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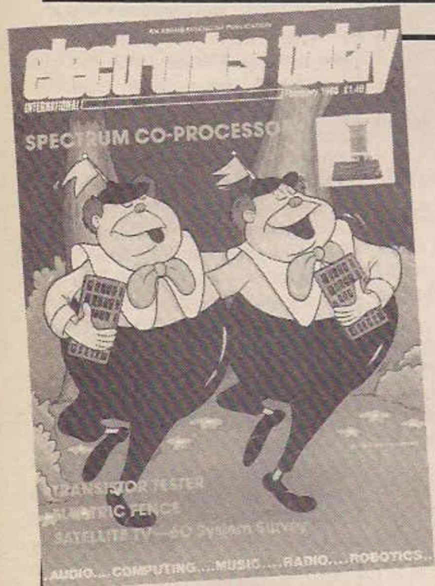
ELECTRIC FENCE

SATELLITE TV – 60 System Survey

. AUDIO.... COMPUTING.... MUSIC.... RADIO.... ROBOTICS..

electronics today

INTERNATIONAL FEB 1988 VOL 17 No. 2



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●Philips has come up with a CD decoding system that uses only two ICs and remarkably few other components. It originates from Holland and will be marketed in this country by Mullard Ltd (01-626 0394) who says that stocks should be available from March(ish).

The two chips are the SAA7310 and SAA7320. The SAA7310 is a third generation version of the SAA7210 providing demodulation, error correction and basic interpolation and in addition has modes for CD-ROM and CD-I.

The SAA7320 provides digital filtering, over-sampling and analogue post-filtering. The two chips together have a much lower power consumption (about 475mW) than the four chips previously required and can now handle temperatures from −40 to +85°C.

Mullard wasn't giving anything away when asked about prices. 'Competitive' was the word used. In Holland Philips estimate a price of about £11 for each chip but this is for large quantity orders only.

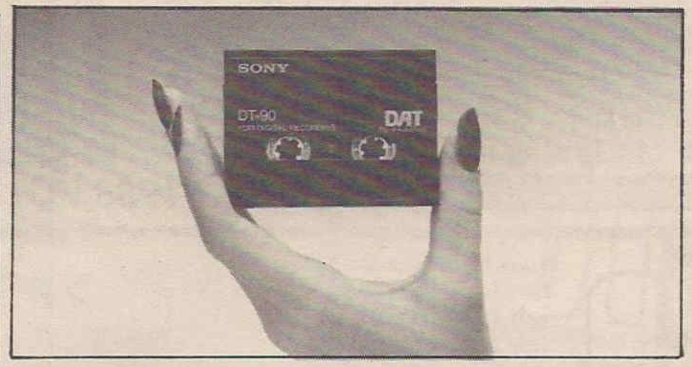
●A series of fine soldering irons are available from EES of Port Talbot. The smallest is an 11W iron weighing only 18.5g and having a maximum temperature of 340°C. All the irons can be supplied for various standard voltages and prices range from £7. Contact EES, Seaway Parade, Baglan Bay, Port Talbot SA12 7BR. Tel: (0639) 813663.

●Readers without the time to construct last month's Mains Cleaner may wish to investigate two protectors from Rendar. The Spikebloc, originally designed for use by BT, is intended for industry and provides an effective block to EM pulses and RF interference.

The Linebloc is for less sensitive equipment (home computers and hi-fi for instance).

Prices before VAT are £29.95 and £10.95 respectively. For more details contact Rendar, Durban Road, South Bersted, Bognor Regis PO22 9RL. Tel: (0243) 825811.

●Blank audio cassettes will NOT have a levy imposed on their retail price as was originally proposed in the upcoming Copyright Bill. The furore surrounding this part of the Bill has obviously made its mark in the halls of Westminster but opponents of the tax claim that although not directly implementing the tax, the Bill still does not positively preclude its introduction in the future.



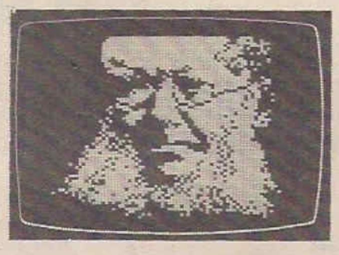
If You Can't Beat Them — Buy Them

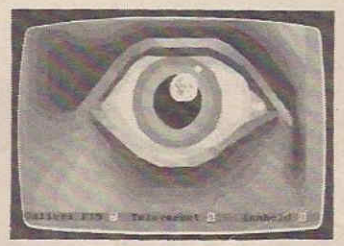
Digital Audio Tape merchant Sony has bought out its main opponent in the fight to get DAT onto the streets. CBS Records has cost Sony $2 billion and even away from its parent group, the company is not cowing to the new owners. 'Sony is not about to go steamrolling through CBS' said Jonathon Morrish for CBS in London 'and the opposition of the CBS management to DAT is unchanged.'

That opposition requires a jammer on all DAT machines to prevent direct digital recording from CD. Sony knows that such CD bootlegging is a major attraction of DAT to domestic users.

Sony has pledged not to interfere with the management of CBS but it is inconceivable that its enormous investment in DAT should be blocked by its own company.

The Sony view of DAT is based on profit motives, the CBS argument is based largely on ethics. It will be interesting to see who triumphs.





The Scene Behind The Screen

Things are changing in the world of Teletext. Since the feature in the November ETI the BBC has purchased the new Signet system from Softel of Reading to replace the Logica system that has been running Ceefax since 1979.

The new system uses two micro PDP11/83s, three 11/53s and can link via modems to other systems such as Prestel and the Stock Exchange (not that you'll be able to dump those BP shares from the safety of your TV remote control but it should help get information onto the screens faster).

The BBC is also increasing the number of spare TV lines used to transmit Ceefax data. Up to now there have been six lines (numbered 13-18) but as of January 4th this will increase to eleven lines. The extra data will be only dummy information until March at the earliest and it seems likely that they will be used for the Datacast system run by BBC Enterprises, used by such customers as Coral betting shops and Marks and Spencers (see November for details).

However, the BBC is hoping the extra line or two that will be devoted to Teletext will give a faster response time and more varied page-format. It is intended that 13 lines (numbered 8 to 20) will be used for both Teletext and Datacast combined.

Meanwhile, the Norwegians are raving about the 'almost complete' Concept 3 development from Lohja Comms Systems. This is an advanced teletext system with vastly improved graphics resolution and a palette of 4096 colours compared to the eight used in Oracle/Prestel (all CEPT 1 systems).

The snag is that existing teletext decoders are unable to understand it and Lohja have yet to design a unit that can update a CEPT 1 decoder to CEPT 3. So don't hold your breath . . .

Integration For UK ICs

Plessey has bought Ferranti's semiconductor operations for £30 million.

The aim of the buyout is to develop growth in Europe and America.

With their combined sales this will put Plessey into the top ten ASIC (Application Specific Integrated Circuits) producing companies in the world, at a time when concern about the fragmentation of the British chip industry is high.

Plessey's first task will be to make cost savings that can bring Ferranti's operations up to the profitability Plessey achieves.

Ferranti is only projected to break even this year and speculation is that the loss-making discrete components business in Manchester may now be axed.

If Plessey now puts all its semiconductor eggs in the ASIC basket, it would do well to remember how Ferranti lost its leading role in the gate-array market to America and Japan back in the 70s.

As integration in ASIC gets more complex, access to microprocessor and memory technology will be essential. The Japanese and American giants would then be able to force prices to levels that Plessey would be unable to match.

Heat From The Home Service

Budget Warmth is a scheme now available in seven of Britain's electricity boards thanks to the Electricity Council's award-winning Radio Teleswitch. Using the switch to alter tariff rates and selected supplies, the Electricity Board guarantees a constant temperature in one room of a customer's house for a fixed weekly charge — currently between £2.50 and £4. Tariff and load control commands are received by the teleswitch in the home from the carrier of Radio 4 (and yes, they *are* prepared for the frequency shift in February). Up to thirty commands per minute can be received plus a two second time code frame.

Please note that the Budget Warmth scheme is currently only being supplied to cases put forward by the social services (so put that phone down) . .

The Answer's EFTPOS At TSB

Customers of the TSB will soon be saved from the late-night search for those elusive TSB Cash Dispensers by a new £2.5m YESNET deal which will link their dispensers with the Nat West/Midland network.

The system (of which dispensers are but a tiny part) is from Plessey-Telenet and is based on a packet-switched data network (PDSN) enabling different computer systems within the TSB to communicate. At the heart of the system is the TP5/II which will allow monitoring and control to take place from a central location.

Other possibilities for the TSB include computer-linking Swan National (a TSB subsidiary) and getting involved with EFTPOS — a new card system projected for the late 1990s where the customer uses a plastic card to transfer money 'instantaneously' from his account to a retailer. Two intermediary services are already in service — Midland Transact (where credit cards are handled without hand-written receipts) and Barclays 'Connect' which is treated as a normal credit card but takes money from a current account.

With a complete EFTPOS system the retailer would receive VDU confirmation of the customer's ability to pay and the transfer of money would take place on the spot.

Maxwell To Take Over The World

Well not quite, but it seems that not a day passes when Cap'n Bob doesn't buy up another publishing house or football team. Now the Maxwell Communications Corporation is acquiring Nimbus Records, the only CD manufacturers in the UK. The money from the sale (£24m) will be used mainly for expansion into CD-related areas such as electronic publishing. The development of CD-ROM will presumably be significantly boosted by Moneybags' loot and we must hope that it is Nimbus' Monmouth plant rather than MCC's American factory that sees the R&D funds from the acquisition.

Twinkle Twinkle Little LED

Do you absentmindedly build up stocks of components that you never get around to using? If you've managed to collect 360,000 LEDs then you could knock them together into a little airship advertising sign like the one Airship Industries is flying over Tokyo.

The UK built skysign can display TV pictures (live or recorded) or graphics generated on board the airship. The image is refreshed up to 25 times a second across the 5 × 19m screen.

We're so inspired by the idea here at ETI that we were preparing to light the whole side of our Golden Square offices with live broadcasts from our editorial department. Unfortunately we're having trouble getting planning permission . . .

New Arrival At Euston Station

The biggest LCD in the world now hangs above the forecourt of Euston station providing train information for the 25 million passengers a year that will gaze upon its splendour.

The display is 75 feet long, 9 feet high and consists of 8000 60mm high characters, each a 12 × 6 dot matrix.

Although at present it is arranged as a standard train indicator with each train allocated 20 lines of 19 characters, it is completely modular and can be formatted in any manner desired.

Racal made the display and already has contracts for similar boards in other major London stations and in Ayr.

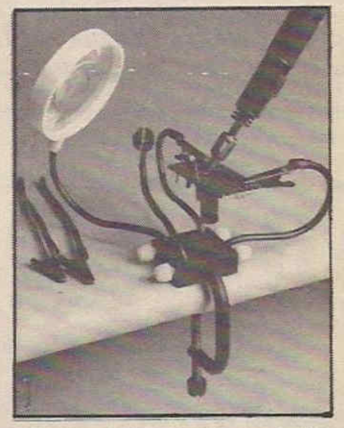
Driving the signboard is a Compaq 386 micro with 20Mb of memory. The central processor has two auxiliary processors — one for details of normal train movements and the other to show departures from that normality.

Train departures are displayed in chronological order (unlike mechanical boards) and as trains depart each set of information shifts across to the left. The characters are bright yellow and easy to read except if drunk when they appear as spectacular blurs of golden starlight. Probably best to ask an inspector . . .

If you want to ask Racal, the number is (0734) 782158.

●*CK (the toolmakers) has brought out a range of delightful little screwdrivers with colour coded buttonheads. Specifically designed for electronics, TV and radio use, the colour code refers to screw type (slotted, Philips or Torx) and range from slot sizes of 0.8mm to 1.8mm, Philips sizes 000, 00 and 0, and Torx sizes from 06 to 09. All drivers are 85mm from tip to button. Prices start at £4 per driver. They are available in shops or contact the Sales Dept of CK on (0758) 612254.*

●Temperature and humidity are measured simultaneously in a new handy sized module from Solex. Readings are displayed by LCD and the unit also features a high/low alarm, a min/max memory and is °C/°F selectable. Probes can be used but are an optional extra. The module measures about 3½ × 1½in and costs £46. Contact: Solex International, 44 Main Street, Broughton Ashley, Leics LE9 6RD.



●A de luxe version of the Octopus work holder is now available. The Super Octopus has a heavy base block and four flexible goose neck arms equipped with two clips, a magnet and a 2½in magnifying lens. The Super Octopus costs £13.17 including VAT and postage from Electronic and Computer Workshop, Unit 1 Cromwell Centre, Stepfield, Witham CM8 3TH. Tel: (0376) 517 413.

●The latest 'new standard' in interface communications is the RS485 which takes over from the RS422, while most people are still using RS232s anyway. The advantage of the RS485 is in its high-speed multimessaging since 32 driver-receivers can be put on a common data bus (the RS422 could have only 1). It also has a wider common mode voltage range, now +12 to -7V.

More information can be obtained from Texas Instruments, Manton Lane, Bedford MK41 7PA. Tel: (0234) 63211.

NEXT MONTH

electronics today INTERNATIONAL

GAS ALARM

Nothing to do with warning of the after effects of Sunday lunch. This professional quality project protects your home from the rather more serious after effects of a gas leak.

BBC MICRO OSCILLOSCOPE

Turn your BBC micro into a piece of test gear with this useful add-on to build. All the hardware and software to give you four input channels and up to 91kHz sampling rate.

SEQUEL IV

There's more on Satellite TV (we'll convince you yet!) and the second part of the Spectrum Co-processor project — the 256K RAM board. Complex numbers finally find a use in electronics in our *Circuit Theory* series and *Chip In* takes a look at programmable counters.

In case that's not enough for you, the March ETI will also be packed to the gills with the usual assortment of News and Reviews, facts and opinions, practice and theory. Don't miss it!

The March ETI - on the shelves on 5th February

All these articles are in preparation but circumstances may prevent publication.

Total AV From Sony's CD-Interactive

Sony has been showing off its latest achievements with CD-I (Compact Disc Interactive). CP-I has a designated Real Time Operating System and associated CPU (68000 series) and blends audio functions with computing, text, graphics, animation and still pictures.

Each disc contains a spiral track arranged into sectors for ease of data management, although two forms of subdivision exist depending on the priorities of the end user.

Form 1 is designed for text-based applications. Form 2 has space (2324 bytes) for user-data such as audio and video. Audio signals can be degraded from the normal 16-bit CD audio (44.1kHz) to rough 'n' ready 4-bit (18.9kHz) to boost the storage capacity.

In Japan Sony has just shown its latest prototype CD-I along with a disc featuring all the options above and music from the group Casiopea. The machine is heavily supported by peripheral hardware but the disc mechanism itself is comparable to that of a large CD player.

High quality moving video is limited to only 10% of the screen area (a full screen takes two-thirds of a second to update). The area to be changed can be increased by enlarging the pixel size and reducing the resolution and Sony disguised some of the limitations of the system by scrolling, zooming, image mixing, fading and wiping.

With room for between 150000 and 200000 pages of text on each disc, CD-I will undoubtedly elbow its way into the education/training and entertainments markets. Nevertheless it is likely to be next Christmas before the first self-sufficient pre-production units are displayed and even longer before CD-I becomes a commercial reality.

A profusion of new multimeters is appearing on the market at the moment. Alpha Electronics has two digital meters – a 3-digit display for £35.95 (+VAT) and a 4½-digit for £79.95 (+VAT). The latter measures capacitance and frequency as well as the more standard circuit tests. Details from Alpha Electronics, Unit 5, Linstock Trading Estate, Atherton M29 0QA (0942 873434).

TMK is hedging its bets with a smart digital meter and the 500TU-B, a new version of a previous analogue multitester. The digital G60 has only basic functions (but looks lovely) and costs £47.00 (+VAT). The 500 TU-B is £49.75 (+VAT). Both are available from Harris Electronics, 138 Grays Inn Road, London WC1X 8AX. Tel: 01-837 7937.

Remote Possibilities

Infra-red remote control of four separate receiver outputs is offered by a new kit from Electronic & Computer Workshop.

The transmitter (K2547) and receiver (K2548) cost £26.27 and £35.04 respectively (inclusive of VAT and postage).

Also new from ECW is a stroboscope kit with a light output of 11 watt-seconds at a frequency variable from 2 to 20Hz. The kit (K2601) costs £16.51 inclusive. Replacement tubes are also available.

Contact ECW, Unit 1, Cromwell Centre, Stepfield, Witham, Essex CM8 3TH. Tel: (0376) 517413.

February Freebies

Those of you who like to have something other than Readers' Digest subscription forms through your door might want to send off for some of the latest catalogues that are free for the taking.

Universal Instruments' Test and Measurement Catalogue has 76 pages covering test gear from the classic Avometer to the latest digital stuff. For your copy just phone (0756) 69737.

ECC Electronics has a 28 page catalogue of capacitors, crystals and relays, mainly Japanese, available from Online on (0234) 217915.

RR Electronics has produced a 48 page engineers' guide to Ferranti ICs with block diagrams and text descriptions. Contact John Perks, RR Electronics, St Martins Way, Bedford MK42 0LF (0234) 47211.

Flight Electronics has released the sixth annual catalogue. The first half lists their lab testing gear and the rest is devoted to 'educational products' including a breadboarding system that interfaces with an IBM PC. Telephone (0703) 227721 and ask for Suzanne Kittow.

Lambda Photometrics has a 6-page brochure with full details of single and dual phase lock-in amplifiers. It's available from: Lambda House, Batford Mill, Harpenden, Herts AL5 5BZ.

DIARY . . . DIARY . . . DIARY . . . DIARY . . . DIARY . . .

Mathematical Modelling Of Semiconductor Devices — January 7-8th
University Of Technology, Loughborough. Contact IEE on 01-240 1871 or The Institute of Mathematics and its Applications on (0702) 612177.

Early Days Of Electric Lighting — January 11th
IEE, London. Lecture by C. N. Brown of the Science Museum. Contact IEE on 01-240 1871.

Corporate Computer Security '88 — January 12-14th
Metropole Exhibition Centre, Brighton. Contact PLF Communications on (0733) 60535.

Gallium Arsenide: A New Generation Of Devices — January 14th
IEE, London. Lecture by Prof. D. V. Morgan (UWIST). Contact IEE on 01-240 1871.

The Illusion Of Colour — January 14th
Lecture by M. B. Halstead (Thorn EMI) at the Gonville Hotel, Gonville Place, Cambridge. Contact Eastern Region IEEIE on (0603) 628321.

British Engineering Supplies & Technology — January 18-21st
Olympia, London. Contact Mack-Brooks Exhibitions on (07072) 75641.

The Which Computer Show — January 19-22nd
NEC, Birmingham. Contact Cahners Exhibitions on 01-891 5051.

Office Update — January 19-22nd
NEC, Birmingham. Contact Cahners Exhibitions on 01-891 5051.

E-Beam Testing Of VLSI Circuits — January 27th
Newport Faculty of Technology. One day seminar. Contact David Jones on (0633) 51525.

Role Of Highly Elliptical Orbits In Satellite Communications — January 28th
IEE, London. Lecture by G. Beretta of the European Space Agency. Contact IEE on 01-240 1871.

Electromagnetic Compatibility And Microprocessor Based Systems — February 2nd
Heathrow Penta Hotel, London. Contact ERA Seminars and Exhibitions on (0372) 374151.

Smartex '88 — February 9-11th
Barbican Exhibition Centre. Surface mount technology exhibition.

European Seminar On Neural Computing — February 8-9th
Royal Garden Hotel, London. Contact IBC Technical Services on 01-236 4080.

Energy '88 — February 10-12th
Harrogate Exhibition Centre. Contact Emap Maclaren Exhibitions on 01-686 9200.

Cable And Satellite '88 — February 25-28th
Wembley Exhibition and Conference Centre, London. Contact Montbuild Exhibitions on 01-486 1951.

E-Beam Testing OF VLSI Circuits — March (date to be finalised)
Cavendish Conference Centre, London. One day seminar. Contact ERA Seminars and Exhibitions on (0372) 374151.

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15 Day 'D' skt £1.00, BNC skt 75p BBC interface cable £5.50

DECCA 80 16" COLOUR monitor. RGB input.
Little or hardly used manufacturer's surplus enables us to offer this special converted DECCA RGB Colour Video TV Monitor at a super low price of only £99.00, a price for a colour monitor as yet unheard of!! Our own interface, safety modification and special 16" high definition PIL tube, coupled with the DECCA 80 series TV chassis give 80 column definition and quality found only on monitors costing 3 TIMES OUR PRICE. The quality for the price has to be seen to be believed! Supplied complete and ready to plug direct to a BBC MICRO computer or any other system with a TTL RGB output. Other features are: internal speaker, modular construction, auto degaussing circuit, attractive TEAK CASE, compact dimensions only 52cm W x 34 H x 24 D, 90 day guarantee. Although used, units are supplied in EXCELLENT condition.
ONLY £99.00 + Carriage.

DECCA 80, 16" COLOUR monitor. Composite video input. Same as above model but fitted with Composite Video input and audio amp for COMPUTER, VCR or AUDIO VISUAL use. ONLY £99.00 + Carr.

REDIFFUSION MARK 3, 20" COLOUR monitor. Fitted with standard 75 ohm composite video input and sound amp. This large screen colour display is ideal for SCHOOLS, SHOPS, DISCO'S, CLUBS and other AUDIO VISUAL applications. Supplied in AS NEW or little used condition ONLY £145.00 + Carr.

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All units are fully cased and set for 240v standard working with composite video inputs. Units are pre tested and set up for up to 80 column use. Even when MINOR screen burns exist - normal data displays are unaffected. 30 day guarantee.
12" KGM 320-1 B/W bandwidth input, will display up to 132 x 25 lines. £32.95
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GOULD OF443 enclosed, compact switch mode supply with DC regulated outputs of +5v @ 5.5a, +12v @ 0.5a, -12v @ 0.1a and -23v @ 0.02a. Dim 18 x 11 x 6 cm. 110 or 240v input. BRAND NEW only £16.95
GOULD G6-40A 5v 40 amp switch mode supply NEW £130.00
AC-DC Linear PSU for DISK drive and SYSTEM applications. Constructed on a rugged ALLOY chassis to continuously supply fully regulated DC outputs of +5v @ 3 amps, -5v @ 0.6 amps and +24v @ 5 amps. Short circuit and overvoltage protected. 100 or 240v AC input. Dim 28 x 12.5 x 7 cm NEW £49.94
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The central processor plinth contains the 64K, Z80A processor, DUAL TEAC 55F 5¼" Double sided 40/80 track disk drives (1Mb per drive), PSU, 4K of memory mapped screen RAM, disk controller, RS232, CENTRONICS and system expansion ports, and if that's not enough a ready to plug into STANDARD 8" DRIVE port for up to FOUR 8" disk drives, either in double density or IBM format. The ultra slim 92 key, detachable keyboard features 32 user definable keys, numeric keypad and text editing keys, even its own integral microprocessor which allows the main Z80A to devote ALL its time to USER programs, eliminating "lost character" problems found on other machines. The attractive, detachable 12" monitor combines a green, anti-glare etched screen, with full swivel and tilt movement for maximum user comfort. Supplied BRAND NEW with CPM 2.2, user manuals and full 90 day guarantee. Full data sheet and info on request.

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PLESSEY VUTEL, ultra compact unit, slightly larger than a telephone features A STANDARD DTMF TELEPHONE (tone dial) with 5" CRT monitor and integral modem etc. for direct connection to PRESTEL, VIEWDATA etc. Designed to sell to the EXECUTIVE at over £600!! Our price BRAND NEW AND BOXED at only £99.00
DECCAFAX VP1 complete Professional PRESTEL system in slimline desk top unit containing Modem, Numeric keypad, CPU, PSU etc. Connects direct to standard RGB colour monitor. Many other features include: Printer output, Full keyboard input, Cassette port etc. BRAND NEW with DATA. A FRACTION OF COST only £55.00
ALPHATANTEL. Very compact unit with integral FULL ALPHA NUMERIC keyboard. Just add a domestic TV receiver and you have a superb PRESTEL system and via PRESTEL the cheapest TELEX service to be found!! Many features: CENTRONICS Printer output, Memory dialling etc. Supplied complete with data and DIY mod for RGB or Composite video outputs. AS NEW only £125.00
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Telephone 01-679 4414 Telex 894502 Data 01-679 1888

READ/WRITE

Decline And Fall?

In all honesty, do you really feel that your current issue can by any stretch of the imagination justify a price tag of £1.40?

As a loyal reader of ETI since it was first published in 1972 I feel more than qualified to complain at the way your publication is plodding drearily downhill.

In 1972 ETI cost 20p and had 88 pages. Now it costs £1.40 and has 68 pages. That is a 700% increase on the price and almost 25% less reading material.

Of the 68 pages on offer, your December issue has:

1 page contents
3 pages news and diary
3 pages foil patterns
2 pages PCB service
3 pages written by Messrs Brindley, Tame, Pitt and Armstrong
2 pages index
18½ pages commercial advertising

Less the front cover this leaves only 34½ pages of actual informative or constructional material. Most of this is well spaced and gobbles up page after page.

Of the remaining 35½ pages, 7½ were given over to your 'feature' on test equipment which was padding almost all the way. For goodness sake get it back together again.

Bob Collins
St. Peter Port, Guernsey.

The size and price of ETI has indeed fluctuated quite wildly over the course of the 15 years it has been published. Although 700% seems to be a horrific increase, this is in line with other standard price comparisons such as a gallon of petrol or a pint of beer.

The size of ETI is dependant on the number of advertisements we carry. It is the ads which largely pay for the magazine. The more we carry, the bigger ETI can be. At its peak in 1981 ETI was regularly over 110 pages. However, things really were spaced out then!

Today ETI is slowly but surely increasing its circulation (and ad revenue) and so we can look forward to larger issues in the future.

Meanwhile, I think you are a little unfair on the contents. The very first ETI which apparently won your loyalty contained a much higher proportion of the 'padding' you now object to. There were six pages of news in that issue, two pages of book reviews and four pages of record reviews!

We do aim the magazine at a wider audience than simply project constructors although we are indeed increasing the number of small projects published. The majority of the letters we receive tend to confirm that the more general interest articles are appreciated by the majority. However, we do need to be told! If you feel strongly about how you think ETI should change, drop us a line and make your case.

Frequently Wrong

Your news story in the December issue incorrectly stated that Radio Four's frequency was changing from 198kHz to 200kHz. In fact the old frequency is 200kHz and the new frequency is 198kHz (1515m).

Tony Carrington
General Systems Engineer
BBC, Bristol

Yes, sorry about that one. Not only that but we said the transmissions maintained a stability of one part in 1011. This should have read one part in 10^{11}.

Meltdown

I read the useful tip from Mr Startin in Read/Write in the December 1987 issue of ETI about reproducing printed PCB artworks using a photocopier.

I find this a great idea but, as an office equipment engineer, I have come across the situation many times where photocopiers use not only compression to fix the toner but also *heat*.

Can you imagine what an A4 sheet of transparent film looks like oozing out of the fuser rollers? Not a pleasant sight I assure you!

Please read any manual you have for your particular copier before trying this tip. Otherwise there may be some big engineers wearing very big boots knocking at your door!

G. Harrison
Seaford, Liverpool

Good point, that. Thanks for warning us of a sticky situation.

Washout

Last year I built your Ecolight ultrasonic activated light switch. The unit was working quite happily as the landing light but has recently been moved outside as a yard light.

All went well until it rained. Yes that's right, the rain activates the switch.

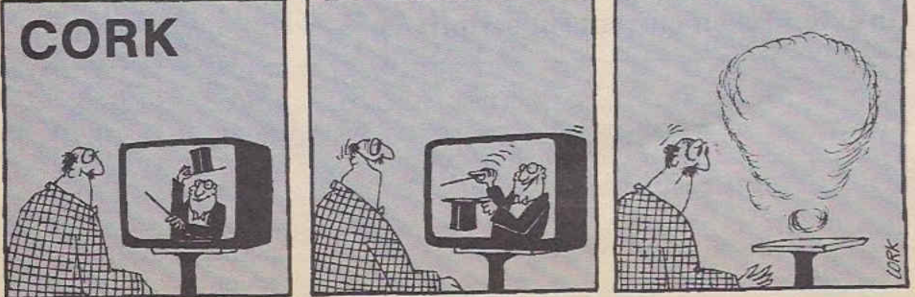
The unit was mounted out of the rain about 4ft off the ground with no bushes or trees within range.

Any bright ideas from ETI or any readers?

Andrew Jenkins
44 Tudor Terrace, Gadlys,
Aberdare, CF44 8EB

Tricky one, this. We can only suggest you mount the sensors horizontally so the rain (falling downwards!) moves at 90° to the sensor and therefore cannot trigger it (in theory). If that doesn't work, use the passive infra-red alarm circuit from last month instead!

Mr Jenkins would be pleased to hear from any readers who can help him on this one.



Mostly criticism this month. Still, we did ask for it. ETI is always happy to receive readers' comments and opinions, whether favourable or otherwise. Don't keep your thoughts to yourself. Write in to:

Electronics Today International
1 Golden Square
London W1R 3AB

COMPETITION

Yes folks — yet again the generous folks at ETI are giving away valuable pieces of technologically advanced stuff for you to cuddle up with in your own homes.

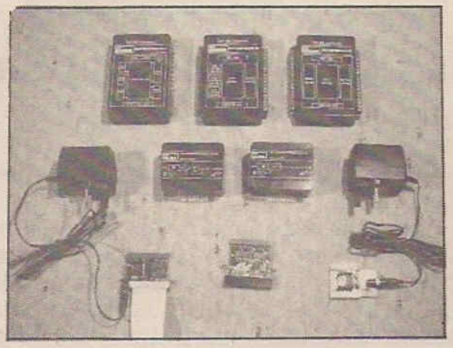
The new *Interpack* range of interfacing modules are hot on the streets from DCP Microdevelopments in Norwich. The *Interpacks* link up to your micro using the appropriate DCP *Intercard* and from there on the application possibilities are endless!

There's a detailed review of the three new DCP *Interpacks* in last month's issue so you can see just what these babies can do.

But what could **you** do? How clever could you be if you had your own *Interpack* and *Intercard*?

Now's your chance to find out. We're giving them away! We want you to come up with an original and stunningly innovative application for one of the three *Interpack* types. You don't have to do a full-blown design, just explain what your 'Thing with an *Interpack*' would do and outline roughly how it would work. The winner gets the *Interpack* that they used and the *Intercard* of their choice.

It's so easy! I've entered twice myself already.



So bung your 150-300 words on an enormous postcard and send it along with
Your name
Your address
Your choice of Intercard

to **'Thing with an Interpack' Competition**
ETI
1 Golden Square
London W1R 3AB

The Interpacks

INTERPACK 1:
- 8-bit I/O ports for TTL
- 4-bit switch input port
- 4 relay-isolated outputs 24V 1A
- 8-channel ADC

INTERPACK 2:
- 8 switch inputs
- 6 relay outputs 24V 1A

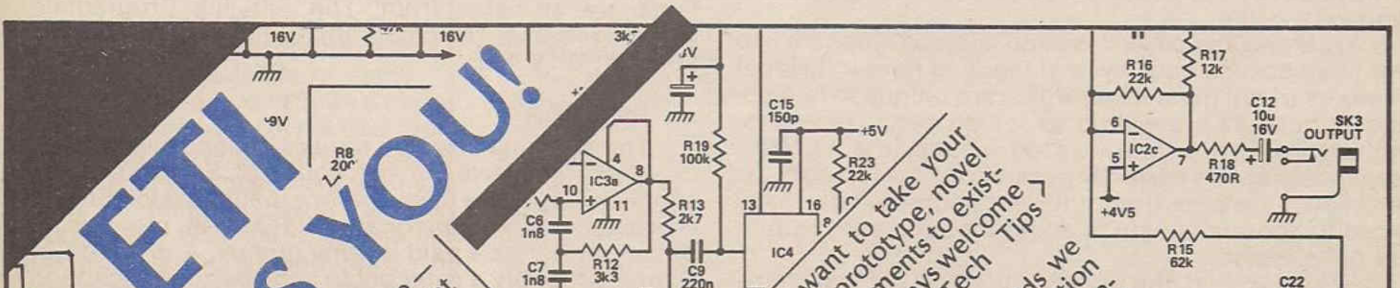
INTERPACK 3:
- stepper motor driver, separate control of 3 motors available

Pick A Card

ZX, BBC micro, Commodore 64, Apple II, Amstrad CPC, IBM PC, Scorpion.
Also: DCP Bus Intercard, Powerbus Card, Invertabus Card.

DCP Microdevelopments, 2 Station Close, Lingwood, Norwich NR13 4AX. Tel: (0480) 830997.

Closing date: 1st February 1988



DISH OF THE DAY

Keith Brindley continues his overview of Satellite TV with a look at 60 systems currently available

First off, we should point out that the systems included in this ETI survey aren't the only systems — not by a long chalk! We had to stop somewhere and so our choice of the systems included here is purely arbitrary, based on the information we have been able to obtain from suppliers before going to press.

The Gen

The table shows short-form information about satellite reception systems which has been made available to ETI by various manufacturers and suppliers.

Some suppliers sell the equipment as a complete system, in which case there is no problem in showing the systems' main features in tabular form.

On the other hand, some suppliers only supply individual parts of systems, it being left to the user (with some guidance from the supplier of course) to choose what is required. In such instances it is a bit more difficult to specify features and so readers are always advised to consult suppliers for final details of a chosen system.

Whatever the case, it is impossible to compare like for like because each system tends to have individual features (if not gimmicks!) which are unique to it. Also, most suppliers are willing to sell all parts (receivers, actuators, antennae, antenna mounts, LNBs) separately so it is perfectly possible for readers to build their own systems from different sources. You really need to know what you're doing though, to make sure all parts match.

We've limited the survey purely to STV *systems* suppliers for the good reason that most of the larger suppliers (NEC, Rediffusion and so on) see the future of STV in terms of systems sales only — not individual parts. STV isn't like hi-fi where users can choose individual kits (a tuner here, cassette deck and amplifier there) and know that a first-class system will result. STV systems are a bit more delicate than audio systems because they are dealing with microwaves.

One supplier made the point to ETI that setting up a microwave system is something like DIY plumbing. A good analogy — you don't know whether it's going to work until you've turned it on, and by then it's too late. Water, water everywhere!

The information detailed here, then, refers only to complete systems supplied from single sources and can only cover the main range of features common to all systems.

You'll see that suppliers in this ETI survey supply a range of systems from simple, fixed position antenna (for single satellite reception) through to complex multi-satellite reception systems.

Prices of systems are shown but are only included as a guideline — some suppliers specify price exactly but as most rely on smaller sales outlets like your local television shop, prices can vary. The moral is to shop around. Prices generally do not include installation so £150 to £250 should be added to the basic system price to cover this — unless you're going to do it yourself.

However, most suppliers do not advise a DIY approach, saying that only qualified personnel can do the job properly. Presumably, many ETI readers will be up to the job and we'll leave the choice to you. Details of DIY system set-up are outside the scope of this article but may be covered in a future issue of ETI if demand sees fit.

Neither do prices include cost of programme reception. At the time of writing only two channels are encrypted (Filmnet and Skychannel) — although Premiere intends to encrypt on the 5th of January). Until the user has paid for a decoder and subscriptions, these cannot be legally received. Even some unencrypted channels require payment of subscription, although the channels would be the first to admit that not every viewer has paid the dues.

Most channels, however, are considering encryption shortly, so all users must bear in mind that future cost. Details of encryption, decoding and subscriptions are available from: The Satellite Programme Clearing House, The Quadrangle, 180 Wardour Street, London, W1V 4AE.

Antenna

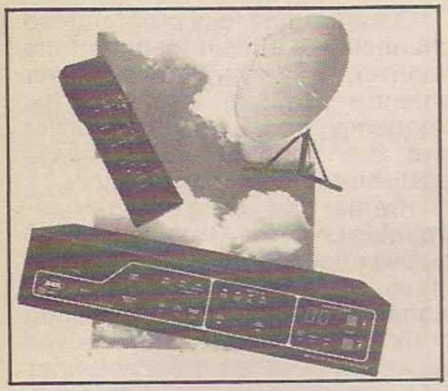
The Antenna size you require depends very much on where you live. In the south of England, some suppliers say that a 0.9m antenna is suitable for current transmissions — personally, I'd ask to see this in operation before I paid out my money. A dish size of 1.2m is probably a safer bet to achieve good reception in London. Further north the antenna needs to be bigger — up to 1.8m or bigger in Scotland. Again, though, always ask to see operation first.

Whatever sized dish you end up with, you can at least be assured that any future television channels received by satellite, either DBS or from the intermediate Astra will be more than adequately picked up.

On the subject of antennae, it might be worth considering when televisions themselves were first being installed (before my time!) their aerials were considered part of the system and installation costs were a necessary evil. Once fitted, however, any television receiver bought at a later date can be used with the same aerial.

That's much the same as the situation now with satellite reception systems — the antenna you buy with your system, if chosen carefully, could be with you for a long time. It should certainly see out your chosen system's receiver and be used with whatever receiver you buy in the future. At the price you'll pay, it can't really be considered a disposable item!

It only remains to look at each supplier's range of systems individually. Further specifications and details of any system can be sought from the supplier's address given with each listing and suppliers will be able to provide readers with details of local outlets and installers.



BEL-Tronics (UK) Ltd
Cherry Orchard North
Kembrey Park
Swindon
Wilts SN2 6BL

BEL-Tronics (UK) is the British subsidiary of Bel-Tronics of Canada. All the company's TVRO equipment is manufactured there having been on sale in Canada for many years. This has the advantage that it is tried and tested before finding its way to the British market place. A Bel system is certainly not the cheapest but in most respects it's one of the best.

The systems offered are based around the Micro Eye receiver. The customer merely has to choose the required size of antenna to suit and decide whether reception is to be from a single satellite or many.

The Micro Eye is quite a classy receiver and is one of the best looking around. Technically speaking, it's one of the most advanced too, with all features being remotely controlled. Over 60 channels can be fully programmed into the receiver and from there on merely calling up a program invokes the necessary adjustments to antenna position, LNB polarity and internal electronics to select the required satellite, transmission polarity, frequency and audio sub-carrier.

A free site survey is included and a maintenance contract offered after the initial guarantee period.

Technical Specification

- receiver (input level: -60dBm to -20dBm. Noise figure: 6dB. Audio sub-carrier tuning: 5-8.5MHz)
- LNB (noise figure: 2.1dB. Gain: 50dB min)
- antenna in sizes of 1.2, 1.5, 1.8m (gain 41, 42.5; 44.5dB. 3dB beam width 1.5°, 1.25°, 1°)

Make	Model	No of prog	Main features	Diam	Type	Price
BEL-Tronics	Micro Eye	>60	P, POL, R, St	1.2	B	1325
BEL-Tronics	Micro Eye	>60	P, POL, R, St	1.5	B	1440
BEL-Tronics	Micro Eye	>60	P, POL, R, St	1.8	B	1550
BEL-Tronics	Micro Eye	>60	P, POL, POS, R, St	1.2	B	2000
BEL-Tronics	Micro Eye	>60	P, POL, POS, R, St	1.5	B	2120
BEL-Tronics	Micro Eye	>60	P, POL, POS, R, St	1.8	B	2250
Champ	WR-516		P, POL, R	1.2		850
Champ	WR-516		P, POL, POS, R	1.8		1500
Connexions	CX1260B	n/a	M, POL	1.2	O	695
Connexions	CX1860B	n/a	M, POL	1.8	*	845
Connexions	CX1260D	32	P, POL, POS, R	1.2	0	995
Connexions	CX1860D	32	P, POL, POS, R	1.8	*	1145
Connexions	CX8012		P, POL, POS, R, St	1.2	0	1195
Connexions	CX8018		P, POL, POS, R, St	1.8	*	1275
Eledyne	00	n/a	M, POL	1.2/1.5	B	770
Eledyne	01	n/a	M, POL, POS (by hand)	1.2/1.5	B	850
Eledyne	02	n/a	M, POL, POS	1.2/1.5	B	1075
Eledyne	03	32	P, POL, POS, R	1.2/1.5	B	1140
Eledyne	04	36	P, POL, POS, R	1.2/1.5	B	1350
Ferguson	ES03	149	P, POL, R	1.2	B	1245
Ferguson	ES01	149	P, POL, R	1.5	B	1345
Ferguson	ES03	149	P, POL, POS, R	1.2	B	1545
Ferguson	ES01	149	P, POL, POS, R	1.5	B	1645
Ferguson	ES02	149	P, POL, R	1.8	*	1645
Ferguson	ES02	149	P, POL, POS, R	1.8	*	1945
Grundig	STR200	29	P, POL, R	1.5	B	1700
Luxor	Mark 2-1	24	P, POL, R, St	1.25	B	916
Luxor	Mark 2-2	24	P, POL, R, St	1.6	B	980
Luxor	Mark 2-3	24	P, POL, R, St	1.8	B	1111
Luxor	Mark 2-4	24	P, POL, POS, R, St	1.25	B	1330
Luxor	Mark 2-5	24	P, POL, POS, R, St	1.6	B	1390
Luxor	Mark 2-6	24	P, POL, POS, R, St	1.8	B	1520
Megasat	XX3R	n/a	M, POL	1.2	O	850
Megasat	XX3RI	99	P, POL, POS, R	1.2	O	1250
Megasat	XX3G	576	P, POL, POS, R, St	1.2	O	1500
NEC	Nesat 2000	50	P, POL, R	1.5	B	1100
NEC	Nesat 2000	50	P, POL, R	1.8	*	1200
NEC	Nesat 2000	50	P, POL, POS, R	1.5	B	1500
NEC	Nesat 2000	50	P, POL, POS, R	1.8	*	1600
Rediffusion	RSR30	30	P, R	1.2	B	800
Rediffusion	RSR30P	30	P, POL, R	1.2	B	970
Rediffusion	RSR50	50	P, POL, POS, R	1.25	B	1350
Rediffusion	RSR50	50	P, POL, POS, R	1.5	B	1430
Rediffusion	RSR50	50	P, POL, POS, R	1.7	B	1450
Salora	SRV1150-1	32	R	0.9	B	549
Salora	SRV1150-2	32	P, R	0.9	B	669
Salora	SRV1150-3	32	P, POL, R	1.25	B	880
Salora	SRV1150-4	32	P, POL, R	1.6	B	950
Salora	SRV1150-5	32	P, POL, R	1.8	B	1070
Salora	SRV1150-6	32	P, POL, POS, R	1.25	B	1290
Salora	SRV1150-7	32	P, POL, POS, R	1.6	B	1360
Salora	SRV1150-8	32	P, POL, POS, R	1.8	B	1480
Skyscan	K1	24	P, POL, POS, R	1.5	O	1299
STS	312	n/a	M	1.2	O	799
STS	314	n/a	M, POL	1.2	O	899
STS	316	n/a	M, POL, POS (by hand)	1.2	O	999
STS	318	n/a	M, POL, POS	1.2	O	1199
STS	322	72	P, POL, POS, R	1.2	O	1299
STS	324	72	P, POL, POS, R	1.2	O	1399
SVT	GS-1	99	P, POL, POS, R			1600

Prices are quoted in most cases as *approximate* retail price including VAT. Installation is generally extra. Check all prices with your local sales outlet.

Main features: tuning (P=preset, M=manual). LNB (POL=polarisation control). Antenna (POS=antenna positioning). Receiver (R=remote control, St=stereo)

Antenna: diameters are quoted in metres. Type (B=basic, O=offset, *=petalised)

Connexions (UK) Plc
Unit 3,
South Mimms Distribution Centre
Huggins Lane
Welham Green
Herts AL9 7LE

Like Bel-Tronics' Micro-Eye, Connexions TVRO systems have been around for a few years which means that equipment is tried and tested and the company has a large foot in the marketplace door. Also like Bel-Tronics, the company originated from abroad — unlike Bel-Tronics, however, the originating company is from Taiwan where the equipment is manufactured.

Systems range from cheap single satellite reception to a multi-satellite programmed reception. New systems are being introduced regularly. Rather than using a single receiver the company has opted to produce different receivers, depending on customer requirement. In this way users requiring simple systems don't have to pay for unused refinements.

For example, the bottom of range systems use a rotary tuning knob while higher up models feature digital readout of channels. Further, medium range systems use a separate antenna positioning control unit from the receiver, while the top of range receiver uses internal electronics to do the job.

Only two antenna sizes are offered: 1.2m and 1.8m but there is a range of LNBs to suit individual applications.

Technical specification

•CX2460 receiver (input level: -45dBm to -30dBm. Audio sub-carrier tuning: 4.5-8MHz)
•CX1321 LNB (noise figure: 1.8dB. Gain: 50dB)
•antenna in sizes 1.2, 1.8m (gain: 43.5, 44.7dB. 3dB beam width: 1.2°, 1°)

Eledyne Ltd
Isaac Newton Way
Alma Park
Grantham
Lincs NG31 9RT

Eledyne is part of a much larger group which has supplied control equipment for 17 years. The company's satellite reception equipment is imported from the east and a great deal of testing and re-tuning is apparently undertaken before customers see it.

Equipment ranges from a cheap and cheerful single satellite receiver system to a full spec multi-satellite remote control system.

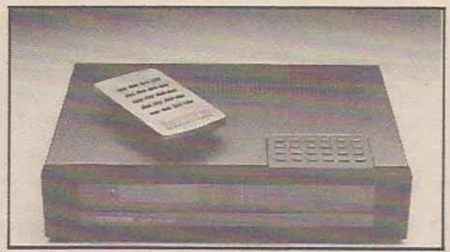
Only 1.2 and 1.5m antennae are shown (system prices are the same for both sizes) but smaller (90cm) and larger (up to 2.4m) are available so check your local outlet for prices and details. Prices listed are for GRP antennae. Spun aluminium antennae are available at a surcharge of about £20.

Technical Specification

•receiver (input level: -55dBm to -20dBm. Noise figure: 2dB. Audio sub-carrier tuning: 4.8-8.2MHz)
•LNB (noise figure: 2dB. Gain: 50dB min)
•antenna in sizes 1.2, 1.5 metre (gain: 40.5, 43.5dB. 3dB beam-width: 1.5°, 1.25°)

Ferguson
(Thorn EMI Ferguson Ltd)
Cambridge House
270 Great Cambridge Road
Enfield
Middlesex EN1 1UL

To our knowledge, Ferguson was the first big name in British electronics to put a toe in the water and test the satellite reception system market. According to reports the



water must have been pretty cold and there seemed to be a number of problems in use with the SMO1 receiver.

However, the original system has been updated to help heat the water and Ferguson has now gone in at the deep end with a full range of systems based around a new receiver, the SM02.

The SMO2 features a 149 channel memory with remote control. Its memory can only be classed as 'semi-programmable' as only transmission frequency is remembered. Antenna position and LNB polarisation have to be done separately.

All-in-all, the prices for the various systems offered seem pretty high but the potential user has to bear in mind the Ferguson name bought with them.

Technical Specification

•receiver (input level: -55dBm to -25dBm. Noise figure: 12dB)
•LNB (noise figure: 2.3dB. Gain: 53dBm)
•antenna in sizes 1.2, 1.5, 1.8m (gain: 42, 43, 44.5dB)

Grundig International Ltd
Mill Road
Rugby
Warwickshire CV21 1PR

Another of the 'big boys' who has recently entered the satellite arena, Grundig offers a single system with a good specification, albeit fairly pricey for what it is. The Grundig name, however, may be the enticement to persuade potential buyers.

Twenty-nine fully programmed channels are a main feature of the receiver, allowing control over antenna position, LNB polarity, frequency and audio sub-carrier and the remote control means push-button choice of channel.

Rather than using a single controllable LNB, the Grundig STR500 receiver used in the system has two input sockets corresponding to signals from two LNBs (receiving horizontal and vertical polarised signals) mounted on the antenna.

Technical Specification

•receiver (no specification available)
•LNB (noise figure: <2.2dB)
•antenna (gain: 43dB. 3dB beam width: 1.25°)

Luxor Satellite
Bridgemead Close
Westmead
Swindon SN5 7YG

Luxor is a subsidiary of Salora, which also produces satellite reception systems and although a comparatively new name in British television it is part of the Nokia Group of Finland originating way

back in 1926. The two companies operate under separate identities.

Luxor satellite reception systems are all based around the Luxor Mark 2 receiver which has some impressive features including Dolby stereo, a signal strength meter and 24 programmable channels.

Use of a single channel receiver to cover all options means a user can upgrade fairly easily and cheaply but it does mean that lower spec systems can be quite pricey because the user has to pay for some unused features.

A separate antenna control unit is used in the multi-satellite system but is controllable directly from the receiver's hand-held remote control unit. Three sizes of antenna are offered.

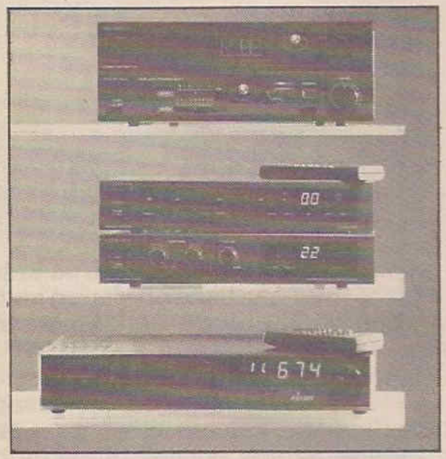
Technical Specification

•receiver (input level: -70dBm) to -30dBm. Audio sub-carrier tuning: 5-8MHz)
•LNB (noise figure: 1.9dB. Gain: 50dB min)
•antenna in sizes 1.25, 1.6, 1.8m

(gain: 41.7, 43.8, 45dB. 3dB beam width: 1.5°, 1.2°, 1°)

Megasat Ltd
5 St Pancras Commercial Centre
Pratt Street
London EC4A 3JB

Megasat has been around in satellite television reception systems for a while and has considerable experience in its marketing.



The company doesn't manufacture (or badge manufacture) receivers as such, merely buying in receivers from outside and combining them with other required hardware to form complete systems. Most manufacturers' hardware can be supplied by Megasat.

Megasat's XX3 range includes Rockdale receivers (XX3R and XX3RI) and the well-known Gensat receiver (XX36). New systems to be released shortly after the time of writing include Drake receivers and the Rediffusion RSR50 receiver. These systems will be available by publication date.

With the release of the latest systems Megasat is also launching the 'Compact Dish' — a 90cm antenna which appears to have extremely good characteristics — and a new LNB with noise figure claimed to be as low as 1.2dB.

Technical specifications and prices for the new systems were unavailable at the time of writing. Interested readers should contact Megasat direct.

NEC Business Systems (Europe) Ltd
35 Oval Road
London NW1 7EA

NEC first entered the TVRO market a year or so ago although its commitment to satellite television reception is far older and far wider. NEC was one of the world's leading manufacturers of satellite reception equipment.

The present NEC TVRO systems are based around the Model 2022 receiver which is a good-looking programmable device offering a number of features such as on-screen graphics, last-channel memory and MAC output (so you can add necessary decoders to receive future signals).

Indeed the only real drawback foreseen with the receiver is that it is not *fully* programmable. Antenna position needs to be set with a separate instruction to the channel number so changing channels on different satellites is not just done by pressing one button. It's really only a small niggle but one which many customers may regard as important — we're not all computer/electronics whizzkids! Other receivers, notably the Rediffusion RSR50, achieve channel *and* satellite changeover with more simple operations.

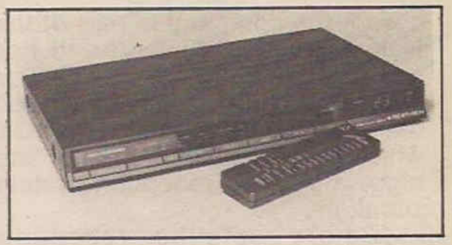
The same receiver services all systems in the range, purely because the antenna actuating

device is classed as optional and there is a choice of two antenna sizes. An electronic polariser is used — a nice finishing touch to a well thought out range.

Technical Specification
- receiver (input level: -60dB to -30dB. Audio sub-carrier tuning: 5.5-8MHz)
- LNB (no data forwarded)
- antenna in sizes 1.5, 1.8m (no data available)

Rediffusion Radio Systems Ltd
Satellite Systems Division
Unit 9 Mole Business Park
Randalls Road
Leatherhead
Surrey KT22 7BA

It was only a matter of time until one of the big British names produced a system capable of doing everything at a reasonable price. It



just happened to be Rediffusion. This type of approach is likely to herald the way forward because most customers don't want to fiddle with dozens of knobs and buttons to change channels — they want a single push button, just as they change channels on their existing television set.

Systems are based around two main receivers, the RSR30 and the RSR50. The RSR30 is nothing to write home about. In fact, in its basic form the receiver doesn't even allow control over LNB polarisation. The RSR30P, a derivative of the basic receiver, does. Also available is a dish position control unit for these receivers.

It is the RSR50 receiver-based systems which are of note. They feature *full* programmability of 50 channels — all channel details (frequency, antenna position, LNB polarity, audio sub-carrier and so on) are stored and you need only to press the channel number to change satellite channels and pick up a new programme.

Three antennae are available with RSR50 systems although only one is specifically for RSR30 systems.

Technical Specification
- RSR30 and RSR50 receivers (input level: -60dBm to -25dBm. Noise figure: 12dB. Audio sub-carrier tuning: 5-8.5MHz)
- LNB (noise figure: 2.2dB. Gain: 55dB)
- antenna in sizes 1.2, 1.25, 1.5, 1.7m (gain: 40, 41, 43.5, 44.5dB)

Salora (UK) Ltd
Bridgemead Close
Westmead
Swindon SN5 7YG

Salora is the parent company of Luxor and like Luxor it manufactures complete satellite reception systems and sells products individually. Although a relative newcomer to the British television

scene, the company is part of the Nokia Group of Finland and has been around since 1926. The company claims to have over 700 dealerships throughout the UK which must make it one of the biggest satellite reception system suppliers.

Salora satellite reception systems are based around the Salora SRV1150 receiver and systems differ only in the extra lines which are bought with the receiver.

The SRV1150 is one of the nicest looking receivers available. It has a 32 channel memory which together with a separate antenna control unit (part of the multi-satellite systems) allows fully programmable control over channel choice.

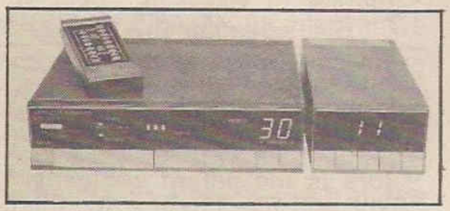
A selection of four antenna sizes complements the range of systems, including a recently introduced 90cm dish.

Technical Specification

- receiver (input level: -60dBm to -30dBm. Noise figure: 6dB. Audio sub-carrier tuning: 5.5-8.5MHz)
- LNB (noise figure: 2dB. Gain: 50dB min)
- antenna in sizes 1.25, 1.6, 1.8m (gain: 41.7, 43.8, 45dB. 3dB beam width: 1.5° 1.2° 1°)

Satellite Technology Systems Ltd
Satellite House
Blackswarth Road
Bristol BS5 8AU

Although a comparative newcomer to the television scene, STS has concentrated on SMATV for a while and has recently entered the TVRO market where its SMATV experience stands it in good stead. The company also offers good training for its dealers in installation techniques.



Systems are based around two main receivers — a simple to operate but basic STS300M and the more complex and programmable STS320R. The STS300M is a manually tuned beast but offers the possibility of antenna position control via hand-cranking or (if you don't like the idea of having to nip outside to turn your antenna) motor drive.

The STS320R is remotely controlled, and allows the facility of programmability, using a separate remotely controlled dish actuator.

All systems are based on use of a 1.2m antenna but a 1.8m antenna option is available for around an extra £250.

Technical Specification

- STS300M and STS320R receivers (input level: -55dBm to -20dBm. Audio sub-carrier tuning: 4.8-8.2MHz)
- LNB (no data available)
- antenna (no data available)

Skyscan Satellite Television
Unit 2, Priors Way
Maidenhead
Berkshire SL6 2HP

Another well established company in the satellite receiving systems arena is Skyscan. The K1 system has been around for a little while, proving to be reliable and versatile. Notably, Skyscan is the only company to have issued an exact retail price — all other companies only state approximate retail prices which depend on local suppliers' mark-up and so forth.

Satellite channels can only be described as 'semi-programmable' because the user has to first tell the receiver a code for the satellite and then change the channel. The receiver alters antenna position and adjusts polarity and the audio sub-carrier to suit.

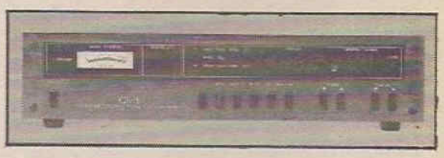
One clever feature which Skyscan is rightly proud of is the fact the antenna steering mechanism is set up to always approach the final antenna position from the same direction, helping to eliminate possible hysteresis effects in the mechanics which may occur with wear through time.

Only one system is offered with just one receiver, one LNB, and one antenna. It really couldn't be simpler. This no doubt helps the company to maintain the system's low price.

Technical Specification

- receiver (input level: -55dBm to -15dBm. Audio sub-carrier tuning: 5-8.5MHz)
- LNB (noise figure: 2dB. Gain: 55dB)
- antenna (gain: 44dB)

SVT Video Systems Ltd
Heybridge Industrial Estate
Holloway Road
Maldon
Essex CM9 7XS



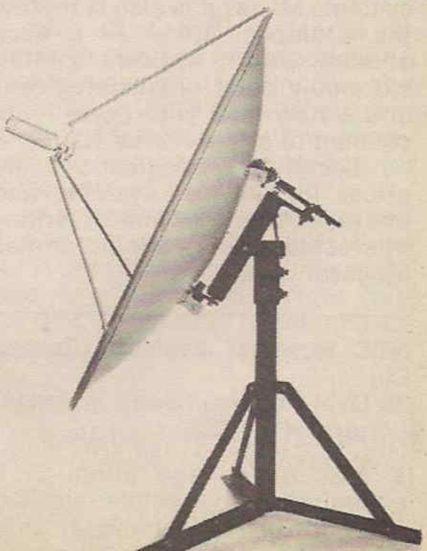
A newcomer to the TVRO marketplace, SVT has been operating for a while in more general areas of television equipment and SMATV television distribution systems.

The SVT system is based around the Palcom GS-1 satellite receiver which in itself offers high flexibility with ease of use. Up to 99 channels can be fully programmed into the receiver which takes care of antenna positioning, LNB polarity, frequency and audio sub-carrier. Useful is an analogue signal strength meter for tuning by scan mode.

Notably, SVT is one of the few companies whose system price includes installation (subject to site survey).

Technical Specification

- receiver (input level): <-60dBm. Noise figure: <dB. Audio sub-carrier tuning 5-8MHz)
- LNB (no data available)
- antenna (no data available) ETI



IMAGINARY TIMES

Paul Chappell continues to delve the depths of the complex plane

In introducing complex numbers last month, I went to some trouble to avoid using the terms 'real' and 'imaginary' which are a hangover from Victorian uncertainty about the status of $\sqrt{-1}$. Sadly, the terms are still in common use so I must now submit to convention and start using the horrible things myself.

For a number like 2+j3, it is usual to refer to the 2 as the *real* part and the 3 (not j3) as the *imaginary* part. There, I've said it. Now I'll go and wash my mouth out.

Complex numbers can be visualised as points on a plane. Figure 1 shows the general idea. The correspondence between the numbers and their representation is obvious, so I'll let the diagram speak for itself.

The plane where complex numbers live is called, naturally enough, the complex plane. It is sometimes referred to as the z-plane since it is conventional to use the symbol z to denote an arbitrary complex number, just as x might stand for any old real number.

Addition of complex numbers is best demonstrated by putting a few arrows into the diagram. Figure 2a represents 2+j0, Fig. 2b shows 3+j0, Fig. 2c shows their sum which is 5+j0. The arrows add nose to tail. When the imaginary part is zero, it is often left out altogether, so this sum might be written: 2+3=5. Revolutionary stuff, eh?

Figures 2d, e and f represent (2+j3)+(4+j1), (2+j3)+(-4+j1) and (2+j3)+(-4-j1) respectively. When a complex number arrow begins at the origin, it is said to be *bound*. The arrow, or vector, representing 2+j3 is bound in Fig. 2d, e and f. If the vector is moved to a different position, it is said to be *free*. The rule for shunting vectors about is demonstrated in Fig. 2d. They keep the same length and direction at all times.

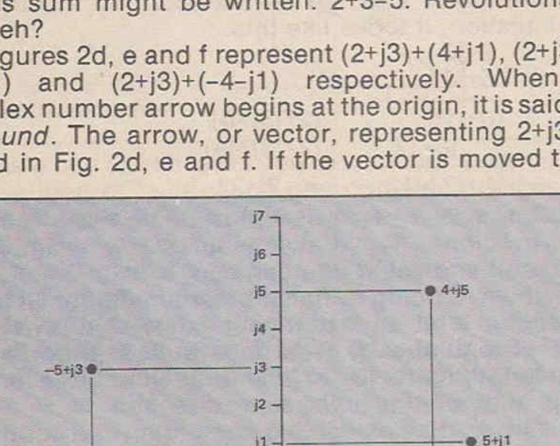


Fig. 1 Complex numbers shown as points on the z-plane

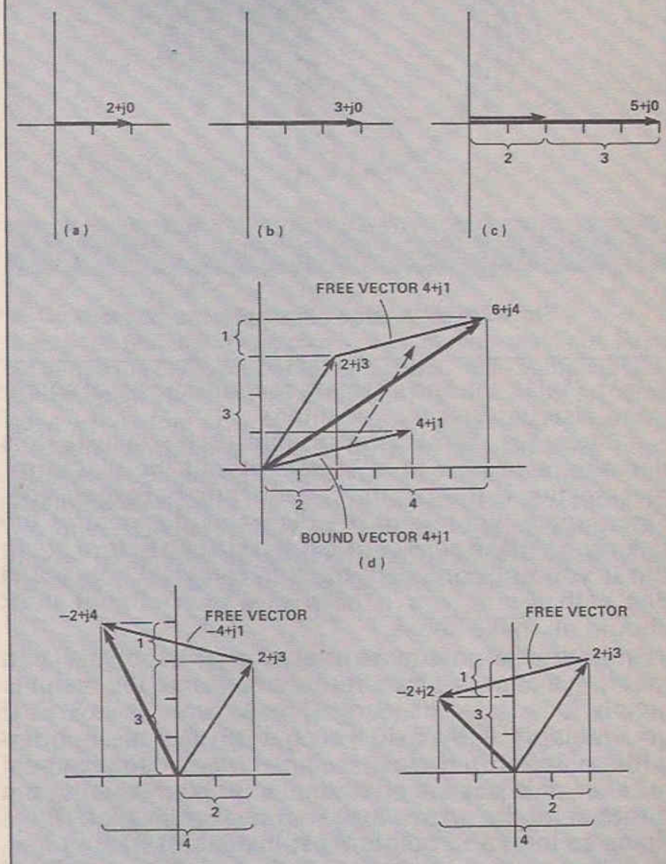


Fig. 2 (a)-(c) The addition of 2+3 as a vector sum. (d)-(f) Some complex number additions

Without the diagrams and arrows, you simply add the real and imaginary parts individually, so (2+j3)+(-4-j1) = (-2+j2). If you remember that we're allowing j the status of a real number and that you'd be quite happy to write $(2+3\pi)+(-4-\pi)$ as $(-2+2\pi)$, the reason for adding in this way becomes evident. With 'pi-numbers,' you add the good parts and the pi-parts individually, right?

Returning to the arrows, subtracting one complex number from another is simply a matter of reversing the arrow for the one to be subtracted. Figure 2d represents (2+j3)+(4+j1) whereas Fig. 2f (where the free vector points in the opposite direction) represents

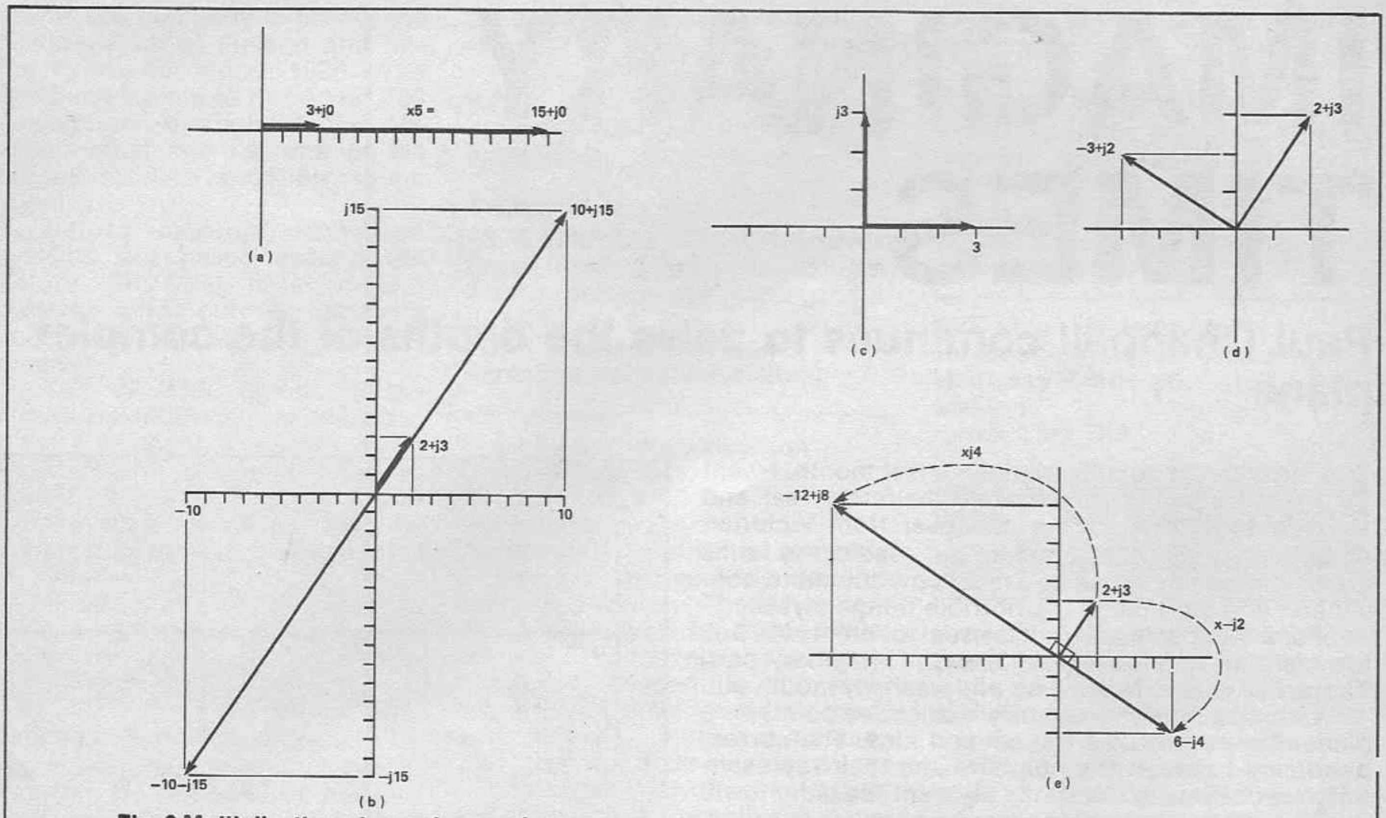


Fig. 3 Multiplication of complex numbers

(2+j3)−(4+j1). (I hope all this is reminding you of something else you've seen recently!)

Since Fig. 2f also represents (2+j3)+(−4−j1), this demonstrates how to subtract without the diagrams: reverse the signs of the second number, then add. Once again, I'm letting the diagrams do most of the talking, so make sure you've got it sussed before going on! If you get confused, think in terms of how you'd deal with pi-numbers (if there were such a thing) and it should all make sense.

Multiplication is more interesting. First of all, if you multiply a complex number by a real one, the result is simply to increase its length. Fig. 3a represents 3+j0. If you multiply it by 5+j0 you get 15+j0. This is often written 3×5=15. If you multiply by a negative real number, this has the additional effect of reversing the direction of the arrow: 3+j0 × −5 = −15+j0, which is five times as long and points West instead of East.

Figure 3b represents 2+j3 and the result of multiplying this by 5 and by −5. The arrow becomes five times as long and when multiplied by −5 it also reverses direction. The results are 10+j15 and −10−j15, which are simply the results of multiplying the real and imaginary parts individually by 5 or −5. You can think of pi-numbers again here but they are about to outlive their usefulness.

Now, what happens if we multiply by j? If 3 is multiplied by j, the result is obviously j3. Figure 3c shows the before-and-after picture.

The arrow has the same length but is now pointing in a different direction. How about (2+j3)×j? The result is $j2 \times j^2 3$ and since $j^2=-1$ (because $j=\sqrt{-1}$, right?) this can be written −3+j2. In Figs. 3c and 3d, multiplying by j leaves the length of the arrow unchanged but rotates it anti-clockwise by 90°. This is no coincidence!

Multiplying by j4 rotates anti-clockwise by 90° and stretches the arrow by a factor of 4. Multiplying by −j2 doubles the length and rotates *clockwise* by 90°. The graphical results are shown in Fig. 3e. You can do the arithmetic for yourself!

Now to multiply a complex number by another. Let's try (2+j3)×(5+j4). Graphically this is a matter of multiplying (2+j3) by 5 (Fig. 3b), then (2+j3) by j4 (Fig. 3e), then adding the results. This time you can draw the diagram for yourself!

Remembering that the vectors add nose-to-tail, you should end up at −2+j23. As a long-hand calculation, it looks like this:

```
  2+j3
  5+j4
 ---------
 10+j15        (2+j3)×5)
     j8−12     (2+j3)×j4)
 ---------
 10+j23−12     = −2+j23
```

The pattern here is not quite so easy to see but there is one. Try drawing out a few examples for yourself and see if you can spot it.

If we're going to finish before midnight I'll have to speed up a bit, so fasten your safety belt! Division of a complex number by a real one results in a shortening of the length so (a+jb)/2=(a/2+jb/2) — half the length of a+jb and pointing in the same direction.

Dividing by a negative number gives a contraction and also a reversal of direction. Dividing by j leaves the length unchanged but rotates *clockwise* by 90°. The way to divide by j in symbols is to notice that 1/j = −j (multiply top and bottom by j, right?) so *dividing* by j is exactly the same as *multiplying* by −j. Dividing by jn gives a reduction in length by a factor of n *and* a 90° clockwise rotation. Dividing by −jn does exactly what you have guessed it will. Try it and see!

When faced with something like (a+jb)/(c+jd) the way to tackle it is not immediately obvious. Let's take the idea we used in dividing by j. We'll try to turn the division into a multiplication. Suppose we could multiply top and bottom by some number which would give a real number as the denominator. Dividing by a real number is something we can already do so it should crack the problem. Let's try an example and see what happens. Try (2+j3)/(4+j5), for instance. First of all, what can we multiply 4+j5 by to turn it into a real number? We begin a long-hand multiplication to see:

4+j5
2+j?
8+j10
j . .+. .

How do I know the number we want is 2+j something? I don't know. I chose the 2 at random to see what would happen. If the imaginary parts are going to cancel out, then ? must clearly be $-2\frac{1}{2}$, so let's continue:

4+j5
2−j2.5
8+j10
−j10 +12.5
8 +12.5 = 20.5

So the original division problem can be transformed into:

$$\frac{2+j3}{4+j5} = \frac{(2+j3) \times (2-j2.5)}{20.5}$$

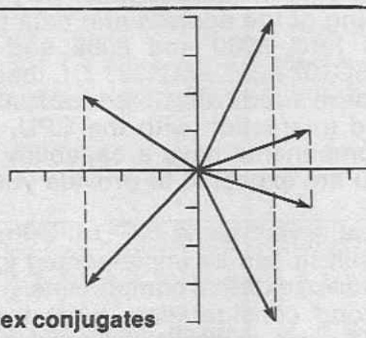


Fig. 4 Complex conjugates

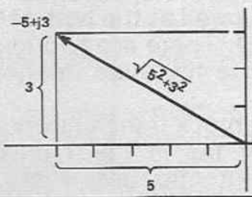


Fig. 5 The modulus of a complex number

which we can do! I'll leave you to work out the answer.

The idea of multiplying one complex number by another to give a real number answer is a very useful one. If you have a complex number a+jb, multiplying it by a−jb will give the answer a^2+b^2, which is a real number — not a j in sight!

The numbers a+jb and a−jb are *complex conjugates* of each other. To find the conjugate of any number, just reverse the sign of the imaginary part. If you want to refer to the complex conjugate of a number, it is usual to put a bar over the top, like the negation sign in logic (although the meaning is entirely different) so $\overline{a+jb} = a-jb$.

Some pairs of conjugates are shown in Fig. 4. They are 'reflections' of each other in the real axis. Bearing in mind that the result of multiplying any pair together will give an answer on the positive real axis, this might give you another clue about the interpretation of multiplying complex numbers, if you haven't already sussed it.

If z is a complex number and $\bar{z}$ its conjugate then anything of the form $kz\bar{z}$, where k is real, will give a real number as the result. The number we hit on by experiment in the earlier division would give k the value 0.5 (because 2−j2.5 is half of 4−j5, which is the conjugate of 4+j5, right?)

Throughout the article I have spoken loosely about the length of a complex number. In formal terms, this is known as its *modulus* and can be calculated from Pythagoras' theorem (Fig. 5). If z=a+jb then the modulus of z (written |z|) will be $\sqrt{a^2+b^2}$. This gives the distance of the number from the origin, or the 'length of its arrow.' The modulus of −4+j0, for instance, will be $\sqrt{16+0} = 4$, often written |−4| = 4. The modulus of 3−j4 will be $\sqrt{9+16} = 5$.

An alternative way of identifying a complex number is to specify its distance from the origin and the angle its arrow makes with the positive real axis. By convention, the angles are measured in an anticlockwise direction. The distance from the origin is the modulus. The angle is referred to by the quaint old term 'argument'. You can't argue with that.

One thing I hope you picked up from this article is that the arithmetic of complex numbers doesn't conflict with the arithmetic of ordinary numbers. (It would cause a lot of problems if it did!) If you apply complex number arithmetic to the set of complex numbers where the imaginary part is zero, it churns out the ordinary number arithmetic that you learned at your mother's knee.

I hope you're also beginning to feel a certain sense of *déja vu* over some of the results. Looks a lot like phasors, doesn't it? Next month I'll be digging a lot deeper into complex numbers and beginning to tie them in to the behaviour of electronic circuits.

ETI

Girolamo Cardano
1501-1576

Cardano is credited with being the first mathematician to derive the basic properties of complex numbers — an idea well before its time.

Cardano was a professor of medicine, astrologer and keen gambler. Apart from his controversial horoscope of Jesus, he is best known for deriving a method for solving cubic equations.

His morals may not have equalled his mathematical skills — his book of dice games contained extensive advice on cheating and rumour has it that his remarkable cubic equation formula was actually the invention of Tartaglia. Cardano stole it!

THE DIRECT APPROACH

Mike Barwise unravels the mysteries of direct memory access

Direct memory access (DMA) was one of the business computer buzz words of the late 1970s. It is really a very simple concept. Any technique of transferring data between peripheral ports and memory without the intervention of a microprocessor can be termed DMA. There are, however, some standard DMA scenarios which form a more common restricted definition of the term.

A typical DMA configuration is that used in the IBM PC. The 8088 microprocessor and the 8257 DMA controller work together to allow double density (MFM) disk transfers, although the processor is not capable of handling the data at the required speed by itself. This highlights the main purpose of DMA — increasing system throughput.

The PC, however, only uses the very simplest implementation of DMA. Some more sophisticated alternatives can do a whole lot more than save you time. I will look briefly at some of these alternatives in due course but first let us consider the time-saving use of a basic DMA controller.

A DMA controller (Fig. 1) consists in principle of an address generator, a data holding register and a control bus via which the controller communicates with the microprocessor.

During normal system operation, the microprocessor puts out addresses onto the address bus and captures the data released by the program ROM. The data is interpreted, causing new addresses to be put out together with output or capture of data. So, the sequence of operations required to move one byte from a port into memory goes something like this:

- 1) put out next address
- 2) when address stable, put out read strobe
- 3) interpret incoming data (read port op code & parms)
- 4) put out address of port
- 5) when address stable, put out read strobe
- 6) put out write address
- 7) when address stable, put out write strobe
- 8) put out next address

This is a narrative of the 8086 MOV instruction which performs a read/write byte transfer in one operation. Other processors (6502 and so forth) need another op-code fetch between stages 5 and 6 as the read and write operations are separate. This means you have to duplicate 1-3 between 5 and 6 making an 11-stage sequence.

The minimum requirement for reading and writing memory is actually much simpler than this. All you really need is:

- set up read address
- output read strobe
- set up write address
- output write strobe.

When you consider that the microprocessor will normally take one clock cycle per stage and that the clock cycle is usually about four times as long as the minimum memory read or write time, it becomes clear that a great deal of time can be saved by a method of data transfer that bypasses the microprocessor.

The DMA Process

To perform DMA, the controller has to take over the address, data and control buses normally driven by the microprocessor. There are two considerations here:

- how control is transferred
- what the microprocessor does during a DMA cycle.

The first depends on the microprocessor. Certain CPUs have a built-in DMA capability by means of tri-state switching of the address and data buses. These include the Intel 8080 and 8086 and the newish Rockwell 65C102 and 65C112. Of these, the Intel processors have a dedicated DMA controller which has a specialised interaction with the CPU, whereas the Rockwell components have a capability and control bus, but you are expected to provide your own DMA mechanism.

Note that even early CPUs without a DMA capability built-in can be implemented to allow DMA by the addition of external components.

The second consideration, what the CPU does during a DMA cycle, depends very much on what result you want as well as the type of DMA interface available on the CPU. There are two main protocols for DMA:

- single byte transfers interleaved with normal CPU activity
- ultra-fast block transfers while the CPU is either held inactive, or (as in the Transputers) while the CPU directs its attention elsewhere.

We will now look at DMA applications, which will demonstrate the pros and cons of the different protocols for various jobs.

The Uses Of DMA

The simplest case, mentioned earlier, is the use of DMA to perform data transfers between memory and peripherals which are too fast for the CPU to handle. The usual given example is disk data transfer.

The original IBM PC used an 8088 processor running at 4.77MHz. This roughly equates to a 1MHz 6502 in throughput. The double density (MFM) data transfer rate is one byte every 32µs and, given the length of code needed to transfer the data as required by MS-DOS (which includes the termination of transfer *immediately* the last wanted byte has been handled) the CPU is just too slow for the job.

However, we are not worried about the actual time the data transfer takes so we just halt the CPU, pass the bus to the DMA controller and transfer a complete disk sector before returning control to the CPU.

The other uses of DMA which follow are all a little hypothetical but they are worthy of mention.

The first provides the ability to run programs of enormous size in small memory maps. It has actually been implemented on the Transputers. Here the task consists of repetitive overlaying of routines into either

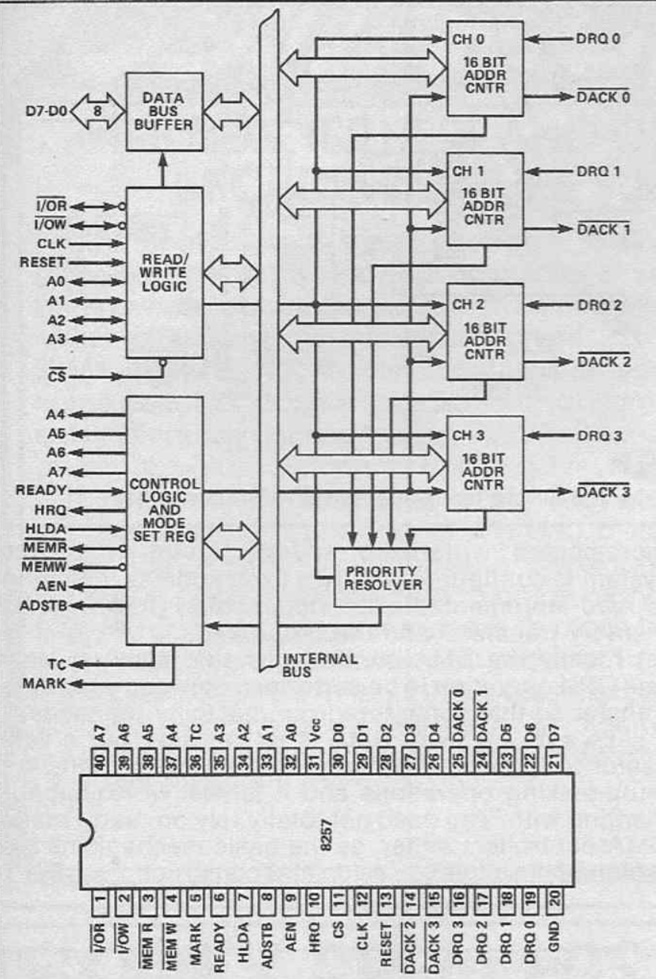


Fig. 1 Pinout and block diagram of a typical DMA controller (8257)

a buffer or an execution area, concurrently with ongoing execution.

There will obviously be some execution speed degradation due to the DMA unless some execution space is 'privatised' but the software will appear to run continuously, rather than in bursts (as occurs when overlaying and execution are alternated).

In the case of the Transputer there is just such a 'private' memory. There is a RAM between the processor and the expansion bus. This bus is the point at which the transfer of control takes place when entering DMA so during DMA to memory beyond the bus interface, processor execution can continue on the 'internal' RAM.

This is the most efficient format. Unless the execution time of the code in the internal memory is shorter than the DMA transfer time, the DMA is invisible. If you want to perform additional overlays, the code transferred under DMA will have to be copied into the private memory, which will waste time. However, supposing the DMA is transferring data for use by a highly iterative *math* routine, the system becomes very efficient indeed.

The next case is that of a data acquisition system. DMA is still DMA even where no microprocessor has direct access to the memory. A typical example is that of a very *slow* data capture system (or an extremely *fast* one) where, for example, an analogue to digital converter generates a stream of bytes and puts them directly into one of our hardware FIFO memories.

There is no direct bus link between the ADC and the CPU bus but the data can get through via the FIFO buffer. Let's take the slow case. Let us suppose it takes about two seconds to capture the required data (typical of, for example, a heating or cooling curve derived by a thermocouple sensor). Let us also suppose we need a spectrum analysis of the data. We put the data through a fast fourier transform which, being highly iterative, takes about a couple of seconds to run. The simplest case would be to run an acquisition sequence (2s) then enter the FFT routine (another 2s) resulting in a system which can update once every four seconds.

However, we can be crafty and double the throughput by taking advantage of the ADC-FIFO DMA. If we cause (by hardware design) the FIFO to be loaded every acquisition by the end-of-conversion signal from the ADC until the FIFO is full and cause the FIFO to generate a maskable interrupt as soon as it is full, we have the required hardware so long as the interrupt remains active until acknowledged by the CPU.

The system software will need a null wait loop at the end of its run (after it has done the FFT and display handling), an instruction to start the acquisition system hardware running and control over the interrupt mask.

The operation will go something like this:

- first time round, there is no data to work on, so the software starts the acquisition system, unmasks the interrupt and enters the null wait loop.
- on interrupt, the software unloads the FIFO into mapped memory, masks the interrupt, restarts the acquisition hardware then continues with the FFT and display.
- as soon as the FFT and display are done, the software unmasks the interrupt and enters the null wait loop.

If you follow this through, you will find the system is a self-prioritising truly concurrent dual process. That means both operations (calculation and data capture) are going on simultaneously and whichever finishes first waits for the other. Let's prove it:

Suppose the data capture finishes before calculation and display (C&D) software. The interrupt is generated but the interrupt mask is active, so the interrupt is postponed until the mask is cleared — as soon as the C&D finishes.

Now suppose the C&D finishes before the data capture. The interrupt mask is cleared and the C&D enters the null wait loop. Some time later, the interrupt is generated and is immediately acted upon as the mask is already clear.

The Hardware For DMA

As previously mentioned, many modern microprocessors have inbuilt capacity for DMA either by dedicated DMA controller or by a control bus for independent implementation. Even the humble 6502 can be configured for DMA. Here is what you do . . .

The only realistic action the 6502 can take during a DMA cycle is ... nothing. Due to the pipelined architecture of the 6502, the bus is active during most processor cycles. There are therefore practically no 'bus idle' cycles to steal.

The 6502 can be stopped during any READ cycle by assertion of the RDY line. However, this could cause the processor to stop during the execution of an operation, as all operations take several clock cycles. The saving grace is an output from the 6502 called SYNC. This signal is high (logic 1) during the whole clock cycle in which an op-code is being fetched from memory. Assertion of RDY while SYNC is active causes the processor to stop with the address bus pointing to the op-code to be fetched until RDY is released, when it commences the fetch and continues. No status, flags or parameters are lost by the process.

If the address, data and control buses are passed through buffers such as 74LS244 (74LS541 is a newer and more convenient alternative) and the DMA controller controls them and RDY and monitors SYNC and READ/WRITE, the DMA controller can at any time halt the processor and take over the bus, along with all memory and peripherals attached to it.

The newer Rockwell 65C102 and 65112 have the buffers built in and also have a couple of minor differences. First, both read and write cycles can be held by RDY and secondly, there is an additional output called ML or memory lock which goes active during the modify and write cycles of read-modify-write operations such as INCREMENT, ROTATE and SHIFT. This means you can hold and DMA at any time except during an RMW instruction, rather than waiting for the next op-code fetch.

As to the DMA controller itself, it typically consists of a counter as large as the memory map (a 16-bit counter for a 64K map) which increments at a rate suitable to the speed of the memory after a start trigger, a comparator to stop the counter when the end of the block has been reached, one or two fixed address registers for device addresses, a read/write data register and some control signals and flags. These consist of a minimum of: write strobe, read strobe and end of block flag although there may be others as well depending on the implementation. These are all fitted together as in Fig. 2.

The counter is loaded with the start address of the block to be transferred, the comparator is loaded with the end of block, the controller is programmed to read-fixed write-incremented address or to read-incremented write-fixed address mode or (if the system is configured with two fixed address registers) to read-incremented write-incremented (for memory-memory transfers) and then triggered.

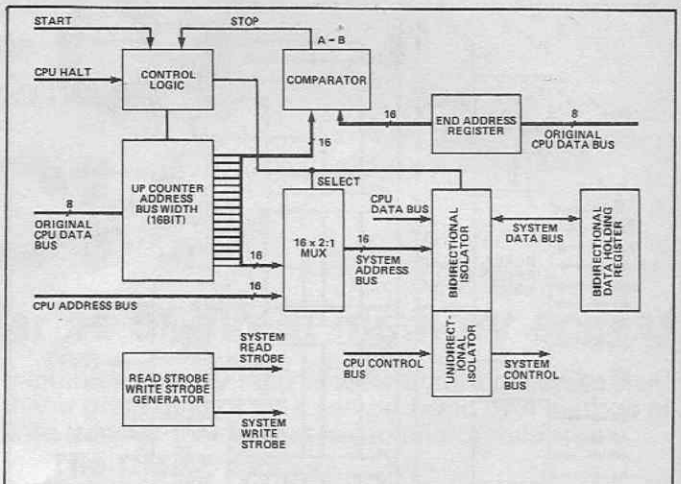


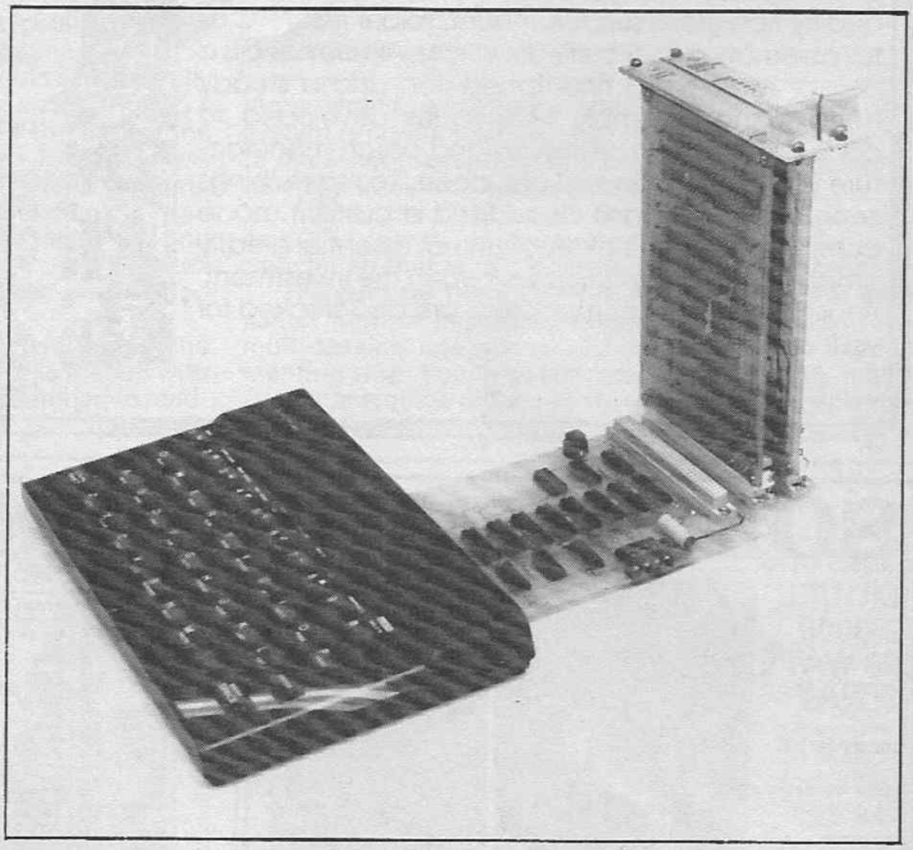
Fig. 2 Building blocks of typical DMA controller

Ideally the DMA controller should allow at least one CPU operation to be performed between each byte transfer so that some foreground activity proceeds.

To sum up then, DMA is no mystery but a very useful tool for improving system throughput and for multi-tasking operations and it is well worth experimenting with. You need not totally rely on ready-made DMA controllers either, as the basic mechanisms are remarkably simple to design and construct. **ETI**

SPECTRUM CO-PROCESSOR

Graeme Durant describes the first part of a twin Z80 system to boost your Spectrum or just use on its own



The term multiprocessing is a much bandied expression these days. It usually refers to the operation of a number of separate processors working together towards a common goal.

The idea is similar to the old maths problem of how long it takes for different numbers of men to dig a hole. The more men you use, the less time it takes.

In simple computer terms, the time taken to complete a given problem can be reduced by using either a faster machine (the sledgehammer approach) or by using lots of slower machines all working simultaneously on the problem (the 'lots of slower machines all working simultaneously' approach!).

As fast machines are so expensive, the multiprocessing system is a good solution to many problems. Its main disadvantage is the need for communication between the individual processors.

Lots of people working together to write a single book with no communication between them would not produce a well structured novel when the individual parts are put together. The same is true of multiprocessing.

However, communication itself takes time and so the advantage of having more than one processor is best applied to problems where the processing itself can be easily partitioned and movement of data between the processes is not a frequent requirement.

Co-processing

Co-processing is just one form of multiprocessing. The co-processor itself is just a specialised processor optimised towards some particular task.

A co-processor is designed to be fed information and commands from a master processor (the 'host') and then to go away and get on with what it is best at while the host does something else. When the co-processor has finished its current task, it will tap the host on the shoulder and the host will exchange data and supply the next command.

On its own, the co-processor can do very little but with a suitable host and sensible allocation of tasks, the result can be a dramatic improvement in overall throughput.

An increasingly common example of co-processing can be seen in the maths co-processor chips, now available to work alongside today's popular microprocessor devices.

These maths chips are designed to perform high-accuracy arithmetic functions very quickly, taking the strain off the general-purpose microprocessor itself, when number crunching is the order of the day.

Since the maths chip is designed specifically to work alongside a particular microprocessor, interfacing and communication are very straightforward. The main disadvantage of maths co-processors is cost — this usually being well over the hundred pounds mark!

Obviously, such cost cannot be justified when simple machines such as the ZX Spectrum are designed. So most basic home computers do not have the facility to add on a maths co-processor, despite the possible rewards.

Of course, co-processors need not be as dedicated to one function as these maths chips.

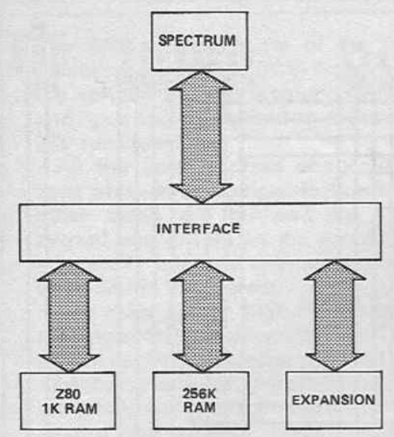


Fig. 1 The Spectrum Co-processor system

Acorn provided the famous 'Tube' interface on the BBC micro designed specifically for communication with a co-processor.

The Acorn co-processors are based on ordinary micro-processors such as the 6502 and the Z80. Jobs usually done solely by the internal processor are shared with the co-processor to speed things up. The result is indeed a speed increase, transparent to the user, but this depends on the machine having been designed from the start with co-processing in mind.

The ridiculously popular ZX Spectrum has been mostly left out of all this co-processing fun. This is mainly because it was never designed for serious expandability and so the designer of a suitable co-processor is forced to start from nothing.

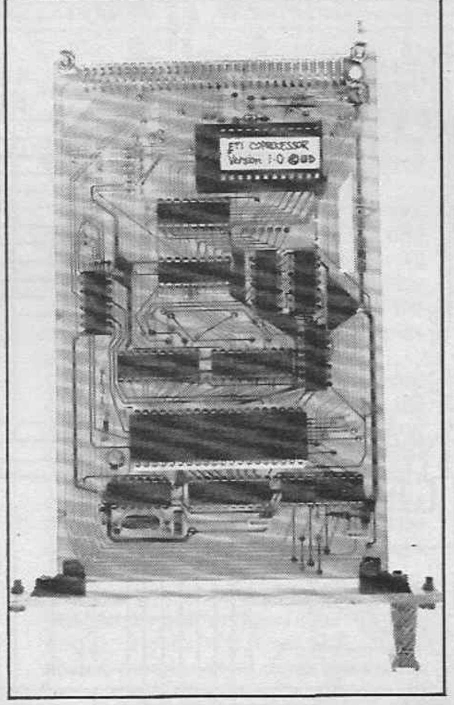
However, there are a great many Spectrums out there — some feeling very lonely and dejected, wanting nothing more than a little companionship. So, here comes the ETI Spectrum Co-processor to the rescue!

The System

The design to be described here consists of three circuits which together form a fully expandable co-processor (Fig. 1). The heart of the system is a general purpose Z80A based CPU card running at 4MHz with its own operating system software in EPROM.

The second card in the system is a general purpose 256K paged dynamic RAM board. This offers the co-processor a large store area for data or programs.

The third board in the system is the interface card to the



Spectrum. This consists of a connector for the Spectrum's expansion port, the bi-directional communication circuits and a three position mini-backplane for the co-processor CPU, DRAM and any other circuits the user may wish to add later such as analogue input or output or serial/parallel interfacing to the outside world.

It must be stressed that the CPU card and the DRAM are completely general purpose

a		Pin		c
0V	O	1	O	0V
+5V	O	2	O	+5V
SYSTEM CLK	O	3	O	$\overline{\text{MI}}$
$\overline{\text{IOREQ}}$	O	4	O	$\overline{\text{MREQ}}$
$\overline{\text{BUSACK}}$	O	5	O	$\overline{\text{BUSREQ}}$
$\overline{\text{WAIT}}$	O	6	O	$\overline{\text{HALT}}$
$\overline{\text{WR}}$	O	7	O	0V
$\overline{\text{RFSH}}$	O	8	O	$\overline{\text{RD}}$
$\overline{\text{RESET}}$	O	9	O	$\overline{\text{SYSTEM RESET}}$
A8	O	10	O	A0
A9	O	11	O	A1
A10	O	12	O	A2
A11	O	13	O	A3
A12	O	14	O	A4
A13	O	15	O	A5
A14	O	16	O	A6
A15	O	17	O	A7
	O	18	O	
	O	19	O	0V
$\overline{\text{INT}}$	O	20	O	$\overline{\text{NMI}}$
	O	21	O	0V
	O	22	O	D0
	O	23	O	D1
	O	24	O	D2
	O	25	O	D3
0V	O	26	O	D4
	O	27	O	D5
D7	O	28	O	D6
	O	29	O	
	O	30	O	
+5V	O	31	O	+5V
0V	O	32	O	0V

Fig. 2 The backplane pinout used throughout the system

circuits and can equally well be applied individually or together to any Z80 based system.

This co-processor design is simply one possible application for their use.

Software

These days, a chunk of hardware, no matter how sophisticated, is useless without its associated software. The Spectrum co-processor is no exception.

The CPU card has provision for a 4K EPROM and in this application the machine code residing there provides the basic functions required to make the co-processor operate.

The co-processor can respond to five different commands when controlled by the Spectrum. Code or data may be moved from the Spectrum and into the co-processor memory (block write), code or data may be moved from the co-processor memory and intc the Spectrum (block read) and user code may be executed in the co-processor (code execute).

Executing code may be stopped by the Spectrum (break), and finally, the co-processor can be commanded to run a self test routine which reports on how much DRAM is present and the state of the EPROM and RAM on the CPU card.

There is also the facility to extend the number of commands to include new user defined functions but that must wait until later.

Why Co-process?

So what advantages are gained by spending all your hard earned cash on a companion to your neglected old Spectrum?

First the bad news. Since the venerable Spectrum was never intended for such serious expansion, there are major limitations on the performance improvements possible. However, put to appropriate use, this co-processor will offer enhanced processing speed over the Spectrum alone.

The Spectrum also provides a superb low-cost base for experimentation and, coupled with this project, offers a great way to learn first hand about multiprocessing environments.

Over and above the obvious speed advantages, there are also a number of important things to be gained by having a pool of processing power detached from the Spectrum, yet under its

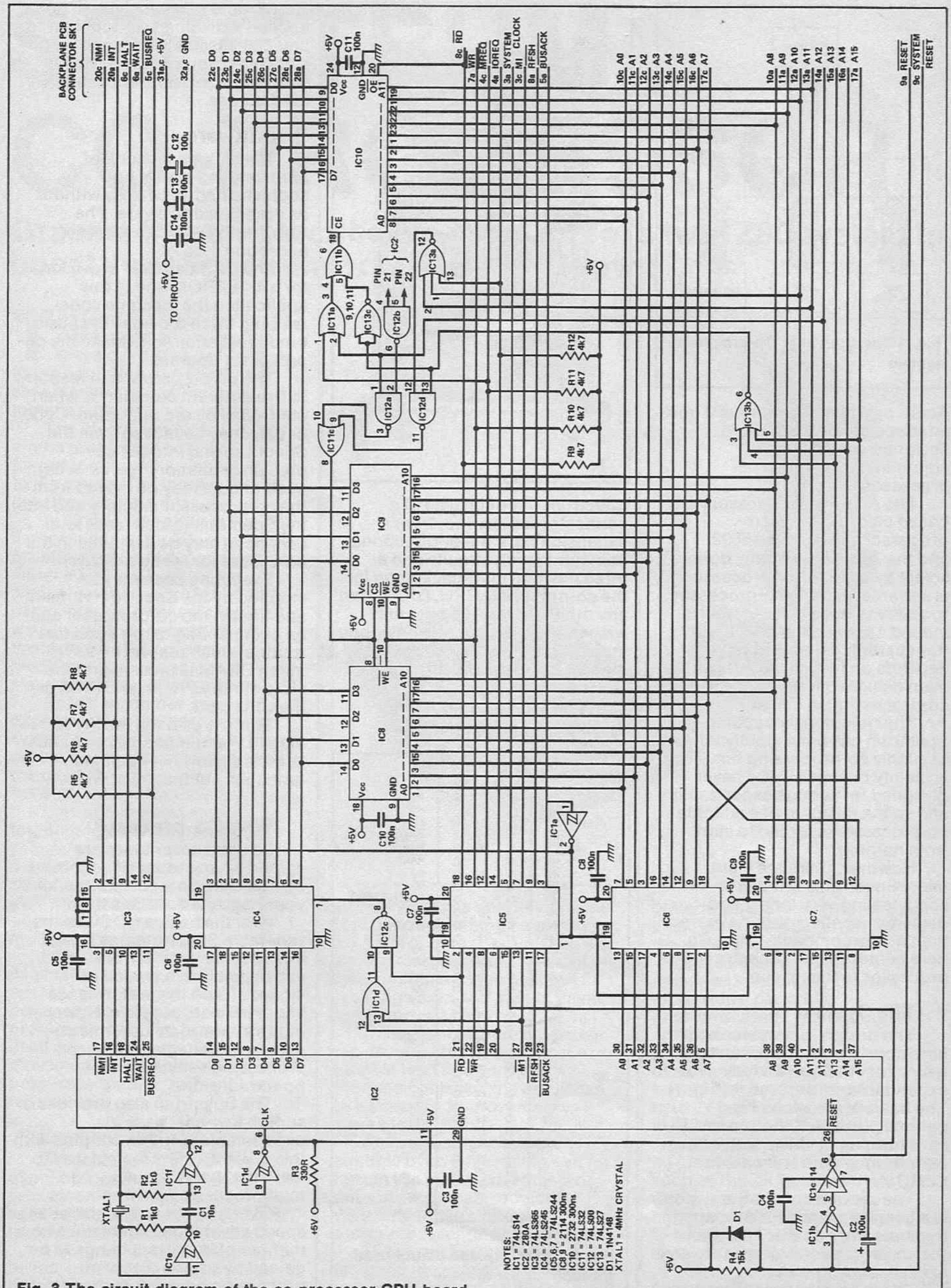


Fig. 3 The circuit diagram of the co-processor CPU board

HOW IT WORKS

The CPU card consists of the Z80 microprocessor itself (IC2) along with the various buffers, memory devices and 'glue logic' required to make the Z80 run software.

All the data, address and control lines which allow communication with other cards are buffered by high current line drivers so the processor may easily interface with many other cards within the system.

The main system high-speed clock running at 4MHz is generated by a TTL crystal oscillator based around IC1e,f. After being buffered, this drives pin 6 of the Z80A, with pull-up resistor R3 to ensure the correct clock voltage transitions.

A further buffered version of the system clock is available at the card edge-connector (SK1) with IC5 acting as the bus driver. This signal is available at all times, since other devices in the system may require the clock signal even when the Z80 itself is disabled.

Two more inverters from IC1 are used to generate the Z80 reset signal. A brief power-up reset pulse is generated by C2 and R4, which acts on IC2 pin 26 via IC1b,c. Diode D1 ensures a reliable reset occurs even when the power is only briefly removed. Alternatively, a reset operation may be initiated by an external device by it pulling low the SYSTEM RESET line on the card connector.

IC3 and IC5 buffer control signals to and from the card connector. IC4 is a bidirectional buffer used to drive the system data bus from the Z80. IC6 and IC7 are unidirectional buffers which drive the address bus from the Z80.

IC4, IC6, IC7 and half of IC5 have their output enable controls wired together and driven by an inverter IC1a. This in turn is driven by the BUSACK signal from the Z80. This disables the data bus, address bus and some of the control lines when an external bus request is granted.

For example, if another processor or a DMA controller sharing the same buses requires use of these buses, it sends an active low signal on the BUSREQ line to the Z80. When ready to release its buses to the requester, the Z80 sends a BUSACK strobe and tristates its own buses. So the buffers must do the same, via IC1a.

When the external bus user has completed its operations, it releases BUSREQ and the Z80 removes BUSACK in response. The buses are then re-enabled and the Z80 can resume its own operations.

In addition to those signals which must be tristated during external bus activity, there are several control signals which need not, and in some cases must not, be disabled at such times.

The system clock, M1, RFSH, BUSACK, NMI, INT, HALT, WAIT and BUSREQ are all left active, even during DMA cycles. So, the buffers which pass these particular signals, IC3 and the other half of IC5, have their outputs permanently enabled.

Pull-up resistors R5-8 are provided on the four signals which enter the processor card via IC3. These four inputs, NMI, INT, WAIT and BUSREQ require such treatment to ensure reliable operation if no signals drive these lines from outside or in the case of a 'wired-OR' connection from more than one peripheral.

Similarly, pull-up resistors R9-12 are fitted to the output signal lines RD, WR, MREQ and IOREQ from IC5. These ensure no erroneous active low pulses can occur as the buffer is disabled via IC1a, during DMA operation.

IC4, the bi-directional buffer which controls the system data bus, must receive a signal pin 1 to determine the direction of data flow — either into or out of the card.

This signal, generated by IC11d and IC12c, depends on two conditions. First and most important,the active RD strobe from the Z80 pulls IC4 pin 1 high via IC12c allowing data flow into the Z80 during read cycles. Second, when the Z80 IOREQ strobe (pin 20) and the Z80 M1 signal (pin 27) go low simultaneously, again the direction control pin of IC4 is pulled high, via both IC11d and IC12d, to allow data flow into the Z80.

This happens only when a Z80 interrupt acknowledge cycle occurs and allows the external interrupt source to put an interrupt response vector onto the Z80 data bus if required. For more details refer to one of the many books available on the operation of the Z80.

If neither of these conditions is in force, IC4 drives data out of the card to allow for wiring data to memory or peripherals.

Now, on to the memory devices on this card: When reset, the Z80 microprocessor starts executing program code from address zero (the processor's operating program must begin here).

A 4K EPROM, IC10, is mapped into the first 4K address locations for this purpose.

The next 1K locations up from the EPROM are inhabited by static RAM, intended for use as a general scratchpad workspace. This is shown on the circuit as IC8 and IC9, each 1K × 4-bit device covering half of the data word width.

Both the EPROM and the static RAM are available at all times to the processor. The mapping of these memories is performed by the logic gates in IC11-13 driving the chip select pins of IC8 and IC9 (pin 8) and of IC10 (pin 18).

These signals are active low when the Z80 addresses a location within the device's allocated range. The write enable inputs of the RAM chips, pin 10 of IC8 and IC9, are driven directly by the Z80 WR strobe. Similarly, the output enable pin of IC10, pin 20, is driven from the Z80 RD strobe. The result is that reading an address between zero and 4K will access the EPROM and reading or writing to an address between 4K and 5K will access the scratchpad RAM.

Any further memory in the system (such as the 256K dynamic RAM card) should be mapped into the rest of the Z80's available address space, this being between addresses of 5K and 64K to avoid contention with the on-board memories.

It is worthwhile noting that the data and address lines to the static RAM devices are not connected here in the same order as described in the manufacturer's data sheet.

This serves to ease the printed circuit layout and does not make any difference to circuit operation so long as a data signal goes to a data pin and an address signal goes to an address pin on the RAM chips. Every unique address location in the RAM is the same and data can be stored there regardless of its value.

The same is not true of the EPROM, which is programmed externally by sticking to the standard manufacturer's pin allocations, so these same pin designations must be (and are) used here.

Finally, a note about supply decoupling. Low value decoupling capacitors are liberally scattered about the circuit to avoid problems with supply and ground noise. A high value electrolytic capacitor (C12) is placed very close to the backplane power connections to provide bulk energy storage and helps to avoid the problems associated with remotely controlled power supplies.

control.

For example, if an application has very critical timing associated with it — say, audio sampling — then the various interrupts already present in the Spectrum can upset operation. Using the co-processor can avoid this problem.

Furthermore, a co-processor offers a great opportunity for the user to develop low-level software in a more controlled environment than on the Spectrum itself. Assembly code can be written and assembled on the co-processor, downloaded into the co-processor memory and then executed there.

Input data can be fed to the program and output data examined. If some kind of endless loop is entered then execution can be stopped by the Spectrum.

Every time user code stops execution, either naturally or via a Break command, all the co-processor Z80 registers are copied into a reserved area in its memory and these can be subsequently examined to aid de-bugging.

Although the co-processor's

operating software in EPROM is completely usable in any desired application, this idea of a 'software development system' seemed so attractive that this project will finish with a complete listing, in ZX Basic, for a menu-driven program to implement such a tool.

This fully commented listing will also serve to illustrate clearly, the ways of passing data to and from the co-processor and how to control its actions afterwards so that any required co-processing application may be realised by the reader.

The CPU Card

Let's take a closer look at the heart of the co-processor — the CPU card. This card is built on a standard 160 × 100mm Eurocard-sized double-sided PCB and consists of the Z80A CPU itself, 4K EPROM for the operating software, 1K static 'scratchpad' RAM and full buffering for all the control, data and address lines going in and out.

Connections to the other boards are made via DIN41612 connectors and the pinout used throughout this project is shown in Fig. 2.

As stated earlier, this CPU card is strictly general purpose and there is absolutely no reason why it should not be used in any application you care to devise, indeed, the co-processor system could be used to develop software for some final target system which in turn would use the same Z80 card at its heart.

Construction

The construction of the Z80 processor card is relatively straightforward, particularly if the suggested PCB design is used.

This PCB is double-sided but is not through-hole plated. So, connections between the layers must be added by wire links or by the component leads themselves.

Where a through connection is marked on the PCB layout diagram (Fig. 4) a short length of tinned copper wire should be pushed through the hole and carefully soldered on both sides before cropping to length.

Where a copper pad encircles a passive component lead on the topside of the board, this lead should be used to form a through connection. The lead should be soldered in place from the underside as normal and then soldered on the topside, being careful not to use too much solder.

A large number of through connections are made via the pins of the ICs themselves (again, a copper pad encircles the IC pin on the topside).

Before the ICs can be fitted, however, there are a small number of through PCB connections and miniature decoupling capacitors which, due to circuit layout constraints, are sited underneath ICs themselves. These must be fitted first. Once these are present, the ICs can be soldered in.

It is strongly recommended that DIL sockets are used for all the ICs on this PCB. Apart from the ease of future repair, sockets rather neatly raise the ICs off the board surface making space for the decoupling capacitors underneath.

The chosen DIL sockets must be capable of being soldered in from the topside as well as from underneath, to form the through connections. This is not as big a problem as might be thought since most 'turned pin' IC sockets leave the base of their pins accessible on the topside of the PCB.

Standard 'sprung contact' DIL sockets rarely offer this feature and so turned pin style sockets are to be preferred.

The trick is to first solder the socket into the PCB from underneath as normal. Then, by heating each pin in turn from underneath with the soldering iron, it will be possible to form a solder joint on the topside by simply dabbing the solder onto the base of the pin. It is advantageous to use fine solder for this operation.

This technique is necessary as the exposed pin bases on the topside are usually too recessed to get a soldering iron to them and you risk melting the plastic socket frame if you try!

If you envisage writing new code for this processor yourself, it is a good idea to use a zero insertion force (ZIF) socket for the EPROM (IC10). This will reduce the risk of damage to EPROMs with repeated insertion and extraction.

The PCB was designed for a ZIF socket for IC10. The construction of ZIF sockets is such that they rarely provide access to their pins on the topside of the PCB. So, the through connections which would normally be made via the pins of IC10 are made conventionally by separate wire links through the board. This means that any type of 24-pin DIL socket can be used to hold the EPROM — including most available ZIF sockets.

After making all the through PCB connections and fitting the IC sockets, the rest of the components can be added. Note that resistors R1 and R2 should be soldered in on end.

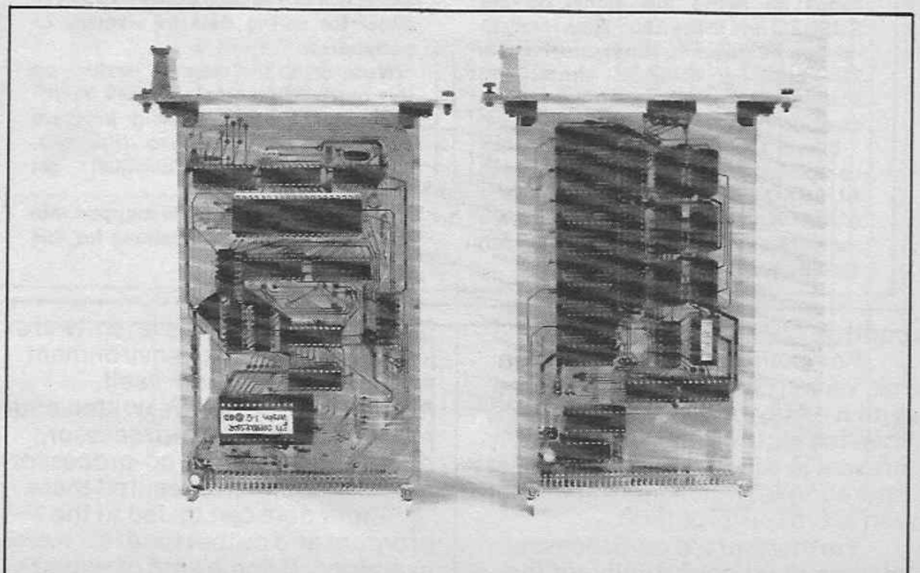
It is suggested that for extra strength, SK1 is bolted to the PCB using short M2.5 bolts and matching nuts.

Finally, after all the components have been fitted, it is a good idea to check for solder splashes which may form short circuits, especially across the closely spaced bus lines.

After this it is always nice to complete the job by removing any remaining traces of flux from the board, using methylated spirits and a stiff brush.

Testing

Testing the completed CPU card is not easy at this stage. If you intend to build the whole co-processor system, the methods for



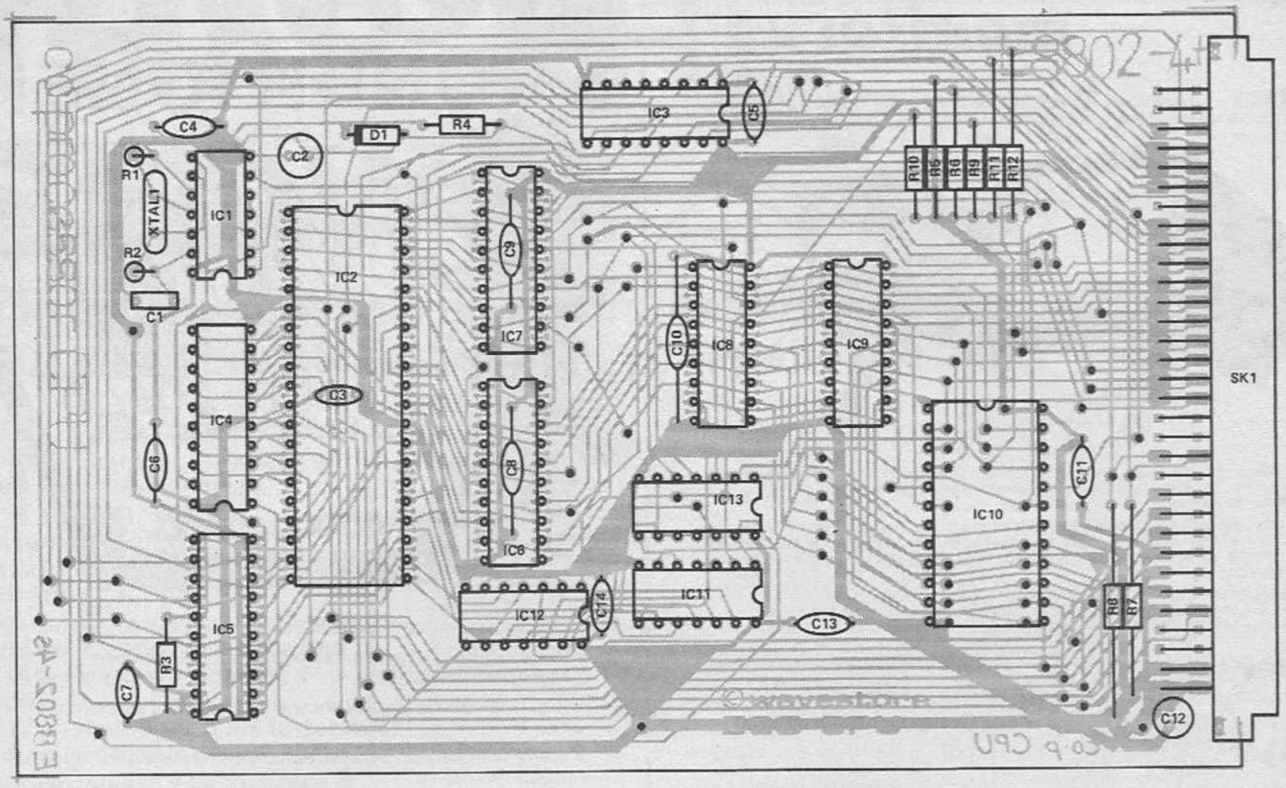


Fig. 4 The component overlay for the CPU board

PARTS LIST

RESISTORS (all ¼W 5% unless otherwise stated)

R1, 2	1k0
R3	330R
R4	15k
R5-12	4k7
CAPACITORS	
C1	10n polyester
C2, 12	100µ 6V ultramin radial electrolytic
C3-11, 13, 14	100n monolithic axial ceramic
SEMICONDUCTORS	
IC1	74LS14
IC2	Z80A
IC3	74LS365
IC4	74LS245
IC5, 6, 7	74LS244
IC8, 9	2114 350ns
IC10	2732 350ns (see Buylines)
IC11	74LS32
IC12	74LS00
IC13	74LS27
D1	1N4148
MISCELLANEOUS	
SK1	DIN41612C 64-pin right angle PCB mounting plug
XTAL1	4MHz crystal

PCB; IC sockets; tinned copper wire for through connections; M2.5 nuts and bolts for DIN connector.

testing all the hardware together will be described later in the series.

However, if the card is destined for your own application then testing must consist of powering up the card, with a suitably programmed EPROM present and simply checking the program runs as expected. If it does not (and there are no dramatic blue flashes) then try running a tight program loop such as a line of code repeatedly jumping to itself and test for activity on the clock, data, address, control and EPROM chip enable lines with a scope.

If all seems fine, try a program which accesses RAM and look at the signals driving the RAM chips.

Fault finding in complex logic circuitry is at best very tricky and without the correct equipment, almost impossible. Think very carefully about what is going on in the circuit and try to narrow down the fault to an area of the circuitry.

Beyond this, consider investing in a Logic Analyser!

Next month we shall move on to look at the design and construction of the general purpose 256K paged dynamic RAM card which provides the co-processor with storage for large programs and databases. Don't miss it!

ETI

BUYLINES

Most of the components used on the CPU card are readily available from your usual supplier. The miniature axial ceramic capacitors used throughout this project are available from Verospeed as order code 92-50952H. Verospeed can be contacted at Stansted Road, Boyatt Wood, Eastleigh, Hants SO5 4ZY. Tel: (0703) 644555.

The ultramin 100µ radial electrolytic capacitors were obtained from Maplin (order code RK50E) as is the DIN41612 backplane connector (FJ51F). The turned pin IC sockets suitable for use with this PCB are supplied by most component stockists but try Maplin's range if uncertain.

For readers set on typing reams of hex into a programmer, a hex dump of the co-processor operating system EPROM will be printed later in the series. Otherwise, an EPROM pre-programmed with this code, is available from the author, price £10 inclusive of postage. A comprehensively commented assembly listing for this code is also available for £3.50. Please send cheques or postal orders, made payable to the author, to 52 Bishops Court, Trumpington, Cambridge CB2 2NN and allow 28 days for delivery.

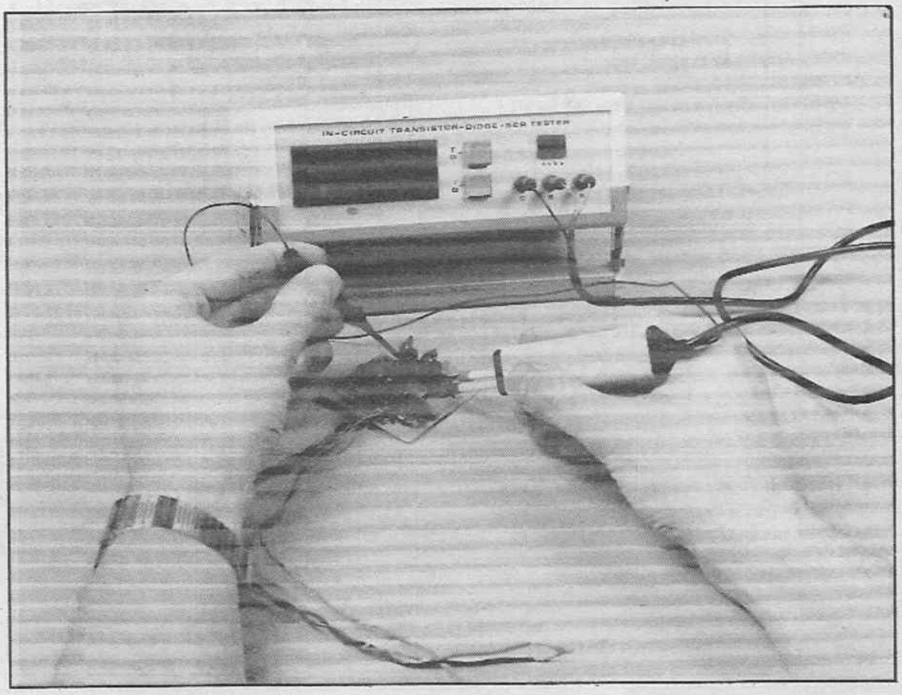
Finally, as ever, the printed circuit board is available from our PCB service.

THAR' SHE BLOWS!

Alan Wilcox presents an in-circuit transistor tester that will test your components rather than your patience

How many hours have you spent testing transistor after transistor in a ponderous search for that monstrous component which has blackened your golden PCB? How often do you wish for a device that could tell a good 'un from a bad 'un with a single prod from a probe?

Wish no longer. This tester will confirm in a single measurement if a diode, transistor or thyristor is OK as well as showing its polarity (PNP/NPN for a transistor and PN/NP for a diode). It is tolerant of in-circuit resistance of the order of 40R across the junctions so you can flit from component to component without once reaching for your soldering iron. There is even a buzzer which sounds whenever a healthy piece of semiconductor is tested.



The Test

To test a transistor, a 5Hz square wave is applied to the collector-emitter terminals of the device being examined (see Fig. 1). Forward bias is supplied to the base, again with a 5Hz square wave.

The low saturation voltage of a good transistor is taken as the indication of a good device but is differentiated from a short circuit by checking that conduction occurs in one direction only.

If conduction occurs on the positive half-cycle (relative to the emitter) this is interpreted as being a good NPN transistor. Conduction on the other half-cycle would be due to a good PNP device.

The design criterium here is that the collector-emitter voltage must fall below 500mV for a good indication to be given. This ensures the tester ignores any diodes that may be in circuit. This is particularly important in order to detect a collector-base short which would act as a diode, conducting on one half-cycle only and erroneously indicating a good device.

Diodes, thyristors and Darlington transistors have a forward voltage drop between 500mV and 1V so to test these a separate range is provided. On this range the threshold for a good indication is increased to approximately 1V.

The Display

A 4-digit LCD is used to show the status of the device under test. The first three 'digits' can show either an **n** or a **p**, and indicate the device type. The first digit is blanked when testing diodes.

The fourth digit shows either a **t** or a **d** to indicate transistor or diode range. It also serves as an 'on' indicator.

Failed devices will give a display of **nnn** on the LCD if the test terminals are short circuited. If they are open circuit, the first three letters of the LCD are blank.

Construction

The component overlay for the main PCB is shown in Fig. 2. All ICs are CMOS and so the usual precautions against static should be taken. Note that they all face the same way on the board.

All odd numbered transistors are PNP and even numbered are NPN. The presets RV1, RV2 may be replaced by 4M7 fixed resistors with just a small increase in the response time resulting.

Avoid any stress on the LCD display, taking care not to overtighten any fixing nuts. The mounting bezel specified comes complete with two socket strips on a board. These were removed and used on the display PCB (Fig. 3). Take care to observe the polarity of the ribbon cable when connecting the main PCB to the display PCB.

Note that the two switches are momentary push to make, similar to a keyboard type. The ones used on the prototype were from the junk box.

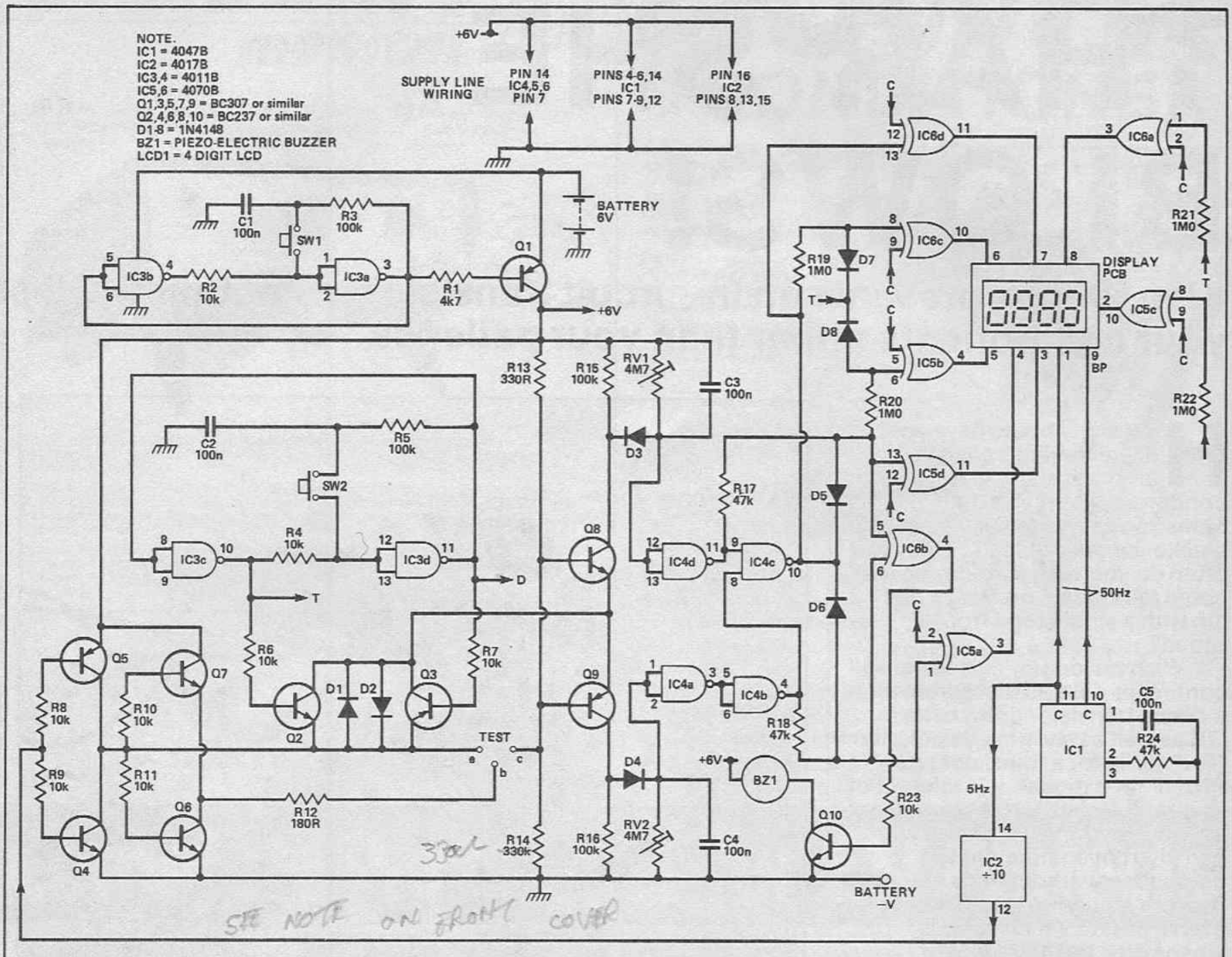


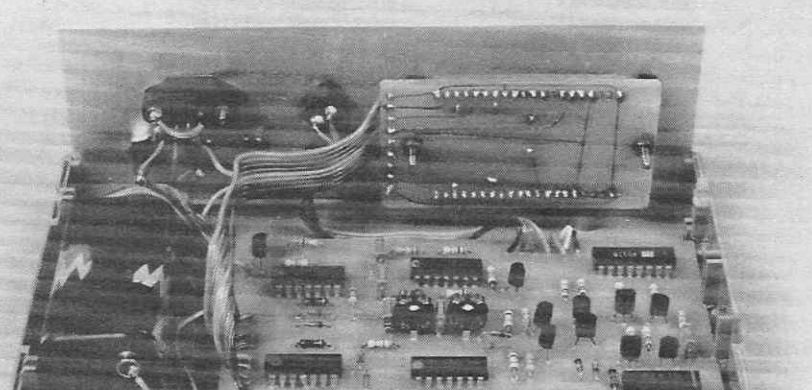
Fig. 1 The complete circuit diagram

Shock, Horror, Probe

Testing a transistor involves connecting into the circuit at three separate points. Manipulating three individual probes with only two individual hands can be a practical problem. To overcome this, a special collector-emitter test probe was constructed using a small Eveready torch case into which were fitted two short lengths of curtain wire to form the probes. Dart points were filed down to fit tightly into these. The result can be seen in the photograph.

The probe used for the base connection is one commercially available.

In addition to sockets for the circuit probes, a transistor socket was fitted to the front panel of the case to ease the testing of devices out of circuit.



Testing And Setting Up

If the presets (RV1,2) are fitted, turn both anticlockwise and connect up the batteries. When on, the display should blank apart from the mode indication which should be a **d** or **t**. This should alternate each time SW2 is operated.

Now select the diode mode and advance a preset until the display starts to flash, then back

HOW IT WORKS

Gates a and b in IC3 are wired as a bistable that changes state each time the on/off switch SW1 is pressed. When pin 3 is low, Q1 is turned on through R1 and power is supplied to the rest of the circuit.

Gates c and d are also connected as a bistable, this time changing state when the transistor/diode switch SW2 is pressed. In the transistor test mode, Q2 and Q3 are biased on, effectively shorting out diodes D1,2. (Some features of the display are also controlled by this bistable).

These diodes come into effect in the diode test mode, raising the threshold voltage for testing as mentioned above.

IC1 is connected in the astable mode having a frequency set at 50Hz by R24 and C5. This provides the waveform to drive the display and is divided by IC2 to give the 5Hz square wave used to drive the bridge circuit formed by Q4-7. The result of this is that the collectors of Q4,5 have a 5Hz square wave that is the inverse of that on the collectors of Q6,7. A 12V peak-to-peak waveform is thus generated, providing an AC supply to the test terminals.

The potential to the collector-emitter terminals is limited to 600mV in each direction by the base-emitter junctions of Q8,9 across these terminals in the transistor text mode. In this mode, Q2 and Q3 are always on as the Q4 and Q5 collectors switch between the supply lines because IC3 pin 10 is high whilst pin 11 is low.

Assuming no device is connected to the test terminals, Q8 and Q9 will conduct alternately, again at 5Hz. When the common emitter line is low Q8 is biased on through R13 and when it is high, Q9 receives its bias via R14. It is the conduction or otherwise of Q8 and Q9 that is monitored by IC4 to provide information on the device being tested.

Q8 charges C3 each time it conducts, and the time constant C3-RV1 is such that the input to gate IC4d remains below its switching threshold, thus holding the output pin 11 high. Conduction through Q9 on the other hand charges C4 so the input to gate a stays just above the switching threshold, keeping output pin 3 low.

The collector-emitter junction of a transistor being tested is effectively across the base-emitter junctions of Q8 and Q9 so if, say, a good NPN transistor is in circuit the bias to Q8 is diverted and it will switch off. Forward bias to the test transistor at this time is through Q7 and R12.

Similarly Q9 will be turned off by the application of a PNP device, this time biased by Q6 and R12. A short circuit across the collector-emitter connection will of course turn off both Q8 and Q9.

A diode across these connections will draw some current but this will be insufficient to effect conduction of Q8 and Q9. This ensures a transistor with a base-emitter or base-collector short will register.

In the diode test mode, the bistable IC changes state, reverse biasing Q2,3. D1 and D2 are effectively in series with the bias feed to Q8 and Q9. A diode connected across the collector-emitter terminals will be able to turn off either Q8 or Q9 depending on which way around it is connected.

The time constant RV1-C3 and RV2-C4 is dictated by the choice of 5Hz as the rate at which the supply to the test terminals is reversed. This in turn is a trade off between the response time of the instrument and reasonable immunity to the effect of any large value electrolytic capacitor that may be in circuit across a junction.

Good immunity to in-circuit resistance is achieved because the resistance across the junction must fall below one tenth of the value of R13,14 in the case of the collector-emitter connection and one tenth of R12 in the case of the base-emitter connection before the conduction of Q8,9 or the transistor being tested is affected.

In-circuit resistance below this will reduce the bias in each case to under the 600mV required for conduction.

A conventional 4-digit LCD is used to indicate the status of the device being tested. The display is driven by a perfect square wave from the bistable output of IC1. The individual segments required to represent the desired letters are driven by the exclusive-OR gates of IC5 and IC6.

The clock output from pin 10 of IC1 is connected to one input of each EX-OR gate and also to the backplate of the LCD. If the second input to any gate goes high, a square wave will then turn on any segments connected to the output of that gate.

Open circuit across the test connections blanks the first three letters of the LCD since both inputs to IC4 from Q8 and Q9 are high, forcing a low on pin 10 and the five control inputs of the relevant gates.

If a good NPN transistor is tested, Q8 turns off, sending the output of IC4d low and IC4c high, displaying nnn and releasing control of the lines through R17 and R18. Since Q9 is on, IC4b is high and the display npn is completed.

With a PNP transistor, the output of IC4b goes low as Q9 turns off, leaving n showing on the second digit. A p is completed each side from IC5b and IC5d, since the output of IC4d is high.

In short circuit, both Q8 and Q9 are off, sending the lines through R17 and R18 low. This leaves a display of nnn from the high output of IC4c.

In the diode mode, the first digit of the LCD is blanked by sending the control inputs of IC5b and IC6c low through D7 and D8. The bistable IC3 turns off Q2 and Q3 placing diodes D1 and D2 in series with the bias path to Q8 and Q9. The voltage across the collector-emitter test connections is now about 1.2V and the application of a diode will cause the cut-off of either Q8 or Q9 depending on its direction. This displays either pn or np as described above.

The buzzer sounds if the inputs of gate IC6b are different, which only occurs when a good device is in circuit.

off until the display just blanks. Repeat this procedure with the other preset.

To test the unit connect a diode across the collector-emitter terminals. The display should show **pn** when the diode anode is connected to the collector terminal and **np** when the diode is reversed. There should be no response from the connection of the diode when the unit is in the transistor test mode.

Check the transistor mode using a good transistor of each type. The display should remain blank until the base connection is made. Now short the collector-emitter probes together and check the display shows **nnn.**

Note that the buzzer will sound continuously whilst a good device of any type is connected. This is useful for rapid testing of components on a board when there is no regard for polarity.

Thyristors should be tested on the diode range due to their higher saturation voltage. The collector, emitter and base terminals become anode, cathode and gate respectively.

A good device will show **pn** (it does of course act as a diode) but *only when the gate connection is made.* Confirm that point otherwise it is faulty.

If the thyristor has an internal diode then it will show **np** before the application of the gate connection due to the conduction of the internal diode.

Once the gate connection is made in this case, the display will show **nn** (which would normally indicate a short circuit) due to a legitimate conduction in both directions.

The display will similarly show **nn** when testing two diodes which are connected 'back to back'. A check can be made that this is due to conduction through two good diodes rather than a short circuit by switching to the transistor range and checking the display blanks off.

Darlington transistors also have a high saturation voltage and can be tested in the same way on

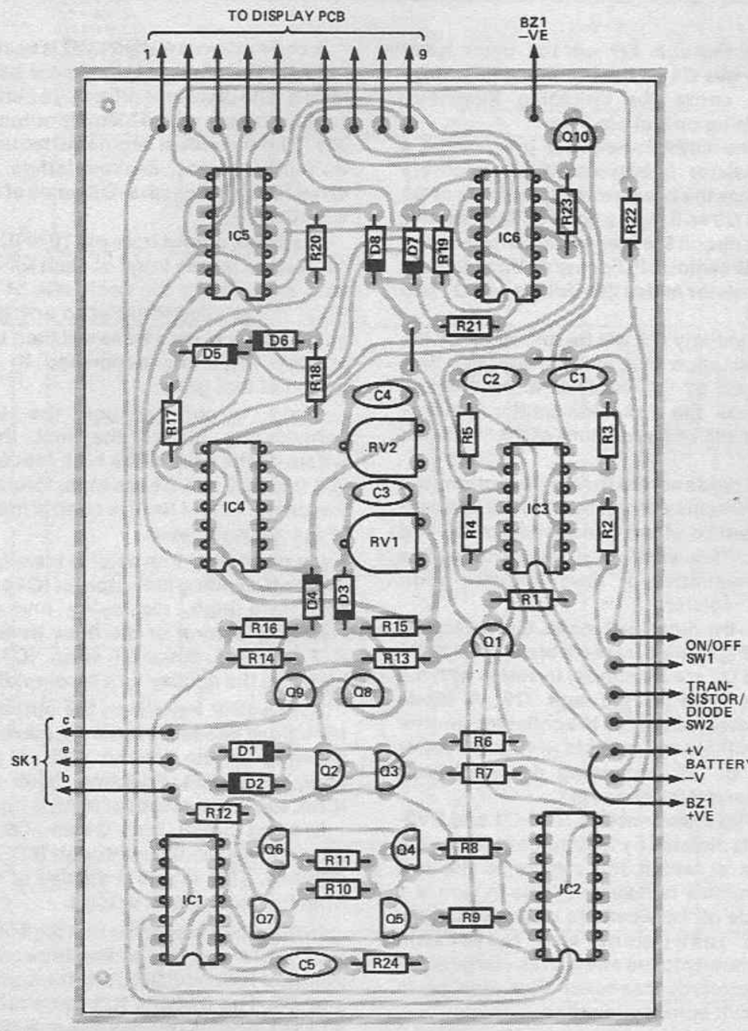


Fig. 2 Component overlay for the main PCB

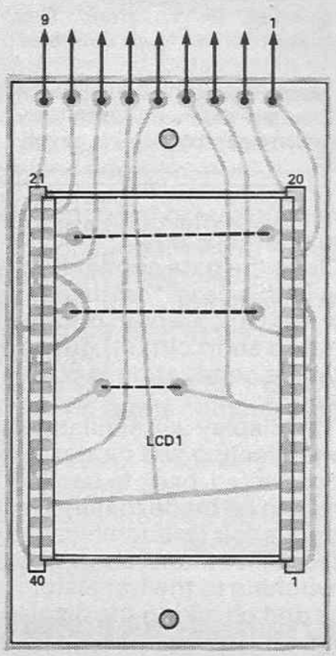


Fig. 3 Component overlay for the display PCB

PARTS LIST

RESISTORS (all ¼W, 5%)	
R1	4k7
R2,4,6-11,23	10k
R3,5,15,16	100k
R12	180R
R13,14	330R
R17,18,24	47k
R19,20,21,22	1M0
RV1,2	4M7 horiz.
CAPACITORS	
C1,2,3,4,5	100n
SEMICONDUCTORS	
IC1	4047B
IC2	4017B
IC3,4	4011B
IC5,6	4070B
Q1,3,5,7,9	BC307 or equiv.
Q2,4,6,8,10	BC237 or equiv.
MISCELLANEOUS	
BZ1	piezo-electric
LCD1	direct drive, 4-digit LCD
SK1	2mm sockets (3) and/or 4-way Minicon Latch connector
SW1,2	push-to-make

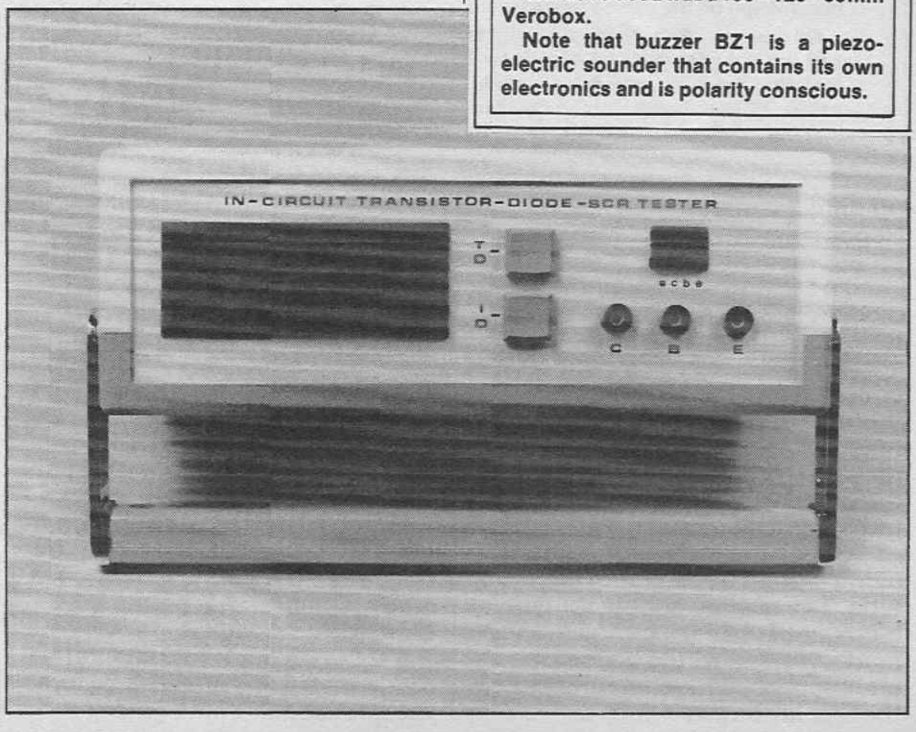
PCB; case; type AA batteries (4); battery holder; LCD mounting bezel; nuts and bolts.

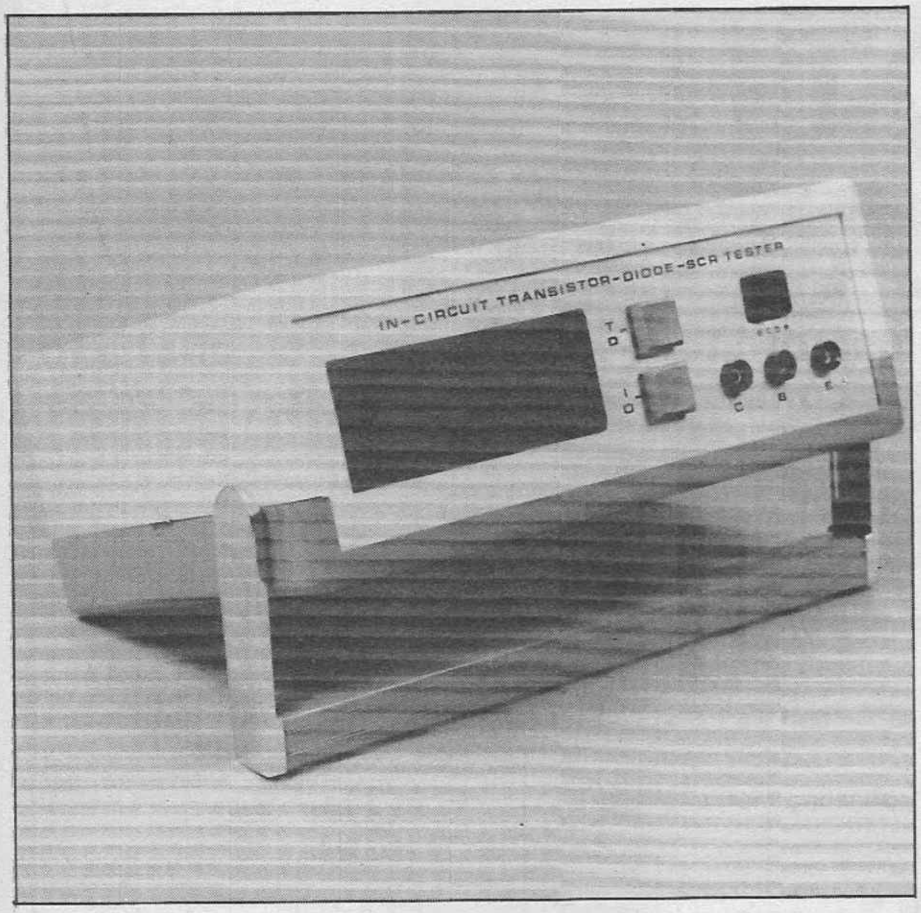
BUYLINES

All components are readily available from component suppliers. The LCD and mounting bezel used in the prototype were from Electromail (Tel: (0536) 204555 stock numbers 588-588 and 587-282 respectively.

The case used was a 180×120×65mm Verobox.

Note that buzzer BZ1 is a piezo-electric sounder that contains its own electronics and is polarity conscious.





the diode range. Darlingtons with internal diodes mean that an NPN device for example will display **np** due to an internal diode which updates to **nn** upon application of the base connection, again due to valid conduction in both directions.

A flashing display at any time should normally be interpreted as being a good device of the type indicated but with the presence of a large value electrolytic capacitor across a junction. The presence of such a component in circuit will give some conduction in the opposite direction to the semi-conductor being tested and cause this effect.

As a result, this unit is not really suitable for checking mains supply rectifiers. Because of the low resistance of the supply transformer winding, the reservoir capacitor is effectively across the diode as far as the tester is concerned. If the capacitive reactance is below 40R or so at 5Hz, a short circuit indication will result even though the rectifier may well be OK.

A low battery will first show up as the display flashing at all times.

ETI

SMOOTH OPERATOR

Henry Davies makes use of the recent abundance of cheap telephones to design a complete system for home or office

Since the liberalisation of the telephone network, inexpensive telephones have become widely available. Obsolescent BT models such as the Trimphone and the once-standard 8746 can be picked up from surplus dealers very cheaply.

Using a little ingenuity and a soldering iron these phones can be linked together to create an intercom system or, if expanded, an entire house telephone system.

Figure 1 shows a complete two phone intercom system with all the necessary signalling, ringing and transmission functions. The switching and signalling take place automatically and are initiated by taking a telephone off-hook in the usual manner.

The familiar 'burr-burr' ringing cadence is generated by an economical circuit shown in Fig. 2 and examined in detail later.

Operation

Each telephone requires a loop detector (indicated by a dotted line in Fig. 1). The internal workings of the telephones themselves are described in the panel but basically when the handset switch of the phone is lifted, current will flow through the diodes of the relevant loop detector and the associated relay will operate.

Assuming both telephones are on-hook, neither loop detector is activated and the relays assume their normally closed positions. The contacts have been interconnected such that if both are in the normally open position or both are in the normally closed position, the result is an open circuit and the ringer is not enabled.

If one relay is energised while the other is not, however, then

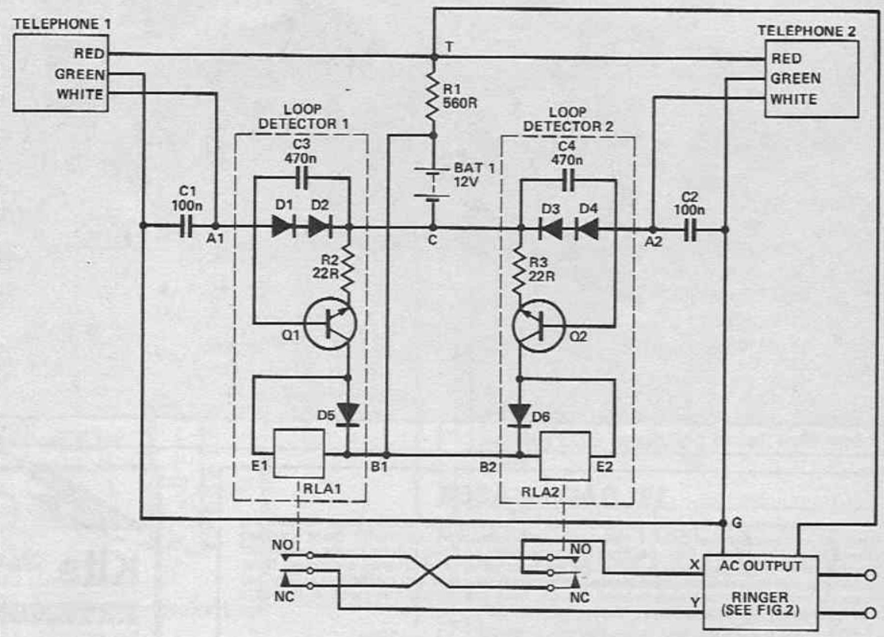


Fig. 1 Circuit diagram for a two phone intercom

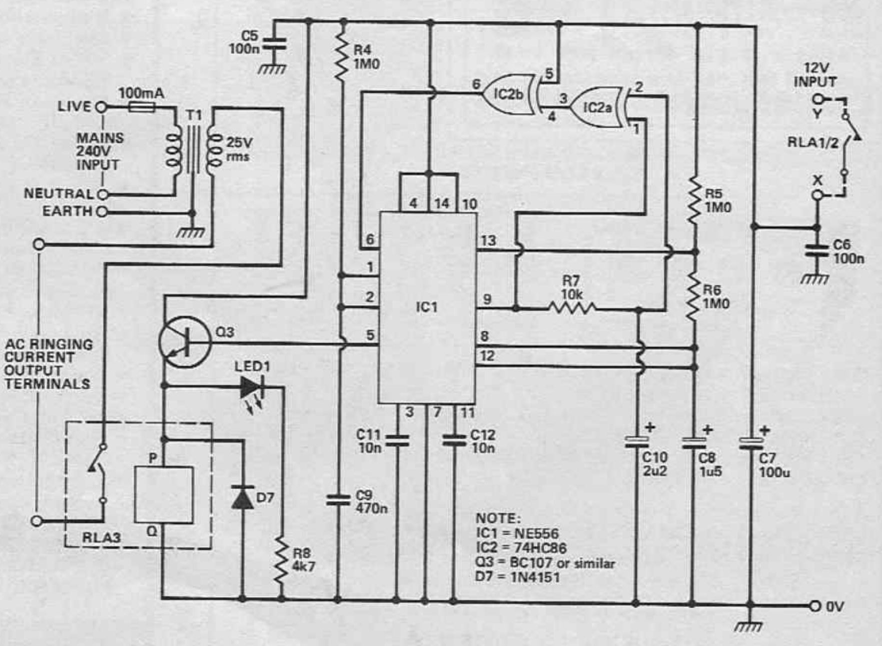


Fig. 2 Circuit diagram for the ringer

the ringer is enabled (it is a form of hard-wired exclusive-OR gate).

In practice this means that ringing current is switched on when the handset of either telephone is lifted and is switched off again when the second handset is lifted (call answered) or when the first handset is replaced (call unanswered).

The ringing current generator cadences the ringing current to produce the familiar UK ringing pattern and the internal configuration of the telephone ensures that only the bell in the on-hook instrument can ring. The capacitors C1,C2 allow a small amount of ringing current into the speech circuit thereby providing a ringing tone to the calling party.

Central Battery

The loop current established by the central 12V battery supplies the power for the carbon or electret microphones as well as operating the loop detector relays. The speech signals are developed across R1 and can therefore be heard by both parties. The loop detectors are designed to amplify the loop current to a sufficient extent to ensure the relays operate.

The ringer circuit is shown in Fig. 2. UK telephone bells and warbling tone ringers (or 'ringing detectors' as they are generically termed in the British Standards) are designed to operate from 25Hz AC at 80V RMS. However, this allows for considerable voltage loss in the line between the exchange and the installation and a lower voltage will be found perfectly adequate (and considerably safer!) in this application.

The experimenter may choose a ringing voltage to suit the range of transformers he or she already possesses. I used a voltage of 25V RMS.

Experiment reveals that the bells can be made to ring satisfactorily from a 50Hz stimulation and this of course

HOW IT WORKS

The loop detector circuits LD1 and LD2 are indicated by the dotted lines in Fig. 1. The circuit is basically a common emitter amplifier with DC negative feedback (developed across R2 and R3). When current flows from A to C, the two diodes in this path are biased on and about 1.4V is dropped across them.

This voltage is used to switch on the transistor and energise the relay. The reverse biased diode across the relay coil is present to protect the transistor from back EMF. The relay can be any nominal 12V type with a set of change-over contacts so long as the coil requires no more than about 30mA for operation.

The cadencing in the ringer is achieved by a single 556 (dual timer) package (IC2) with two EX-OR gates functioning as an edge detector as shown in Fig. 2. The 556 is used in a conventional configuration with one half acting as an astable and the other as a monostable multivibrator.

The edges of the astable output are processed by the EX-OR gates and each edge is used to trigger the monostable section. By choosing a suitable mark-to-space ratio for the astable, the desired cadencing is achieved — pairs of on periods repeating after a suitable off period. The timing waveforms are shown in Fig. 3.

The LED (optional) will glow in sympathy with the ringing cadence.

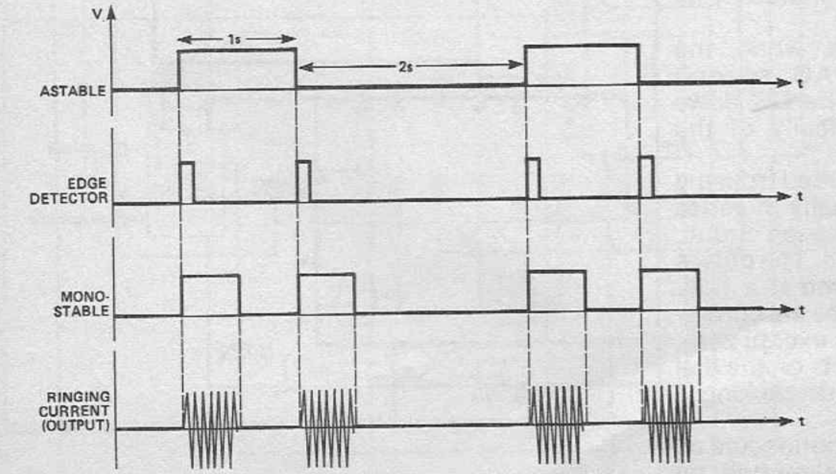


Fig. 3 Ringing generator waveforms and timing diagram

considerably simplifies its generation as little more than a mains transformer is required. Note that there is no easy way of converting 50Hz to 25Hz. Half-wave rectification, for example, produces harmonics of 50Hz but the period of the resulting waveform is still 20ms — a means of extending the period to 40ms needs to be employed if a 25Hz fundamental is to be generated. It is fortunate, therefore, that the bells and tone ringers respond to 50Hz!

Construction

The PCB design is laid out for a two station system (see Fig. 4). Note the wire link between pins 10 and 14 of IC1.

The mains transformer and relays are mounted off the circuit board to allow freedom of choice in the types used and flexibility from the point of view of layout within the enclosure. However, some spare space has been left on the board to allow the loop detector relays to be mounted there if desired.

Fit the components to the board ensuring that the diodes and electrolytic capacitors are oriented with the correct polarity. Check the location of pin 1 when installing the ICs. Use of IC sockets is recommended to avoid soldering the IC and for ease of replacement in case of failure. Refer to the wiring diagram (Fig. 5) to complete the connections.

Observe safe practices in terminating the mains cord securely and shielding the live terminals from contact. Ensure that a 100mA fuse is fitted in series with the mains live.

Testing

Taking both telephones off-hook should allow speech to be conveyed. This can be tested without the ringer switched on in the first instance. If no DC is present (blow in the microphone to check) suspect a wiring error. Check the polarity of the loop detectors.

With the supply to the ringer switched on, the ringer should be found to operate following a short delay when one but not both of the telephones is off-hook. If the ringing pattern is incorrect, check the components around IC1.

If no ringing current is generated at all, check the wiring to the transformer and relays, and the condition of the fuse. Shorting terminals X and Y together should cause the

Internal Telephone Configuration

The old BT telephones such as the 8746 and Trimphone contain numbered screw terminals and a system of links with spade-type cut-outs. The essential circuit details of these telephones are shown in Fig. A.

In normal use, the red and white wires are connected to the two wires of the telephone line. Green is connected to white in the junction box external to the telephone. A link is usually fitted across the handset switch A in series with the telephone bell. The remaining contacts of the handset switch B in series with the speech circuits control whether or not the instrument draws DC from the telephone line. This switch is open-circuit when the handset is on-hook but becomes short-circuit when the handset is lifted to initiate or answer a call. The exchange central battery acts as a source of 50V DC.

Note that DC is prevented from flowing in the bell circuit by a 1µ8 capacitor. Therefore, the presence or absence of a DC path enables the exchange to detect the state of the handset. The telephone bell is rung when the instrument is on-hook by supplying AC ringing current to the line, flowing through the capacitor and energising the bell or tone caller. Incidentally, it is this capacitor which is now fitted in the master socket of the new style connection arrangement (defined by BS6305) being shared by all the telephones plugged into the system.

The capacitor also plays a role when the instrument is off-hook, coupling AC speech waveforms to the telephone receiver. The DC flows through the microphone which is typically of the carbon or, more recently, electret type.

The dial pulse contacts have been omitted from the diagram for clarity but these are essentially in series with the handset switch contacts in the speech circuit. They interrupt the DC in the off-hook state. The pulses are counted at the exchange and registered as a digit. Each digit on the dial (or keypad) generates the corresponding number of current break pulses except zero, which generates ten pulses. Other contacts on the dial assembly short out the earpiece so that loud clicking is not heard during dialling.

You should make sure your phone is connected as in Fig. A. Remove the case of the telephone by unscrewing the rear retaining screw (or in old designs the two screws adjacent to the handset switch buttons). The red, green and white wires of the telephone lead (when not fitted with the new style plug) should already be connected as in Fig. A. Be careful to distinguish between the wires of the telephone lead and those of the curly lead to the handset which uses the same colours.

Check that the links are correctly located. If a link is fitted between terminals T5 and T6, remove it. If you omit to do this, the bell of the calling station will ring in addition to that of the called station during the set up of a call — a somewhat confusing situation. This is because the method of applying ringing current to be used here differs from the BT network arrangement.

If the telephones you obtain are fitted with the new style line jack plugs, you will find that the green wire needs to be connected to the bell as shown in the figure and it will be necessary to transfer the wire to the appropriate terminal. The link between T7 and T6 must be fitted. The blue wire in the telephone lead is not required and may be connected to a spare terminal.

You will usually find some spare links inside the telephone, connected to unused terminals.

The numbering of the terminals within the Trimphone agrees with that of the 8746 so the above instructions apply equally to either instrument.

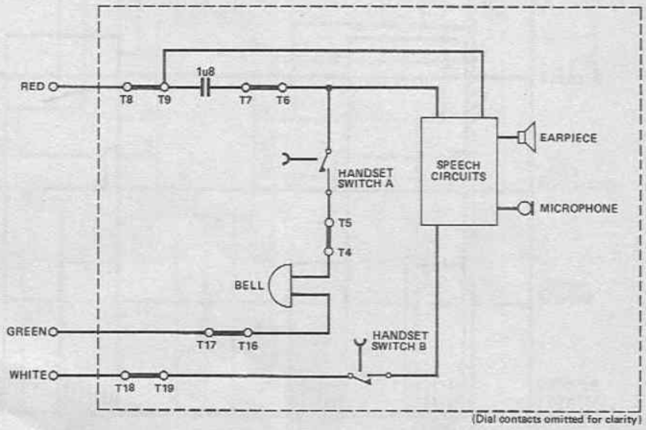


Fig. A Telephone internal configuration

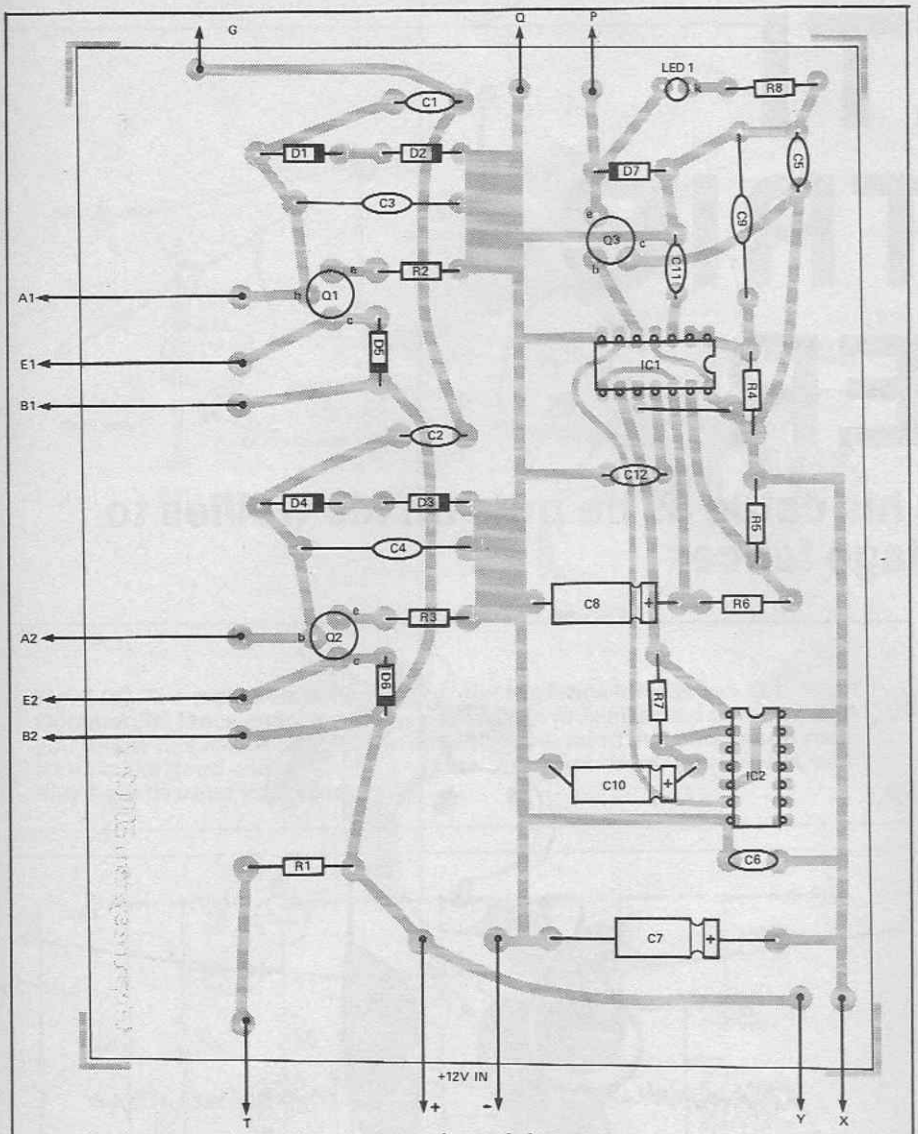


Fig. 4 Component overlay for two phone intercom

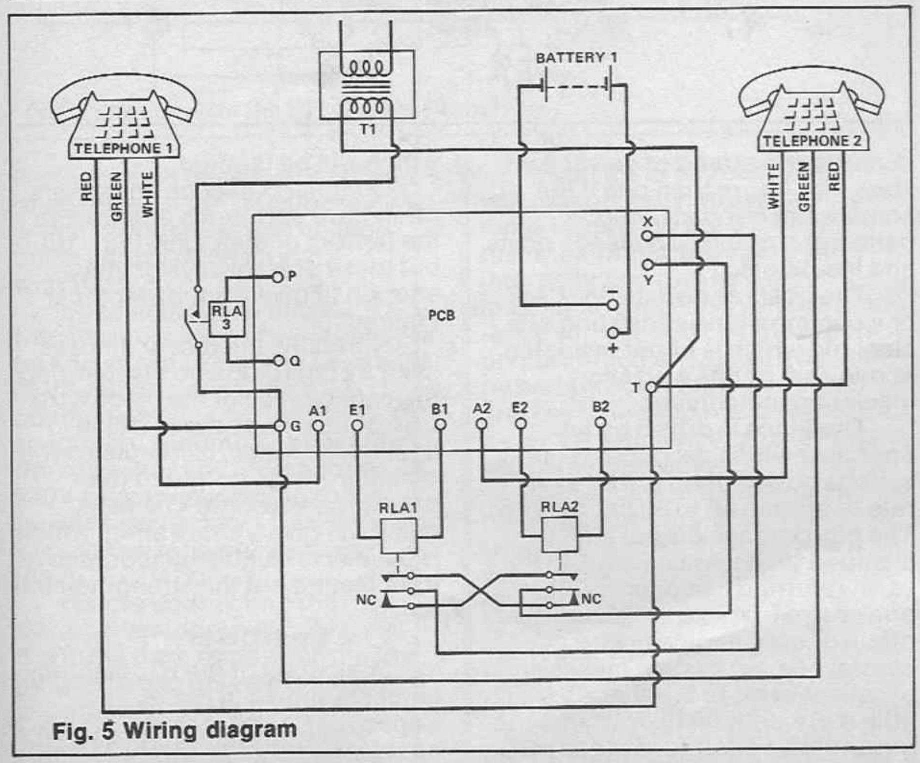


Fig. 5 Wiring diagram

PARTS LIST

RESISTORS (all ¼W 5% unless specified)

RI	560R ½W
R2,3	22R
R4,5,6	1MO
R7	10k
R8	4k7

CAPACITORS

C1,2,5,6	100n polyester
C3,4,9	470n polyester
C7	100µ 25V electrolytic
C8	1.5µ tantalum
C10	2.2µ 25V electrolytic
C11,12	10n ceramic

SEMICONDUCTORS

IC1	NE556
IC2	74HC86
Q1,2,3	BC107 or equiv.
D1,2,3,4,5,6,7	1N4151
LED1	LP301

MISCELLANEOUS

BAT1	12V accumulator or dry cells
RLA1,2	12V relays with change-over contacts (SPCO)
RLA3	12V relay with a normally open contact (SPST)
T1	Mains transformer approx 25V AC, 250mA

PCB; 100mA fuse (20mm) and fuseholder; case; wire; nuts and bolts; ex-BT telephones.

BUYLINES

All components are easily available from the usual sources. The transformer used in the prototype was the Greenweld XO57 transformer. The SPCO relays were National RS12 sub-miniature SPCO relays. The PCB is available from the PCB Service as detailed in the back of this issue.

ringing generator to operate irrespective of the loop detectors so that LED1 if fitted will start to flash after a short delay and the ringing relay should be heard to operate.

Expansion

Further telephones can be added to the system by including additional loop detectors for each one and inter-connecting the relay contacts as necessary. The basic building blocks presented here could be developed to form a more complex system if desired. I leave it to the experimenter to develop an automatic dialling facility for a multi-station version!

ETI

THE ETI ELECTRIC FENCER

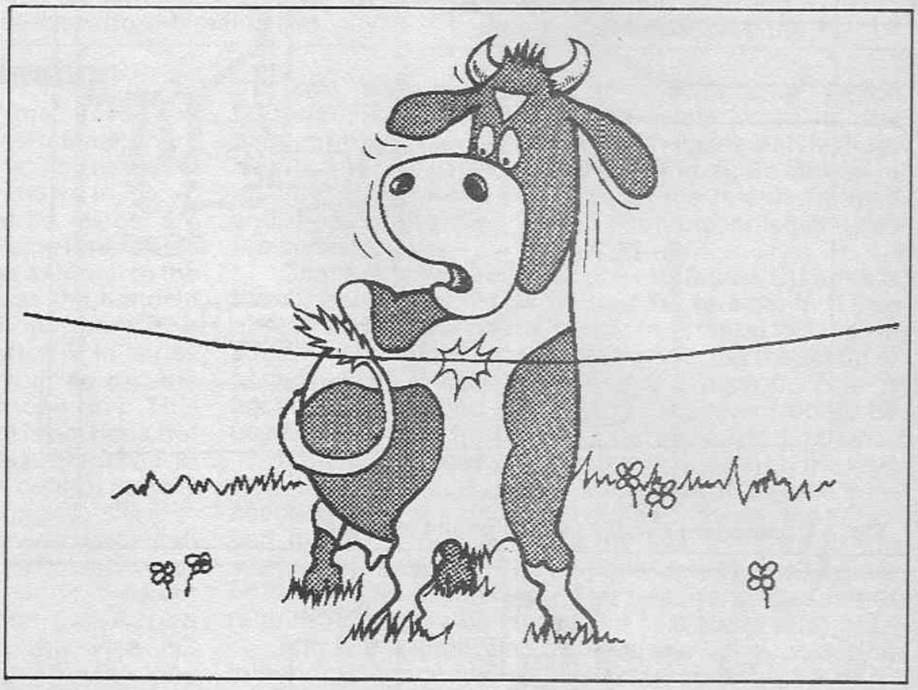
Paul Chappell rattles his cattle as he puts on his wellies to present this high-voltage fencer

The image of returning to a simpler, slower-paced way of life is one which must have crossed the mind of many a tired and frustrated city worker caught in yet another traffic jam or having the breath squeezed out of him on a well stuffed tube train.

A few acres of good, fertile land, a cow for milk, a few hens to lay eggs for the family breakfast, a vegetable garden, the kids playing in fresh country air and learning the names of trees and flowers . . . a blissful dream.

For many people this dream has become a reality. Probably not in the way they first thought when they set off for the country, heads crammed with TV images of wacky subsistence farming in a Surbiton garden, or the nonsense spouted by early proselytes of the 'back to the land' movement. A good life all the same.

One of the problems of taking on a smallholding is that the fences are likely to be in poor condition. This is by no means the only problem but it's one that ETI can help with! An electric fence can be set up in hours, rather than the weeks it may take to put up a conventional fence, so you can get everything moving without delay.



Electric Fencing

The attractions of electric fencing are in its very low cost and in the ease with which it can be set up or moved. Since it doesn't rely on physical strength for its effectiveness, the posts and wire can be much lighter and cheaper than for conventional fencing methods.

The main components of an electric fence installation are shown in Fig. 1. The fence itself consists of a strand of galvanised steel wire (more than one if the animals are good at limbo dancing) supported by fence posts and insulators.

The posts shown in Fig. 1 are of a common type consisting of a steel rod which is either insulated at one end, or has a plastic insulating attachment.

The fence is driven by an energiser which produces high voltage pulses of up to 4kV at a rate of around 40 to 60 per minute. The high voltage output lead is clamped to the fence wire and the earth return to a copper rod sunk one or two feet into the ground. An offcut of copper pipe from a central heating system makes an excellent earth rod, although it's a little more difficult to drive into the ground than a purpose made rod, which will be tapered.

Commercial fence energisers often have earth rods attached to the bottom of their case (Fig. 1b) but these don't always go deep enough to give a good electrical connection.

Normally, the fencer amuses itself by charging and discharging the capacitance of the fence wire. If an animal happens to brush against the fence, it completes the circuit from HT output to the ground connection. The next pulse will give a sharp sting, which is usually enough to discourage it from testing out the strength of the fence.

The Energiser

The circuit of the ETI electric fencer is shown in Fig. 2. Capacitor C1 charges at a constant current through Q1 and

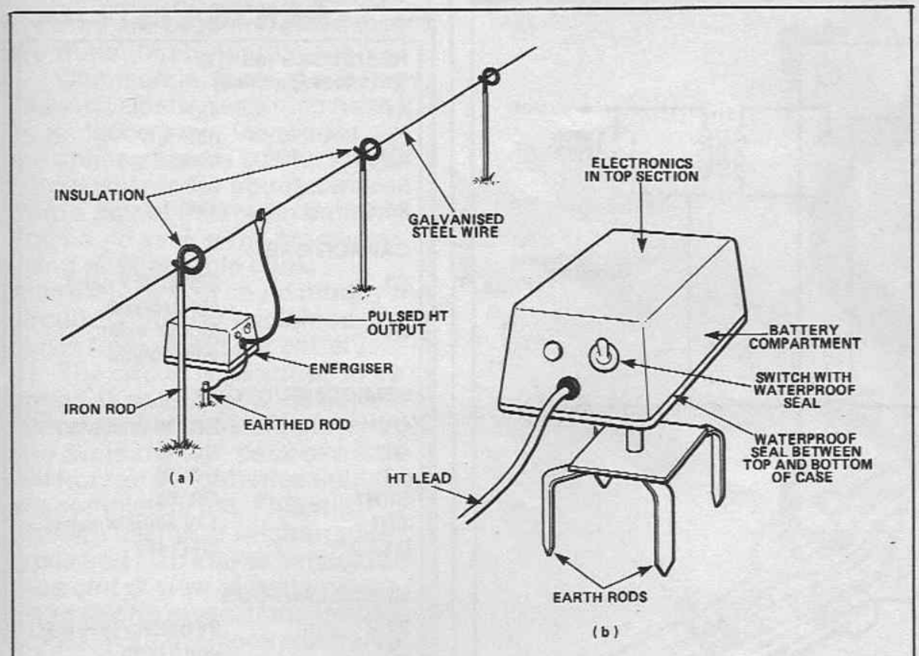


Fig. 1 (a) The main components of an electric fence installation. (b) Commercial fence energisers often have earth rods attached to the case. If you follow this idea for your own fencer, bear in mind that short earth rods won't make good contact in dry weather. When you water your plants, you may have to water your fencer too!

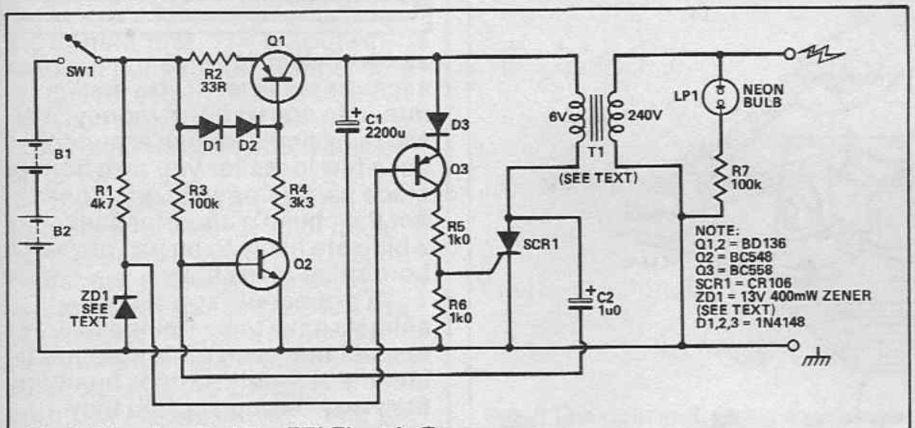


Fig. 2 The circuit of the ETI Electric Fencer

is discharged once every second or so through the transformer T1 which produces a high voltage pulse across its secondary windings.

Special purpose pulse transformers are not easy to come by and so the prototype used a 6V 25VA mains transformer connected 'back to front' — its 6V secondary winding connected to the capacitor and SCR and its 240V primary becoming the fencer's secondary and delivering the high voltage pulses to the fence.

Before connecting the transformer, about two thirds of the turns were removed from the 6V winding to give a greater open circuit output voltage — about 1.5kV on the prototype which should be enough for anybody!

If you try to increase the voltage too much (by removing more turns from the 6V winding) the transformer will spark internally and ruin its own insulation. Since the voltage of the fence will depend to a great extent on how much energy can be pulsed through the transformer and removing too many turns will lower the efficiency, your efforts will be wasted anyway.

Construction of the PCB poses no particular problems. The overlay is shown in Fig. 3 and if you follow it carefully, the circuit should work first time. Q1 and SCR1 do not need heatsinks.

It's worth giving some thought to the case for the project, bearing in mind that it will be outside in all weathers and won't last long if it's not properly protected.

By far the best solution is to use a weather-proof plastic case. West Hyde do a range of cases with a sealing gasket between the base and lid. If you can find anything similar in the home constructor catalogues, this will be ideal. Be prepared to pay about £8-£10 for a good one.

A low cost alternative is to use a die-cast box of suitable size (see Buylines) and to use it upside down with the PCB and transformer suspended from the top and the batteries on a stand of some sort (two lengths of wood baton will do) to keep them clear of any puddles that might form by ingress of rain or by condensation (Fig. 4). Drill drainage holes in the base and stand the fencer on some bricks when in use to prevent the holes from becoming blocked with mud (or build a stand if you want to make a professional looking job of it).

A low cost insulator for dry weather can be made from a humble plastic cotton reel. A nail through the centre into a wooden post, a groove or notch to hold the fence wire away from the post, wind the wire once around the reel and you're done. It can be quite effective.

HOW IT WORKS

Capacitor C1 is charged at a constant current through transistor Q1. The base of Q3 is held at 13V by ZD1 so the transistor will begin to conduct via D3 when the capacitor has charged to about 14.3V.

Conduction in Q3 supplies the gate trigger to SCR1 which discharges C1 through the primary (the modified 6V winding) of the transformer. This produces a high voltage pulse at the output of the circuit, which is connected to the fence.

The discharge of C1 removes the gate drive from the SCR which is then free to turn off as soon as the current sinks to zero. Diode D3 prevents excessive current flowing in the base-emitter junction of Q3 if reverse breakdown should occur. The current is limited to the diode's reverse leakage current so the transistor will come to no harm.

Under open-circuit conditions, the SCR will turn off without help since the transformer will ring slightly and will divert Q1's current from the SCR to C1. When the circuit is loaded, there's no guarantee that this will happen, so to ensure reliable turn-off of the SCR, the current from Q1 is briefly cut off by C2 and Q2 until the SCR has had time to recover.

The resistor and neon bulb serve to give an indication that the fencer is working without the need to touch the output terminals (rather you than me!) The lamp flashes on each pulse of the fencer.

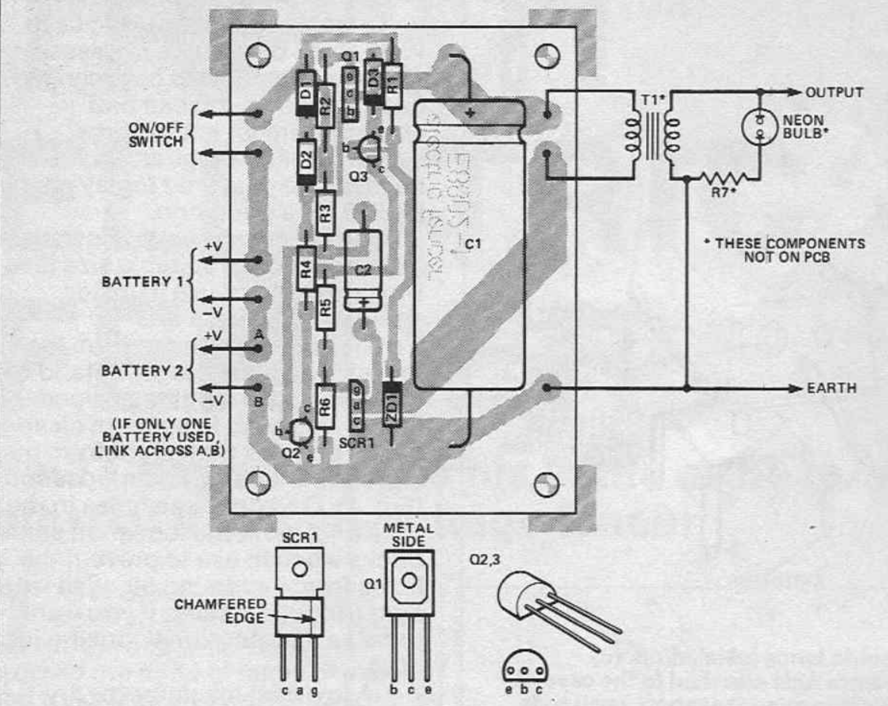


Fig. 3 The component overlay for the project

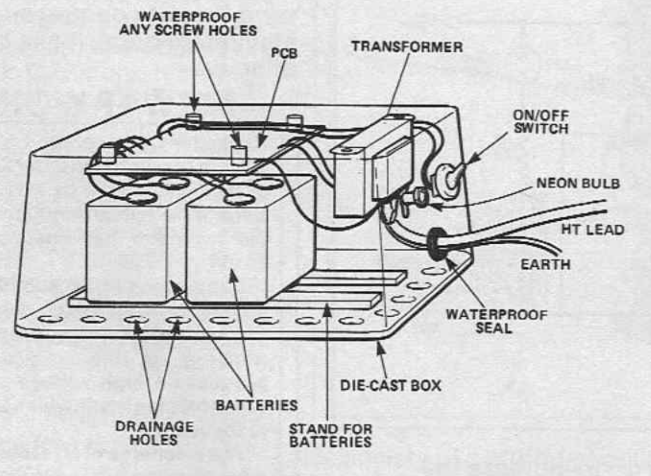


Fig. 4 A suggested layout for the project in a low cost die-cast box

PARTS LIST

RESISTORS (all ¼W 5% unless specified)	
R1	4k7
R2	33R ½W
R3,7	100k
R4	3k3
R5,6	1k0
CAPACITORS	
C1	2200μ 25V axial electrolytic
C2	1μ 25V axial electrolytic
SEMICONDUCTORS	
Q1	BD136 or similar
Q2	BC548
Q3	BC558
SCR1	CR106
ZD1	13V 400mW zener
D1,2,3	1N4148
MISCELLANEOUS	
B1,2	9V battery (see text)
LP1	neon bulb
SW1	SPST switch
T1	modified 6V mains transformer (see text)

PCB; case (see text); battery connectors; connecting wire; EHT wire for output lead; clips for fence and earth wires.

Electricity can also leak away from the fence by corona discharge, ionisation and surface tracking. The first two are prevented by not using an excessively high voltage and avoiding frayed fence wire with sharp points. Surface tracking can be cut down by using insulators with a long surface path to the nearest conducting material — some are better than others in this respect.

The end of the fence is usually held by an insulator in the form of a twisted figure eight (like the old ceramic 'egg' insulators) which should be in compression (Fig. 5a) and not in tension (Fig. 5b) when it will be likely to break. The ceramic ones are best avoided, by the way, since the glaze cracks easily and this reduces their effectiveness considerably.

Weather proofing is the order of the day for any equipment to be used outdoors. Use a good strong clamp to connect the ground wire to the earth rod and another to connect the HT wire to the fence. Croc clips will rust faster than you can say 'where are my sheep?' and will not make good contact once the spring has failed.

Most agricultural merchants (look in Yellow Pages!) will have a stock of electric fence accessories. Even if you don't intend to spend much money, it's worth having a mooch around to get a few ideas for you own home-made parts. Copy the good ones, not the cheap'n'cheerful ones, which are likely to be just on the borderline of usability.

It's generally agreed that animals have to be trained to respect the fence otherwise you'll find the slow witted ones bumbling their way through before they realise what's happening. Introduce them to the fence under controlled conditions and they'll soon learn to avoid it.

Safety

It goes without saying, I hope, that the fence must *not* be powered from the mains or any kind of battery eliminator. Batteries only. If the fence is placed where members of the general public might come into contact with it — around the boundaries of your land, for instance — you are required to put up warning signs. You can get little tags to hang on the fence wire itself.

Any holes drilled for the PCB and transformer supports must be sealed and a good coating of waterproof lacquer over the electronics and transformer wouldn't go amiss.

Batteries for electric fencers are always a problem, since they are quite thirsty for current.

Commercial fencers use large, expensive batteries which have to be replaced every few weeks, so the upkeep can be costly. The ETI fencer will run for about a week from a pair of PP9 radio batteries. You could save some money by using re-chargable ones. Alternatively you could modify the circuit slightly (as explained later) to run from an old car battery.

The circuit is designed to be as gentle as possible on the batteries, taking a fairly constant current and avoiding high peak currents. It will not run the batteries until they are completely flat. This will prolong the life of re-chargable types and also makes sense from the point of view of sustaining a good strong pulse. If the fence just tickles, your livestock will trample it down in no time!

Modifications

To run the fencer from a car battery, all that is needed is to reduce the value of ZD1 to 7V5 and to remove a few more turns from the transformer. The output will be reduced but you can compensate for this by using a higher value of capacitor for C1 (4700µ instead of 2200µ) and reducing the value of R2 to 15R.

If you are determined to squeeze every last drop of juice from your batteries, at the risk of ineffective pulses, this can be achieved by replacing ZD1 with a 12k resistor. With the zener, the pulse strength will remain constant until the circuit eventually ceases to fire. With the resistor, the pulses will get weaker as the batteries run down.

You may like to experiment with different kinds of transformer for T1. You can try large TV line output transformers or car ignition coils, for example. The transformer must have a large enough core to transmit the burst of energy from primary to secondary without undue loss. Miniature transformers are no good at all.

As it stands, the fencer will energise several hundred yards of fence. If this is not enough, the output can be increased by stepping up the value of C1. Choose a capacitor with a high peak current rating or use several smaller capacitors in parallel. The value of R2 should be decreased to maintain the pulse rate. Keep an eye on the temperature of Q1 and R2 — use a 1W resistor and a heat sink on the transistor if necessary. Use a larger transformer (50 or 100VA) and batteries that are man enough for the job.

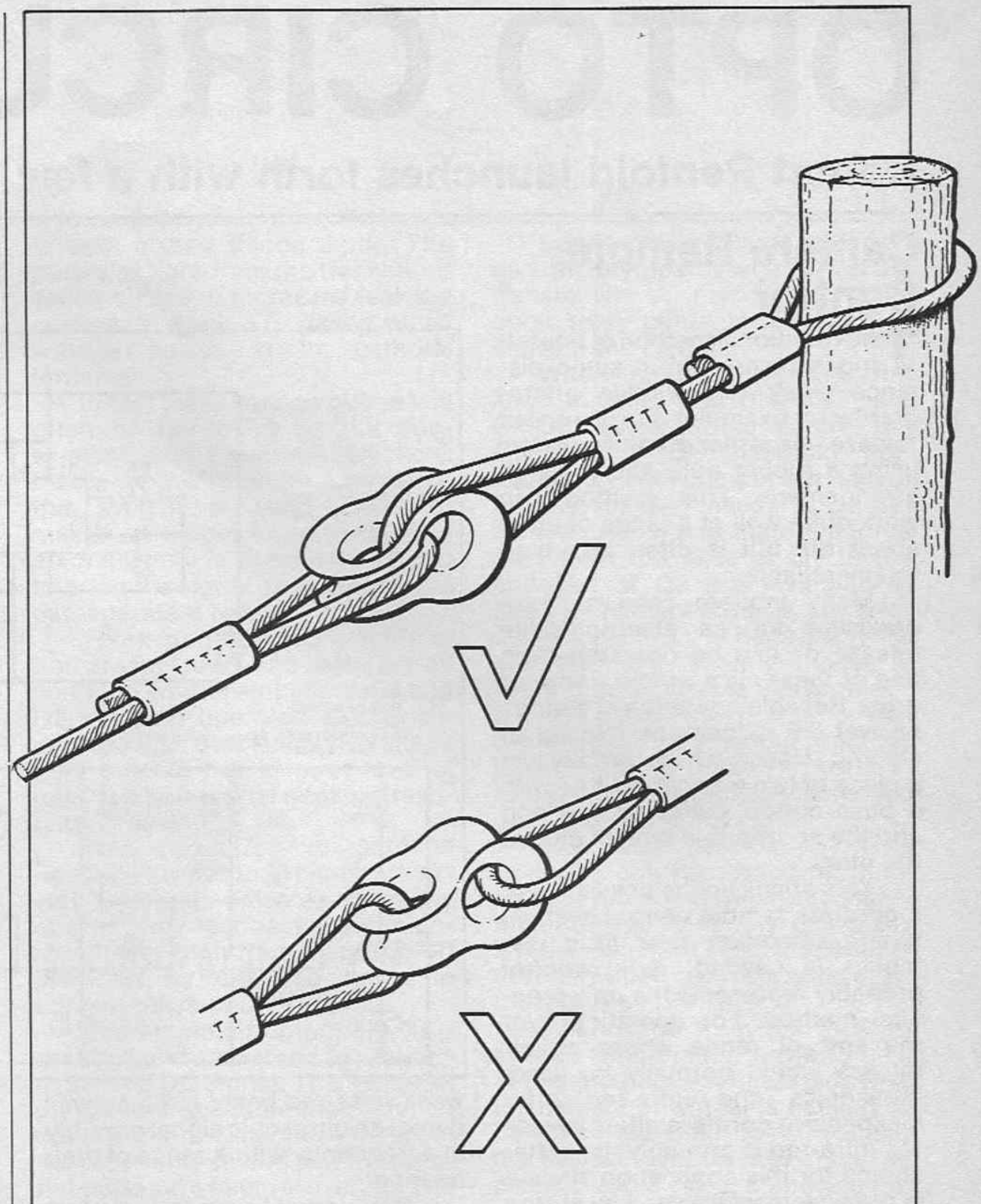


Fig. 5 The right and wrong way to use a 'figure eight' end insulator

BUYLINES

A die-cast box for the project can be obtained from: Cirkit, Park Lane, Broxbourne, Herts. EN10 7NQ. Tel: (0992) 444111. The size you need will depend on whether or not you want to fit batteries inside it, so perhaps the best thing to do is to send for a catalogue and choose your own. None of the components should cause any problems.

The PCB is available from the PCB Service.

If you'd like to know more about small-scale farming and the profit opportunities from keeping special breeds of livestock, a year's subscription to ***Home Farm*** **magazine will cost £9.00 inclusive from Broad Leys Publishing, Widdington, Saffron Walden, Essex. Tel: (0799) 40922.**

Using the Fencer

Very often, using an electric fencer for the first time means learning the facts about high voltage electricity the hard way. Materials which are OK as insulators for low voltages (wood, for instance) may be hopeless at high voltages. When a wooden post is sodden with rain, it may as well be a direct short to ground. Even when bone dry it's none too good. It's essential to use insulators. **ETI**

OPTO CIRCUITS

Robert Penfold launches forth with a few Tech Tips.

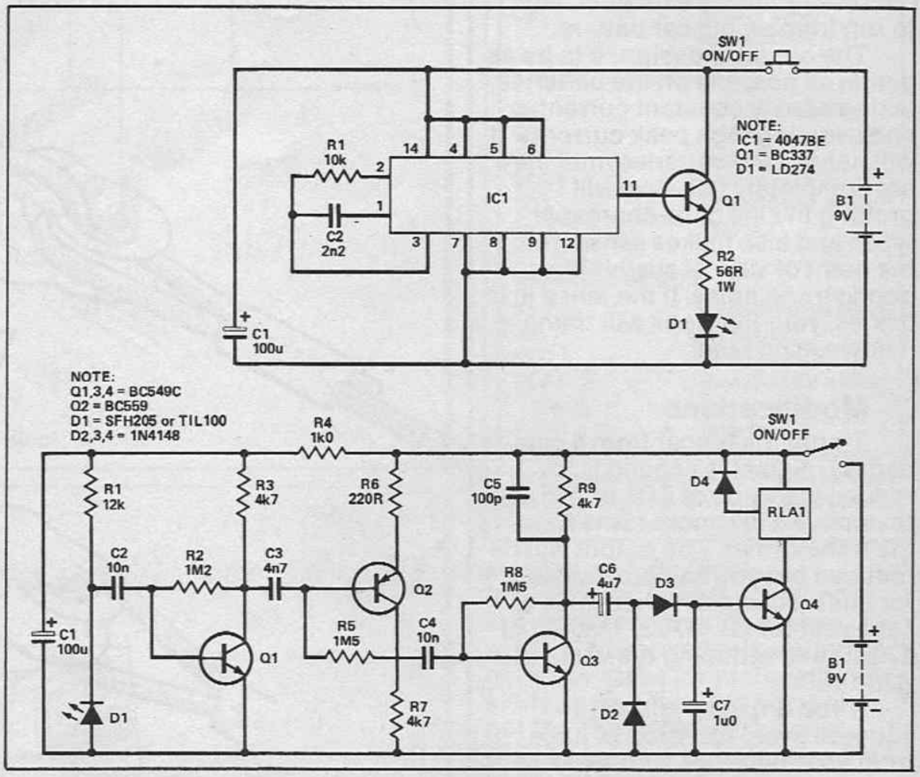
Camera Remote Control

The traditional method of operating a camera from some distance away (for wildlife photography for example) is to use an 'air release — a rather primitive system using a rubber bulb and a piston arrangement. This method can work quite well at a range of up to about 6m but is often less than totally reliable.

Many modern cameras have provision for an electric cable release or can be operated from one of these via a winder or motor drive. Reliable operation at a range of over 6m is then possible via an electric release, which is really just a piece of two way cable fitted with a push-button switch at one end and the appropriate type of plug at the other.

This opens up the possibility of a cordless remote control system. Where operation over long distances is needed, radio control probably represents the only practical method. For operation over the sort of range where an air release would normally be used, ultrasonics and infra-red offer inexpensive cordless alternatives.

Infra-red is probably the better choice for this application since it is not adversely affected by strong winds if it is used outdoors. Also, if used for wildlife photography the animals are unlikely to react to a weak infra-red beam but may well detect an ultrasonic signal possibly at a frequency within range of their hearing!



The remote control system described here was designed solely for cordless remote control of a camera and will work over a range of about 8m or so. It is a simple on/off type controller and as such it probably has many potential uses in other fields of interest. Of course, it is only a practical proposition if you have a camera or winder that permits electrical operation of the shutter,

Passive IR Sensor

Passive infra-red alarms operate by detecting body heat and are generally accepted as being amongst the most reliable (and false-alarm free) of alarms. In fact their use is not limited to burglar alarms and they can be used as general purpose presence detectors. Possible applications include energy saving (automatic) lighting and automatic doors.

Passive infra-red detectors can be quite simple and although an optical system is required to obtain optimum performance, where only short range is required this can be dispensed with. This design is simple and cheap and suitable for presence sensing.

IC1 is the passive infra-red detector. This is a special *pyro* sensor which is specifically designed for this application. Infra-red photo-diodes and other common types of infra-red sensor are totally unsuitable for use in passive detector circuits.

It is quite long infra-red wavelengths which must be detected whereas most infra-red devices are only sensitive in the part of the infra-red spectrum close to visible red wavelengths. IC1 has a special ceramic sensor plus a built-in source follower buffer amplifier.

Other pyro sensors can be used in the circuit, but most alternatives (including the SRA02) require a discrete 47k load resistor from the source terminal to the negative supply rail.

The output from IC1 is a weak AC signal at a frequency of between about 0.3Hz and 3Hz. This is amplified by a high gain common emitter amplifier based on Q1 and then by a non-inverting operational amplifier circuit built around IC2. These provide a total gain of around 70dB which gives an output signal of a few volts peak-to-peak when the unit is activated. Lowpass filtering is provided by C3 and C5 and this helps to minimise problems with noise.

IC3 is an operational amplifier which is connected to act as a voltage comparator. RV1 is adjusted so that it provides a reference voltage that is higher than the maximum quiescent output potential from IC3. So, under of if you build a simple actuator to drive a mechanical cable release from this unit.

Adequate performance can be obtained without having to resort to any exotic circuitry and the system can be built for quite a modest cost. The transmitter circuit is built around a CMOS 4047BE astable/monostable device. In this circuit it is connected in the free running astable (oscillator) mode with timing components R1 and C2 setting the operating frequency at around 10kHz.

The infra-red LED (LED1) is driven from an output of IC1 via an emitter follower buffer stage based on Q1. The latter is needed as IC1 is unable to provide the 100mA required to fully drive LED1. Of course, LED1 is fed with a squarewave signal and it is therefore switched off for 50% of the time. This gives an average control consumption of about 50mA.

The LD274 LED specified gives quite a narrow beam of light (about 20°). However, the beam is not so narrow as to make aiming the unit excessively critical and by concentrating the infra-red energy into a tighter beam a significantly improved range is obtained.

The receiver circuit uses a large area photo-diode as the sensor (D1). This is operated in the reverse bias mode, where it normally passes the low levels of leakage current associated with a reverse biased silicon diode. The pulses of light from the transmitter cause pulses of increased leakage current through D1 giving small voltage pulses at its cathode terminal.

In fact these voltage pulses will often be bordering on the non-existent, with a peak-to-peak level that will be way under 1mV when the system is used close to maximum range. A vast amount of amplification is therefore needed to bring the signal up to a level that can operate a relay.

Three stages of AC amplification are included, and these are all common emitter amplifiers. Q1 and Q3 are both operated at full gain and provide over 40dB of voltage gain but Q2 has a lower level of gain due to the local negative feedback provided by R6.

This reduction in gain is needed in order to avoid problems with excessive noise or instability due to stray feedback. The minor amount of high frequency roll-off provided by C5 also helps to combat noise and instability.

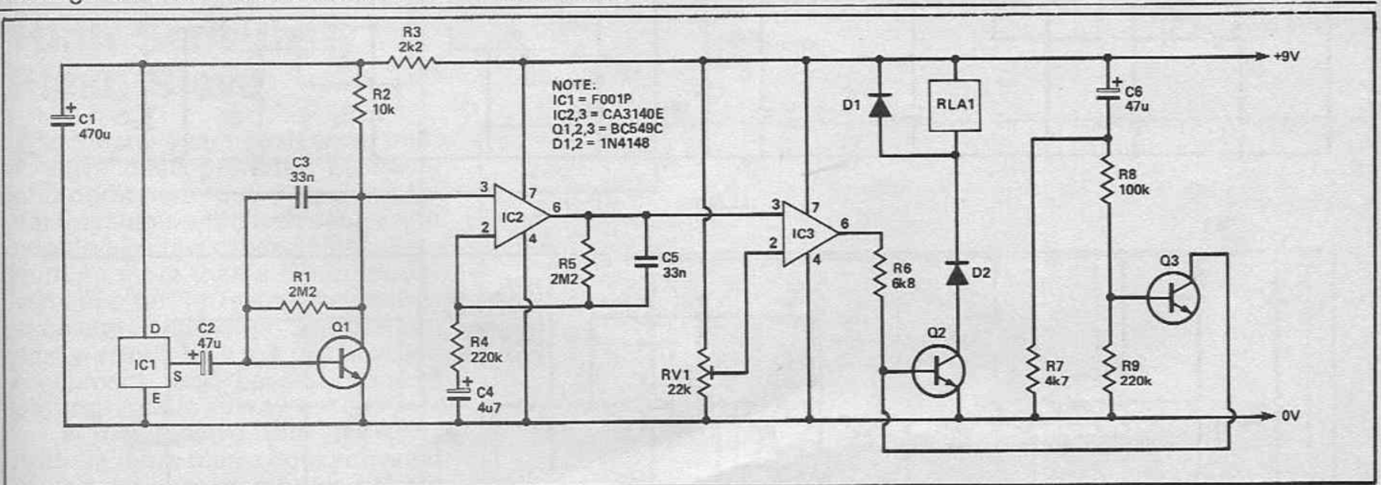
The amplified output signal is rectified and smoothed to produce a positive DC signal. This switches on Q4 and activates the relay. Of course, this only happens if SW1 at the receiver is closed and the infra-red pulses are being transmitted. In their absence only noise is fed to the rectifier circuit and this generates a DC signal that cannot switch on Q4.

So the relay contacts switch on and off in sympathy with SW1 at the transmitter. A pair of normally open relay contacts are used to activate the camera.

When constructing the unit keep in mind that the 4047 is a CMOS device and so requires the standard CMOS handling precautions. The component layout for the receiver needs to be designed carefully as there is a lot of gain from the base of Q1 to the collector of Q3 and instability is likely if there are any easy paths for stray feedback. If necessary, R6 can be made slightly higher in value in order to ease this problem. On the other hand, with a well designed layout it would probably be possible to make R6 lower in value, which would give increased gain and operating range.

The relay can be any type having a coil resistance of about 180R or more that will work reliably on a nominal 9V supply. Obviously it must also have at least one set of normally open contacts rated at 2A (or more) at 12V DC.

Connection from the receiver to the camera might prove to be a little difficult as a suitable plug to fit the camera or winder is unlikely to be an of-the-shelf item. Probably the easiest solution is to obtain an electric cable release and then to remove the push button switch and connect the relay contacts in its place.



stand-by conditions the output of IC3 is in the low state and both Q2 and the relay are switched off.

When the unit is activated, the output voltage of IC2 swings well outside its normal limits and on positive excursions it goes above the reference voltage. IC3's output then goes high, Q2 is switched on and the relay is activated.

As the circuit stands it does not incorporate latching. If this feature is required it is merely a matter of connecting a spare set of normally open relay contacts across the collector and emitter terminals of TR2.

One slight problem with the basic circuit is that it takes a few seconds for the capacitors to settle down to their normal working charges after switch-on. During a substantial proportion of this time the relay will be activated. In some applications this might be no more than a minor inconvenience, but in others it could make the unit virtually impossible.

To overcome this problem a simple timer circuit based on Q3 is used to short circuit the base of Q2 to the negative supply rail for about 20 seconds after switch-on, so that the initial triggering of the relay is avoided.

Construction is in most respects quite easy but IC1 does provide a slight problem. It has quite a wide angle of view, and it will only respond to changes in the detected infra-red level. This gives rather poor sensitivity to anything moving across its field of view at anything less than about 60mph!

Much improved results are obtained by adding a special lens or a grating in front of it, so as to give alternative blind spots and areas of high sensitivity. As someone crosses in front of the unit they move continuously from sensitive zones to blind spots and back again, generating a strong output from the sensor.

A simple grating made by cutting a few slits in a piece of cardboard is sufficient to give a range of up to about 3 metres, which is adequate for many purposes.

The relay can be any type that has a coil resistance of about 200R or more, will operate reliably from a nominal 9V supply and has sufficient contacts of adequate rating for the application.

Fibre Optic Link

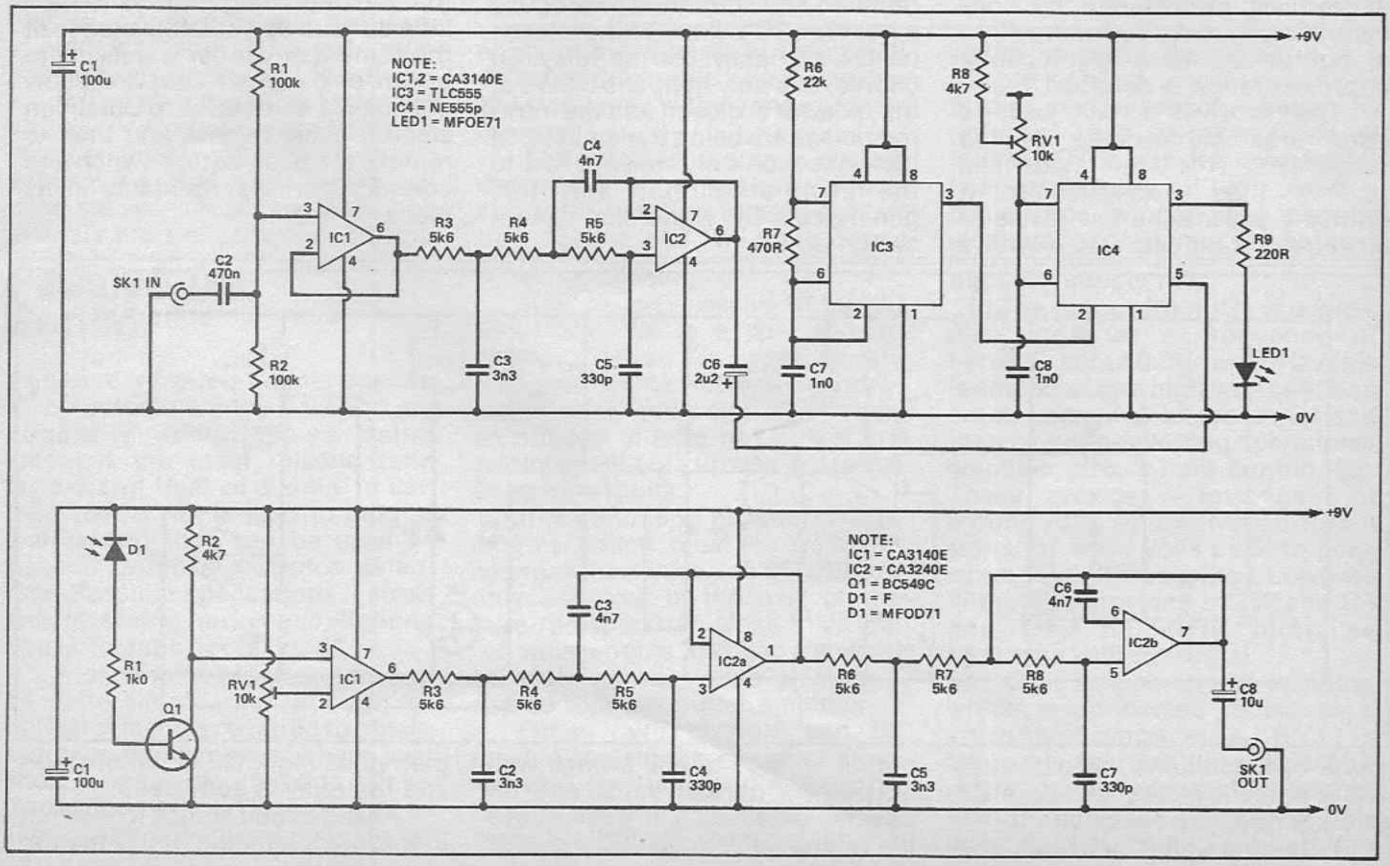
Fibre optics is one of those technical innovations that seems to be forever about to revolutionise the world but never quite makes it! The years of development do now seem to be paying dividends and fibre optic communications links are a reality at last. Fibre optic cables and components are available to the home constructor at reasonable prices and represent an interesting line of experimentation.

The main appeal of an audio link based on this technology is its novelty value but there are advantages to an optical link. There is no radiation of electrical signals from the connecting cable and there is complete immunity to electrical pick up in the cable. A lack of problems with earth loops is also helpful but the potential ultra-wide bandwidth is obviously of little value in a simple audio link.

Although extremely simple, this audio link offers quite reasonable performance with low levels of noise and distortion. It has only been tried with a cable 6m long but good results over a somewhat longer range should be possible. However, even good quality fibre optic cable has relatively high losses and a system of this type is unsuitable for communication over long distances.

Good results can be obtained using a simple amplitude modulation (AM) circuit but some form of pulsed system is needed for optimum results. Any lack of linearity through the photocells is then rendered irrelevant and has no effect whatever on the linearity of the system. This is determined primarily by the linearity of the modulator and demodulator circuits.

Both frequency modulation (FM) and pulse width modulation (PWM) can be used to good effect



in this application and this system utilises PWM.

The transmitter is based on two 555s, with one (IC3) acting as a clock oscillator and the other (IC4) operating in the monostable mode. The 555 works well in PWM circuits and this is actually one of the tasks for which it is was originally designed. However, this seems to be a facet of the device which is little used in practical published designs.

The clock oscillator must operate at a frequency well above the maximum input frequency and in this case an operating frequency of around 50kHz is used.

In order to trigger IC4 a series of short negative pulses are required and a suitable output waveform is obtained by making R7 very low in comparison to the value of R6. RV1 is adjusted so that with no output signal there is a 1:1 mark:space ratio on the output signal from IC4. This gives an average output voltage.

By modulating the voltage at pin 5 of the device the mark:space ratio (and hence the average output voltage) can be varied. There is a linear relationship between the input and average output voltages.

The output signal drives an LED but the suggested type is one which is specifically designed for fibre optic applications. It is quite ordinary from the electronic point of view but physically it is designed to efficiently couple its light output into a narrow optical fibre, and it has a built-in connector which can be used to lock a standard 1mm fibre optic cable in position.

At the input of the unit there is a buffer amplifier based on IC1 which gives the unit an input impedance of about 50k. This is followed by a third order lowpass filter having a cutoff frequency at just under 20kHz. This removes any high frequency signals on the input which could otherwise cause heterodyne whistles or other problems if they were to reach the modulator stage.

The receiver must first recover the PWM signal with the mark: space ratio intact and then some lowpass filtering is all that is required to produce a properly demodulated output signal. Remember that the average voltage of the signal is proportional to the input voltage. Lowpass filtering integrates the output pulses to give a voltage equal to the average level of the signal.

D1 is the receiving photocell and this is the complementary device to the LED used in the transmitter. Like this LED, it couples efficiently to the fibre optic cable and includes a sort of screw gland coupling arrangement which holds the cable firmly in place. Normally it passes an insignificant current but the pulses of light from the cable cause pulses of increased leakage current to flow through the device.

These pulses are amplified by common emitter amplifier Q1 but the signal at its collector is not an accurate replica of the transmitter's output signal. However, a simple trigger circuit based on IC1 is all that is needed in order to restore the original wave shape. RV1 is adjusted to give a 1:1 mark: space ratio from the unit under quiescent conditions.

The low pass filter consists of two third-order filters connected in series, giving a total attenuation rate of 36dB per octave. This gives an output having a reasonably low carrier content but a third filter block can be added if a really low ripple level on the output signal is essential.

Construction of the two units is mainly quite straightforward, but bear in mind that the CA3140E and CA3240E devices are both MOS input types. They consequently require the standard anti-static handling precautions to be observed.

The only unusual aspect of construction is dealing with the fibre optic cable. Avoid bending the cable through a tight radius as this can damage the filament and reduce light transmission.

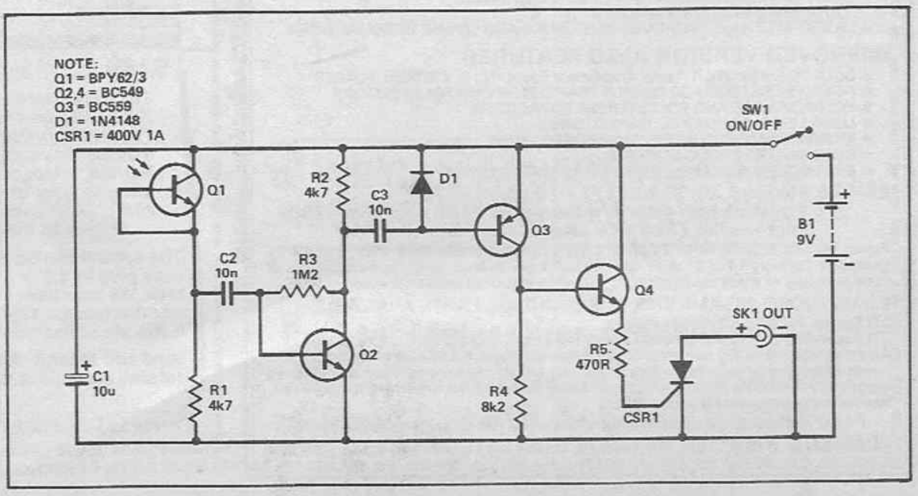
The end of the cable must be prepared by first cutting the ends at right angles using a sharp modelling knife. Provided each cut is made in a single movement this should give surfaces that efficiently transmit and receive light, without any polishing being required. Next a few millimetres of the cladding are carefully removed from each end of the cable, again using a sharp modelling knife. To fix the cable to one of the opto devices, slacken off the screw terminal, push the end of the cable fully into the aperture, and then tighten the screw terminal. Do not tighten the terminal any more than is really necessary in order to securely hold the cable in place.

The system is designed to handle high level signals of around 3V peak-to-peak. Using a much lower level will give a reduced signal to noise ratio, while going much beyond this level will result in severe distortion.

High Sensitivity Flash Slave

For many years flash slave units have been preferred by many photographers to wiring up multi-flash systems with flash cables and adapters. A few cables might seem nothing more than a minor inconvenience but in reality they act as excellent trip-wires which can easily result in a lot of damaged equipment (and possibly injured photographers as well!)

A flash slave unit is really nothing more than a light activated switch. It senses the pulse of light from the main flashgun (normally on or near the camera) and triggers a second flashgun. If more than two flashguns are needed, it is



merely necessary to have a slave unit for each secondary flashgun.

In this way it is possible to have quite complex flash lighting arrangements that are completely devoid of any connecting cables.

Although a flash slave unit is just a light activated switch, to work well it must have suitable characteristics. In particular, it must operate very fast. With the shutter set to the fastest flash synchronisation speed and a powerful gun in use, the shutter may not stay fully open for much longer than the flash duration. A reasonably fast form of photocell must be used and a solid state switching device at the output is definitely preferably to a relay.

To work well the unit should also have high sensitivity and operate over a wide range of ambient light levels.

This circuit uses a phototransistor as the detector together with a thyristor as the output device and these ensure a fast response time. Some flash slave units avoid the need for a battery by either using a photosensitive thyristor, or extracting power from the flashgun. This circuit was designed primarily with high performance and reliability in mind and it was decided to opt for a battery supply rather than to compromise with a so-called 'self-powered' circuit.

The higher than average sensitivity is obtained by using a comparatively large gain in the circuit but with AC coupling to minimise any problems with the unit saturating under bright conditions.

Q1 is the photo-transistor and it is connected in the emitter follower mode. Its base is tied to its emitter, which gives lower sensitivity than if it was to be given a small forward bias or just left unconnected. However, the overall sensitivity of the circuit is still excellent and the relatively low sensitivity of Q1 itself gives good immunity to the unit being saturated in high ambient light levels.

When Q1 detects a pulse of light from the primary flashgun, this causes a small increase in its leakage current. This in turn results in an increase in its emitter voltage and this signal is coupled by C2 to the input of a common emitter amplifier based on Q2. Here it is substantially amplified and the strong negative pulse this produces is coupled by C3 to the base of Q3 which is switched on, supplying a trigger current to CSR1 via emitter follower buffer stage Q4 and current limiting resistor R5.

The thyristor is driven with a gate current of nearly 20 milliamps and even inexpensive, insensitive types should work well in this circuit (R5 can be reduced in value if necessary).

The unit will only work properly if the flashgun is connected to CSR1 with the polarity shown in the circuit diagram. The 'suck it and see' method can be used to find the correct polarity if you do not have a multimeter (note that the voltage on the flashlead is quite high — 175V).

If a miniature coaxial socket for SK1 cannot be obtained, a socket and short length of cable cut from a flash extension lead can be used here. The unit is very sensitive but there must still be a reasonably effective path for the light from the main gun to reach Q1. Aiming Q1 straight at the main flashgun is not usually necessary, reflected light is generally sufficient to give reliable operation. **ETI**

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D.C. VOLTAGE	RESOLUTION	ACCURACY
200mV	100μV	
2V	1mV	
20V	10mV	±(0·25% of reading + 1 digit)
200V	100mV	
1000V	1V	

Input Impedance: 10M on all ranges. Overload Protection: 1000V d.c. or peak on all ranges.

D.C. CURRENT	RESOLUTION	ACCURACY	MAX. F.S. VOLTAGE DROP
200μA	100nA	±(0·5 % rdg+1d)	0·25V
2mA	1μA	±(0·5 % rdg+1d)	0·25V
20mA	10μA	±(0·5 % rdg+1d)	0·25V
200mA	100μA	±(0·75% rdg+1d)	0·25V
2000mA	1mA	±(2 % rdg+5d)	0·75V
10A	10mA	±(2 % rdg+5d)	0·30V

Overload Protection: mA Input: 2A/250V fuse. 10A Input: Unfused up to 15A for 15 seconds.

A.C. VOLTAGE	RESOLUTION	ACCURACY	FREQ RANGE
200mV	100μV		
2V	1mV		
20V	10mV	±(0·5% rdg+5d)	45Hz–500Hz
200V	100mV	on all ranges	on all ranges
750V	1V	±(1% rdg+5d)	

Conversion: Calibrated for rms of sine wave. Input Impedance: 10M shunted by 100pF on all ranges except 200mV range. Overload Protection: 1000V d.c. or 750V r.m.s. a.c. continuous, except 15 sec max above 300V on 200mV range.

A.C. CURRENT	RESOLUTION	ACCURACY	MAX. F.S. VOLTAGE DROP
200μA	100nA	±(0·75% rdg+5d)	0·25V rms
2mA	1μA	±(0·75% rdg+5d)	0·25V rms
20mA	10μA	±(0·75% rdg+5d)	0·25V rms
200mA	100μA	±(0·75% rdg+5d)	0·25V rms
2000mA	1mA	±(2 % rdg+5d)	0·75V rms
10A	10mA	±(2 % rdg+5d)	0·30V rms

Overload Protection: mA Input: 2A/250V fuse. 10A Input: Unfused up to 15A for 15 seconds.

RESISTANCE	RESOLUTION	ACCURACY	MAX. OPEN CIRCUIT V
200Ω	100mΩ	±(0·5 % rdg+3d)	2·8V
2KΩ	1Ω	±(0·3 % rdg+1d)	2·8V
20KΩ	10Ω	±(0·3 % rdg+3d)	500mV
200KΩ	100Ω	±(0·3 % rdg+3d)	500mV
2MΩ	1KΩ	±(0·75% rdg+5d)	500mV
20MΩ	10KΩ	±(3 % rdg+5d)	500mV

Max allowable input: 500V d.c. or rms.

CONTINUITY TEST

Resistance range: Buzzer sounds at approximately less than 200Ω.

DIODE TEST

Test voltage: 2·8 Volts. Maximum test current: 3mA.

TEMPERATURE	RESOLUTION	ACCURACY
−20°C to 1370°C	1°C	±(3°+1d) up to 150°C ±3% of rdg over 150°C

Sensor: Type K (NiCr–NiAl).

CONDUCTANCE	RESOLUTION	ACCURACY
200nS	0·1nS	±(1·5% rdg+10d)

CAPACITANCE	RESOLUTION	ACCURACY
2000pF	1pF	±(1·5 % F.S.+5d)
2μF	0·001μF	±(2 % F.S.+5d)
20μF	0·01 μF	±(2 % F.S.+5d)

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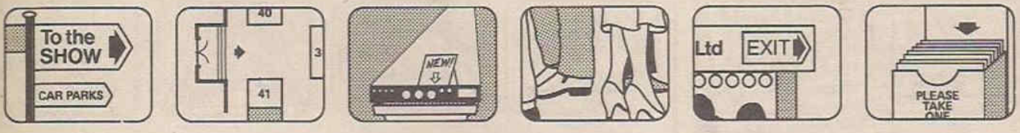
TOKYO AUDIO FAIR



At about the same time Ian Pitt was exercising his sexual frustrations at the Heathrow Penta Show in the UK, several disgruntled journalists had just arrived at Narita Airport to learn that their luggage had been left in the good old USSR.

Perhaps we had got out of the wrong side of the plane but this was not the most impressive introduction to the hectic delights of Japan. Later that afternoon we engaged in a running battle with a myriad of oriental shop assistants in a vain attempt to procure *clean* shirts, underwear and the like — despite the raving gesticulations of our party, they simply failed to understand that it really did not matter if the shirts were too small.

This accomplished, we struggled out of our hotel in ill-fitting garb to descend upon the Japanese equivalent of Pizzaland only to pass our luggage going the other way. Having broken down much of our party's resilience we were finally re-united with our cases just in time to change for an assault on the dreaded Tokyo Audio Fair.

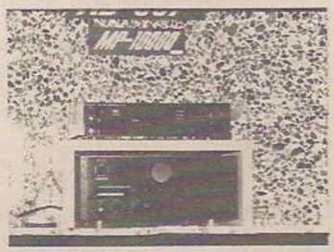
This annual event is actually housed in two extremely large venues which looked for all the world like a couple of disused aircraft hangers. Nevertheless, the bustling hordes seemed more interested in the vast quantities of gadgetry than the dubious acoustics presented by this man-made cavern.

Although there were peripheral exhibitions of 'tweaky' high-end audio gear, it has to be said that the bulk of the show was concerned with the latest in digital and video technology — CD, CDV, high-definition VCR's and DAT machines of every description filled the arena. The contrast with Heathrow's Penta Show could not have been greater.

Our hosts, Sony, were demonstrating their DTC-1000ES DAT player by allowing groups of visitors to actually make their own recordings of a live music session. Meanwhile on the stand proper they were displaying an entirely new range of ESD CD players. In this country we are still oggling over their first-generation ES players such as the CDP-555ES whereas their home market is now enjoying the CDP-557ESD, 337ESD and 227ESD machines.

The top player is one of the new breed employing 'hi-Bit' DAC's offering the resolution and noise performance of 18-Bits — the price in Japan was about £750.

Other '18-Bit' CD-players included the huge Onkyo Integra C-2001 (£1300), Technics SL-P990 and SL-P770 and Hitachi DA-703D, although how long it will be before they are competing with Yamaha in this country is anyone's guess.



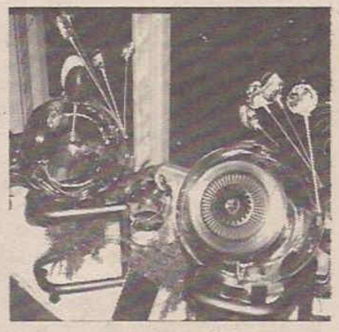
Yamaha themselves were busily showing off their millionaire-budget 100000 series which includes CD-player and exotic amplification.

The latest DSP-3000 'Natural Sound' digital sound field processor was also exhibited, now including some 20 artificially replicated acoustic environments.

Technics showed their SV-D1000 home DAT player in addition to a portable unit called the RQ-MD1 and in-car player, the CQ-DT1D. The portable would still set you back £1300 in Japan.

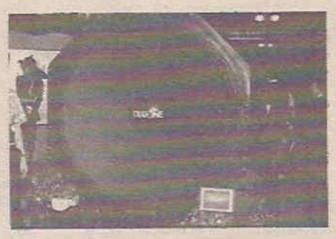
Many more companies appeared to be dabbling with external digital to analogue convertor units, either included in chunky integrated amplifiers or manufactured as add-on accessories. Accuphase (a company last seen over here with the AC-2 moving-coil cartridge displayed their DD80 CD player and optically-coupled DC81 convertor. Luxman boasted a similar level of OTT construction with their 'Limited Edition' series of digital hardware and back-breaking pre/power amplifiers.

Technics revealed a pair of rather frightening planar loudspeakers with a scary price-tag to match. Costing some £10,000, the 320kg SB-AFP1000's utilised garishly blue, flat rectangular drive units to create a wall of sound — they sounded so overwhelmingly bright that I was forced to exit soon after clapping eyes (and ears) on them!



The daftest loudspeaker award must go to Sasaki Acoustics who were seriously marketing a range of single and dual-concentric loudspeaker systems based around glass-crystal spheres. They were duly christened the 'eyeball' speakers. Apparently designed for non-military purposes, Bose were demonstrating two huge drainpipes under the guise of an 'Acoustic Wave Cannon System.' The low frequency extension was considerable (25Hz) but domestic applicability was not their strong point.

Likewise for the monstrous Diatone bass drive unit that must have had a diameter of around 2m!



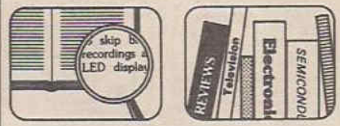
Any visitor who managed to frequent both the London and Tokyo shows could not have failed to experience the vast contrast between events — both cultural and electronic.

At Penta, analogue replay equipment and 'old-technology' valve gear was still reigning supreme while in Japan only Ortofon were daring to represent the black disc.

Whether the tide will turn so strongly against the revered turntable in our own marketplace is uncertain at present. However I rue the day that this ever happens — regardless of all the technological arguments I cannot help but feel detached from the antiseptic precision engendered by this new age of digital audio.

Paul Miller

BOOKS



More and more projects in ETI and other electronics magazines are (when stripped of a few external frills) little more than a microcomputer with input and output interfacing.

Although projects go some way to teaching you all there is to know about bolting bits onto microprocessors, a solid founding in theory is also a good idea and what this month's tome provides.

Practical Microprocessor Interfacing by S. A. Money (Collins) £20.

The 'practical' of the title does not mean you will find ready to make projects nestling in these pages. There are no PCB designs nor even full circuits.

It is only an introduction to the subject and many ETI readers will have already passed on to greater things. Nevertheless, it is a reasonably thorough and eminently readable grounding.

The book starts with a look at CPUs and bus systems. At once the spread afforded by this book is shown. This chapter doesn't just concentrate on one processor, not even one family. All the processors you are likely to meet are here — 6802, 6809, 6502, 8085, Z80, 68000, 8086.

In a classic Von Neumann manner, memories are next. How they work and what you do with them are both covered in reasonable detail and a friendly style. Then it's theory of parallel interfacing, practical parallel interfacing, theory of serial interfacing, practical serial interfacing, counting, timing, analogue input and output and finally, a short discourse on interrupts.

The whole work is spattered with small, easily digestible part-circuit diagrams showing the relevant section of a whole system. Every aspect seems to be covered — both the fundamentals and the use of specialised chips to perform all the interfacing tasks.

The biggest lack is anything in the way of examples. It would be nice to see some 'case studies,' even of the most trivial nature.

The price is certainly over the top. Twenty quid for book (even a well produced hardback) is steep. It's a shame that the price will put off a great many potential readers no matter how much I recommend it. Catch it in your local library instead.

Malcolm Brown

PLAYBACK

Regardless of the quality of modern electronics, a cassette recorder cannot function well unless it is mechanically sound.

The purpose of the mechanics is to move the tape in a stable, straight path past the heads at an absolutely even speed, with a moderate, even tension and at exactly 90° to the head gap.

One obvious necessary condition for all this is that every part of the mechanism should be stably positioned relative to every other part. Flimsy bits of metal supporting the tape heads and pinch wheel(s) won't do.

Drive In

Let's start with the drive mechanism. This must use a capstan with a substantial flywheel to pull the tape through the system at an even speed and must employ precise motor control to ensure the speed is accurate.

The motor speed control system cannot control short term speed fluctuations (which is why a flywheel is essential) but it should respond rapidly to changes in average loading to cope with the varying pull from an unevenly wound tape.

If two capstans are used, they must be driven in such a way as to maintain an even tension on the tape and not either stretch it or build up a loop around the heads. This can become a serious problem.

On an old Tandberg machine, I found that if the capstans were not cleaned frequently enough, the buildup of tape oxide and dirt (faster on the first capstan than the second) increased the effective diameter of the first capstan enough to build up a self-destructive loop of tape. This machine worked well clean but it illustrates the point that a good single capstan is better than a poor dual capstan machine.

Going to the other extreme my present machine (a Nakamichi) uses two capstans of different sizes so that any resonance due to imbalance of the flywheels is at a different frequency for each capstan. This avoids low frequency beat effects which would be audible as wow and flutter. The first capstan is driven so as to pull the tape through the system a fraction of a per cent slower than the second one which provides an accurately calculated tape tension.

While we are on the subject of the capstan drive, it should be noted that the humble pinch-wheel plays a vital role. In order that the tape shall move in a straight line, the axis of rotation of the pinch wheel must be exactly parallel to the axis of rotation of the capstan. This will avoid driving the tape to one side or another.

An easy way to find out if this is happening is to record white noise such as the interstation hiss on an FM tuner and then replay the recording with the amplifier set to mono.

If the tape is wandering (or if the head angle itself is unstable) then the timing of the signal from left and right channels will vary and this will produce phasing effects on the sound. If the sound replayed in mono is the same as that in stereo, then the mechanism is accurate and stable, which is a big step in the right direction.

Into Reverse

Some machines boast an auto reverse facility and in some cases this involves the record/replay head turning through 180° when the tape is reversed. This can work well but the quality of the turning mechanics must be very high in order to return the head to the same position accurately.

If we assume a stereo recording takes up 40% of the total width of the tape and that to obtain good response the maximum error over this width must not exceed, say, a quarter wavelength of 15kHz, then the maximum angular error of the tape head is approximately 1½ *minutes* of arc.

The take up spool must also work smoothly. The tape tension must be enough to wind on the tape even if the take up reel is sticking slightly. However it must do this without stretching or dragging the tape.

If a separate motor is used for this purpose, it must provide even tension without 'cogging' and its speed must be limited so that, should it be required to take up a loop, it does not run away and snap the tape.

Critical examination of these factors will rule out many machines, leaving a choice between fewer better quality models.

Andrew Armstrong

OPEN CHANNEL

A couple of recent happenings make it prudent to take a look to the future of telecommunications services, both here in Britain and around the world — or at least in Europe.

First, PTTs (Postal, Telephone and Telegraph) companies from some of the major European countries have started talking about the sorts of service wanted when digital telephone networks become the norm. An integrated services digital network (ISDN) can obviously be of benefit within a country. However, *international* ISDNs could have even greater benefits — not the least of which would be common standards. Cheaper equipment should result.

PTTs in Germany, France, Italy and Britain (BT) are beginning to combine resources with this European network aim. Eventually, any service available in one country will be available throughout all.

Second, GEC has been seen playing around with Iris!

You'll be pleased to know that Iris is the codename of a new videophone for use on digital networks. It will be available, as far as I am aware, as you read this column.

A while ago (February 1987), I reported in these very pages of research into videophone techniques, specifically about ways to reduce required bandwidth of a videophone to a low enough level to allow transmission down single digital telephone lines. It appears the research also being conducted on behalf of GEC at BT's Martlesham labs has found a way to do it. Iris allows connection to a single 64Kbit/s digital line such as will be available when ISDNs get off the ground.

X Marks The Spot

Talking of GEC, Plessey has negotiated a significant order of System X exchanges, sold to China Railways. This follows other worldwide orders of the exchanges recently and according to Plessey it won't be the last.

However, it will probably be the last as a single company. Plessey of course is in the process of being united with GEC in a new company, GEC Plessey Telecommunications Holdings, with the aim of unifying both companies' interests.

Some 26 exchanges and concentrators are to be delivered by Plessey to the railway in China by 1989 — a fact which will perhaps help to allay fears that System X is a duff 'un.

China is a massive and as yet untapped potential market so even greater sales may result. Maybe the London Business School would like to reconsider its earlier muck-spreading report which criticised System X and its development by BT.

DBS and Chips

Within a matter of weeks several announcements about chip sets for DBS receivers should be made.

RCA had announced it was in the process of producing chips at the time of writing and a joint Plessey/Philips agreement was to have chips ready by ETI's current publication date. Chip designs for both RCA and Plessey/Philips have been originally developed by Nordit, a Norwegian manufacturer, and are to be compatible with all proposed European DBS broadcasts.

All DBS broadcasts will follow the multiplexed analogue component (MAC) format but there the similarity ends. DMAC is to be used in the British DBS service, while D2MAC is to be used in German and French systems.

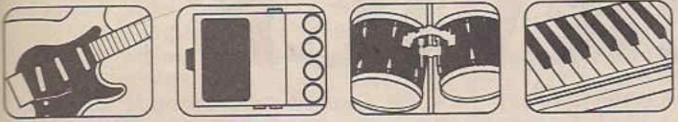
ITT is about to produce D2MAC-only chips which of course will not be usable for the British market. This means that European manufacturers such as Grundig, Thomson and so forth will not have a product to sell in Britain if they choose to use ITT chips. Philips, however, will!

I suspect that ITT's preliminary drive will be to produce an initial batch of chips for D2MAC purposes — giving European manufacturers what they need to make receivers for the home markets. Then ITT will turn its attention rapidly to multi-format compatible chips, so that the same manufacturers can sell into Britain.

In turn, this implies that Grundig et al will beat Philips to the European home markets but later Philips et al will beat them to the British market with a multi-format product which will undercut previous ones.

Keith Brindley

KEYNOTES



Hot gossip at the moment is that IBM and Yamaha are putting their heads together to produce an FM synth/MIDI interface plug-in card for IBM PCs, to be known as the IBM Music Feature.

IBM is keen to trample all over clone makers and will therefore be leaning hard on Yamaha to make the board as uncopiable as possible.

It is certainly becoming difficult for the home constructor to emulate the performance of the modern digital synthesiser. The problem is compounded by a heavy reliance on custom or semi-custom ICs.

Not only is it usually impossible to get hold of these proprietary ICs but it is difficult to even figure out what they do, let alone how they do it. Secrets are being hidden from us under a heavy silicon mattress.

Ensoniq was the first to break the ice by selling their Q chips to Apple Computer. Ensoniq is nevertheless reluctant to make them more generally available (I tried).

Quite surprisingly, Yamaha is now prepared to sell FM chips to all and sundry – with a catch. These sales will be discretionary, the intention being to protect their right to refuse supplying competitors they don't like or don't trust. The main difficulty at the moment is that of getting hold of small quantities and data, so I will have to report back on this in a future issue of *Keynotes*.

Yamaha is offering four main devices, all intended for use under microprossessor control: YM2149, YM2163, Y8950 and YM2203. Taking these in turn, the NMOS YM2149 is pin-compatible with General Instruments' AY-3-9810 (available from Maplin) but with enhanced features. Output resolution is a whopping five bits and no FM is provided.

The YM2163 is a similar non-FM NMOS sound chip with 24 pins and 7-bit output.

The Y8950 is what Yamaha used in their ill-fated commercial failure, the MSX computer. This is a complex 64-pin CMOS device which can do FM, sing, dance and make coffee but requires a fair amount of external hardware to do so.

Top of my list comes the 40 pin NMOS YM2203, which is software compatible with the AY-3-8910 but more importantly offers three channels of FM sound, each comprising four operators.

Output is in a serial floating point format with ten bits of mantissa and three bits of exponent. This is a good technique for keeping signal to noise ratio high when outputting signals of low amplitude but means you are compelled to use the matching YM3014 DAC which costs extra.

So far as I know, the YM2203 is not actually used in any Yamaha machines. Since data on the device has already been made commercially available, it is unlikely that IBM would agree to its use as the mainstay of their Music Feature card. So in the near future we can at least hope to see some FM chips becoming available in small quantities through distributors.

There is some more good news on the chip front. Curtis Electromusic Specialities (CES) have launched no less than ten new devices. CES did (and still do) the CEM33xx series of ICs, as used extensively by Digisound, Sequential Circuits, Moog, Roland and Simmons, back in the days when the analogue grass was greener than the digital grass.

CES is now prudently straddling the analogue/digital fence with a wide variety of DAC multiplexer, anti-aliasing filter and VCA combinations.

Also on offer is a cheap current in/out dual VCA with a claimed 100dB S/N and 0.1% distortion. What is really clever about these is that they come in eight pin packages. Normally a VCA operating from dual supply rails requires an earth connection, if the control voltage is to be referenced to zero volts but unfortunately this takes the pin count up to nine.

CES wanted to use a VCA *output* as the 0V reference, given that it feeds a virtual earth supplied by an external opamp in the inverting amplifier configuration. However, this is easier said than done as an unwanted instability-causing feedback loop is created and it was two years' work before the problem was solved.

CES are intending to make available a data/applications handbook early in the new year.

Bruno Hewitt

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E8405-3	Mains Remote Control Transmitter	H
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E8405-6	Drum Synth	F
E8406-1	Oric EPROM Board	O
E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
E8406-4	AD Buffer/Filter/Tone	H
E8406-5	AD Headphone Amp	F
E8406-6	AD Preamp PSU	K
E8406-7	AD Power Amp	H
E8406-8	AD Power Amp PSU	J
E8406-9	AD Stereo Power Meter	F
E8406-10	AD Input Clamp	C
E8407-1	Warlock Alarm	M
E8408-2	EPROM Emulator	N
E8408-3	Infrared Alarm Transmitter	E
E8408-4	Infrared Alarm Receiver	F
E8409-1	EX42 Keyboard Interface	F
E8409-2	Banshee Siren Unit	F
E8410-1	Echo Unit	F

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E8411-6 Temperature Controller ..... D
E8411-7 Mains Failure Alarm .... D
E8411-8 Knite Light .... D
E8411-9 Stage Lighting Interface ...... F
E8411-10 Perpetual Pendulum .... E
E8412-1 Spectrum Centronics Interface .... F
E8412-4 Active - 8 Protection Unit ..... F
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E8502-2 Data Logger .... J
E8503-1 Combo Preamplifier .... F
E8503-2 THD Meter mV & oscillator bds (2 boards) .... K
E8503-3 THD Meter Mains PSU .... F
E8504-1 Framestore Memory .... M
E8504-3 Framestore Control .... N
E8504-4 Buzby Meter .... E
E8504-5 CCD Delay .... F
E8505-5 Stereo Simulator .... F
E8506-1 Audio Mixer Main .... J
E8506-2 Audio Mixer PSU .... F
E8506-3 Audio Mixer RIAA .... D
E8506-4 Audio Mixer Tone Control ... D
E8506-5 EPROM Prog MKII .... O
E8508-1 RCL Bridge .... N
E8508-2 EX42/BBC Interface .... E
E8508-3 EPROM Emulator L
E8509-1 Spectrum .... F
E8509-2 Direct Injection Box .... E
E8510-9 Sunrise Light Brightener ...... K
E8511-1 MTE Waveform Generator ... H
E8511-2 Millifaradometer .... H
E8511-3 Cymbal Synth .... J
E8511-5 Chorus Effect .... H
E8511-7 Enlarger Exposure Meter ..... F
E8511-8 Switching Regulator .... E
E8511-9 Second Line of Defence ..... M
E8512-1 Specdrum connector .... F
E8512-2 MTE Pulse Generator .... H
E8511-3 Specdrum L
E8601-2 Walkmate L
E8601-3 MTE Counter-timer .... M
E8602-1 Digibaro .... O
E8603-2 Programmable Logic Evaluation Board .... H
E8603-3 Sound Sampler Analogue Board .... R
E8604-1 JLLH PA PSU .... H
E8604-2 Matchbox Amplifier C
E8604-3 Matchbox Amp Bridging Version C
E8604-4 MTE Analogue/Digital Probe .... M
E8605-1 Microlight Intercom .... E
E8605-2 Baud Rate Converter .... M
E8605-3 Baud Rate Converter PSU Board .... G
E8605-4 Portable PA .... H
E8606-1 Midi-CV Converter Board .... H
E8606-2 Midi-CV Converter PSU ..... D
E8606-3 Troglograph .... F
E8606-4 80m Receiver .... H
E8606-5 Sound Sampler .... R
E8607-1 Direction .... E
E8607-2 Upgradeable Amp, MC stage (Stereo) .... G
E8607-3 BBC Motor Controller .... F
E8608-1 Digital Panel Meter .... G
E8608-2 Upgradeable Amp, MM stage (mono) .... H
E8609-1 Mains Conditioner .... E
E8609-2 Experimental preamp .... F
E8609-3 Upgradeable amp, Tone board (mono) .... H
E8609-4 Upgradeable amp, Output board (mono) .... F
E8610-1 Audio Analyser Filter Board L
E8610-2 Audio Analyser Display Driver .... K
E8610-3 Audio Analyser Display .... H
E8610-4 Audio Analyser Power Supply .... F
E8611-1 Audio Switcher (2 bds) .... H
E8611-2 PLL Frequency meter (4 bds)...Q
E8611-3 Upgradeable Amp PSU .... J
E8611-4 Call meter, main bd. .... O
E8611-5 Call meter, interface bd ...... N
E8612-1 Bongo Box .... J
E8612-2 Biofeedback monitor (Free PCB) .... E
E8701-1 RGB Converter .... F
E8701-2 Mains Controller .... D
E8701-3 Flanger .... H
E8701-4 Audio Selector main board ... M
E8701-5 Audio Selector PSU .... H
E8701-6 Tacho-Dwell .... F
E8702-1 Ratemeter main board .... K
E8702-2 Ratemeter ranging board ..... F
E8702-3 Photo Process Controller (3bds) .... O
E8702-4 LEDline display board (2 off) .... K
E8702-5 LEDline PSU and controller (2 bds) .... G
E8703-1 Capacitometer .... F
E8703-2 Geiger Counter L
E8703-3 Credit Card Casino .... E
E8704-1 BBC micro MIDI interface L
E8704-2 ETIFaker patch box .... H
E8704-3 24Hr. Sundial .... E
E8705-3 MIDI Keyboard keyswitch boards (3 boards) ....W
E8705-4 Batlite C
E8705-5 Budget Power Meter ....E
E8706-1 Hi-fi Power Meter ....N
E8706-2 MIDI Keyboard CPU ....U
E8706-3 MIDI Keyboard Front Panel ...O
E8706-4 Flame Simulator ....G
E8707-1 MIDI Keyboard PSU ....H
E8707-2 Telephone Alarm ....J
E8707-3 Nuclear Strategy Simulator .....J
E8708-1 Remindalite ....F
E8708-2 Rear Wiper Alarm ....G
E8708-3 Rev Counter ....F
E8708-4 Car alarm ....F
E8708-5 Knight Raider ....J
E8709-1 Boiler Controller ....G
E8709-2 Amstrad Sampler (2 bds) ....P
E8709-3 Portable PA ....G
E8709-4 EEG Monitor (2 bds) L
E8710-1 Concept CPU board.............N
E8710-2 Concept Power board...........K
E8710-3 Concept display board.........G
E8710-4 Hyper-Fuzz ....F
E8710-5 Big Digits digit board...........N
E8710-6 Big Digits minute board.........F
E8710-7 Big Digits battery board.........G
E8711-1 Quiz Controller..................E
E8711-2 256K Printer Buffer.............N
E8712-1 Heating Management System...O
E8712-2 SWR Meter.....................H
E8712-3 Dream Machine (free PCB).....D
E8801-1 Smart Talker L
E8801-2 Passive IR Alarm .... H
E8801-3 Mains Cleaner .... G
E8801-4 RGB Dissolve L
E8802-1 Electric Fencer .... E
E8802-2 Telephone Intercom L
E8802-3 Transistor Tester (2 bds) L
E8802-4 Spectrum Co-processor CPU .. N

OOPS!

Flat Alarm (June 1987)
In the circuit diagram Q2 is shown as an NPN transistor. It should be a PNP device as given in the parts list. IC4 is given in Fig. 2 as a 74LS260 and C5 as 470n. They should be 74LS132 and 4µ7 as in the parts list. R13 is incorrectly given as 280R in the parts list instead of 270R.

Nuclear Strategy Simulator (July 1987)
The bridge rectifier (BR1) on the overlay diagram has no polarity markings. It should be positioned with the positive at bottom left, connected to the track which connects to IC8 IN and C4 positive.

Telephone Alarm (July 1987)
In the component overlay (Fig.2) IC1 and IC2 should be swapped. The capacitor to the right of IC1,2 is C1 and the inductor between them is L1. The unmarked resistor to the left of L1 should be a wire link. In the circuit diagram (Fig.1b) IC4a,b should be AND gates. IC5 should be NAND gates. The parts list is correct.

Kappellmeisters (July 1987)
The position of the speaker port in the front panel was omitted from Fig.2. This should be a 7¼x4½in ellipse centred across the panel with its top edge 2½in below the panel top.

Knight Raider (August 1987)
In Fig.1(a) pins 4 and 5 of ICI are swapped. IC2-3 show the correct pin-out.

Car Alarm (August 1987)
In Fig. 1 Q7 is not numbered and its emitter is shown unconnected. This connects to earth. The transistors in the parts list went a little awry. Q2-6 are BC237 and Q7 is a TIP31.

Boiler Controller (September 1987)
In Fig. 2 (a) the primary of T2 is shown connected to Earth. This should be neutral. In Fig. 2(b) one of the bridge rectifier diodes, D6-9, is shown the wrong way around. This is correctly shown in Fig. 5.

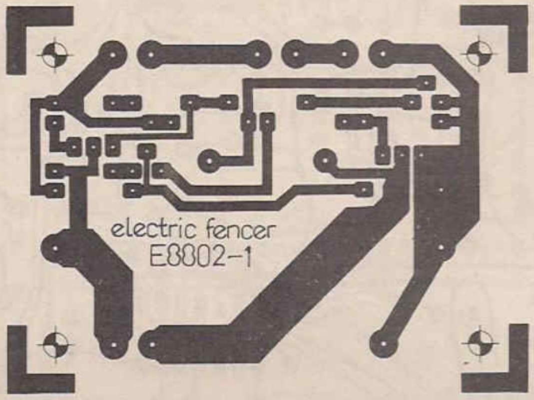
EEG Monitor (September 1987)
In Fig.3a the pins of IC1 connected to the power rails are shown swapped around. In Fig.4a R7 is unlabelled and is between C3 and C6. In Fig.5 C20 should be £10 and R18 is unlabelled. It lies between R17 and R19.

ETI Concept (October 1987)
The Power Board parts list wrongly lists R6 as 270R. This should be 270k. Also, note that the power board's 0V rail must *not* be connected to Earth or the 0V rail of the CPU board.

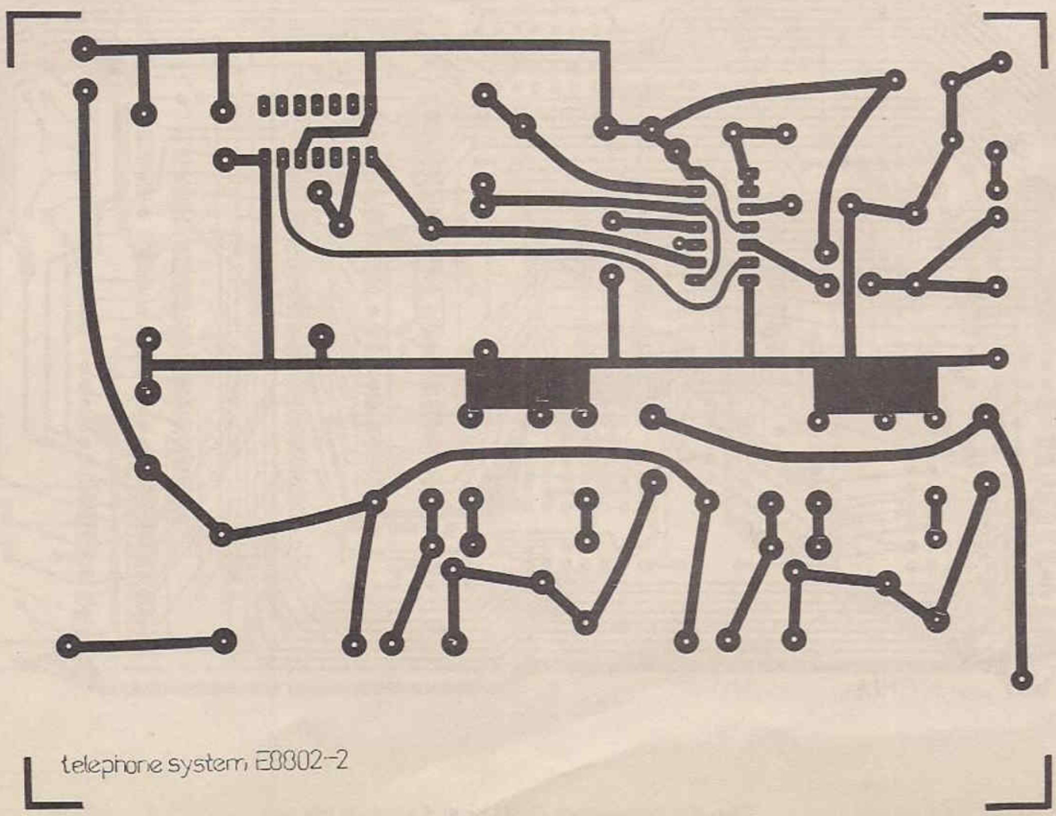
Printer Buffer (November 1987)
The software for the EPROM had three errors listed. The byte at 039A should read 20, at 039B 14 and at 0492 30. All numbers are in Hex.

Dream Machine (December 1987)
The transistors used in this project are ST1702. BC108s can be substituted.

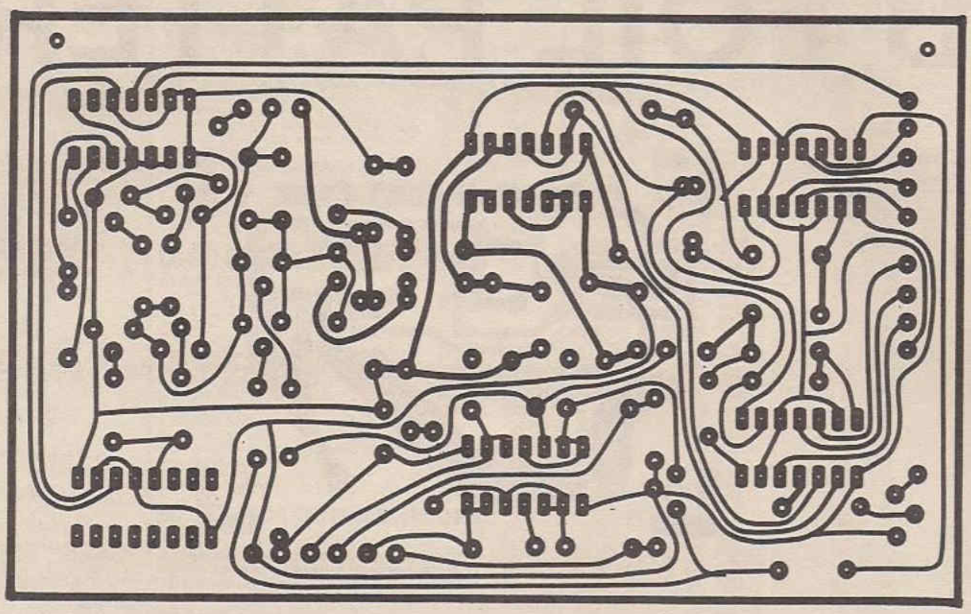
PCB FOIL PATTERNS



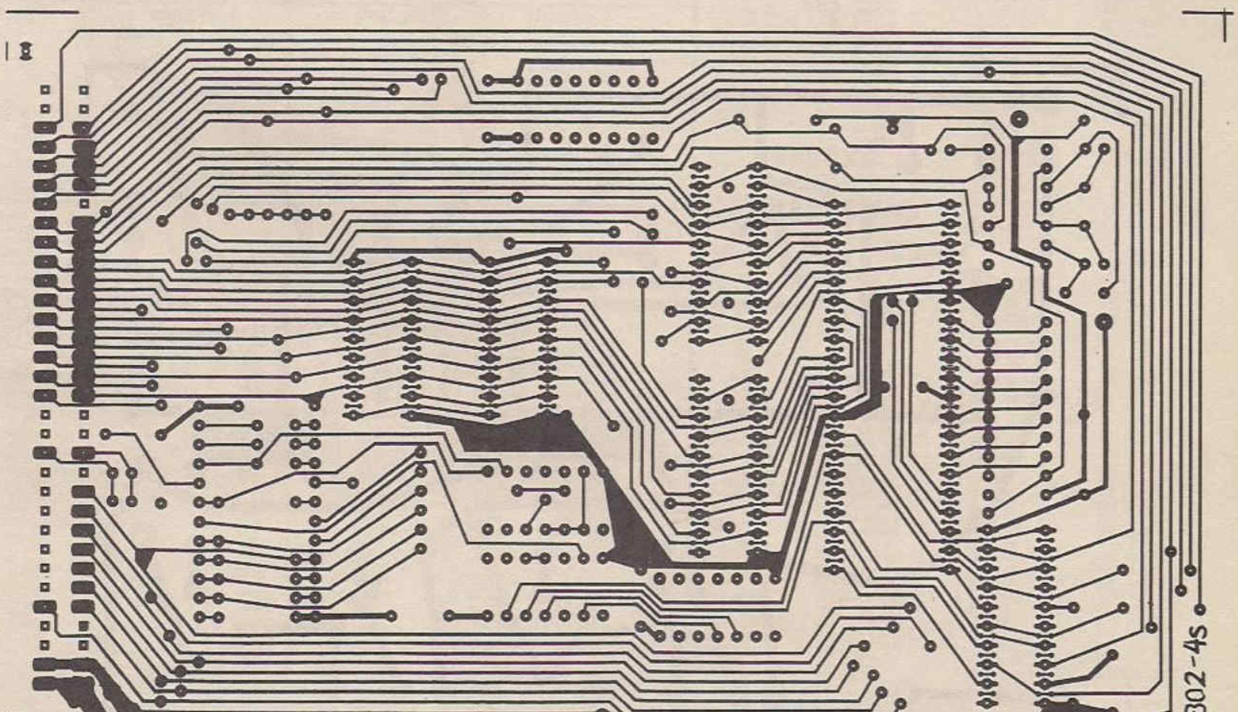
The Electric Fencer PCB



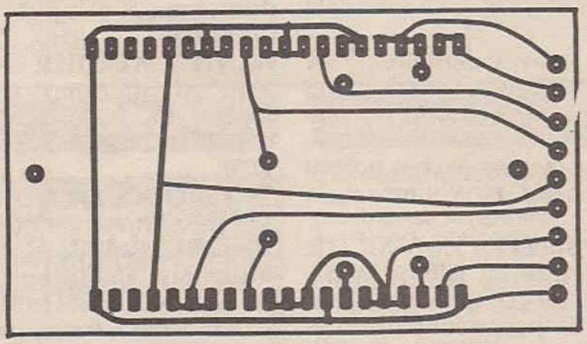
The Telephone Intercom foil pattern



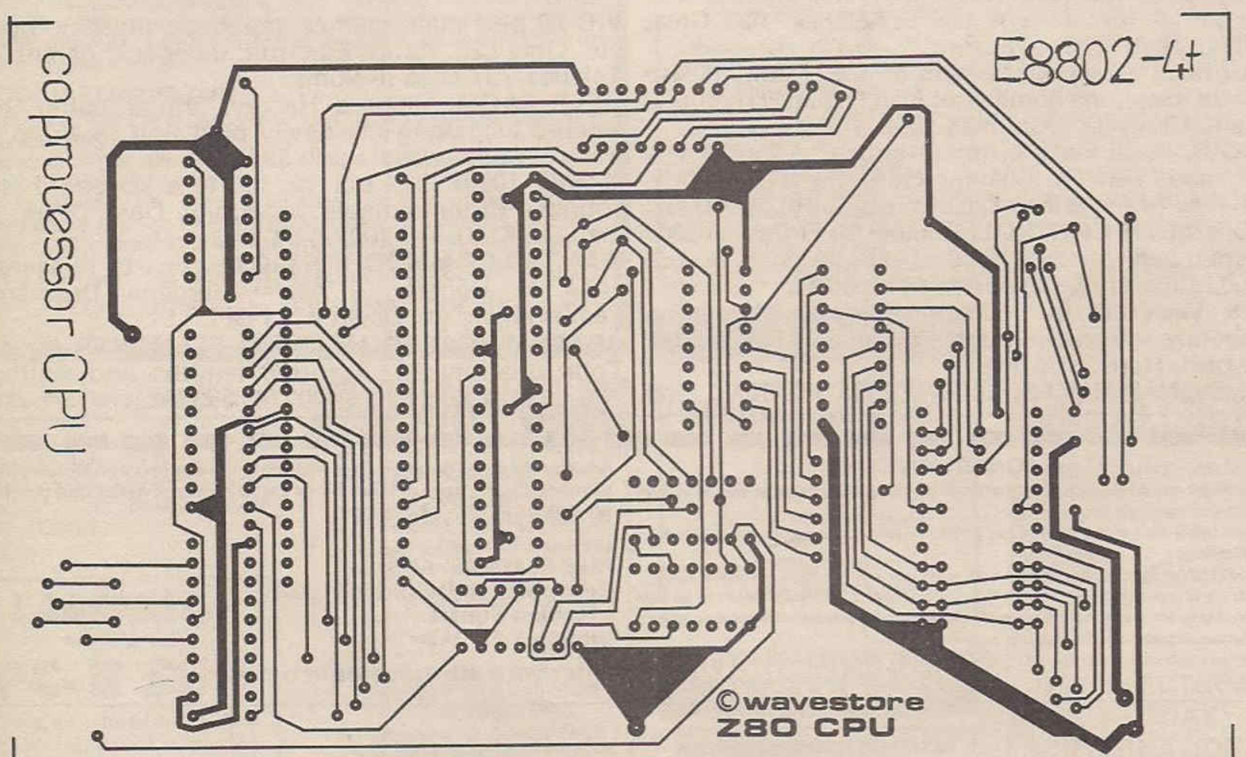
The Transistor Tester main board



The Co-processor CPU board solderside foil



The Transistor Tester display board



The Co-processor CPU board topside soil

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4012B	0.120
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4018B	0.225
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74LS04	0.130
74LS08	0.135
74LS10	0.130
74LS11	0.130
74LS14	0.210
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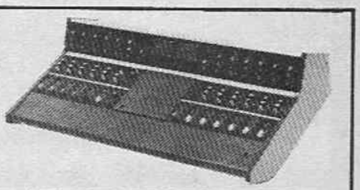

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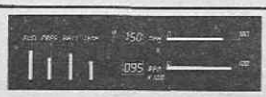

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