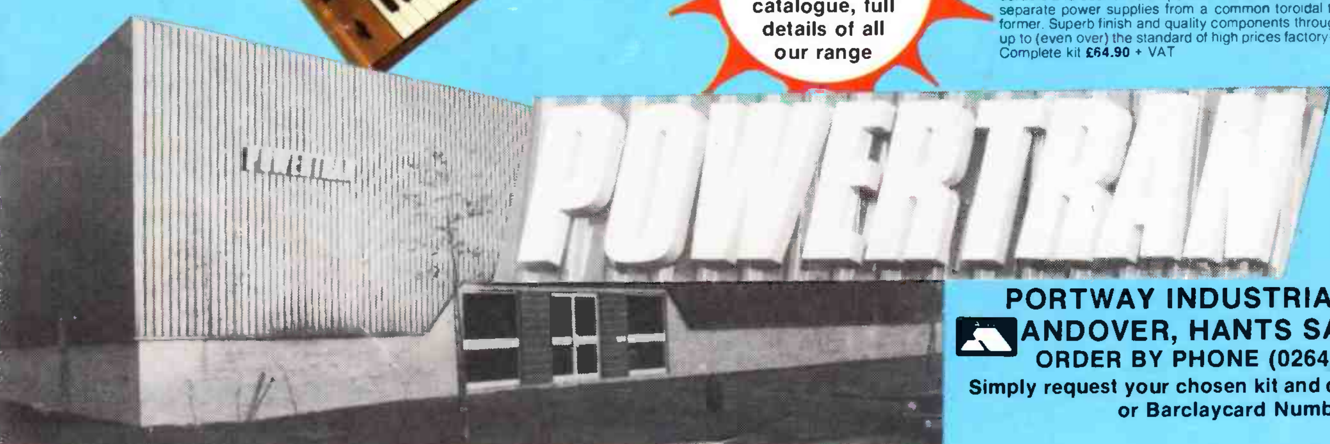
MPA 200 — is a low price, high power 100W amplifier, its smart styling, professional appearance and performance, make it one of our most popular designs. With adaptable inputs the mixer accepts a variety of sources yet straightforward construction makes it ideal for the first time builder. Complete kit **£49.90** + VAT.

Chromatheque 5000 — a 5 channel lighting system powerful enough for professional discos yet controllable for home-effects. Sound to light, strobe to music level, random or sequential effects — each channel can handle up to 500W yet minimal wiring is needed with our unique single board design. Complete kit **£49.50** + VAT

ETI VOCODER — 14 channels, each with independent level control, for maximum versatility and intelligibility; Two input amplifiers — for speech/excitation — each with level control and tone control. The Vocoder is a powerful yet flexible machine that is interesting to build and thanks to our easy to follow construction manual, is within the capability of most enthusiasts. Complete kit **£175.00** + VAT

SP2 200 twice the power with two of the reliable, durable and economic amps from the MPA 200; fed by separate power supplies from a common toroidal transformer. Superb finish and quality components throughout — up to (even over) the standard of high prices factory-built units! Complete kit **£64.90** + VAT

Component packs for most kits are available See our great free catalogue, full details of all our range



WORLD LEADERS IN ELECTRONIC KIT DESIGN AND SUPPLY

PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SA10 3NM.
ORDER BY PHONE (0264) 64455

Simply request your chosen kit and quote your Access or Barclaycard Number.

electronics today INTERNATIONAL

AUGUST 1983 VOL 12 NO 8

Dave Bradshaw: Editor
Phil Walker: Project Editor
Jerry Fowler: Technical Illustrator
David Kitchener: Advertisement Manager
Joanne James: Assistant Advertisement Manager
Ron Harris B.Sc: Managing Editor
T.J. Connell: Managing Director

PUBLISHED BY:
Argus Specialist Publications Ltd.,
145 Charing Cross Road, London WC2H 0EE.
DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.,
12-18 Paul Street, London EC2A 4JS
(British Isles)
PRINTED BY:
QB Limited, Colchester.
COVERS PRINTED BY:
Alabaster Passmore.

OVERSEAS EDITIONS and their EDITORS
AUSTRALIA — Roger Harrison
CANADA — Halvor Moorshead
GERMANY — Udo Wittig
HOLLAND — Anton Kriegsman

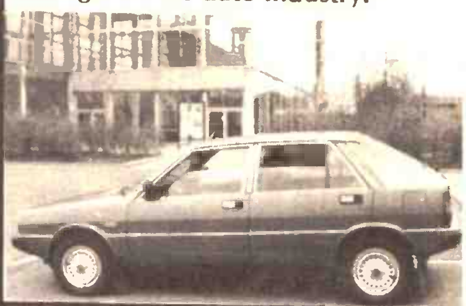
ABC **Member of the Audit Bureau of Circulation**

Electronics Today is normally published on the first Friday in the month preceding cover date.

☐ Subscription Rates. UK £13.15 including postage. Airmail and other rates upon application to ETI Subscriptions Department, 513 London Road, Thornton Heath, Surrey CR4 6AR.

EDITORIAL AND ADVERTISEMENT OFFICE
145 Charing Cross Road, London WC2H 0EE. Telephone 01-437 1002/3/4/5.
Telex 8811896.

FEATURES



PROJECTS

INFORMATION

NEXT MONTH

electronics today INTERNATIONAL

64K DRAM

A little short on memory? ETI comes to the rescue with this project which is just the ticket for 6502 or 6800 based systems. Latching it into your system just couldn't be easier, because the DRAM board uses an EPROM to do the address decoding. No more lash-ups, just program the PROM to define where the memory goes in the micro's space. Why didn't we think of it before?

Smart NiCad Charger

Now there have been plenty of NiCad chargers that have graced these pages — but this one will automatically rejuvenate worn out cells. (Wonder if it would work on the cells in the Editor's brain?)

New Series: Audio Design

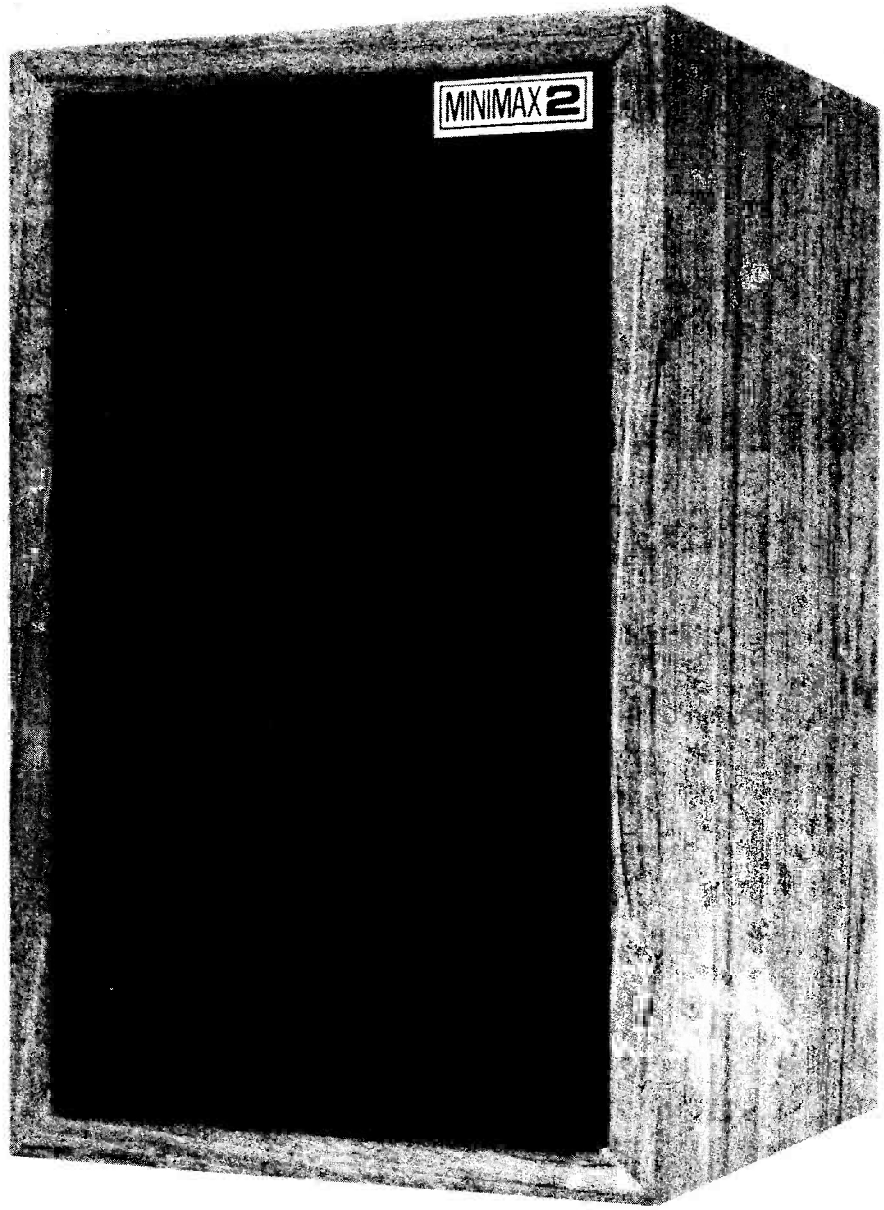
John Linsley Hood is one of the best known audio designers, and he'll be guest-writing this series for us. The emphasis will be on practicalities, with easy-to-follow explanations and simple but useful calculations. Although as little as possible be assumed about the level of expertise of the reader, there will be something here for even the most experienced of you.

Audiophile review

The Videotone Minimax speakers have provided a touch-stone in price-effective audio for many years. Now there's a Mark II version — can it be as good, or, possibly, even better? Our intrepid Audiophile investigates.

The Digger

No, nothing to do with our Australian colleagues, but a useful little device for digging around inside digital circuits — a logic oscilloscope trigger. The idea is very simple, really, all you do is . . . but if we told you that, you might not buy next month's mag, mightn't you?



ALL THIS AND MORE IN THE SEPTEMBER ISSUE OF ETI, ON SALE AUGUST THE 5th. PLACE YOUR ORDER NOW, OR RISK MISSING OUT!

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

DIGEST

Smart Cable

The SC817 SMART CABLE from KPG-Hardware House provides a simple, low cost method of interfacing 98% of RS232 equipment. Ideal for equipment salesmen and engineers the Smart Cable's unique logic senses the RS232 configuraiton at each end and automatically configures the correct pin to pin connection. Providing male to male and male to female connection the Smart Cable totally eliminates the need for break out boxes, debugging cables and custom cables. KPG-Hardware House, 578-586 Chiswick High Road, London W4 5RP.

New Current Probe

The Model 711 Miniature Wideband Current Probe manufactured by American Laser Systems, California, measures wideband current pulses without loading the circuit being tested. It induces no appreciable capacitive nor inductive effects on circuitry, therefore the signal under measurement does not change. The 711 exhibits only 0.02 ohm shunted by 4 μH insertion impedance. The current is sensed by placing the conductor through the centre of the probe, which will accept a maximum lead diameter of No. 20 AWG. For general use as a test probe with oscilloscopes and test equipment, Model 711 is available in a potted package with a 3ft co-ax cable and standard BNC connector. The UK agent is Dynamic Technology Limited, Zonal House, Alliance Road, Acton, London W3 0BA.

TOBIE Award For LCD Team

The TOBIE Award for Research Achievement has this year been won by the Physics Research team at the Royal Signals and Research Establishment, Malvern. For some years now this team has been working on the various uses of liquid crystals, including displays and addressing methods, this technology has made possible the 128 x 256 matrix liquid crystal cell developed in conjunction with Scopex Instruments Ltd., for use in the Voyager digital storage oscilloscope.

Many of the Voyager's applications are, apparently, linked to water or marine life. For instance, Water Boards find its lightness and ease of handling very useful on certain of their very remote pumping and control locations, and one of the strangest of applications to date has been for use on an expedition to the Amazon where it will be used for tests on a type of electric fish. Scopex ask: is this the dawn of a new era in ATE (Aquatic Test Equipment)? Scopex Instruments Limited, Pixmore House, Pixmore Avenue, Letchworth, Herts SG6 1HZ. Tel (04626) 72771.

The Bead's Needs

A new range of ferrite beads manufactured by Stackpole are vailable exclusively to UK manufacturers from Walmore Electronics Ltd, 374 City Road, 11-15 Betterton Street, Drury Lane, London WC2H 9BS. Particularly interesting is a lead tape bead for use with automatic insertion equipment.

Ferrite beads are a simple, inexpensive, yet effective way to obtain RF decoupling, shielding and parasitic suppression without sacrificing low frequency power or signal level. Unlike conventional RF chokes, beads are compact, have no DC losses, and will not couple to stray capacity and introduce detuning or spurious oscillations. Installation of beads is easy. Simply slip over the appropriate conductor for the desired noise suppression or high frequency isoltion.

Fibre Optic Links

Lightdata have two new modules: on the left is the Blue Box 16-channel RS232 to fibre optic interface that is, apparently, simplicity itself to set up and use. It is intended to be mounted on a wall, and can provide a link over up to 1 km of optic cable. On the right is a Eurocard mounted version that requires a single 5 V supply. Lightdata, 4 Lias Road, Porthcawl, Mid Glamorgan, Wales CF36 3AH.

Whoops!

Stotron Ltd were just a little annoyed with us for saying that their latest catalogue was dated 1982 (Digest Shorts, June). In fact, they have now supplied us with their latest, 1983/4 catalogue, to prove that the other dropped through a worm-hole in the space-time continuum (that's our story, and we're sticking to it).

Stotron would also like us to point out that while they do continue to have offices in Hastings, readers should write to them at 72 Blackheath Road, Greenwich, London SE10 8DA, to obtain their copy of the catalogue.

Energy In The Outback

A new $250,000 Solar Energy Research Centre is to be built in Western Australia. It will be located next to the site earmarked for a proposed new technology park, which is to be established at the Western Australian Institute of Technology in Bentley.

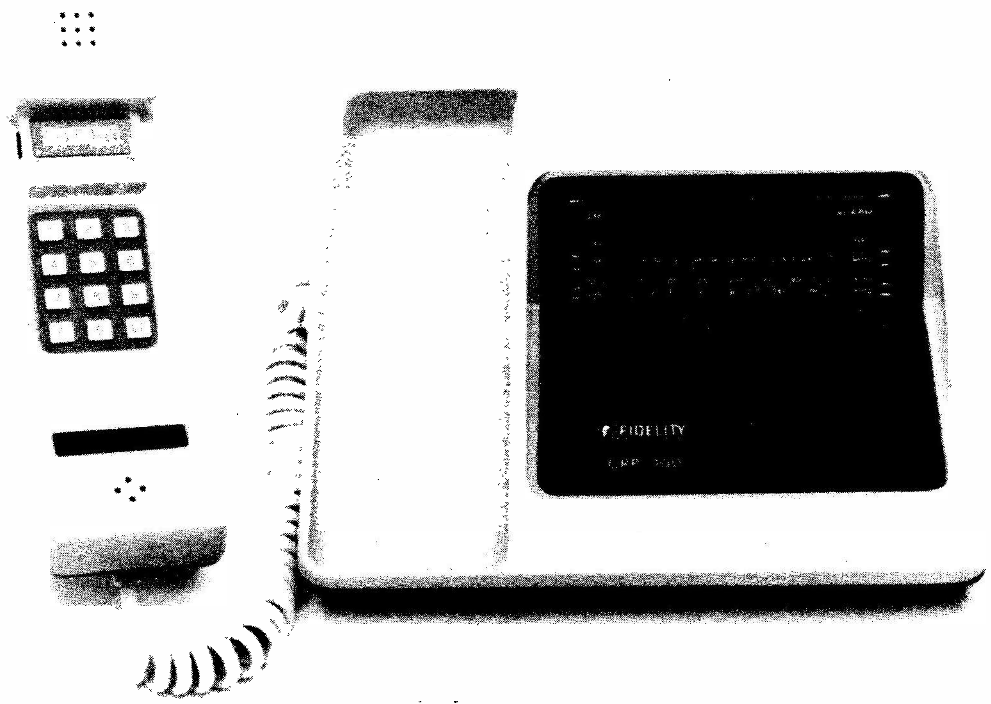
The new centre will contain testing and monitoring equipment, computer facilities for automated data analysis, an information and display area, and office space for the staff of the Solar Energy Research Institute of Western Australia (SERIWA). Outside areas will be used to test various types of solar equipment.

The Phone That Thinks It's A Clock

The new Clock Radio Phone from Fidelity Radio, the CRP 100, is a compact unit incoporating the three facilities of radio, alarm clock and telephone. Operation is precisely the same as a conventional clock radio but with an automatic cut off when the telephone receiver is lifted. British Telcom approval is already applied for and the CRP 100 can be installed by connection to the mains and a standard British Telecom socket. The Clock Radio Phone is expected to retail at around £69, and should be in the shops by September.

Also from Fidelity is a new colour television chassis design, the ZX 3000. The chassis is smaller, more advanced with reduced component volume and covers eight programme channels. Advantages across the range include greater reliability, less weight and an even more economical price for high quality vision and sound reproduction.

You'll find the new chassis in some new models, the CTV 22T and CTV 20T Teletext models, the CTV 22R remote control model and a new 14 inch colour monitor. The existing CTV 20R and CTV 14S portable will continue in the range but with the new chassis.



Micros Go Down The Drain

Intel Corp has introduced its "Data Pipeline" hardware and software designed to link mainframe computer data bases with personal computers. The Data Pipeline is built around Intel's Data-Base Information System, iDIS 86/735, a microcomputer-based "traffic-manager" that interprets, stores and distributes mainframe data to and from terminals and personal computers. The Data Pipeline uses an enhanced version of Intel's System 2000 Data-Base Management System (DBMS). System 2000 currently handles data storage and retrieval in hundreds of large mainframe computer installations.

New Data Pipeline extensions to System 2000 provide a relational data-base capability, graphics and a fourth-generation software architecture, System 2000 On-Line Operation (SOLO).

Intel also has broadened its 700 family of Data-Base Information Systems with the iDIS 86/730, an iDIS version aimed at original equipment manufacturers and large-volume end users. Intel Corporation S.A., Rue du Moulin a Papier, 51, Boite 1, B-1160 Brussels, Belgium.

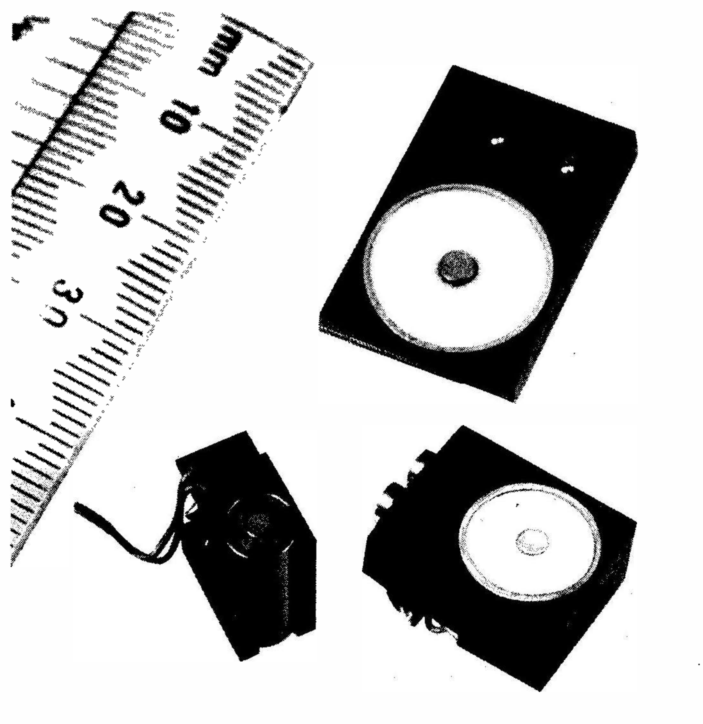
Speedy Prototypes

Computing Techniques (Mfg) Limited has introduced a fast and economic service on operational amplifiers designed and built to special requirements. Now, all but the most exacting orders can be met in two weeks or less. Many orders can be turned round in as little as seven days, and this British company is offering prices at up to 25% lower than those quoted by other major manufacturers.

The service should prove of great interest to small and medium quantity users, who often experience difficulty in eqsily, or economically, meeting specifications when selecting standard linear integrated circuits from the major suppliers. Computing Techniques supplies a complete, packaged operational amplifier which it guarantees will meet the customer's specification, however tight. Computing Techniques (Mfg) Ltd, Brookers Road, Billingshurst, West Sussex RH14 9RZ.

Please . .

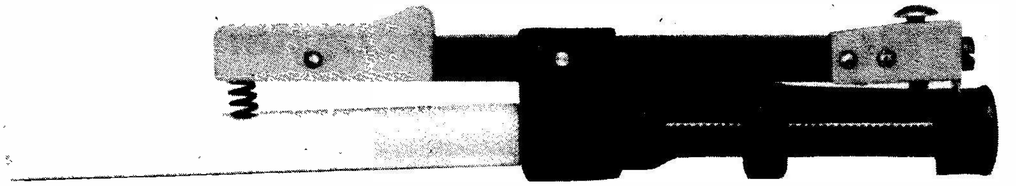
At the time of writing, ETI is still without a replacement for Peter Green, our former deputy editor turned Computing Toady. So please, keep your enquiries of us to a minimum, and follow the guidelines on page 70.



A Little Pull Helps

Miniature solenoids for use where space is at a premium have been introduced by Magnetic Components to augment its established recording head capability. Manufactured to meet manufacturers' specific requirements, the units are expected to have particular application to electronic security locks, access controls, low power system controllers, printer mechanisms, electronic camera shutters, etc.

Typical is one producing a latch pull force of 150 gms when 1.9 volts D.C. is applied to the 75 ohms coil. In addition to the solenoid component, MCL provides methods of controlling the unlatching force so as to give a higher level of release time repeatability; this is achieved by a specially developed keeper and/or the use of 'kick-off' electronic circuitry. Magnetic Components Limited, Bridge Wharf Industrial Estate, Chertsey, Surrey KT16 8LJ.



What Is It?

We know what it is — but do you? We get all sorts of obscure objects passing under our noses here at ETI, but this particular one seems to mark a new all-time height in enigma.

Actually, it's use is pretty boring, so we're not giving any prizes for the correct answer. However, the most ingenious incorrect answer will get some prize, though what it is, we haven't decided. It could be a guided tour of the ETI office, or it may even be one of these things — you'll have to wait and see.

Filters For CD

RIFA have introduced a new series of hybrid active filters, which have been designed for anti-aliasing applications in equipment such as digital audio systems. Constructed in RIFA's thick film process, the PBA 3167 and PBA 3179 hybrid active filters feature an extremely flat response over their operational passband. Included in their circuitry is a group-delay equalising network, which effects a constant group-delay response within +10µs up to 19KHz in the case of the PBA 3167, and up to 13.5 KHz for the PBA 3179.

Cut off frequencies are specified as 20KHz (3167) and 15KHz (3179). Accordingly, the filters are ideally suited for applications in digital audio systems having sampling frequencies from 48 to 50KHz, or 32KHz. RIFA AB, Market Chambers, Shelton Square, Coventry.

More Motorola Manuals

Motorola have been busy scribling away, and the following new books bring the total number of Motorla tehcnical publications up to 22: B012A — 8 bit Microprocessor Data Manual; B012B — 16 bit Microprocessor Data Manual; B001 — A/D and D/A Conversion Manual; B0015 — Switchmode and TMOS Power Transistors; B038 — Linear/Switchmode Voltage.

These are available from Motorola Distributors, or write to Motorola's European Literature Centre (at Milton Keynes) for the leaflet, describing each publication and detailing prices. Motorola Semiconductors, 88 tanners Drive, Blakelands, Milton Keynes.

Accurate Robot

Zehntel's Series 600 Robotic Board Handling System, the first fully operational robot aid for automatic testing equipment, is described in a 4 page brochure. The RBHS is easily programmed and has a unique 6 axis motion. Positioning accuracy is 0.022", believed to be the best available.

As well as loading and unloading boards at the test head, the RBHS can also be used for light mechanical tasks connected with testing, such as operating switches etc. It will also handle simple assembly tasks if required. Zehntel Limited, 62 Tanners Drive, Blakelands, Milton Keynes MK14 5BP.

Shorts

- United Components Ltd, Unit 5, Wye Estate, London Road, High Wycombe, Bucks HP11 1LH now carry stocks of Clare Reed and mercury wetted relays, as well as many other GI and related companies' products.
- Any manufacturer wishing to exhibit at the fourth Middle East Electricity and Electronics Exhibition in Kuwait in January 1984 should contact the British Electrical and Allied Manufacturers' Association (BEAMA) at 8 Leicester Street, London WC2H 7BN.
- Peripheral Hardware Ltd, Unit 13, Monkspath Industrial park, Highlands Road, Shirley, West Midlands B90 4NY have been appointed as an authorised dealer for Epson printers and personal computers.
- Apples have fallen. A new 256K Apple III will now cost a mere £2,395 (it was £2,869); the 128K Apple III is no longer available. Apple Computer (UK) Ltd, Eastman Way, Hemel Hempstead, Herts HP2 7QH.
- AKG are setting up a studio sound award, for professional and non-professional sound engineers. Details from AKG Acoustics Ltd, 191 The Vale, London W3 7QS.
- Instem Computer Systems Limited, formerly known as Kratos, has launched a new software programme for the Hewlett Packard HP-86 microcomputer to perform industrial monitoring and control functions using Instem's range of Link-On input/output stations. Instem Computer Systems Limited, Walton Industrial Estate, Ston, Staffordshire, ST15 0LT.
- One of the consequences of the general election being called at fairly short notice was the fall of a bill that would have made it illegal to sell "any machine capable of reproducing a sound recording . . . where the naute of the machine is such that the primary or substantial use to which it will be likely to be put is likely to result in the unauthorised making of any record embodying the recording . . . ". Sounds like a cassette deck they were talking about, doesn't it?
- Thorn EMI have just released a leaflet describing a new range of rubidium caesium photocathode photomultiplier tubes. Contact the Sales Department, Thorn EMI Electron Tubes Limited, Bury Street, Ruislip, Middlesex HA4 7TA.
- Belling Lee have published a comprehensive 64 page catalogue of their range of RFI filters for up to 800 amps. Belling Lee, 540 Great Cambridge road, Enfield, EN1 3QU.
- Cotswold Electronics, Unit T1, Kingsville road, Kingsditch Trading Estate, Cheltenham GL51 9NX have issued a leaflet describing their "budget range" of toroidal mains transformers.
- Tasbian, the automated electronic assembly plant near Plymouth, have also issued a leaflet, describing their design, manufacturing and test facilities. Tasbian Ltd, 2/3 Burrington Way, Plymouth, Devon PL5 3LS.
- You'll no doubt be pleased to hear that the 20 companies involved in the development of magnetic disc stills cameras have reached agreement of standardisation of the disc. This should prevent the usual problem of a multiplicity of standards confusing the consumer, such as happened in video.

Noisy Fault Locator

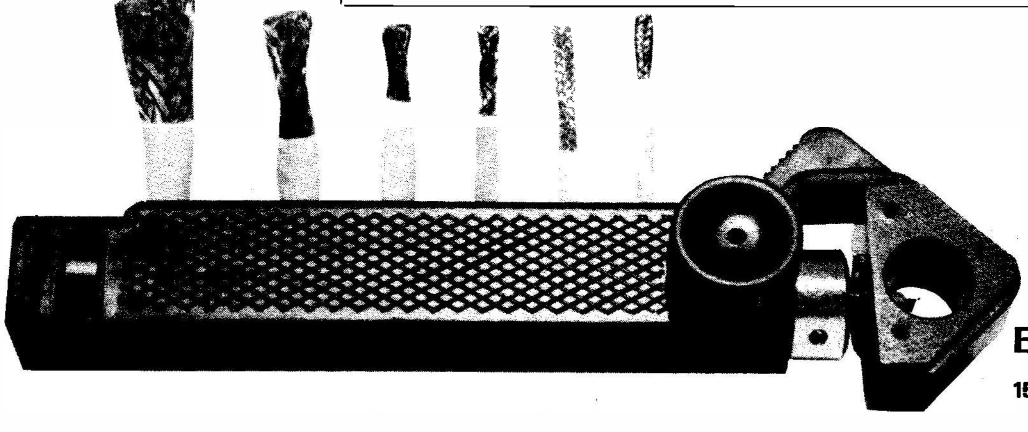
A new British manufacturered and designed portable Audio/Visual faults locator is now available from Antron Electronics Ltd, Hamilton House, 39 Kings Road, Haselmere, Surrey GU27 2QA. Codenamed Toneohm 700, the instrument is used to locate short and partial short circuits caused by solder bridges, poor etching, partial device failure, i.e. substrate shorts, leaking capacitors etc., by tone or meter readout without removing components or cutting tracks.

The instrument has four ranges to allow resistance measurement up to 20k and D.C. voltages between ±20V to be made, so giving a complete range of diagnostic capability in one instrument. Kelvin needle probes are used for fault finding and are protected against accidental connection up to ± 30V.

The instrument can also source a test voltage to stimulate circuit under test, with a maximum output voltage of 0.55V and maximum output current 150mA.

Twin Stripper

AB Engineering Company has developed a unique new cable stripper for the fast and safe removal of outer sheathing from twisted pair coaxical cables. Also suitable for other cables of irregular cross section, the new Coax-3 incorporates a spring loaded cutting head which when revolved accurately follows contours to produce a precise circumferencial cut to a predetermined depth. The operator then simply twists the cutting blade through 90 degrees and the outer sheating is separated along the axis of the cable for ease of removal. AB Engineering Co., Timber Lane, Woburn, Milton Keynes MK17 9PL.



74 SERIES

- 7400 11p
- 7401 11p
- 7402 11p
- 740C 12p
- 7404 12p
- 7405 15p
- 7406 18p
- 7407 18p
- 7408 14p
- 7409 14p
- 7410 14p
- 7411 18p
- 7412 14p
- 7413 18p
- 7414 18p
- 7416 18p
- 7417 18p
- 7420 14p
- 7421 18p
- 7422 20p
- 7423 20p
- 7425 18p
- 7426 18p
- 7427 18p
- 7428 18p
- 7430 14p
- 7432 18p
- 7433 22p
- 7437 22p
- 7438 22p
- 7439 25p
- 7440 18p
- 7441 55p
- 7442A 30p
- 7443 70p
- 7444 70p
- 7445 60p
- 7446A 58p
- 7447A 50p
- 7448 50p
- 7450 18p
- 7451 15p
- 7453 15p
- 7454 15p
- 7460 15p
- 7470 30p
- 7472 25p
- 7473 25p
- 7474 18p
- 7475 22p
- 7476 25p
- 7480 48p
- 7481 120p
- 7482 65p
- 7483A 35p
- 7484 85p
- 7484A 60p
- 7485 60p
- 7486 18p
- 7489 170p
- 7490A 20p
- 7491 35p
- 7492A 25p
- 7493A 24p
- 7494 35p
- 7494A 35p
- 7496 40p
- 7497 90p
- 74100 60p
- 74107 22p
- 74109 25p
- 74110 30p
- 74111 55p
- 74112 170p
- 74116 50p
- 74118 55p
- 74119 80p
- 74120 80p
- 74121 25p
- 74122 30p
- 74123 35p
- 74125 30p
- 74126 35p
- 74128 30p
- 74132 30p
- 74136 28p
- 74141 55p
- 74142 175p
- 74143 200p
- 74144 200p
- 74145 40p
- 74147 75p
- 74148 60p
- 74150 50p
- 74151A 30p
- 74153 40p
- 74154 50p
- 74155 36p
- 74156 40p
- 74157 30p
- 74159 75p
- 74160 40p
- 74161 40p
- 74162 40p
- 74163 40p
- 74164 45p
- 74165 45p
- 74166 48p
- 74167 150p
- 74170 120p
- 74172 250p
- 74173 50p
- 74174 55p
- 74175 50p
- 74176 40p
- 74177 45p
- 74178 70p
- 74179 70p
- 74180 40p
- 74181 115p
- 74182A 60p
- 74184A 90p
- 74185 90p
- 74186 470p
- 74188 250p
- 74190 45p
- 74191 45p
- 74192 45p
- 74193 45p
- 74194 40p
- 74195 40p
- 74196 40p
- 74197 40p
- 74198 80p
- 74199 80p
- 74221 55p
- 74251 45p
- 74259 100p
- 74265 45p
- 74273 120p
- 74276 90p
- 74278 100p
- 74279 40p
- 74283 50p
- 74284 160p
- 74285 160p
- 74290 75p
- 74293 80p
- 74298 100p
- 74351 150p
- 74365 30p
- 74366 30p
- 74367 30p
- 74368 30p
- 74376 100p
- 74390 75p
- 74393 90p
- 74490

74LS SERIES

- 74LS00 11p
- 74LS01 11p
- 74LS02 11p
- 74LS03 12p
- 74LS04 12p
- 74LS05 12p
- 74LS06 12p
- 74LS07 12p
- 74LS08 12p
- 74LS09 12p
- 74LS10 12p
- 74LS11 12p
- 74LS12 12p
- 74LS13 15p
- 74LS14 25p
- 74LS15 12p
- 74LS20 12p
- 74LS21 12p
- 74LS22 12p
- 74LS26 12p
- 74LS27 12p
- 74LS28 14p
- 74LS30 12p
- 74LS32 12p
- 74LS33 14p
- 74LS37 14p
- 74LS38 14p
- 74LS40 14p
- 74LS42 30p
- 74LS47 30p
- 74LS48 45p
- 74LS51 14p
- 74LS54 14p
- 74LS55 14p
- 74LS63 120p
- 74LS73 18p
- 74LS74 16p
- 74LS75 18p
- 74LS76 17p
- 74LS83 35p
- 74LS85 50p
- 74LS86 18p
- 74LS90 22p
- 74LS91 60p
- 74LS92 32p
- 74LS93 22p
- 74LS95 40p
- 74LS96 50p
- 74LS107 20p
- 74LS109 27p
- 74LS112 20p
- 74LS113 20p
- 74LS114 22p
- 74LS122 34p
- 74LS123 30p
- 74LS124 90p
- 74LS125 24p
- 74LS126 24p
- 74LS132 34p
- 74LS133 30p
- 74LS136 24p
- 74LS138 25p
- 74LS139 27p
- 74LS145 70p
- 74LS147 120p
- 74LS148 75p
- 74LS151 40p
- 74LS153 40p
- 74LS154 80p
- 74LS155 40p
- 74LS156 40p
- 74LS157 25p
- 74LS158 30p
- 74LS160 35p
- 74LS161 35p
- 74LS162 35p
- 74LS163 38p
- 74LS164 40p
- 74LS165 50p
- 74LS166 80p
- 74LS168 85p
- 74LS169 85p
- 74LS170 70p
- 74LS173 55p
- 74LS174 40p
- 74LS175 40p
- 74LS181 90p
- 74LS183 120p
- 74LS190 38p
- 74LS191 38p
- 74LS192 38p
- 74LS193 38p
- 74LS194 35p
- 74LS195 35p
- 74LS196 45p
- 74LS197 45p
- 74LS221 50p
- 74LS240 55p
- 74LS241 55p
- 74LS242 55p
- 74LS243 50p
- 74LS244 50p
- 74LS245 70p
- 74LS247 50p
- 74LS248 55p
- 74LS249 55p
- 74LS251 38p
- 74LS253 38p
- 74LS256 160p
- 74LS257 30p
- 74LS258 35p
- 74LS259 85p
- 74LS260 29p
- 74LS261 138p
- 74LS266 20p
- 74LS273 60p
- 74LS275 225p
- 74LS279 30p
- 74LS280 100p
- 74LS283 40p
- 74LS290 45p
- 74LS293 40p
- 74LS295 90p
- 74LS297 900p
- 74LS298 90p
- 74LS299 180p
- 74LS321 180p
- 74LS323 180p
- 74LS324 160p
- 74LS348 90p
- 74LS352 60p
- 74LS353 60p
- 74LS356 250p
- 74LS363 140p
- 74LS364 140p
- 74LS365 27p
- 74LS366 27p
- 74LS367 27p
- 74LS368 27p
- 74LS373 55p
- 74LS374 65p
- 74LS375 45p
- 74LS377 60p
- 74LS378 60p
- 74LS390 45p
- 74LS393 45p
- 74LS395 90p
- 74LS399 180p
- 74LS445 100p
- 74LS467 90p
- 74LS490 200p
- 74LS540 80p
- 74LS541 80p
- 74LS610 £19
- 74LS624 90p
- 74LS626 160p
- 74LS628 150p
- 74LS629 90p
- 74LS640 100p
- 74LS641 100p
- 74LS643 100p
- 74LS644 100p
- 74LS645 100p
- 74LS668 120p
- 74LS669 120p
- 74LS670 140p
- 74LS678 550p
- 74LS682 400p
- 74LS684 400p
- 74LS687 400p

74S SERIES

- 74S00 30p
- 74S02 30p
- 74S04 30p
- 74S05 60p
- 74S08 60p
- 74S10 40p
- 74S11 50p
- 74S20 40p
- 74S22 50p
- 74S30 40p
- 74S32 70p
- 74S37 60p
- 74S74 75p
- 74S85 300p
- 74S86 90p
- 74S112 90p
- 74S113 90p
- 74S114 90p
- 74S124 300p
- 74S132 160p
- 74S133 60p
- 74S138 110p
- 74S139 120p
- 74S157 250p
- 74S158 195p
- 74S163 300p
- 74S174 250p
- 74S175 320p
- 74S194 320p
- 74S195 300p
- 74S225 510p
- 74S241 300p
- 74S244 300p
- 74S251 250p
- 74S257 250p
- 74S258 250p
- 74S260 70p
- 74S261 300p
- 74S262 850p
- 74S373 400p
- 74S374 400p
- 74S387 250p
- 74S471 650p
- 74S474 400p
- 74S571 620p
- 74S573 900p

4000 CMOS

- 4000 10p
- 4001 10p
- 4002 12p
- 4006 50p
- 4007 14p
- 4008 38p
- 4009 24p
- 4010 24p
- 4011 11p
- 4012 16p
- 4013 20p
- 4014 48p
- 4015 40p
- 4016 20p
- 4017 32p
- 40244 160p
- 40245 180p
- 4018 45p
- 4019 25p
- 4020 40p
- 4021 40p
- 4022 45p
- 4023 13p
- 4024 32p
- 4025 13p
- 4026 80p
- 4027 20p
- 4028 40p
- 4029 45p
- 4030 15p
- 4031 125p
- 4032 80p
- 4033 125p
- 4034 45p
- 4035 275p
- 4036 110p
- 4037 110p
- 4038 290p
- 4039 40p
- 4040 40p
- 4041 40p
- 4042 40p
- 4043 40p
- 4044 40p
- 4045 105p
- 4046 50p
- 4047 45p
- 4048 50p
- 4049 24p
- 4050 24p
- 4051 45p
- 4052 80p
- 4053 50p
- 4054 90p
- 4055 90p
- 4056 90p
- 4059 450p
- 4060 55p
- 4063 90p
- 4066 27p
- 4067 225p
- 4068 14p
- 4069 14p
- 4070 14p
- 4071 14p
- 4072 14p
- 4073 14p
- 4075 14p
- 4076 48p
- 4077 16p
- 4078 16p
- 4081 14p
- 4082 15p
- 4086 55p
- 4089 125p
- 4093 24p
- 4094 90p
- 4095 75p
- 4096 70p
- 4097 290p
- 4098 90p
- 4099 100p
- 4500 575p
- 4501 28p
- 4502 60p
- 4503 45p
- 4504 75p
- 4505 400p
- 4506 35p
- 4507 35p
- 4508 130p
- 4510 45p
- 4511 45p
- 4512 48p
- 4514 120p
- 4515 110p
- 4516 55p
- 4518 40p
- 4520 50p
- 4521 90p
- 4522 120p
- 4526 80p
- 4527 80p
- 4528 50p
- 4532 70p
- 4534 400p
- 4536 270p
- 4538 90p
- 4539 70p
- 4543 75p
- 4553 245p
- 4555 35p
- 4556 35p
- 4557 300p
- 4560 120p
- 4566 160p
- 4568 250p
- 4569 170p
- 4572 30p
- 4583 90p
- 4584 40p
- 4585 75p
- 40014 40p
- 40085 90p
- 40097 45p
- 40102 140p
- 40103 170p
- 40105 110p
- 40106 40p
- 40109 100p
- 40110 275p
- 40163 80p
- 40174 50p
- 40175 75p
- 40193 75p
- 40244 160p
- 40245 160p
- 40257 180p
- 40373 180p
- 40374 160p
- 14495 300p
- 14500 700p
- 14599 290p

COUNTERS

- 74C925 £4
- 7216B £22
- 74C926 £5

LINEAR ICs

- AD7581 1450p
- ADC0808 990p
- AN103 200p
- AY1-5050 99p
- AY3-1270 825p
- AY3-1350 350p
- AY3-8910 440p
- AY3-8912 625p
- AY5-3600 600p
- AY4007D £6
- CA3019 80p
- CA3028 120p
- CA3046 70p
- CA3048 220p
- CA3059 285p
- CA3060 350p
- CA3080E 72p
- CA3086 48p
- CA3089E 200p
- CA3090 £4
- CA3130E 90p
- CA3130T 110p
- CA3140T 90p
- CA3140E 50p
- CA3160E 100p
- CA3161E 150p
- CA3162E 450p
- CA3189E 300p
- CA3240E 110p
- CA3280G 200p
- D7002C 420p
- DAC0800 £2
- DG308 300p
- HA1366 195p
- HA1388 270p
- ICL7106 700p
- ICL7611 95p
- ICL7650 400p
- ICL7660 250p
- ICL7660 200p
- ICL8038 300p
- IM72168B £22
- ICM7217 750p
- ICM7555 80p
- ICL7611 90p
- LC7120 300p
- LC7130 325p
- LC7137 270p
- LF347 150p
- LF351 40p
- LF353 95p
- LF356P 95p
- LF357 110p
- LF13331 150p
- LM10C 325p
- LM301A 25p
- LM308N 75p
- LM310 120p
- LM311 70p
- LM318 £3
- LM319 215p
- LM324 30p
- LM334Z 90p
- LM335Z 140p
- LM339 50p
- LM348 65p
- LM358P 60p
- LM377 175p
- LM380 75p
- LM381AN 180p
- LM382 120p
- LM386 90p
- LM387 120p
- LM389 95p
- LM391 150p
- LM392N 80p
- LM393 100p
- LM394CH 300p
- LM709 38p
- LM710 50p
- LM711 70p
- LM725 300p
- LM733 80p
- LM741 18p
- LM747 70p
- LM748 35p
- LM1014 150p
- LM1801 300p
- LM1830 250p
- LM1871 450p
- LM1872 450p
- LM1886 700p
- LM1889 350p
- LM2917 200p
- LM3302 75p
- LM3900 50p
- LM3909 85p
- LM3911 125p
- LM3914 200p
- LM3915 200p
- LM3916 225p
- LM13600 110p
- M51513L 23..
- M51516L 500p
- MB3712 200p
- MB3730 400p
- MC1310P 150p
- MC1413 75p
- MC1445 250p
- MC1458 38p
- MC1493 100p
- MC1495L 350p
- MC1496 70p
- MC3340P 120p
- MC3401 50p
- MC3403 75p
- MF10CN 250p
- MK50240 £9
- MK50398 £7
- ML920 800p
- MN57160 620p
- MN6221A 600p
- NE531 140p
- NE544 150p
- NE555 16p
- NE556 45p
- NE564 420p
- NE565 120p
- NE566 155p
- NE567 140p
- NE570 410p
- NE571 400p
- NE592 60p
- NE5534P 110p
- NE5534AP 120p
- PLL02A 500p
- RC4136 80p
- RC4151 200p
- S566B 225p
- SAA1900 £16
- SFF9634 800p
- SL490 350p
- SN76131 125p
- SN76477 450p
- SN76488 450p
- SN87489 400p
- SN76495 400p
- SN76660 120p
- SP0256ALZ £10
- TA7120 150p
- TA7130 150p
- TA7204 200p
- TA7205 90p
- TA7222 150p
- TA7310 150p
- TBA800 80p
- TBA810 100p
- TBA820 80p
- TBA920 200p
- TBA950 225p
- TC9109 900p
- TCA210 350p
- TCA220 350p
- TCA270 350p
- TCA940 175p
- TCA965 120p
- TDA1004A £3
- TDA1008 320p
- TDA1010 200p
- TDA1022 500p
- TDA1024 120p
- TDA1170 300p
- TDA2003 325p
- TDA2002V £3
- TDA2006 360p
- TDA2020 320p
- TL064 100p
- TL071/81 25p
- TL072/82 45p
- TL074 100p
- TL083 75p
- TL084 90p
- TL094 200p
- TL170 50p
- TL430C 70p
- TMS1601 £12
- UA1003-3 935p
- UA2240 150p
- UAA170 170p
- ULN2003A 75p
- ULN2004 75p
- ULN2068 290p
- ULN2802 200p
- ULN2804 150p
- UPC575 275p
- UPC592H 200p
- UPC1156H £3
- UPC1185H £5
- XR2206 300p
- XR2207 375p
- XR2211 575p
- XR2216 675p
- XR2240 120p
- ZN414 80p
- ZN419C 180p
- ZN423E 130p
- ZN424E 130p
- ZN425E 350p
- ZN426E 300p
- ZN427E 590p
- ZN428E 490p
- ZN1034E 200p
- ZN1040E 670p
- ZNA134 £23
- ZNA234 850p

VOLTAGE REGULATORS FIXED PLASTIC

1A	+ve		-ve	
5V	7805	40p	7905	45p
6V	7806	40p	7906	45p
8V	7808	40p	7908	45p
12V	7812	40p	7912	50p
15V	7815	40p	7915	50p
18V	7818	40p	7918	45p
24V	7824	40p	7924	45p
5V 100mA	78L05	30p	79L05	50p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS

- LM309K 1A 5V 140p
- LM317K TO3 250p
- LM317T 100p
- LM337T 225p
- LM323K 3A 5V 450p
- LM723 150mA Adj 30p
- LM350T 350p
- TL494 300p
- 78S40 225p
- 78P05 900p
- 78HGKC 600p
- 78H05KC 550p
- 78GUIC 200p
- 79GUIC 225p
- 79HGKC 700p
- ICL7660 200p
- LM305AH 250p
- 78H12 650p
- SG3524 300p

OPTO ELECTRONICS

- 2N5777 40p
- OCP71 180p
- ORP12 120p
- ORP60 120p
- ORP61 120p
- TIL78 55p
- TIL31A 120p
- TIL32 55p
- TIL81 90p
- TIL100 75p

OPTO ISOLATORS

- ILD74 130p
- MCT26 100p
- MCS2400 190p
- ILQ74 240p
- MOC3020 150p
- TIL111 70p
- TIL112 70p
- TIL113 70p
- TIL116 70p

LEDS

- 0.125"
- TIL209 Red 10p
- TIL211 Gr 12p
- TIL212 Yel 15p
- 0.2"
- TIL220 Red 10p
- TIL222 Gr 12p
- TIL228 Ye 15p
- Rectangular LEDs (R,G,Y) 30p

DISPLAYS

- DL704 140p
- DL707 Red 140p
- FND... 120p
- FND500 90p
- FND507 90p
- MAN3640 200p
- MAN4640 200p
- NSB5881 570p
- TIL311 600p
- TIL312/3 110p
- TIL321/3 130p
- TIL330 140p
- 7750/60 200p
- Bargraph 225p

DRIVERS

- 9368 250p
- 9370 300p

COMPUTER COMPONENTS

CPUs

- 1802CE 650p
- 2650A £12
- 6502 350p
- 6502A 500p
- 6800 225p
- 6802 250p
- 6809 650p
- 68B09 £12
- 6809E £12
- 8035 350p
- 8039 300p
- 8086 £22
- 8080A 280p
- 8085A 350p
- INS8060 £11
- TMS9980 £20
- TMS9995 £12
- TMS1601 £12
- Z8 £24
- Z80 290p
- Z80A 320p
- Z808 £12
- 8088 £18
- 8748 £18
- 8288 £11
- 8755 £16
- 9902 £3
- TMS4500 £14
- Z80P10 250p
- Z80AP10 280p
- Z80CTC 250p
- Z80ACTC 280p
- Z80ADART 700p
- Z80ADMA £10
- Z80S10/1/2 £9

SUPPORT DEVICES

- 3242 800p
- 3245 450p
- 6520 280p
- 6522 310p
- 6522A 650p
- 6532 550p
- 6551 650p
- 6821 100p
- 68B21 220p
- 6829 £12.50
- 6840 375p
- 68B40 600p
- 6850 110p
- 68B50 220p
- 6852 250p
- 6854 700p
- 68B54 800p
- 6875 570p
- 8154 950p
- 8155 350p
- 8156 350p
- 8205 225p
- 8212 110p
- 8216 100p
- 8224 110p
- 8226 250p
- 8228 270p
- 8243 280p
- 8250 850p
- 8251 250p
- 8253 390p
- 8255 250p
- 8256 £36
- 8257 400p
- 8259 400p
- 8271 £36
- 8279 440p
- 8284 350p

RAMS

- 2101-4A 400p
- 2102-3L 120p
- 2107B 500p
- 2111A 300p
- 2112-A 300p
- 2114-2L 100p
- 2147 450p
- 4027-3 300p
- 4116-15 120p
- 4116-20 80p
- 4118-3 450p
- 4164-2 400p
- 4164-15 450p
- 4416-20 500p
- 4532-20 300p
- 4416-20 £5
- 4816APZ-3 270p
- 5101 300p
- 5516 750p
- 6116LP-3 750p
- 6116P-3 375p
- 6514-45 550p
- 6810 120p
- 7489 210p
- 74S189 225p
- 74S201 350p
- 74S289 175p
- 93415 600p
- 93425 600p

ROMs PROMs

- 74S188 325p
- 74S287 350p
- 74S288 225p
- 74S387 325p
- 74S471 650p
- 74S473 650p
- 74S474 650p

EPROMs

- 2516(+ 5v) 250p
- 2532 370p
- 2532-30 £7
- 2564 £7
- 2708 250p
- 2716. + 5v) 250p
- 27128-25 £25
- 2764 £5
- 2732 375p
- 2732-35 425p

CRT CONTROLLER

- CRT6545 900p
- CRT5027 £18
- CRT5037 £18
- EF9365/6 £45
- MC6845 650p
- MC6847 650p
- SFF96364 £8
- TMS9918 £80
- TMS9927 £18
- TMS9928 £20
- TMS9929 £20

INTERFACE ICs

- AD558CJ 775p
- AD561J £21
- AM25S10 350p
- AM25LS2521 £2
- AM26LS31 125p
- AM26LS32 125p
- D7002 480p
- DAC80 £28
- DM8131 375p
- DP8304 460p
- DS3691 300p
- DS8830 140p
- DS8831 140p
- DS8832 250p
- DS8833 225p
- DS8836 150p
- DS8838 225p
- LF13201 450p
- MC1488 55p
- MC1489 55p
- MC3418 950p
- MC3446 300p
- MC3480 850p
- MC3486 500p
- MC3487 300p
- MC4024 325p
- MC4044 325p
- MC14411 675p
- MC14412 750p
- 75107 90p
- 75110/12 160p
- 75114/15 180p
- 75121/22 140p
- 75150P 120p
- 75154 140p
- 75182 90p
- 75361 150p
- 75363 150p
- 75365 150p
- 75451/2 65p
- 75453/4 72p
- 75491/2 70p
- 8T26 120p
- 8T28 120p
- 8T95/96 90p
- 8T97/98 90p
- 81LS95/96 80p
- 81LS97/98 80p
- 88LS120 250p
- 9602 220p
- 9637AP 180p
- ZN425E-8 350p
- ZN426E-8 350p
- ZN427E-8 600p
- ZN428E-8 500p

DISC CONTROLLER ICs

- FD1771 £20
- FD1791 £22
- FD1793 £23
- FD1795 £28
- FD1797 £28
- 8271 £36
- WD1691 £15
- WD2143 550p
- FD2793 £42
- FD2797 £42

CHARACTER GENERATORS

- RO-3-2513UC 750p
- RO-3-2513LC 700p
- SN74S262AN £10
- MC66760 750p
- DM86564 £12

KEYBOARD ENCODER

- AY5-2376 700p
- 74C922 420p
- 74C923N 500p

BAUD RATE GENERATORS

- MC14411 675p
- COM8116 700p
- 4702B 750p

UARTs

- AY-3-1015P 300p
- AY-5-1013P 300p
- COM8017 300p
- IM6402 450p
- TR1602 300p

ZIF SKTs

(TEXT TOOL)

- 24 pin 600p
- 28 pin 800p
- 40 pin £10

MODULATORS

- 6MHz UHF 375p
- 8MHz UHF 450p

CRYSTALS

- 32.768KHz 100p
- 100HKz 250p
- 200HKz 280p

Freq in MHz

- 1.0 290p
- 1.008 275p
- 1.8432 210p
- 2.00 225p
- 2.45760 210p
- 2.5 250p
- 2.662 250p
- 3.276 150p
- 3.5795 100p
- 3.686 300p
- 4.00 150p
- 4.194 200p
- 4.43 110p
- 4.608 250p
- 4.915 250p
- 5.0 175p
- 6.0 150p
- 6.144 150p
- 7.0 150p
- 7.168 175p
- 8.00 175p
- 8.86 175p
- 10.00 175p
- 10.5 250p
- 10.7 150p
- 12.00 150p
- 14.318 175p
- 14.756 250p
- 15.00 200p
- 16.00 200p
- 17.7 200p
- 18.00 200p
- 18.432 150p
- 19.968 150p
- 20.00 200p
- 26.690 150p
- 27.145 200p
- 38.6667 175p
- 48.0 175p
- 55.5 400p
- 116 300p
- 145.80 250p
- 15.068 £2
- 124 00 £2

DIL SWITCHES

- 4 way 70p
- 6 way 85p
- 8 way 90p
- 10 way 145p

REAL TIME CLOCK

- MM58174 700p
- MSM5832 600p
- MK3805 £ TBA

LOW PROFILE SOCKETS BY TI

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TI

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

TRANSISTORS

- AD161/2 45p
- BC107/8 10p
- BC109C 14p
- BC117 20p
- BC147/8 9p
- BC149 10p
- BC157/8 10p
- BC159 11p
- BC169C 12p
- BC172 12p
- BC177/8 17p
- BC179 18p
- BC182/3 10p
- BC184 11p
- BC187 30p
- BC212/3 11p
- BC214 12p
- BC237 15p
- BC327 16p
- BC337 16p
- BC338 16p
- BC461 25p
- BC477/8 30p
- BC516/7 40p
- BC547B 14p
- BC548C 12p
- BC549C 16p
- BC557B 14p
- BC559C 16p
- BCY70 18p
- BCY71 22p
- BD131 75p
- BD132 50p
- BD135/6 40p
- BD139 40p
- BD140 40p
- BD189 60p
- BD232 60p
- BD233 75p
- BD235 85p
- BD241 60p
- BD242 60p
- BD379 60p
- BD380 60p
- BD677 60p
- BF244B 35p
- BF256B 50p
- BF257/8 32p
- BF337 30p
- BR39 25p
- BFR40/1 25p
- BFR79 25p
- BFR80/1 25p
- BFR96 180p
- BFX29 30p
- BFX30 27p
- BFX84/5 27p
- BFX86/7 27p
- BFX88 27p
- BFX89 108p
- BFY51/2 24p
- BFY56 33p
- BFY90 80p
- BRY39 45p
- BSX19/20 24p
- BU104 225p
- BU105 190p
- BU108 250p
- BU109 225p
- BU126 150p
- BU180A 120p
- BU205 200p
- BU208 200p
- BU406 145p
- BUX80 600p
- BUY69C 350p
- E310 50p
- MJ802 400p
- MJ2501 225p
- MJ2955 90p
- MJ3001 225p
- MJ4502 400p
- MJE340 60p
- MJE2955 100p
- MJE3055 70p
- MPF102 40p
- MPF103/4 30p
- MPF105 30p
- MPSA06 30p
- MPSA12 50p
- MPSA13 50p
- MPSA20 50p
- MPSA42 50p
- MPSA43 50p
- MPSA56 32p
- MPSA70 50p
- MPSA93 40p
- MPSU06 63p
- MPSU07 60p
- MPSU45 90p
- MPSU65 78p
- TIP29A 35p
- TIP29C 40p
- TIP30A 35p
- TIP30C 40p
- TIP31A 40p
- TIP31C 45p
- TIP32A 40p
- TIP32C 40p
- TIP33A 70p
- TIP33C 80p
- TIP34A 90p
- TIP34C 120p
- TIP35A 120p
- TIP35C 140p
- TIP36A 140p
- TIP36C 150p
- TIP41A 50p
- TIP41C 55p
- TIP42A 60p
- TIP42C 65p
- TIP54 160p
- TIP120 75p
- TIP121 75p
- TIP122 80p
- TIP142 120p
- TIP147 120p
- TIP2955 78p
- TIP4055 70p
- TIS93 30p
- ZTX108 12p
- ZTX300 13p
- ZTX452 15p
- ZTX500 15p
- ZTX502 16p
- ZTX504 18p
- ZTX552 55p
- ZTX652 60p
- ZTX752 70p
- VN66AF 72p
- VN10KM 60p
- VN66 80p
- 2N697 25p
- 2N698 45p
- 2N706A 30p
- 2N708 30p
- 2N918 45p
- 2N930 18p
- 2N1131/2 36p
- 2N1613 25p
- 2N1711 25p
- 2N2102 70p
- 2N2160 350p
- 2N2219A 25p
- 2N2222A 25p
- 2N2369A 17p
- 2N2484 25p
- 2N2646 40p
- 2N2904/5 25p
- 2N2906A 25p
- 2N2907A 25p
- 2N2926 9p
- 2N3053 25p
- 2N3054 55p
- 2N3055 35p
- 2N3442 140p
- 2N3553 240p
- 2N3584 250p
- 2N3643/4 48p
- 2N3702/3 10p
- 2N3704/5 10p
- 2N3706/7 10p
- 2N3708/9 10p
- 2N3773 200p
- 2N3819 20p
- 2N3820 40p
- 2N3823 30p
- 2N3866 90p
- 2N3902 700p
- 2N3904 15p
- 2N3906 16p
- 2N4037 65p
- 2N4123/4 27p
- 2N4125/6 27p
- 2N4401/3 25p
- 2N4427 90p
- 2N4871 50p
- 2N5087 27p
- 2N5089 27p
- 2N5172 27p
- 2N5191 90p
- 2N5245 40p
- 2N5401 60p
- 2N5459 30p
- 2N5460 30p
- 2N5485 36p
- 2N5875 250p
- 2N6027 30p
- 2N6052 300p
- 2N6059 325p
- 2N6107 65p
- 2N6247 190p
- 2N6254 130p
- 2N6290 65p
- 2SC1306 100p
- 2SC1307 150p
- 2SC1957 90p
- 2SC1969 150p
- 2SC2028 80p
- 2SC2029 200p
- 2SC2078 160p
- 2SC2335 200p
- 2SC2612 200p
- 3N128 120p
- 3N140 120p
- 3N141 110p
- 3N201 110p
- 3N204 200p
- 40290 250p
- 40361/2 75p
- 40408 90p
- 40409 100p
- 40410 100p
- 40594 120p
- 40595 120p
- 40673 75p
- 40871/2 100p

DIODES

- BY127 12p
- BYX36300 20p
- OA47 8p
- OA90/91 9p
- OA95 9p
- OA200 9p
- OA202 10p
- 1N941 4p
- 1N916 7p
- 1N4148 4p
- 1N4001/2 5p
- 1N4003/4 6p
- 1N4005 6p
- 1N4006/7 7p
- 1N5404/5 14p
- 1N5404/7 19p
- IS920 9p

BRIDGE RECTIFIERS

- 1A 50V 19p
- 1A 100V 20p
- 1A 400V 25p
- 1A 600V 30p
- 2A 50V 35p
- 2A 100V 35p
- 2A 400V 45p
- 3A 200V 80p
- 3A 600V 72p
- 4A 100V 95p
- 4A 400V 100p
- 6A 50V 80p
- 6A 100V 100p
- 6A 400V 120p

- 0A 400V 200p
- 25A 400V 400p

ZENERS

- 2.7V-33V 400mW 9p
- 1W 15p

TRIACS PLASTIC

- 3A 400V 60p
- 6A 400V 70p
- 6A 500V 88p
- 8A 400V 75p
- 8A 500V 95p
- 12A 400V 85p
- 12A 500V 105p
- 16A 400V 110p
- 16A 500V 130p
- T2800D 130p

THYRISTORS

- A 400V 100p
- 8A 600V 140p
- 12A 400V 160p
- 16A 100V 150p
- 16A 400V 180p
- C106D 40p
- MCR10136 38p
- TIC44 27p
- 2N3525 130p
- 2N4444 180p
- 2N5060 30p
- TN5064 35p

PCB MOUNTING RELAYS

- 6 or 12V DC Coil SPDT 2A 24V DC 150p
- 6 or 12V DC Coil DPDT 5A 24V DC 240V AC 200p
- 6 or 12V DC Coil SPDT 10A 24V DC 240V AC 225p

TECHNOMATIC LTD

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS AT: 17 BURNLEY ROAD, LONDON NW10
(Tel: 01-452 1500, 01-450 6597. Telex: 922800)
305 EDGWARE ROAD, LONDON W2

PLEASE ADD 40p p&p & 15% VAT
(Export: no VAT, p&p at Cost)
Orders from Government Depts. & Colleges etc. welcome.
Detailed Price List on request.
Stock items are normally by return of post.

1/3 OCTAVE EQUALISER

One of the ironies of life is that the largest single factor in determining how well any sound system performs has nothing to do with the system itself: it is the room.

Now you could adopt an all-or-nothing approach and take a pneumatic drill to your listening room, to get rid of all those resonances, throw out all the furniture, because it's too absorbent, and keep everyone else out of the listening area, because clothes absorb sound too (and bodies, so it's no good asking your friends to go naked). However this could lead to a certain amount of domestic unrest, and anyway, would be impractical at a large scale concert.

A less radical approach that has fewer disadvantages is to tailor the response of the electronics so that the overall response of the audio system plus the room is neutral. This is most usually done with a graphic equaliser.

While octave equalisers do have some use, most equalisers supplied for domestic use are pure gimmickry. If you're taking your equalisation seriously, the only real option is a ⅓-octave device, which, by pure coincidence, is what we're about to describe here.

The ETI ⅓-octave equaliser is of sufficient quality not to seriously degrade the sound of a high quality system. It should be noted however, that the use of any ⅓-octave equaliser will affect the performance of the system simply because it is in circuit. Each of the filters has a relatively high Q and will therefore cause significant modification to the overall phase linearity as well as the frequency response when cut or boost is applied. I have seen many otherwise high quality systems degraded significantly by the excessive use of ⅓-octave equalisers and we do not recommend the incorporation of these units into a high quality system unless a specific need is apparent. Nevertheless, when modification of the frequency response is required, no matter how drastic or how modest, a ⅓-octave graphic equaliser is an almost ideal way of doing this.

Each channel of the equaliser is controlled by a separate slider potentiometer so the array of pots gives an approximate indication of the response inserted.

Design

Each filter is formed by a series resonant network incorporated into the feedback loop of a high quality operational amplifier. In this case we have used the NE5534N. 'Gyrators' are used to simulate

In order to illustrate the principle of operation of the graphic equaliser we first need to consider the operation of a simplified version of a single stage, as illustrated in Figure 1. Here, the input signal is fed to the non-inverting input of an op-amp through a 10k resistor. A potentiometer is connected between the non-inverting inputs with its wiper going to signal common (ground) via a network represented by Z. Here, a series-resonant circuit is employed. Feedback is provided between the op-amp output and the inverting input.

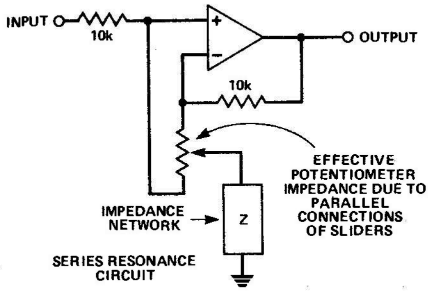
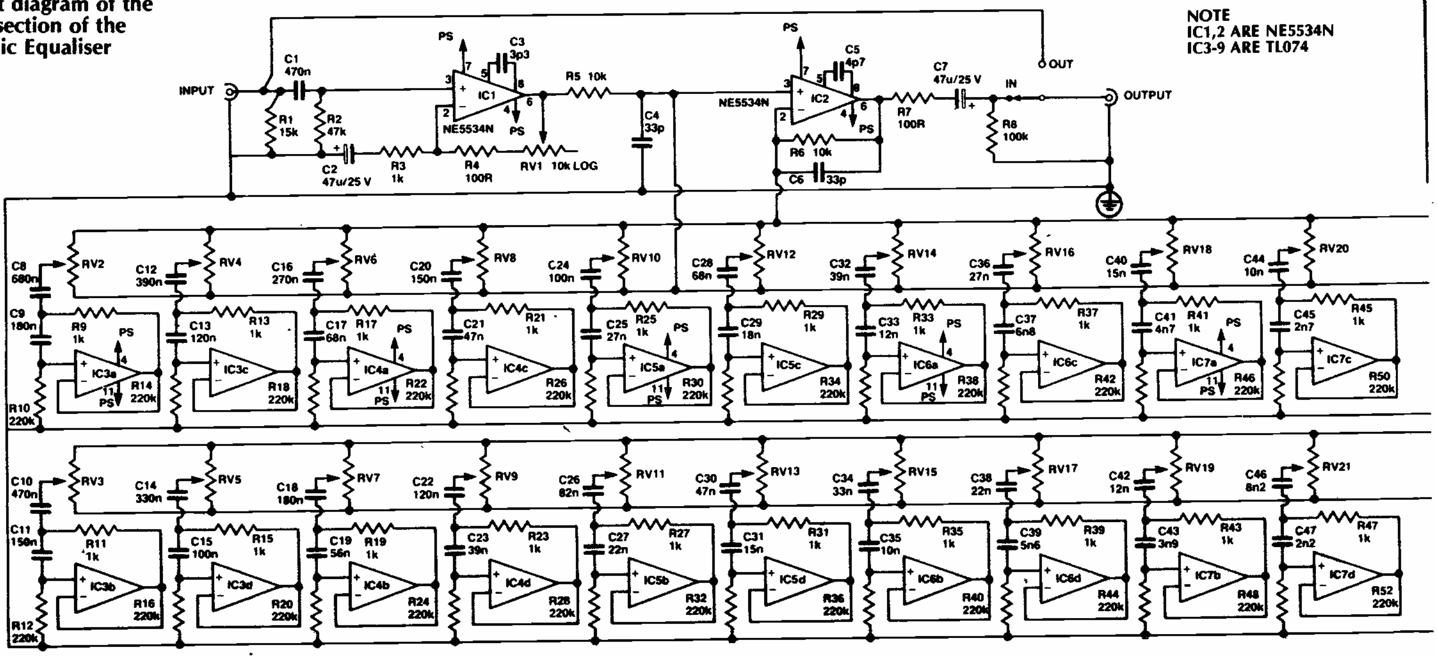


Fig. 1

The input resistor forms a potential divider with part of the potentiometer

Circuit diagram of the main section of the Graphic Equaliser



GRAPHIC

Is your listening room/concert hall dull and lifeless? Or does it echo and ring like the Whispering Gallery? David Tilbrook comes to the rescue with a project that will help get your response into shape.

HOW IT WORKS

(from the op-amp + input to the wiper) and the impedance Z to common. The feedback resistor also forms a potential divider with the end of the pot from the inverting input and the impedance Z to ground.

If the wiper of the pot is set to mid-travel, the attenuation of the input signal due to the potential divider is compensated by the gain of the op-amp and the overall gain from input to output is unity. If the pot wiper is now moved toward that end of the pot connected to the op-amp's inverting input, the gain of the stage is increased as the feedback ratio is reduced owing to a reduction of the impedance from the op-amp's inverting input to common. At the same time less attenuation of the input signal occurs as the impedance from the non-inverting input to common is decreased. The stage will have gain, maximum gain being determined by the impedance of the series resonant networks. If this is low, gain will be high. Series resonant networks exhibit very low impedance at resonance, rising either side of that frequency.

When the wiper of the pot is moved toward the non-inverting input of the op-amp, the attenuation due to the input potential divider is increased. The gain of the op-amp is decreased at the same time as the feedback ratio is increased because the impedance from the inverting input to common is increased. Once again, the overall gain of the circuit is a function of the impedance of the series resonant circuit, but this time the gain is at a minimum — in fact, attenuation occurs.

By choosing a suitable Q for the series resonant network, the bandwidth can be set to cover a desired frequency range. The potentiometer then sets gain or attenuation of the stage at the centre of the chosen frequency band.

The technique just described above can be used whenever it is desired to incorporate a relatively large number of filters into the signal path as in graphic equalisers or tone controls. The filter networks need not be bandpass or notch filters, simpler bass and treble controls can also be used.

Once this basic configuration is set up, all that remains is to design the filter networks. As mentioned before, series resonant networks were used since these give the required characteristic of low impedance at the resonant frequency. In their simplest form these networks consist of an inductor, capacitor and resistor in series. At the resonant frequency, the impedance of the circuit is equal to that of the resistor assuming a perfect inductor and capacitor were used. To eliminate the inductor an op-amp circuit has been used to simulate the characteristics of an inductor. Such a circuit is called a 'gyrator'.

The gyrator circuit can provide both the inductance and the series resistance required in the network so this can simply be placed in series with the capacitor to form the required resonant circuit. This is shown in block diagram form in Fig. 2.

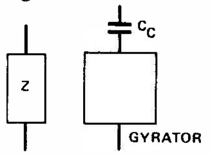
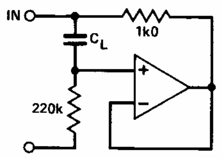


Fig. 2



BASIC GYRATOR CIRCUIT

Fig. 3

Figure 3 shows the general circuit of the gyrator used in this project. The amount of inductance 'generated' by this circuit is given by the simple equation:

$L = 1k \times 220k \times C_L$ in Henries

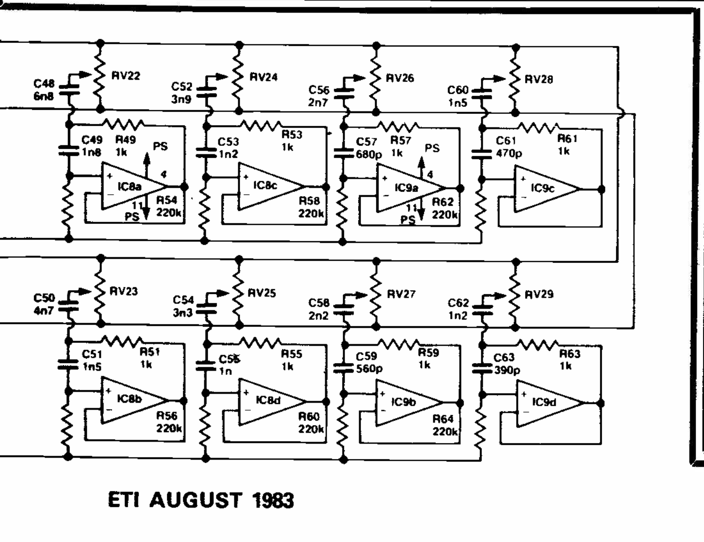
where the value of C_L is in Farads

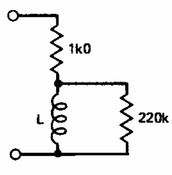
The equivalent circuit of the gyrator is shown in Fig. 4. The series resistance is equal to the 1k resistor while the 220k resistor becomes the parallel resistance of the coil. This value is high enough not to affect circuit operation drastically. The resonant frequency of this filter is given by the standard formula:

$$F = \frac{1}{2\pi\sqrt{LC}} \text{ in Hertz}$$

The general circuit, simplified, of the Third-Octave Graphic Equaliser is shown in Fig. 5. IC1 is simply a variable gain stage which also provides some input buffering. IC2 is the filter stage with a group of 28 gyrator circuits, all connected in parallel, in the feedback circuit. Commencing at a centre frequency of 31.5 Hz, each gyrator filter has a Q chosen such that its bandwidth covers one-third of an octave. Thus the upper and lower the 3 dB points of adjacent filters 'touch'. A total of 28 filters are required to cover the audio frequency band. Filters are not placed on the band limits of 20 Hz and 20 kHz as they are not really required. To reduce the IC count a set of seven quad op-amps (TL074s or uA774s) are used for the gyrators.

Slide pots are used to set the gain or attenuation inserted for each third-octave band as it is easy to see, at a glance, how much gain or attenuation has been set and, as all the pots are lined up in parallel across the front panel, one can instantly see the total modification made to the audio system's frequency response.





EQUIVALENT CIRCUIT OF GYRATOR IN FIG. 2

Fig. 4

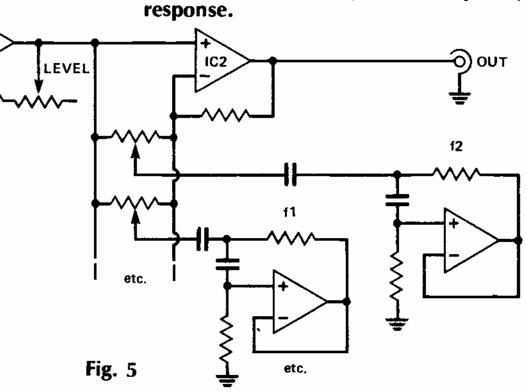
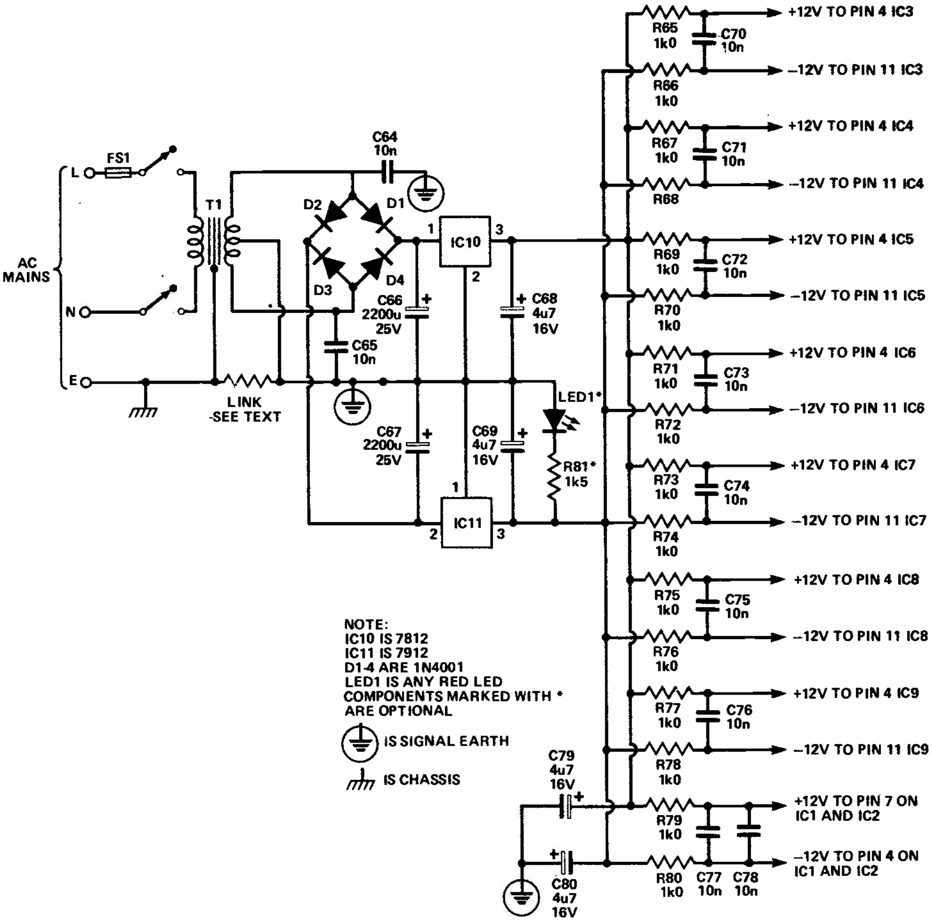


Fig. 5

the inductors necessary for the series of band-pass filters so there are no coils to wind. The gyrator is covered in more detail in the How it Works section, but the main problem associated with this approach is caused by phase shifts occurring in the op-amps used in the gyrators. The basic principle of a gyrator is to invert the phase response of a capacitor to simulate the characteristics of an inductor. The problem is that all amplifiers introduce a phase shift which increases towards the extremes of the frequency response. For this reason, care must be taken when choosing op-amps for use in gyrators at the top end of the frequency spectrum. This problem is accentuated when the Q of the filters concerned is increased. Since the Q of the filters must be higher in a ⅓-octave equaliser, an op-amp with greater phase linearity at high frequencies must be used. Fortunately, op-amps with the desired characteristics are not difficult to obtain and we are using the TL074 or uA774. These are both quad FET op-amps with almost identical performance and are capable of excellent results in the circuit, even in the top-most filter.



Circuit of the power supply for the Graphic Equaliser.

Earthing

In any large multi-component audio system, earthing is a continuous nightmare because of hum loops. The theory says that the entire audio circuit should be earthed at only one point. However, adding an extra earth connection can sometimes cure a hum that you've spent many hours chasing round the circuit — this is one of those occasions when the best approach is to leave it like that (but keep your fingers firmly crossed), hope it holds while the band is playing, and forget about it afterwards . . .

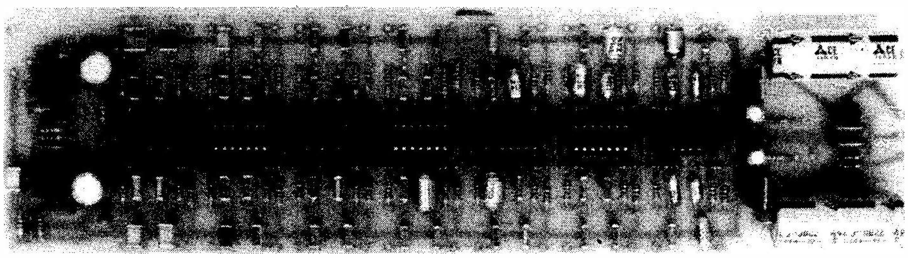
The other problem is deciding exactly where this one earth should be in the first place. Some people say the very start of the signal path — or, at least, as close as you can get to it. Others say that it should be at the power amp input. But everyone agrees — it's definitely never at the graphic equaliser. OK, then, what connection should there be between the mains earth and the graphic equaliser electronics? Some opt for a capacitor (100n is a reasonable value); others use a resistor (10 to 100R). We've left this up to you. However, all agree that there must also be a very low impedance path to earth through the rest of the equipment for safety reasons: if there isn't, you're asking for a nasty shock. Note also that you must use insulated audio input and output sockets, and be careful not to inadvertently connect the signal and mains earth in any other way — watch how you secure the PCB to the case, for example.

Capacitors

One possible area of trouble is in finding a supplier for the capacitors. If you look at the Parts List, you'll see that lots of the capacitors are in the E12 series: we hadn't realised how many suppliers had switched to supplying just the E6 series until we tried to locate a supplier for a suitable type. In the end, we used Siemens polycarbonate layer types from Cricklewood for all the capacitors above 10n in value, and mixture of these and polystyrene for those under 1n0. Ours were all 5% types or better, and we'd strongly suggest that you use 5% tolerance or better for all the capacitors in the gyrators. We've designed the PCB so that it should accommodate most types you're likely to want to use.

Next month we will give constructional details of the Graphic Equaliser, including details of a super specially designed case from Newrad Instruments.

ETI



This is the completed PCB — more details next month.

RESISTORS

CARBON FILM 5%
HI STAB 10Ω TO 10M
¼W E24 2p
½W E24 2½p
1W E24 6p
2W E24 12p

METAL FILM E24 ULTRA HI STAB ULTRA LOW NOISE 0.4W 10Ω TO 1M
2% E24 5p
1% E24 6p

LOW OHMIC GLAZE E12
0.22Ω to 8.2Ω 11p

WIRE-WOUND E12
2 to 3W 0.22Ω to 330Ω 28p
4 to 7W 0.47Ω to 6K8 33p
10 to 11W 1Ω to 33K 37p

POTS & PRESETS

LOW NOISE E3 ROTARY POTS WITH ¼" SPINDLES 4K7 TO 2M
LIN 32p
LOG 32p
As above with DP Mains Switch 79p
As above stereo (no switch) 89p

DUSTPROOF PRESETS E3 100Ω TO 10M
Mini Vert 15p
Mini Horiz. 15p
Standard Vert. 18p
Standard Horiz. 18p
Thumbwheel or ¼" Spindle for Standard Types only 8p

¾" CERMET 20 TURN PRESETS
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K each 89p

THERMISTORS & VDRs PLEASE PHONE

CAPACITORS

CERAMIC DISC/PLATE MICRO–MINI 100V TYPICALLY 5% E12
1pF to 10nF 7p

SIEMENS 63V MONOLYTHIC MINI CERAMIC
10nF, 22nF 10p
33nF, 47nF 10p
68nF 14p
100nF 14p

BARRIER LAYER CERAMIC DISC
220nF, 25V 15p

POLYSTYRENE 160V 5% OR BETTER
10pF, 15pF, 22pF, 27pF, 33pF, 39pF, 47pF, 68pF, 100pF, 150pF, 180pF, 220pF, 270pF, 330pF, 390pF 10p
470pF, 680pF, 1nF, 1.5nF 12p
2.2nF, 3.3nF 13p
4.7nF 14p
10nF 15p

SILVERED MICA 1% PLEASE PHONE

POLYESTER C280 TYPE (RADIAL) 250V
10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF 7p
150nF, 200nF 10p
330nF, 470nF 13p
680nF 18p
1µF 22p
1.5µF 39p
2.2µF 39p

SIEMENS POLY-C 5% 250V 7.5MM
1nF, 1n5, 2n2, 3n3, 4n7, 6n8 7p
8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 39n, 47n 8p
56n, 68n, 82n, 100n, 150n 10p

SIEMENS POLY-C 5% 100V 7.5MM
100n, 120n, 150n 11p
180n, 220n, 270n 14p
330n, 390n 20p
470n, 560n 26p
680n 30p
1µF (10mm) 35p

400V POLYESTER
1n, 1n5, 2n2, 3n3, 4n7, 6n8, 10n 10p
15n, 22n, 33n 11p
47n, 68n, 100n 14p
150n, 220n 18p
330n 39p
470n 50p

630VPC 250VAC IDEAL AS MAINS SUPPRESSORS
10nF 28p
15nF, 22nF 35p
47nF 39p
100nF 43p
150nF 49p
220nF 55p

1000VDC PLASTIC
1nF, 2n2 26p
4n7, 6n8 29p
10nF 31p
22nF, 33nF 37p
47nF 41p
100nF 45p
220nF 79p
470nF 1.25

HI VOLT CERAMIC
100pF 1KV 25p
100pF 2KV 30p
100pF 3KV 33p
100pF 4KV 37p
220pF 6KV 45p
470pF 2KV 39p
470pF 6KV 48p
1nF 2KV 39p
1nF 6KV 44p
2n2 2KV 44p
2n2 5KV 49p
3n3 2KV 47p
3n3 4KV 52p
4n7 4KV 57p
10nF 2KV 57p

FEEDTHRO' CAP
1nF 500V 7p

TRIMMERS MINI FILM (MULLARD) UP TO 100VDC
1p4 to 5pF (800MHz) 23p
2pF to 10pF (600MHz) 27p
2pF to 22pF (400MHz) 29p
5p5 to 65pF (200MHz) 36p

ELECTROLYTICS Axial by Siemens or Matsushita (Nat. Panasonic)

uFd	V	
47	63	6p
47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	18p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2000	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	89p

Radial by Matsushita

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

CAN ELECTROLYTICS
4700µF 40V 2.50
4700µF 63V 3.50
10,000µF 80V 4.50

TANTALIUM BEADS
0.1 35V 14p
.22/35V 14p
.33/35V 14p
.47/35V 14p
.68/35V 14p
1.0/35V 14p
2.2/16V 14p
2.2/35V 14p
3.3/35V 18p
4.7/16V 18p
4.7/35V 20p
6.8/25V 20p
6.8/35V 21p
10/16V 18p
10/35V 27p
15/16V 22p
15/25V 32p
22/6.3V 26p
22/16V 29p
33/10V 30p
47/6.3V 30p

100/3V 32p

MANY MORE CAPACITORS IN STOCK: PLS PHONE

TRANSFORMERS

100mA
6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V 95p

6VA
0-6 + 0-6V 2.65
0-12 + 0-12V 2.65
0-15 + 0-15V 2.65
0-20 + 0-20V 2.65

30VA
6 + 6 + 9 + 9V (total 30V 1A) 4.30

50VA
0-12 + 0-12V 4.35

100VA
0-12 + 0-12V 6.95

TOROIDALS
Up to 500VA in stock. Please Phone

Please add adequate P&P as transformers are heavy!

WIRE & CABLE

PRICES PER METRE
Solid Hook-up Any colour 5p

MAINS/SPEAKER
Twin 1 Amp 14p
Twin 2½ Amp 16p
3 Core 2½ Amp 18p
3 Core 6 Amp 31p
3 Core 13 Amp 56p

SCREENED
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core, Single Screen 54p
8 Core 61p
12 Core 80p
Heavy Duty Mike/Guitar Lead 25p

AERIAL
50Ω RG58A 25p
75Ω UHF 29p
75Ω VHF 28p
300Ω Flat 14p

RAINBOW RIBBON
Prices per foot
8 way 25p
10 way 25p
16 way 39p
20 way 48p
24 way 62p
30 way 75p
32 way 82p
40 way 88p

PCB MATERIALS

GRADE ONE GLASS PCB SINGLE – SIDED
178 × 240mm 95p
420 × 195mm 1.30
420 × 245mm 1.96

FERRIC CHLORIDE PELLETS
Quick dissolving Enough to make over 1 litre 1.69

ETCH RESIST PEN
(inc. Spare Nib) 90p

ETCH RESIST TRANSFERS
1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge connectors
9. Mixture
Any sheet of above 35p

PHOTO SENSITIVE PCB
1st Class Epoxy Glass. For better results than spraying. Expose to UV.
Single sided
100 × 160 1.55
100 × 220 1.90
203 × 114 1.86
233 × 220 3.99
Double sided
100 × 160 1.65
100 × 220 2.15
203 × 114 2.21
233 × 220 4.55
Developer for above (do not use Sodium Hydroxide) 500 ml 2.50

VEROBOARD

VEROBOARD 0.1" COPPER CLAD
2.5 × 3.7 83p
2.5 × 5 99p
3.75 × 3.75 99p
3.75 × 5 1.14
2.5 × 17 2.99
3.75 × 17 3.85
4.79 × 17 4.93
VQ Board 1.92
Dip Board 3.90
Track Cutter 1.48
Pin Inserter 1.79
100 Pins 55p

Verobloc 3.99
Vero Wiring
Pen + Spool 3.35
Spare Spool 75p
Combs 6p

SWITCHES

DIL SPST
4 way 67p
6 way 82p
8 way 90p
10 way 1.40

TOGGLE (MINI)
SPST 49p
SPDT 59p
DPDT 69p
DPDT C OFF 79p
4PDT 2.75
All types of biased toggles in stock. Please phone

PUSH BUTTON
Non-Latching
Push to Make 15p
Push to Break 25p

KEY-SWITCH
Mains 4 amps DPST withdraw Key in both positions (inc. 2 keys) 3.80

FOOTSWITCH
with metal buttons
SPDT 1.85
DPDT 2.75

ROTARY
Main DP 4 amps with ¼" spindle 55p
Lorlin Adjustable Stop Type
1p 1 to 12 way 55p
2p 2 to 6 way 55p
3p 3 to 4 way 55p
4p 4 to 3 way 55p

Many other switches in stock Please Phone

CONNECTORS PLUGS AND SOCKETS

DIL SOCKETS

Pins	Lo-prof	W Wp
8	8p	25p
14	9p	35p
16	10p	40p
18	16p	50p
20	20p	–
22	22p	–
24	24p	70p
28	28p	79p
40	30p	99p

ZERO INSERTION FORCE DIL SOCKETS
24 pin 4.25
40 pin 5.25

UHF PL259 TYPES
Low loss, superior quality 50Ω
Line plug 45p
Reducer 15p
Round skt. 40p
Sqr skt 40p

BNC 50Ω
Plug 1.10
Socket 1.00
Line skt 1.15

COAX (TV)
All Metal
Plug 25p
Socket 25p
Line Skt 40p

CANNON TYPE AUDIO PLUGS (3 PIN XLR)
Male 1.70
Female 1.65
Sockets (Chassis)
Male 1.50
Female 2.35

JACK PLUGS
Huge Discount for quantity Please phone
¼" Mono 20p
¼" Stereo 30p
¼" Metal Mono 30p
2½" mm Mono 12p
2½ mm Metal Mono 20p
3½ mm Mono 12p
3½ mm Stereo 35p
3½ mm Metal Mono 20p

JACK SOCKETS
Chassis
¼ Mono 20p
¼ Stero 25p
2½ mm Mono 15p
3½ mm Mono 15p
Line
¼" Mono 20p
¼" Metal 40p
¼" Stero 30p
¼" Stero Metal 50p
3½ mm Mono 15p
3½ mm Mono Line 20p

D CONNECTORS

Solder Type
Male
9 way 80p
15 way 1.03
25 way 1.60
37 way 2.50
Female
9 way 99p
15 way 1.75
25 way 2.05
37 way 3.30
Angled PCB
25w Male 2.45
25w Female 2.90
Covers 99p

EURO CONNECTORS
Male
31 way 1.75
64w. A + B Straight 2.25
64w. A + B Angled 2.95
64w A + B Straight 2.40
64w. A + C Angled 2.95
Female
31 way 1.75
64w. A + B Straight 2.75
64w A + B Angled 3.25
64w A + C Straight 2.95
64w. A + C Angled 3.35

IDC CONNECTORS
PCB Male + Latch Straight
10 way 89p
16 way 1.29
20 way 1.45
26 way 1.75
34 way 1.99
40 way 2.25
50 way 2.45
PCB Male + Latch Angled
10 way 95p
16 way 1.47
20 way 1.60
26 way 1.99
34 way 2.40
40 way 2.55
50 way 2.75
Female Header
10 way 84p
16 way 1.07
20 way 1.25
26 way 1.49
34 way 1.75
40 way 1.95
50 way 1.99

DIN PLUGS
2 pin 9p
3 pin 11p
5 pin 180° 12p
5 pin 240° 15p
5 pin Domino 50p
6 pin 18p
7 pin 30p

DIN CHASSIS SOCKETS
2 pin 9p
3 pin 10p
5 pin 180° 10p
5 pin 240° 16p
6 pin 20p
7 pin 25p

DIN LINE SOCKETS
2 pin 10p
3 pin use 5p 180°
5 pin 15p

PHONO PLUGS
Metal 20p
Plastic: Red, Yellow, Green, Black 15p

PHONO CHAS. SOCKETS
Single 16p
Dual 20p
Quad 25p

BATTERY CONNECTORS
PP3 Snaps 10p
PP9 Snaps 12p
Box for 4HP7 27p
Box for 6HP7 33p
Box for 4HP11 33p

TRANSISTOR SOCKETS
TO18 (BC109) 30p
TO5 (BFY50) 35p
TO3 (2N3055) 40p

'KEYNECTOR'
Bare Wire Mains Safety Block
£7.95

IEC MAINS 6 AMP 3 PIN
Plug (Holes) 58p
Chassis Skt. (Pins) 35p
Line Skt. Pins 60p
Chassis Plug (Holes) 50p

13 AMP DOMESTIC
Plug + Fuse 50p
Adaptor 2 way 1.95
Trailing skt. 82p

BOXES & CASES

ALUMINIUM CASES
Covered with Black Rexine (Scratchproof)
R1 6x4½x1¼" 2.35
R2 8x5x2" 2.75
R3 9x5x2½" 3.15
R4 11x6x3" 3.85
R5 11x7½x3½" 4.75
R6 13x8x4½" 7.35
R7 15x8x4" 7.75

VEROBOXES
Black Plastic
V1 3x2x1" 55p
V2 120x80x 35mm 90p
V3 180x110x55 1.60

SLOPING FRONT VEROCASES
V5 220x174x 100mm 10.40
V6 171x121x 75mm 5.65

REMOTE CONTROL (Handheld) BOX
94x61x22.5mm White 89p

KNOBS

SIFAM PROFESSIONAL COLLET KNOBS
All fit ¼" spindles
Black (suffix B)
Grey (Suffix G)
15mm Short
S150B plain 56p
S150G plain 56p
S151B + line 64p
S151G + line 64p
15mm Standard
K150B plain 57p
K150G plain 57p
K151B + line 66p
K151G + line 66p
15mm Winged
W150B 74p
W150G 74p
21mm Short
S210B plain 69p
S210G plain 69p
S211B + line 75p
S211G + line 75p
21mm Standard
K210B plain 69p
K210G plain 69p
K211B + line 78p
K211G + line 78p
21mm Winged
W210B 86p
W210G 86p
29mm Standard
K290B 88p
K290G 88p

CAPS: Blk, Red, Yel, Grn, Grey, Blue. (Please state colour)
15mm plain 5p
15mm + dot 8p
15mm + line 8p
21mm plain 5p
21mm + dot 8p
21mm + line 8p
29mm (Red, Blk, Grey only) 8p

Nut Covers 15mm
Colours as above 8p

POINTERS 15mm or 21mm
Colours as above 8p

DIALS 15mm
Red + Point 26p
Blk + Point 6p
Grey + Point 26p
Clear 1 to 10 26p
Clear Taper 26p

DIALS 21mm
Red + Point 28p
Blk + Point 28p
Grey + Point 28p
Clear 1 to 10 28p
Clear Taper 28p

STANDARD KNOBS
(All for ¼" spindles)
Grub Screen Fitting
Black Plastic
M1.25 + metal insert 34p
M2. 33mm + metal insert 39p
M3. 36mm + metal insert & skirt 39p
M4. As M3 numbered 1 to 10 39p
M5. As M3 but 30mm 42p
M6. As M4 but 30mm 42p
M7. Pointer 24p

16mm SOLID ALUMINIUM MATCHING KNOBS
M8. 15mm 48p
M9. 24mm 56p
M10. 30mm 69p

FUSES

20mm	Slow	Fast
100mA	19p	15p
250mA	17p	10p
315mA	17p	10p
500mA	17p	10p
630mA	17p	10p
800mA	17p	10p
1A	17p	10p
1.6A	17p	10p
2A	17p	10p
3.15A	17p	10p
4A	17p	10p
5A	17p	10p
6.3A	17p	10p
10A	17p	10p

1¼"	Slow	Fast
100mA	19p	15p
250mA	17p	10p
315mA	17p	–
500mA	17p	10p
600mA	17p	10p
800mA	17p	10p
1A	17p	10p
1.5A	17p	10p
2A	17p	10p
3A	17p	10p
4A	–	10p
5A	–	10p
6A	–	10p
10A	–	10p
15A	–	10p
20A	–	10p

1" PLUG FUSES
In Packs of 4
2 amp 59p
3 amp 59p
5 amp 59p
7 amp 59p
13 amp 59p

PANEL FUSEHOLDERS
20mm 36p
1¼" 36p

QUARTZ CRYSTALS

Please enquire about types not listed
32.768K Hz 95p
100KHz 2.35
200KHz 2.65
1.00MHz 2.74
1.008MHz 2.74
2.00MHz 2.24
2.097152MHz 3.49
3.2768MHz 1.49
4.00MHz 1.49
4.194394MHz 1.99
4.433619MHz 99p
5.00MHz 1.50
6.00MHz 1.39
6.9375MHz 3.50
8.00MHz 1.49
10.00MHz 1.75
18.00MHz 1.79
20.00MHz 1.99
27.648MHz 1.69
48.00MHz 1.69
100.00MHz 2.95
5.5 MHz Ceramic filter 90p

TOOLS

Top quality Hand Tools Lindstrom
L670. Side Cutters 4.3" 14.55
L890. Snipe Nose Pliers 5.2" 10.35
L870. Snipe Nose Pliers 4.7" 10.35
L160. Long Nose Pliers 14.95

CK TOOLS
C80 4¼" Side Cutter 10.02
C73 4½" Side Cutter 9.28
C72 4½" Pliers (Snipe) 7.52

DE-SOLDERING PUMP
BT 100. High Suction Anodised 4.55
Spare Teflon Nose 85p

TEST METERS

BTC601 LCD
Push Button
2 amps AC/DC, 1KV DC 750v AC
Fully guaranteed 34.50

MINI TESTER
Pocket Size 2000 OPV Analog Meter 5.55

MICROTEST 80
Superior 20,000 OPV 1000v AC/DC, 5 ADC, 2.5A AC, 0.1Ω to 5M 16.60

680R 20,000 OPV 1000v DC, 2000v AC, 0-1Ω to 10M 32.00

RELAYS

DIL REED
100VA Normally open (1 amp)
5v 380Ω 1.99
5v 380Ω + Diode & Screen 2.95
12v 530Ω 1.99
24v 2kΩ 1.99

PCB RELAYS
240VAC 10 amps Contacts SPDT 1x½" 6v 72Ω 2.75
12v 285Ω 2.75
24v 1150Ω 2.95
48v 4600Ω 3.04

RECHARGEABLE BATTERIES

Guaranteed minimum 500 charges
HP2(1.2AH) 2.39
HP2(4AH) 4.75
HP7(½AH) 99p
HP11(1.2AH) 2.29
PP3(110mAH) 4.95

Chargers
TYPE H: Adjusted to 6 of any HP type Above £15.59
TYPE M: As above but faster charge for 4AH £25.95
TYPE P: PP3 £5.50
TYPE A: HP7 (Up to 4 at a time) £5.85

HEAT SINKS

TO1 (AC128) 18p
TO5 (BFY51) 18p
TO18 (BC 109) 18p
TO220 (TIP29) 36p

UHF MODULATOR

Aztec 8MHz Wideband 4.50

BOOKS NO VAT

Prices inc. post in UK. Cheaper to callers.
Tower Transistor Manual (Bible) 10.50
Elektor 301 Circuits 6.50
Texas TTL Data 10.50
Texas Op to 5.18
Texas Mos Memory 4.95
Texas Linear 4.95
National Interface 2.95
National Special Function 2.95
National Data Conversion 2.95
Toshiba CMOS 7.95
Hitachi Micro-processor 9.00
Hitachi Memory 7.50
Hitachi Powerfet 8.00

TEXAS "UNDER-STANDING"
Solid State 4.95
Digital 4.95
Car Electronics 4.95
Security Electronics 4.95
Optronics 4.95
Communications 4.95
Computer Science 4.95
Microprocessors 4.95

SOLDERING EQUIPMENT

Antex Irons
C240 (15W) 4.49
XS250 (25W) 4.99
Iron Stand 1.65
Elements
(State Iron) 2.05
C240 Bits
No. 2 (Small) 65p
No. 3 (Med.) 65p
No. 6 (Micro) 65p
XS250/X25 Bits
No. 50 (Small) 65p
No. 51 (Med.) 65p
No. 52 (Lge.) 65p

SOLDER 125gms
18swg 2.95
22swg 3.10

SEMICONDUCTORS

UK's Greatest Retail Variety. Please phone about types not listed due to insufficient space.
Only top quality devices sold

2N918 33p
2N929 36p
2N929A 45p
2N930 20p
2N930A 30p
2N1131 24p
2N1132 25p
2N1302 45p
2N1303 65p
2N1304 60p
2N1306 65p
2N1308 65p
2N1711 35p
2N1889 50p
2N1890 50p
2N1893 49p
2N2060 7.14
2N2102 35p
2N2217 39p
2N2218 33p
2N2218A 26p
2N2219 27p
2N2219A 28p
2N2220 22p
2N2221 22p
2N2221A 23p
2N2222 24p
2N2222A 25p
2N2223 2.60
2N2223A 4.15
2N2368 25p
2N2369 19p
2N2369A 20p
2N2405 88p
2N2410 1.15
2N2411 3.60
2N2483 25p
2N2484 26p
2N2646 45p
2N2647 98p
2N2714 12p
2N2848 60p
2N2890 1.10
2N2891 2.28
2N2892 3.00
2N2904A 27p
2N2905 28p
2N2905A 29p
2N2906 25p
2N2906A 30p
2N2907 25p
2N2907A 26p
2N2920 3.47
2N2923 25p
2N2924 15p
2N2925 15p
2N2926 10p
2N3010 75p
2N3011 65p
2N3019 50p
2N3053 27p
2N3054 56p
2N3055 60p
2N3055RCA 80p
2N3055H 1.20
2N3107 46p
2N3109 48p
2N3232 1.50
2N3250 36p
2N3251 36p
2N3439 98p
2N3440 80p
2N3441 1.25
2N3442 1.35
2N3442RCA 1.85
2N3444 1.70
2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3512 1.06
2N3553 2.65
2N3563 20p
2N3564 25p
2N3565 20p
2N3566 50p
2N3567 55p
2N3568 50p
2N3569 50p
2N3570 6.95
2N3571 5.73
2N3572 4.95
2N3584 2.76
2N3585 2.99
2N3632 9.88
2N3638 55p
2N3638A 70p
2N3639 65p
2N3641 69p
2N3642 50p
2N3643 30p
2N3644 56p
2N3645 66p
2N3646 28p
2N3662 15p
2N3663 16p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2.00
2N3713 1.38
2N3714 2.98
2N3715 3.31
2N3716 3.60
2N3724 75p
2N3725 85p
2N3730 4.65
2N3732 2.88
2N3734 1.30
2N3735 2.45
2N3738 2.00
2N3740 2.38
2N3741 2.76
2N3766 2.90
2N3767 3.19
2N3771 1.75
2N3772 1.83
2N3773 1.99
2N3773 Motorola 2.67
2N3773 RCA 2.75
2N3773 Thomson 2.75
2N3779 1.70
2N3789 3.27
2N3790 2.73
2N3791 2.47
2N3792 2.68
2N3794 25p
2N3819 25p
2N3820 38p
2N3821 1.84
2N3822 90p
2N3823 45p
2N3824 1.70
2N3826 78p
2N3827 78p
2N3854 44p
2N3855 30p
2N3855A 40p
2N3856 45p
2N3858 31p
2N3858A 37p
2N3859A 31p
2N3860 31p
2N3866 90p
2N3877A 35p
2N3900 25p
2N3902 3.33
2N3903 13p
2N3904 13p
2N3905 13p
2N3906 13p
2N3924 8.30
2N3945 85p
2N3962 30p
2N3964 1.42
2N4030 75p
2N4031 65p
2N4032 69p
2N4036 63p
2N4037 49p
2N4058 10p
2N4059 17p
2N4060 12p
2N4061 10p
2N4062 10p
2N4064 1.15
2N4069 1.00
2N4416A 1.80
2N4220 75p
2N4221 95p
2N4222 97p
2N4223 97p
2N4224 98p
2N4234 45p
2N4236 45p
2N4237 1.21
2N4238 95p
2N4239 95p
2N4240 3.00
2N4248 15p
2N4249 17p
2N4250 17p
2N4258 75p
2N4266 45p
2N4275 48p
2N4284 32p
2N4285 35p
2N4288 22p
2N4289 15p
2N4290 45p
2N4291 45p
2N4292 45p
2N4294 45p
2N4297 2.50
2N4302 39p
2N4303 40p
2N4304 41p
2N4400 15p
2N4401 27p
2N4402 30p
2N4403 30p
2N4409 36p
2N4410 42p
2N4416 1.50
2N4427 79p
2N4440 12.58
2N4870 80p
2N4871 55p
2N4888 99p
2N4898 1.29
2N4901 1.69
2N4902 1.85
2N4903 1.98
2N4904 2.15
2N4905 2.75
2N4906 2.99
2N4907 3.20
2N4908 3.15
2N4909 2.90
2N4910 1.95
2N4913 2.59
2N4914 2.69
2N4915 2.95
2N4916 48p
2N4917 47p
2N4918 65p
2N4919 75p
2N4920 85p
2N4921 55p
2N4922 69p
2N4923 99p
2N4924 92p
2N4926 95p
2N4927 95p
2N4928 1.59
2N4964 27p
2N4965 25p
2N4966 25p
2N4967 25p
2N4968 26p
2N4969 31p
2N5010 12.75
2N5011 13.85
2N5030 44p
2N5033 48p
2N5036 1.60
2N5039 1.90
2N5086 36p
2N5087 39p
2N5088 37p
2N5089 37p
2N5172 15p
2N5175 58p
2N5179 39p
2N5180 43p
2N5183 1.00
2N5184 1.10
2N5188 1.15
2N5189 1.00
2N5190 68p
2N5191 70p
2N5193 90p
2N5194 79p
2N5195 99p
2N5195 99p
2N5196 1.08
2N5209 24p
2N5210 25p
2N5220 15p
2N5221 25p
2N5222 28p
2N5223 15p
2N5224 38p
2N5226 25p
2N5226 25p
2N5227 25p
2N5245 37p
2N5246 40p
2N5247 45p
2N5248 46p
2N5249 48p
2N5266 2.88
2N5293 98p
2N5294 1.28
2N5295 1.37
2N5296 1.28
2N5298 1.37
2N5302 3.20
2N5303 3.80
2N5305 25p
2N5306 37p
2N5307 40p
2N5308 25p
2N5354 19p
2N5355 19p
2N5358 73p
2N5366 25p
2N5367 28p
2N5401 35p
2N5415 1.10
2N5416 1.54
2N5447 16p
2N5448 19p
2N5449 21p
2N5450 23p
2N5451 25p
2N5457 29p
2N5458 29p
2N5459 29p
2N5460 72p
2N5461 60p
2N5482 80p
2N5484 40p
2N5485 29p
2N5490 1.37
2N5492 1.56
2N5494 1.37
2N5496 1.59
2N5543 12.00
2N5551 37p
2N5640 45p
2N5654 35p
2N5786 80p
2N5813 23p
2N5884 5.95
2N5886 5.95
2N6027 30p
2N6030 6.60
2N6031 6.95
2N6082 11.99
2N6099 1.20
2N6101 1.30
2N6109 1.15
2N6111 1.00
2N6121 67p
2N6122 59p
2N6123 65p
2N6124 59p
2N6125 65p
2N6126 75p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.14
2N6134 1.36
2N6212 3.27
2N6253 1.45
2N6254 1.55
2SC1096 95p
2SC1306 95p
2SC1307 1.60
2SC1923 40p
2SC2078 1.70
2SJ49 3.60
2SJ50 3.75
2SJ82 4.29
2SK134 3.50
3SK135 3.75
2SK226 4.29
2N139 3.30
3N140 1.07
3N143 2.85
3N152 3.00
3N153 2.47
3N154 2.56
3N200 6.93
3N201 2.98
3N211 3.35
3SK88 89p
40360 80p
40361 67p
40362 67p
40363 2.95
40364 3.25
40372 1.80
40373 2.60
40374 2.84
40406 1.39
40407 75p
40408 1.59
40409 1.50
40410 1.80
40411 2.85
40412 90p
40422 2.95
40467A 1.29
40513 1.75
40537 96p
40594 99p
40595 99p
40600 2.58
40601 2.36
40602 1.68
40603 1.09
40604 1.85
40608 2.44
40631 2.12
40635 1.36
40637 2.00
40643 1.80
40673 70p
40822 1.80
40871 79p
40872 79p
AC125 49p
AC126 32p
AC127 32p
AC128 35p
AC132 68p
AC151 51p
AC152 45p
AC153 55p
AC153K 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 28p
AC188 25p
AC188K 40p
ACY17 1.50
ACY20 75p
ACY21 75p
ACY22 75p
ACY28 75p
ACY44 98p
AD136 6.75
AD149 79p
AD150 2.80
AD161 39p
AD162 39p
AF106 75p
AF109 75p
AF114 65p
AF117 1.00
AF118 89p
AF124 72p
AF125 72p
AF126 72p
AF139 40p
AF170 88p
AF172 88p
AF178 88p
AF200 65p
AF201 75p
AF239 55p
AF240 1.00
AF279B 1.19
AF279G 1.19
AL102 3.49
AU106 4.57
AU110 2.20
AU113 3.67
BC107 10p
BC107A 12p
BC107B 12p
BC108 10p
BC108A 12p
BC108B 12p
BC108C 14p
BC109 10p
BC109B 12p
BC109C 12p
BC113 30p
BC114 19p
BC115 22p
BC116 32p
BC116A 37p
BC117 19p
BC118 19p
BC119 38p
BC121 82p
BC123 82p
BC125 37p
BC132 39p
BC134 36p
BC135 45p
BC136 45p
BC137 39p
BC138 55p
BC140 29p
BC141 37p
BC142 29p
BC143 30p
BC147 10p
BC147A 10p
BC147B 10p
BC147C 20p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 12p
BC149C 13p
BC152 35p
BC153 23p
BC154 27p
BC157 11p
BC157A 12p
BC157B 13p
BC158 10p
BC158A 12p
BC158B 13p
BC159 11p
BC159A 12p
BC159B 13p
BC159C 18p
BC160 42p
BC161 48p
BC167 10p
BC167A 10p
BC167B 13p
BC168 10p
BC168B 10p
BC168C 10p
BC169 10p
BC169B 10p
BC169C 10p
BC170 15p
BC170A 17p
BC170B 17p
BC170C 18p
BC171 12p
BC171A 15p
BC171B 15p
BC172 12p
BC172A 15p
BC172B 15p
BC172C 16p
BC173 11p
BC173B 16p
BC173C 16p
BC174 21p
BC174A 24p
BC174B 24p
BC175 75p
BC177 16p
BC177A 25p
BC177B 26p
BC178 16p
BC178A 24p
BC178B 25p
BC179 20p
BC179A 25p
BC179B 25p
BC179C 27p
BC182 10p
BC182A 12p
BC182B 13p
BC182L 10p
BC182LA 13p
BC182LB 14p
BC183 10p
BC183A 11p
BC183B 12p
BC183C 13p
BC183L 10p
BC183LA 13p
BC183LB 13p
BC183LC 14p
BC184 10p
BC184B 12p
BC184C 13p
BC184L 10p
BC184LB 13p
BC184LC 14p
BC186 24p
BC187 24p
BC204 29p
BC205 29p
BC206 29p
BC207 29p
BC208 29p
BC209 29p
BC212 10p
BC212A 12p
BC212B 13p
BC212L 10p
BC212LA 13p
BC212LB 14p
BC213 10p
BC213A 11p
BC213B 12p
BC213C 13p
BC213L 10p
BC213LB 13p
BC213LC 14p
BC214 10p
BC214B 12p
BC214C 13p
BC214L 10p
BC214LB 13p
BC214LC 14p
BC237 14p
BC237A 16p
BC237B 17p
BC237C 18p
BC238 14p
BC238A 15p
BC238B 16p
BC238C 17p
BC239 15p
BC239A 16p
BC239B 17p
BC239C 18p
BC250 22p
BC250A 23p
BC250B 24p
BC250C 25p
BC251 25p
BC251A 26p
BC251B 27p
BC251C 28p
BC252 22p
BC252B 23p
BC252C 24p
BC253 22p
BC253B 23p
BC253C 24p
BC256 25p
BC256A 26p
BC256B 27p
BC257 26p
BC257A 27p
BC258 24p
BC258A 25p
BC258B 26p
BC259 25p
BC259B 26p
BC259C 27p
BC260 30p
BC260B 32p
BC260C 33p
BC261 33p
BC261A 34p
BC261B 35p
BC261C 36p
BC262 31p
BC262A 32p
BC262B 33p
BC262C 34p
BC263 30p
BC263B 31p
BC263C 32p
BC264 40p
BC264B 42p
BC266 35p
BC266A 36p
BC266B 37p
BC300 46p
BC301 44p
BC302 43p
BC303 47p
BC304 46p
BC307 13p
BC307A 14p
BC2078 16p
BC308 12p
BC308A 13p
BC308B 14p
BC309 14p
BC309A 15p
BC309B 16p
BC309C 17p
BC317 15p
BC318 16p
BC320 25p
BC321 25p
BC327 14p
BC328 14p
BC337 16p
BC338 16p
BC347 20p
BC350 20p
BC382 30p
BC382L 30p
BC383 30p
BC383L 30p
BC384 30p
BC384L 30p
BC407 24p
BC408 24p
BC409 30p
BC413 25p
BC414 26p
BC415 30p
BC416 30p
BC418 30p
BC440 32p
BC441 33p
BC460 32p
BC461 33p
BC478 29p
BC479 30p
BC516 40p
BC517 40p
BC547 13p
BC547A 14p
BC547B 14p
BC548 12p
BC548A 13p
BC548B 14p
BC548C 15p
BC549 13p
BC549B 14p
BC549C 15p
BC550 15p
BC550C 25p
BC557 15p
BC557A 16p
BC557B 16p
BC558 14p
BC558A 15p
BC558B 16p
BC559 16p
BC559B 16p
BC559C 17p
BC560 32p
BC560 15p
BC560C 25p
BC650 48p
BC651 46p
BCY70 18p
BCY71 16p
BCY72 19p
BCY77 34p
BCY78 22p
BCY79 22p
BCY87 6.80
BCY88 4.90
BCY89 4.10
BD115 58p
BD116 2.50
BD121 95p
BD124 (Mullard) 2.28
BD131 44p
BD132 44p
BD135 36p
BD136 35p
BD137 37p
BD138 37p
BD139 38p
BD140 38p
BD142 2.40
BD153 1.25
BD155 1.20
BD157 54p
BD158 56p
BD160 3.80
BD181 1.75
BD182 2.50
BD183 2.70
BD187 1.09
BD201 1.30
BD202 1.39
BD204 1.44
BD220 1.00
BD221 95p
BD223 1.00
BD224 95p
BD232 1.11
BD233 70p
BD234 72p
BD237 98p
BD238 98p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 67p
BD242A 65p
BD242C 70p
BD243A 72p
BD143C 85p
BD244A 82p
BC244C 1.00
BD245A 1.14
BD245C 1.30
BD246A 1.20
BD246C 1.50
BC249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.46
BD433 79p
BD 434 55p
BD435 81p
BD436 81p
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.20
BD530 1.30
BD535 75p
BD536 75p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 86p
BD540C 1.20
BD675 72p
BD676 77p
BD677 78p
BD678 83p
BD711 1.32
BD712 1.32
BDX14 1.30
BDX18 1.58
BDX32 3.47
BDY54 1.70
BDY55 1.75
BDY56 1.80
BDY57 5.25
BDY58 6.15
BDY60 1.80
BDY61 2.80
BDY62 2.34
BDY92 3.75
BF115 35p
BF119 1.00
BF121 78p
BF123 70p
BF127 80p
BF153 39p
BF154 28p
BF157 58p
BF158 28p
BF159 58p
BF160 65p
BF161 68p
BF163 80p
BF166 57p
BF167 29p
BF170 79p
BF173 28p
BF174 77p
BF177 28p
BF178 30p
BF179 35p
BF180 35p
BF181 36p
BF182 36p
BF183 38p
BF184 36p
BF185 37p
BF194 12p
BF195 12p
BF196 12p

CRICKLEWOOD ELECTRONICS LTD

Stocking parts other stores cannot reach!

VISA

* ACCESS
* BARCLAYCARD
* VISA
* AMERICAN EXPRESS

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET.
TELEPHONE 01-452 0161 TELEX 914977
ALL PRODUCT FIRST GRADE FRANCHISED SOURCE

All advertised items are guaranteed to conform with, or surpass manufacturer's current data sheets. This list represents a fraction of our stock. New items are constantly being brought into stock. Cricklewood Electronics keep up with the times. Please phone about all your electronic needs.

HOW TO ORDER: 1 Mail order with cheque, P.O., Bank Draft, Registered Cash, or write Credit Card* number on order with signature. Please add 60p post, packing and insurance, more for heavy goods, Securicor available. 2 Phone your order quoting Credit Card* number. 3 Call in. You will be more than welcome. 4 Official orders accepted from Govt. Depts., Schools, Colleges, Armed Service Establishments, P.L.C.s and approved accounts. 5 Overseas orders by Bank Draft in Sterling and £2.00 minimum post and packing. DHL plus £65.00 no V.A.T.

V.A.T. applicable to U.K. only. Please add 15% after adding P&P to order. No V.A.T. on books and datasheets.

DELIVERY all in stock items despatched same day (95% of all advertised items are in stock), items out of stock in a few days — any problems and you will be informed immediately.

BF197	12p
BF198	15p
BF199	15p
BF200	75p
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	30p
BF245B	51p
BF246	52p
BF246A	39p
BF246B	51p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF262	80p
BF263	90p
BF270	65p
BF271	68p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BF494	29p
BF495	29p
BF900	1.09
BFR39	22p
BFR40	22p
BFR41	22p
BFR79	22p
BFR80	22p
BFR81	22p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT18	1.65
BFT66	2.48
BFW10	1.48
BFW11	1.48
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX84	27p
BFX85	28p
BFX86	28p
BFX87	25p
BFX88	28p
BFX89	1.75
BFY19	1.10
BFY37	1.20
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	88p
BFY90	78p
BLY83	11.60
BSV81	1.96
BSX19	24p
BSX20	24p
BSX21	40p
BSX27	78p
BSX28	66p
BSX29	34p
BSY95A	25p
BU104	2.22
BU105	1.70
BU108	3.95
BU109	3.29
BU126	1.47
BU204	2.26
BU205	1.75
BU206	1.89
BU208	1.98
BU226	3.95
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.96
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUW81A	4.49
BUX20	17.00
BUY18S	3.95
E430	6.95
J300	48p
J310	63p
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	45p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4102	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p

ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ4502	3.99
MJ15003	4.85
MJ14004	5.55
MJ15015	2.45
MJ15016	3.34
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE2955	99p
MJE3055	89p
MP8111	1.20
MP8112	1.68
MP8121	1.62
MP8122	1.68
MP8231	1.38
MP8512	1.89
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS6518	47p
MPS6530	45p
MPS6560	45p
MPS6562	45p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	43p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	45p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF475	6.50
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.95
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
TIP29A	29p
TIP29C	38p
TIP30A	35p
TIP30C	36p
TIP31A	33p
TIP31C	35p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	46p
TIP41C	55p
TIP42A	56p
TIP42C	59p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	84p
TIP127	84p
TIP130	93p
TIP132	93p
TIP135	99p
TIP137	99p
TIP140	1.04
TIP142	1.04
TIP145	1.15
TIP147	1.15
TIP162	4.96
TIP2955	77p
TIP3055	70p

TIS43	40p
TIS45	45p
TIS46	45p
TIS47	49p
TIS48	50p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	12p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	24p
ZTX530	24p
ZTX531	25p
ZTX650	48p

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	8p
1N1184	2.95
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	3p
1N4150	18p
1N4448	22p
1N5400	12p
1N5401	13p
1N5402	14p
1N5404	15p
1N5406	18p
1N5407	19p
1N5408	20p
1S44	10p
1S131	40p
1S134	56p
AA119	28p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	28p
BA316	25p
BA317	25p
BA318	30p
BAV10	18p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	11p
BY127	12p
BY134	52p
BY182	1.26
BY184A	65p
BY206	36p
BY207	36p
BY223	1.29
BY297	48p
BY299	55p
BYX10	36p
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
SPD9000	75p
SPD9002	95p

EF9365	35.00
EF9366	35.00

BRIDGE RECTIFIERS

1 amp type

W01 (100)	20p
W02 (200)	28p
W04 (200)	28p
W08 (800)	40p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietary Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

DIACS

BR100	25p
ST2	25p

THYRISTORS

Sensitive Gate Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BR103	69p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps
Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

4A	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
	TIC106D	49p
	TIC106M	68p
8A	TIC116A	66p
	TIC116B	68p
	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
12A	TIC126A	72p
	TIC126B	73p
	TIC126C	73p
	TIC126D	77p
	TIC126M	96p

DOMESTIC SCRs/TRIACS

2N4444	1.80
BT101-500R	1.40
BT106	2.25
BT116 Use TIC116M	
BT119	2.37
BT120	2.27
BT121	2.22

Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11
TIC263N (25A 800V)	2.48

Other Triacs

2N5756 (TO5)	1.44
2N6070	1.00
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.66
40512	2.70
40576 (TO66)	3.33
40842	1.92
BT139-600	1.95

ZENER DIODES

400-500 mW
E24 Series
2.4-47 V 7p

1.3 Watt
E24 Series
3.3-82 V 14p

2.5 Watt
E24 Series
7.5 75V 1.10

5W wired ended
following voltages only
3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 82V, 68V 1.26

20W Pos. Stud
(BZY93 series)
E24 values
7V5-75V 2.10

OPTO

LED LAMPS
R = Red
G = Green
Y = Yellow

Large Diffused	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p
Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0 1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p

Super bright large. High Efficiency. At least 100 times brighter than standard LEDs for the same current.

R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p

RECTANGULAR LEDs
Stackable End to End

R5R	17p
G5R	18p
Y5R	19p

RECTANGULAR LEDs WITH BOWED TOP (Tombstone)

R5B	21p
G5B	22p
Y5B	23p

MISC. OPTO

2N5777	45p
2N5778	60p
2N5779	70p
4N25	74p
4N27	74p
4N28	74p
BP104	1.00
BPW34	1.43
BPX25	2.47
BPX29	2.47
BPX48	6.76
BPX60	4.75
BPX61	3.48
BPX63	2.93
IL74	55p
ILD74	95p
ILQ74	1.85
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1.00
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1.70
LD489	1.89
LD599	81p
MOC3020	1.49
ORP12	95p
TIL32	71p
TIL38	44p
TIL78	60p
TIL81	1.60
TIL100	72p
TIL111	1.10
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	9p
TIL211	14p
TIL212	14p
TIL312	1.02
TIL313	1.02
TIL401	3.50
TIL403	3.80
TIL406	4.10
TIL722A	49p

AY1-5050	95p
AY3 8910	3.66
AY3 8912	4.40
AY5-2376	5.90
CA3018	75p
CA3018A	1.99
CA3020	1.99
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	95p
CA3028B	1.99
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.65
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	2.75
CA3046	69p
CA3047	4.60
CA3048	2.15
CA3049	3.21
CA3050	4.11
CA3051	3.90
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	2.30
CA3075	2.10
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.20
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	48p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	95p
CA3160AE	99p
CA3161E	1.59
CA3162E	4.49
HA1366W	2.40
HA1388	2.54
ICL7106	6.85
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.40
LC7137	3.95
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF397	4.62
LF13201	2.99
LF13331	3.30
LF13741H	69p
LF13741N	59p
LM10CH	4.50
LM11CH	4.50
LM114	7.50
LM301AH	95p
LM301AN	19p
LM305AH	2.90
LM305H	88p
LM307H	69p
LM307N	45p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	1.35
LM310H	1.89
LM310N	1.89
LM311H	1.04
LM311N	69p
LM317K	2.60
LM317T	1.75
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.28
LM324N	29p
LM335	1.30
LM337K	4.39
LM337MP	1.65
LM337T	1.75
LM339AN	1.60
LM339N	44p
LM345K	8.60
LM348N	62p
LM349N	92p
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	69p
LM377N	1.69
LM378N	3.40
LM379S	4.60
LM380N	75p
LM380N8	1.60
LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM387N	1.00
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.49
LM709N8	69p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	75p
LM723CH	95p
LM723CN	35p
LM725CH	3.40
LM725CN	3.19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM748C14	70p
LM1011	8.60
LM1303N	1.20
LM1304N	2.50
LM1305	3.10
LM1307	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	75p
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	4.00
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.78
LM1871	3.25
LM1872	4.39
LM1877	3.95
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907N8	2.60
LM2917N	1.89
LM2917N8	1.89
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3524	6.77
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	2.50
LM3915	2.50
LM3916	2.50
LM4250CH	2.63
LM4250N	2.38
LM13600	95p
MB3712	2.18
MB3756	3.80
MB8719	7.95
MC1304	2.50
MC1305	3.10
MC1307	2.75
MC1310	1.45
MC1330	2.25
MC1352	2.25
MC1456	2.25
MC1458	44p
MC1466L	6.95
MC1468L	4.35
MC1495	4.90
MC1496	75p
MC3302	1.00
MC3340	1.20
MC3357	2.48
MC3401	65p
MC3403	75p
MC3404	75p
MC3405	1.45
MC3446	3.25
MC4024	3.25
MC4044	3.25
MM5387	9.95
MM58174	7.50
NE529	2.25
NE531N	1.36
NE540L	4.95
NE543N	2.50
NE544N	1.95
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	4.07
NE571	3.99
NE592	1.95
NE5534	95p
OM335	7.20
PLL02A	4.95
PLL03A	12.75
RC4136	59p
RC4194	3.95
RC4195	2.95
S566B	2.59
SAA1024	4.99
SAB3209	3.99
SAB3210	3.18
SAS560	2.59
SAS570	2.59
SAS580	2.95
SAS590	2.95
SFF96364	7.99
SL470	3.47
SL490	3.47
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN76023N	2.95
SN76033N	2.95
SN76477	4.20
SN76550	80p
SN76666	2.90
SO41P	1.95
SO42P	1.95
TA7066	4.49
TA7073	3.49
TA7120	1.99
TA7130	1.75
TA7202	4.49
TA7203	4.99
TA7204	1.99
TA7205	1.20
TA7210	6.95
TA7222	1.75
TA7223	3.98
TA7227	5.82
TA7310	1.49
TAA263	3.88
TAA300	3.95
TAA320	2.06
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621	2.95
TAA661A	2.50
TAA661B	2.50
TAA700	2.80
TAA930A	2.50
TAA930B	2.63
TAA970	2.45
TBA120AS	69p
TBA500	2.97
TBA500Q	3.11
TBA510	2.96
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.78
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	2.80
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	85p
TBA920	1.95
TBA920Q	1.97
TBA950	2.26
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA210	2.75
TCA220	3.44
TCA270	2.44
TCA440	2.69
TCA450	2.65
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TCA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1006	3.94
TDA1008	2.99
TDA1010	1.79
TDA1022	4.95
TDA1024	1.14
TDA1170	3.10
TDA2002	3.25
TDA2003	3.25
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2523	4.95
TDA2530	3.30
TDA2532	4.95
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2582	4.95
TDA2590	5.20
TDA2591	4.73
TDA2593	3.15
TDA2600	6.15
TDA2610	5.35
TDA2611A	2.50
TDA2640	3.84
TDA3000	2.76
TDA3300	15.60
TL061	40p
TL062	80p
TL064	95p
TL071	24p
TL072	45p
TL074	99p
TL081	24p
TL082	45p
TL083	75p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	75p
UPC575C2	2.00
UPC1024H	99p
UPC1025H	3.95
UPC1032H	1.50
UPC1035C	2.95
UPC1156H	2.95
UPC1158H	99p
UPC1181H	1.95
UPC1182H	3.75
UPC1183H	2.95
UPC1185H	6.45
UPC1186H	1.58
UPC1188H	3.90
UPC1190C	3.50
UPC1212C	1.60
UPC1213C	2.50
UPC1228H	1.37
UPC1447H	1.40
UPC1470H	1.29
UPC2002H	2.95
UPC2002V	2.95
XR2206	2.92
XR2207	4.00
XR4212	1.80
ZN414	1.00
ZN419	2.25
ZN1034	1.99
ZNA134E	29.95
ZNA234E	8.47
ZTK22	89p
ZTK33	89p

74 TTL

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	19p
7407	19p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	19p
7417	19p
7420	15p
7421	19p
7422	19p
7423	19p
7425	19p
7426	19p
7427	19p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	21p
7440	15p
7441	55p
7442	32p
7443	89p
7445	49p
7446	56p
7447	39p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	25p
7475	25p
7476	25p
7480	49p
7481	1.19
7482	64p
7483	38p
7484	69p
7485	59p
7486	19p
7489	1.68
7490	19p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	35p
7497	88p
74100	79p
74104	49p
74105	55p
74107	19p
74109	25p
74110	39p
74111	45p
74116	49p
74118	55p
74119	59p
74120	59p
74121	25p
74122	35p
74123	35p
74125	35p
74126	34p
74128	36p
74132	29p
74136	27p
74141	55p
74142	1.73
74143	2.08
74144	2.08
74145	50p
74147	74p
74148	59p
74150	49p
74151	39p
74153	29p
74154	49p
74155	39p
74156	39p
74157	29p
74159	75p
74160	39p
74161	48p
74162	39p
74163	39p
74164	39p
74165	49p
74166	48p
74170	1.25
74172	2.49
74173	49p
74174	54p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	80p
74184	89p
74185	89p
74186	4.69
74188	2.48
74190	48p
74191	48p
74192	45p
74193	45p
74194	39p
74195	39p
74196	45p
74197	39p
74198	79p
74199	83p
74221	53p

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	15p
74LS14	24p
74LS15	13p
74LS20	13p
74LS21	12p
74LS22	12p
74LS27	12p
74LS28	14p
74LS30	13p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	16p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	16p
74LS75	19p
74LS76	18p
74LS78	18p
74LS83	36p
74LS85	41p
74LS86	18p
74LS90	24p
74LS92	28p
74LS93	24p
74LS95	39p
74LS96	93p
74LS107	35p
74LS109	23p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	32p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	29p
74LS136	24p
74LS138	24p
74LS139	28p
74LS145	69p
74LS147	99p
74LS148	75p
74LS151	37p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	24p
74LS158	29p
74LS160	31p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	49p
74LS168	84p
74LS169	85p
74LS170	69p
74LS173	49p
74LS174	34p
74LS175	34p
74LS181	88p
74LS183	1.06
74LS190	35p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	35p
74LS195	32p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	50p
74LS245	49p
74LS247	55p
74LS248	55p
74LS249	55p
74LS251	29p
74LS253	29p
74LS257	29p
74LS258	35p
74LS259	55p
74LS261	99p
74LS266	18p
74LS273	55p
74LS275	1.25
74LS279	29p
75LS280	89p
74LS283	39p
74LS289	4.70
74LS290	39p
74LS293	39p
74LS295	74p
74LS298	79p
74LS299	1.49
74LS323	1.59
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	89p
74LS352	61p
74LS353	61p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	55p
74LS378	68p
74LS386	1.14
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	89p
74LS541	79p
74LS640	99p
74LS641	99p
74LS643	99p
74LS644	99p
74LS669	99p
74LS670	1.19
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	28p
74S02	28p
74S04	28p
74S08	58p
74S20	38p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	62p
74S112	75p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	87p
74S139	1.10
74S140	2.50
74S153	7.95
74S157	2.20
74S163	3.00
74S174	2.50
74S175	3.20
74S188	1.40
74S189	1.40
74S194	1.90
74S200	4.50
74S201	2.40
74S225	2.40
74S261	3.00
74S262	8.50
74S287	2.19
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	7.95
74S571	6.09
74S573	9.00

74C00	30p
74C02	30p
74C04	13p
74C08	30p
74C10	30p
74C14	39p
74C20	35p
74C30	35p
74C32	35p
74C42	99p
74C48	1.40
74C73	75p
74C74	75p
74C76	60p
74C83	1.25
74C85	1.25
74C86	1.10
74C89	3.95
74C90	1.05
74C93	1.05
74C95	1.25
74C107	80p
74C151	2.09
74C154	2.99
74C157	2.10
74C160	1.06
74C161	1.05
74C162	1.05
74C163	1.05
74C164	1.20
74C165	1.20
74C173	45p
74C174	1.50
74C175	1.05
74C192	1.05
74C193	1.05
74C194	3.75
74C195	1.05
74C200	6.50
74C221	1.55
74C901	57p
74C902	57p
74C903	57p
74C904	57p
74C905	7.75
74C907	57p
74C908	1.10
74C911	8.50
74C912	8.50
74C914	1.10
74C915	1.55
74C918	1.30
74C920	11.00
74C922	4.85
74C923	4.99
74C925	6.75
74C926	6.75
74C928	6.25
74C929	11.40
74C930	4.40
74C932	1.95

4000	10p
4001	10p
4002	11p
4006	49p
4007	14p
4008	32p
4009	24p
4010	24p
4011	10p
4012	15p
4013	19p
4014	46p
4015	39p
4016	19p
4017	32p
4018	45p
4019	24p
4020	42p
4021	39p
4022	39p
4023	12p
4024	32p
4025	12p
4026	79p
4027	19p
4028	39p
4029	43p
4030	14p
4031	1.19
4032	79p
4033	1.19
4034	1.29
4035	44p
4036	2.49
4037	1.13
4038	99p
4039	2.45
4040	39p
4041	39p
4042	39p
4043	39p
4044	39p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	58p
4053	49p
4054	79p
4055	83p
4056	83p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.39
4068	14p
4069	15p
4070	13p
4071	13p
4072	13p
4073	15p
4075	13p
4076	45p
4077	13p
4078	15p
4081	13p
4082	13p
4085	49p
4086	60p
4089	1.23
4093	19p
4094	69p
4095	71p
4096	69p
4097	2.88
4098	74p
4099	89p

4502	55p
4503	39p
4507	33p
4508	1.26
4510	44p
4511	44p
4512	48p
4514	1.13
4515	1.13
4516	55p
4518	39p
4519	29p
4520	48p
4521	88p
4526	68p
4527	62p
4528	74p
4532	69p
4534	3.96
4536	2.59
4538	78p
4539	89p
4543	68p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.65
4584	39p
4585	59p

CPUs

1802	6.50
6502	3.24
6800	2.10
6802	2.40
6809	6.20
8035	3.49
8060	10.50
8080A	2.50
8085A	3.49
8900	57.75
9900	19.95
SCMP1	20.00
Z80A	2.98

2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	92p
2532	2.98
2564	7.99
2708	2.25
2716 (5v)	2.10
2764	5.90
4027	3.00
4060	9.50
4116(200ns)	80p
4118-3	3.25
4164	3.95
5204	7.50
6116P3	3.85
6514	3.30
6810	1.15
7489	1.65
74189	4.00

75LS289	3.25
74LS289	3.25
74LS287	3.05
74LS288	2.25

ADC0804	4.40
ADC0816	14.95
ADC0817	10.39
AY5-1013A	3.00
AY5 2376	5.90
INS1671	20.00
INS1771	14.60
MC1466L	6.95
MC1488	55p
MC1489	55p
MC4024	3.26
MC4044	3.25
MK50250	10.00
MK50398	8.35
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	12.00
MM57161	12.00
MM58174	11.80
RO2513LC	6.50
RO2513UC	6.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
8T26	95p
8T28	1.20
8T95	85p
8T97	85p
81LS95	80p
81LS96	85p
81LS97	90p
81LS98	85p
6522	3.19
6522A	4.00
6532	5.70
6821	1.09
6845	6.50
6847	6.50
6850	1.10
6852	2.40
6875	4.85
8131	2.75
8154	9.00
8155	3.50
8212	1.10
8216	99p
8223	1.80
8224	1.10
8226	2.50
8228	2.19
8238	5.75
8243	2.60
8250	8.40
8251	2.50
8253	3.95
8254	10.00
8255	2.19
8257	4.00
8259	3.82
8279	3.75
8601	1.20
9062	2.20
Z80ACTC	2.60
Z80ADART	5.50
Z80ADMA	6.70
Z80APIO	2.70
ZN425E8	3.39
ZN426E8	2.97
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGS

(See also Linear ICs)
– Positive –

100 mA	
78L05A	29p
78L12A	29p
78L15A	29p
78L24A	29p
500 mA TO202	
7805M	55p
7812M	55p
7815M	55p
7824M	55p
1 Amp TO220	
7805T	39p
7812T	39p
7815T	39p
7824T	39p
1.5 Amp TO03	
7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39
– Negative –	
100 mA TO92	
79L05	49p
79L12	49p
79L15	49p
50 mA TO202	
7905M	65p
7912	65p
7915M	65p
7924M	65p
1 Amp. TO220	
7905T	44p
7912T	44p
7915T	44p
7924T	44p
1.5 Amp. TO3	
7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99

THE MOTOCAR

Could this fairly ordinary looking Lancia car be the Car Of The Future? Motorola certainly think so. Read on and see if you agree.

At a press conference recently, Motorola revealed their Motocar (who says ETI has a monopoly on bad puns?). It's a Lancia Delta with a lot of electronics where there used to be switches and yards and yards of copper wire.

Even though they were very nice to us, impressing the press wasn't Motorola's reason for spending the equivalent of several Rolls Royces on building the car. Their main targets are the car and car component manufacturers. Not only are Motorola trying to persuade them that they need to bring car electrics up to date, but that they should use Motorola products to do this; and further, that they should work closely with Motorola to get the products they need. So, the car itself is by no means a finished design, it's a try out for a large number of different ideas.

Why Go Electronic?

Conventionally-wired cars have been around for quite a while now, so why should anyone want to change? Well, from the manufacturers' point of view, there are a number of good reasons.

Firstly, and always firstly in manufacturing, there's cost. At present, a wiring loom for a car costs around £35. Motorola's electronic system, with a great host of additional features that we'll be looking at in a moment, would cost around £100 to build after a tidy up of the prototype. Obviously, Motorola learned a few things during the building, and some newer components better suited to the project have since come on the market, so with a little optimisation, the cost could probably be halved to £50. However, once you start to use specially made components, a lot more cost saving can be carried out, and the price would easily go below that of the conventional loom, especially if the price of copper rises. And the electronic system will almost certainly be a lot easier to install.

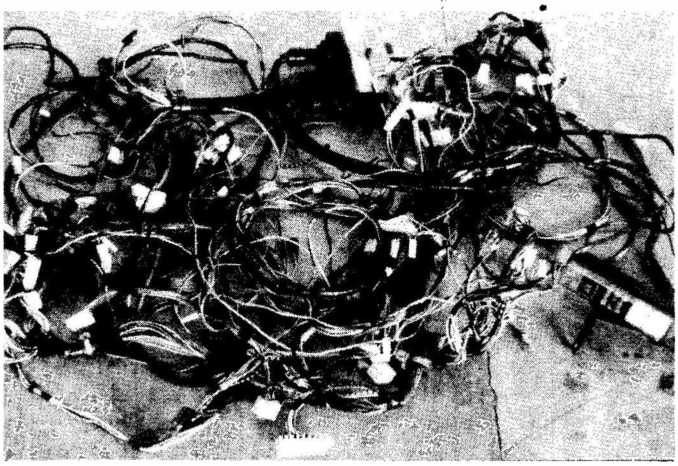
Secondly, there's reliability. Well designed electronics should always be much more reliable than electromechanics. An electronic loom would considerably reduce the number of connectors in the system. Not only would this improve the car's reliability after sale, it would also cut down on manufacturing costs. Did you know that around 40% of all cars straight off the production line require some remedial work to be done on their electrical systems?

Thirdly, by using electronic control, the engine's performance can be much improved. Fuel efficiency is very important in Europe, but over in the States, tough anti-pollution legislation has led to emphasis on emmission control. It was, in fact, this legislation that provoked the interest in electronic engine control in the first place — who says that conservation is always bad for industry?

Finally, an electronic control system can offer driver and servicing facilities very much more easily than the conventional system; for example, fault finding and fault monitoring can be automated.

Why The Rush?

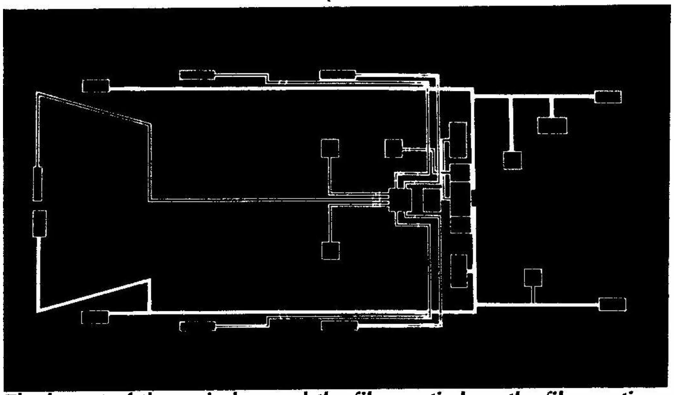
Motorola are keen to get into the market as soon as possible. They reckon that by 1987, 7% of the European semiconductor market will be for cars. Naturally, they're expecting a certain amount of competition, but they hope that their early start will catch their competitors napping.



This is what the Motocar no longer has — a conventional (messy) wiring loom containing about 500 metres of wire.

Take A Bus

At the heart of Motorla's electronics is a four-wire multiplexed bus. This links the master control unit to a number of outstations that are responsible for controlling



The layout of the main bus and the fibre-optic bus: the fibre optic bus radiates out from where you'd expect the gearshift to be. The main bus is in a H-shape and is drawn with a solid white line.

and monitoring the car's functions. The master control has a separate interface with the controls on the steering column, and there is also a completely separate fibre optic system that controls some 'luxury' items.

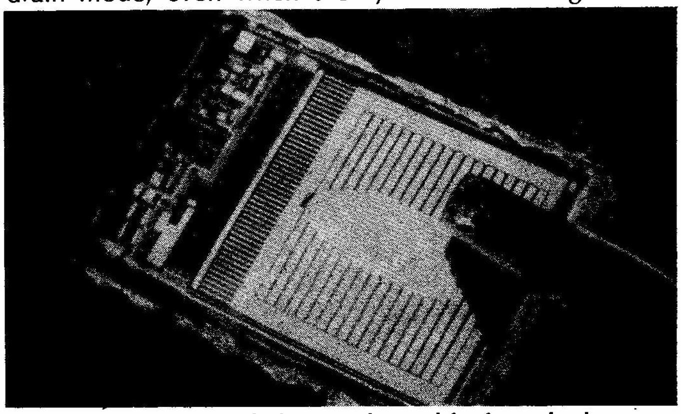
The four wires of the bus have the following functions: power (positive, negative return through chasis), signal earth, data, and bus control. Data transmission is sequential and bidirectional in half duplex mode with auto-clocking and RZ. The control line is used to sort out which unit is sending what to where. The power line is for the controlled devices as well as for the outstations themselves, so it has to be fairly meaty. All the other conductors can be light weight.

Outstations

All the outstations are based on the Motorola MC6805P2 microprocessor, as is the master control unit. Motorola now say that they would now use the cheaper and more appropriate MC6804P2, but it was not available when the design work was done.

The simplest of the outstations are the load-switching units, of which there are six, all identical. Each is capable of switching eight loads of up to 10 A, although in the present car, the most that is used in any one unit is seven (some units switch rather fewer). Because N-channel devices are cheaper to make than P-channel ones, N-channel T-MOS FETs are used to switch between the ground connection to the controlled devices and the car chasis; this means that the controlled load is always at positive supply potential with respect to the chasis, and this could lead to a corrosion problem.

Motorola's proposed solution is to use an on-board DC to DC converter to provide a higher voltage supply of 30 V. This will allow the N-channel FETs to switch reliably at the standard supply voltage (nominal 12 V) in common drain mode, even when the system is suffering from a reduction in supply voltage (for instance, while the battery is turning over the engine on the starter motor). Surprising though this may seem, it is apparently cheaper to do this than to use P-channel FETs.



Motorola's smart power device — to be used for future load switching stations.

Each load switching unit has an A-to-D converter on board, so that it can measure, for example, the output from the petrol tank gauge. It also has a load-state monitor that can sense blown bulbs. This information is all transmitted back along the bus to the central control.

Further development of the load switching unit will almost certainly involve Motorola's smart power device, soon to enter production. These devices have a T-MOS power transistor with logic and drive components on the same chip (together with, perhaps, a DC to DC converter). These may make it feasible to use single load switching units, with each load on the bus having its own dedicated switching unit. In order to avoid increasing the number of connections by using these units, they may well be housed within the controlled load itself.

Condition Monitoring

Hard at work just gathering and transmitting data is the vehicle condition monitor, one of the four other types of outstation. It sits inside the engine compartment and monitors fluid levels and other information to be presented to the driver. A single A-to-D is used to monitor the alternator output, and, as well as being used to provide the system's equivalent of an ignition warning light, this also determines the control of the battery charging.

The other three outstations are semi-autonomous in that they are not under direct central control: for instance, you could not have the engine control unit having to deal with an interrupt when it was just about to fire a spark plug. Besides the engine control unit, there are the cruise control, so that you can take your foot off the accelerator and the car will maintain a steady (and legal) speed, and the climate control, a posh phrase for an air conditioner control unit.

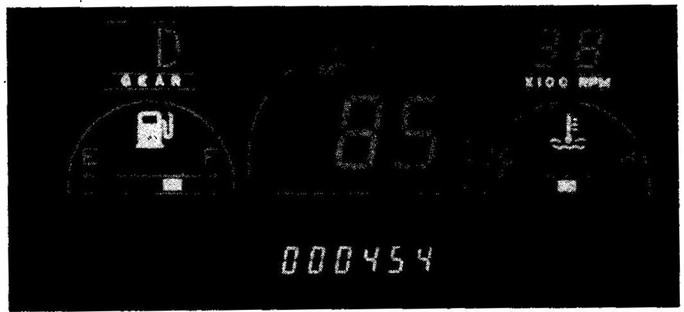
The engine control has a pressure transducer in the inlet manifold; it also measures the position of the distributor arm in 0.35° increments (by using a phase locked loop to multiply up the output from a position sensor). Thus it can control the spark and fuel injection timing to a resolution of 0.35°; it can also control the amount of fuel injected. However, the opening and closing of the inlet and outlet valves is still done mechanically.

Alternative Bus

To avoid running lots of wires from the controls mounted on the steering column, Motorola engineered a much more simple multiplexed bus to link the steering column to the central control unit. It's a three wire bus, with unidirectional data flow; the encoding is done with standard CMOS, rather than a microprocessor (shame!).

Gone is the familiar needle and dial speedo — it's replaced by a flourescent digital display, as in the latest Maestro. The display itself is an off the shelf Futaba plasma display, driven by (you've guessed it) a dedicated microprocessor, this time an MC6801. To be fair, the micro is kept busy displaying a range of messages (in a choice of several languages and imperial or metric units) on two separate LCD displays to tell the driver about the state of the car, distance travelled, etc. For instance, it is this that will tell you if one of bulbs has blown.

One interesting feature is the use of an EEPROM to store the odometer reading. When the ignition is turned off, power is held on long enough to allow the old reading to be erased and the new one written into the EEPROM. Motorola have put quite a lot of though into developing a system that is as secure as possible, to prevent

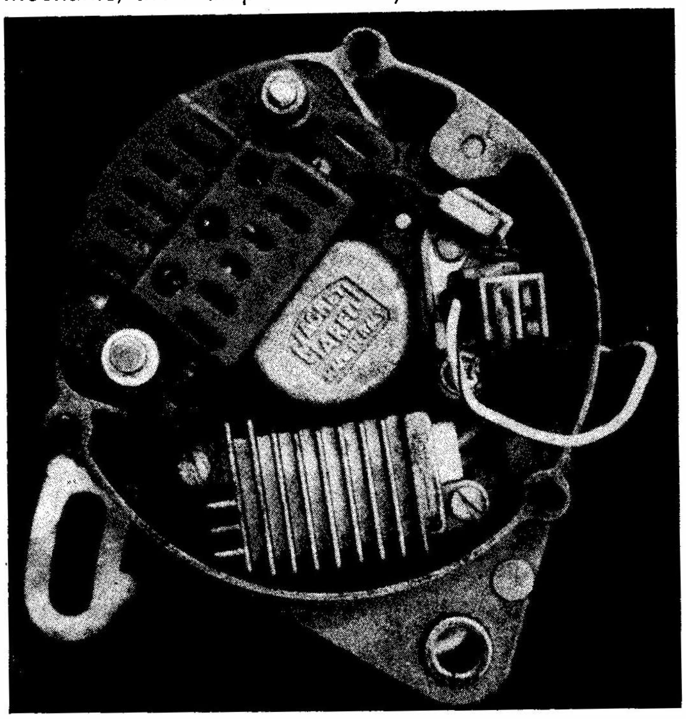


The Futaba display used, in ful action. Unfortunately, you can't see that the figures are in a rather reasuring green, and the main beam indicator is in a baby blue . . .

unscrupulous dealers from being able to wind back the reading.

Multiperplexed?

Motorola claim that rather than confusing the poor mechanic, the multiplexed bus system should make servicing and repair easier — but only provided that the garage buys a special adapter! This special unit would, when plugged into the car, take control of the bus and run the car through a test sequence, with a readout that tells the mechanic what needs attention. The special adaptor units should be around the size of a largish pocket calculator and cost about £150 (a special one will be needed for each car type).



Shine A Light

The other multiplex system uses optical fibres to control seat positioning servos, windows, door locking and window mirror positioning. This system is entirely separate from the other bus system, and it has its own control unit; it's also arranged in a different way, as a star network. Each unit has its own line running back to the control unit: this was necessary because of the lack of T-junctions for optical fibres.

Motorola's optical fibre system is unusual in two ways. Firstly, the same devices are used as transmitters and receivers, thus allowing two-way transmission along a single fibre. Because only short transmission distances are involved, signal strength is not a problem and a relatively inefficient detector can be tolerated.

Secondly, visible light is used because this will make it easier for a "mechanic" (perhaps Motorola had better invent a new term for this person while they're at it) to detect if a signal is present. The cost of the components needed for a visible light system is also considerably lower than those for an infra-red system.

Motorola say that fibre optic systems are used because they offer higher noise immunity and lower weight than copper wire systems. However, the fact that they've been confined to the luxury features of the car is probably evidence of a reliability problem — or is it just my cynicism?

Parting Shot

One last system that we haven't mentioned yet is the radio. It too (yes!) uses a dedicated microprocessor, and even though it's a Grundig radio, the micro is a Motorla MC6220. It's worth reflecting that Motorola started out by making car radios; having partially surrendered that market and gone on to greener pastures, they're now set to invade the rest of the car.

ETI

Above: one nice touch not mentioned so far is that Motorola have tackled the problem of supply line transients at source, the alternator, by replacing three out of nine of the diodes with transient suppression types.

The present test unit (right) is just a little bigger than a hand-held calculator (though this does depend on how big your hands are . . .) Apparently the production model would need little more than a (yes, another) microprocessor, some ROM (possibly on board the micro) and a display.

LB ELECTRONICS

LIMITED STOCKS

Brand new havard H452, power supply and Nickel charger, output 13 volts at 0.7A (max 1 amp) 7" x 3" x 3½" appx. Fully cased and boxed only **£4.95p p/p £1.70p.**

SPECIAL OFFERS (while stocks last)

Mullard .2" Red L.E.D.'s 0.06p, 7805 **38p**, 7805KC 5 Volt 1.5A **75p**, 78H05 5V 3 AMP **£3.50p**, 5K ¾" multiturn trim pots 14 for **£2.50p**

DISC DRIVE BONANZA

PERTEC FD650 DSDD	**£199** + VAT
TEAC FD-55F ½ Height DSDD 80 track	**£228** + VAT
Cannon 2/3 drive SSDD Shugart Compatable 40 Track	**£129** + VAT

Apple controller card for two drives..... **£40.00 + VAT p&p 50p**

ASC11 coded qwerty Keyboard, manufactured by Alphanumeric (Woking UK). Model 60K brand new plus data...... £19.95p p&p £1.50

25 WAY 'D' Types, plugs **£1.85**, sockets **£1.85** (solder tail) p&p 30p. Telephone for bulk prices.

8" Drive Cabinets complete with power supply (LINEAR) to take two 8" Drives, Brand New £99.95p + VAT (carriage cost)

Twin 5" Cabinets with power supply £30.00 + VAT (providing a disc drive is purchased from us, if drives purchased elsewhere £40.00 + VAT)

9" Green Phosphor Monitors Brand New and Cased Composite Video Input 18mhz band width £78 + VAT each (carriage cost)

Textool 24 dil Zif Skt (used) £3.95p p&p 30p

Brand New 13" Colour monitor fully cased. Full warranty 540 x 236 pixel. RGB TTL Input plus apple Input £220 + VAT (carriage at cost).

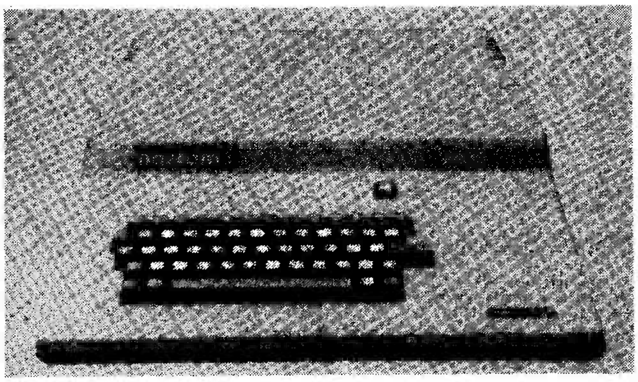
BNC Lead Bonanza coax lead with BNC plug at one end, 2 metres plus £1.00 p&p 30p and 10 metres plus £2.50 p&p 75p

Buy it with Access — American Express — VISA

LB ELECTRONICS
11 HERCIES ROAD, HILLINGDON, MIDDLESEX UB10 9 LS, ENGLAND
TEL: UXBRIDGE 55399

ELECTROVALUE

FIRST FOR NASCOM 3



Highly recommended for its versatility, this latest **Nascom** microprocessor can be the foundation of a superb professionally styled system of excitingly useful applications and development... and of course, **Electrovalue** are accredited Nascom suppliers, ready to deliver your **Nascom 3** (and ancillaries) NOW!

Nascom 3 Microprocessor (to drive monitor or TV set)	**£549** + V.A.T.
Monitor for above	**£120** + V.A.T.
Nascom Dual Disc Drive SS/DD (takes standard 5¼")	**£685** + V.A.T.
Nascom High Capacity Dual Drive	**£945** + V.A.T.
Nascom 2 in kit form inc. keyboard but less power supply, case and RAM. Always available.	**£225** + V.A.T.

DID YOU KNOW that for almost 20 years Electrovalue have been foremost suppliers of components, etc. costing from pennies to hundreds of pounds? So why not send for our new Summer Price List and see why it pays to buy from us.

ELECTROVALUE LTD.
Head office, Mail Order and Shop: 28 St Judes Road, Englefield Green, Egham, Surrey TW20 0HB. Egham (STD 0784: London 87) 33603: Telex 264475. *North —personal shoppers only.* **680 Burnage Lane, Burnage, Manchester M19 1NA (061-432 4945).**
EV Computing Shop, **700 Burnage Lane, Manchester (061-431 4866).**
Electrovalue and EV Computing Shop are members of the Microvalue group.

AUDIO ELECTRONICS

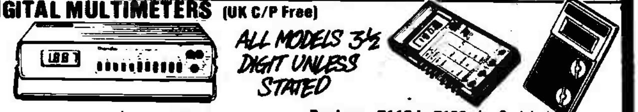
CALL IN AND SEE FOR YOURSELF — ALL PRICES INCLUDE VAT

TEST EQUIPMENT CENTRES

ALL MODELS ON DISPLAY OPEN SIX DAYS A WEEK

RETAIL • MAIL ORDER • EXPORT • INDUSTRIAL • EDUCATIONAL

DIGITAL MULTIMETERS (UK C/P Free)



ALL MODELS 3½ DIGIT UNLESS STATED

HAND HELD ■With free carry case

KD25C■13 range 0.2A DC 2 meg ohm	£24.95
KD305■16 range 10A DC. 2 meg ohm	£29.95
KD30C■26 range 1A AC/DC 20 meg ohm	£34.95
KD55C■28 range 10A AC/DC 20 meg ohm	£39.95
6010+ 28 range 10A AC/DC 20 meg ohm	£34.40
7030+ As 6010 but 0.1% basic.	£41.30
KD615■16 range 10A DC. 2 meg plus Hfe tester	£39.95
189M 30 range 10A AC/DC. 20 meg plus Hfe tester	£69.95
HD30 16 range 0.2A AC/DC 2 meg ohm	£41.95
HD30/B As above plus cont. buzzer	£44.50
HD31 22 range 10 AC/DC 2 meg ohms plus cont. buzzer	£58.95
DM2350 ■ 21 range 10A AC/DC 20 meg ohm miniature hand held auto range	£49.95
Beckman T100 34 range 10A AC/DC 20 meg ohm	£56.35
Beckman T110 As **T100** plus Cont. test. etc.	£67.85
Sifam 2200B 21 range 2A AC/DC 20 meg ohm	£39.95

+Optional carry case £2.95

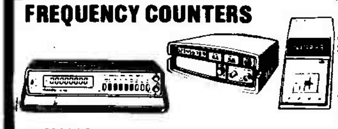
BENCH MODELS

TM353• 27 range LCD 2A AC/DC	£86.25
TM355• 29 range LED 10A AC/DC	£86.25
TM351• 29 range LCD 10A AC/DC	£113.85

•Optional carry case £6.84

2001 28 range LCD 10A AC/DC plus 5 range Cap. Meter with case	£108.00
TM451 4½ digit LCD every facility (0.02%)	£171.00
1503a 4¾ digit LCD every facility (0.05%)	£171.00
1503Ha 0.03% basic version of above	£189.00
1504 true RMS version	£201.25
Sifam 2500 24 range LCD 2A AC/DC	£99.95
Metrix (ITT) professional 3½ + 4½ digit DMM's standard & true. RMS 4 models stocked	£77.00 - £201.25

FREQUENCY COUNTERS



PFM200A MHZ hand held pocket 8 digit LED	£77.60
8110A 8 digit LED bench 2 ranges 100 MHZ	£77.00
8610B 9 digit LED bench 2 ranges 600 MHZ	£113.85
8000B 9 digit LED 3 ranges 1 GHZ	£178.00
TF040 ■ 8 digit LCD 40 MHZ	£126.50
TF200 ■ 8 digit LCD 200 MHZ	£166.75

■Optional carry case £6.84

Prescalers – Extended range of most counters

TP600 600 MHZ	£43.00
TP1000 1 GHZ	£74.00

ELECTRONIC INSULATION TESTER

YF 501 500 V/0-100m with carry case £63.00

MULTIMETERS (UK C/P 65p)

HM102Z 20K/V 10A DC 22 range & cont. buzzer	£13.50
HM102Z 20 K/V 22 range & cont buzzer	£14.95
ETC5000/5001 21 ranges. 50K/V. Range doubler. 10A DC.	£18.95
TMK500 23 ranges 30K/V. 12A DC plus cont. buzzer.	£24.75
NH56R 20K/V. 22 range pocket	£10.95
ETU 102 14 range 2K/V pocket	£6.50
830A 26 range 30K/V. 10A AC/DC overload protection, etc.	£23.95
360TR 23 range 100K/V. Large scale 10A AC/DC plus Hfe	£39.95
AT1020 18 range 20K/V. Deluxe plus Hfe tester	£18.95
YN 360TR 19 range 20K/V plus Hfe tester	£15.95
Metrix Professional multimeters In stock 3 models from	£74.75

VARIABLE POWER SUPPLIES (UK C/P £1.00)

PP241 0/12/24V. 0/1A.	£35.00
PP243 3 amp version	£59.95
PS 1307S 8/15V 7 amp twin meter	£24.95

DIGITAL THERMOMETER

TH301 LCD –50°C to +750° with thermocouple £68.43

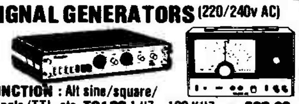
AC CLAMPMETER

ST300 0/300A: 0/600 VAC. 0/1 Kohm 9 ranges With carry case (UK C/P 65p) £28.50

LOGIC PROBES

LP10 10 MHZ	£28.50
DLP50 50 MHZ with carry case and accessories	£52.33

SIGNAL GENERATORS (220/240v AC)



FUNCTION : All sine/square/triangle/TTL, etc

TG100 1 HZ - 100 KHZ	£90.00
TG102 0.2 HZ - 2 MHZ	£166.75

PULSE

TG105 Various facilities 5 HZ - 5 MHZ	£97.75

AUDIO : Multiband Sine/Square

LA627 10 Hz to 1 MHz	£98.85
AG202A 20 Hz to 200 KHz (List £94.50)	£83.50

RF

SG402 100 KHz to 30 MHz (list £79.50)	£69.50
LSG17 100 KHz to 150 MHz	£79.35

OSCILLOSCOPES

Full specification any model on request. SAE by post.
'HM' Series HAMEG: 'SC' THANDAR: 'CS' TRIO: '3' CROTECH 'DT' Saigan

SINGLE TRACE UK C/P £3.00

3030 15 MHZ 5mV: 95mm tube plus component tester C/P £3.00	£177.10
SC110A■ Miniature 10 MHZ battery portable Post free	£171.00
HM103 15 MHZ 2mV. 6 x 7 display plus component tester C/P £3.00	£181.70

■Optional carry case £6.84 AC adaptor £6.69 Nicads £12.50

DUAL TRACE (UK C/P £4.00)

DT 520 Dual 20 MHZ	£241.50
HM203/4 Dual 20 MHZ plus component tester	£287.50
CS1562A Dual 10 MHz (List £321.00)	£269.50
3131 Dual 15 MHZ + component tester	£276.00
CS1566A Dual 20 MHZ All facilities (List £401.35)	£349.50
HM204 Dual 20 MHZ plus component tester sweep delay.	£419.75
CS1820 Dual 20 MHz with extra facilities (List £508.30)	£485.00
DX710 Metrix dual 15 MHZ + component tester	£304.75

OPTIONAL PROBE KITS
X1 **£7.95** X1 - X10 **£10.50** X10 **£9.45** X100 **£16.95**

HIGH VOLTAGE METER

Direct reading 0/40 KV. 20K/Volt. (UK C/P 65p) £23.00

DIGITAL CAPACITANCE METER

0.1 pf to 2000 mfd LCD 8 ranges
DM6013 £52.75 (Carry case £2.95)

TRANSISTOR TESTER

Direct reading PNP: NPN, etc.
TC1 £21.95
(UK C/P 65p)

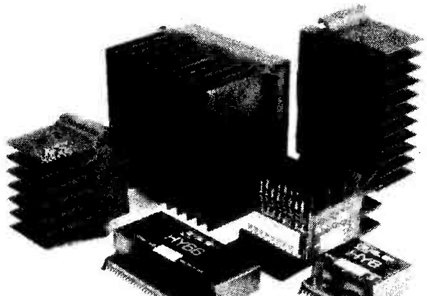
FREE CATALOGUE! SEND LARGE SAE (UK 20p)

ALL PRICES INCLUDE VAT

AUDIO ELECTRONICS Cubegate Limited
301 EDGWARE ROAD, LONDON W2 1BN. TEL: 01-724 3564
ALSO AT HENRYS RADIO.
404/406 EDGWARE ROAD, LONDON, W2. TEL: 01-724 0323
HENRY'S COMPONENT SHOP. TEL: 01-723 1008

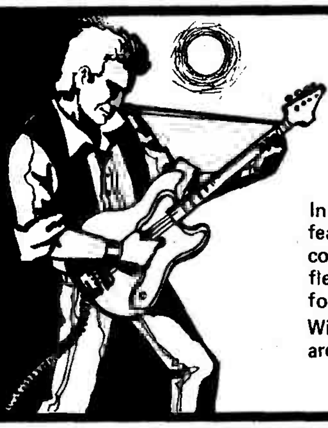
Order by Post with CHEQUES/ACCESS/VISA or you can telephone your orders. All orders despatched within 5 days unless advised.

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 MOOULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

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
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

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 MOOULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.O. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/μs. Rise time: 3μs. S/N ratio: 100db
Frequency response (−3dB): 15Hz – 100KHz. Input sensitivity: 500mV rms
Input impedance: 100K Ω Damping factor: 100Hz > 400.

'NEW to ILP' In Car Entertainments

C15
Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

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

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4Ω.
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB. Load Impedance 3Ω.
Input Sensitivity and impedance (selectable) 700mV rms into 15K Ω 3V rms into 8 Ω.
Size 95 x 48 x 50mm. Weight 256 gms.

C1515
Stereo version of C15. **£17.19 (inc. VAT)**
Size 95 x 40 x 80. Weight 410 gms.

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

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 HY244	£17.07

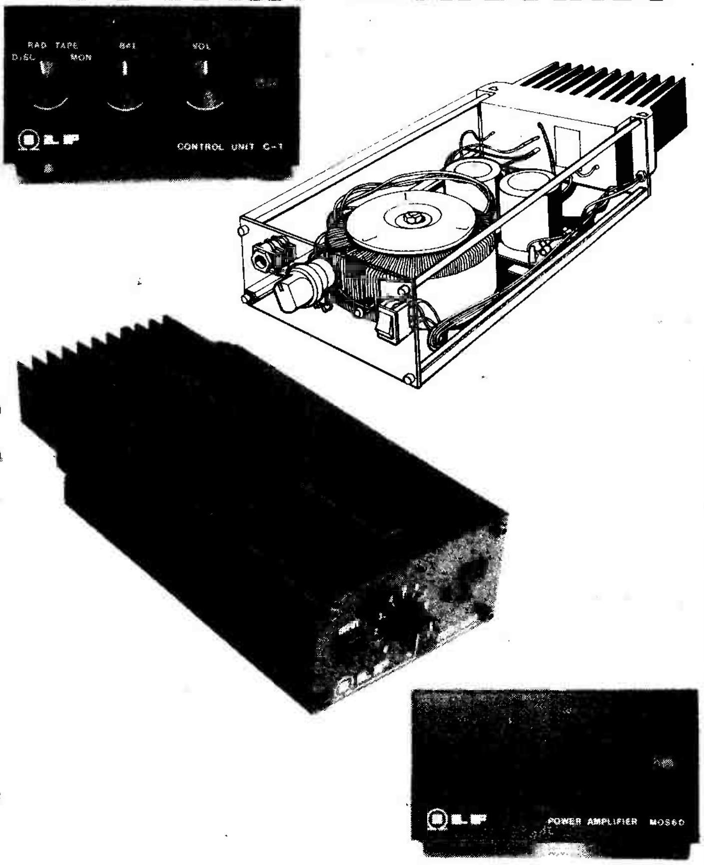
Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

Please note: X in part no. indicates primary voltage. Please insert "O" 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 '0' 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 ____________

TV STORAGE SCOPE

The Tele-Scope 200S is a storage oscilloscope which utilises a number of electronic techniques to convert signals into a form suitable for display on a television screen. The unit is designed around the latest technology in analogue-to-digital conversion, using the Ferranti ZN441 flash converter to convert the input signal to a six-bit binary word at a point in time, which is determined by the sample rate. This sample rate can be selected to be up to 10 million samples per second (or one sample producing one word every 100 nS).

The resulting words are stored in one of two memories, which take it in turns to store the incoming data and display the stored data. In manual trigger mode, the incoming signal controls the changeover of the two memories, so if the input signal only occurs once, or is removed, the last signal is displayed on the screen. When measuring DC levels, the auto trigger mode is used to give a continuous trigger, as the DC level has no recognisable transitions for the circuit to begin operation.

Functional Description

The analogue input is taken via the input coaxial socket to a switchable attenuator and is buffered with a source-coupled FET. A second FET in the source of this buffer puts a DC offset on the buffer, which can be varied to produce a shift in the position of the display.

The resultant analogue signal is fed to the analogue-to-digital flash converter which produces a six-bit word for each sample. The sample rate can be up to 10 MHz (one sample every 100 nS), and is selected using the front panel switch marked 'width' in the same way that a conventional scope has a time base selector. The six-bit word will appear on the data bus and the input address clock, which is running at the sample rate, writes the data in to the selected memory.

When both the memory cycle and frame scan are completed, the memory is switched to read and the

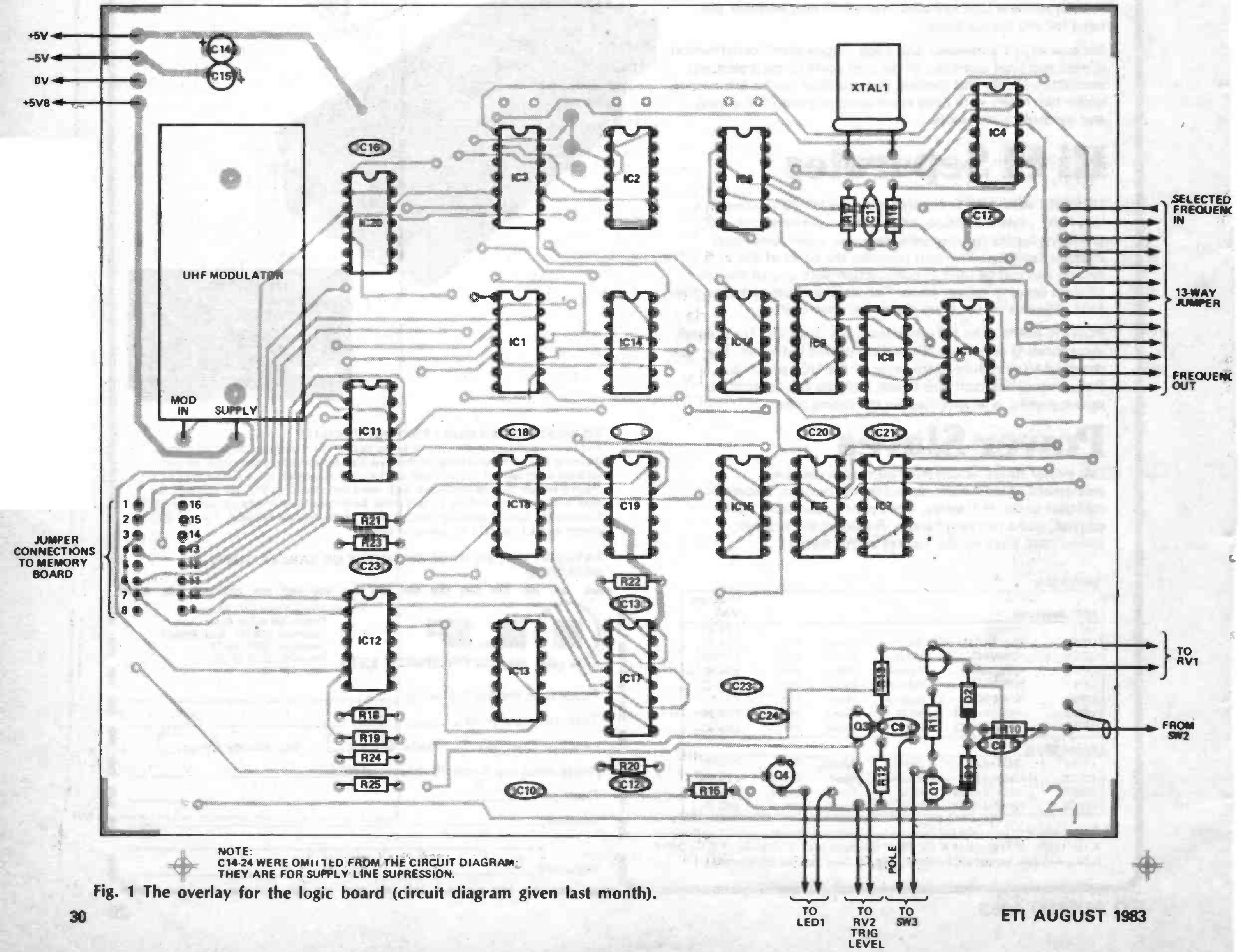


Fig. 1 The overlay for the logic board (circuit diagram given last month).

We conclude our description of this innovative piece of test gear with the circuit of the data processing board and full constructional details. Design and development by Ian Gooderson.

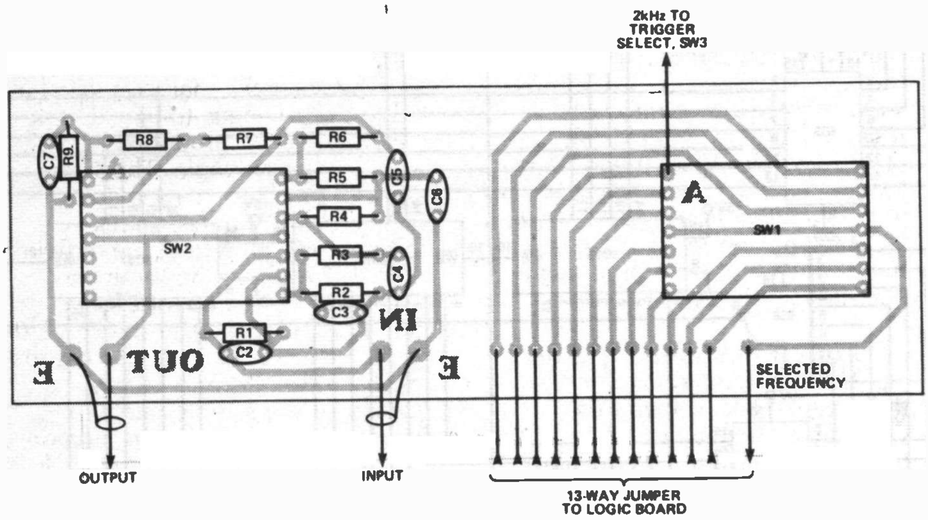


Fig. 2 Overlay for the front panel PCB, containing the input attenuator.

output address counter is routed to this memory for the output sequence to begin. The output address counter is cycled at 5 MHz and the six-bit words are output to a comparator, which compares the word to the video line number. If the six-bit word and the line number are equal, the comparator outputs a data bit to the video summing amplifier.

This data is then mixed with the line and frame sync pulses and output to the UHF modulator. The display has a memory map which is 247 pixels wide by 64 pixels high; each pixel is 200 nS wide and four lines high, utilising a screen area of 49.4 nS wide and 256 lines high. This data is repeated on the second field of the interlaced TV scan to prevent any flashing on the display, even at high input frequencies.

The memories are addressed by two counters and during the input cycle the input address counter is running at the same rate as the A-to-D, storing each data bit in a separate serial memory location. The output address counter is running at a constant 5 MHz as the display time is constant.

Construction

The Tele-Scope contains two double-sided, plated-through hole circuit boards, one for the data storage and routing, one for the control logic and analogue input buffering. The case cover has a small PCB on the reverse, which holds some of the components associated with the input and trigger controls and the corresponding input sockets. The power supply board is mounted in the rear of the case, with the transformer to the left (viewed from the front).

First build the data storage and routing board (the circuitry for this board is described in this month's article). All the components are mounted on the circuit board (see the overlay in Fig. 5). All the connections to this board are made via a 16-way jumper lead to the control logic board (whose circuitry was described last month). All the ICs used are LS TTL series, with the exception of the memories and the ZN441. Although this latter chip is not static-sensitive, great care should be taken when handling it because it is the single most costly item in the equipment. For this reason it should be mounted in a 24-pin IC socket.

Next, build the control logic/input buffer board. All the chips on this board are LS TTL, with no special handling problems for them or any of the other discrete components used. A 16-way jumper lead connects this board to the data processing PCB. A 13-way length of ribbon cable should also be connected at the other end of the PCB at this point in the proceedings, for later connection to the sampling frequency selector

PARTS LIST — LOGIC BOARD

Resistors (all ¼W, 5% except where stated)

R1	560k 2%
R2	270k 2%
R3	180k 2%
R4	56k 2%
R5	27k 2%
R6	18k 2%
R7	5k6 2%
R8, 9	2k7 2%
R10, 15	10k
R11	220R
R12	1M0
R13	470k
R14, 25	47R
R16, 17	330R
R18, 19	270R
R20	4k7
R21, 23	1k0
R22	56k
R24	470R

Potentiometers

RV1,2	10k linear

Capacitors (all ceramic except where stated)

C1,8-10,16-24	100nF
C2	100pF
C3, 5	20pF
C4	120pF
C6	68pF
C7	10pF
C11	27pF
C12, 13	2n2
C14,15	22uF 16 V PCB electrolytic

Semiconductors

IC1	74LS04
IC2, 6, 11	74LS74
IC3	74LS10
IC4	74LS00
IC5, 7-10	74LS90
IC12	74LS03
IC13-16, 19	74LS93
IC17	74LS123
IC18	74LS73
IC20	74LS08
Q1-3	2N3819
Q4	BC107
D1, 2	1N4148
LED1	red LED

Miscellaneous

SW1	SPDT slide switch
SW2	9-way PCB-mounting rotary switch
SW3	2-pole, 3-way slide switch (only one half used)
SW4	12-way PCB-mounting rotary switch
XTAL1	10 MHz

PCBs (see Buylines); UHF modulator type UM 1111E36; ribbon cable; sloping front case (see Buylines); screened cable for input; PCB pillars; power supply board (see Buylines).

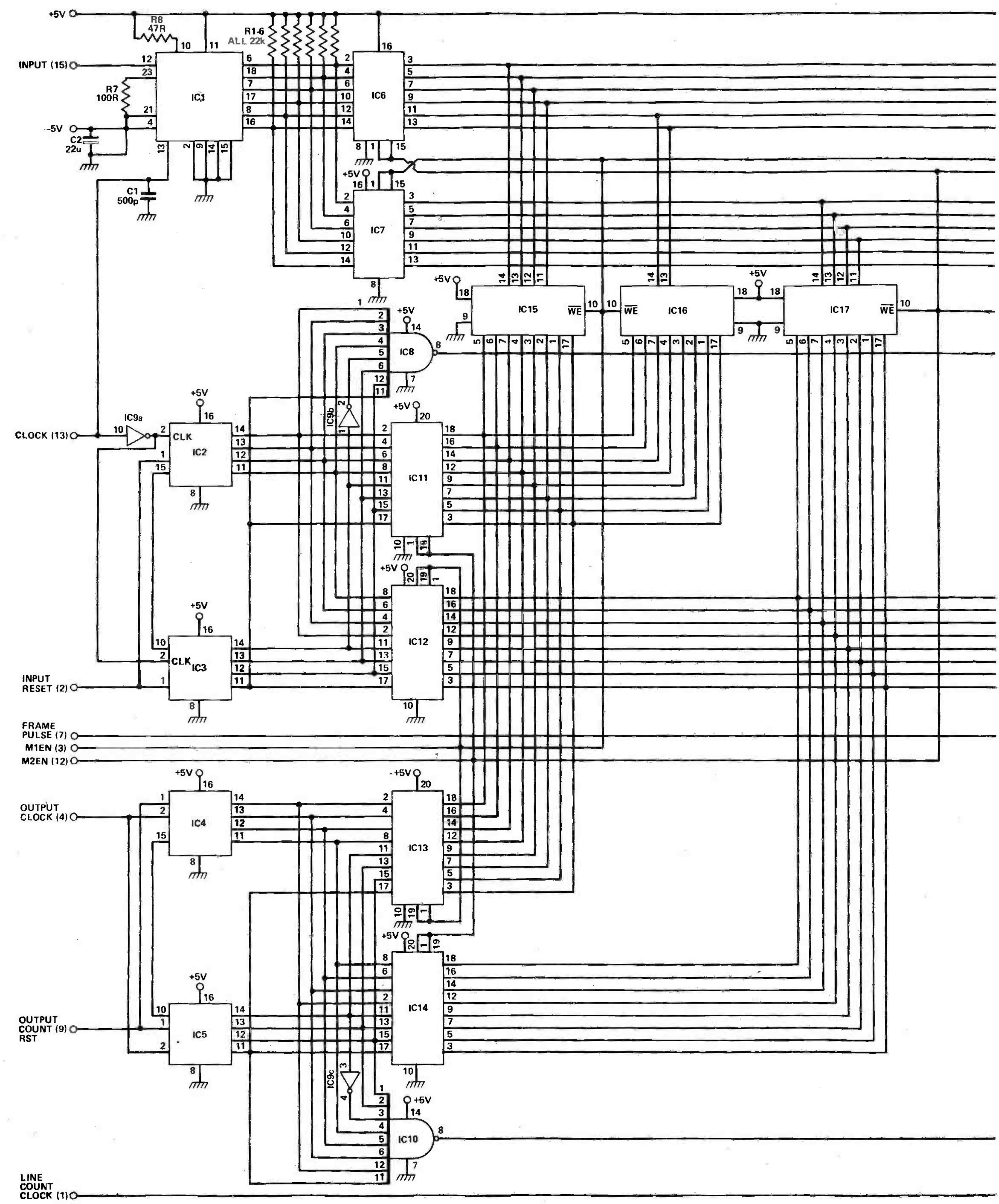
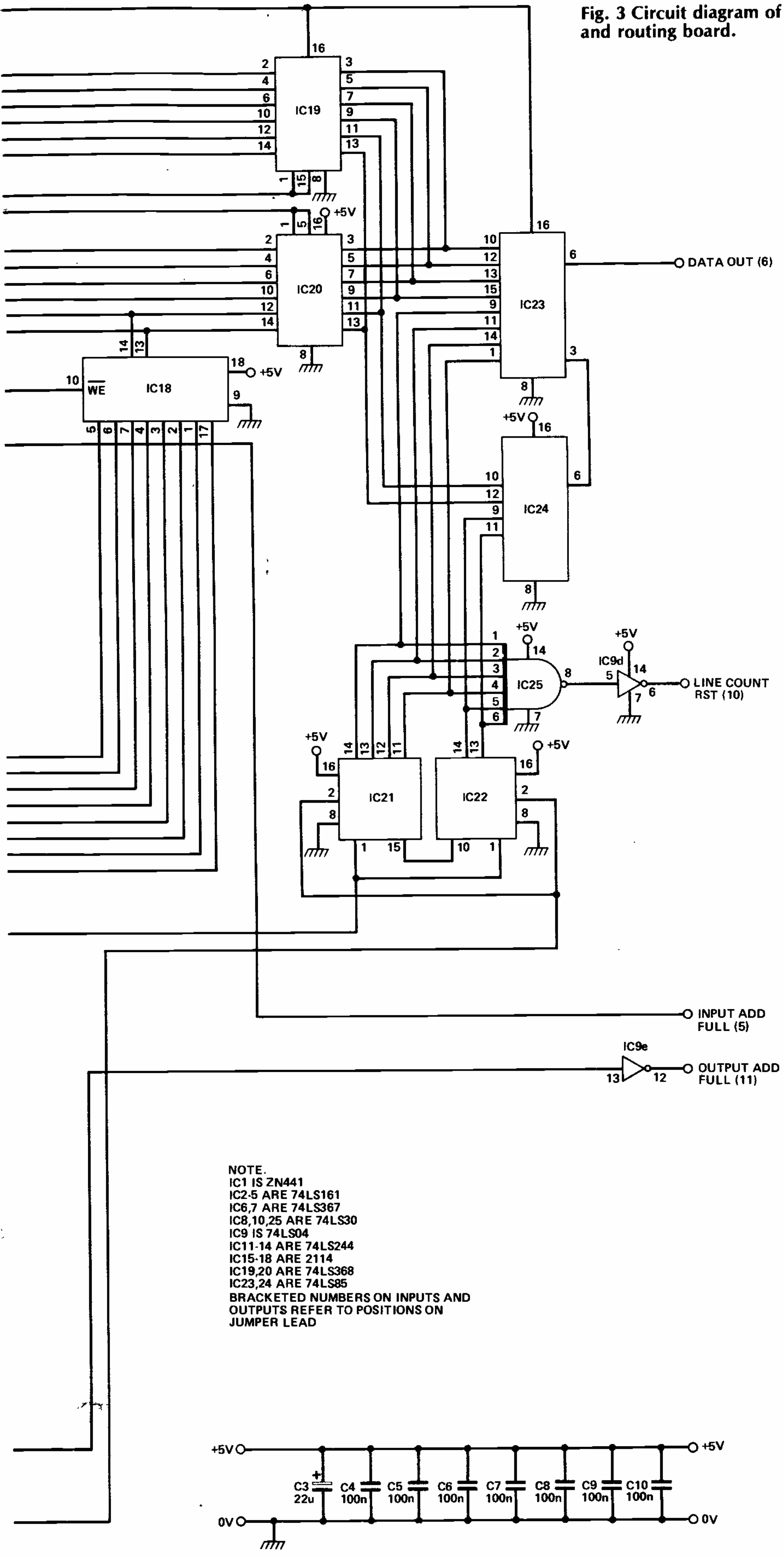

+5V
R8
47R
R1-6
ALL 22k
INPUT (15)
R7
100R
-5V
C2
22u
C1
500p
IC1
IC6
IC7
IC8
IC9a
IC9b
IC9c
IC2
IC3
IC4
IC5
IC10
IC11
IC12
IC13
IC14
IC15
IC16
IC17
WE
CLK
CLOCK (13)
INPUT
RESET (2)
FRAME
PULSE (7)
M1EN (3)
M2EN (12)
OUTPUT
CLOCK (4)
OUTPUT
COUNT (9)
RST
LINE
COUNT
CLOCK (1)

Fig. 3 Circuit diagram of the data storage and routing board.



HOW IT WORKS

IC1 is the ZN441 A-to-D converter. This converts the analogue input signal into a six-bit binary word at rates up to 10 million samples a second. The six-bit word from each sample is then passed to the memory buffers IC6 and IC7. If IC6 and IC20 are selected, then data is written to the memory block IC15, 16. In this case IC19 and IC7 are in the high impedance output mode, and IC20 enables data from the second memory block, IC17, 18, to be read to the comparator IC23, 24. The memory and buffer enables also select the address buffers, routing the input addressing to IC15, 16, and the output addressing to IC17, 18 in this example. In other words, in this phase of the operation IC11 is allowing the synchronous counters IC2 and IC3, which are acting as an eight-bit address counter, to cycle IC15, 16 synchronously with the sample rate, while IC14 is allowing the output address counter IC4, 5 to address IC17, 18. IC12, 13 are disabled to block the respective unwanted address lines. On the alternate phase, ICs 11 and 14 would be disabled, ICs 12 and 13 would be enabled, and the two memory blocks IC15, 16 and IC17, 18 would receive the opposite sets of address signals. The output of IC8 goes low when the input address cycle is completed, while the output of IC10 goes low when the output address cycle is complete.

IC21, 22 form the 256-line counter, which is advanced every four video lines for a total of 64 steps. This six-bit output is compared with the six-bit output from the memory by IC23, 24, and when these are equal, a data bit is output to the video summing circuit. The output of IC25 goes low when a count of 256 is completed.

When the input cycle is complete (the input memory block is full), the input clock is disabled. The output clock is only enabled for 256 lines of the scan and is therefore disabled during the first and last lines of the display and the frame flyback time. When the input address is completed and the frame scan is completed, the memories are switched over and the new data is output to the comparator. The video data is therefore refreshed every 50 mS unless the incoming data cycle is longer.

The power supply unit has regulated +5 V and −5 V rails at 650 mA and 160 mA respectively, with a separate 5V8 supply for the UHF modulator.

Oops

A couple of errors crept into the first part: IC6a pin 3 is connected to IC7 pin 12, etc, and not as shown; the supply line decoupling capacitors were not shown, and they are C15 (22u tant) and C16-24 (100n ceramic) on the +5 V line and C16 (22u tant) on the −5 V line. Additionally, R14 has now been ommitted. (Note that all the above component numbering refers to the logic board circuit diagram, published last month).

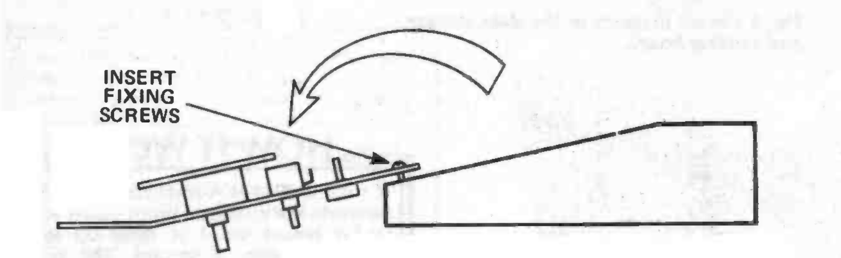


Fig. 4 This is how you attach the front panel to the box to make it easier to do the interconnecting

switch (see the overlay in Fig. 1). Incidentally, Q4 was incorrectly identified on the circuit diagram last month — it is actually a BC107.

The power supply is mounted on a single-sided PCB and is supplied ready-built with the kit. The front panel switches are also PCB-mounted as described earlier (see Figs. 2 and 6):

With the boards completed, the data processing board can be connected to the control logic

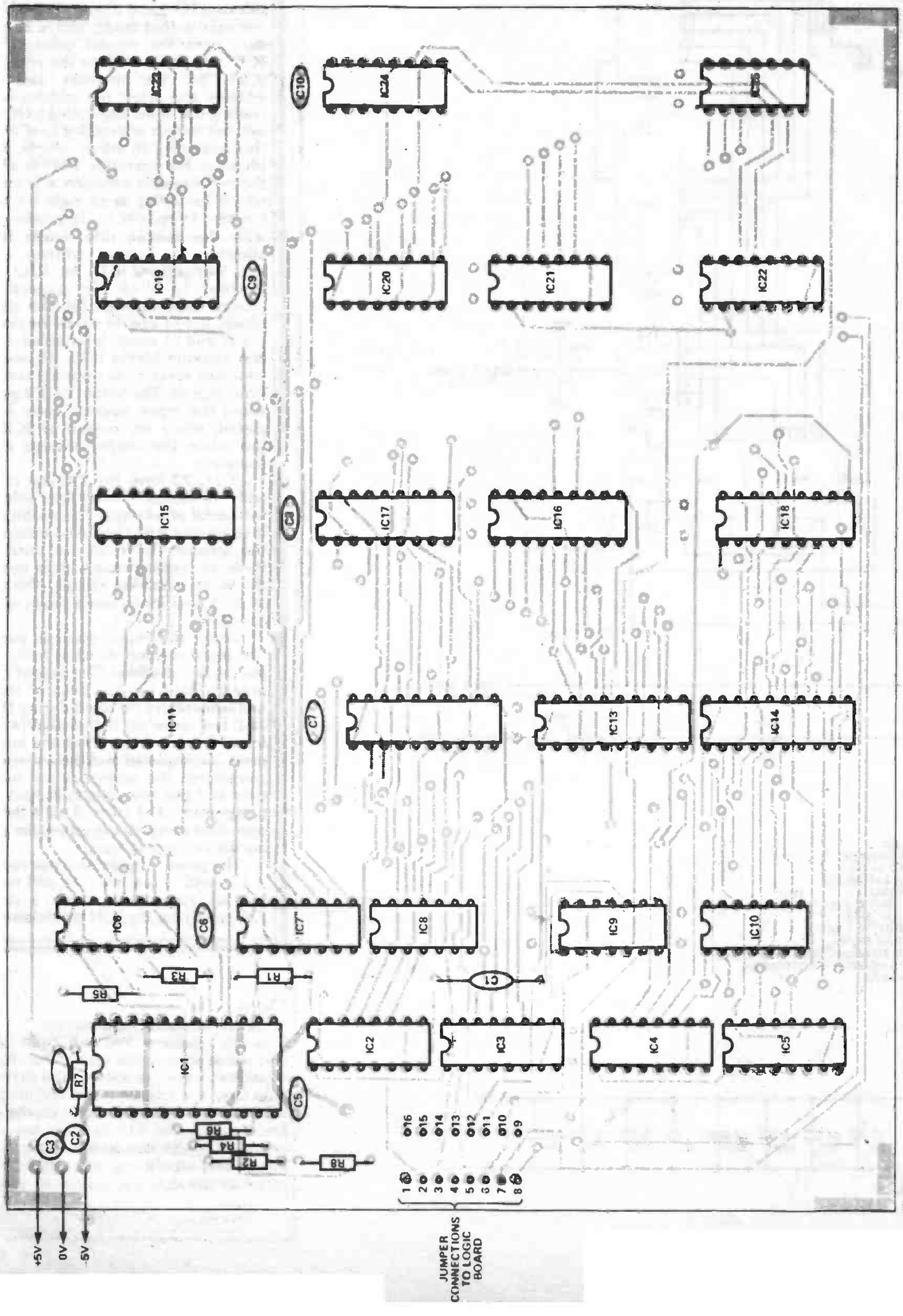
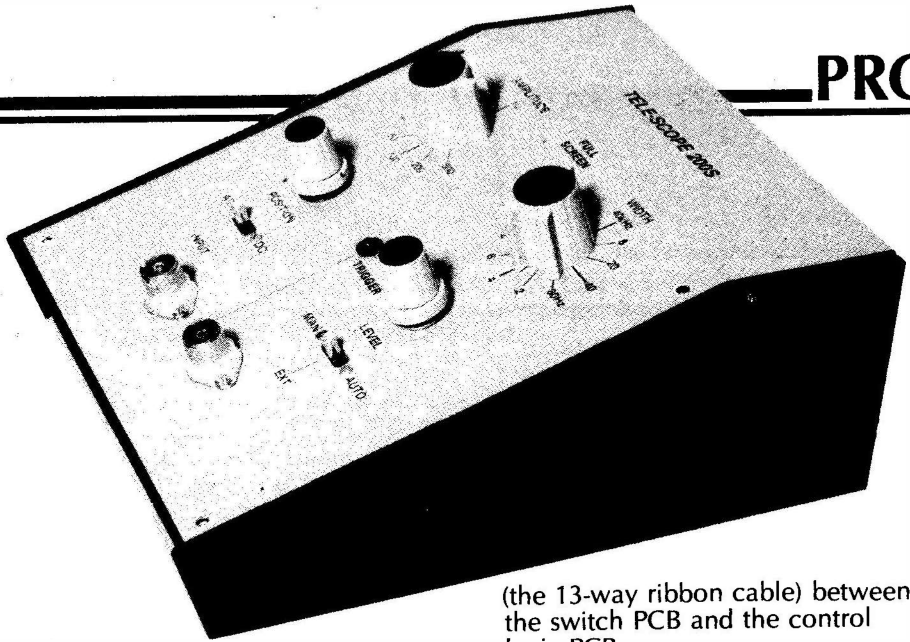


Fig. 5 Overlay of the data storage board



board using the 16-way jumper. The data processing board is then mounted on the base of the case with adhesive pillars, and the logic board is mounted on top of it, again using adhesive pillars. These special pillars are supplied with the kit and are required because there isn't enough space between tracks on either PCB to allow for fixing holes to be drilled. The power supply is fitted to the rear of the case, with the supply leads being soldered to the upper PCB. Don't forget to drill access holes in the rear of the case for the mains lead and UHF TV cable first, though!

Now mount the controls on the lid of the case. The lid should be screwed face down in the open position, using one pair of holes only, in order to make the front panel wiring easier. Figure 4 makes this clear.

First the input lines should be connected to the AC/DC input switch with C1 mounted directly across the switch terminals. Next wire the trigger switch (see Fig. 6) and the trigger LED, and finally connect the frequency selector lead (the 13-way ribbon cable) between the switch PCB and the control logic PCB.

Operation

First switch on your television and tune in the Tele-Scope signal on an unused channel select button. Set the trigger switch to auto and locate the trace (a white line) using the position control. Set the voltage control to 10 V full screen and the full screen width control (the time base) to 80 Hz FSW. On touching the input socket with your finger, a 50 Hz sine wave will be displayed (due to mains pick-up).

By switching to manual trigger and adjusting the trigger level, it is possible to remove your finger and keep the sine wave display on the screen. This feature of the Tele-Scope allows you to do some interesting experiments — for instance, you can examine the EMF induced in a coil when a bar magnet is dropped through it.

Try using the Tele-Scope as a sampling scope on repetitive waveforms above 250 kHz (not calibrated, but it works). You can even capture one-shot events up to 250 kHz.

ETI

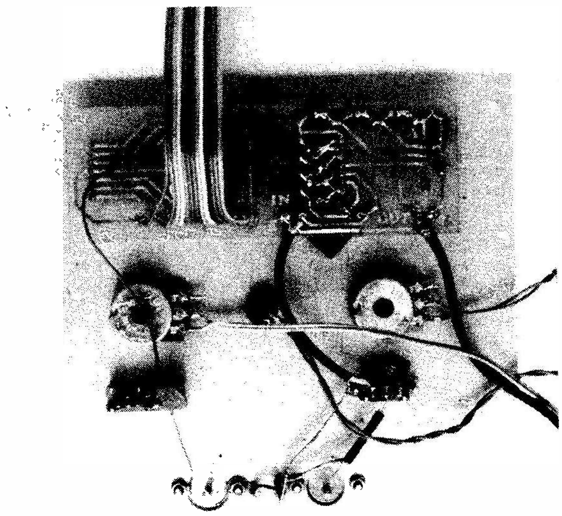


Fig. 6 Wiring the back of the front panel.

THE ZN441

The ZN441 is an ultra-high-speed parallel (flash) A-to-D converter comprising an array of 64 strobed comparators and encoding logic. A reference voltage applied across a tapped resistor chain defines 63 quantisation levels plus overrange and underrange, one input of each comparator being connected to the resistor string, while the other inputs are commoned and connected to the analogue input. When an analogue input is applied, all the comparators whose reference voltage is less than the analogue input will change state, ie if the input voltage is V_{REF}. n/64 then n comparators will have tripped. The comparator outputs are decoded into a 1-of-64 format by NOR gates and then re-encoded into binary by a high-speed ROM.

Two or four ZN441s can be stacked to give a seven- or eight-bit converter with a minimum of external components. Applications include high-speed data acquisition, video an radar data conversion, digital signal storage and image processing.

PARTS LIST — DATA BOARD

Resistors (all ¼W, 5%)	
R1-6	**2k2**
R7	**100R**
Capacitors	
C1, 2	**22uF 16 V PCB electrolytic**
C3-9	**100nF ceramic**
Semiconddductors	
IC1	**ZN441**
IC2-5, 21, 22	**74LS161**
IC6, 7	**74LS367**
IC8, 10, 25	**74LS30**
IC9	**74LS04**
IC11-14	**74LS244**
IC15-18	**2114**
IC19, 20	**74LS368**
IC23, 24	**74LS85**
Miscellaneous	
PCB (see Buylines); 24 pin IC socket for IC1.	

BUYLINES

Hawk Electronics Test Equipment supply a full kit of parts for this project. All PCBs, the case (drilled and screen-printed), the ZN441 and all the other components are included, together with a comprehensive manual. The kit price is £89. The 'Tele-Scope' is also available built and tested for £109.

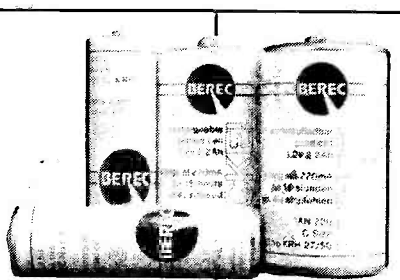
The manual may be purchased separately for £1.50 (no VAT required) refunded on the subsequent purchase of a kit or finished circuit.

Prices exclude 15% VAT, and postage and packing is £2.95 extra. The case, A-to-D converter, and the PCBs may all be purchased separately.

Hawk Electronic Test Equipment,
Unit 1,
Park Wood Industrial Estate,
Bircholt Road,
Maidstone,
Kent.
Telephone: 0622 686811.

NOW 'LIVE' THE AMBIT TOP TEN

* TOBIE DISTRIBUTOR OF THE YEAR *



AA NICADS

High quality Ever Ready nickel cadmium rechargeable batteries.
Size: 14.5x50mm; 1.2V; Capacity: 500mAH
Stock No. **01-12004** Price: **0.80**

C NICADS

High quality Ever Ready nickel cadmium rechargeable batteries.
Size: 26 x 49mm; 1.2V; Capacity 2.2AH
Stock No. Price: **2.35**

CRYSTAL FILTER

A crystal filter for the first IF of CB receivers, in place of the usual ceramic filter can perform the single most significant improvement in blocking and cross mod in most circuits.
Model: 10M15A; Centre Freq: 10.7MHz; Band Width: 15kHz(3dB); Term Imp: 3kΩ
Stock No. **20-10152** Price: **1.99**

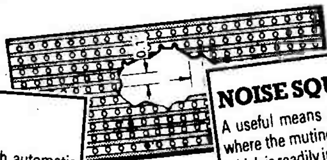
MODEM KIT

A 300 baud full duplex originate only accoustically coupled modem. Use with any home computer with RS232 capability.
Not PO approved!!!

Electronics Stock No. **41-00201** Price: **19.94**
Hardware Stock No. **41-00208** Price: **12.00**

VEROBOARD

0.1" pitch. No. holes: 36x50; Size("): 3.75x3.75.
Stock No. **21-09003** Price: **1.14**

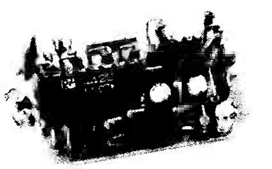


CH4/RX4

Will recharge AA, C, D and PP3 size cells with automatic voltage selection.
Stock No. **01-02204** Price: **7.49**

NOISE SQUELCH SYSTEM

A useful means of curing the deficiencies of NBFM sets where the muting control is derived from the signal level - which is readily influenced by ignition noise etc.
Kit Stock No. **40-44362** Price: **4.12**
Built Stock No. **40-44363** Price: **8.45**



FET DIP OSCILLATOR

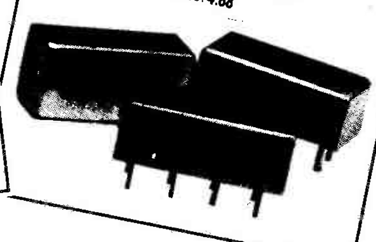
Stock No. **40-16215** Price: **18.79**
An essential piece of test equipment for the RF constructor. GDO or absorption wavemeter function covering 1.6-215MHz in five ranges.
Fibre-glass PCB, all components, all hardware, punch, painted and screen printed case, wire etc. for coils and printed scale.

Z8 TBPDS

Based on the Z8 basic/debug CPU is the most adaptable and understandable entry to this design on MPU based control systems.
Needs only to be connected to an RS232 terminal, or a home computer configured as one, to provide complete program development/support.
Stock No. **40-00802** Price: **160.00**

SCHOTTKY DIODE BALANCED MIXER

Hermetically sealed for receiver and modulator applications. SBL1, 1-500MHz premium type.
Stock No. **12-00003** Price: **4.68**



Please add 60p postage & packing per order

AND LOTS, LOTS MORE IN THE CATALOGUE AVAILABLE FROM JULY

ALL PRICES EXCLUDING VAT

Ambit international
200 North Service Road
Brentwood, Essex
CM14 4SG

Telecom directory:
Consumer 0277-230909
Industrial 0277-231616
Telex 995194 AMBIT G
DATEL 0277-232628

VISA

Access

R&EW

TELEPHONE SALES 8 am - 7 pm MON - FRI 9 am - 6 pm SAT

IC UPDATE

Dear Reader,

What we've indulged in here is a slightly speculative venture, in that neither of the two ICs featured this month are actually available to the hobbyist, so far as we know (if you're in industry, then you'll be able to get the LM2877/8 from your Nat Semi supplier, and the RC4193 from Raytheon). However, we think that by bringing these to the light of day, we shall motivate someone, somewhere to stock them. And far be it from us to suggest our advertisers, but a word in their ear from you may not go amiss . . .

RC4193 Switched Mode PSU

What, not another switched mode PSU? Well, yes, but this one can keep your tranny going for longer, amongst many other applications.

The RC4193 is a monolithic switching regulator IC that, with very few external components is capable of stepping up or down, or inverting, with a typical efficiency of 80%.

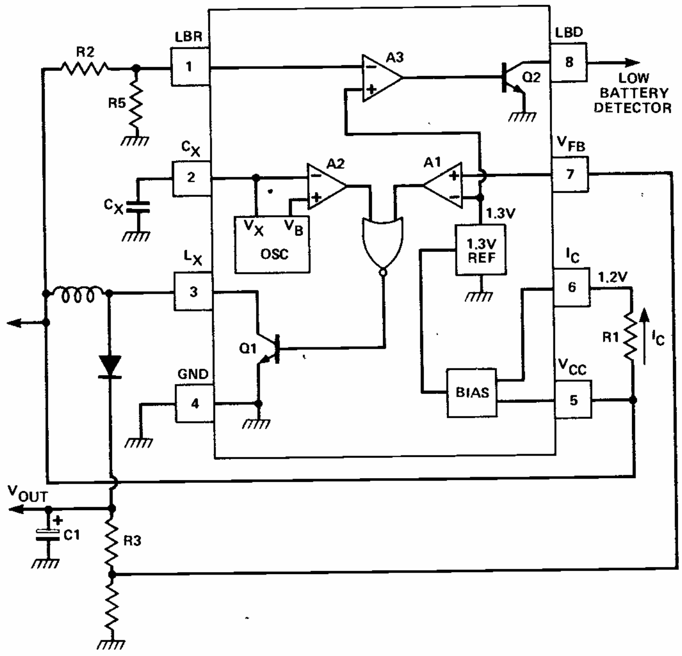


Fig. 1 RC4193 functional diagram.

Principles of Operation

The circuit has an on chip 1.31 V band gap reference with a typical TC of 50ppm. In addition to setting the bias currents in the 4193, this voltage is used as the reference at the input of comparators A1 and A3. The 1.31 V at the input of A1 is used as the threshold to compare to the feedback output voltage at pin 7 (V_{FB}). The output of A1 is fed to a NOR gate which is used to gate the output of the oscillator comparator (A2) which turns off Q1 whenever V_{FB} is greater than 1.31V. note when the output of A1 of A2 is high the switch transistor Q1 cannot turn on.

The oscillator has its frequency determined by a single capacitor C_X and outputs two waveforms, a square wave V_B and a saw tooth V_X (which appears at pin 2) both of which appear at the input of A2. The portions of the waveform where Q1 can be saturated as a result of the oscillator, are labelled T_C in Fig. 2, and the portion of the waveform where Q1 would be off is labelled T_o. Q1 can

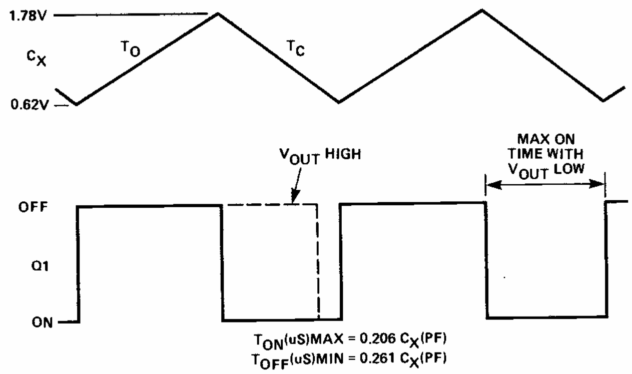


Fig. 2 Switching timing diagram.

be saturated only when V_{FB} is less than 1.31V. The voltage of the sense line from the R3/R4 voltage divider at the V_{FB} pin is directly proportional to the output voltage V_{OUT}, where V_{OUT} = 1.31 (R3 + R4)/R4. When V_{FB} is less than 1.31V, Q1 will saturate on every negative going oscillator cycle until V_{OUT} reaches the programmed value.

The 4193 also includes an uncommitted comparator and output transistor shown as A3 and Q2 in Fig. 1. The 1.31V internal reference is used as the threshold at the + input of A3. The voltage divider R2/R5 is used to determine the voltage at which Q2 switches. When the voltage at LBR (pin 1) falls below 1.31V then Q2 will saturate. A3 has about 0.7µA of hysteresis to produce a positive turn on/turn off at LBD (pin 8). The voltage at which Q2 switches is determined by V = 1.31 (R2 + R5)/R5.

Absolute Maximum Ratings

Internal Power Dissipation	500mW
Supply Voltage (without external series pass transistor)	24V
Operating Temperature Range	0°C to +70°C
Switch Current (Isw)	150mA
Reference Set Current (Ic)	1mA
V_{FB}, LBR, C_x Voltage	
L_x, LBD Voltage	24V

PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage, V_{CC}		2.4		24	V
Reference Voltage (internal), V_{REF}		1.24	1.31	1.38	V
Switch Current, I_{SW}	V_3 = 400mV	75	100		mA
Quiescent Current, I_{CC}	Measure at Pin 5 I_3 = 0		135	200	uA
Efficiency			80		%
Line Regulation	$0.5V_O < V_{CC} < V_O$		0.08	0.5	% V_{OUT}
Load Regulation	$V_{CC} = 0.5V_O$ P_L = 150mW		0.2	0.5	% V_{OUT}
Operating Frequency, f_O		0.1	25	150	kHz
Reference Set Current, I_C		1	5	50	uA
Switch Voltage	I_3 = 100mA		0.4	1	V
Switch Leakage Current	V_3 = 24V		0.01	5	uA
Supply Current (Disabled)	I_C < 0.01uA		0.1	5	uA
Low Battery BiasCurrent	V_1 = 1.2V		0.7		uA
Capacitor Charging Current			5.0		uA
Capacitor Threshold Voltage +			1.78		V
Capacitor Threshold Voltage −			0.62		V
Feedback Input Current	V_7 = 1.3V		0.1		uA
Low Battery Output Current	V_8 = 0.4V, V_1 = 1.1V	100	600		uA

Table 1 Electrical characteristics

The 4193 series circuits contain an internal bias network which maintains the correct operating currents to the 4193 independent of temperature and input voltage variations. The internal bias network is turned on by supplying a current I_C between 1μA and 100μA into pin 1, and no change will resuilt in the operating characteristics when I_C is varied over this range. To shut down the 4193, simply force pin 1 to less than 0.5V by using a mechanical switch or open collector transistor. The quiescent current in the 4193 will fall to less than 5μA (typically less than 0.1μA).

Design Equations

Table 2 is a set of design equations which can be used to determine resistor, capacitor and inductor values for step-down, step-up and voltage inverting applications. To use the equations, you determine the oscillator frequency (f_O), input voltage (V_{IN}), output voltage (V_{OUT}) and maximum output load current (I_L).

Basic Step-Up Switching Regulator

Figure 5 is the basic low current step-up configuration to be used for most battery powered applications requiring less than 150mW of load power (when $V_{IN} > 0.5\ V_{out}$).

The output voltage V_{OUT} is determined by the expression 1.31 (R3 − R4)/R4; in this case V_{OUT} would be 9.0V. This configuration makes a good subsititute for a 9V transistor battery, since a stable output voltage will be achieved with any input between 9.3V and 2.4V.

If a lower supply voltage can be tolerated, the output of the 4193 can be set to start regulating at 7V (1.16V/Cell), effectively keeping the 4193 in its quiescent state (drawing only 150μA) until the battery voltage falls to 7.5V. Below 7.5V the 4193 will regulate the V_{OUT} at 7.0V until the battery falls below 2.4V. In this circuit R2 and R5 are used to indicate a low battery condition when the input voltage falls below 5.9V; any other voltage can be selected by changing the value of R2. If the Low Battery Detector circuitry is not going to be used, leave pin 1 and 8 unconnected. As mentioned previously, the top of R5 can also be connected to V_{OUT} when a low output indication is

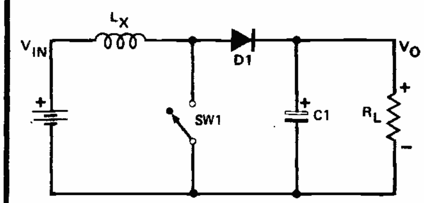


Fig. 3 Basic circuit for stepping up mode.

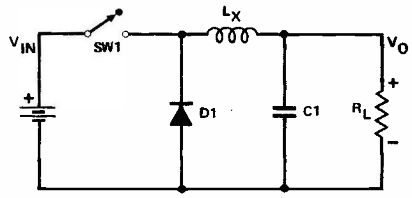


Fig. 4 Basic stepping down circuit.

	Step Up	Step Down	Inverting
R1(M)	$\frac{V_{IN} - 1.2}{5\mu A}$	$\frac{V_{IN} - 1.2}{5\mu A}$	$\frac{V_{IN} - 1.2}{5\mu A}$
R2(M)	$\frac{V_{IN} - 1.31}{5\mu A}$	$\frac{V_{IN} - 1.31}{5\mu A}$	$\frac{V_{IN} - 1.31}{5\mu A}$
R3*	$\frac{V_{OUT} - 1.31}{I_1}$	$\frac{V_{OUT} - 1.31}{I_1}$	$\frac{V_{OUT}}{I_1}$
R4*	$\frac{1.31}{I_1}$	$\frac{1.31}{I_1}$	$\frac{1.31}{I_1}$
R5	261kΩ	261kΩ	261kΩ
C_x (pF)	$\frac{2.14 \times 10^6}{f_0}$	$\frac{2.14 \times 10^6}{f_0}$	$\frac{2.14 \times 10^6}{f_0}$
L_x	$\frac{0.3V_8(V_{OUT}-V_{IN})}{f_O I_{LOAD} V_{IN}}$	$\frac{0.3V_{OUT}}{f_O I_{LOAD}}$	$\frac{0.3V_{IN}\lvert V_{OUT}\rvert}{f_O I_{LOAD}(V_{IN}+\lvert V_{OUT}\rvert)}$
CI	$\frac{2V_{OUT}-V_{IN}}{4f_O V_{OUT} V_R}$	$\frac{I_{LOAD}}{4f_O V_R}$	$\frac{0.15I_{LOAD}N+2\lvert V_{OUT}\rvert)}{f_O V_{IN}(V_{IN}+\lvert V_{OUT}\rvert)V_R}$
R6	$\frac{35V_{IN}}{I_{LOAD}V_{OUT}}$	$\frac{35}{I_{LOAD}}$	$\frac{35V}{I_{LOAD}(V_{IN}+\lvert V_{OUT}\rvert)}$
R7	$\frac{R6}{7}$	$\frac{R6}{7}$	$\frac{R6}{7}$

Units are ohms, fards, henries, and hertz unless indicated otherwise.
I_1 = current into pin 1; recommended value 100uA.

Table 2 Design equations for the three modes.

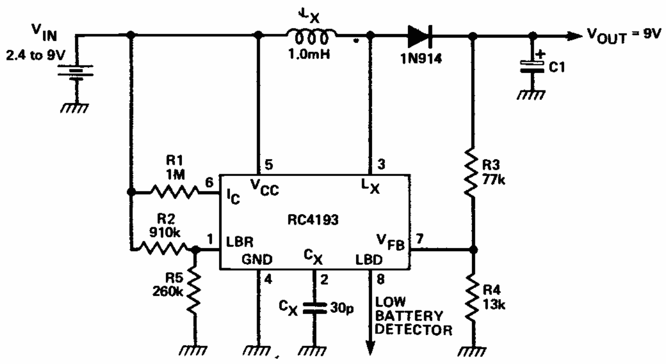


Fig. 5 RC4193 low current step-up mode.

desired.

A feature of the 4193 is the ability to shut off when pin 6 is forced below 0.5V. An example of this feature is shown in Fig. 6. In this circuit as long as V_C remains low the output will regulate to 5V. This type of circuit can be used to back up the main supply voltage when line interruptions occur, a particularly useful feature when using volatile memory systems.

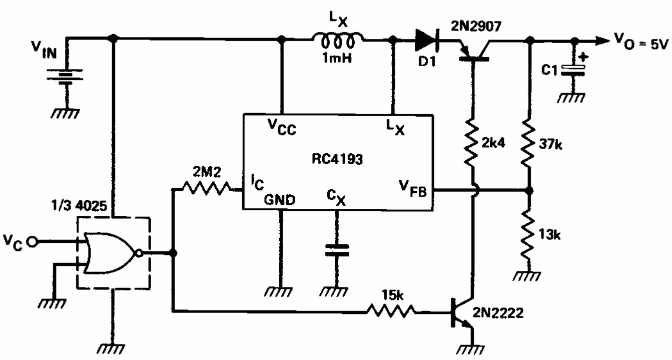


Fig. 6 RC4193 battery-back-up circuit.

In step-up application, power to the 4193 can be derived from the output voltage by connecting the V_{CC} pin and the top of R1 to the output voltage (for example see Fig. 7). One requirement is that the battery voltage must be greater than 3.0V when the circuit is energized or else there is not enough voltage at the V_{CC} pin to operate the 4193. However, once running, the battery can decay to 1.0V before the circuit stops operating.

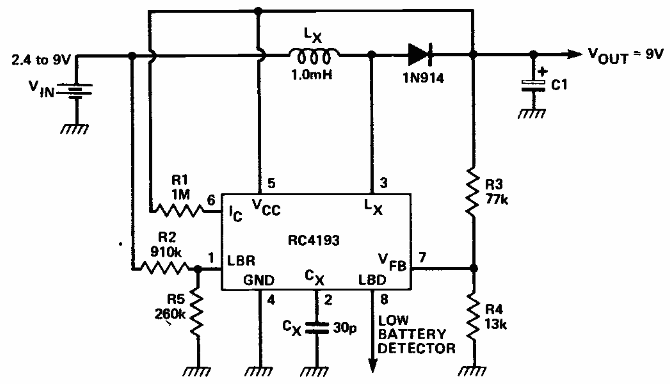


Fig. 7 Bootstrapping the supply to the RC4193.

Basic Step-Down Switching Regulator

Since the switch transistor in the 4193 is in parallel with the load a method must be used to convert it to a series connection; the circuit of Fig. 8 accomplishes this.

The 2N2907 replaces S1 of Figure 4, and R6 and R7 are added to provide the base drive to the 2N2907 in the correct polarity to operate the circuit properly; refer to Table 2 for equations for component values. Since the L_X pin is capable of sinking 100mA, high current switching transistors can be used in place of the 2N2907.

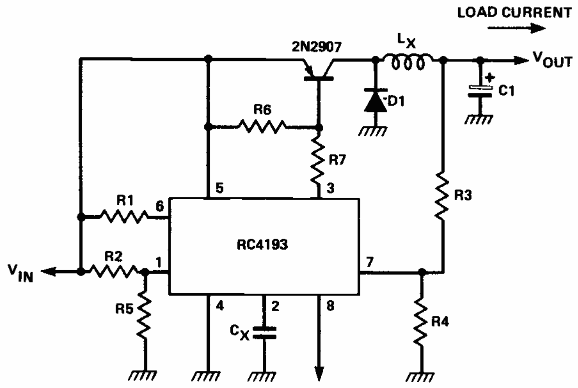


Fig. 8. RC4193 step-down mode.

Greater Than 30 Volt Application

Adding a zener diode in series with the base of the 2N2907 allows the input voltage to increase by the value of the zener, with only a slight decrease in efficiency. As an example, if a 24V zener is used, the maximum input voltage can go to 48V.

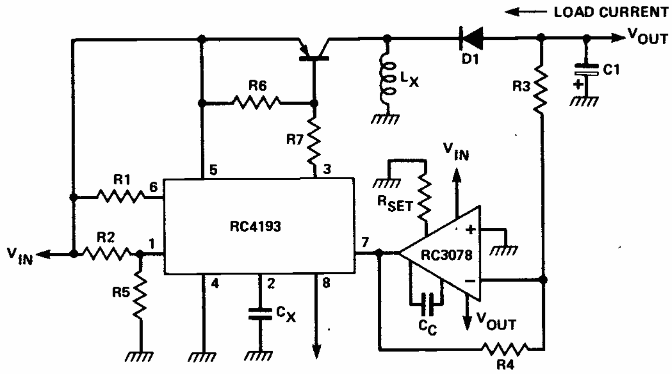


Fig. 9 RC4193 used as an inverter-regulator.

Inverting Switching Regulator

Many single-supply systems require an occasional negative voltage for a specific application; this circuit will meet those needs.

The circuit is similar to the type used in Fig. 8, except the lcoation of L_X and the diode are reversed and a micropower op-amp RC3078 is added to provide inversion for the sense voltage. The output voltage is 1.31 R3/R4.

The RC3078 operates at a closed-loop gain of close to one in most applications, therefore the value of C_C must be such to frequency compensate the RC3078 for unity gain conditions. The value for R_{SET} will determine the quiescent current in the 3078 and for micropower applications can be set to operate at approximately 10μA. Where a larger amount of amplifier quiescent current can be tolerated, a ground sensing op-amp such as the LM324 or RC3403A can be used, eliminating the need for R_{SET} and C_C.

An important point is that pin 7 must be below 1.3V when $|V_{OUT}|$ is below the design output voltage or else the circuit will not start.

Due to their output stage design, op-amp types similar in design to the 741 may cause the circuit to not start properly since they fail to keep pin 7 below 1.3V when power is first applied.

LM2877/8 Audio Power Amps

The LM379 has had a good innings as linear ICs go, but it's now being replaced by the LM2877 and LM2878 in manufactured equipment.

The LM2877/8 are monolithic dual power amplifiers designed to deliver 4W (2877) or 5W (2878) continuous into eight ohm loads. Each power amplifier is biased from a common internal regulator to provide good power supply rejection and output centering. Both devices are internally compensated for gains greater than 10 and come in 11-lead single in-line packages.

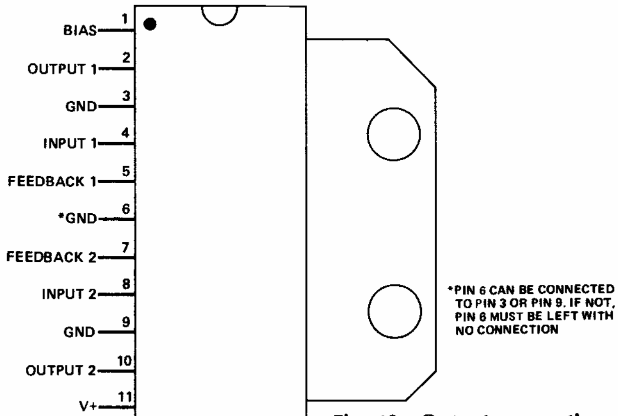


Fig. 10 Output connections.

Absolute maximum ratings

Supply voltage	26 V (35 V 2878)
Input voltage	+0.7 V
Operating temperature	0°C to +70°C
Junction temperature	150°C

Electrical Characteristics for LM2877: Where those of the LM2278 differ, they are given in brackets; otherwise the same figure applies.

V_S = 20V (22V), T_{TAB} = 25°C, R_L = 8Ω, A_V = 50 (34 dB) unless otherwise specified

Note 1: For operation at ambient temperatures greater than 25°C, the LM2877 must be derated on a maximum 150°C junction temperature using a thermal resistance which depends upon device mounting techniques.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Total Supply Current	P_O = 0W		25(10)	50	mA
Operating Supply Voltage		6		24(35)	V
Output Power/Channel	f = 1 kHZ, THD = 10%, T_{TAB} = 25°C				
	V_S = 20V	4.0(5.0)	4.5(5.5)		W
	V_S = 12V, R_L = 4Ω	1.5	1.9		W
Distortion, THD	f = 1 kHz, V_S = 20V				
	P_O = 50 mW/Channel		0.1(0.2)		%
	P_O = 2W/Channel		0.07(0.14)	1	%
Output Swing	R_L = 8Ω		V_S-4 (V_S-6)		Vp-p
Channel Separation	C_F = 50 uF, C_{IN} = 0.1 uF, f = 1 kHz Output Referred V_S = 20V, V_O = 4 Vrms	−50	−70		dB
PSRR Power Supply Rejection Ratio	C_F = 50 uF, C_{IN} = 0.1 uF, f = 120 Hz, Output Referred V_S = 20V, V_{RIPPLE} = 1 Vrms	−50	−68(−60)		dB
Noise	Equivalent Input Noise R_S = 0, C_{IN} = 0.1 uF, BW = 20 Hz-20 kHz		2.5		uV
Open Loop Gain	R_S = 0, f = 1 kHz, R_L = 8Ω		70		dB
Input Offset Voltage			15		mV
Input Bias Current			50(100)		nA
Input Impedance	Open Loop		4		MΩ
DC Output Level	V_S = 20V (22V)	9(10)	10(11)	11(12)	V
Slew Rate			2.0		V/us
Power Bandwidth			65		kHz
Current Limit			1.0(1.5)		A

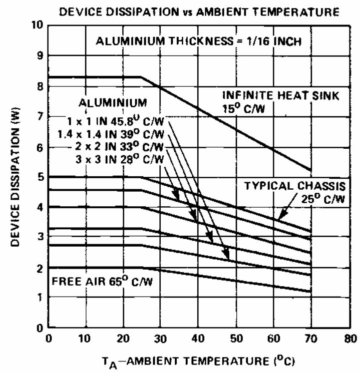


Fig. 11 Device dissipation vs. ambient temperature (LM2877).

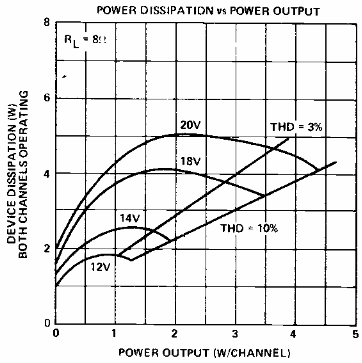


Fig. 12 Power dissipation vs. power output (LM2877).

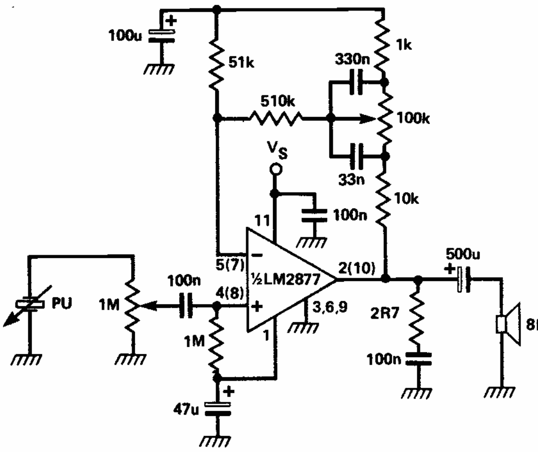


Fig. 13 Ceramic PU amplifier with bass control.

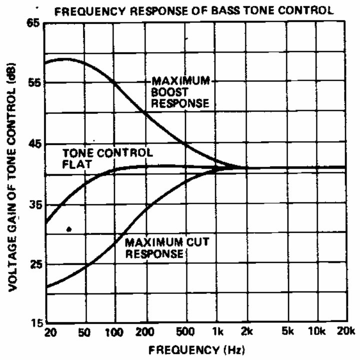


Fig. 14 Frequency response of bass control in Fig. 13.

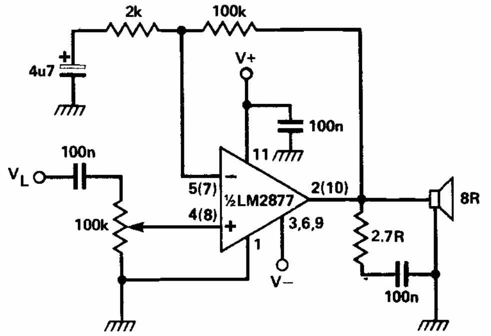


Fig. 15 Non-inverting amplifier using split supply.

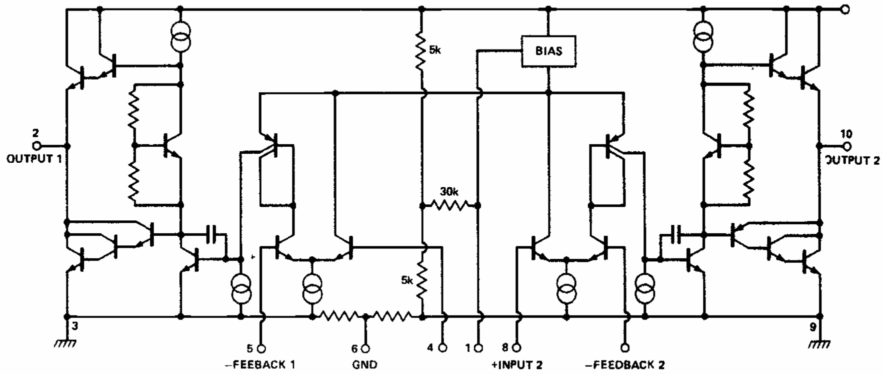


Fig. 16 Internal circuit.

Next month we'll take a look at a few more newcomer ICs.

ORIC SOFTWARE from TANSOFT

ORIC CHESS

A superb chess game written in Basic with a Machine Code Move Search Routine. Features high resolution colour graphics, record of moves, allows Castling and En-Passant. 5 levels of play and computer can play black or white.

ONLY £9.99 inc VAT

48K only

ZODIAC

A 36K adventure game that will test your intelligence and patience for hours. Find the 12 hidden signs of the Zodiac to discover incredible treasures. Can you ward off the angry Yeti? What is the meaning of the radio that plays the 'Archers' over and over again (through your loudspeaker!)?

Only £9.99 inc VAT

48K only

ORIC FLIGHT

Can you fly your new 787 jet on to the runway without crashing, stalling or running out of fuel? Full digital instrument readout plus cockpit view of final runway approach. Superb graphics and sound.

Only £7.95 inc VAT

48K only

Please send me	Quantity	Total
Oric-Chess at £9.99		
Zodiac at £9.99		
Oric-Flight at £7.95		
TOTAL		

Postage per cassette is 40p

Name

Address

Please send me latest price list

Please allow 28 days for delivery

All cheques payable to
TANSOFT LTD
3 CLUB MEWS
ELY
CAMBS
CB7 4NW

Tansoft is the software division of Tangerine Computers.

UNIVERSAL EPROM PROGRAMMER

Get to grips with the bits using our Universal EPROM programmer. Design and development by Mike Bedford.

EPROMs provide a convenient means of storing commonly used software, but many microcomputer users are deterred from using this media due to the difficulties of erasure and programming. EPROM programmers are both commercially available and have been featured as constructional articles in some magazines, but the former are relatively expensive and the latter tend to be limited as regards types of EPROM supported. For these reasons, it was considered appropriate to develop a universal EPROM programmer which could be built by the amateur for a modest sum. The programmer presented here will support the following EPROMs: 2758, 2716, 2516, 2732, 2732A, 2532, 2764, 2564, 27128 and 27256. This list includes every single supply version of the 27-Series and 25-Series devices up to and including 256k bit capacity, which seems likely to be the largest EPROM which will be produced as further development will probably be of EAROMs and EEPROMs. The programmer is intended for use in conjunction with a 6502 computer system and appropriate software is presented. Although the hardware is designed to support the 27256, this one EPROM is not as yet supported by the software due to lack of preliminary data on this device, the chip itself having not been released by the manufacturer at the time of writing. To complete the requirements for programming EPROMs, some hints are given on building an erasure unit.

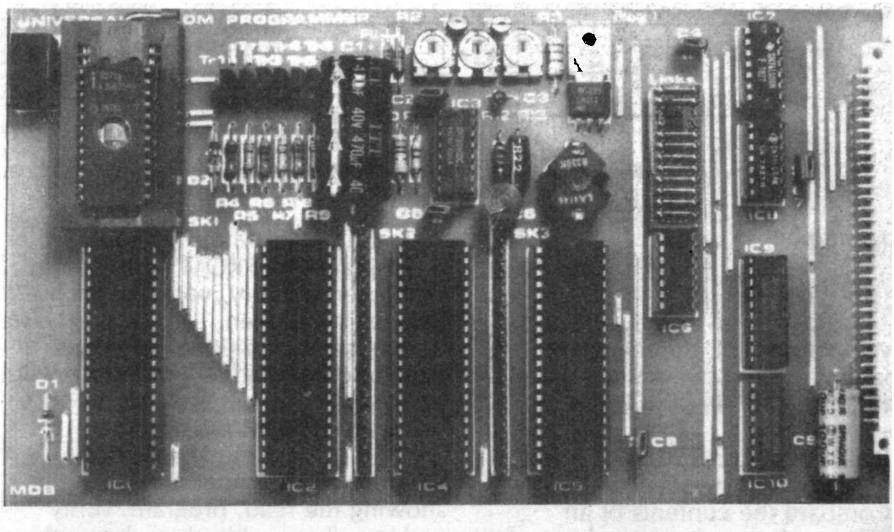
Hardware

The hardware has been designed for a Tangerine Microtan system, the physical dimensions of the circuit board being selected such that it will plug directly into the system rack. Non-Tangerine users should not be deterred, however, as electronically it should be quite simple to interface this card to any computer using the 6502 or 6809 processors. No special power supplies are required as all voltages required for programming are derived from a single +5v supply.

Although the PCB has sufficient space for a zero insertion force socket to be mounted on board, it is probably more convenient, especially if the card is to be rack mounted, to mount this socket in a separate console, making a connection with a length of ribbon cable. Note that a switch should be provided on the console to isolate V_{pp} and V_{cc} on pins 1 and 28 respectively. This is necessary since inserting or removing an EPROM with these supplies present may result in its destruction.

If the console is not used, switch SW1 should be mounted on board to isolate these supplies. On EPROMS which have V_{pp} and V_{cc} on other pins, these supplies may be isolated under program control. It will also be noticed that only a single zero insertion force socket has been provided on PCB. This decision was taken on grounds of economy and some constructors may prefer to add a 24-pin socket in addition. If a single 28-pin socket is used, 24-pin devices should be inserted into the bottom part of the socket, ie leaving pins 1, 2, 27 and 28 empty. Table 1 shows the pin outs of all EPROMs which are supported.

The programmer applies a TTL level to all pins with the exception of pin 1 which is connected to V_{pp}, pin 14 (0V) and pin 28 (+5v). V_{pp} is program selectable to +25 V, +21 V or +5 V and may also be applied to pins 22 and 23 as an alternative to a TTL level. To summarise this information, the programmer may be considered as a glorified 29-bit output port. This being the case, and since the circuitry required to implement the above would not completely fill a 8" x 4½" PCB, it seemed appropriate at the cost of only two more ICs to add four additional 8-bit output ports to make maximum use of the board space available. These ports are completely independent from the



The Universal EPROM Programmer. Note that this prototype differs slightly from the final version — in particular, the component numbering is completely different!

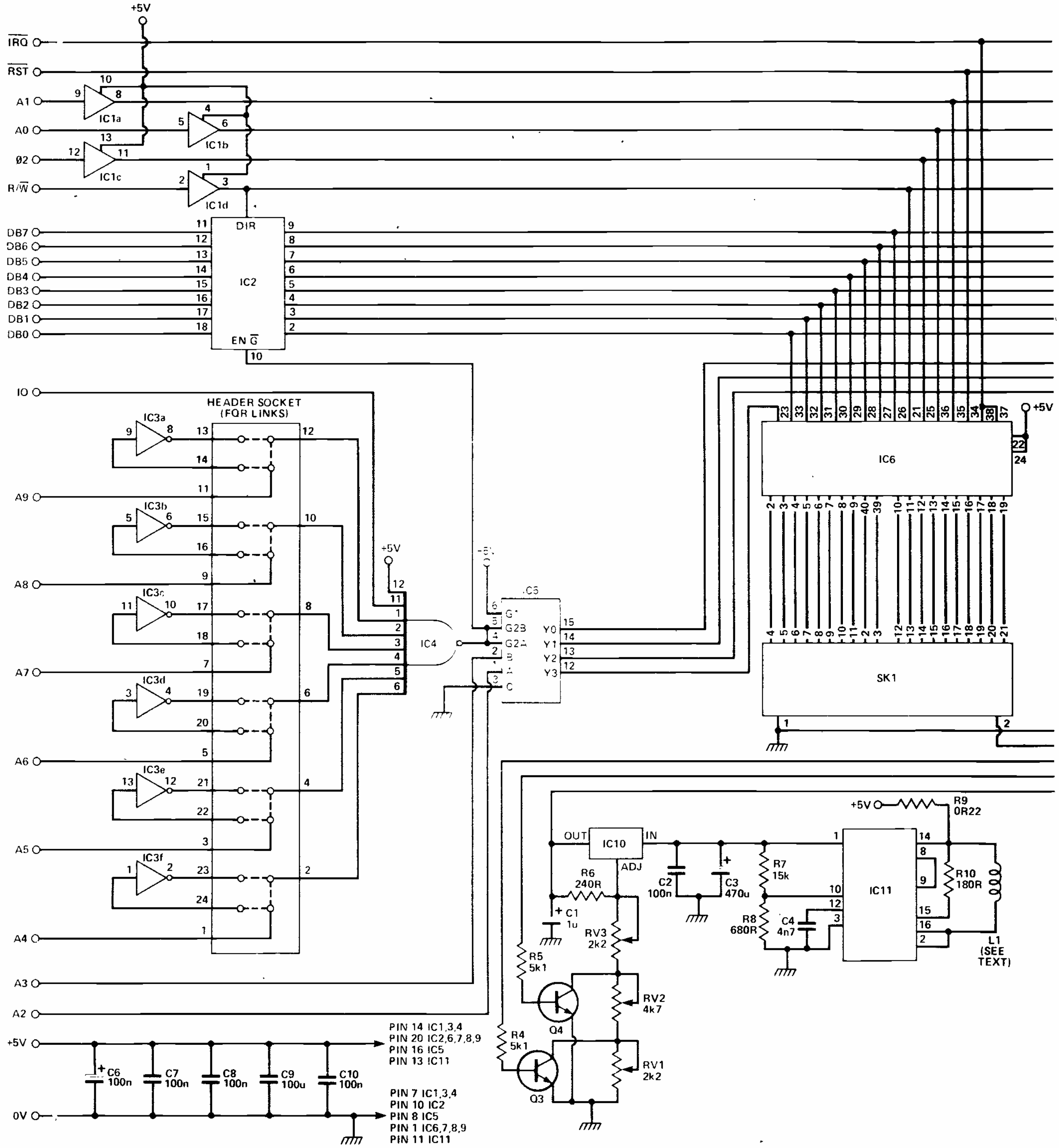


Fig. 1 Circuit diagram of the Universal EPROM Programmer.

programmer.

Software

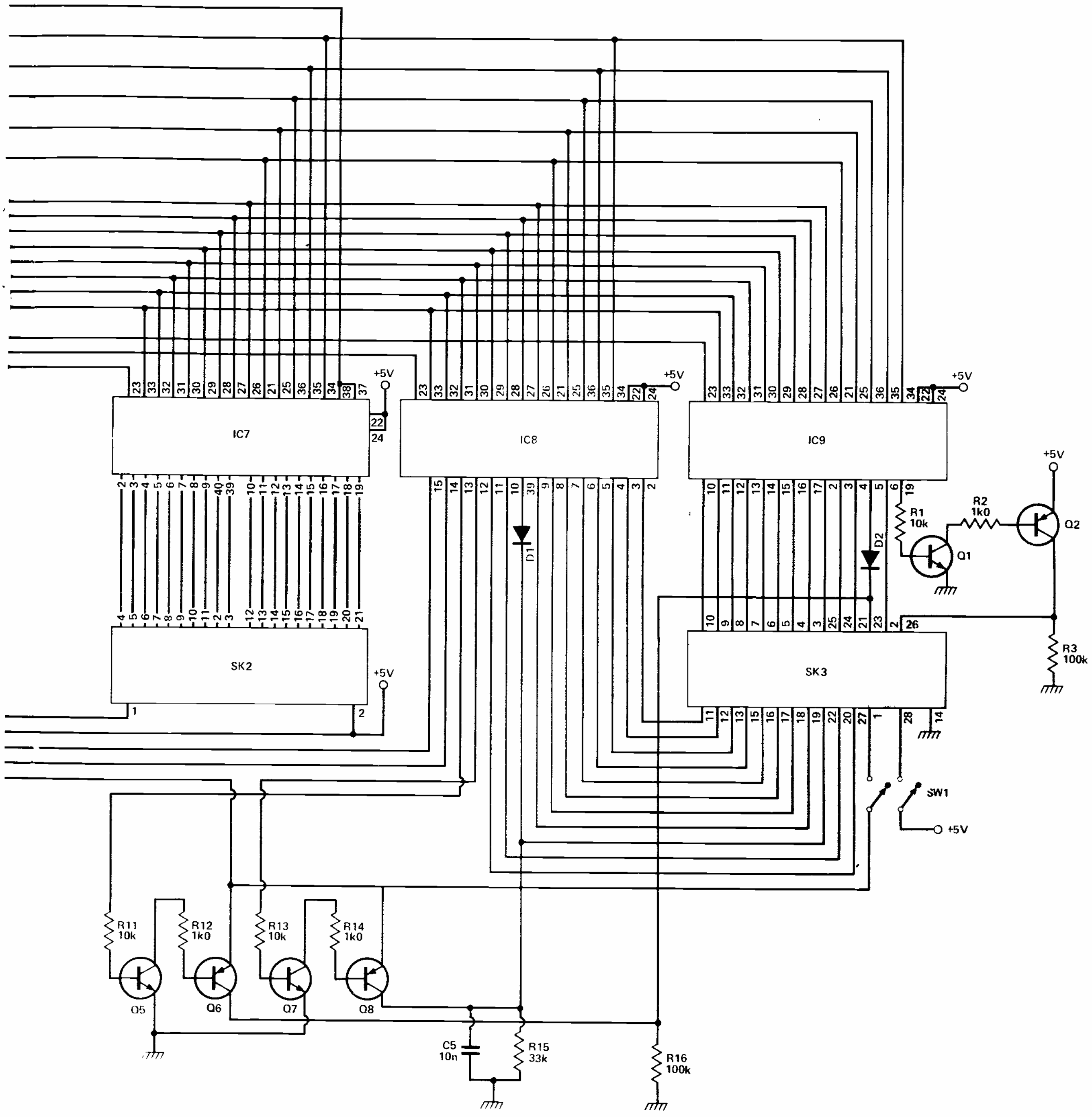
In order to be a useful development tool, the following functions are the minimum requirements of an EPROM programmer:

1. Read data from an EPROM into computer memory;
2. Compare the contents of an EPROM with the contents of computer memory;
3. Test an EPROM for erasure;
4. Program an EPROM from data in computer memory, verifying each byte as it is written.

In fact, some additional functions have also been added and these will be described under the section on using the EPROM programmer.

Table 2 is a mode selection table for all supported devices, showing the read, program, verify and standby modes, these being the modes necessary to implement the

The design is based around four 6821 20-bit PIOs. The circuitry comprising IC3, IC4 and IC5 provides the interface to the Tangerine bus and, in conjunction with the links, allows the board to be configured to occupy a 16-byte block within the 1k I/O area. IC1 and IC2 are used to buffer various signals in order that no more than one TTL load is presented to any bussed input. Of the four 6821s, IC6 and IC7 provide the four independent I/O ports. These being connected to the outside world via SK1 and SK2, whereas IC8 and IC9 are used to drive the EPROM programmer. Most of the signals required to drive the pro-

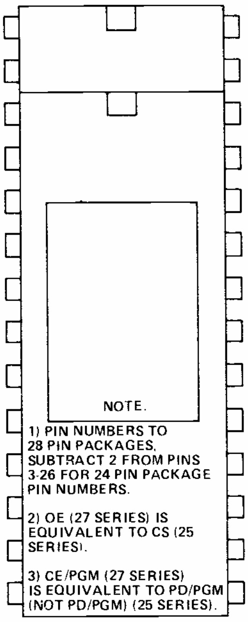


HOW IT WORKS

grammer are TTL levels and are taken directly from the two 6821s to the ZIF socket, SK3. Pin 26 on SK3 is slightly different in that although it is a pure TTL signal on all 28 pin devices, it is the V_{cc} supply on all EPROMs in 24-pin packages and hence requires a much greater current capacity than is available from a port on a 6821. Q1 and Q2 are therefore used to switch the +5 V supply to SK3 pin 26 under the control of IC9/CB2 (pin 19). A similar technique is used to switch V_{pp} onto SK3 pins 22 and 23 using transistor pairs Q5/Q6 and Q7/Q8 respectively. Since these two pins on SK3 are also required to present TTL levels under different conditions, they are also connected to 6821 ports, isolating these signals by use of Germanium diodes D1 and D2 respectively.

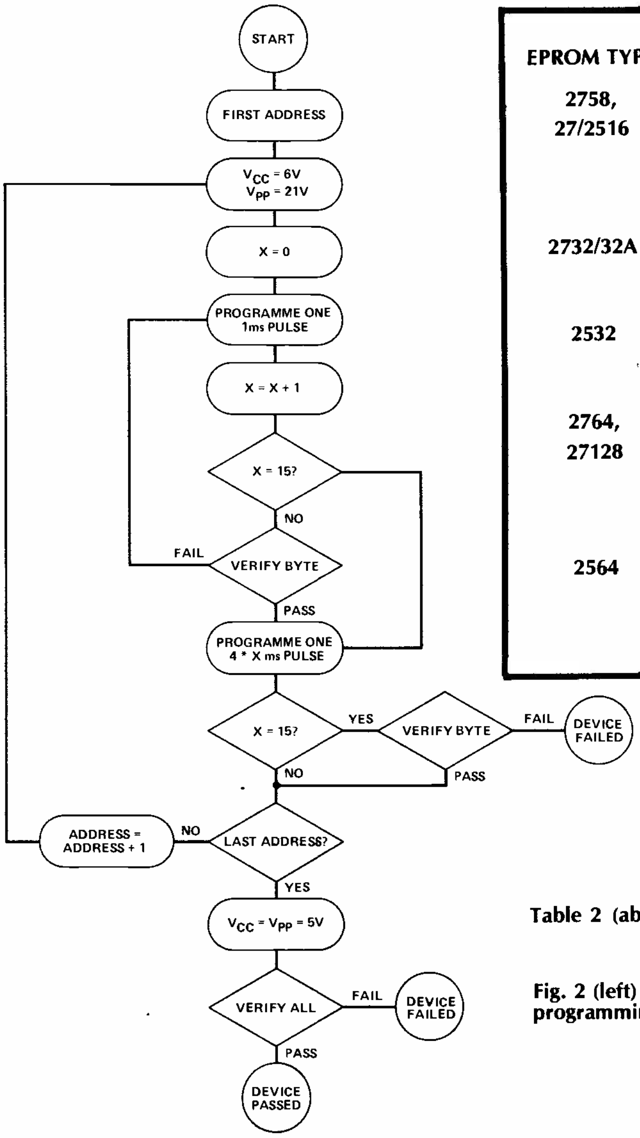
It should be noted that when a 6821 is required to drive a transistor, A 'B' port is used, these having a greater current sourcing capacity than 'A' ports, and when a port needs to be isolated by a diode, an 'A' port is used as these give a full +5 V high signal so that, even allowing for the voltage drop across the diode, a good TTL high is presented. The V_{pp} supply is generated from the +5 V supply using IC11, a 78S40 switching regulator IC, in connection with timing components L1 and C4. Although this component should be capable of regulating V_{pp} to within the required limits, experiments showed that it is advisable to select R7 and R8 such that IC11 would output about +30 V and use a separate LM317MP regulator to give the required voltage. Since V_{pp} may need to be +25 V, +21 V or +5 V, Q3 and Q4 are used, to switch out portions of the resistor chain between the regulator adjust terminal and 0 V hence altering the output voltage. These two transistors are connected to IC8 PB4 and PB5 (pins 14 and 15) hence allowing V_{pp} to be changed under program control.

27 256	27 128	25 64	27 64	25 32	27 32/ 32A	27/ 25 16	27 58	IC/ PIN
VPP	VPP	VPP	VPP					/1
A12	A12	$\overline{CS1}$	A12					/2
A7	A7	A7	A7	A7	A7	A7	A7	1/3
A6	A6	A6	A6	A6	A6	A6	A6	2/4
A5	A5	A5	A5	A5	A5	A5	A5	3/5
A4	A4	A4	A4	A4	A4	A4	A4	4/6
A3	A3	A3	A3	A3	A3	A3	A3	5/7
A2	A2	A2	A2	A2	A2	A2	A2	6/8
A1	A1	A1	A1	A1	A1	A1	A1	7/9
A0	A0	A0	A0	A0	A0	A0	A0	8/10
D0	D0	D0	D0	D0	D0	D0	D0	9/11
D1	D1	D1	D1	D1	D1	D1	D1	10/12
D2	D2	D2	D2	D2	D2	D2	D2	11/13
GND	GND	GND	GND	GND	GND	GND	GND	12/14



IC PIN	27 58	27/ 25 16	27/ 32 32A	25 32	27 64	25 64	27 128	27 256
/28					VCC	VCC	VCC	VCC
/27					$\overline{PGM}$	$\overline{CS2}$	$\overline{PGM}$	A14
24/26	VCC	VCC	VCC	VCC	N/C	N/C	A13	A13
23/25	A8	A8	A8	A8	A8	A8	A8	A8
22/24	A9	A9	A9	A9	A9	A9	A9	A9
21/23	VPP	VPP	A11	VPP	A11	A12	A11	A11
20/22	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$/ VPP	PD/ $\overline{PGM}$	$\overline{OE}$	PD/ $\overline{PGM}$	$\overline{OE}$	$\overline{OE}$
19/21	AR	A10	A10	A10	A10	A10	A10	A10
18/20	$\overline{CE}$/ PGM	$\overline{CE}$/ PGM	$\overline{CE}$	A11	$\overline{CE}$	A11	$\overline{CE}$	$\overline{CE}$
17/19	D7	D7	D7	D7	D7	D7	D7	D7
16/18	D6	D6	D6	D6	D6	D6	D6	D6
15/17	D5	D5	D5	D5	D5	D5	D5	D5
14/16	D4	D4	D4	D4	D4	D4	D4	D4
13/15	D3	D3	D3	D3	D3	D3	D3	D3

Table 1 Pin-outs of all the EPROMs our programmer will process.



			MODE			
EPROM TYPE	FUNCTION	PIN	READ	STANDBY	PROGRAMME	VERIFY
2758, 27/2516	*AR	19	VIL	VIL	VIL	VIL
	$\overline{CE}$/PGM	18	VIL	VIH	VIL→VIH	VIL
	$\overline{OE}$	20	VIL	X	VIH	VIL
	VPP	21	+5 V	+5 V	+25 V	+25 V
2732/32A	$\overline{CE}$	18	VIL	VIH	VIL	—
	$\overline{OE}$/VPP	20	VIL	X	**VPP	—
2532	PD/$\overline{PGM}$	20	VIL	VIH	VIH→VIL	—
	VPP	21	+5 V	+5 V	+25 V	—
2764, 27128	$\overline{CE}$	20	VIL	VIH	VIL	VIL
	$\overline{OE}$	22	VIL	X	X	VIL
	$\overline{PGM}$	27	VIH	X	VIH→VIL	VIH
	VPP	1	+5 V	+5 V	+21 V	+21 V
2564	PD/$\overline{PGM}$	22	VIL	VIH	VIH→VIL	—
	$\overline{CS1}$	21	VIL	X	VIL	—
	$\overline{CS2}$	27	VIL	X	VIL	—
	VPP	1	+5 V	+5 V	+25 V	—

NOTES:
X = DON'T CARE
* AR IS ONLY ON THE 2758
** VPP IS +25 V ON THE 2732, +21 V ON THE 2732A

Table 2 (above) Mode selection table.

Fig. 2 (left) Flowchart for intelligent programming mode.

functions mentioned. It may be noticed that some devices can perform both read and verify. Functionally, these modes are the same but verify is carried out with V_{pp} high, hence simplifying the program/verify process. From this table it may be seen that there is a great deal in common between the various EPROMs, hence simplifying the design of software.

To get the full picture, the timing diagrams of each device should be scrutinised, but for the general user this information is probably not relevant. To summarise, however, EPROMs generally require about 50 ms to program each byte giving total programming times of from around 50 seconds for a 2758 to 13 minutes for a 27256. You may consider these times rather long, especially for the larger devices and although not implemented in the software presented here, there is an alternative programming method referred to as the *intelligent programming mode* which can reduce programming times by a factor of six for the 2764, 27128 and 27256. Figure 2 is a flow diagram of the functions which need to be performed in order to implement this method of prorgramming. Notice that V_{cc} needs to be increased to +6V for this process to be carried out and that there is no provision in the hardware to select this value of V_{cc} under program control. This need present no great problem, however, to the user wishing to implement this mode, as +6v may be switchable from the programming console, perhaps by deriving this voltage from the system +12v supply.

Any additions to, or modifications of the software will need to be made in the light of the information presented in Tables 3 and 4. These may be described as a programmer's view of the EPROM programmer, Table 3 showing the address of each register and Table 4 indicating which bits of the various 6821 ports connect to which EPROM pins or perform the various control functions required.

Construction And Alignment

Although the circuit of the programmer is of sufficient complexity that if it were to be produced commercially it would probably be double sided, it is not so complex that a single sided board would be impossible to design. It was considered that cost would be of prime importance to an amateur building a one-off project, and on these grounds it was artworked as a single-sided board. As a result of this, a number of insulated wire links need to be inserted prior to fitting the components. No special instructions are required on the fitting of components with the exception of socket SK3 and switch SW1. If a separate programming console is to be used, then an ordinary low profile DIL socket should be used as SK3, and two wire links should replace SW1. On the other hand, if the programmer is intended to be self contained on a single board, a zero insertion force DIL socket should be used as SK3 and switch SW1 is needed. Once the construction is complete, the links need to be configured to place the board at the desired address. The offset from the start of the I/O area is 16 times the binary number represented by the links. The best way to illustrate exactly how the links are used is probably graphically; Fig. 3 shows a few examples.

The other part of the circuit which requires setting up is associated with V_{pp} generation. This is very important as EPROMs will be destroyed if V_{pp} is more than 0V5 too high. The best way to check this

Table 3 Register addresses.

FUNCTION	6821 NUMBER	REGISTER	OFFSET FROM BASE
	IC9	DDRA/ORA	00
	IC9	CRA	01
REGISTERS	IC9	DDRB/ORB	02
FOR	IC9	CRB	03
EPROM	IC8	DDRA/ORA	04
PROGRAMMER	IC8	CRA	05
	IC8	DDRB/ORB	06
	IC8	CRB	07
	IC7	DDRA/DRA	08
REGISTERS	IC7	CRA	09
FOR	IC7	DDRB/ORB	10
GENERAL	IC7	CRB	11
PURPOSE	IC6	DDRA/ORA	12
I/O	IC6	CRA	13
PORTS	IC6	DDRB/ORB	14
	IC6	CRB	15

Table 4 Port functions.

6821 NUMBER/ PORT	SK3 PIN NO.	PROGRAMMER FUNCTION
IC9/PB0	10	A0
IC9/PB1	9	A1
IC9/PB2	8	A2
IC9/PB3	7	A3
IC9/PB4	6	A4
IC9/PB5	5	A5
IC9/PB6	4	A6
IC9/PB7	3	A7
IC9/PA0	25	A8
IC9/PA1	24	A9
IC9/PA2	21	A10 (EXCEPT 2758), AR (2758)
IC9/PA3	23	A11 (2732/32A/64/128/256), A12 (2564)
IC9/PA4	2	A12 (2764/128/256), $\overline{CS1}$ (2564)
IC9/CB2	26	A13 (27128/256), VCC (2758/16/32/32A, 2516/32)
IC8/PA0	11	D0
IC8/PA1	12	D1
IC8/PA2	13	D2
IC8/PA3	15	D3
IC8/PA4	16	D4
IC8/PA5	17	D5
IC8/PA6	18	D6
IC8/PA7	19	D7
IC8/CA2	22	$\overline{OE}$ (2758/16/38/32A/64/128/256,2516), PD/$\overline{PGM}$ (2532/64)
IC8/PB0	20	A11 (2532/64), $\overline{CE}$/PGM (2758/16, 2516), $\overline{CE}$ (REMAINDER)
IC8/PB1	27	$\overline{PGM}$ (2764/128), $\overline{CS2}$ (2564), A14 (27256)
IC8/PB2	22	VPP (2732/32A)
IC8/PB3	23	VPP (2758/16, 2516/32)
IC8/PB4	—	VPP +5V SELECT*
IC8/PB5	—	VPP +21V SELECT*
		*NOT (VPP+5) AND NOT (VPP+21V) = +25V SELECT

is with a voltmeter probe on the output of IC2, with IC8 removed from its socket. Apply +5 V to pin 14 of the IC8 socket and adjust RV3 until +5 V is recorded on the test meter. Now replace +5 V on pin 14 by +5 V on pin 13 of IC8 socket and adjust RV2 for +21 V on the meter. Finally, remove +5 V from pin 13 of IC8 socket and adjust RV1 for a potential of +25 V at IC2 output. Setting up is now complete.

Using The Programmer

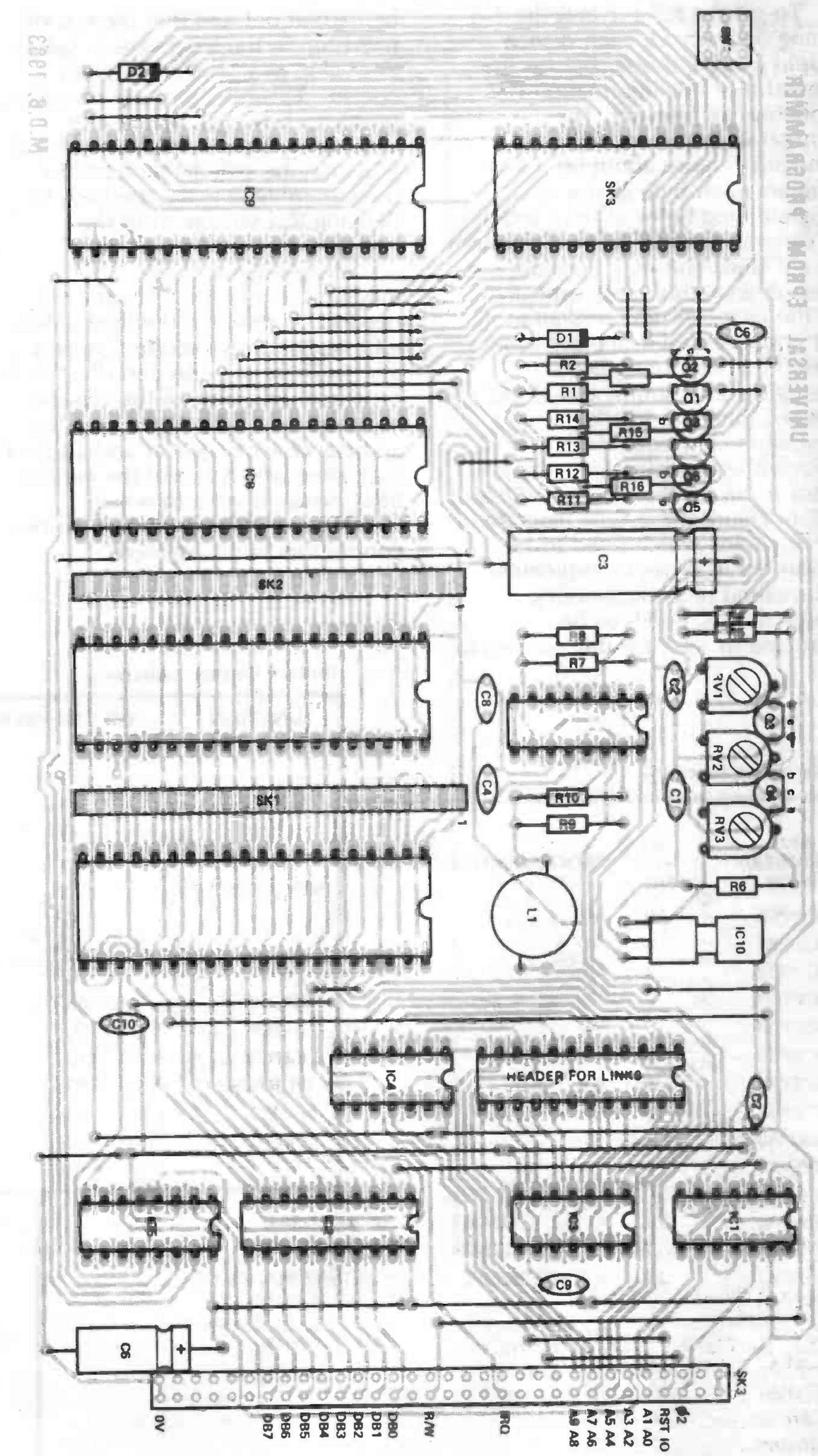
The first stage in using the EPROM programmer is to load and run the support package software which is written in BASIC and assembly code. The user will first be prompted for EPROM type, valid responses being 2758, 2716, 2516, 2732, 2732A, 2532, 2764, 2564 and 27128. A request for a base address will then be made and the user should respond with a four-figure hexadecimal number. The base address is the address relative to which all references to computer internal memory are made and this means that the user does not need to be concerned with the actual absolute addresses in computer memory. The reasons for being able to select the base address are two fold. Firstly, to fit in with the memory map of any computer on which the software may be run and, secondly, to allow more than one set of data to be maintained at one time by using different base addresses. A table showing all the commands available will the be printed before the *? prompt appears on the screen. When this prompt indicates that the program is waiting for input of a command, it is safe to insert or remove EPROMs from the ZIF socket, provided, of course, that the isolating switch is in the OFF position for 28 pin devices.

The following describes the function of the EPROM programmer support package commands. It should be noted that in each case, either the whole word or the initial letter may be used:-

(N)EW, (B)ASE These two commands cause the user to be prompted for a new EPROM type or a new base address respectively, hence allowing these two parameters to be altered without exiting and re-running the program.

(T)EST This performs a test on the EPROM, reporting whether or not it has been erased.

(R)EAD, (P)ROGRAMME, (V)ERIFY These commands cause the user to be prompted for start and finish addresses which should be entered as two four-figure hexadecimal numbers separated by a comma. These addresses define the portion of the EPROM to be used and also the portion of computer internal memory into which data will be written for a read operation or from which data will be read for program or verify operations. The computer addresses are offset from the base address. In program and verify, any discrepancies between EPROM and computer memory will be reported. Such discrepancies will be printed, one per line, stopping after every 16 lines. Pressing return at this point will return to the *? prompt, whereas pressing any other key will



Overlay diagram of the programmer.

PARTS LIST

RESISTORS (all ¼W 5% unless stated)

R1, 11, 13	10k
R2, 12, 14	1k0
R3, 16	100k
R4, 5	5k1
R6	240R
R7	15k
R8	680R
R9	0R22 wire wound
R10	180R, 1W
R15	33k
RV1, 3	2k2 min horizontal preset
RV2	4k7 min horizontal preset

CAPACITORS

C1	1u 35 V axial electrolytic
C2, 7, 8, 9, 10	100n ceramic
C3	470u 35 V axial electrolytic
C4	4n7 polyester
C5	10n ceramic
C6	100u 6V3 axial electrolytic
C10	10n ceramic

SEMICONDUCTORS

IC1	74LS126
IC2	74LS245
IC3	74LS04
IC4	74LS30
IC5	74LS138
IC6, 7, 8, 9	MC6821 (or similar)
IC10	LM317M
IC11	78S40
Q1, 3, 4, 5, 7	BC184L
Q2, 6, 8	BC214L
D1, 2	OA91

MISCELLANEOUS

L1	34 turns 24 swg wire on RM6 pot core (AL = 250)
SK1, 2	0.1" pitch 22-way male molex connectors (or shorter ones made up to required length)
SK3	28 pin zero insertion force socket (or ordinary socket is console is used, see text)
SW1	two pole single throw switch (omit if using console)

One 16-way and one 80-way DIL headers and sockets; edge connector (2 × 32-way A + B DIN Euro connector, male angled pins, for Tangerine) PCB, wire, etc.

continue the programming or verification.

(L)IST, (M)ODIFY These commands probably duplicate facilities available in the computer monitor but are included here to allow minimum changes to be made to computer memory or data to be checked without the need to exit from this package. LIST will request start and finish addresses and will list on the screen the addresses and data of the portion of memory requested, offset from the base address. The listing will stop after every 16 lines at which point pressing return will exist to the *? prompt, whereas pressing any other key will continue with the listing.

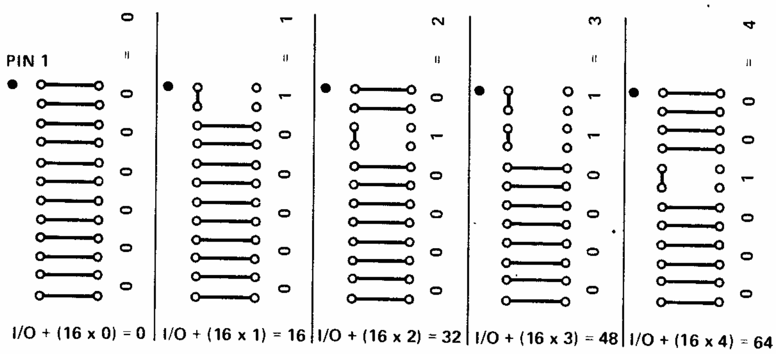


Fig. 3 Setting the address offset by wire links.

MODIFY will prompt for a single address, the contents of the base address offset by the value given being displayed on the screen. Entering an X at this point will return to the *? prompt leaving the data in that location unchanged, whereas entering a two-figure hexadecimal number will cause the relevant address to be updated with the data entered.

(H)ELP Lists all the commands available and reminds the user of the currently selected EPROM type and base address.

(E)XIT Causes the program to terminate.

In the above commands, any wrongly entered information will result in self-explanatory error messages. The one error message which, perhaps, requires a word of explanation is TYPE/RANGE INCOMPATIBLE. This error is a result of entering a start and finish address to any command which defines a range larger than the capacity of the selected EPROM type.

Erasing EPROMs

EPROMs are erased by exposure to ultra-violet light through the transparent window on the top of the package. Small commercially available erasing units with capacities of up to six chips cost typically in the £40-£50 region. If the requirements for erasing EPROMs are considered, it becomes obvious that an erasing unit can be constructed for considerably less than the price of commercial equipment. The requirements stated by EPROM manufacturers to erase such a device are a 20 to 30 minute exposure of 2357 A (253.7 nm) wavelength ultra-violet light at an intensity of 12000 uW/cm^2. The Philips TUV 15 W tube emits UV at the required wavelength and at an intensity of 37 uW/cm^2 at about one inch from the tube, the distance metre from the tube, which corresponds to about 12000 uW/cm2 at a distance of one inch, as used in most EPROM erasers.

The tube costs in the region of £10 and will fit into an ordinary 15 " fluorescent light fitting, it provides the basis for a relatively inexpensive unit which could accommodate about ten ICs.

A few words of caution are appropriate at this point. Ultra-violet radiation, and in particular shortwave UV as emitted by the TUV 15 W, is harmful to both the eyes and the skin. It is therefore essential to build the tube into a light-tight cabinet, ideally with a micro switch fitted under the lid to isolate the supply when opened, which will prevent UV light from coming into contact with skin or eyes.

EPROMs may also be erased by UV of longer wavelength (3000 A - 4000 A) although longer exposure times will probably be required. Since 'black light' tubes of the type used for disco lighting emit at about 3500 A and are more easily available than short-wave UV tubes, it may be worthwhile experimenting with this type of light source.

One final point on the topic of erasing EPROMs is that both sunlight and ordinary fluorescent tubes emit some radiation in the 3000 A - 4000 A region with the result that prolonged exposure to these light sources will result in erasure. For this reason it is recommended that an opaque adhesive label is used to cover the windows of programmed EPROMs.

Next month, we'll describe the software for the unit. **ETI**

BUYLINES

There should be relatively few problems in obtaining components for this project. The 0.22R resistor can be found in several suppliers' lists, including Watford's. The RM6 potcore is available from RS Components.

our PCB service — see page 77 for details.

electronics today international

BOOK SERVICE

How to order: indicate the books required by ticking the boxes and send this page, together with your payment, to: ETI Book Service, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC2 0EE. Make cheques payable to ETI Book Service. Payment in sterling only please. All prices include P & P. Prices may be subject to change without notice.

BEGINNERS GUIDE

- ☐ **Beginner's Guide to Basic Programming** Stephenson £5.35
- ☐ **Beginner's Guide to Digital Electronics** £5.35
- ☐ **Beginner's Guide to Electronics** £5.35
- ☐ **Beginner's Guide to Integrated Circuits** £5.35
- ☐ **Beginner's Guide to Computers** £5.35
- ☐ **Beginner's Guide to Microprocessors** £5.35

COOKBOOKS

- ☐ **Master IC Cookbook** Hallmark £10.15
- ☐ **Microprocessor Cookbook** M. Hordeski £7.70
- ☐ **IC Op Amp Cookbook** Jung £14.25
- ☐ **PLL Synthesiser Cookbook** H. Kinley £7.70
- ☐ **Active Filter Cookbook** Lancaster £13.40
- ☐ **TV Typewriter Cookbook** Lancaster £11.15
- ☐ **CMOS Cookbook** Lancaster £11.85
- ☐ **TTL Cookbook** Lancaster £10.95
- ☐ **Micro Cookbook Vol. 1** Lancaster £15.30
- ☐ **BASIC Cookbook** K. Tracton £6.00
- ☐ **MC6809 Cookbook** C. Warren £7.25

ELECTRONICS

- ☐ **Principles of Transistor Circuits** Amos £8.50
- ☐ **Design of Active Filters with experiments** Berlin £11.30
- ☐ **49 Easy to Build Electronic Projects** Brown £6.00
- ☐ **Electronic Devices & Circuit Theory** Boylestad £13.20
- ☐ **How to build Electronic Kits** Capel £3.55
- ☐ **How to Design and build electronic instrumentation** Carr £9.35
- ☐ **Introduction to Microcomputers** Daglecs £7.20
- ☐ **Electronic Components and Systems** Dennis £15.00
- ☐ **Principles of Electronic Instrumentation** De Sa £11.40
- ☐ **Giant Handbook of Computer Software** £12.95
- ☐ **Giant Handbook of Electronic Circuits** £17.35
- ☐ **Giant Handbook of Electronic Projects** £11.75
- ☐ **Electronic Logic Circuits** Gibson £5.55
- ☐ **Analysis and Design of Analogue Integrated Circuits** Gray £30.25
- ☐ **Basic Electronics** Grob £11.30
- ☐ **Lasers – The Light Fantastic** Hallmark £7.70
- ☐ **Introduction to Digital Electronics & Logic** Joynson £5.25
- ☐ **Electronic Testing and Fault Diagnosis** Loveday £7.85
- ☐ **Electronic Fault Diagnosis** Loveday £6.25
- ☐ **Essential Electronics A-Z Guide** Loveday £7.50
- ☐ **Microelectronics Digital & Analogue circuits and systems** Millman £12.70
- ☐ **103 Projects for Electronics Experimenters** Minis £8.30
- ☐ **VLSI System Design** Muroga £34.10
- ☐ **Power FETs and their application** Oxner £9.40
- ☐ **Practical Solid State Circuit Design** Olesky £25.00
- ☐ **Master Handbook of IC Circuits** Powers £12.85
- ☐ **Electronic Drafting and Design** Raskhodoff £22.15
- ☐ **VOM – VTVM Handbook** Risse £8.50
- ☐ **Video and Digital Electronic Displays** Sherr £28.85
- ☐ **Understanding Electronic Components** Sinclair £7.50
- ☐ **Electronic Fault Diagnosis** Sinclair £4.50
- ☐ **Physics of Semiconductor Devices** Sze £17.35
- ☐ **Digital Circuits and Microprocessors** Taub £32.00
- ☐ **Active Filter Handbook** £7.60
- ☐ **Designing with TTL Integrated Circuits** Texas £15.20
- ☐ **Transistor Circuit Design** Texas £15.20
- ☐ **Digital Systems: Principles and Applications** Tocci £12.95
- ☐ **Master Handbook of Telephones** Traister £10.00
- ☐ **How to build Metal/Treasure Locators** Traister £6.00
- ☐ **99 Fun to Make Electronic Projects** Tymony £8.50
- ☐ **33 Electronic Music Projects you can build** Winston £6.95

COMPUTERS & MICROCOMPUTERS

- ☐ **BASIC Computer Games** Ahl £6.35
- ☐ **From BASIC to PASCAL** Anderson £9.95
- ☐ **Mastering Machine Code on your ZX81** T. Baker £7.25
- ☐ **UNIX – The Book** Banaham £8.75
- ☐ **Z80 Microcomputer Handbook** Barden £10.95
- ☐ **Microcomputer Maths** Barden £11.90
- ☐ **Digital Computer Fundamentals** Barter £9.90
- ☐ **Visicalc Book. APPLE Edition** Bell £15.55
- ☐ **Visicalc Book. ATARI Edition** Bell £15.55
- ☐ **Introduction to Microprocessors** Brunner £23.00
- ☐ **Programming your APPLE II Computer** Bryan £9.25
- ☐ **Microprocessor Interfacing** Carr £7.70
- ☐ **Microcomputer Interfacing Handbook A/D & D/A** Carr £9.50
- ☐ **Musical Applications of Microprocessors** Chamberlain £28.85
- ☐ **30 Computer Programs for the Home Owner in BASIC** D. Chance £9.25
- ☐ **Microcomputers** Dirkson £9.30
- ☐ **APPLE Personal Computer for Beginners** Dunn £9.50
- ☐ **Microcomputers/Microcomputers – An Intro** Gioone £11.80
- ☐ **Troubleshooting Microprocessors and Digital Logic** Goodman £9.25
- ☐ **Getting Acquainted with your VIC 20** Hartnell £8.50
- ☐ **Getting Acquainted with your ZX81** Hartnell £5.95
- ☐ **Let your BBC Micro Teach you to program** Hartnell £7.90
- ☐ **Programming your ZX Spectrum** Hartnell £8.50
- ☐ **The ZX Spectrum Explored** Hartnell £6.95
- ☐ **How to Design, Build and Program your own working Computer System** Haviland £9.30
- ☐ **BASIC Principles and Practice of Microprocessors** Heffer £7.15
- ☐ **Hints and Tips for the ZX81** Hewson £5.25
- ☐ **What to do when you get your hand on a Microcomputer** Holtzman £9.95
- ☐ **34 More Tested Ready to Run Game Programs in BASIC** Horn £7.70
- ☐ **Microcomputer Builders' Bible** Johnson £12.40
- ☐ **Digital Circuits and Microcomputers** Johnson £14.55
- ☐ **PASCAL for Students** Kemp £7.20
- ☐ **The C – Programming Language** Kernighan £18.20
- ☐ **COBOL** Jackson £9.25
- ☐ **The ZX81 Companion** Maunder £9.50
- ☐ **Guide to Good Programming Practice** Meek £6.40
- ☐ **Principles of Interactive Computer Graphics** Newman £13.95
- ☐ **Theory and Practice of Microprocessors** Nicholas £11.35
- ☐ **Exploring the World of the Personal Computer** Nilles £12.95
- ☐ **Microprocessor Circuits Vol. 1. Fundamentals and Microcontrollers** Noll £9.80
- ☐ **Beginner's Guide to Microprocessors** Parr £5.35
- ☐ **Microcomputer Based Design** Peatman £11.30
- ☐ **Digital Hardware Design** Peatman £9.80
- ☐ **BBC Micro Reavealed** Ruston £9.45
- ☐ **Handbook of Advanced Robotics** Safford £14.45
- ☐ **1001 Things to do with your own personal computer** Sawusch £8.50
- ☐ **Easy Programming for the ZX Spectrum** Stewart £7.15
- ☐ **Microprocessor Applications Handbook** Stout £34.40
- ☐ **Handbook of Microprocessor Design and Applications** Stout £37.60
- ☐ **Programming the PET/CBM** West £17.80
- ☐ **An Introduction to Microcomputer Technology** Williamson £8.20
- ☐ **Computer Peripherals that you can build** Wolfe £12.40
- ☐ **Microprocessors and Microcomputers for Engineering Students and Technicians** Wooland £7.10

REFERENCE BOOKS

- ☐ **Electronic Engineers' Handbook** Fink £56.45
- ☐ **Electronic Designers' Handbook** Giacoletto £59.55
- ☐ **Illustrated Dictionary of Microcomputer Technology** Hordeski £8.45
- ☐ **Handbook for Electronic Engineering Technicians** Kauffman £27.50
- ☐ **Handbook of Electronic Calculators** Kauffman £35.00
- ☐ **Modern Electronic Circuit Reference Manual** Marcus £44.00
- ☐ **International Transistor Selector** Towers £10.70
- ☐ **International Microprocessor Selector** Towers £16.00
- ☐ **International Digital IC Selector** Towers £10.95
- ☐ **International Op Amp Linear IC Selector** Towers £8.50
- ☐ **Illustrated Dictionary of Electronics** Turner £12.95

VIDEO

- ☐ **Servicing Home Video Cassette Recorders** Hobbs £12.95
- ☐ **Complete Handbook of Videocassette Recorders** Kybett £9.25
- ☐ **Theory and Servicing of Videocassette Recorders** McGinty £12.95
- ☐ **Beginner's Guide to Video** Matthewson £5.35
- ☐ **Video Recording: Theory and Practice** Robinson £14.40
- ☐ **Video Handbook** Van Wezel £21.90
- ☐ **Video Techniques** White £12.95

Please send me the books indicated. I enclose cheque/postal order for £.......... Prices include postage and packing
I wish to pay by Access/Barclaycard. Please debit my account.

5	2	2	4												

4	9	2	9												

Signed..

Name..

Address..

....

....

READ/WRITE

Hyconomiser

Dear Sir,

I have been a more or less regular reader of ETI since its inception and I think generally you do a pretty good job; however, you have now made a serious error by recommending a product which you are not really qualified to pronounce upon. I refer to the feature on the Hyconomiser in your June issue.

If, instead of questioning the garages involved in selling the device, who you must admit have a vested interest, you had spoken to a recognised authority on the subject, I am sure you would have been told not to waste your time on it, and certainly not to give any recommendation. Talking to garage mechanics about engine fuelling and exhaust emission technology (a subject not far behind aerospace and electronics for expenditure and complexity) is rather like asking an electrician to comment on the latest microprocessor.

For many years, including a number as a senior development engineer at Jaguar Cars, fuel economy had been a specialist subject of mine and devices such as the Hyconomiser invariably come my way for appraisal. In fact, two or three years ago this device was being marketed as the PED with a rather different story behind it. I enclose a copy of the advertising material relevant to that incarnation which you will see employs the same diagram you reproduced. In an attempt to win me over I was visited by the alleged inventor of the device, a certain Canadian called Andrew MacGuire, and was presented with an impressively thick report, produced in the USA, purporting to show how effective it was. To the uninitiated it was most convincing but on close examination most of the tests were based on unrealistic baseline figures, in one case an exhaust CO level of 8% (a vastly over-rich condition) was used as a basis for comparison. I still have a copy of the report if you should wish to see it.

Whilst it may be that your reviewer obtained a measurable improvement after fitting the device, any air bleed into the inlet manifold (which in essence is what the Hyconomiser is) will have a mixture weakening effect more or less compensating for wear of the carburettor metering orifice. For the car in question a new carburettor, or even simply replacing the metering needle costing about £3, would undoubtedly have shown similar, if not better gains. In any event the only way to test a device such as this is under carefully controlled conditions and even then so many variables can be involved that results are likely to have a spread of 10% or so.

As for the claim that fuel droplets are broken up with sonic waves generated by three pulsating balls, if you believe that I would also expect you to look for fairies at the bottom of your garden. For sonic waves to pulverise fuel droplets it is necessary for a large amount of energy to be expended in shearing the mixture and even then economy gains are unlikely to exceed 10%.

The claim that the device maintains the air/fuel ratio close to stoichiometric is quite unfounded. If you can find out how this is achieved pleased let me know — nobody has been able to explain to me how it can happen.

Finally, if a device such as this was able to offer the improvements claimed, the motor manufacturers would be already using it rather than running multi-million pound retooling programmes to obtain relatively modest gains, and electronic engine management systems (surely a more appropriate subject for you to become involved in) would be unnecessary.

If you wish to maintain the high reputation of your magazine I think you would be well advised to print a retraction on the subject as soon as possible.

Yours faithfully
Roger Bywater
Roger Bywater Engineering Ltd
Stockport
Cheshire

The author replies:

Much more about the Hyconomiser, its inventor and history was known to me before undertaking the review, but my brief from the editor was to confine the report to 1,000 words so much had to be omitted. The device reduces pollution as well as effects fuel economy. In Canada where it was first produced, pollution control is of greater interest than economy because of government controls, hence it was called the PED., (Pollution Elimination Device). Out of 400 devices tested by the American Environmental Protection Agency, the PED came out first. To the British motorist economy is the more important factor, hence the change of name. There is nothing sinister in that.

Mr Bywater scorns the idea that sonic waves produced by plastic balls can break up fuel droplets. Perhaps he would likewise scorn the suggestion that a piece of flapping paper could permanently damage scores of human eardrums at a range of many yards, yet if he would visit his nearest disco he will find loudspeaker cones doing just that. It is the power actuating the medium, not the medium itself that is important. Here, the power is provided by the vacuum generated by the engine intake or induction stroke. If this has sufficient power to atomise fuel from the carburettor in the first place why should it be insufficient to complete the job by means of the Hyconomiser?

The balls are in fact tuned to resonance, and when resonating any physical object is capable of high amplitude oscillation which can even be destructive, as any student of mechanical stress engineering would know. The effect has in fact been observed in tests carried out by a motor manufacturer. An intake manifold with transparent quartz window was assembled to a production engine. With normal running, drops of fuel could be seen coursing the over the inside surfaces to be ejected with the exhaust, but when Hyconomiser was switched in by a control valve, the drops instantly vaporised into a mist. Special rapid-exposure photographic techniques and precision measurements revealed the particle size to be in the region of eight microns.

The motor manufacturer, (a well-known name that I cannot reveal at present) will in fact be using the Hyconomiser in future production models. It has not been used before because car design and planning is usually at least three years ahead of current production. Other manufacturers are actively considering it.

Mr Bywater's assertion that my economy figures were due to a leaner mixture produced by bleeding air past the carburettor can be refuted on two counts. First, the carburettor mixture setting must be made slightly richer before fitting the Hyconomiser to compense for the extra air thus restoring the correct air/fuel ratio. Se-

cond, when the device went off tune for reasons described in my review, the consumption climbed to its former figure. On re-tuning, the economy returned. According to Mr Bywater tuning should have made no difference as air was still passing through. He alleges that the air bleed merely neutralizes wear in the fuel needle and orifice of the carburettor, and that a replacement would have the same result. However, the device has been fitted to brand new cars with notable economy improvements.

The 8% CO emission figure he complains of does indeed represent an abnormally rich mixture, some 9:1 air/fuel ratio. However, this was merely the starting point of a graph plot which shows the comparative CO emissions with and without the Hyconomiser, over a wide range of mixtures from 9:1 to 20:1. You have to start a plot somewhere, usually it is best to do so outside of the area of intersst so that a complete picture is presented.

As to the question as to how the stoichiometric (optimum) 14.6:1 ratio is maintained by the device, this is done firstly by improved atomisation and distribution of fuel. Thus the anomalies of lean and rich areas in different cylinders and parts thereof are avoided. Secondly, the lowest ball in the Hyconomiser seats against its exit orifice. This expands and contracts according to the vacuum in the inlet manifold and so controls the airflow. Thereby the amount of air, hence mixture ratio, varies in response to engine speed and throttle setting, so compensating for the mixture vagarities produced by the carburettor under differing conditions.

Garages who fit the Hyconomiser may indeed, as Mr Bywater says, have a vested interest, but not of the sort he insinuates. All those I contacted were reputable main-agent establishments with large factory-trained staffs and the latest in elecronic tuning and diagnostic equipment. Their vested interest is in their reputation which would soon be in tatters if they fitted rubbish that didn't work. As the proprietor of a fuel injection and economy development company, may I suggest that HE is the one that has a vested interest in knocking the Hyconomiser!

Vivian Capel.

We doubt whether we have heard the last of this topic. For those of you still sending us missives by various means, the Hyconomiser is now made under licence by: Atwell Construction Ltd, Station Road, Wrington, Avon, Tel: Bristol 719441.

Compact Disc

Dear Sir,

The article in your May '83 issue concerning recommended high-quality turntable systems was punctuated by a small section on the new Compact Disc format. As the author observes, 'in about a year' CD players will be altogether affordable, probably considerably cheaper than specialist analogue turntables and therefore likely to oust them on grounds of both performance and value. At that time, second hand (one year old), once-expensive analogue players would presumably be demoted to duties such as door-stopping or pot-throwing in view of their likely marketability. I would therefore query the advisability of any recommendation to buy high quality analogue disc equipment.

Of course, my premis in such a sweeping statement is that CD will be a vastly superior format, bringing me onto my second beef; why so little space for such an important breakthrough, about which plentiful information has been distributed in advance certainly to many Hi-Fi magazines who have seen fit to publish reports on the subject? Now I would not expect you to give a high priority to reporting on Hi-Fi matters normally, though surely the presence of an audio article anyway might have been used to better advantage.

I would certainly be interested to know what levels of fidelity are claimed for the pressing and then optimal reading of vinyl discs so that these could be compared with the plentiful information available for digital format.

The world of audio performance assessment has become altogether cluttered with highly subjective judgement. Hi-Fi magazines persist in, what seems to me, the odious convention of allowing poets with 'golden ears' to subjectively assess nebulous qualities, transferring little hard information to the reader. For reference, it would be interesting to see, published alongside a reviewer's observations, the rèsults of a thorough hearing test performed on him at a relevant time. Could controlled levels of distortion, on identical pieces of recorded music, be used to test a 'golden auditor's' true calibration?

Personally, I find it difficult to give more credence to the doubtless limited-bandwidth response of ageing reviewers than laboratory test equipment. Admittedly, standards of distortion measurement are confusing, and it is not sufficiently relevant to music reproduction to be testing pure tones, but why not simply compare 'scope photos of microphone signals at the recording studio with the ultimate, played-back signal from analogue and digital discs? Could such a test be arranged or would vested interests prevent it?

An article devoted to bringing more rigour into Hi-Fi assessment along these lines would certainly have my fullest attention, and should not be irrelevant to the aims of your magazine, since it would not labour the subject of the Hi-Fi market or the present state of the manufactured art, but would deal rather with 'transduction'.

Yet more relevant, of general interest and, as yet, unreported (to my knowledge) would be an investigation of the digital disc format and its protocol; how are the discs manufactured, what is this error correction business? Would it be at all possible to produce an alternative erasible and programmable, ideally compatible, optical recording system, perhaps by populating a disc fully with reflective logic cells but positioning an optically switchable window in front of each?

Presumably it is the variability in performance of D-to-A convertors that accounts for the present variability in CD player performance. Would it be conceivably possible to delay the mapping to as late a stage as possible, having a (perhaps integral) D-to-A power output stage, or is the process of amplification (and transduction) best left to conventional analogue techniques? An acquaintance has described to me his attempts to make a digital switching amplifier. (A-to-D-to-A), but, presumably digital speakers could not successfully operate composed of an array of switching drivers, (one twice the size of the next) whilst the idea of linear stepper motors attached to conventional diaphragm(s) would seem unrealistic.

Any ideas?
Yours faithfully
Mr P.E. Cox
Derby

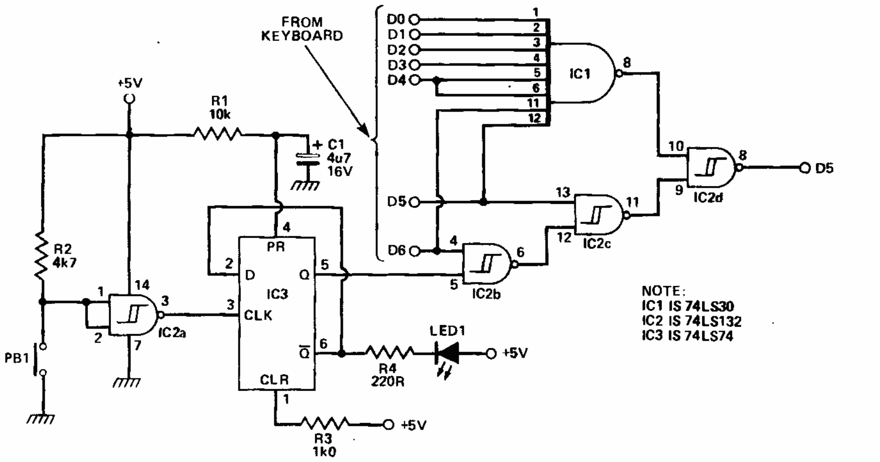
Mr Cox raises far too many points for us to answer in the space available! Suffice to say that CD will not make analogue players obsolte because there will still be a lot of analogue discs around for many years to come. We'll obviously be reporting further on CD in the future.

ETI

TECH TIPS

Keyboard Alphanumeric Lock Switch

G. Franklin, Mid Glamorgan



If your ASCII keyboard is like mine, then you too will have become tired of having to press 'SHIFT' for capital letters. SHIFT lock is useless because you have to 'unlock' to use the numbers. This circuit does away with this problem by providing you with yet another key to press. This is the 'ALPHA LOCK' switch.

If you study the ASCII codes you will find that to change 'a' into 'A' requires only the removal of the logic '1' on the data bit 5 line (of the 8 bit bus from the keyboard to your computer).

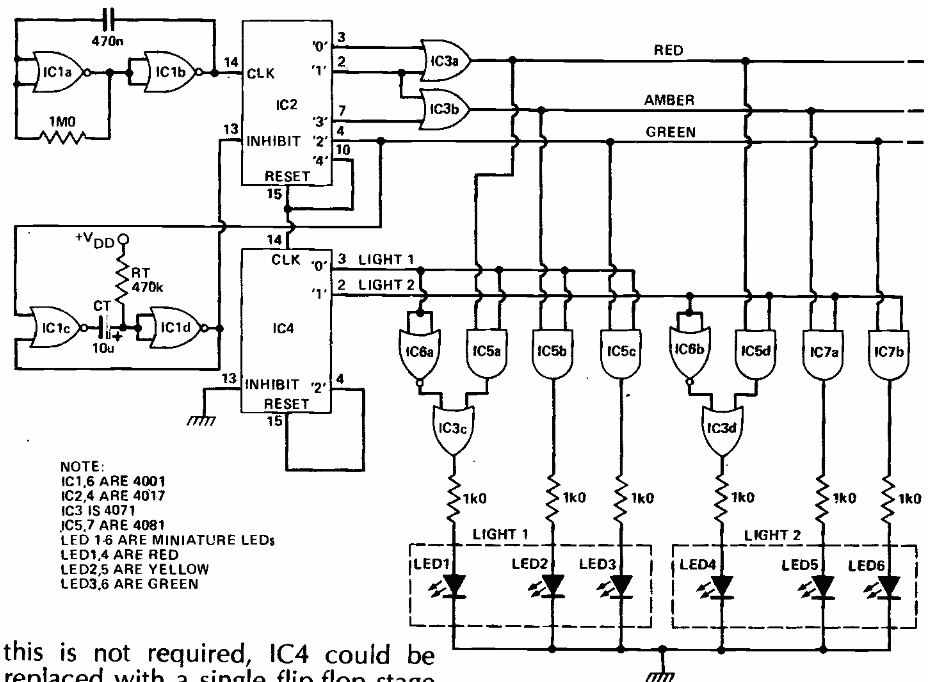
e.g.:—	a	A
ASCII code	$61	$41
in binary:-	0110 0001	0100 0001

We require to alter the complete alphabet, this stretches from a ($61) to z ($7A). The circuit cheats slightly, by altering codes $60 to $7F inclusive, the only problem with this is that $7F is the ASCII code for 'DELETE'. IC1 deals with this, by detecting the $7F code and making sure D5 stays at a logic 1 via the NAND gate at the end of the circuit.

One quarter of the 74LS132 is used to give a degree of switch bounce to S1. Every time S1 is pressed, the Q output of the latch (IC 3) will change, R1 and C1 ensure that on power-up the output is at a logic 1. This, along with data bit 6 being 'HIGH' will make D5' a 'LOW', thus shifting a $60 code down to $40 (unless of course it was the 'DELETE' key that was pressed). The LED will come on to show when the ALPHA mode is selected. To insert this circuit into your keyboard, it is only necessary for D5 to come via this circuit, D5' then continuing in its place to the computer, the other data lines just connect to the circuit. The only other requirement is that you insert a switch somewhere.

Controller For Model Traffic Lights

P. Bailey, Glasgow



The circuit shown was devised to control LED traffic lights at a road junction in a model railway layout, for added realism. IC2, a decade counter, together with IC3a and IC3b, generates the normal traffic light sequence continuously at a rate determined by the oscillator formed around IC1a and IC1b. A monostable formed by IC1c and IC1d is triggered by a '1' on the 'GREEN' output, and inhibits IC2 for a period set by C_T and R_T, thus causing the green light to be on for a longer period than the others.

IC4 selects either LIGHT 1 or LIGHT 2 to display the sequence, these being selected alternately. When one light is changing or at green, the other is held at red.

The controller is easily expanded to operate more than two lights by using further outputs from IC4, but if this is not required, IC4 could be replaced with a single flip-flop stage (eg a 4013), set to toggle, LIGHT 1 and LIGHT 2 being connected to the Q and $\overline{Q}$ outputs respectively. With a little ingenuity, realistic-looking traffic lights can be constructed from miniature LEDs and empty pen refill tubes.

ETI

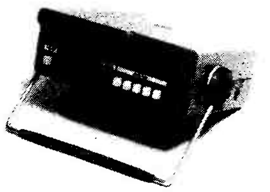
hi! performance hi! competitive hi!

FULL HOUSE OF MULTIMETERS

TRIO

Bench Models DL 705, 706, 720 and DF 760

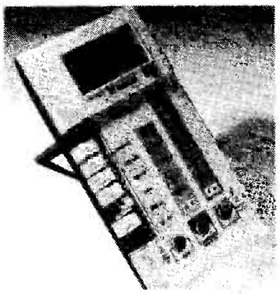
- 3½ and 4½ digit LED
- Rugged and Reliable
- 2 YEAR GUARANTEE
- Simple Operation – Auto Ranging
- Mains or Battery
- 7 Digit Frequency Counter
- Resolutions 1 and 0.1 mV
- DCV, ACV, DCA, ACA and Ohms
- Basic accuracy 0.8, 0.25, 0.1 and 0.05%
- Prices from just over **£100** includes FREE Batteries, Hand Book and Test Leads



HC

Hand Held Models HM101 and 102 Series, HC 601, 703, 6010 and 7030.

- 3½ digit LCD and Analogue
- Colour coded front panel and edge switches
- High impact ABS with Tilt stand
- Safety features meets UL 1244
- Basic accuracy 0.6 and 0.2%
- Full Range of DCV, ACV, DCmA, ACmA and Ohms
- Audio Continuity Tone Plus 10A capability.
- Switched HI and LO ohms
- FREE Battery, Manual and Test Leads
- Analogue from approx **£6** – Digital from approx **£34**



BBC GOERZ METRAWATT

MA1H, 2H, 3E and 5D. M2011, 2012, 2030, 2031 and 2032. Unigor 3N.

- Digital and Analog – Hand Held and Bench
- Huge LCDs – Many Safety Features
- Black, Rugged and Reliable
- 1 Year Guarantee
- 3½ and 4½ Digits
- Variable Viewing Angle – Hand free operation
- 20 Amp capability
- DCV, ACV, DCA, ACA, Ohms, Capacitance, Temp and Level in dBs
- Meet DIN 40050, 43780, 57410 or 57411 Requirements
- Prices from approx **£27** includes FREE Batteries, manual and Test Leads

MIC

Hand Held Models 6000Z and 3300A

- 3½ digit LCD with easy single rotary control.
- 10 Amp., 1000V and 20M ohm capability.
- TRANSISTOR hFE measurement.
- Audible Continuity check and Diode Test.
- Optional accessories incl. Carry Case and Battery Eliminator.
- Fully Guaranteed for 12 months.
- Prices from approx **£39** include Free Battery, Manual and Test Leads.

Prices do not include VAT or P + D.

House of Instruments
Clifton Chambers, 62 High Street
Saffron Walden, Essex CB10 1EE
Tel: (0799) 24922 Telex: 818750

Extended CREDIT available

hi!

House of Instruments Ltd.

hi! reliability hi! service hi! performance hi! competitive

hi! reliability hi! service hi! performance hi! competitive

hi! competitive hi!

---

pantechnic

THE POWERFET SPECIALISTS

OEM USERS

Pantechnic present the most adaptable high powered amplifier ever.

FET SYSTEM AMP

Features:

- HIGH POWER. 1.2KW (single ended).
- LOW VOLUME. 1/15 Cubic foot inc. Heat Sink.
- VERSATILE. Delivers more than 1KW into ½ to 8 ohms.

OR 2 x 600W into 2 to 8Ω
OR 4 x 300W into 2 to 4 Ω (200W into Ω)
1 x 600W into 2 to 8Ω
OR 1 x 300W into 2 to 4Ω
1 x 150W into 4 to 8Ω
Etc. Etc.

Having been closely involved in a wide variety of OEM applications of their amp boards, Pantechnic became aware of numerous implementation problems often left untackled by other amp board manufacturers. These problems specifically of size and thermal efficiency became particularly aggravated at high powers and considerably lengthened OEM product development time.
By including thermal design in the totality of board design it has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heatskink thermal circuit. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heatsink assembly. The **SYSTEM** Amp offers 1.2KW of power in a space of 102mm x 102mm x 77mm, excluding PSU and Fan.
The basis of this considerable advance is the PANTECH 74 Heat Exchanger, newly designed and manufactured by us. By eliminating the laminar air flow found in conventional, extruded heat sinks, heat transfer to the environment is greatly enhanced.
The flexibility of the 1.2KW amp stems from its division into 4 potentially separate amplifiers of 300W each (downrateable with cost savings to 150W.) These can be paralleled, increasing current capability or seriesed (bridged in pairs) doubling voltage capability. In consequence a large variety of amplifier/load strategies can be implemented.
As ever Pantechnic offer a full range of customising options including DC coupling, ultra high slew etc. Contact Phil Rimmer on 01-800 6667 with your particular application problem.
P.S. Specs, as ever, are exemplary.

OTHER POWERFET AMPLIFIER MODULES

Model	Price	Range (Rms)	Dyn-loads	Notes
*PFA100	**20.65**	50-150W	4Ω, 8Ω	Physically small (32 x 78 x 108mm)
*PFA200	**27.35**	100-300W	4Ω, 8Ω	High watts/£ ratio
PFA/HV	**36.04**	200-300W	4 , 8Ω, 16Ω	5dB dynamic headroom Drives 70V line direct.
*PFA500	**42.00**	250-600W	2Ω, 4Ω, 8Ω	25A cont. output current.
	52.50	mounted on type 74 Heat Exchanger (see below).		

*The power output of these amplifiers can be increased by approx 15% with no diminution in quality by adding PSU102 (**£7.61**) to your existing power supply.

Some Other Products & Components

Type 74 Heat Exchanger. Dissipates 300 W (1.2KW fan cooled) **£7.50**
25A 400PIV Bridge Rect. **£2.17**
10,000uF 80v electrolytic with clip **£4.75**
PAN20 Pre-amplifier module. Very low noise and distortion **£7.61**
PAX2/24 2 Way active crossover (specify frequency) **£10.10**
PSU103 Powers 2 x PAN20 + 2 x PAX2/24 **£6.91**
PAN1397 20W power amp. (LOW THD) **£5.04**
PSU101 Powers 2 x PAN1397 **£3.43**
Transformer for above **£4.30** (inc. postage)

TOROIDAL TRANSFORMERS

with special low flux windings

Nom. VAC	160VA	225VA	300VA	500VA	625VA	750VA
40-0-40	**10.43**	**12.00**	**13.04**	–	–	–
45-0-45	–	**12.00**	**13.04**	**16.96**	–	–
50-0-50	–	–	–	**16.96**	**19.84**	**22.00**
70-0-70 (for PFA/HV)	–	–	–	**16.96**	–	–

Transformer prices include postage. Ask for leaflet "Choosing a Transformer."

Carriage 75p. Add VAT at 15% to all prices.

THE POWERFET SPECIALISTS
pantechnic
Mail order only to
Dept ETI/8 148 Quarry Street, Liverpool L25 6HQ
Telephone 051-428 8485
Technical enquiries
Phil Rimmer 01 800 6667

RADIO CONTROL SERVO FAIL–SAFE

Up, up and away? Bring your model aircraft down to earth *without* a bump using the ETI Conservo. Phil Walker shows you how to make your servos fail safe.

No-one who has spent many hours and pounds constructing their radio-controlled boat, plane or animated aardvark would want it to sail, fly or crawl out of range of their transmitter. However, there is always the remote possibility that some nasty little gremlin will creep in and throw the spanner in the works. When that happens all your controls may well be stuck in the last position you used; and by a well-known Law of Nature (Lex Divoti*), the position will make it as hard as possible to retrieve your model.

Help is at hand! This project will set your servos to any position you require (if you fit it beforehand) and if set up correctly your precious model should sail, fly or waddle home safely.

Use

The ETI Conservo is simply connected into the servo leads (get the polarity right) and the variable resistor can then be set to make the servo take up what you hope is a safe position. This setting is best done with slightly used batteries, to get a true position. Do not have the radio link operating while doing this or you won't be able to make the setting.

If your system uses low voltage (ie, around 3.6 volts) don't forget to increase the size of C2 to its higher value.

The Circuit

The circuit of this project is designed around a 4093 CMOS quad Schmitt trigger. This device will operate down to quite low supply voltages while still providing reliable switching performance.

One section of the device (IC1a) is used to detect the possibility that the input signal has stuck at a high

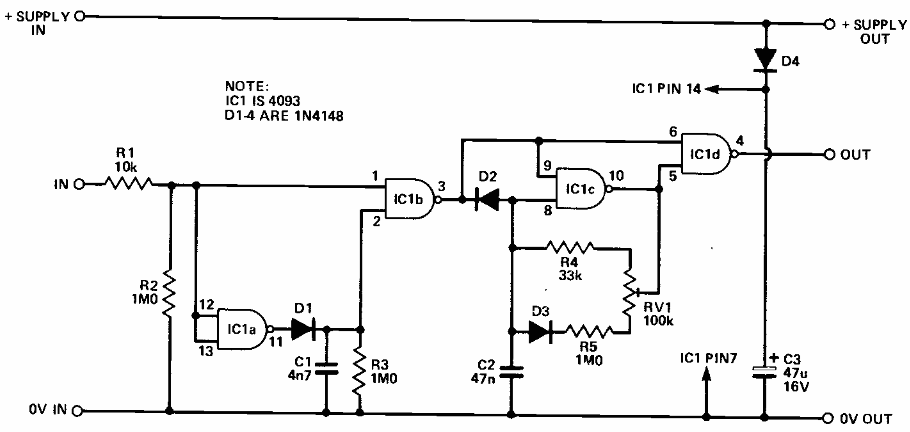


Fig. 1 Circuit diagram of the Conservo.

HOW IT WORKS

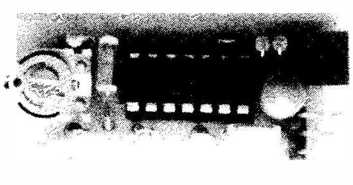
R1 and R2 protect the inputs of the CMOS devices from overload or static damage. The normal input to the device is a series of 1 to 2 ms positive pulses repeated at about 20 ms period. When the input is low, IC1a holds C1 high via D1 thus maintaining IC1b pin 2 at a high level.

When a pulse arrives, the output of IC1b goes low, discharges C2 and forces the output of IC1d high for the duration of the pulse. When the input pulse goes low again, C2 starts to charge via RV1 and R4 but will be discharged again by another input pulse before its voltage reaches the trigger threshold of IC1c. This means that the output of IC1c will stay high permanently in normal operation.

If another pulse does not arrive and the input stays low, the output of IC1b will stay high and C2 will charge up until its voltage reaches the threshold of IC1c whose output will then go low and discharge C2 via RV1, R5 and D3 until the lower threshold of IC1c is reached. IC1c's output will then go high again and the cycle will repeat. When the output of IC1c is low, the output of IC1d will be forced high. The component values used in the circuit are such that this cycle approximates to the normal servo control signal with RV1 controlling the pulse width.

If for any reason the input sticks at a high level, C1 which is normally kept charged up by IC1d will have time to discharge effectively putting a low level on the input to IC1b. This will cause the same sequence of events to occur as when the input stuck low but after a short delay.

Finally, D4 and C3 form a reserve power supply to ensure that the circuit is not affected by supply line transients.



A small project (this is actual size) but a long name — and a large degree of usefulness.

level. Since normally the input only goes high for relatively short periods at a time, the output from IC1d spends most of the time at a high level. This fact is used to charge a capacitor to near the supply potential. This capacitor can only be discharged by a resistor connected in parallel with it and then only if it has enough time to do so. In normal operation this will not be the case.

The second part of IC1 (IC1b) combines the original input signal with the 'stuck at high' signal and its output goes high when either is low. Note that this output only usually goes low when normal control pulses are being received. The low periods of the output from IC1b are used to discharge the timing capacitor of the oscillator formed around IC1c. The output from this oscillator would normally be a series of low going pulses of approximately the same frequency as the usual control pulses. The width of these pulses can be set by the variable resistor to simulate any servo position required. However these pulses will only be generated if the normal input fails to discharge the timing capacitor within a reasonable time.

The output from the gated oscillator described above and the output from IC1b are combined in IC1d to give the final output from the unit.

In normal operation the output will follow the input with no alteration as C1 will not discharge enough and C2 will not charge enough to have any effect. In a fault condition, however, the output form IC1b will stay at a high level (driven either by the input being low or by IC1a detecting the input high) and enable the gated oscillator (IC1c) whose output will be passed on to the servo being controlled. This will send the controlled servo to its preset position.

Construction

This should pose no real problems provided that care is taken to put the diodes, IC1 and C3 the right way round. This is a little more awkward than usual since some components must be mounted vertically to conserve PCB area.

A socket is recommended for IC1 — at least the first time you build it. Take care when handling IC1 to discharge yourself of any static charge. This also applies to your soldering iron which must be earthed. CMOS devices are still delicate things.

RV1 can be either vertical or horizontal mounting and the PCB is laid out for both. If you want to save space and weight use a vertical mounting device and cut off the end of the PCB as shown by the dotted line. Inputs and outputs can be soldered directly to the board or alternatively, there are some 0.1 in. pitch PCB connectors available from Maplin in 3 way versions which would do the job.

The whole unit could be mounted in a box or possibly just varnished to keep out moisture (but not if the device is likely to be immersed!). For use on low voltages, ie less than 5 V, it may be necessary to increase the value of C2 up to 100nF in order to maintain the required output timing.

PARTS LIST

RESISTORS (¼W 5% carbon film)

R1	10k
R2,3,5	1M0
R4	47k
RV1	100k min. preset horizontal or vertical mounting

CAPACITORS

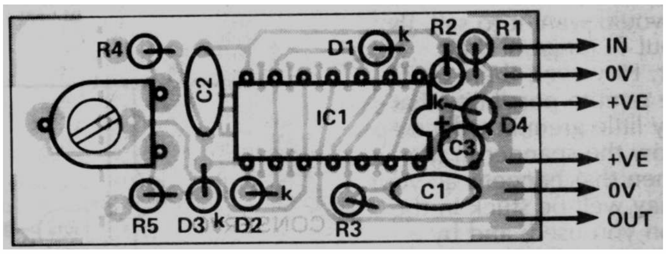
C1	4n7F min. layer polycarbonate
C2	47nF min. layer polycarbonate (100nF for 3.6 volt operation)
C3	47uF 16 V min electrolytic

SEMICONDUCTORS

D1,2,3,4	1N4148
IC1	4093

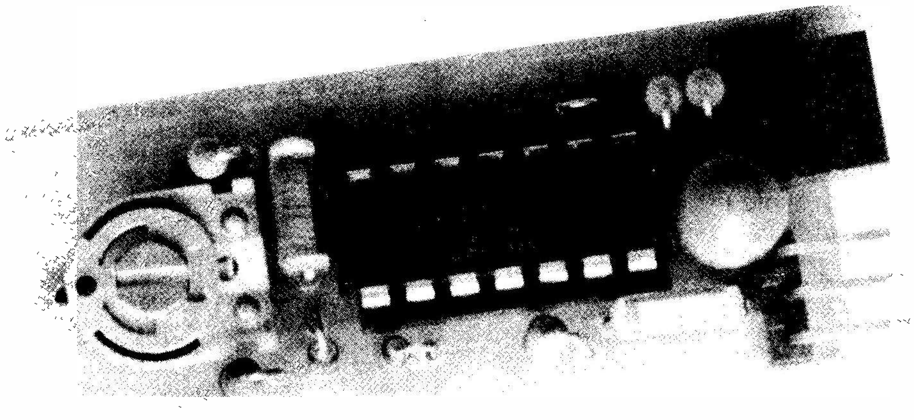
MISCELLANEOUS

PCB: see Buylines. 2 off 3 way 0.1 in. connectors (if required).



k = CATHODE

Fig. 2 Overlay diagram of the Conservo. Here we show a horizontal preset, but a vertical one could be used to save space — just cut the PCB along the marked line.



FOOTNOTE

*For those of you who are not scholars of Latin, Lex Divoti is a Law of Nature known by a number of names, most of them not printable, but can be summed up as: "If something can possibly go wrong, it will, at the most inconvenient moment and in the way that causes maximum damage."

BUYLINES

None of the components in this project should be at all difficult to obtain. The PCB is available through our PCB service — see page 77 for details.

ETI

Midwich
COMPUTER COMPANY LIMITED

1st choice for microcomputer components

BBC COMPUTERS

Model B	346.95
Model B + Disc Interface	441.95

(Carriage 6.50 by Securicor)
Please phone to check delivery

BBC MICRO DISC DRIVES

BBC 31 Single 100K Drive Expandable to 2x100K	199.00
BBC 32 Dual 100K Drives	330.00
BBC 33 100K Upgrade for BBC 31	140.00
BBC 34 Dual 400K Drives	575.00
BBC 35 Utilities Disc (supplied only with BBC 31, 32, 34)	25.00

All Disc Drives (except BBC 33) are complete with Manual, Utilities Disc, and Connecting Cables

BBC MICRO UPGRADE KITS

BBCA2B Complete A to B Upgrade	44.75
BBC 1 16K Memory	18.00
BBC 2 Printer/User I/O Kit	7.50
BBC 3 Disc Interface Kit only supplied with Disc Drives.	95.00
BBC 4 Analogue Input Kit	6.70
BBC 5 Serial I/O & RGB Kit	7.30
BBC 6 BUS Expansion Kit	6.45

All Kits are supplied with full fitting instructions

PRINTERS

NEC 8023 Printer (Carriage 10.00)	320.00

BBC CONNECTORS

BBC 21 Printer Cable and Amphenol Plug (not assembled)	13.00
BBC 22 User Port Connector and Cable 36"	2.46
BBC 23 Cassette Lead	3.50
BBC 24 7 Pin DIN Plug	0.60
BBC 25 6 Pin DIN Plug	0.60
BBC 26 5 Pin DIN Plug	0.60
BBC 25 Disc I/O Cable 34W IDC to 2x34 way card edge	12.00
BBC 36 Disc Power Cable	6.00
BBC 44 Analogue Input Plug and Cover	2.25
BBC 66 IM Bus Connector + 36" Cable	3.50

BBC ACCESSORIES

BBC 45 Joysticks (per pair)	11.30
BBC 67 Eprom Programme (assembled)	57.95
BBC 71 Teletext Receiver	225.00
BBC 72 Second Processor (6502)	170.00
BBC 73 Second Processor (Z80)	170.00

ACORNSOFT FOR THE BBC

SBE03 Business Games	8.65
SBE04 Tree of Knowledge	8.65
SBE02 Peeko Computer inc Manual	8.65
SBE01 Algebraic Manipulation Pk	8.65
SBX01 Creative Graphics Cassette	8.65
SBX02 Graphics and Charts Cassette	8.65
SBB01 Desk Diary inc Manual	8.65
SBL01 LISP Cassette	14.65
SBL02 FORTH Cassette	14.65
SBG01 Philosophers Quest	8.65
SBG07 Sphinx Adventure	8.65
SBG03 Monsters	8.65
SBG04 Snapper	8.65
SBG15 Planteoid	8.65
SBG06 Arcade Action	10.35
SBG05 Rocket Raid	8.65
SBG13 Meteors	8.65
SBG14 Arcadians	8.65
SBG10 Chess	8.65

ACORNSOFT BOOKS FOR THE BBC MICRO

SBD01 Creative Graphics	7.50
SBD02 Graphs and Charts	7.50
SBD04 LISP	7.50
SBD03 FORTH	7.50

Please ring for current delivery on Acornsoft Products before ordering.

BBC MICRO COMPONENTS

4516 100ns	2.25	8271	36.00
6522	3.19	20 Way Header	1.46
74LS244	0.59	26 Way Header	1.76
74LS245	0.69	34 Way Header	2.06
74LS163	0.34	40 Way Header	2.32
DS3691N	4.50	15 Way D Skt	2.15
DS88LS120N	4.50	6 Way DIN Skt	0.90
UPD7002	4.50	5 way DIN Skt	0.90

BBC SOFTWARE IN EPROM

Wordprocessor "View"	52.00
1.2 MOS	10.00

SPECIAL OFFER
Spectrum 32K Upgrade Kit
24.95

DATA SHEETS are available on items marked *D*.

D1	0.75	D5	2.50
D2	1.00	D6	3.00
D3	1.25	D7	4.00
D4	2.00		

MEMORIES

2114L 200ns	D1	0.80
2706 450ns	D2	2.95
2716 450ns	D1	2.45
2716 350ns	D1	4.95
2716 3 rail	D1	7.25
2532 450ns	D2	3.45
2732 450ns	D1	3.45
2732 350ns	D1	5.45
2764 300ns	D1	5.99
4116 150ns	D2	0.85
4116 200ns	D2	0.80
4118 150ns	D1	3.25
5516 200ns	D2	9.45
6116 150ns	D1	3.30
6116 Low Power 150ns	D2	4.95
4164 150ns TI	D3	4.45
4164 200ns TI	D3	3.95
4164 150ns Mnstek	D3	4.45
4516/4816 100ns	D2	2.25
4532 200ns	D2	2.95

6800 FAMILY

6800	D7	2.25
6802	D5	2.50
6809	D6	6.30
6810	D1	1.15
6821	D3	1.00
6840	D4	3.75
6845	D5	6.50
6850	D2	1.10
68488	D2	7.30
68B00	D7	5.25
68B09	D6	12.00
68B10	D1	2.26
68B21	D3	2.20
68B40	D4	6.00
68B50	D2	2.20

Z80 FAMILY

Z80ACPU	D2	2.99
Z80BCPU	D2	9.00
Z80ACTC	D1	2.80
Z80BCTC	D1	9.00
Z80ADART	D1	5.50
Z80ADMA	D2	6.95
Z80AP10	D1	2.75
Z80BP10	D1	9.00
Z80AS10	D4	9.00

8080 FAMILY

8085A	D4	3.50
8212		1.10
8216		1.00
8224		2.10
8228		3.27
8251A	D5	2.50
8253		4.00
8255A	D5	2.25

6500 FAMILY

6502	D3	3.25
6502A	D3	5.00
6520	D1	2.50
6520A	D1	3.16
6522	D5	3.19
6522A	D5	5.50
6532	D2	5.50

FLOPPY DISC CONTROLLERS

8271		36.00
FD1771	D5	15.00
FD1791	D6	22.00
FD1793	D6	23.00
FD1795	D6	28.00
FD1797	D6	28.00
WD1691	D2	12.00
WD2143-01	D2	6.99

INTERFACE DEVICES

6402		3.80
75107		0.47
75110		0.56
75150		0.64
75154		0.77
75160		2.56
75161		2.80
75162		3.95
75172		1.95
75173		1.44
75174		1.95
75175		1.44
75182		0.50
75183		0.50
75188		0.37
75189		0.37
75451		0.22
75452		0.22
75453		0.22
75454		0.22
75468		0.88
75491		0.31
75492		0.42
AY31015	D2	3.00
AY31270		6.47
AY38910	D6	4.40
AY53600	D2	6.70
DP8304	D1	2.50
MC1488	D1	0.37
MC1489	D1	0.37
MC3242A		6.30
MC3446	D1	2.50
MC3448A	D1	3.75
MC3480	D5	7.30
MC3487	D1	2.00
MC14411	D1	7.65
MC14412		9.45
RO32513L	D1	6.50
RO32513U	D1	6.50

UHF MODULATORS

UM1111 6MHz	D1	2.60
UM1233 8MHz	D1	3.90

BUFFERS

81LS95	0.80
81LS96	0.80
81LS97	0.80
81LS98	0.80
8T26A	0.90
8T28A	0.90
8T95	0.90
8T97A	0.90
8T98	0.90

LINEARS

L203	0.65
LF398N	4.75
LM301AN	0.24
LM308N	0.48
LM311P	0.50
LM319N	1.99
LM324N	0.30
LM348N	0.60
NE555P	0.16
NE556CP	0.45
TL010	0.39
TL011	0.32
TL012	0.34
TL014	0.36
TL021	0.34
TL061	0.29
TL062	0.49
TL064	0.98
TL066	0.29
TL068	0.32
TL071	0.29
TL072	0.47
TL074	1.00
TL081	0.26
TL082	0.46
TL084	1.58
TL091	0.40
TL092	0.58
TL094	1.34
TL487	0.62
TL489	0.62
TL494	1.63
TL496	0.60
TL507	1.33
725	1.60
741	0.14
747	0.48
748	0.27

REGULATORS

78L05	0.30
78L12	0.30
78L15	0.30
7805	0.40
7812	0.40
7815	0.40
7905	0.45
7912	0.45
7915	0.45
LM309K	1.20
LM317K	2.40
LM323K	4.50
LM338K	6.25

DATA CONVERTERS

UPD7002	D1	4.26
ZN425	D1	3.45
ZN426	D1	3.00
ZN427	D1	5.99
ZN428	D1	4.75
ZN429	D1	2.10
ZN432	D1	13.00
ZN449	D1	2.55

CRYSTALS

1M	2.75
1008M	2.75
1.8432M	1.92
2.4576M	2.00
3.6864M	1.86
4M	0.64
6M	0.86
8M	0.86
9.8304M	1.68
19.6608M	2.48

DIL SOCKETS (TEXAS)

PINS	TIN	GOLD	WW
8	7	16	25
14	10	26	35
16	10	29	40
18	13	33	50
20	15	37	60
22	17	38	65
24	21	46	70
28	24	55	80
40	30	76	99

ZIF SOCKETS (TEXTOOL)

24 pin	5.75
28 pin	8.20
40 pin	9.75

CMOS 4000

4000	0.10
4001	0.10
4002	0.12
4006	0.42
4007	0.14
4008	0.32
4009	0.24
4010	0.24
4011	0.10
4012	0.16
4013	0.20
4014	0.40
4015	0.36
4016	0.20
4017	0.32
4018	0.36
4019	0.36
4020	0.36
4021	0.40
4022	0.40
4023	0.13
4024	0.32
4025	0.13
4026	0.74
4027	0.20
4028	0.32
4031	0.94
4033	1.80
4034	0.94
4035	0.38
4040	0.36
4041	0.36
4042	0.34
4043	0.36
4044	0.36
4045	1.35
4046	0.42
4047	0.70
4048	0.38
4049	0.23
4050	0.23
4051	0.38
4052	0.44
4053	0.44
4054	0.85
4055	0.85
4060	0.39
4063	0.85
4066	0.24
4068	0.14
4069	0.14
4070	0.13
4071	0.13
4072	0.13
4073	0.14
4075	0.13
4076	0.43
4077	0.13
4078	0.15
4081	0.13
4082	0.13
4085	0.50
4086	0.44
4093	0.20
4502	0.46
4507	0.32
4508	0.96
4510	0.40
4511	0.41
4512	0.40
4514	0.96
4515	0.96
4516	0.40
4518	0.40
4519	0.27
4520	0.40
4521	0.90
4522	0.52
4526	0.52
4527	0.52
4528	0.41
4532	0.72
4541	0.50
4543	0.50
4553	1.57
4555	0.35
4556	0.35
4585	0.75

74LS SERIES

00	0.11
01	0.11
02	0.11
03	0.12
04	0.12
05	0.12
08	0.12
09	0.12
10	0.12
11	0.12
12	0.12
13	0.12
14	0.25
15	0.12
20	0.12
21	0.12
22	0.12
26	0.12
27	0.12
28	0.12
30	0.12
32	0.12
33	0.12
37	0.12
40	0.12
42	0.28
47	0.35
48	0.45
49	0.12
51	0.12
54	0.12
55	0.12
73	0.18
74	0.16
75	0.18
76A	0.17
78A	0.18
83A	0.36
85	0.42
86	0.16
90	0.22
91	0.60
92	0.32
93	0.22
95B	0.40
109A	0.27
112A	0.20
113A	0.20
114A	0.22
122	0.28
123	0.34
125A	0.24
126A	0.25
132	0.34
136	0.25
138	0.25
139	0.27
145	0.57
148	0.70
151	0.40
153	0.40
155	0.30
156	0.25
157	0.25
168	0.30
160A	0.32
161A	0.35
162A	0.35
163A	0.35
164	0.40
165A	0.50
166A	0.60
173A	0.55
174	0.40
175	0.38
181	0.90
190	0.35
191	0.35
192	0.35
193	0.35
194A	0.35
195A	0.35
196	0.45
197	0.45
221	0.46
240	0.55
241	0.55
242	0.55
243	0.55
244	0.55
245	0.70
248	0.55
249	0.55
251	0.30
253	0.35
257A	0.30
258A	0.35
259	0.55
261	1.00
266	0.20
273	0.54
279	0.30
283	0.40
290	0.39
293	0.39
365	0.27
366	0.27
367	0.27
368	0.27
373	0.62
374	0.62
375	0.35
377	0.60
378	0.60
379	0.90
386	0.35
390	0.45
393	0.45

DIL JUMPERS
Single Ended 24"

14 pin	1.45
16 pin	1.65
24 pin	2.40
40 pin	3.80

Double Ended

	6"	12"	18"
14 PIN	1.85	1.98	2.42
16 PIN	2.05	2.15	2.58
24 PIN	3.00	3.15	3.96
40 PIN	4.65	4.90	6.18

25 WAY D-TYPE CONNECTORS

Male-Male 36" Cable	12.00
Male-Female 36" Cable	12.00
Male single ended 18" Cable	4.95
Female single ended 18" Cable	3.95

IDC CONNECTORS (with ejectors) (Right Angle PCB Mfg)

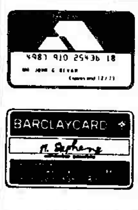
10 PIN	0.86
14 PIN	1.22
16 PIN	1.34
20 PIN	1.46
26 PIN	1.76
34 PIN	2.06
40 PIN	2.32
50 PIN	2.35
60 PIN	3.20

IDC SOCKETS
Fitted with 36" cable

10 PIN	1.40
14 PIN	1.82
16 PIN	2.10
20 PIN	2.48
26 PIN	3.24
34 PIN	3.50
40 PIN	4.90
50 PIN	5.48
60 PIN	6.38

DATA BOOKS by Texas Instruments

Linear Control Circuits	4.00
Voltage Regulators	4.50
MOS Memory	3.95
Interface Circuits	7.00
TTL 5th Edition	8.50
Bipolar Micro	4.50
TTL Pkt Guide	3.50
Linear Pkt Guide	2.50



Carriage Orders up to £199 are sent by 1st class post and £200 + by Securicor
[illegible] 0.50 £100-£199 1.25 £200 + 5.00 by Securicor
Prices quoted (+ carriage charges) are exclusive of VAT and are subject to change without notice
Quantity Discounts are available on many products, please ring for details
Official Orders are welcome from Education Establishments, Government Bodies, and Public Companies.
Credit Accounts are available to others subject to status. Payment is due strictly nett by the 15th of the month
Credit Cards are accepted (Access and Visa) for telephone and postal orders and NO SURCHARGE is made
Out of stock items will follow automatically at our discretion or a refund will be given if requested

Please complete this coupon for a copy of our FREE catalogue.

NAME ____________________

ADDRESS ____________________

____

____

TEL. NO. ____________________

MIDWICH COMPUTER COMPANY LIMITED
RICKINGHALL HOUSE, RICKINGHALL, SUFFOLK IP22 1HH
TELEPHONE (0379) DISS 898751

All devices guaranteed Brand New and to full spec. Items ex stock despatched same day. Prices are EXCLUSIVE of VAT. Please add 60p to order to cover P&P BEFORE calculating VAT. Payment by cheque, Postal Order, Bankers Draft or Cash (PLEASE register) with order. Official orders from Govt. Depts and Educational Institutes Welcome. Trade Accounts opened subject to satisfactory status — send for details. We are pleased to receive overseas orders (please allow adequate postage — surplus refunded) which, unless accompanied by Bankers Draft in UK Currency may be subject to Bankers Commission and slight delay in despatch. Overseas trade enquiries welcome — send for full details. VAT not applicable to export orders. Price List detailing full range of components available — 30p refundable with first order. Please send SAE.

COMMQUIP
LTD.
HAMILTON HOUSE 11 WALKERN ROAD
STEVENAGE HERTS SG1 3QD
Telephone (0438) 729771 Telex 825378 G

COMPARE OUR PRICES

LINEAR

555CMOS	80
556CMOS	140
709	25
741	14
748	35
9400CJ	345
AY-3-1270	710
AY-3-8910	370
AY-3-8912	540
CA3046	60
CA3080	65
CA3089	190
CA3090AQ	370
CA3130E	85
CA3140E	36
CA3161E	100
CA3189	200
CA3240E	110
ICL7106	680
ICL7611	95
ICL7621	180
ICL7622	180
ICL8038	290
ICL8211A	150
ICM7224	775
ICM7555	80
LF353	85
LF356	90
LM10	325
LM301A	24
LM311	70
LM318	120
LM324	30
LM334Z	90
LM335Z	120
LM339	45
LM348	60
LM358	55
LM377	165
LM380	65
LM381	120
LM382	110
LM384	130
LM386	65
LM387	120
LM393	95
LM711	60
LM725	325
LM733	69
LM747	60
LM1458	40
LM2917	185
LM3900	45
LM3909	70
LM3911	120
LM3914	175
LM3915	195
LM13600	105
MC1496	68
MC3340	120
MF10CN	350
ML924	195
NE529	225
NE531	135
NE544	180
NE555	16
NE556	45
NE565	110
NE566	140
NE567	100
NE570	370
NE571	370
RC4136	55
RC4558	45
SL490	250
SL76477	380
SP8629	250
TBA120S	70
TBA800	75
TBA810	95
TBA820	70
TBA950	220
TDA1008	310
TDA1022	480
TDA1024	115
TL061	40
TL062	60
TL064	95
TL071	25
TL072	45
TL074	95
TL081	24
TL082	45
TL084	90
TL170	49
UA2240	115
ULN2003	75
ULN2004	75
XR2206	285
ZN414	79
ZN423	130
ZN424	130
ZN425E	340
ZN426E	290
ZN427E	575
ZN428E	395
ZN459	285
ZN1034E	200

LOGIC ICs

AY5-2376	590
MC1488	55
MC1489	55
MM5303	625
MM5307	1250
MM58174	700
TMS6011	365
ULN2003	75
8T26	99
8T28	120
8T95	90
8T97	90
81LS95	80
81LS96	80
81LS97	80
81LS98	85
6522	310
6532	675
6821	110
6845	650
6847	650
6850	110
6852	250
6875	485
8155	350
8212	110
8216	100
8224	110
8226	250
8228	220
8243	270
8250	865
8251	250
8253	400
8255	225
8257	400
8259	395
8279	385
8832	250
9602	220
Z80ACTC	260
Z80ADART	775
Z80ADMA	975
Z80AP10	270
ZN425E8	320
ZN426E8	320
ZN427E8	575
ZN428E8	395

CMOS

4000	11
4001	11
4002	11
4007	14
4008	34
4009	24
4011	11
4012	14
4013	20
4015	39
4016	20
4017	32
4020	42
4021	39
4022	39
4023	12
4024	32
4025	12
4027	20
4028	37
4029	43
4035	45
4040	40
4042	38
4043	40
4044	40
4049	21
4050	22
4051	42
4052	48
4053	48
4066	22
4068	14
4069	13
4071	13
4072	13
4073	13
4075	13
4076	44
4078	13
4081	12
4082	12
4093	23
4099	70
4502	50
4508	110
4510	45
4511	45
4512	42
4514	110
4515	110
4516	50
4518	39
4520	48
4521	90
4522	105
4526	55
4527	55
4528	45
4531	65
4532	60
4538	60
4539	80
4543	60
4555	35
4556	35
4561	100
4583	80
4584	40
4585	50

COMPUTER ICs

1802	650
2650A	1175
6502	320
6800	220
6802	250
6809	615
8035	345
8060	1090
8080A	250
8085A	345
Z80A	315

MEMORIES

2101	395
2114(200ns)	85
2532	295
2708	225
2564	1000
2708	225
2716(5V)	210
2764	750
4116(200ns)	80
4118-3	325
4164	420
5101(450ns)	150
5204	725
6116(150ns)	375
6514	330
6810	115

74LS

LS00	11
LS01	11
LS02	11
LS03	11
LS04	12
LS05	12
LS08	12
LS09	12
LS10	12
LS11	12
LS12	12
LS14	22
LS*5	12
LS20	12
LS21	12
LS22	12
LS27	12
LS28	14
LS30	12
LS32	13
LS33	14
LS37	14
LS38	14
LS40	12
LS42	28
LS47	35
LS48	40
LS49	50
LS51	14
LS54	14
LS55	14
LS74	16
LS75	16
LS76	16
LS78	17
LS83	33
LS85	39
LS86	15
LS90	22
LS92	25
LS93	22
LS95	36
LS109	21
LS112	20
LS113	20
LS114	21
LS123	34
LS125	24
LS126	25
LS132	29
LS136	23
LS138	24
LS139	27
LS151	30
LS153	38
LS155	29
LS156	33
LS157	25
LS158	27
LS160	30
LS161	35
LS162	35
LS163	35
LS164	40
LS165	50
LS168	80
LS170	70
LS173	47
LS174	36
LS175	36
LS181	87
LS183	105
LS190	35
LS191	35
LS192	35
LS193	36
LS194	32
LS195	32
LS196	43
LS197	45
LS221	50
LS240	55
LS241	55
LS242	55
LS243	55
LS244	55
LS245	70
LS251	28
LS253	30
LS257	29
LS258	32
LS259	53
LS266	18
LS273	53
LS279	30
LS283	38
LS290	40
LS293	40
LS365	27
LS366	27
LS367	27
LS368	27

MICRO-MINI 100V CERAM PLATE CAPS

1pF 10nF	7

TANTALUM BEADS

0.1/35	12
0.22/35	12
0.33/35	12
0.47/35	12
0.68/35	12
1.0/35	12
1.5/35	14
2.2/35	16
3.3/35	17
10/25	18
15/25	28
22/16	14
3.3/16	14
4.7/16	16
6.8/16	16
10/16	18
15/16	27
22/16	27
33/16	40
47/16	40
100/16	75
15/10	22
22/10	24
33/10	30
47/10	35
100/10	55
100/6.3	42

63V MINI MONOLYTHIC CERAMIC

10nF	10
22nF	10
33nF	10
47nF	10
68nF	10
100nF	14

DIODES

0A47	10
1N4001	4
1N4002	4
1N4003	5
1N4004	5
1N4005	6
1N4006	7
1N4007	
1N4148	2
1N5401	12
1N5404	14
1N5406	17
1N5408	19

ZENER DIODES

2V7-33V 500MW	7
5V1-75V 1.3W	14

BRIDGE RECTIFIERS

1A/100V	20
1A/200V	23
1A/400V	25
1A/800V	38
2A/100V	36
2A/200V	40
2A/400V	40
2A/800V	52
25/100V	
25/200V	
25/400V	
25/600V	

REGULATORS

78L05	30
78L12	30
78L15	30
78L24	30
7805T	36
7812T	36
7815T	36
7824T	36
79L05	60
79L12	60
79L15	60
7905T	42
7912T	42
7915T	42
7924T	42
LM309K	130
LM317K	270
LM317T	120
LM323K	350
LM723	35
78H05-5A/5V	550

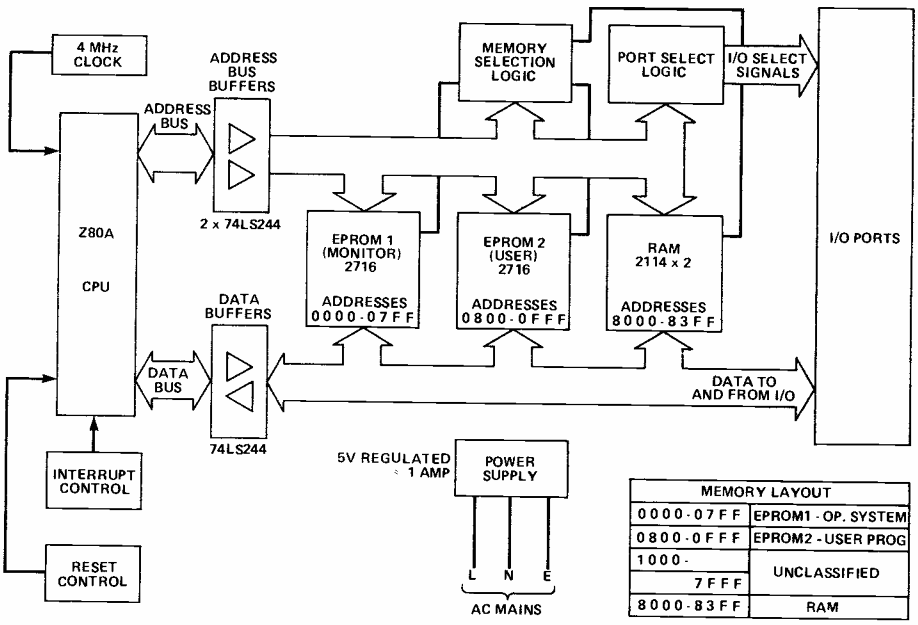
RESISTORS

Carbon Film, High Stab 5%	
¼W 10Ω-1M	2
½W 10Ω-10M	2
Metal Oxide/Film	
2% Met. Film E24	5
1% Met. Film E24	8

Z80 CONTROLLER COMPUTER

This article describes the design and construction of a simple microcomputer control unit. (We called it MARVIN for reasons that would take too long to explain.) The unit is designed specifically for control functions which usually require complex purpose-built hardware. Consisting of a microprocessor and support chips, the unit is cheap enough to be used as an alternative to hard-wired logic with the advantage that its function is determined by easily-changed software.

The system can be used in conjunction with analogue devices, heavy duty switching, light dimmers, remote controllers, etc, to control anything from a Stirling Moss style computer controlled futuristic home to a morse code tutor.



MEMORY LAYOUT	
0000-07FF	EPROM1 - OP. SYSTEM
0800-0FFF	EPROM2 - USER PROG
1000-7FFF	UNCLASSIFIED
8000-83FF	RAM

Fig. 1 Block diagram of Marvin.

Since there are so many possible uses, the construction of only the central computer parts (CPU, I/O, interrupt board) will be described; you will be left to chose external circuits according to your needs. Some additional interfaces will be available from the kit suppliers (see Buylines for details).

Split Personality

For maximum flexibility, MARVIN is divided into a CPU board and two other types of board. The CPU board houses the micropocessor, a 2K EPROM containing the operating system, a second 2K of EPROM for the user's programs, 1K of RAM accessible to both the operating system and the users, and the selection circuitry for the various types of external port board.

Although 2K of program may seem small in comparison with the memory capacity of a personal computer, it will hold a surprisingly complex machine code program, of up to nearly 1000 instructions.

Several of the routines that you are likely to need are built into the operating system, and are directly accessible to the user by simple two-byte instructions. Your program must be inserted into the EPROM before use by a suitable PROM programming unit. Some further details of programming will be given in a further article.

Since the I/O ports are on individual boards, you can add as many or as few as you need. MARVIN's I/O board provides 16 latched output lines and 16 input lines, which are TTL compatible. You can use up to five of these boards.

The other type of board we shall describe provides up to eight individual lines which can interrupt the CPU. These are useful for allowing external devices to force the CPU to carry out a predesignated routine. A typical use might be for controlling devices that need servicing at regular intervals, using an external clock to provide the timing.

This first part describes the functioning and construction of the CPU board. This will be followed by a description of MARVIN's I/O and interrupt board and of MARVIN's operating system.

EPROMs

A Z80A running at 4 MHz theoretically needs memory capable of 375 nS access time. Most 2716s have an access time of 450 nS and although some may work adequately, it is strongly recomended that for reliable operation you make sure that you buy 350 nS EPROMs. If you decide

Computer projects are usually complex affairs, as anyone who saw the Cortex will testify. This one isn't. Design and development by Peter Grigson and David Harris.

to make do with 450 nS types, then the crystal should be changed to 3.2768 MHz.

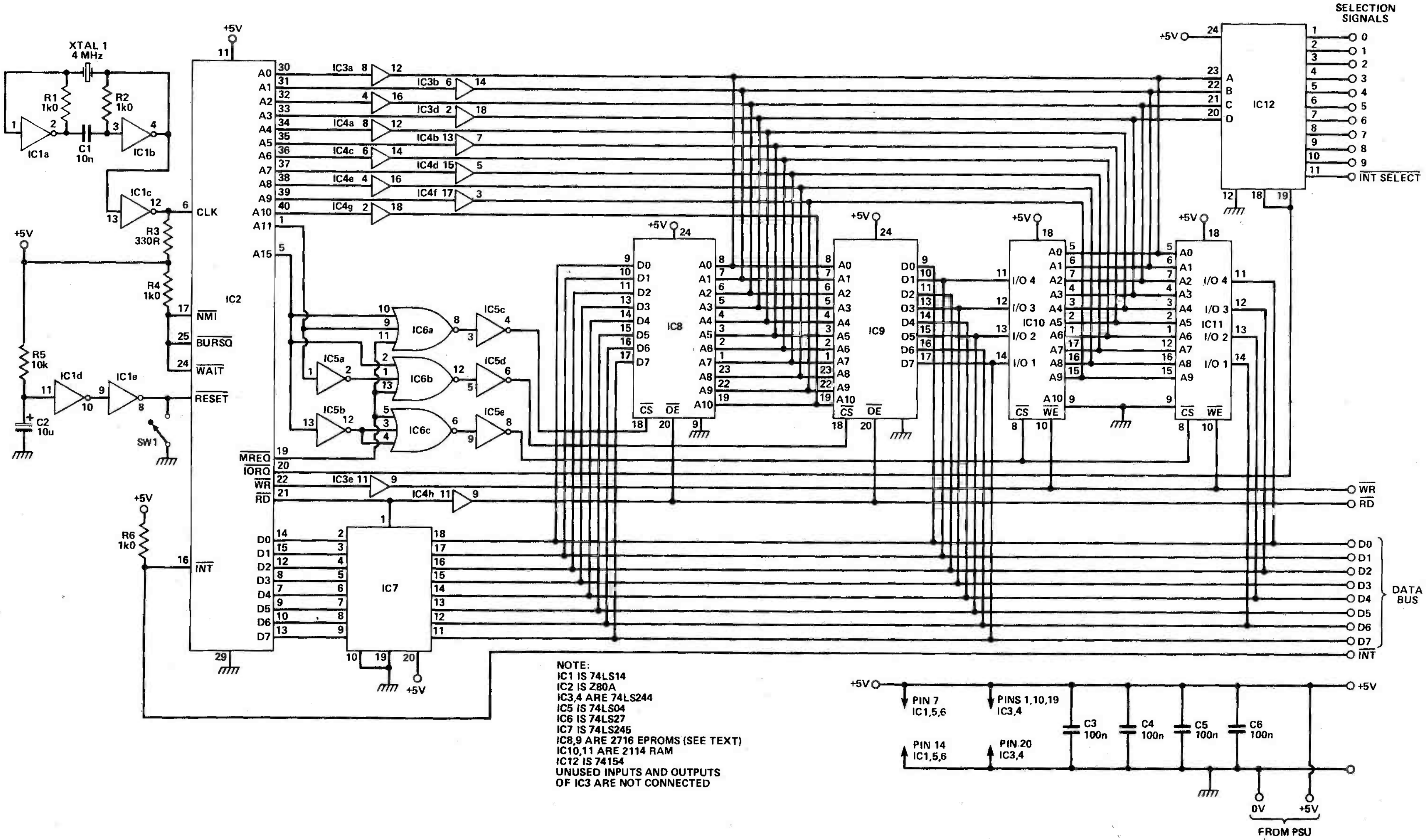
Also, we suggest that you should use a zero insertion force socket for the user EPROM, as you'll probably be taking it in and out quite a lot.

Construction

The component layout of the PCB is shown in Fig. 4. The PCB is double sided, but as PCBs with plated through holes are expensive, pins have been used to make connections between the two sides.

The PCB is difficult to make unless you have access to suitable equipment: see Buylines for the source of the PCB. If you do make it yourself, you must be very careful to align the two sides accurately. All the holes are cut using a 0.8 mm (or approx) drill.

Fig. 2. Circuit diagram of Marvin's main board.



HOW IT WORKS

Schmitt triggers IC1a and b form a standard oscillator circuit whose frequency is stabilised at 4 MHz by XTAL1; the output from this oscillator is buffered by IC1c and fed into the clock input of the Z80 CPU, IC2 (R3 is necessary to fulfil the Z80's input requirements as it has no internal pull-up resistor). $\overline{NMI}$, $\overline{BUSRQ}$, and $\overline{WAIT}$ inputs are not used in this design, so they are tied high by resistor R4.

At switch-on, execution would begin at a random location in the memory but for C2 (via IC1d and e) holding $\overline{RESET}$ low until voltages and internal CPU register contents stabalise. The CPU may be reset at any future time by momentarily closing SW1 (note that debouncing is unnecessary). After being reset, the Z80 will begin by fetching an instruction from memory location 0000 hexadecimal, and executing it. Therefore, it places this address on the address bus and then takes $\overline{MREQ}$ and then $\overline{RD}$ low.

The memory selection logic, ICs 5 and 6, detects that this address is less than 07FFH and enables IC8, the EPROM containing the operating system. MARVIN then proceeds with the initialisation program in the operating system.

The address bus is buffered by most of two 74LS244s, ICs 3 and 4, and the data bus by a single 74LS245, IC7. As data can pass to and from the CPU, IC7 has to be a bidirectional device. The EPROMs, ICs 8 and 9, and the RAM, ICs 10 and 11 have their address and data lines permanently wired to the buses, but each has an individual selection line ($\overline{CS}$) that takes its bus connections to a high impedance state until the selection line is pulled low by the memory selection logic.

The output enable inputs ($\overline{OE}$) on the EPROMs are connected to $\overline{RD}$ (read) from the Z80, and the RAMs' $\overline{WE}$ (write enable) inputs are connected to $\overline{WR}$ (write).

If the MPU wants to perform an output or input operation it takes $\overline{IORQ}$ low; address lines A0 and A3 will contain (in binary, of course) the number of the port to be selected. Either $\overline{RD}$ or $\overline{WR}$ can be low, depending on whether the port is to be read from or written to.

IC12 is a four to 16 line decoder, and it's used to provide an individual selection line for each port. IC12 is active only when $\overline{IORQ}$ is low, so port boards may be selected by one of these lines and either $\overline{RD}$ and $\overline{WR}$. Only one interrupt board is usable, so there is only one interrupt selection line, $\overline{INT\ SELECT}$.

The interrupt line itself, $\overline{INT}$, is normally held high by R3; however, it may be pulled low by a suitable external device. Because we have chosen to use $\overline{INT}$ rather than $\overline{NMI}$ (non maskable interrupt), it is possible to program MARVIN to ignore interrupts. If this has not been done, the result of pulling $\overline{INT}$ low will be to make the CPU service the interrupt according to your predesignated routine.

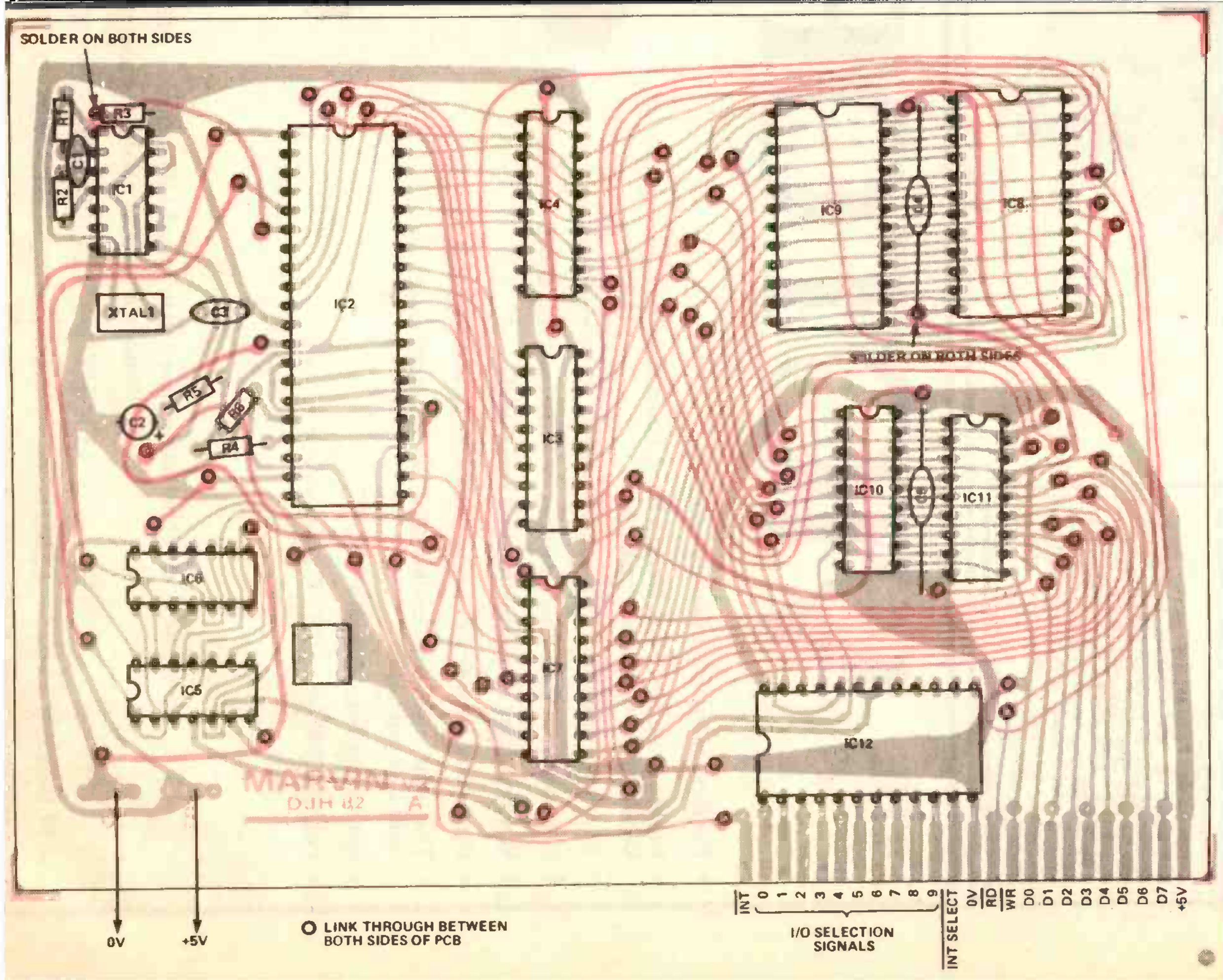


Fig. 3 Overlay diagram.

PARTS LIST

RESISTORS (all ¼ W 5%)

R1, 2, 4, 6	1k0
R3	330R
R5	10k

CAPACITORS

C1	10n ceramic
C2	10u axial electrolytic
C3, 4, 5, 6	100n ceramic or polyester

SEMICONDUCTORS

IC1	74LS14 or 7414
IC2	Z80A
IC3, 4	74LS244
IC5	74LS04 or 7404
IC6	74LS27 or 7427
IC7	74LS245
IC8, 9	2716 EPROM (see text)
IC10, 11	2114 RAM (300nS or less)
IC12	74154

MISCELLANEOUS

SW1	push to make single pole switch as required
XTAL1	4 MHz crystal (see text)

IC sockets: one 40 pin, two 24 pin, two 18 pin; Veropins (about 130); PCB; edge connector if required; ribbon cable.

ICs 2,8,9,10,11 should be socketed as they are NMOS devices; Sockets are optional for the remaining TTL ICs, and there should be no problems in soldering them directly provided the usual precautions are observed.

To proceed with the construction, first insert and solder, on the underside only, all the TTL ICs, and the sockets for the NMOS. It is a good idea to use a fine-tipped soldering iron and to be careful to check that you do not make any bridges between tracks, especially where they pass between IC pins.

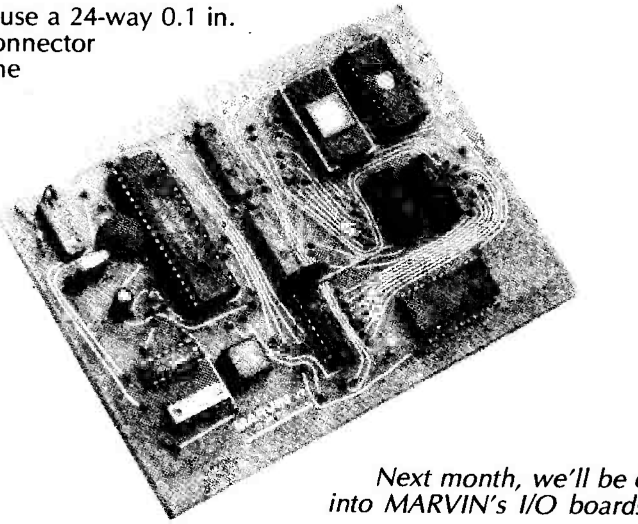
Next insert and solder the crystal, resistors and capacitors (noting the polarity of C1). Where there are pads on both sides of the board the components' leads should be soldered to both. There will remain a large number of unused holes, and many of these are used for the pins that link tracks on both sides of the board. You can tell these holes by looking to see if there are pads on both sides of the hole: if this is the case, then you should insert a pin and solder on **both** sides.

You can use a 24-way 0.1 in. pitch edge connector to connect the board to the others; we recommend that power connections to all the bords be hard-wired to the positions provided and not taken through the connector. If you're very cost-conscious, you could hard-wire direct; holes have been provided for you to insert pins for this purpose next to the edge connector strips.

Finally, solder SW1 (reset) into position, or, if you prefer, take off wires to a control panel.

BUYLINES

The following will be available from ARK Electronics, Ashes Lane, Wentworth, Rotherham, S. Yorks S62 7TY:
EPROM containing the monitor program, 4 MHz clock, £6.00; 3 MHz (or lower) clock £4.00;
Double sided PCB, £6.00;
Complete 4 MHz kit excluding the operating system EPROM £26.00.
Please add 50p p&p and make cheques payable to ARK Electronics. Sending an SAE to ARK will secure further details of D-to-A and A-to-D converters, lighting dimmers, remote controllers and a speech synthesiser.



Next month, we'll be delving into MARVIN's I/O boards.

ETI

Interak 1

THERE'S NO LIMIT TO WHAT A COMPUTER WITH NO CARDS CAN DO!

It's the oldest trick in the book to grab your attention with a stupid title, but in this case there's a grain of truth in the statement above.

The Interak 1 Computer System is a 4MHz Z80A development system, one which you build yourself, perhaps for enthusiastic home use, or more often for industrial or educational purposes.

The fundamental structure is a 3U 19" rack which has space for 13 cards ("International" size, i.e. 4.5" x 8") on 1" pitch, with space for a power supply at one end of the rack. International size — rack mounting: Inter-rak Interak!

13 cards 4.5" by 8" gives a total potential board area of over 400 square inches, enough for a couple of hundred chips or more; there's no real limit on what that could do is there? (It would leave a few of today's marvels a bit in the shade eh?)

But don't be scared, you don't have to build a Frankenstein's monster until you're ready. The first few cards are pretty straightforward: First the VDU-K, which can be connected to your own T.V. (or monitor), then the Z80A-CPU card, the brains; then dynamic RAM, and finally the Keyboard interface (to any standard parallel ASCII keyboard), and you've got a computer — with the ultimate resource: 9 empty slots for the future. (Perhaps use one of them for a 2400 baud tape interface or later floppy disks.)

Example prices (excluding VAT), everything is available separately and full after sales service in case you make a mistake: Z80A CPU card £10.95, Manual £1.50, Main Parts £13.41.

40 type-written pages of description, specification, price lists etc. are yours for the asking (a 25p stamp and/or SAE is a help, but not essential), or telephone if you prefer. You'll have to live with your computer for a long time, so make the effort and find out all about Interak now; a couple of minutes is all it takes to ask for a leaflet!

Greenbank

Greenbank Electronics (Dept. T8E), 92 New Chester Road,
New Ferry, Wirral, Merseyside L62 5AG
Telephone: 051-645 3391

---

circuit board components

Castle House, 1 Castle Lane, Bedford MK40 3QE
Telephone 0234 214219

Please note our new address

All components brand new — Please add 35p P&P plus 15% VAT. Please send cheque or P.O. with your order. Official orders are welcome from educational establishments, Government bodies and public companies. Credit accounts are available. Please ask for details.

LOW PROFILE SOCKETS

8 Pin	9p	14 Pin	10p	16 Pin	11p
18 Pin	16p	20 Pin	18p	22 Pin	22p
24 Pin	24p	28 Pin	26p	40 Pin	30p

ORDER 12 OF ANY ONE TYPE AND WE WILL SUPPLY 13.
"A BAKERS DOZEN"
SPECIAL FOR JUNE-JULY '83

MEMBRANE KEYPADS. By F.S.T.
Multi-choice Graphics Keypad. 57 standard characters to choose from.
Blue or white as standard graphic options keypad complete with flexible backing with Berg connector.

PANEL DIMENSIONS

3 x 4 —	79 x 98 mm	£5.98
4 x 4 —	97 x 98 mm	£6.69
5 x 4 —	116 x 98 mm	£7.41

TTL

7400	11p	7427	18p	7474	19p
7401	11p	7428	25p	7475	26p
7402	11p	7430	13p	7476	25p
7403	12p	7432	20p	7480	45p
7404	12p	7433	20p	7482	65p
7405	14p	7437	23p	7483	30p
7406	19p	7438	24p	7485	60p
7407	19p	7440	14p	7486	19p
7408	13p	7442	30p	7489	180p
7409	13p	7444	85p	7490	19p
7410	13p	7446	58p	7491	34p
7411	15p	7447	36p	7491	24p
7412	17p	7448	43p	7493	24p
7413	17p	7450	14p	7494	33p
7414	23p	7451	14p	7495	33p
7416	19p	7453	14p	7496	38p
7417	19p	7454	14p	7497	86p
7420	14p	7460	14p	74100	78p
7421	19p	7472	22p	74107	22p
7422	19p	7473	24p	74109	24p

CMOS

4000	10p	4020	42p	4042	38p
4001	10p	4021	40p	4043	40p
4002	12p	4022	45p	4044	40p
4006	50p	4023	16p	4046	40p
4007	14p	4024	33p	4047	35p
4008	36p	4025	12p	4048	38p
4009	24p	4026	75p	4049	21p
4010	24p	4027	20p	4050	21p
4011	10p	4028	40p	4051	42p
4012	15p	4029	45p	4052	48p
4013	20p	4030	14p	4053	48p
4014	45p	4031	125p	4054	78p
4015	40p	4034	140p	4055	80p
4016	20p	4036	249p	4059	430p
4017	30p	4039	280p	4060	42p
4018	45p	4040	40p	4063	80p
4019	25p	4041	40p	4066	22p

Free — Satin Gold Biro
With all orders over £3.00 in "June and July" '83

TRAIN FOR SUCCESS
in Television, Radio & Electronics

ICS have helped thousands of ambitious people to move up into higher paid more secure jobs in the field of electronics—now it can be your turn. Whether you are a newcomer to the field or already working in the industry, ICS can provide you with the specialised training so essential to success.

Personal Tuition and Guaranteed Success

The expert and personal guidance by fully qualified tutors, backed by the ICS guarantee of tuition until successful, is the key to our outstanding record in the technical training field. You study at the time and pace that suits you best and in your own home. In the words of one of our many successful students: "Since starting my course, my salary has trebled and I am expecting a further increase when my course is completed."

City and Guilds Certificates

Excellent job prospects await those who hold one of these recognised certificates.
ICS can coach you for:

Basic Electronic Engineering (C & G/ICS)
Radio Amateurs

Certificate Courses

TV & Audio Servicing
TV, Radio and Audio Engineering
Radio & Amplifier Construction
Electronic Engineering*
Computer Electronics*
Industrial Electronics*
Radio Frequency Electronics*
Electrical Engineering*
Electrical Contracting & Installation

*Qualify for IET Associate Membership

CACC — Approved by CACC
ICS — Div. National Education Corporation
ABCC — Member of ABCC

FREE BOOK

Please send me your FREE School of Electronics Prospectus

Subject of interest ______________________

Name ______________________

Address ______________________

____

ICS
Dept K265
ICS School of Electronics
160 Stewarts Road
London SW8 4UJ

01 622 9911 (All Hours)

SERVICE SHEET

Enquiries

We receive a very large number of enquiries. Would prospective enquirers please note the following points:

- We undertake to do our best to answer enquiries relating to difficulties with ETI projects, in particular non-working projects, difficulties in obtaining components, and errors that you think we may have made. We do not have the resources to adapt or design projects for readers (other than for publication), nor can we predict the outcome if our projects are used beyond their specifications;
- Where a project has apparently been constructed correctly but does not work, we will need a description of its behaviour and some sensible test readings and drawings of oscillograms if appropriate. With a bit of luck, by taking these measurements you'll discover what's wrong yourself. Please do not send us any hardware (except as a gift!);
- Other than through our letters page, Read/Write, we will not reply to enquiries relating to other types of article in ETI. We *may* make some exceptions where the enquiry is very straightforward or where it is important to electronics as a whole;
- **We will not reply to queries that are not accompanied by an SAE** (or international reply coupon). **We are not able to answer enquiries over the telephone.** We try to answer promptly, but we receive so many enquiries that this cannot be guaranteed.
- Be brief and to the point in your enquiries. Much as we enjoy reading your opinions on world affairs, the state of the electronics industry, and so on, it doesn't help our already overloaded enquiries service to have to plough through several pages to find exactly what information you want.

Subscriptions

The prices of ETI subscriptions are as follows:

UK:	£13.15
Overseas:	£16.95 Surface Mail
	£36.95 Air Mail

Send your order and money to: ETI Subscriptions Department, 513 London Road, Thornton Heath, Surrey CR4 6AR (cheques should be made payable to ASP Ltd). Note that we run special offers on subscriptions from time to time (though usually only for UK subscriptions, sorry).

ETI should be available through newsagents, and if readers have difficulty in obtaining issues, we'd like to hear about it.

Backnumbers

Below we list the backnumbers that are available from our backnumbers department. Please note that this list will be out of date if you use an old copy of the magazine. Backnumbers cost £1.50 (UK or overseas by surface mail) and are available from: ETI Backnumbers Department, 513 London Road, Thornton Heath, Surrey CR4 6AR (cheques should be made payable to ASP Ltd).

Even if the copy of ETI you need is not listed, all may not be lost, because we run a photocopying service. For £1.50 (UK and overseas) we will photocopy an entire article (note that parts of a series of articles count as separate articles). Your request should clearly state what article you require and the month and year in which it appeared (the index for 1980 and 1981 was published in January 1982, and the index for 1982 appeared in December 1982). Send your request to ETI Photocopies, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC2H 0EE (cheques should be made out to ASP Ltd).

November 78	June 81
November 79	November 81
April 80	December 81
September 80	March 82
October 80	May 82
November 80	June 82
December 80	July 82
January 81	August 82
February 81	September 82
March 81	October 82
April 81	December 82
May 81	February 83

Write For ETI

We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you you all the boring details.

We don't bother with the bureaucracy for Tech Tips — all you do is to send in your idea, stating clearly if you want an acknowledgement of receipt. If possible, please *type* your explanation of why the circuit is different, what it does and how it works, on a separate sheet from the circuit diagram; both sheets should carry your name, address and the circuit title. We'll let you know (within a month or so) if we want to use your Tech Tip.

Trouble With Advertisers

So far as we know, all our advertisers work hard to provide a good service to our readers. However, problems can occur, and in this event you should:

1. Write to the supplier, stating your complaint and asking for a reply. Quote any reference number you may have (in the case of unsatisfactory or incomplete fulfilment of an order) and give full details of the order you sent and when you sent it.
2. Keep a copy of all correspondence.
3. Check your bank statement to see if the cheque you sent has been cashed.
4. If you don't receive a satisfactory reply from the supplier within, say, two weeks, write again, sending your letter recorded delivery, or telephone, and ask what they are doing about your complaint.

If you exhaust the above procedure and still do not obtain a satisfactory response from the supplier, then please drop us a line. We are not able to help directly, because basically the dispute is between you and the supplier, but a letter from us can sometimes help to get the matter sorted out. But please, don't write to us until you have taken all reasonable steps yourself to sort out the problem.

We are a member of the mail order protection scheme, and this means that, subject to certain conditions, if a supplier goes bankrupt or into liquidation between cashing your cheque and supplying the goods for which you have paid, then it may be possible for you to obtain compensation. From time to time, we publish details of the scheme near our classified ads, and you should look there for further details.

OOPS!

We have in the past published small corrections to projects on the letters page, and major corrections separately. From now on corrections will appear on this page, and will be repeated for several months (just to increase our embarrassment). If a correction is too large to fit on here, we will publish it just once, but will note the fact that a correction does exist, and that copies of it can be obtained from us provided you send in an SAE. But please — request copies only if you really do need them; if this service is abused, we may be forced to withdraw it.

ZX A to D (Jan '83)
D2 is shown the wrong way round on the overlay; wires on the RH side of the switch SW1 should go to top contacts. Some of the early PCBs had an error: pins 2 & 4 of IC1 should go to pin 16 (top) of edge connector (published foil pattern is OK).

Stage Lighting Unit (Jan, Feb, April, May '83)
Transformer specs are as follows: Primaries all 250 V; secondaries T1: 0-6, 0-6 V, 12 VA tot; T2: 0-12, 0-12 V, 12 VA tot; T3: 0-6 V, 3 VA. ICs 34, 35, 36 are 7805 5V regulators.

ZX Sound Board Design Comp. results, Feb '83)
The first line of the program has to be entered in reverse order to get it to go in (COS, GOSUB, COPY, ASN and RND are functions). The line should read:

```
10 REM :"Y - =?COS GOSUB 5 COP
Y ??ASN ?RNDF??RND
```

Alarm Module (MArch '83)
R21 is 220k (parts list OK, circuit diagram wrong) Q5 is BC182L (left off parts list).

Max Min Thermemeter (April '83)
A revised foil pattern was published in July ETI. To get original PCB to work, replace D4 and D5 with wire links, cut tracks from pins 7 and 8 on IC6, and solder 15k resistor across cut — remove ICs while doing this! (It's messy but it works.)

Real Time Clock (April '83)
Frequency of XTAL1 is 32.768 kHz.

NDFL Power Amplifier (May '83)
C13 is 33p (parts list correct, circuit diagram wrong). Table 1: lengths of wire quoted do not allow for lead lengths — add 40 mm or so to them. This is particularly important for L3. Resistors R29 and R30 can be wire-wound types, it isn't necessary to use carbon types (thier inductance will be small).

Flash Sequencer (July '83)
Q1 should be BC184L; Q2-5 should be BC182L.

Subscription Order Form

To: ETI Subscriptions Department, 513 London Road, Thornton Heath, Surrey, CR4 6AR, England.

Please commence my subscription to Electronics Today International. I enclose a cheque*/Postal Order*/International Money Order* for the appropriate fee*, made out to ASP Ltd.

Please debit my Access*/Barclaycard* account number*

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Signature ....

(* delete as appropriate)

Please indicate subscription required and fee enclosed

UK & Rep of Ireland:	UK £13.15	☐
Overseas surface mail:	£16.95	☐
Overseas air mail:	£36.95	☐

Until further notice, each subscription includes a free binder (normal price £4.25)

PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS

Name ....

Address ....

....

....

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE

Date of order..

THIS COUPON IS VALID UNTIL: 30th SEPTEMBER 1983

Binder Order Form

To: ETI Binders, 513 London Road, Thornton Heath, Surrey CR4 6AR, England.

Please send me..binder(s) for ETI. I enclose a cheque*/Postal Order*/International Money Order* to the value of £4.25 per binder required, made out to ASP Ltd (* please delete as appropriate).

Total money enclosed £..

PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS

Name..

Address ....

....

....

....

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE

Date of order..

Note that binders cost the same for UK and overseas; overseas orders will be send by surface mail.

THIS COUPON IS VALID UNTIL: 30th SEPTEMBER 1983

Backnumber Order Form

To: ETI Backnumbers Department, 513 London Road, Thornton Heath, Surrey CR4 6AR, England.

Please supply me with the following backnumber(s) of ETI

Month .... Year ....

Month .... Year ....

Month .... Year ....

I enclose cheque*/Postal Order*/International Money Order* to the value of £1.50 per magazine ordered, made out to ASP Ltd (* delete as appropriate).

Total money enclosed £..

PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS

Name..

Address ....

....

....

....

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE

Date of order..

Note that the cost is the same for orders from overseas as for UK orders; overseas orders will be sent by surface mail.

PLEASE CHECK THAT THE BACKNUMBER YOU REQUIRE IS AVAILABLE BEFORE ORDERING.

THIS COUPON IS VALID UNTIL: 30th SEPTEMBER 1983

Photocopy Order Form

To: ETI Photocopies Department, 145 Charing Cross Road, London WC2H 0EE, England.

Please supply me with the following photocopies:

Month...............Year .... Article ....

....Page No...............

Month...............Year .... Article ....

....Page No...............

I enclose cheque*/Postal Order*/International Money Order to the value of £1.50 per photocopy ordered, made out to ASP Ltd (* delete as appropriate).

Total money enclosed £..

PLEASE COMPLETE YOUR NAME AND ADDRESS IN BLOCK CAPITALS

Name..

Address ....

....

....

....

PLEASE INCLUDE POSTAL CODE AS APPROPRIATE

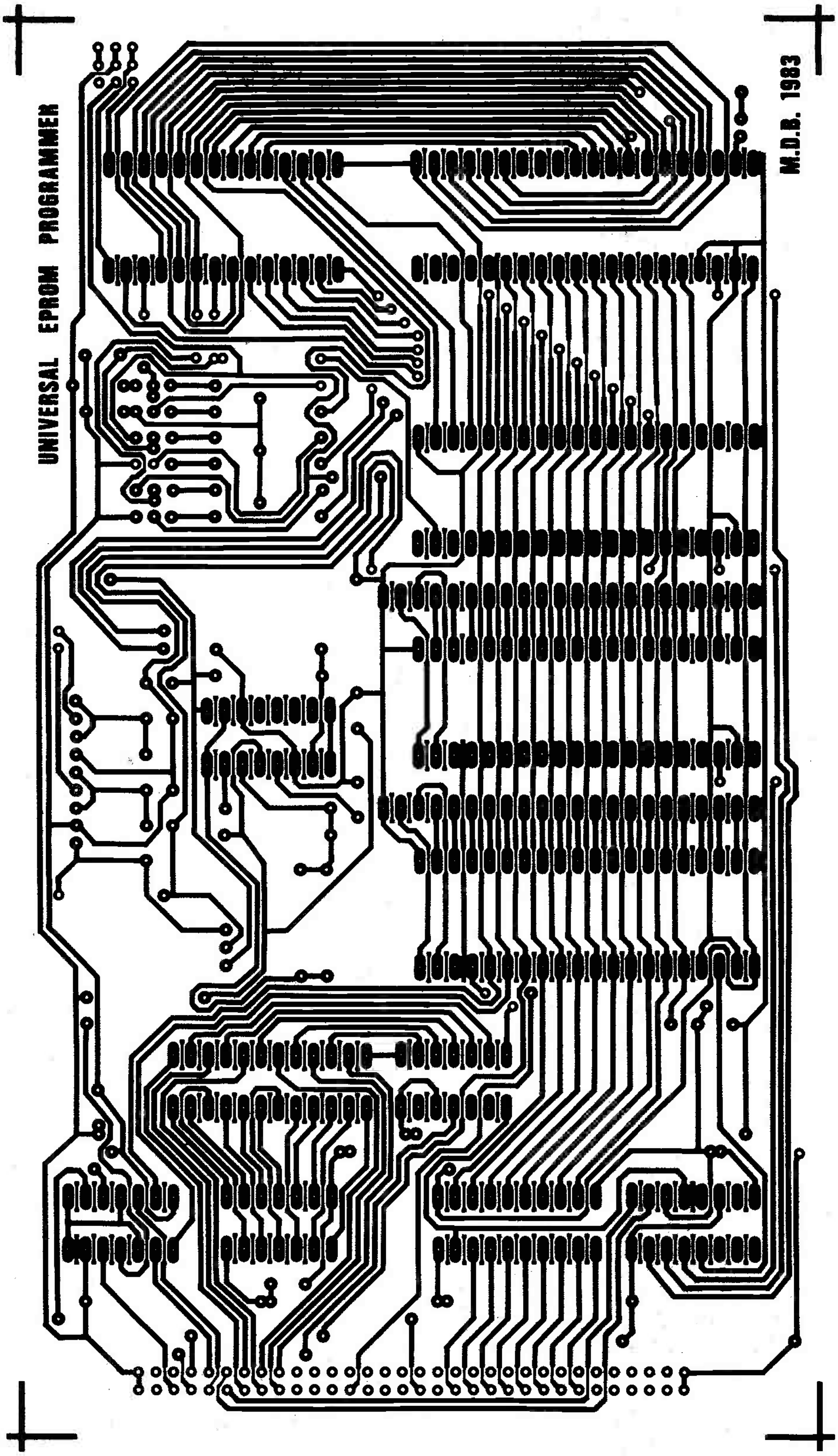
Date of order..

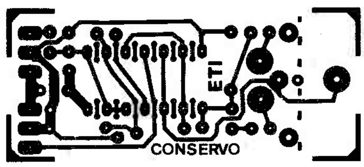
Note that the cost is the same for overseas orders as for UK orders; overseas orders will be sent by surface mail.

PLEASE REMEMBER TO INCLUDE MONTH AND YEAR WHEN ORDERING.

THIS COUPON IS VALID UNTIL: 30th SEPTEMBER 1983

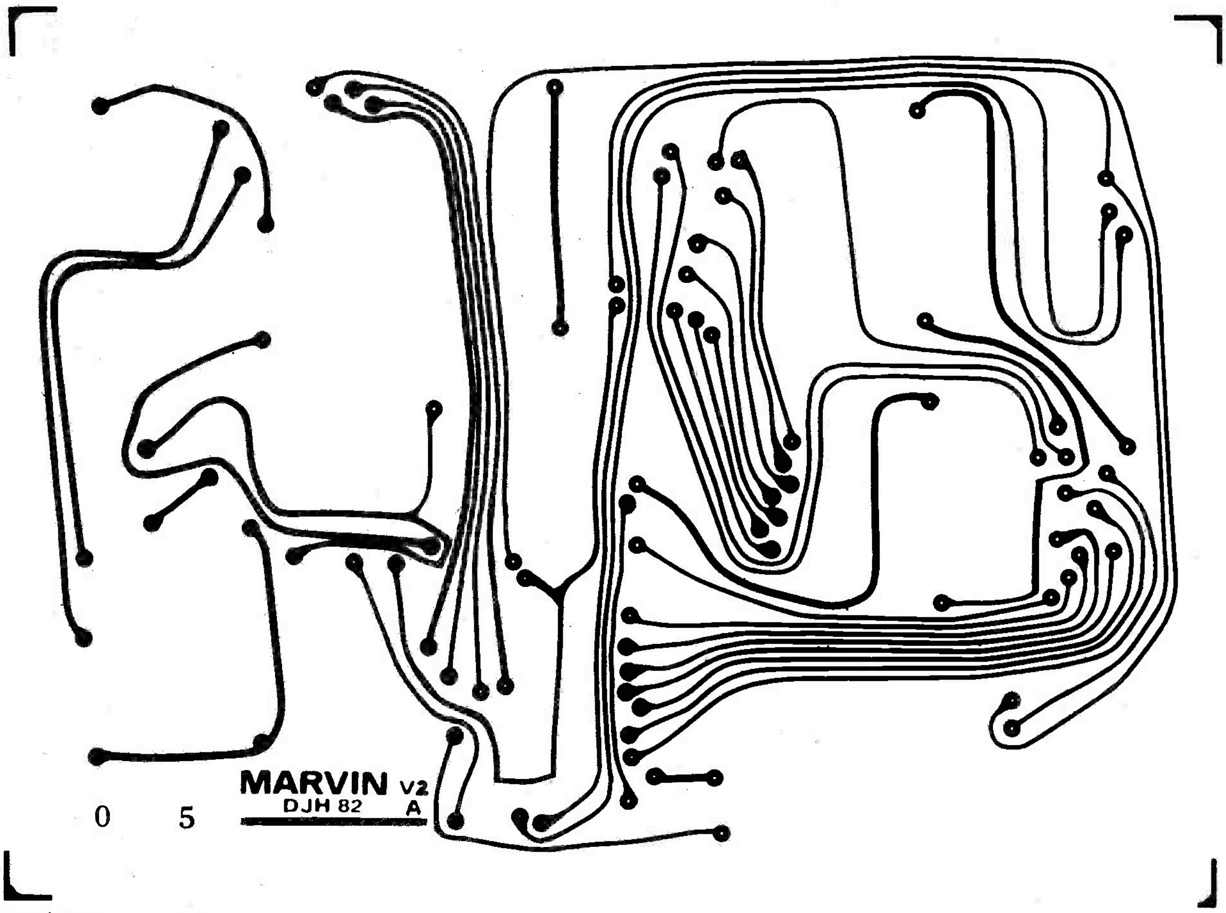
PCB FOIL PATTERNS



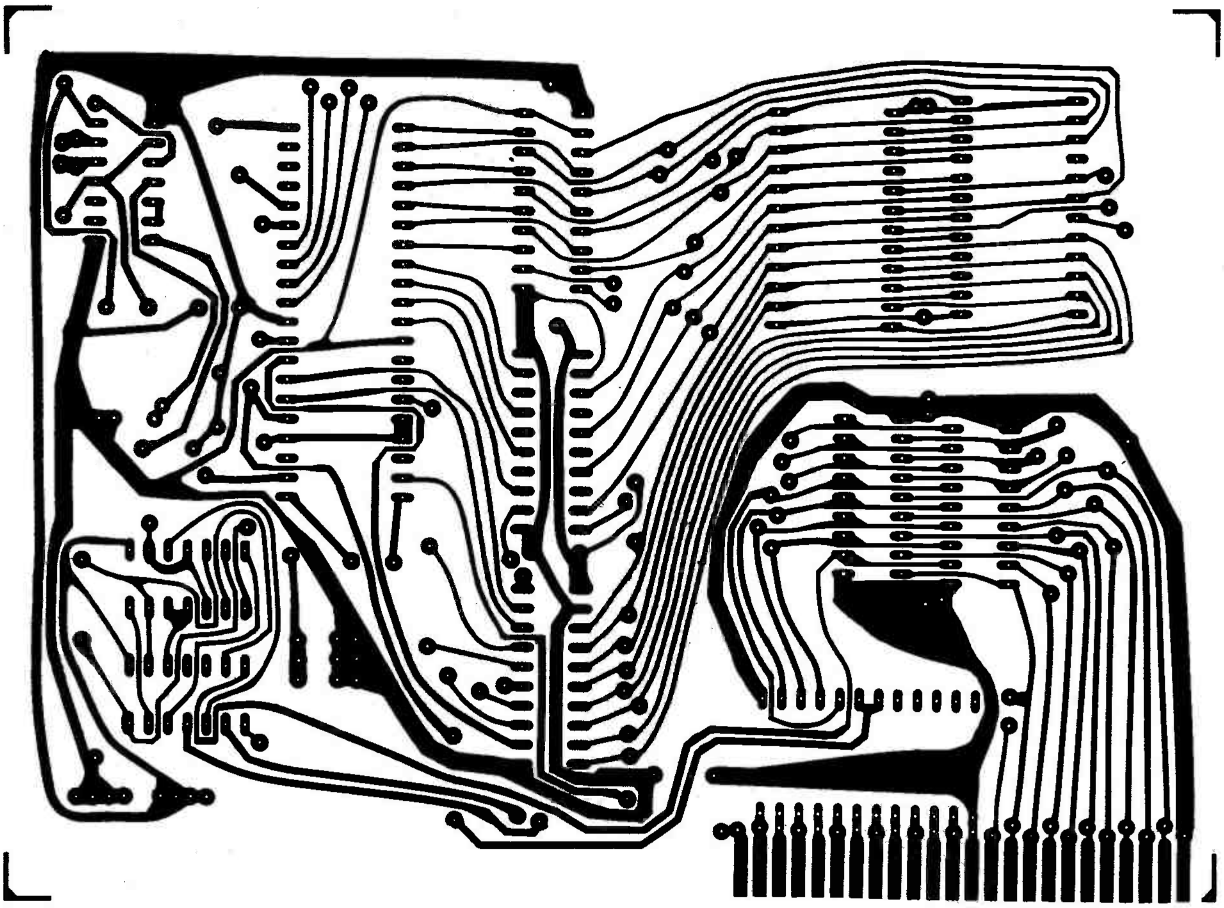


The Servo Fail-Safe

Universal EPROM Programmer



Marvin (component side)



Marvin (solder side)

VIDEO GAMES

ATARI

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
Trigs Commd
Vid Command
Wicos
Zircon

ACCESS Misc
Video Storage
Units

ACTIVISION
Barnstorming
Boxing
Bridge
Chopper Cmd
Dolphin
Oragstar
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 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.

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

£79

ATARI/Contd
Super Brkout
Surround
Swordquest E
Swordquest F
Tennis (rlspt)
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
Comunst Mut
Dragonstmper
Escape from M
Fire Ball
Killer Satellite
Phaser Patrol
Suicide Mission

TELESYS
Coconuts
Cosmic Creeps
Demoltn Herby
Fast Food
Ram - It

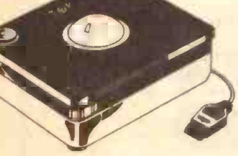
TIGERVISION
Jawbreaker
King Kong
Marauder
Miner 2049er
Polaris
River Patrol
Threshold

ZIMAG
Cosmic Coridor
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.

MATTEL CONSOLE £85.22 + VAT = £98.00

£98

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: .... ZETI 0883

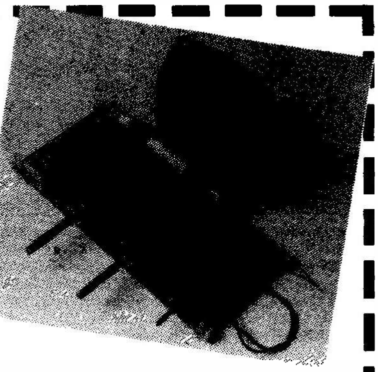
FREE LITERATURE

01-309 1111

SILICA SHOP

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

EDUCATIONAL ELECTRONIC KITS



RADIO KIT

This AM radio is supplied with building instructions plus comprehensive electronic theory, exercises and test procedure. A complete learning package, requiring only a 9V battery.

The large fibreglass printed circuit board has been designed in 3 sections — a TRF radio, a bass treble control and an amplifier push-pull output circuit. Each section can be built and tested as a separate project.

This comprehensive radio circuit shows an application of tuned circuits, I.C.'s, field effect and bipolar transistors, common emitter and collector configurations, stabilizer circuits, feedback circuits, complementary output stages, etc.

The radio project kit should given entertainment and interest to the novice, yet provide valuable learning material for the electrical student. Particularly relevant to current T.E.C. electronic courses.

The price is only **£16.70** inc. VAT + £1.50 p&p. (Allow 28 days delivery).

Educational and quantity enquiries welcome.

Send cheque or postal order to:-

HAZZLEWOOD ELECTRONICS LTD.,
Sales Department,
149 Main Street,
Grenoside,
Sheffield, S30 3PN.
Tel: 0742 463585

Send an S.A.E. to receive a list of our current electronio project kits.

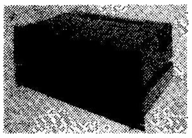
For Hi-Fi & Electronics Enthusiasts!

Concept Electronics Ltd.

51 Tollington Road, London N7 6PB

We are the specialist of electronic kits and rack mounting cabinets. A catalogue with complete range of products including pre-amp modules, power amp modules, pre and power amplifier modules, complete kits of amplifiers, equalizers, reverberation amplifiers (with cases), alarm clocks, appliance timers, CB amplifiers, test equipment, control modules, music generator, battery fluorescent light and high quality rack mounting cabinets etc. with illustrative pictures now available at the cost of 35p + 25p p&p.

Professional rack mounting cabinet



● Suitable for high quality amplifiers and many other purposes ● Top, bottom and rear cover removable for access ● Separate front mounting plate ● Front panel is made of black anodised aluminium, the rear box is manufactured from steel painted in black ● With ventilation slits and plastic feet ● Heavy gauge front panel is of brushed aluminium finish

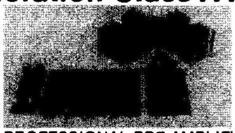
Panel Size W H (inch)	Rear Box W H D	Inc VAT £
19x5	17x4.5x10	**23.54**
19x4	17.3.5x10	**21.24**
19x3.5	17x3x10	**20.09**
19x2.5	17x2x10	**18.94**
19x6	17x5.5x12	**24.69**
19x5	17x4.5x12	**23.54**
19x4	**17x3.5x12**	**21.24**
19x3.5	17x3x12	**20.09**
17x3.5	15.5x3x9	**17.79**
17x2.5	15.5x2x9	**16.64**
17x4	15.5x3.5x12	**21.24**
17x3	15.5x2.5x12	**20.09**

* Please add £2.00 p&p per item

The above sizes are also available in black anodised aluminium. Front panel & rear box are both wholly made of black anodised aluminium sheets at only £4.00 extra per item.

Second Generation Class A Amplifiers

Mail order only



TA-1020A DC CLASS A PROFESSIONAL PRE-AMPLIFIER
TA-1000A 100W DYNAMIC BIAS CLASS A POWER AMPLIFIER
TY-25A SUPER SPEAKER PROTECTOR

TA-1020Ax1	£25.50 (kit)	TA-1000Ax2	£55.00 (kit)
TA-1000Ax2	£55.00 (kit)	TY-25Ax1	£6.75 (kit)
TY-25Ax1	£6.75 (kit)		
Total	£87.25	Total	£61.75

Special offer kit £69.99 + £2.50 p/p
Ass £86.99 +£2.50 p/p

Special offer kit £49.99 + £2.00 p/p
Ass £60.99+ £2.00 p/p

The above offer ends 31 August 1983
Note: discount voucher not valid

Price inc. VAT

E.T.I. KITS

Full Kits Inc. PCBs, hardware, electronics, cases (unless stated). Less batteries.

ZX ADC Jan 83 .... **£34.98**
BALANCED INPUT PREAMP May 83 less case **£10.99**
COMPRESSOR/LIMITER May 83 less case **£19.43**
MAX/MIN THERMOMETER Apr 83 .... **£43.78**
LOGIC PROBE Mar 83 less case **£6.96**
ALARM MODULE Mar 83 .... **£24.57**
DUAL LOGIC PROBE Sept 82 .... **£14.99**
AUTO VOLUME CONTROL Sept 82 **£4.28** less case
INSULUATION TESTER May 82 .... **£17.57**
HIGH QUALITY PHONE AMPLIFIER Feb 82.
MOVING COIL STAGE less case **£19.75**
MOVING MAGNET STAGE less case **£19.69**
PEST CONTROL Feb 82 .... **£7.45**
GUITAR TUNER Jan 82 .... **£31.87**
COMPONENT TESTER Dec 81 .... **£8.78**
CAR ALARM Nov 81 .... **£19.77**
SOUND BENDER Oct 81 .... **£22.84**
WATCHDOG SECURITY ALARM Aug 81 ... **£47.66**
RECHARGEABLE BATTERY extra **£19.96**
HANDCLAP SYNTHESISER Aug 81 .... **£32.98**
WAH PHASE June 81. Less pedal **£14.78**
LED JEWELLERY June 81. Cross **£2.96**
Star **£9.91** Spiral **£7.98**
GUITAR NOTE EXPANDER April 81 .... **£17.98**
DRUM MACHINE April 81 .... **£65.97**
ENGINEERS STETHOSCOPE Mar 81 ..... **£20.98**
SOUND PRESSURE LEVEL METER Feb 81 **£43.98**
INFRA RED ALARM Feb 81 .... **£59.98**
4 INPUT MIXER Dec 80 .... **£21.74**
MUSICAL DOORBELL Dec 80 .... **£12.77**
METRONOME Nov 80 .... **£6.58**
ULTRASONICBURGLARALARM Aug 80 ... **£29.50**
CAPACITANCE METER Aug 80 .... **£22.28**
CMOS LOGIC TESTER Aug 80 .... **£11.98**
CLICK ELEMINATOR April 79 **£67.70** Or less case **£49.98**

MAGENTA ELECTRONICS LTD
EG31, 135 Hunter St., Burton-on-Trent
Staffs., DE14 2ST. Mail Order Only
Add 45p p&p to all orders. Prices include VAT. Access & Visa phone/post

Official school orders welcome.
OVERSEAS: Payment must be in sterling.
IRISH REPUBLIC + BFPO — UK PRICES.
EUROPE: UK PRICES + 10%.
ELSEWHERE: WRITE FOR QUOTE.

HORIZON ELECTRONICS

(Midands)

Dept H/E Charlotte St. Rugby Tel: 78138

Prime quality. TERRIFIC PRICES. Mail order only

REGULATORS (5/12/15V)

100mA +ve	28p
1 amp +ve	33p
723 var	28p

ZENERS (3 3 to 30V)

500mW	6p
1 3 watt	12p

DIODES

IN 4001	3p
4002	4p
4004/6	6p
IN 5401	12p
5405	13p
5406	14p

BRIDGES

1 amp 50v	20p
2 amp 100v	30p
2 amp 200v	35p
2 amp 400v	38p
6 amp 100v	45p
6 amp 200v	65p
6 amp 400v	75p
10 amp 50v	170p
10 amp 100v	180p
10 amp 200v	195p

THYRISTORS (plastic)

4 amp 400v	35p
8 amp 400v	60p

TRIACS (plastic)

4 amp 400v	50p
8 amp 400v	60p
25 amp 400v	168p

TOGGLE SWITCHES

Min. SP ST	57p
Min DP DT	70p
S. Min SP ST	46p
S. Min DP DT	62p

TRANSISTORS

BC107B	9p	BFY50	20p
BC108B	9p	BF178	25p
BC109B	10p	BF179	30p
BC140	25p	BF257	30p
BC142	22p	BF258	30p
BC160	35p	BF259	33p
BCY70	15p	BFX85	27p
BCY71	15p	BFX86	28p
BC182	7p	BFX87	26p
BC212	7p	BFX88	25p
BC237	8p	BFY51	22p
BC337	8p	TIP31B	35p
BD139	32p	TIP32B	38p
BD139	33p	VN10KM	50p
BD140	33p	VN66AF	65p
BD149	32p	VN88AF	95p

LINEAR IC's

747	50p
748	33p
ICM 7555	70p
ICM 7556	130p
LF 351	40p
LF 353	70p
LM 301A	24p
LM 324	27p
LM 380	60p
LM 3909	66p
NE 567v	65p
TDA 2020	285p
TDA 2002	185p

SOLDERING IRONS

Antex C 15w	445p
CCN 15w	465p
X25 25w	470p
All bits	60p

LED's

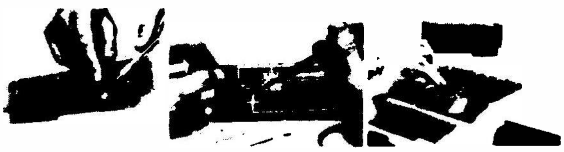
.22" Red	7p
.22" Green	8p
.2" Yellow	8p

'D' (Min) connectors

15 way plug	86p
Socket	128p
Cover	99p
25 way plug	122p
Socket	190p
Cover	99p

ABOVE: Just a few exmples Send S.A.E./List
ADD: 65p p&p to all orders under £5.00
VAT: add 15% VAT to total order value

THE "INSTANT" PC BOARD



E-Z CIRCUIT. . . "quick, easy & reliable . . . the best way to make one or two-of-a-kind PC boards"! That's what "Doc" Savage (hobby editor, Radio Electronics magazine) says about E-Z CIRCUIT.

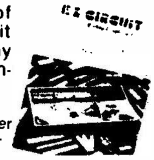
Why all the excitement?

Simple, E-Z CIRCUIT's exclusive 1 oz., pressure-sensitive copper tapes & patterns apply directly to the PC board, creating an actual current carrying circuit. Simply apply E-Z CIRCUIT's Copper Mounting Configurations to the board, solder your components into place, and you have a professional, production quality PC board . . . *instantly* . . . with*out* artwork, photography, screening or etching.

There's no need to worry about mistakes either. With E-Z CIRCUIT's special two-phase adhesive, you can make corrections, modifications or improvements quickly & easily . . . without damaging the performance or appearance of your PC board.

For building, prototyping or repairing PC boards instantly, E-Z CIRCUIT truly is the *quick, easy, reliable way!*

Prove it to yourself, send for your FREE copy of the E-Z CIRCUIT Copper Products Printed Circuit Technical Manual & Catalog EZ-3001. See why "Doc" Savage & thousands of other users recommend E-Z CIRCUIT for instant PC boards.



Send for your FREE E Z CIRCUIT Printed Circuit Copper Products Technical Manual & Catalog EZ 3001

Engineering & Electronic Design Services Ltd.

Unit 7, Enterprise Centre, Childers Road, Limerick. IRELAND Tel: (061) 49366

ETI PCB SERVICE

Up until now PCBs were always the hardest component to obtain for a project. Of course you *could* make your own, but why bother anymore?
Now you can buy your boards straight from the designers — us! As of this issue all (non-copyright) PCBs will be available automatically from the ETI PCB Service. Each board is produced from the same master used to build our prototypes, so you can be sure it's accurate and will be finished to the high standard you would expect from ETI.
In addition to the PCBs for this month's projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please note that NO OTHER BOARDS ARE AVAILABLE. If it's not listed, we don't have it!

ALWAYS QUOTE THE PCB CODE WHEN ORDERING PLEASE

1979

- ☐ E/794-1 Guitar Effects Unit 2.64
- ☐ E/794-2 Click Eliminator 6.64
- ☐ E/796-1 Accented Beat Metronome 3.60

1980

- ☐ E/803-1 Signal Tracer 2.27
- ☐ E/808-1 CMOS Logic Tester. 2.64
- ☐ E/808-3 Ultrasound Burglar Alarm . 2.87
- ☐ E/8010-1 Cassette Interface 2.93
- ☐ E/8010-2 Fuzz/Sustain Box 3.27
- ☐ E/8011-5 RIAA Preamp 1.93
- ☐ E/8011-6 Audio Test Oscillator . . . 3.13
- ☐ E/8012-1 Musical Doorbell 2.80
- ☐ E/8012-3 Four Input Mixer 2.64

1981

- ☐ E/811-1 LED Tacho 4.13
- ☐ E/811-2 Multi-Option Siren 3.20
- ☐ E/813-1 Universal Timer. 3.31
- ☐ E/812-1 IR Alarm (4 boards) 6.64
- ☐ E/812-5 Pulse Generator. 3.57
- ☐ E/813-1 Engineer's Stethoscope. . . 2.65
- ☐ E/814-2 Drum Machine (2 boards) . 5.60
- ☐ E/814-4 Guitar Note Expander . . . 3.20
- ☐ E/816-8 Waa-Phase 1.53
- ☐ E/816-9 Alien Attack. 3.48
- ☐ E/817-1 System AS- Input (MM or MC). 2.65
- ☐ E/817-2 System A — Preamp 5.17
- ☐ E/817-3 Smart Battery Charger . . . 1.97
- ☐ E/818-3 Hand Clap Synth 3.97
- ☐ E/818-5 Watchdog Home Secuity (2 boards). 5.31
- ☐ E/819-1 Mains Audio Link (3 boards) 7.35
- ☐ E/819-4 Laboratory PSU. 4.53
- ☐ E/8110-1 Enlarger Timer. 3.40
- ☐ E/8110-2 Sound Bender 2.65
- ☐ E/8111-1 Voice Over Unit 3.97
- ☐ E/8111-2 Car Alarm 2.81
- ☐ E/8111-3 Phone Bell Shifter. 2.96
- ☐ E/8112-1 Alcohometer (2 boards) . 5.21
- ☐ E/8112-3 Bodywork Checker 1.75
- ☐ E/8112-4 Component Tester 1.49

1982

- ☐ E/821-1 Parking Timer. 2.20
- ☐ E/821-3 Guitar Tuner (2 boards) . . 5.55
- ☐ E/822-1 Ripple Monitor 1.92
- ☐ E/822-2 Allez Cat Pest Repeller. . . 1.68
- ☐ E/822-5 Moving Magnet Stage. 3.49
- ☐ E/822-6 Moving Coil Stage. 3.49
- ☐ E/823-4 Capacitance Meter (2 Bd) 10.14
- ☐ E/824-5 Voltage Monitor 1.86
- ☐ E/825-1 DV Meg 2.72
- ☐ E/825-2 Analogue PWM 3.06
- ☐ E/825-3 Slot Car Controller 4.51
- ☐ E/826-1 Ion Generator (3 Bds) . . . 8.00
- ☐ E/826-4 MOSFET Amp Module. . . 6.78
- ☐ E/826-5 Logic Lock 3.06
- ☐ E/826-6 Digital PWM 3.34
- ☐ E/826-7 Optical Sensor. 1.74
- ☐ E/826-9 Oscilloscope (4 Boards) . 11.60
- ☐ E/827-7 TV Bargraph Main 4.56
- ☐ E/827-3 TV Bargraph Channel . . . 2.28
- ☐ E/827-4 Hotwire 2.63
- ☐ E/827-5 Bridging Adaptor 2.38
- ☐ E/828-1Playmate (3 Boards). 7.20
- ☐ E/828-4 Kitchen Scales. 1.84
- ☐ E/828-5 Sound Track. 4.25
- ☐ E/829-1 Auto Volume Control . . . 1.84
- ☐ E/829-2 Dual Logic Probe 1.93
- ☐ E/8210-1 Message Panel (2 Boards) 10.70
- ☐ E/8211-4 Pulse Generator 5.29
- ☐ E/8212-1 ELCB 2.41
- ☐ E/8212-2 Servo Interface (2 Boards) 5.87
- ☐ E/8212-4 Spectracolumn. 4.82

1983

- ☐ E/831-1 Fuel Guage 3.00
- ☐ E/831-2 ZX ADC 2.25
- ☐ E/831-3 Programmable PSU. 3.00
- ☐ E/833-1 Sound Board 11.16
- ☐ E/833-2 Alarm Module. 3.15
- ☐ E/833-3 ZX81 User Graphics 0.93
- ☐ E/833-4 Logic Probe 2.17
- ☐ E/834-1 Real Time Clock 7.60
- ☐ E/834-2 Thermemeter (2 Boards). . 8.47
- ☐ E/834-4 Stage Lighting — Main . . 11.94
- ☐ E/834-5 Stage Lighting — Display. . 3.00
- ☐ E/835-1 Compressor/Limiter 5.38
- ☐ E/835-2 Single PSU. 2.75
- ☐ E/835-3 Dual PSU 3.49
- ☐ E/835-4 60 W NDFL Amp. 4.70
- ☐ E/835-5 Balanced Input Preamp . . 2.81
- ☐ E/835-6 Stage Lighting — Autofade 5.38
- ☐ E/835-7 Stage Lighting — Triac Board 4.12
- ☐ E/836-1 to 3 PseudoROM (3 Bds) . 3.15
- ☐ E/836-4Immersible Heater. 2.00
- ☐ E/836-5 Atom Keypad 4.50
- ☐ E/837-1 Flash Sequencer. 2.32
- ☐ E/837-2 Trigger Unit Main Board . . 2.32
- ☐ E/837-3 Trigger Unit Transmitter. . 1.44
- ☐ E/837-4 Switched Mode PSU . . . 14.00
- ☐ E/838-1 Graphic Equaliser. 7.91
- ☐ E/838-2 Servo Fail-Safe (four off) . 2.55
- ☐ E/838-3 Universal EPROM prog. . . 8.38

What The PCB Code Means

The first two numerals indicate the year in which the project was published; the third the year. The numeral after the dash uniquely identifies the board within those boards published that month.

STRICLY CASH WITH ORDER — OFFICIAL ORDERS ARE NOT ACCEPTED

Prices Quoted are valid until 1st November 1983

How to order: indicate the boards required by ticking the boxes and send this page, together with your payment, to: ETI PCB Service, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC2H 0EE. Make cheques payable to ETI PCB Service. Payment in sterling only please. Prices subject to change without notice.

Total for boards	£. . . . .
Add 45p p & p	0. 45
Total enclosed	£. . . . .

PLEASE ALLOW 28 DAYS FOR DELIVERY

Signed. . . . .

Name . . . .

Address. . . . .

. . . .

. . . .

WILMSLOW AUDIO
The firm for Speakers

Bigger and Better

the colourful Wilmslow Audio brochure – the definitive loudspeaker catalogue!

Everything for the speaker constructor – kits, drive units, components for HiFi and PA.

50 DIY HiFi speaker designs including the exciting new dB Total Concept speaker kits, the Kef Constructor range, Wharfedale Speakercraft, etc.

Flatpack cabinet kits for Kef, Wharfedale and many others.

★ Lowest prices — Largest stocks ★
★ Expert staff — Sound advice ★
★ Choose your DIY HiFi Speakers in the comfort of our ★ two listening lounges
(Customer operated demonstration facilities)
★ Ample parking ★

Send £1.50 for catalogue
(cheque, M.O. or stamps – or phone with your credit card number)

★ Access – Visa – American Express accepted ★
also HiFi Markets Budget Card.

WILMSLOW AUDIO
The firm for Speakers

0625 529599

35/39 Church Street, Wilmslow, Cheshire SK9 1AS

Lightning service on telephoned credit card orders!

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 . . . .

ETI/8/817 BLOCK CAPS PLEASE

MULTIMETERS
(UK C/P 65p)

RANGE DOUBLER 10A DC1 Special price £15.95
ETC 5000/5001 121 Ranges 50K/V Range Doubler 10A DC £16.50
TMK 500 23 Ranges 30K/V 12A DC Plus cont. buzzer £23.95
NH56R 20K/V 22 Range Pocket £10.95
360TR 23 Range 100K/V. Large scale 10A AC/DC plus Hfe £36.95
ATI 020 18 Range 20K/V. DeLuxe plus Hfe Tester £17.50
ST303TR 21 Range 20K/V plus Hfe Tester £16.95

SPEAKERS
(Hi-Fi, P.A., Disco, Bass Guitar)

8" 60W . . . **£11.95**
10" 50W . . . **£12.95**
12" 100W . . . **£26.95**
18" 100W . . . **£39.95**

MOTOROLA PIEZO TWEETERS IN STOCK
RETAIL ● MAIL ORDER
EXPORT ● INDUSTRIAL
EDUCATIONAL

Order by Post with cheques, Access/Visa or you can telephone your orders.

ALL PRICES INCLUDE VAT

FREE CATALOGUE SEND LARGE SAE (UK 20p)

MUSICRAFT 303 EDGWARE RD, LONDON W.2. TEL: 01-402 9729/2898

PARNDON ELECTRONICS LTD.
Dept. 23, 44 Paddock Mead, Harlow, Essex. CM18 7RR. Tel: 0279 32700

RESISTORS: ¼ Watt Carbon Film E24 range ± 5% tolerance
Bandoliered and colour coded. Full Range 1RO-10M.
£1.00 per hundred mixed (Min 10 per value) **£8.50** per thousand mixed (Min 50 per value)
Special stock pack 60 values. 10 of each **£5.50**

1 AMP VOLT REG
+ve 5v, 12v, 15v, 24v — **£0.40**
—ve 5v, 12v 15v — **£0.43**

3½ Digit LCD Display: 1 colon, 3 decimal points plus/minus sign and lo bat indicator.
Complete with low power 7106 A/D converter display driver.
Driver set **£8.95**
Display **£3.50** Driver **£6.50**

DIODES: IN4148 **£1.60** per hundred

DIL SOCKETS
8 pin – **10p**. 14 pin – **11p**. 16p pin – **12p**. 18p pin – **19p**. 20p pin – **21p**
22 pin – **23p**. 24 pin – **25p**. 28 pin – **27p** 40 pin – **42p**.

Full List Available — Send SAE
ALL PRICES INCLUDE V.A.T. & POST & PACKING — NO EXTRAS
MIN ORDER — UK £1.00 OVERSEAS £5 CASH WITH ORDER PLEASE
Same Day Despatch

Visual Display Units
Burroughs MT686 VDUs These versatile micro controlled programmable terminals have 3 RCA 1802 CPUs and 64K of memory. 12" Green screen (80 × 25) RS232. 106 key detached keyboard. Can also be used as quality video monitor. **£149** + **£15** carr. WHILE STOCKS LAST.

CENTRONICS 306 LINE PRINTERS

professional fast compact line-printer. 80 columns, 120 char/sec. Parallel i/f. Quality at a silly price. Vertical format unit. To inc. operations manual. **ONLY £149.00.** Carriage (England) £17.50. Tech manual (230 pages) £10.00.

FLOPPY DISC DRIVES
Fantastic MEMOREX 550 8" discs mounted in attractive case with power supply and fan. Shugart standard 50 way interface. Space for second drive. **£199** (carr. £9.50).

MAWSON ASSOCIATES
124 Lennard Rd, Beckenham, Kent BR3 1QP
01-778 3600

WE ALSO BUY COMPUTERS AND COMPUTER PERIPHERALS

Callers welcome by appointment
s/h items sold working but not g'teed

NEW! MODULAR AUTOMATIC TELEPHONE SYSTEM
£24.50 + £1 p&p

Each ready built module is a complete exchange providing up to ten extension lines

- ★ Simply connect 'phones and power supply
- ★ Only two wires to each telephone
- ★ Uses ordinary dial or push-button 'phones
- ★ Complete privacy for conversations
- ★ Range of several miles
- ★ Fully expandable system

Each module allows two 'phones to be used at one time, two modules allows four, etc.

RECONDITIONED TELEPHONES
Push Button Trimphones £15 + £1.80 p&p. 2 for **£28** + £2.50
Push Button 746 £9.75 + £1.80. 2 for **£18** + £2.50
Recent Style Dial Phones £4.75 + £1.80. 2 for **£9** + £2.50. 5 for **£20** + £5
Seconds (in good working order)
Class 1 £3.50 + £1.80. 5 for **£15** + £5
Class 2 (discoloured) **£2.25** + £1.80. 5 for **£9** + £5

UNISELECTORS. 50v, 4 Bank - Homing Bank, 25 way **£3.50**

Desk-top Ten Way Manual Exchange (key & lamp unit) with instructions
£8 + £1.80 P&P

Send S.A.E for free leaflet on telephone systems.

TEMPERATURE GUAGE 0-120°C
Remote sensor on 38" capilliary, panel mounting dial 55mm. dia. Only **£2.50**

16A 240V RANCO THERMOSTAT
Wide control range (low room temp. to over boiling point). Sensor on 22" capillary. **2.30**, including control knob

BUY ONE EACH OF ABOVE FOR £5.50

GEARED Synchronous motor, 8 r.p.m. 240V A.C. 3 Watt **£2.**

SOLENOID GAS VALVE. 240V A.C. 5 P.S.I. suitable for non-corrosive fluids. **£2.20**

BULGIN 3 pin free plug & panel socket. 2A 240V **50p**

DIAL-OUT WITH YOUR COMPUTER. PCB.'s convert binary to dialing pulses and enable your computer to dial-out (with suitable interface). Ex-equipment. Tested. **£12** with explanatory notes.

L.E.M. SERVICES
22 Emscote Road, Warwick, Warwickshire
Tel: 0926 490740

ADD 50p P&P
ORDERS OVER £7.50 POST FREE
unless stated otherwise

ALL ITEMS — MONEY BACK IF NOT DELIGHTED

ELECTROMART

AVON

ANNLEY ELECTRO
190 Bedminster Down Road
Bedminster Down, Bristol
Tel: 0272 632622
Open: Mon-Sat 9am-6.30 pm Wed 9am-2pm

PROGRESSIVE RADIO
93 Dale Street. Tel 051 236 0982
47 Whitechapel, Tel 051 236 5489
Liverpool 2
'THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9.30-5.30

WARWICKSHIRE

HORIZON ELECTRONICS
Charlotte St, Rugby. Tel: Rugby 78138
Open 5 Days 10-6 (closed Wed)
Wide range of components and R.S. stockists
1983 Mail Order Catalogue 75p

LANCASHIRE

ETESON ELECTRONICS
E•E• 15B Lower Green,
Poulton-le-Fylde, Blackpool
Tel: (0253) 885107
Open: 9.30am-12.30, 1.30-5.30. Closed Wed & Sun.
Electronic Component Specialists.

NORTHAMPTONSHIRE

EMOS
* A new company selling electronic components.
* Mail order and walk-round supermarket.
* Vast stocks and very competitive prices.

High March, Daventry. NN11 4HQ.
Telephone 03272 5523. Telex 311245.
(Off A45 opposite John O'Gaunt.)

WORCS/W. MIDLANDS

WAVEBANDS
103 Coventry St., Kidderminster
Components, computers, car radios,
C.B.'s, amateur radio
Spares & Repairs
Open: Mon-Sat 9-6,
TEL: 0562 2179

MERSEYSIDE

MYCA ELECTRONICS
2 VICTORIA PL, SEACOMBE FERRY,
WALLASEY, L44 6NR.
Tel: 051 638 8647
Open Mon-Sat 10am-5.30pm
Mail Order price list 50p refundable

S. WALES

STEVE'S ELECTRONIC SUPPLY CO. LTD.
45 Castle Arcade, Cardiff
TEL: 0222 41905
Open: Mon-Sat 9-5.30
For components to computers

YORKSHIRE

ACE MAILTRONIX LTD.
3A Commercial Street,
Batley. Tel: (0924) 441129
Open: Mon-Fri 9am-5.30pm. (Sat 1pm)
Retail and wholesale.

JUST OUT

OUR *NEW* CATALOGUE

Presented with a Professional Approach and Appeal to ALL who require Quality Electronic Components, Semiconductors and other Accessories ALL at realistic prices.

There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember, BI-PAK's policy has always been to sell quality components at competitive prices and THAT WE STILL DO.

We hold vast Stocks "in stock" for fast immediate delivery, all items in our Catalogue are available ex stock.

The Catalogue is designed for use with our 24 hours "ansa-phone" service and the Visa/Access credit cards, which we accept over the telephone.

To receive your NEW 1983 BI-PAK Catalogue, send 75p PLUS 25p p&p to:—

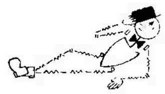
BI-PAK Dept. ET1/8 [illegible]

Access & VISA accepted
Ring 0920 3182 for
immediate despatch

WHY WRITE TO LONDON

When you can walk to the Midlands largest selection of DIY.
Plugs, sockets, connectors, cable, flex, leads, boxes, Aerials, styli, components, elements, semi-conductors, meters.
In fact the lot!
Spares and repairs for all electronic, electrical and audio.

H. G. Electronics Co.
1350 Stratford Road, Hall Green,
Birmingham B28 9EH
Telephone: 021-777 2369



ALARMS ADE

FREE BOOKLET
on
BURGLAR ALARMS
with
LOWEST U.K. DIY PUBLISHED PRICES
PHONE OR WRITE FOR YOUR COPY
051-523 8440
AD ELECTRONICS
217 WARBRECK MOOR
AINTREE, LIVERPOOL L9 0HU

Lineage:
35p per word (minimum 15 words)
Semi Display: (minimum 2 cms)
£10.00 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

FOR SALE

ELECTRONIC ORGAN KEYBOARDS and other parts being cleared out as special offer. Elvins Electronic Musical Instruments, 40A Dalston Lane, London E8. 01-986 8455.

SHEETMETAL FOLDERS 18" x 18c Steel, 16G Aluminium bench or vice held. Hobby or Light industrial use. £38. 01-890-7838. Day/evening.

1000 16 PIN WIREWRAP SOCKETS, gold plated £3 for 10, £25 for 100. 75 ITT lever switches, gold contacts eg. 4 c/o + 4 c/o 3 way 60p, 2 c/o 1 way 40p. Miniature DP centre off 40p. Some TTL eg. 7400 8p, 7474 14p, 74121 20p. Phone: 0477 32754 evenings.

A LASER for £125. Complete in cabinet with power supply. Send 50p for details, plus information regarding other Lasers, Holograms available new andex-exhibit. D.H.S. Developments, 21 Grosvenor Road, Scarborough.

PERSONAL STEREO FM/AM radio + headphones. Superb tone. Fully guaranteed. Only £12.95. Taits Mail Order, 31 Lime Grove, Addlestone, Surrey.

300 WATT SLAVES £15 E/E!! ... Illustrated leaflet. S.A.E. KIA-8, Cunliffe Road, Ilkley. 120 Watt, case + sliders £10.85.

TEKTRONIX SCOPES £110, Teletypes £80. Free leaflet:- James Sinclare, 82 Plumstead Common Rd., SE18. 01-316 1779.

MAPLIN 3800 SYNTH. Fully completed and tuned, plus internal speaker and manual. £250. Tel: Christchurch 478935 evenings.

FOUR OLIVETTTI TE. 300 input/output terminals. Integral 8 hole paper tape punch and reader. 110 Baud Standard ASC11 serial input/output. 120 columns untested, unguaranteed. Buyer to collect, £40 each. Mr. A. J. Stitchman, Chesterfield College of Technology, Infirmary Road, Chesterfield (0246) 201011, extension 337.

PLANS 'N DESIGN

AMAZING ELECTRONICS PLANS. Lasers, super-powered 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.

CONVERT any TV into large screen oscilloscope. External unit plugs into aerial socket of TV. Circuit & plans £3 or S.A.E details. J. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

HARDWARE

COMPUTER SPARES

POWER SUPPLIES
BBC MICROCOMPUTER PSU MOD D1597
240V ac 30W. Outputs — 5V dc 100 ma, + 5V dc 2.25A. Conform to BS415. **£10.00** + £2.00 p&p + VAT.
RACAL MILGO EX EQUIP
POWER MODULE MOD 001
240V ac Input. Outputs:- 2 x +5V dc, 1 x −12V dc, 1 x +12V dc.
£25.00 + £2.95 p&p + VAT.

MAINS ADAPTORS
INGERSOLL MOD XK2598
Output 9V dc 500ma, *4 metres* twin lead to 2.5mm jack. Conforms to BS415. **£3.00** + 75p p&p + VAT.
(Other types available S.A.E. for list).
VULCAN NL CAD CHARGER MOD V92
Charges 8aa cells and 4aa cells. **£5.00** + 75p p&p + VAT.

IMP PRINTER KITS
To enable building of complete printer (no main board components or top cover included). Kit consits of:
Imp main drive, base plate, transformer, ribbon cable, capacitor, switch assembly, printer PCB (unpopulated) plus circuit diagrams and connection instructions. Free Nascom 1 PCB & 8 amp PSU PCB with each order received before end of August. **£55.00** + £5 p&p + VAT. Some discrete components available for printer PCB. S.A.E. for details.
LONDEX TIMER STP-NR SUB MINY 110V ac 0-215 secs **£10.00** + £1.00 p&p + VAT.
OMRON MIN PCB RELAY. LCIN-E 48V dc SPCD **50p** + 25p p& p + VAT.
4 WAY POWER Plug – Consists 2.5mm or 3.5mm jacks. Plus 2.1mm x 2.5mm power-in plugs on 2 metre lead. **£1.25** + 25p + VAT.
4 WAY DIN SOCKET on 1.5 metre 4 core lead. **£1.00** + 25p + VAT.

Trade enquiries on all above welcome.

Dionics, 17 Hawkesworth Drive, Kenilworth, Warks.
Tel. 0926 59658 Tx. 312440

VALVES

EX-GOVT VALVE and Semi-conductor Equivalents Guide. Contains an up to date fully comprehensive cross referenced guide to British and American Service valves and semiconductors. £2.50 plus pp 30p. Valve List. Valves from 1925 to 1980. Many obsolete types. Modern TV, radio and transmitting valves. Send 60p (refundable on purchase). Or free with Ex-Govt., Valve Guide. We sell valves of all types. Please send SAE for your requirements. Dept. ETI Myers Electronic Devices. 12/14 Harper Street, Leeds LS2 7EA. Tel: (0532) 452045.

AERIALS

AERIAL BOOSTERS
NEXT TO THE SET FITTING.
B45H/G-UHF TV. Gain about 20 dbs. Tunable over the complete UHF TV band. **Price £8.70.**
BII-VHF/FM RADO. Gain about 14dbs. When on the off position connects the aerial direct to the radio. **Price £7.70.**
All boosters we make use a PP3/006p/6F22 type battery or 8v to 18v DC.
P&P 30p per order.
Electronic Mailorder Ltd
62 Bridge St., Ramsbottom, Lancs, BL0 9AG.
Tel: (070682) 3036
Access/Visa Cards Welcome, sae leaflets

EXHIBITIONS

SUSSEX MOBILE RALLY. A day by the sea with the family for £1. Brighton Raceground. 17th July. 10.30 am - 5.00 pm. Free car parking. Good catering under cover.

COMPUTERS

CORTEX COMPUTER with RS232 working fast and powerful. £310. Phone Mr Hill, Midhurst 3632 after 7pm.

For All ETI Classifieds
Tel: 01-437 1002
ext 282

WIRES 'N CABLES

THE SCIENTIFIC WIRE COMPANY
811 Forest Road, London E17
01-531.1568

ENAMELLED COPPER WIRE

SWG	1lb	8oz	4oz	2oz
8-34	3.63	2.09	1.10	88p
35-39	3.82	2.30	1.26	93p
42-43	5.20	2.91	2.25	1.60
44-47	8.56	5.80	3.49	2.75
48	15.96	9.58	6.38	3.69
SILVER-PLATED COPPER WIRE				
14-30	9.09	5.20	2.93	1.97
TINNED COPPER WIRE				
14-30	3.97	2.41	1.39	0.94

Prices include P&P and VAT. Orders under £2 add 20p. Dealer inquiries welcome.

EQUIPMENT

PCB's
Printed Circuit Boards to your specification from artwork through to finished board.
QUICK DELIVERY – COMPETITIVE PRICES
CROFTON ELECTRONICS LIMITED
35 Grosvenor Road,
Twickenham, Middlesex
TEL: 01-891 1923/1513 Telex: 295093

COPPER CLAD double sided fibreglass, 12" x 18". 10 sheets £6.50, – 5 sheets £4.50, – 20 sheets £10.50. Davron, 1 Industrial Unit, Parker Road, Chelmsford, Essex.

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. Acorn Atom 12K Rom. 12K Ram. Sony Cassette Recorder and games programs £110. Telephone 01-568 4254.

RS232 CABLES and D-type connectors at competitive prices. 25-way D connector plate/wallbox for only £5.25. Write or phone for details. VEP Limited, 5 Hewens Road, Uxbridge UB10. Tel: 01-848 7207.

WANTED

WANTED: ELECTRONIC COMPONENTS and test equipment. Factories cleared. Good prices given. Q Services, 29 Lawford Crescent, Yateley, Camberley.

TURN YOUR SURPLUS transistors, IC's etc into cash. Contact Coles Harding & Co., 103 South Brink, Wisbech, Cambs. Tel: 0945 584188. Immediate settlement.

E.T.I. AUGUST 1983 ADVERTISERS INDEX

Get moving with these new developments in UK Robotics

— advanced electrohydraulic designs for education, industry and now available to the home constructor.

Hebot II is a turtle-type robot which takes programming out of the two dimensional world of the VDU into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control — forwards, backwards, left and right — with each wheel independently controlled. It has blinking eyes, bleeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensors coupled to its shell return data, about its environment, to the computer for it to calculate evasive or exploratory action. Hebot II connects directly to an I/O port or alternatively with the universal interface board to the expansion bus of a ZX81 or other computer.

Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus – the ZX81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep programming simple and the robot is operated under BASIC commands with no computer specific software required. The interface board is memory mapped using only 64 bytes at any of 1024 switch selectable locations.

MICROGRASP robot kit with power supply	£145.00
Universal computer interface board kit	£48.50
23 way edge connector	£2.50
ZX81 peripheral/RAM Pack splitter board	£3.00

MICROGRASP, INTERFACE BOARD AND ZX81

HEBOTT II

Up to the nano-second hard, firm and software developments embodied in a complete system. 12 Mega Hertz 16 bit CPU; 64K upwardly compatible DRAM; separate 16K video DRAM and 24K TI Power Basic with overwrite. Supports up to four Disc drives of mixed type with 16 serial I/O ports. Programmable Baud rate and comprehensive E Bus interface designed to support real world applications.

Very high resolution graphics gives 3D simulation in 16 colours on 36 prioritised planes of user definable characters. Software FORTH coming includes this trendy language along with NOS C/PM.

Hardware components available separately with details in Nov, Dec, and Jan issues of ETI. Software features include; Real time clock, full renumber command, buffered I/O to free machine whilst printing, call to machine code routines, hexadecimal support and user-friendly textual error trapping messages.

If computers interest you then the Cortex will expand your understanding infinitely more than off the shelf machines. Use it in business, education, research or just play with the incredible graphics capability. At Powertran we are using these machines in conventional roles, in product control and R & D. We shall co-ordinate the Cortex user group and distribute software for the TMS 9995 CPU. Complete 16 bit 64K computer kit **£295.00** + VAT. Complete 16 bit 64K computer ready built **£395.00** + VAT.

Top of the range is the Genesis P102 which has dual speed control, continuous servo operation and double acting cylinders for increased torque on the wrist and arm rotation joints. The microprocessor based control system has additional memory, position interrogation via the RS232C interface increasing the versatility of computer control and inputs are provided for machine tool interfacing.

6 axis system READY BUILT	**£1950.00**
Powertran CORTEX 16 bit 64K computer Kit **£295.00**: READY BUILT	**£395.00**

(Electronics Today International December issue on CORTEX)

GENESIS P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER

Example prices and specifications

Genesis S101
Base: 19.5" × 11" × 7.5"
Lifting capacity: 1500gm
Arm lift: 6.6"
Weight: 29Kg

4 axis model in kit form	£425
5 axis model in kit form	£475

Genesis P101
Base: 19.5" × 11" × 7.5"
Lifting capacity: 2000gm
Arm lengths between axles: 14.0"
Weight: 34Kg

4 axis model in kit form	£675
6 axis model in kit form	**£595**

Complete Systems as shown in Photograph above

Genesis S101

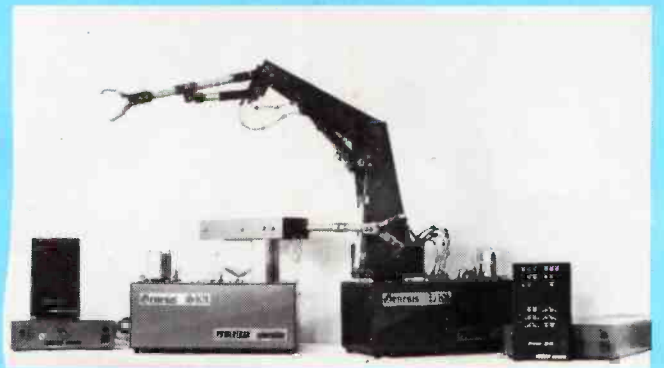
4 axis system in kit form	£681.50
5 axis system in kit form	£737.50
5 axis system Ready Built	£1450

Genesis P101

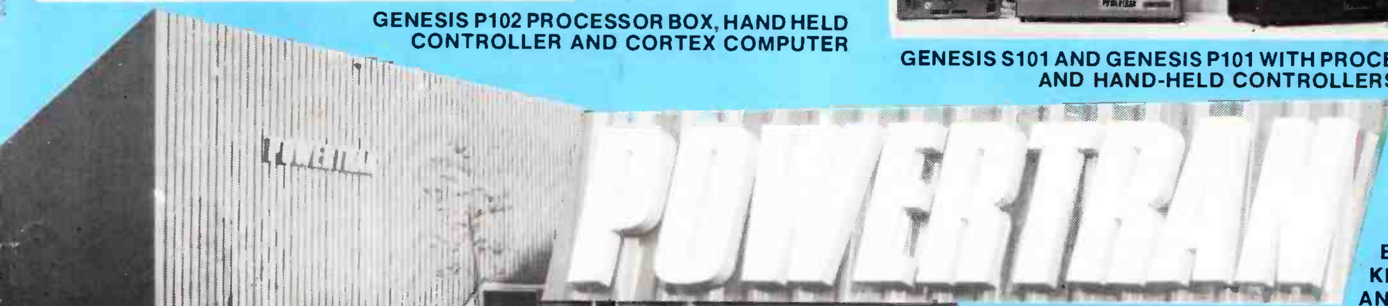
6 axis system in kit form	£945.00
6 axis system Ready Built	£1650

All prices exclusive of VAT

With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operated from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.



GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS



WORLD LEADERS IN ELECTRONIC KIT DESIGN AND SUPPLY

(CYBERNETIC DIVISION) PORTWAY INDUSTRIAL ESTATE ANDOVER HANTS SP10 3NM Phone Enquiries (0264) 64455

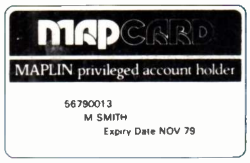
Export Enquiries Powertran International Hollom Down Farm Lopcombe Salisbury Wiltshire SP5 1BP

Tel: 0264 781545 TLX: 477407 ZENMON

Send now for an application form — then buy it with MAPCARD.

MAPCARD gives you real spending power — up to 24 times your monthly payments — instantly!

Maplin News



Sole UK Agents for Heathkit

NOW THE world-famous Heathkit range of superb electronic kits is available from Maplin — the newly appointed exclusive UK distributor. Kits range from a simple clock for beginners to a unique Robot (see pic) with which you can learn about robotics.

There is a range of training courses covering electronics and computing topics, many containing constructional projects. For full details, pick up a copy of the latest Maplin magazine or write for a free copy of our Heathkit catalogue. Order As XH62S.

GREAT PROJECTS FROM E&MM

OUR NEW book "Best of E&MM Projects Vol. 1" brings together 21 fascinating and novel projects from E&MM's first year.

Projects include Harmony Generator, Guitar Tuner, Hexadrum, Syntom, Auto Swell, Partylite, Car Aerial Booster, MOS-FET Amp and other musical, hi-fi and car projects. ORDER AS XH61R. PRICE £1.

Computer Shopping Arrives

AS FROM June 1st you can place orders directly with our computer from your personal computer. The computer shopping revolution has arrived! To communicate, you'll need a modem (our RS232 compatible modem kit is LW99H price £39.95) and an interface (our ZX81 interface LK08J price £24.95 is available already with many more for most popular micros coming soon).

Just dial us up on 0702 552941 and you'll be able to interrogate our stock file then place your order, type in your credit card number and a few minutes after you hang up your order will print out in our warehouse ready for packing. And all without saying a word.

Try out the future way of shopping now! You'll see immediately what stock we've got available and you'll discover how easy it is to ensure your order is exactly right. And you'll see precisely what the current price is for each item and what total amount will be charged to your credit card. It all helps to make buying easier. So give us a ring now!

Maplin's Fantastic Projects

FULL DETAILS in our project books. Price 70p each.

In Book 1 (XA01B) 120W rms MOSFET Combo-Amplifier ● Universal Timer with 18 program times and 4 outputs ● Temperature Gauge ● Six Vero Projects.

In Book 2 (XA02C) Home Security System ● Train Controller for 14 trains on one circuit ● Stopwatch with multiple modes ● Miles-per-Gallon Meter.

In Book 3 (XA03D) ZX81 Keyboard with electronics ● Stereo 25W MOSFET Amplifier ● Doppler Radar Intruder Detector ● Remote Control for Train Controller.

In Book 4 (XA04E) Telephone Exchange for 16 extensions ● Frequency Counter 10Hz to 600MHz ● Ultrasonic Intruder Detector ● I/O Port for ZX81 ● Car Burglar Alarm ● Remote Control for 25W Stereo Amp.

In Book 5 (XA05F) Modem to European standard ● 100W 240V AC Inverter ● Sounds Generator for ZX81 ● Central Heating Controller ● Panic Button for Home Security System ● Model Train Projects ● Timer for External Sounder.

In Book 6 (XA06G) Speech Synthesiser for ZX81 & VIC 20 ● Module to Bridge two of our MOSFET Amps to make a 350W Amp ● ZX81 Sound on your TV ● Scratch Filter ● Damp Meter ● Four Simple Projects.

In Book 7 (XA07H) Modem Interface for ZX81/VIC20 ● Digital Enlarger Timer/Controller ● DXers Audio Processor ● Sweep Oscillator ● CMOS Crystal Calibrator.

MATINEE ORGAN

EASY-TO-BUILD, superb specification. Comparable with organs selling for up to £1000.

Full construction details in our book (XH55K). Price £2.50. Complete kits available. Electronics (XY91Y) £299.95*. Cabinet (XY93B) £99.50*. Demo cassette (XX43W) £1.99.

*Carriage extra

25W Stereo MOSFET Amplifier

- Over 26W/channel into 8Ω at 1kHz both channels driven.
- Frequency response 20Hz to 40kHz ± 1dB.
- Low distortion, low noise and high reliability power MOSFET output stage.
- Extremely easy to build. Almost everything fits on main pcb, cutting interwiring to just 7 wires (plus toroidal transformer and mains lead terminations).
- Complete kit contains everything you need including pre-drilled and printed chassis and wooden cabinet.

Full details in Projects Book 3. Price 70p (XA03D). Complete kit only £55.20 incl. VAT and carriage (LW71N).

Maplin's New 1983 Catalogue

Over 390 pages packed with data and pictures and all completely revised and including over 1000 new items.

On sale in all branches of WH SMITH. Price £1.25.

POST THIS COUPON NOW!

Please send me a copy of your 1983 catalogue. I enclose £1.50 (inc. P&P). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the UK send £1.90 or 10 International Reply Coupons.

Name ....

Address ....

....

....

Post Code ....

MAPLIN ELECTRONIC SUPPLIES LIMITED, P.O. Box 3, Rayleigh, Essex SS6 8LR. Telephone: Sales (0702) 552911 General (0702) 554155.

Shops at: 159 King St., Hammersmith, London W6. Tel: 01-748 0926. 284 London Rd., Westcliff-on-Sea, Essex. Tel: (0702) 554000. Lynton Square, Perry Barr, Birmingham. Tel: (021) 356 7292.

Shops closed Mondays.

All prices include VAT & carriage. Please add 50p handling charge to orders under £5 total value.