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electronics today

INTERNATIONAL

July 1983 85p

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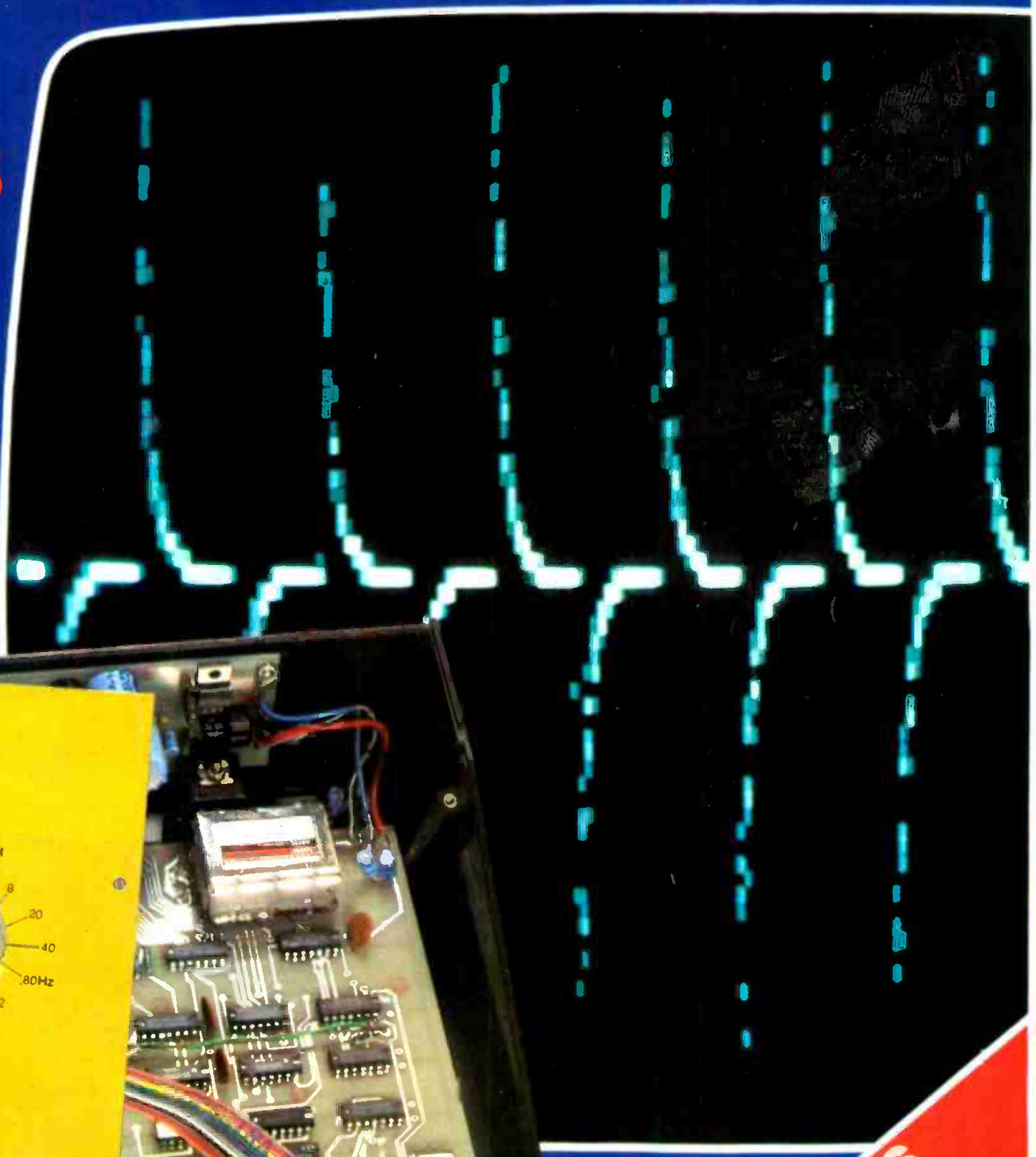

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BIG NEWS ABOUT OUR LATEST ADVANCES IN ROBOTICS SEE INSIDE BACK COVER

DJ90 Stereo Mixer — this is a really versatile new mixer that enables the constructor DJ to produce a professional performance every time. There are two stereo inputs for magnetic cartridges, a stereo auxiliary input and mike input. Other 'plus' features are 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

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

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

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

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

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

KIT PRICES

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

All prices are VAT exclusive

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

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

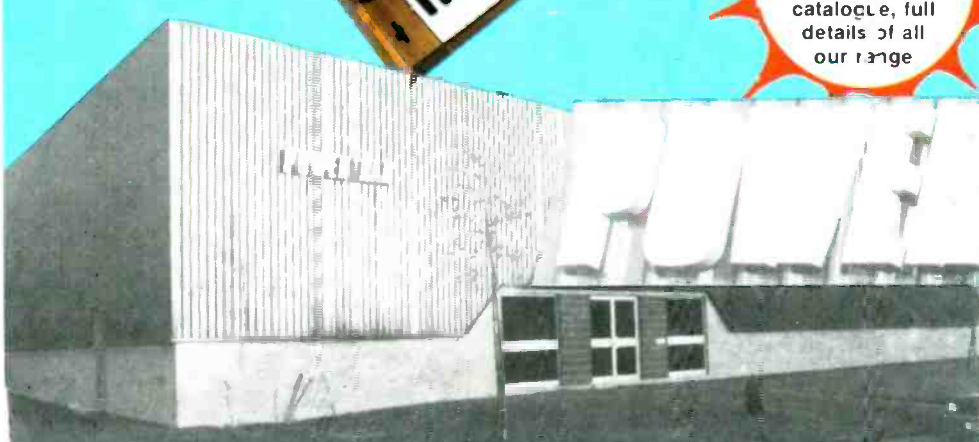
MPA 200 — is a low price, high power 100W amplifier, its smart styling, professional appearance and performance, make it one of our most popular designs. With adaptable inputs the mixer accepts a variety of sources yet straightforward construction makes it ideal for the first time builder. Complete kit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

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

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

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

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



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FEATURES

PROJECTS

INFORMATION

NEXT MONTH

electronics today INTERNATIONAL

THE "MARVIN" MICROCONTROLLER

The microprocessor is so strongly identified with the microcomputer that most people forget that it started life as an industrial control device. We haven't forgotten, though: next month we present a multi-purpose Z80-based control computer that you can use for a wide variety of domestic, laboratory or industrial control functions. The system is modular, consisting of an MPU board and two types of interface board, and a variety of control boards will be available.

I think you should know I'm feeling very depressed.

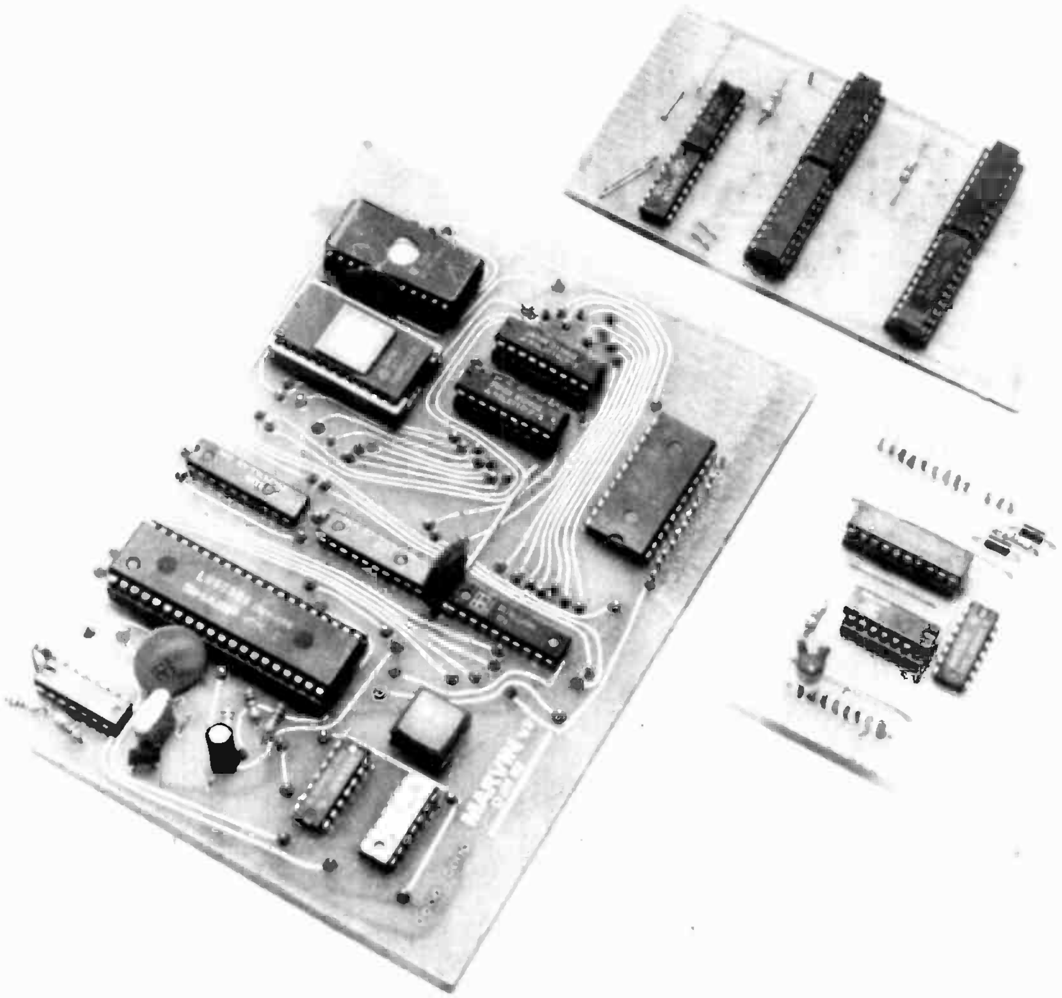
GRAPHIC EQUALISER

The circuit diagram in the March '83 Audiophile has led to so much interest that we've decided to publish it as a full project. The unit is a very high quality device offering one-third octave intervals, as required for professional applications, and an impressive noise and distortion performance. For reasons that will be obvious when you see the size of the thing, this is a mono unit; two are required for stereo.

EPROM PROGRAMMER

Hands up all those readers who'd prefer the convenience of programs stored in EPROM, but are put off by the sheer inconvenience caused by erasure and programming difficulties. Next month's ETI will feature a project that is cheap to build and capable of blowing every single-supply EPROM in the 27- and 25-series up to and including 256K bit devices. The appropriate driving software for 6502-based computers will also be provided.

LOOK OUT FOR THE AUGUST ISSUE ON SALE JULY 1st



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

DIGEST

Hyconomiser

Would all those readers who've rung us, sent telexes, telegrams, telemessages, letters, carrier pidgeons and so on, please note that you can get information on dealers in your area from the manufacturers, who are: Atwell Construction Ltd, Station Road, Wrington, Avon (telephone Bristol 719441). (Yes, we know, we should have said so in the first place . . .)

Static RAM Lookalike

Integrated RAMs offering all the advantages of a static RAM but with the higher circuit density and lower cost of dynamic RAMS are shortly to be available from Jermyn.

The Intel 2186 is a 64K IRAM organised as an 8K x 8 device but having the major advantage that it requires no external refreshing circuitry. All the DRAM refresh control circuitry is integrated on the chip allowing the user to treat the IRAM as a purely static device yet with all the advantages and performance of Intel's high volume HMOS dynamic RAM production technology.

Incorporating many systems oriented features such as low power dissipation, automatic initialisation, extended cycle operation and two-line bus control to eliminate bus contention, the 2186 is particularly suited to microprocessor systems applications where higher integration yet lower cost is required.

For further information contact Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.

Man Overboard!

We're sad to report that Peter Green will be leaving the ETI fold, taking his hideous puns with him. He won't be going far, though, just across the corridor in fact, to the Computing Toady, whoops, I mean Today, office, where he'll be assuming the editor's chair (and funny little peaked cap too). The things some people will do for a bigger desk . . .

Unfortunately, until we find a successor to Peter, our ability to answer technical enquiries will be severely restricted, so we'd appreciate it if you could try and sort out the problem yourself before writing. If you do write, it would help enormously if you could follow the guidelines given our Reader Services page, page 86.

The ex-deputy editor unwinds after a hard day battling against broken typewriters, Space Invaders and colour-blind artists.

Government Unveils Cable Plans

Work on advanced cable systems in up to 12 areas could start this year under proposals published recently by the Government in the White Paper, "The Development of Cable Systems and Services".

The White Paper, presented to Parliament jointly by the Home Secretary and the Secretary of State for Industry, is a comprehensive statement of Government policy across the range of cable issues. In the broadcasting field, it sets out the Government's reponse to the Hunt Report, published last October.

In outline, the broad strategy is:

- Cable investment should be privately financed and marketted.
- Regulation should be as light as possible to allow the development of a wide range of services and facilities.
- The regulatory framework should be flexible so that it can adapt as technology changes.
- Key safeguards are needed to ensure that existing broadcasting and telecommunications services are not impoverished and to take account of the fact that cable services will be directly available in the home.

Legislation will be introduced to establish a new Cable Authority to award franchises, supervise programme services and promote cable development. If this then goes ahead as the White Paper envisages, the Government will be prepared to authorise up to 12 pilot cable systems each covering a maximum of about 100,000 homes. The systems will have to offer a positive contribution to advanced technology, comprehensive programme services, and interactive capability. In the interim, the pilot projects will be set up under existing legislation. The Department of Industry will assess technological and telecommunications proposals, while programme services will require Home Office approval.

Existing relay operators will be allowed to offer new programme services over their systems for a transitional period, pending the installation of advanced technology. (Most relay services are limited to 4 or 6 channels.) Where necessary, the normal "must carry" rule — under which they have to relay current broadcast services — will be relaxed if customers are provided with alternative means of receiving BBC and IBA channels at no extra cost.

First Come . . .

Competition for our attention can be pretty hot, you know, and PR companies sometimes resort to dirty tricks, like, having noticed that ETI has an all male staff, sending us pictures of scantily clad women adorning their products. They really should know better, because here, at ETI, it's the naked truth about electronics we are after.

What has provoked this little diatribe is the near simultaneous announcement of two companies that they were the first to introduce legal cordless telephones.

We think that the fact that Fidelity (left) look so relaxed probably means it was them, and that's also the reason why British Telecom didn't send us a photo, for fear of giving the game away with their false smiles . . .

No, we're not going to give you any addresses — both phones will be very widely available.

Yes, Ma'am?

A new robot, designed to work alongside rather than replacing a human being, has been launched by Patscentre International and Prutec. Yes-Man (he's the one in the middle, without a silly grin) is the latest development from the association between Patscentre, the science and technology division of PA International, the management consultancy group, and Prutec, the high technology funding subsidiary of the Prudential Assurance Company.

The importance of Yes-Man lies in its ability to work with an operator in 'mixed assembly' tasks. Yes-Man carries out the more routine portions of the task leaving the human being free to exercise his skills in the cognitive and manipulative elements to which he is best suited. This specialisation is claimed to both improve productivity and contribute to a more rewarding working environment.

Shorts

● Non-volatility in Sinclair memory has its advantages, or so think Cambridge Microelectronics Ltd, because they've just released the CRAMIC-81 upon an unsuspecting world. For £79.95 (plus VAT, but including p&p), you can have 16K of long-life (10 years) of memory retention on your ZX81 . . . they must have seen our PseudoROM project. If you want complete permanance, Cambridge Microelectronics are also offering an EPROM programmer for the '81, called PROMER-81. Cambridge Microelectronics Ltd may be found at One Milton Road, Cambridge CB4 1YU.

● Looking for a way to get rich? The National Computing Centre, Oxford Road, Manchester M1 7ED, have launched a management training package entitled 'Profits from Microchips'. Mind you, you've got to be fairly well off to start off with, as the package will cost you a cool £800.

● Ferranti have extended their range of microphone amplifier ICs by introducing three new products, the ZN475E, ZN476E and ZN477E, designed for piezo-electric, moving coil and simple electret transducers. Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancashire OL9 8NP.

● They've been busy at ILP, as they've recently launched a new range of regulated power supply modules, as well as a new range of modular power units. Do they ever sleep? ILP Electronics Ltd, Graham Bell House, Roper Close, Canterbury, Kent CT2 7EP.

● NEC Electronics (UK) Ltd, of 116 Stevenson Street, New Stevenson, Motherwell ML1 4LT, have launched a new 1 F (yes, one *farad*) super-cap, specifically for on-board memory power back-up. Rated at 5 V DC, the unit occupies less than 1 cubic inch in volume.

● Why buy when you can hire? Aughton Automation Ltd have written a brochure on their range of computers, peripherals and robots that you can hire. Aughton Hire, Woodward Road, Kirkby Industrial Estate, Kirkby, Liverpool L33 7UZ.

● OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA have launched a new desoldering station, the SA-4, for production, prototype or laboratory use.

● Also from OK, a desolder pump that has a bronze alloy tip in order to avoid CMOS static problems.

● Litesold also have a new product, the MG self-feeding soldering gun, which allows the option of using solder from a bench-mounted reel or from a reel mounted on the gun itself. Light Soldering Develoments Ltd, Spencer Place, 97/99 Gloucester Road, Croydon, CR0 2DN.

● Enclosure Technology of Unit G, Southampton Airport, Southampton SO2 2HG have launched two new product ranges: the Chassis Europe, a range of chassis kits in 11 height ranges and four depths and the Harmonite instrument cases, in five heights, three widths and three depths, and also with a range of accessories.

● First of this month's rash of catalogues: this one's from HB Electronics, of Lever Street, Bolton, BL3 6BJ, and features Ungar soldering and de-soldering equipment.

● Not exactly a catalogue, but 'a new 8pp colour brochure' is available from BICC-Vero Packaging, Industrial Estate, Chandlers Ford, Eastleigh, Hants SO3 3ZR, and it describes Speedwire, as reviewed in your very own ETI in June 1982.

● There seem to be a lot of small companies based in Cambridge and specialising in ZX peripherals. Here's another one, called (original name, this) Cambridge Computing. They're ever so excited about their new, 'totally unique' joystick for both the '81 and the Spectrum, that they say will work with all software. They won't be launching the thing till June, though (they're at 1 Benson Street, Cambridge).

● We mentioned Southampton Universities' computer holidays a couple of months ago in Digest. They now tell us that they are able to offer places to disabled people, due to their having a purpose built hall for disabled students. For more information write to M.A.P.S., 37 University Road, Southampton SO2 1TL (tel 0703 558621).

● Why do suppliers seem to shy away from calling a catalogue a catalogue? Latest offenders (again) are Elkan Electronics, Freepost, 11 Bury Road, Prestwich, Manchester M25 8JZ, who call their catalogue of soft and hardware for the Dragon computer the 'Dragon Supermarket'. Well, really.

● Cetronic Components Ltd have issued a brochure on their wire-wound resistors and potentiometers. Free to trade people, your copy may be had from Cetronic Components Ltd, Hoddesdon Road, Stanstead Abbots, Ware, SG12 8EJ.

● The Computer Trade Association inform us that if you managed to join them before June 1st, then the membership would have cost you £20, whereas after it'll set you back £50. The association aims to represent all sections of the industry, including retailers, distributors, software houses, manufacturers and consultants, and may be found at 108 Margaret Street, Coalville, Leicestershire LE6 2LX.

● Pronto Electronic Systems, 466-478 Cranbrook Road, Gants Hill, Ilford, Essex have released two new ultra-low noise op-amps, the OP-27 and the OP-37. Depending on their availability, we're hoping to bring you a data sheet on these in the near future.

● Feeling boxed in? You may be a case for assistance from Boss Industrial Mouldings Ltd, who have extended their range of ABS potting boxes. Boss Industrial Mouldings Ltd, James Carter Road, Mildenhall, Suffolk IP28 7DE.

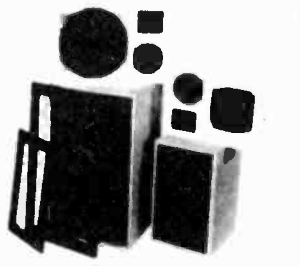
● At last! Someone who calls their catalogue a catalogue, and not a short-form supermarket file system. Rafi Electronics, 98 Croydon Road, London SE20 7AB present a range of professional DIN standard keyboards with considerable scope for customisation.

● The Irish Amateur Computer Club has written to inform us of their existence, and to say that our readers will get a warm welcome from them. In particular, they say that they are keen to recruit people with a good knowledge of hardware. The club may be reached via Nigel Carry (general secretary), 166 McKee Avenue, Finglas East, Dublin 11.

● Last but by no means least on our list (actually, it was at the top of the pile until it fell on the floor) comes Towers' International Digital IC Selector. From 1L311 to ZN74119F, it lists a very large number of ICs (no, we didn't count) with brief details of use, an indication of the pin-out, and any substitutes that are available. Published by W. Foulsham & Co, it should be available through any good technical bookshops. (Note that it doesn't cover microprocessor ICs, these have a volume of their own in the series).

● We would tell you that the British Amateur Electronics Club, c/o Dickens, 26 Forrest Road, Penarth, South Glamorgan, have just published their latest newsletter . . . we would tell you, but they addressed the accompanying letter to "The Editor, Electronics and Music Maker . . ."

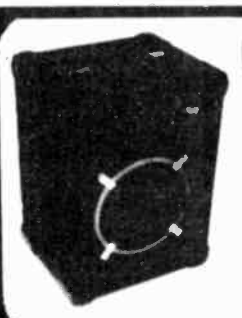
MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.
8" 40W system — recommended cabinet size 240 x 216 x 445mm
Price £14.90 each + £2.00 P & P.
5" 30W system — recommended cabinet size 160 x 175 x 295mm
Price £13.90 each + £1.50 P & P.

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

OMP 80 LOUDSPEAKER



The very best in quality and value.
Ported tuned cabinet in hard-wearing black vynide with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz-20KHz; Size: 20in x 15in x 12in; Weight: 30 pounds.
Price: £49.00 each
£90 per pair
Carriage: **£5 each £7 per pair**

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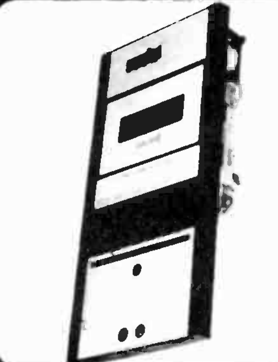
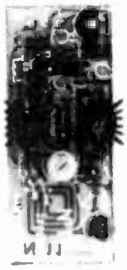
STEREO CASSETTE TAPE DECK MODULE



Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5¼in x 11¾in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

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

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 5 x 46 x 14mm (9 volt) **Price: £7.99p**
DIGITAL THERMOMETER -9.9°C to +99.9°C. LED display. Complete with sensor. 70 x 70 mm (9 volt) **Price: £27.60p**
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled, professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) **Price: £12.49p**
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHZ Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22 mm 9/12 volt) **Price: £16.49** Transmitter 80 x 50 x 15 mm (9/12 volt) **Price £10.29** P&P All Kits +50p. S.A.E. for complete list.



3 watt FM Transmitter

BSR P256 TURNTABLE

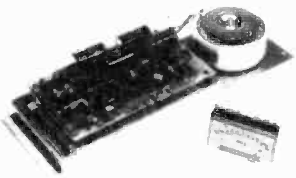
P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required
Price £31.35 each. £2.50 P&P

LOUDSPEAKERS

THREE QUALITY POWER LOUDSPEAKERS (15", 12" and 8" See Photo) **Ideal for both Hi-Fi and Disco applications.** All units have attractive cast aluminium (ground finish) fixing escutcheons. **Specification and Prices.**
15" 100 watt R.M.S. Impedance 8 ohms. 50 oz. magnet. 2" aluminium voice coil. Res. Freq. 20 Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. Price: £34.00 each + £3.00 P&P
12" 100 watt R.M.S. Impedance 8 ohms. 50 oz. magnet. 2" aluminium voice coil. Res. Freq. 25Hz. Freq. Resp. to 4 KHz. Sens. 95dB. Price: £24.50 each + £3.00 P&P
8" 50 watt R.M.S. Impedance 8 ohms. 20 oz. magnet. 1½" aluminium voice coil. Res. Freq. 40Hz. Freq. Resp. to 6 KHz. Sens. 92dB. Black Cone. Price: £9.50 each. Also available with black protective grille Price: £9.99 each. P&P £1.50.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £22.00 + £3 carriage.**
12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. **Price £22 + £3 carriage.**
15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. **Price: £47 + £4 carriage.**

OMP POWER AMPLIFIER MODULE

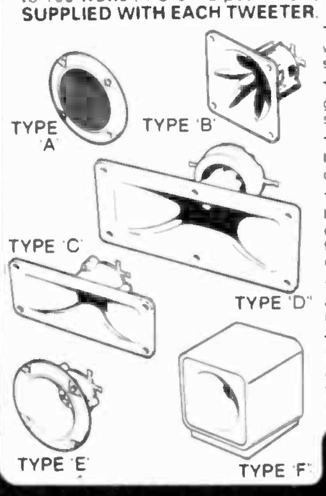


New model.
Improved specification

NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module **complete** with integral heat sink, toroidal transformer power supply and glass fibre p.c.b. assembly. Incorporates drive circuit to power a compatible LED Vu meter. New **Improved** *specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.*
SPECIFICATION
Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16 ohms.
Frequency Response:— 15Hz - 30KHz -3dB.
T.H.D.:— 0.01%.
S.N.R. (Unweighted):— -118dB ±3.5dB.
Sensitivity for Max. Output:— 500mV @ 10K.
Price:— £31.99 + £2.00 P&P.
Vu Meter Price:— £7.00 + 50p P&P.

PIEZO ELECTRIC TWEETERS – MOTOROLA

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

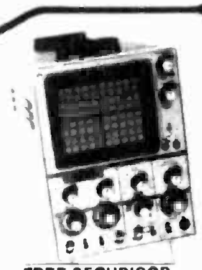


TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.29 each.**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.99 each.**
TYPE 'C' (KSN6016A) 2" x 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.99 each.**
TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £7.99 each.**
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.99 each.**
TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each.**
P&P 20p ea. (or SAE for Piezo leaflets).

HOME PROTECTION SYSTEM

Better to be '**Alarmed**' then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**
Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
Indoor alarm — Electronic swept freq. siren. 104dB output.
Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.
SAVE OVER £100 Usual price £228.85
— B.K.E.'s BARGAIN PRICE £128.00
+ £5.00 P&P.
S.A.E. for colour brochure.

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



FREE SECURICOR DELIVERY

B.K. ELECTRONICS

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

Extended Bleep

Britain's first wide-area radiopager with a message display was launched by British Telecom Radiopaging in April.

A ten-digit liquid crystal display on the new pager can be used to identify the caller (by giving a phone number), or to convey a message. The last two messages are stored in its memory and can be displayed at the touch of a button.

Like a tone pager, the new version gives a distinctive bleep to alert users. It also has a tiny lamp which flashes in response to a call. This enables users to keep in touch even when the bleep is muted to avoid disturbing others.

Display Page is the name of British Telecom Radiopaging's new service. For the first time it makes it practical for customers to advertise their paging numbers so that anyone may call them.

Guildford Gets The Wire

Discussions have been taking place between Rediffusion and Guildford Borough Council on a proposal by the company to install and operate an advanced multi channel cable television system in the city.

The proposed network would be a modern switched star cable system providing initially up to 30 television channels together with up to 20 FM channels. The system would be interactive, offering the community opportunities for several new information technology services. These include teleshopping, telebanking, security and education in the home.

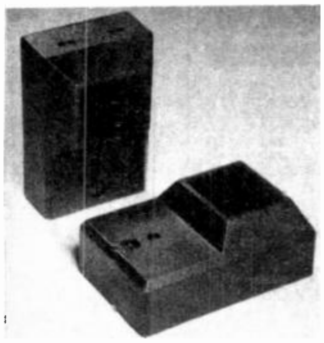
If central government approval is given, Rediffusion's plans could make Guildford the first city in Britain to possess a system which, while providing a wide range of national and other tv programmes, would enable a new concept in community television to be developed. As such it would become a model for other similar systems both in the UK and abroad.

Guildford is considered by Rediffusion to be ideally suited to this new enterprise with a demographically well balanced community (we think that means rich). It encompasses a wide range of activities and interests with opportunities for cultural and educational services provided by the university, the cathedral and other local organisations.

Modular Security

Riscomp Limited announce an addition to their range of security modules and accessories with an infra-red system known as the IR 1470. The unit, which operates from a conventional supply, consists of a separate infra-red transmitter and receiver, and provides a modulated beam of infra-red light over distances of up to 50ft. In the event of the beam being interrupted, a relay in the receiver unit is energised, which if connected to an appropriate warning device can be used to sound an alarm. Both transmitter and receiver are housed in compact moulded enclosures and easily mounted on most surfaces.

The system which is British made and fully guaranteed, is supplied with comprehensive data and costs £25.60 + VAT. For further information contact Riscomp Limited, 21 Duke Street, Princes Risborough, Bucks HP17 OAT.



EMI Joins CD

As you may have seen in the newspapers, EMI have decided to join in on the compact disc bandwagon. They had been a significant absentee from the furore of the CD launches, but it looks as though the fact that all the players have sold out wherever they've been put on sale has persuaded EMI to adopt the medium.

They say that they will be building a catalogue strength of over 200 titles during the first twelve months. Though this is a tiny proportion of just the new releases from EMI and its subsidiaries, it would still represent a 100% increase on the CD launch catalogue.

Watch With The BBC

Digithurst's latest vision analysis product has been designed to run with the BBC microcomputer. It enables the Model B BBC computer to be linked to a standard home video recorder and pre-packaged images to be transferred into the micro.

The interface, known as MicroEye, enables pictures to be digitised with a 256 x 256 resolution, although with the BBC Model B only 128 x 128 pixels are used. Digithurst decided to go for a high resolution as it feels users will want to upgrade the system when they add a second processor to their BBC kit. The interface is supplied as a total package providing the cable connections to both the video recorder and the BBC user port. A complete suite of software is supplied allowing the user to analyse captured images, and to dump them onto the disk or a printer.

As well as running with the BBC machine the above package can also be connected to a range of other microcomputers such as Research Machine 380Z, Apple, Commodore, Hewlett Packard, IBM, Sirius, etc.

The package price is £295 + VAT. Digithurst Ltd, Leaden Hill, Orwell, Royston, Herts, SG8 5QH.

No Mail Order Orics

Oric Products' own mail order operation for the Oric 1 and all peripherals has stopped accepting orders, and Oric is putting its promotional strength behind retailers with a £50,000 advertising campaign for the April-June period and full colour point of sale kits available to all stockists. Oric 1 is now available from W. H. Smith, Dixons, Greens, Laskys, Micro C, Micro Peripherals, Spectrum, Computers for A11 and other specialist outlets.

Play the AMBIT numbers game ......

The long awaited implementation of on-line order processing is with us at last, and whilst this means that orders for in-stock items can now be processed more efficiently, it also means that orders should be submitted using stock codes for best results. Our current catalogue (75p) includes all order codes (watch out for the new expanded Spring edition), but here's an abstract from some of the more popular lines to use as a quick reference.

Remember that you can also access our catalogue via REWSHOP on REWTEL, which now includes on-line current price and delivery information. You need a 300 baud MODEM and RS232 terminal, (various suitable configurations based on popular micros have been published in recent past issues of Radio and Electronics World).

Prices shown here exclude VAT, and the P&P charge is currently 60p per order (unless otherwise indicated). Remember that our telesales service operates with human beings (not 'dumb' machines) from 8am to 7pm (and frequently later) Monday to Friday, and 9am to 6pm on Saturdays. REWSHOP operates 24 hours a day, 365 days a year with full price and delivery information.

ALWAYS USE STOCK NUMBERS WHEN ORDERING PLEASE.

4000 CMOS

Type	Stock No	Price
4000UB	22 04000	0.11
4001	23 04001	0.11
4002	23 04002	0.12
4007	23 04007	0.13
4008	23 04008	0.50
4009UB	22 04009	0.25
4011	23 04011	0.11
4011UB	22 04011	0.11
4012	23 04012	0.14
4013	23 04013	0.25
4015	23 04015	0.50
4016	23 04016	0.22
4017	23 04017	0.40
4020	23 04020	0.55
4021	23 04021	0.55
4022	23 04022	0.55
4023	23 04023	0.15
4024	23 04024	0.33
4025	23 04025	0.15
4027	23 04027	0.26
4028	23 04028	0.50
4029	23 04029	0.55
4035	23 04035	0.67
4040	23 04040	0.88
4042	23 04042	0.50
4043	23 04043	0.80
4044	23 04044	0.88
4046	23 04046	0.80
4049UB	22 04049	0.24
4050	23 04050	0.24
4051	23 04051	0.55
4052	23 04052	0.55
4053	23 04053	0.55
4060	23 04060	0.75
4066	23 04066	0.30
4068	23 04068	0.18
4069UB	22 04069	0.14
4070	23 04070	0.16
4071	23 04071	0.16
4072	23 04072	0.16
4073	23 04073	0.16
4075	23 04075	0.16
4076	23 04076	0.55
4077	23 04077	0.18
4078	23 04078	0.18
4081	23 04081	0.18
4082	23 04082	0.18
4093	23 04093	0.30
4099	23 04099	0.80
4175	23 04175	0.80
4502	23 04502	0.80
4503	23 04503	0.50
4506	23 04506	0.70
4507	23 04507	0.37
4508	23 04508	1.50
4510	23 04510	0.55
4511	23 04511	0.45
4512	23 04512	0.55
4514	23 04514	1.25
4515	23 04515	1.25
4516	23 04516	0.80
4518	23 04518	0.35
4520	23 04520	0.80
4521	23 04521	1.30
4522	23 04522	0.89
4526	23 04526	0.80
4527	23 04527	0.80
4528	23 04528	0.85
4529	23 04529	0.70
4531	23 04531	0.65
4532	23 04532	0.80
4534	23 04534	4.00
4536	23 04536	2.50
4538	23 04538	0.85
4539	23 04539	0.80
4543	23 04543	0.80
4549	23 04549	3.50
4553	23 04553	2.70
4554	23 04554	1.20
4555	23 04555	0.35
4556	23 04556	0.40
4557	23 04557	2.30
4558	23 04558	0.80
4559	23 04559	3.50
4560	23 04560	2.50
4561	23 04561	1.00
4562	23 04562	2.50
4566	23 04566	1.20
4568	23 04568	1.45
4569	23 04569	1.70
45672UB	23 04572	0.32
4580	23 04580	3.25
4581	23 04581	1.40
4582	23 04582	0.70
4583	23 04583	0.80
4584	23 04584	0.27
4585	23 04585	0.45
4702	23 04702	4.50
4703	23 04703	4.48
4704	23 04704	4.24
4705	23 04705	4.24
4706	23 04706	4.50
4720	23 04720	4.00
4723	23 04723	0.95
4724	23 04724	0.95
4725	23 04725	2.24
40014	23 40014	0.84
40085	23 40085	0.99
40098	23 40098	0.54
40106	23 40106	0.69
40160	23 40160	1.05
40161	23 40161	1.05
40162	23 40162	1.05
40163	23 40163	1.05
40174	23 40174	1.05
40175	23 40175	1.05
40192	23 40192	1.08
40193	23 40193	1.08
40195	23 40195	1.08

74LSXX

Type	Stock No	Price
74LS00	31 07400	0.11
74LS01	31 07401	0.11
74LS02	31 07402	0.11
74LS03	31 07403	0.11
74LS04	31 07404	0.14
74LS05	31 07405	0.14
74LS08	31 07408	0.14
74LS09	31 07409	0.14
74LS10	31 07410	0.14
74LS11	31 07411	0.14
74LS12	31 07412	0.14
74LS13	31 07413	0.32
74LS14	31 07414	0.32
74LS15	31 07415	0.14
74LS20	31 07420	0.14
74LS21	31 07421	0.14
74LS22	31 07422	0.14
74LS26	31 07426	0.14
74LS27	31 07427	0.30
74LS28	31 07428	0.18
74LS30	31 07430	0.14
74LS32	31 07432	0.14
74LS33	31 07433	0.14
74LS37	31 07437	0.18
74LS38	31 07438	0.14
74LS40	31 07440	0.18
74LS42	31 07427	0.30
74LS47	31 07447	0.75
74LS48	31 07448	0.40
74LS49	31 07449	0.80
74LS51	31 07451	0.14
74LS54	31 07454	0.14
74LS55	31 07455	0.14
74LS74	31 07474	0.21
74LS75	31 07475	0.21
74LS76	31 07476	0.25
74LS78	31 07478	0.19
74LS83	31 07483	0.33
74LS85	31 07485	0.44
74LS86	31 07486	0.15
74LS90	31 07490	0.24
74LS91	31 07491	0.36
74LS92	31 07492	0.32
74LS93	31 07493	0.24
74LS95	31 07495	0.38
74LS107	31 74107	0.31
74LS109	31 74109	0.25
74LS112	31 74112	0.21
74LS113	31 74113	0.21
74LS114	31 74114	0.21
74LS122	31 74122	0.27
74LS123	31 74123	0.38
74LS125	31 74125	0.27
74LS126	31 74126	0.27
74LS132	31 74132	0.27
74LS133	31 74133	0.24
74LS136	31 74136	0.20
74LS138	31 74138	0.30
74LS139	31 74139	0.30
74LS151	31 74151	0.30
74LS153	31 74153	0.34
74LS155	31 74155	0.30
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74LS157	31 74157	0.27
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74LS160	31 74160	0.34
74LS161	31 74161	0.38
74LS162	31 74162	0.38
74LS163	31 74163	0.38
74LS164	31 74164	0.40
74LS165	31 74165	0.80
74LS166	31 74166	0.58
74LS168	31 74168	0.89
74LS170	31 74170	0.83
74LS173	31 74173	0.47
74LS174	31 74174	0.37
74LS175	31 74175	0.40
74LS181	31 74181	0.87
74LS183	31 74183	1.05
74LS190	31 74190	0.39
74LS191	31 74191	0.39
74LS192	31 74192	0.39
74LS193	31 74193	0.39
74LS194	31 74194	0.39
74LS195	31 74196	0.39
74LS196	31 74196	0.39
74LS197	31 74197	0.47
74LS221	31 74221	0.50
74LS240	31 74240	0.60
74LS241	31 74241	0.60
74LS242	31 74242	0.56
74LS243	31 74243	0.55
74LS244	31 74244	0.80
74LS245	31 74245	1.00
74LS251	31 74251	0.36
74LS253	31 74253	0.36
74LS257	31 74257	0.36
74LS258	31 74258	0.36
74LS259	31 74259	0.51
74LS260	31 74260	0.26
74LS266	31 74266	0.20
74LS273	31 74273	0.70
74LS279	31 74279	0.35
74LS283	31 74283	0.40
74LS290	31 74290	0.40
74LS293	31 74293	0.40
74LS298	31 74298	0.54
74LS365	31 74365	0.34
74LS366	31 74366	0.40
74LS367	31 74367	0.30
74LS368	31 74368	0.30
74LS373	31 74373	0.72
74LS374	31 74374	0.72
74LS375	31 74375	0.31
74LS377	31 74377	0.60
74LS378	31 74378	0.44
74LS379	31 74379	0.44
74LS385	31 74385	1.30
74LS386	31 74386	0.27
74LS390	31 74390	0.51
74LS393	31 74393	0.48
74LS398	31 74398	0.80
74LS399	31 74399	0.65
74LS490	31 74490	0.80
74LS670	31 74670	1.15

74CXX

Type	Stock No	Price
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74C02	29 07402	0.35
74C04	4069C	
74C08	29 07408	0.35
74C10	29 07410	0.35
74C14	4584C	
74C20	29 07420	0.35
74C30	29 07430	0.35
74C32	29 07432	0.35
74C42	29 07442	1.05
74C48	29 07448	1.50
74C73	29 07473	0.75
74C74	29 07474	0.75
74C76	29 07476	0.60
74C83	29 07483	1.30
74C85	29 07485	1.30
74C86	29 07485	1.30
74C89	29 07489	3.60
74C90	29 07490	1.05
74C93	29 07493	1.05
74C95	29 07495	1.25
74C107	29 74107	0.60
74C151	29 74151	2.10
74C154	29 74154	3.05
74C157	29 74157	2.10
74C160	40160	
74C1610	40161CM	
74C1620	40162CM	
74C1630	40163CM	
74C164	29 74164	1.05
74C165	29 74165	1.10
74C173	4076C	
74C1740	40174CM	
74C1750	40175CM	
74C1920	40192CM	
74C1930	40193CM	
74C1950	40195CM	
74C200	29 74200	6.50
74C221	29 74221	1.65
74C901	29 74901	0.55
74C902	29 74902	0.55
74C903	29 74903	0.55
74C904	29 74904	0.55
74C905	29 74905	6.50
74C906	29 74906	0.66
74C907	29 74907	0.55
74C908	29 74908	1.10
74C909	29 74909	2.10
74C910	29 74910	5.00
74C914	29 74914	1.10
74C918	29 74918	1.30
74C925	29 74925	6.00
74C926	29 74926	6.00
74C927	29 74927	6.00

74HCXX

Type	Stock No	Price
74HC00	30 07400	0.58
74HC02	30 07402	0.58
74HC04	30 07404	0.68
74HC10	30 07410	0.58
74HC20	30 07420	0.66
74HC86	30 07486	0.74
74HC132	30 74132	1.26
74HC266	30 74266	0.81
74HC4002	30 04002	0.56
74HC4075	30 04075	0.56
74HC242	30 74242	2.00
74HC243	30 74243	2.00
74HC74	30 07474	0.74
74HC109	30 74109	0.88
74HC175	30 74175	1.08
74HC373	30 74373	2.40
74HC374	30 74374	2.40
74HC533	30 74533	2.40
74HC534	30 74534	2.40
74HC165	30 74165	1.96
74HC173	30 74173	1.20
74HC160	30 74160	1.33
74HC161	30 74161	1.33
74HC162	30 74162	1.33
74HC163	30 74163	1.33
74HC4538	30 74538	2.10
74HC85	30 74280	2.95
74HC280	30 74280	2.95
74HC42	30 07442	1.00
74HC138	30 74138	1.08
74HC139	30 74139	1.08
74HC4514	30 04514	3.40
74HC4543	30 04543	2.75
74HC157	30 74157	0.92
74HC158	30 74158	0.90
74HC257	30 74257	0.90

LINEAR ICs

Type	Stock No	Price
LM10CN	61 00010	3.88
MF10	61 00011	5.05
L149	61 00149	1.86
ZNA234	61 02340	8.50
U237B	61 00237	1.28
U247B	61 00247	1.28
U257B	61 00257	1.28
U267B	61 00267	1.28
LM301AH	61 03010	0.87
LM301AN	61 03011	0.27
LM308H	61 03080	0.70
LM308CN	61 03081	0.65
LM324	61 03240	0.45
LM339N	61 03390	0.68
LF347	61 00347	1.60
LM348	61 03480	0.90
LF351	61 03510	0.49
LF353	61 03530	0.78
LM380N	61 00380	1.00
LM381	61 00381	1.81
LM382	61 00382	1.81
ZN419CE	61 00419	1.98
ZNA423	61 04230	1.00
ZN425E/8	61 04250	3.50
ZN426E/8	61 04260	3.00
ZN427E/8	61 04270	8.28
ZN428E/8	61 04280	4.78
ZN429E/8	61 04290	2.10
ZN432CJ10	61 04320	28.09
ZN433CJ10	61 04330	22.59
ZN450E	61 04500	7.61
NE542	61 05420	1.20
NE544	61 00544	1.80
NE555N	61 05550	0.20
NE556N	61 05560	0.50
SL560C	61 05600	1.98
NE562	61 00562	4.05
NE564	61 00564	4.29
NE565	61 00565	1.00
NE566	61 00566	1.30
NE567	61 00567	1.30
NE570N	61 00570	3.85
SL624	61 00624	3.28
uA709HC	61 07090	0.84
uA709PC	61 07091	0.38
uA710HC	61 07100	0.84
uA710PC	61 07101	0.59
uA711CN	61 07110	0.85
uA733CN	61 07330	0.89
uA741CH	61 07410	0.96
uA741CN	61 07411	0.20
uA747CN	61 07470	0.70
uA748CN	61 04780	0.30
uA758	61 00758	2.35
TBA820M	61 00820	0.78
TDA1028	61 01028	2.11
TDA1029	61 01029	2.11
ZNA1034	61 01034	2.10
LM1035	61 01034	2.10
TDA1054M	61 01054	1.45
TDA1062	61 01062	1.95
TDA1072	61 01072	2.69
TDA1074A	61 01074	5.04
TDA1083	61 01083	1.95
TDA1090	61 01090	3.05
HA1137	61 12411	1.20
HA1196	61 01196	2.00
HA1197	61 01197	1.00
TDA1220	61 01220	1.40
LM1303	61 01303	0.99
LM1307	61 01307	1.55
MC1310P	61 01310	1.90
MC1330	61 01330	1.20
MC1350	61 01350	1.20
HA1370	61 11370	1.90
HA1388	61 01388	2.75
LM1458N	61 14580	0.45
MC1496P	61 01496	1.25
SL1610	61 01610	1.92
SL1611	61 01611	1.92
SL1612	61 01612	1.92
SL1613	61 01613	2.08
SL1620	61 01620	2.60
SL1621	61 01621	2.50
SL1623	61 01623	2.50
SL1625	61 01625	2.50
SL1626	(SL6270)	
SL1630	61 01630	1.62
SL1640	61 01640	2.25
SL1641	61 01641	2.25
MC1648	61 01648	3.25
TDA2002	61 02002	1.25
ULN2240	61 02240	3.25
ULN2242	61 01090	3.05
ULN2283	61 02283	1.00
CA3080	61 03080	0.70
CA3089	61 03089	1.84
CA3123	61 03123	1.40
CA3130E	61 31300	0.80
CA3130T	61 31301	0.90
CA3140E	61 31400	0.46
CA3189E	61 03189	2.20
CA3240E	61 32400	1.27
MC3357	61 03357	2.85
MC3359 (see ULN3859)		
ULN3859	61 03859	2.95
KM3701	61 03701	85.53
KM3702	61 03702	74.84
LM3900	61 39000	0.60
LM3909N	61 39090	0.68
LM3914N	61 03914	2.80
LM3915N	61 03915	2.80
KB4400	61 04400	0.80
KB4412	61 04412	1.95
KB4413	61 04413	1.95
KB4417	61 04417	1.80
KB4420B	61 04420	1.09
TDA4420	61 14420	2.85
TDA4421	61 14421	2.65
KB4423	61 04423	2.30
KB4424	61 04424	1.65
KB4430	61 04430	2.30
KB4431	61 04431	1.95
KB4432	61 04432	1.95
KB4433	61 04433	1.52
KB4436	61 04436	2.53
KB4437	61 04437	1.75
KB4438	61 04438	2.22
KB4441	61 04441	1.35
KB4445	61 04445	1.29
KB4446	61 04446	2.75
KB4448	61 04448	1.65
NE5044	61 05044	2.26
MC5229	61 05229	9.60
NE5532	61 55320	1.85
KM5624	61 05624	4.35
SD6000	61 06000	3.75
SL6270	61 06270	2.03
SL6310	61 06310	2.45
SL6440	61 06440	3.38
SL6600	61 06600	3.75
SAS6610	61 06610	1.48
SL6640	61 06640	2.75
SL6690	61 06690	3.75
SL6700	61 06700	2.75
SAS6710	61 06710	1.48
LS7225	61 07225	3.85
ICM7555	61 75550	0.80
CL8038CC	61 08038	4.50
MSL9362	61 09362	1.75
MSL9363	61 09"	1.75
K10170	61 10170	1.87
TK10321	61 10321	2.75
HA11223	61 11223	2.15
HA11225	61 11225	1.45
HA12002	61 12002	1.22
HA12017	61 12017	0.80
HA12402	61 12402	1.95
HA12411	61 12411	1.20
HA12412	61 12412	1.55
LF13741	61 13741	0.33
MK50366	61 50366	3.35
MK50375	61 50375	3.85
MM53200	61 53200	3.90

PRESCALER

Type	Stock No	Price
U264	61 02640	2.27
U265	61 02650	3.18
U266	61 02660	2.43
11C90DC	61 01190	12.95
MSL2312R	61 02312	3.94
MSL2318	61 02318	3.84
MSM5523	61 05523	11.30
MSM5524	61 05524	11.30
MSM5525	61 05525	7.85
MSM5526	61 05526	7.85
MSM55271	61 55271	8.75
ICM7106CP	61 07106	9.55
ICM7107CP	61 07107	9.55
LC7137	61 07137	7.50
ICM7216B	61 72161	19.50
ICM7216C	61 72162	19.95
ICM7217A	61 07217	9.50
SP8629	61 08629	3.85
SP8647	61 08647	8.00
SP8793	61 08793	7.70
95H90	61 09590	7.80
HD10551	61 10551	2.45
HA12009	61 12009	6.00
HD44015	61 44015	4.45
HD44752	61 44752	8.00
MC145151P	61 14151	8.00
MC145152P	61 14151	8.80
MC145156P	61 14156	4.60

SMALL SIGNAL AUDIO

Type	Stock No	Price
BC182	58 00182	0.10
BC212	58 00212	0.10
BC237	58 00237	0.08
BC238	58 00238	0.08
BC239	58 00239	0.08
BC307	58 00307	0.08
BC308	58 00308	0.08
BC309	58 00309	0.08
BC327	58 00327	0.13
BC337	58 00337	0.13
BC413	58 00413	0.10
BC414	58 00414	0.11
BC415	58 00415	0.10
BC416	58 00416	0.11
BC546	58 00546	0.12
BC550	58 00550	0.12
BC556	58 00556	0.12
BC560	58 00560	0.12
BC639	58 00639	0.22
BC640	58 00640	0.22
MPSA13	58 04013	0.30
MPSA63	58 04063	0.30
ZTX108	58 01108	0.10
ZTX212	58 01212	0.10
ZTX653	58 01653	0.20
ZTX753	58 01753	0.20
2N2904	58 02904	0.25
2N2905	58 02905	0.25
2N3905	58 03905	0.10
2SB646A	58 03646	0.30
2SB648A	58 03648	0.40
2SD666A	58 03666	0.30
2SD668A	58 03668	0.40
2SA872A	58 02872	0.19
2SA1084E	58 01084	0.25
2SA1085E	58 01085	0.25
2SC1775A	58 01775	0.19
2SC2546E	58 02546	0.24
2SC2547E	58 02547	0.24

AUDIO POWER

Type	Stock No	Price
BD139	58 15139	0.28
BD140	58 15140	0.31
BD165	58 15165	0.48
BD166	58 15166	0.48
BD179	58 15179	0.38
BD180	58 15180	0.41
TIP31A	58 15031	0.35
TIP32A	58 15032	0.35
MJ2955	58 12955	0.88
2N3055	58 13099	0.58
2SB720	58 15720	0.80
2SD760	58 17600	0.80
2SJ49	60 01049	3.10
2SJ50	60 01050	4.25
2SJ83	60 01083	3.55
2SK134	60 00134	3.10
2SK135	60 00135	4.25
2SK227	60 00227	3.55
2SD753	58 03753	2.34

SMALL SIGNAL RF

Type	Stock No	Price
BFY50	58 06500	0.22
BF241	58 06241	0.18
BF273	58 06273	0.18
BF274	58 06274	0.20
BF362	58 06362	0.49
BF440	58 06440	0.21
BF441	58 06441	0.21
BF479	58 06479	0.88
BF6795	58 06679	0.55
BFR91	58 07091	1.33
BFT95	58 10095	0.98
BFW92	58 08092	0.80
BFY90	58 09090	0.90
NE21936	58 21936	5.00
ZTX323	58 06232	0.80
2N2369A	58 02369	0.38

RF POWER

Type	Stock No	Price
BFW16A	58 08016	0.65
MRF237	58 14237	3.20
MRF238	58 14238	18.50
MRF245	58 14245	40.00
MRF449A	58 14449	18.50
MRF472	58 14472	1.26
MRF475	58 14475	4.80
MRF629	58 14629	4.89
PT8811	58 18811	8.50
TP2320	58 12320	10.24
VN66AF	60 02066	0.95
ZTX3866	58 03866	0.45
2N3866	58 13866	1.20

SMALL SIGNAL FET

Type	Stock No	Price
BF256	59 00256	0.38
BF960	60 06960	0.99
BF961	60 06961	0.70
BF963	60 06963	0.99
J310	59 02310	0.89
J176	59 02176	0.65
2SK55	59 01055	0.32
2SK168	59 01168	0.37
3SK45	60 04045	0.49
3SK51	60 04051	0.54
3SK60	60 04060	0.58
3SK88	60 04088	0.89
40673 see 3SK51		
40822 see 3SK51		
40823	60 03823	0.85
3SK112	60 04112	4.80

DIODES

Type	Stock No	Price
AA112	12 01126	0.25
BA244	12 02447	0.17
BA379	12 03797	0.35
NO4981-7E	12 49817	0.51
OA91	12 00916	0.07
OA47	12 00476	0.10
PW02	12 62006	0.75
S04	12 24006	0.45
W005	12 10506	0.28
1N4001	12 40016	0.08
1N4002	12 40026	0.07
1N4004	12 40046	0.07
1N4148	12 41486	0.05
1N5404	12 54046	0.18
1N6263	12 62637	0.82

VARICAPS

Type	Stock No	Price
BA102	12 01025	0.30
BA121	12 01215	0.30
BB105B	12 01055	0.30
BB109B	12 01095	0.27
BB204B	12 02045	0.38
BB212	12 02125	1.95
ITT210	12 02105	0.30
MVAM115 see KV1236		
MVAM125 see KV1225		
KV1210	12 12105	2.45
KV1211 see KV1236		
KV1225	12 12255	2.75
KV1235	12 12355	2.75
KV1236	12 12365	2.55
KV1310	12 13105	0.40
KV1310	12 13205	0.40

ZENER DIODES

BZY88C 400mW 5%

Type	Stock No	Price
2V7	12 00278	0.10
3V3	12 00338	0.10
3V9	12 00398	0.10
4V7	12 00478	0.10
5V1	12 00518	0.10
5V6	12 00568	0.10
6V8	12 00688	0.10
8V2	12 00828	0.10
9V1	12 00918	0.10
10	12 01008	0.10
11	12 01108	0.10
12	12 01208	0.10
15	12 01508	0.10
18	12 01808	0.10
22	12 02208	0.10
27	12 02708	0.10
33	12 03308	0.10

SCRS TRIACS

Type	Stock No	Price
BRY55 100	52 55100	0.50
C106D1	52 00106	0.78
C122D1	52 00122	1.45
2N6403	52 06403	2.22
2N6073A	58 06073	0.98

BALANCED MIXERS

Type	Stock No	Price
SBL1	12 00003	4.88
SBL1-8	12 00013	5.80
SBL1-X	12 00023	6.33
SRA1	12 00033	10.60
SRA1-1	12 00043	12.77
SRA1H	12 00053	18.34
SRA3	12 00063	15.35

LEDs

Type	Stock No	Price
3mm round types		
CQX25 Red/Clr	15 20250	0.15
V179P Red	15 01780	0.15
CQX26 Grn/Clr	15 20260	0.18
V179P Green	15 01790	0.18
CQX27 Yel/Clr	15 20270	0.18
V180P Yellow	15 01800	0.18
CQX41A Or/Rd	15 20410	0.18
Standard 5mm DIA LEDs		
COY40L Red	15 10400	0.12
COY72L Green	15 10720	0.15
COY74L Yellow	15 10740	0.15
CQX38A Or/rd	15 20380	0.20
CQX39B Or/cl	15 20390	0.28
Rectangular 2.5 x 5mm LEDs		
CQX10 Red	15 20100	0.17
CQX11 Green	15 20110	0.20
CQX12 Yellow	15 20150	0.20
CQX40 Or/Red	15 20400	0.24
Infra-Red LEDs		
COY99 Emit	15 10990	0.56
BPW41 Det	15 30410	1.61

I-R Optocoupler

Type	Stock No	Price
BNY37	15 40370	1.44

FLAT DIFFUSED

Type	Stock No	Price
V320	15 03200	0.17
V321	15 03210	0.28
V322	15 03220	0.20
V323	15 03230	0.20
V330	15 03300	0.17
V331	15 03310	0.28
V332	15 03320	0.20
V333	15 03330	0.20
V340	15 03400	0.17
V341	15 03410	0.28
V342	15 03420	0.20
V343	15 03430	0.20
V510	15 05100	0.17
V511	15 05110	0.28
V512	15 05120	0.20
V513	15 05130	0.20
V520	15 05200	0.17
V521	15 05210	0.26
V522	15 05220	0.20
V523	15 05230	0.20
V530	15 05300	0.17
V531	15 05310	0.26
V532	15 05320	0.20
V533	15 05330	0.20
V540	15 05200	0.17
V541	15 05410	0.26
V542	15 05420	0.20
V543	15 05430	0.20
V550	15 05500	0.17
V551	15 05510	0.28
V552	15 05520	0.20
V553	15 05530	0.20

TRI COLOUR

Type	Stock No	Price
V518	15 05180	0.40

Ambit international

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Brentwood, Essex
CM14 4SG

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Industrial 0277-231616
Telex 995194 AMBIT G
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Bistromathics?

A new restaurant management system being introduced by Automatic Revenue Controls claims to be easier for table staff to use and give more accurate control over inventories than comparable systems. But will it stop you getting soup spilt on your lap?

Dart is the name of the system which has been on field trial in the UK for six months and has undergone several improvements to software as a result.

Waiter terminals, where staff enter their orders instead of rushing them to the kitchen or bar physically, are not the conventional off-putting numeric keypads. Instead, what waiters and waitresses see is a mimic of the menu itself, with page turnover just like the folder the guest uses at the table. Every menu item is identified by name and one-button selections are possible for most, if not all, of them. Up to 350 different individual items can be ordered at each terminal in this way. Those items may be varied between terminals — no point in having a key for Rump Steak rare in the bar, for example.

Details from Automatic Revenue Control Ltd, Home Park Estate, Station Road, Kings Langley, Hertfordshire WD4 8LZ.

Get Taped With Aiwa

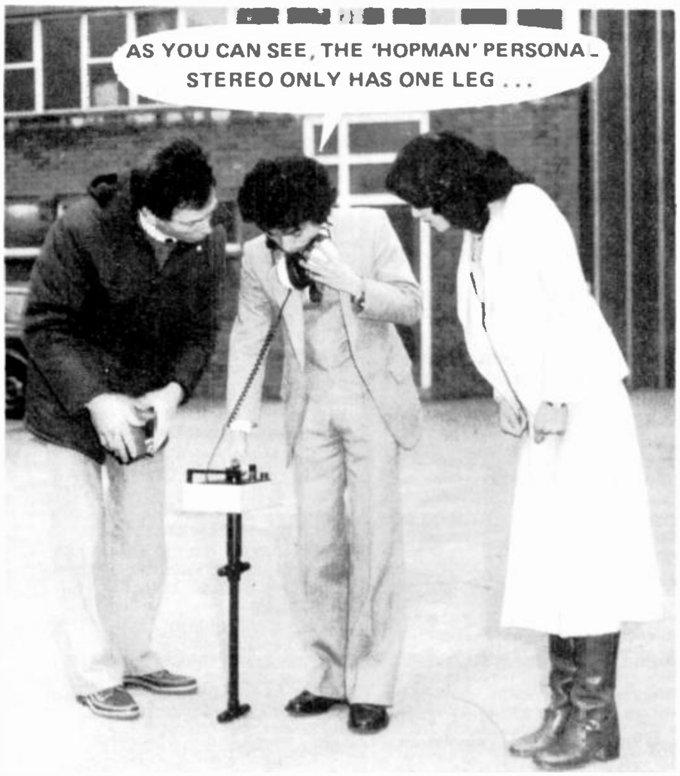
Aiwa, renowned for their high specification cassette decks, have introduced three new top line decks. According to Aiwa, these decks will capture on tape the crystal clear sound of the Compact Disc. We do hope that this doesn't mean they're encouraging our readers to break the copyright law. All three machines — the AD-F990, AD-F770 and the AD-F660 — feature Dolby HX Professional Circuitry and Micro-grain Dual Capstan Tape Transport. Dolby HX Pro is a specially developed anti-saturation circuit that prevents high frequency loss, and therefore greatly improves the dynamic range at the top end of the frequency response curve

It is claimed that a metal tape-like performance can be achieved with Dolby HX Pro, even when recording with normal tapes, so the sound quality on play-back is excellent, even through a car stereo. Dolby HX Pro is not a noise reduction system — Dolby B & C noise reduction systems are also incorporated into the decks for improving the dynamic range over a wider frequency range.

Aiwa developed the Micro-grain Dual Capstan Tape Transport to increase the contact between tape and capstan. The Micro-grain surface which is incorporated in the AD-F990 is composed of millions of uniform hemispheric domes, each only 2μ (micron) in diameter to ensure correct tape tension and reduced modulation noise, plus reduced wow and flutter — 0.025% (WRMS).

At a cool £349 or so, the AD-F990 is Aiwa's top-of-the-range Digital Era (for so they are called) cassette deck, which as well as featuring Dolby HX Pro and Dolby B & C has high performance 3 head technology and introduces a newly developed amorphous alloy combination head. Also new for the AD-F990 is the auto noise reduction detector, which selects the correct noise reduction system automatically for tapes previously recorded on it.

Offering most of the features of the above, is the AD-F770 that weighs in at £279.95. Slightly lower down the market (but only very slightly) is the AD-F660, at £229.95. All these should be available through Aiwa dealers.



Digivision

ITT Television & Video have announced the results of a 10 year 20 million pound investment project which, they say, has led to a revolutionary new system of television receiver technology known as Digivision. According to ITT, this represents not one but a series of quantum jumps in the design, giving the consumer enhanced performance, reliability and greatly increased flexibility.

Digivision is not simply an extension of the digital techniques already incorporated in the tuning and remote control sections of some receivers, but a completely new European development which will transform television receiver design world-wide.

In the first production designs up to 300 components of a comparable analogue-technology receiver will be replaced by seven VLSI chips, bringing increased reliability, greater stability of performance and extended yet simplified control features, together with quicker and more certain diagnosis and servicing. Later designs will include improved picture displays, with zoom and picture-in-picture facilities, noise and ghost suppression and direct digital inputs from data networks and other signal sources.

A recent study of the market for TV, by Mackintosh International, has predicted that digital technology will be taken up by a large proportion of TV manufacturers, resulting in up to 40% of the market of colour receivers sold in the developed nations being taken by TVs with digital chassis. These results are in the company's report, 'Television Receivers: The Next Ten Years', which also analyses trends in other areas, such as display technology, cable TV and DBS. Unfortunately, this report is not publically available (well, they wouldn't give us a copy). ETI

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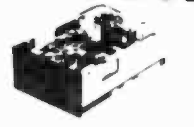
8" FLOPPY DISK DRIVES



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 superb 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.
7100 Single sided £225.00 + Carr. **7200 Double sided £295** + Carr.
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.

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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 I/O TERMINALS

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 *£12.50* + VAT
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The amazing SOFTY 2. 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 units costing 7 times the price! Only *£169.00* pp £1.95 *Data sheet on request*

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. ***ONLY £45.00 PLUS £9.50 CARR.***
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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**
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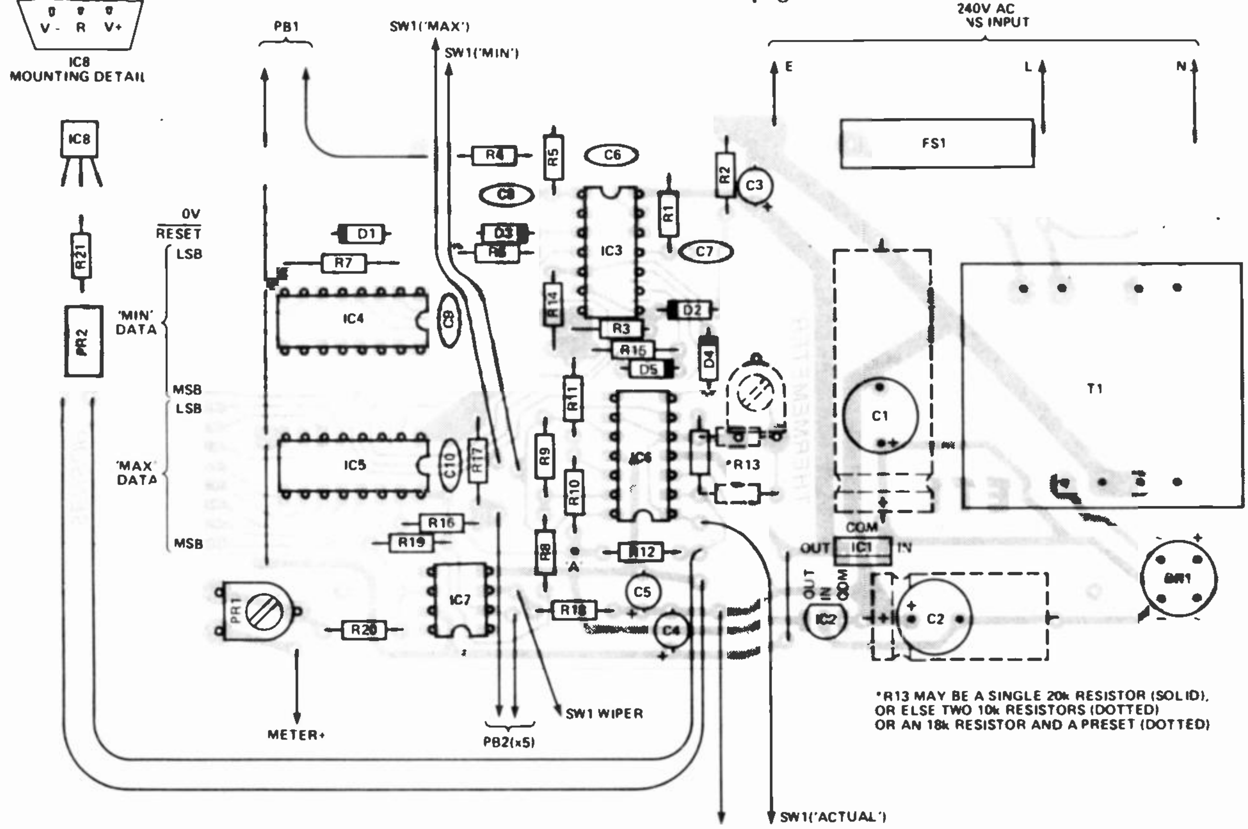
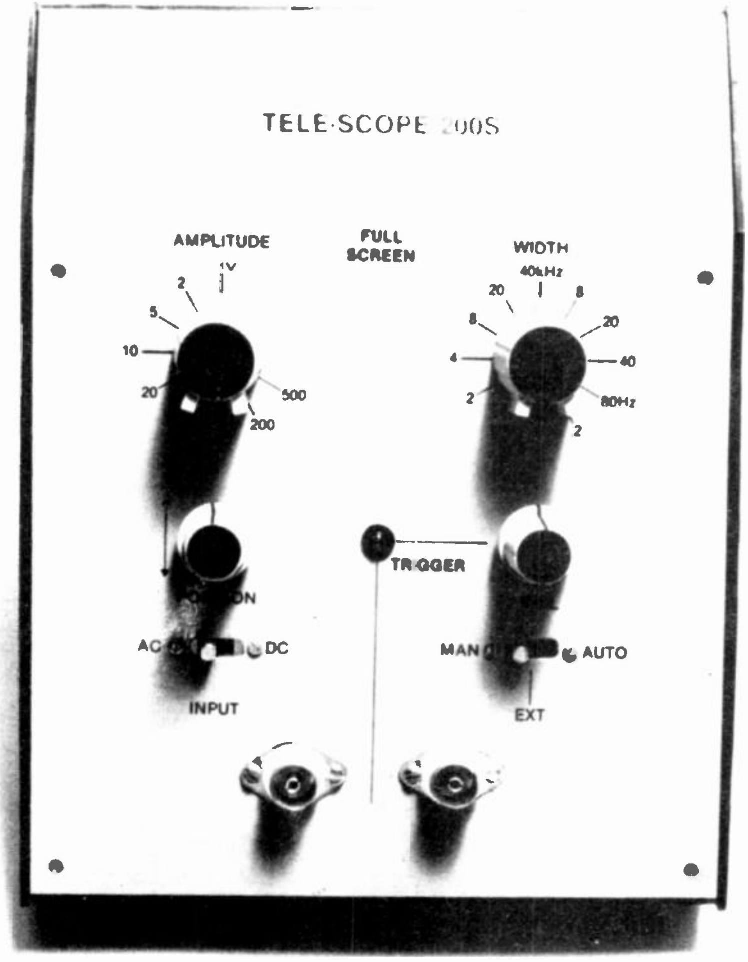
The published Thermeter PCB was in error. This is the correct overlay, and the correct PCB is on page 89.



TV STORAGE SCOPE

The ETI Telescope is so simple, it's surprising no-one thought of it before. Well, they did, but the new range of high-speed A-to-Ds from Ferranti have made it possible to get the 'scope to work at over 1 MHz, while keeping the price within acceptable limits.

The project splits into two main sections: the logic board, featured here, and the memory board, to be featured next month. Unfortunately, you need both circuit diagrams in front of you to understand how the creature works, so we'll have to save the overall explanation until then.



BUYLINES

HOW IT WORKS

The input attenuator is a series chain of resistors to ground, whose collective resistance is 1M2. The front panel amplitude switch (SW2) provides the voltage range select by tapping from this chain. The cpacitors connected to the chain (C2-7) compensate for the inductive effects of the resistors at high frequencies.

The input may be AC or DC-coupled by switching C1 in and out of circuit with SW1.

The trigger select switch SW3 provides either an input signal trigger, an auto trigger (a 2 kHz signal derived from the sample rate switch), or an external trigger.

Q1 is a source-coupled FET which buffers the input signal between the input series chain variable attenuator and the flash A-to-D converter (which will be described in the next article). Q2 acts as a current source, enabling a DC offset to be added to the input signal. This offset is adjusted by RV1 and is used to shift the vertical position of the displayed trace. Q3 and RV2 set the trigger level, and LED1 is lit when the trigger is running.

IC2a is a D-type flip-flop, which enables the input address clock (IC3a) on the leading edge of the input data via the trigger level. It is held in the reset state by a signal on pin 1 (from interboard link 5) when the input addressing is completed.

IC4a-c and the crystal XTAL1 form a 10 MHz oscillator and ICs 6 to 10 provide a series dividing network at divide-by-5 and divide-by-2 stages, thus producing division in steps of 10, 5, and 2 etc down to 100 Hz. The sampling rate is selected from this chain by the rotary switch on the front panel. IC13a is a divide-by-2 and is used as the output address clock at 5 MHz. It is also used to re-time the data out to the modulator via IC11a.

IC2b is a D-type flip-flop which is enabled by a line synchronisation pulse thus enabling IC3b. IC3b then allows IC14 to count eight pulses, each of one microsecond duration, before the output clock cycle is started (by IC7b). This produces an eight microsecond delay at the beginning of each line, so all data is displayed and none of the output is outside the video display area. When the output address cycle is completed (50 microseconds later), this counter resets and waits for the reset line sync pulse.

In the same manner, IC18, 12b and 19 count line synchronisation pulses at the beginning of each field scan to enable the video output only during the middle 256 lines of interlaced scanning.

By dividing the 1 MHz signal by 16 using IC15 and IC16a, we produce a signal of 15.625 kHz, and IC17a, a monostable, then produces the line synchronisation pulses (4.7 microseconds wide), which are mixed into the UHF modulator by IC12c and 12d. IC17b produces the field synchronisation pulses from the 50 Hz clock provided by IC16b: these are approximately 50 microseconds wide. IC11b provides the control lines to switch over the memories and addressing. This changeover occurs when the input address counter has completed its cycle and the frame scan is completed.

The summing circuits used to mix the video data and the line and field synchronisation pulses are the open-collector gates IC12c and 12d at the UHF modulator input, with the resistor network providing the DC offset and modulation depth required to drive the video circuitry.

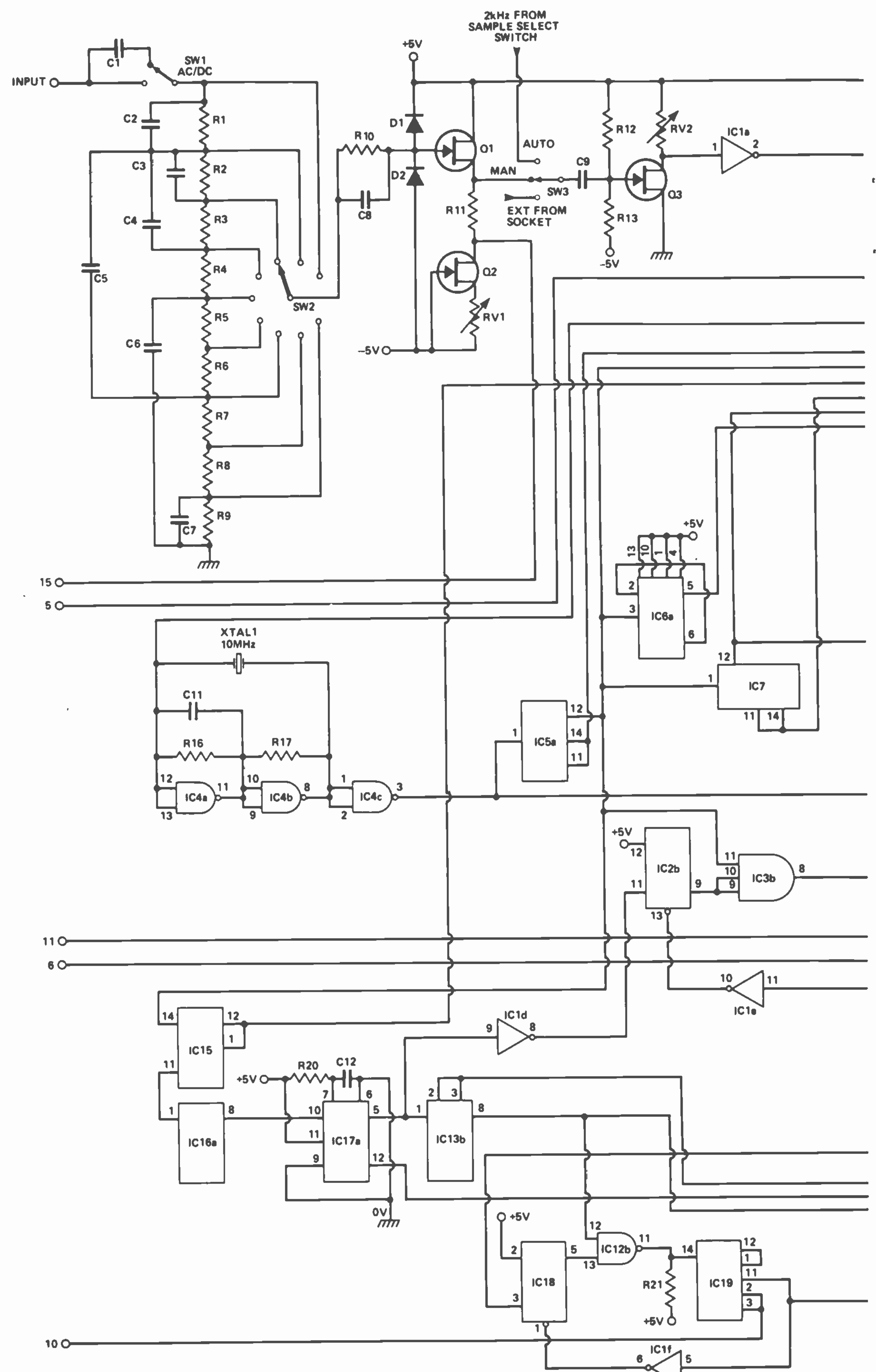
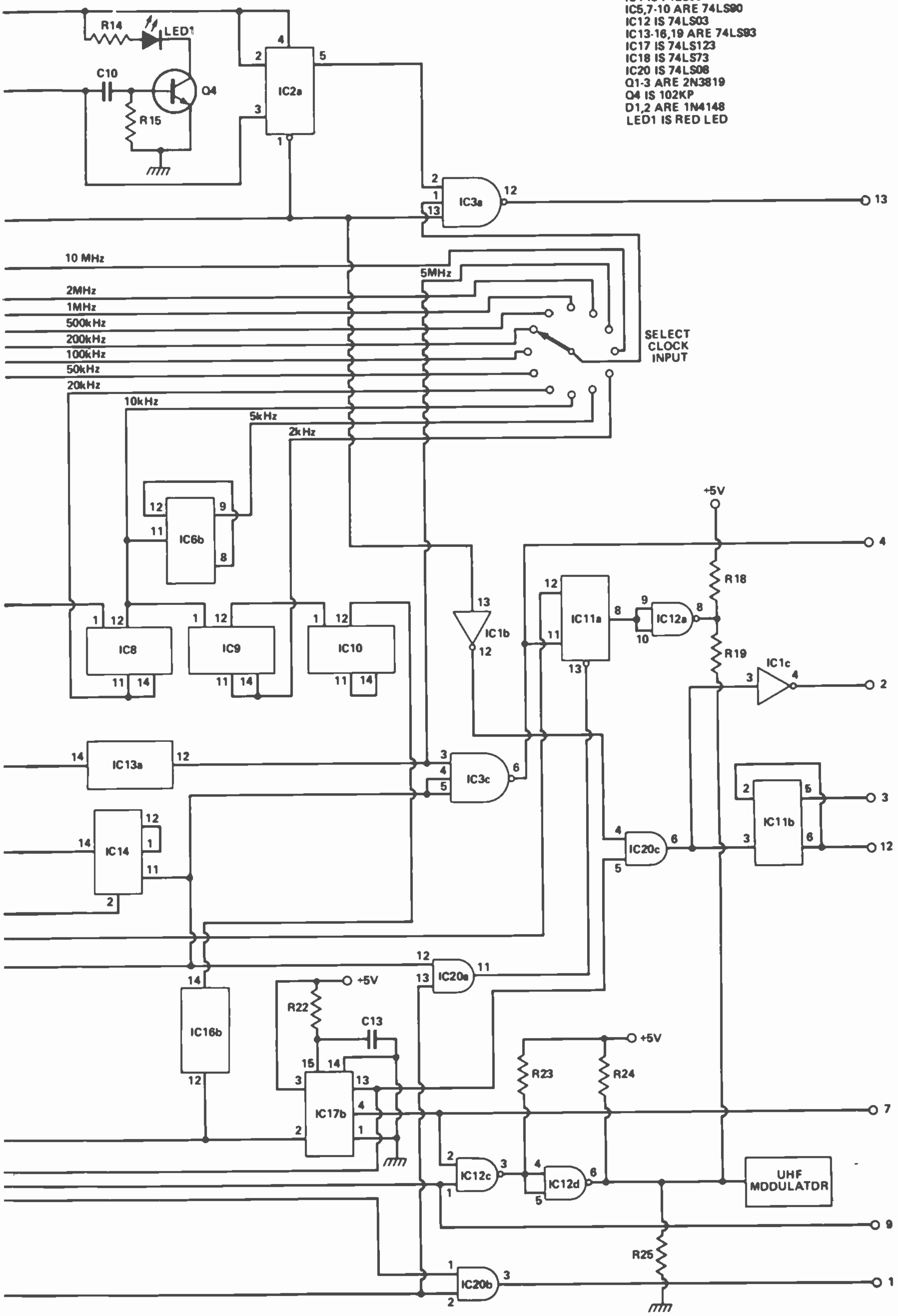


Fig. 1 Circuit diagram of the ETI 'TeleScope' logic board.

NOTE:
IC1 IS 74LS04
IC2,6,11 ARE 74LS74
IC3 IS 74LS10
IC4 IS 74LS00
IC5,7-10 ARE 74LS90
IC12 IS 74LS03
IC13-16,19 ARE 74LS93
IC17 IS 74LS123
IC18 IS 74LS73
IC20 IS 74LS08
Q1-3 ARE 2N3819
Q4 IS 102KP
D1,2 ARE 1N4148
LED1 IS RED LED



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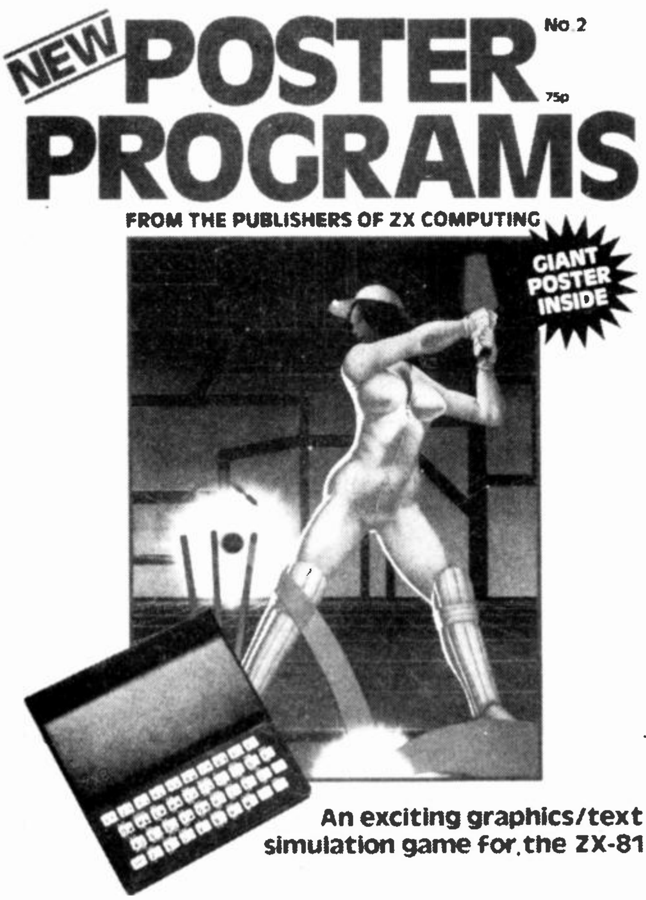

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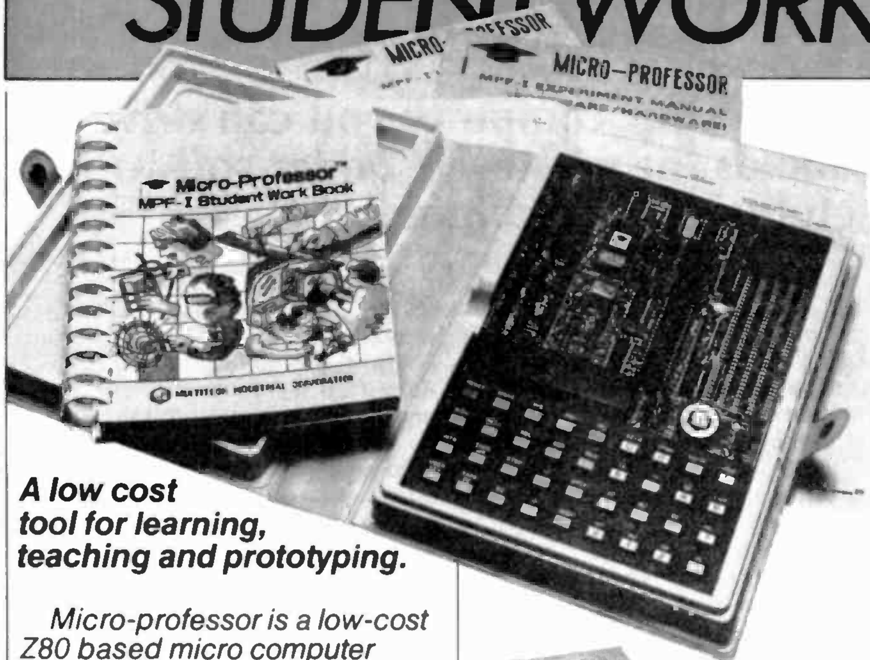

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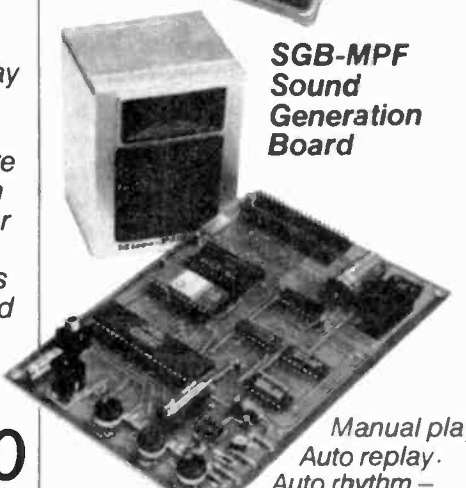

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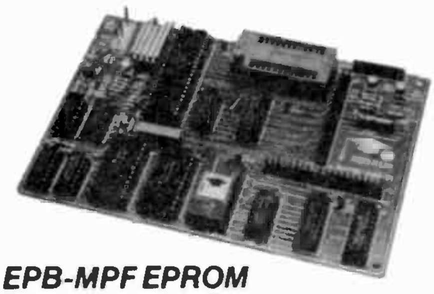

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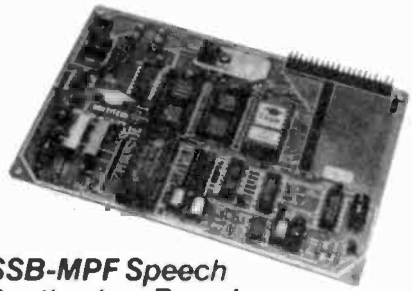

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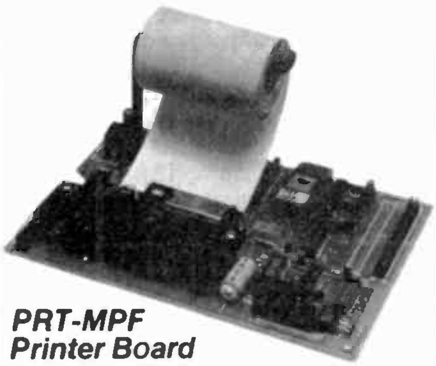

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COMPUTER OUTPUT DRIVER

With this project hooked up to your computer you can drive relays, motors, lamps, solenoids, or whatever, under software control. Do something useful with your computer! Design by Geoff Nicholls.

A personal computer need not necessarily be used for playing games, learning programming or producing computer club newsletters. With this project, you can put it to some *practical* use. Just what that is I'll have to leave to your imagination and ingenuity!

Two independent groups of eight outputs are provided. Each of the 16 output driver circuits is configured to run from a 12 V supply, although higher supply voltages may be used. Each can be configured to sink up to 3 A. Simple address selection for the board is provided by an on-board DIP switch. It's a pretty straightforward project and you can vary things to suit your application(s).

Component Options

The component values shown in the circuit diagram are for output currents of up to 2 A. If other load currents are desired, then a few components need changing in order to reduce power dissipation in the output transistors.

For currents of less than 1 A, the TIP31Bs (Q17-32) may be replaced by BD139s — which have the distinct advantage of costing considerably less than TIP31Bs. However, note that BD139s have a different pinout such that the metal face on BD139s is on the opposite side of the package to the TIP31Bs.

The base current drive to the output devices is determined by R17 and R32 and may be optimised for different loads. The table here (Table 1) summarises component values for various output currents.

If the total output current is expected to exceed 20 A for more than a few minutes, then it is advisable to make the following changes:

(a) Use a terminal strip capable of passing half of the total load current through each terminal OR solder the power ground directly to the PCB ground plane.

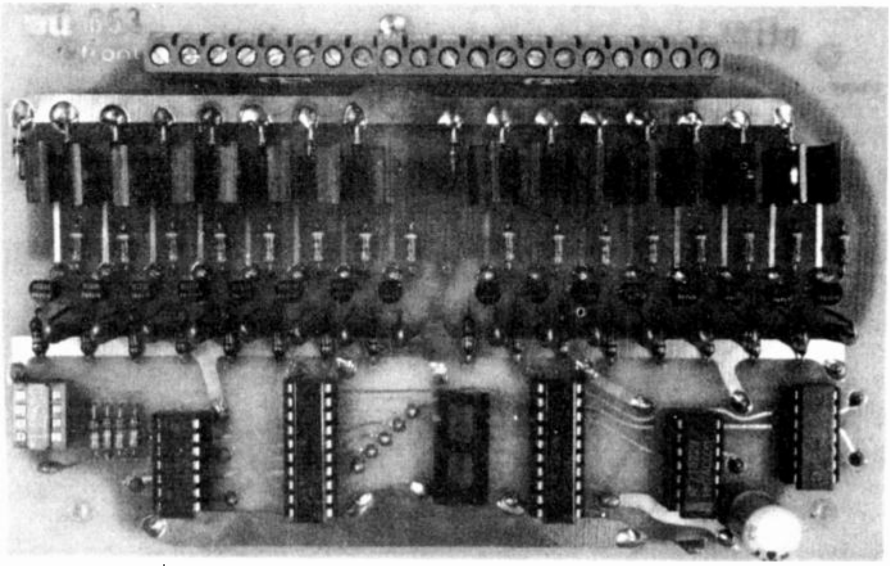
(b) Solder several lengths of tinned copper wire to the heavy power ground track on the PCB.

Intermittent use over 20 A should not require these changes. The power dissipation calculations for transistors Q17 to Q32 were based on data for RCA-manufactured TIP31Bs. The prototype transistors developed a collector-emitter voltage of 0V65 at 2 A, which does not necessitate heatsinking the transistors. If high current loads are to be used, measure $V_{CE} \times I_C$.

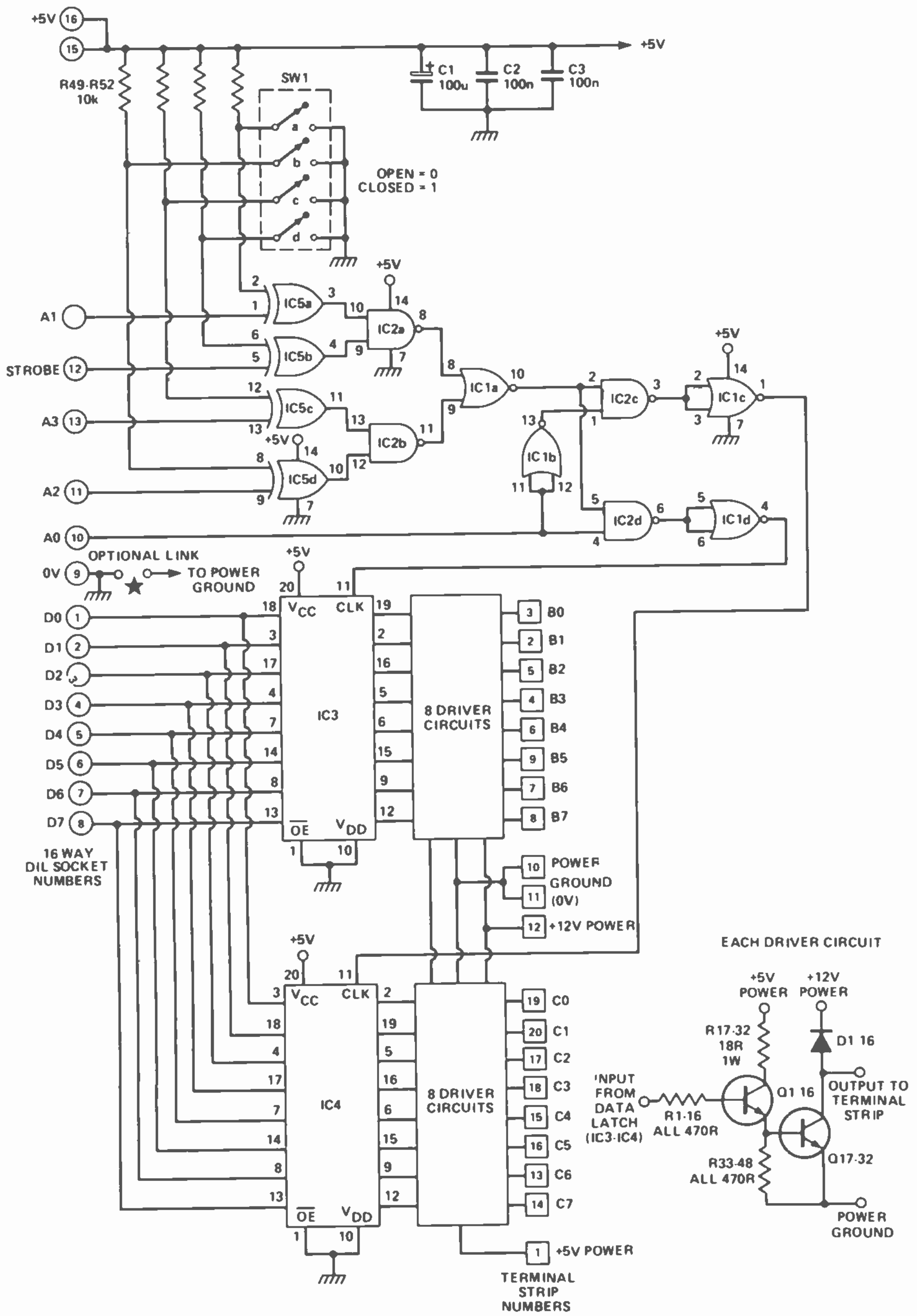
The TIP31B can dissipate 2 W at 25°C ambient without heatsinking. Continuous use at high currents may require a small flag heatsink on each TIP31B.

The entire electronics for this project is mounted on a double-sided PCB. During the early design phase, it was found that a single-sided PCB would require an unacceptably huge number of links. To keep the cost down, through-hole plating was not specified for this board and connections between top and bottom side tracks are made with links of 22 swg tinned copper wire, of which there are a total of 61. IC sockets were installed on the prototype, but these are not essential.

Commence construction by giving the PCB a good inspection, looking for broken tracks and undrilled holes. Make sure the tracks are clean and bright so that soldering is easily carried out. Insert all the links first. These are identified on the component overlay diagram by a ●. Note that a large star is next to a '62nd' link more or less in the centre of the board. This is the optional 0 V link — see the text under the heading 'Power supplies'.



The project is built on a board measuring 103 × 165 mm.



HOW IT WORKS

First of all, note that the component values shown on the circuit diagram are for the 2 A output version. Other output current versions are possible, as explained in the text, but basic circuit operation is the same.

The host processor connects to the driver board via the 16-pin DIL socket. IC5 compares the logic levels present on the DIL socket pins 14 (A1), 11 (A2), 13 (A3) and 12 (STROBE) to the settings of SW1a-d respectively. When a match is found, pin 10 of IC1 goes high. The STROBE input should receive a pulse edge timed to coincide with a valid data bus (pins 1 to 8 of the DIL socket) and a valid address (pins 11, 13, 14). Note that either a positive-going or a negative-going edge of the strobe pulse may be used, according to whether the setting of SW1d is closed or open, respectively.

The A0 input on pin 10 of the DIL socket determines which of the two on-board latches are being addressed. When pin 10 is low, IC4 is selected ('B outputs active'), if high, then IC3 ('C outputs active').

Each driver circuit buffers one of the 16 latch outputs and provides an open collector current sink of up to 3 A (see the text on 'Component options').

To simplify the description of the driver circuits, consider the one comprising R1, Q1, R17, R33, Q17 and D1. Diode D1 is a flywheel diode and protects transistor Q17 from excess back emf voltage when turning off inductive loads, such as a solenoid. When the latch output is low, Q1 is held off via R1 and Q17 is held off by R33. Resistor R33 speeds up the turn-off time of Q17 by providing a path to remove stored charge in the base-emitter junction.

When the latch output is high, about 5 mA of current flows into the base of Q1, thus turning it on. R17 sets the base current of Q17 and is chosen according to the output current requirement. Transistor Q17 must be saturated in order to reduce power dissipation and up to 300 mA of base current may be required for 3 A loads (see component options in main text).

Fig. 1 Circuit diagram for the ETI Computer Output Driver. Our artist drew the line (!) at reproducing 16 identical driver circuits, so we've shown just the one.

Next, solder diodes D1 to D17 in place. Note that the cathodes of these diodes are soldered on the *component* side of the board. Solder resistors R1 through R16, then R33 through R48 in place next. Mount and solder the BFR39 transistors, Q1 to Q16, in place next. All the 1 W resistors, R17 through R32, stand up on end and these may be soldered in place after the transistors. Follow with the remaining four resistors and the three capacitors. Now you can mount and solder in the output devices, Q17 to Q32. Watch orientation.

Now mount SW1, but take care you put it round the right way. The ON position of the switches should be adjacent to the edge of the board. If you're using IC sockets, put these on next. If not, solder the ICs in place. A 16-pin DIL IC socket is used for the input connections and this can be mounted now. Last of all, mount and solder in the output terminal strip or strips. We used one 12-way and one 8-way strip as we could not obtain a single 20-way strip.

Having completed the construction, go over the board very carefully, looking for missed links and components, bad joints or mis-oriented semiconductors. Fix any faults and, if you're satisfied all is well, the best way to test the board is to hook it up and try it out!

Power Supplies

The logic power supply of +5 V should be supplied from the host computer V_{cc} rail through the DIL socket pins 15 and 16. The computer's ground (0 V) should be connected to pin 9.

The +5 V power to the drive circuits should not come from the host computer unless it has the

PARTS LIST

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

R1-16,33-48	470R
R17-32	18R, 1W
R49-52	10k

Capacitors

C1	100uF 16 V PCB electrolytic
C2,3	100n ceramic

Semiconductors

IC1	74LS02
IC2	74LS00
IC3,4	74LS374
IC5	74LS86
Q1-16	BFR39
Q17-32	TIP31B, BD139 (see text)
D1-16	1N4002, 1N4004 etc

Miscellaneous

SW1 4-way SPST DIP switch

PCB (see Buylines); 16-pin DIL socket; 2 off 16-pin DIP headers; one off 12-way and one off 8-way PCB-mounting terminal strips; 16-way ribbon cable; 22 swg tinned copper wire.

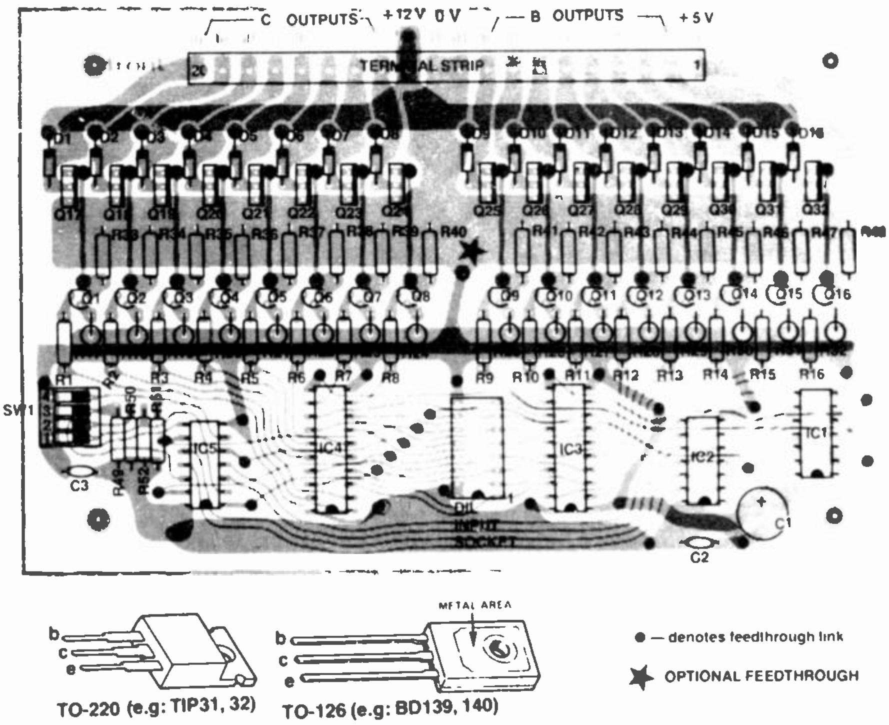


Fig. 2 Component overlay for the driver board, and lead details for some suitable output transistors.

BUYLINES

No severe supply problems are anticipated with anything we've used for this project. The hardest thing to find will probably be the PCB-mounting terminal strips, but Maplin, at least, stock a suitable type, and you may be able to find other suppliers too. The PCB will, as usual, be available from the PCB Service as advertised on page 91.

TABLE 1

OUTPUT CURRENT (amps)	Q17-32	R17-32	R1-16	+5 V SUPPLY CURRENT (maximum)
3	TIP31B	15R, 1W	330R	3A4
2	TIP31B	18R, 1W	470R	2A8
1	TIP31B	22R, ½W	470R	2A3
<1	BD139	33R, ¼W	470R	1A6

capability to supply at least an extra 3 A. In any case, heavy wire should be used (at least 24 x 0.2 mm hookup wire) for the power connections to the terminal strip to minimise voltage drop.

The optional 0 V link (marked with a star) should only be used for light loads. Normally, the connection between 0 V logic and power should be at the power supply.

The output drivers' power supply is shown as +12 V, but other voltages may be used, up to about 70 V. The PIV rating of diodes D1 to D16 should not be exceeded, however (best use 400 V diodes here, at least).

Hooking It Up

This project has been designed to allow up to eight boards to be connected to a computer through a single ribbon cable. In order to do this a special strobe signal must be supplied by the computer whenever any of the driver boards are being selected. This will probably require a small hardware circuit, unless your computer is favoured by the famous Murphy! If there is sufficient interest we may publish a general purpose interface board, but until then you will have to work out for yourself how to connect a particular computer from the following guidelines.

Assuming that the computer has an I/O scheme with eight I/O address lines — AD0 to AD7 — then the driver board inputs A0 to A3 are connected to the lowest four I/O address lines of the computer, ie AD0 to AD3. Each driver board is then set up at a different address via the DIL switches, SW1a-d. This means that the driver boards will occupy 16 consecutive I/O ports. Now for the hard part!

The STROBE input (A4) must have a positive or negative going edge (see the How it Works box) that occurs when an I/O WRITE to the driver boards is taking place. In order to fully decode the I/O port address space, the other I/O address lines (AD4 to AD7) must be gated with the I/O control signals to produce the STROBE signal. In order to get the STROBE transition timing correct, a signal such as WRP (write pulse) should also be gated in the STROBE logic. This allows the data bus to settle before the latches are locked.

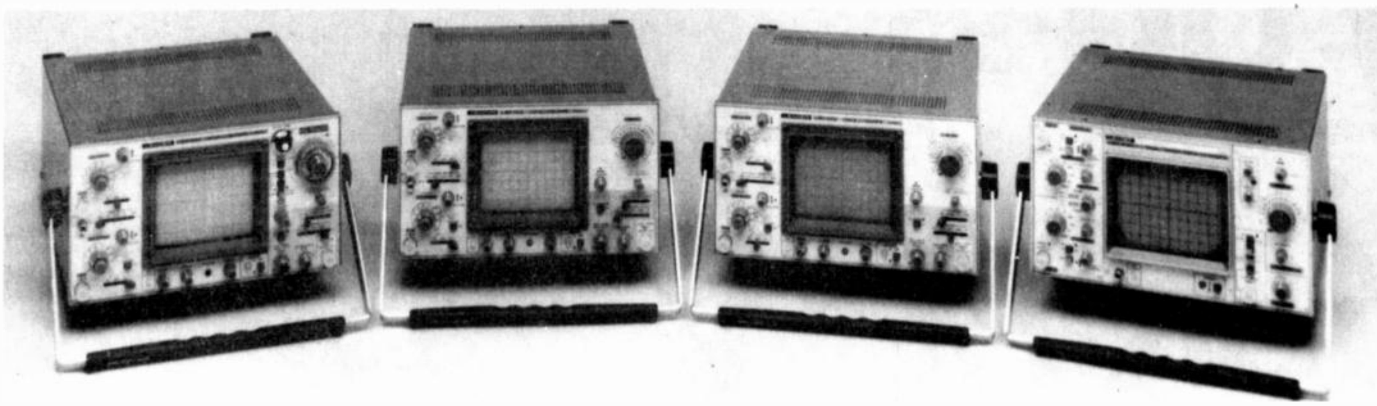
The ribbon cable requires a buffered driver for each wire carrying logic signals, especially if multiple driver boards or long cable runs are envisaged.

A simpler interconnection may be implemented if a couple of I/O ports are available. In this case, the D0-D7 inputs can connect to one output port and the A0-A4 inputs to another output port. The timing of the STROBE pulse is then a matter of software driving routines.

ETI

BUYER'S GUIDE TO TEST EQUIPMENT

This month, all you ever wanted to know about oscilloscopes



but were afraid to ask the man in the shop.

Next to a multimeter, an oscilloscope is the most basic measuring instrument of electronics, yet comparatively few hobbyists possess one. It's true that they're not cheap, we didn't find a single one for less than £100, but they're not that expensive either. In this survey, we've found a very wide choice of instruments is available for around £350 or less (excluding VAT).

All the oscilloscopes in the table have the following basic facilities: a Y-amplifier, with switched calibrated ranges, switchable AC or DC coupling, and a shift control; a timebase generator, with switched ranges, position control, and some means of synchronising sweep commencement at a particular point on the input Y-waveform; an on-off switch, and brightness and focus controls. (None of these features is listed in the table).

All the sensitivities are given in volts per division (note that unless a 'scope has a 130 mm screen, 1 division will be smaller than a centimetre), but not all the sweep speeds are in seconds per division: the two cheapest 'scopes (the Leader LBO-310A and the Trio CS1303D) give sweep frequencies. These two 'scopes, and the Leader LBO-512B, have relatively few calibrated Y and sweep ranges, so you would have to rely a lot on the variable controls to view, but would not be able to measure intermediate waveforms.

All the other 'scopes have their sweep and voltage ranges in 1, 2, 5 sequences, eg 1 mV/div, 2 mV/div, 5 mV/div, 10 mV/div, etc.

Expansion Options

Scopes with X and Y expansion options (features E and F) will have maximum sweep rates and sensitivities higher than those quoted in the calibrated range columns; expansions are typically ×5 or ×10. However, note that Y-expansion amplifiers usually have a lower bandwidth than the main Y amplifier, sometimes less than 1 MHz, and often decrease the accuracy as well. Variable gain controls, on the other hand, nearly all decrease sensitivity and variable sweep controls nearly all increase sweep times (from calibrated positions).

As all the scopes have DC coupling, the bandwidth quoted is just the upper limit; in AC coupled modes, the lower −3 dB point is typically 2 Hz.

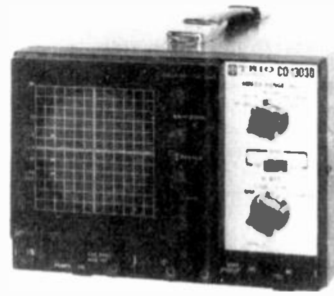
Trigger Happy

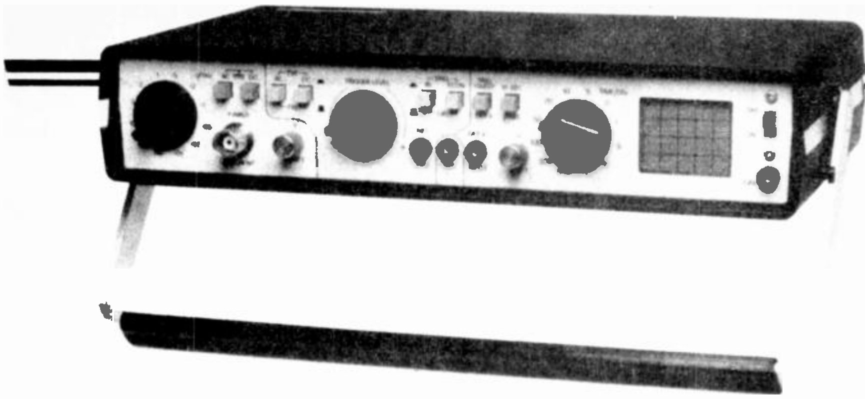
After finding the on/off switch, the next most difficult task on any oscilloscope is persuading the thing to trigger when and where you want it to. The 'scopes we've looked at have a wide variety of trigger facilities, mostly in an attempt to be user-friendly.

Firstly, in nearly all cases you can select triggering from the Y-channel or from an external trigger input. Most dual trace 'scopes allow you to select which Y-channel the triggering comes from as well. Usually the threshold signal level at which you can get any scope to trigger is equivalent to around 0.3 to 1 division on the screen. The vast majority of trigger circuits are AC coupled; DC coupled types are easier to get to trigger on slowly rising waveforms.

A level control and a slope polarity control will allow you to move the trigger point along a waveform. Some 'scopes have a single control that sets

The Trio CO-1303D: not quite our cheapest 'scope





The Thandar SC110A

both the level and slope polarity (eg, Scopex 4S6, Trio CS1575). A few 'scopes have trigger delay facilities, so that you can delay triggering for a pre-selected time: this is particularly useful for observing pulses with a low but regular repetition rate, because you can set the 'scope to trigger on one pulse, yet wait until just before the next pulse before commencing the sweep. One 'scope in the survey, the Hitachi V302F, achieves this in another manner, by delaying the signal slightly; however, this will only be of use on very high frequency pulses. In any case, trigger delay is extremely useful for general digital work, so that you can pick out sections of words to examine.

Many 'scopes have TV video signal filters (also called LF filters by some manufacturers) that will enable the scope to synchronise to line or frame pulse signals embedded in the video signal. The Scopex 14D10V (similar to the 14D15 in the table) takes this a stage further, by having a delay system that allows any line between number 17 and 312 to be selected and examined.

Some scopes give you the choice between bright line (or auto-triggering) where the 'scope free runs in the absence of a signal, and normal triggering, where the trace is only present when there is sufficient signal to trigger the 'scope. Also available on some 'scopes is a line triggering option, where the sweep free runs all the time, with or without a signal. The battery-operated Thandar SC110A has a further, economy option, that shuts down unused sections of the scope in the absence of a signal, so reducing the average power consumption (in this mode) to 350 mW.

None of the new dual beam 'scopes in this survey are true two beam types; that is they all have just one beam that is switched between the two traces, either by chopping the beam or by switching it at the end of each sweep. Which mode is appropriate depends on the sweep rate, and some 'scopes will switch between the two modes automatically, depending on the setting of the sweep control (feature P); the others have manual selection of display mode (feature M).

Other Features

Some 'scopes have a component testing facility (feature T); in this mode, the scope itself applies a low frequency (usually 50 Hz or 1 kHz) signal to a component connected to it, and displays the resultant V/I graph on the screen automatically. Some waveforms for the component tester on the Crotech 3131 are shown in Fig. 1.

Oscilloscopes with an internal graticule will enable you to make parallax free measurements, because the graticule is actually on the same side of the screen glass as the phosphor.

Direct connection to the 'scope plates can be a handy facility on occasions, as this will allow much higher frequencies to be examined than the Y or X amplifiers can cope with. Z-modulation can also be a handy facility, particularly when the 'scope is used for less orthodox measurements.

Hanging On?

Most 'scopes are normally supplied with a short or medium persistence phosphor tube as standard. To our knowledge, the following manufacturers offer a choice of persistences: Farnell, Gould, Hameg, Scopex. It may be worth approaching other manufacturers if you want a particular 'scope but with a longer persistence tube.

Oscilloscope probes are usually designed to feed an input impedance of 1M0 in parallel with 30 pF, with some adjustment usually available to compensate for slightly different impedances. Using an oscilloscope with a significantly different impedance will lead to ringing at high frequency, and possibly other problems. If the input capacitance is on the low side, you can always increase it, but if it's high, then you will have to use a probe that is designed specially for the input impedance.

All Singing . . .

Trio don't seem to have been content with offering just normal 'scope features on their CS1575, because it has the facility to do phase comparisons at the same time as observing the two Y channels. In fact, as you may guess from its relatively

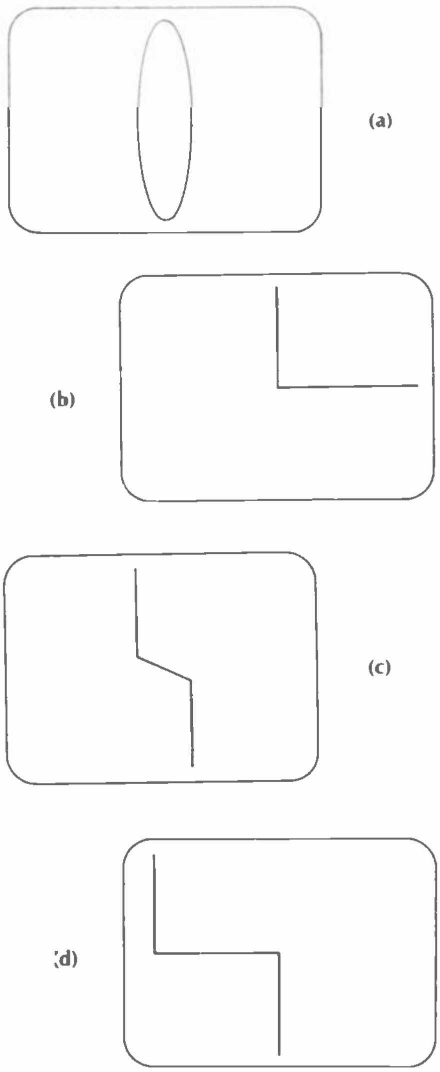
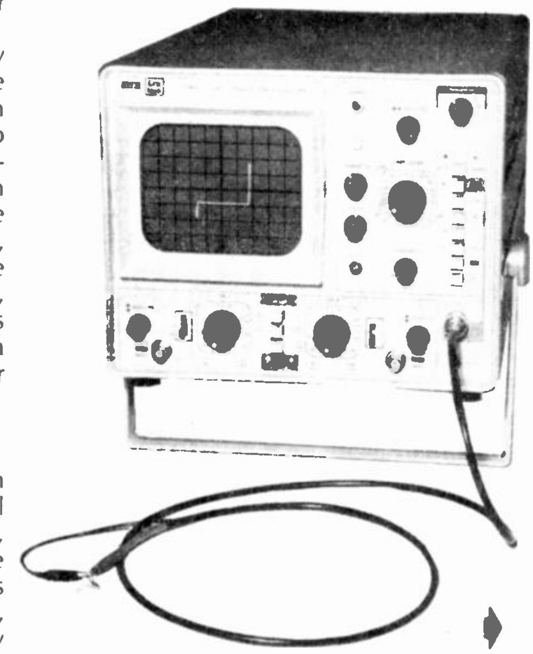


Fig. 1 Above: some typical traces for the 3131; (a) when looking at a capacitor; (b) a diode; (c) diodes back to back; (d) a J-FET source to drain. Below: the beast itself in action on a transistor.



OSCILLOSCOPES

	Model	Price £ ex VAT	Similar Models	Single or Dual Trace	Calibrated Y Sensitivities, V/div (Number of Ranges)	Basic Y Accuracy, %	Bandwidth (—3 dB), MHz	Input Impedance, M//pF	Calibrated Sweep Speeds, sec/div (Number of Ranges)
1	Crotech 3030	154	3033,3035	Single	5m to 20(12)	3	15	1//35	0.5u to 200m(18)
2	Crotech 3131	250	3034	Dual	5m to 20(12)	3	15	1//35	0.5u to 200m (18)
3	Farnell DTC12	345	DT12	Dual	5m to 20(12)	3	12	1//30	0.5u to 500m (19)
4	Gould OS300	325	—	Dual	2m to 10(12)	3	20	1//28	0.5u to 200m(18)
5	Hameg HM103	158	—	Single	5m to 20(12)	3	10	1//28	0.5u to 200m(18)
6	Hameg HM203-4	264	—	Dual	5m to 20(12)	3	20	1//28	0.5u to 200m(18)
7	Hitachi V152F	260	V302	Dual	5m to 5(10)	5	15	1//30	0.2u to 200m(19)
8	Hitachi V203F	355	V2102	Dual	5m to 5(10)	3	20	1//30	0.2u to 200m(19)
9	Kikusui COS5020	265	—	Dual	5m to 5(10)	NS	20	1//30	0.2u to 500m (20)
10	Leader LBO-310A	119	LBO-510B	Single	20m to 2(3)	NS	4	1//40	10Hz to 100kHz(4)
11	Leader LBO-512B	223	LBO-510B	Single	10m to 10(4)	3	10	1//30	1u to 1m(4)
12	Leader LBO-514A	313	LBO-513A	Dual	5m to 10(11)	3	15	1//30	0.5u to 200m(18)
13	Leader LBO-522	338	—	Dual	5m to 5(10)	3	20	1//30	0.2u to 200m(19)
14	Philips PM3207	385	—	Dual	5m to 10(11)	5	15	1//35	0.5u to 200m(9x2)
15	Safgan DT420	183	DT410,415	Dual	5m to 20(12)	5	20	1//22	0.5u to 200m(18)
16	Scopex 4S6	148	—	Single	10m to 50(12)	5	6	1//35	1u to 100m(16)
17	Scopex 14D15	230	14D10,SG315	Dual	5m to 20(12)	3	15	1//33	1u to 100m(16)
18	Thandar SC110A	149	—	Single	10m to 50(12)	3	10	1//47	0.1u to 500m(21)
19	Trio CO1303D	120	CO1303G	Single	10m to 1(3)	NS	5	1//35	10Hz to 100kHz(4)
20	Trio CS1560A	324	—	Dual	10m to 20(11)	NS	15	1//22	0.5u to 500m(19)
21	Trio CS1562A	258	CS1559A	Dual	10m to 20(11)	NS	10	1//22	1u to 500m(18)
22	Trio CS1575	298	—	Dual	10m to 3(6)	NS	5	1//27	0.5u to 2m(12)

SECOND HAND OSCILLOSCOPES

	Model	Price £ ex VAT	Similar Models	Single or Dual Trace	Calibrated Y Sensitivities, V/div (Number of Ranges)	Basic Y Accuracy, %	Bandwidth (—3 dB), MHz	Input Impedance, M//pF	Calibrated Sweep Speeds, sec/div (Number of Ranges)
23	Advance OS1000B	330	—	Dual	5m to 20(12)	3	20	1//28	0.5u to 1(20)
24	Solartron CD1400	*125*	—	Dual	100m to 50(9)	5	15	1//35	0.5u to 200m(18)
25	Tektronix 545B	*100*	—	Dual	50m to NS	NS	33	NS	0.1u to 5(24)
26	Telequipment D63	300	—	Dual	1m to 20(12)	3	15	1//29	0.2u to 1(21)

Note: prices in italics are for equipment that has not been reconditioned.

Basic Sweep Accuracy %	Trigger Facilities	General Features	Screen: shape/size (mm)/ number of divisions	
5	(AM)(BN)ES	CGRTUW	Rect/95/8×10	1
5	(AM)(BN)CELST	CDGIMRSTWYZ	Circ/130/8×10	2
3	BCEMNST	ACDEIMRSTVWYZ	Rect/130/8×10	3
3	BCEMNST	CDEGIPRSVWYZ	Rect/130/8×10	4
5	(AM)(BN)EST	CGKRTVWX	Rect/95/6×7	5
3	(AM)(BN)EFLST	CDEGIKLMORSTVWY	Rect/130/8×10	6
5	BCELMNST	CDEFGJOPRSVWYZ	Circ/140/8×10	7
3	BCELMNST	CDEFGJKLOPRSVWYZ	Rect/140/8×10	8
NS	ABCDEMNOT	CDEFGIJKLMOPRSUWY	Rect/152/8×10	9
NS	AM	VWXZ	Circ/75/8×10	10
5	BEMS	CVWXY	Circ/130/8×10	11
5	(AM)(BN)CEFST	CEFGMORVWYZ	Circ/130/8×10	12
3	(AM)(BN)CEFLST	CDEFGIKLMORSVWYZ	Rect/130/8×10	13
5	BCEMST	CDEIOPSY	Rect/130/8×10	14
5	BCEMNST	CEGOPYZ	Circ/102/8×10	15
5	(BS)EMN	GX	Circ/100/6×8	16
3	BEMNST	CDEGHIPRSYZ	Rect/130/8×10	17
3	BELMNST	BCY	Rect/41/4×5	18
NS	EN	GQVWZ	Circ/75/8×8	19
NS	(AM)(BN)CET	ACDEGOPRSVWY	Circ/130/8×10	20
NS	(AM)(BNS)CET	CEGOPVWY	Circ/130/8×10	21
NS	(BS)CEJM	CGOPUVWY	Circ/130/8×10	22
5	(AM)(BN)CDEFLST	ACDEFGIJLOPSVWYZ	Rect/130/8×10	23
5	ABCEFPS	ACEFLYW	Circ/130/8×10	24
3	(AM)(BN)DEFGOT	ACEFKLYW	Circ/130/8×10	25
3	(AM)(BN)DELOS	ACEFGHVWXZ	Rect/115/8×10	26

Key to Trigger Facilities

A Automatic or preset level control
B Manual level control
C Trigger source channel selectable
D DC coupling of trigger available
E External trigger available
F HF trigger facility
G Delay facility
H Sweep hold-off facility
J Separate trigger level controls for two Y channels
L Line triggering available
M Automatic (or bright line) triggering available
N Normal triggering available
O One shot triggering available
T TV sync pulse separator available

Where facilities are bracketed together, they are only available together.

General Features

A Astigmatism control
B Operates from batteries
C Calibrator output provided
D Difference of two Y channels can be displayed
E Expansion facility on sweep
F Expansion facility on Y channel(s)
G Facility to ground Y input
H Trace locate function
I Inverting facility on one or both Y channels
J Y output socket provided
K Internal graticule
L Illuminated graticule
M Manual selection on chopping or alternating
O Y channel turn-off facility
P Auto selection of chopping or alternating
Q Direct connection to deflection plates
R Trace rotation adjustable
S Sum of two traces can be displayed
T Component testing facility
U Variable sweep length control
V Variable Y gain control
W Variable sweep rate control
X Access to X amplifier (ie for X-Y mode)
Y One Y channel can be used as X amplifier
Z Z modulation available

* = maximum value

modest bandwidth, this 'scope is specially designed for audio test work.

New Or Second Hand?

There is quite a healthy market in second hand oscilloscopes, and you can get a slightly outdated but still very useful 'scope for a fraction of the price that a new 'scope with similar specs would cost you. Newish 'scopes do turn up on the second hand market from time to time, but they don't tend to spend very long on the shelves before being snapped up. So, if you're buying a 'scope it's well worth taking a look at the second hand market.

The 'pro' of buying a second hand oscilloscope is, then, price; however, there are a few 'cons' that you should consider:

- **Size:** due to integration and rectangular tubes, new 'scopes are typically smaller, lighter and more economical on power (ie, don't get as hot) than older models (particularly 'scopes with valves).
- **Guarantees:** with any new 'scope, you will get a guarantee, though the length of the guarantee will vary from manufacturer to manufacturer, and sometimes from supplier to supplier. In addition, the manufacturer has a legal obligation to provide goods of a merchantable quality. With a second hand 'scope, you may get a warranty for up to a year if the instrument has been fully reconditioned, or no warranty at all if you're buying the 'scope "as seen". We'd advise that unless you know what you're doing, you should steer well clear of the latter option.
- **Parts:** older scopes will probably be more unreliable and more easily damaged by a knock than new 'scopes, so you could find yourself having to scour the country while searching for a vital yet elusive bit.
- **Information:** though good dealers will do their best to give you reliable information, you're unlikely to get a glossy brochure to take away and peruse at your leisure. So, to an extent, unless you are already well acquainted with instruments of that type, you will possibly be purchasing an unknown quantity.

To give you an idea of what you can get second hand, we've included in the table a few 'scopes that do turn up on this market fairly often. However, dealers can't predict what their stocks will be, and that's why we can't give you a full break-down of what's available; the only way is to go to (or telephone) a dealer for up-to-date information.

The Gould Advance OS1000B is a conventional 'scope with fixed features; the other second hand 'scopes are all modular, ie you can buy different Y and, in the case of the Solartron and Telequipment, different X modules, so the actual specs you get depend on what modules the 'scope you buy has. And a word of warning: we'd like beginners to beware the Tektronix, as you need at least a pilot's licence to fly that thing (go and look at one and you'll see what we mean).

The Trio CS-1559A (left) and the CS-1662A (right): spot the difference.

Similar Models

(all prices ex VAT)

Crotech 3033 (287) rechargeable battery-powered version of the 3030, but without component tester
Crotech 3035 (174) similar to 3030, but with lower bandwidth (10 MHz), larger screen (130 mm) and calibrator output
Crotech 3034 (370) similar spec to 3131, but rechargeable battery powered and smaller screen (95 mm)
Farnell DT12-55 (235) as DTC12, but without component tester, sum and difference Y modes, and a slightly lower accuracy (5% on Y deflection)
Farnell DT12-14J (255) as DTC12 but without component tester
Hitachi V302F (350) similar to V152F, but with 30 MHz bandwidth and signal delay line
Hitachi V202F (220) as V203F but without delay sweep facility
Leader LBO-510B (164) vertical amplifier has same specs as LBO-310; rest as LBO-512 (tube not identical but similar)
Leader LBO-513A (263) single trace version of LBO-512
Safgan DT-410 (164), **Safgan DT-415** (172) 10 MHz and 15 MHz versions of the DT-420
Scopex 14D10V (260) similar to 14D15, but lower bandwidth (10 MHz), 2 mV/div max. sensitivity, TV delay system (see text) and no Z modulation
Scopex SG315 (270) as 14D15, but with integral function generator
Trio 1303G (161) as 1303D but with 1.8-54 MHz two-tone generator
Trio CS1559 (235) single trace version of the CS1562A

Addresses

Crotech Instruments Ltd, 5 Nimrod Way, Elgar Road, Reading, Berkshire RG2 0EB
Farnell Instruments Ltd, Sandbeck Way, Wetherby, West Yorkshire LS22 4DH
Gould Instruments Ltd, Roebuck Road, Hainault, Essex IG6 3EU
Hameg Oscilloscopes Ltd, 74-78 Collingdon Street, Luton, Bedfordshire LU11 1RX
Hitachi: Reltech Instruments, Coach Mews, St Ives, Huntingdon, Cambridgeshire
Kikusui: Martin Associates (see secondhand 'scopes)
Leader: Thandar (see below)
Philips Instrument Dept, Pye Unicam Ltd, York Street, Cambridge CB1 2PX
Safgan Electronics Ltd, Omega Road, Woking, Surrey GU21 2PX
Scopex Instruments Ltd, Pixmore House, Pixmore Avenue, Letchworth, Herts SG6 1HZ
Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambridgeshire PE17 4HJ
Trio: House of Instruments Ltd, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE

Suppliers of secondhand oscilloscopes

Carston Electronics Ltd, Shirley House, 27 Camden Road, London NW1 9NR (Tel 01-267 5311)
Martin Associates, Parthia, Beckhampton, Nr Marlborough, Wiltshire SN8 1JQ (Tel 06723-219)
P F Ralfe (Electronics), 10 Chapel Street, London NW1 (Tel 01-723 8753)
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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
SIN	MCH	NEXT	WAIT	COLOUR	MEM
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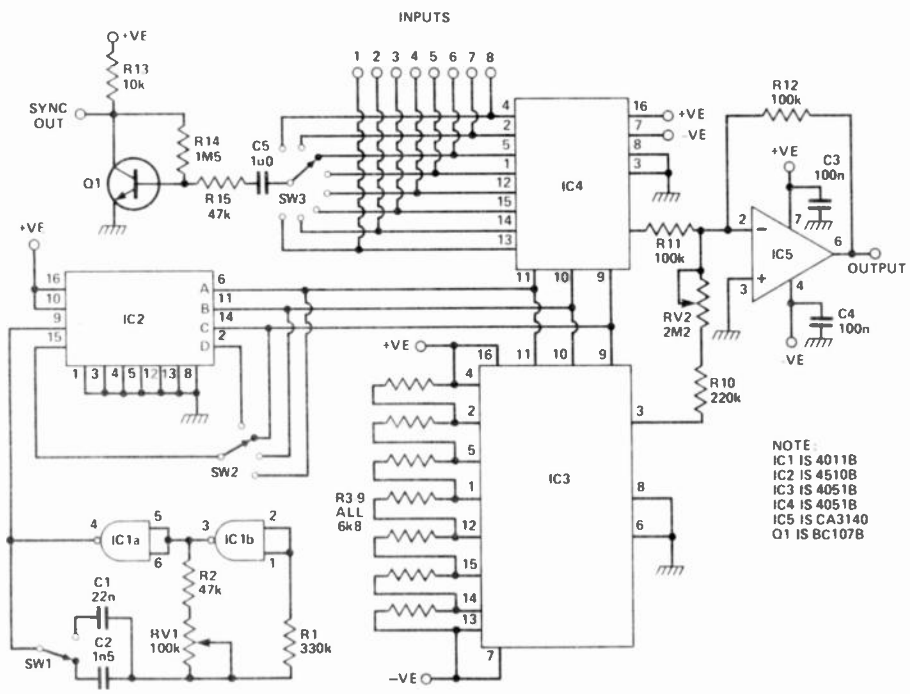
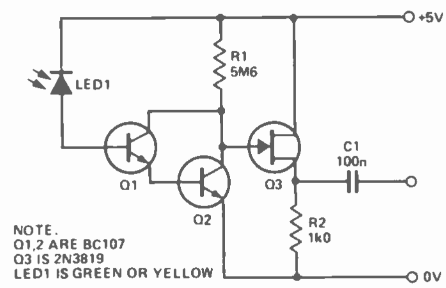


Cheap Photodiodes

Donald Hopkins, Tarves

This circuit was evolved using an LED in place of a photodiode. Diode D1 can be any run-of-the-mill green or yellow LED. Red LEDs do not work, presumably because of their spectral response.

When the light source to D1 is interrupted, its reverse leakage current decreases sufficiently to cause the Darlington pair Q1, Q2 to switch off. This in turn causes the FET to conduct giving a pulse at the output.



Eight Traces On A Single Trace Scope

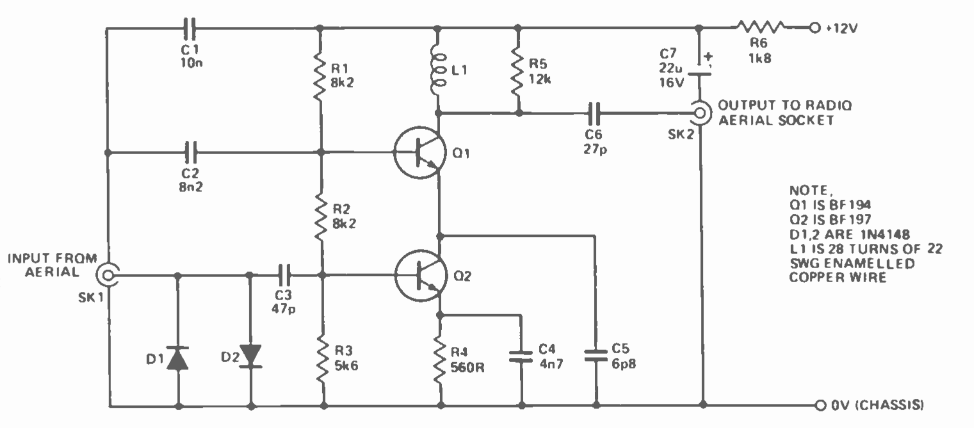
Tore Solheim, Norway

This simple and inexpensive circuit can display up to eight traces on a single beam oscilloscope. Even though the capacity of such a simple circuit is limited, it will be fine as part of a home workshop. The frequency response is DC to 100 kHz with the circuit shown, and the scope sensitivity should be 0V5 per division, preferably DC-coupled.

IC1 is the clock oscillator: SW1 selects chopped or alternate mode. RV1 allows the frequency to be adjusted over the range 10-30 kHz or 200-700 Hz depending on the setting of SW1. The counter IC2 controls the two analogue multiplexers IC3, 4. One, two, four or eight traces may be selected using SW2, which couples one of the counter outputs back to the reset pin to reset the IC after the desired count length. The analogue inputs of IC3 are connected to a voltage divider, R3-9, and the output is connected, via R10 and RV2, to the negative input of the op-amp, IC5. This allows the offset voltage of the op-amp to be adjusted over a wide range. The trace changes position by changing the offset voltage, which has no effect on the gain of the op-amp. RV2 allows the voltage offset between the upper and lower traces to be adjusted from ±0V3 to ±3 V, ie RV2 is the position control. Separate controls aren't needed here. The eight channel inputs are connected to the analogue inputs of IC4.

The circuitry around Q1 and SW3 is to allow external triggering of the scope. This circuit isn't strictly necessary, but will often give a better display. The whole circuit is designed for a ±6 V power supply, and the inclusion of IC3, 4 means that ±7V5 should never be exceeded.

Why is IC5 wired in the inverting mode, when the non-inverting mode would give better results? The offset adjustment of a non-inverting low-gain amplifier using the method shown here would affect the gain. Also, the inputs should not be left open-circuit as this will cause notches on the traces. The inputs should therefore be connected to an inverting amplifier, preferably with an attenuator due to the low sensitivity.



Adding Preset Channels To A Tuner

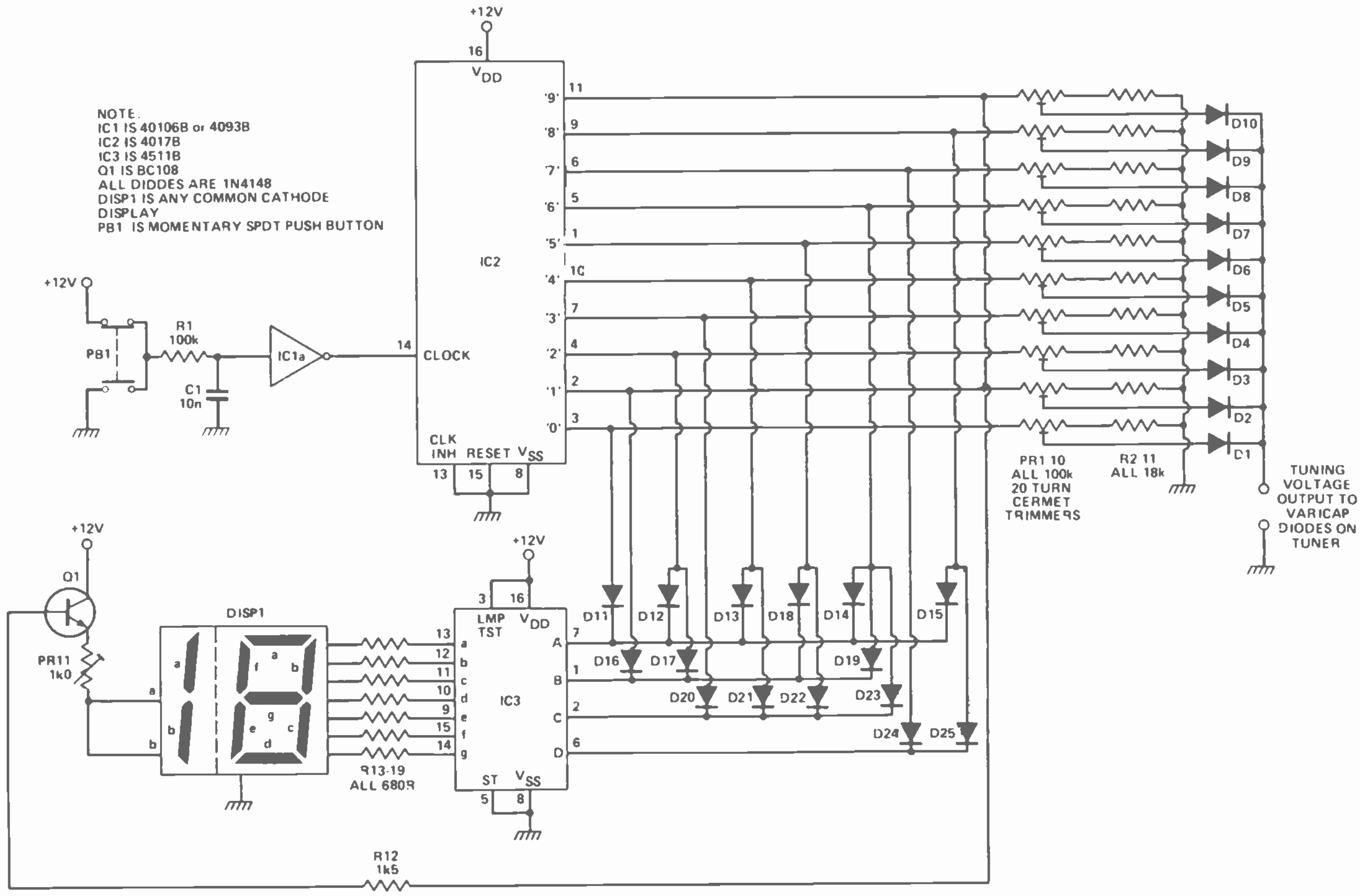
A. Cassarrubios, London

The following circuit is a modification I made to my Audiophile FM Tuner (ETI January 81). My main design concept was to increase the number of preset channels to 10 but not increase the number of push-buttons on the front panel, and if possible reduce the number to one. Some form of indication of which channel is selected must also be provided.

The operation of the circuit is simple to understand and is as follows. IC1 along with R1 and C1 provide switch debouncing to produce clean pulses for IC2's clock input. IC2 is a decade counter with 10 decoded outputs. The outputs from IC2 are taken to PR1-PR10 which along with R2-R11 provide a potential divider from which to tap off the required tuning voltage. The tuning voltage ranges from about 1V5 to about 10 V with the values shown, which is adequate for most tuners. Diodes D1-D10 stop any interaction between channels. The tuning voltage output is taken from the cathode end of these diodes and is fed to the varicaps on the tuner.

Diodes D11-D25 are a decoding matrix for IC3, which is a seven-segment decoder driver. When pin 11 of IC2 is high, there are no logic signals on any of the binary inputs of IC3, so a zero is displayed. The logic signal from pin 11's output drives Q1, which in turn illuminates the figure '1' in the display. PR11 is set so that the intensity of the figure '1' matches that of the seven-segment display.

The circuit is relatively easy to construct and component layout is not critical.



Car Radio Aerial Preamplifier

Neil Dobson, Newcastle-Upon-Tyne

This circuit is a very high gain, high frequency amplifier using two NPN transistors in cascode. The input is taken via SK1 and C3 to the base of Q2. The amplified signal (between 200 kHz and 200 MHz) is passed to the base of Q1, which is connected in the common base mode, giving a very good gain at high frequencies. R1-3 set the bias voltages for the two transistors, while R4 and C4 provide negative feedback and help increase the bandwidth of the stage.

Capacitor C1 and C7, along with R6, are the supply decoupling components and also help to filter out any noise generated by the engine. Note that L1 is a radio frequency choke, which can be made by winding 28 turns of 22 swg copper wire on resistor R5; this will give a lower gain on long and medium wave, but as the desired frequency increases (ie VHF) the reactance of L1 will increase, allowing more of the amplified signal to pass through capacitor C6.

The two diodes connected across the input socket are to protect the transistors against static discharges and overloading. If it is found that the gain is too high, then by changing C4 to, say, 500pF, the gain can be reduced to a lower level.

The amplifier has been in use for over five months now and has proven to be very stable and surprisingly quiet as regards adding any noise to signals in low signal-strength areas — especially on VHF.

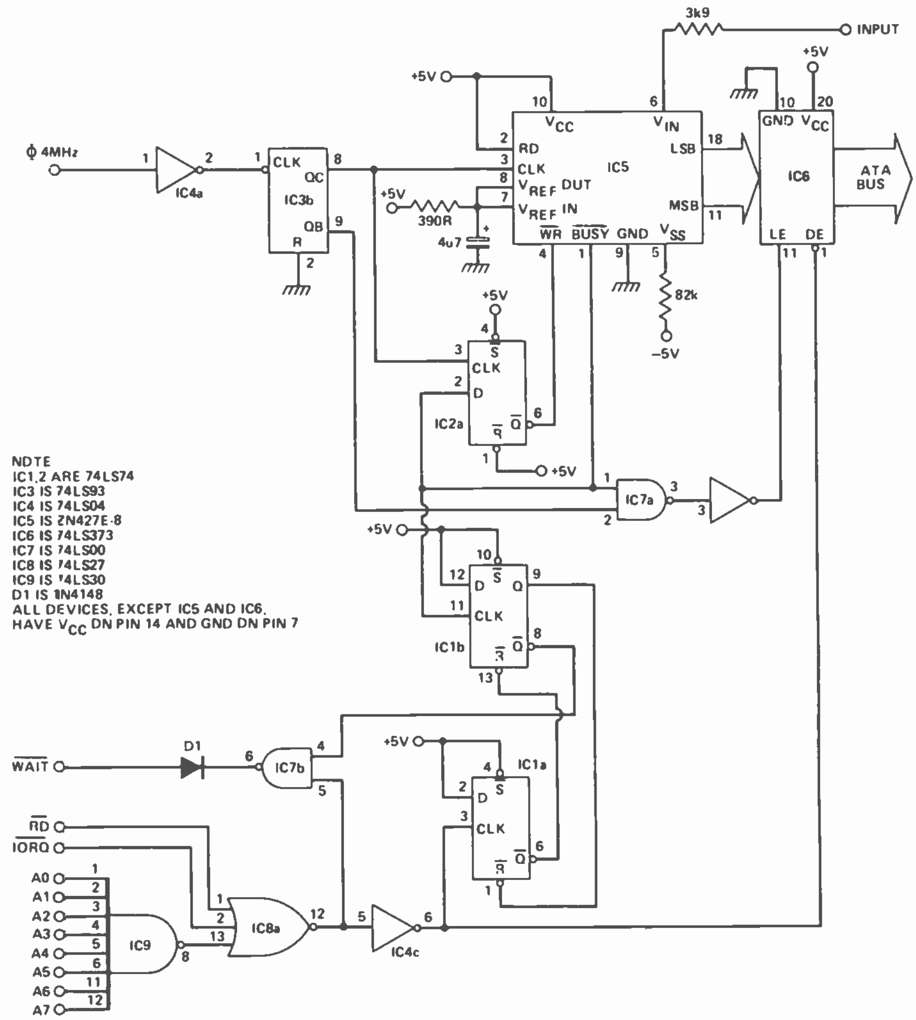
High Speed Eight-Bit A-to-D Converter

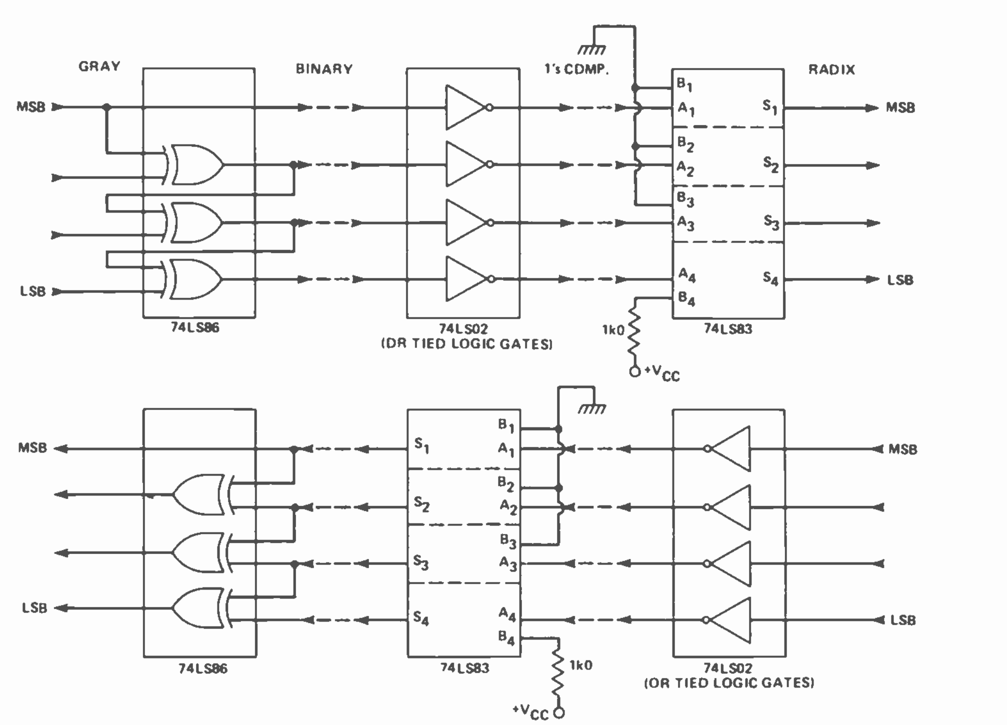
Michael Jones, Dorset

An analogue-to-digital converter is a useful device for any computer system. The circuit shown operates at up to 100,000 conversions per second — making it ideal for use with the full range of audio frequencies. As shown, the circuit has just one channel; more may be added by using more converter ICs (for maximum speed) or using an analogue multiplexer, such as the CD4051, which has eight channel inputs selectable under software with a three bit output port. If it is to be used at full speed, machine code programming is essential.

The given circuit will work on any Z80A system running at 4 MHZ without automatic I/O cycle wait state insertion. It will work with slower clock frequencies with corresponding increases in conversion time. Decoding occurs on port 0FFH only; this may be changed by placing inverters on the appropriate input to IC9. There is no need for a status port since the circuit is constantly converting and latching the result in IC6. It returns the result of the most recent conversion when read, unless it has already been read, in which case it inserts wait states until the current conversion is complete. In this way continuous reading will guarantee one result per 10 microseconds. It is not possible, because of time constraints, to use polling software. In addition, this arrangement permits a DMA device to carry out the transfer in the background. By adjusting the clock reduction circuit around IC3 it should be possible to cater for frequencies of 2 MHZ or less, but still having 100,000 conversions per second.

Circuit operation is fairly simple. ICs 8 and 9 decode the input port, so enabling the tri-state latch (IC6), the WAIT gate (IC7b) and the wait latch (IC1). The latter ensures that WAIT is only issued when there is no new data. IC2a restarts the conversion as soon as possible after the end of the previous conversion. IC7a and IC4b latch the data into IC6 after it has settled. The actual converter (IC5) accepts an input in the range 0-2V55 in 10 mV steps, continually outputting its best estimate on pins 18 through 11 using successive approximation (binary search). Care should be taken that the input doesn't exceed 3V5 or become negative.



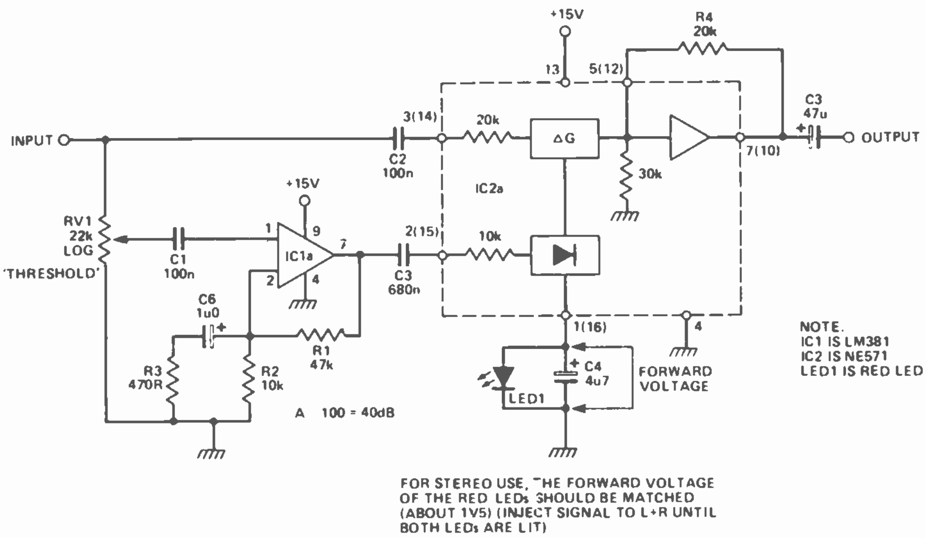


Expander Gate

W. K. Todd, Colchester

This circuit is a simple expander gate and can be used to reduce the surface noise of records and tapes. It is based around an NE571 compander chip, used as an expander below the threshold set by the red LED. The LM381 amplifies the input signal by 40 dB; this is rectified in the 571 by a current mirror circuit and is smoothed by C4. When the voltage reaches the forward voltage of LED1 it draws current and hence limits the current to the gain cell. This causes linear operation above the threshold.

For stereo operation the LEDs should be matched for forward voltage. The circuit as shown is designed for 15 V; if other supplies are to be used R2 will have to be changed. Better DC biasing around the op-amp in the 571 will improve the DC offset.

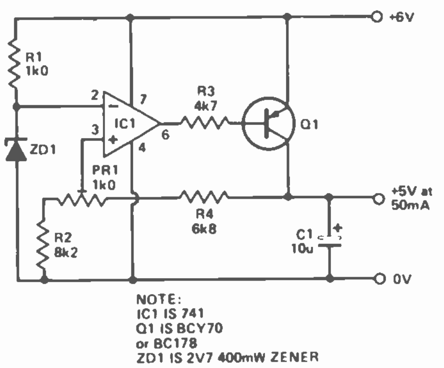


Battery Back-up Supply For RAM

R. Metcalf, Sheffield

Using a rechargeable 6 V lead acid battery and the voltage control circuit shown here, data can be held in a memory for a considerable length of time (governed only by the storage capacity of the battery). Nicads have a comparatively small Amp-hour rating for their package size and recharge rate.

An IC regulator would find the 1 V voltage margin between input and output too small for reliable operation. In this circuit the 741 op-amp sees a fixed 2V7 on its inverting input and subtracts the difference between this and the non-inverting input from its output. The ratio, once set by the preset, remains constant.



Gray, Binary And Radix Code Manipulation

L. N. Owen B.Sc, Beaulieu

When working with encoders it is desirable to use a coding system which changes only one bit at a time — Gray code is designed for this purpose. However, for manipulation Gray code is not very convenient and has to be converted to another form; this usually being binary, one's complement or radix. The modules shown provide simple means of converting from one code to another by using standard TTL hardware. Using these circuits, code manipulation to and from any of the above conventions is possible. In many cases the speed of operation has considerable advantages over that of microprocessor software-based code conversions.

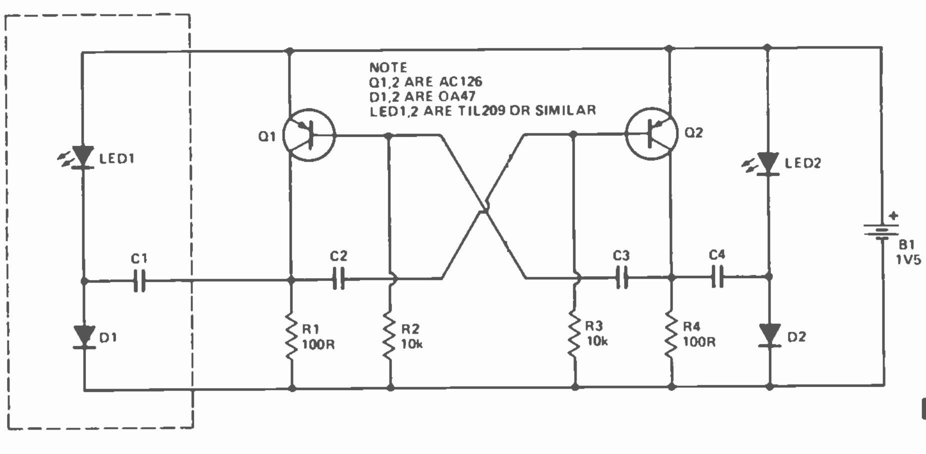
Running LEDs From A 1V5 Battery

Andrew Marshall, Nottingham

Most LEDs require operating potentials of between 1V6 and 2 V, but the circuit shown here enables light emitting diodes to operate from a 1V5 battery. The circuit uses a 'voltage doubler' and an astable multivibrator. Germanium transistors and diodes are used, as these have a smaller forward voltage drop across p-n junctions than comparable silicon devices. (This is to increase the output voltage and enable the circuit to operate at lower input voltages.)

To operate the circuit to make the LEDs appear on continuously C1 and C2 should be chosen to be 47nF, and C3 and C4 to be 10uF. To make the LEDs flash alternately, C1 and C2 should be around 100uF and C3 and C4 should be about 1000uF. To operate only one LED omit the circuitry within the dotted box.

Although TIL 209s are indicated in the circuit diagram, other LEDs may be used.



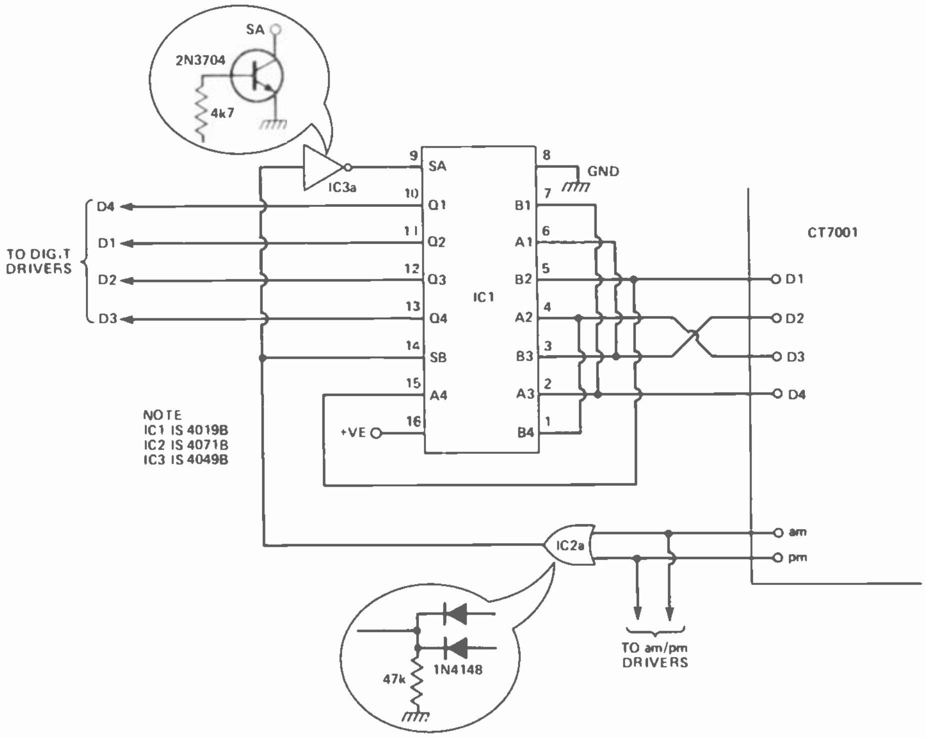
Date Display In European Format Using American Digital Clock Chips

R.C. Callister, Cambridge

Many hobbyists will have built digital clock/calendars based on American LSI circuits. These invariably display the date in American format (month-day) rather than the day-month preferred in European countries. The following simple circuit allows inversion of the month and day displays on a typical chip (the CT7001) without affecting the time display, even though the latter is multiplexed on the same digit lines.

The trick is to use the am/pm indicator output signals to tell whether the time or date is currently being displayed. When the time is being output either the am or pm signal is active (high); when the date is output both are inactive (low). Thus the am/pm outputs may be ORed together and used to switch a four pole data selector. A single CMOS 4019B chip provides all the required logic except for the OR gate and one inverter. If spare inverter and OR gates are not available on the clock board, they may be replaced by a transistor and diodes as indicated.

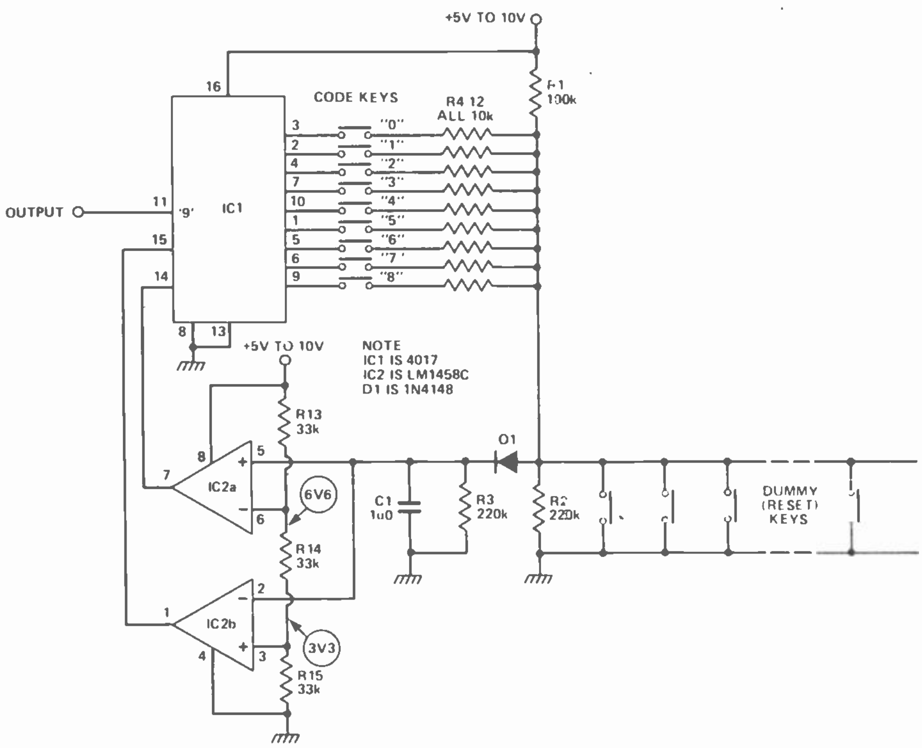
When the output of the OR gate is high (time displayed) the data selector outputs follow the A inputs; when the OR gate output is low they follow the B inputs. The A and B inputs are interconnected so that the digit pairs D1/2 and D3/4 are interchanged when the data selector switches.



ZX Graphics Board Modification No. 1

Simon Gamble, Coventry

This is a modified circuit diagram for the ETI ZX Graphics Board. With the



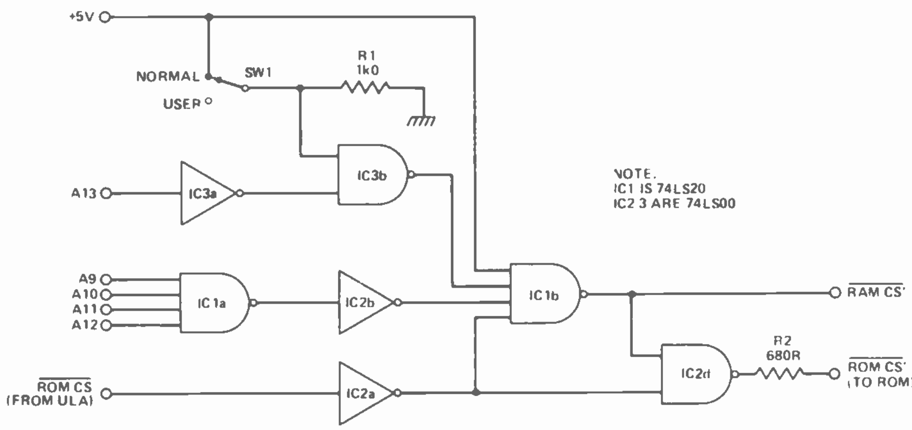
Foolproof Combination Lock

Ben S. Meyer, South Africa

This lock really is foolproof, as all the keys except the correct one will cause a reset. The problem with other types of lock is that only the dummy keys will cause a reset. All voltages given are for a 10 V supply.

A power-on reset is provided by C1. When reset, pin 3 of IC1 is at 10 V. When code key '0' is pressed, the voltage across C1 rises to above 8 V. This triggers IC2a whose output clocks IC1. This causes pin 3 to return to 0 V, and pin 2 goes high. Pressing the other keys repeats this action until pin 11 goes high.

Pressing a dummy key will cause the voltage across R2 to fall to zero, while pressing a code key out of order will cause a drop to 1 V. C1



MINIMUM PAYMENT £20

addition of the two NAND gates as shown, the character RAM appears in the memory map at both 7680-8191 and 15872-16383. However, when the switch is set to 'normal', the RAM only appears at 15872-16383. This means that the graphics set can be PEEKed from ROM and POKEd straight into the character RAM without having to be loaded into the user RAM first and does not require switching midway through the setting up program.

If R1 is removed from the ETI board and placed together with IC3 on a separate piece of Veroboard, then connect the output of IC3b to the connection originally used by the switch on the ETI board. No further changes need to be made to this PCB and it can then be sold at a later date in pristine condition! Note that the switch functions are now reversed.

Incidentally, when PEEKing from the ROM, if the value PEEKed is subtracted from 255 and the remainder is POKEd to the character RAM, then on switching to 'user' the whole screen will be inverted except for the border.

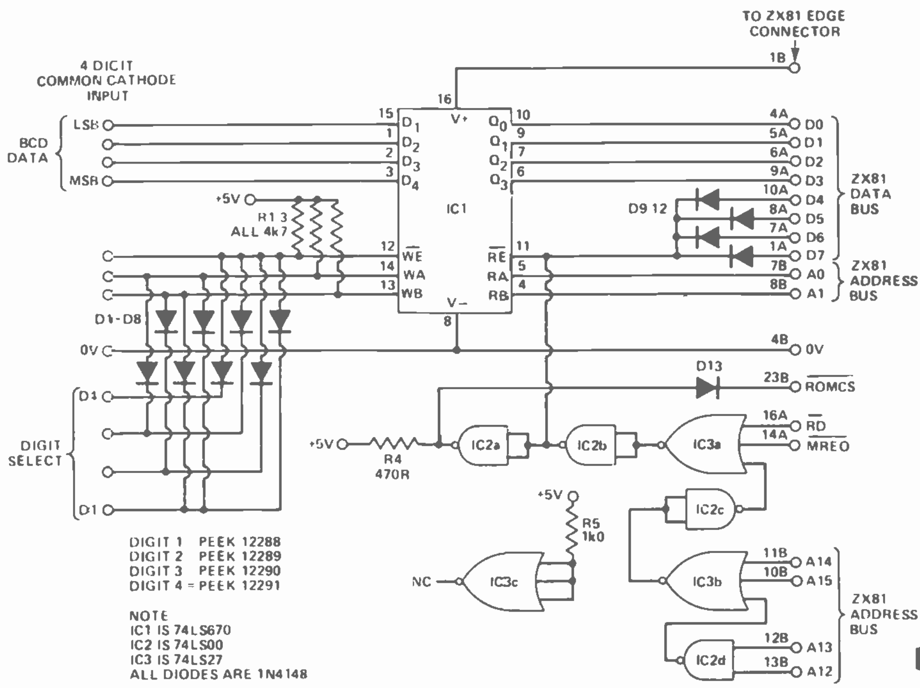
Four-digit Multiplexed BCD to ZX81 Adaptor

W.K. Todd, Colchester

This device interfaces a four-digit common-cathode multiplexed BCD output device, such as the 7217 counter IC, with a ZX81. The circuit is based around IC1, a 74LS670 4 × 4 register file. The digit select inputs address the Write Address pins, WA and WB, via diodes D1-4. The Write Enable pin, $\overline{WE}$, is pulled low by diodes P5-8 when any digit is selected.

The ZX81 address decoding is performed by IC3a, b and IC2d in the same manner as the A-to-D interface in ETI, January '83. When an address between 12288 and 16383 is PEEKed, the output of IC2b goes low and enables the outputs of IC1 via the $\overline{RE}$ pin: the data is output onto the data bus on lines D0-3. Data lines D4-7 are pulled low via the diodes D9-12, allowing the computer to read the data bus directly. The Read Address of the register file is driven directly by the address lines A0 and A1. IC2a disables the internal ROM via D13 when the device is being PEEKed.

Common anode devices could be used with this circuit if the digit select lines were driven by transistor inverters.



discharges via R3 and as soon as the voltage at pin 2 falls below the 3V3 reference, IC1 is reset by a high at pin 15.

All the output pins except the one currently switched high by the count are held at ground by IC1. This causes a problem, as it would be impossible to advance the counter since the respective switch would be grounded before it could be released and so reset the count to zero. C1 holds the charge on it during clocking, long enough for the key to be released. The diode prevents any discharge through R2. R3 discharges C1 and provides a bias path for the diode. The value of the capacitor can be altered to suit your needs, but R3 is a part of the voltage divider R1, 2, 3 and its value cannot be changed.

R4-12 are current limiters which prevent damage to IC1 if more than one key is pressed. To reset the system after the output has been enabled, just press any key.

Digital Audio Switch

J. W. Harris, Macclesfield

The circuit uses a CMOS 555 which oscillates at a frequency determined by the equation:

$$F = \frac{1.46}{C1(R1 + R2)}$$

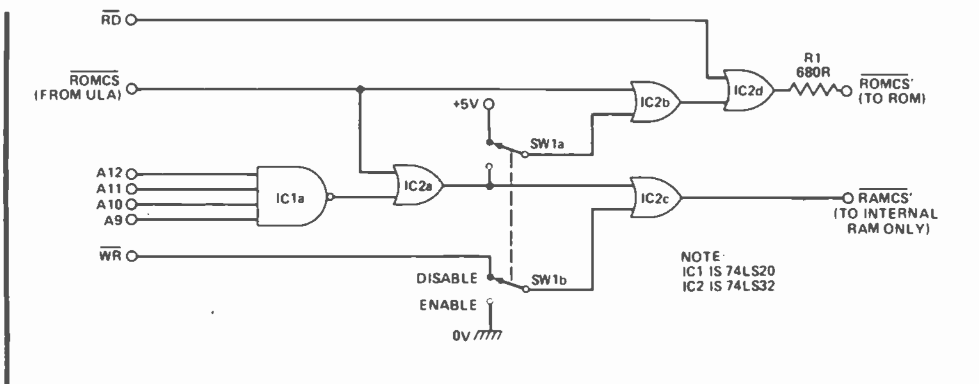
The output from IC1 is decoded by IC2, a decade counter divider, which is activated by PB1. When PB1 is pressed, IC2 produces a positive voltage at one of its four outputs, each of which controls two of the eight switches in ICs 3 and 4, and an LED circuit.

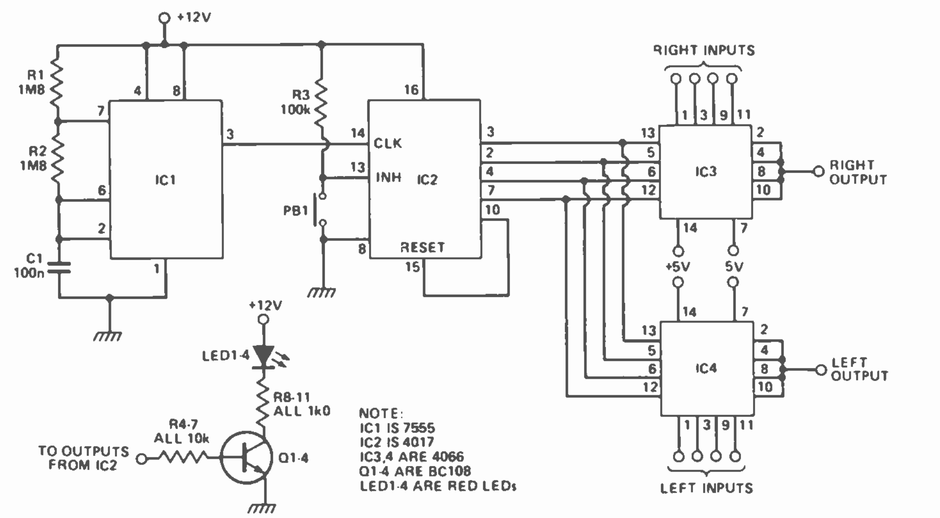
When a switch control goes high, the corresponding audio input is selected, and an LED lights to indicate which input has been selected.

Output 5 on IC2 is connected to RESET, so when pin 10 of IC2 goes high the decoder resets and the next pulse from IC1 selects input A.

The chosen values for R1, R2, and C1 produce a frequency of 4 Hz, so IC2 selects each audio input and then resets in 1 second. If PB1 is kept pressed, the input will change every quarter of a second.

ICs 1 and 2 are powered from +12 V, and ICs 3 and 4 are powered from +5 V and −5 V.





Logic State Analyser

L. V. Barker, Swansea

When testing a logic circuit, it is sometimes necessary to know the simultaneous state of several nodes. A logic probe or oscilloscope will not easily tell this and the best solution is usually a logic analyser. These are, unfortunately, rather expensive; a solution presented here is a logic state analyser. This is an eight bit latch controlled by an input from the circuit under test and easily expandable to more input lines.

The heart of the circuit is the 74LS373, IC3: an eight bit latch. It is controlled by pin 11; when this pin is high (logic 1) the output data is equal to the input data, but when it is taken low, the device latches the data then on the input pins, thereby remembering it. In this application the input pins are connected to the circuit under test and the outputs drive light emitting diodes LED3-10.

IC1 is a D-type flip flop used to control IC3. In its reset state, achieved by pressing PB1, $\overline{Q1}$ is at logic 1 as is IC3 pin 11. The LEDs now follow the input data. When a rising edge appears on IC1 pin 3, $\overline{Q1}$ goes to logic 0 causing the data on the input pins to be latched. It stays in this condition until PB1 is pressed. LED1 and LED2 give readouts on the state of IC1.

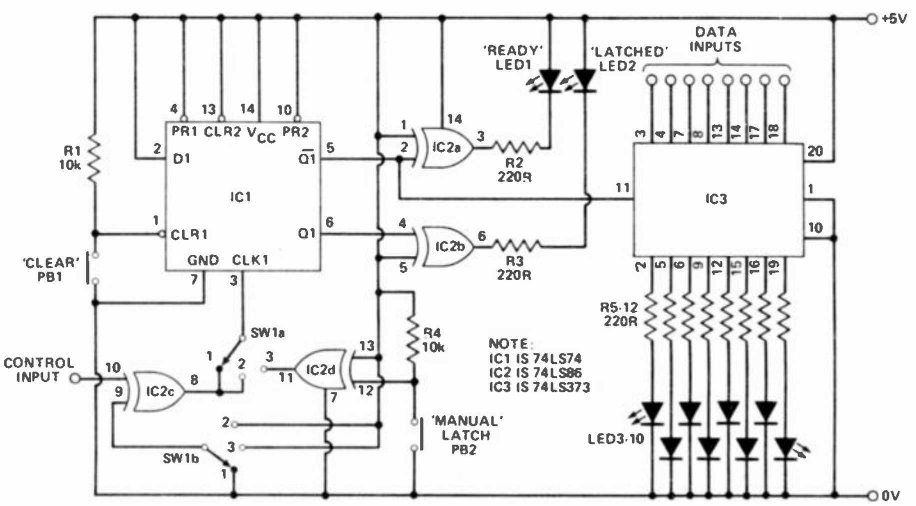
IC2 is a quad exclusive-OR gate; IC2c is used as either a buffer or as an inverter depending on the position of SW1. Three triggering modes exist; these are:

1) SW1 in position 1: latch on rising edge on control input

2) SW1 in position 2: latch on falling edge on control input

3) SW1 in position 3: latch when PB2 is pressed

To increase the number of channels, more 74LS373 devices can be connected, with the pin 11 of each connected to pin 6 of IC1. The prototype used five devices giving 40 channels of input.



ZX Graphics Board Modification No. 2

M. Austen B.Sc, Hatfield

I must congratulate G.N. Hill on an extremely simple and clever circuit for obtaining user-defined graphics from a ZX81. However, I was a little disappointed that the idea had not been thought out a little more carefully to provide an improved circuit. The problem with the published circuit is that of having to first read the character data from the ROM and store it in memory, and then enable the character RAM before writing the stored character data into this RAM. A slightly different circuit will allow data to be written to the RAM without it being 'selected', and without causing a bus contention with the ROM. The revised circuit has a lower component count (by one), but does require two further connections to the ZX81 circuit board.

When the address lines A9, A10, A11 and A12 all go high, the output of IC1a will go low. If ROMCS from the ULA is low also, the output of IC2a will be low too. With the switch in the position shown, the output of IC2c (and hence RAMCS') will go low only if a write operation is being performed by the CPU. The output of IC2d, and hence ROMCS', will only go low if a read operation is being carried out. With the switch in the alternative position, RAMCS' will go low whenever the output of IC2a goes low, and ROMCS' will not go low when IC2a goes low.

This means that when the switch is in the disable position as shown, the character ROM can only be read from, and the character RAM can only be written to. With the switch in the enable position, the character ROM is effectively disabled and the character RAM can be read from and written to.

Therefore, to transfer the character data from ROM to RAM, simply read from the appropriate location and then write the data to the same location. When the RAM is then enabled, it will contain the required character data. The BASIC program given will illustrate this.

```
10 FOR I = 7680 TO 8191
20 POKE I, (PEEK (I))
30 NEXT I
```

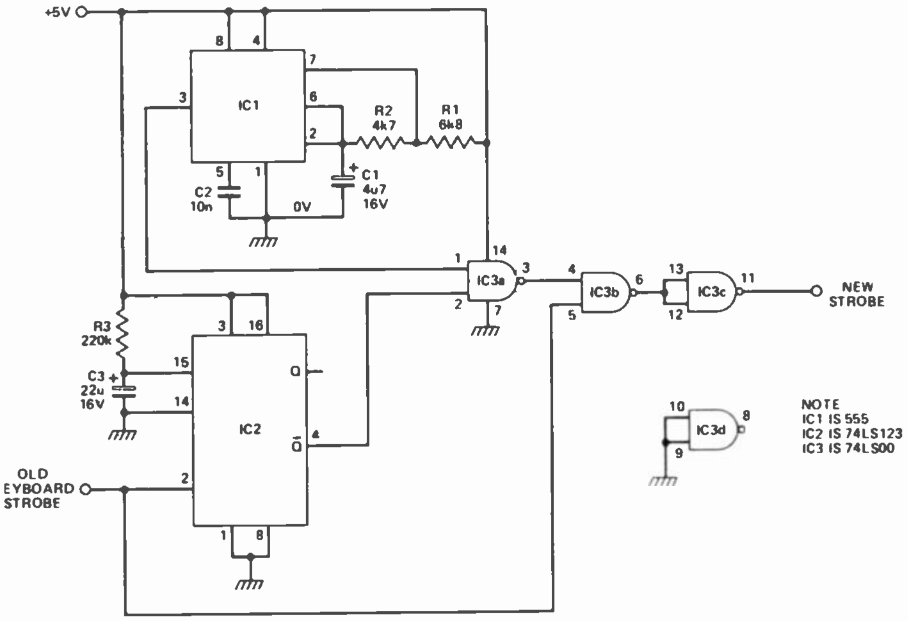
Keyboard Auto-Repeat Circuit

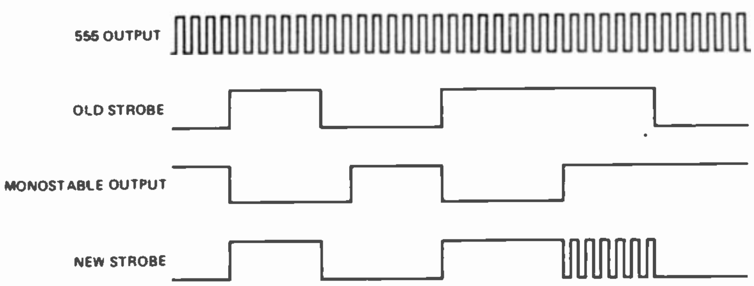
G Franklin, Mid-Glamorgan

This circuit is intended for use with keyboards that do not have a 'repeat' facility. It is not only simple to install, but gives the user the repeat facility on every key on the keyboard.

Basically, the strobe line from the keyboard activates the monostable (IC2); this disables the output of the 555 and prevents its pulses reading the new strobe line. After approximately 3 seconds, the output of IC2 changes state and the signal from the 555 is passed on to the new strobe line. If the key is released before the monostable finishes its timing period, only one character will be sent. For a key press of longer than 3 seconds, approximately 10 characters per second will be entered (the frequency being set by the 555, used in its astable mode). The circuit is shown for use with a positive-going strobe signal: for a negative strobe, simply move the last NAND gate (used as an inverter) to the input strobe line.

Connecting the circuit into your computer requires the removal of the current strobe line from your keyboard and re-routing it through the circuit.

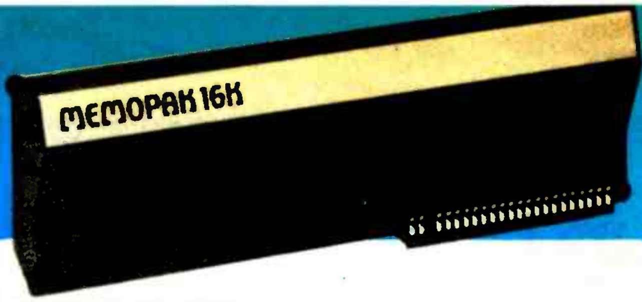




Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ITI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for at a competitive rate.

Drawings should be as clear as possible and the text should be typed. Text and drawings must be on separate sheets. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

ETI



MEMOPAK 16K For those just setting out on the road to real computing, this pack transforms the ZX81 from a toy to a powerful computer. Data storage, extended programming and complex displays become feasible.
For even greater capacity, memory packs can be added together (16 + 16 + 16K or 16 + 32K). The MEMOPAK 32K and the MEMOPAK 64K offer large memories at economical prices.

MEMOTECH

The Memotech approach to microcomputing is to take the well-proven and popular ZX81 as the heart of a modular system. This small computer houses the powerful Z80A processing unit and acts as the central processor module through which the MEMOPAKS operate.

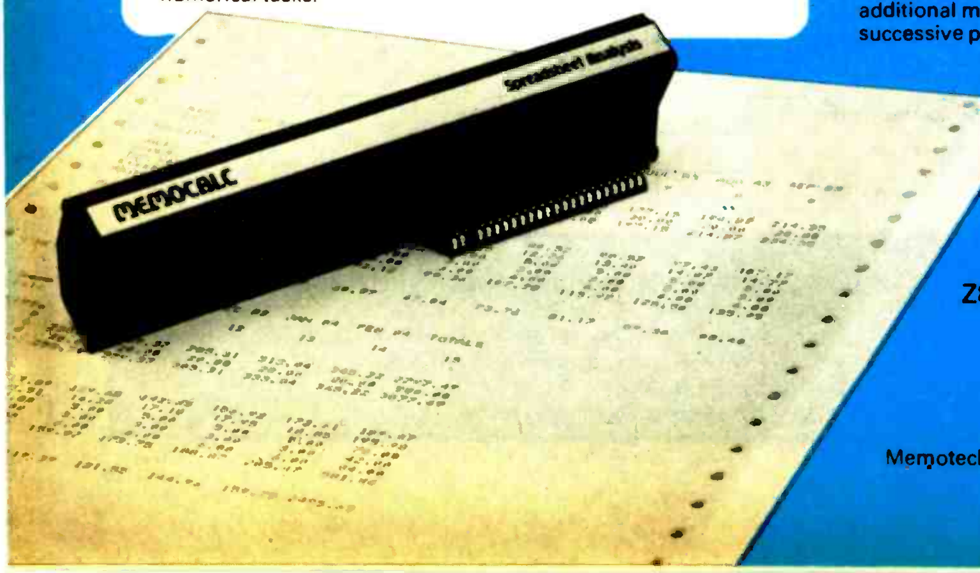
Memotech has a reputation for professional quality, producing units which are designed to fit perfectly, to look well-balanced, and to work efficiently and reliably.

The modular approach gives ZX81 owners the freedom to design the system they really need. Furthermore, the intercompatibility of the modules ensures that later additions will click straight in, to give you a system that grows with your ambitions and abilities.

As one example, a system with 16K of memory and MEMOCALC is all that is required to perform sophisticated numerical calculations giving the same results as a computer at 10 times the price. The problem may be as complicated as a cash flow or production schedule, or as simple as household accounts or pocket money budgeting. If the bank manager wants to see the cash flow, then a single print instruction to the Centronics I/F will give a printout which is more than acceptable to any bank.

The example system which is shown, on the other hand, would satisfy the needs of someone who wanted to enter data via a light-touch keyboard, construct and label graphs, and then copy the screen to an 80-column printer. Only 16K of memory is used here but with additional memory, more than one video page can be stored. Up to 7 successive pages can be displayed cyclicly to give animated displays.

MEMOCALC The screen display behaves as a 'window' on a large sheet of paper on which a table of numbers is laid out. The maximum size of the table is determined by the memory capacity, and with a MEMOPAK 64K a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Each location in the table can be either a number which is keyed in or a formula which generates a number. Every time the command to 'calculate' is given, all the formulae in the table are re-evaluated. Spreadsheet analysis started as an aid to cash-flow analysis, but this powerful tool has now been generalised and MEMOCALC with its special ability to perform iterative calculations is invaluable in the performance of numerical tasks.



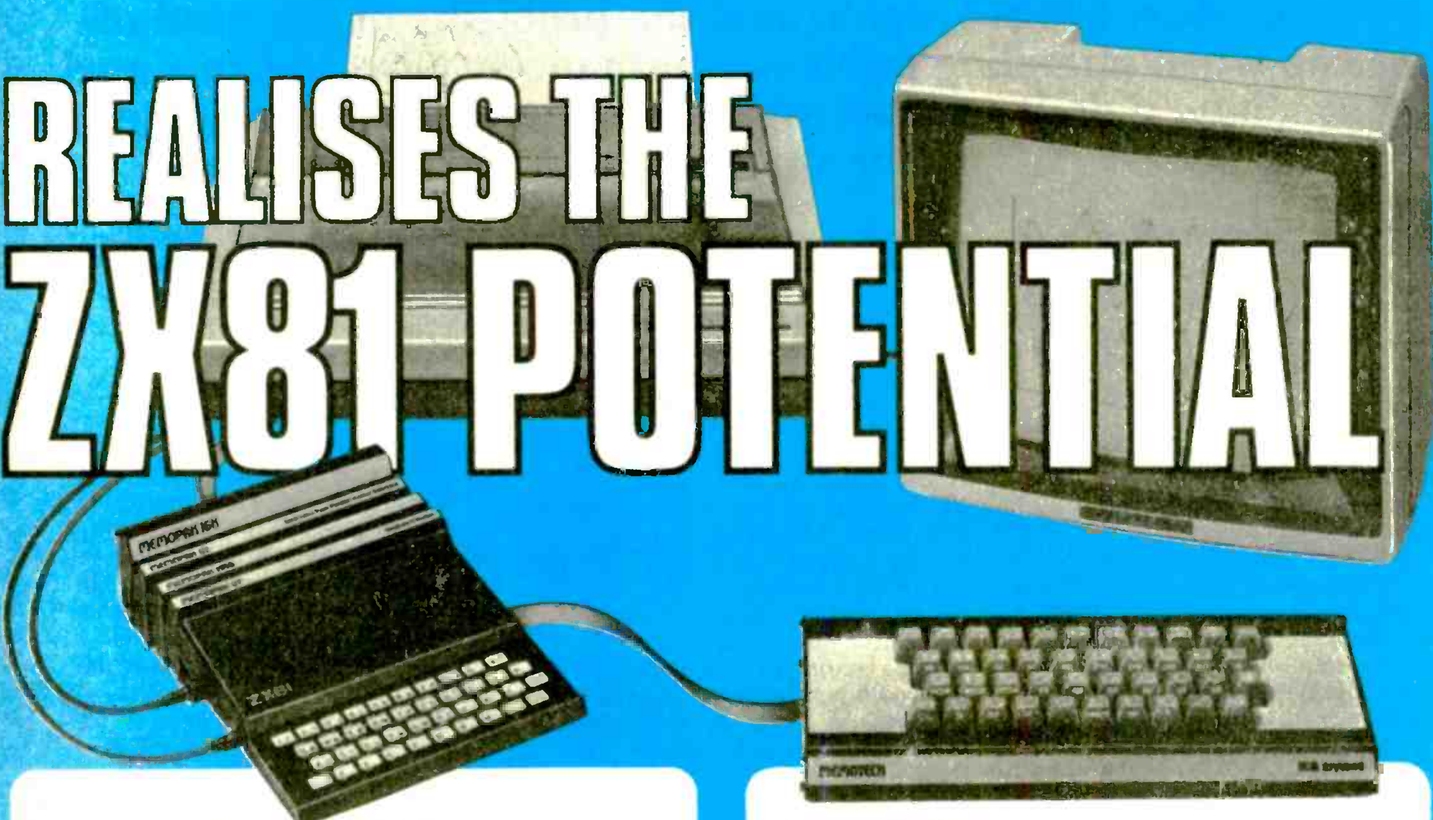
16K	£26.00	+	£3.90	VAT	£29.90
32K	£43.43	+	£6.52	VAT	£49.95
64K	£68.70	+	£10.30	VAT	£79.00
HRG	£34.70	+	£5.20	VAT	£39.90
CI/F	£34.70	+	£5.20	VAT	£39.90
MEMOCALC	£26.00	+	£3.90	VAT	£29.90
Z80 ASSEMBLER	£26.00	+	£3.90	VAT	£29.90
KEYBOARD WITH BUFFER	£43.43	+	£6.52	VAT	£49.95

Memotech products are available at larger branches of WHSMITH

MEMOPAK HRG This pack breaks down the constraints imposed by operating at the ZX81 character level and allows high definition displays to be generated. All 248 × 192 individual pixels can be controlled using simple commands, and the built in software enables the user to work interactively at the dot, line, character, block and page levels. Scrolling, flashing and animation are all here.

MEMOPAK Centronics I/F The BASIC commands LPRINT, LLIST and COPY are used to print on any CENTRONICS type printer. All ASCII characters are generated and translation takes place automatically within the pack. Reverse capitals give lower case. Additional facilities allow high resolution printing. The full capabilities of your printer are now under the control of the ZX81.

REALISES THE ZX81 POTENTIAL



MEMOPAK Z80 Assembler This click-in EPROM based pack accepts standard Z80 assembly language mnemonics to allow you to write faster and more compact programs. It has its own ADD, EDIT, LIST, ASSM and QUIT functions, the editor allowing insertion, deletion, automatic line renumbering and error checking. Source code and object code listings can be displayed and printed in decimal or hex format.

MEMOTECH Keyboard The light-touch positive stop keys of this elegant typewriter-pitch keyboard allow you to work faster, more accurately and more confidently. To speed you along we have added an extra SHIFT key to the array at top right. The keyboard is attached by a cable to the Keyboard Buffer which fits in amongst your other Memopaks or straight onto the back of your ZX81.

To ensure that your expectations are realised, care is taken at every stage to design features into the system to anticipate your frustrations and to forestall them. For example:

A) Memories are cumulative e.g. 16K and 32K can be added to the MEMOPAK 16K or even to the Sinclair 16K RAM pack.

B) The HRG firmware allows commonly used constructions (such as scrolling, shading and labelling graphs), which might otherwise be beyond the user's programming capabilities, to be evoked by a few simple commands.

C) The Centronics I/F converts ZX81 character codes into ASCII and extends the print line to the width of the printer, still using the LLIST, LPRINT and COPY commands.

Looking forward, Memotech will continue to back the ZX81 through 1983 with fast storage devices, pressure sensitive electronic drawing boards and more software packs including a wordprocessor and an RS232 interface.

MEMOPAKS may be ordered by post (cheque, Access/Barclaycard quoting number) or by telephone. Please make cheques payable to Memotech Ltd. and please include £2.00 per unit for packaging and postage inland (overseas £3.00).

Memotech products are available from major branches at W.H. Smith and John Menzies.

We want to be sure you are satisfied with your Memopak – so we offer a 14-day money back guarantee on all our products.

MEMOTECH

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PORTABLE INDUCTION LOOP

A few months ago we highlighted the problems of the hard-of-hearing when attending public performances. Now Vivian Capel shows how a do-it-yourself system can be easily implemented for small halls.

The problems of the hard-of-hearing when trying to listen to a public address system in hall, and how these can be eliminated by the installation of an induction loop was fully covered in the article contained in the February 83 issue of ETI. For the benefit of readers who might have missed it we will give a brief recap.

When listening through a hearing-aid hall acoustics are emphasised, as also are nearby audience sounds. This makes the PA sound almost unintelligible. For the past few years, most NHS hearing-aids have an internal induction coil which can be switched in in place of the microphone: this enables the user to pick up electromagnetic fields directly from some telephones and so avoid the distortion of double conversion from electrical signal to sound and from sound back to electrical signal. The switch on the hearing-aid is labelled T (telephone) and M (microphone).

If an induction loop is wired around the hall and fed from the PA system, any such hearing aids switched to T will pick up the programme free from acoustics and all extraneous noises. The design of a loop depends on the area to be enclosed, total length of loop wire, resistance of suitable cable, number of turns in the loop, available output impedance of amplifier and output power available. Optimum vertical displacement from the hearing aid is 3-4 feet, which for a seated audience puts it at skirting board or floor level. This gives a fairly even field intensity over the whole loop area. Wiring over obstructions such as doorways has little effect, nor do intervening objects such as chairs, even if these are metal framed.

In short, the induction loop is an ideal method of enabling the hard-of-hearing to hear perfectly via their own hearing-aids and with few problems in design or installation.

Having enjoyed the facility in halls where loops are installed, disappointment has been expressed by some hearing aid users when attending meetings or functions in premises not so equipped. Where the halls are hired for one-off occasions, installing a loop is hardly practical, especially in a large auditorium unless of course it was to remain permanently thereafter. Even then, the installation would take time, and the design some advance measurement and calculations.

Loop the Loop

A solution which has been devised and proved highly successful is that of a portable loop of fixed length, which is run to enclose a selected block of seating. Although the whole hall is not covered, the block is large enough to be more than adequate to serve those needing it along with their friends and families, thus avoiding segregation.

The loop is housed in a Portabloc cable drum (or similar) and consists of 30 yards of three-core 16/0.2 mains cable. One end is connected to a socket on the side of the drum, while the free end is terminated in a matching plug. When the plug is inserted in the socket, the three cores are connected in series to form a three-turn loop.

PARTS LIST

One Portabloc empty cable drum (see Buylines).
One MT 10 10 watt 100 V line transformer, Eagle or similar (see Buylines).
One pair of three (or more) contact plug and socket (socket to be chassis-mounting).
One red LED with mounting clip.
One silicon diode (any type).
One 68R ¼W resistor.
One pair of screwed terminal blocks.
30 yards of three-core 16/02 mains cable (see Buylines).

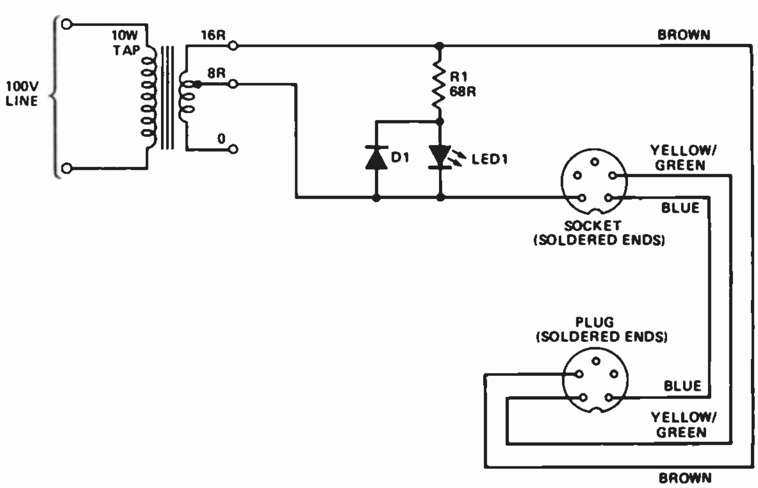

Fig. 1 Circuit diagram for the portable induction loop.

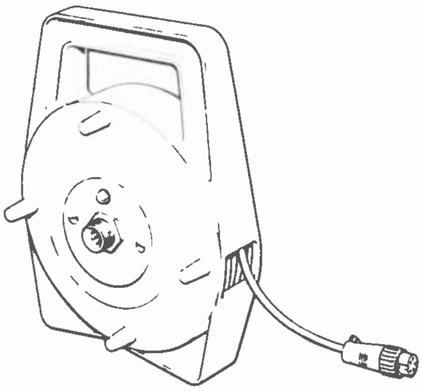

Fig. 2 Assembling the self-contained loop. The socket and the LED are mounted on the central plate on this side, the terminal block for the 100 V line connection on the other.

BUYLINES

There are some specialist items in this project, but nothing that could cause great difficulties. The cable drum is supplied by RS Components, order code 488-668, but as RS do not supply to the public you will have to buy this through a local component supplier or radio shop. Eagle, too, will not supply small orders direct to the public, but if you ring them at 01-902 8832 they will give you the address of your nearest local distributor. The mains cable can be expensive if bought by the yard at a local shop; in addition to the profit there is also a mark-up for the cutting wastage. It will be cheaper to buy a 50 metre drum and keep the extra for something else.

The 30 yards of cable is about the maximum that the drum will hold, and when paid out will give a loop of some 28 yards circumference. A couple of yards must be allowed going to and from the drum. The cable is just run around the desired area, laying it on the floor. If required it can be secured to a wooden floor at certain points with masking tape to keep it in place, especially the ends leading to the drum which should be placed at a convenient nearby position. It is not usually necessary to tape it excessively.

A feature of this arrangement is the flexibility of the shape of the area served. On average, seating rows are a yard apart, and along the row there are two seats to the yard. So if the loop is formed into a square with 7-yard sides, it will serve seven rows of 14 seats each, a total of 98 seats. Another configuration could be a 10 x 4 yard rectangle which would enclose four rows of 20 seats. Of course, any combination up to the maximum loop length can be accommodated. There need be little cable left over, as each extra row takes only a further 2 yards approximately, irrespective of its length. So the number of rows can be selected to take almost the full length of cable.

Got A Match?

Loop resistance is 3.2 ohms total. This might appear to present a matching problem for the amplifier: however, there is a simple solution. As the loop will be fed from a PA amplifier, it is assumed that the output will be 100 V line; so the matching is done by a 100 V transformer. The 10 watt MT 10 unit supplied by Eagle will just fit inside the hub of the Portabloc drum. There are two taps on the secondary, 16 ohms and 8 ohms, but it is often overlooked that taking the output from between the 16 and 8 ohm taps does not, as might be expected, result in an impedance of a further 8 ohms but a much lower value.

When the tappings are accurate, the impedance between the 16 and 8 ohm connections is a surprising 1.37 ohms. In practice, the tappings are often higher than the nominal value. With the transformer used for the prototype they measured 8.7 and 22.5 ohms. The formula for calculating intertapping impedance is:

$$Z = (\sqrt{Z_1} - \sqrt{Z_2})^2$$

where Z is the unknown impedance, Z_1 is the impedance of the higher tap and Z_2 the impedance of the lower one.

Remarkably, the value for the transformer used worked out to 3.2 ohms, an exact match for the loop resistance. However, any impedance from this value down to the 1.37 ohms would drive the loop satisfactorily. This method of obtaining low impedance outputs by intertapping connection is a useful one which could be applied for driving other unconventional loads. Using the 4 and 8-ohm taps gives lower impedances still, of the order of 0.68 ohms.

The primary of the transformer is set to the 10 watt tap, and the loop takes 8 watts from the line. With a lower impedance output between the tappings, power consumption would be less. Most PA amplifiers would have enough reserve power to drive this, so it can be connected to any convenient amplifier in the system.

Connections are brought out from the transformer in the drum hub to a terminal block on the outside, this being the opposite side to the socket for the loop itself. The Portabloc drums have aluminium discs on each side which can easily be drilled to take sockets or component mountings.

The final feature is the provision of an LED to indicate that the loop is working. This is connected across the loop via a 68-ohm resistor and with a shunt reverse-connected diode to protect it from inverse voltages. It can be mounted on the aluminium disc bearing the loop socket, and the drum placed when in use so that the LED can easily be seen. It will flicker on and off in sympathy with the sound and so indicate whether power is reaching the loop. If it is brighter than usual, the loop may be open-circuit somewhere.

The plug and socket used was a metal clad five-pin pair obtained quite reasonably from the local electronics emporium. This gives a couple of spare contacts in case of future trouble, but only three contacts are required and any suitable plug combination will serve. Robustness is the main consideration, and some means of securing the plug in the socket by a screwed ring or latch is desirable.

Installation

This is simple and can be done in very little time. First select the area to be served: count the number of seats in the row, subtract from 28, and halve the remainder. The result will be the number of rows that can be covered, unless the seats or rows are wider than normal. Start paying out the cable at the point where the drum will rest, and circumnavigate the block until you return to the stating point. If there is more than a couple of yards left, the loop can be extended to another row; if it doesn't quite make it, the loop will have to be brought forward a row. Secure to the floor where necessary with masking tape.

Plug in the cable plug to the socket, then run a twin pair from the connecting block back to the PA amplifier and connect to the 100 V output. Put some music and check that the LED is flickering and that's it.

Remind the ushers to direct users to the right place and tell them to switch their hearing aids over to the T position. A notice to this effect can also be displayed in the foyer or somewhere where potential users will see it. ETI

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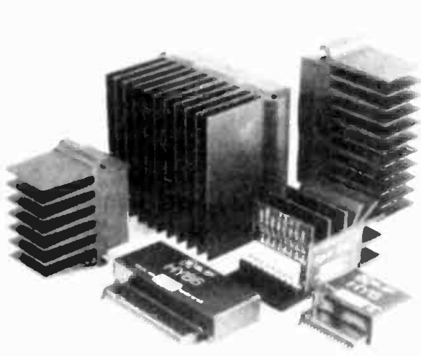

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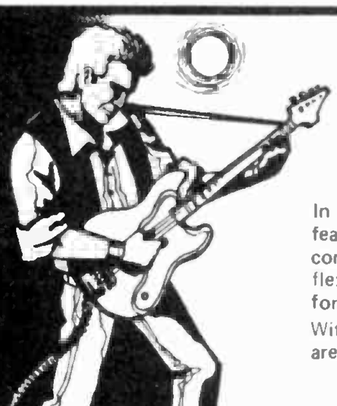

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Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 × 68 × 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 × 68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

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HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
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MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 × 78 × 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 × 78 × 80	450	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 × 78 × 100	1025	£45.51

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

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PSU 42X	1 × HY128	£15.90
PSU 43X	1 × MOS128	£16.70
PSU 51X	2 × HY128, 1 × HY244	£17.07

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

Model Number	For Use With	Price inc. VAT
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PSU 73X	1 × HY364	£22.54
PSU 74X	1 × HY368	£24.20
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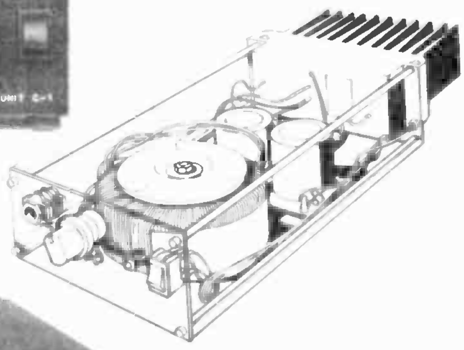

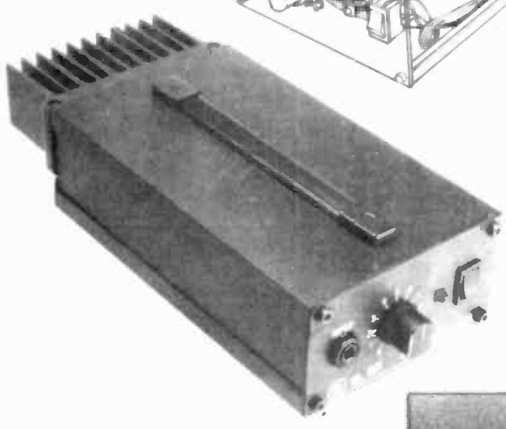

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CONFIGURATIONS

It's been a year since Configurations started, and now Ian Sinclair brings the series to a close, shutting the AND, OR, and NOT gates behind him.

For anyone who has worked with linear circuits for a long time, the first contact with digital circuits always comes as a shock because the action of digital circuits is unfamiliar, and the way in which the circuits respond to signals is equally unfamiliar. In this final part of Configurations, therefore, we shall concentrate on the most basic of digital circuit, the gate, and how the two most common of 'families' of digital circuits, TTL and CMOS, carry out gate action. For once, also, we're going to assume rather less in the way of background knowledge than we've taken for granted in previous parts, because all the problems in adapting to digital circuitry are at the start — once you have had some experience, this sort of message is not needed!

Let's be clear from the start what we mean by digital circuits and gates. A digital circuit is, strictly speaking, one which works with signals that consist of several separate voltage levels, so that a voltage which is to be counted as a signal must be at or near one of these levels. The digital circuits that we make most use of are binary digital circuits, meaning that the signals into them and from them consist of only two voltage levels which we refer to as a matter of convenience as 0 and 1. What the actual voltages happen to be is unimportant — the important feature is that there should be just these two levels. Most logic circuits operate with what we call positive logic, in which 0 means zero volts and 1 means a positive voltage; a few older circuits can still be found which use negative logic, in which 1 is a negative voltage.

The advantages of using just two voltage levels are considerable. We don't have to worry about bias, for example, in the design of circuits, provided that we arrange for each active device in a circuit to be turned on at one voltage level and off at the other. This encourages the use of ICs, because bias is difficult to arrange reliably inside ICs. We don't need much in the way of voltage amplification, because with only two voltage levels to consider, the output signals can be of about the same voltage levels as the input signals. The only voltage amplification we need to consider is as much as is needed to restore the 1 level to normal when it has been reduced by, say, the 0V6 drop across a conducting diode (Fig. 1). The third major factor is that tolerances in component values have much less effect on signals than they have in linear circuits. A logic 1 voltage which is nominally 5 V can drop as low as 3V6 and still be useable as a logic 1 voltage. The logic 0 voltage can rise as high as 0V8 and still be useable as a logic 0 voltage.

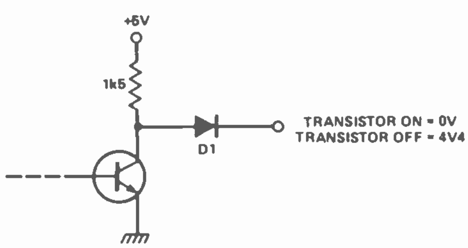
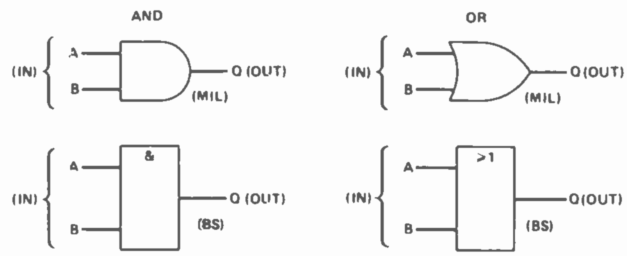


Fig. 1. Voltage levels. The presence of a diode, or a transistor junction, in the path of an output can change the output level by 0V6 or so. The tolerance of voltage must be enough to make allowances for this.



A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 2. The two main gate types, with International (MIL) symbols, and the BS symbols that are used for TEC and C & G courses. The truth tables describe the gate actions.

Since the normal concern of linear circuits, amplification with low distortion, is simply not necessary for digital circuits, the actions that digital circuits perform are necessarily quite different. One of the fundamental actions of a digital circuit is gating, and it is gating that we shall look at in the rest of this article.

Digital Gates

A digital gate is a circuit which has inputs that are digital signals and an output (or more than one output) which is also a digital signal. Since the output is a digital signal, it must have a voltage level at any instant which is at logic 0 or at logic 1, and what the level actually is depends entirely on the combination of inputs that happens to be present at that instant. It is for this reason that the gate circuit is often referred to as a **combinational** circuit. The two most important types of gate circuits are referred to as AND and OR gates respectively, and we can describe their actions by a table that shows what the output will be for every possible combination of inputs. Such a table is called a 'truth table', and the truth tables for AND and OR gates with two inputs are illustrated in Fig. 2. These tables show that for the two-input AND gate, the output will be at logic level 1 only when both inputs are at level 1: for the OR gate, the output will be at level 1 when either or both inputs are at level 1.

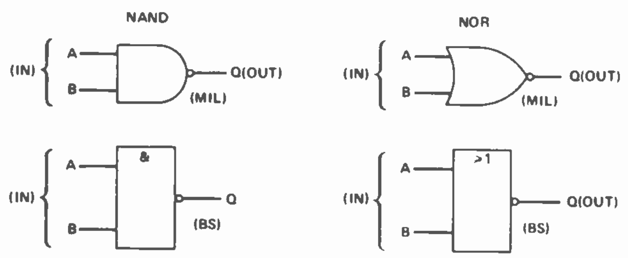
Truth tables become less useful when a gate has a large number of inputs, because the number of lines needed for a truth table is 2^n, where n is the number of inputs to the gate. The same rules apply, however, irrespective of the number of inputs, so that the action of the AND and the OR gates can be described in ways that are more compact

A	Q
0	1
1	0

Fig. 3. The inverter or NOT gate.

than truth tables, using what is called Boolean Algebra. We haven't space to deal with this here.

Another circuit which is usually classed among the gates is the inverter, sometimes called a NOT gate. Its truth table (Fig. 3) is simple — the logic voltage output is the inverse of its logic voltage input. Circuits which combine the action of the NOT gate with the action of AND are called NAND gates; circuits which combine NOT action with OR action are called NOR gates, and the truth tables for these types are shown in Fig. 4. One further gate which is less important as a basic circuit, but which is needed in arithmetic circuits, is the exclusive-OR gate, or EXOR-gate, whose action is illustrated in Fig. 5. The name comes from the fact that the action is like that of the OR gate but excluding the case where both inputs are 1.

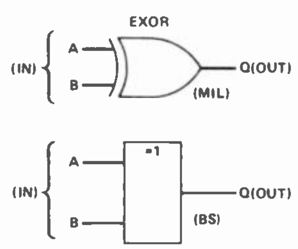


A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 4. NAND and NOR gates, formed by combining AND/OR gates with inverters.

Logic circuits which make use of gates are connected so that the output of one gate can pass signals to the input of the next gate in the circuit — we say that one output can **drive** one or more inputs. This usually means that the output has to be able to supply (**source**) or absorb (**sink**) current, and the number of inputs that can be driven by one output is called the **fanout** of that gate. The size of the



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

Fig. 5. The exclusive-OR (EXOR) gate and its truth table.

fanout depends on the design of the input and the output stages of the gates. A fanout of 10 is generally considered to be satisfactory, meaning that 10 gate inputs can reliably be driven from one gate output.

TTL Gates

The old-style 'standard' TTL gate uses bipolar transistors, but using a common-base circuit rather than the more familiar common-emitter. The inputs (Fig. 6) are to the emitters of transistors whose bases are connected through a current-limiting resistor to the supply positive voltage of 5 V. A common feature of the IC construction is the creation of several emitters on to one base, so that several inputs are fed in by the same transistor. An input stage like this will draw no current when the input voltage is logic 1, because such an input biases the transistor off. An input which is at logic 0, however, has the effect of earthing the input terminal, and current will flow through the base-emitter junction of the transistor to earth. Unlike our linear circuits, this input current comes *out* from the input! Standard TTL is constructed so that this current is about 1.6 mA, so the resistance between the input terminal and earth must be low enough to ensure that when this amount of current flows, the input voltage at the terminal must not rise above the maximum voltage level permitted for logic 0, usually around 0V8.

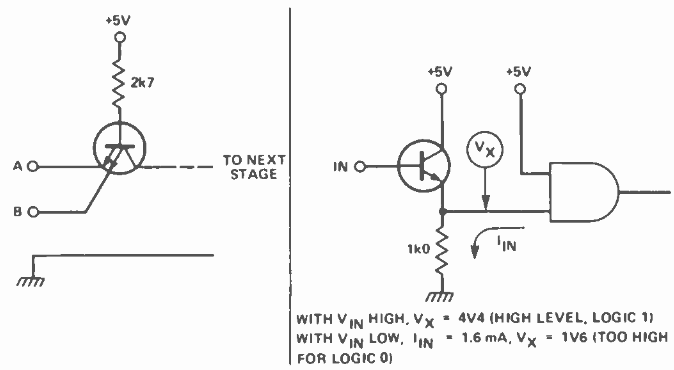
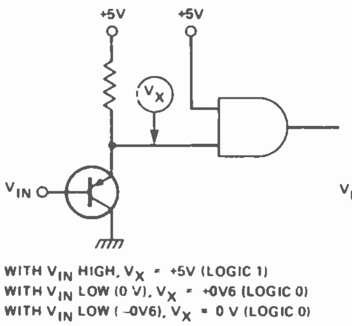


Fig. 6 (Left) TTL input. The base of the transistor is connected to + 5 V through a resistor, and the inputs are to emitters — more than one emitter (and as many as 13) can be formed on to one base.

Fig. 7 (Right) Driving a TTL stage from an NPN emitter-follower. The logic 0 voltage is likely to be too high because of the current from the input of the gate.

The requirement to have current flowing *out* from the input at logic 0 means that not all driving circuits are useable. In particular, the NPN emitter-follower, which is so often the automatic choice for many purposes, is unsuitable because (Fig. 7) when the input is at logic 0, the current from the gate will flow through the emitter resistor. A PNP emitter-follower, arranged as shown in Fig. 8, can allow a satisfactory logic 0 voltage, but only if the voltage at the base of the emitter follower can be taken low enough — preferably to a negative voltage, because of the inevitable 0V6 difference between base and emitter voltage levels. The most satisfactory simple driving stage is the straightforward common-emitter amplifier circuit as shown in Fig. 9.

No driving problems should exist if the input of a gate is driven by the output of another gate of the same family. Figure 10 shows the conventional circuit arrangement for a standard TTL gate output, which uses two transistors and a diode in series. A logic 1 output corresponds to having



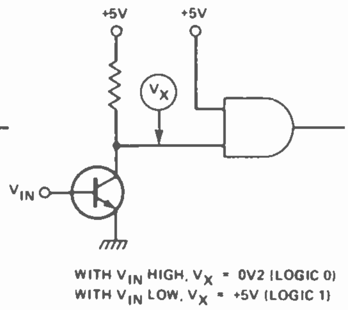


Fig. 8. (Left) Using a PNP emitter follower as a driving stage — a better approach.

Fig. 9. (Right) Driving a gate from a common-emitter stage — the most satisfactory single-transistor drive stage.

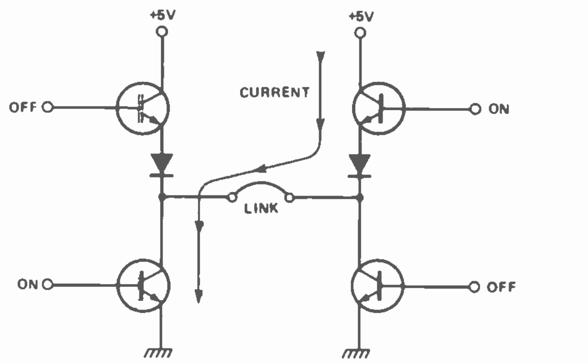
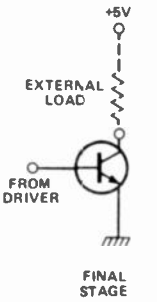


Fig. 11. Why gate outputs should not be connected together.



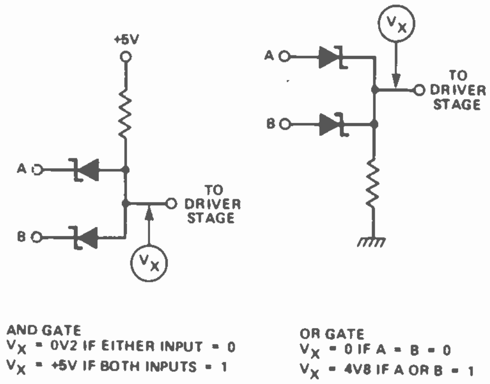


Fig. 12. (Left) The output stage of an 'open-collector' stage. These stages need an external load resistor.

Fig. 13. (Right) Using Schottky diodes as logic elements.

the top transistor of the pair conducting and the bottom transistor shut off, and because the base voltage of this top transistor cannot be more than the supply voltage of +5 V, the emitter voltage must be no more than 4V4-4V5, which makes the output voltage (because of the diode) only around 3V8-4V0. Don't be surprised, then, if you find that the logic 1 output from a gate is lower than the supply voltage. The logic 0 voltage from this circuit will be the voltage across the bottom transistor when it is fully conducting, which can be as low as 0V2, depending on the load.

The layout of the output stage is such that only one of the output pair of transistors will be conducting at any time during normal operation. If two gate outputs are connected together, however, it would be possible to have one output at logic 1 (top transistor conducting) and the other at logic 0 (bottom transistor conducting), so that at a low resistance path for current was created (Fig. 11). This would have the effect of burning out one transistor in each gate, so that for the few applications in which gate outputs have to be connected together, special gate ICs described as open-collector types are used. These have no 'top' transistor in the output stages, and are designed to work with an externally connected resistor load (Fig. 12).

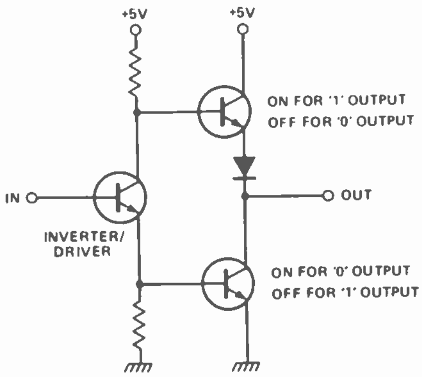


Fig. 10. The usual TTL output stage. One of the pair of output transistors will conduct to connect the output to either 0 or 1 levels.

Standard TTL, though still circulating in very large numbers, has been replaced in production by the low-power Schottky TTL chips, distinguished by the letters LS in the type numbers. These LS chips make use of a component, the Schottky diode, which is not particularly well known, so that some description is called for. The Schottky diode uses a combination of metal (usually aluminium) and semiconductor in its junction to obtain a very low forward voltage, between 0V1 and 0V2 as compared to the 0V6 for a silicon diode. This makes these diodes ideal for use in logic circuits, as illustrated in Fig. 13, and also makes it possible to construct transistor stages which do not saturate. Saturation occurs in a conventional transistor stage when the base current of a transistor, which has a collector load, is so high that the collector voltage bottoms. The effects of saturation are to achieve a very low collector voltage, around 0V2, but also to flood the base junction with charge carriers (electrons or holes depending on whether the transistor is PNP or NPN). When the base voltage is suddenly removed from such a saturated transistor, this charge takes some time to clear, so that the transistor remains conducting — it will not switch rapidly from the conducting state to the non-conducting state. The time is usually less than a microsecond, but it limits the speed at which a gate circuit can operate reliably.

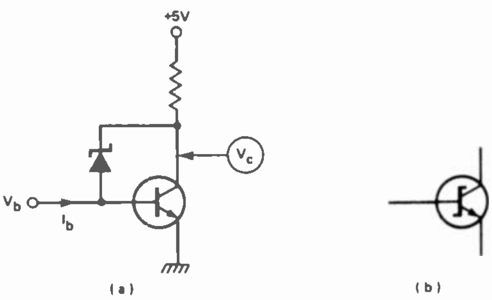


Fig. 14. (a) Using a Schottky diode to prevent transistor saturation. (b) The symbol for a transistor into which a Schottky diode has been incorporated.

A Schottky diode placed between the collector and the base of a transistor (Fig. 14) will prevent such saturation. When the collector voltage reaches a level which is about 0V2 lower than the base voltage, the Schottky diode wil conduct, connecting the base and the collector circuits and so bypassing the base. By avoiding saturation in this way, the transistor can be made to switch very much more rapidly at the minor expense of having a collector voltage which does not reach quite so low as that of a standard TTL stage. Figure 15 shows the internal circuitry of a typical LS type of gate circuit in which the presence of Schottky diodes is indicated by the modification to the shape of the base symbol in the transistors.

CMOS

Finally among the commonly-used logic gate circuits we have the CMOS types. These depend on the use of MOSFETs rather than bipolar transistors, and the inputs are invariably to the gates of the MOSFETs as compared to the emitters of the transistors in TTL stages. For this reason, no measurable current flows either into or out from the input of a CMOS gate when we use low-frequency signals, and the fanout under these conditions can be very high. The size of fanout is limited by the ability of the outputs of CMOS gates to supply currents of more than a milliamp or so, because the capacitance of each CMOS input is fairly high, and rapid switching demands that each capacitance be charged and discharged rapidly, calling for current which the output of a CMOS gate may not be able to supply. The operating currents and the dissipation of a CMOS gate will therefore increase as the operating frequency is increased, and it is this factor which limits the fanout and the speed of these gates. A typical CMOS gate circuit is shown in Fig. 16.

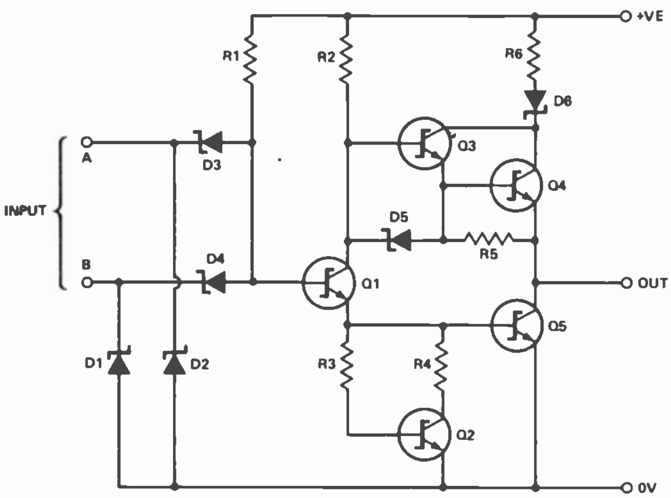


Fig. 15. Circuit for a NAND gate using Schottky diodes.

CMOS gates have a convincing list of advantages for many purposes. The supply voltage can be in the range + 3 V to + 15 V rather than the fixed + 5 V of the TTL circuits. The currents that are required by CMOS gates are very much smaller, so that CMOS is almost an automatic choice when battery operation is required.

For most practical purposes, your choice of logic circuits will be between LS TTL types and CMOS types, with the CMOS types chosen from the 4000 family (RCA), or from the less-well known 74C series (National Semiconductor) in which the type numbers correspond to those of the 74 series of TTL chips. For all purposes which require

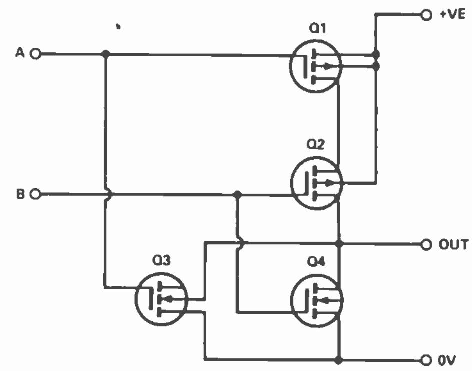


Fig. 16. Circuit of a typical CMOS gate — this one is an AND gate.

low consumption, lower operating speeds and small power outputs, CMOS is the more likely choice, but LS TTL chips are essential for many computing operations in which a high clock-rate is used — you may even find that you need the still-faster (and more power-consuming) 74H types.

We have now reached the end of Configurations, having covered a large number of devices and circuits. I hope that you have found the descriptions and the hints useful, and that some of them will have opened up new frontiers in circuit design for you, because that was the aim of the series. All I can do now is to wish that your circuits will always do what you want them to!

ETI

FLASH SEQUENCER

Astound your friends, freak out your budgie and out-do David Bailey (who?) with the ETI Flash Sequencer (trick photos a speciality). Design by Phil Walker.

This unit has been designed to be used either on its own or with the multi-function trigger unit described on page 70.

It can be used with up to four separate flashguns connected directly to it and will enable you to get some very interesting action shots.

The delay between each flash can be set by means of the single control over a range of about 1 millisecond to 1 second. This should cover most needs of this sort of shot, but could be altered easily by changing component values.

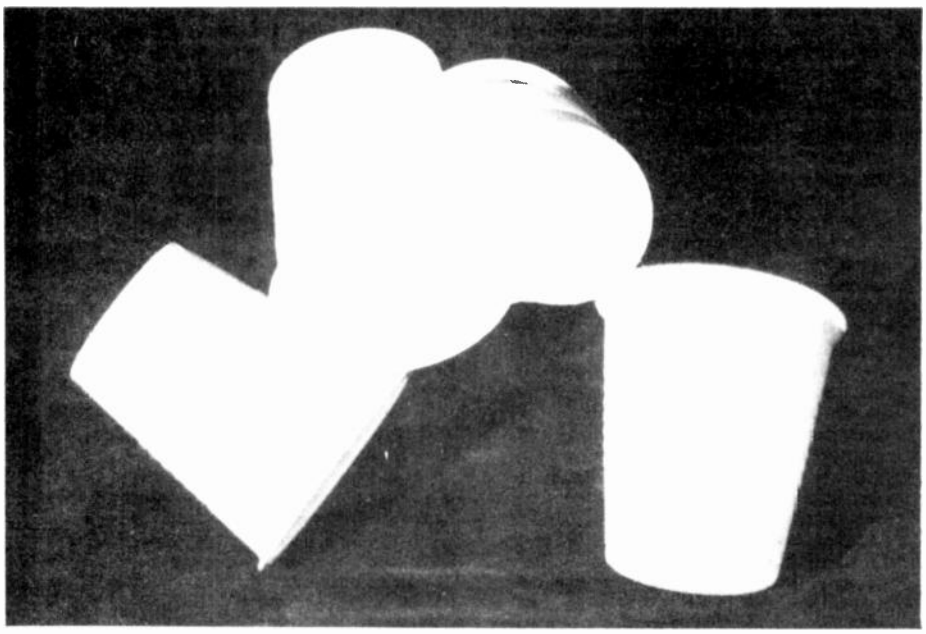
The ETI Flash Sequencer can control up to four flashguns.

Use

This is, of course, up to the individual user but with the basic unit described here it would probably be reasonable to set up camera and flash guns on tripods or similar firm supports. Then connect the trigger unit to the camera flash socket (use a suitable adaptor if necessary) and the flashguns to the unit. Set up the focus and aperture to suit the subject and flashguns used and set the shutter speed so that it is longer than the TOTAL delay on the unit. This usually means that you will have to work on a dark night or indoors if you use long delay times.

You will probably have to find the proper aperture setting by trial and error at first, but if you use a black or very dark background and your subject moves between flashes, the normal or slightly smaller aperture is a good starting point.

With the multi-function trigger unit all sorts of interesting possibilities open up for photographing wildlife or transient events, especially if a solenoid-operated shutter release can be arranged.



Not four, but one. This bouncing plastic cup was captured at various points in its flight using the sequencer.

The Circuit

The main parts of the circuit are the input latch configured around IC1e and f, the sequence generator consisting of IC2, IC1a, b, c and d, and the output pulse generators IC3, 4, 5, 6, 7 and Q2, 3, 4 and 5. The input latch can be reset to the READY condition by SW2 and will force the timing network to discharge all its capacitors by means of Q1 and D4 to 7. This state is indicated by the LED.

A negative-going pulse at the input or a press on SW1 will make the latch change state and allow the sequence to start. After the first delay period the LED in IC4 will be turned on for about 10 mS, causing its associated SCR (or triac) to turn on and trigger the flashgun to which it is connected. This action occurs when C3 has been charged by the current through RV1 and R6 to the upper threshold voltage of IC1b. The output from IC1b is coupled via a differentiating network (C7 and

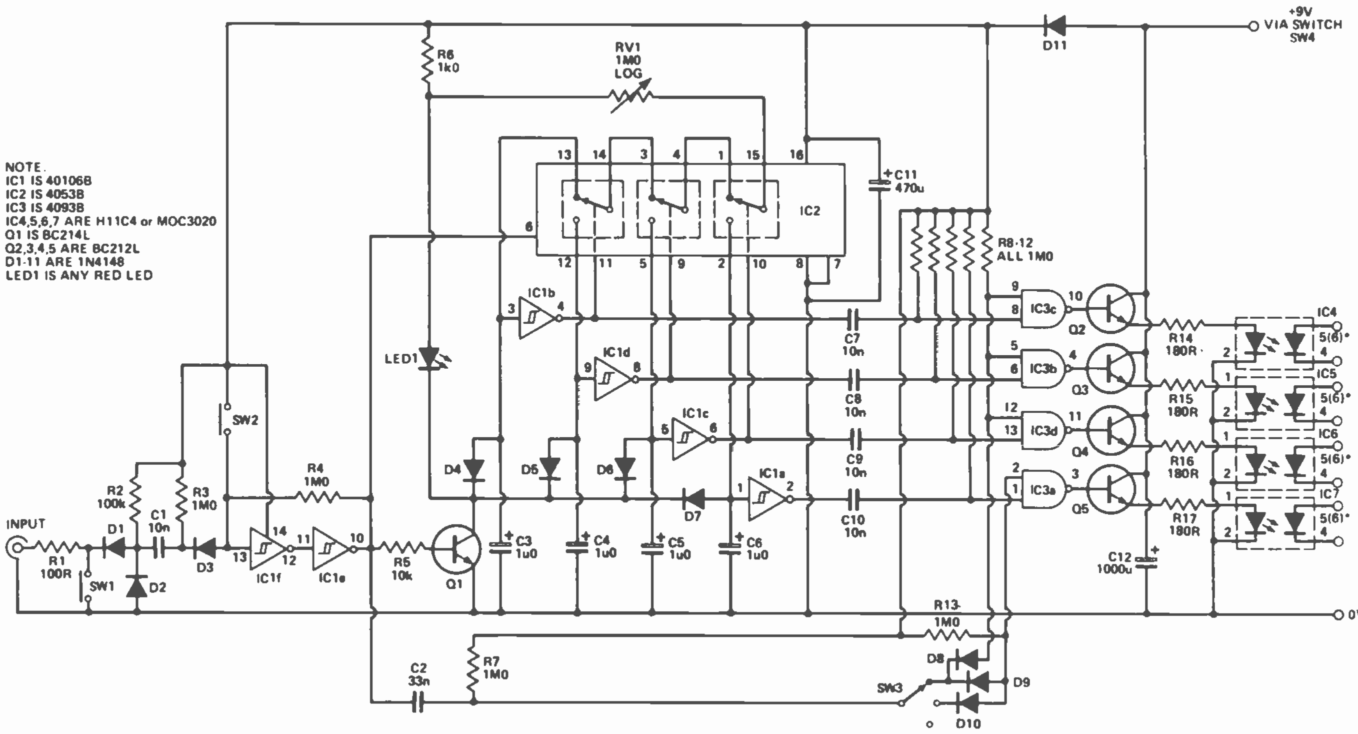


Fig. 1 Circuit diagram. The output connections (marked with an asterisk) depend on the opto device used — see text.

R8) to IC3c — also a Schmitt trigger. This negative-going pulse causes the output from IC3c to go high for about 10 mS, thus turning Q2 on and hence IC4.

IC1b having changed state, the current from RV1 is now diverted to C4 and will charge this up at the same rate until its voltage reaches the upper threshold of IC1d. A similar set of actions now occurs in IC3b and IC5, resulting in another flashgun being triggered and the timing current being diverted yet again to C5.

The sequence ends when C6 charges and the final flashgun triggers. The circuit is now ready to be reset for another operation.

By means of SW3, a negative pulse generated by C2 and R7 can be routed to the sections of IC3 such that one or all the outputs can be triggered with no delay. This could be used to advantage if the unit is triggered direct from a camera socket and no other lighting is used for special effects or just to get as much light as possible. Beware when using this facility with long delay times set on RV1, as one or more flashguns may recharge and trigger again as the delay operates.

The circuit should not take more than about 10 mA when READY and much less than that when timed out.

The negative-going input pulse to trigger the unit can be derived from a switch or logic source.

HOW IT WORKS

IC1e and f are connected together to form a simple latch: R4 is included to avoid shorting the output of IC1e. When SW2 is pressed the output from this latch is set high, this will cause C2 to discharge via R7 and turn Q1 on. Q1 will discharge C3, 4, 5, 6 via D4, 5, 6 and 7 while lighting LED1 via R6. At the same time IC2 will be disabled by the high level on pin 6 from the input latch. This prevents LED1 from being bypassed by the switches in IC2.

In this condition the outputs from IC1a, b, c and d will be high and C7, 8, 9 and 10 can discharge via their associated resistors. This will set the inputs to IC3a, b, c and d to high levels and thus the outputs to a low. Q2, 3, 4 and 5 will be off and the outputs of IC4, 5, 6 and 7 will not conduct.

Assume for the moment that SW3 is in the open position (delayed sequence). If SW1 is now closed or a negative-going pulse appears at the input, this will be passed on via C1 and D3 to the latch formed by IC1e and f causing its output to go low. Q1 will now turn off, extinguishing LED1 and releasing C3, 4, 5 and 6. IC2 will now be enabled and current can now flow in C3 via R6, RV1 and the three switch sections of IC2. This capacitor will charge up until its voltage reaches the upper threshold of IC1b (this is a Schmitt trigger device), whereupon IC1b output will go low. This causes the current to be diverted to C4, where a similar process occurs. At the same time the high-to-low transition is passed through C7 to IC3c whose output will go high from 10 mS or so. This will turn Q2 on and thus IC4 will turn on.

Some time later C4 will charge up to the Schmitt threshold and IC1d will go low, diverting the current into C5 while also causing IC5 to conduct. The cycle of events will continue with IC1c/IC6 and IC1a/IC7. The result of all this is that flashguns connected to the outputs of IC4, 5, 6 and 7 will be fired in sequence with a delay between each one determined by R6 and the setting of RV1 (and the residual resistance of IC2). IC2 is in fact a triple CMOS changeover switch with a typical on state resistance of 200 ohms.

C7, 8, 9 and 10 have been included to ensure that the opto-coupler LED inputs are not driven continuously, as this would take a lot of current. These capacitors and R8, 9, 10 and 11 define the 'on' time to be about 10 mS. C12 will hold enough charge to provide this even from an aging battery. C11 and D11 isolate the rest of the circuitry from the LED drivers to maintain proper operation.

C2 and R7 (via SW3, D8, 9, 10) provide the alternative operating modes. The initial trigger pulse can be fed via these components to the sections of IC3 such that IC7 will turn on immediately or all the outputs will come on together. Care must be used here as the outputs may pulse again after the set delay time and thus trigger the flashgun(s) again if they recharge in time.

You may notice that the inputs to IC1a, b, c and d will only have their capacitors connected, and no DC path exists to bias them, once the switches have been operated. This will not cause any problems over the 5 seconds maximum of the timing period, as the leakage of the tantalum bead capacitors is quite low and they will have to discharge a long way before the Schmitt trigger gates change state.

PARTS LIST

Resistors (all ¼W, 5%)

R1	100R
R2	100k
R3,4,7-13	1M0
R5	10k
R6	1k0

Potentiometer

RV1	1M0 logarithmic

Capacitors

C1	10nF miniature disc ceramic
C2	33nF miniature polyester
C3-6	1u0 35 V tantalum bead
C7-10	10nF miniature polyester
C11	470uF 10 V aluminium PCB electrolytic
C12	1000uF 10 V aluminium axial electrolytic

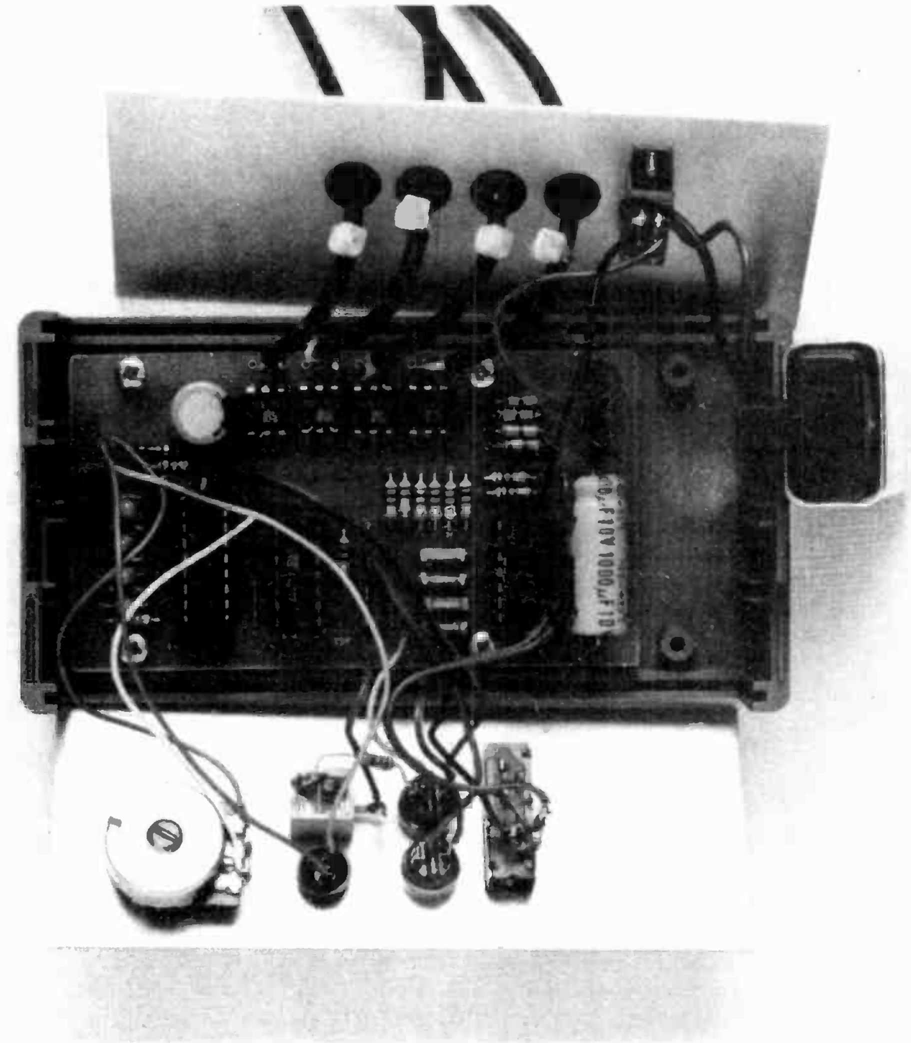
Semiconductors

IC1	40106B
IC2	4053B
IC3	4093B
IC4-7	H11C4 (opto-SCR) or MOC3020 (opto-triac). See text.
Q1	BC214L
Q2-5	BC212L
D1-11	1N4148
LED1	any red LED

Miscellaneous

SW1,2	miniature push-to-make push-button switch
SW3	three-way slide switch
SW4	miniature on/off slide switch

PCB (see Buylines); box — Verocase 125 × 65 × 50 mm (order ref. 202-21049A); 3.5 mm jack socket and plug; PP3 battery and clip; four small grommets; four off 1 metre flash extension cables; wire, cable ties etc.



Inside the sequencer.

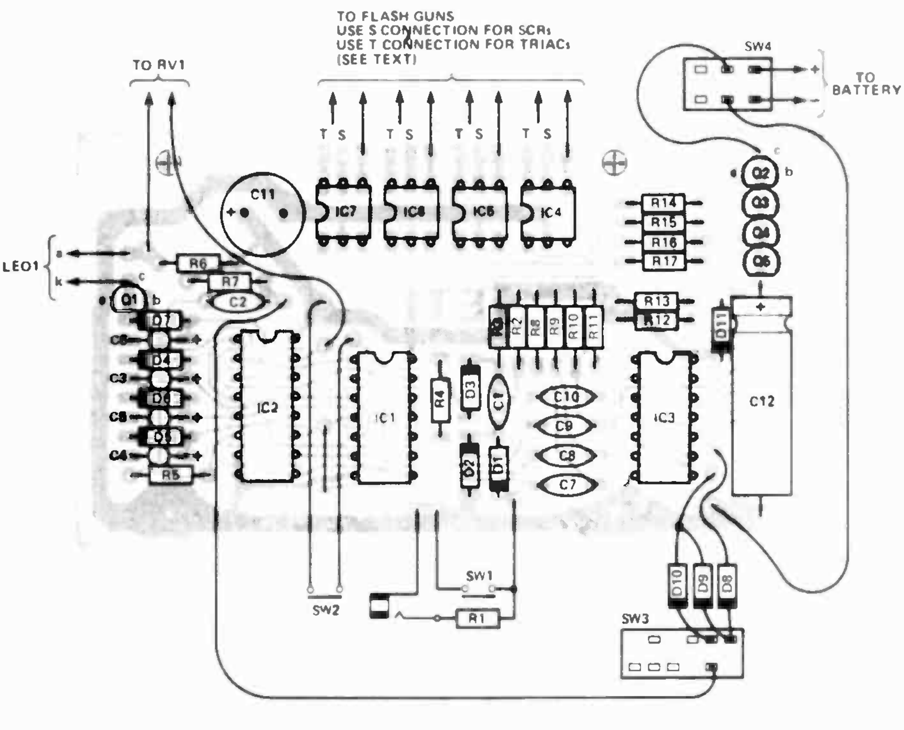


Fig. 2 Component overlay of the ETI Flash Sequencer.

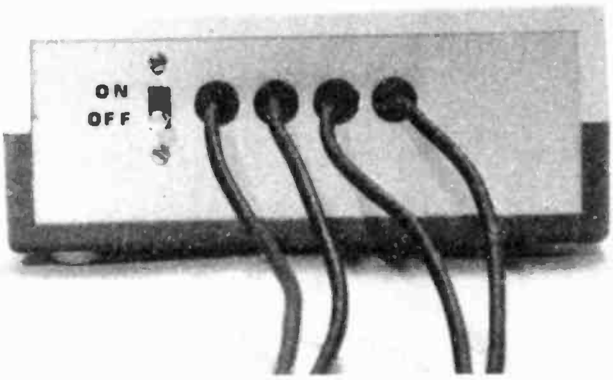
Construction

Construction of this project should pose no great problems. Take care when positioning the front panel components that they do not foul the parts on the assembled PCB. Note that R1, D8, 9 and 10 are mounted on the panel. It is essential that all the diodes, ICs, and any other polarised components are mounted the correct way round.

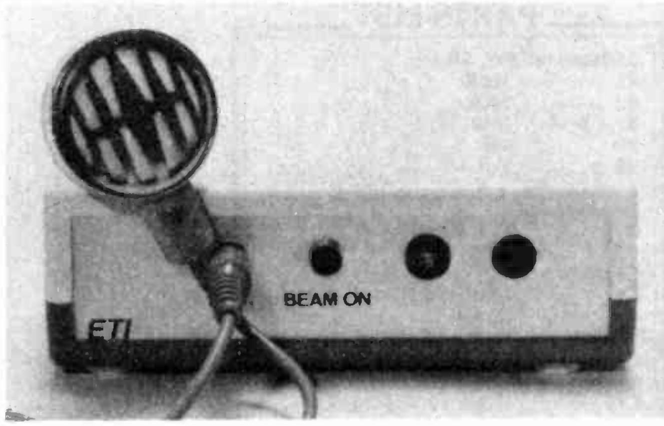
We recommend that IC holders are used for the CMOS devices and that care is taken to avoid static discharge damage to these devices.

BUYLINES

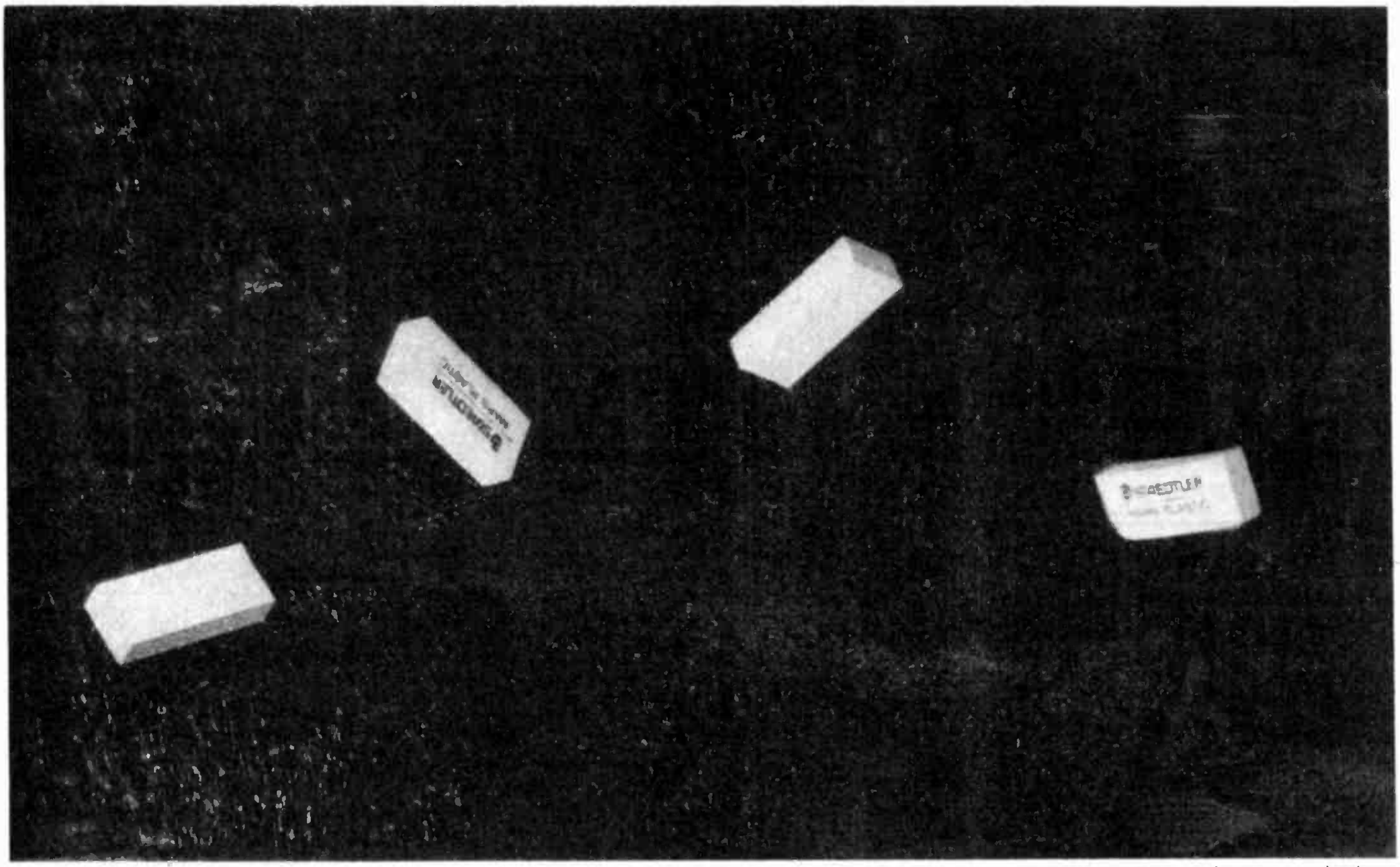
The MOC3020 is available from Technomatic and is much easier to obtain than the H11C4. Everything else is standard and readily available, although if you can't find the specified case in the catalogue of your favourite supplier, it can be bought direct from BICC-Vero Electronics, Retail Dept., School Close, Industrial Estate, Chandlers Ford, Eastleigh, Hants SO5 3ZR. The PCB can be bought from our PCB Service as advertised on page 91.



The rear of the sequencer carries the on-off switch. We bought four flash extension cables in order to get the right connectors.



The picture on page 63, and the one below of an eraser bouncing from right to left, were shot using the sequencer and the trigger unit above. See page 70.



Output Connections

There are two different connection points for the output from the opto-couplers. This is to accommodate either opto-SCR or opto-triac devices. If opto-SCR devices are used, the flashgun trigger leads must be connected across pins 4 and 5 with pin 4 negative and pin 5 positive. You will have to check the polarity of the connections to the base of the flashguns you use, and this will vary from make to make (ours had a positive inner). If you connect up for one particular make, the trigger unit may not work on another.

If you use opto-triacs, the flashgun trigger leads should be connected across pins 4 and 6; polarity is unimportant, which will save all the above messing about, so we recommend this option.

Other Points

As we found that sockets for flashgun connectors are unobtainable (unless already connected to something such as a camera) we bought four flash extension cables and cut the unwanted ends off. These were then taken into the box via small grommets and wired directly to the proper terminals. A small cable tie on each lead just inside the box served to take the strain off the connections. It may be a good idea to buy three one-metre extension cables and one much longer one, so that you can use the extra length from this for the camera-to-unit link (it will have the correct connector).

For greater protection the unit could be built inside a diecast box. This may also be necessary if static discharge causes premature triggering of a flashgun.

Calibration of the delay control would need special apparatus and would depend on the quality of RV1. But the type of device specified should give a reasonable subjective control over the required range.

ETI

74 SERIES

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18p
7417	18p
7420	14p
7421	18p
7422	20p
7423	20p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7484A	60p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7494A	35p
7496	40p
7497	90p
74100	80p
74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	36p
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74156	40p
74157	35p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	50p
74175	50p
74176	40p
74177	45p
74178	70p
74179	70p
74180	40p
74181	115p
74182A	60p
74184A	90p
74185	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
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74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74273	120p
74276	90p
74278	100p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
74351	150p
74365	30p
74366	30p
74367	30p
74368	30p
74376	100p
74390	75p
74393	90p
74490	95p

74LS SERIES

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS06	12p
74LS07	12p
74LS08	12p
74LS09	12p
74LS10	12p
74LS11	13p
74LS12	13p
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74LS37	14p
74LS38	15p
74LS40	12p
74LS42	30p
74LS47	36p
74LS48	45p
74LS51	14p
74LS54	14p
74LS55	14p
74LS63	120p
74LS73	18p
74LS74	18p
74LS75	18p
74LS76	17p
74LS83	36p
74LS85	40p
74LS86	18p
74LS90	22p
74LS91	66p
74LS92	32p
74LS93	22p
74LS95	40p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	28p
74LS123	34p
74LS124	90p
74LS125	24p
74LS126	25p
74LS132	34p
74LS133	30p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	120p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
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74LS157	25p
74LS158	30p
74LS160	36p
74LS161	36p
74LS162	36p
74LS163	36p
74LS164	40p
74LS165	50p
74LS166	60p
74LS168	85p
74LS169	85p
74LS170	70p
74LS173	55p
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74LS181	90p
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74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	50p
74LS244	55p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	35p
74LS253	35p
74LS256	150p
74LS257	30p
74LS258	36p
74LS259	56p
74LS260	20p
74LS261	138p
74LS266	20p
74LS273	60p
74LS275	225p
74LS279	30p
74LS280	100p
74LS283	40p
74LS290	45p
74LS293	40p
74LS295	90p
74LS297	900p
74LS298	90p
74LS299	180p
74LS321	150p
74LS323	180p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS356	250p
74LS363	140p
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74LS365	27p
74LS366	27p
74LS367	27p
74LS368	27p
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74LS374	56p
74LS375	45p
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74LS378	60p
74LS390	45p
74LS393	45p
74LS395	90p
74LS399	160p
74LS445	100p
74LS467	90p
74LS490	200p
74LS540	90p
74LS541	80p
74LS610	£19
74LS624	90p
74LS626	150p
74LS628	150p
74LS629	90p
74LS640	100p
74LS641	100p
74LS643	100p
74LS644	100p
74LS645	100p
74LS668	120p
74LS669	120p
74LS670	140p
74LS678	550p
74LS682	400p
74LS684	400p
74LS687	400p

74S SERIES

74S00	30p
74S02	30p
74S04	30p
74S05	60p
74S08	60p
74S10	40p
74S11	50p
74S20	40p
74S22	50p
74S30	40p
74S32	60p
74S37	70p
74S74	75p
74S85	450p
74S86	90p
74S112	90p
74S113	90p
74S114	90p
74S124	300p
74S132	160p
74S133	60p
74S138	120p
74S139	120p
74S140	120p
74S157	250p
74S158	195p
74S163	300p
74S174	250p
74S175	250p
74S194	320p
74S195	500p
74S225	510p
74S241	300p
74S244	300p
74S251	250p
74S257	250p
74S258	250p
74S260	70p
74S261	300p
74S262	850p
74S373	400p
74S374	400p
74S387	250p
74S471	650p
74S474	400p
74S571	620p
74S573	900p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	50p
4009	36p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4032	80p
4033	125p
4035	45p
4036	275p
4037	110p
4038	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4078	16p
4081	14p
4082	15p
4086	55p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
4500	575p
4501	28p
4502	60p
4503	45p
4504	75p
4505	400p
4506	35p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	120p
4515	110p
4516	55p
4518	40p
4520	50p
4521	90p
4522	120p
4526	60p
4527	60p
4528	50p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4543	70p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	40p
4585	75p
40014	40p
40085	90p
40097	45p
40102	140p
40103	170p
40105	110p
40106	40p
40109	100p
40110	275p
40163	60p
40174	50p
40175	75p
40193	75p
40244	160p
40245	180p
40257	160p
40373	160p
40374	160p
14495	300p
14500	700p
14599	290p
40244	160p
40245	180p

COUNTERS

74C925	£4
7216B	£16
74C926	£5

LINEAR ICs

AD7581	1250p
ADC0808	990p
AN103	200p
AY1-0212	700p
AY1-1313	668p
AY1-1320	225p
AY1-5050	99p
AY3-1270	825p
AY3-1350	350p
AY3-8910	440p
AY3-8912	625p
AY5-3600	600p
AY4007D	£6
CA3019	80p
CA3046	70p
CA3048	220p
CA3059	285p
CA3060	350p
CA3080E	72p
CA3086	48p
CA3089E	200p
CA3130E	90p
CA3130T	110p
CA3140T	90p
CA3140E	50p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	110p
CA3280G	200p
HA1366	195p
HA1388	270p
ICL7106	700p
ICL7611	95p
ICL7660	200p
ICL8038	300p
ICM7216B	£18
ICM7217	750p
ICM7555	80p
ICL7611	90p
LC7120	300p
LC7130	325p
LC7137	270p
LF347	150p
LF351	48p
LF353	95p
LF356P	95p
LF357	110p
LF13331	150p
LM10C	325p
LM301A	25p
LM308N	75p
LM310	120p
LM311	70p
LM318	£3
LM319	215p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM386	90p
LM387	120p
LM389	95p
LM391	150p
LM392N	60p
LM393	100p
LM394CH	300p
LM709	36p
LM710	50p
LM711	70p
LM725	300p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	450p
LM1872	450p
LM1886	700p
LM1889	350p
LM2917	200p
LM3302	75p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
MS1513L	230p
MS1516L	500p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	75p
MC1445	250p
MC1458	36p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3401	50p
MC3403	75p
MFIO	250p
MK50240	£9
MK50380	635p
MK50398	£7
ML920	800p
MN57160	620p
MN6221A	600p
NE531	140p
NE544	150p
NE555	16p
NE556	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE570	410p
NE571	400p
NE592	60p
NE5534P	110p
NE5534AP	120p
PLL02A	500p
RC4136	60p
RC4151	200p
S566B	225p
SAA1900	£16
SFF9634	800p
SL490	350p
SN76131	125p
SN76477	450p
SN76488	450p
SN87489	400p
SN76495	400p
SN76660	120p
SP8515	750p
TA7120	150p
TA7130	150p
TA7204	200p
TA7205	90p
TA7222	150p
TA7310	150p
TBA800	80p
TBA810	100p
TBA820	80p
TBA920	200p
TBA950	225p
TC9109	900p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TCA965	120p
TDA1004A	£3
TDA1008	320p
TDA1010	200p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2003	325p
TDA2002V	£3
TDA2006	350p
TDA2020	320p
TL064	100p
TL071/81	25p
TL072/82	45p
TL074	100p
TL083	75p
TL084	90p
TL094	200p
TL170	50p
TL430C	70p
TMS1601	£12
UA1003-3	935p
UA2240	150p
UAA170	170p
ULN2003A	75p
ULN2004	75p
ULN2068	290p
ULN2802	200p
ULN2804	150p
UPC575	275p
UPC592H	200p
UPC1156H	£3
UPC1185H	£5
XR2206	380p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN414	80p
ZN419C	180p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	590p
ZN428E	410p
ZN1034E	200p
ZN1040E	670p
ZNA134	£23
ZNA234	850p

VOLTAGE REGULATORS FIXED PLASTIC

	+ve		−ve	
1A				
5V	7805	40p	7905	45p
6V	7806	40p	7906	45p
8V	7808	40p	7908	45p
12V	7812	40p	7912	50p
15V	7815	40p	7915	50p
18V	7818	40p	7918	45p
24V	7824	40p	7924	45p
5V 100mA	78L05	30p	79L05	50p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	60p
15V 100mA	78L15	30p	79L15	60p

OTHER REGULATORS

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

OPTOELECTRONICS

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

OPTO ISOLATORS

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

LEDS

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

DISPLAYS

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

DRIVERS

9368	250p
9370	300p

TRANSISTORS

AD161/2	45p
BC107/8	13p
BC109C	14p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	25p
BC477/8	30p
BC516/7	40p
BC547B	14p
BC548C	12p
BC549C	15p
BC557B	14p
BC559C	16p
BCY70	18p
BCY71	22p
BD131	75p
BD132	80p
BD135/6	50p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	35p
BF256B	50p
BF257/8	32p
BF337	30p
BFR39	25p
BFR40/1	25p
BFR79	25p
BFR80/1	25p
BFR96	180p
BFX29	40p
BFX30	27p
BFX84/5	40p
BFX86/7	27p
BFX88	27p
BFX89	108p
BFY51/2	24p
BFY56	33p
BRY90	80p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	100p
MJE3055	70p
MPF102	40p
MPF103/4	30p
MPF105	30p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU95	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	40p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP120	75p
TIP121	75p
TIP122	80p
TIP142	120p
TIP147	120p
TIP2955	78p
TIP4055	70p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX452	45p
ZTX500	15p
ZTX502	16p
ZTX504	18p
ZTX552	55p
ZTX652	60p
ZTX752	70p
VN66AF	72p
VN10KM	60p
VN66	80p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	25p
2N2222A	25p
2N2369A	17p
2N2484	25p
2N2646	40p
2N2904/5	25p
2N2906A	25p
2N2907A	25p
2N2926	9p
2N3053	25p
2N3054	55p
2N3055	35p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	10p
2N3704/5	10p
2N3706/7	10p
2N3708/9	10p
2N3773	200p
2N3819	20p
2N3820	40p
2N3823	30p
2N3866	90p
2N3902	700p
2N3904	15p
2N3906	10p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/2	27p
2N4403/4	27p
2N4427	90p
2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	60p
2N5485	36p
2N5875	250p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	200p
40290	250p
40361/2	75p
40408	90p
40409	100p
40410	100p
40594	120p
40595	120p
40673	75p
40871/2	100p

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	350p
6502A	500p
6800	225p
6802	250p
6809	650p
68B09	£12
6809E	£12
8035	350p
8039	300p
8080A	280p
8085A	350p
INS8060	£11
TMS9980	£20
TMS9995	£12
TMS1601	£12
Z8	£24
Z80	290p
Z80A	320p
Z80B	£12
8088	£18
8748	£18
8288	£11
8755	£16
9902	£3
TMS4500	£14
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80ACTC	280p
Z80ADART	700p
Z80ADMA	£10
Z80S10/1/2	£9

SUPPORT DEVICES

3242	800p
3245	450p
6520	280p
6522	550p
6522A	560p
6532	560p
6551	650p
6821	100p
68B21	220p
6829	£12.50
6840	375p
68B40	600p
6850	110p
68B50	220p
6852	250p
6854	700p
68B54	800p
6875	570p
8154	950p
8155	350p
8156	350p
8205	225p
8212	110p
8216	100p
8224	110p
8226	250p
8228	270p
8243	280p
8250	850p
8251	250p
8253	390p
8255	250p
8256	£36
8257	400p
8259	400p
8271	£36
8279	440p
8284	350p

RAMs

2101-4A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	100p
2147	450p
4027-3	300p
4116-15	120p
4116-20	80p
4118-3	450p
4164-2	400p
4816APZ-3	270p
5101	300p
5516	750p
3101-3	420p
6116LP-3	750p
6514-45	550p
6810	120p
7489	210p
74S189	225p
74S201	350p
74S289	175p
93415	600p
93425	600p

ROMs/PROMs

74S188	325p
74S287	350p
74S288	225p
74S387	325p
74S471	650p
74S473	650p
74S474	650p
74S570	650p
74S571	650p
74S573	950p

EPROMs

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

CRT CONTROLLER

CRT6545	900p
CRT5027	£18
CRT5037	£18
EF9365/6	£45
MC6845	650p
MC6847	650p
SFF96364	£8
TMS9918	£60
TMS9927	£18
TMS9928	£20
TMS9929	£20

INTERFACE ICs

AD558CJ	775p
AD561J	£14
88LS120	250p
AM25S10	350p
AM25LS2521	£2
AM26LS31	125p
AM26LS32	125p
D7002	480p
DAC80	£28
DM8131	375p
DP8304	460p
DS3691	300p
DS8830	140p
DS8831	140p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	750p
MC14412	750p
75107	90p
75110/12	160p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75182	90p
75361	150p
75363	150p
75365	150p
75451/2	65p
75453/4	72p
75491/2	70p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
81LS95/96	90p
81LS97/98	90p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	600p
ZN428E-8	500p

DISC CONTROL ICs

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

CHARACTER GENERATORS

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

KEYBOARD ENCODER

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

BAUD RATE GENERATORS

MC14411	675p
COM8116	700p
4702B	750p

UARTs

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

ZIF SKTs

(TEXT TOOL)

24 pin	600p
28 pin	800p
40 pin	£10

LOW PROFILE SOCKETS BY TI

8 pin	9p	18 pin	15p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TI

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

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

CRYSTALS

32.768KHz	100p
100KHz	250p
200KHz	280p
Freq in MHz	
1.0	290p
1.008	275p
1.5	450p
1.8432	210p
2.00	225p
2.45760	210p
2.5	250p
2.662	250p
3.276	150p
3.5795	100p
3.686	300p
4.00	150p
4.194	200p
4.43	110p
4.608	250p
4.915	250p
5.0	175p
6.0	150p
6.144	150p
7.0	150p
7.168	175p
8.00	175p
8.86	175p
10.00	175p
10.5	250p
10.7	150p
12.00	150p
14.318	175p
14.756	250p
15.00	200p
16.00	200p
17.7	200p
18.00	200p
18.432	150p
19.968	150p
20.00	200p
26.690	150p
27.145	200p
38.6667	175p
48.0	175p
55.5	400p
116	300p
145.80	250p
15.068	£2
124.00	£2

DIL SWITCHES

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8 way	90p
10 way	145p

REAL TIME CLOCK

MM58174	700p
MSM5832	500p
MK3805	£ TBA

ZENERS

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1W	15p

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

SCRs

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

DIODES

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

THYRISTORS

A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
C106D	45p
MCR10136	38p
TIC44	27p
2N3525	130p
2N4444	180p
2N5060	30p
TN5064	35p

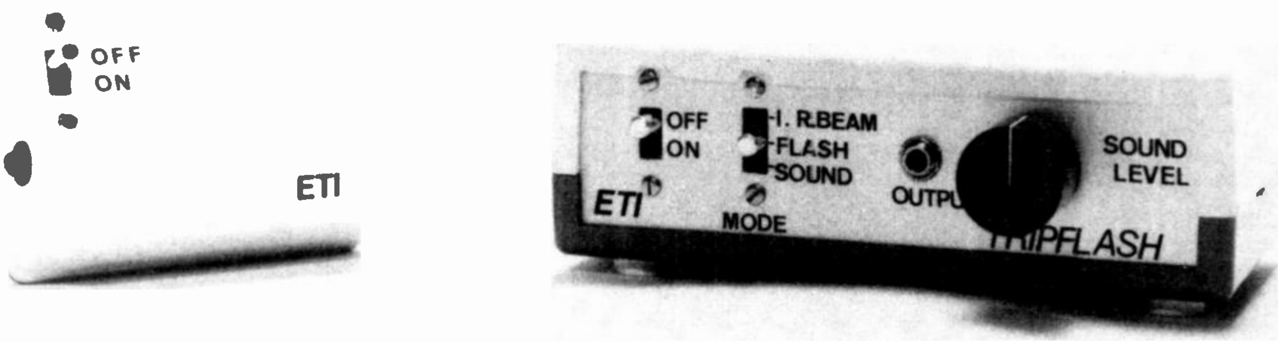
BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p

PCB MOUNTING RELAYS

6 or 12V DC Coil SPDT 2A 24V DC	160p
6 or 12V DC Coil DPDT 5A 24V DC 240V AC	200p
6 or 12V DC Coil SPDT 10A 24V DC 240V AC	225p

TRIGGER UNIT



If you're building the ETI Flash Sequencer described elsewhere in this issue, a unit to fire it on various stimuli is a must. This design triggers on sound, light or an infra-red beam. Design by Phil Walker.

This project has been designed to drive the ETI Flash Sequencer and provide facilities to trigger one or more flashguns and get the effect of a multiple exposure at one go. It can be used to trigger on the breaking of an invisible infra-red light beam up to 1 metre in length, on the sound of a pin dropping or even when another flashgun goes off. These functions add a new dimension to creative photography, especially on action shots.

Use

The visible light trigger will normally be used as a slave trigger, allowing up to four extra flashguns to be set off by one which may be fitted to the camera. This will allow 'filling in' or special effects to be created by using relatively cheap flashguns.

The sound trigger option allows all sorts of things to be captured on film, such as objects being thwacked by hammers, drops of water being thrown in all directions and many other noisy events.

Lastly the infra-red beam will allow many other events to be recorded in which the object of the picture is not broken, mangled, or disturbed except by the flash. The content of your pictures can now explore new fields.

If you wish to use this unit to trigger the camera shutter, there are two possibilities open. The first is that you have an electrical release on your camera, in which case the maker's handbook should be consulted to see whether it can be used.

The second is that a small extra circuit will be necessary, consisting of a power switch and solenoid. Some mechanical linkage could connect the solenoid to a cable or air release and thus release the shutter. The flashgun or flash sequencer would then connect to the camera in the normal way. These methods will avoid the shutter being open for long periods, which might cause unwanted images if all the extraneous light has not been kept out.

Construction

Construction of this unit is relatively straightforward but care must be taken that the components on the front panel do not foul the PCB or battery when assembled. The most critical part in this respect is the three-way mode-select switch. If you use the case specified it will be found necessary to cut off the screw pillars on the lid portion of the box so that the battery and switches fit in. It is recommended that thin screened wire is used for the PCB-to-panel connections (except LED and power) as there are two high-gain amplifers on board which will probably pick up any stray signals.

Keep the transistor leads short (not more than 5 mm above board) and take full anti-static precautions when fitting IC1 into its socket. Make sure all the diodes, transistors and electrolytics etc are fitted the right way round.

The infra-red photodiode should have its leads kinked before soldering in place so that it can be positioned properly in front of the hole in the back panel. It will be about 8 to 10 mm above the board. The visible light photodiode is mounted in a small grommet and connected to the PCB with flying leads.

It may be advisable to use a panel-mounting LED as the infra-red beam indicator, or paint the rear of an ordinary one black to prevent light from it reaching the photodiode. From this point of view it may be a good idea to paint the whole interior of the case black or line it with black light-proof tape.

Transmitter

This is very easy to assemble so long as the components are put in the right way round. The leads of the IR transmitter LED should be left long enough so that the LED can be bent round and fitted through the case. Make sure that there is enough room for this when fitting the switch. There should be enough space to fit the PCB into the box vertically but a little filing may be needed.

HOW IT WORKS

RECEIVER

The circuit can be considered in three sections. First the modulated infra-red receiver circuit starts with the detector diode D1. This converts the incoming light pulses to small current changes through R1. The resulting voltage is greatly amplified by Q1 and Q2 before being converted to a suitable logic signal in Q3. The output from Q3 is shaped by IC1f before triggering the 700 uS monostable formed by IC1a and b. When the infra-red beam is being received the output from this monostable consists of a train of pulses 700 uS low and 300 uS high (approximately). This train of pulses is applied via R13, 14 and D4 to C6. The time constant for C6 charging is about 1 mS while for discharging it is about 10 uS. This means that the voltage on C6 is always low while the IR beam is being received. Thus the output from IC1c is normally high and LED1 will be lit to indicate this condition. If the beam is broken for more than 1 mS a pulse will be missed, the monostable will not discharge C6 and will allow it to charge to the threshold of IC1c. This is a Schmitt trigger device and its output will change state sharply to a low level. This will be transferred via C7 and may be selected by SW1 as the required trigger signal.

Secondly, any sound in the area may be picked up by the crystal microphone and amplified by Q5 and Q6. A portion of this is tapped off by RV1 (acting as a sensitivity control) to drive Q7 which converts it to a suitable logic signal. This may now be selected by SW1 as the desired trigger.

Thirdly, D6 may selected as the signal source. This will respond to bright lights such as other flashguns to give a 'slave' capability. Any of these signals can be selected by SW1 and used to drive the monostable formed by IC1d and e. This provides a low-going output pulse each time the required trigger conditions are met — that is, on a broken IR beam, a loud noise or a bright light.

THE INFRA-RED TRANSMITTER

This produces a 1 uS pulse through the IR transmitter diode every 1 mS. The pulse width is determined by R2 and C2 while the repetition rate is set by R1 and C2. IC1 is a 555 timer IC whose output drives the LED via R3 to limit the current a little. D1 and C1 isolate the timing network from the effect of the high current pulses on the battery supply. C3 also helps to reduce these effects.

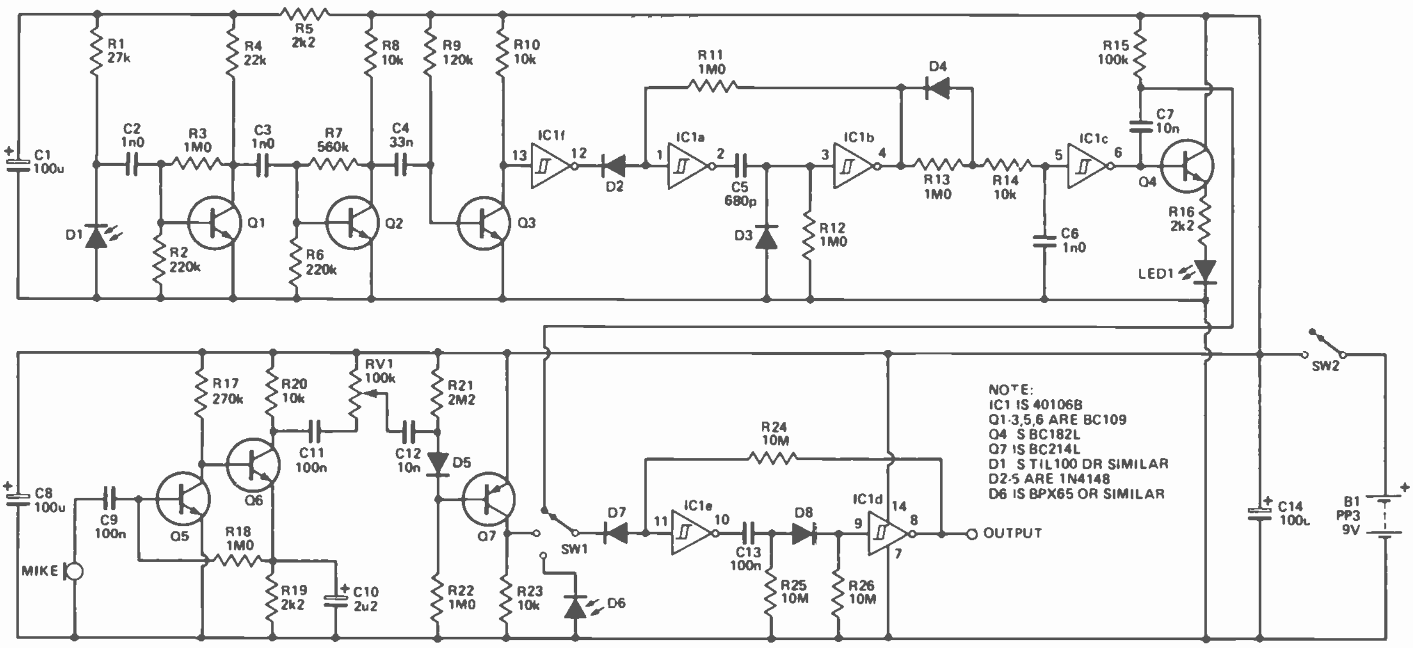


Fig. 1 Circuit diagram for the main board.

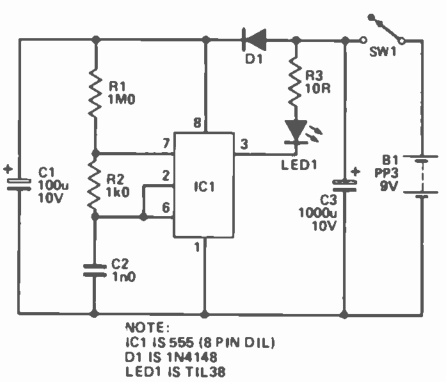
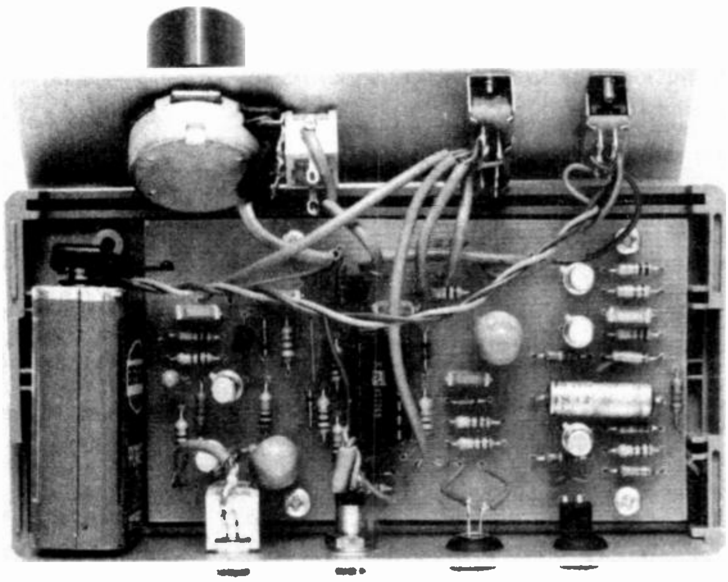
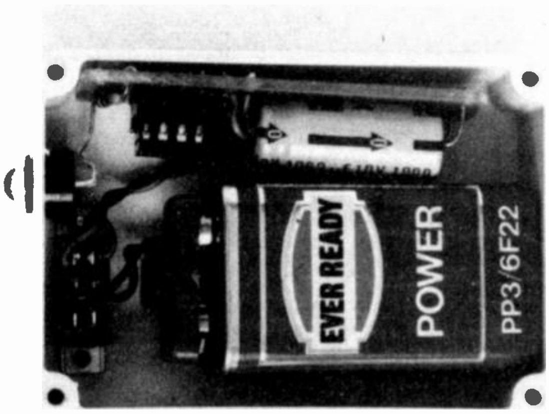


Fig. 2 Circuit diagram for the separate transmitter.



Right: Inside the main unit. Take care when wiring to the switches.



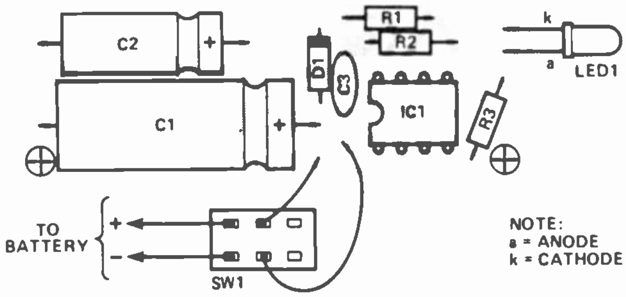


Fig. 3 Component overlay for the transmitter.
Left: A tight squeeze but it will all fit in!

PARTS LIST

Resistors (all ¼W, 5%)	
R1	1M0
R2	1k0
R3	10R
Capacitors	
C1	100uF 10 V axial aluminium electrolytic
C2	1n0 miniature disc ceramic
C3	1000uF 10 V axial aluminium electrolytic
Semiconductors	
IC1	555
D1	1N4148
LED1	TIL38 IR transmitter diode
Miscellaneous	
SW1	miniature on/off slide switch

PCB; box — Verocase 71.5 × 49 × 25.4 mm (order ref. 202-21025K); PP3 battery and clip; M2 × 5 mm screws, wire etc.

PARTS LIST — RECEIVER

Resistors (all ¼W, 5%)	
R1	27k
R2,6	220k
R3, 11-13, 18, 22	1M0
R4	22k
R5,16,19	2k2
R7	560k
R8,10, 14, 20, 23	10k
R9	120k
R15	100k
R17	270k
R21	2M2
R24-26	10M
Potentiometer	
RV1	100k logarithmic
Capacitors	
C1	100uF 10 V axial aluminium electrolytic
C2,3,6	1n0 ceramic
C4	33nF ceramic
C5	680pF ceramic
C7,12	10nF ceramic
C8,14	100uF 10 V tantalum
C9,11,13	100nF ceramic
C10	2u2 35 V tantalum
Semiconductors	
IC1	40106B
Q1-3,5,6	BC109
Q4	BC182L
Q7	BC214L
D1	TIL100 IR receiver photodiode
D2-5,7,8	1N4148
D6	BPX65 or similar visible light photodiode
Miscellaneous	
SW1	three-way slide switch
SW2	on/off slide switch

PCB; box — Verocase 125 × 65 × 39 mm (order ref. 202-21048D); two off 3.5 mm miniature jack sockets and plugs; miniature crystal microphone; PP3 9 V battery; M2 × 5 mm screws, wire etc.

Setting up

The infra-red beam link may need a little adjustment for best operation. While doing this it will be necessary to shade the receiver from room lights and other sources. First, switch on the transmitter and place its LED close to the unmarked side of the photodiode (this should be the side nearest the rear panel and visible through the hole in it). Make sure that the 'beam-on' LED lights up. Keeping the transmitter LED pointing toward the receiver, move it away until the indicator LED goes out. Adjust the receiver LED so that it comes on again. Repeat this until a range of about 1 metre is achieved.

The visible light photodiode should not need much attention unless it is too sensitive. If this is the case, it can be de-sensitised with a small piece of masking tape or similar material over the front surface.

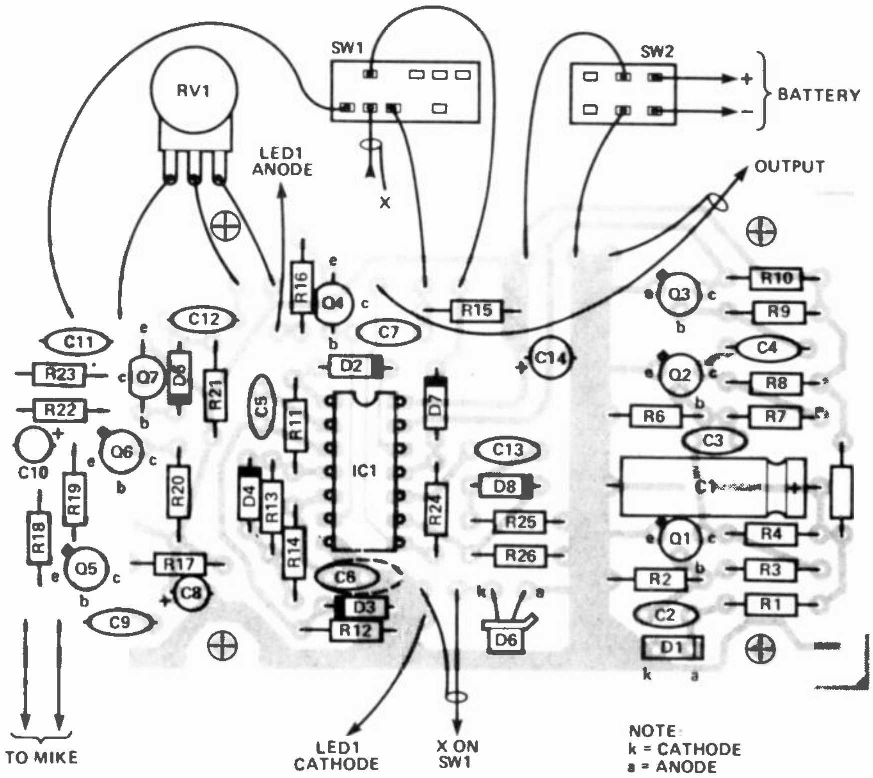


Fig. 4 Component overlay for the trigger unit main board.

ETI

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74LS11	13p	74LS162	38p
74LS12	12p	74LS163	38p
74LS13	16p	74LS164	40p
74LS14	25p	74LS165	60p
74LS15	12p	74LS166	80p
74LS20	12p	74LS168	85p
74LS21	12p	74LS169	85p
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74LS26	12p	74LS173	55p
74LS27	13p	74LS174	40p
74LS28	14p	74LS175	40p
74LS30	12p	74LS181	90p
74LS32	13p	74LS183	120p
74LS33	14p	74LS190	38p
74LS37	14p	74LS191	38p
74LS38	16p	74LS192	38p
74LS40	12p	74LS193	38p
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74LS47	38p	74LS195	36p
74LS48	46p	74LS196	46p
74LS51	14p	74LS197	46p
74LS54	14p	74LS221	50p
74LS55	14p	74LS240	56p
74LS63	120p	74LS241	56p
74LS73	18p	74LS242	66p
74LS74	18p	74LS243	66p
74LS75	18p	74LS244	66p
74LS76	17p	74LS245	70p
74LS83	38p	74LS247	50p
74LS85	48p	74LS248	56p
74LS86	18p	74LS249	56p
74LS90	22p	74LS251	38p
74LS91	66p	74LS253	35p
74LS92	32p	74LS257	30p
74LS95	40p	74LS258	36p
74LS96	60p	74LS259	66p
74LS107	20p	74LS260	20p
74LS109	27p	74LS261	138p
74LS112	20p	74LS266	20p
74LS113	20p	74LS273	80p
74LS114	22p	74LS275	225p
74LS122	28p	74LS279	30p
74LS123	34p	74LS280	100p
74LS124	90p	74LS283	40p
74LS125	24p	74LS363	140p
74LS126	25p	74LS364	140p
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74365	40p
74366	40p
74367	40p
74368	60p
74390	88p
74393	88p
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BC178	16p
BC179	20p
BC182L	10p
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BC213L	10p
BC214L	10p
BC547	12p
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BC549C	14p
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BFY52	23p
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4081	14p
4082	16p
4086	65p
4089	128p
4093	24p
4094	80p
4095	78p
4096	70p
4501	28p
4502	60p
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CA3130T	110p
CA3140T	80p
CA3140E	60p
CA3160E	100p
CA3161E	160p
CA3162E	450p
CA3189E	300p
CA3240E	110p
CA3280G	200p
LF347	[illegible]
LF351	[illegible]
LF353	[illegible]
LF355	[illegible]
LF356	[illegible]
LF357	110p
LM301A	25p
LM310	120p
LM311	70p
LM318	160p
LM319	215p
LM324	30p
LM334Z	80p
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LM339	50p
LM348	65p
LM380	75p
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NE531	140p
NE544	160p
NE555	16p
NE556	46p
NE564	420p
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NE566	158p
NE567	140p
NE570	410p
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DL707	115p	TIL322	99p

ZENER DIODES
2.7-33V 400mW 9p

THYRISTORS

5A 400V	[illegible]	BT116	[illegible]
5A 600V	[illegible]	C106D	[illegible]
8A 600V	[illegible]	TIC44	24p
12A 400V	[illegible]	TIC45	[illegible]
BT106	[illegible]	TIC47	[illegible]
		2N5062	32p
		2N5064	[illegible]

OPTO ISOLATORS

IL74	65p
ILD74	[illegible]
ILQ74	[illegible]
TIL111/2/4	[illegible]
TIL117	125p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
2A 100V	30p
2A 400V	46p

DIODES

0A47	8p
0A90	9p
0A91	9p
0A200	9p
0A202	9p
1N914	4p
1N916	7p
1N4148	4p
1N4001	5p
1N4004	6p
1N4007	7p

ELECTROLYTIC CAPACITORS
(Axial & Radial) Values in uf.
63V: 1, 2.2, 3.3, 4.7, 6.8, 10 6p; 15m 22m 33 8p.
40V: 330, 470 48p; 1,000 48p; 2,200 70p.
25V: 47, 100 8p; 220, 330 12p; 470 25p; 680, 1,000 34p; 2,200 60p; 3,300 78p, 4,700 92p.
16V: 470 14p; 1000 20p.
10V: 1000 16p; 2200 25p.

TRANSFORMER
Min Split Bobbin
Primary: 240V
Secondary: 6-0-6, 9-0-9, 12-0-12, 24-0-24
PCB Mounting

3VA	280p
6VA	270p
Standard	
6VA	220p
12VA	285p
24VA	330p

POLYESTER CAPACITORS (Radial Lead) 250V.
10n, 15n, 22n, 33n, 47n 8p; 68n, 100n 8p; 150n, 220n, 330n 10p; 470n 150p; 680n 20p; 1000n 25p.

DIAC
ST2 25p

MYLAR FILM CAPACITORS (Radial Lead) 100V
1n, 1n5, 2n2, 3r3, 4n7, 6n8, 10n 6p; 15n, 22n, 33n, 47n 8p.

CERAMIC CAPACITORS 50V (Radial Lead).
22pf – 47,000pf E12 Values 4p each.

DIL SOCKETS
Low Profile

8 pin	8p	20 pin	22p
14 pin	10p	24 pin	25p
16 pin	10p	40 pin	30p

POTENTIOMETERS:
Carbon track, 0.25W log & linear

5K-2M single gang	30p
5K-2M single gang D/P switch	78p
5K-2M dual gang stereo	88p

PRESET POTENTIOMETERS
Horizontal & Vertical

0.1W	100R-1 Meg	7p
0.25W	100R-1 Meg	10p

RESISTORS 5% Carbon Film
E12 values.

0.25W	1R-5M	1p
0.5W	1R-5M	1.5p

SWITCHES

Slide 1A

DPDT	14p
DPDT c/off	15p

Sub-min Toggle

SPST on/off	54p
SP c/over	60p
DPDT	75p
DPDT c/off	88p

Push Button

Push to Make	15p
Push to Break	25p

VEROBOARDS 0.1in

	clad	plain
2½ × 3¾"	73p	62p
2½ × 5"	83p	–
3¾ × 3¾"	83p	–
3¾ × 5"	95p	79p
3¾ × 17"	325p	211p
4¾ × 18"	425p	–
Pkt of 100 pins	50p	
Spot face cutter	118p	
Pin insertion tool	182p	

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

AUDIOPHILE

Stop press. Just in time for this issue, Vivian Capel supplied a report on the topical and apparently revolutionary Hugo Zuccarelli and Holophonic Head. Don't go away, it isn't a music hall act . . .

What caused hard-bitten cynical audio experts to gasp in amazement? What produces multi-directional sound from two channels; and still does so when one channel is switched off? What has put conventional stereo, and even quad, into the same class as the wind-up trumpet gramophone? What modern discovery has been clouded with more myths and confusion than The Ring? Who or what is Ringo?

The answer to all these questions lies in the new brainchild of 26-year old inventor Hugo Zuccarelli, the Argentine-born Italian now resident in London. The system is termed holophony after a claimed, though rather tenuous, comparison with holography.

It seems that Mr. Zuccarelli has been musing over the principles of holophony for a long time, since he was nine no less, but it wasn't until October 1981 that he filed a European Patent Application which describes his invention and gives patent protection in nine European countries.

Since then, particularly in January and February of this year, there have been press demonstrations and a TV programme in the 'Real World' series. The results of these have been impressive indeed, with audio experts and reviewers being converted from scepticism to astonished acceptance. Neurophysiologist Dr. Martin Rosenberg of London University has joined the redoubtable Angus Mackenzie (who is not given to extravagant praise) in acclaim with phrases such as "quite striking and novel," and "absolutely remarkable."

Sounds Interesting

So what was the cause of all the excitement? The demonstrations were conducted with recordings played through a pair of conventional stereo headphones, although a pair of stereo speakers suitably placed will give the same result. This immediately strikes a favourable note, as it means that potential users do not have to buy or change expensive hi-fi, or find room for extra speakers as with the defunct quad systems. Existing speakers can do the trick, with perhaps a move from the usual stereo front location to a side position. Another proviso we shall see later.

Some of the recorded material was played by digital recorder, but there were also recordings from an ordinary stereo cassette machine. There was no evidence of a special decoder (as needed with the quad systems): in fact there was little different from an ordinary stereo system — except the recordings.

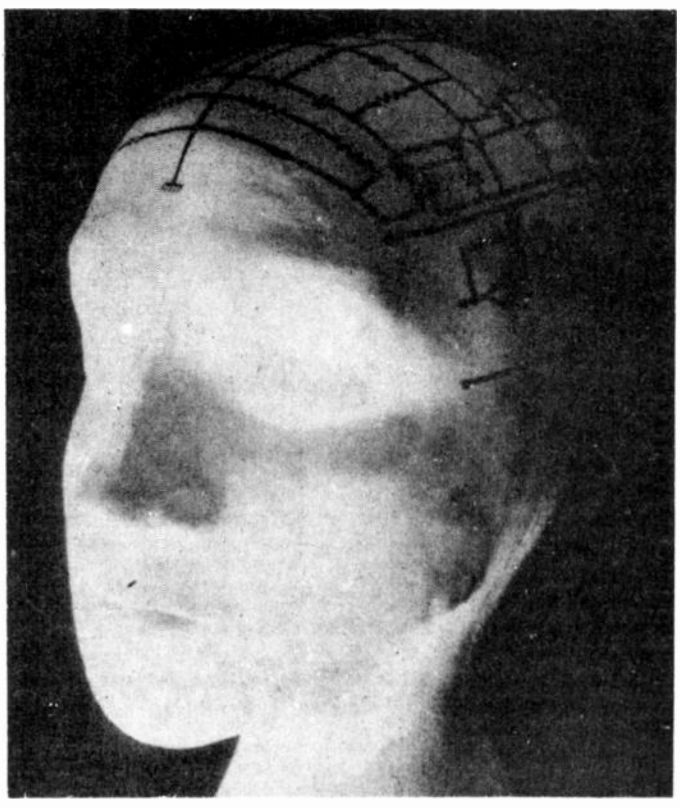
These consisted of everyday sounds rather than music, and so were more readily comparable to normal experience; people moving about and talking, matches being struck, birdsong and jet aircraft. The remarkable thing was that in every case the exact location of the sounds could be pin-pointed. Not only in front, as is the case with normal good stereo, but at the sides and the back, and even overhead and below at floor level. There was a complete sphere of locatable sound sources. This demonstrated the superiority over quad systems, which imperfectly create the illusion of 'surround sound' and fail to give a height dimension.

The degree of realism was so great as to produce descriptions such as 'terrifying' from the subjects — especially when the experience took place in a darkened room, and the eyes could not contradict the evidence of the ears. One auditioner spoke of withdrawing his feet instinctively as he heard someone walking directly in front of him, the sound of footsteps coming unmistakably from the floor, while another claimed to have felt the "heat" from a match that was struck in front of his face. Those listening in a normally lit room but with eyes closed as instructed, frequently had to open them to reassure themselves that it was only a recording.

Myths And Legends

There is then no doubt, that the system does work, and it works quite remarkably. The question (and it is a big one) is HOW does it work?

Although protected by patent, Zuccarelli is more than normally protective in guarding the secret. Perhaps he has good reason to be, as imitators in the past have not found it impossible to get around patents. So, in addition to be-



ing vague in describing the principle of working, he has disseminated half-truths which have been interpreted in various ways by journalists, mostly with completely erroneous 'explanations'. Also statements have been made which are quite misleading.

The result, as readers who may have seen press reports in other magazines will have gathered, is confusion and conflicting theories. Some of these appear to be contrary to the known facts of physics and biology, and unfortunately have done little to raise the system's credence in the minds of doubters. It is a pity that what is undoubtedly a genuine breakthrough should be so surrounded by clouds of suspicion and scepticism.

Let us take a look at what has been already published. Firstly, the name holophony is meant to imply a similar mode of operation to that of holography. With this, a beam from a coherent light source such as a laser is split into two parts. One is the reference beam which is directed at a photographic plate or film. The other illuminates the object to be photographed from which reflections are also received at the plate. These are delayed by reason of the extra distance they have travelled, the delay thus being proportional to the depth of the object.

The object beam is now has a slightly different phase than the reference, and re-combining them at the photographic plate produces interference patterns. Where there are no reflections from the object such as from holes in its surface or beyond its boundaries, there are no patterns on the plate, only the reference beam.

Thus the plate carries two-dimensional information corresponding to the flat or frontal appearance, but in addition it has information reagarding the depth as conveyed by phase differences and the resulting patterns. So the original image in depth can be reconstituted with the use of a laser.

Your Theory Is Crazy . . .

In an attempt to reconcile this principle with the claimed workings of holophony, writers have tried to idenfity the two components, the signal and reference, and have met with trouble, especially in the case of the latter. They report Zuccarelli as asserting that the ear is not a receiver but a transmitter. It actually radiates a sound which interacts with the incoming pressure waves and compares them to produce a resultant signal which somehow has spatial information.

A variant of this is that the reference is like 'pink' noise (the audio technician's term for noise in which each octave of random frequencies contains equal power, in contrast with 'white' noise where the power increases according to a square law for each rise in octave), and that we call this noise 'silence'. Incoming signals are alleged to mix with this and thereby become spatially identifiable.

There are two obstacles to this theory. One is that there seems to be nothing published in the medical and biological books as to the ear radiating sound — strange that such a phenomena has passed unnoticed before!

The second is that, even if true, in what way could the mixture of an internally generated signal and the external ones identify the location of the latter? Remember that with the hologram, the reference and object beams originate from the same source, and it is the displacement from the phase of the original that conveys the spatial information in the reflected one.

Mr Zuccarelli is also reported as saying that he communicates directly with the brain: "We actually record brain codes". As we shall see, spatial coding which the brain unravels as spatial information certainly does take place, but such a statement is rather misleading. It suggests that sound and the ears are not involved at all, in which case one might expect to have electrodes implanted in the head in order to accept the recorded signals!

This mysterious non-auditory concept of the recorded signals is further heightened by Zuccarelli's reported emphatic denial that microphones are used at all in the recording process. In fact this is simply not true; two cardioid microphones with a minimum diaphragm diameter of 7 mm are employed as transducers in the recording device.

Allusions to 'encoding', the 'generator', and the coments that "if an electronics expert were to examine the latter it is unlikely he would understand it", all serve to enhance the aura of way-out complexity, and discourage too-close investigation. We are further told that Hugo would never sell the secret, and that "someone might find it in 10 or 20 years".

All highly intriguing stuff, but having blown away the chaff, let us see what remains.

Limitations Of Traditional Hearing Theory

The traditional explanation of how we distinguish the origin of sounds is that the pressure waves reach one ear slightly later than the other, thus giving rise to a phase difference. Furthermore, the amplitude is marginally greater at the nearer ear. The head casts an acoustic shadow, thus giving rise to these effects. The extent of the phase and amplitude differences depend on the sound location, allowing us to sense direction.

Zuccarelli correctly points out that this theory is inadequate to explain all the facts of spatial identification in hearing. For example, persons who are completely deaf in one ear can still identify sound-source locations, although to a limited extent. According to the theory they should have no spatial information at all.

You can check this for yourself by closing your eyes and plugging one ear, then getting someone to rattle a box of matches or some keys at various points around your head. You will find that the locations can be closely identified both laterally and vertically, especially around the hemisphere of the exposed ear.

Another fact is that two microphones placed on either side of a dummy head in the position of the ears will indeed give a spatial location to sounds coming from the front, this being the way binaural recordings are made. However, the effects are ambiguous: sounds from the rear have the same effect and there is no way they can be distinguished. Furthermore, there is no means of telling whether sources are high or low-height information is absent.

Now why should this be? We have only two auditory receptors on our heads, just like the microphones. We have no hearing organs on the top or at front or back, only at the sides. Yet these can identify sound sources in any direction, and for good measure, whether they are near or distant! How? Why?

Holophony

By asking questions such as these, Hugo Zuccarelli arrived at an explanation which seems to fit all the known facts. The spatial encoding takes place as the sound enters the ear. While the head plays a part in this, the major factor is the auricle or the external part of the ear. A pressure wave enters the ear canal directly and is conducted down to the eardrum, but a larger portion is collected by the auricle (due to its larger area) and is reflected around the whorl, to follow the direct wave slightly later. The delay is small, but it does produce a phase difference, especially at higher frequencies.

If the auricle was symmetrical, then such reflections would be similar irrespective of the direction of the wave fronts. What is required is a reflector that is asymmetric in all directions. The human auricle fits this need perfectly, there being no two directions in which the reflective path is the same. Hence the delay and phase difference depends largely on the direction of the sound source. It is in this sense that the ear generates its own spatial code, by comparing these reflections with the direct sound originating from the same source.

Thus the similarity with holography can be more clearly appreciated and the term holophony justified.

Reflection of a sound pressure wave only occurs to any degree when the reflecting surface is a quarter-wavelength in size or larger. The spatial location facility would therefore be expected to be frequency-dependent. Frequencies above 3.4 kHz are well handled by the shortest auricle dimension, and down to 1.4 kHz by the longest. Below this, the head itself comes into play at frequencies down to 450 Hz, although with rather less precision.

It must be remembered, though, that there are few if any natural sounds that are pure fundamentals; nearly all consist of fundamental plus a varying number of harmonics. Thus a sound in the low frequency range could be spatially located by reason of its harmonics.

This is in accord with common experience; low frequency sounds with few harmonics are notoriously difficult to place. Have you ever tried to locate the source of a mains hum from several separate pieces of equipment? Or the direction of a distant explosion? Such low frequencies travel through the auditory system without modification and so without any spatial coding.

The theory also fits the phenomena of the retention of restricted locational ability with one ear only. One of the things that can be affected by hearing in mono is the facility for judging the distance of a sound. Each ear fixes the direction, and if the directions are notably different it must be because the sound source is near. Conversely a virtually similar direction means the source is distant.

All this information is fed to the brain which supplies an instantaneous fix on the location of any sound. Thus it serves as the decoder of the data encoded by the external ear and its orifice.

Recording

So now we come to the big question; how can audio signals be recorded and encoded to simulate our natural direction-finding mechanism? It doesn t take long to arrive at the conclusion that the best way is to copy nature. If an artificial head is constructed that contains an auditory system closely resembling that of the human head, but has microphones in the position of the ear drums, then the sounds picked up by them will have spatial coding just as those reaching the natural ear drums. The same phase displacements and diffractions are all present.

This is the basis of Zuccarelli's system; an artificial head called Ringo. Of course artificial heads have been used before for making realistic binaural recordings, but these have not duplicated the auditory system with any accuracy, and their main object is to simulate the acoustic shadow of the human head between the ears.

Ringo is quite different. The head is made of a plastic material such as polystyrene and rubber, and has two ears which faithfully copy the auricle of the human ear. These lead into cavities which again duplicate the ear orifice, and from there pass into the auditory canal. This is some 24 mm long, the first 8 mm of which is the same plastic material as the auricle, but the remaining 16 mm is lined with a more rigid plaster coating. This is to simulate the fibro-cartilaginous and bony portions of the human canal respectively. It is of elliptical cross-section which is twisted

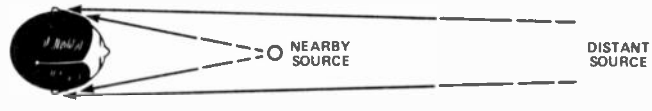


Fig. 1. The received sound from a nearby source makes different angles at each ear. From a distant sound the angles are vitually the same. The brain interprets the directional differences between the ears in terms of distance.

through about a quarter turn, and has an abrupt dilation some half-way along. Thus the internal contour of the human channel is closely duplicated.

At the end of each canal is a cardioid microphone oriented in the same plane as the ear drum. Cardioid microphones are not pressure-operated but are exposed at the rear of the diaphragm, giving them the pressure-gradient or velocity mode of operation. The ear drum is also not enclosed at the rear but opens through a tube known as the Eustachian tube into the pharynx at the top of the throat. By means of this, air pressure is equalised on both sides of the ear drum.

In a similar manner, a tube runs from the back of each microphone diaphragm to a large cavity which corresponds to the human oral cavity. In this way, the acoustic properties of the Eustachian tubes and oral cavity (which influence the result although they may not be in the direct sound path) are duplicated. Microphone cables pass out through the oral orifice.

It was found in the development of the head that the identification of front and rear sounds was influenced by the presence of hair. In fact, it seems that men who are bald are less able to distinguish between certain front and rear originating sounds than those with normal hair (one wonders if a hat might improve the ability in such cases). Anyway, Ringo is also equipped with a wig, and so has all the features for accurate spatial sound identification demanded by the theory.

Reproduction

Recorded sounds are amplified in the usual way and fed to a pair headphones or loudspeakers. They are heard by listeners, but because they include the natural spatial coding, the brain interprets them as coming from some location relative to the listener corresponding to that of the original sound relative to the recording head.

So far so good, but in entering the listener's ear do not the reproduced sounds ungergo a spatial coding again and so present the brain with a doulbe coded signal? The short answer must be yes, and if the reproduced sounds were *actually* coming from various directions the brain would be much confused.

However, the *real* direction of the reproduced sounds is fixed; in the case of headphones, it is on an axis with the ear. The sounds are therefore unidirectional and no different spatial coding takes place in the ear. The recorded coding provided by the dummy head herefore takes over, and the brain responds. We can therefore regard the side position as a mean point or reference from which the apparent direction deviates according to the recorded coding.

However, as may be expected, the human auditory system consists of various air chambers producing resonances, and some frequencies are favoured at the expense of others. According to the International Standard Loudness Contours, peaks in human hearing occur at 400 Hz, 4 kHz, and 12 kHz, these being the average over a large number of subjects tested.

The dummy head also has resonances, although these are somewhat lower at 2.5 kHz and 7.5 kHz. Like the human hearing system, the peaks are due to the fundamental and third harmonic.

If uncorrected, these peaks would appear in addition to those present in natural hearing and would result in a distorted frequency response. They play no part in the spatial coding, so can be ironed out without any detriment to the working of the system.

Correction can be done by means of acoustic boxes in the head near the microphone diaphragms, but more conveniently it is done by connecting an equaliser circuit somewhere in the recording chain.

It was also found in developing the system, that sounds coming from the front and rear differed in their frequency response from those facing the ear at the side. Front radiated sounds emphasize the high frequencies, while those from the rear accentuate the low. Furthermore, there is a displacement between the fundamental and harmonics caused by the auricle reflection, and these also differ according to the direction of propagation. All this adds to the spatial coding.

Earlier the point was made that holophonic recordings need no decoder other than the brain, and so can be played on any domestic playing equipment, disc or tape. This is true but there is one proviso: hi-fi speakers having two or more units fed by a crossover network may not be suitable. The reason is that these often introduce phase anomalies. Since it is the subtle phase differences that constitute the spatial codification, any other introduced by the speakers (or amplifiers, for that matter) would disrupt the code.

The best type of loudspeaker for holophonic material is a single wide-range driver. Alternatively a multi-driver speaker may be used providing it has been designed to give zero phase shift between the drivers. Some have been produced with this characteristic.

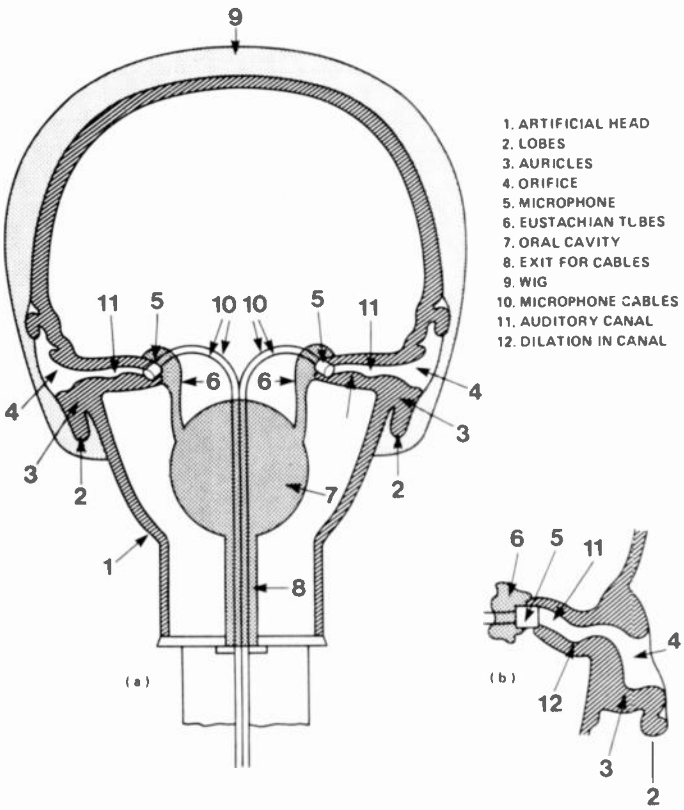


Fig. 2. The anatomy of Ringo.

Future Prospects

As prospective users do not have to equip themselves with special players or decoders, and the results are so startlingly better than conventional stereo or quad, the future of holophony would appear to be bright. As one-channel reproduction gives results almost as good as twin-channel, even cheap mono player users could benefit.

The technique could be used in broadcasting and television to considerably enhance some of the existing dreary fare. All that is required is to convince the upper echelons of the BBC and ITA of the fact. Unfortunately, the confusion and mysticism surrounding the subject won't have improved its chances there.

On the recording front things are more hopeful, with discs being made and more on the way. So far (as might be expected) the recordings are of pop, but serious music lovers may well imagine the effect with a large-scale choral work. In live broadcasts, the coughs and programme rustling come from various points behind and would be less intrusive (as at an actual performance) than they usually are when broadcast. Imagine what could be done with broadcast drama with the constraints of the small television screen replaced by a wide stage stretching all round. The possibilities for creative use are almost without limit.

Hugo Zuccarelli and his associate Mike King have formed a company, Holophonic Zuccarelli Laos Ltd, for the exploitation of holophony. Ringo is understood to be an active partner!

Postscript

Since preparing the above article, I have had the opportunity of a conversation with Hugo Zuccarelli. He blames the confusion surrounding holophony entirely on the journalists who have reported it and describes their efforts in rather strong terms that I would prefer not to repeat. Now it is true that non-technical reporters writing for the popular press often get the wrong end of the stick when reporting on technical matters, and many use their imagination to fill in the bits they don't know. However, the extent of the misinformation in this case points to a paucity of information at the source. I found this to be true myself; in response to my request for details and specific questions about the system, I received merely a montage of photocopied press-cuttings. These just underlined the confusion of the reporters who wrote them. Accordingly I had dig elsewhere and pursue other channels for the information.

Now this may be due to inexperience in PR and disseminating accurate information to the press — a fault not unknown in more established enterprises — or it could be attributable to the aforementioned caution over giving too much away to potential competitors.

In our conversation he maintained that holophony does not consist of recorded sound, and referred to the analogy of the hologram which is not a record of a picture as such but interference patterns. True, but a hologram is a recording of *light*, although in a different pattern from a normal photograph. Similarly holophony is a recording of *sound* which can be defined as vibrations in air that produce sensations of hearing, even though these contain spatial-encoded phase delay.

If this were not so, holophonic recordings could not be reproduced directly through headphones and loudspeakers.

It seems that Mr Zuccarelli restricts his definition of sound to the original propagations from the sound source, and this could well be responsible for the confusion and some of the more fanciful descriptions. **ETI**

READ/WRITE

Letters for this page should be addressed to Read/Write at our Charing Cross Road address.

Dear Sir

I was most disappointed to see your article on FEVAs or Valves, in the April edition of ETI. I see enough stupidity in the world without reading it in electronics magazines.

I can do without that sort of rubbish. You have just lost one regular customer.

Yours sincerely,
K. J. Sparkes, BSc, AIEE, ARCS,
Hemel Hempstead.

Dear ETI

Any prizes for spotting the April fool? Mind, the FEVAs nearly had me fooled — I read half the article like a lamb — then it clicked!

Nice try — ETI!
Margaret Hibbert,
Pontypridd.

Dear Sir

Please find enclosed a photo of a FEVA in my possession. It was found that Bakelite did not like high temperatures, and the pins were a little weak. An Edison screw was much more robust, and, as you can see, it is the No. 6 Valve.

This one is brand new; the heater is low voltage for safety and runs very bright. Ideal for reading ETI by.

Name and address supplied.

You can please some of the people some of the time ....

Dear ETI

Your RAM has had a power failure. Gareth Lee (Read/Write October 1982) wrote asking you about expander/compressor noise reduction circuits and you FORGOT even to MENTION your own — November 1977 — "COMPANDER" based on the NE571. I built one and it did have some unsatisfactory features: the record/play switch and compression ratio switch introduced noise and made tape monitoring impossible, but a Mark II version using one NE570 per channel and based on the "100 Circuits" design works well and produces a major noise reduction. Mark III — using 4066s to control expansion/compression ratio — is now on the breadboard.

Howard B Broughton
Putney, London

We look forward to receiving a Tech Tip from Howard!

Dear Sir

I read with interest your article in the April 1983 ETI, using our MM58174AN (the Real Time Clock — Ed.) Unfortunately, the design breaks many of the design rules for using the part.

1. The diode derived supply will be typically 4.3 volts normally, well out of spec. This will cause read errors. It may also cause latch up if any pin is driven above 4.3 volts. This is usually destructive.

2. The write protect switch SW1 is a good idea, but will not prevent IC6 and IC5c producing glitches on power up/down, causing erroneous data to be written into the MM58174AN. This is a common but serious design fault, and typically stops the clock or corrupts data during power down.

3. Most 6502 based systems demand memory and peripherals with an access time of less than 1 microsecond. The MM58174AN does not meet this requirement, having an access time of 1.2 microseconds at 5 volts and 25 deg C. At 4.5 volts and 70 deg C, this increases to 1.9 microseconds. Clearly wait states must be introduced. Typically some registers will be read correctly and others will not if this important parameter is ignored.

4. I commend your designer for fitting C5, many people fail to realise its importance. Ideally it should be 12 or 15 pF, but 10 pF will probably be OK.

5. You correctly state the importance of reading all required registers of the MM58174AN in 100 mS, which is tricky in BASIC, but make no mention of servicing the Interrupt, which is somewhat involved.

6. The PCB track to pin 15 (clock in) should be moved further away from the track to pin 12 (AD0), or noise may be coupled in causing the clock to run fast.

Quirky behaviour may be tolerable in some home constructed equipment, but I honestly believe that your readers will demand utter reliability from a real time clock if it is to have any practical value.

My fear is that many of your readers will waste their time building a real time clock card that doesn't work very well. They will probably blame the component and waste the manufacturer's time, craving advice and assistance. They will probably also waste much of your time, by phoning and writing to ETI.

Sorry to sound super critical, but I have spent three years helping and persuading people to use the MM58174AN properly, and I think you have undone it all!

Yours sincerely
D.E.Brown,
Applications Manager,
National Semiconductor (UK) Ltd.

The author replies:

Taking National Semiconductor's points in order:

1. If a supply voltage of 4V3 is "well out of spec", then the data sheets contain wrong information. I have both an N.S. and an R.S. data sheet for the device, both of which quote a minimum supply voltage of 4V0.

2. Whereas in theory I accept that powering up/down could cause glitches on CS and NWDS hence corrupting data, I haven't found in practice that this happens. If the device is prone to this sort of problem, it is unfortunate that it is not mentioned in the data sheet which in actual fact suggests the contrary. The N.S. data sheet describes a typical microprocessor application in which the circuit diagram includes a battery back up and is therefore intended for uses in which it will be powered up and down without resetting the MM58714AN. This circuit contains no write protection facility at all, CS and NWDS being connected directly to the bus.

3. I was concerned whilst designing the RTC board that the access time on the MM58714AN was rather long for the 6502 processor. However, since an alternative method of interfacing would have greatly increased the complexity of the board, I was tempted to experiment with the configuration actually used. The circuit proved to be successful in practice and my choice of this configuration was confirmed when I encountered a similar circuit in another magazine (Shame! — Ed). I have more recently spoken to the author of this article who informed me that the circuit was closely based on applications information supplied by R.S. Components and that the circuit has also been manufactured on a commercial basis with no problems.

4. No comments.

5. I would imagine that no more than 5% of readers building this board would wish to use it in the interrrupt mode. It was therefore my intention to make mention of the fact that the board could also be used to generate interrupts without using a lot of space to describe something that would be of interest to a small minority. Obviously any reader intending to use interrupts may obtain all the relevant information from the data sheet.

6. I have noticed that the RTC does in fact run slightly fast. I had originally explained this as being due to the tolerance of the crystal, as the inaccuracy is no greater than that which I experience with my digital wrist watch which presumably uses a similar chip and crystal. I would imagine that the comment made by N.S. is a more likely explanation. It is a pity that if the circuit board geometry is so critical to the correct operation of this device that no mention of this requirement is made in the data sheet.

To summarise, I think that the following two points sum up my thoughts:

A. The board does in fact work.

B. All but one of the points above could not have been discovered by reading the data sheet. Perhaps there is a need here for a more accurate and more detailed data sheet.

Mike Bedford

ETI

POWER SUPPLY PART 2

Before powering up the complete supply it is better to check each of the control circuit functions separately. The first check should be the auxiliary power supply for the control IC. Connect an isolated 12 V power supply to V_A and check that the current is not greater than 200 mA. Verify that the collector waveforms of Q3, Q4 and the waveform at the gate of each HexFET is as shown in the photographs at the end of last month's article.

The next task is to set up the dead time. With a dual trace scope connected to pins 11 and 14 of IC1, adjust the preset PR3 so that the dead time measures 1.5 microseconds.

To set up the current limit circuit, disconnect R15 and apply a voltage of 550 mV in its place. With the scope connected to pin 11 of IC1, adjust preset PR1 until the waveform disappears. The current limit is now set for about 5.5 amps.

To adjust the stabilisation circuitry, connect an auxiliary adjustable power supply across the output terminals (making sure you follow the polar ty), and slowly increase the voltage from zero to 12 V. With the scope still connected to pin 11 of IC1, check that the frequency of operation changes from 40 kHz to 75 kHz as the voltage passes through 5 V. This confirms that the short circuit protection is working. When the voltage reaches 12 V, adjust the preset PR2 until the waveform present at pin 11 disappears.

Now the power supply is ready to be powered up. Connect the main line to the AC input through a variac, and connect a load to the output. Slowly increase the input voltage and verify that the supply begins to operate. With a nominal 220 V AC input adjust again, if necessary, PR1 and PR2. If everything is working correctly, remove the variac and plug the supply directly into the AC mains for normal operation.

TABLE 1

Output Inductor L1: Siemens pot cores 30 x 19 AL400, with 20 turns of 1.4 mm diameter enamelled copper wire in three layers (7 turns per layer). L = 160 uH ±5%.

Power Transformer T1: Siemens pot cores 30 x 19 AL10500; Primary P1, 24 turns of 0.355 mm diameter enamelled copper wire in one layer;
Secondaries S1, S2, 6 + 6 turns of 0.95 mm diameter enamelled copper wire wound bifilar in one layer;
Primary P2, 24 turns of 0.355 mm diameter enamelled copper wire in one layer;
insulation suitable for 220 V should be wound between each primary and secondary layer; primaries and secondaries should be wound in the order listed.

Drive Transformers T2,3: Siemens pot cores 14 x 8 AL3300-5500; Primary is 60 turns of 0.2 mm enamelled copper wire;
Secondary is 60 turns of 0.2 mm enamelled copper wire. Insulation suitable for 220 V should be wound between the primary and secondary layers.

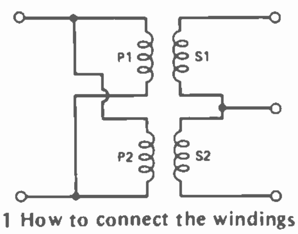


Fig. 1 How to connect the windings of T1.

Kindly Note . . .

The text for the switched mode power supply was originally written in Italian, and some errors have occurred in the translation. Please note the following corrections to the June article:

Page 36, column 2. The sentence should read "A 400 V HexFET allows a 15% margin in voltage and gives a lower loss during the conduction time than would a device with a higher voltage rating, because of its lower 'on' resistance".

Page 37, column 1. The statement before the first equation should be "— must be chosen higher than the critical value so that current circulation will *not* be stopped".

Page 37, column 2. The first paragraph should read "— the zener diodes ZD5 and ZD6 are connected in parallel with the transistors on the *primaries* of the transformers".

Page 37, column 3. The first paragraph should read "The width of this dead time is controlled by the value of the timing *capacitor* CT . . ."

Page 38, column 2. The figure referred to under DC Output Stabilisation should be Fig. 6, not Fig. 5.

In the specification, the sixth line is "100 Hz ripple", not "100 kHz ripple".

Additionally, not that the control circuit is 'grounded' to the positive rail of the output, providing a −12 V supply rather than a +12 V supply. Also, the first photo was printed upside down.

PARTS LIST

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

R1,2	390k
R3,4,15	27R
R5,6	270R
R7,8	1k0
R9-12	430R
R13	2k2 3W
R14	0R1 3W
R16	2k2
R17	1M0
R18	10k
R19	12k
R20	1k5
R21	5k6
R22,25	510k
R23,24	5k1
R26	51k
R27,28	2k49 ½% metal oxide

Potentiometers

PR1	200R multiturn cermet
PR2	2k0 multiturn cermet
PR3	5k0 multiturn cermet

Capacitors

C1,2	10nF 630 V polyester
C3,4	220uF 250 V aluminium electrolytic (switching)
C5	2u2 63 V polycarbonate
C6,7	560pF 630 V ceramic
C8,14,16	1u0 polycarbonate
C9	470pF 630 V ceramic
C10	4n7 1000 V ceramic
C11	4u7 50 V polycarbonate
C12,19	1000uF 25 V aluminum electrolytic (switching)
C13	4n7 ceramic
C15	33uF 10 V tantalum
C17	100nF polycarbonate
C18	2n21 ½% polycarbonate

Semiconductors

IC1	SG3524
Q1,2	IRF720
Q3,4	BSX32
Q5	2N3502
Q6	2N1613
D1-4	1N5408
D5,6	1N3981
D7-9	BAV20
ZD1 4	15 V, 1W zener
ZD5,6	33 V, 1W zener
ZD7	10 V, 400 mW zener
ZD8	2V7, 400 mW zener

Miscellaneous

TH1 15R NTC thermistor
L1 (see Table); T1-3 (see Table); PCB (see Buylines); heatsinks for Q1,2 and rectifier diodes.

BUYLINES

A complete kit of components for this project can be obtained from Electrovalue, 28E St. Judes Road, Englefield Green, Egham, Surrey TW20 0HB. The price is £51 plus VAT and does not include the double-sided, plated-through hole board which is available from our PCB Service for £14 plus postage and packing (see the ad on page 91).

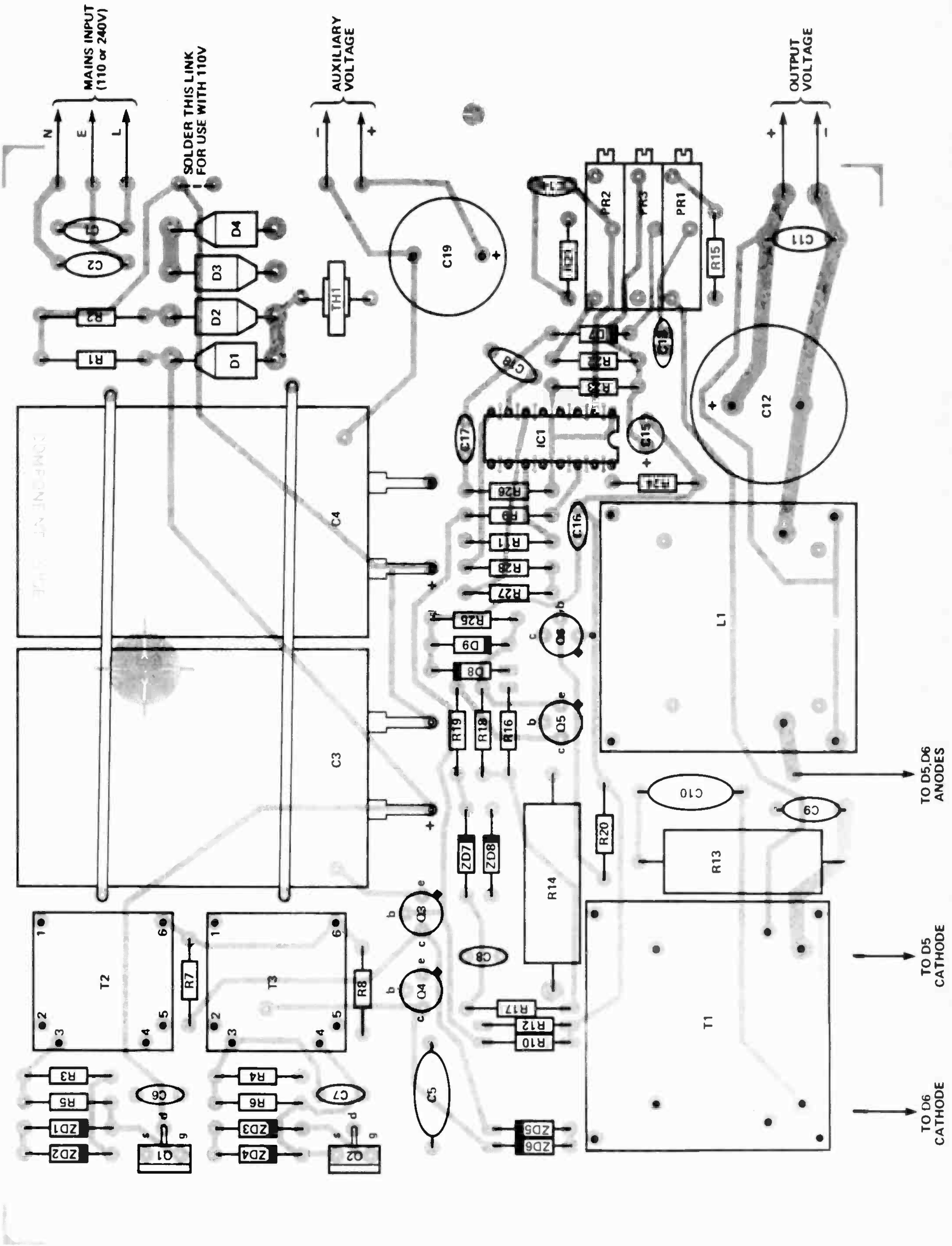


Fig. 2 Component overlay for the switched mode power supply. D5 and D6 are mounted off-board on a heatsink.

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

Write For ETI

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

We don't bother with the bureaucracy for Tech Tips — all you do is to send in your idea, stating clearly if you want an acknowledgement of receipt. If possible, please *type* your explanation of why the circuit is different, what it does and how it works, on a separate sheet from the circuit diagram; both sheets should carry your name, address and the circuit title. Unused Tech Tips will be returned.

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.

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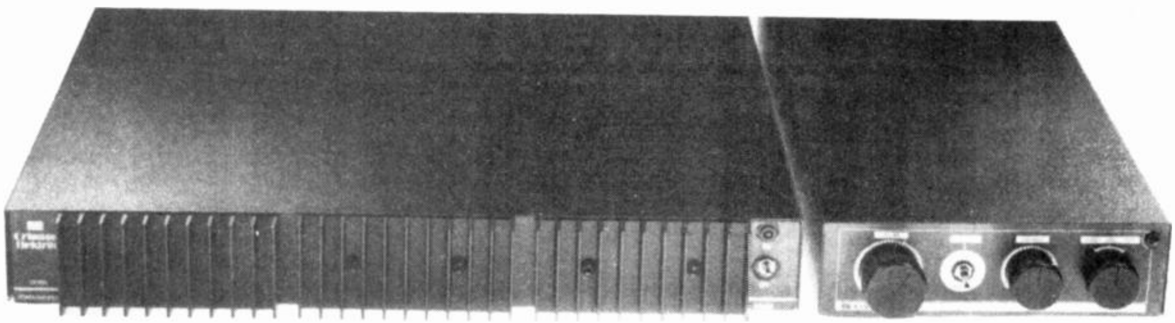

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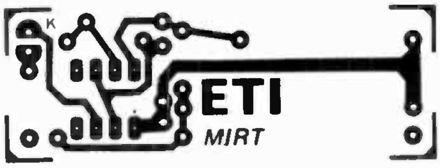

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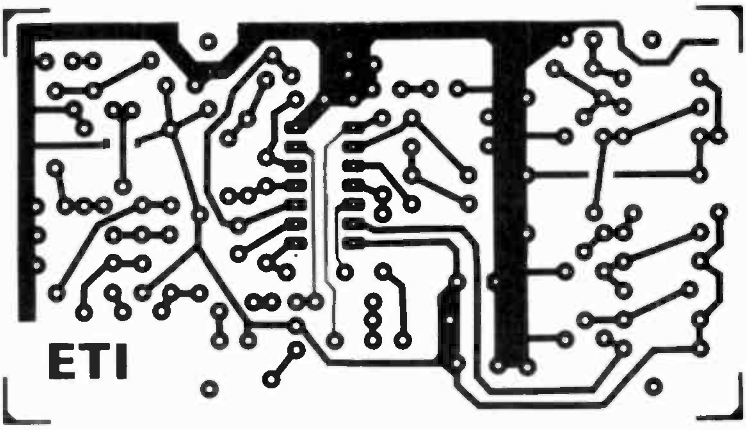

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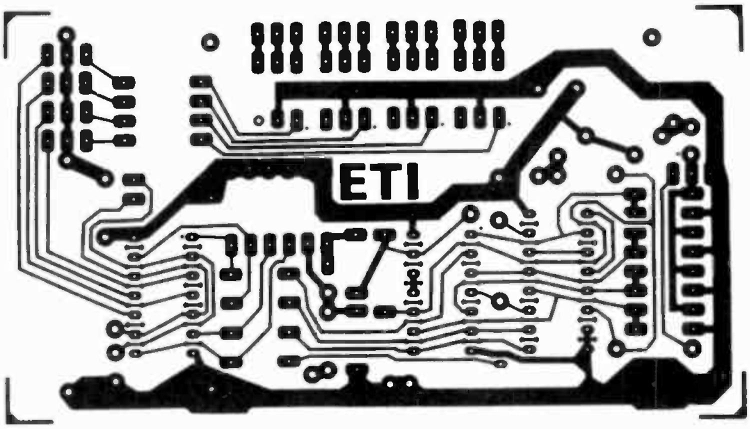

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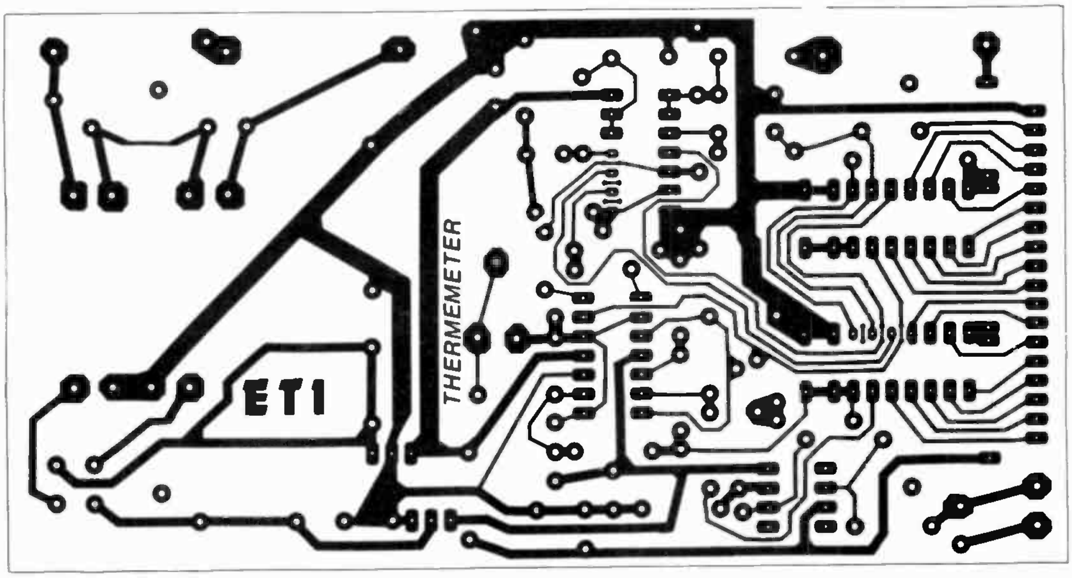

The correct version of the Thermemeter (see page 29).

ETI

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23 way edge connector	£2.50
ZX81 peripheral/RAM Pack splitter board	£3.00

MICROGRASP, INTERFACE BOARD AND ZX81

HEBOTT II

Up to the nano-second hard, firm and software developments embodied in a complete system. 12 Mega Hertz 16 bit CPU; 64K upwardly compatible DRAM; separate 16K video DRAM and 24K TI Power Basic with overwrite. Supports up to four Disc drives of mixed type with 16 serial I/O ports. Programmable Baud rate and comprehensive E Bus interface designed to support real world applications.

Very high resolution graphics gives 3D simulation in 16 colours on 36 prioritised planes of user definable characters. Software FORTH coming includes this trendy language along with NOS C/PM.

Hardware components available separately with details in Nov, Dec, and Jan issues of ETI. Software features include; Real time clock, full renumber command, buffered I/O to free machine whilst printing, call to machine code routines, hexadecimal support and user-friendly textual error trapping messages.

If computers interest you then the Cortex will expand your understanding infinitely more than off the shelf machines. Use it in business, education, research or just play with the incredible graphics capability. At Powertran we are using these machines in conventional roles, in product control and R & D. We shall co-ordinate the Cortex user group and distribute software for the TMS 9995 CPU. Complete 16 bit 64K computer kit **£295.00** + VAT. Complete 16 bit 64K computer ready built **£395.00** + VAT.

Top of the range is the Genesis P102 which has dual speed control, continuous servo operation and double acting cylinders for increased torque on the wrist and arm rotation joints. The microprocessor based control system has additional memory, position interrogation via the RS232C interface increasing the versatility of computer control and inputs are provided for machine tool interfacing.

6 axis system READY BUILT	£1950.00
Powertran CORTEX 16 bit 64K computer Kit **£295.00**. READY BUILT	£395.00

(Electronics Today International December issue on CORTEX)

GENESIS P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER

Example prices and specifications

Genesis S101
Base 19.5" × 11" × 7.5"
Lifting capacity 1500gm
Arm lift 6.6"
Weight 29Kg

4 axis model in kit form	£425
5 axis model in kit form	£475

Genesis P101
Base 19.5" × 11" × 7.5"
Lifting capacity 2000gm
Arm lengths between axles 14.0"
Weight 34Kg

4 axis model in kit form	£675
6 axis model in kit form	£595

Complete Systems as shown in Photograph above

Genesis S101

4 axis system in kit form	£681.50
5 axis system in kit form	£737.50
5 axis system Ready Built	£1450

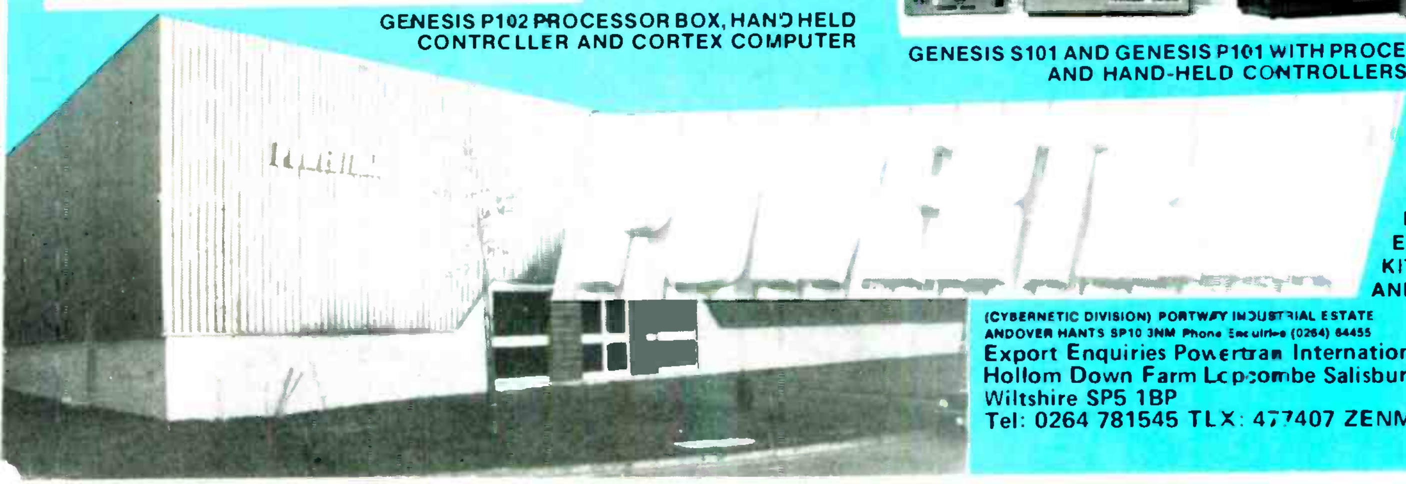
Genesis P101

6 axis system in kit form	£945.00
6 axis system Ready Built	£1650

All prices exclusive of VAT

With prices starting below £1 000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operated from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.

GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS



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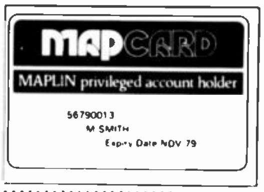

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NOW THE world-famous Heathkit range of superb electronic kits is available from Maplin — the newly appointed exclusive UK distributor. Kits range from a simple clock for beginners to a unique Robot (see pic) with which you can learn about robotics.

There is a range of training courses covering electronics and computing topics, many containing constructional projects. For full details, pick up a copy of the latest Maplin magazine or write for a free copy of our Heathkit catalogue. Order As XH62S.

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Just dial us up on 0702 552941 and you'll be able to interrogate our stock file then place your order, type in your credit card number and a few minutes after you hang up your order will print out in our warehouse ready for packing. And all without saying a word.

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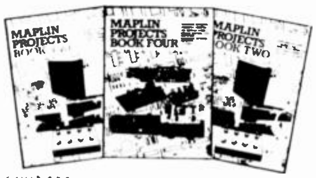
In Book 3 (XA03D) ZX81 Keyboard with electronics ● Stereo 25W MOSFET Amplifier ● Doppler Radar Intruder Detector ● Remote Control for Train Controller.

In Book 4 (XA04E) Telephone Exchange for 16 extensions ● Frequency Counter 10Hz to



600MHz ● Ultrasonic Intruder Detector ● I/O Port for ZX81 ● Car Burglar Alarm ● Remote Control for 25W Stereo Amp.

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In Book 6 (XA06G) Speech Synthesiser for ZX81 & VIC 20 ● Module to Bridge two of our MOSFET Amps to make a 350W Amp ● ZX81 Sound on your TV ● Scratch Filter ● Damp Meter ● Four Simple Projects.

In Book 7 (XA07H) *Modem Interface for ZX81/VIC20 ● Digital Enlarger Timer/Controller ● DXers Audio Processor ● Sweep Oscillator ● Minilab Power Supply ● Electronic Lock ● and others.

**Projects for Book 7 were in an advanced state at the time of writing, but contents may change prior to publication (due 14th May 1983).*

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