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DJ90 Stereo Mixer - this is a really

Star features **

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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 autopanning 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

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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 Output channel Auxiliary channel Blank Panel

£19.90 Base unit and wooden front Pair of mahogany end cheeks £12.50 Power Supply and cabinet £19.50

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TRANSCENDENT POLYSYNTH - A four octave polyphonic synthesiser with outstanding design characteristics and versatility and performance to match.

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

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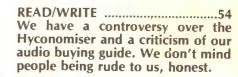
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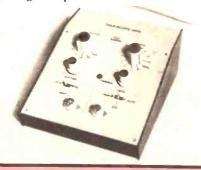
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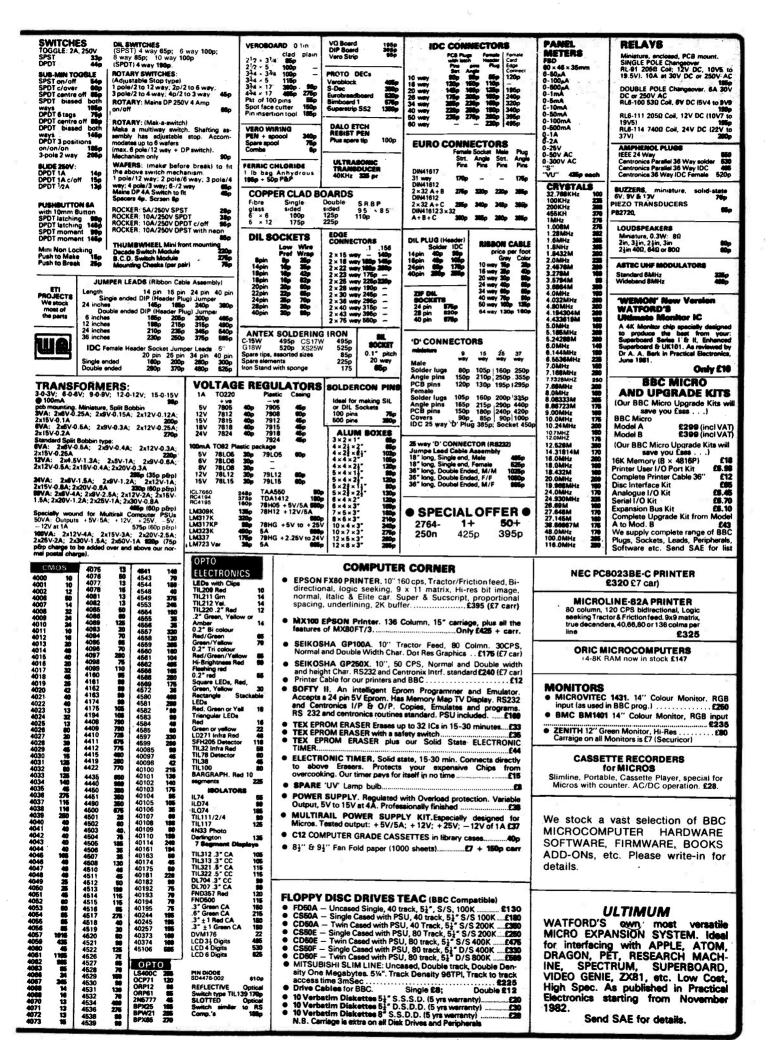
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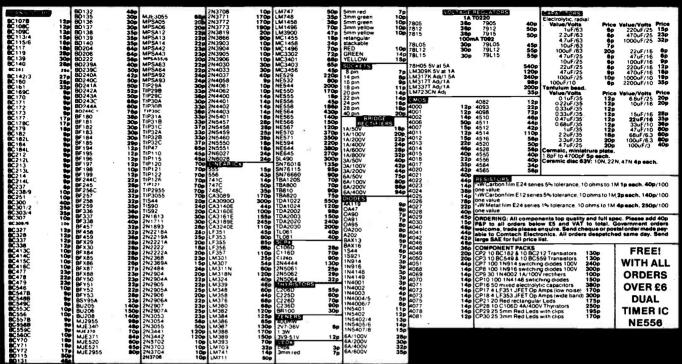
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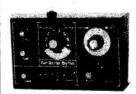
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ETI/8/83

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the sound quality. Small speakers
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Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer.
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'81). For ease of construction and alignment it incorporates three Mullard modules and an

it incorporates three Mullard modules and an I.C. IF System,
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Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x8½"x3¼". £3.50 Plus £1.50 p&p.

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ACCESSORIES: Stereo/mono mains power supply kit with transformer: £10.50 plus £2,00 p&p.



SPECIFICATIONS:

SPECIFICATIONS:
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Ideal for either Hi-Fi or Disco use this speaker

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× 216 × 445mm Price £14.90 each + £2.00 P & P. 5" 30W system — recommended 160 × 175 × 295mm Price £13.90 each + £1.50 P 8 P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.



80 LOUDSPEAKER

The very best in quality and value

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

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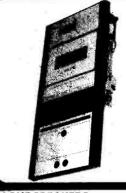
DIGITAL THERMOMETER-9.9°C to +99.9°C. LED display. Complete with sensor. 70 x 70 mm (9 volt) Price: £27.60p 3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap con-

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



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

one complete unit for norizontal instalazion into catoriesi un console of own choice. These units are brand new, ready built and tested. Peaturies: Three digit tape counter. Autostop. Six piano type kays, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. Input Sensitivity: 100mV to 2V. Input impedance: 68K. Output level: 400mV to both left and right hand channels. Output Impedance: 10K. Signal to noise ratio: 45d8. Wow and flutter: 0.1%. Power Supply requirements: 18V DC at 300mA. Connections: The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with prion plugs (phono sockets provided). Dimensions: Top parel 5½ in Signiled complete with circuit diagram and connecting Stepled complete with circuit diagram and connecting Perios 25.87, 37 - 22.80 counter and micking. Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) \$3.55.

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P256 turntable chassis • S shaped tone arm
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template supplied • Completely manual arm. template supplied © Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.

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POWER AMPLIFIER MODULE



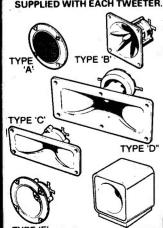
New model. Improved specification NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module complete with integral heat sink, toroidal transformer power supply and glass fibre p.c.b. assembly incorporates drive circuit to power a compatible LED Vu meter. New improved specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications. SPECIFICATION Output Power:— 110 watts R.M.S. Loads:— Open and short circuit proof 4/16 ohms.

onms, Frequency Response:— 15Hz - 30KHz -3dB, T.H.D.:— 0.01%, S.N.R. (Unweighted):— -118dB ±3.5dB.

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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.

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	BIT	ON	DATA	RENUM	DEF
FUNCTIONS	CRB	GOTO	READ	BOOT	NEW
ABS	CRF	GOSUB	RESTOR	GRAPH	END
ADR	MEM	POP	RETURN	TEXT	BIT
ASC	MWD	REM	STOP	PLOT	CRB
ATN	LEN	FOR	TIME	UNPLOT	CRF
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CORTEX B — Basic machine + RS232C £410.00

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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 configuration 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 Hardware House, 578-586 Chiswick High Road, London W4

New Current Probe

The Model 711 Miniature Wide-band 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 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. Dynamic Zonal

Whoops!

S totron 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

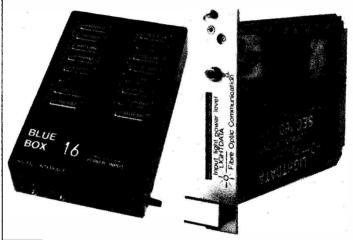
Stotron would also like us to point out that while they do continue to have offices in Hastings, readers should write to them at 72 Blackheath Road, Greenwich, London SE10 8DA, to obtain their copy of the catalogue.

TOBIE Award For LCD Team

he TOBIE Award for Research The TOBIE Award for Research Achievement has this year been won by the Physics Research team at the Royal Signals and 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 × 256 liquid crystal cell developed in conjunction with Scopex Instruments Ltd., for use in the Voyager digital storage oscilloscope.

Many of the Voyager's ap-

plications 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 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

new range of ferrite beads manufactured by Stackpole vailable exclusively to UK nufacturers from Walmore 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, in-expensive, yet effective way to obtain RF decoupling, shielding and parasitic suppression without 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 ap-propriate 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.

Energy In The Outback

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 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 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HARD DISK DRIVES

Fully refurbished Diablo/DRE Series 30 2.5 mb hard disk drive for DEC RKO5, NOVA, TEXAS etc. Front load £550.00 - Top load £295.00 PSU type ME3029 for 2 drives £125.00

DRE 44A/4000A/B 10 mb 5+5 all configurations from £995.00. Call sales office for details.

5 AMP MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference. Matchbox size – Up to 5 amp 240 v load. As recommended by the ZX81 newsletter. Suppression Devices \$D5A 25.95.

The UK's FIRST free of charge, 24 hr. public access data base. Get information on 1000's of stock items and order via your computer and credit card. On line now, 300 baud. CCITT tones, full duplex, fully interactive.

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COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and to mode PSU, Mains filtering, and twin fan cooling.
Originally made for the famous DEC PDP8 computer Originally made for the famous DEC PDP8 computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and -15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc. to units are in good but used condition - supplied for 240v operation complete with full circuit and tech. man. Give your system that professional finish for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high. Useable area 16" u 10.5" h 1.5" d. Also available LESS PSU with internal dim. 19"w. 16"d. 10.5"h, £19.95". Carriage & insurance £9.50.

GOOLING PANS
Geep your hot parts COOL and RELIABLE
with our range of BRAND NEW professional

with our range of BRAND NEW professional cooling fam.
ETRI 99XUOI Dim. 92 x 92 x 25 mm.
Ministure 240 v equipment fan complete with finger guard £9.95.
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. NEW £8.95
BUHLER 69.11.22. B-16 v DC micro ministure reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Messures only 62 x 62 x 22 mm.
Current cost £32.00. OUR PRICE ONLY £12.95 complete with data.
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000'S of other fans EX Stock.
Call for Details. Post & Packing on all fans £1.60.

FLOPPY DISK DRIVES



Unbelievable value the DRE 7100 8" floppy disk drives utilise the finest technology to give you 100% bus compatibility with most drives available today. The only difference being our PRICE and the supert manufacturing quality!! The 7100 single sided and 7200 double sided drive accept hard or soft sectoring IBM or ANSI standard formats giving a massive 0.8 MB (7100) 1.6 MB (7200) of storage. Absolutely SHUGART, BASF, SIEMANS etc. compatible. Supplied BRAND NEW with user manual and full 90 day warranty. Carriage and insurance £9.75.

Ontional accessories: Full technical manual 200 00 alone. £10.50 with drive Refund

Optional accessories: Full technical manual £20.00 alone. £10.50 with drive. Refund of difference on drive purchase. DC and AC power connector and cable kit £8.45.50 way IDC connector £5.50.50 way ribbon cable £3.20 per metre.

RECHARGEABLE BATTERIES
CYCLON type DO01 sealed lead acid
maintenance free 2 v 2.5 ah. will deliver over
300 amps on short circuit!! Brand new at
only £2.95

VIDEO MONITORS

12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. 6WIY 543.00 PUSS 529 SARR. 12" CASED. Made by the British KGM Co.

operation. **WKI F48.00 PLBI 59.30 CARR.** 24" CASED. Again made by the KGM Co with a similar spec as the 12" monitor. Originally used for large screen data display. Very compact unit in lightweight alloy case dim. 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs, shops etc. Supplied in a used but working condition.

ONLY ESS OO PLUS E9.50 CARR. & INS.

14" COLOUR superb chassis monitor made by a subsidiary of the HITACHI Co. Inputs are TTL RGB with separate sync and will plug direct into the BBC micro etc. Exceptional bandwidth with good 80 col. definition. Brand new and guaranteed. Complete with full data & circuit. 240 v AC working. Dim. 14" x 13" x 13". 6NLYE199.00 PLUSES. SO CARR.

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GRAB BAGS'

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guaranteed brand new full spec, with manufacturer's markings, fully guaranteed, 50+£2.\$3 100+£5.15.
TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TFL" grab bags at a price which two or three chips in the bag would nnormally cost to buy. Fully guaranteed all I.C.'s full spec. 100+£6.90 200+£12.30 300+£19.50

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Daisy wheel printer at a fraction of its original cost. BRANDNEW AT ONLY £499+ VAT

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print mechanism giving superb registration and print quality. Micro-processor electronics offer full DIABLO/QUME

offer full DIABLO/CUME
command compatability
and full control via CPM Wordstar etc.
Many other features include bi directional
printing, switchable 10 or 12 pitch, full width 381 mm paper handling with upto
163 characters per line, friction feed rollers for single sheet or continuous paper,
internal buffer, standard RS232 serial interface with handshake.
Supplied absolutly BRAND NEW with 90 day guarantee and FREE daisy wheel
and dust cover. Order NOW or contact sales office for more information.
Optional extras: RS232 data cable £10.00. Tech manual £7.50. Tractor feed
£120.00. Spare daisy wheel £3.00. Carriage & ins. (UK Mainland) £10.00.

TELETYPE ASR33

FROM £195 + CAR + VAT
Fully fledged industry standard ASR33 data terminal. Many features including ASCII keyboard and printer for data I/O auto data detect circuitry. RS232 serial interface. 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order
Options: Floor stand£12.59 + VAT
KSP32 with 20ms learn interface. \$125.00 + VAT KSR33 with 20ma loop interface£125.00 + Sound proof enclosure £25.00 + VAT

SOFTY 2

The amazing SOFTY2. The complete "toolkit" for the open heart software surgeon. Copies, Displays, Emulates ROM, RAM and EPROMS of the 2516, 2532 variety. Many other features include keyboard, UHF modulator. Cassette interface etc. Functions exceed capabilities of unit of the control of the units costing 7 times the price! Only £169.00 pp £1.95 Data sheet on request

DATA MODEMS

oin the communications revolution with our ange of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day. Units are made to the CCIIT tone spec. With R5232 (v) levels via a 25 way 'D' skt. Units are sold in a tested and working condition with data Permission may be required for connection to PO lines. MODEM 13A compact, async, same size as telephone base. Up to 300 baud, full duplex over 2 wires, but call mode only £75.00 MODEM 2B/C Fully fledged, up to 300 baud async, ANSWER & CALL modes, auto answer, auto switching, ideal networks etc. Just 2 wire connection to comms line. £85.00

MODEM 20-1 Compact unit for use with PRESTEL or full duplex 2 wire link 75 baud transmit – 1200 baud receive. Auto answer. £130.00

MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit. £130.00 MODEM 20-3 Made for data rates up to 1200 baud in full duplex mode over 4 wire circuit or half duplex mode over 2 wires. £130.00 Carriage. 13A £4.50. 2B/C & 20 £9.50.

DATA PUMP MODEM compact unit upto 1200 baud full duplex over 4 wires or half duplex over 2 wires. BELL specification with data i/o via RS232 25 way D socket, remote test etc. 240 v operation. Supplied complete with data 285.00 carr. £4.50.

For more information or details of other types of ex. stock modems contact sales office.

8" WINCHESTER price SLASH

Worldwide purchasing brings you two amazing Winchester SCOOPS at prices that will likely NEVER be repeated. BASF 6172 8" 24 Mb. Complete unit consists of micro-BASF 6172 8" 24 Mb. Complete unit consists of microprocessor controlled logic on 3 PCBs for all read/write and
servo control functions. Fast data transfer is by the BASF 'Disk
Bus' interface on a single 40 way multiplexed i/o bus. Units have
been carefully removed from believed working equipment, but at
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guarantee. Supplied complete with 200 page + tech. Manual.
Dim 45 x 22 x 11 cm. DC requirements +5v, +12v, +24v.
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NEWS:NEWS:NEWS:NEWS:NEWS:NEWS

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 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

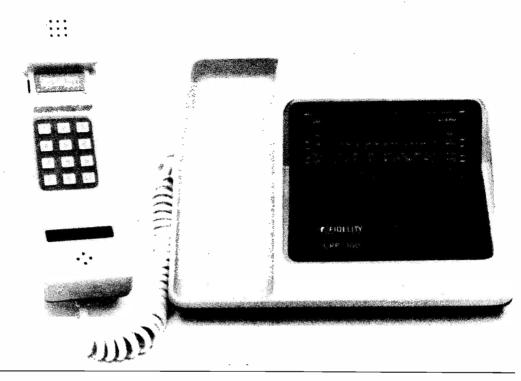
reproduction. You'll find the new chassis in some new models, the CTV 22T and CTV 20T Teletext models, the CTV 22R remote control model and a new 14 inch colour monitor. The existing CTV 20R and CTV 14S portable will continue in the range but with the new chassis.

Micros Go Down The Drain

ntel 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 in-terprets, 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 manufacdupinial equipment manufac-turers and large-volume end users. Intel Corporation S.A., Rue du Moulin a Papier, 51, Boite 1, B-1160 Brussels, Belgium.



Speedy Prototypes

omputing 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

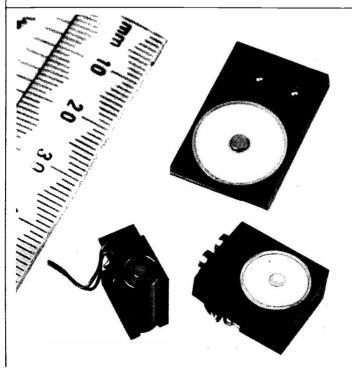
manufacturers.

The service should prove of great interest to small and 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 been introduced have 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, low access controls, controllers, system 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 Com-ponents Limited, Bridge Wharf Industrial Estate, Chertsey, Surrey KT16 8LJ.

electror/ize

AUTO-ELECTRONIC PRODUCTS

KITS OR READY BUILT

TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION



15

YOUR CAR

AS GOOD AS IT COULD BE?

- Is it EASY TO START in the cold and the damp? Total Energy Discharge will give the most powerful spark and maintain full output even with a near flat battery.
- Is it ECONOMICAL or does it "go off" between services to the ignition performance deteriorates? Total or error Displaying the much more output and majntain or transcribed.
- Has it PEAK PERFO is it if the at the and fow revs. where the ign is to be it if the attention of the performance of the perfor
- Total energy Discharge eliminates the more present spark of Total energy Discharge eliminates the interest built an electronic filter smoother with the effects of a place beautic etc.
- Do the PLUG and SUNTS streys had changing to bring the engine because it is a py Discharge eliminates contact arcing are osic by amoving the heavy electrical load. The timing stays "state and the contact condition doesn't affect the performance fier. Larger plug gaps can be used, even wet or badly fouled plugs can be fired with this system.
- ★ TOTAL ENERGY DISCHARGE is a unique system and the most powerful on the market 3½ times the power of inductive systems 3½ times the energy and 3 times the duration of ordinary capacitive systems. These are the facts:

Performance at only 6 volts (max. supply 16 volts)
SPARK POWER — 140W, SPARK ENERGY — 36mJ
SPARK DURATION — 500µS, STORED ENERGY — 135mJ

LOADED OUTPUT VOLTAGE 50pF load - 38kV,

50pF + 500k — 26kV

We challenge any manufacturer to publish better performance figures. Before you buy any other make, ask for the facts, its probably only an inductive system. But if an inductive system is what you really want, we'll still give you a good deal.

- what you really want, we'll still give you a good deal.

 All ELECTRONIZE electronic ignitions feature:
 EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER
 SWITCH, STATIC TIMING LIGHT and DESIGNED IN
 RELIABILITY (14 years experience and a 3 year guarantee).
- ★ IN KIT FORM it provides a top performance system at less than half the price of comparable ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2µF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

Most NEW CARS already have electronic ignition. Update YOUR CAR

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM



- ★ 2000 COMBINATIONS provided by an electronic key a miniature jack plug containing components which must match each individual alarm system. (Not limited to a few hundred keys or a four bit code).
- ★ 60 SECOND ALARM PERIOD flashes headlights and sounds horn, then resets ready to operate again if needed.
- ★ 10 SECOND ENTRY DELAY allows owner to dis-arm the system, by inserting the key plug into a dashboard mounted socket, before the alarm sounds. (No holes in external bodywork, fiddly code systems or hidden switches). Reclosing the door will not cancel the alarm, before or after it sounds, the key plug must be used.
- ★ INSTANT ALARM OPERATION triggered by accessories or bonnet/boot opening.
- ★ 30 SECOND DELAY when system is armed allows owner to lock doors etc.
- **★ DISABLES IGNITION SYSTEM** when alarm is armed
- IN KIT FORM it provides a high level of protection at a really low cost. The kit includes everything needed, the case, fibreglass PCB, CMOS IC's, random selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

FITS ALL 12 VOLT NEGATIVE EARTH VEHICLES.
SUPPLIED COMPLETE WITH ALL NECESSARY LEADS
AND CONNECTORS PLUS TWO KEY PLUGS

Don't Wait Until Its too Late ~ Fit one NOW!

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ELECT	RONIZE DESIGN	Dept D Magnus Rd	Wilnecote · Tamworth · B77 5BY · tel 08	27 281000
TOTA	L ENERGY DISCHARGE (6 o	r 12 volt negative earth)	CAR ALARM	
L A	ssembled ready to fit	£28:70 £19.95	Assembled ready to fit	£37.95
	I.Y. parts kit	£15:90 £14.95	D.I.Y. parts kit	£24.95
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	vin, Assembled ready to fit	£36:45 £29.95	MSA	
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INDU	CTIVE DISCHARGE (12 volt o	only)	Address	
A:	ssembled ready to fit	£15.95 £12.75		
Prices	Include VAT.	P+P £1-00 (UK)	Co	ode

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What Is It?

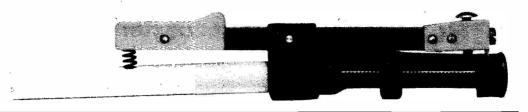
We know what it is — but do you? We get all sorts of obscure objects passing under our noses here at ETI, but this particular one seems to mark a new all-time height in enigma.

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

R IFA have introduced a new series of hybrid active filters, which have been designed for anti-aliasing applications in anti-aliasing 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.



Transistors; B038 - Linear/Swit-

These are available from Motorola Distributors, or write to

More Motorola Manuals

Motorola have been busy scribling away, and the following new books bring the total number of Motorla tehenical 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

ehntel'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 con-

nected with testing, such as operating switches etc. It will also

handle simple assembly tasks if required. Zehntel Limited, 62

Blakelands,

Accurate

Robot

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

 Any manufacturer wishing to exhibit at the fourth Middle East Association (BEAMA)

• 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

 AKG are setting up a studio sound award, for professional and non-professional sound engineers. Details from AKG Acoustics Ltd, 191 The Vale, Lon-

ware programme for the Hewlett Packard HP-86 microcomputer to perform industrial monitoring and control functions using Instem's range of Link-On in-put/output stations. Instem Computer Systems Limited, Walton Industrial Estate, Ston, Stafford-

Motorola's European Literature Centre (at Milton Keynes) for the leaflet, describing each publica-tion and detailing prices. Motorola Semiconductors, 88 tanners Drive, Blakelands, Milton

Shorts

chmode Voltage.

companies' products.

Electricity and Electronics Exhibition in Kuwait in January 1984 should contact the British Electrical and Allied Manufacturers' Leicester Street, London WC2H

 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 Hemp-stead, Herts HP2 7QH.

don W3 7QS.

Instem Computer Systems
Limited, formerly known as
Kratos, has launched a new softshire, ST15 OLT.

 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

 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 describ-ing 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

new British manufacturered A 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 com-

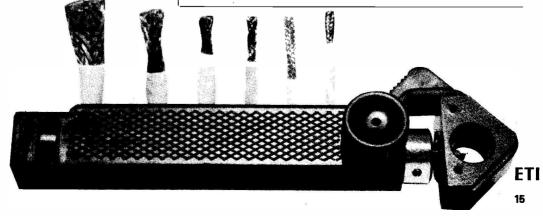
Twin Stripper

B Engineering Company has A B Engineering Company, and 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 cir-cumferencial cut to a pre-determined 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. ponents or cutting tracks. The instrument has allow ranges to

Tanners Drive, Blak Milton Keynes MK14 5BP.

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 \pm 30V.

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



01-452 1500 Technomatic Ltd 01-450 6597

OFFICIAL

Micro Computer System

Please phone for availability



WORD PROCESSOR 'VIEW' 16K ROM £52

> **TELETEXT ADAPTOR** £195.00

BBC Model B £399 including VAT plus £8 carr. Model A to Model B Upgrade kit £50 Fitting charge £15 Individual upgrades also available

WORDWISE **8K ROM £39 TORCH Z80** DISC PACK £780

FLOPPY DISC INTERFACE Incl. 1.2 operating system

£95 + £20 installation

BBC FLOPPY DISC DRIVES

Single drive 51/4" 100K £230 + £6 carr. Dual drive 51/4" 800K £699 + £8 carr.

BBC COMPATIBLE DRIVES

These drives are self powered and supplied in BBC matching colour cases. SINGLE 100K £180; 200K £250;

400K **£330** DUAL 200K **£350**; 400K **£475**; 800K £590

Drive Cables: Single £8 Dual £12 Disc Manual & Formatting Diskette £17.50

Phone or send for our BBC leaflet

BUSINESS. EDUCATION & FUN SOFTWARE IN STOCK

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MONITORS

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- 24 hour 7 day timer

2 x M485 2 Mbytes

- 4 independent switch outputs directly interfacing to
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 6 digit 7 seg. displays to indicate real time, ON/OFF and Reset
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10 way

40 way

DIL SWITCHES 4 way 70p 6 way 85p 8 way 90p 10 way 140p

ID CONNECTORS

90 20 way 145 26 way 175

200

D-CONNECTORS

Header Recep-Edge

160 320

tacle Conn 85 120p 125 195p 150 240

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31 way 170p 170p
DIN 41612 220p 275p
2x32 way St. Pin
2x32 way Ang. Pin
3x32 way St. Pin
3x32 way Ang. Pin
3x52 say St. Pin
3x52 say Ang. Pin
3x52 say St. Pin
3x52

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7497 74100 74107 74109 74110 74111 74112	90p 80p 22p 25p 30p 56p 170p	74LS86 74LS90 74LS91 74LS92 74LS93 74LS96 74LS96	18p 22p 88p 32p 22p 40p 50o	74500 74502 74504 74505 74508 74510 74511	30p 1 30r 30p	4502 4503 4504	60p 45p 75p	LM335Z LM339 LM348 LM358P VOLTAC	140p NE571 S0p 65p 60p SEREGULA ED PLASTI	400p 60p	UPC592H UPC1156H UPC1185H XR2206 XR2207 XR2211 XR2216	200p £3 £5 300p 375p 575p	LOW 8 pin 14 pin	350p 2ROF 9p 1 10p 2		ETS 8 24 pin 28 pin 40 pin	24p 26p	8 pin 44 pin 16 pin	25p 18 35p 20	-	MK3805 KETS BY p 24pin p 28pin	£TBÀ
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7497 74100 74107 74109 74110 74111 74112 74116 74118 74119 74120 74121	90p 80p 22p 25p 30p 55p 170p 50p 80p 25p	74LS86 74LS90 74LS91 74LS92 74LS93 74LS96 74LS107 74LS109 74LS112 74LS112	18p 22p 66p 32p 22p 40p 50p 27p 20p 20p	74500 74502 74504 74505 74508 74510 74511 74520 74522 74530 74532	30p 30p 60p 60p 40p 50p 40p 50p 40p	4502 4503 4504 4505 4506 4507 4508 4510 4511 4512 4514	60p 45p 75p 400p 35p 35p 130p 45p 48p 120p	LM335Z LM339 LM348 LM358P VOLTAC FIX 1A 5V 6V 8V 12V	140p NE571 80p NE592 80p SE REGULA ED PLASTI + ve 7805 40p 79 7808 40p 79 7812 40p 79	400p 60p TORS ve 605 45p 606 45p 608 45p 612 50p	UPC592H UPC1156H UPC1185H XR2206 XR2207 XR22116 XR2216 XR2240 ZN414 ZN419C ZN423E ZN424E	200p £3 £5 300p 375p 575p 575p 120p	8284 8 pin 14 pin 16 pin BD235 BD241 BD242 BD379	350p 2003 9p 1 10p 2 11p 2 85p 60p 60p	18 pin 16 p 20 pin 18 p 22 pin 22 p MPSA93 MPSU06 MPSU07	24 pin 28 pin 40 pin 40p 63p 60p	24p 26p 30p 2N2219A 2N2222A 2N2369A	8 pin 14 pin 16 pin	25p 18 35p 20 40p 22 2SC2335 2SC2612 3N128	P SOC pin 50 pin 60 pin 66 200p 200p 120p	MK3805 KETS BY p 24pin p 28pin p 40pin	ETBÅ 70p 80p 100p
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ne 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-ornothing 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 \(\frac{1}{3}\)-octave device, which, by pure coincidence, is what we're about to describe here.

The ETI $\frac{1}{3}$ -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 $\frac{1}{3}$ -octave equaliser will affect the performance of the system simply because it is in circuit. Each of the filters has a

1/3 OCTAVE EQUALISER

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 \(\frac{1}{3}\)-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 \frac{1}{3}-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.

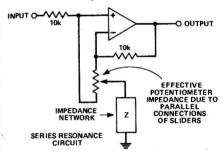
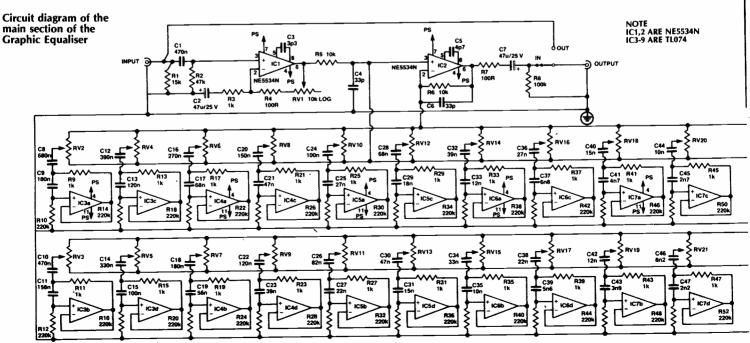


Fig. 1

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



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 midtravel, 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 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

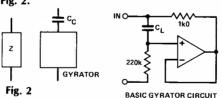


Fig. 3

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:

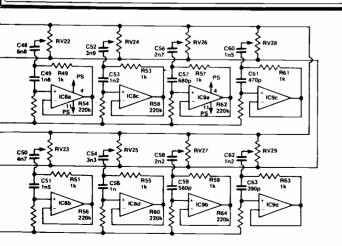
L = $1k \times 220k \times C_L$ in Henries where the value of C_L is in Farads The equivalent circuit of the gyrator

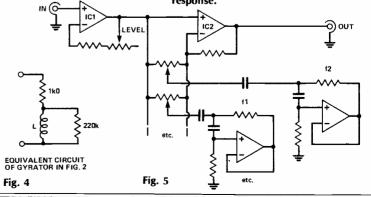
The equivalent circuit of the gyrator is shown in Fig. 4. The series resistance is equal to the 1k resistor while the 220k resistor becomes the parallel resistance of the coil. This value is high enough not to affect circuit operation drastically. The resonant frequency of this filter is given by the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

$$F = \frac{1}{2\pi\sqrt{LC}}$$
 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 thirdoctave 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.





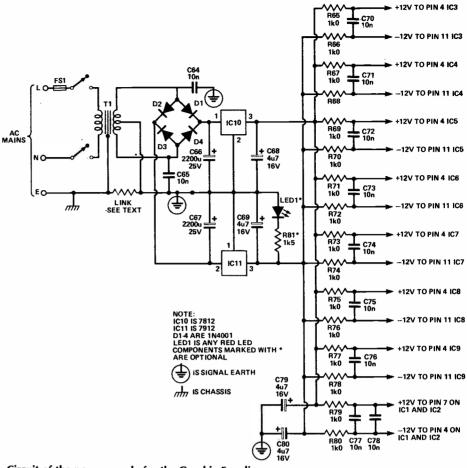
PROJECT: Graphic Equaliser

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 1-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 guad FET op-amps with almost identical performance and are capable of excellent results in the circuit, even in the top-most filter.

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



Circuit of the power supply for the Graphic Equaliser.

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.

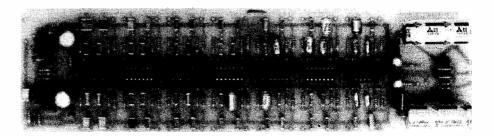
Capacitors

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.

₹Rapid ₹Electronics

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	540	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
CA3046		▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
►CA3080	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
	65 190	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3090AQ		LM10	360	LM733	75	MM5387.	A 465	TBA820	70	ZN424	135
CA3130E		LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
	85	LM311	70	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA102		ZN427E	650
	100	LM324	40	LM2917	200	▶ NE555	16	TDA1024	125	ZN428E	480
	290	LM334Z	100	LM390Q	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	110	LM335Z	125	▶LM3909	70	NE565	110	TL062	60	ZN1034E	200
			0.054	- 40	Brass	40			_		
TRANSIS	· T O 0		BC517		BF337		MPSU56	60 ZTX		8 2N3055	
HANSIS	TOR	12	BC547		BFR40		TIP29A	30 ZTX		12 2N3442	
			BC548		BFR80		TIP29B	55 ZTX		14 ▶2N370	
AC125 35		149 9	BC549		▶BFR8		TIP29C	37 ZTX		16 2N3703	
AC126 25	BC	157 8	BC558	10	BFX29	25	TIP30A	35 7TY	303	15 ▶2N370	M 6

064 071 072 074 L081 082 084 170 2240 N2003 N2004 2206 414	96 30 50 95 25 45 95 120 85 90 290	20 metre ing cable Speaker Standard Twin scr 2.5A 3 c 10 way r 10 way g 20 way g
424	135 135	REGU
424 425E	135 350	
424 425E 426E	135 350 330	7BL05
424 425E 426E 427E	135 350	
424 425E 426E 427E 428E 459	135 350 330 650 480 285	78L05 78L12 78L15 7805
423 424 425E 426E 427E 428E 459 1034E	135 350 330 650 480	78L05 78L12 78L15 7805 7812
424 425E 426E 427E 428E 459 1034E	135 350 330 650 480 285 200	78L05 78L12 78L15 7805
424 425E 426E 427E 428E 459 1034E	135 350 330 650 480 285 200	78L05 78L12 78L15 7805 7812 7815 LM309K
424 425E 426E 427E 428E 459	135 350 330 650 480 285 200	78L05 78L12 78L15 7805 7812 7815 LM309K
424 425E 426E 427E 428E 459 1034E 2N3055	135 350 330 650 480 285 200 50	78L05 78L12 78L15 7805 7812 7815 LM309K LM317K
424 425E 426E 427E 428E 459 1034E	135 350 330 650 480 285 200 50	78L05 78L12 78L15 7805 7812 7815 LM309K

CABLES

O metre pack single core connecting cable ten different colours, 656 piceaker cable ten different colours, 650 piceaker cable 10pr/m itandard screened 16pr/m win screened 24pr/m 5.5A 3 core mains 23pr/m 0 way rainbow ribbon 65pr/m 0 way rainbow ribbon 120pr/m 0 way geny ribbon 80pr/m 0 way geny ribbon 80pr/m 0 way geny ribbon 80pr/m

130 LM723 35 270 SPECIAL OFFERI 120 78PO5 10A +5V 350 only 390p each.

▶1N4001 1N4002 1N4006 1N4007 1N5401 1N5404 1N5404

>3mm red 7 >5mm red 7 >3mm green 10 >5mm green 10 >3mm yellow10 >5mm yellow10

EGULATORS

DIODES

BY127 12 OA47 10 OA90 8 OA91 7 OA200 8 OA202 8 1N914 4 ▶1N4148 3

OPTO

HARDWARE

PP3 battery clips
Red or black crocodile clips
Black pointer control knob Black pointer control knob
Pr Ultrasonic transducers
>6V Electronic buzzer
>12V Electronic buzzer
>P82720 Piezo transducer
>64mm 64 ohm speaker
>64mm panel fuseholder

POTENTIOMETERS

Rotary, Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K

Preset submin. hor, 100 ohms -1M

7p each. Cermet precision multiturn, 0.75W %" 100 ohms to 100K - 88p each.

TRIACS 400V 8A 400V 16A 400V 4A 50 BR100

JUMPER LEADS

CAPACITORS

CAPACITORS
Polyester, radial leads, 250v. C280 type: 9.01, 0.015, 0.022, 0.033 - 6p: 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 8p; 0.30, 0.47 - 13p; 0.88 - 20p; 1u - 20, 1d; 0.47 - 13p; 0.88 - 20p; 1u - 20, 1d; 0.47 - 20,

500. Tantalum baed:
0.1, 0.22, 0.33, 0.47, 1,0 @ 35V ⋅ 20p.
12p. 22, 4,7, 10 @ 25V ⋅ 20p.
15/16V ⋅ 30p. 22/16V ⋅ 27p. 34/16V ⋅ 37p. 34/16V ⋅ 40p. 106/10V ⋅ 90p.
Cer. disc. 22p. 0.01 s0V ⋅ 3p each.
Mullard miniature ceramic plate:
1.8pF to 100pF 6p sach.

per	pF, 22p; 2-	22pF,	30p; 5.5-65p	oF, 35¢
65 90 40 95	BRIDGE RECTIFI	ERS	2A 200V 2A 400V 6A 100V	40 45 80
5p.	1A 50V	20	6A 400 V 9 VM18 DIL	

. £288.00

EPSON PRINTERS

RX80 100 CPS 80 column Tractor feed

FX80 160 CPS 80 column Tractor Feed

£398.00 Carriage £7 per printer.

223 ---

	_					, ,, ,,			1200	2 60		.W 1034E	200
				BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
TRAN	SIS	TORS		BC547	. 7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
			-	BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	. 6
AC125	35	BC149	9	BC549	10	▶BFR81		TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
►AC128	20	BC159	8	BCY71	18	8FX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18		170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	6D137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	8D138	30	BFY56	32		105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	8RY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L		▶BD140	35	8SX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N221BA	45	2N3906	10
BC107B	12	BC184	10	BD222	85	8U205	160	TIP42A	45	2N2219A		2N4037	45
▶BC108	10	BC184L		BF180	35	8U206	180	TIP120	90	2N2221A	25		10
BC108B	12	BC212	10	BF182	35	8U208	170	TIP121	90	2N2222A		2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF 185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	8F194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95		110	2N2646	45	2N5458	36
BC115	22	▶BC214L		BF196	12	MJE3055		TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF 197	12	MPF102	40	TIP3055	55			2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45			2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244E		MPSA12	30	TIS91	30	2N2906A		40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC142	25	BC338	- 14	BF2568	45	MPSA56	30	VN46AF	75	2N2907A		40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF		2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF		▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55		
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95 ►FND500 FND507 0.5" 100 0.5" 100 TIL313 0.3"115 TIL312 0.3"115 TIL322 0.5"115 TIL321 0.5"115 LCD: 3½ digit 580p. 4 digit 620p.

Combs

RESISTORS %W 5% Carbon film E12 series 4.7 ohm - 1M, 1p each, %W 5% Carbon film E12 series 4.7 ohm to 4M7 2p each, %W 1% metal film E24 series 10 ohm - 1M 6p each.

PCB MATERIALS

Alfac transfer sheets — pleatype (e.g. DIL pads etc.)
Dalo etch resistant pen
Fibre glass board 3.75 x 8"
Fibre glass board 8 x 12"

BOXES

M .		6p eac			loride cry		100		x 2"
)S	4016	20	4034		4054	78	4081	12	40193
,3	4017	30	4036		4055	80	40B2	12	4502
	4018	45	4039		4059	430	4085	48	4503
10	4019	25	4040		4060	42	4086	50	4507
10	4020	42	4041		4063	80	4089	125	4508
12	4021	40	4042	38	4066	22	4093	18	4510
50	4022	45	4043	40	4067	225	4094	68	4511
14	4023	16	4044	40	4068	14	4095	65	4512
36	4024	33	4046	40	4069	13	4097	290	4514
24	4025	12	4047	35	4070	13	4098	70	4515
24	4026	75	4048	38	4071	13	4099	70	4516
10	4027	20	4049	21	4072	13	40106	40	4518
15	4028	40	4050		4073	13	40109	110	4520
20	4029	45	4051		4075	13	40163	60	4521
45	4030	14	4052		4076	45	40173	100	4526
40	4031	125	4052		4077	14	40175	75	4520

d			4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
ı	CMC	os	4017	30	4036	249	4055	80	40B2	12	4502	60	4529	150
			4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
1	4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
1	4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
	4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
1	4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
	4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
н	4008	36	4024	33	4046	40	4069	13	4097	290	4514	115.	4555	35
1	4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
3	4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
ı	4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
1	4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
ı	4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
ı	4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
п	4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		. 40
ı						-		_		_		_		_
	LS T	TI	LS20	12	L\$75	20	LS1 23	34	LS160	35	L\$197	45	LS353	60
1			L\$21	12	L\$76	17	LS125	24	L\$161	35	L\$221	50	LS365	28
1	-		LS22	12	LS78_	17	LS126	25	L\$162	35	LS240	60	LS366	28
ı	LS00	11	LS22 LS26	12 14	LS78,	17 35	LS126 LS132	25 35	L\$162 L\$163	35 35	LS240 LS241	60 55	LS366 LS367	28 28 28
	LS00 LS01	11 11	LS22 LS26 LS27	12 14 - 12	LS78, LS83 LS85	17 35 48	LS126 LS132 LS136	25 35 26	LS162 LS163 LS164	35 35 40	LS240 LS241 LS242	60 55 55	LS366 LS367 LS368	28 28 28
	LS00 LS01 LS02	11 11 11	LS22 LS26 LS27 LS30	12 14 12 12	LS78, LS83 LS85 LS86	17 35 48 16	LS126 LS132 LS136 LS138	25 35 26 30	LS162 LS163 LS164 LS165	35 35 40 55	LS240 LS241 LS242 LS243	60 55 55 56	LS366 LS367 LS368 LS373	28 28 28 29 58
	LS00 LS01 LS02 LS03	11 11 11 12	LS22 LS26 LS27 LS30 LS32	12 14 12 12 13	LS78, LS83 LS85 LS86 LS90	17 35 48 16 24	LS126 LS132 LS136 LS138 LS139	25 35 26 30 30	LS162 LS163 LS164 LS165 LS166	35 35 40 55 60	LS240 LS241 LS242 LS243 LS244	60 55 55 56 56	LS366 LS367 LS368 LS373 LS374	28 28 28 29 58 60
	LS00 LS01 LS02 LS03 LS04	11 11 11 12 12	LS22 LS26 LS27 LS30 LS32 LS37	12 14 12 12 13 14	LS78, LS83 LS85 LS86 LS90 LS92	17 35 48 16 24 25	LS126 LS132 LS136 LS138 LS139 LS145	25 35 26 30 30 70	LS162 LS163 LS164 LS165 LS166 LS170	35 35 40 55 60 75	LS240 LS241 LS242 LS243 LS244 LS245	60 55 55 56 56 70	LS366 LS367 LS368 LS373 LS374 LS375	28 28 28 29 58 60 43
	LS00 LS01 LS02 LS03 LS04 LS05	11 11 11 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38	12 14 12 12 13 14	LS78, LS83 LS85 LS86 LS90 LS92 LS93	17 35 48 16 24 25 24	LS126 LS132 LS136 LS138 LS139 LS145 LS147	25 35 26 30 30 70 150	LS162 LS163 LS164 LS165 LS166 LS170 LS173	35 35 40 55 60 75 60	LS240 LS241 LS242 LS243 LS244 LS245 LS247	55 55 56 56 70 48	LS366 LS367 LS368 LS373 LS374 LS375 LS377	28 28 29 58 60 43 60
	LS00 LS01 LS02 LS03 LS04 LS05 LS08	11 11 11 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40	12 14 12 12 13 14 15	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95	17 35 48 16 24 25 24 38	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS148	25 35 26 30 30 70 150 75	LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174	35 35 40 55 60 75 60 45	LS240 LS241 LS242 LS243 LS244 LS245 LS247 LS251	60 55 55 56 56 70 48 28	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378	28 28 29 58 60 43 60 57
	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09	11 11 11 12 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42	12 14 12 12 13 14 15 13 28	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS95	17 35 48 16 24 25 24 38 95	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS148 LS151	25 35 26 30 30 70 150 75 38	LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174 LS175	35 35 40 55 60 75 60 45 45	LS240 LS241 LS242 LS243 LS244 LS245 LS247 LS251 LS257	60 55 55 56 56 70 48 28 32	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390	28 28 29 58 60 43 60 57 45
The second second	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10	11 11 11 12 12 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47	12 14 12 13 14 15 13 28 35	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS96 LS107	17 35 48 16 24 25 24 38 95 40	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS147 LS151 LS151	25 35 26 30 30 70 150 75 38 38	LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174 LS175 LS190	35 35 40 55 60 75 60 45 45 35	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$247 L\$251 L\$257 L\$258	60 55 55 55 56 70 48 28 32 32	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393	28 28 29 58 60 43 60 57 45
The second named in column 2 is not a se	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10 LS11	11 11 11 12 12 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48	12 14 12 13 14 15 13 28 35 45	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS96 LS107 LS109	17 35 48 16 24 25 24 38 95 40 21	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS148 LS151 LS153 LS153	25 35 26 30 30 70 150 75 38 3B 75	LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174 LS175 LS190 LS191	35 35 40 55 60 75 60 45 45 35	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$247 L\$251 L\$257 L\$258 L\$258	60 55 55 55 56 56 70 48 28 32 32 32	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393 LS399	28 28 29 58 60 43 60 57 45 40 156
The second second	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10 LS11 LS12	11 11 11 12 12 12 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48 LS47	12 14 12 13 14 15 13 28 35 45	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS96 LS107 LS109 LS112	17 35 48 16 24 25 24 38 95 40 21 21	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS148 LS151 LS151 LS153 LS154 LS155	25 35 26 30 30 70 150 75 38 38 75 33	LS162 LS163 LS164 LS165 LS170 LS173 LS174 LS175 LS190 LS191 LS192	35 35 40 55 60 75 60 45 35 35	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$251 L\$257 L\$257 L\$258 L\$258 L\$259 L\$266	60 55 55 56 55 70 48 28 32 32 56 20	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393 LS399 LS541	28 28 29 58 60 43 60 57 45 40 156 78
The state of the last of the l	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10 LS11 LS12 LS13	11 11 11 12 12 12 12 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48 LS51 LS55	12 14 12 13 14 15 13 28 35 45 14	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS96 LS107 LS109 LS112 LS113	17 35 48 16 24 25 24 38 95 40 21 21 21	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS148 LS151 LS153 LS155 LS155 LS156	25 35 26 30 30 70 150 75 38 38 75 33	LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174 LS175 LS190 LS191 LS192 LS193	35 35 40 55 60 75 60 45 45 35 35 35	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$251 L\$257 L\$258 L\$259 L\$266 L\$273	60 55 55 55 56 56 70 48 28 32 32 32 55 20 58	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393 LS399	28 28 29 58 60 43 60 57 45 40 156
The state of the s	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10 LS11 LS11 LS12 LS13 LS14	11 11 11 12 12 12 12 12 12 12 12 19	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48 LS51 LS55 LS73	12 14 12 12 13 14 15 13 28 35 45 14 14	LS78, LS83 LS85 LS96 LS90 LS92 LS93 LS95 LS96 LS107 LS109 LS112 LS113 LS114	17 35 48 16 24 25 24 38 95 40 21 21 21 22	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS151 LS153 LS154 LS155 LS156 LS156	25 35 26 30 70 150 75 38 38 75 33 36 26	LS162 LS163 LS164 LS165 LS170 LS173 LS174 LS175 LS190 LS191 LS192 LS193 LS195	35 35 40 55 60 75 60 45 45 35 35 36 32	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$251 L\$257 L\$258 L\$258 L\$258 L\$258 L\$273 L\$273 L\$279	60 55 55 55 56 56 70 48 28 32 32 32 55 20 58 30	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393 LS399 LS541	28 28 29 58 60 43 60 57 45 40 156 78
The state of the last of the l	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10 LS11 LS12 LS13	11 11 11 12 12 12 12 12 12 12 12	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48 LS51 LS55	12 14 12 13 14 15 13 28 35 45 14	LS78, LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS96 LS107 LS109 LS112 LS113	17 35 48 16 24 25 24 38 95 40 21 21 21	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS148 LS151 LS153 LS155 LS155 LS156	25 35 26 30 30 70 150 75 38 38 75 33	LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174 LS175 LS190 LS191 LS192 LS193	35 35 40 55 60 75 60 45 45 35 35 35	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$251 L\$257 L\$258 L\$259 L\$266 L\$273	60 55 55 55 56 56 70 48 28 32 32 32 55 20 58	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393 LS399 LS541	28 28 29 58 60 43 60 57 45 40 156 78
The state of the s	LS00 LS01 LS02 LS03 LS04 LS05 LS08 LS09 LS10 LS11 LS11 LS12 LS13 LS14	11 11 11 12 12 12 12 12 12 12 12 19	LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48 LS51 LS55 LS73	12 14 12 12 13 14 15 13 28 35 45 14 14	LS78, LS83 LS85 LS96 LS90 LS92 LS93 LS95 LS96 LS107 LS109 LS112 LS113 LS114	17 35 48 16 24 25 24 38 95 40 21 21 21 22	LS126 LS132 LS136 LS138 LS139 LS145 LS147 LS151 LS153 LS154 LS155 LS156 LS156	25 35 26 30 70 150 75 38 38 75 33 36 26	LS162 LS163 LS164 LS165 LS170 LS173 LS174 LS175 LS190 LS191 LS192 LS193 LS195	35 35 40 55 60 75 60 45 45 35 35 36 32	L\$240 L\$241 L\$242 L\$243 L\$244 L\$245 L\$251 L\$257 L\$258 L\$258 L\$258 L\$258 L\$273 L\$273 L\$279	60 55 55 55 56 56 70 48 28 32 32 32 55 20 58 30	LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS390 LS393 LS399 LS541	28 28 29 58 60 43 60 57 45 40 156 78

1310	12	2074	.,	LSTZZ	30	L3130	28	LS190	40	LS283	38		
	•	7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
TTL	ŀ	7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
_	_	7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33 33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14`	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		~
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	743B	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17.	7442	30	7482	85	74121	24	74160	55	74182	55		

MIN. D CONNECTORS

y 25 way 37 way 125p 170p 240p 350p 195p 290p 290p 440p 4 100p 110p

SCRs

CONNECTORS

DIN Plug Skt Jack Plug Skt 2pin 8p 9p 2.5mm 10p 10p 3pin 12p 10p 3.5mm 9p 9p 5pin 13p 11p Standard16p 20p Phono 10p 12p Stereo 24p 25p Phono 10p 12p Stereo 24p 25p 1mm 12p 13p 4mm 18p 17p UHF (CB) Connectors: PL259 Plug 40p. Reducer 14p. SO239 square chassis skt 38p. SO2395 round chassis skt 40p. IEC 3 pin 250 V/68. 38p 60p 120p Socket free hanging Socket with 2m lead

Submin toggle: SPST 65p. SPDT 60p. DPDT 65p. SPST 55p. SPDT 60p. DPDT 65p. Ministure toggle: SPDT 80p. SPDT centre off 90p. DPDT 90p. SPDT centre off 100p. Standard toggle: SPST 35p. DPDT 48p. SPST 35p. DPDT 48p. Ministure DPDT slide 12p. Push to break 14p. Push to break 22p. Rotary type adjustable stop. 1P1 2W, 2PSW, 3P4W sli 55p sach. DIL switches. DIL switches: 4SPST 80p 6 SPST 80p. 8SPST 100p.

SOLDERING IRONS

VERO

VEROBLOC ◀ Size 0.1 matrix:

Antex CS 17W Soldering iron 460 Antex XS 1 /W Soldering iron 460 2.3 and 4.7mm bits to suit 65 CS 17W iron: 450, element: 210 Antex XS 25W 480 3.3 and 4.7mm bits to suit 65 Solder pump desoldering tool 480 Spare nozzle for above 70 10 metres 22swg solder 100

VOICE SYNTHESISER!

is able through synthesize spec (extended pho unlimited voca Easily interface system; ten TT nals are used to phones.	speech processor stored program to ech, Allophone neme) system gives	3.75 x 1 VQ boa Veropir Single s Double Spot fac Pin inse	75 rd is per 1 ided sided sided rtion to pen and	er .
MICRO	6116P3 320 6502 CPU 325 6522 VIA 295	6852 6875 6880	240 495 100	82: 82: 82:
	6532 570 6551 ACIA 650	81LS95	85	82

MIGRO	1852 240 8228 220 228 239 258 259 390 248 259 390 248 259 258 25
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SOCKETS

COMPONENT KITS

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RESOLUTIONS.	630VPC 250VAC	100/3V 32p	2.5 × 17 2.99 3.75 × 17 3.85	Solder Type	R3 9x5x2½" 3.15	630mA 17p 10r	PCB RELAYS	2N2102 38- 2N2217 39p 2N2218 33p	2N4416A 1 80 2N4220 75p	2N6126 75p 2N6129 79p 2N6130 93p	BC187A 10p BC187B 13p	BC409 35 BC413 25p
CARBON FILM 5% HI STAB 100 TO	IDEAL AS MAINS SUPPRESSORS 10nF 28p 15nF, 22nF 35p	MANY MORE CAPACITORS IN STOCK: PLS PHONE	4.79 x 17 4.93 VQ Board 1.92 Dip Board 3.90 Track Cutter 1.48	9 way 80p 15 way 1.03	R4 11x6x3" 3.85 R5 11x7½x3½"	17p 10p	amps Contacts SPDT 1x½" 6v 72Ω 2.75	2N2218A 26p 2N2219 27p 2N2219A 28p	2N4221 95p 2N4222 97p 2N4223 97p	2N6131 98p 2N6132 83p 2N6133 1.14	8C168 10p 8C168B 10p 8C168C 10p	8C.009 34
10M % W E24 2p % W E24 2% p 1W E24 6p	47nF 39p 100nF 43p 150nF 49p 220nF 55p	100mA	Pin Inserter 1.79 100 Pins 55; Verobloc 3.99	37 way 2.50 Female 9 way 99p	4.75 R6 13x8x4½ " 7.35 R7 15x8x4"	2A 17p 10p	2.75 24v 1150Ω	2N2220 22p 2N2221 22p 2N2221A 23p 2N2222 24p 2N2222A 25p	2N4224 96p 2N4234 45p 2N4236 45p 2N4237 1,21 2N4238 95p	2N6134 1.36 2N6212 3.27 2N6253 1.45 2N6254 1.55	BC169 10p BC169B 10p BC169C 10p BC170 15p BC170A 17p	BC440 32p BC441 33p BC460 32p BC461 33p
METAL FILM E24 ULTRA HI STAB	1000VDC PLASTIC 1nF, 2n2 26p	6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V 95p	Vero Wiring Pen + Spool 3.35 Spare Spool 75p Combs 6p	15 way 1.75 25 way 2.05 37 way 3.30	7.75 VEROBOXES	5A 17p 10p 6.3A 17p 10p 10A 17p 10p	48v 4600Ω 3.04	2N2222A 25p 2N2223 2.60 2N2223A 4.15 2N2368 25p	2N4239 95p 2N4240 3.00 2N4248 15p	2SC1096 95p 2SC1306 95p 2SC1307 1.60	BC1706 17p BC170C 18p BC171 12p BC171A 15p	BC478 29p BC479 30p BC516 40p
ULTRA LOW NOISE 0.4W 10Ω TO 1M	4n7, 6n8 29p 10nF 31p 22nF, 33nF 37p 47nF 41p	0-6+0-6V 2.85 0-12+0-12V 2.85	SWITCHES	Angled PCB 25w Male 2.45 25w Female 2.90	550	1¼" Slow Fast 100mA 19p 15p	Guaranteed	2N2369 19p 2N2369A 20p 2N2405 88p 2N2410 1.15	2N4250 17p 2N4258 75p 2N4266 45p	2SC 2078 1 70 2SJ 49 3 60 2SJ 50 3.75	BC171B 15p BC172 12p BC172A 15p	BC517 40p BC547 13p BC547A 14p BC547B 14p
2% E24 Sp 1% E24 Sp	100nF 45p 220nF 79p 470nF 1.25	0-15+0-15V 2.65 0-20+0-20V	DIL SPST 4 way 67p 6 way 82p	Covers 99;	35mm 90r V3 180x110x55	250mA 17p 10p	charges	2N2411 3.60 2N2483 25p 2N2484 26p	2N4275 48p 2N4284 32p 2N4285 35p 2N4288 22p 2N4289 15p	25J82 4.29 25K134 3.50 35K135 3.75 25K226 4.29	BC172B 15p BC172C 16p BC173 11p BC173B 16p	BC548 12p BC548A 13p BC548B 14p BC548C 15p
GLAZE E12 0 22Ω to 8 2Ω1 tp	HI VOLT CERAMIC 100pF 1KV 25p	30VA 6+6+9+9V	8 way 90p 10 way 1.40 TOGGLE (MINI)	CONNECTORS Male 31 way 1.75 64w. A + 8	SLOPING FRONT VEROCASES	500mA 17p 10p	HP11(1 2AH) 2.29 PP3(110mAH)	2N2646 45p 2N2647 98p 2N2714 12p 2N2848 60p	2N4290 45p 2N4291 45p 2N4292 45p	2N139 3.30 3N140 1.07 3N143 2.85 3N152 3.00	BC173C 16p BC174 21p BC174A 24p BC174B 24p	BC549 13p BC5498 14p BC549C 15p BC550 15p
WIRE-WOUND E12 2 to 3W 0.22Ω to 330Ω 28p 4 to 7W 0 47Ω	100pF 2KV 30p 100pF 3KV 33p 100pF 4KV 37p 220pF 6KV 45p	(total 30V 1A) 4.30	SPST 49p SPDT 59p DPDT 69p DPDT C OFF 79p	Straight 2.25 64w. A + B Angled 2.95	V6 171x121x	800mA	Chargers TYPE H: Adjusted to 6	2N2890 1 10 2N2891 2 28 2N2892 3.00 2N2904A 27p	2N4294 45p 2N4297 2.50 2N4302 39p	3N153 2.47 3N154 2.56 3N200 6.93 3N201 2.98	BC176 75p BC177 16p BC177A 25n	BC550C 250
4 to 7W 0 47Ω to 6K8 33p 10 to 11W 1Ω to 33K 37p	470pF 2KV 39p 470pF 6KV 48p 1nF 2KV 39p 1nF 6KV 44p	0-12+0-12V 4.35	APDT 2.75 All types of biased toggles in stock.	64w A + B Straight 2.40 64w A + C	REMOTE CONTROL (Mandheld) ROX	1A 17p 10p 1.5A 17p 10p 2A 17p 10p		2N2905 28p 2N2905A 29p 2N2906 25p 2N2906A 30p 2N2907 25p	2N4400 15p 2N4401 27p	3N211 3.35 3SK88 89p 40360 60p 40361 67p	8C177B 26p .BC178 16p BC178A 24p BC178B 25p BC179 20p	BC558 14p BC558A 15p BC558B 16p BC559 16p
1995 A. Beel	2n2 2KV 44p 2n2 5KV 49p 3n3 2KV 47p 3n3 4KV 62n	0-12+0-12V 6-95 TOROIDALS	Please phone PUSH BUTTON Non-Latching	Angled 2.95 Female 31 way 1.75 64w. A+8	94x61x22.5mm White 89p	3A 17p 10p 4A - 10p 5A - 10p 6A - 10p	faster charge for 4AH £25.95 TYPE P: PP3 £5.50	2N2907 25p 2N2907A 26p 2N2920 3.47 2N2923 25p	2N4402 30p 2N4403 30p 2N4409 36p 2N4410 42p 2N4416 1.50	40362 87p 40363 2.95 40364 3.25 40372 1.80	BC179A 25p BC179B 25p BC179C 27p	8C557 16 8C557A 16 8C557B 164 8C557B 164 8C558B 144 8C558B 146 8C558B 169 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C559C 176 8C59C 176 8C59C 176 8C59C 176 8C59C 176 8C777 166 8C777 166 8C777 166 8C777 166 8C777 240 8C777 24
ROTARY POTS WITH % SPINDLES	4n7 4KV 57p 10nF 2KV 57p FEEDTHRO CAP	Up to 500VA in stock. Please Phone	Push to Make 15p Push to Break 25p	Straight 2.75 64w A + 8 Angled 3.25	SIFAM PROFESSIONAL COLLET KNOBS	10A — 10p 15A — 10p 20A — 10p	TYPE A: HP7 (Up to 4 at	2N2924 15p 2N2925 15p 2N2926 10p 2N3010 75p	2N4427 79p 2N4440 12 58 2N4870 80p	40373 2.60 40374 2.84 40406 1.39	BC182A 12p BC182B 13p BC182L 10p	BC560C 25p BC650 48p BC651 46p
LIN 32p LOG 32p As above with	TRIMMERS MINI	Please add adequate P&P as transformers are heavy!	KEY SWITCH	64w A + C Straight 2 95 64w A + C Angled 3.35	All fit 1/4" spindles Black (suffix B) Grey (Suffix G)	1" PLUG FUSES	HEAT WARN	2N3011 66 p 2N3019 50p 2N3053 27p	2N4888 99p 2N4898 1.29 2N4901 1.69	40407 75p 40408 1.59 40409 1.50 40410 1.80	8C182LB 14p BC183 10p BC183A 11p	BCY70 16p 8CY71 16p BCY72 19p BCY77 34p
DP Mains Switch 79p As above stereo (no switch) 89p	UP TO 100VDC 1p4 to 5pF (800MHz) 23p 2pF to 10pF	WIRE - ARI I	Mains 4 amps DPST withdraw Key in both positions (inc. 2	IDC	15mm Short S1508 plain 56p S150G plain 56p S1518 + line 64p	3 amp 59p	TO1 (AC128)18p TO5 (BFY51) 18p TO18 (BC 109)	2N3055 60p 2N3055ACA 80p 2N3055H 1.20	2N4902 1.85 2N4903 1.98 2N4904 2.15 2N4905 2.75	40411 2.85 40412 90p 40422 2.95 40467A 1.29	BC183B 12p BC183C 13p BC183L 10p BC183LA 13p	BCY78 22p BCY79 22p BCY87 6.60 BCY88 4.90
DUSTPROOF PRESETS E3 1000 TO 10M	(600MHz) 27p 2pF to 22pF (400MHz) 29p 5p5 to 65pF	METRE Solid Hook-up Any colour 5p	FOOTSWITCH with metal	PCB Male + Latch Straight 10 way 89p	S151G + line 64p 15mm Standard K150B plain 57p	7 amp 59p 13 amp 59p	UHF	2N3107 48p 2N3109 48p 2N3232 1.50 2N3250 36p	2N4906 2.99 2N4907 3.20 2N4908 3.15 2N4909 2.90	40513 1.75 40537 98p 40594 99p 40595 99p	BC183LA 13p BC183LB 13p BC183LC 14p BC184 10p BC184B 12p BC184C 13p	BD115 58p BD116 2.50 BD121 98p
Mini Vert 15p Mini Horiz. 15p Standard Vert.	(200MHz) 36p ELECTROLYTICS	MAINS/ SPEAKER Twin 1 Amp 14p Twin 2½ Amp	SPDT 1.85 DPDT 2.75	16 way 1.29 20 way 1.45 26 way 1.75 34 way 1.99	K150G plain 57p K151B + line 66p K151G + line 66p 15mm Winged	PANEL FUSEHOLDERS		2N3250 38p 2N3251 38p 2N3251 38p 2N3439 98p 2N3440 80p 2N3441 1.25	2N4910 1.95 2N4913 2.59 2N4914 2.69 2N4915 2.95	40595 99p 40600 2.58 40601 2.36 40602 1.68 40603 1.09	BC184L 10p BC184LB 13p BC184LC 14p	BD124 (Mullard) 2.28
Standard Horiz. 18p Thumbwheel or '4' Spindle for	Axial by Siemens or Metsushita (Nat. Penasonic) uFd V	3 Core 2½ Amp 18o	ROTARY Main DP 4 amps with '4" spindle 55p	40 way 2 25 50 way 2 45 PCB Male + Latch	W150B 74p W150G 74p 21mm Short	36	Wideband 4.50	2N3442 1.35 2N3442RCA 1.85 2N3444 1.70	2N4916 48p 2N4917 47p 2N4918 65p 2N4919 75p	40604 1.85 40608 2.44 40631 2.12 40635 1.36	BC186 24p BC187 24p BC204 29p BC205 28p	BD132 44p BD136 35p BD136 35p BD136 35p BD137 37p BD138 37p
Standard Types only 8p	47 63 6p 47 100 9p .47 350 30p 1 63 8p	3 Core 6 Amp 31p 3 Core 13 Amp 56p	Stop Type 1p 1 to 12 way	Angled 10 way 95p 16 way 1.47 20 way 1.60	\$210B plain 69p \$210G plain 69p \$211B + line 75p		Prices inc. post in UK. Cheaper to callers.	2N3445 4.80 2N3446 6.09 2N3447 5.72 2N3448 6.66	2N4920 85p 2N4921 55p 2N4922 69p 2N4923 99p	40637 2.00 40643 1.80 40673 70p	BC 206 29p BC 207 29p BC 208 29p BC 209 29p BC 212 10p	BO138 37p BO139 38p BO140 38p BO142 2.40 BO153 1.25 BO155 1.20
% CERMET 20 TURN PRESETS 50Ω, 100Ω 200Ω, 500Ω, 1K,	1 100 9p 1 500 40p 2 2 25 8p 2.2 63 9p	SCREENED Single 14p Stereo 27p	55p 2p 2 to 6 way 55p 3p 3 to 4 way	26 way 1.99 34 way 2.40 40 way 2.55	S211G + line 75p 21mm Standard K210B plain 69p K210G plain 69p	32,768K Hz 95p 100KHz 2,35 200KHz 2,65	Tower Transistor Manual (Bible) 10.50	2N3512 1.06 2N3553 2.65 2N3563 20p 2N3564 25p	2N4924 92p 2N4926 95p 2N4927 95p	40871 79p 40872 79p	BC212A 12p BC212B 13p	BO153 1.25 BO155 1.20 BO157 54p
2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K each 89p	2.2 100 11p 2.2 350 30p 3.3 25 10p 3.3 40 11p	Mini Single 12p Mini Stereo 15p 4 Core 4 Screens 44p	55p 4p 4 to 3 way 55p	50 way 2.75. Female Header 10 way 84p	K2118 + line 78p K211G + line 78p 21mm Winged	1.00MHz 2.74 1.008MHz 2.74 2.00MHz 2.24 2.097152MHz	Elektor 301 Circuits 6.50 Texas TTL Data 10.50	2N3565 20p 2N3566 50p 2N3567 55p	2N4964 27p 2N4965 25p 2N4966 25p	AC125 49p AC126 32p AC127 32p AC128 35p AC132 68p AC151 51p	BC212LA 13p BC212LB 14p BC213 10p	BO157 54p BO158 55p BO160 3.80 BO181 1.75 BO182 2.50
THERMISTORS & VDRs PLEASE PHONE	3 3 63 12p 4.7 16 8p 4.7 25 9p 4.7 40 11p	4 Care, Single Screen 54p 8 Care 61p 12 Care 80p	Many other switches in stock	16 way 1.07 20 way 1.25 26 way 1.49 34 way 1.75	W210B 86p W210G 86p 29mm Standard	3.49 3.2768MHz 1.49 4.00MHz 1.49 4.194394MHz	Texas Op to: 5.18 Texas Mos	2N3569 50p 2N3570 6.95 2N3571 6.73	2N4967 25p 2N4968 25p 2N4969 31p 2N501012 75	AC152 45p AC153 55p AC153K 64p	BC213A 11p BC213B 12p BC213C 13p BC213L 10p	BD 183 2.70 BD 187 1.09 BD 201 1.30 BD 202 1.39
CAPACITORS CERAMIC	4.7 63 12p 4.7 100 14p 10 25 Bp	Heavy Duty Mike/Guitar Lead 25p	Flease Rhone	40 way 1.95 50 way 1.99	K 290G 88p	1.99 4.433619MHz 99p 5.00MHz 1.50	Memory: 4.95 Texas Linear: 4.95 National	2N3572 4.95 2N3584 2.76 2N3585 2.99 2N3632 9.88	2N501113.85 2N5030 44p 2N5033 48p 2N5036 1 60	AC176K 37p AC187 25p	BC213LB 13p BC213LC 14p BC214 10p BC214B 12p	BD204 1.44 BD220 1.00 BD221 95p BD223 1.00
DISC/PLATE MICRO MINI 100V TYPICALLY 5%	10 40 12p 10 63 14p 10 100 16p 10 350 55p	AERIAL 50Ω RG 58A 25p 75Ω UHF 29p 75Ω VHF 28p	PLOUS AND SUCKETS	DIN PLUGS 2 pin Sp 3 pin 11 p 5 pin 180° 12 p	Yel, Grn, Grey, Blue. (Please state	6.00MHz 1.39 6.9375MHz 3.50 8.00MHz 1.49 10.00MHz 1.75	Interface: 2.95 National Special Function 2.95	2N3638 55p 2N3638A 70p 2N3639 65p 2N3641 69p	2N5039 1.90 2N5086 36p 2N5087 39p 2N5088 37p	AC187K 28p AC188 25p AC188K 40p ACY17 1.50 ACY20 75p	BC214C 13p BC214L 10p BC214LB 13p BC214LC 14p	BD224 95p BD232 1.11 BD233 70p BD234 72p
E12 1pF to 10nF 7p SIEMENS 63V	22 25 11p 22 40 14p 22 63 16p 22 100 21p 47 25 14o	300Ω Flat 14p RAINBOW	DIL SOCKETS Lo- Pins prof W Wp 8 8p 25p	5 pin 240° 15p 5 pin Domino 50p 6 pin 18p	colour) 15mm plain 5p 15mm + dot 8p 15mm + ine 8p	18.00MHz 1.79 20.00MHz 1.99 27.648MHz 1.69 48.00MHz 1.69	National Data Conversion 2.95	2N3642 50p 2N3643 30p 2N3644 56p 2N3645 66p	2N5089 37p 2N5172 15p 2N5175 58p 2N5179 39p	ACY21 75p ACY22 75p ACY28 75p	BC237 14p BC237A 16p BC237B 17p BC237C 18p	8D224 95p 8D232 1.11 8D233 70p 8D234 72p 8D237 98p 8D238 98p 8D239A 55p 8D240A 55p 8D240C 73p 8D241A 61p
MONOLYTHIC MINI CERAMIC 10nF, 22nF 10p 33nF, 47nF 10p	47 40 17p 47 63 26p 47 100 28p	Prices per foot 8 way 25p 10 way 25p	16 10p 40p 18 16p 50p 20 20p -	7 pin 30p DIN CHASSIS SOCKETS	21mm plain 5p 21mm + dot 8p 21mm + line 8p	100.00MHz 2.95 5.5 MHz Ceramic filter 90p	Toshiba CMOS 7.95 Hitachi Micro- processor 9.00	2N3646 28p 2N3662 15p 2N3663 16p 2N3702 10p	2N5180 43p 2N5183 1.00 2N5184 1.10 2N5188 1.15	AD136 6.75 AD149 79p AD150 2.80	BC238 14p BC238A 15p BC238B 18p BC238C 17p	BD240A 59p BD240C 73p BD241A 61p BD241C 67p
68nF 14p 100nF 14p BARRIER LAYER	100 16 14p 100 25 16p 100 40 22p 100 63 25p	16 way 39p 20 way 48p 24 way 62p	22 22p - 24 24p 70p 28 28p 79p 40 30p 99p	2 pin 9p 3 pin 10p 5 pin 180° 10p 5 pin 240° 16p	29mm (Red. Blk, Grey only) 8p Nut Covers	TOOLS Top quality	Hitachi Memory 7.50 Hitachi Powerfet	2N3703 10p 2N3704 10p 2N3705 10p	2N5189 1 00 2N5190 68p 2N5191 70p 2N5193 90p	AD161 39p AD162 39p AF106 75p AF109 75p AF114 65p AF117 1.00	BC239 15p BC239A 16p BC239B 17p	BD242A 65p BD242C 70p BD243A 72p
CERAMIC DISC 220nF, 25V 15p POLYSTYRENE	100 100 30p 220 10 16p 220 16 17p 220 25 22p	30 way 75p 32 way 82p 40 way 88p	ZERO INSERTION FORCE DIL SOCKETS	6 pin 20p 7 pin 25p	15mm Colours as above	Hand Tools Lindstrom L670.	TEXAS "UNDER-	2N3707 10p 2N3708 10p 2N3709 10p	2N5194 79p 2N5195 99p 2N5195 99p	AF124 720	BC250 22p BC250A 23p BC250B 24p	BD244A 82p BC244C 1.00 BD245A 1.14
180V 5% OR BETTER 10pF, 15pF.	220 40 25p 220 63 30p 220 100 40p 470 16 22p 470 25 28p	MATERIÁ; S	24 pin 4.25 40 pin 5,25 UHF PL269	DIN LINE SOCKETS 2 pin 10p 3 pin use 5p	POINTERS 15mm or 21mm	Side Cutters 4.3" 14.55 L890.Snipe Nose	STANDING' Solid State 4.95 Digital 4.95	2N3710 10p 2N3711 10p 2N3712 2.00 2N3713 1.38 2N3714 2.98	2N5209 24p 2N5210 25p 2N5220 15p	AF126 72p AF139 40p AF170 88p	BC250C 25p BC251 25p BC251A 26p BC251B 27p	BD245C 1.30 BD246A 1.20 BD246C 1.50 BC249A 2.00
22pF, 27pF, 33pF, 39pF, 47pF, 68pF, 100pF, 150pF,	470 40 33p 470 63 43n	GRADE ONE- GLASS PCB SINGLE - SIDED 178 × 240mm	TYPES Low loss, superior quality 500	180° 5 pin 15p PHONO PLUGS	Colours as above 8p DIALS 15mm	Pliers 5.2" 10.35 L870. Snipe Nose Pliers 4.7"	Car Electronics 4.95 Security Elec-	2N3714 2.98 2N3715 3.31 2N3716 3.60 2N3724 75p	2N5221 25p 2N5222 28p 2N5223 15p 2N5224 38p	AF172 88p AF178 88p AF200 65p AF201 75p	BC251C 2Bp BC252 22p BC252B 23p BC252C 24n	BD249C 2.31 BD250A 2.11 BD250C 2.46 BD433 79p
180pF, 220pF, 270pF, 330pF, 390pF 10p 470pF, 680pF,	1 1000 16 30m	95p 420 × 195mm 1.30 420 × 245mm	Line plug 45p Reducer 15p Round skt. 40p	Black 15n	Red + Point 26p Blk + Point 6p Grev + Point 26p	10.35 L160, Long Nose	tronics 4.95 Optronics 4.95 Communications	2N3725 85p 2N3730 4.65 2N3732 2.88 2N3734 1.30	2N5226 25p 2N5226 25p 2N5227 25p 2N5227 37p	AF239 55p AF240 1.00 AF279B 1.19	BC253 222p	BD 434 55p BD 435 81p
1nF, 1.5nF 12p 2.2nF, 3.3nF 13p 4.7nF 14p 10nF 15p	1000 25 38p 1000 40 48p 1000 63 65p 2000 16 40p 2200 25 63p 2200 40 70p	1.95 FERRIC CHLORIDE	Sqr skt 40p BNC 50Ω Plug 1.10		Clear 1 to 1026p Clear Taper 26p	CK TOOLS C80 4 % " Side Cutter 10.02	4.95 Computer Science 4.95 Microprocessors	2N3735 2.45 2N3738 2.00 2N3740 2.38	2N5246 40p 2N5247 45p	AU106 4.57 AU110 2.20	BC2538 23p 8C253C 24p BC256 25p BC256A 26p BC256A 26p BC256B 27p 8C257 26p BC257A 27p	80436 81p 80437 88p 80438 88p 80438 90p 80440 91p 80441 91p 80441 91p 80442 93p 80530 1.30 80535 75p 80537 80p 80538 80p 80538 80p 80538 80p
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POLYESTER C280	Radial by Matsushita uFd V 10 16 6p	ETCH RESIST PEN	All Metal Plug 25p Socket 25p Line Skt 40p	CONNECTORS PP3 Snaps 10p PP9 Snaps 12p	Clear 1 to 1028p. Clear Taper 28p	(Snipe) 7.52	Antex froms C240 (15W)	2N3772 1,83 2N3773 1.99 2N3773 Motorola 2.67	2N5296 1.28 2N5298 1.37 2N5302 3.20		BC259B 26p BC259C 27p BC260 30p	80536 75p 80537 80p 80538 80p
TYPE (RADIAL) 250V 10nF, 15nF, 22nF, 33nF,	22 10 6p 22 16 7p 47 10 7p 47 16 8p	(inc. Spare Nib) 90p ETCH RESIST TRANSFERS	CANNON TYPE AUDIO PLUGS (3 PIN XLR)	Box for 4HP7 27p Box for 6HP7 33p Box for 4HP11	(All for ¼"	PUMP BT 100. High Suction Anodised 4.55	XS250 (25W) 4.99 Iron Stand 1.65	2N3773 RCA 2.75 2N3773	2N5303 3,80 2N5305 25p 2N5306 37p 2N5307 40p 2N5308 25p	BC108A 12p BC108B 12p BC108C 14p BC109 10p BC109B 12p BC109C 12p BC113 30p BC114 19p	BC260C 33p BC261 33p BC261A 34p	BD539 80p BD539C 1.10 BD540 86p BD540C 1.20
47nF, 68nF, 100nF 7p 150nF, 200nF 10p	100 10 9p 100 16 10p 220 10 11p	1. Thin lines 2. Thick lines 3. Thin bends 4. Thick bends	Male 1.70 Female 1.65 Sockets (Chassis)	33p TRANSISTOR	Grub Screen Fitting Black Plastic	Spare Tefion Nose 85p	Elements (State Iron) 2.05 C240 Bits No. 2 (Small)	2N3779 1.70 2N3789 3.27 2N3790 2.73	2N5308 25p 2N5354 19p 2N5355 19p 2N5358 73p	BC114 19p BC115 22p BC116 32p BC116A 37p BC117 19p BC118 19p BC119 38p BC121 82p BC123 82p BC125 37p	BC262A 320	BD540 85 ₀ BD540C 1,20 BD675 72 _p BD676 77 _p BD677 78 _p BD678 83 _p BO711 1.32 BO712 1.32 BOX14 1.59 BDX18 1.59 BDX18 1.59 BDX18 1.59
330nF, 470nF 13p 680nF 18p 1µF 22p	470 10 17p 470 16 18p 1000 10 20p	5. DiL peds 6. Transistor pads	Male 1 50 Female 2 35	70 18 (BC 109) 30p	M1.25 + metal insert 34p M2.33mm + metal insert 39p	BTC601 LCD Push Button	No. 3 (Med.) 65p No. 6 (Micro) 65p	2N3792 2.68 2N3794 25p 2N3819 25p	2N5354 19p 2N5355 19p 2N5355 19p 2N5358 73p 2N5366 25p 2N5367 28p 2N5401 35p 2N5401 1.10 2N5415 1.10	BC117 19p 8C118 19p BC119 38p BC121 82p	BC262B 33p BC262C 34p BC263 30p BC263B 31p	BD711 1.32 BD712 1.32 BDX14 1.30 BDX18 1.59
1.5µF 39p 2.2µF 39p SIEMENS	2200 10 34p 2200 16 44p 3300 10 50n	7. Dots + holes 8. 0.1 edge connectors 9 Mixture	JACK PLUGS Huge Discount for quantity Please phone	703 (2N3055) 40p	VI 3 . 36mm + metal nsert & skirt	2 amps AC/DC, 1KV DC 750v AC	XS250/X25 Bits No 50 (Small) 65p No. 51 (Med.)	2N3820 38p 2N3821 1.84 2N3822 90p	2N5448 19p	BC121 82p BC123 82p BC125 37p BC132 39p BC134 36p	BC263B 31p BC263C 32p BC264 40p BC264B 42p BC266 35p	BDY55 176
POLY-C 5% 250V 7.5MM 1nF, 1n5, 2n2 3n3, 4n7, 6n8 7p	4700 10 65p 4700 16 95p	Any sheet of above 35p PHOTO SENSITIVE PCB	¼ Mono 20p ¼ Stereo 30p ¼ Metal Mono 30n	KEYNECTOR' Bare Wire Mains Safety Block	39p M4. As M3 numbered	Fully guaranteed 34 50	No. 52 (Lge.) 65p	2N3823 45p 2N3824 1 70 2N3826 78p 2N3827 78p 2N3854 44p	2N5450 23p 2N5451 25p 2N5457 29p 2N5458 29p	BC135 45p BC136 45p BC137 39p BC138 85	BC266A 36p BC266B 37p BC300 45p BC301 44n	BDY57 5.25 BDY58 6.15
8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 39n,	CAN ELECTROLYTICS 4700µF 40V 2 50 4700µF 63V 3 50	1st Class Epoxy Glass. For better results than	2½ mm Mono 12p 2½ mm Metal	IEC MAINS	1 to 10 39p M5, As M3 but 30mm 42p M6, As M4 but	MINI TESTER Pocket Size 2000 OPV Analog	SOLDER 125gms 18swg 2.95 22swg 3.10	2N3855 30p 2N3855A 40p 2N3856 45p	2N5459 29p 2N5460 72p 2N5461 60p 2N5481 80p 2N5484 40p	BC138 55p BC140 29p BC141 37p BC142 29p	BC302 43p BC303 47p BC304 46p BC307 13p BC307A 14p	BDY62 2.34 BDY92 3.75
56n, 68n, 82n, 100n, 150n 10p SIEMENS	10,000µF 80V 4.50	spraying. Expose to UV Single sided 100 × 160 1.55 100 × 220 1.90	Mono 20p 3½ mm Mono 12p 3½ mm Stereo	Plug (Holes) 58p Chassis Skt. (Pins) 35p Line Skt.	30mm 42p M7, Pointer 24p	Meter 5.55 MICROTEST 80	UK's Greatest Retail Variety	2N3858A 37p 2N3859A 31p 2N3860 31p	2N5484 40p 2N5485 29p 2N5490 1.37 2N5492 1.56	BC143 30p BC147 10p BC147A 10p BC147B 10p		BF119 1.00 BF121 7Bp BF123 70p BF127 80p
POLY-C 5% 100V 7.5MM 100n, 120n, 150n 11p	BEADS 0 1 35V 14p .22/35V 14p .33/35V 14p	203 × 114 1 85 233 × 220 3.99 Double sided	3½ mm Metal Mono 20p	Pins 60p Chassis Plug (Holes) 50p	MATCHING KNOBS	Superior 20,000 OPV 1000v AC/DC, 5 ADC,	Please phone about types not listed due to insufficient	ZN3866 90p 2N3877A 35p 2N3900 25p 2N3902 3.33 2N3902 3.33	2N5494 1.37 2N5496 1.59 2N5543 12.00	BC147A 10p BC147B 10p BC147C 20p BC148A 10p BC148A 12p BC148B 13p BC149B 13p BC149B 12p BC149B 12p BC149C 13p BC152 35p BC153 23p BC154 27p	9C309B 14p 9C309 14p 8C309A 15p	BF163 39p BF164 28p BF167 58p BF168 28p
180n, 220n, 270n 14p 330n, 390n 20p 470n, 560n 26p	.47/35V 14p .68/35V 14p 1.0/35V 14p 2.2/16V 14p	100 × 160 1 65 100 × 220 2 15 203 × 114 2 21 233 × 220 4 55	JACK SOCKETS Chassis 4 Mono 20p	13 AMP DOMESTIC Plug + Fuse 50p Adaptor 2 way	M8. 15mm 48p M9. 24mm 56p M10. 30mm	2.5A AC, 0, 1Ω to 5M 16.60 680R 20,000 OPV 1000v DC,	space Only top quality devices sold 2N918 33p 2N929 36p	2N3903 13p 2N3904 13p 2N3905 13p 2N3906 13o	2N5551 37p 2N5640 45p 2N5654 35p 2N5786 80p 2N5813 23p	BC148C 13p BC149 10p BC149B 12p BC149C 13p BC152 35p	BC309B 16p BC309C 17p BC317 16p BC318 16p	BF158 25p BF159 58p BF160 55p BF161 56p BF163 50p BF166 57p
680n 30p 1µF (10mm) 35p	2.2/35V 14p 3.3/35V 18p 4.7/16V 18p 4.7/35V 20n	Developer for above (do not use Sodium Hydroxide)	3 12 mm Mono	1.95 Trailing skt. 82p	f USES	2000v AC, 0-1Ω to 10M 32.00	2N929 36p 2N929A 45p 2N930 20p 2N930A 30p 2N1131 24p	2N3945 85p 2N3962 30p	2N5813 23p 2N5884 5.95 2N5886 5.95 2N6027 30p	BC157 11p	BC320 25p BC321 25p BC327 14p BC328 14p	BF166 B7p BF167 29p BF170 79p BF173 26p
400V POLYESTER 1n, 1n5, 2n2, 3n3, 4n7, 6n8,	6.8,25V 20p 6.8,35V 21p 10/16V 18p 10/35V 27p	500 ml 2.50 .	Line 20e	ALOMINION I	20mmSlow Fast	RELAYS DIL REED	2N1132 25p 2N1302 45p 2N1303 65p	2N4030 75p 2N4031 65p 2N4032 69p 2N4036 63p	2N6027 30p 2N6030 8.80 2N6031 6.95 2N6082 11.99	BC157A 12p BC157B 13p BC158 10p	BC337 1Bp BC338 15p BC347 20p BC350 20p	8F174 77p 8F177 26p 8F178 30p 8F179 36p
10n 10p 15n, 22n, 33n 11p 47n, 68n,	15.16V 22p 15/25V 32p	VEROBOARD 0.1' COPPER CLAD	¼ "Stero 30p ¼ "Stero Metal 50p	Covered with Black Rexine	19p 15p 250mA 17p 10p	100VA Normally open (1 amp) 5v 380Ω 1.99 5v 380Ω piode	2N1304 60p 2N1306 65p 2N1308 65p 2N1711 35p	2N4031 65p 2N4032 63p 2N4036 63p 2N4037 45p 2N4058 10p 2N4059 17p 2N4060 12p 2N4061 10p 2N4064 1.15	2N6099 1.20 2N6101 1.30 2N6109 1.15 2N6111 1.00	BC158A 12p BC158B 13p BC159 11p BC159A 12p BC159A 12p BC159B 13p BC159C 13p BC160 42p BC161 48p BC167 10p	BC382 30p'	BF180 35p BF181 36p BF182 36p BF183 35p
100n 14p 150n, 220n 18p 330n 39p 470n 50p	33/10V 30b 47/6 3V 30p	2.5 × 3.7 83p 2 5 × 5 99p 3 75 × 3.75 99p	3½ mm Mono 15p	1 044/74 7 2 2-	17p 10p	5v 380Ω + Diode & Screen 2.95 12v 530Ω 1.99 24v 2kΩ 1.99	2N1711 35p 2N1889 50p 2N1890 50p 2N1893 48p 2N2060 7.14	2N4060 129 2N4061 10p 2N4062 10p 2N4064 1.15	2N6121 67p 2N6122 59p 2N6123 65p 2N6124 59p	BC1598 13p BC159C 18p BC160 42p BC161 48p	BC383 30p BC383L 30p BC384 30p BC384L 30p BC407 24p BC407 24p	BF184 36p BF185 37p BF194 12p BF195 12p
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23 **ETI AUGUST 1983**

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.

t 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.

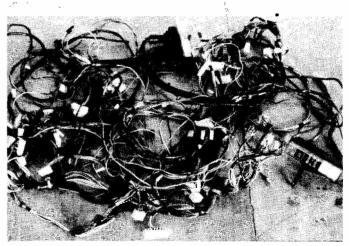
Secondly, there's reliability. Well designed electronics should always be much more reliable than electromechanics. An electronic loom would considerably reduce the number of connectors in the system. Not only would this improve the car's reliability after sale, it would also cut down on manufacturing 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 antipollution 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.

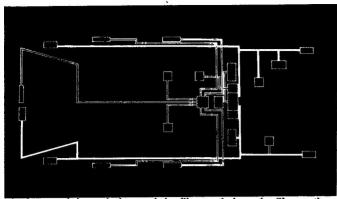


This is what the Motocar no longer has — a conventional (messy) wiring loom containing about 500 metres of wire.

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 autoclocking 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.

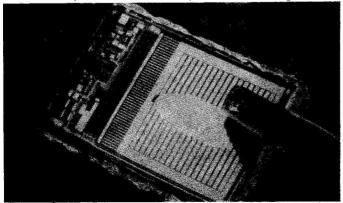
Outstations

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



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

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.

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

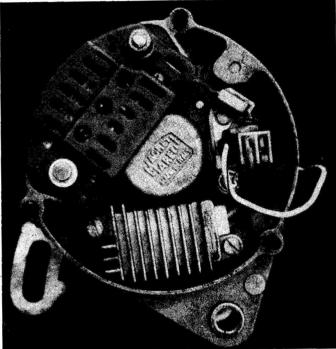


The Futaba display used, in ful action. Unfortunately, you can't see that the figures are in a rather reasuring green, and the main beam indicator is in a baby blue . . .

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 ser-



vicing 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.

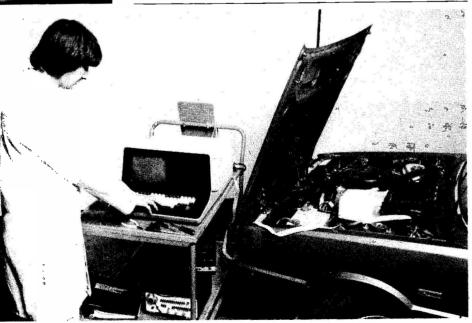
Motorola say that fibre optic systems are used because they offer higher noise immunity and lower weight than copper wire systems. However, the fact that they've been confined to the luxury features of the car is probably evidence of a reliability problem — or is it just my cynicism?

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.

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.



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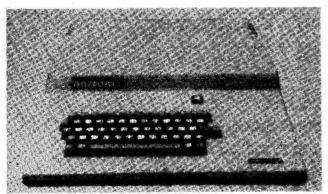
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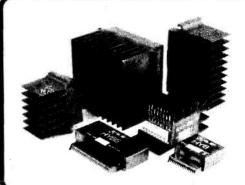


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Module Number	Output Power Watts	Load Impedance	T.H.D. Typ at	I.M.D. 60Hz/	Supply Voltage Typ	Size	WT gms	Price inc. VAT
	rms		1KHz	7KHz 4:1				
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4.8	0.015%	< 0.006%	± 25	120 x 78 x 40	420	£18.69
HY 124	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.

ORF. AMP SVSTEMS

Module Number	Module Functions		Current Required	Price inc.
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vor/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		20mA	£15.36
HY78	Stereo pre amp		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.

Module	Output	Load	DISTO	RTION	Supply	Size	WT	Price
Number	Power Watts rms	Impedance 	T.H.D. Typ at 1KHz	i,M.O. 60Hz/ 7KHz 4:1	Voltage Typ	nten.	gms	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/js. Rise time: 3µs. S/N ratio: 100db

Frequency response t-3aBis: 15Hz - 100kHz. Input sensitivity: 500mV rms
Input impedance: 100K Ω. Damping factor: 100Hz > 400.

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C1515 Stereo version of C15.

Size 95 x 40 x 80, Weight 410 gms.

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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.
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 MQS248	£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
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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.

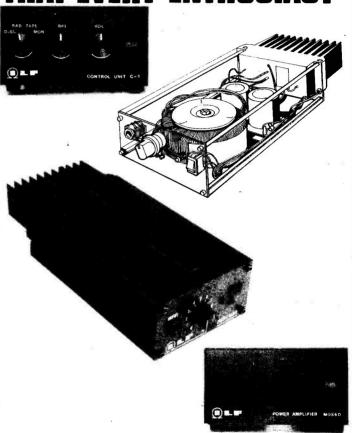
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UNICASES

					Price inc.
HIFI Sep	arates				VAT
UC1	Preamp				£29.95
UP1X	$30 + 30W/4 - 8\Omega$	Bipolar	Stereo	HIEL	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8 \O	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4 Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8 Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4—8 Ω	MOS	Mono	HiFi	£64.95
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U\$1X	60W/4Ω	Bipolar	Power	Slave	£59.95
U\$2X	120W/4 \Oldot	Bipolar	Power	Slave	£79.95
US3X	60W/4-8Ω	MOS	Power	Slave	£69.96
U\$4X	120W/4-8 Ω	MOS	Power	Slave	£89.95

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



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TV STORAGE SCOPE

he 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

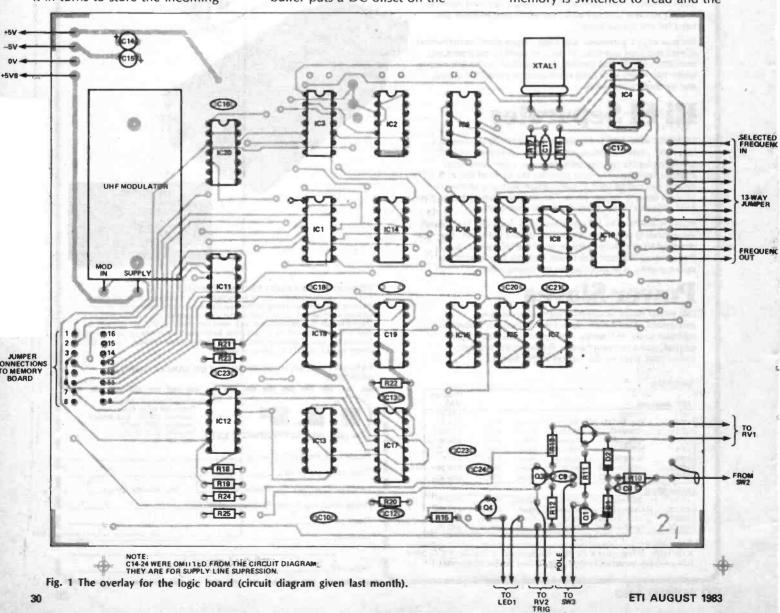
data and display the stored data. In manual trigger mode, the incoming signal controls the changeover of the two memories, so if the input signal only occurs once, or is removed, the last signal is displayed on the screen. When measuring DC levels, the auto trigger mode is used to give a continuous trigger, 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



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.

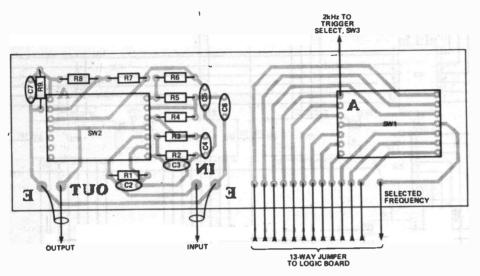


Fig. 2 Overlay for the front panel PCB, containing the input attenuator.

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

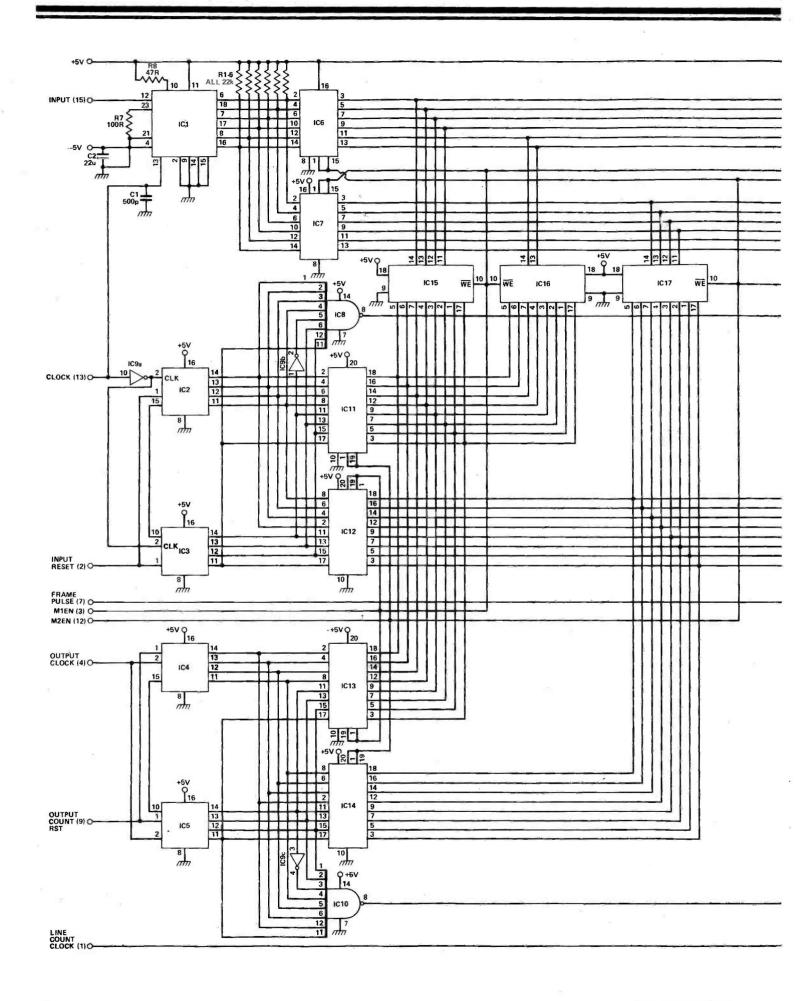
small PCB on the reverse, which holds some of the components associated with the input and trigger controls and the corresponding input sockets. The power supply board is mounted in the rear of the case, with the transformer to the left (viewed from the front).

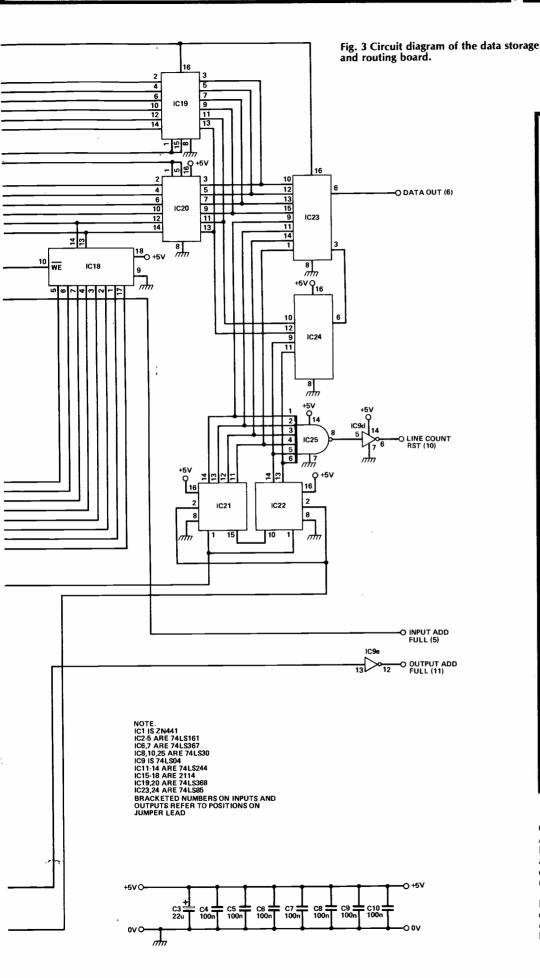
First build the data storage and routing board (the circuitry for this board is described in this month's article). All the components are mounted on the circuit board (see the overlay in Fig. 5). All the connections to this board are made via a 16-way jumper lead to the control logic board (whose circuitry 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.

LOGI	C BOARD_
Resistors (all 1V	V, 5% except where
stated)	
	k 2%
	k 2% k 2%
	2%
R5 27k	2%
R6 18k	2%
	2%
	2%
R10, 15 10k	
R11 220 R12 1M	
R13 470	
R14, 25 47R	
R16, 17 330	
R18, 19 270	
R20 4k7 R21, 23 1k0	
R22 56k	
R24 470	
Potentiometers	
RV1,2 10k	linear
Capacitors (all	ceramic except where
stated)	
C1,8-10,16-	
24 100	THE RESERVE OF THE PARTY OF THE
C2 100	
C3, 5 20p	
C4 120 C6 68	
C7 10	
C11 27	
C12, 13 2n	
C14,15 221	IF 16 V PCB
	ctrolytic
Semiconductors	LS04
	LS74
1 / -/	LS10
1.00	LS00
	LS90
IC12 74	LS03
IC13-16, 19 74	LS93
	LS123
	LS73 LS08
	3819
	107
	4148
LED1 rec	LED
246	
Miscellaneous	DT slide switch
	way PCB-mounting
ro	tary switch
SW3 2-	pole, 3-way slide switch
(0	pole, 3-way slide switch nly one half used)
SW4 12	-way PCB-mounting
ro	tary switch
XTAL1 10	MHz }
PCBs (see Buy	lines); UHF modulator 36; ribbon cable; sloping
front care (see	36; rippon cable; sloping Buylines); screened cable
for input PCF	pillars; power supply
board (see Buyl	nes).
Tour (see cay)	1984





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 com-pleted, 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).

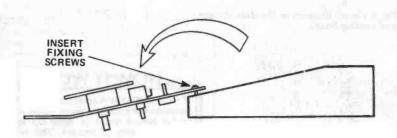


Fig. 4 This is how you attach the front panel to the box to make it easier to do the interconnecting

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

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

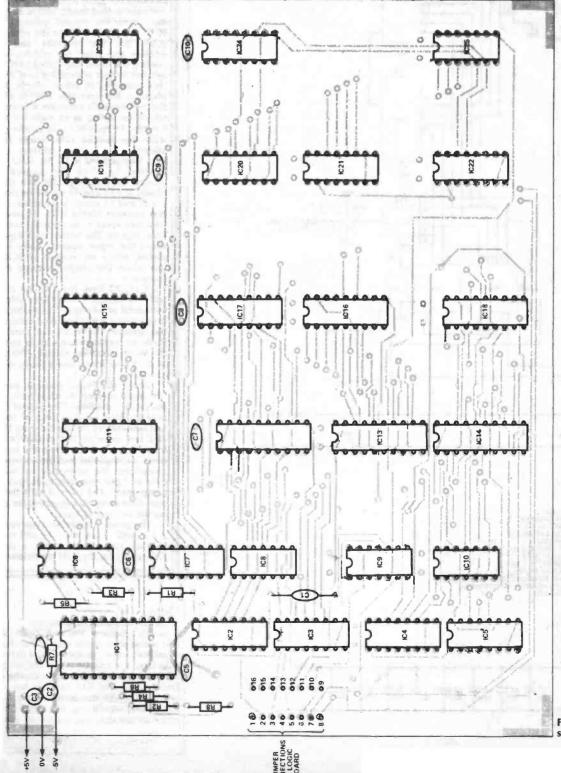
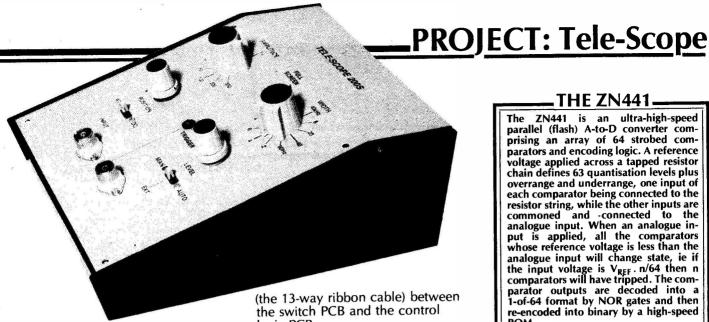


Fig. 5 Overlay of the data storage board



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

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.

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_{RFF}. 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 highspeed data acquisition, video an radar data conversion, digital signal storage and image processing.

PARTS LIST — DATA BOARD _

Resistors (all ¼W, 5%) R1-6 2k2 R1-6 100R

Capacitors

22uF 16 V PCB C1, 2 electrolytic C3-9 100nF ceramic

Semiconddductors 7N441 IC2-5, 21, 2274LS161 74LS367 IC6, 7 74LS30 IC8, 10, 25 74LS04 IC9 74LS244 IC11-14 IC15-18 2114 IC19, 20 IC23, 24 74LS368 74LS85

Miscellaneous PCB (see Buylines); 24 pin IC socket for



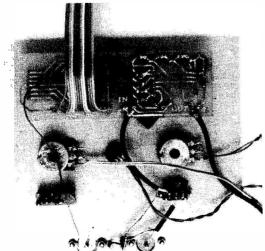


Fig. 6 Wiring the back of the front panel.

.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,

Park Wood Industrial Estate, Bircholt Road, Maidstone.

Telephone: 0622 686811.

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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.

he 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%.

RESTERY DETECTOR

WYEB

OUT

A3

A3

B

LBD

BATTERY
DETECTOR

VFB

7

A1

A2

A1

A1

A3

BATTERY
DETECTOR

VFB

FINA

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 ($V_{\rm FB}$). 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

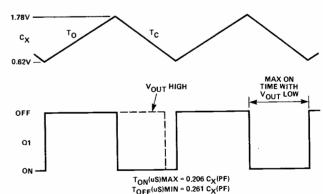


Fig. 2 Switching timing diagram.

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 0.7μ A 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.

ed 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 150 μ A) until the battery voltage falls to 7.5V. Below 7.5V the 4193 will regulate the V_{our} 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

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, Isw	$V_3 = 400 \text{mV}$	75	100		mA
Quiescent Current, I _{cc}	Measure at Pin 5 $I_3 = 0$		135	200	uA
Efficiency			80		%
Line Regulation	$0.5V_{\rm o}$ $<$ $V_{\rm cc}$ $<$ $V_{\rm o}$		0.08	0.5	% V _{out}
Load Regulation	$V_{CC} = 0.5V_{O}$ $P_{L} = 150mW$		0.2	0.5	% V _{очт}
Operating Frequency, fo		0.1	25	150	kHz
Reference Set Current, Ic		1	5	50	uA
Switch Voltage	$l_3 = 100 \text{mA}$		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

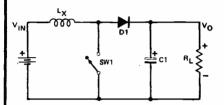


Fig. 3 Basic circuit for stepping up mode.

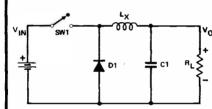


Fig. 4 Basic stepping down circuit.

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 $1\mu A$ and $100\mu A$ 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 $5\mu A$ (typically less than $0.1\mu A$).

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_I).

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 substitute for a 9V transistor battery, since a stable output voltage will be achiev-

	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)	$\frac{V_{IN}-1.31}{5\muA}$	$\frac{V_{IN}-1.31}{5\mu A}$	$\frac{V_{IN} - 1.31}{5\mu A}$
R3*	$\frac{V_{OUT} - 1.31}{I_1}$	$\frac{V_{OUT} - 1.31}{I_1}$	<u>V_{оит}</u> I,
R4*	$\frac{1.31}{l_1}$	1.31	1.31
R5	261k Ω	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	$\frac{0.3V_8(V_{\text{OUT}} - V_{\text{IN}})}{f_{\text{O}}I_{\text{LOAD}}V_{\text{IN}}}$	$\frac{0.3V_{OUT}}{f_OI_{LOAD}}$	$\frac{0.3V_{\text{IN}} V_{\text{OUT}} }{f_{\text{O}l_{\text{LOAD}}}(V_{\text{IN}}+ V_{\text{OUT}})}$
Cl	$\frac{2V_{\text{OUT}}\!-\!V_{\text{IN}}}{4f_{\text{O}}V_{\text{OUT}}V_{\text{R}}}$	$\frac{I_{LOAD}}{4f_{O}V_{R}}$	$\frac{0.15I_{LOAD}N + 2 V_{OUT} }{f_{O}V_{IN}(V_{IN} + V_{OUT})V_{R}}$
R6	35V _{IN} I _{LOAD} V _{OUT}	35 I _{LOAD}	$\frac{35V}{I_{LOAD}(V_{IN} + V_{OUT})}$
R7 -	<u>R6</u> 7	<u>R6</u> 7	R6 7
Units a	re ohms, fards, h	enries, and he	ertz uniess

Table 2 Design equations for the three modes.

I, = current into pin 1; recommended value 100uA.

indicated otherwise.

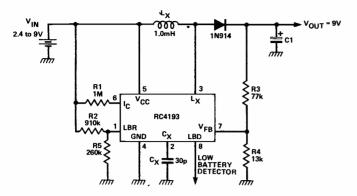


Fig. 5 RC4193 low current step-up mode.

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.

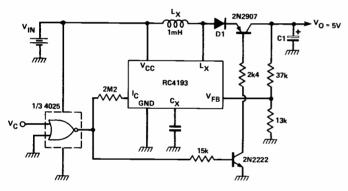


Fig. 6 RC4193 battery-back-up circuit.

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.

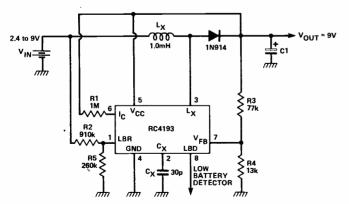


Fig. 7 Bootstrapping the supply to the RC4193.

Basic Step-Down Switching Regulator

Since the switch transistor in the 4193 is in parallelwith 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.

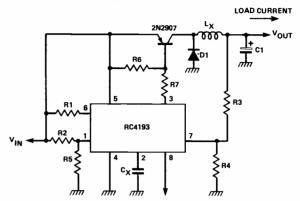


Fig. 8. RC4193 step-down mode

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.

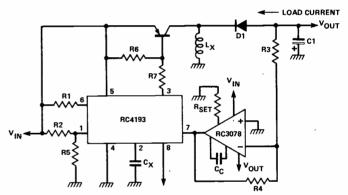


Fig. 9 RC4193 used as an inverter-regulator.

Inverting Switching Regulator

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

The circuit is similar to the type used in Fig. 8, except the Icoation of Lx 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 $|V_{\text{out}}|$ is below the design output voltage or else the

circuit will not start.

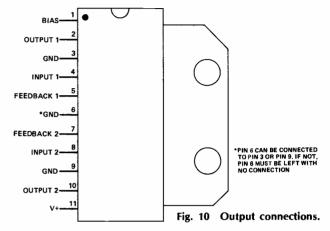
Due to their output stage design, op-amp types similar in design to the 741 may cause the circuit to not start properly since they fail to keep pin 7 below 1.3V when power is first applied.

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.

he 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.

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, $R_L = 8\Omega$, $A_V = 50$ (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 Total Supply Current	CONDITIONS $P_{O} = 0W$	MIN	TYP	MAX 50	UNITS
. ,	10 - 000		25(10)		mA
Operating Supply Voltage		6		24(35)	V
Output Power/Channel	$ f = 1 \text{ kHZ, THD} = 10\%, T_{\text{TAB}} = 25^{\circ}\text{C} $ $ V_{\text{S}} = 20\text{V} $ $ V_{\text{S}} = 12\text{V, } R_{\text{L}} = 4\Omega $	4.0(5.0) 1.5	4.5(5.5) 1.9		W W
Distortion, THD	$f = 1 \text{ kHZ}, V_s = 20V$ $P_o = 50 \text{ mW/Channel}$ $P_o = 2\text{W/Channel}$		0.1(0.2) 0.07(0.14)	1	% %
Output Swing	$R_t = 8\Omega$		$V_5 - 4$ $(V_5 - 6)$		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	- 7 0		dВ
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)		dВ
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, $R_L = 8\Omega$		70		. dB
Input Offset Voltage .			15		mV
Input Bias Current			50(100)		nA
Input Impedance	Open Loop		4		ΜΩ
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)		Α

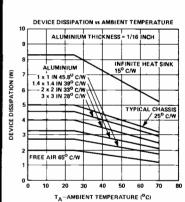


Fig. 11 Device dissipation vs. ambient temperature (LM2877).

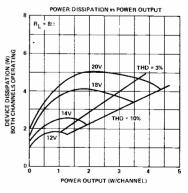
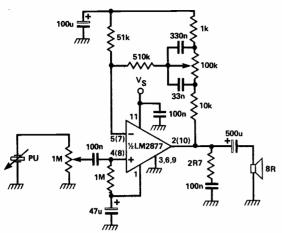


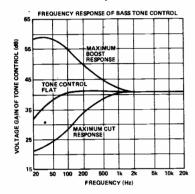
Fig. 12 Power dissipation vs. power output (LM2877).



2k 100k 4u7 100n 100n

Fig. 15 Non-inverting amplifier using split supply.

Fig. 13 Ceramic PU amplifier with bass control.



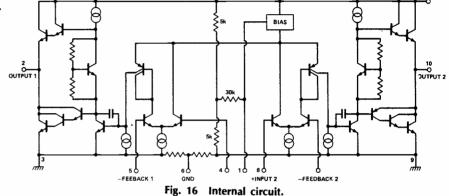


Fig. 14 Frequency response of bass control in Fig. 13.

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

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UNIVERSAL EPROM PROGRAMMER

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

PROMs 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,

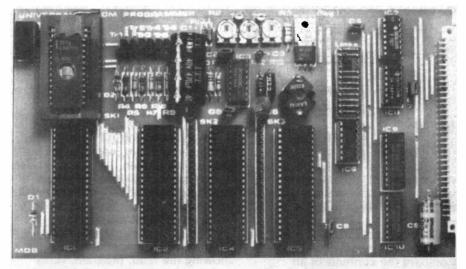
however, as electronically it should be quite simple to interface this card to any computer using the 6502 or 6809 processors. No special power supplies are required as all voltages required for programming are derived from a single +5v supply.

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 +5V 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!

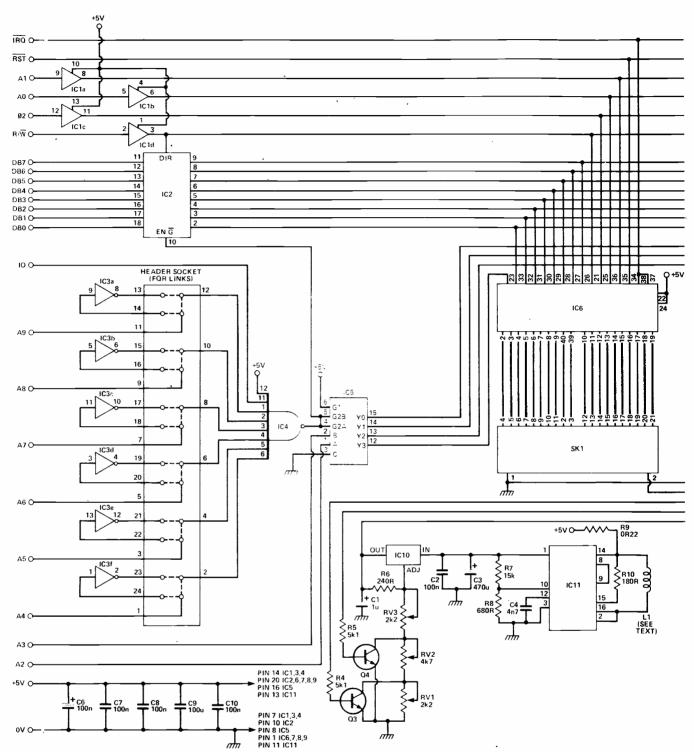


Fig. 1 Circuit diagram of the Universal EPROM Programmer.

programmer.

Software

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

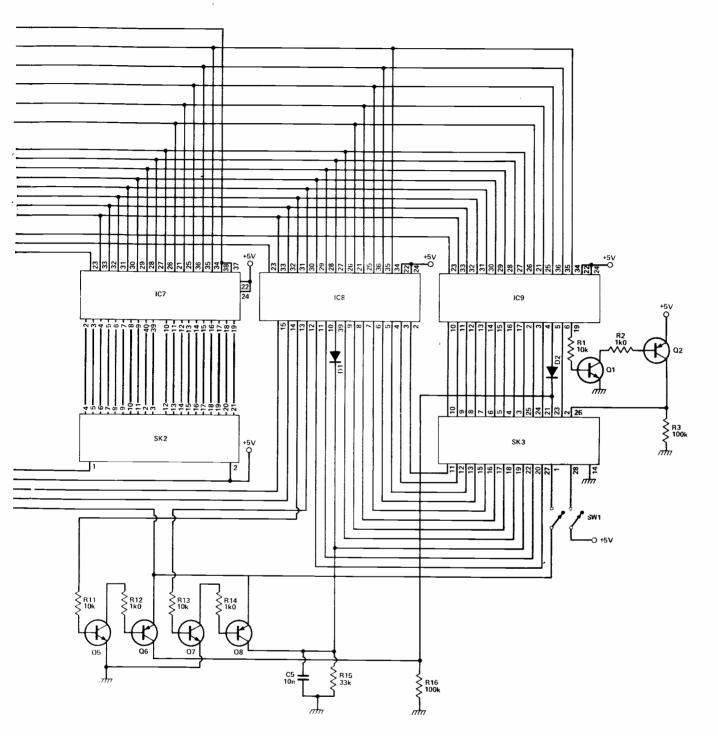
- Read data from an EPROM into computer memory;
- 2. Compare the contents of an EPROM with the contents of computer memory;

- 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-

PROJECT: EPROM Programmer



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 78540 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		IC PIN	27 58	27/ 25 16	27/ 32 32A	25 32	27 64	25 64	27 128	27 256	
VPP	VPP	VPP	VPP					/1		/28					vcc	vcc	vcc	vcc	
A12	A12	ČS1	A12					-/2		/27					PGM	CS2	PGM	A14	
Α7	Α7	A7	Α7	Α7	Α7	Α7	Α7	1/3		24/26	vcc	vcc	vcc	vcc	N/C	N/C	A13	A13	
A6	Αô	A6 -	A6	A6	А6	А6	A6	2/4	d þ	23/25	A8	A8	A8	А8	А8	A8	А8	А8	
A5	A 5	A5	A5	A5	A5	А5	А5	3/5		22/24	А9	А9	А9	А9	А9	А9	A9	А9	
A4	Д4	A4	Д4	Α4	A4	Α4	Α4	4/6	 	21/23	VPP	VPP	A11	VPP	A11	A12	A11	A11	
А3	А3	А3	А3	А3	А3	А3	А3	5/7	 	20/22	ŌĒ	ŌĒ	OE / VPP	PD/ PGM	ŌĒ	PD/ PGM	ŌĒ	ŌĒ	
A2	A2	A2	A2	A2	A2	A2	A 2	6/8	4	19/21	AR	A 10	A 10	A10	A10	A10	A 10	A10	100
Α1	A1	A 1	A1	A1	Α1	A1	A1	7/9	d þ	18/20	CE/ PGM	CE/ PGM	CE	Δ11	CE	A11	CE	CE	
AO	A0	Α0	AO	A 0	Α0	Α0	ΔĐ	8/10	NOTE. 1) PIN NUMBERS TO 28 PIN PACKAGES.	17/19	D7	D7	D7	D7	D7	D7	D7	D7	
D0	D0	D0	D0	D0	D0	D0	D0	9/11	28 PIN PACKAGES. SUBTRACT 2 FROM PINS 3-26 FOR 24 PIN PACKAGE PIN NUMBERS.	16/18	D6	D6	D6	D6	D6	D6	D6	D6	
D1	D1	D1	D1	D1	D1	D1	D1	10/12	2) OE (27 SERIES) IS EQUIVALENT TO CS (25	15/17	D5	D5	D5	D5	D5	D5	D5	D5	
D2	D2	D2	D2	D2	D2	D2	D2	11/13	SERIES). 3) CE/PGM (27 SERIES)	14/16	D4	D4	D4	D4	D4	D4	D4	D4	
GND	GND	GND	GND	GND	GND	GND	GND	12/14	IS EQUIVALENT TO PD/PGM (NOT PD/PGM) (25 SERIES).	13/15	D3	D3	D3_	D3	D3	D3	D3	D3	

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

VERIFY BYTE

DEVICE FAILED

PASS

X = 15?

AST ADDRES

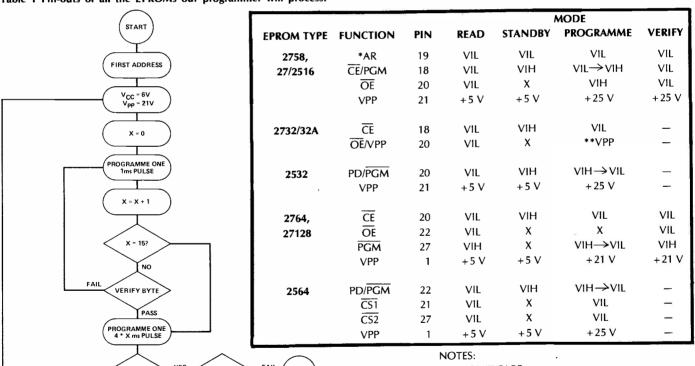
V_{CC} = V_{PP} = 5V

VERIFY ALL

NO

YES

PASS



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

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

Table 2 (above) Mode selection table.

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.

ADDRESS = ADDRESS + 1

PROJECT: EPROM Programmer

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

OFFSET FROM BASE

00

01

02

03

Table 3 Register addresses.

6821 NUMBER

IC9

IC9

IC9

FUNCTION

REGISTERS

	,	 ions.
-		

			REGISTERS	ics
6821	SK3		FOR	IC9
NUMBER/	PIN	PROGRAMMER FUNCTION	EPROM	IC8
PORT	NO.		PROGRAMMER	IC8
IC9/PB0	10	A0		IC8
IC9/PB1	9	A1		IC8
IC9/PB2	8	A2		IC7
IC9/PB3	7	A3	REGISTERS	IC7
IC9/PB4	6	A4	FOR	IC7
IC9/PB5	5	A5	GENERAL	IC7
IC9/PB6	4	A6	PURPOSE	IC6
IC9/PB7	3	A7	I/O	IC6
IC9/PA0	25	A8	PORTS	IC6
IC9/PA1	24	A9		IC6
IC9/PA2	21	A10 (EXCEPT 2758), AR (2758)		
IC9/PA3	23	A11 (2732/32A/64/128/256), A	12 (2564)	
IC9/PA4	2	A12 (2764/128/256), CS1 (2564	1)	
IC9/CB2	26	A13 (27128/256), VCC (2758/1	6/32/32A, 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	OE (2758/16/38/32A/64/128/25	6,2516), PD/PGM (2532/	64)
IC8/PB0	20	A11 (2532/64), CE/PGM (2758/	/16, 2516), CE (REMAIND	ER)
IC8/PB1	27	PGM (2764/128), CS2 (2564), A	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 (VP	P+21V) = +25V SELECT	

DDRA/ORA Ω4 CRA 05 DDRB/ORB 06 **CRB** 07 DDRA/DRA 08 **CRA** 09 DDRB/ORB 10 **CRB** 11 DDRA/ORA 12 **CRA** 13 DDRB/ORB 14 CRB 15 replace SW1. On the other hand, if the programmer is intended to be zero insertion force DIL socket

REGISTER

DDRA/ORA

CRA

DDRB/ORB

CRB

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

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.

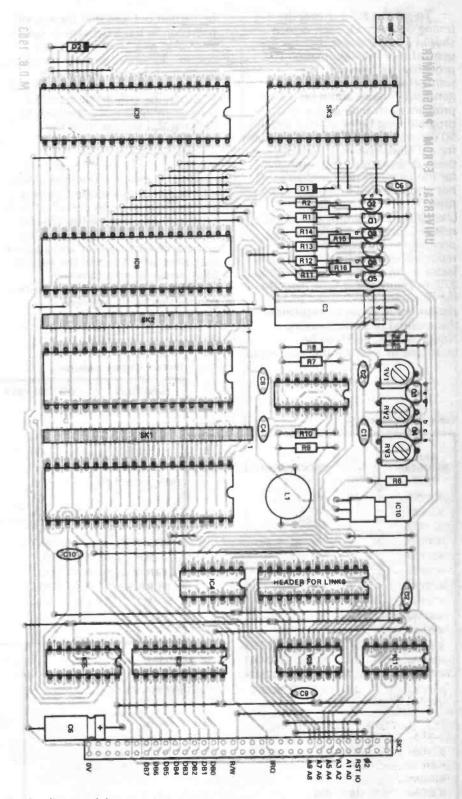
Using The Programmer

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.

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



Overlay diagram of the programmer.

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

PROJECT: EPROM Programmer

	PARTS LIST
R1. 11. 13	6 (all ¼W 5% unless stated) 10k
R1, 11, 13 R2, 12, 14	1k0
R3, 16 R4, 5	100k
	5k1
R6	240R
R7	15k
R8 R9	680R
R10	0R22 wire wound 180R, 1W
R15	33k
RV1, 3	2k2 min horizontal preset
RV2	4k7 min horizontal preset
CAPACITO	RS
C1	1u 35 V axial electrolytic
C2, 7, 8, 9,	
10	100n ceramic
C3	470u 35 V axial
C4	electrolytic
C5	4n7 polyester 10n ceramic
C6	100u 6V3 axial electrolytic
C10	10n ceramic
SEMICONE	UCTORS
IC1	74LS126
IC2	74LS245
IC3	74LS04
IC4	74LS30
IC5	74LS138 MC6821 (or similar)
IC10	LM317M
IC11	78S40
Q1, 3, 4, 5,	
7	BC184L
Q2, 6, 8 D1, 2	BC214L
D1, 2	OA91
MISCELLAN	
L1	34 turns 24 swg wire on
SK1 2	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,
SW1	see text)
3441	two pole single throw switch (omit if using
	console)
One 16-wa	y and one 80-way DIL
headers and	y and one 80-way DIL sockets; edge connector (2
× 32-way	A + B DIN Euro connector,
male angled	pins, for Tangerine) PCB,
I WILL CILL.	

DADTC LICT

continue the programming or verification.

wire, etc.

(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.

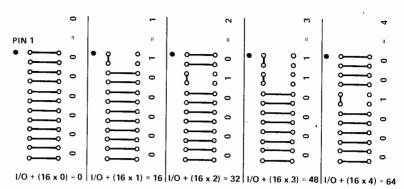


Fig. 3 Setting the address offset by wire links.

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/cm². The Philips TUV 15 W tube emits UV at the required wavelength and at an intensity of 37 uW/cm² 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.

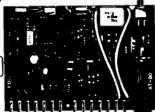
BUYLINES

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.

Step-by-step fully Mustrated assembly and fitting instructions are included together ith circuit descriptions. Highest quality components are used throughout.

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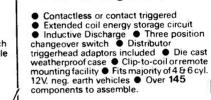
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READ/WRITE

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 unlike-

ly 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 in-duction 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 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 rapidexposure 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 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 would presumably players demoted to duties such as doorstopping 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 results 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 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.

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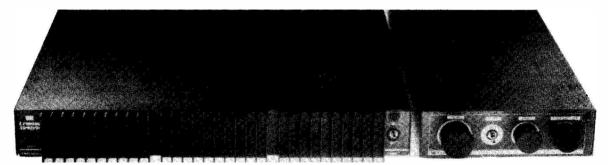
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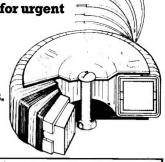
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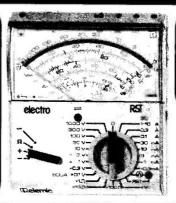




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TECH TIPS

Keyboard Alphanumeric Lock Switch

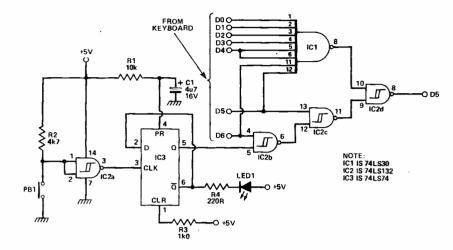
G. Franklin, Mid Glamorgan

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

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.

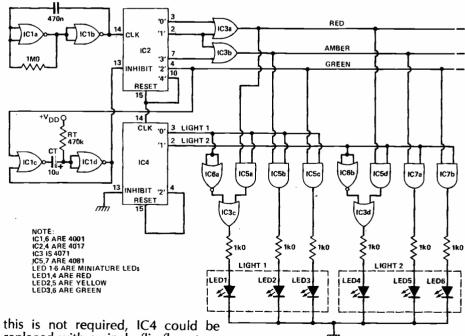
Controller For Model Traffic Lights

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_{τ} and R_{τ} , 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



replaced with a single flip-flop stage (eg a 4013), set to toggle, LIGHT 1 and LIGHT 2 being connected to the Q and Q outputs respectively. With a little ingenuity, realistic-looking traffic

lights can be constructed from miniature LEDs and empty pen refill tubes.

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Accessories. Carrying case £6.84, Universal test lead set £12.65. Service Manual £3.00.



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Pocket size. ● 3½-digit 0.5" LCD, ● 0.75% basic accuracy. ● 14 ranges ● Battery life 200 hrs £45.94. Carrying case £3.45. Universal test lead set £12.65. Service Manual £3.00.

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HANDAH 1M451

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THANDAR TF040 10 Hz to 40 MHz

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Besolution 1 Hz. ● Sensitivity 40 mV rms.

Timebase accuracy 0.5 ppm ● Battery life 80 hours. ● Frequency, totalize & reset: 2 gate times ● Complete with batteries. £126.50.

ACCESSORIES FOR TF200 & TF040 AC adaptor £7.99, Carrying case £6.48, X1 Probe £8.05, X10 Probe £9.20, Service manual £3.00. TP600 prescaler £51.75. TP1000 prescaler £74.75.



THANDAR PFM200A 20 Hz to 200 MHz

● Pocket size ● 8-digit LED display ● Frequency range 20 Hz - 200 MHz. ● Resolution
0.1 Hz. Sensitivity typically 10 mV rms. Timebase accuracy 2 ppm ● Battery life 10 hours. ● Frequeny; 2 ranges, 4 gate times ● BNC input sockets £77.62. Accessories:Carrying case £3.45, AC adaptor £7.99, X1 probe £8.05, X10 probe £9.20, Service Manual £3.00.

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P.S. Specs, as ever, are exemplary.

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PFA/HV	36.04	200-300W	4 ,8Ω,16Ω	5dB dynamic headroom Drives 70V line direct.
*PFA500	42.00	250-600W	2 Ω, 4 Ω, 8 Ω	25A cont. output current.
	52.50	mounted on type	e 74 Heat Excha	nger (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.

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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.

o-one who has spent many hours and pounds constructing their radiocontrolled 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 somé 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

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

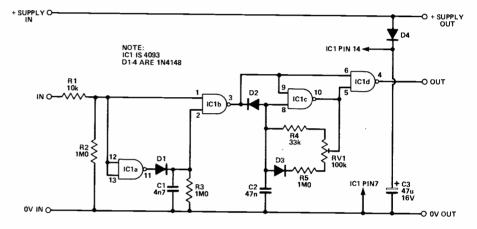


Fig. 1 Circuit diagram of the Conservo.

.HOW IT WORKS.

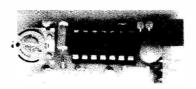
R1 and R2 protect the inputs of the CMOS devices from overload or static damage. The normal input to the device is a series of 1 to 2 ms positive pulses repeated at about 20 ms period. When the input is low, IC1a holds C1 high via D1 thus maintaining IC1b pin 2 at a high level.

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 dolar.

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 (1W 5% carbon film)

R2,3,5 1M0

R4 RV1 100k min. preset horizon-tal or vertical mounting

CAPACITORS

4n7F min. layer polycarbonate

C2 47nF min. layer polycarbonate (100nF for 3.6 volt

operation)

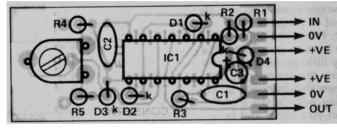
47uF 16 V min electrolytic **C3**

SEMICONDUCTORS 1N4148 D1,2,3,4

4093

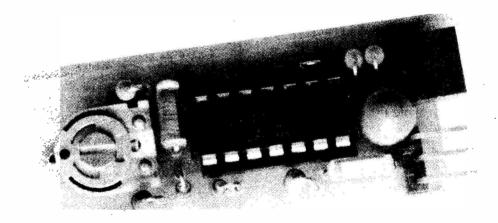
MISCELLANEOUS

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.



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AY-3-1270 AY-3-8910	710	MC3340	120	MC1488	55	4011	11	4528	45	LS08	12 12	LS161	30 35	0.68/35 1.0/35	12	RECTIFIERS	
AY-3-8910		MF10CN	35 0	MC1489	55	4012	14	4531	65	LS09	12	LS162 -	35	1.5/35	14	ALC III IENG	- 1
CA3046		ML924 NE529	· 195 225	MM5303 MM5307	625	4013	20	4532	60	LS10	12	LS163	35	2.2/35	16	1A/100V	20
CA3080		NE531	135	MM58174	1250 700	4015	39	4538 4539	60 80	LS11	12	LS164	40	3.3/35	17	1A/200V	23 25
CA3089		NE544	180	TMS6011	365	4016 4017	20 32	4543	60	LS12 LS14	12	LS165	50	10/25	18	1A/400V	25
CA3090AQ		NE555	16	ULN2003	75	4020	42	4555	35	LS15	22 12	LS168 LS170	80	15/25	28	1A/800V	38
CA3130E	85	NE556	45	8T26	99	4021	39	4556	35	LS20	12	LS173	70	2 2/16	14	2A/100V 2A/200V	36
CA3140E	36	NE565	110	8T28	120	4022	39	4561	100	LS21	12	LS174	47 36	3.3/16 4.7/16	14	2A/200V 2A/400V	40 40
CA3161E CA3189	100	NE566 NE567	140	8T95 8T97	90	4023	12	4583	80	LS22	12	LS175	36	6.8/16	16 16	2A/800V	52
CA3240E		NESTO	100 370	811S95	90 80	4024	32	4584 4585	40 50	LS27 LS28	12	LS181	87	10/16	18	25/100V	52
ICL7106		NE571	370	81LS96	80	4025 4027	12	4363	50	LS28	14	LS183	105	15/16	27	25/200V	1
ICL7611	95	RC4136	55	81LS97	80	4028	20 37	COMPUTER	lCs.	LS32	12 13	LS190 LS191	35	22/16 33/16	27	25/400V	1
ICL7621	180	RC4558	45	81LS98	85	4029	43			LS33	14	LS191	35	33/16	40	25/600V	
ICL7622 ICL8038	180	SL490	250	6522	310	4035	45	1802	650	LS37	14	LS193	35 35 35 36	47/16 100/16	40 75	REGULATORS	
ICL8038		SL76477 SP8629	380	6532 6821	675	4040	40	2650A	1175	LS38	14	LS194	32	15/10	22	701.05	
ICM7224	775	TBA120S	250 70	6845	110 650	4042	38	6502 6800	320 220	LS40	12	LS195	32	22/10	24	78L05 78L12	30
ICM7555		TBA800	75	6847	650	4043 4044	40 40	6802	250	LS42 LS47	28 35	LS196	43	33/10	30	78L15	30 30
LF353	85	TBA810	95	6850	110	4049	21	6809	615	LS47 LS48	40	LS197 LS221	45	47/10	35	78L24	30
LF356	90	TBA820	70	6852	250	4050	22	8035	345	LS49	50	LS240	50	100/10	55	7805T	36
LM10 LM301A	325	TBA950	220	6875	485	4051	42	8060	1090	LS51	14	1 5241	55 55	100/6.3	42	7812T	36
LM301A	70	TDA1008 TDA1022	310	8155 8212	350	4052	48	8080A	250	LS54	14	LS242 LS243 LS244	55	63V MINI		7815T	36
LM318	120	TDA1022	480 115	8216	110	4053	48	8085A Z80A	345	LS55	14	LS243	55	MONOLYTHI	C	7 8 24T 79L05	36
LM324	30	TL061	40	8224	110	4066 4068	22 14	200A	313	LS74 LS75	16 16	LS244	55 l	CERAMIC	_	79L12	60 60
LM334Z		TL062	60	8226	250	4069	13	MEMORIES		LS76	16	LS245	70	40 =		79L15	60
LM335Z	120	TL064	95	8228	220	4071	13			LS78	17	LS251 LS253	28 30		10	7905T	42
LM339 LM348	45 60	TL071	25 45	8243	270	4072	13	2101	395	LS83	33 39	LS257	29		10 10	7912T	42
LM358	55	TL072 TL074	45 95	8250 8251	865 250	4073	13	2114(200ns) 2532	85 295	LS85	39	LS258	32		10	7915T	42
LM377		TL081	24	8253	400	4075 4076	13 44	2708	225	LS86 LS90	15	LS259	53		10	7924T LM309K	42
LM380	65	TL082	45	8255	225	4078	13	2564	1000	LS90 LS92	22	LS266 LS273	18		14		130 270
LM381		TL084	90	8257	400	4081	12	2708	225	LS93	25 22	LS279	53	DIODEO		LM317T	120
LM382 LM384	110	TL170	49	8259	395	4082	12	2716(5V)	210	LS95	36	LS283	30	DIODES		LM323K	350
LM384 LM386	65	UA2240 ULN2003	115	8279	385	4093	23	2764	750	LS109	21	LS290	40	0A47	10	LM723	35
LM387		ULN2004	75 75	8832 9602	250	4099	70	4116(200ns)		LS,112	20	LS293	40	1N4001	10	78H05-5A/5V	5 50
LM393		XR2206	285	ZBOACTC	220	4502 4508	50 110	4118-3 4164	325 420	LS113 LS114	20	LS365	27	1N4002	4	RESISTORS	- 1
LM711	60	ZN414	79	ZBOADART	775	4510	45	5101(450ns)		LS123	21 34	LS366 LS367	27	1N4003	5	incold i Ond	- 1
LM725	325	ZN423	130	Z80ADMA	975	4511	45	5204	725	LS125	24	LS368	27 27	1N4004	5	Carbon Film,	1
LM733 LM747	69 60	ZN424	130	Z80AP10	270	4512	42	6116(150ns)		LS126	24 25 29		21	1N4005 1N4006	6	High Stab 5%	
LM1458	40	ZN425E ZN426E	340 290	ZN425E8 ZN426E8	320	4514	110	6514 6810	330	LS132	29	MICRO-MINI		1N4007	′	%W 10Ω-1M	2
LM2917		ZN427E	575	ZN427E8	320 575	4 5 15	110	0010	115	LS136 LS138	23	100V CERAM	- 1	1N4148	2	1/2W 10(2-10M Metal Oxide/Film	_ 2
LM3900	45	ZN428E	395	ZN428E8	395	4516	50			LS138 LS139	24 27	PLATE CAPS		1N5401	12	2% Met. Film E2	ⁿ 5
		,		-	- 50		- 1			LS151	30	1pF 10nF	٦, ١		14	1% Met. Film E2	4 8 l
				-		557.0						1011	_7	1N5406	17		

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CONTROLLE PIIT

his 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

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.

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

MEMORY SELECTION LOGIC

PORT SELECT LOGIC

I/O SELECT SIGNALS

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.

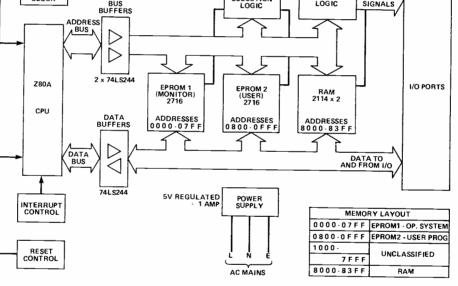


Fig. 1 Block diagram of Marvin.

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

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

Also, we suggest that you should use a zero insertion force socket for the user EPROM, as

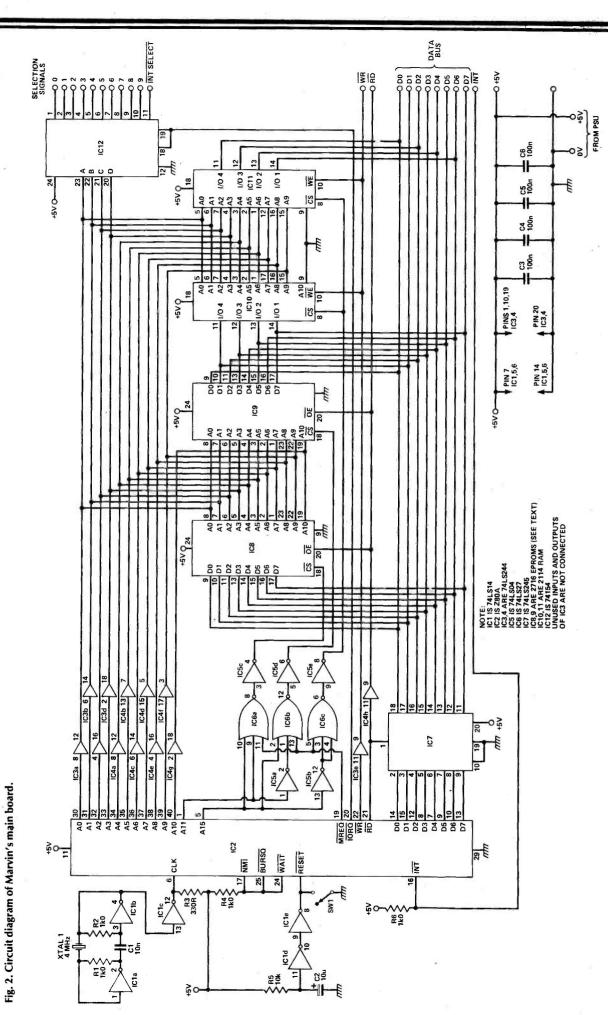
you'll probably be taking it in and out quite a lot.

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.



HOW IT WORKS

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

At switch-on, execution would begin at a random location in the memory but for C2 (via IC1d and e) holding RESET low until voltages and internal CPU register contents stabalise. The CPU may be reset at any future time by momenbouncing is unnecessary). After being SW1 (note that closing

Therefore, it places this address on the address bus and then takes MREQ and then then RD low. reset, the Z80 will begin by fetching an instruction from memory location 0000

system. MARVIN then proceeds with the and 6, detects that this address is less initialisation program in the operating స్త enables IC8, selection 07FFH and The memory system.

data can pass to and from the CPU, IC7 has to be a bidirectional device. The EPROMS, IC8 8 and 9, and the RAM, IC8 The address bus is buffered by most of two 7415244s, ICs 3 and 4, and the data bus by a single 74LS245, IC7. As

10 and 11 have their address and data lines permanently wired to the buses, but each has an individual selection line (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 $(\overline{OE})_C$ CEPROMs are connected to \overline{RD} (from the Z80, and the RAMs' WE

E (write to WR on the (read) tain (in binary, of course) the number of the port to be selected. Either RD or WR can be low, depending on whether the port is to be read from or written to. or input operation it takes IORQ put or input operation it takes IORQ low; address lines A0 and A3 will coninputs are connected enable) (write)

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

terrupt), it is possible to program MAR-VIN to ignore interrupts. If this <u>has</u> not been done, the result of pulling INT low will be to make the CPU service the in-terrupt according to your predesignated routine. mally held high by R3; however, it may be pulled low by a suitable external be pulled low by a suitable external device. Because we have chosen to use INT rather than NMI (non maskable in-The interrupt line itself, INT, is nor-

PARTS LIST

10n ceramic 10u axial electrolytic 100n ceramic or polyester 2716 EPROM (see text) 2114 RAM (300nS or less) push to make single pole 74LS14 or 7414 74LS04 or 7404 74LS27 or 7427 **2716 EPROM** RESISTORS (all ‡ W 5%) R1, 2, 4, 6 1k0 R3 330R R5 10k 74LS244 741.5245 SEMICONDUCTORS MISCELLANEOUS CAPACITORS 4, 5, 6 C15, <u>202022</u> SW1 208

۸9+ 70 90 IO SELECTION
SIGNALS
S O 00 00 Ö 00 O LINK THROUGH BETWEEN BOTH SIDES OF PCB 0 00 23 SOLDER ON BOTH SIDES XTALS

Fig. 3 Overlay diagram.

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.

switch as required 4 MHz crystal (see text)

67

Ö

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

BUYLINES.

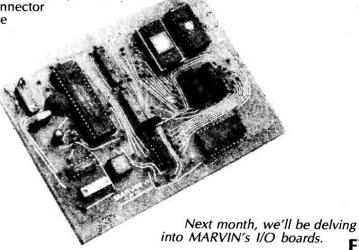
The following will be available from ARK Electronics, Ashes Lane, Wentworth, Rotherham, S. Yorks S62 7TY: EPROM containing the monitor program, 4 MHz clock, £6.00; 3 MHz (or lower) clock £4.00; Double sided PCB, £6.00; Complete 4 MHz kit excluding the operating system EPROM £26.00. Please add 50p p&p 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.

(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 costconscious, 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.



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educational purposes.

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would leave a lew of today's mavers a bit in the same eh?)

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7403	12p	7432	20p	7480	45
7404	12p	7433	20p	7482	65
7405	14p	7437	23p	7483 7485	30j
7406	19p	7438	24p		
7407	19p	7440 7442	14p 30p	7486 7489	190 180
7408	13p 13p	7442	85p	7490	190
7410	13p	7446	58p	7491	346
7411	15p	7447	36p	7491	24
7412	170	7448	43p	7493	24
7413	17p	7450	140	7494	33
7414	23p	7451	140	7495	333
7416	190	7453	140	7496	38
7417	190	7454	14p	7497	86
7420	140	7460	14p	74100	786
7421	190	7472	22p	74107	22
7422	19p	7473	24p	74109	24
		CMOS			
4000	10p	4020	42p	4042	381
4000	100	4021	40p	4043	40
4002	120	4022	45p	4044	40
4006	50p	4023	16p	4046	40
4007	140	4024	33p	4047	35
4008	36p	4025	12p	4048	38
4009	24p	4026	75p	4049	211
4010	24p	4027	20p	4050	211
4011	10p	4028	40p	4051	42
4012	15p	4029	45p	4052	48
4013	20p	4030	14p	4053	48
4014	45p	4031	125p	4054	78i
4015	40p	4034	140p	4055	80
4016	20p	4036	249p	4059	430
4017	30p	4039	280p	4060	42
4018	45p	4040 4041	40p	4063 4066	80 22
4019	25p	4041	40p	4000	22

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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 foreced 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

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

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.)

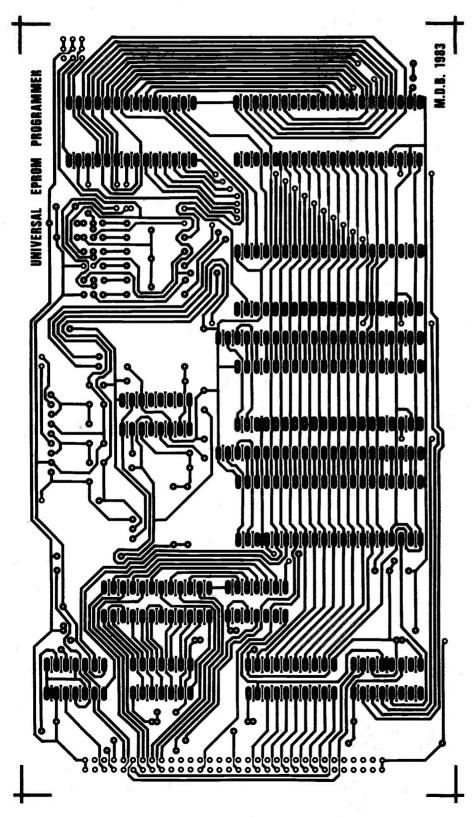
Real Time Clock (April '83) Frequency of XTAL1 is 32.768 kHz.

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 wirewound 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.

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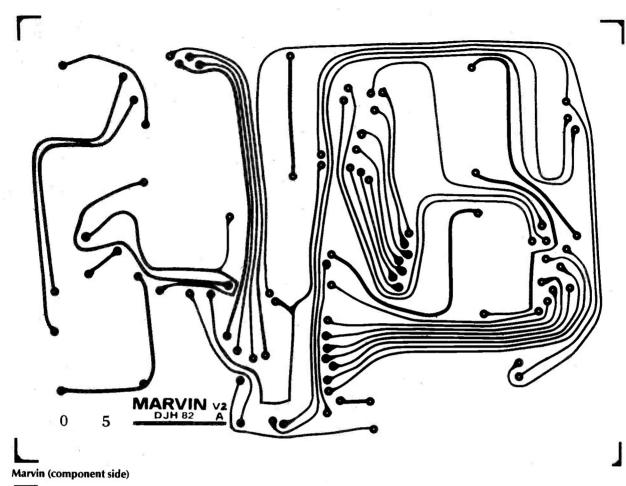
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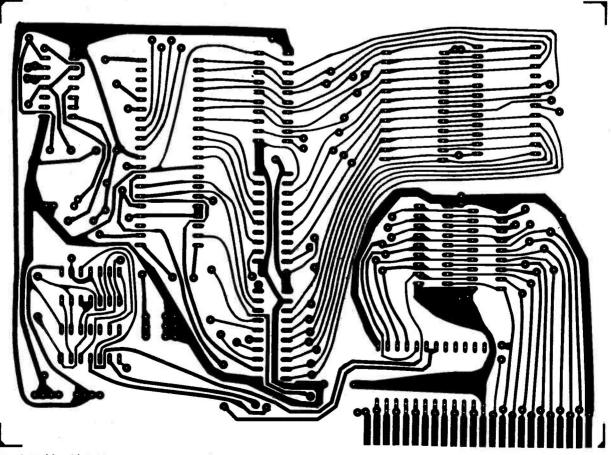




The Servo Fail-Safe

Universal EPROM Programmer





Marvin (solder side)

AQUARIUS



AQUARIUS: The brand new Aquarius Personal Computer is part of Mattel Electronics latest developments in advanced technology and offers full home computing facilities, as well as extensive game play, using a very wide range of plug in cartridges. Since Aquarius is a Mattel Electronics product, it benefits by the company's

product, it benefits by the company's wide experience of producing high technology equipment, as well as their game programming expertise which is evident from the advanced games which have been produced for the Intellivision. Aquarius costs £79 and comes with microsoft basic built in. It is so simple to use that you'll be writing your first-programs within minutes of taking the machine out of its box. You can even record the programs on your own cassette recorder at home, so you can use them again at a later date. Most available domestic tape recorders are compatible with the Aquarius.

A POWERFUL MACHINE: For all its simplicity, it is also very sophisticated. It has a Z80A processor and 8K of built in R0M as well as 4K of RAM, which is user expandable to 52K. It has a display of 40x 24 characters, and a graphic resolution of 320 x 192 with a total character set of 256 (including the complete ASCII set with upper and lower case letters, numbers and additional graphic symbols). The keyboard has 49 full stroke moving keys, unlike some of the cheaper machines which have membrane keyboards. The size of the machine (excluding any of the additional peripherals), is 13" x 6" x 2".

PERIPHERALS: It is very easy to increase the capabilities of your Aquarius as all the peripherals plug straight into one another. You can add a Printer, a Modem, a Data Recorder, Mini Expander and other items. All of the peripherals are very easy to install and what is more, they're easy to use. But the best news of all is, they're easy to afford.

CPM OPERATING CAPABILITY: The Aquarius is capable of being expanded to 52.

RAM and later in 1983 a disk drive will be available for it, with the commercial CPM business operating system. This will allow you access to one of the largest software libraries in the world, with literally hundreds of programs available for you to use.

CARTRIDGES: Various sophisticated programs will be launched on plug in cartridges such as a Visicalc type spreadsheet and a word processor. In addition there will be

such as a Visicalc type spreadsheet and a word processor. In dozens of games and utilities and alternative languages such as Logo, which combined with the built in microsoft basic gives an unbeatable combination of high quality programming ability.

MATTEL AQUARIUS - £68.70 + VAT = £79



NEW LOW PRICES

ATARI 400/800: With the Atari Personal Computers, you can play the ultimate in T.V. games, teach yourself new subjects or skills, balance budgets, and even write your own computer programs in Basic.

SPECIFICATIONS: Both the Atari 400 and 800 can display in up to 16 colours, each with 16 intensities. They have four independent sound synthesizers for music tunes/game sounds, giving four octaves with variable volume and tone control on your T.V.'s speaker. The display graphics

your T.V.'s speaker. The display graphics are of amazing quality, having a detailed resolution of 320 x 192, comprising 24 lines of 40 characters. Atari personal computers have a standard 10K ROM operating system. In addition the standard Atari 400 (E149) comes with 16K of RAM, and the expanded version with 48K (E198). The Atari 800 (E299) comes with 48K as standard. Both the 400 and 800 are now supplied with a FREE £40 Basic Programming Kit, which includes the Basic Programming Cartridge, as well as a 120 page Basic Reference Manual and the 184 page Self Teaching Manual by Bill Carris called 'Inside Atari Basic', so you can begin programming straight away, without buying any 'extras'. Even a mains plug is supplied!

OVER 500 PROGRAMS AVAILABLE: The Atari computers are supported by well over 500 programs available for your use, a larger selection than you will find on any other television game or home computer! The wide selection puts Atari way ahead of the competition. Just fill in the coupon and we will be pleased to send you a full price list which gives details of our range of software available for entertainment, home education, programming and home office use. We think you'll agree when we say it's quite impressive.

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100 FREE PROGRAMS FROM SILICA SHOP: If you buy your Atari Home Computer from Silica Shop, you will recieve a FREE presentation pack of 6 cassettes, containing 100 programs including games, utilities and demonstrations. A 16 page booklet giving full details of all of these programs is available on request. If you have already purchased your computer elsewhere you can buy the set of 6 cassettes for £30. What's more, Silica Shop offer a two year guarantee on all computers as well as a FREE joystick. This adds up to a great offer that we believe can't be beaten or matched by any of our competitors.

ATARI 400 16K - £129.57+VAT=£149 ATARI 400 48K - £172.17+VAT=£198 ATARI 800 48K - £260.00+VAT=£299



THE SYSTEM: The CBS Colecovision offers new standards in video game play. The excellent graphics are well play. The excellent graphics are well implemented with arcade titles such as Zaxxon, Lady Bug, Gorf, Wizard of Wor, Carnival, Mouse Trap and the lovable Smurfs. The console comes supplied with a three screen arcade quality version of DONKEY KONG. Parker and other companies have also announced ranges of cartridges for Colecovision, to further enhance the wide range of quality titles available for this new television games machine.

THE CONSOLE: The CBS Colecovision video games system has advanced technology which produces superlative graphics resolution and excellent sound effects. The styling of the console and hand controllers has been carefully researched; the console is designed to complement modern hi-tech equipment, and has clear features for easy operation. The hand controllers allow fingertip control via the 8 direction joystick, and feature 2 independent fire buttons. The push button keyboard is used for game selection and for game control with some cartridges. The hand controllers are detachable and are connected to six feet of telephone coil cable, storing neatly away in the console when not in use.

ATARI EXPANSION MODULE: The Atari converter module allows Atari VCS software cartridges to be played on the Colecovision console, allowing owners the freedom to purchase from the extensive range of Atari compatible cartridges. It also means that existing Atari owners can buy the CBS Colecovision games system without discarding their software library. Silica Shop offer part exchange facilities if you wish to upgrade.

TURBO EXPANSION MODULE: The Turbo Driver Expansion Module allows you to actually drive the vehicle that appears on your T.V. screen. The module consists of a steering wheel, dashboard and accelerator pedal. One hand controller is mounted on the dashboard to provide a gear change unit. The module comes complete with a Turbo Driver cartridge, the first of several cartridges to make use of the module, which provides all the action of sitting in the driving seat. This facility is unique to CBS Colecovision.

HOME COMPUTER EXPANSION MODULE: The Home Computer Module scheduled for late 1983, allows conversion of the games unit into a sophisticated Home Computer, This flexibility of design is an important feature of the CBS Colecovision System.

COLECOVISION - £127,82 + VAT = £147

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THE SYSTEM: Vectrex is a totally unique Home Arcade System, which has been exclusively designed and engineered to duplicate real arcade game play. Complete with its own monitor display, Vectrex won't cause any arguments over the use of the family's television because it has its own built in screen.

THE SCREEN: Vectrex does not use ordinary display techniques, instead it uses vector scanning to control the images on the screen. With this scanning method, the gun only updates the area of the screen that has changed, whereas a normal T.V. re-transmits the ENTIRE screen 50 times a minute. It is this that gives Vectrex its speed, and means that very little computer power is required for screen control, and the results provide very fast responding and clear images. These 'Vector Graphics' responding and clear images. These vector graphics are used in several arcade games such as Asteroids and Battlezone, to give you incredibly high resolution and quality. Vectrex brings all of this from the arcade right into your living room. The Vectrex screen is capable of displaying 80 columns by 40 lines, which is significant to the extensive developments planned for the system.

EXCITING SOUNDS AND ELECTRONICS: Vectrex has an advanced microprocessor with more speed and power and exciting effects than many home video games systems.

REAL ARCADE CONTROLS: Vectrex has a unique control panel, similar to those used in many real arcade games, with 4 concave action buttons and a full 360° self centering joystick. This control panel has a 4 foot detachable cord for maximum player freedom.

REAL ARCADE GRAPHICS: Vectrex has its own 9 inch vertical screen and unlike a conventional T.V. screen, uses advanced display technology to achieve brilliant, high resolution imagery and superb game play never before possible. The Vectrex display provides special effects too, such as 3-D rotation and zooming in and out, which a regular T.V. cannot match, Using a black and white monitor, each Vectrex game comes supplied with its own coloured plastic screen overlay to add to the excitement of game play. The range of Vectrex cartridges (E2195 each), gives a good selection of arcade games such as Berzerk, Scramble, Rip-Off and Bomber Attack, Vectrex comes complete with a fast paced 'Minestorm' game built into memory.

VECTREX: Vectrex has an advanced state-of-the-art microprocessor with more speed than other T.V. games. VECTREX - £129.57 + VAT = £149.00

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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.

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EXTENSIVE CARTRIDGE RANGE: The Atarl 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 certridge 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.

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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.

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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

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.



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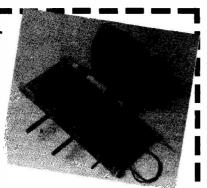
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In addition to the PCBs for this month's projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please note that NO OTHERS BOARDS ARE AVAILABLE. If it's not listed, we want have it!

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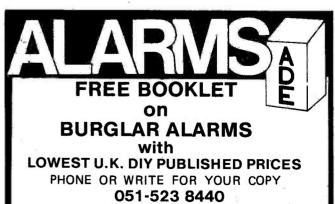
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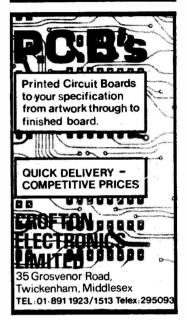
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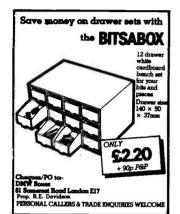
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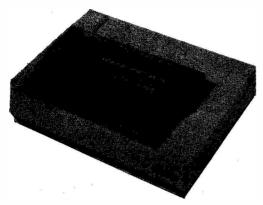
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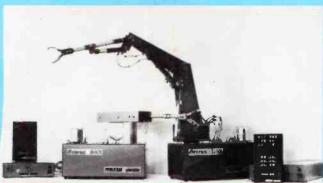
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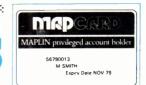
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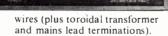
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