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OCTOBER 1984 · 90p

ELECTRONICS

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RADAR SECURITY ALARM

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MAPLIN PRICE RIGHT! 82p

Recommended for general purpose, fine work and pcb's, a top quality flux-cored 60% tin, 40% lead solder. 22swg.
ONLY 82p for 10 metres (FR21X)

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Copy video tapes to and from virtually any VHS or Beta machine. Kit makes six different video and six different audio leads.
ONLY £9.95 (RK71N)

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Pack of 5 good quality C12 cassettes.
ONLY £1.95 (BK95D)

Pack of 10 top quality 5¼in floppy disks single-sided, single or dual density.
ONLY £17.95 (YJ00A)

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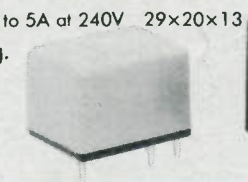
Far superior to carbon film, these superb quality, very high stability, exceptionally low noise resistors have a ±1% tolerance and are rated 0.4W at 70°C yet are only 6.5mm long and 2.5mm diameter nominal. E24 range 10Ω to 1M.
EXCEPTIONALLY LOW PRICE 2p each (M+VALUE)

RELAYS

Sub-miniature 12V relays will switch up to 10A at 240V AC.

	Coil voltage	Coil resistance	Contact ratings DC current	AC Current (resistive)	Size (mm)
Single-pole changeover	8.4 to 15.6V	400Ω	up to 10A at 30V	up to 10A at 240V	21×16×14
Double-pole changeover	8.4 to 13.2V	270Ω	up to 5A at 30V	up to 5A at 240V	29×20×13

MAPLIN PRICE RIGHT! £1.65



Relays are fully enclosed and direct pcb mounting.
INCREDIBLY LOW PRICE £1.65 each
(SINGLE-POLE YX97F)
(DOUBLE-POLE YX98G)

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Well over £1½ million worth of top quality electronic components always in stock

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Gold over nickel plated contacts and solder terminations. Thermo-plastic cover allows side or top entry and includes cable clamp.

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SUPERB QUALITY AND AMAZINGLY LOW PRICES

	Plug	Socket	Cover
9-way	**68p** (RK60Q)	**95p** (RK61R)	**£1.14** (RK62S)
15-way	**95p** (BK58N)	**£1.43** (BK59P)	**99p** (BK60Q)
25-way	**£1.39** (YQ48C)	**£2.19** (YQ49D)	**£1.14** (YQ50E)

TELEPHONE CONNECTORS

Three examples from our range of telephone fittings. All are BT approved and sockets are shuttered.

MAPLIN PRICE RIGHT! from £2.65

Flush fitting jack socket for main telephone. **ONLY £3.99** (FJ27E)

Flush fitting jack socket fc extension telephones.
ONLY £2.65 (FT34N)

Line cord, 3m long, spade terminals to phone plug.
ONLY £1.95 (FG29G)

MAPLIN PRICE RIGHT! £1.95

COMPARING OUR PRICES

When you compare our prices, remember that many of our competitors quote VAT exclusive prices. This hidden extra makes a big difference to their seemingly low prices.
On an order as little as £6.67, the VAT is a whole £1 extra !

5%

SHOPS ONLY

PRESENT THIS COUPON IN ONE OF OUR SHOPS AND WE'LL KNOCK 5% OFF ANY ONE COMPLETE ORDER VALID UNTIL 29th SEPTEMBER 1984

SHOPS ONLY

PE10

N.B. All our prices INCLUDE VAT and Carriage. A 50p handling charge must be added if your total order is less than £5 on mail-order.

MAPLIN ELECTRONIC SUPPLIES LTD.
Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) 552911.
SHOPS
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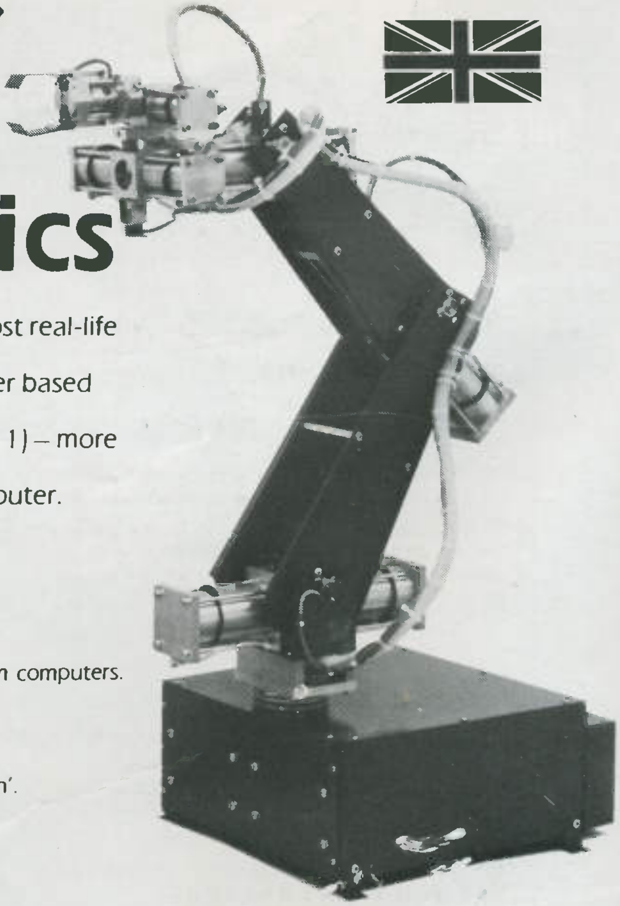
- SOUTHAMPTON 46-48 Bevois Valley Road, Tel: 0703 25831.
- SOUTHEND 282-284 London Road, Westcliff-on-sea, Essex. Tel: 0702 554000.

Shops closed all day Monday. Despatch by return of post where goods available.

neptune

for low-cost training in

real-life robotics



The advanced design of the Neptune 2 makes it the lowest cost real-life industrial robot.
It is electro-hydraulically powered, using a revolutionary water based system (no messy hydraulic oil!)
It performs 7 servo-controlled axis movements (6 on Neptune 1) – more than any other robot under £10,000.
Its program length is limited only by the memory of your computer.
Think what that can do for your BASIC programming skills!

And it's British designed, British made.

Other features include:

- Leakproof, frictionless rolling diaphragm seals.
- Buffered and latched versatile interface for BBC VIC 20 and Spectrum computers.
- 12 bit control system (8 on Neptune 1).
- Special circuitry for initial compensation.
- Rack and pinion cylinder couplings for wide angular movements.
- Automatic triple speed control on Neptune 2 for accurate 'homing in'.
- Easy access for servicing and viewing of working parts.
- Powerful – lifts 2.5 kg. with ease.
- Hand held simulator for processing (requires ADC option).

Neptune robots are sold in kit form as follows:

Neptune 1 robot kit (inc. power supply)	£1250.00
Neptune 1 control electronics (ready built)	£295.00
Neptune 1 simulator	£45.00
Neptune 2 robot kit (inc. power supply)	£1725.00
Neptune 2 control electronics (ready built)	£475.00
Neptune 2 simulator	£52.00
ADC option (components fit to main control board)	£95.00
Hydraulic power pack (ready assembled)	£435.00
Gripper sensor	£37.50
Optional extra three fingered gripper	£75.00
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.

mentor

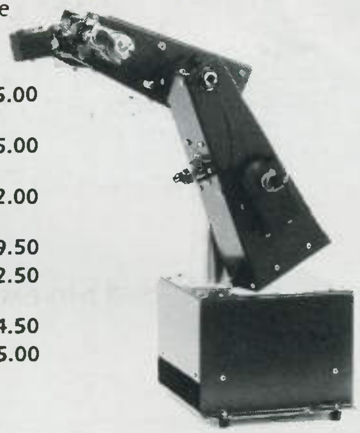
desk-top robot

This compact, electrically powered training robot has 6 axes of movement, simultaneously servo-controlled. It gives smooth operation, and its rugged construction makes it ideal for use in educational establishments. Other features include long-life bronze and nylon bearings, integral control electronics and power supply, special circuitry for inertial compensation, optional on-board ADC, and hand-held simulator as the teaching pendant. Like Neptune, Mentor's program length is limited only by your computer's memory. Programming is in BASIC.

Mentor is all-British in design and manufacture and comes in kit form at an astonishingly low price:

Mentor robot kit (inc. power supply)	£345.00
Mentor Control electronics (ready built)	£135.00
Mentor Simulator (requires ADC option)	£42.00
ADC option (Components fit to control electronics board)	£19.50
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclar ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.



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PRACTICAL
ELECTRONICS

VOLUME 20 No. 10 OCTOBER 1984

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR NOVEMBER ISSUE WILL BE ON SALE FRIDAY, OCTOBER 5th, 1984
(for details of contents see page 37)

BI-PAK BARGAINS

MINIATURE TOOLS FOR HOBBYISTS

Miniature round nose side cutters – insulated handles 4½inch length. Order No: Y043

Miniature long nose pliers – insulated handles 5¾inch length. Order No: YO44.

Miniature bend nose pliers – insulated handles 5½inch length. Order No: YO45.

Miniature end nippers – insulated handles 4½inch length. Order No: YO46.

Miniature snipe nose pliers with side cutter and serrated jaws – insulated handles 5inch length. Order No: YO42.

ALL AT £1.25 each

FLEXEY DRIVER

A flexible shaft screwdriver for those awkward to get at screws. Overall length 8¾inch. Order No: FS-1 Flat blade 4mm FS-2 Cross point no. 1 **£1.75 each.**

GRIP-DRIVER

8inch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places. Order No: SD-1 Flat blade 4mm SD-2 Cross point no.0. **£95p each.**

SIGNAL INJECTOR

Simple push button operation. Oscillates at 700 – 1k Hz with harmonics to 30MHz. 1.4V p/p output. Impedance 10kΩ. Ideal for trouble shooting with audio equipment. One "AA" penlight battery supplied. O/No VP96 **£2.50**

LOGIC PROBE

Automatic levelling. White LED indication. Minimum width of measuring pulse 30 millisecs. Maximum input frequency 10M Hz.

Input impedance:	100kΩ
Power consumption:	40mA maximum
Power supply:	4.5 – 18 V d.c.

ORDER No. VP97 **£10.50**

CURRENT/POL CHECKER

Heavy duty test prods with built-in indicators for testing polarity: indicates whether a.c. or d.c. 3.5V to 400V. O/No. VP98 **£2.50**

TESTER

Universal tester with ceramic buzzer. Tests diodes, transistors, resistors, capacitors and continuity. One "AA" penlight battery included.

Test current:	Max 2μA
Test voltage:	1.2V
Response range:	100MΩ
Max voltage:	500V
Internal resistance:	390kΩ
Length:	135mm

£5.00 O/No. VP99

CIRCUIT TESTER

D.C. continuity tester for circuit checking on all low voltage equipment and components. Diode checking also possible. Takes two AA batteries. 90cm lead has crocodile clip. Body length 145mm. O/No. VP100 **75p**

ELECTRONIC SIREN 12v DC

Red plastic case with adjustable fixing bracket. Emits high-pitched wailing note of varying pitch - 100 cycles per minute. Dims - 90mm (dia.) 60mm (depth). Power - 12v DC. O/P 90dBA 1m type.

Our Price: £5.50 O/No. VP79

TAPE RECORDER SWITCH

Unit to control motor of tape recorder. 1.8m cord and 2.5mm plug attached. On/Off switch. Dims: 55 × 20 × 20mm. O/No. VP 127 **£1.00**

POWER SUPPLY OUR PRICE £4.25

Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug. Input – 240V AC 50HZ. Output – 3, 4, 5, 6, 7.5, 9 & 12V DC Rating – 300 ma VP109.

RATCHET SCREWDRIVER KIT

Comprises 2 standard screwdriver blades 5 & 7mm size. 2 cross point size 4 & 6. 1 Ratchet handle. 5-in-1 Kit. £1.45 each. O/No 329B

ELECT & PIEZO BUZZERS

PIEZO

Miniature round piezo-electronic buzzer. White plastic. Low consumption.
Frequency: 4kHz approx.
Output: 70dB (A) @ 1. typ.
Power: 12Vd.c. 4mA
Dims: 22 (dia.) × 11.5mm.
Fixing Centres: 26.5mm

O/No. VP 107 **95p**

PIEZO

Piezo buzzer. White plastic. 90mm leads. For use on a.c mains.
Frequency: 3.5kHz approx.
Output: 85dB (A) @ 1m typ.
Power: 240Va.c. 5mA
Dims: 32 (dia.) × 14mm
Fixing centres: 38mm

O/No. VP 108 **£1.15**

ELECTRONIC

Miniature electronic buzzers. Solid state. Ivory plastic. 150 leads. Frequency 500 Hz approx.
Dims: 22 × 16 × 15mm
Output: 82dB (A) @ 1m typ.
Fixing centres: 26mm

3V 25mA. O/No. VP 82	6V 25mA. VP 83
9V 25mA. O/No. VP 84	12V 25mA. VP 86

80p each

SUB-BOX

A neat swivelling disc provides close tolerance substitution resistors of 36 preferred values from 5ohms to 1Kohm. Simply fix clips into circuit and swivel until optimum result is achieved.
O/No. VP 112 **£4.75**

MINIATURE VICE

Miniature plastic and metal vice with strong suction base for portability. Single action to secure or release suction. Plastic jaws with rubber pads 20mm wide, open out to 40mm. Dims: 85 × 65 × 60mm approx.
FANTASTIC VALUE
O/No. VP 95 ONLY £1.60

LEARN A LINGO!

PILLOW SPEAKER

Slim under pillow unit. 8ohms 2" speaker. 1.5m lead with 3.5mm mono jack plug. Black. Dims: 65 (dia.) ×17mm.
O/No. VP 88 **£1.25**

METRIC & BRITISH MEASURES

Steel tapes in sturdy ABs plastic case. Silk wrist strap. These yellow coated convex tapes have inch and metric graduations. Automatic push-button return.

2m long × 13mm wide. O/No. VP 89	£1.00
3m long × 13mm wide. O/No. VP 90	£1.50
5m long × 16mm wide. O/No. VP 91	£2.00

13 PIECE TOOL KIT AND CASE

13-piece tool set housed in attractive moulded plastic case with clear sliding cover ● 1 off 5" snipe nose "radio" pliers with side cutters ● 1 off 4½" side cutters ● 1 off 4½" end cutters ● 2 off hex. "Allen" key drivers 2mm and 2.5mm; 2 off cross-point "Phillips" drivers No. 0 and No. 1 (with tommy bar) ● 6 off precision screwdrivers. Sizes from 1mm to 3.5mm ●

ONLY £7.50 ORDER No. VP102

PRECISION JEWELLERS' TOOLS

Rustproof, Tempered Handles and Blades. Chrome Plated Handles. Swivel Heads for use on Precision Work.

5T21 SCREWDRIVER SET
6 precision screwdrivers in hinged plastic case. Sizes – 0.8, 1.4, 2, 2.4, 2.9 and 3.8mm £1.75

5T31 NUT DRIVER SET
5 precision nut drivers in hinged plastic case. With turning rod. Sizes – 3, 3.5, 4, 4.5 and 5mm £1.75

5T41 TOOL SET
5 precision instruments in hinged plastic case. Crosspoint (Philips) screwdrivers – H0 and H1 Hex key wrenches. Sizes – 1.5, 2 and 2.5mm £1.75

5T51 WRENCH SET
5 precision wrenches in hinged plastic case. Sizes – 4, 4.5, 5, 5.5 and 6mm £1.75

BI-PAK SOLDER — DESOLDER KIT

Kit comprises: O/No. VP 80
1 High Quality 25 Watt General Purpose Lightweight Soldering Iron 240v mains incl. 3/16" (4.7mm) bit.
1 Quality Desoldering Pump High Suction with automatic ejection Knurled anti-corrosive casing and Teflon nozzle 1.5 metres of De-Soldering braid on plastic dispenser.
2 yds (1.83m) Resin Cored Solder on Card
1 Heat Shunt too tweezer Type
Total Retail Value over £12.00
OUR SPECIAL KIT PRICE £9.95

MULTITESTER

1,000 opv including test leads & Battery
AC volts - 0-15-150-500-1,000
DC volts - 0-15-150-500-1.000
DC currents - 0 .1ma-150ma
Resistance - 0 .25 K ohms 100 K ohms
Dims - 90 × 61 × 30mm.

O/No. 1322 OUR PRICE £6.50 ONLY

BI-PAK PCB ETCHANT AND DRILL KIT

Complete PCB Kit comprises
1 Expo Mini Drill 10,000RPM 12Vd.c. incl. 3 collets & 3 × Twist Bits
1 Sheet PCB Transfers 210mm × 150mm
1 Etch Resist Pen
1 ½lb pack FERRIC CHLORIDE crystals
3 sheets copped clad board
2 sheets Figreglass copper clad board
Full instructions for making your own PCB boards
Retail Value over £15.00
OUR BI-PAK SPECIAL KIT PRICE £9.95
ORDER NO. VP 81

BATTERY TESTER

Tests all types of battery including standard, NICAD, Alkaline etc. Takes all standard sizes including 6V lantern batteries and watch/hearing aid cells. Also tests fuses and lamps by means of internal 9V (PP3) battery. Can also be used to recharge NICAD batteries by means of external 3-12Vd.c. power supply (not included). Full instructions provided. Dims: 185 × 103 × 30mm (approx.).
O/No VP 101 **£7.00**

SPEAKER PROTECTOR

Limits voltage to speaker or to the permissible max., by automatically introducing a resistor in series with speakers. When excessive voltage is reduced the unit resets itself. Electronic voltage-sensing relay circuit. Spring terminals. Cut-off level adjustable from 10W-120W. Full instructions included. Dims: 85 × 74 × 25mm.
O/No. VP 118 **£9.95**

HIGH PASS FILTER/SUPRESSOR

CB/TV. High pass filter. Reduces unwanted signals picked up by antenna. Dims: 45 × 25 × 17mm
O/No. VP 115 **45p**

LOW PASS FILTER

Designed to reduce harmonics on the VHS and TV band. Cut-off frequency: 30MHz. V.S.W.R.: Less than 1.2 to 1. Insertion loss: –0.2dB @ 27MHz. Impedance: 50 ohms. Dims: 80 × 55 × 40mm.
O/No. VP116 **£2.75**

ANTENNA COUPLER

Transceiver/car radio antenna coupler. With co-axial cables. One co-axial terminates in antenna plug and the other in PL259 plug. Dims: 67 × 46 × 30mm.
O/No. VP 117 **£2.00**

FM MONITOR

FM monitor for 2 metre band. All metal. Attached earphone. PL259/SO239 connectors. 144MHz. 10W maximum. Dims (Body) 55 × 30 × 23mm
O/No VP 120 **£4.20**

DUMMY LOAD

50 ohms 30W UHF co-axial plug fitting (PL259)
O/No. VP 121 **£5.20**

ANTENNA SWITCH 2 and 3 WAY

Co-axial switch for one transceiver to two antennae or one antenna to two transceivers. Dims: 86 × 55 × 32mm (Body).
O/No. VP 113 **£4.50**
As above but 3-way.
O.No. VP 114 **£4.75**

DC-DC POWER SUPPLY

DC to DC adaptor. Plugs into car cigar lighter aperture. Output 3, 4.5, 6, 7.5, 9, 12V @ 800mA. Has universal output spider plug, also 9V battery snap and polarity reversing facility.
O/No. VP 119 **£2.45**

PICK-UP COIL

Large telephone pick-up coil for high sensitivity. Suction pad to stick to telephone. 90cm lead to 3.5 jack plug. Connects direct to cassette recorder. Dims: 32 (dia.) × 17mm (body) 36mm (dia.) sucker
O/No. VP 87 **£1.00**

BI-PAK

Send your orders to Dept PE10 BI-PAK PO BOX 6 WARE, HERTS
SHOP AT 3 BALDOCK ST. WARE, HERTS
TERMS CASH WITH ORDER. SAME DAY DESPATCH. ACCESS. BARCLAYCARD ALSO ACCEPTED. TEL (0920) 3182. GIRO 388 7006
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Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods normally sent 2nd Class Mail.
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PE

VOLUME 20 No. 10 OCTOBER 1984

LICENSING

THE Government has just published a consultative paper on the relaxation of licensing requirements for low power radio devices in the UK. The proposals cover such items as aids for the disabled, garage door openers, radio microphones and radio doppler alarm systems.

Licensing restrictions on metal locators and model control equipment were changed some time ago and this new move will allow further freedom to buy and use equipment working on approved frequencies and below specified power levels—providing of course the proposals are passed.

At the present time however you will need a licence to use the *Doppler Radar Alarm* published in this issue. We will keep you informed if the situation changes.

This alarm system with up to four transmitter/receiver units can be easily set up to protect your home and could well be a very worthwhile investment.

MORE ROBOTICS

Maybe one or two readers are a little tired of reading about robots and robotics on this page but I make no apology for including some more on the subject. Much of the future of industry is tied up with robotics and it is now becoming a significant subject in education and of course for hobbyists with an eye on the future and possibly a career.

Next month we take an in-depth look at small robots with two articles from Tom Ivall and a buyers' guide to products available from around twenty UK companies. These items will form a Free 16-page Robotics Supplement which will also be carried by our sister publication *Everyday Electronics*.

PE is the leading publication in the area of serious use of small robots with designs for six units now published. Back in October 1981 we published an article by Professor Wilfred Heginbotham OBE, D.Sc. Director General of PERA (Production Engineering Research Association) which set the scene on industrial robots and the future. Readers bred on our designs may have a significant part to play in that future. PE intends to also play a part in the development of robotics and we are actively pursuing new designs and ideas in the small robot area which will continue to break new ground.

Everyday Electronics will also publish some interesting low cost educational robotics projects starting with *Alfred* next month and moving on to other *new* educational ideas in robotics.

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We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to **one published project only.**

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers and Binders
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

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Copies of Practical Electronics are available by post, inland for £13, overseas for £14 per 12 issues, from: Practical Electronics, Subscription Department, IPC Magazines Ltd., Room 2816, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques, postal orders and international money orders should be made payable to IPC Magazines Limited. Payment for subscriptions can also be made using a credit card.

Pirates caught RED handed

Piracy of software has reached such staggering proportions in the UK that (according to the Guild of Software Houses) for every one legitimate manufacturers' copy sold there are ten counterfeit copies sold. It is further estimated that this contraband market is depriving software houses of around £100 million per annum in lost revenue.

Many software producers are funding and/or working on systems to ensure that illegal copies cannot be made, in order to keep original programs 'original'.

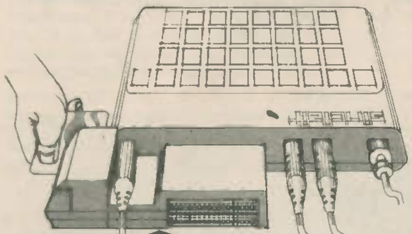
One such company is Rising Edge Data Ltd., who have developed a patented protection system to prevent mass copying of computer software. The system is known as RED and can be adopted by any computer company or programmer and while preventing mass copying will still allow the originator to make back-up copies.

The secret of RED is in the digitised security card which is the same size and shape as a credit card and the reader unit which plugs into the computer. The reader unit will prevent a program being run until the unit is activated by the insertion of the magnetically encoded card. The code on the 'key' card is identical to a program code written into the software, only when the two codes match will the computer allow the program to be run. This means that without the 'key' card a user cannot run the program; RED can be used with most of the popular micros.

The system as yet is being considered by software houses and independent writers and if adopted would mean that home users would have to buy a RED reader unit in order to run protected software. Tapes could then be sold along with their 'key' cards.

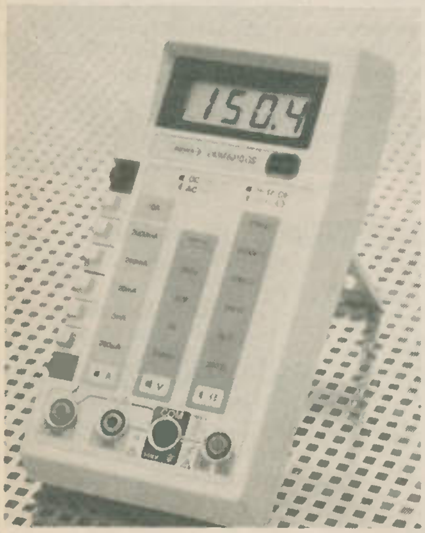
RED's success will depend on the willingness of software originators to accept the concept and of course the users' willingness to buy a reader unit. Although no price has been set for a reader unit, the manufacturers accept that it will have to be very low.

Rising Edge Data is a subsidiary of Abacus Programs, Swansea. For further information contact Active Marketing, 113 Walter Road, Swansea SA1 5QQ. (0792 472927).



RED Card Reader

BEWA MULTIMETERS



An impressive range of 3½ digit hand-held multimeters have been introduced into the UK by House of Instruments.

The range of 9 models in colour coded format (i.e. the Multimeter body) are in three model ranges of accuracy 0·1%; 0·25% and 0·5% each model in the 0·5% and 0·25% range offering a.c./d.c. current facilities of 2A, 10A and 20A, the 20 Amp being a new facility not hitherto available in this price range.

The BEWA multimeters conform to DIN & VDE specifications and are ruggedly conceived with side push-button selection. Ample protection is offered and prices start as low as £43.41 inc VAT and P & P for the 6010GS (pictured). From House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE. (0799 24922).

BBC WIND TESTS

An Acorn BBC Microcomputer is being used in wind tunnel tests at Southampton University to improve the performance of aircraft, racing cars and other motor vehicles.

The wind tunnel enables engineers to measure the aerodynamic forces operating on the racing car. To simulate normal race circuit air conditions a 200 horse power fan blows air over a detailed one/third scale model of the car, while a moving belt under the wheels simulates the ground effects of travelling at speed.

The computer, a BBC Model B Micro, scales up the data gained from the model car in the tunnel tests to direct loads that the real car would encounter. This allows the racing team to study the effect of modifications to the basic design under controlled and economical conditions.

A further program on the machine works out how these modifications will affect lap times. The software 'models' the Silverstone circuit and calculates lap times after the model car has undergone changes in aerofoil settings and body design. These are then adapted to the real car for 'live' testing.

Quadriennium

The BBC has extended the agreement with Acorn Computers for the manufacture and distribution of the BBC Microcomputer for a further four year period from 1 September 1984.

The BBC Computer Literacy Project is now in its third successful year. There is a growing demand for computer education, and the BBC plans to make new computer series and produce new books and software, as well as repeating existing series.

More than 350,000 BBC Microcomputers have been sold to date. Over half the micros used in education in Britain are BBC machines, and during the last year, three quarters of the computers bought by schools were BBC micros. It is against this background that the BBC has decided to renew the contract with Acorn.

MARKET PLACE

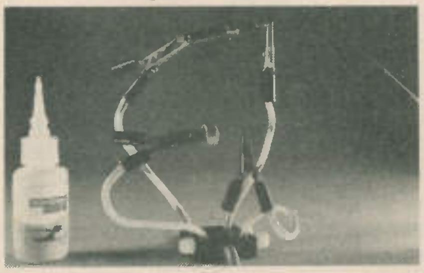
Helping hand

Few DIY jobs are more frustrating than the one that needs "three hands"—two to hold the work and a third to apply solder or adhesive. The smaller the component, the more difficult it is to position it accurately and firmly.

Gripmate, produced by an innovative Sussex company, is a tiny clamp that provides not just one extra "hand" but four, able to grip small electronic components and similar items in an infinite number of positions.

A base block clamped to any bench or table top carries four semi-rigid wires, each fitted with a crocodile clip to hold the work. Alternatively, any of the wires can be replaced with one holding either a magnifying glass for close-up work, or perhaps a magnet.

The four-handed model costs £4.85 (a basic type with two arms sells for £1.00 less), and the magnifier and magnet come for £2.50 and £1.50 respectively, prices include VAT and p & p, from Kemplant Ltd, Durfold Wood, Plaistow, Billingshurst, W. Sussex RH14 0PN. (048 649344).



NEON DRIVER OPTION

An electronic single-pole voltage tester, designed as an effective alternative to the conventional neon voltage testers, is announced by Steinel (UK) Ltd. The Mono Check will give a bright, easily visible indication in virtually any circumstances, when voltage is detected. A special electronic sensing circuit overcomes the problems of neon types which can often be very difficult to see when the user presents a very high insulation to earth.

DIY enthusiasts will appreciate the tough, high quality construction of the Mono Check and the safety aspects of the design. The voltage testing range is from 80V to 240V a.c. and there is a very generous overvoltage range of six times normal maximum (1500V). The Mono Check can be used in all situations in temperatures from −20 to +80 degrees C and in humidities up to 95 per cent. The battery lasts for around one year. The price of £3.99 includes the 12V battery, VAT and P & P. From J. E. M. Marketing, 180 Princess Avenue, Palmers Green, London N13 6HL. (01-889 1415).

Briefly...

Job hunters who take TOPS computer training courses stand a 10 per cent better chance of finding employment this year than last. So far this year 59 per cent of leavers found a job within three months of completing their courses. Improved prospects in trade and industry along with curriculum changes are believed to be the main factors in this encouraging trend.

The Rt. Hon. Kenneth Baker, MP, Minister for Information Technology, announced recently that Britain will be a major participant in the European Space Agency's ERS-1 programme to develop a remote sensing satellite. The data provided will be of value to a range of users for forecasting winds, waves, sea-ice and weather; users will be able to receive information within three hours. Britain is one of the first countries to sign-up and will take a 14 per cent share in the £325 million project. ERS-1 is due to be launched in 1989.

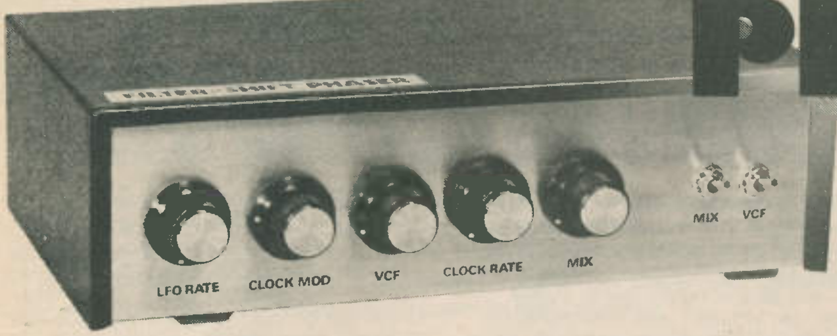
Countdown . . .

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Computer Roadshow (Architects/surveyors) Sept. 11–13. B/ham. **U2**
Testmex Sept. 11–13. Grosvenor Ho. Pk. Lane, London. **E**
Leeds Energy Manager Sept. 12–13. **W3**
What Peripherals Sept. 13–16. Barbican. **J3**
Computer Roadshow (Healthcare) Sept. 14–16. Birmingham. **U2**
Personal Computer World Show Sept. 19–23. Olympia 2, London. **M**
Computer Roadshow (Healthcare) Sept. 22–24. Manchester. **U2**
Semiconductor International Sept. 25–27. NEC. **T1**
Computer Trade Forum Sept. 25–28. NEC, Birmingham. **T1**
Pemec (British Robot Assn.) Sept. 25–28. NEC. **G2**
Building & Home Improvement Sept. 25–30. Earls Court, London. **M**
Computer Fair Sept. 29. Prestatyn High School. See the I.T. mobile exhibition, armed forces and Microelectronics Education Programme Centre. Competition, clubs, hardware/software. **Z9**
Computer Roadshow (Healthcare) Sept. 29–Oct. 1. Edinburgh. **U2**
Computer Graphics Oct. 9–11. Wembley Conf. Cntr., London. **O**
Machine Intelligence Oct 9–11. Cunard Int. Hotel, London. **I**
Software Expo Oct. 16–18. Wembley Conf. Cntr., London. **O**
Internepcon Oct. 16–18. Metropole, Brighton. **T1**
Scottish Energy Manager Oct 23–24. Skean Dhu Hotel, Glasgow. **W3**
Business Equipment Show Oct. 23–26. Olympia, London. **Z**
Drives, Motors & Controls Oct. 24–26. Harrogate Exhibition Cntr. **E**
Electron & BBC Micro User Oct. 25–28. Alexandra Palace, London. **L**
International Test & Measurement Oct. 30–Nov. 1. Olympia. **D4**
Leisuretronics Nov. 8–11. Royal Horticultural Hall, London. **T**
P.c.b. Manufacture & UV Box Construction (meeting) Nov. 17. Electronic Organ Constructors Society. **Y4**
Computers In The City Nov. 20–22. Barbican, London. **O**
Data Security Nov. 20–22. Barbican, London. **O**

D4	Network ✆ 0280 815226
E	Evan Steadman ✆ 0799 26699
G2	✆ 01-747 3131
I	ITF ✆ 021-705 6707
J3	Computer Marketplace ✆ 01-930 1612
L	Database ✆ 061-456 8383
M	Montbuild ✆ 01-486 1951
O	Online ✆ 01-868 4466
T	Trident Exhibitions ✆ 0822 4671
T1	Cahners ✆ 0483 38085
U2	Macro Exhibitions Ltd. ✆ 0992 469556
W3	MCM ✆ 01-231 1481
Y4	Percy Vickery ✆ 0202 423863
Z	Beta Exhibitions ✆ 01-405 6233
Z9	Mr. Carson ✆ 0244 535606

FILTER SHIFT PHASER



JOHN M.H. BECKER

AN ENHANCED phasing effect is produced in this unit by passing a music signal through modulated voltage controlled filter and delay line stages, then mixing this processed signal with the original at the output. The rate and depth of modulation, the v.c.f. response and mixing balance are panel controlled. The v.c.f., phase and by-pass modes are selected via electronic gates for quiet switching. It may be used with most electronic musical instruments or pre-recorded sources. A block diagram is given in Fig. 1.

INPUT SPLITTING

The signal to be processed is brought into the unity gain buffer stage IC1a and fed simultaneously to the final output stage IC1c, the voltage controlled filter around IC1b and IC2, and the selector gates IC3a and IC3b.

VOLTAGE CONTROLLED FILTER

The purpose of the filter is to give enhancement to a frequency bandwidth that is being constantly shifted up and down depending on the modulating control voltage applied. On its own the modified output gives a marked change to the quality of the audio signal, and when combined with phase shifting of the delay stage further interesting changes result. At a slow rate of modulation the filter effect on its own is similar to phase shifting with harmonic overtones. At a fast rate, a bubbly *wah* effect results. VR7 controls the frequency bandwidth emphasised, but should not be regarded as a level control, though at its lower end it behaves in a similar fashion as the bandwidth is moved out of the audio range. The circuit for the v.c.f. consists of a mixer stage IC1b, two transconductance op. amps IC2a and IC2c, and two high impedance stages IC2b and IC2d. The workings are too complex to be described here, but essentially the bandpass range as seen at pin 8 of IC2b is determined by the current flowing into C5 and C6, as set by the control voltage on R21 via VR7, with a gain factor determined by the value of R7.

GATE AND STATIC FILTER

The electronic changeover gates IC3a and IC3b are connected to allow either the original or v.c.f. processed signal to pass through, and are activated by S1. R22 maintains a small d.c. current on the output of the gates to minimise switch over noise. The output from the gates is then fed to the first static filter stage around IC4d in which C11 and C12 limit the maximum frequency to about 5kHz at unity gain. This limit is imposed to reduce harmonic distortion in the delay stage where the maximum signal frequency preferred is approximately one third of its controlling clock signal.

DELAY STAGE

IC8 is a 512-stage bucket brigade delay line chip that passes the audio signal through at a rate determined by the frequency of the controlling clock. The delay increases as the clock frequency reduces. Waveform distortion through the chip is kept to a minimum by applying an optimum bias voltage on its input via VR1. The twin outputs are summed at VR2, to produce a slightly attenuated delayed signal that inherently includes a trace of the clocking signal. This is partially balanced out by adjusting VR2. The remainder is filtered out by the second static filter stage around IC1d, where unity gain is maintained for the low pass signal as set by C17 and C18.

MIXER AND OUTPUT

From IC1d the signal may be switched through the electronic gate IC3c activated by S2. VR3 then allows the desired level to be mixed with the original signal at IC1c. Here a gain of two is given to the processed signal to allow for attenuation in the delay stage. The original signal passes through at unity gain with little insertion loss. The phasing effect is produced when the phase relationship between the two signals changes. Note that the maximum level of the

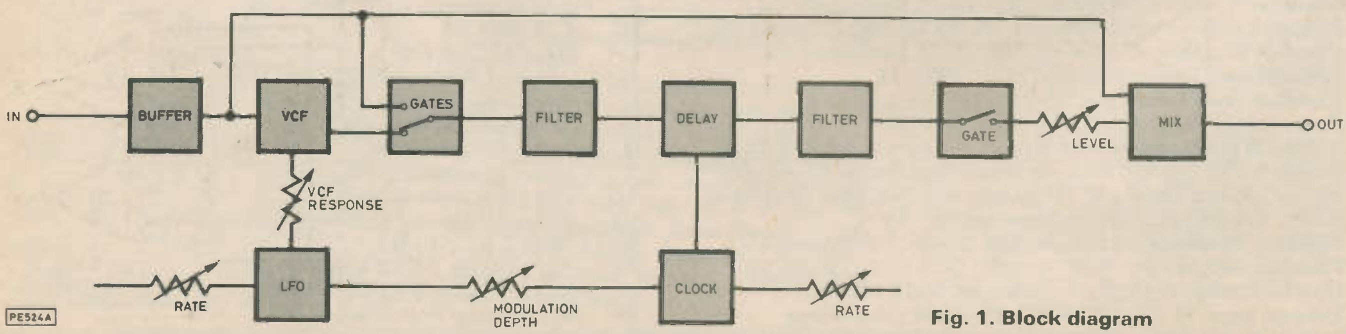


Fig. 1. Block diagram

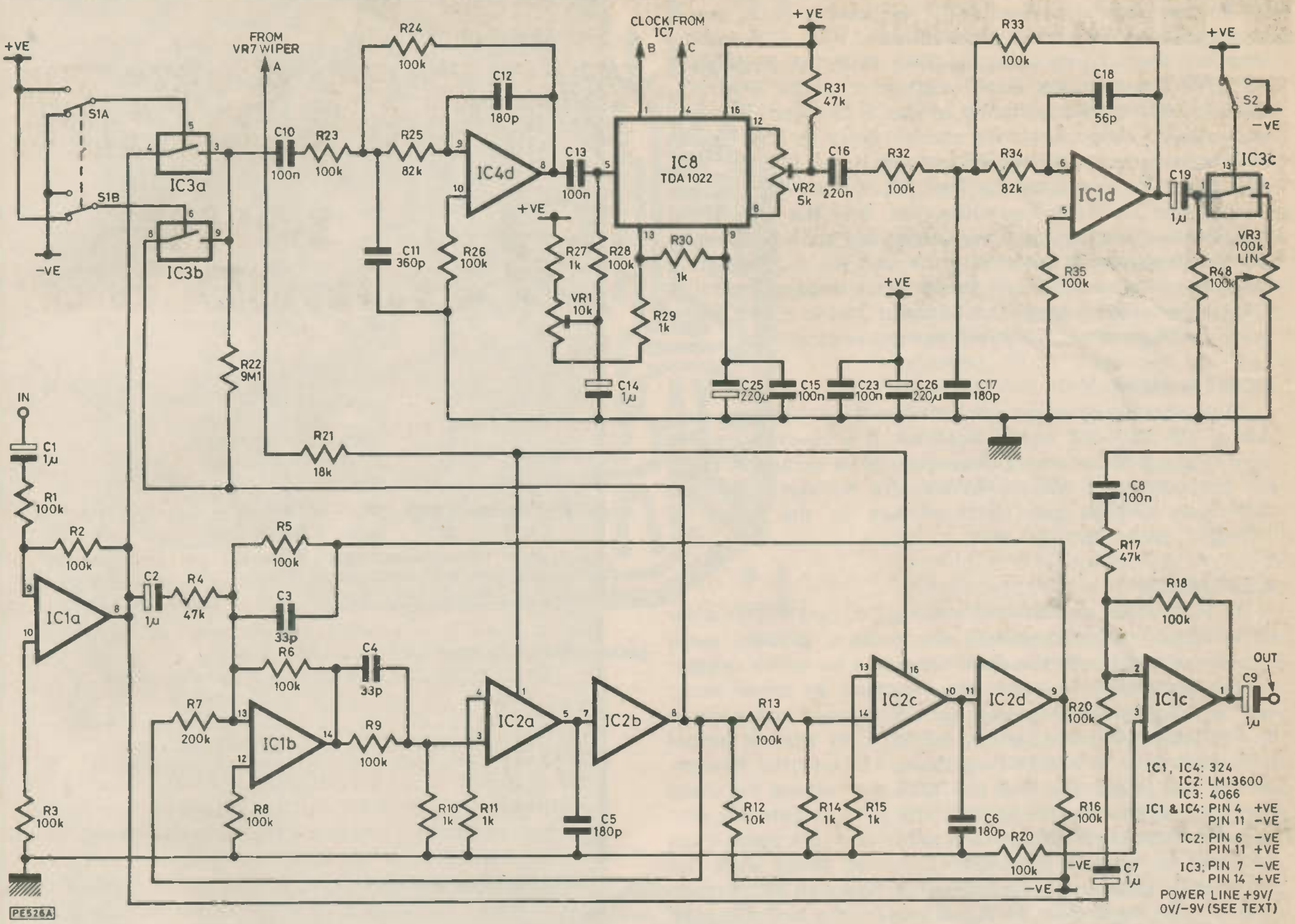


Fig. 2. Circuit diagram

combined signal can be up to twice that of the original depending on the relationship. From IC1c the combined signal can be fed to the normal amplifier system.

MODULATING OSCILLATOR

The modulation voltage needed to vary the phase and v.c.f. changes is derived from the circuit around IC4a/b. The frequency range is determined by C20 which varies its charge at a rate set by VR4. Each time the threshold trigger point of the comparator IC4b is passed, the direction of charge is reversed resulting in a triangular waveform at pin 7 of IC4a, variable by VR4 between about 7 and 2 cycles per minute. This can modulate the v.c.f. via VR7, and the delay clock generator stage via VR5, with IC4c optimising the voltage swing. C24 slightly smooths the peaks of the modulating waveform.

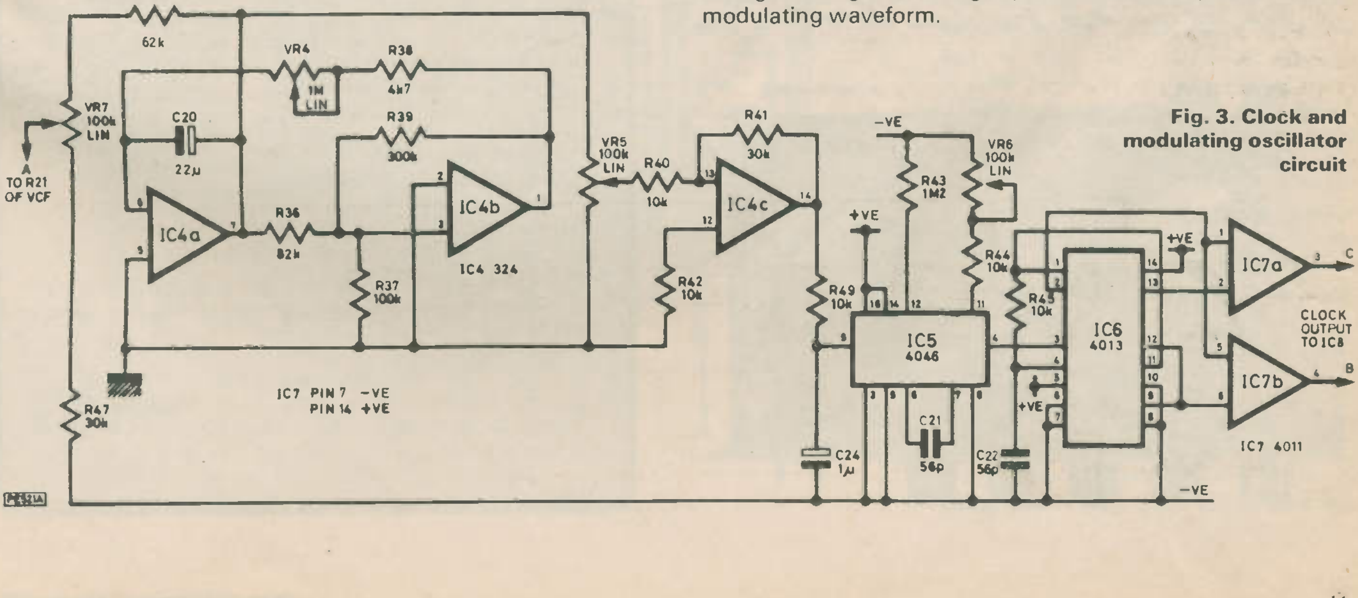


Fig. 3. Clock and modulating oscillator circuit

CLOCK GENERATOR

IC4 is a linear voltage controlled oscillator where the output frequency is determined by the relationship of the power supply voltage, R43, the total of R44 and VR6, C21 and the voltage present on its input via IC4c. With the modulation off, VR6 can vary the clock range from about 46kHz to 430kHz. With a voltage swing of about 13V from IC4c the clock sweep range becomes about 15kHz to 83kHz with VR6 at maximum resistance, and 86kHz to 840kHz with VR6 at minimum resistance. The output from IC5 is taken through the twin flip flop stage IC6, and the twin gates IC7a/b. Here the output is two antiphase square waves at half the frequency of the input clock, and without overlap to their edges thus achieving a quieter clock residual from IC8. The full signal delay range is thus about 3ms to 17ms. These calculated figures may vary with component tolerances.

POWER SUPPLY

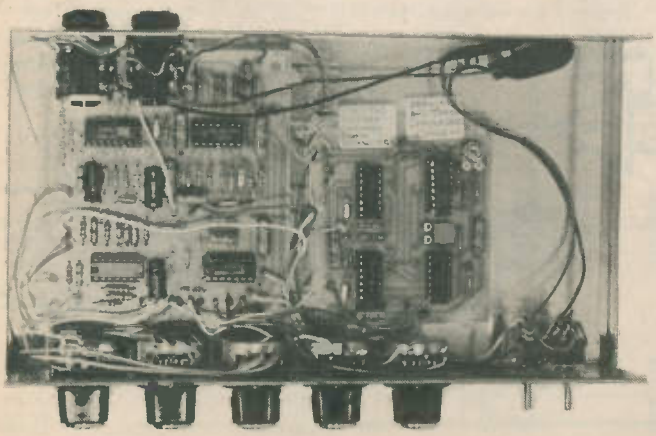
The unit is designed for use with two 9 volt batteries supplying +9V/0V/—9V at about 10mA. If a power supply is used in place of batteries this should not be exceeded, but it can be reduced to about +5V/0V/—5V without significant detriment, though the optimum lies in the range of +6V/0V/—6V to +9V/0V/—9V.

ASSEMBLY

Be methodical and assemble the p.c.b. carefully in order of resistors, small capacitors, i.c. sockets, presets, large capacitors and finally the short link wires for which resistor off-cut leads may be used. Ritually check all solder joints with a magnifying glass, even for experienced constructors this still pays off in trouble-free testing. Only after all control wiring has been finished should the i.c.s be inserted, remembering that i.c.s 3 and 5–8 are MOS and require the usual handling precautions. Note that the jack sockets are also wired as battery on-off switches and mono jack plugs must be used for correct operation. Screened leads were not found to be necessary with the battery operated unit, though they may be needed for the signal leads to the jack sockets if a mains power supply is used in the same box. Ensure that the box is grounded. For the battery unit a link wire from a pot body to the 0V line is adequate. Upon completion the box may be painted and control legends applied with letraset or similar, covering them with a clear varnish or plastic film.

SETTING UP

VR1 and 2 midway, VR3–VR7 minimum, S1 and 2 off. Apply a music signal to the input, at this time a pre-recorded source such as a cassette music track of an orchestral nature will show the best effect. Plug output into amplifier and



COMPONENTS . . .

Resistors

R1–3,R5,R6,R8,R9,R13, R16,R18–20,R23,R24,R26, R28,R32,R33,R35,R37,R48	100k (21 off)
R4,R17,R31	47k (3 off)
R7	200k
R10,R11,R14,R15,R27,R29, R30	1k (7 off)
R12,R40,R42,R44,R45,R49	10k (6 off)
R21	18k
R22	9M1
R25,R34,R36	82k (3 off)
R38	4k7
R39	300k
R41,R47	30k (2 off)
R43	1M2
R46	62k

Potentiometers

VR1	10k skel.
VR2	5k skel.
VR3,VR5–7	100k lin. mono rota (4 off)
VR4	1M lin. mono rota

Capacitors

C1,C2,C7,C9,C14,C19,C24	1μF/24V elect (7 off)
C3,C4	33p polystyrene (2 off)
C5,C6,C12,C17	180p polystyrene (4 off)
C8,C10,C13,C15,C23	100n (5 off)
C11	360p polystyrene
C16	220n
C18,C21,C22	56p (3 off)
C20,C25,C26	22μF/10V elect (3 off)

Integrated Circuits

IC1,IC4	324 (2 off)
IC2	LM13600
IC3	4066*
IC5	4046*
IC6	4013*
IC7	4011*
IC8	TDA1022*

Miscellaneous

PP3 battery clip (2 off)
P.c.b. clip (8 off)
Round knobs (5 off)
Main Control p.c.b.
Clock p.c.b.
14-pin i.c. sockets (5 off)
16-pin i.c. sockets (3 off)
Stereo jack socket (2 off)
S1 DPDT switch
S2 SPDT switch
Case—Phonosonics type BK3
Rubber stick-on feet (4 off)
Connecting wire

***CAUTION**—MOS devices are liable to sudden death from static electricity and are subject to special handling precautions.

Constructors' Note

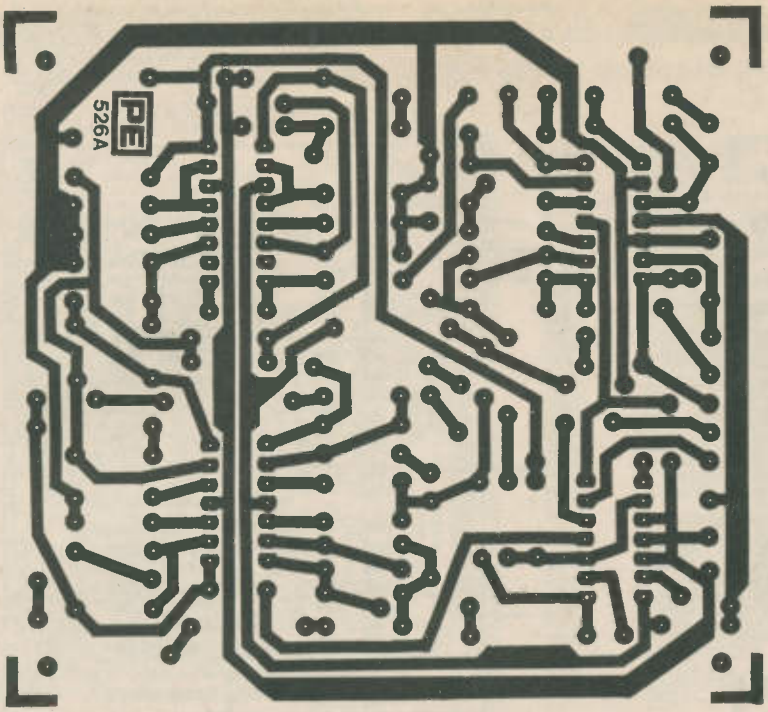


Fig. 4. Main board p.c.b. layout (actual size)

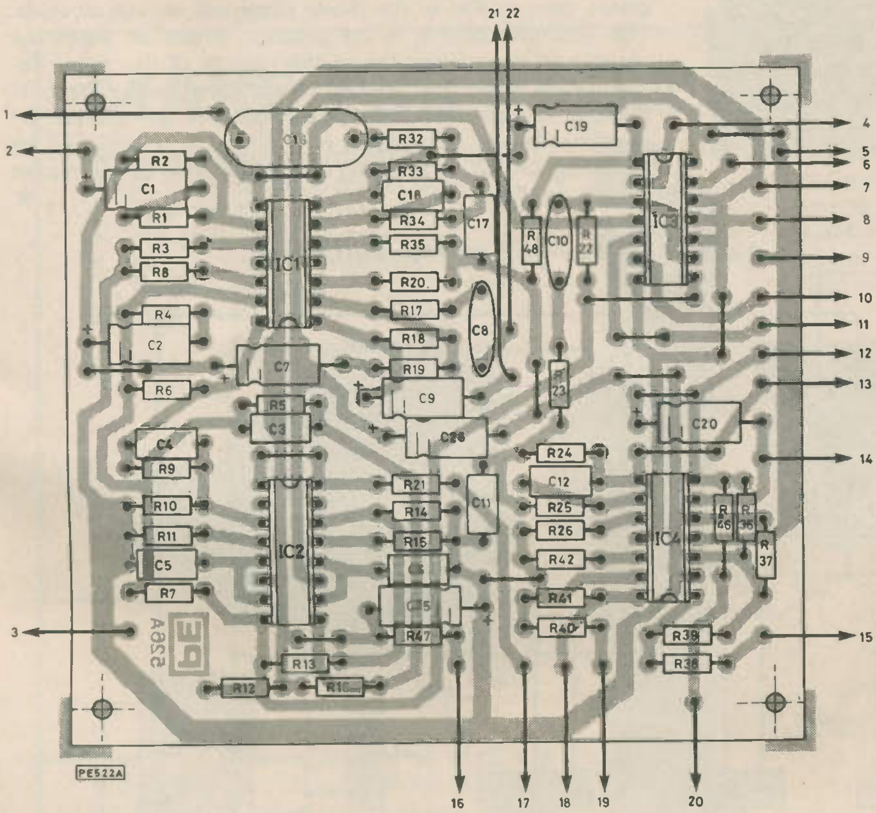


Fig. 5. Main board component layout

check that the signal passes through at a normal level. Switch on S2, bring up VR3 fully and a change in signal level and quality should be apparent as the delayed and original signals are mixed without modulation. Vary VR6 and the phase shifting effect should be heard. Adjust VR1 around its midway point until minimum distortion is apparent on higher volume signals. Remove music source, return VR6 to min (slowest clock), increase amplifier volume until background hiss from the delay stage is heard, then adjust VR2 around its midway point until this minimises, at which point the twin outputs of IC8 are balanced. If no significant change is observed with the variation of VR1 and VR2, leave them midway and ignore. If an oscilloscope is used the balance points will be obvious. Return amplifier to normal volume, reapply music, maximise VR6, bring up VR4 and VR5 to about three-quarters and automatic phasing at a moderate rate should be evident. Adjusting VR6 will change the quality, VR4 the rate, and VR5 the depth. Taking VR4 and VR5 beyond the three-quarters position will introduce extreme results best reserved for producing unusual effects. Turn down VR5 so removing the automatic phasing. Switch the v.c.f. into circuit with S1 and by bringing up VR7 the filter shifting effect will come in. This affects the higher frequencies first, and as VR7 is progressively increased lower frequencies will be modified. Adjusting VR4 will vary the rate of shifting. Switching on S1 will now introduce phase shifting as well as filter shifting.

USE

For the best signal to noise characteristics the input level should preferably be close to, but not greater than, 2·5V r.m.s. The final output of course must not exceed the amplifier requirements. The inherent noise output of the TDA 1022 is typically 0·2mV r.m.s. at a clock frequency of 100kHz. The quality of the phasing effect can be introduced for most music inputs, though it will be most apparent with those having higher harmonic contents or harsher waveforms in the mid to upper octave ranges. The filter shifting effect will be apparent with practically any input music signal and will give further emphasis to the phasing effect when the filter characteristics are set for a low to mid frequency pass range. For normal use three-quarters settings of VR4–7 will usually be best, with VR3 from three-quarters upwards. With the latter much less than about half, the

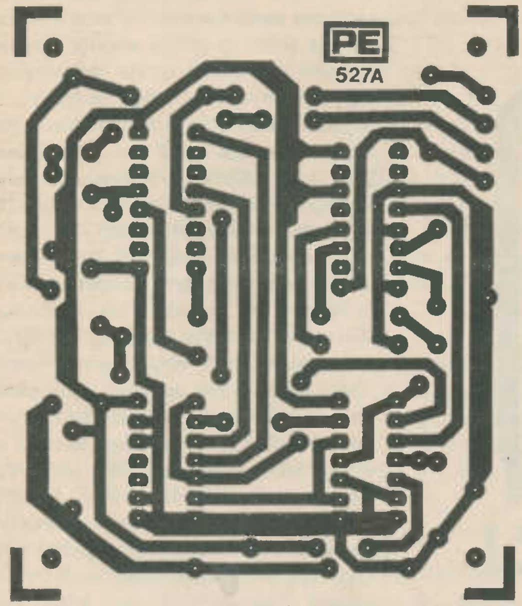


Fig. 6. Delay board p.c.b. (actual size)

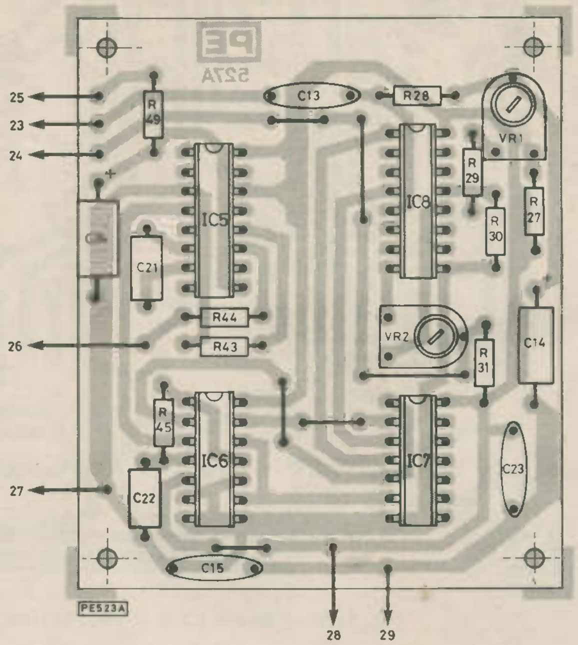
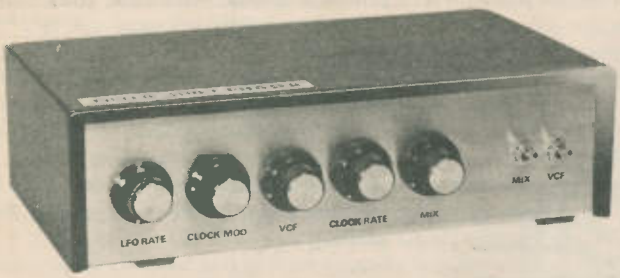
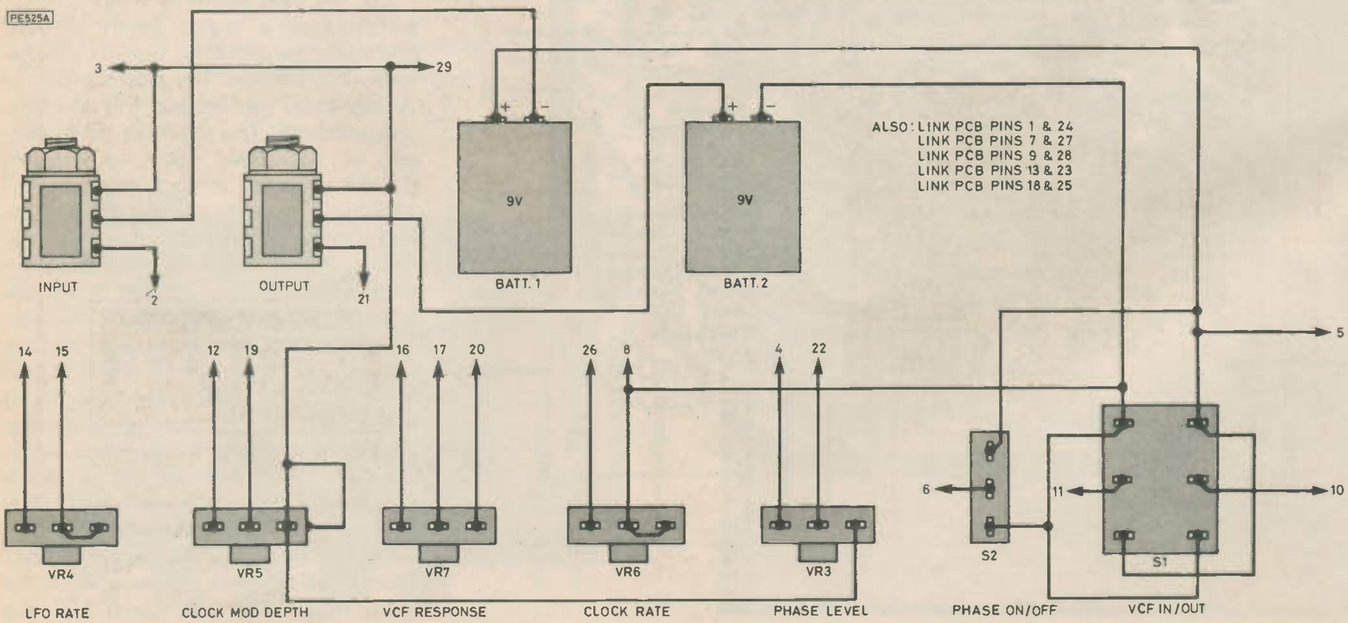


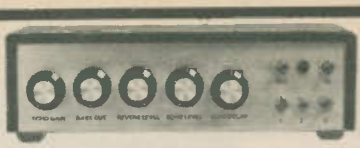
Fig. 7. Delay board component layout



phase cancellation at the mixer stage will be less obvious. The optimum setting is the position where an antiphase signal can completely cancel the original of the same frequency at some point during the shifting cycle. The best position can be determined experimentally and marked on the front panel. By-passing of the effects is achieved by switching off S2, so allowing only the original signal to pass to the amplifier. ★

Fig. 8. Wiring diagram of the Filter Shift Phaser





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P.E. FILTER-SHIFT PHASER (OCT84). Enhanced Phasing with modulated filter shifting. Kit as published – BLK box: SET 226 £39.13

PANEL CONTROLLED SUPERKITS	CODE	STD BOX	BLK BOX
BASS BOOST: Increases volume of lower octaves	SET 138B	£8.46	£11.46
BLOW BOX: Voice operated VCF & VCA for fascinating effects	SET 214	£24.33	£28.33
CHORUS UNIT: A solo voice or instrument sounds like more!	SET 162	£31.40	£34.90
COMPRESSOR: Limits & levels maximum signal strength	SET 133	£10.86	£13.86
DIGITAL TO ANALOGUE: 8-bit binary to Lin & Log voltage	SET 176	£23.96	£26.96
ENVELOPE SHAPER: Note triggered ADSR unit with VCA	SET 174	£17.15	£20.65
EQUALISER: Variable combinations of Low, Mid, Top & Notch	SET 217	£22.33	£25.83
EQUALISER: 10 Channels fully variable	SET 134	£37.83	£41.83
FADER: Voice operated with 5 response controls	SET 167	£14.21	£17.21
FILTER: For voice bandwidth enhancement over background	SET 142	£9.23	£12.23
FLANGER: Fascinating music effects, plus phasing	SET 153	£22.74	£26.24
FREQUENCY CHANGER: Tunable note & waveform modifier	SET 172	£34.46	£37.96
FREQUENCY DOUBLER: Guitar octave raiser & tone changer	SET 98	£9.80	£12.80
FREQUENCY GENERATOR: Multiwaveform, 0.4Hz-470KHz	SET 128	£19.04	£22.54
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FUZZ: Smooth distortion, retains attack & decay	SET 91	£10.57	£13.57
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GUITAR SUSTAIN: Extends note decay time, with noise gate	SET 222	£22.81	£25.31
GUITAR TO SYNTH INTERFACE: With voltage & trig outputs	SET 173	£32.87	£36.37
HANO CLAPPER: Auto & manual variable clap effects	SET 197	£22.69	£25.69
HEADPHONE AMP: 2 watts into phones or speaker, variable	SET 156M	£12.03	£15.53
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METRONOME: With audio output & visual beat & downbeat	SET 143	£13.81	£16.81
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RHYTHM GENERATOR: Computer driven, 9 drum effects	SET 185	£30.64	£34.64
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SYNTHESISER: 2-oct push sw, variable ES, Freq, Shape, Span	SET 182	£39.76	—
TOM-TOM SYNTH: Sound triggered, multivariable	SET 190	£15.05	£18.05
TONE CONTROL: Bass, mid, treble, gain & cut	SET 139	£13.17	£16.67
TREBLE BOOST: Increases volume of upper octaves	SET 138T	£8.13	£11.13
TREMOLO: Mono variable rate & depth modulation	SET 136	£9.71	£12.71
TUNING FORK: 96 note audio/visual tuning aid	SET 46L	£29.38	£32.88
VOLTAGE CONTROLLED FILTER: 12dB, variable modes	SET 178	£17.02	£20.52
VIBRATO: Variable rate & depth of freq shift	SET 137	£23.94	£27.44
VOCOOAVOX: Modular vocoder, 7 chans, extendable	SET 152	£64.31	£68.31
VOOALEK: Robot type voice modulator	SET 155	£12.44	£15.44
VOICE OP SWITCH: Variable sensitivity & delay	SET 123L	£13.41	£16.41
WAH-WAH: Auto, manual & note triggered	SET 140	£17.26	£20.76
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LINKAFEX OISTORTIDN: Variable level & tone, v. smooth	SET 209	£23.24
LINKAFEX EQUALISER: Low, mid, top, notch, width, 12dB	SET 216	£25.43
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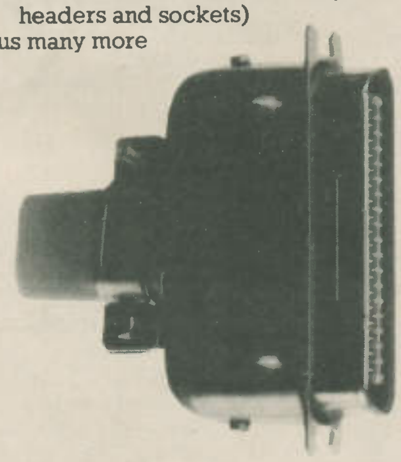

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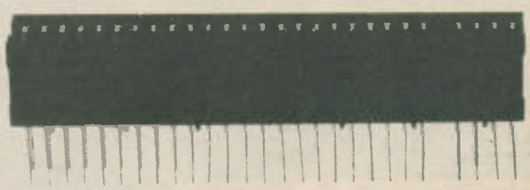

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Sequential Logic Techniques Part 1

M.TOOLEY BA and D.WHITFIELD MA MSc C Eng MIEE

THIS six-part series follows on from our previous series entitled "Introduction to Digital Electronics" and aims to both extend the concepts developed in that series and introduce some new material. The accompanying practical exercises have all been designed around the PE Logic Tutor. *(See PE Oct '83 for constructional details or the constructor's note at the end of this article.)*

We start, this month, with a further look at digital counters and consider both programmable and decade types.

PROGRAMMABLE COUNTERS

The binary counters which we have previously met have all been based on simple arrangements of bistable stages. Readers will not need reminding that each bistable stage functions as a modulo-2 counter and that, where we need to increase the counting capacity (say to 8 or 16) we only need to cascade several stages together. A three-stage counter will, for example, have 2^3 (=8) output states whereas a four-stage counter will have 2^4 (=16) output states, and so on.

For some applications it is desirable to have counters which can operate to a different number base. A modulo-10 counter would, for example, be very useful in a packing plant where items are to be packed in tens.

In other applications we may require a counter that can be programmed to count up or down. In yet other applications we may require a counter that can be pre-loaded with data rather than always starting its counting sequence at zero.

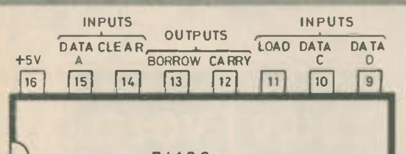


Fig. 1.1. Pin connections for the 74193

74193 PROGRAMMABLE COUNTER

We shall now consider a practical example of a programmable binary counter using the 74193. This reversible binary counter incorporates the equivalent of no less than 55 individual logic gates contained in a single 16-pin d.i.l. package, the pin connections of which are shown in Fig. 1.1.

The internal logic arrangement of the 74193 is shown in Fig. 1.2. As can be seen, the device contains four bistable stages together with some sophisticated gating. Synchronous operation is provided by having all of the bistable stages clocked simultaneously so that the outputs change coincidentally with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous ripple counters.

The four master-slave bistables of the 74193 are triggered by a low-to-high level transition present on either of the two clock inputs. The direction of counting (up or down) is determined by which clock input is pulsed low whilst the other input remains high.

All four binary dividers are fully programmable and their outputs can be preset to either logical state by entering the desired data at the data inputs during the period in which the load input is low. The output will then change to agree with the data inputs independently of the clock. This feature allows the 74193 to be used as a modulo-N divider by simply modifying the count length using the preset inputs.

A clear input is provided which forces all outputs to the low level. This input is independent of the count and load inputs. The clear, count, and load inputs are all buffered to reduce the drive requirements. This is an important consideration in practical applications where several programmable counters are to be driven from common clock and control lines.

The 74193 was designed to be cascaded without the need for external circuitry hence carry and borrow outputs are provided in order to extend the up- and down-counting functions respectively. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-down input when an overflow condition exists. The counters can then easily be cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding stage.

A typical timing diagram for the 74193 is shown in Fig. 1.3. This diagram shows how the outputs are first cleared, then pre-set to an output state of 7 (0111) by means of a low applied to the load input. Five positive edge transitions are then applied to the upward clock and the 74193 counts through the states: 8, 9, 0, 1 and 2. At this point the upward clock goes high and five positive edge clock transitions are applied to the downward clock input. The output states then follow the progression: 1, 0, 9, 8 and 7. It should be noted that, once the desired data input has been loaded, the data outputs are unaffected by the state of the data input lines until the load input next goes low.

UP/DOWN COUNTER USING THE 74193

As a practical example of the use of the 74193, we shall consider a single stage counter in which the count can proceed in either direction as determined by a single up/down direction control input. The counter is also provided with a clear input which restores the count to zero.

The circuit of the 74193 up/down counter is shown in Fig. 1.4. The clock input is steered to the desired clock input by means of a simple gating arrangement configured around a 7400 quad two-input NAND gate. The clock input signal is derived from the Logic Tutor's own clock oscillator whereas the four-bit binary output is displayed on the four logic level indicators. In this particular example, use is not made of the ability to preload data and hence the active-low load input is taken to logic 1.

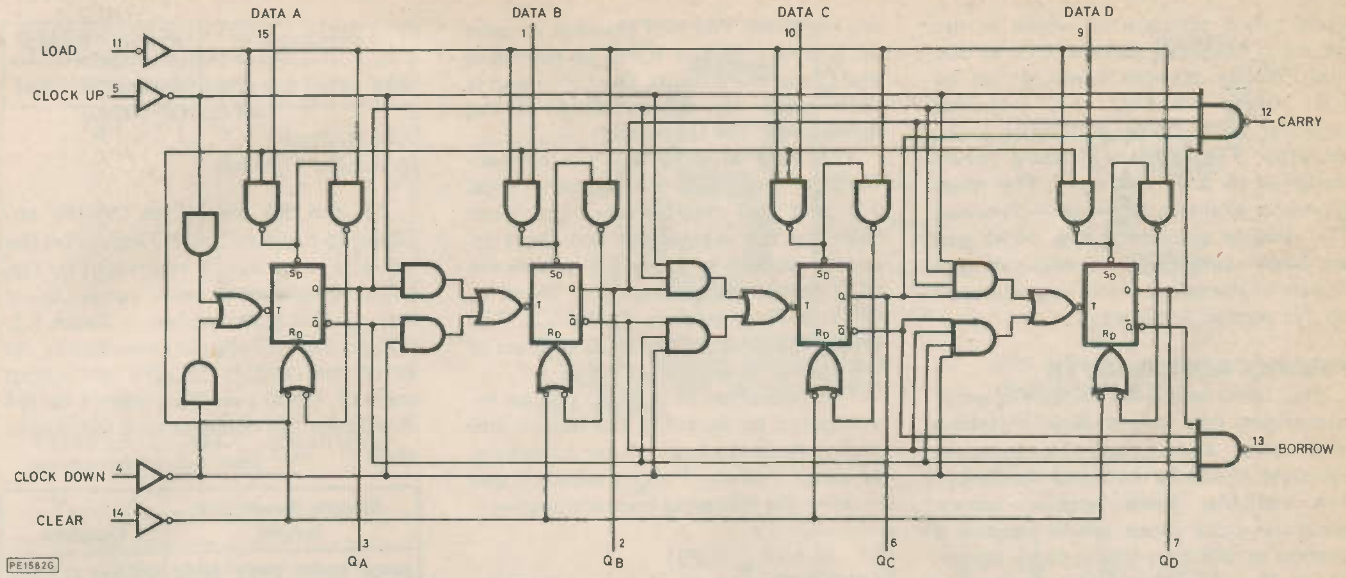
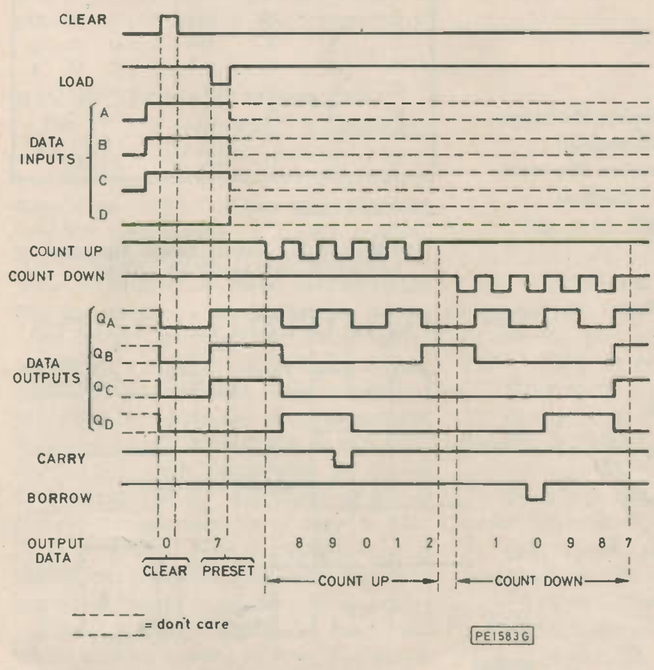


Fig. 1.2. Internal logic of the 74193



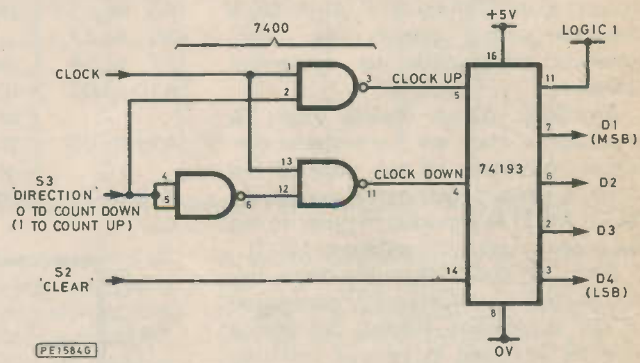


Fig. 1.3 (left). Typical timing diagram for the 74193

Fig. 1.4 (above). Up/down counter using a 74193

The 74193 and 7400 devices should be inserted into sockets C and F respectively. As usual, care should be taken to ensure the correct orientation with pin-1 of each device aligned with pin-1 of the relevant socket. The following links should be made on the Logic Tutor:—

C2	to D3	(D3 indicates QB)
C3	to D4	(D4 indicates QA)
C4	to F13	(clock down)
C5	to F3	(clock up)
C6	to D2	(D2 indicates QC)
C7	to D1	(D1 indicates QD)
C8	to 0V	(common)
C11	to logic 1	(active-low load input)
C14	to S2	(S2 clears the counter)
C16	to +5V	(supply)
F1	to clock	
F2	to S3	(direction control)
F4	to F5	
F5	to F2	
F6	to F14	
F7	to 0V	(common)
F15	to F1	
F16	to +5V	(supply)

With S3 set to give a logic 1 (count up), depress S2 to reset the counter (D1 to D4 will all become immediately extinguished indicating a count of '0000'). After releasing S2, a normal 4-bit binary count will be produced with D1 indicating the most significant bit (MSB) and D4 the least significant bit (LSB). Readers should confirm that all changes of state take place on the falling edge of the clock input.

On the second counting sequence, allow the count to proceed to, say, '1000' and then depress S3 to generate a logic 0 on the direction input. On the next falling clock pulse, the count should be decremented (to '0111') and should then continue to count down. It should also be noted that, at any time, the output can be cleared by means of S2.

DECADE COUNTERS

Counters which have ten states in their counting sequence are particularly useful in a number of applications, most obvious of which is the counting of digital pulses prior to display. Whilst decade counters can be built using standard J-K bistables together with some additional logic, several TTL devices have been designed to fulfil this need. The most common example of an asynchronous TTL decade counter is the 7490 and we shall continue by investigating a variety of decade counter stages based on this particular device.

7490 DECADE COUNTER

The 7490 is a 4-bit decade counter comprising four master-slave bistables internally connected to provide separate divide-by-two and divide-by-five sections. Each section has a separate clock input which causes a change of state on falling clock transitions. Due to internal ripple delays, state changes of the Q outputs do not occur simultaneously and thus decoded output signals are unfortunately susceptible to unwanted spikes.

An AND gated master reset is provided to clear all the bistable elements regardless of the state of the clock. A similar AND gated master set (MS1, MS2) is provided in order to set the output state to nine (binary 1001).

Since the output from the divide-by-two section is not internally connected to the succeeding stages, the device may be operated in various counting modes. In a BCD (8421) counter, the $\overline{\text{CP1}}$ input must be externally connected to the Q0 output. The $\overline{\text{CP0}}$ input receives the incoming count producing a BCD count sequence. In a symmetrical bi-quinary divide-by-ten counter, the Q3 output must be connected externally to the $\overline{\text{CP0}}$ input. The input count is then applied to the $\overline{\text{CP1}}$ input and a divide-by-ten square wave is obtained at output Q0. To operate as a divide-by-two and a divide-by-five counter, no external interconnections are required. The first bistable is used as a binary divider ($\overline{\text{CP0}}$ as the input and Q0 as the output). The $\overline{\text{CP1}}$ input is then used to obtain divide-by-five operation at the Q3 output.

The internal logic and pin connections for the 7490 are shown in Figs. 1.5 and 1.6 respectively. The truth table for the master set and reset inputs is shown in Table 1.1 whilst the BCD counting sequence (Q0 linked to $\overline{\text{CP1}}$) is illustrated in Table 1.2. The timing diagram for the BCD outputs of the counter is illustrated in Fig. 1.7.

The operation of a 7490 can be investigated by inserting the device into socket A of the Logic Tutor (checking, as usual, that pin-1 aligns with A1) and making the following connections:—

A1	to A14	(CP1)
A2	to A3	
A3	to S3	(reset)
A5	to +5V	(supply)
A6	to A7	
A7	to S4	(set)
A10	to D2	(D2 indicates the state of the Q2 output)
A11	to D3	(D3 indicates the state of the Q1 output)
A12	to 0V	(common)
A13	to D1	(D1 indicates the state of the Q3 output)
A14	to D4	(D4 indicates the state of the Q0 output)
A16	to clock	

(A total of 12 links)

S4 and S3 should be initially adjusted to produce logic 0 inputs on the set and reset inputs respectively. The count should now cycle continuously through the states shown in Table 1.2. A logic 1 on S3 should immediately set all of the outputs to zero (an output state of '0000') whilst a logic 1 on S4 should set the count to nine (an output state of '1001').

Master Reset/Set Inputs				Outputs			
MR1	MR2	MS1	MS2	Q3	Q2	Q1	Q0
1	1	0	X	0	0	0	0
1	1	X	0	0	0	0	0
X	X	1	1	1	0	0	1
0	X	0	1	count			
X	0	X	0	count			
0	X	X	0	count			
X	0	0	X	count			

(X=don't care)

Table 1.1. Truth table for the set and reset inputs of a 7490

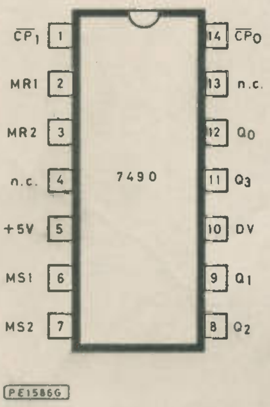


Fig. 1.6. Pin connections for the 7490

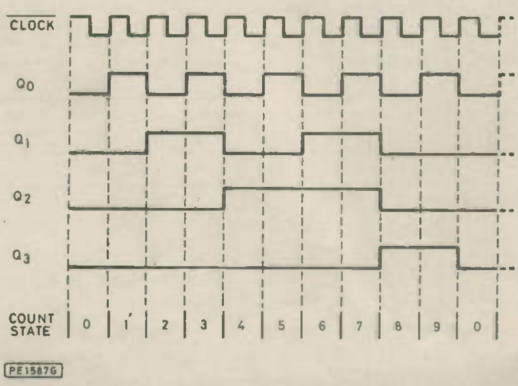


Fig. 1.7. Timing diagram for the BCD outputs of a 7490

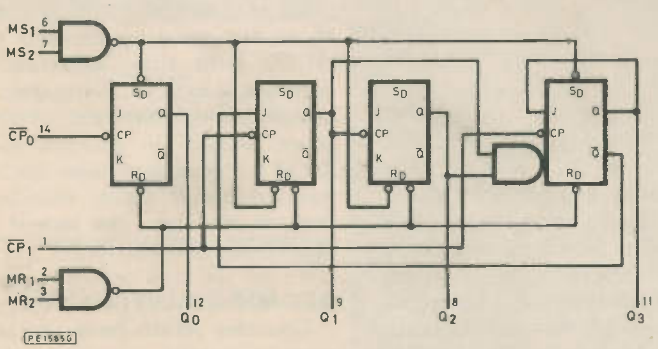


Fig. 1.5. Internal logic of the 7490

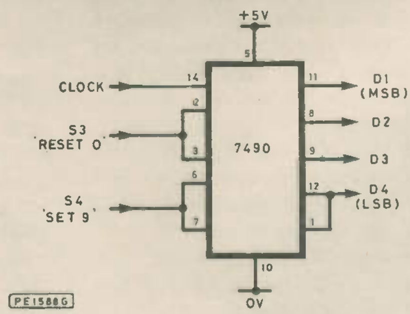


Fig. 1.8. Simple BCD counter using a 7490

COUNT STATE	OUTPUTS			
(I/P clock pulse)	Q3	Q2	Q1	Q0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

(Q0 connected to $\overline{CP1}$)

Table 1.2. BCD counting sequence for the 7490

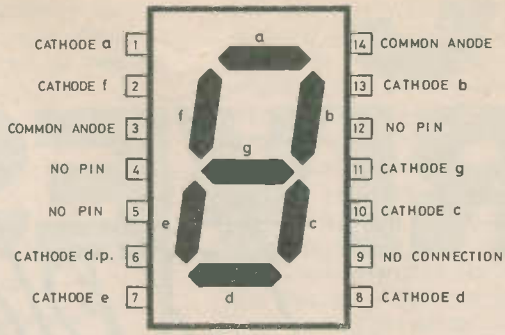


Fig. 1.9. Normal format for a common anode seven-segment l.e.d. display

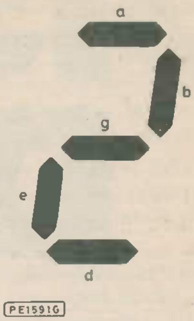


Fig. 1.11. Typical seven-segment display output

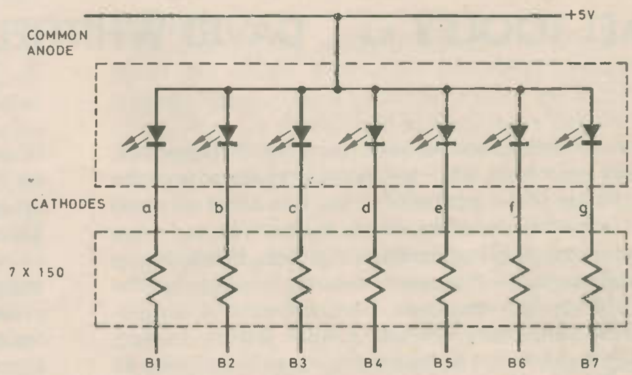


Fig. 1.10. Typical arrangement for driving a seven-segment l.e.d. display

An obvious disadvantage of this simple decade counter is that the output stage is displayed in binary form, hence we shall now turn our attention to producing a display in conventional denary form.

SEVEN SEGMENT DISPLAYS

The normal format and pin connections for a common anode seven-segment display is shown in Fig. 1.9. It should be noted that the segments are labelled a to g and that, with a common anode display, it is necessary for these inputs to be taken low in order that the display is illuminated.

In order to illuminate a particular segment, a current of typically 20mA needs to be supplied. This is usually achieved by taking the common anode to the +5V rail, whilst the seven segments are each connected in series with a resistor of 150 ohms or so. A typical arrangement is shown in Fig. 1.10. A logic 1 (high) applied to any particular segment line will not forward bias the l.e.d. concerned into conduction. A logic 0 (low), on the other hand, causes current to flow, the value of current being dependent on the forward characteristic of the l.e.d. and the value of series connected resistance.

Before proceeding further, readers may like to confirm that the seven-segment display is functional by 'hard-wiring' it to produce various patterns. The display used MUST be of the common anode variety (common cathode displays are also available) and should be inserted into the d.i.l. socket marked C on the Logic Tutor. The device should be oriented so that pin-1 aligns with C1 and segment a is uppermost. (Note that pins C8 and C9 are unused).

Rather than use seven individual series connected resistors, a 14-pin d.i.l. 150 ohm resistor network may be employed to limit the segment currents. This should be inserted into d.i.l. socket B, again ensuring that pin-1 aligns with B1. Where readers have difficulty in obtaining such a network, seven 0·25W 150 ohm resistors may be connected from B1 to B16, B2 to B15, B3 to B14, and so on, ending with B7 to B10.

The following links should be made on the Logic Tutor:—

B16 to C1	(cathode a)
B15 to C15	(cathode b)
B14 to C12	(cathode c)
B13 to C10	(cathode d)
B12 to C7	(cathode e)
B11 to C2	(cathode f)
B10 to C13	(cathode g)
C16 to +5V	(common anode)
C3 to +5V	

(A total of 9 links)

The arrangement now conforms to the circuit shown in Fig. 1.10 in which each segment has its own 150 ohm series resistor terminated at B1 to B7 for segments a to g respectively. Now connect a link from 0V to B1 and check that segment a becomes illuminated, then repeat for each of the other segments in turn.

Having checked that each individual segment of the display is operational, it is worth demonstrating that we can use the 'hard-wiring' technique to provide any particular indication that we may require. If, for example, a '2' is required, we should arrange for segments a, b, d, e, and g to be illuminated. This is achieved by linking B1, B2, B4, B5 and B7 to 0V. The resulting display should be similar to that shown in Fig. 1.11.

Hard-wiring of displays is fine if the indication is never to be changed. In most practical applications this is not, of course, the case. Usually the display is used to indicate the state of a count and we thus need some arrangement which can accept a binary coded decimal (BCD) input and provide the required decoding logic to illuminate the appropriate l.e.d. segments. Fortunately, several TTl devices are available which are designed to fulfil this particular need.

Constructor's Note

Logic Tutor Board p.c.b's, components and constructional details are available from Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT13 9SU (0932 42376).

NEXT MONTH: Decade counters.

DISC DRIVES *Explained!*

MICHAEL TOOLEY BA **DAVID WHITFIELD** MA MSc CEng MIEE **PART 2**

LAST month we looked at the basic features of floppy disc drives. This month we continue by looking at some of the options which are often available to buyers. Most of these are not so much a feature of the drives themselves, but more of the way in which they are packaged for sale. If this seems a rather mundane point, it is worth bearing in mind that the difference in price between two 'bare' drives and a twin-drive package can easily exceed £100! Before buying, therefore, it is a good idea to be sure that you are getting all that you need, but not paying for what you neither want nor need.

The 5·25" floppy disc drive packages available today usually (but not always) contain drive units of Japanese origin. High reliability and excellent value for money result from high volume production since this allows the very latest in floppy disc and manufacturing technology to be applied. Indeed, the floppy disc drive market is now so competitive that this must be done in order for the manufacturers to remain in business. Typical drive units currently on the market come from TEC, TEAC, Mitsubishi, Hitachi, Tandon, Canon and Shugart, to name but a few of the more popular makes.

When we are looking for a floppy disc unit to connect to our computer system, we usually want a little more than just the bare drives. We will begin, therefore, by looking at the additional features which may be appropriate for us to consider.

POWER SUPPLIES

Floppy disc drives are invariably designed to be operated from an external power supply, rather than directly from the mains. Modern drives typically require d.c. power at +5 volts and at +12 volts. The +12 volt supply is normally used to drive the rotational motor, the stepping motor and part of the read/write circuitry. The +5 volt supply, on the other hand, powers the remainder of the read/write circuitry and the logic circuits. Power requirements are now fairly modest; the M4853 half-height Mitsubishi drive, for example, requires 0·5 to 0·7 amps at +5 volts, and 0·5 to 1·0 amps at +12 volts. Supply current requirements, however, continue to fall with the use of more advanced technology. The latest TEAC FD-55 drives, for example, require only 4·9W when operating, and only 1·6W in standby mode.

Some computers have power supplies which are capable of powering one or two floppy disc drives. The BBC Micro, for example, is capable of supplying external equipment with up to 1·25 amps at +5 volts and 1·25 amps at +12 volts. Thus, we can often use the internal power supply when using discs with the BBC Micro. However, even where the computer is able to supply power for the disc drives, a separate supply is often still preferred. This is because a separate supply keeps the load on the computer's power supply to a minimum, allowing it to run cooler and leaving the spare supply capacity free for other uses. Another advantage of a separate power supply is that it gives the system the greatest flexibility, since the disc unit is then self-contained. Many computers, however, do not offer the option of using the internal power supply, and then we are left to provide an external power supply. The additional cost of a disc power supply will usually be around £30–£40.

Although it is possible to build your own disc drive power supply, it is usually much easier to buy one which has been specially designed for disc drive applications. Power supply units of this type now commonly employ switched-mode designs. These are compact, efficient and light-weight, are usually installed in the case of the disc drive(s), and are almost always capable of powering two 5·25" drives. A point to check in a packaged unit is that the supply is fully wired, complete with a mains switch, fuse and 3-core lead.

If you are putting together your own disc drive package, however, it will be necessary to obtain a suitable power supply. This should preferably be a fully-shrouded unit, but an open-chassis supply may be used provided that all points at mains potential are safely protected to avoid electric shock risk. In addition to the power supply, a two-pole mains switch, warning neon and mains fuse will also be required. The mains lead should be 3-core, and secured to the case with a cable clamp (not knotted!), and protected with a grommet. You will also need to provide d.c. power leads between the power supply and the drive(s). These leads should be suitably rated for the expected maximum supply current, and it will be necessary to obtain the appropriate power connectors to suit the drive(s) being used. Typically the power connector is a 4-pin type, but unfortunately there is little or no standardisation at present. Fig. 1 shows a typical power connector as found on Mitsubishi M4852 and M4853 drives. In addition to the power leads, a further lead is required to securely bond the chassis of each drive to a common mains earth terminal; a suitable bonding point is usually provided on the drive's chassis for this purpose. Where a metal case is being used, this should also be bonded securely to the common earth terminal.

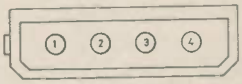


Fig. 1. Mitsubishi disc drive power connector

CASES

As we have mentioned, the disc drives produced by the drive manufacturers are bare drives and nothing more. They are produced with a front panel which is usually styled and suitable for mounting in an equipment cabinet or in a case of their own. The basic drive, however, is usually of an open chassis construction, with the electrical connections (disc interface bus and power) at the rear. To prevent the intrusion of foreign bodies (biscuit crumbs, dust, electronic components, children's fingers, etc.) into the delicate workings of the drive mechanics, therefore, a case becomes an essential addition. Any power supply can then also be mounted safely out of harm's way inside the same case.

With the market now increasingly dominated by half-height drives, we usually consider twin-drive arrangements when thinking of cases. This is usually true even if funds dictate that our initial purchase is of one rather than two drives. Adding a second drive to a case bought with this upgrade in mind will usually be neater, easier and cheaper in the long term. Thus we can start with a twin case which is fitted with a single drive (and possibly a power supply), and upgrade to a second drive at a later date.

There is usually a choice of mechanical arrangements for two half-height drives; side-by-side or vertically stacked, as shown in Fig. 2. One arrangement may be more convenient than the other, but either way, the drives themselves are usually mounted horizontally. The side-by-side arrangement can be very convenient if bench space is at a premium; the computer may be situated below a 'perch' which supports the drives, with the monitor/TV on top of the disc unit. This can have the added advantage of raising the monitor/TV to a more comfortable height. Alternatively, the computer may rest on the drives, with the monitor/TV above.

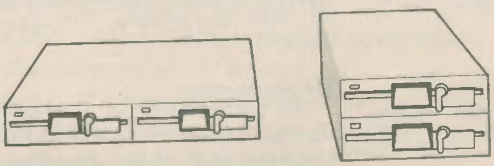


Fig. 2. Twin drive configurations

If making your own case, it is important to make sure that adequate ventilation is provided. The amount necessary will depend on the efficiency of the power supply (usually quite high with switched-mode designs, and hence there is little waste heat generated), and the power consumed by the disc drives themselves. Ventilation slots should be carefully positioned to minimise the possibility of unwanted objects falling into them, and they should be small enough to keep out even the smallest of probing fingers. One approach to the problem is to provide slots on the base of the case, with exit slots on the sides near the top of the case. Provided that the case is then mounted on suitable feet, this arrangement is usually more than adequate. With the very low power drives, it may be possible to dispense with ventilation slots altogether, provided that a metal case is used; waste heat is then removed by conduction. Any case should provide substantial and secure mountings for the drives and power supply. On vertically stacked units, it is usually necessary to provide a heavy gauge spacer bracket to separate the two drives to allow free air circulation.

In conclusion, the disc unit's case should be considered as the first line of defence against the attentions of dirt and the hardships of the computer workplace. It may also affect how easy the drives are to use, and consequently careful consideration should be given to the design of the disc case.

CABLES

Connecting the newly acquired disc drives to the computer can be an unexpectedly expensive and/or confusing business. If we buy a package tailored for a particular computer, then all this should already have been sorted out by the supplier, but watch out for an additional charge for the cables. Typically a twin-disc cable may cost around £10 to £15, mostly as a result of the cost of the connectors. As for the complete cables themselves, there is often quite some confusion regarding how they should be connected.

The signals on the standard disc interface bus were shown in Table 2 last month. Each of these signals is driven either from the drive to the computer, or from the computer to the drive. The disc interface bus uses open-collector gates for driving these signals, and the general arrangement for each signal is as shown in Fig. 3. The open-collector signals must each be terminated by a resistor at the receiving end (as shown in Fig. 3). If this is not done, the signal on the line swings only a few mV when changing state between logic 0 and logic 1. The bus should, however, only be terminated at one of the drives; the disc manual should indicate how to select whether a particular drive terminates the bus or not.

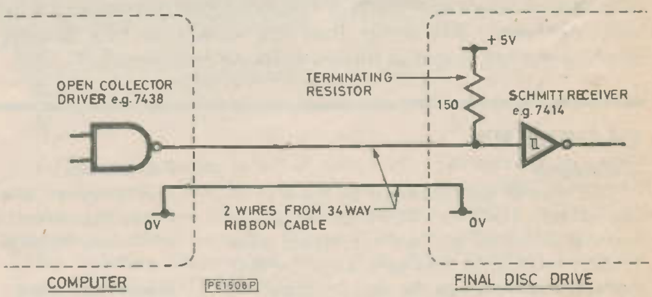


Fig. 3. Disc interface signal driving

Each signal in the bus goes to all of the drives connected to the bus, using the so-called 'daisy-chain' arrangement, as shown in Fig. 4. The normal arrangement is to use a flat 34-way ribbon cable, with the appropriate number of drive connectors (usually of the insulation displacement type) fitted at suitable intervals along the cable. The connectors then fit onto the data connectors at the rear of each drive. As already mentioned, the bus should only be terminated once, and this should be done at the drive which is furthest away from the computer, i.e. last on the lead. If buying only a single drive initially, it is worth buying a twin-drive cable, since this will be required eventually and will work just as well with only one drive connected, provided this uses the last connector on the cable.

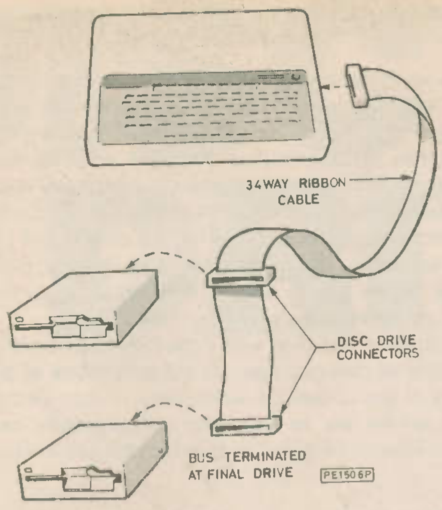


Fig. 4. Daisy-chain disc cable arrangement

At any given instant, only the drive identified by the drive select signals (pins 6/10/12/14) takes any notice of the signals on the bus. The drives must thus each be able to identify themselves. This is normally achieved by setting up links in each drive; a procedure which should be fully described in the drive manual. Needless to say, we can expect that setting two drives to the same identity will cause all manner of problems! Drives are typically numbered starting from zero, and a twin drive unit will thus usually have its two drives set up as 0 and 1. The numbering of the drives does not need to bear any relationship to their physical order of connection on the cable, and can be done purely for our own convenience. It is a good idea, however, to label the drives after set-up, otherwise confusion may well result!

OTHER EXTRAS

There are a few remaining points which mustn't be overlooked when completing the shopping list for the disc unit 'package'. Assuming that the computer has already been upgraded, some of the other items needed are:

Blank discs
Manual
Formatter

When buying blank discs, it is well worth buying only good quality types. There is nothing worse than losing valuable software due to unreliable discs; learning the lesson of false economy the hard way is no fun! Do not be tempted to use single-sided discs for double-sided applications; although they will usually work satisfactorily, the second side (the top) is not guaranteed to be reliable. A good start is to buy a box of ten double-sided double-density 80-track discs; this will encourage the keeping of backup copies, initially at least, and the discs will be suitable for all future applications. In addition to the discs themselves, it is also a good idea to invest in a suitable disc storage case to protect the discs when not in use.

A manual is essential for getting the maximum benefit out of your floppy disc drives. In addition, it will usually be necessary to refer to the DFS software documentation when setting up for the first time. It is always worth checking that adequate documentation is provided with the drive unit before taking delivery. There is nothing worse than having to make a second trip to collect the missing data, particularly if there is an additional charge involved.

The final item on the list is actually a piece of software; the formatting program. This is often supplied on a disc, itself already formatted, and it must be suitable for your particular computer system. In many cases, the formatter is supplied with the DFS software, but this is not always the case.

FINALLY

So, the great day has finally arrived and the floppy disc drives have come to the top of the shopping list. The discussion above and last month's article should allow you to put together a list of points to consider when choosing a drive unit for your system. It is often easier to buy a complete package, but you may prefer to build up your own, at least in part. In either case, make sure you know what you need, and then shop around for the best value. The buyer's guide should help you by providing a selection from the currently available models. The glossary summarises the meaning of some of the terms involved. Next month we shall be reviewing some of the drives mentioned in the buyer's guide.

GLOSSARY

Catalogue
The area of the disc used by the disc filing system (DFS or DOS) to record the names, locations and various status information relating to files stored on the disc. Sometimes known as the disc directory.

Disc interface
The hardware in the computer which provides the interface between the computer's CPU and the disc drives themselves.

Double density
A method of recording data which uses a higher data rate and the MFM recording technique to double the disc's data storage capacity when compared to single density recording.

FDC
The Floppy Disc Controller Chip (FDC) is the LSI integrated circuit which is usually at the heart of the disc interface in the computer. The FDC provides most of the detailed control functions in the interface.

Formatter
A program used to lay down the basic track, sector and catalogue structure on a previously blank disc.

Head load time
The time taken for the read/write head(s) to be brought into contact and settle on the disc surface. Typically around 50msec.

Motor start time
The time taken for the rotational motor to run up to full speed (300 r.p.m.) after commanded to do so by the computer. Typically around 250msec.

Sector
The basic unit of data which is read from or written to a floppy disc is a sector. All data transfers to/from a disc involve one or more complete sectors. A sector, sometimes known as a block, is usually 256 bytes.

Settling time
The time which must be allowed after a read/write head movement before data may be read or written. Typically around 15msec.

Single density
The basic method of recording data on the disc surface using FM encoding. This usually provides 2560 bytes on each track.

Step time
The time taken for the read/write head(s) to move from the current track position to an adjacent track position. Typically a figure in the range 3 to 25msec. Also known as the track-to-track seek time.

Track
A circular magnetic track laid down on the recording surface of a floppy disc, and used for the storage of data. Typically there are 40 or 80 tracks on one side of a disc.

DISC DRIVES BUYER'S GUIDE

The Teac FD55F from Viglen is one of five models in the FD55 series. They are all 5·25in., half-height drives with capacities which vary from 125K to 1·6Mbytes. The 55F is a 40/80 track switchable, double-sided, single drive unit with a 400K capacity and is priced at £225. **Viglen Computer Supplies,** Unit 7, Trumpers Way, London W7 2QA. (01-843 9903)

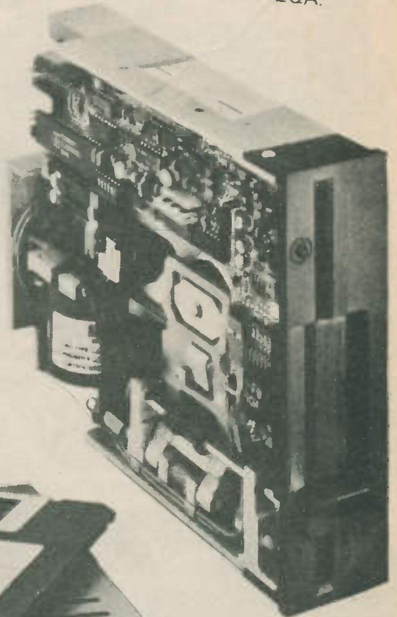
THIS Buyer's Guide has been designed to show the wide range of disc drive units currently available. The important points to look for when considering which particular drive to purchase are difficult to list in order of importance because they will depend greatly upon your own personal requirements, i.e. in certain cases the physical size may be more important than the actual weight or an integral p.s.u. may be more important than whether the drive is 40 or 80 track.

However, no matter what your own personal requirements are, all the following points should be borne in mind when considering any disc drive to ensure you understand exactly what you are buying:

1) ***The size of the discs to be used in the drive, i.e. 8in., 5·25in., 3·5in. or 3in.***
2) ***Whether the drive is a single or dual unit.***
3) ***If the drives are dual, are they mounted side by side or one above the other?***
4) ***Is a p.s.u. included or housed separately?***
5) ***Can your computer's p.s.u. support the drives if a p.s.u. is not supplied?***
6) ***Is the drive unit cased or not?***
7) ***Is the drive half or full height?***
8) ***Is a manual supplied with the drive?***
9) ***Are the cables and formatter disc supplied and are they compatible with your computer?***
10) ***Is the drive 40 or 80 track?***
11) ***What is the capacity of the drive?***
12) ***What is the physical size and weight?***
and, finally, what is the PRICE?

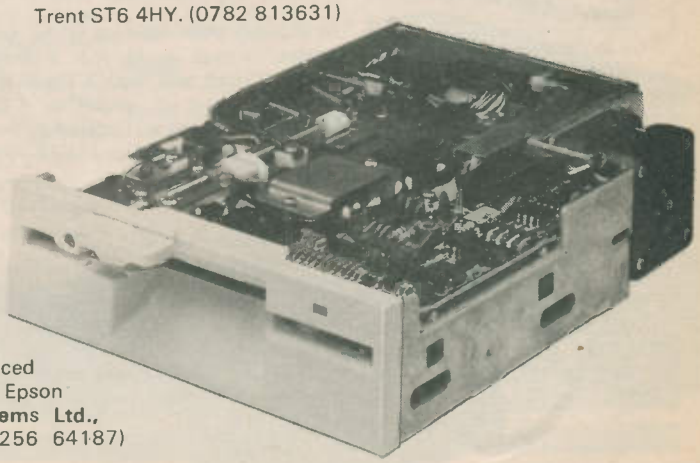
Although we cannot cover all these points in our guide we have given as much information as possible, together with addresses and phone numbers where a full specification on the drives mentioned can be obtained. (Prices include VAT).

The Hitachi HFD range from Datafax have unformatted capacities of 500K, 1M and 1·6Mbytes with the HFD510 being a 5·25in. double-sided, half-height, with 80 tracks and a 1Mbyte capacity, priced at £210. The Datafax range also includes the 3·5in. drives from Epson and the 3in. range from Hitachi. Full details from: **Datafax Systems Ltd.,** Datafax House, Bounty Road, Basingstoke, Hants RG21 3BZ. (0256 64187)

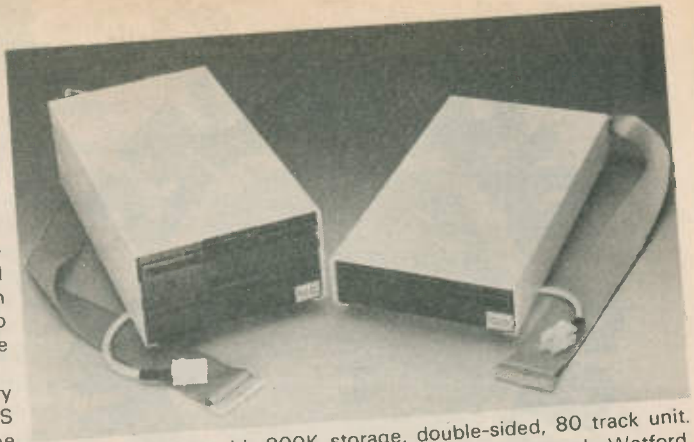


The CDC 9428 and 9429 5·25in. half-height disc drives provide 500K or 1Mbytes of storage respectively. The 9428 is a 40 track, double-sided drive (price on application), whilst the 9429 is an 80 track, double-sided, double-density drive (price on application). **Control Data Ltd.,** 179/199 Shaftesbury Avenue, London WC2 8AR. (01-240 3400)

The Teac FD35 series of 3·5in. drives from Tekdata are a condensed version of the FD55 series and are fully compatible. There are 8 models in the range offering capacities from 250K to 1Mbyte. The FD35B is a 500K capacity 80 track, double-sided drive, priced at £159. **Tekdata Electronics,** Federation Road, Burslem, Stoke-on-Trent ST6 4HY. (0782 813631)



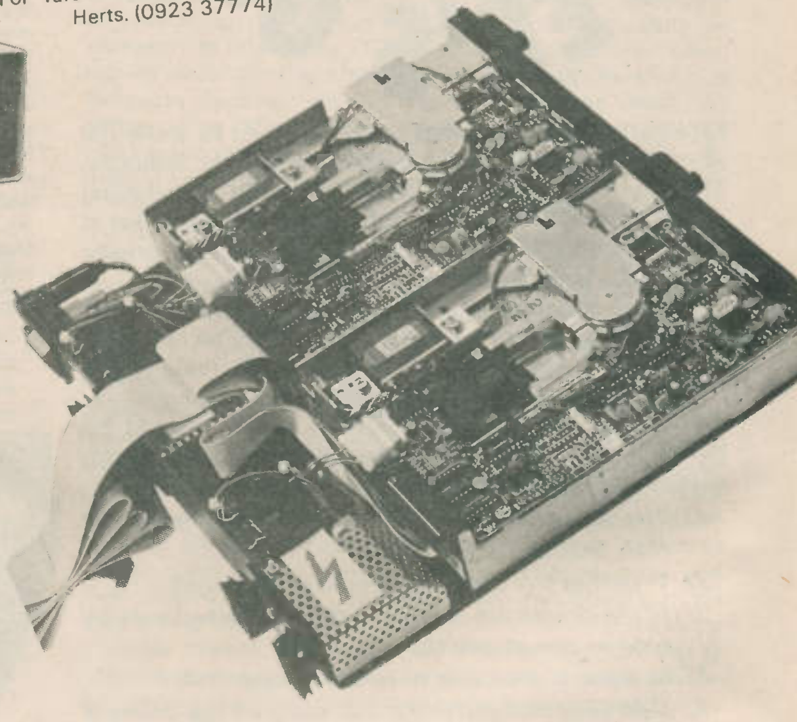
DISC DRIVES BUYER'S GUIDE

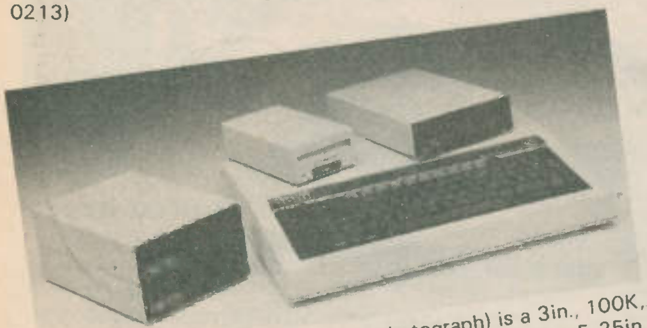


The Watford Electronics disc drive range includes the CLS 100 which is a cased, single-sided, 40 track, 100K, 5·25in. drive, without a p.s.u.; the CLS 400, a double-sided, 80 track, 400K drive and the CLS 400/S a 40/80 track switchable 400K unit. All three of these units are also available as dual drives and all six units can be supplied with integral p.s.u.'s. Cables are also supplied suitable for use with the BBC micro with all drives.

The prices of the range vary from £115 for the CLS 100 to £395 for the CD800 which is a cased, dual drive with 800K storage, double-sided, 80 track unit. For further details: **Watford Electronics**, Dept PE, Cardiff Road, Watford, Herts. (0923 37774)

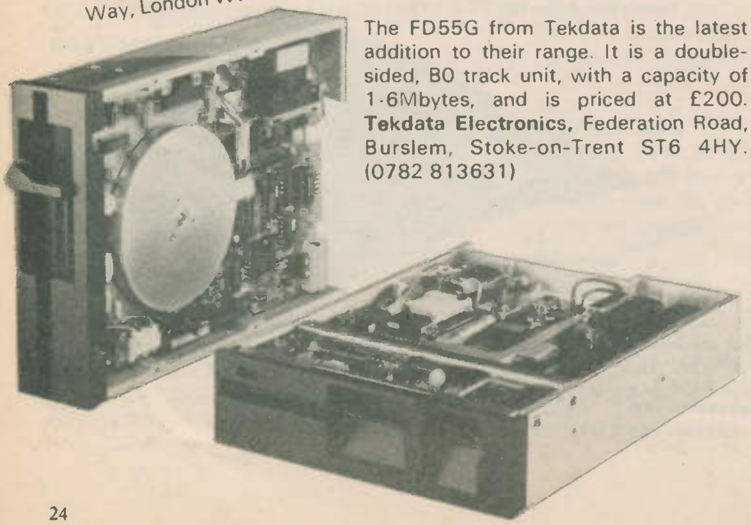
The Micronix range of 5·25in. drives are supplied complete with a DFS manual, formatter disc and disc drive cable. The MX150 is a 100K, 40 track, single-sided drive (£170.20), and the MX151 is a 200K, 40 track, double-sided drive (£216.20); the MX152 is a 400K, 80 track, double-sided drive (£238). **Micronix Computers Ltd.**, Suite 2, 26 Charing Cross Road, London WC2. (01-240 0213)





The Teac FD30A (shown centre in photograph) is a 3in., 100K, single-sided drive, and is fully compatible with Teac's 5·25in. drives. The actual floppy disc used in the 30A is stored in a hard case, not the soft sleeve used by other floppy discs. This makes loading more positive and reduces the disc's susceptibility to damage by handling. The FD30A is priced at £159 and is available from **Viglen Computer Supplies**, Unit 7, Trumpers Way, London W7 2QA. (01-843 9903)

An internal view of the CD400K drive unit from Cumana



The FD55G from Tekdata is the latest addition to their range. It is a double-sided, 80 track unit, with a capacity of 1·6Mbytes, and is priced at £200. **Tekdata Electronics**, Federation Road, Burslem, Stoke-on-Trent ST6 4HY. (0782 813631)

The Cumana range of disc drives include the CD200K: a 40 track, single-sided drive with 200K of memory. The CD400K: an 80 track, single-sided drive with 400K of memory. The CD400/S: a 40/80 track, single-sided drive. The CD800/S: a double-sided version of the 400/S; and the CD400/D, a 40 track, double-sided drive with 400K of memory. Prices for the drives vary from £350 to £575. **Cumana Ltd.**, Unit 1, The Pines Industrial Estate, Broad Street, Guildford GU3 3BH. (0483 503121)

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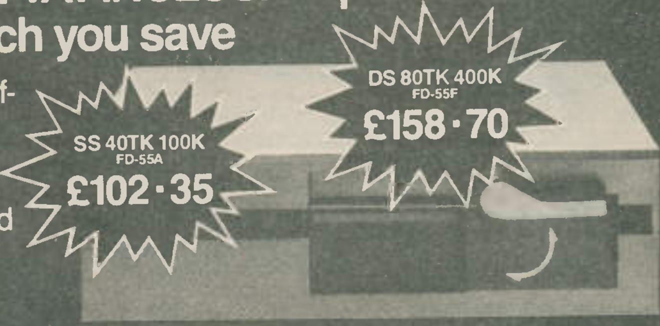

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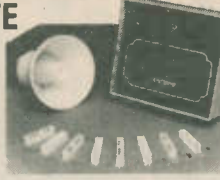

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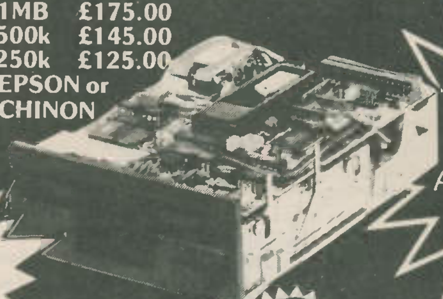

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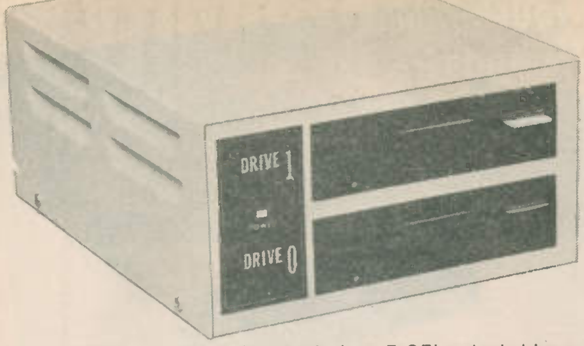
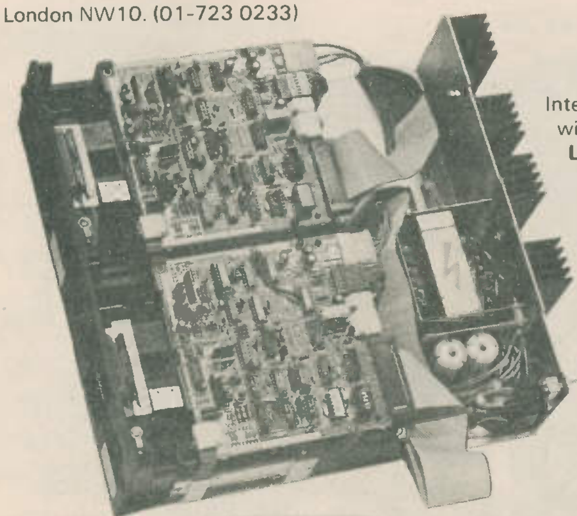


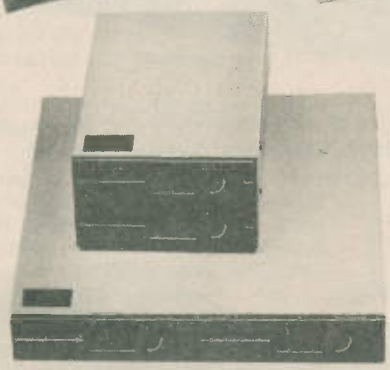
The CD55FS from Technomatic is a 5·25in. dual drive disc unit with a maximum 800K storage (2 x 400K switchable drives), incorporating double-sided discs. Each drive is separately switchable between 40 track and 80 track via a hardware switch. This unit has a built-in p.s.u. with mains switch and is supplied with a manual, formatter disc, connector cables and a 13A mains plug. Price £483; **Technomatic Ltd.,** 305 Edgware Road, London NW10. (01-723 0233)

The MX1350 is a single 3·5in. drive from Micronix, it will provide a capacity of 100Kbytes of storage; a dual unit, the (MX2350) is also available with a 200Kbyte storage capability. Both these units are 40 track and are single-sided, and are boxed in metal housings, supplied complete with power cable, disc drive cable, formatter disc and DFS manual. Prices respectively are £181.70 and £353.05. **Micronix Computers Ltd.,** Suite 2, 26 Charing Cross Road, London WC2. (01-240 0213/0217)

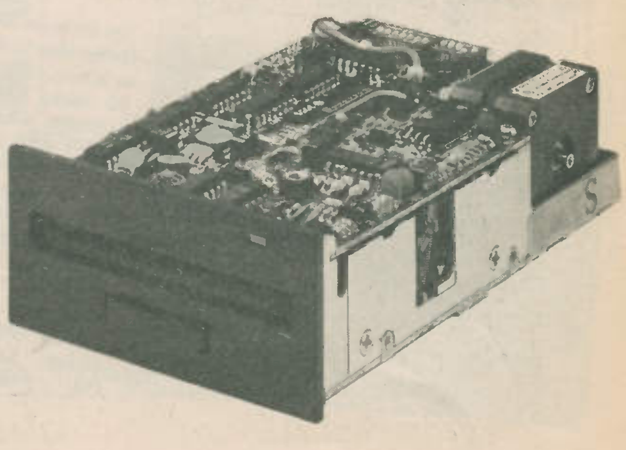


Internal photograph of the Cumana full-height unit with integral power supply. **Cumana Ltd.,** Unit 1, The Pines Trading Estate, Broad Street, Guildford, Surrey GU3 3BH. (0483 50312)

The TRK1 from Tech OP Ltd is a dual 5·25in. drive unit offering 800Kbytes storage on 80 track, single-sided discs. The TRK2 will provide 1600Kbytes of storage using 80 track, double-sided discs. These half-size units are supplied with full documentation, all connectors and a formatting and utilities disc for BBC B micros. Prices respectively are £275 and £349. **Tech OP Ltd.,** 19 Rodney Road, Cheltenham. (0242 570999)



Mail Order Micros supply a range of twelve disc drives for use with the BBC micro. The units are available with integral p.s.u.'s in dual stacked or dual flat versions or, without a p.s.u. in a dual stacked version. All versions are supplied with formatting/utility disc and manual. Disc capacities are from 200K, 40 track, single-sided drives to 800K, 80 track, double-sided units. **Mail Order Micros,** 2a Green Street, Sandbach, Cheshire CW11 9AX. (0782 811711)

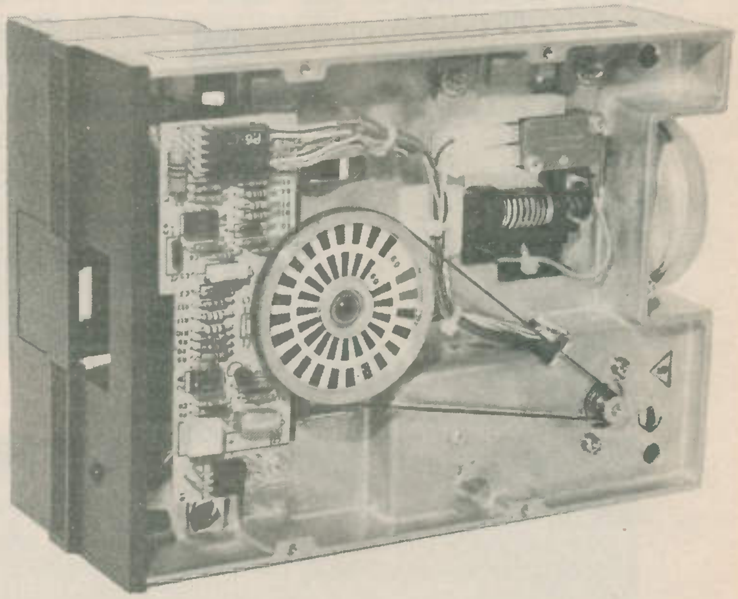


The HFD 305's from Datafax have been designed for use with the new 3in. compact floppy disc by Maxell; two units are available in this range—the 305(S) a single drive and the 305(D) a dual drive. Storage capacity is from 125Kbytes (single density—single drive) to 500Kbytes (double density—dual drive). Supplied with formatter disc, cables and manual, these units are respectively priced at £155 and £180. **Datafax Systems Ltd.,** Datafax House, Bounty Road, Basingstoke, Hants RG21 3BZ. (0256 64187)

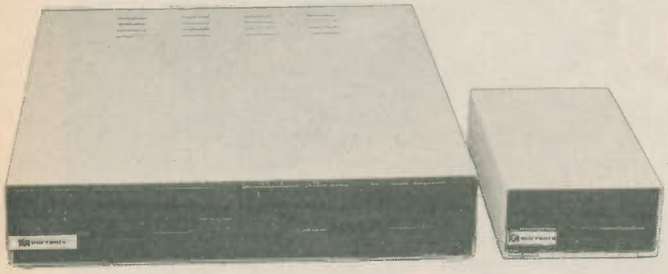
DISC DRIVES BUYER'S GUIDE

The XLtron drive is a BBC compatible, half-height, single or double-sided drive complete with an interconnecting cable and manual. The single drive is priced at £150, and the double-sided drive at £166. **Disco Technology Ltd.,** 20 Orange Street, London WC2H 7ED. (01-930 1612)

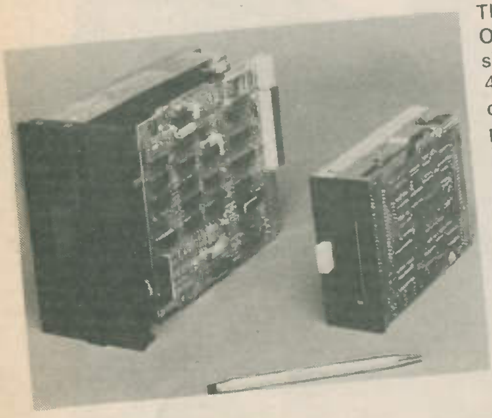
The 3in. drives from Mail Order Micros are available in single or dual units. They are supplied with leads and connectors, formatting/utility disc and a manual. The drives can be powered from the p.s.u. of the BBC micro. The single drive has 80 tracks and a 200Kbytes capacity, whilst the dual drive has a 400Kbytes capacity. **Mail Order Micros.** (Address below.)



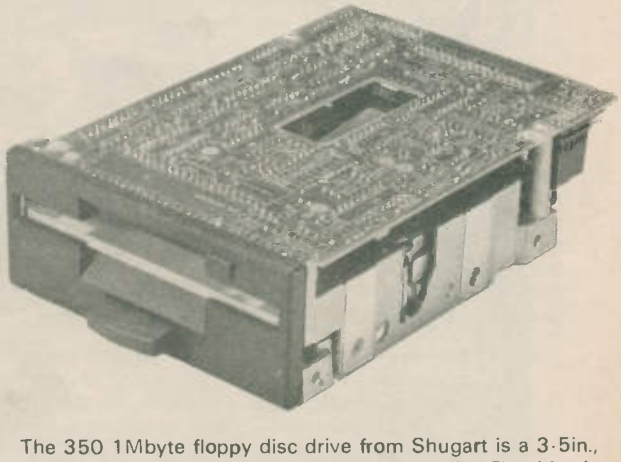
An internal view of a standard height disc drive showing the drive belt arrangement. **(Courtesy of Cumana Ltd.)**



The MX252 from Micronix is an 800K dual, 5·25in., 80 track, double-sided drive, priced at £492. It is shown alongside the MX-130 which is a 100K 3in. single-sided, 40 track unit, priced at £181.70. Both units are supplied complete with drive cables, formatter and DFS manual. **Micronix Computers Ltd.,** Suite 2, Charing Cross Road, London WC2. (01-240 0213)



The Shugart SA300 from Mail Order Micros is 3·5in., single-sided microfloppy drive with 40 tracks and 500K memory capacity. The drive is compatible with 5·25in. units and is available in either a single or dual drive configuration. A formatter, instruction manual and connecting cables are supplied. The single drive is priced at £102.35, and the dual unit at £201.28. **Mail Order Micros,** 2a Green Street, Sandbach, Cheshire CW11 9AX. (0782 811711)



The 350 1Mbyte floppy disc drive from Shugart is a 3·5in., double-density, single drive unit with 80 tracks. The drive is supplied complete with a formatter disc, manual and interconnecting leads. **Mail Order Micros.** (Address left.)

MICRO-BUS

and MICROPROMPT

Appearing every month, Micro-Bus now presents ideas, applications and programs for the most popular micro-computers and all micro-related projects so far published in PE. Ideas must be original, and payment will be made for any contribution featured.

SPECTRUM "CLOUSEAU"

Sir—"Clouseau" is a cheap, reliable, extremely sensitive, acoustic burglar alarm system for the ZX Spectrum. Clouseau requires no soldering, and, in the case of the BASIC system, no knowledge of electronics. Clouseau works by taking the input from the EAR socket, and checking to see if there is any noise indicating, perhaps, a burglar.

Clouseau can also be used as a baby minding device, indicating when the baby, being monitored, makes any noise.

Clouseau is extremely sensitive, and networks of microphones can be set up, allowing more than one room to be monitored at a time.

The IN command on the Spectrum is used for reading the values at the Spectrum's I/O ports. These are not merely for the connections on the back edge-connector of the computer, but also for reading data from the keyboard, and EAR connector.

The value from the EAR socket is read with the line:

LET A = IN 65022

The value at the EAR socket is determined by what the computer can hear at the socket. When there is no noise at the connection, a value of 255 is returned. However, if there is any noise at all, the value read will be different.

It is, by connecting a system of leads, amplifier, tape recorder, and microphones to this connector, that a simple, but very sensitive Burglar Alarm/Child Minder experiment can be constructed.

For the basic system of one monitoring station, you will need:

The set-up shown in Fig. 1, and run the program with the tape recorder in RECORD mode. To do this, without a tape in, you will need to manually press down the erase protection detector tab at the rear left hand corner of the cassette receptacle.

More microphones can be added in series or parallel, but Ohm's law must be followed. If the original resistance is 8 ohms, then the final resistance of the microphone network must be 8 ohms.

A suitable sound amplifier can be purchased from many high street outlets, or the hi-fi system may be used.

The microphone with your cassette recorder will do. Most are compatible, but, just in case, check in your cassette recorder manual. The extra lead can be bought from specialist electronic shops or by mail order. The amplifier is required to make the Spectrum's BEEP loud enough to be used as an alarm.

The program gives an e.c.g. type printout of the trace from the EAR socket, on the T.V. screen. The alarm sounds when any noise is heard. A time delay is included so that you can set the alarm, and leave the room before the system activates. The sensitivity depends upon the volume setting of the cassette recorder.

David Harrison,
Burgess Hill,
West Sussex.

```
 1Ø REM ————————————————
 2Ø REM
 3Ø REM        CLOUSEAU
 4Ø REM ————————————————
 5Ø REM
 6Ø REM    Intruder Alarm V 1.Ø
 7Ø REM ————————————————
 8Ø REM
 9Ø REM © David Harrison 1983
1ØØ REM ————————————————

11Ø BORDER Ø: PAPER Ø: INK 7: 8
RIGHT 1: FLASH Ø: CLS
12Ø GO SUB 28Ø
13Ø LET A =1ØØ
14Ø PLOT Ø,A
15Ø FOR N=Ø TO 252 STEP 2
16Ø LET EAR=(IN 65Ø22) /2
17Ø DRAW 2, A–EAR
18Ø IF EAR <> 255/2 THEN GO SUB 2
2Ø
19Ø LET A=EAR
2ØØ NEXT N
21Ø CLS : GO TO 13Ø
22Ø REM HEARD A NOISE
23Ø FLASH 1: INK 2: BORDER 2:
PAPER 2: INK 7: CLS
24Ø PRINT AT 8, Ø; "
I N T R U D E R"
25Ø PRINT AT 12,Ø; " A L E R T"
26Ø BEEP 1.5, 45
27Ø GO TO 26Ø
28Ø REM TIME DELAY
29Ø INPUT "Time Delay in Seconds"; TD
3ØØ PAUSE TO*5Ø
31Ø RETURN
```

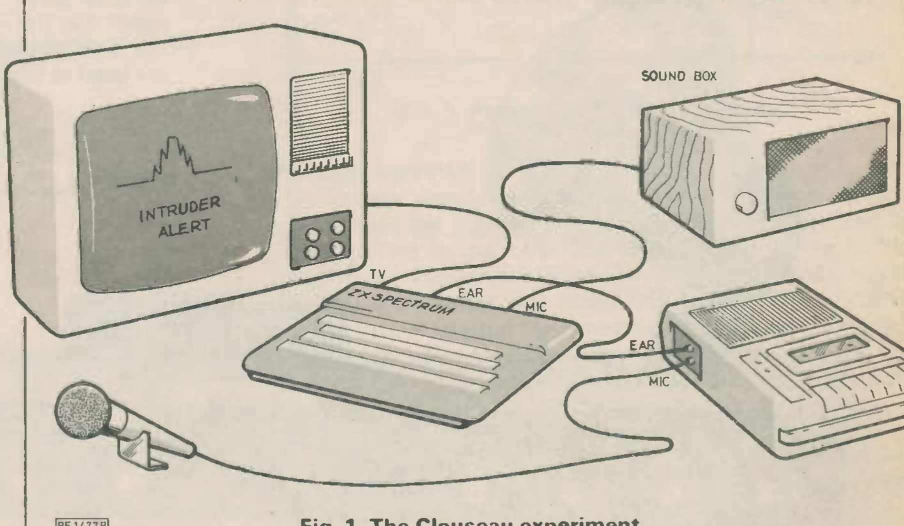


Fig. 1. The Clouseau experiment

Radar Security Alarm

Part One

A DESIGN BY POWERTRAN CYBERNETICS

INTRUDER alarm systems fall into several distinct categories as far as the actual detection is concerned. These can be summarised generally as follows:

a) HARD WIRED

Hard wired systems where doors, windows and other entry points are wired to a central control unit. Magnetic switches and magnets, either surface mounting or flush mounting types, are positioned so that the contacts break as the door or window is opened. Pressure mats may also be placed at strategic points on stairs or landings. These are normally open contact devices where the pressure of a person's foot will make the contact.

b) ULTRASONIC

These sensors are usually self contained in one small box which can be conveniently mounted high on a wall covering the area to be protected. Ultrasonic sound waves are generated in one head and a similar head 'listens' to the sound pattern generated within the protected area. If the pattern remains constant no output appears from the receiver head and associated electronics. If a disturbance occurs in the protected area the received signal changes and the change is amplified and used to trigger the alarm circuit. The ultrasonic system is very sensitive and is affected by draughts or anything causing air movement.

c) INFRA-RED

i) *Active Infra-Red*

An infra-red emitter is arranged within a housing for its energy to be collimated by a lens to provide a narrow beam. An infra-red detector in a similar housing is positioned to intercept the transmitter beam, thus providing a signal all the while the beam remains unbroken. The system can be made very robust and is suitable for inside or outside use. The beam is invisible and unaffected by sunlight or other outside influences and responds instantly to passage of an object through the beam. The transmitter and receiver can be mounted in the same housing with energy transfer accomplished using an optical reflector of the multi face type similar to a cycle reflector.

ii) *Passive Infra-Red*

The Passive infra-red detector uses a pyro-electric element of doped ceramic, sensitive to infra-red (heat) radiation. This produces an electrical output when there is a change in the amount of infra-red radiation striking the sensitive area. Physically, the detector, in its wall-mounted housing, 'looks' at the area of coverage through an infra-red filter and an infra-red opaque grid which has the effect of allowing infra-red radiation from objects within 'windows' to fall on the detector. If an infra-red source (intruder) passes across these windows the detector plays 'now you see me, now you don't' with the result that the intruder causes several sudden changes in the level of radiation reaching the detector any of which are used to trigger the alarm system.

d) RADIO DETECTION

This usually takes the form of a module emitting radio energy in the 10 Giga Hertz region. The active element is a Gunn diode in a self-oscillating circuit which is tuned by the cavity in which it is located. The energy is directed to the area to be protected by the antenna and an adjacent cavity contains the detector diode. This, in a similar manner to the ultrasonic unit, reacts to movement within the protected area by producing an output from the detector at the Doppler fre-

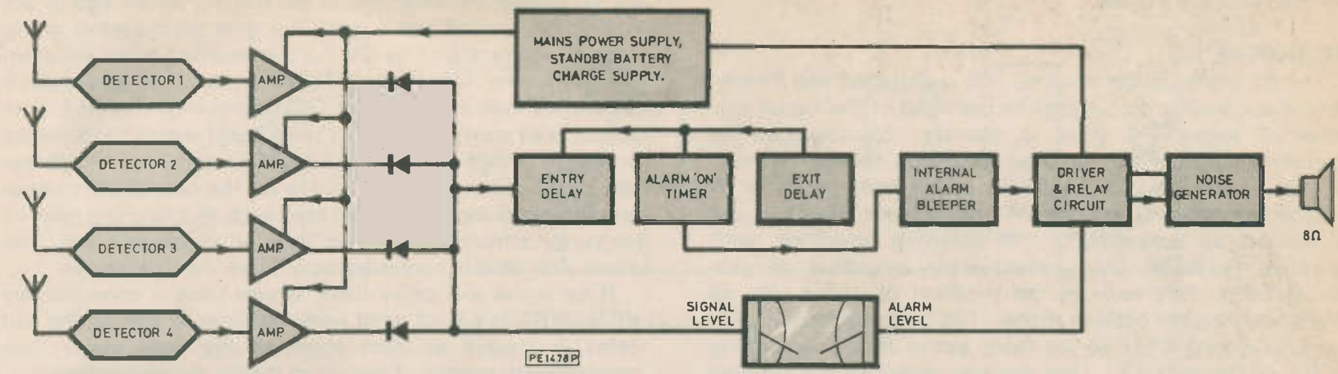


Fig. 1. Schematic diagram of the complete unit

quency caused by the movement of the intruder.

The system described here is a Doppler Radar Alarm which can be made by the home constructor from readily available components.

HOW IT WORKS

The oscillator frequency is generated on the oscillator (lower) printed circuit board and radio frequency energy is transferred to the detector (upper) board by the proximity of the two loops. One end of the upper loop is connected to the system ground (0 volts) and the other end is connected directly to the antenna. The mid point of the antenna loop is connected via the detector and diode D101, to C104. If the transmitted energy is represented by Pt and energy reflected from nearby objects back to the antenna is represented by Pr then the signal presented to the detector is the vector sum of Pt + Pr where the frequencies are the same but the relative phases are different, hence a steady d.c. level appears across C104. If a moving target enters the area an additional component within Pr appears at the detector due to the Doppler frequency shift. It is this shift which causes the d.c. level on C104 to vary at a frequency equal to the difference between the transmitted signal and the reflected signal—which for a man size target moving at 1m.p.h. (1·5 feet per second) is about 1 cycle per second. Hence under steady state conditions the detected d.c. level will not pass through the a.c. coupled signal amplifier but the 1Hz Doppler signal will.

UHF OSCILLATOR

The critical frequency determining components of the UHF oscillator are formed by the printed circuit wiring. The dimensions of the main centre tapped loop form the tuned circuit for the oscillator. The transistors are BFY90 devices which oscillate satisfactorily at the working frequency. The remaining components are feedback and decoupling capacitors and biasing resistors.

The antenna pick-off coil is positioned on a second p.c.b. mounted parallel to the oscillator board and spaced by nuts on the mounting screws. A tapping on the antenna loop is fed to the detector and filter circuit. The complete oscillator/detector unit is coupled to the control box using miniature 2 core screened cable. Up to four detectors can be accommodated by the control box and each detector has its own amplifier and hence the sensitivity of the system is individually controlled on the front panel of the control unit.

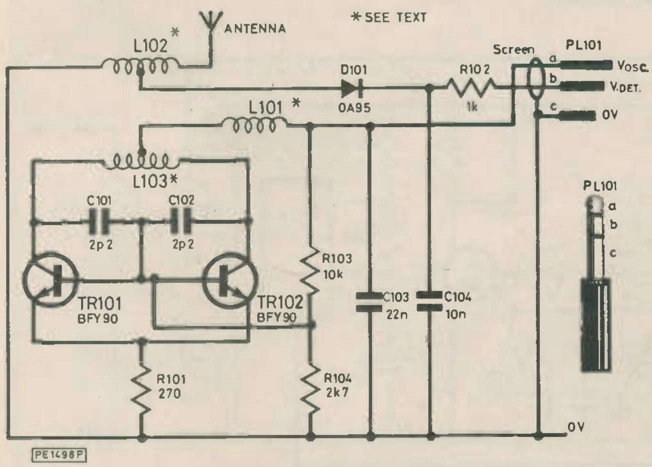


Fig. 2. Oscillator/Detector circuit

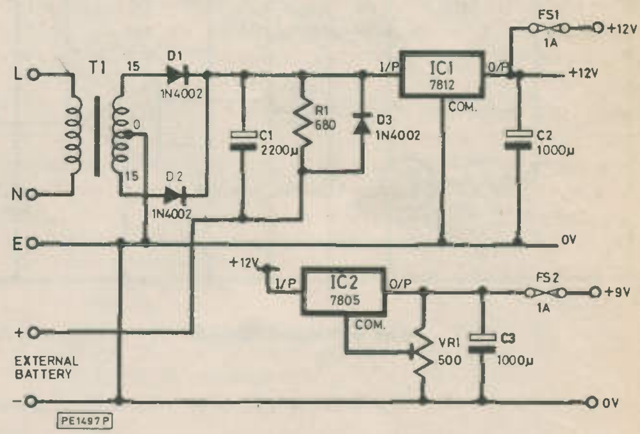


Fig. 3. Power Supply circuit diagram

POWER SUPPLY

A toroidal transformer is used to derive the low voltage supply from the mains. The mains plug should be fused at 3 amps. This is the only fuse in the primary side of the transformer. The centre tapped secondary is full wave rectified by D1 and D2 and smoothed by C1. R1 is a trickle charge resistor to keep the external back up battery charged. In the event of mains failure the battery will supply the circuits via D3. IC1 provides 12 volts and IC2 provides 9 volts (adjustable by VR1). The 9 volt (nominal) powers the signal amplifiers and the oscillator detector units.

The oscillators are powered via R105 (R205 etc.) and VR1 is adjusted to give a voltage at the junction of R105 and D107 of 8 volts. At this voltage level, D107 will not conduct and D108 in the collector of TR103 will be off.

Should the 2 core cable to the detector be broken the voltage on D107 will rise above 8·2 volts and TR103 conducts to indicate a break.

RF SIGNAL

The RF signal in the antenna coil is detected and filtered to give a standing d.c. voltage at the input of the signal amplifier of about 1·5 volts. A moving object within the operating range of the detector will cause this d.c. level to change at the Doppler frequency which is of the order of 1 cycle per second. The two 741 operational amplifiers are connected as conventional non-inverting amplifiers with selective feedback giving appreciable reduction of gain above 20Hz. This reduces the problem of mains pick up whilst keeping the circuits simple. The output from IC102 is a.c. coupled via C110 to the diode pump circuit comprising D103, D104 and C111. Low leakage capacitors are required throughout the signal amplifier and tantalum bead types are satisfactory. A moving target within the range of a detector produces a low frequency signal and continued movement 'pumps up' the voltage of C111, this voltage in turn causes the Darlington pair TR104, TR105 to conduct and D109 lights, indicating a moving target. As TR105 collector goes low the signal level is indicated on the VU meter, ME1a.

The earthy side of the VU meter is the signal summing line from all the detectors and if any one goes low IC3a timer is triggered. This is the entry delay timer and the length of delay is controlled by VR2.

When the entry timer IC3a is triggered, pin 5 goes high. The positive going edge is differentiated by C5 and D4 with no net change in the status of pin 8 IC3b. At the end of the entry delay period pin 5 goes low and the negative going edge is differentiated by C5, R3 the resulting pulse initiating the alarm time 'ON' timer IC3b. When this is triggered pin 9 IC3b goes high and turns on TR3 energising relay RL1. One pair of relay contacts connect the 12 volt supply to the noise generator circuit comprising IC5a, IC5b and TR4. A separate pair of relay contacts is available on the rear of the control unit for switching an external load such as a latching relay or contactor controlling a flood light or an electric bell. The alarm 'ON' time is controlled by VR3 on the front panel.

IC4a is the exit delay timer whose time is controlled by VR2b (VR2 is a dual gang potentiometer to ensure the exit delay is always at least equal to the entry delay thus preventing triggering of the alarm during the exit period).

The only switch on the front panel is the ALARM ON-OFF switch. When the alarm is switched to the 'OFF' position, pin 6 is grounded causing the output pin 5 to be high. This causes TR2 to conduct with the collector low. The collector is connected to the RESET pins 4 and 10 of IC3a and b thus keeping the entry timer and alarm timer inhibited during the exit period. The alarm signal from pin 9 IC3b also drives TR1 emitter follower. The emitter of TR1 is connected to pin 10 of IC4b. This is connected as an astable timer whose output drives the internal piezo electric bleeper, to give an audible indication that the alarm has been triggered.

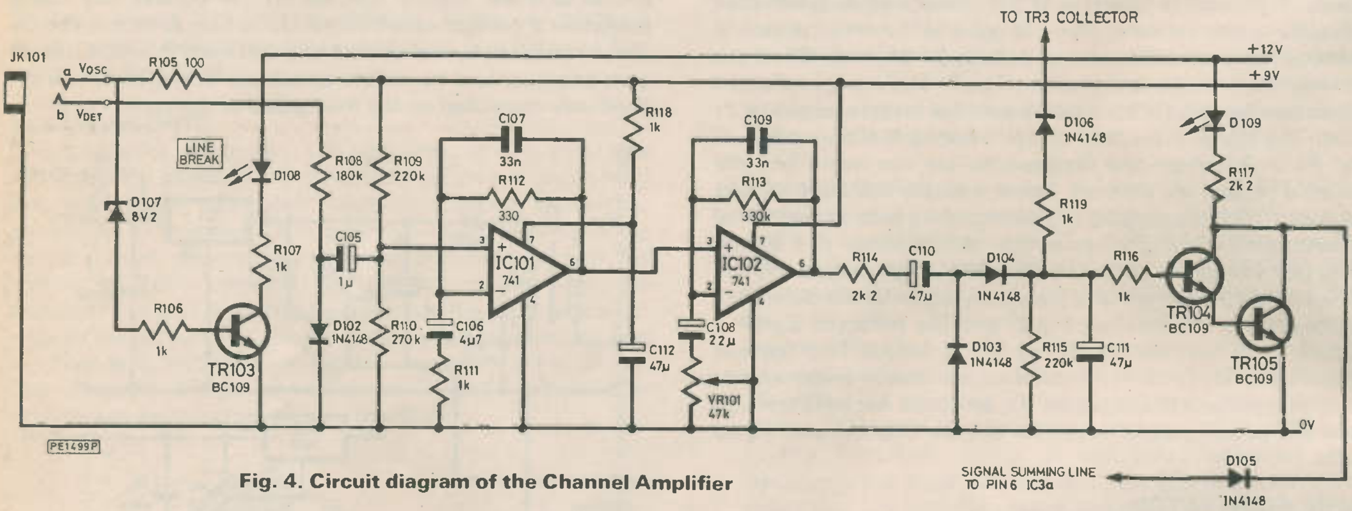
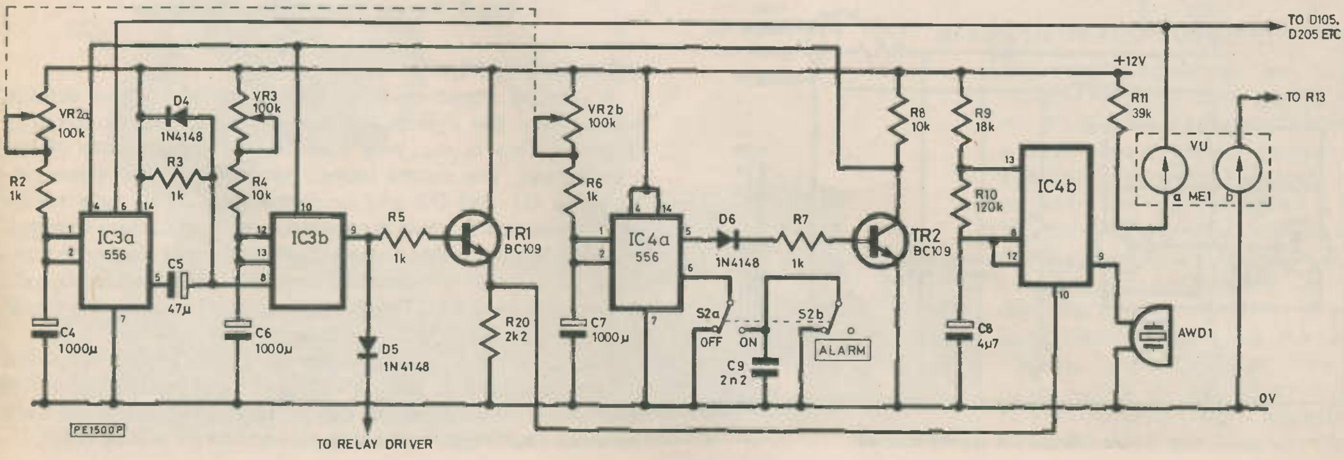


Fig. 4. Circuit diagram of the Channel Amplifier

Fig. 5. Circuit diagram of the Timing and Delay circuits



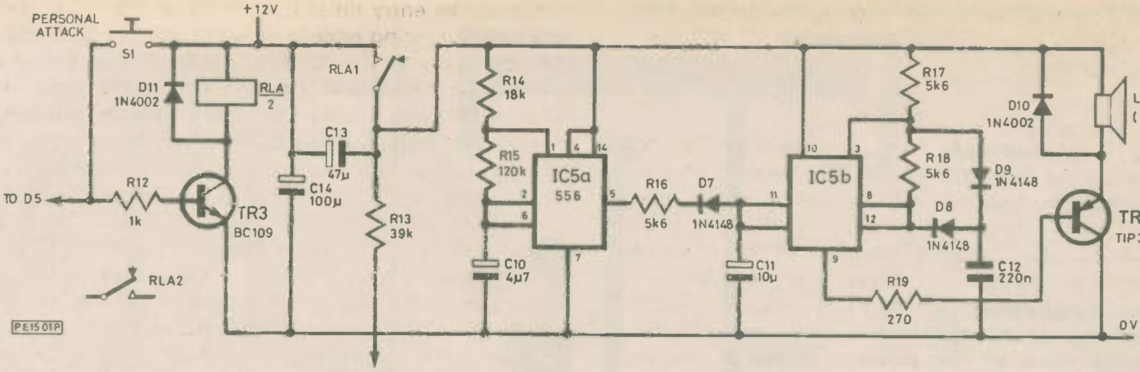


Fig. 6. The Noise Generator circuit diagram

NOISE GENERATOR

The Noise Generator uses a dual timer i.c. which produces a wailing high level sound in an 8Ω re-entrant horn loudspeaker. The output from pin 9 drives a *pnp* power transistor with the loudspeaker forming the emitter load. The main printed board has an area of copper strips at one end. This is provided to allow extra components to be added if required such as a thyristor and associated components to switch an external load.

The junction of D5 and R12 to +12V is a suitable point to insert personal attack buttons. As the system is powered all the time mains is connected, the PA button will activate the siren as soon as it is operated. If the base connection of TR3 is brought out to the rear panel, this, together with the BATT—VE terminal, forms a useful point for remotely disarming the alarm simply by shorting the base to ground via a suitable keyswitch. It is important to use the base of TR3 rather than the PA connection on the left hand side of R12 because, if the PA button is pressed while the alarm is switched off at the remote key switch position, a short circuit will appear across the supply.

The only part of the system on the outside of the building is the siren and its enclosure. A high degree of security is obtained if the cable supplying the horn enters the enclosure through the rear of the box straight through the wall so that no cable is exposed. Further protection is afforded if 4 core cable is used with a reed switch/magnet assembly between the lid of the enclosure and the fixed part. The reed switch should be arranged to make contact if the lid containing the magnet is removed. The resulting contact pair is arranged to parallel the PA wiring as described earlier.

COMPONENTS . . .

OSCILLATOR/DETECTOR UNIT

Oscillator/Detector unit and signal amplifier.
NOTE The 4 oscillator/detector units and the 4 signal amplifiers are all identical. The electronic components have a prefix of 100, 200, 300, 400. Only the components of channel 1 are listed.

Resistors

R101	270
R102, R106, R107, R111, R116, R118	1k (6 off)
R103	10k
R104	2k7
R105	100
R108	180k
R109, R115	220k (2 off)
R110	270k
R112, R113	330k (2 off)
R114, R117	2k2 (2 off)

All resistors $\frac{1}{4}$W 5%

Potentiometer

VR101	47k lin (panel mtg)

Capacitors

C101, C102	2p2 ceramic (2 off)
C103	22n
C104	10n
C105	1µ 35V tant
C106	4µ7 10V tant
C107, C109	33n 400V polycarb (2 off)
C108	22µ 16V tant
C110, C111	47µ 6·3V tant (2 off)
C112	47µ 10V elect

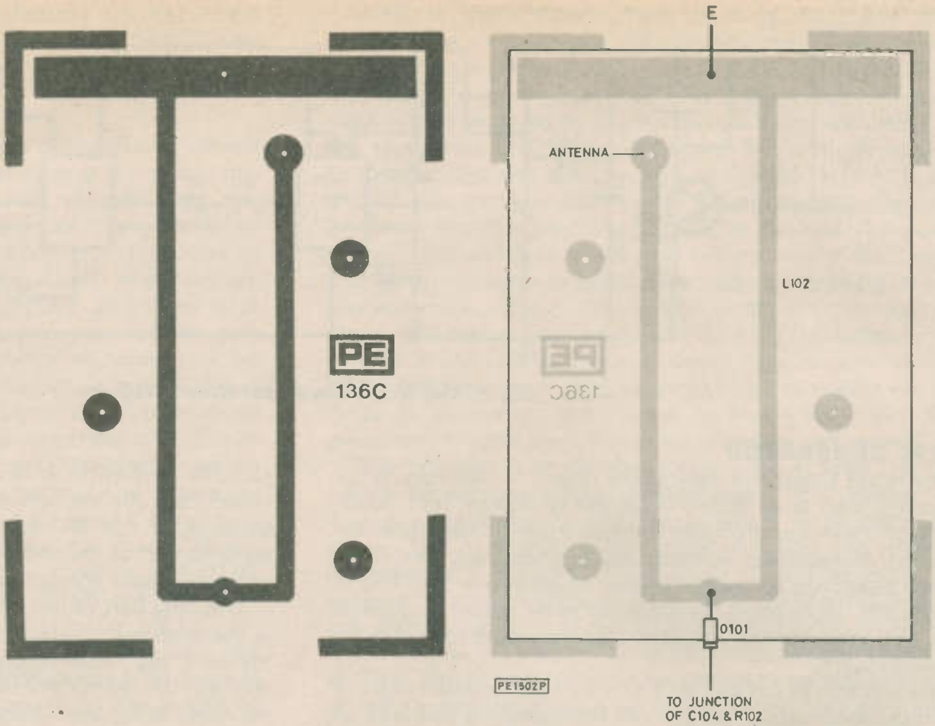
Semiconductors

D101	OA95
D102–106	1N4148 (4 off)
D107 8V2 Zener	BZX61
D108 green l.e.d.	TIL 220
D109 red l.e.d.	TIL 220
TR101, TR102 transistor	BFY90 (2 off)
TR103, TR104, TR105 transistor	BC109 (3 off)
IC101, IC102 op.amp.	741 (2 off)

Miscellaneous

Oscillator P.c.b.
Detector P.c.b.
Base Plate cover assy.
Telescopic Antenna
Grommet
Insulator
Antenna Fixing Screw M3 PH 30mm
P.c.b. mounting screws M3 CSK 20mm (3 off)
P.c.b. antenna fixing nuts M3 (17 off)
Cable min 2 core + screen 10 metres
0·25 in. Jack plug 3 Pole
Antenna adaptor
M3 15mm PH
TIL Grommet and clip (8 off)

Fig. 7 (right). The P.c.b. assembly and component layout of the Detector board



Photographs showing the internal and external view of the Oscillator / Detector unit

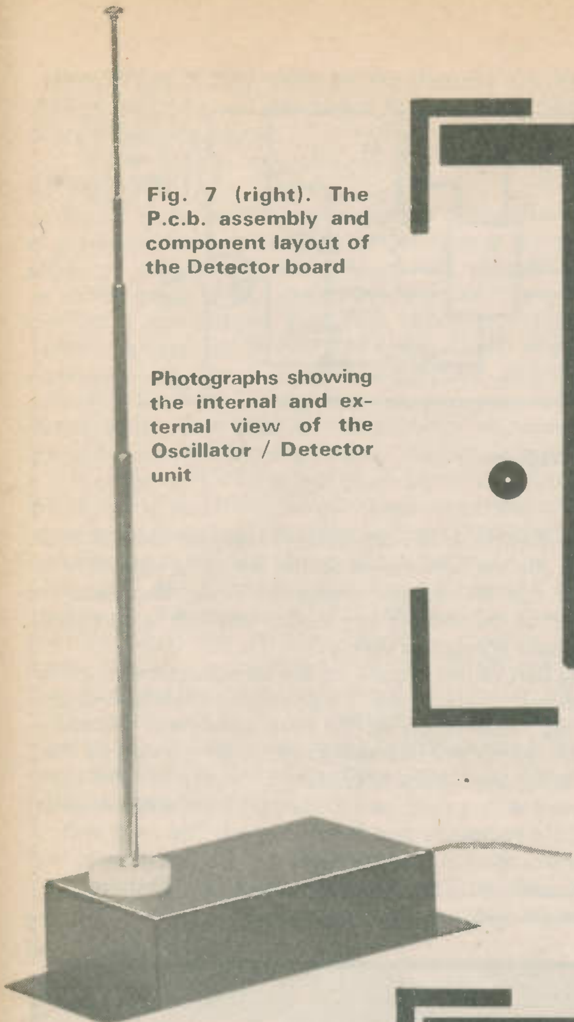
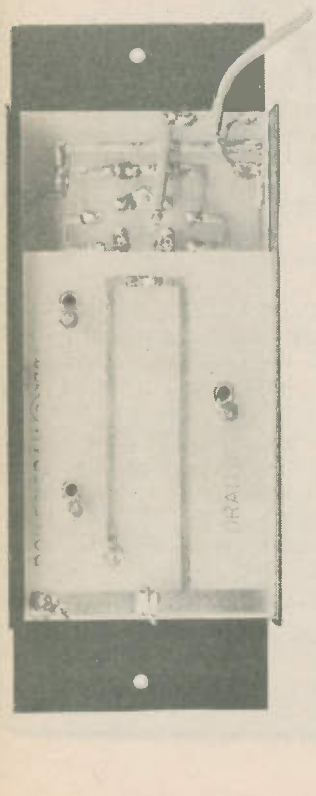
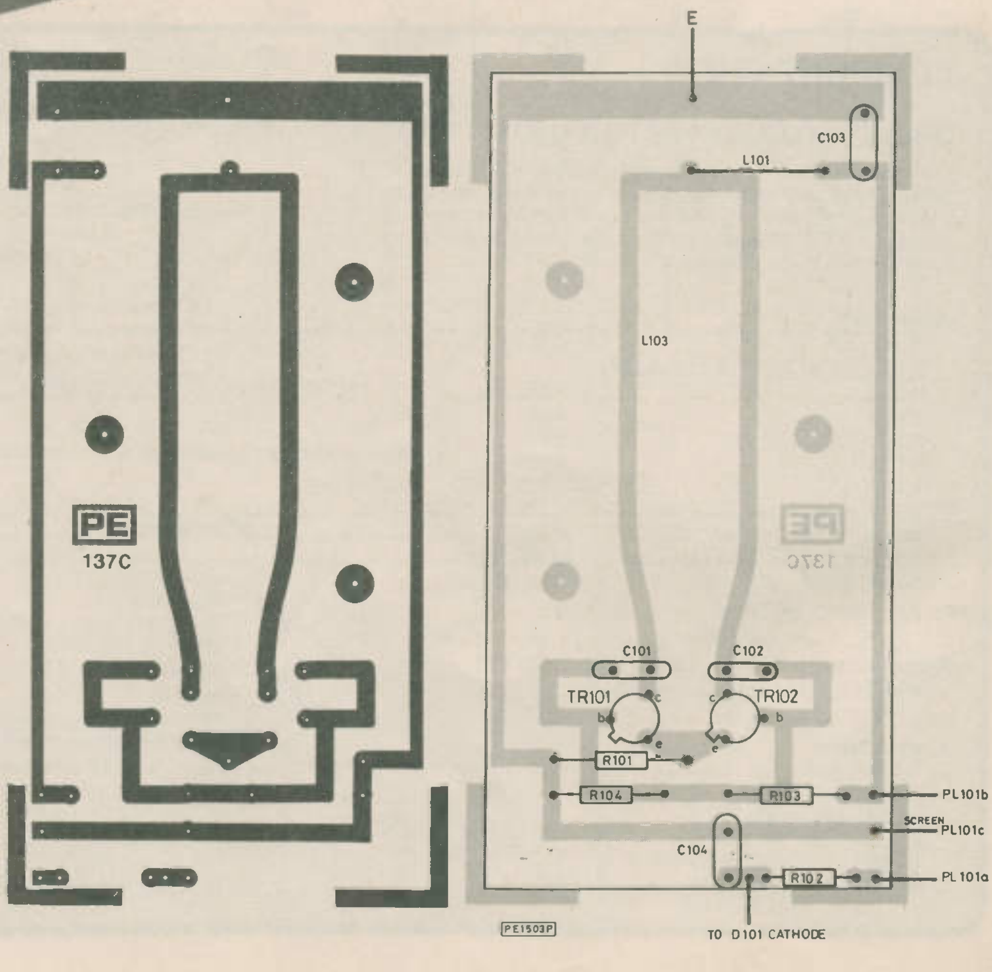


Fig. 8 (below). The P.c.b. and component layout of the Oscillator board





COMPONENTS . . .

MAIN PC BOARD

Timing Circuits

Resistors

R1	680 $\frac{1}{2}$W
R2, R3, R5, R6, R7, R12	1k (6 off)
R4, R8	10k (2 off)
R9, R14	18k (2 off)
R10, R15	120k (2 off)
R11, R13	39k (2 off)
R16, R17, R18	5k6 (3 off)
R19	270
VR1 P.c.b. Trim Pot	500R
VR2a,b	100k dual gang pot
VR3	100k pot
All resistors $\frac{1}{4}$W 5%	

Capacitors

C1	2200µ 25V
C2, C3	1000µ 16V (2 off)
C4, C6, C7	1000µ 16V elect (3 off)
C5, C13	47µ 16V elect
C8, C10	4µ7 25V elect (2 off)
C9	2n2 polycarb (2 off)
C11	10µ 16V elect
C12	220n 400V polycarb
C14	100µ 25V

Semiconductors

D1,2,3	IN4002 (3 off)
D4–9 diode	IN4148 (6 off)
D10,11 diode	IN4002 (2 off)
IC1 Voltage regulator	7812
IC2 Voltage regulator	7805
IC3,4,5 timer	556 (3 off)
TR1,2,3 transistor	BC109 (3 off)
TR4 power transistor	TIP30

Miscellaneous

Speaker 8Ω re-entrant horn speaker
Piezo bleeper
VU meter
Cabinet
Relay DPCO 12V 110Ω
Chassis assy
P.c.b.
3 Pole jack socket (4 off)
2 Pole jack socket
Knobs (2 off)
DPCO Min rocker switch
Terminal block 5A 6-way
Grommet
M3 6mm PH (7 off)
M3 8mm CSK (4 off)
10mm M3 T spacer (4 off)
Heatsink TV5 (3 off)
M3 16mm PH (2 off)

Chassis Assy Nuts & Bolts

M3 8mm CSK (4 off)
M3 washers (11 off)
M3 nuts (8 off)
M3 6mm PH (2 off)
M3 6mm CSK (2 off)
M4 Taptite × 10mm PH (2 off)
4BA PH × $\frac{5}{16}$

Power Supply

3 core 3 amp mains cable	3 metre
PCB Fuse holder	(2 off)
Fuse 1A	(2 off)

Toroidal transformer prim. 240V, sec. 15–0–15
6 way 5A terminal block
4BA solder tag

Constructors' Note

A complete kit of parts is available from:
Powertran Cybernetics Ltd.,
West Portway,
Andover, Hants.
SP10 3WN.
Tel: (0264) 64455.

Standard kit inc. 2 Transmitters £129.00
Pair of extra Transmitters £39.00
Special Offer: Extended kit inc. 4 Transmitters £149.50

CONSTRUCTION

When assembling the oscillator and detector boards, the components should be kept as close to the board as possible. The case connection of the BFY90's (TR101/TR102) should be snipped off as close to the body as possible and when mounting TR101 it should be noted that the base connection will pass through the collector and emitter legs. All the component legs should be long enough to enable the components to be bent over to lie on the board.

OSCILLATOR/DETECTOR UNITS

After all the components have been mounted and soldered the assembly should continue as follows:

1) Insert the three 20mm CSK screws through the base plate and secure with nuts, then add extra nuts to support the oscillator board, copper side up. Ensure that the board is spaced to prevent components touching.

2) Add three more screws and insert the antenna fixing screws through the detector board, and secure with a nut on the copper side making sure there is a good contact between the nut and the copper.

3) Place the detector board on the assembly and adjust the nuts until the boards are about 6mm apart. Connect points E on the two boards and connect the mid point of the detector loop with the cathode of the D101 to the junction of R102 and C104.

4) Strip the two core screened cable and after passing through the grommet connect the red and blue wires to the circuit board as shown, with the screen soldered to the copper earth strip.

5) Place the cover over the boards with the grommet in place and secure the assembly with a nut, after insulating the antenna screw. The antenna should then be screwed on and the jack plug soldered to the cable. This may have to be removed after testing in order to route the cable. The connections to the jack plug are shown in Fig. 2.

NEXT MONTH: Assembly, Testing and Calibration.

INDUSTRY NOTEBOOK

By Nexus

Tale of Two Thorns

Speculation on the future ownership of Inmos was finally quashed with Thorn-EMI buying out the government holding for £95 million. The Inmos board was pleased. Uncertainty had disappeared and confidence restored.

Government was pleased to pass on a responsibility no longer welcome and to recover the taxpayers' investment. Opposition from the Labour left was routinely ideological but there was consolation at least in control remaining nominally in British hands.

Lofty sentiments on protecting national technological heritage are just plain silly when targeted at an electronics industry which since its earliest days has been international through cross-licensing of designs. Inmos is no exception with most of its production development having taken place in the United States and its "most secret" dynamic RAM technology being made available under licence to NMB/Minibea of Japan. As part of the agreement Inmos will purchase a significant portion of the output of NMB.

Another gigantic "leak" of Inmos technology is the agreement for Racal-Redac to market worldwide the complete Inmos hardware/software package for designing advanced VLSI circuits including the transputer.

Of course, you don't give the information away for nothing. In both cases Inmos gains a down payment plus continuing royalties.

The other Thorn in the news is Waldo Thorn who had much to do with the early build-up of International Rectifier in its Italian and British plants. He then turned his attention to component distribution as MD of Celdis and is now MD Northern Europe for the Italian semiconductor manufacturer SGS. The company was well in the red until gripped by the throat by ex-Motorola executive Pasquale Pistorio whose shake-up resulted in turning huge losses into a small profit.

Waldo has boosted sales by 83 percent on his patch and has been setting up a £1·5 million CAD centre at his Aylesbury HQ.

Long Life

Technology advances so rapidly that this year's exciting new product can be obsolescent in a couple of years' time and obsolete in five. But Mullard's Hazel Grove factory has recently ended a 14-year long production run of SOD 38 rectifiers used mainly in TV sets and domestic appliances.

Over the period 87 million had been produced which placed end-to-end would extend to 1,370 miles, nearly as far by air from London to Moscow. But this enormous throughput generated only £12 million of revenue, peanuts by today's standards but a wonderful example of how cheaply we get our components by well-managed mass production.

Big Spenders

Well beyond the peanut bracket is the proposed £800 million investment in Britain by STC and ITT over the next five years. The development plan is interesting in that the two companies, nominally separate, made virtually a joint announcement.

The ITT investment of £196 million was announced by Daniel Weadock, president of ITT Europe, the STC investment of £600 million by STC chairman Sir Kenneth Corfield. Forecast is the creation of 5,000 new jobs, 3,000 in STC the rest in ITT although in ITT's case most will be in that company's hotel and insurance businesses.

Although the two companies were "divorced" in 1982 when ITT sold £500 million worth of its majority shareholding in STC, there is still a family connection. In fact ITT still holds about 35 percent of STC's equity and STC chairman Sir Kenneth Corfield is senior officer of ITT, UK.

On a smaller scale is the new £6 million factory for BICC-Vero at Chandler's Ford near Southampton. Vero products are well known and enthusiastically used by electronic hobbyists as well as the professionals.

Another £2 million is being spent on equipping the factory with the most up-to-date design and production equipment in order, in the words of MD John Grillo, to beat the Japanese and Germans at their own game. The existing workforce will be reinforced with 150 new jobs.

Vive le Sport

Love it or hate it—it's been a great year for sport. Detractors are right to point out the blemishes, too commercialised, too political, too little decency and courtesy, general lack of purity in the old traditional sense of playing the game. There's no denying, however, that as an industry it is a vigorous growth area in both cash throughput and employment.

What's in it for the industry? Let's look at the football World Cup to be staged in Mexico in 1986 at a dozen separate stadia. I am pleased to report that the new equipment needed is to be supplied by Pye TVT of Cambridge under a contract valued at £30 million and won against strong international competition, an industrial sporting event in its own right.

They are to supply more than 100 main and 60 portable cameras coupled into nine completely equipped OB vehicles with all the modern ancillaries such as caption generators and video effects. The overall distribution system includes hundreds of TV monitors, headsets and microphones for a thousand commentary positions. Each match will have seven fixed and three portable cameras, the latter for tunnel and touch-line shots and for on-the spot interviews.

The electronics doesn't stop at TV. Every venue of sporting importance has a powerful PA system, electronic scoreboards, electronic timekeeping. Then there are walkie-talkies for security people and medical electronics to check on personal fitness and possible drug abuse. Computers are in there for instant recall of past performances and advance bookings.

It is impossible to estimate the overall fall-out to industry one way and another. All one can say is that it's huge, so perhaps we should not grumble too much about the inflated earnings of the superstars.

Antique Yet Modern

This year is the 116th since the Anglo-Mediterranean Telegraph Company was founded under the chairmanship of Lord William Hay. We know it today as Cable & Wireless.

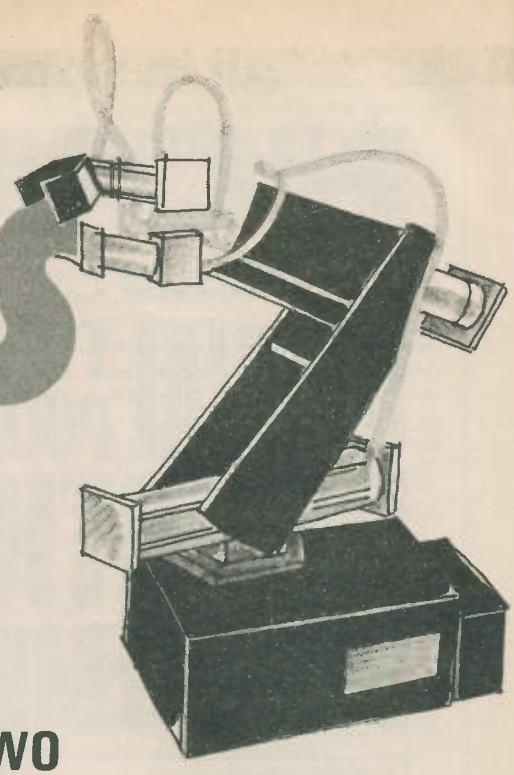
It is still strong in tradition. The outdated "wireless" which came into the title 50 years ago has been retained, as indeed the court of directors rather than a humdrum board, now chaired by recently knighted Sir Eric Sharp, again following a procession of peers and knights.

There is, however, nothing old-fashioned in the conduct of C & W's world wide communications activities today. Privatised in 1981, the company used its new-found liberty to go for growth. Turnover has risen from £403 million to £650 million with a rise in pre-tax profit of 21 percent.

In the UK, formerly prohibited territory to preserve the old GPO (now BT) monopoly, the main business is still Mercury Communications in which the first international links were established via satellite in August. But now an agreement with Western Union has resulted in setting up Easylink, a flexible electronic mail service which, in the United States, is attracting 10,000 new subscribers a month. C & W is investing £5 million in UK's Easylink and has a 75 percent stake with Western Union holding the remainder.

C & W's involvement in the Far East was emphasised earlier this year by the first ever overseas meeting of the court of directors at the Hong Kong HQ. They visited the People's Republic of China where C & W is involved in joint ventures and also Macau to attend the opening of C & W's new satellite earth station. In all, the company expects to invest £1 billion in the Far East over the next decade.

neptune ROBOTS



RICHARD B. H. BECKER — SYSTEM DESIGN AND MECHANICAL ENGINEERING.

TIM ORR — COMPUTER INTERFACE AND CONTROL ELECTRONICS.

PART TWO

THE ROBOTS are directly controlled by a BBC, VIC-20, or Spectrum computer, and the way that control is achieved is explained here. It involves digital-to-analog conversion, multiplexing to each of the axes; and then conversion of the position data back from analog into digital form, to be fed back to the computer for display on the TV.

THE CONTROL SYSTEM

The robot arm behaves in a very simple manner. It goes to where it is told to go! Once it has been given its instructions it is left to its own devices to proceed to the next set of position co-ordinates. This makes interfacing it with a remote computer extremely easy. All that the computer has to do is to WRITE the 7 axis position co-ordinates into some memory locations. These memory locations are in fact the robot's internal latches.

The position co-ordinates are 12 bits long, and so the computer sends the information in two stages, first an 8-bit byte and second a 4-bit nibble. These 12-bit words are held in the robot's internal latches, with one pair of latches per axis. Each latch has a different address in memory: the computer can alter the data in any one or all of the latches, merely by writing to the appropriate addresses. The data held in each pair of latches then represents the intended axis position. The data is converted into a d.c. voltage by a 12-bit digital-to-analog converter (DAC) and then it is fed into individual axis servo units. 12-bit DACs are rather expensive, and so the cost of having one per axis would be prohibitive. To avoid this expense a single DAC together with a multiplexer is used to distribute the position voltage to each axis.

Great care has to be used when multiplexing a 12-bit signal because extraneous events in the multiplexing process could destroy the accuracy of the system. The position voltages are sent to the axes' servo units. These units compare this voltage with the position feedback voltages from the axles of the arm and wrist. The servo units open and close hydraulic valves so

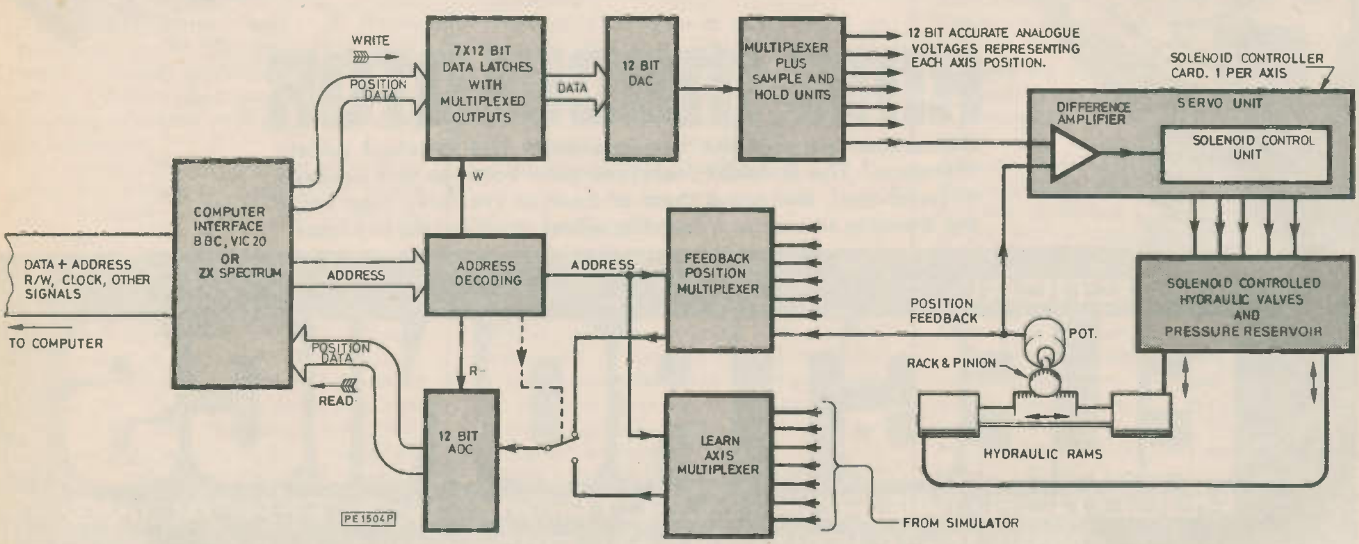


Fig. 2.1. Block diagram of the NEPTUNE Robot system

that the arm moves to a position of balance where all the feedback voltages equal the computer-generated position voltages. When this occurs, the arm has reached the position that it is told to go to.

The host computer can also measure the time-varying position of the arm: a multiplexed analog-to-digital converter (ADC) looks at the position feedback voltages. Multiplexing is used here too as 12-bit ADC's are even more expensive than 12-bit DAC's, at about 4 times their price. By performing a READ from two address locations, the axis position can be measured with 12-bit accuracy, but before performing a READ the multiplexer must be addressed to the required axis. This is done by writing a control byte into the multiplexer's latch. Also, the ADC must be told to Start Converting, which means toggling a data bit (part of the control byte) from a 1 to a 0 to a 1. This entails two more WRITE instructions, but can be over within microseconds. The ADC generates an answer in about 35 microseconds from the "Start Conversion" command. At that rate you could READ all 7 axes in about 0·5 milli-seconds.

The system also incorporates a "learn" axis input to which the simulator teaching pendant connects. This input is essentially the same as the position feedback multiplexing unit; by changing one bit in the control byte the ADC will measure d.c. voltages from the simulator. The simulator is a small mechanical model of the arm which can be manipulated by hand. By continuously READING these voltages and then WRITING to the arm, the arm will follow the movements of the simulator. All this information passes through the computer and so it is possible to record it either as a function of time or as a sequence of points in space.

The general system is shown in Fig. 2.1. Most of the hardware lives on the main p.c.b., and the external computers plug directly into this board via ribbon cable connector leads.

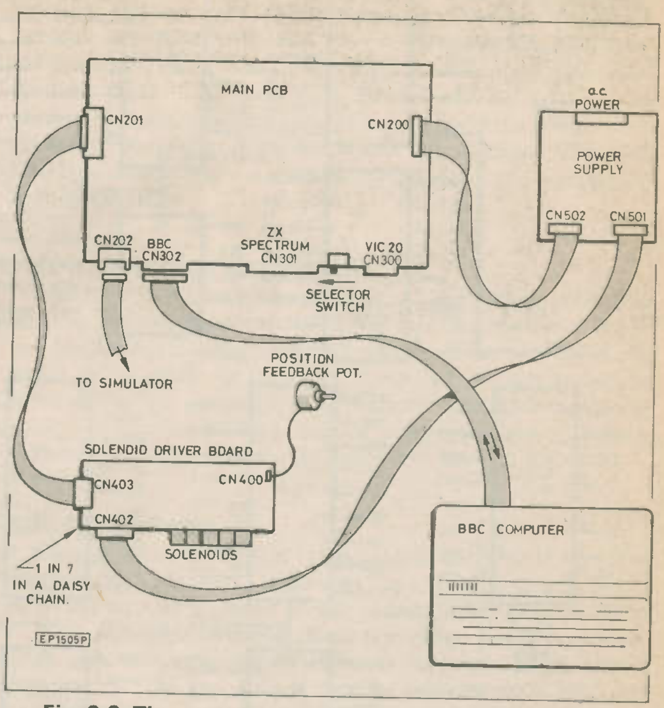


Fig. 2.2. The system interconnected with ribbon cable

The servo units (7 off) are directly connected to the solenoid valves which are in turn directly connected to the manifold. The power supply is on a separate p.c.b. All interconnections are made with pre-assembled ribbon cable IDC two-part connectors (Fig. 2.2).

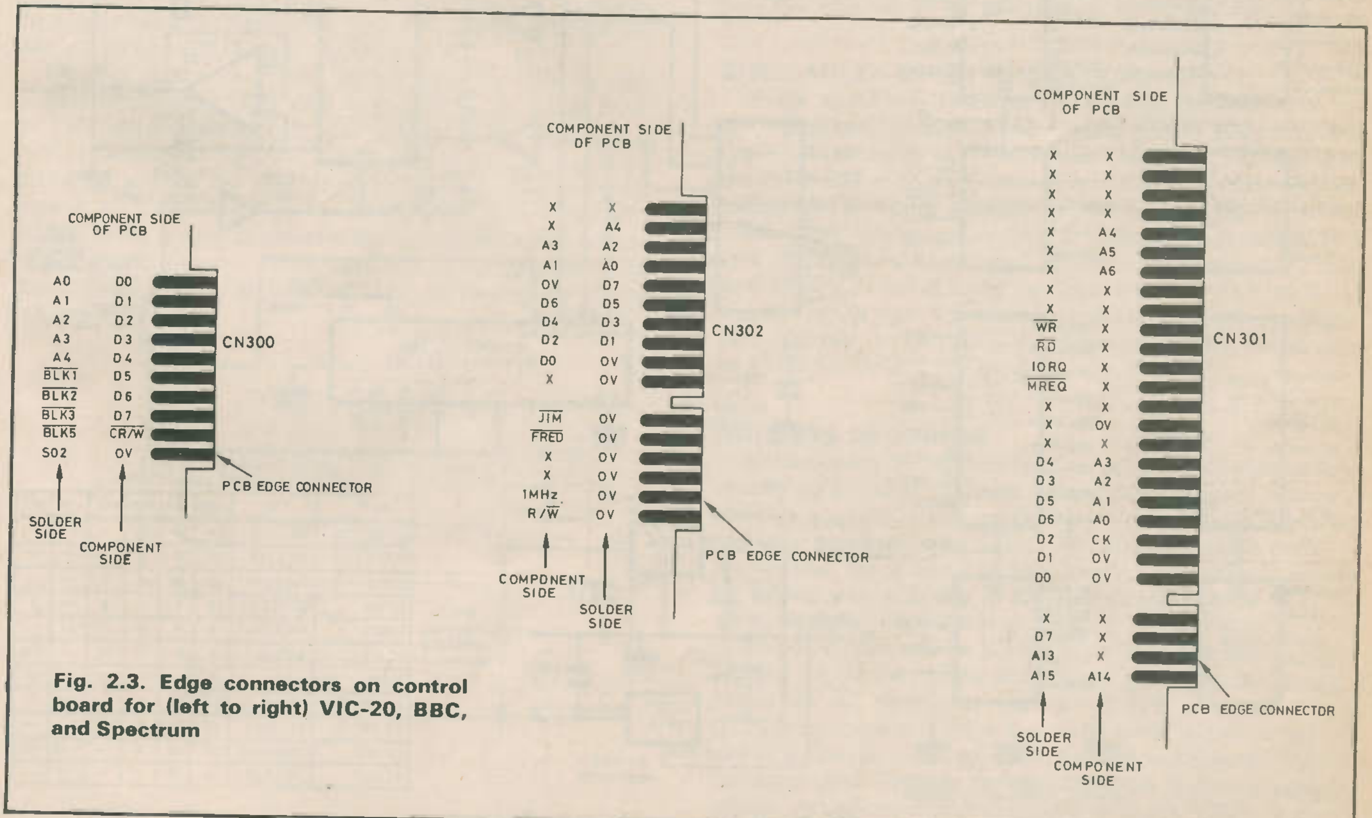
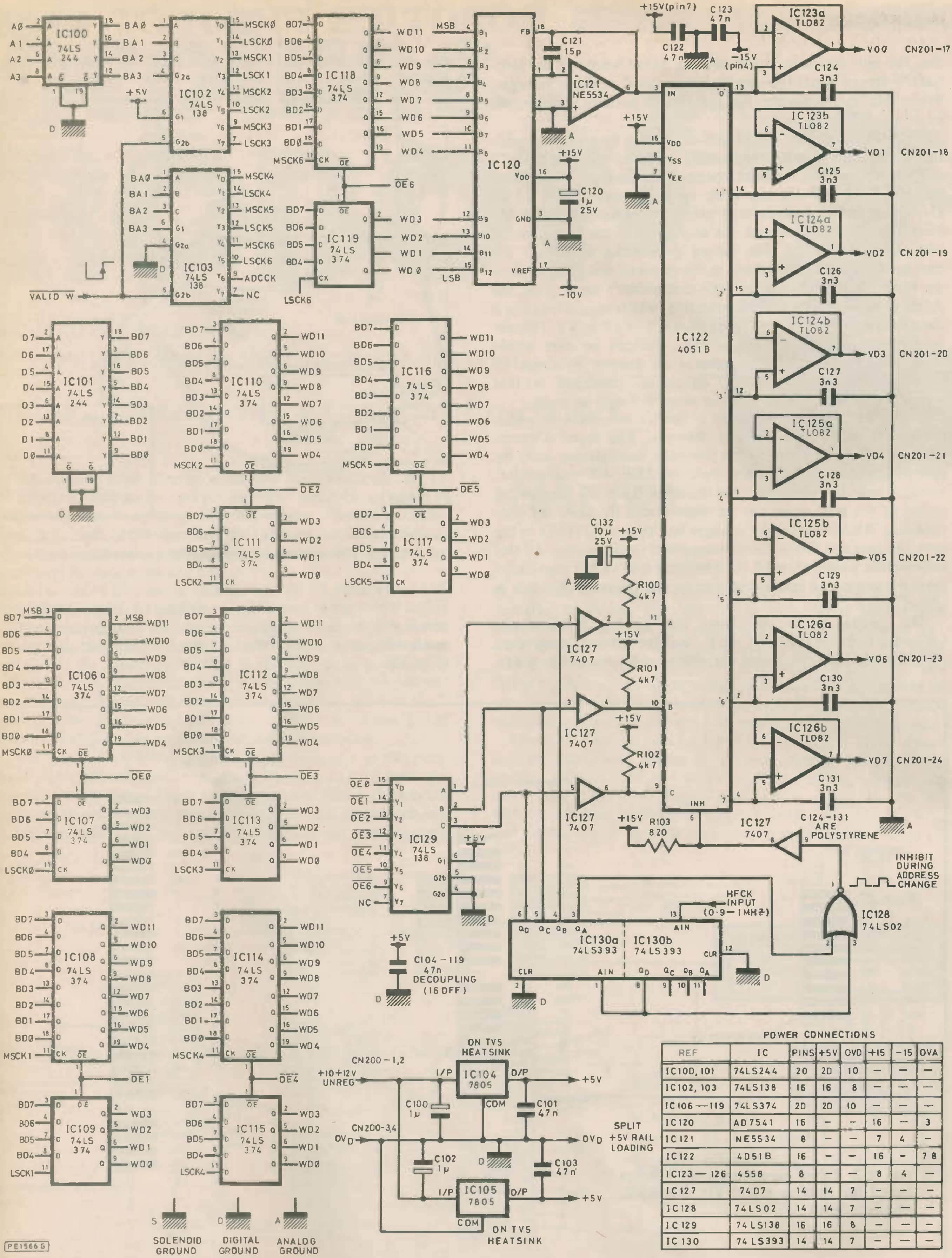


Fig. 2.3. Edge connectors on control board for (left to right) VIC-20, BBC, and Spectrum



POWER CONNECTIONS

REF	IC	PINS	+5V	OVD	+15	−15	OVA
IC10D, 101	74LS244	20	2D	10	—	—	—
IC102, 103	74LS138	16	16	8	—	—	—
IC106 — 119	74LS374	2D	2D	10	—	—	—
IC120	AD7541	16	–	–	16	—	3
IC121	NE5534	8	—	—	7	4	–
IC122	4D51B	16	–	—	16	–	7 8
IC123 — 126	4558	8	—	—	8	4	—
IC127	74D7	14	14	7	–	–	–
IC128	74LS02	14	14	7	–	—	–
IC129	74LS138	16	16	8	—	—	–
IC130	74LS393	14	14	7	—	—	–

Fig. 2.4. Robot control electronics

INTERFACES

The NEPTUNES can be driven by any one of three popular micro computers: the BBC, the Commodore VIC-20 and the Sinclair ZX Spectrum. Most micros have user-accessible interfaces and with small changes others could also be used. The NEPTUNE's requirements are a parallel data bus (8 bits), the lower address lines, the clock signal from the micro and the READ and WRITE signals. By using these basic signals it is possible to write 12-bit data words (a byte and a nibble) to the 7 axes of the robot. Also, using this simple interface, the axis position can be read (again with 12-bit resolution) by the host computer.

This enables the real time motion of the arm to be monitored and recorded. The learn axis information is first read by the computer and then written into the arm, enabling direct control of the position of the arm without writing-in software and position control data. The signal pinout for all three computers on the main NEPTUNE board is shown in Fig. 2.3. All three edge-connectors are directly accessible to the user. Other signals from the computer are available, but are not used.

THE HARDWARE

The hardware shown in Fig. 2.4 is used to store the position co-ordinates and convert them into d.c. voltages for the servo units. IC101 is used to buffer the computer data bus. If the robot electronics were directly connected to the host computer's data bus the loading of it and the spurious signals picked up by it, would almost definitely crash the system. The same is true for the address bus, hence the buffer IC101. IC102 and IC103 decode the bottom 4 address lines, providing 16 available address locations to WRITE into.

A VALID WRITE signal is also required to activate the address decoders. This is obtained from the computer interface circuits. When one of the outputs of IC102 or 103 goes low and then high, it clocks the latch to which it is connected (IC106 to 119). Any data on the data bus at this time is then stored in the latch. This is a WRITE cycle. As the system uses 12-bit words, the writing has to be done twice. First an 8-bit byte is stored and then a 4-bit nibble at the next address location.

The data is extracted from these latches by enabling their outputs in sequence. This data is wired into the 12-bit DAC (IC120) which generates the d.c. position voltages. IC122 is used to demultiplex the DAC output voltage, the voltages being stored on sample and hold devices, IC123 to 126. A binary counter (IC130), which is clocked by the host computer's system clock, is used to generate the multiplexer addresses and output enable decodes. Great care has to be taken over the demultiplexer design, as it is very easy to corrupt the output voltages.

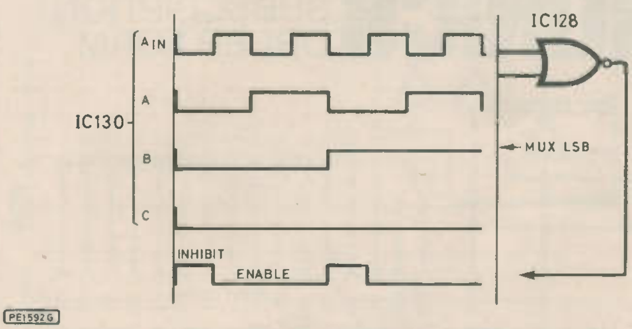


Fig. 2.5. Demultiplexer inhibit timing

The 4051 (IC122) suffers from momentary internal short circuits when the address changes on its inputs and this can seriously damage your sampled and held output voltage which would then become corrupted. An overlapped inhibit signal prevents this (Fig. 2.5). Also, when is a capacitor not a capacitor? Answer, when it is used in a sample and hold circuit. A parameter called dielectric absorption can make the voltage on a capacitor go soggy. Fortunately not all dielectric materials behave similarly and the cure is to use a capacitor constructed from polystyrene.

THE COMPUTER INTERFACE

The NEPTUNE robots were designed to interface with three popular micro-computers, the BBC, the Commodore VIC-20 and the Sinclair ZX Spectrum. All computers perform reads and writes to the robot. As far as the computers are concerned, the robot arm is just another area of memory. The three computers have significantly different internal electronics and so require different interface circuits at the robot end. See Fig. 2.6.

BBC INTERFACE

Connection to the BBC is via the 1MHz bus. This is a parallel interface with the lower 8 address lines, 1MHz system clock, $R/\overline{W}$ and an address block decode called $\overline{\text{FRED}}$ (Hex FCØØ to FCFF). The BBC computer internally buffers the data and address lines, which makes the interfacing very easy indeed. Simple decoding (IC300 and 301) is used to generate valid read and write pulses.

VIC-20 INTERFACE

The VIC-20 is similar to the BBC in that both computers use a 6502A microprocessor. The VIC provides four 8K block decodes, one of which is to be selected by the user with link 12, that is the first position selects block 1 (Hex 2ØØØ-3FFF). Valid read and write signals are generated by IC303 and 304.

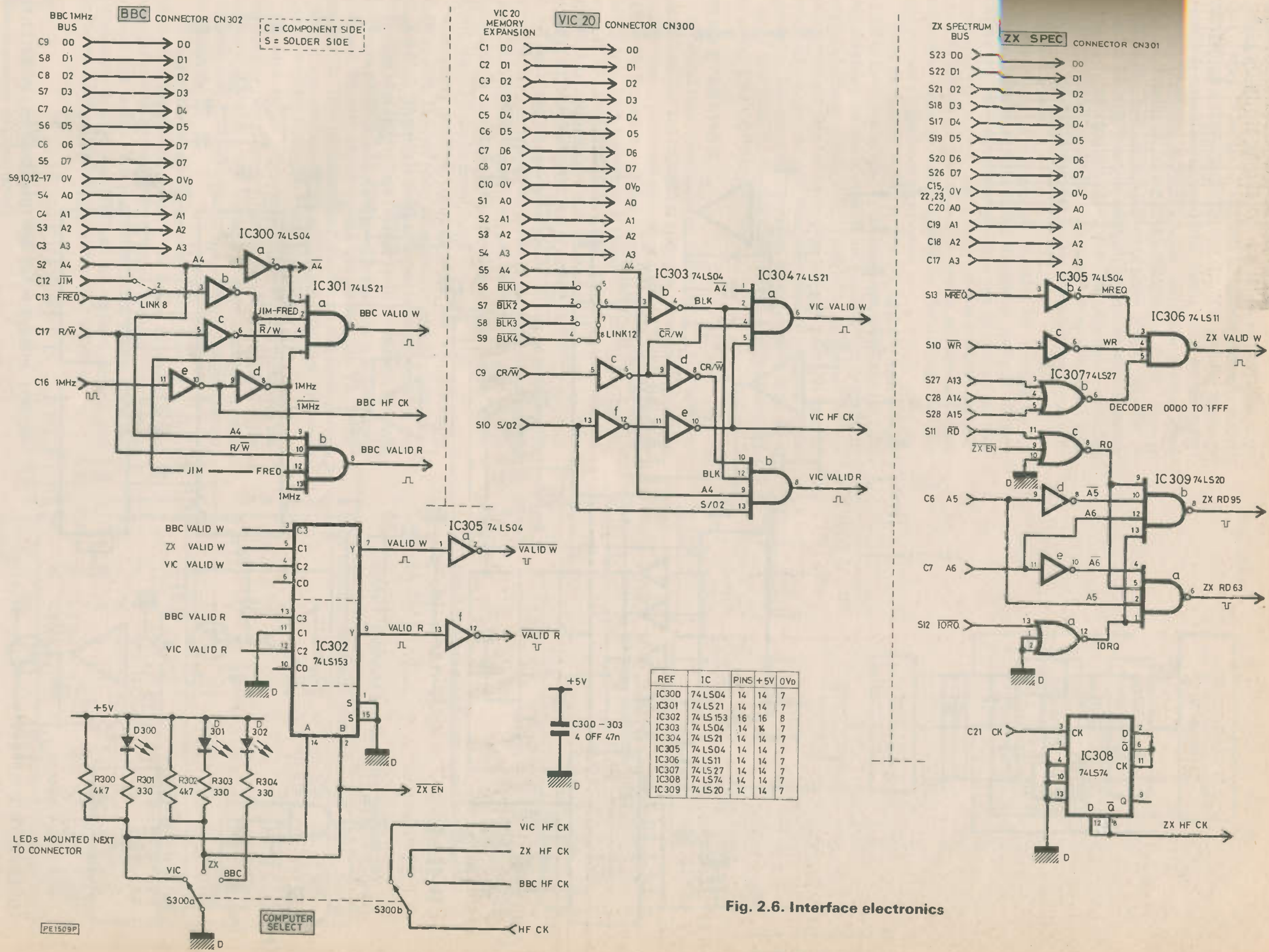
SINCLAIR ZX SPECTRUM INTERFACE

Every signal is available at the back of the Spectrum, but there are many possible problem areas and so great care was needed in the design of this interface. The Spectrum uses a Z80 processor and so some dissimilarities between this computer interface and the other two are inevitable. Also the use of the memory map varies and reading presents a few problems. In a 48K Spectrum, a PEEK read anywhere in the memory map would cause a read of either the Spectrum's ROM or the RAM and this would clash with data from the robot interface connected to the bus. An IN read is therefore used treating the robot as an I/O device instead of part of memory.

ADDRESS DECODING

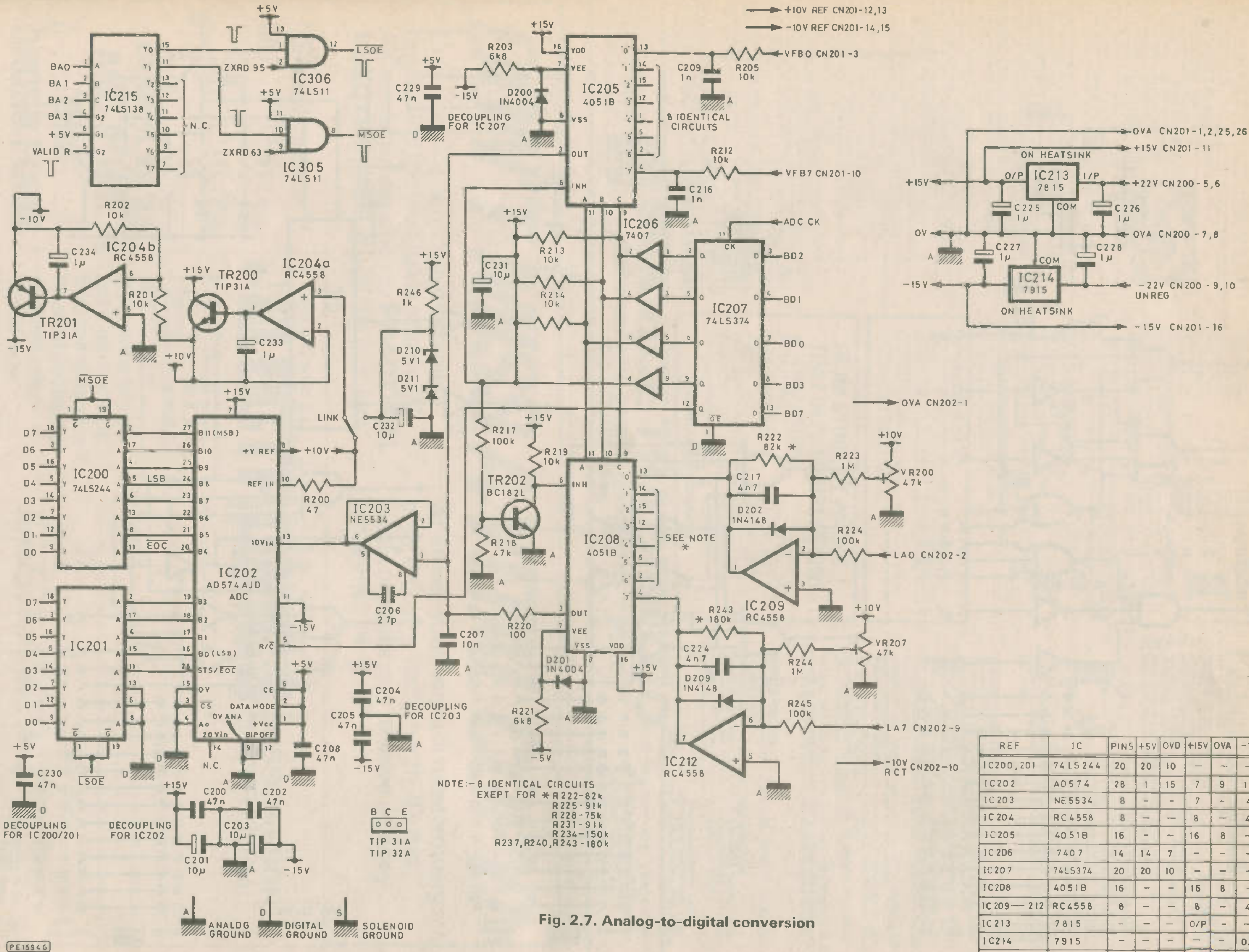
Unfortunately the address lines are not decoded and are used directly for keyboard scanning and peripheral control. There are however a couple of non-conflicting addresses (hex 3F and 5F) and these are decoded by IC305–309. Writing requires more addresses than are available as I/O, however no conflict is caused by writing with a POKE to the address space ØØØØ to 1FFF where the Spectrum ROM is resident.

Only one computer at a time must be connected to NEPTUNE. All the data buses and address buses are directly connected to all interfaces, and so if two computers were simultaneously connected, a bus clash would occur. A selector switch is used to route the valid read and write signals and the computer clock signal to the relevant places in the control electronics. A l.e.d. near each connector indicates which computer interface has been selected.



REF	IC	PINS	+5V	0V_D
IC300	74LS04	14	14	7
IC301	74LS21	14	14	7
IC302	74LS153	16	16	8
IC303	74LS04	14	14	7
IC304	74LS21	14	14	7
IC305	74LS04	14	14	7
IC306	74LS11	14	14	7
IC307	74LS27	14	14	7
IC308	74LS74	14	14	7
IC309	74LS20	14	14	7

Fig. 2.6. Interface electronics



REF	IC	PINS	+5V	OVD	+15V	OVA	-15V
IC200, 201	74LS244	20	20	10	—	—	—
IC202	AD574	28	1	15	7	9	11
IC203	NE5534	8	–	–	7	–	4
IC204	RC4558	8	—	—	8	—	4
IC205	4051B	16	–	–	16	8	—
IC206	7407	14	14	7	–	–	—
IC207	74LS374	20	20	10	–	–	–
IC208	4051B	16	–	–	16	8	—
IC209—212	RC4558	8	–	—	8	–	4
IC213	7815	–	—	—	O/P	–	—
IC214	7915	–	—	–	—	–	O/P
IC215	74LS138	16	16	8	—	–	—

Fig. 2.7. Analog-to-digital conversion

ANALOG TO DIGITAL CONVERTER

NEPTUNE has the ability to read in, via an ADC, the position of each of its arm joints and to transfer this information back to the host computer. See Fig. 2.7. The position feedback voltage is converted into a 12-bit binary code by the ADC IC202. This device performs a single conversion in about 25µs, which is fast enough for real time monitoring of all the 7 axes. A read of all 7 axes can be achieved in under 200µs. The ADC is an AD754 which uses an internal, successive approximation register to perform a fast conversion. The only signal needed to operate the ADC is a high-to-low Start Conversion signal, R/$\overline{C}$ on pin 5. The ADC then performs the conversion and 25µs later the result is ready.

Two sources of voltages are available for selection by the system. When multiplexer IC205 is selected, feedback voltages (VFBØ to VFB7) from the robot axes can be read by the host computer. This is a very useful feature in that it enables the computer to observe the dynamics of the system and optimise future trajectories based upon past experiences. The computer can also plot out these trajectories on a printer.

When multiplexer IC208 is selected the learn axis voltages (LAØ to LA7) can be read by the computer. VFB7 and LA7 are not necessary for the control of the robot but are provided to enable additional sensors to be connected to the system. The LA parameters are then fed back to the axis controllers so that the robot arm copies the real time motions and positions of the simulator. The computer memorises the movements either on a regular time basis, for example every 100ms, or when instructed by pressing the COPY key.

READ OPERATION

A typical read operation is as follows (Fig. 2.8). The multiplexer selection and multiplexer address is set up in control latch IC207. This is performed by writing a control byte to this latch (Table 1). The selected analog voltage is then connected to the ADC input. Start conversion is initiated by taking BD7 on the latch IC207 from a high to a low. This is another write to IC207. The conversion is now underway. It is best to delay resetting BD7 until after the end of conversion ($\overline{EOC}$) so as not to risk disturbing the analog voltage. A test can be performed to see if the ADC is finished, as pin 28 of the ADC is a status bit (also called $\overline{E}$nd $\overline{O}$f $\overline{C}$onversion), and when this bit goes low the conversion is complete. By performing a read on bus buffer IC201, the $\overline{EOC}$ can be tested.

Alternatively the host computer could just wait a suitable length of time. This will occur automatically with programs written in BASIC. Reading is then performed in two steps. First the most significant byte is read ($\overline{MSOE}$ IC200) and then the least significant nibble ($\overline{LSOE}$ IC201). The conversion is now complete and the next analog voltage can be selected. The ADC provides the 10V reference signal for use on the servo potentiometers and simulator. If the ADC is not fitted then the zener diode (D210, 211) reference is used.

The axes operate independently; the voltage representing the required axis position is sent to the solenoid driver board of the appropriate axis, together with the position feedback voltage. For seven axes of movement, therefore, there are seven solenoid driver boards.

The system utilised is a closed loop servo system. When it is desired to change an axis position, the analog equivalent of the data operates the hydraulic valves, via the solenoid driver board, and the axis moves. The position feedback voltage from the potentiometer is then compared with the requried position, and movement continues until the two voltages are the same.

NEXT MONTH: Details of the servo system, and the power supply requirements.

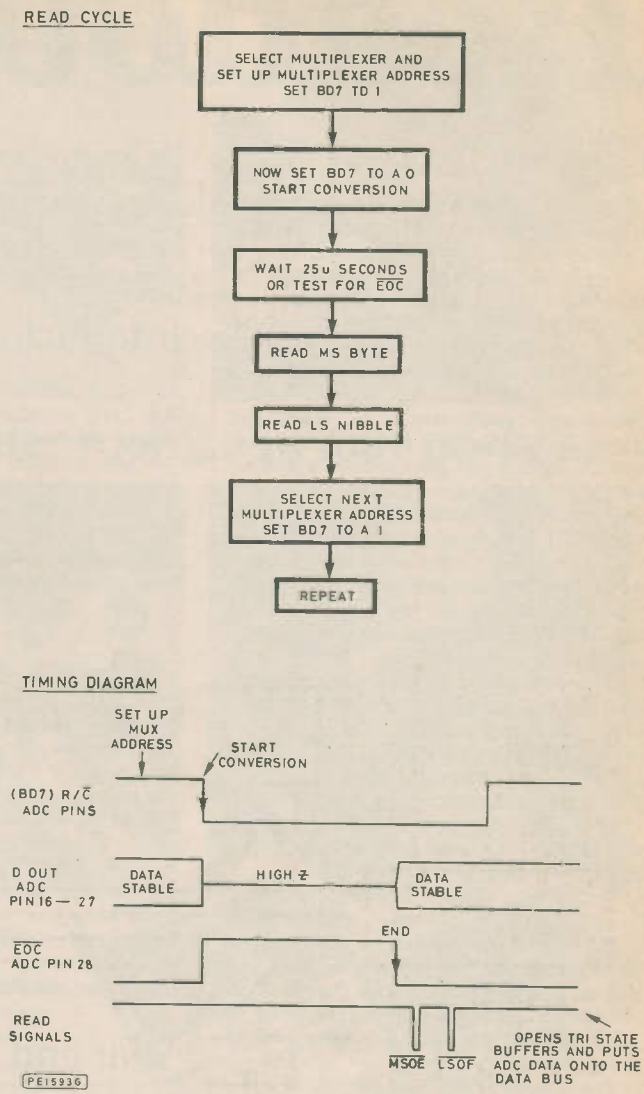


Fig. 2.8. Sequence for read and conversion

Table 1. Neptune axis selector, latch IC207

BD7	BD6	BD5	BD4	BD3	BD2	BD1	BDØ	HEX	Signal
/	x	x	x	0	0	0	0	x0	VFBØ
/	x	x	x	0	0	0	1	x1	VFB1
/	x	x	x	0	0	1	0	x2	VFB2
/	x	x	x	0	0	1	1	x3	VFB3
/	x	x	x	0	1	0	0	x4	VFB4
/	x	x	x	0	1	0	1	x5	VFB5
/	x	x	x	0	1	1	0	x6	VFB6
/	x	x	x	0	1	1	1	x7	VFB7
/	x	x	x	1	0	0	0	x8	LAØ
/	x	x	x	1	0	0	1	x9	LA1
/	x	x	x	1	0	1	0	xA	LA2
/	x	x	x	1	0	1	1	xB	LA3
/	x	x	x	1	1	0	0	xC	LA4
/	x	x	x	1	1	0	1	xD	LA5
/	x	x	x	1	1	1	0	xE	LA6
...	x	x	x	1	1	1	1	xF	LA7

x = don't care. / = start conversion bit. 1→0 = start conversion.

Readout...

Forward Looking

Sir—I read with interest and some amusement your comments on the IEE in *Vernon Trent at Large* in the August issue of P.E.

You accuse the Institution of living in the past. May I suggest it must be some time since you yourself visited the Institution. The statue of Faraday which you regard as 'off-putting' has now been put off and no longer dominates the entrance hall. Some of us thought that 'all that marble' really was a bit much and proposed that the floor should be carpeted. Our members would have none of it and we are now hard at work re-laying the marble floor (at some considerable expense). You say we do not hold meetings, debates and conferences but only seminars or conversaziones. Again have you seen our programme? I cannot recall when last we held a conversazione and only a limited number of seminars which are essentially tutorial are held.

One of the interesting aspects these days is the large number of younger members who have joined the Institution. The vigour with which they promote their views and their effectiveness in influencing the affairs of the Institution is most encouraging.

We believe we are a forward-looking Institution; why not come and see where we are going rather than dwell on the past.

Howard Losty (Sec),
IEE, London.

It is about two years since I was last in direct contact with the IEE and at that time I did not detect any appreciable change in the atmosphere and outlook of the preceding 18 years. It seems times are a'changing with the speed of light.

The removal of the giant Faraday is a real step forward. But what has happened to this awesome example of the sculptor's art? I do hope he's not being kept on ice in the basement in case some future generation of the IEE management has a change of heart.

It's a shame about the marble. But I can't help feeling that the spirited objection of your members to its removal only goes to prove my argument that reluctance to change is still deep-seated. Of course, you could have saved a lot of money if you had broken up Faraday and used the pieces in your relaying operation.

No, I haven't seen any of your latest programmes, I'm afraid. That's remiss of me. But in fairness, I was cheered to read, sometime after my article was written, that you had taken over the Dominion Theatre for the Faraday Lecture. This is really reaching out, staging such an august event in a building to which in earlier months people were flocking to see Mary Poppins.

I stand duly rebuked over the seminars and conversaziones.

Your statement that younger people are joining the Institution in large numbers is clearly at variance with the official report on which my observations were based. But obviously I must accept what you say so far as the IEE is concerned. I only hope that the 'vigour with which they promote their views and their effectiveness in influencing the affairs of the Institution' will continue to bring that breath of fresh air, which from my viewpoint seemed to be lacking.—VT.

Interfacing VIC

Sir—With reference to your *Commodore 64 RS 232C Interface* by R.A. Penfold in the August issue of Practical Electronics. Could you please inform me whether the described interface is also appropriate to the VIC 20?

I have recently wished to couple a Tandy CGP115 printer/plotter to the VIC 20 and, of course, came up against the very problem that your article solves for the '64.

R.A. Prince,
Welwyn Garden City,
Herts.

I have tried the CBM64 RS232C Interface *with a VIC-20, and without any software or hardware modifications it does seem to work. However, there is a slight problem in that as the electrolytics in the power supply section of the unit charge up the 20mm 1A quick-blow fuse in the VIC does occasionally blow. This does not seem to affect the CBM64 which has a slower acting 1·25 inch fuse. The problem with the VIC can be overcome by replacing the quick-blow fuse with an anti-surge type, or adding current limiting resistors of about 10R in series with each 9V output of the user port would probably eliminate the problem.—R.P.*

War and Peace

Sir—Isn't it enough that we have to put up with political views being pressed on us by national newspapers and TV, without our hobby magazine attempting to do the same?

I refer to *Industry Notebook* by Nexus. He's at it again (August); airing his views about Unions—one of his hobby horses—and giving his blessing to military electronics. Miners, lorry drivers etc.,—Nexus is there to give us his opinion and to lecture us. Just *what* 'industry' are you reporting on, Nexus?

There's no mistaking his allegiance, I'll give him that, but I don't think he should use his page to stir up this sort of stuff. To clarify (I hope), I mean that I am not interested in his *opinions* or *views*, only his reporting, and even that ought to be relevant to the magazine's title.

Of all the developments and news about industry there is no *need* for him to scrape the bottom of the barrel. News of rival Standards, processes, who's first with what system etc., is what I like to read.

I haven't expressed that very well, but if I can give you an example of interesting reporting on the Electronics Industry—the newspaper "Electronics Times," should give a good idea. Of course, there will be large amounts on military electronics in it, and an occasional mention of Unions (especially in relation to Telecoms)—but not in that irritating 'take it from me, sonny' style, which Nexus seems to have.

Give it a rest, Nexus, and stop using *Industry Notebook* as a platform for your political views.

D. Field,
Poole, Dorset.

Bigoted Outlook

As your publication provides no forum for political answers to the highly prejudiced statements of your contributor 'Nexus' I am writing to you in order to express my opposition to some of his/her more outrageous sentiments over the past few months.

I have in mind *Industry Notebook* in the August issue. Having criticised the GCHQ Union for a "prolonged and noisy protest" the writer (wrongly) states "with GCHQ employees surrendering their membership for immediate financial advantage" (Paragraph 2).

This is not the case—the workforce at GCHQ were faced with three alternatives—1) Drop out of the Union with a cash sweetener. 2) Be transferred (under a cloud) to regions unknown. 3) Be sacked. Equally vain is this writer's claim that it was "a lost cause"—vis-a-vis the recent High Court finding.

I am not an ex-employee of GCHQ nor have I been a member of a Civil Service T.U.

After a vicious attack, culled from the right-wing press, which contained all the heavy old clichés about ballots, violence, obscenities, provocation, civil war and union 'bosses', the writer dissolved the working class in eight lines of nonsense and in the next paragraph brought in the questions of "sweetheart agreements, peaceful negotiation, creation of wealth".

Where have you been keeping this character? Can he/she inform us how you create wealth in a closed coal mine after you have been sacked?

I am aware that this letter deals with political issues but nonetheless I consider that a technical journal should confine itself to technical matters. General interest items should of course be included but please, not a column devoted to the bigoted outlook of one contributor.

I feel so strongly about this issue that it puts a severe strain on my loyalty to 'P.E.' I am certain that there are other electronics journals who do not inflict one-sided-no right of reply-articles on their readers.

W.L. Thomas,
Lydney, Glos.

Nexus replies:

Nobody has been 'attacked' by me. I did comment that the GCHQ and Miners' causes were just. The remainder of which Mr Thomas complains was fact, not opinion. The GCHQ picket was prolonged and noisy and the NUM remains split and picketing was as described. There is a movement, led by the EETPU in the new industries, to eliminate strikes as being outdated, destructive and benefiting nobody. The initiative is from the EEPTU, not from me, and deserves to be put on record. Build-up rather than smash-up seems reasonable. Why not give it a chance!—Nexus.

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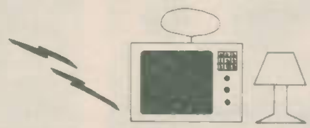

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DL3000K	3-Channel Sound-to-Light	£12.95
TD300K +	300W Touchdimmer	£7.75
TS300K +	300W Touchswitch	£7.75
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TDR300K +	IR Remote Controlled Lightdimmer	£14.95
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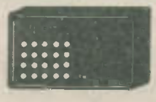

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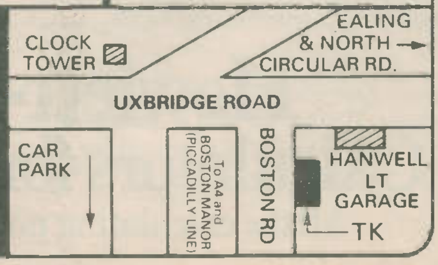

OTHER SOLAR SYSTEMS?

The Infra-Red Astronomical Satellite (IRAS) was launched on 25 January 1983, as a joint Anglo-American-Dutch venture. Its orbit carried it round the Earth in a period of 103 minutes, and it stayed in sunlight for most of the time, because its path took it above the poles; its mean altitude was 560 miles.

Almost immediately after launch, the first important results started to come in, and during its active career, which lasted through most of 1983, *IRAS* sent back a stream of fascinating information. Several new comets were discovered (including one which became briefly visible with the naked eye) and one known periodical comet, Tempel 2, was found to have a dust-tail twenty million miles long. There were also "dust rings" in the Solar System itself, and *IRAS* detected a strange asteroid whose orbit carries it within 9,000,000 miles of the Sun.

Yet the main work concerned the infra-red sources far beyond the Sun's realm. *IRAS* surveyed the whole sky, and detected thousands of new sources. All in all, it was possibly the most successful astronomical satellite to date.

The information was collected at the Rutherford-Appleton Laboratory at Chilton, in Oxfordshire, where the preliminary analyses were carried out. Two of the American scientists there were Dr. Hartmut Aumann of the Jet Propulsion Laboratory in California, and Dr. Fred Gillett of the Kitt Peak Observatory in Arizona.

They were using various stars as sources for calibrating the infra-red telescope on board *IRAS* when they made a startling discovery. Dr. Gillett was examining some of the records when he said, suddenly: "Hey! Alpha Lyrae has a huge infra-red excess." Alpha Lyrae is, of course, the brilliant blue Vega, 26 light-years away and over 50 times as luminous as the Sun.

What did it mean? At first Aumann and Gillett wondered whether there could be some mistake, so they examined other bright stars, such as Altair, which is of the same type as Vega though it is less powerful. Nothing unusual was found.

There really was material associated with Vega, and the two scientists wondered whether it could be "mass flowing out" from the star, but this idea was soon abandoned. Further studies showed that the material took the form of a cloud of particles, larger than the "dust" particles found in interstellar space.

The infra-red radiation came from a region extending out to more than 7,000,000 miles from Vega. This is eight times the distance between the Sun and the Earth, so there had to be a considerable quantity of material. In fact, it was estimated that the total mass was about the same as that of all the planets in our Solar System put together.

Could it be a cloud of the same kind as the "solar nebula" from which the Earth and the other planets in the Sun's family were formed, more than 4,500 million years ago? Aumann and Gillett came to the conclusion that this was a possibility, but very small particles would have been drawn back into Vega; this would leave intermediate and larger-scale débris in orbit, and this could have condensed into planets, or at least started to do so.

Moreover, there was the question of temperature. The material was found to be about −300 degrees Fahrenheit, about the same as that of the particles making up the rings of Saturn.

All this was exciting. Surveys were continued, and one more star—Fomalhaut—was found to have a similar infra-red excess, for the same reason. There could be no doubt about it; the material was there, and planets were a real possibility. But could they be of the same type as the Earth, and could they support our kind of life?

To answer this, we must look more closely at the two stars concerned. Vega, as we have seen, is more than 50 times as powerful as the Sun; Fomalhaut, at a distance of 22 light-years, is the equal of 13 Suns. Both are much hotter than the Sun, and both are more massive. This means that they run through their life-cycles much more quickly.

Nothing much will happen to the Sun for the next 5000 million years or so, which is fortunate for us; but Vega will not last for more than a few hundreds of millions of years before it uses up the available nuclear "fuel" which keeps it shining steadily. It will then have to change its whole structure, and there will be a period during which it will send out

THE SKY THIS MONTH

For the next fortnight or so you have a good opportunity to see the elusive little planet Mercury—provided that you get up early! It is emerging from the morning twilight, and reaches its greatest elongation (apparent distance from the Sun) on 14 September, when it will appear telescopically as a tiny half-moon. Rather surprisingly, it is then brighter than any star visible from Britain except Sirius, but this is not obvious, because Mercury is always seen against a light background.

Most of our knowledge of it comes from one space-probe, Mariner 10, *which made three active passes of the planet and sent back pictures showing a rough, crater-scarred surface very like that of the Moon. Mercury is smaller than the Earth (its diameter is 3000 miles) and has practically no atmosphere, so that life there is out of the question.*

Look for Mercury with binoculars by all means—but only when the Sun is still below the horizon. Never sweep around with binoculars after sunrise; there is always the danger of looking straight at the Sun by mistake, with tragic results for your eyesight.

The other inner planet, Venus, is visible after sunset, low in the west; it is over 90 per cent illuminated. Mars and Saturn are being lost in the evening twilight, though Jupiter is still brilliant in the south-west during evenings. The Moon is full on 10 September, and will be new on the 25th.

Now that the nights are lengthening, the stars can be seen to better advantage. The "Summer Triangle" of Vega, Altair and Deneb is still very much in evidence. The Plough or Great Bear is at its lowest, in the north, though over Britain it always remains well above the horizon. Arcturus is setting in the north-west, Capella rising in the north-east.

Also in the east, during late evening, look for the lovely star-cluster of the Pleiades or Seven Sisters, in Taurus (the Bull). The Pleiades have been recorded since very ancient times, and there are many legends about them; according to one tale they were seven beautiful girls who were chased by the hunter Orion, and were saved from a fate worse than death by being transformed into stars and placed in the sky! I always think that the first sign of the Pleiades in the evening is an indication that winter, with its fogs and snows, lies ahead.

The main autumn constellation is Pegasus. In mythology, Pegasus was a flying horse. In the sky he is marked by four reasonably bright stars forming a "Square". At present the Square is high in the south during evenings, and is not hard to locate, even though many people looking at maps imagine it to be smaller and brighter than it really is.

Follow down the line of the two western (right-hand) stars of the Square, almost to the horizon, and you will come to the bright star Fomalhaut, which is always very low down as seen from Britain—from North Scotland it is unlikely to be seen at all. It is one of two stars (Vega is the other) being studied by IRAS, *the Infra-Red Astronomical Satellite, and found to be associated with material which may be planet-forming.*

much more energy than it does now, with disastrous results for any life-bearing planets. The same is true of Fomalhaut, though here the time-scale may be rather longer.

Therefore, it seems that Vega's system (and also Fomalhaut's) will never evolve into a Solar System like ours, because it will not have sufficient time before conditions become hopelessly hostile. We cannot expect Earth-type life, and probably no life of any kind. For this, we must look to more sedate stars which more closely resemble the Sun.

INVISIBLE BODIES

In spite of this, the *IRAS* revelations are immensely significant. It had already been suspected that some dim, relatively nearby stars are attended by planets, because they show slight "wobblings" in their slow motion across the background of more distant stars, and these "wobblings" may be produced by invisible bodies of planetary type.

Now, with the news from Vega and Fomalhaut, the presence of other Solar Systems becomes even more plausible. And after all, why not? Our Sun is an ordinary star—one of 100,000 million in our Galaxy alone, and modern telescopes can record at least a thousand million galaxies. It would be absurd to suggest that in all this host, the Sun is unique in having a family of planets.

IRAS has come to the end of its active career. It will be succeeded by new infra-red satellites, which will examine other stars and will almost certainly detect material around some of them.

There is also the forthcoming space telescope (the Hubble Telescope), due to be launched within the next few years; it will have a 94-inch mirror, and will operate from above the atmosphere in free flight round the Earth, controlled from the ground. Its main investigations will be in the visible and near infra-red parts of the electromagnetic spectrum, and it will be far more effective than any telescope at ground level could hope to be.

SEARCH FOR ET

If planetary systems are common (as now seems more likely than ever), we must ask ourselves about the chances of extra-terrestrial life. Here, too, we would surely be conceited in claiming that we are unique, but as yet we have no positive information to guide us, and contact with other civilisations will be a very difficult matter—even assuming that they exist within reasonable range of us.

Meanwhile, the new findings have caused something of a change in outlook, and we may hope for more striking developments in the near future. So if you go outdoors on the next clear night and locate Vega and Fomalhaut, you will be able to realise that there is something very significant about them—even though to us they appear as nothing more than tiny points of light.

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PRACTICAL Electronics 1965 to 1974 inclusive. A few missing. Offers please. Mr. K. Chorley, 7 Foxfield, Everton, Lymington, Hants SO4 0LR. Tel: Lymington 45231.

HAMEG scope HM307 built-in component tester as new with probes £85. Tel: Milton Keynes 564737.

WANTED circuit diagram for 'Intellivision' speech module. Write to: Mr. P. Blomley, 6 Pennine Drive, Milnrow, Lancs. OL16 3DT. Tel: Rochdale 32863.

WANTED JVC GNC 80 Genlock/Sync coupler for JVC video cameras type G71 or S100 (or circuit). Mr. J. Henderson, 27 Poplar Avenue, Great Harwood, Blackburn, Lancs. Tel: (0254) 885129.

WANTED Signalite (general instrument) gas discharge display type SL 700-4 (or direct equivalent). Brian C. O'Donnell, 15 Glenmoy Terrace, Forfar, Angus DD8 1NL. Scotland. Tel: (0307) 64239.

OSCILLOSCOPE USSR S Beam £30. Collins TX/RX TCS-12 £25. Practical Electronics/Wireless 1966-1979 offers—buyers collect. Mr. J. B. Carlile, 10 Cedric Avenue, Marshalls Park, Romford RM1 4JL. Tel: Romford 67627.

WANTED large sheets glass fibre PCB DS & SS. PCB drill with optics. High class R.F. test gear. Mr. S. J. Branson, 111 Park Road, Peterborough PE1 2TR. Tel: (0733) 67604 (weekends).

HELP. Wanted any information on oscilloscope made by A.C. Cossor model 1052. To buy or borrow. Mr. R. Parkes, 102 Abbotts Street, Bloxwich, Walsall, West Midlands WS3 3BP. Tel: Bloxwich 78144.

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PE BAZAAR OCTOBER '84

VERNON TRENT at Large!

V.T.'s views and opinions are entirely his own and not necessarily those of PE

OVER the past few months I've been looking (sometimes, as you've probably noticed, with a jaundiced eye) at the continuing impact that electronics is making on the way we live, play and work.

I've wandered into industry, agriculture, retail trading, the domestic scene, the Church, medicine, help for the blind and so on. I've even been able, in our April issue, to lift the veil on certain hush-hush developments in the United States that can only be described as revolutionary. And if you believed that report, you will—as the Duke of Wellington said to someone who asked him if his name was Simpkins—believe anything.

Until last week, however, I hadn't got around to the subject of sport, with which the visual and audio media confidently thinks every man-jack of us is besotted. It was then that I ran into an old buddy, Jerry Monk, group publicity manager of the Greyhound Racing Association. He came up with a lot of interesting facts, including the shameful revelation that his particular sport seems, by and large, to be getting along, thanks very much, with no more than a modicum of electronic intervention.

As a sporting attraction, Jerry told me, greyhound racing ranks second only to football in the UK, drawing about eight million fans through the turnstiles every year. The animal itself has a noble history. King Solomon described it as "one of the four things that are comely in going" (he didn't say what the other three were—I'm longing to find out).

Greyhound kennels existed in Anglo-Saxon times and Canute—probably still smarting under the disobedience of the waves—petulantly decreed that only those of royal descent should be allowed to keep greyhounds. The regal touch was revived in 1968 when the Duke of Edinburgh's *Camira Flash* won the Greyhound Derby at White City.

Originally greyhound coursing involved a live hare. Then in 1876 there came a startling innovation at Hendon in North London. For the first time the prey was an artificial hare which ran on a live rail embedded in the turf of a 400-yard straight course.

The forerunner of modern greyhound racing came into being in Tucson, Arizona, in 1909, with dogs competing on a circular course. Belle Vue, Manchester, saw the first British meeting within this concept in July 1926.

★ ★ ★

On-course betting on greyhound races is handled by the totalisator. Mindful that PE readers have in many cases led sheltered lives, let me explain that this is an electro-mechanical system in which the aggregate stake, less admin charges and tax, is paid out to winners in proportion to their stakes. It is, in essence, a jumbo-size calculator with a jumbo-size read-out.

"Many of these machines," said Jerry, "have been in use for more than 30 years and are approaching the end of their useful lives. We can't replace them because they aren't being made anymore.

"So, bowing to the march of technological time, we are just embarking on a heavy capital investment to provide the 10 stadia we own throughout the UK with fully-computerised totes based on microprocessors. Already they have been installed at Wimbledon in SW London, Slough and Portsmouth.

"They will have the great advantage of faster operation and will make possible a much wider variety of betting combinations. And eventually the giant visual boards which have been with us for so long will be replaced by monitors set up in strategic positions round a course and giving much more information than hitherto.

"It's an expensive operation, as I say, but we believe that it will eventually more than pay its way."

Another project in hand, though it cannot accurately be described as one involving electronics, is to run the hare on a linear motor. The dividend here is vastly simplified maintenance.

"But while we naturally want to keep up with the times so as to give our patrons the advantages of modern developments," said Jerry, "you have to remember that basically our business is based on animals. Greyhounds are motivated by instinct and training, not by what electronic research and development offers.

"People often ask whether the hare is really necessary to a successful race. On the face of it, it isn't. Generally speaking, greyhounds will run because they are trained that way, whether or not they have a prey to follow.

"We've proved that by experiment. But the hare still has to be there. Should one nervous dog cotton on to its absence and falter, the rest of the field will falter too."

★ ★ ★

Greyhound racing has had a somewhat chequered career in Britain. Originally it was regarded as a cloth-cap type of sport. Indeed, at one point the totalisator was outlawed because it was thought it encouraged the working classes to fritter their money away.

Then by the early 1950s it had achieved a greater respectability. Track managements went out of their way to build up an "have-an-evening-out-with-the-wife" image. Catering facilities were improved out of all recognition.

Industry was wooed to provide sponsorship—many of the big classic races are now backed by household names. A night at the dogs became as much a feature of company-customer entertaining as a box at Goodwood.

Nevertheless, the sport has been hard-hit by the cold wind of recession and by the emergence of the betting shops which have enabled punters to back their fancies without turning out on a cold night. But the tide is turning again and attendances are on the up-turn.

" . . . only those of royal descent should be allowed to keep greyhounds."

But however one may advocate the adoption of chip and other modern technology as a means of cutting costs, improving profits and increasing efficiency in other fields, one stark fact remains. Greyhound racing, while still hovering on the electronics periphery, manages to achieve a staggering betting turnover of more than £600 million a year.

Maybe there's some sort of moral here.

★ ★ ★

My friends at the Sutton (Surrey) "Talking Newspaper for the Blind" (see the March issue of PE) have been looking at a new type of reading machine, developed in the USA and available in this country at the bargain price of £25,000!

This is how it works: The material to be read is placed face downwards on a scanner, similar to a photo-copier. A remote hand-held control panel is then activated which causes the machine to automatically locate the first line of text and begin scanning the page. Within seconds an electronic voice reproduces the material.

The machine is designed to read any printed material in book or magazine form. It will also handle documents, office memoranda or typewritten correspondence. It can speed up or slow down, repeat previous lines or spell out difficult words. And while many other facilities can be achieved via its 32 controls, it cannot, alas, cope with handwriting.

While the cost of this machine could not possibly be borne by any individual charitable organisation, efforts are being made in the USA to provide its benefits at major public libraries.

Ways and means are now being sought in Sutton for bringing this benefit to its 500 sightless persons.

Here's a thought. The cost of a reading machine is probably around the equivalent of the annual salaries of three Deputy Assistant Administrators (Class III), or whatever, whiling away their time in the Civic Offices.

PULSE DIRECTION LOGIC PROBE

S.A.WITHEY

IN modern electronic circuits it is necessary to be able to detect high speed clock pulses and their direction, in addition to the d.c. logic levels of inputs and outputs. This is possible if a very expensive oscilloscope is available which can hold and stretch very short duration pulses. Many logic probe designs either omit the pulse function, or include it in association with the alternate switching of the logic level l.e.d.s. In the design presented here, a logic "0" is indicated by a green l.e.d. and a logic "1" by a red l.e.d. High speed pulses are indicated by a yellow l.e.d. in conjunction with a double pole, single throw switch, which indicates whether the pulse is positive or negative. This is not a fussy circuit. Apart from the 7404 Hex inverter and the miniature switch, the components used are values normally found in the workshop. TR1 can be any general purpose npn transistor and D1 and D2 any silicon switching diodes of 4148 or 914 type. Resistors R4 to R6 can be any value between 47 and 150 ohms, according to the brightness of the l.e.d.s available, 100 ohms being suitable for a normal quality l.e.d. and 47 ohms if using cheap pack l.e.d.s. C1 stretches a detected pulse sufficiently to illuminate the yellow l.e.d. The value and type is not critical, a 4μ7 electrolytic being chosen because it is of small physical size when laid on its side, but having sufficient capacity to hold a slow frequency pulse.

CIRCUIT DESCRIPTION

The circuit shown in Fig. 1 is powered by the host circuit which is being tested. This must be a +5V supply. With the probe in its quiescent state, i.e. not in contact with any active circuit, the input to IC1a (inverter 1) is floating—it is neither at logic "0", nor logic "1". Its output, which is connected to the input of IC1b is at logic "0". Therefore the output of IC1b is at logic "1" and unable to turn D3 on. TR1 is turned off leaving a logic "0" at the input to IC1c and logic "1" at its output disabling D4. At the same time, the input to IC1d is floating and its output is at logic "0". The input to IC1e is also at logic "0" and its output, being at logic "1", disables D5.

With a logic "0" at the tip of the probe and the input to IC1a the junction of IC1a output and IC1b input is at logic "1". The resulting logic "0" at the output of IC1b pulls the cathode of D3 to ground potential, turning it on and indicating a logic "0" at the tip of the probe. Meanwhile, TR1 remains turned off. If S1 is in the "0" position, touching a logic "0" with the tip of the probe produces a pulse at D5. Whilst there is a logic "0" at the cathode of D3 the input of IC1d which has been floating, is pulled down to logic "0" through D1. Its output goes to logic "1", charging C1, which acts as an a.c. coupling capacitor to the input of IC1e placing a logic "1" at its input and a logic "0" at its output. This pulls the cathode of D5 down, causing it to turn on. A series of high frequency pulses prevents C1 from discharging, holding D5 on.

With a logic "1" at the tip of the probe, TR1 is turned on, bringing the input to IC1c to logic "1" and its output to logic "0". This brings the cathode of D4 low and turns it on. At the same time the input of IC1a being at logic "1" disables indicator D3. If switch 1 has been changed to the "1" position, any pulses appearing at the probe tip will be indicated by D5 turning on, as previously described.

TR1 and its associated resistors have the effect of stabilizing the inputs from the probe tip. Without it the inputs would float, causing either D3 or D4 to turn on. Similarly D2 prevents the input to IC1d from floating. R3 ties the input of IC1e to ground until pulled up by the output from IC1d.

CONSTRUCTION AND TESTING

The circuit is constructed on a p.c.b. 35 × 60mm. The circuit design is shown in Fig. 2 and the component layout in Fig. 3.

The circuit is simple and could be a suitable introduction to drawing with etch resist pen. This is carried out by first taping a photocopy or tracing of the p.c.b. design over the copper side of the board and drilling the holes. Holes should

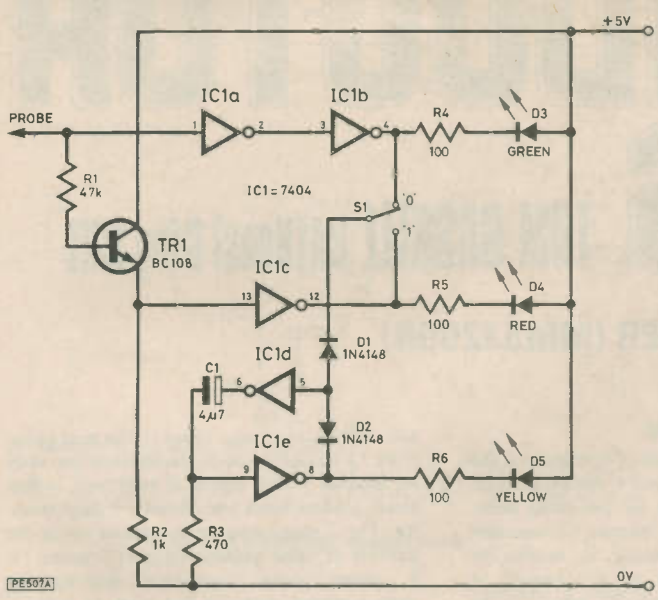


Fig. 1. Circuit diagram

COMPONENTS . . .

Resistors

R1	47k
R2	1k
R3	470
R4–R6	100* (3 off)

Capacitors

C1	4µ7* elect. 16V

Semiconductors

D1–D2	1N4148 (2 off)
D3	Green l.e.d.
D4	Red l.e.d.
D5	Yellow l.e.d.
TR1	BC108 or general purpose *npn*
IC1	7404

Miscellaneous

D.p.s.t. miniature slide switch (0·15") pitch; Case type 21026 (Electrovalue); 2mm dia. conductive rod (probe tip); Croc clips (2 off).

*See Text

Constructor's note

Case available from, Electrovalue, 28 St Judes Road, Englefield Green, Egham, Surrey. TW20 0HB. (0784 33603).

be 0·8mm for IC1, the transistor, the diodes and capacitor and 1mm for the resistors, l.e.d.s and leads. After drilling, the board should be cleaned to remove any burrs. When drawing with the etch resist pen, first draw pads around the holes and use these as a guide for drawing the lines. Since the inverter at pins 11 and 10 of the i.c. are not used, there is no need to draw these pads, allowing a line to pass between them. Etch in a solution of ferric chloride. Clean off the etch-resist when etching is complete.

Mount resistors, followed by diodes, i.c., with or without socket, transistor, capacitor and last of all the l.e.d.s. The l.e.d.s should stand-off from the surface of the p.c.b. so that they will locate in the holes in the case. Care should be taken with the polarisation of the diodes, the cathode being indicated by a broad band; the l.e.d.s, where the cathode is indicated by a flattened side and the capacitor, usually indicated by a + or – sign. The transistor emitter is indicated by a small lug on the metal case. S1 is a miniature d.p.s.t. type with 0·15" space between connectors; it is soldered directly onto the edges of the p.c.b. Stranded red and black wires with miniature croc leads are used for the power leads.

After completion of the board, a probe tip made from a suitable conductive rod is first of all bent at the p.c.b. end before it is inserted, from the component side, through the 2mm hole provided and soldered to the large pad on the copper side. The probe was designed to fit into a small plastic case of the type shown. The p.c.b. basically 'clips' into position once the holes for the switch (S1), the probe and the croc leads have been made; non-conductive foam could be used to hold the board more firmly if necessary. It was found that a small piece of plastic had to be cut away from one of the securing pillars in order to seat the p.c.b. properly so that the other edge rested on the ledge on the inside of the case.

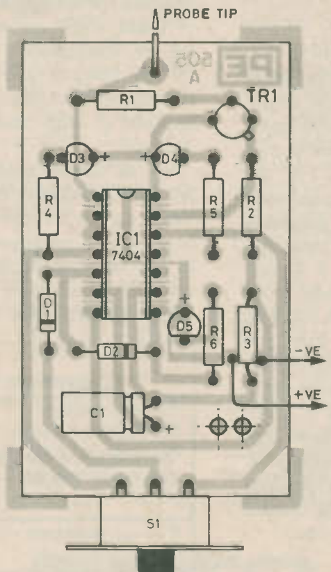


Fig. 2. Component layout

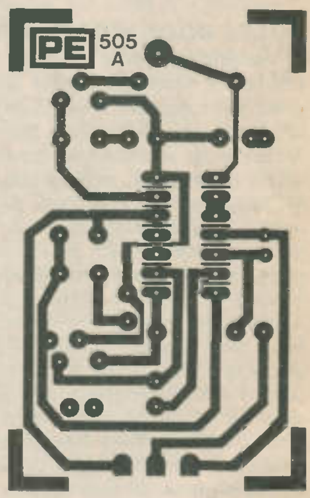
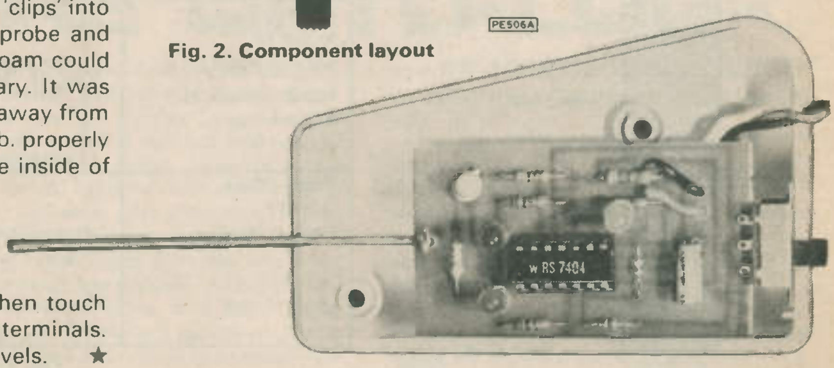


Fig. 3. P.c.b. design



TESTING

Connect the probe to a suitable +5V source, then touch the probe tip to each of the positive and negative terminals. The l.e.d.s will then respond to the relevant logic levels. ★

SEMICONDUCTOR CIRCUITS

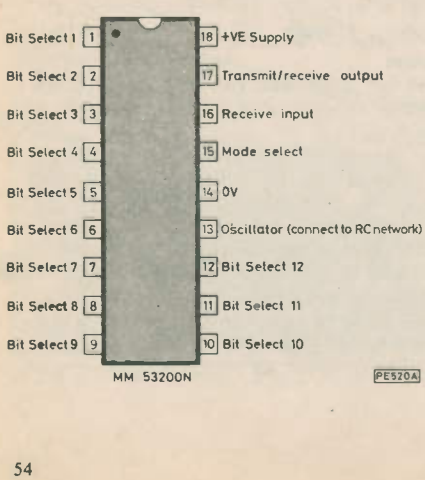
TOM GASKELL BA(Hons) CEng MIEE

ENCODER/DECODER (MM53200N)

THE encoding and decoding of information is a very complex business, and is done for many different reasons. One of the most common of these is in control applications where one unit must control a number of others independently of each other, or where any given unit should respond only to instructions from one other specific unit. Under these circumstances there must be some means by which units can uniquely identify and recognise each other. This can prove difficult to implement, especially when a high degree of immunity against error is called for; for example, in security systems. This month we look at the MM53200N, a novel i.c. from National Semiconductor which provides an interesting solution to some of these problems.

PULSE CODE MODULATION

The MM53200N is an 18 pin digital MOS LSI device which can behave as both an encoder and a decoder. It works on the principle of pulse code modulation, as illustrated in Fig. 2. The basic waveform is shown in Fig. 2a, and is a continuous series of pulse codes each of which is 11·52ms long. (All durations quoted assume the nominal 100kHz clock frequency.) Between each pulse code is a reset pulse, also 11·52ms long. Each pulse code consists of 12 individual bits; Fig. 2b and Fig. 2c show the arrangement of these. For each bit, a short negative duration of pulse corresponds to a logic 0, and a long negative duration of pulse corresponds to a logic 1. Since there are 12 bits in each code it follows that there are 2^{12}, or 4096, different combinations. When used as a decoder the i.c. only responds to one of these, so each encoder can control up to 4096 decoders without interaction.



BASIC OPERATION

The two different modes of operation of the i.c. are shown in Figs. 3 and 4. All the connections are identical except for the mode selector, pin 15 (high level = encode, i.e. transmit the signal, low level = decode, i.e. receive the signal), the receive input, pin 16 (connect to 0V for transmit), and pin 17 which is the transmit output or the negative pulse to indicate that a valid sequence of codes has been received, as appropriate.

The bit select inputs have internal pull-up resistors to the positive supply, so a switch being open corresponds to a logic 1, and closed to a logic 0. In the transmit mode, these 'bit select inputs' are scanned sequentially to produce the waveforms shown in Fig. 2.

There is no transmit enable facility as such, so the transmission of codes will continue for as long as power is applied, although the mode select pin (pin 15) could effectively be used to stop transmission of codes if required.

In the receive mode the incoming signal is fed into a Schmitt trigger circuit to help to 'clean up' the waveform, and is then compared to the locally programmed code at switches S1 to S12 in a sequential manner. If there is an error in the incoming code compared with the locally programmed code the system is reset and comparison starts again on the next pulse. If all 12 bits of the code are received correctly an internal 'valid' signal is generated, which clears a 64ms timer and clocks a 3 stage counter. The 3 stage counter is used to count the number of 'valid' pulses, and after 4 pulses, i.e. 4 correct codes, have been received, the receive output goes to a low level, i.e. logic 0. Four valid codes must be received within the 64ms time window or else the system is reset without the receive output ever being allowed to go to a low level. The process must then start all over again. After the receive output goes low (signalling the correct receipt of four valid codes) the next valid code must be received within 128ms. Hence, at least 1 code in 6 received must be valid to maintain the receive output at a low level.

USING THE I.C.

The specification and pinout of the MM53200N are given in Fig. 1. Note that the supply range is only +7 to +11V, limiting its use in some applications but making it ideal for use with 9V batteries. The internal oscillator uses an external 100k resistor and 180p capacitor, as shown in Figs. 3 and 4. Oscillator stability is non-critical, so ±5% tolerance components can be used. As with most MOS logic families the output is much

Characteristic	Notes	Minimum value	Typically	Maximum value	Units
Supply voltage	All spec's measured over the full supply range	7	9	11	V
Quiescent current				12	mA
Temperature range		−25		+70	°C
Oscillator frequency	For 100k resistor & 180p capacitor (*exact* values)	87	100	115	kHz
Pull-up resistors	Pins 1 to 12, internally connected to pin 18	200k		1·2M	Ω
Input voltage to pin 16 (receive input)	For logic 1 level	4·0		(+ve supply)	V
	For logic 0 level	0		2·0	V
Input voltage to pins 1 to 12 & pin 15	For logic 1 level	(+ve supply −0·5)		(+ve supply)	V
	For logic 0 level	0		0·5	V
Output voltage at pin 17:					
Logic 1 level	Output (source) current = 5µA	(+ve supply −0·5)		(+ve supply)	V
Logic 0 level	Output (sink) current = 2mA	0		1·0	V

Fig. 1. Pinout and specification

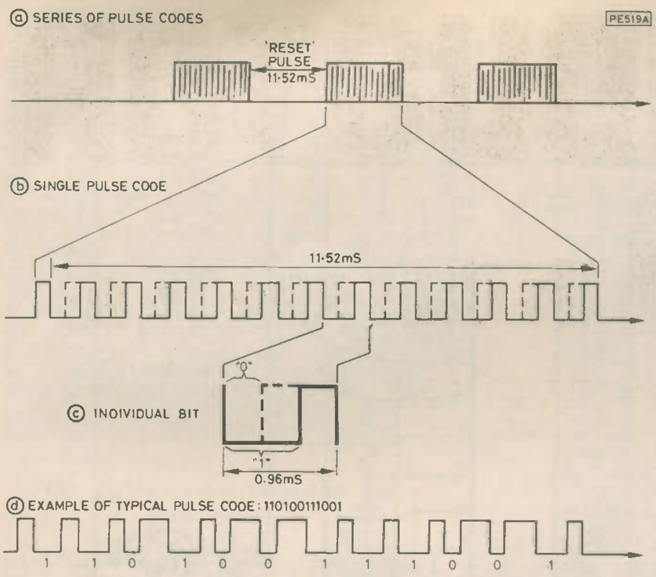


Fig. 2. Pulse code waveforms

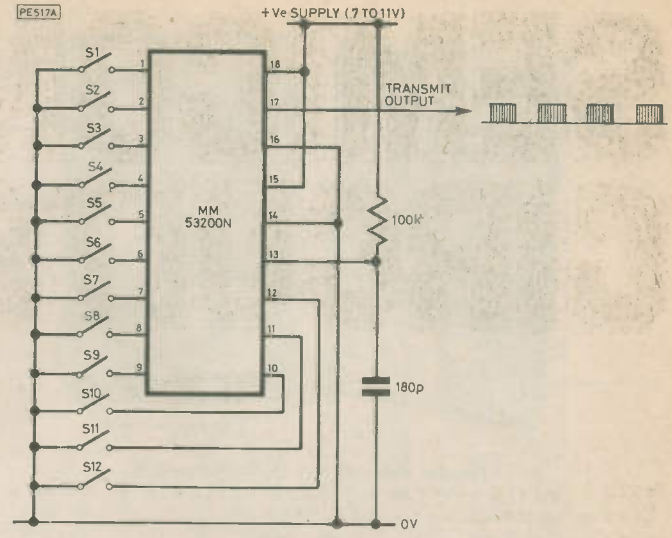


Fig. 3. I.c. in transmit mode

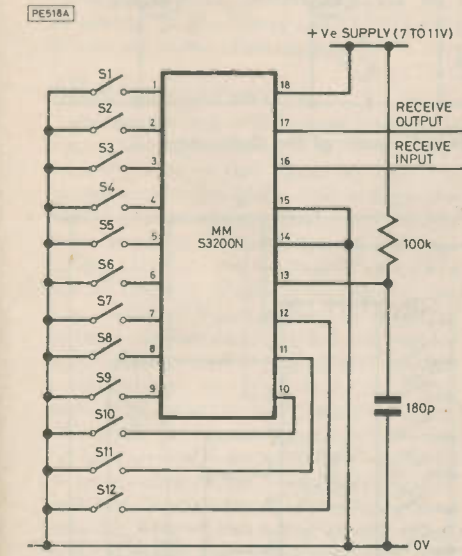


Fig. 4a. I.c. in receive mode

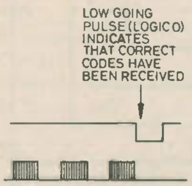


Fig. 4b. Output/input receive waveforms

better at sinking current to 0V than it is at sourcing current from the supply. No maximum current specifications are available from the manufacturer, so to be safe the transmit/receive output should be used either to feed directly into a CMOS input, or to sink current only, at up to 2mA.

The i.c. is almost completely immune to false triggering, largely due to the internal timing which requires valid codes to be received within very definite time windows. Cross interference of devices, even those in very close proximity, is eliminated under almost all conceivable circumstances. However . . . there is a penalty to be paid! The MM53200N is very critical of incoming waveforms, which must have no 'jitter' on any of the pulse edges and must have a very accurate pulse width or mark/space ratio. The low frequency component of 11·52ms in the waveform, combined with the high frequency demands of accurate pulse width, mean that a fairly wide bandwidth is necessary when communicating between i.c.s. If this communication is via lengths of wire all is well, but when resorting to more esoteric transmission media there can be potential problems! (Many of these can be overcome, of course.) Certainly other types of encoder and decoder i.c.s are more tolerant of serious waveform distortion than the MM53200N, although they cannot usually offer the same high security, high numbers of combinations, or simplicity of use.

TYPICAL APPLICATIONS

One of the main applications of this i.c. is in security based systems, acting as an electronic lock and key. This is the basis of the applications circuit this month, which also incorporates an infra-red optical link designed to overcome waveform pulse width difficulties over short transmission ranges. Although the i.c. is designed to work at 100kHz, this can easily be varied over a considerable range (assuming that both send and receive circuits are modified in the same way). No manufacturer's data is available about the limits of frequency variation; however, several different operating frequencies (spaced apart by much more than 30% to prevent the i.c.s locking to the wrong frequency) could give even more effective combinations of codes.

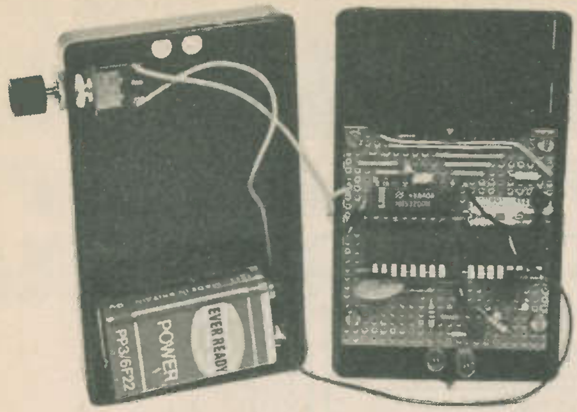
Consider also the use of the i.c.s in a burglar alarm system; they could pass codes over two out of the four cores used in the interwiring of sensors, and could raise the alarm if the cable was cut, shorted, or otherwise interfered with. The i.c.s could also be used as part of a simple remote control system, with up to 4096 devices actuated by one controller. This would be a fairly expensive exercise, however, since the i.c.s cost several pounds each! The bit select inputs, pins 1 to 12, need not be switch controlled, of course; they could be controlled by a logic system, enabling automatic changing of codes or even 'searching' for a specific incoming code. The i.c. could also be used as a 'transponder', reacting to the receipt of one valid code with the transmission of another.

The MM53200N is an i.c. which offers a simple solution to a number of encoding and decoding problems, although care must be taken with the quality of code transmission. It is available from **Macro Marketing, Burnham Lane, Slough, Bucks SL1 6LN.**

THE OPTO-LOCK

THIS is an applications project using the MM53200N as a 'security device'. It consists of two parts: a portable 'key' and a fixed 'lock' which is used to interface with a house burglar alarm, car alarm, electrical garage doors, solenoid operated mechanical lock, or whatever else needs turning on or off. It is an optically based design, using infra-red light to carry the coded signal from the key to the lock. The range was designed to be fairly low, from a few centimetres to a metre or so, dependent on ambient light conditions. This is ideal for locking and unlocking an alarm via a window or windscreen, making the lock and the alarm less vulnerable to being tampered with.

The circuit diagram of the opto-key is shown in Fig. 5. IC1 is used in the transmit mode as already described. TR1, R2, and R3 are arranged so that the output of IC1, pin 17, only sinks current as advised in the specifications. The infra-red emitters, D2 and D3, are driven by the high gain Darlington pair TR3 and TR4. TR2 provides an inverting function between TR1 and TR3 so that the l.e.d.s are turned off when the output of IC1 is at a low



Internal view of the Opto-Key case

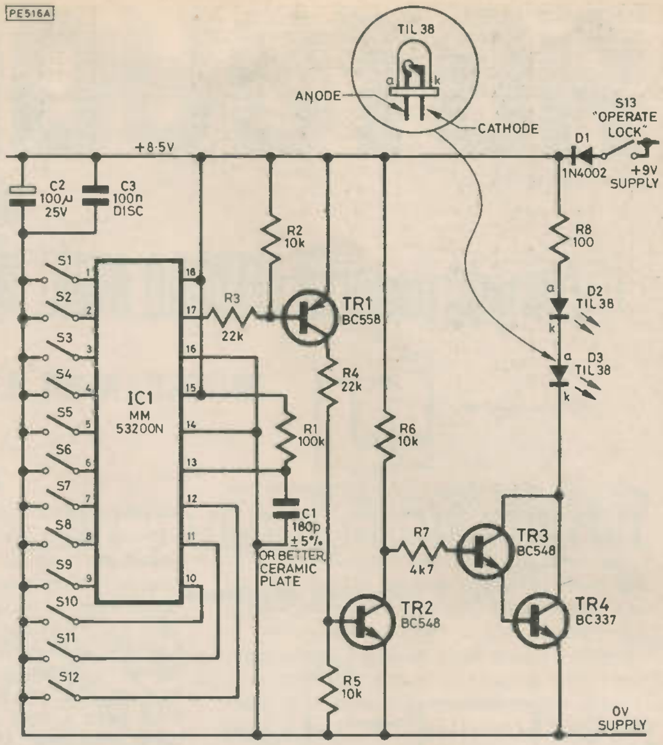


Fig. 5. Circuit diagram of the Opto-Key

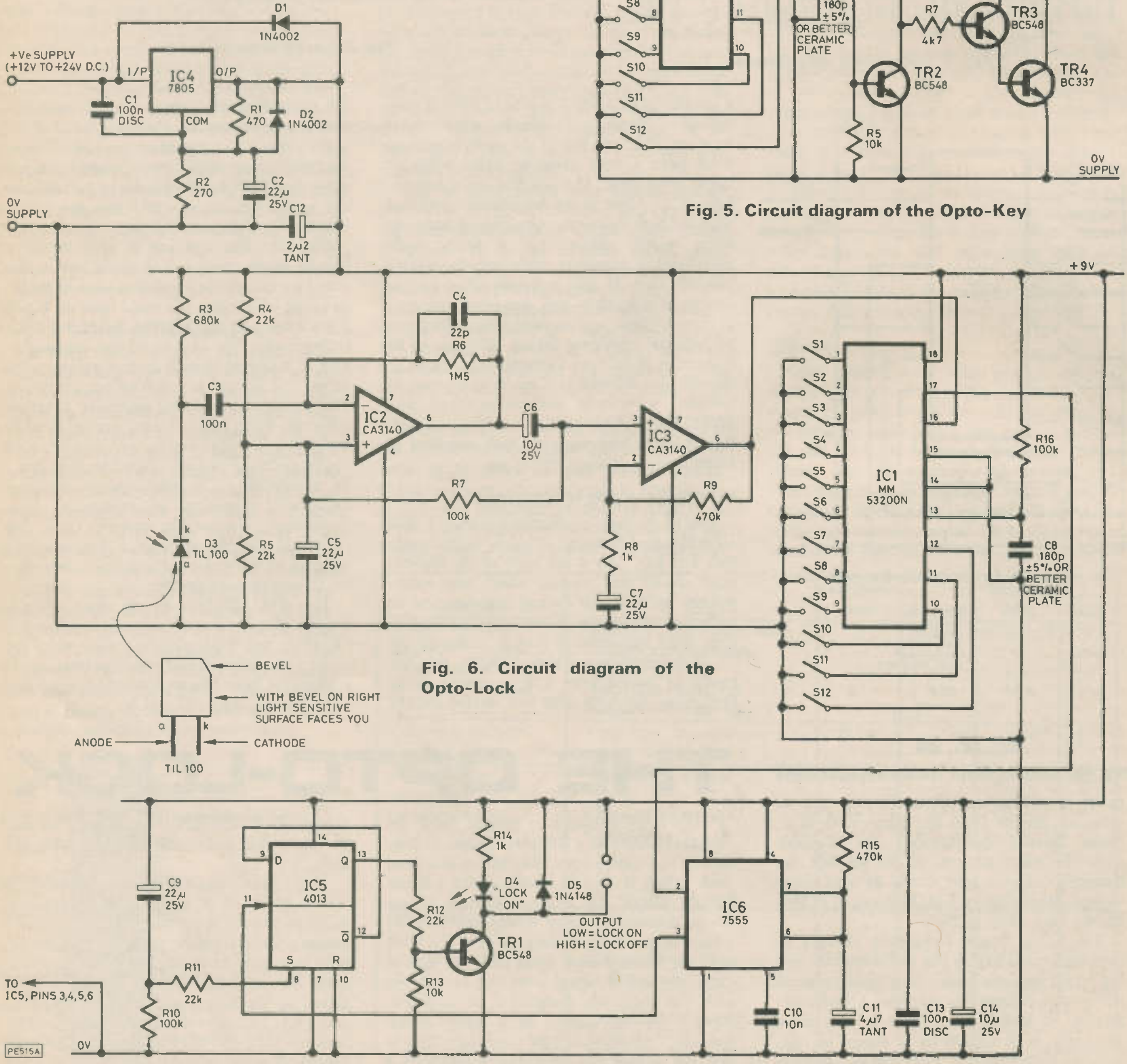


Fig. 6. Circuit diagram of the Opto-Lock

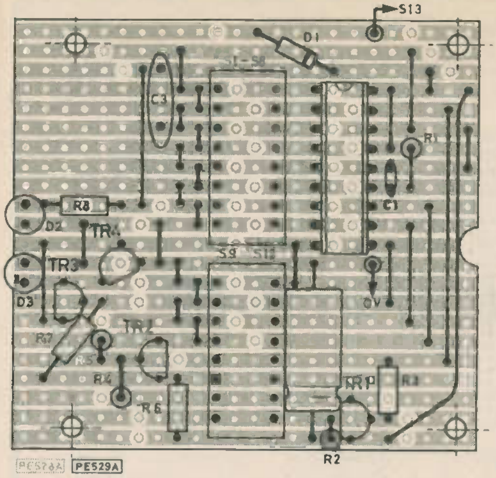


Fig. 7. Veroboard layout of the Opto-Key

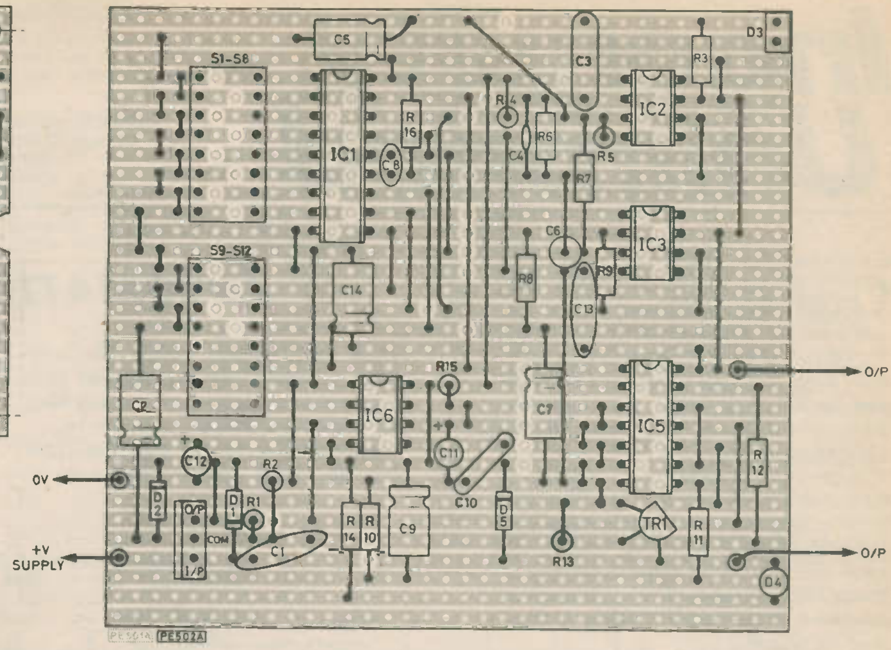


Fig. 8. Veroboard layout of the Opto-Lock

level, and on when the output of IC1 is high. This ensures that the emitters are turned on for as little time as possible, minimising power consumption. D1 protects against misconnection of the battery, and C2 and C3 provide smoothing of the supply.

RECEIVE CIRCUITRY

The receive side of the system is shown in Fig. 6, the 'opto-lock'. D3 is an infra-red detector diode reverse biased by R3. The leakage current through the diode is dependent on the infra-red radiation falling on it. A f.e.t. input amplifier, IC2, amplifies this leakage current variation. R4, R5, and C5 provide a half rail reference voltage at the non-inverting input, which necessitates the use of C3 to decouple the inverting input. R6 sets the gain of this amplifier and C4 rolls off the frequency response to optimise the waveform shape. The output of IC2 feeds into IC3, which is connected in a non-inverting configuration. R7 biases the non-inverting input to the half rail reference voltage, and C7 decouples the feedback loop. R8 and R9 determine the gain of this stage (471x), the output of which is of sufficient amplitude (normally clipping the rails) that it can be fed directly into the receive input of IC1, which is an MM53200N connected in the receive mode.

The receive output of IC1 triggers a 7555 CMOS timer to give an output duration of a minimum of several seconds when the lock is operated. This output pulse triggers IC5, a D-type flip flop connected as a divide-by-two counter. The first operation of the key will unlock the system, the next will lock it again, the next will unlock it, etc. The inclusion of IC6 ensures that a wait of several seconds must occur between each operation of the lock, reducing the chances of an unauthorised person quickly checking all 4096 possible combinations!

The output of IC5 turns on TR1, which illuminates the 'lock on' l.e.d. and provides an open collector for turning on a low power relay or operating other circuitry. For solenoid or higher power relay switching, extra buffer circuitry should be provided as required. C9, R10, and R11 provide a power-on reset action to ensure that the lock is always turned on when power is first applied, as a failsafe measure. To do the reverse, and turn the lock off when power is first applied, interchange pins 8 and 10, i.e. pin 10 should go to R11, and pin 8 to 0V. Finally, because of the specific supply voltage limits of IC1, a +9V regulator circuit has been provided, using IC4 and associated components. IC4 is actually a 5V device, but the resistive divider in the common lead forces it up to a 9V output. The input to this i.c. can be from +12 to +24V d.c., and a heatsink should not normally be necessary unless a relay or other circuitry also have to be driven from the regulated supply.

CONSTRUCTION

The circuits are laid out on Veroboard as shown in Figs. 7 and 8. The opto-key has been specifically designed to fit into a plastic West Hyde 'Tinos' case, type TIN600D. This has internal p.c.b. mounting pillars, a battery compartment with a battery clip provided, and a pocket clip. A momentary action switch S13 is mounted at the side on the top half of the case, and a space is allowed for its body on the Veroboard. (See the photograph). Holes should be drilled in the top of the case to allow the infra-red emitters to poke through. These should be left standing well clear of the Veroboard surface so that they do protrude when the case is screwed together. When testing the circuit, be aware that these emitters do not show any visible light; if necessery, temporarily replace them with ordinary l.e.d.s, which should glow with a slight flicker when S13 is operated.

8-way (octal) s.p.s.t. p.c.b. switches have been used to program IC1 in both key and lock circuits to allow for flexible code setting. If preferred, of course, these can be replaced with wire links where appropriate. Since only 12 switches, not 16, are used, the last 4 switches in one bank of 8 are unused. Note that the Veroboard tracks beneath these unused 4 switches are left uncut. Needless to say, the switch settings of lock and key should be exactly the same! The opto-lock is shown uncased since it will usually be fitted in other equipment. Note carefully the orientation of infra-red sensor D3. The sensor tends to be susceptible to visible light as well as infra-red, and although the circuitry will work quite well without optical filters, the addition of a piece of infra-red transmitting filter in front of D3 will enhance performance considerably; use Kodak type 87 or 87c, or their equivalents, available from many photographic suppliers. A simple lens arrangement will also help to collect the available infra-red radiation most efficiently. D3 and D4 have been arranged at the edge of the board to make it easy to fit the unit into an enclosure while leaving these devices board mounted. If D3 must be taken off the Veroboard, use screened cable to connect it, of as short a length as possible. C4 may have to be changed in value to optimise the waveform shape if this is done.

The circuits are designed to work at a range of several centimetres to a metre or so. Under high ambient light conditions, especially artificial light, the range decreases. At very close proximity of key and lock amplifier IC2 saturates badly, distorting the waveform and preventing detection by IC1. If used in this way, reduce the value of R6 or place several thicknesses of paper directly in front of D3 (both on the lock board) to attenuate the signal.

For ranges greater than one metre, try adding extra stages of amplification and possibly pulse shaping. Extra infra-red emitters can be added to the opto-key, with their own driving stages. Ideally, for optimum range, a high frequency carrier should be used. Indeed, in the prototype system a 200kHz carrier was tried, with a wideband receive amplifier and a phased-locked loop i.c. to extract the modulating envelope and feed it to IC1. The range extended to many metres, but jitter on the capture time of the PLL was sufficient to cause IC1 to fail to read the input reliably.

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AUTOMATIC BILGE PUMP

ONE of the chores associated with small boats is the need to bail out rain water etc., often at inconvenient times. Providing a 12V supply is available a small bilge pump will take care of the pumping and the following circuit will ensure the water level is kept to a minimum without constant attention.

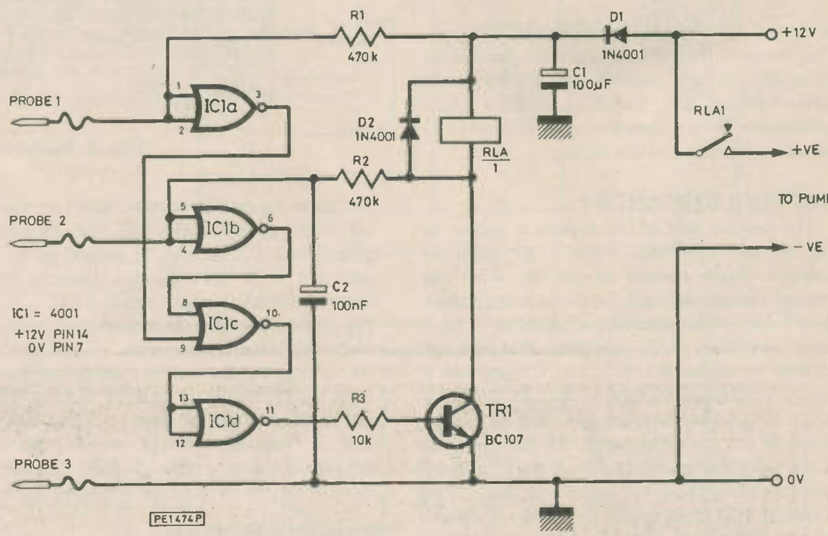
A probe is connected to IC1a which is biased so that its output is low, similarly IC1b is connected to a shorter probe and biased in the same way. Both outputs are gated via IC1c whose output is inverted to make TR1 normally off. A third probe is connected to the negative supply to complete the circuit.

As the water level in the bilge rises and touches probe 1 the output from IC1a goes high but has no effect. If the water level rises further so as to touch probe 2 then TR1 will switch on and activate the pump via RLA1. As the water level drops the pump will remain on as the bias for IC1b remains low due to the volt drop at the collector of TR1. As the water level falls further the output of IC1a goes low and the circuit returns to the normal state with the pump turned off.

Obviously the circuit had to be waterproof so it was fitted into a plastic tube. The probes were connected to the circuit board via insulated mains cable. It was found that stainless steel wire (ex fishing tackle) made suitable probes. The relay should be totally encapsulated and after fitting inside the tube, the tube was filled with potting compound.

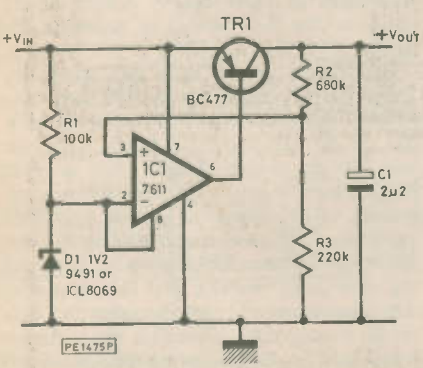
It is best to mount the unit close to the centre line of the boat to minimise the effects of movement. The standby current is only a few microamps, probably less than the normal loss of charge of the battery.

G. W. Coles,
Polruan,
Cornwall.



MICROPOWER REGULATOR

THE voltage regulator described here was designed to power a CMOS microprocessor data logger which had to run for several days from Ni-Cad cells without recharging. An ordinary low power regulator such as a 78L05 consumes several milliamps and thus in a circuit with a very low quiescent current, would contribute quite significantly to the current drain of the batteries. The regulator shown here requires approximately 100μA, and thus gives a considerable saving in battery current. The common or garden low power regulator also requires an input voltage which is about 2 volts above the output voltage, whereas the design given here will work with an input only 0·5 volts above the output voltage, so fewer cells can be used to power the circuit.



The 9491 is a bandgap voltage reference which gives a very stable 1·2V and can operate from a current as low as 50μA. This reference voltage is fed to the inverting input of a CMOS op-amp where it is compared with a fraction of the output voltage. The output of the op-amp drives the base of the BC477 and this transistor increases the output current of the op-amp.

If the output voltage Vout starts to decrease due to increasing load, then the fraction of Vout at the non-inverting input of the op-amp decreases and this causes the output voltage of the op-amp to fall, and thus turn the transistor on more and so compensate for the increased load.

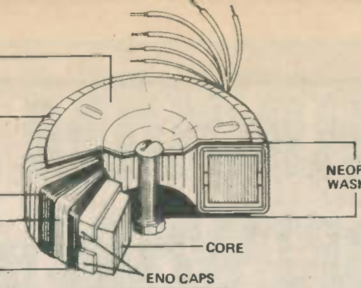
Pin 8 of the op-amp sets the quiescent current of the op-amp to one of three values. If it is connected to V+ then the quiescent current is 10μA, if connected to V− then the quiescent current is 1mA, and if connected to a voltage between V− and +0·8V or V+ and −0·8V, then the quiescent current is 100μA. Therefore connecting pin 8 to the reference voltage gives a quiescent current of 100μA. The capacitor across the output prevents any oscillation of the circuit.

Using the component values given, the circuit performs as follows.

Vout 5·06V with 10mA load Vin minimum =5·27V
with 40mA load Vin minimum =5·57V
No load current = 112μA

B. Hunter,
Monifieth,
Dundee.

TOROIDALS



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0x011	9+9	0.83
0x012	12+12	0.63
0x013	15+15	0.50
0x014	18+18	0.42
0x015	22+22	0.34
0x016	25+25	0.30
0x017	30+30	0.25

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30 VA 70 x 30mm 0.45Kg Regulation 18%

1x010	6+6	2.50
1x011	9+9	1.66
1x012	12+12	1.25
1x013	15+15	1.00
1x014	18+18	0.83
1x015	22+22	0.68
1x016	25+25	0.60
1x017	30+30	0.50

50 VA 80 x 35mm 0.9Kg Regulation 13%

2x010	6+6	4.16
2x011	9+9	2.77
2x012	12+12	2.08
2x013	15+15	1.66
2x014	18+18	1.38
2x015	22+22	1.13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0.45
2x029	220	0.22
2x030	240	0.20

80 VA 90 x 30mm 1Kg Regulation 12%

3x010	6+6	6.64
3x011	9+9	4.44
3x012	12+12	3.33
3x013	15+15	2.66
3x014	18+18	2.22
3x015	22+22	1.81
3x016	25+25	1.60
3x017	30+30	1.33
3x028	110	0.72
3x029	220	0.36
3x030	240	0.33

120 VA 90 x 40mm 1.2Kg Regulation 11%

4x010	6+6	10.00
4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2.40
4x017	30+30	2.00
4x018	35+35	1.71
4x028	110	1.09
4x029	220	0.54
4x030	240	0.50

160 VA 110 x 40mm 1.8Kg Regulation 8%

5x011	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4.44
5x015	22+22	3.63
5x016	25+25	3.20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1.45
5x029	220	0.72
5x030	240	0.66

225 VA 110 x 45mm 2.2Kg Regulation 7%

6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6.25
6x015	22+22	5.11
6x016	25+25	4.50
6x017	30+30	3.75
6x018	35+35	3.21
6x026	40+40	2.81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0.93

300 VA 110 x 50mm 2.6Kg Regulation 6%

7x013	15+15	10.00
7x014	18+18	8.33
7x015	22+22	6.82
7x016	25+25	6.00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3.75
7x025	45+45	3.33
7x033	50+50	3.00
7x028	110	2.72
7x029	220	1.36
7x030	240	1.25

500 VA 140 x 60mm 4Kg Regulation 4%

8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7.14
8x026	40+40	6.25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4.54
8x029	220	2.27
8x030	240	2.08

625 VA 140 x 75mm 5Kg Regulation 4%

9x017	30+30	10.41
9x018	35+35	8.92
9x026	40+40	7.81
9x025	45+45	6.94
9x033	50+50	6.25
9x042	55+55	5.68
9x028	110	5.68
9x029	220	2.84
9x030	240	2.60

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