ETI

ELECTRONICS TODAY INTERNATIONAL

THE ELECTRONICS, SCIENCE & TECHNOLOGY MONTHLY

APRIL 1989 £1.50

EASi Alarm System

The ultimate in treasure protection with curse-free installation

Artificial Intelligence

Reaction Timer

Beginners' Camera Trigger

Plus: Exclusive Pan-Atlantic Necktie

AUDIO•COMPUTING•MUSIC•DOMESTIC

RACKS CABINETS & FANS · SURPLUS BOUGHT & SOLD · ELECTRONIC COMPONENTS & OBSOLETE IC'S · MONITORS VDU'S & PLOTTERS · 1000'S OF ITEMS IN STOCK · COMPUTER SYSTEMS & PERIPHERALS · RELAYS MOTORS & STEPPERS · POWER SUPPLIES & INVERTORS · ALL TYPES OF TEST EQUIPMENT · PRINTERS DISK DRIVES & KEYBOARDS · VIDEO EQUIPMENT & CAMERAS

THE 'ALADDINS' CAVE OF ELECTRONIC & COMPUTER EQUIPMENT

COLOUR MONITORS

16" Decca, 80 series budget range, colour monitors, features include: PIL tube, attractive teak style case, **guaranteed 80 column resolution**, only seen on monitors costing 3 times our price, ready to connect to a host of computer or video outputs. Manufacturers fully tested surplus, sold in little or hardly used condition with 90 day full RTB guarantee. **1000's Sold to date.**
DECCA 80 RGB - TTL + SYNC input for BBC type interface etc.
DECCA 80 COMP 75 Ω composite video input with integral audio amp & speaker ideal for use with video recorder or TELEBOX ST or any other audio visual use. **Only £99.00 (E)**

HIGH DEFINITION COLOUR

BRAND NEW **CENTRONIC 14"** monitors in attractive style moulded case featuring hi res Mitsubushi 0.42 dot pitch tube with 669 x 507 pixels. 28Mhz bandwidth. Full 90 day guarantee.
Order as 1004-N2 for TTL + sync RGB for BBC etc £159.00 (E)
1003-N1 for IBM PC etc fully CGA equiv £189.00 (E)
1005-N2 RGB interface for QL 85 columns. £169.00 (E)

20" & 22" AV Specials

Superbly made, UK manufacture, PIL tube, all solid state colour monitors, complete with composite video and sound inputs, attractive teak style case. Ideal for a host of applications including Schools, Shops, Disco's, Clubs etc. Supplied in EXCELLENT little used condition with 90 day guarantee.
20" Monitor £165.00 (F) 22" Monitor £185.00 (F)

MONOCHROME

MOTOROLA M1000-100 5" CRT black & white compact chassis monitor measuring only cm 11.6h, 12w, 22d, ideal for CCTV or computer applications. Accepts standard Composite video or individual H & V syncs. Operates from 12v DC at approx 0.8a. Some units may have minor screen marks, but still in very usable condition. Fully tested with 30 day guarantee & full data. Only £29.00 (C)
Fully cased as above, with attractive moulded, desk standing swivel and tilt case Dim. cm 12h, 14.5w, 26d. £39.00 (C)
JVC type 751-7 5" ultra compact black & white chassis monitor for 12v 0.7a DC operation Dim cm 11h, 14w, 18d. Simple DIY circuit data included to convert data and separate sync input to composite video input. Ideal portable equipment etc. Supplied with full data. Brand New £65.00 (B)
KGM 324 9" Green Screen. Little used fully cased, mains powered high res monitors with standard composite video input. Fully tested and in excellent condition £49.00 (E)
20" Black & White monitors by AZTEK, COTRON & NATIONAL All solid state, fully cased monitors, ideal for all types of AV or CCTV applications. Units have standard composite video inputs with integral audio amp and speaker. Sold in good, used condition - fully tested with 90 day guarantee. Only £85.00 (F)

FLOPPY DRIVE SCOOP Drives from Only £39.95

A MASSIVE purchase of standard 5.25" disk drives enables us to offer you prime product at all time super low prices. All units unless stated are removed from often **BRAND NEW equipment, fully tested** and shipped to you with a full 120 day **guarantee.** All units offered operate from +5 and +12 volts DC, are of standard size and accept the common standard 34 way interface connector.
TANDON TM100-2A IBM compatible 40 track FH double sided Only £39.95 (B)
TANDON TM101-4 FH 80 track double sided Only £49.95 (B)
JAPANESE Half Height double sided drives by **Canon, Tec, Toshiba etc.** Specify 40 or 80 track Only £75.00 (B)
TEAC FD55-F 40-80 track double sided Half Height Brand New £115.00 (B)

DISK DRIVE ACCESSORIES

34 Way interface cable and connector single £5.50, Dual £8.50 (A)
5.25" DC power cable £1.75. Fully cased PSU for 2 x 5.25" Drives £19.50 (A) Chassis PSU for 2 x 8" drives £39.95 (B)

8" DISK DRIVES

SUGART 800/801 single sided refurbished £175.00 (E)
SUGART 851 double sided refurbished £260.00 (E)
MITSUBISHI M2894-63 Double sided switchable Hard or Soft sector BRAND NEW £275.00 (E)
SPECIAL OFFER Dual 8" drives with 2mb capacity in smart case with **integral PSU** ONLY £499.00 (F)

COMPUTER SYSTEMS

TATUNG PC2000. Big brother of the famous **EINSTEIN**, the **TPC2000** professional 3 piece system comprises: Quality high res **GREEN 12"** monitor. Sculptured **92 key keyboard** and plinth unit containing the **Z80A CPU** and all control electronics **PLUS 2** integral **TEAC 5.25" 80 track double sided disk drives.** Many other features include **Dual 8" IBM format** disk drive support, Serial and parallel outputs, full expansion port, 64k ram and ready to run software. Supplied complete with **CPM, WORDSTAR, BASIC** and accounts package. **BRAND NEW**
Full 90 day guarantee.
Original price OVER £1400 **Only £299(E)**

EQUINOX (IMS) S100 system capable of running either **TURBO** or standard **CPM**. Unit features heavy duty box containing a powerful PSU, **12 slot S100** backplane, & **dual 8" double sided disk drives.** Two individual **Z80** cpu boards with **192k of RAM** allow the use of multi user software with upto **4 RS232 serial** interfaces. Many other features include battery backed real time clock, all IC's socketed etc. Units in good condition and tested prior despatch, no documentation at present, hence price of only £245.00 (F)
S100 PCB's IMS A465 64K dynamic RAM. £55.00 (B) IMS A930 FDC controller £85.00 (B). **IMS A862** CPU & i/o £65.00 (B)

SAE for full list of other S100 boards and accessories.

PRINTERS

Bulk purchase brings you incredible savings on a range of printers to suit all applications. Many other "one off bargains" can be seen at our South London Shop

HAZELTINE ESPRINT Small desktop 100 cps print speed with both **RS232** and **CENTRONICS** interfaces. Full pin addressable graphics and 6 user selecable type fonts. Up to 9.5" single sheet and tractor paper handling **Brand New Only £199.00 (E)**
CENTRONICS 150 series. A real workhorse for continuous use with tractor feed paper, either in the office, home or factory, desk standing, **150 cps 4** type fonts and choice of interfaces. Supplied **BRAND NEW** Order as:
150-SN up to 9.5" paper handling £185.00 (E)
150-SW up to 14.5" paper handling £225.00 (E)
150-GR up to 14.5" paper plus full graphics £245.00 (E)
When ordering please specify RS232 or CENTRONICS interface.

Ultra Fast 240 cps NEWBURY DATA NDR 8840 High Speed Printers Only £449 !!

A special purchase from a now defunct Goverment Dept enables us to offer you this amazing British Made, quality printer at clearance prices, **SAVING YOU OVER £1500 !!** The **NDR8840** features **high speed 240 cps** print speed with integral, fully adjustable paper tractor, giving exceptional fast paper handling for multi part forms etc. The unit features **10** selectable type fonts **giving up to 226 printable characters on a single line.** Many other features include Internal electronic vertical and horizontal tabs, Self test, 9 needle head, Up to 15.5" paper, 15 million character ribbon cartridge life and standard **RS232 serial interface.** Sold in **SUPERB** tested condition with 90 day guarantee Only £449.00 (F)
EPSON model 512 40 column 3.5" wide paper roll feed, high speed matrix (3 lines per second) printer mechanism for incorporation in point of sale terminals, ticket printers, data loggers etc. Unit features bi directional printhead and integral roll paper feed mech with tear bar. Requires DC volts and simple parallel external drive logic. Complete with data. RFE and tested Only £49.95 (C)
EPSON model 542 Same spec as above model, but designed to be used as a slip or flatbed printer. Ideal as label, card or ticket printer. Supplied fully cased in attractive, small, desk top metal housing. Complete with data. **RFE** and tested Only £55.00 (D)
PHILIPS P2000 Heavy duty **25 cps** bi directional daisy wheel printer. Fully **DIABLO, QUME, WORDSTAR** compatible. Many features include full width platten - up to 15" paper, host of available daisy wheels, single sheet paper handling, superb quality print. Supplied complete with user manual & 90 day guarantee **plus FREE** dust cover & daisy wheel. **BRAND NEW Only £225.00 (E)**

Most of the items in this Advert, plus a whole range of other electronic components and goodies can be seen or purchased at our

** South London Shop **

Located at **215 Whitehorse Lane, London SE25.** The shop is on the main **68 bus route** and only a few miles from the main A23 and South Circular roads. **Open Monday to Saturday from 9 to 5.30**, parking is unlimited and **browsers are most welcome.** Shop callers also save the cost of carriage.

MODEMS

Modems to suit all applications and budgets. Please contact our technical sales staff if you require more information or assistance.

SPECIAL PURCHASE V22 1200 baud MODEMS ONLY £149 !!

MASTER SYSTEMS type 2/12 microprocessor controlled **V22 full duplex 1200 baud.** This fully BT approved modem employs all the latest features for error free data comms at the staggering speed of 120 characters per second, **saving you 75% of your BT phone bills and data connect time !!** Add these facts to our give away price and you have a superb buy !! Ultra slim unit measures only 45 mm high with many integral features such as Auto answer, Full LED status indication, RS232 interface, Remote error diagnostics, SYNC or ASYNC use, **SPEECH** or **DATA** switching, integral mains PSU, 2 wire connection to BT line etc. Supplied fully tested, **EXCELLENT** slightly used condition with data and full 120 day guarantee.

LIMITED QUANTITY **Only £149 (D)**

CONCORD V22 1200 baud as new £330.00 (E)
CONCORD V22 1200-2400 BIS £399.00 (E)
RIXON Ex BT Modem 27 V22 1200 £225.00 (E)
DATEL 4800 / RACAL MPS 4800 EX BT modem for 4800 baud sync use. £295.00 (E)
DATEL 2412 2780/3780 4 wire modem unit EX BT fully tested. £199.00 (E)
MODEM 20-1 75-1200 BAUD for use with PRESTEL etc EX BT fully tested. £49.00 (E)
TRANSDATA 307A 300 baud acoustic coupler with RS232 I/O Brand New £49.00 (E)
RS232 DATA CABLES 16 ft long 25w D plug to 25 way D socket. Brand New Only £9.95 (A)
As above but 2 metres long £4.99 (A)
BT plug & cable for new type socket £2.95 (A)

POWER SUPPLIES

All power supplies operate from 220-240 v AC Many other types from 3v to 10Kv in stock. Contact sales office for more details.
PLESSEY PL12/2 Fully enclosed 12v DC 2 amp PSU. Regulated and protected. Dim cm 13.5 x 11 x 11 New £16.95 (B)
AC-DC Linear PSU outputs of +5v 5.5a, -5v 0.6a, +24v 5a. Fully regulated and short proof. Dim cm 28 x 12.5 x 7 New £49.50 (C)
POWER ONE PHC 24v DC 2 amps Linear PSU fully regulated New £19.95 (B)
BOSHERT 13088 switch mode supply ideal disk drives or complete system. +5v 6a, +12 2.5a, -12 0.5a, -5v 0.5a. Dim cm 5.6 x 21 x 10.8 New £29.95 (B)
BOSHERT 13090 same as above spec but outputs of +5v 6a, +24v 1.5a, +12v 0.5a, -12v 0.5a New £39.95 (B)
GREENDALE 19AB0E 60 Watt switch mode outputs +5v 6 a, +12v 1a, -12v 1a, +15v 1a.D. 11 x 20 x 5.5 RFE Tested £24.95 (B)
CONVER AC130-3001 High grade **VDE spec** compact 130 watt switch mode PSU. Outputs give +5v 15a, -5v 1a, +&-12v 6a. Dim 6.5 x 27 x 12.5 Current list price £190. Our price New £59.95.00 (C)
FARNELL G6/40A Compact 5v 40 amp switch mode fully enclosed New £140.00 (C)
FARNELL G24 5S Compact 24v 5 amp switch mode fully enclosed New £95.00 (C)

Special Offer EXPERIMENTORS PSU — ONLY £16.95 (C)

Made to the highest spec for BT this unit gives several fully protected DC outputs most suited to the **Electronics Hobbyist.** +5v 2a, +&-12v 1a, +24v 1a and +5v fully floating at 50ma. Ideal for school labs etc. Quantity discount available.
Fully tested with data RFE = Removed From Equipment

The AMAZING TELEBOX Converts your monitor into a QUALITY COLOUR TELEVISION

Brand new high quality, fully cased, 7 channel UHF PAL TV tuner system. Unit simply connects to your TV aerial socket and video monitor turning same into a fabulous colour TV. Dont worry if your monitor doesn't have sound, the TELEBOX even has an integral audio amp for driving a speaker plus an auxillary output for Headphones or Hi Fi system etc. Many other features: LED Status indicator, Smart moulded case, Mains powered, Built to BS safety specs. Many other uses for TV sound or video etc. Supplied BRAND NEW with full 1 year guarantee. **Carriage code (B)**

TV SOUND & VIDEO TUNER ONLY £29.95

TELEBOX ST for monitors with composite video input £29.95
TELEBOX STL as ST - but fitted with integral speaker £34.95
TELEBOX RGB for use with analogue RGB monitors £59.95

Colour when used with colour CRT. RGB version NOT suitable for IBM-CLONE type colour monitors. DATA sheet on request. PAL overseas versions CALL

RECHARGEABLE BATTERIES

Maintenance free, sealed longlife **LEAD ACID**
A300 12v 3 Ah £13.95 (A)
A300 6v 3 Ah £9.95 (A)
A300 6-0-6 v 1.8 Ah RFE £5.99 (A)

NICKEL CADMIUM

Quality 12 v 4 Ah cell pack. Originally made for the **TECHNICOLOUR** video company, this unit contains 10 high quality **GE nicad, D** type cells, configured in a smart robust moulded case with DC output connector. Dim cm 19.5 x 4.5 x 12.5. Ideal portable equipment etc **BRAND NEW £24.95 (B)**
12v 17 Ah Ultra rugged, all weather, virtually indestructable **refillable NICAD** stack by **ALCAD.** Unit features 10 x individual type **XL1.5** cells in wooden crate. Supplied to the MOD and made to deliver exceptionally high output currents & **withstand** long periods of storage in discharged state. Dim cm 61 x 14 x 22 **Cost over £250** Supplied unused & tested complete with instructions £95.00 (E)
EX EQUIPMENT NICAD cells by GE Removed from equipment and believed in good, but used condition. **'F' size** 7Ah 6 for £8 (B) Also **'D' size** 4Ah 4 for £5 (B)

BRAND NEW 85 Mb Disk Drives ONLY £399

End of line purchase enables this brand new unit to be offered at an all time super low price. The **NEC D2246 8" 80 Mb** disk drive features full CPU control and industry standard **SMD interface,** Ultra high speed data transfer and access times leave the good old ST506 interface standing. Supplied **BRAND NEW** with full manual Only £399.00 (E)
Dual drive, plug in **135 Mb** sub system for **IBM AT** unit in case with **PSU** etc. £1499.00 (F)
Interface cards for **upto 4 dives** on IBM AT etc available **Brand new at £395.00**

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of BRAND NEW cooling fans

AC FANS Specify 240 or 110 v
3" Fan dim 80 x 80 x 38 £8.50 (B)
3.5" ETRI slimline 92 x 92 x 25 £9.95 (B)
4" Fan Dim 120 x 120 x 38 £9.95 (B)
As above - TESTED RFE Only £4.95 (C)
10" round x 3.5" Rotron 10v £10.95 (B)
DC FANS
Papst Miniature DC fans 62x62x25 mm
Order **812 6-12v** or **814 24v** £15.95 (A)
4" 12v DC 12w 120 x 120 x 38 £12.50 (B)
4" 24v DC 8w 120 x 120 x 25 £14.50 (B)
BUHLER 12v DC 62 mm £12.95 (A)

1000's of other fans and blowers in stock CALL or SAE for more details

SPECIAL INTEREST

Please call for availability or further info.
RACAL-REDAC real time, colour drafting PCB layout system £3950
DEC VAX11/750 inc 2 Mb Ram DZ, and full doc etc. Brand New £8500
HP7580A 8 pen digital A1 drum plotter with IEEE interface As New £4750
CHEETAH Telex machine £995
1.5 kw 115v 60 Hz power source £950
500 watt INVERTER 24v DC to 240v AC sine wave 50 Hz output £275
SOLDER SYSTEMS tin lead roller tinning machine for PCB manufacture £350
CALLAN DATA SYSTEMS multi user **INTEL** based **UNIX** system complete with software and 40 Mb winchester disk drive. £2750
WAYNE KERR RA200 Audio, real time frequency response analyzer £3000
TEKTRONIX 1411/R PAL TV test signal standard. £6900
TEKTRONIX R140 NTSC TV test signal standard. £875
HP 3271A Correlator system £350
PLESSEY portable Microwave speech / data link, 12v DC, 70 mile range **The pair £275.00**
19" Rack cabinets 100's in stock from £15.00

DISPLAY -ELECTRONICS-

All prices for UK Mainland. UK Customers must **ADD 15% VAT to total order value. Minimum order, cash £5, Credit Card £10.** Official account orders from Government Depts, Universities, Schools & Local Authorities welcome – **minimum account order value £25.** Carriage charges (A) £1.50, (B) £3.50, (C) £6.50, (D) £8.50, (E) £10.00, (F) £15, (G) Call. All goods are supplied subject to our standard conditions of sale. All guarantees given on a return to base basis. We reserve the right to change prices & specifications without prior notice. Bulk trade & export enquiries most welcome.

VISA

MAIL ORDER & OFFICES
Open Mon-Fri 9.30-5.30
32 Biggin Way,
Upper Norwood,
London SE19 3XF

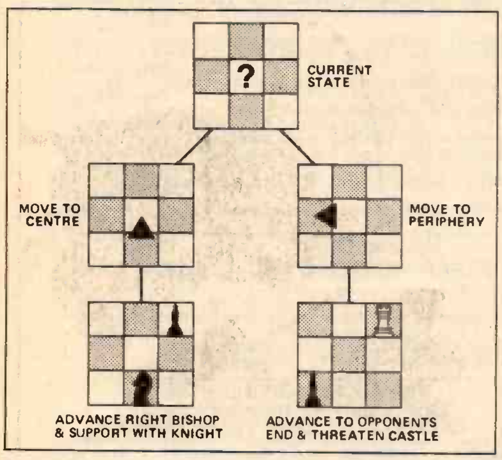
LONDON SHOP
1000's of Bargains for callers
Open Mon-Sat 9-5.30
215 Whitehorse Lane,
South Norwood, London SE25

DISTEL © The ORIGINAL
FREE of charge dial up data base
1000's of items + info **ON LINE NOW!!**
300 baud 01 679 1888, 1200/75 01 679 6183, 1200 FDX 01 679 8769

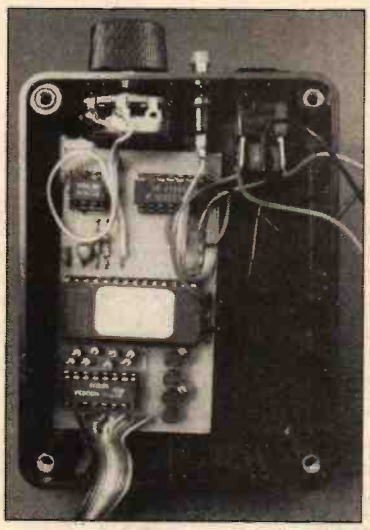
ALL ENQUIRIES
01 679 4414
FAX 01 679 1927
TELEX 894502

April
1989
VOLUME 18 No 4

Geoff Bains: Editor
Jez Ford: Assistant Editor
Paul Chappell: Projects Editor
Jerry Fowler: Technical Illustrator
Heather Hopkinson: Design
Mark Warford: Photography
Cass Gilroy: Ad Manager
Heather Wust: Classified Sales
Andrew Selwood: Copy Control
Mark Webb: Group Editor



Page 12



Page 35

REGULARS

ISSN 0142-7229

ABC Member of the Audit Bureau of Circulation

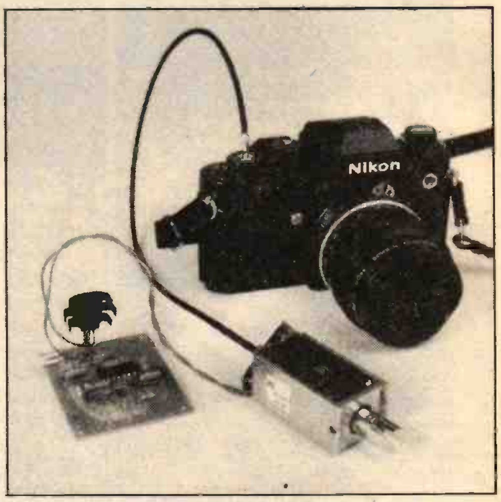
● Subscription rates — UK: £18.00. Europe: £22.20. Middle East: £22.40. Far East: £24.00. Rest: £22.70 or US$39.00.

ARGUS PRESS GROUP
1 Golden Square
London W1R 3AB
Tel: 01-437 0626
Telex: 8811896

Published by Argus Specialist Publications Ltd., 1 Golden Square, London W1R 3AB. Tel: 01-437 0626. UK newstrade distribution by SM Distribution Ltd., 6 Leigham Court Road, London SW16 2PG. Tel: 01-677 8111. Overseas and non-newstrade sales by Magazine Sales Department, 1 Golden Square, London W1R 3AB. Tel: 01-437 0626. Subscriptions by Infonet Ltd., 5 River Park Estate, Berkhamsted HP4 1HL. Tel: (0442) 876661. US subscriptions by Wise Owl Publications, 4314 West 238th Street, Torrance, CA90505 USA. Typesetting and origination by Project 3 Filmsetters, Whitstable. Printed and bound by The Chesham Press, Chesham. Covers printed by Loxley Brothers Ltd., Sheffield.

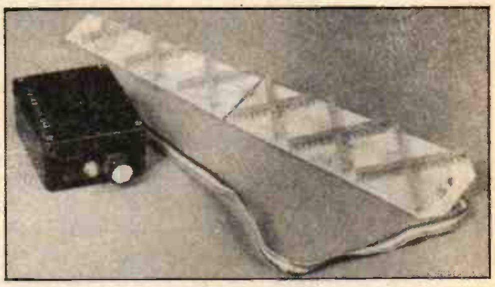
ETI
ELECTRONICS TODAY INTERNATIONAL

FEATURES/PROJECTS

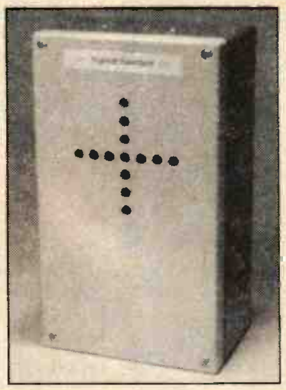


Page 40

Cover photograph courtesy of Images Colour Library (Eric Bach)

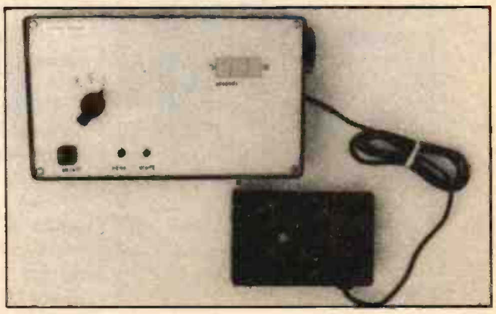


Page 35



Page 30

Page 50



NEWS

EC ICs

New European legislation defining exactly what constitutes an EC-origin IC should lead to a massive capital investment in the Community from Japanese and US companies.

The new rules state clearly that all diffusion processes involved in chip manufacture must take place within the EC if the IC is to receive EC-origin status.

Until now it has been possible to import diffused wafers and merely assemble the chips here, keeping the more complex and costly procedures elsewhere.

The immediate effect will be a boost for European companies. In the longer term it will mean an increase or switch in US and Japanese activities and investment within the Community.

The legislation is a great success for EC companies who have fought for such measures over the past six years.

AB GOES BACK TO SCHOOL

In Mid Glamorgan AB Electronics is donating funds, skill and expertise to a local school to increase understanding of electronics in education and remove some of the problems that can surround its tuition.

Coed-y-Lan Comprehensive in Pontypridd has set up an electronics room for all third years pupils to learn basic electronics and older pupils to take GCSE Electronics as an option.

Graduate trainees from AB are assisting the school with technical guidance and working with the pupils to select suitable projects. Work experience at AB is also available for pupils.

The sixth form at Coed-y-Lan is establishing a small company to design, produce and market small electrical items, again with the support and guidance of AB.

Apart from demonstrating its commitment to the area, AB hopes that the scheme will give its own trainees experience of management and presentation. If successful the ideas may be extended to other local schools.

For further details contact AB Electronics, Abercynon, Mid Glamorgan CF45 4SF. Tel: (0443) 740331.

CD-R FOR THE PROFESSIONALS

Recordable compact discs now seem certain to reach the world marketplace by this summer.

Taiyo Yuden, manufacturer of the *That's* range of audio tape, has perfected a marketable 'write-once' CD-R system and hopes to launch the system in Japan this spring. The discs are compatible with normal CD equipment and should retail at around a third of the price of a pre-recorded disc.

The recording surface appears green. A dye recording layer is introduced during the manufacturing of the discs with a spiral guide groove in the polycarbonate replacing the usual pit system.

Taiyo Yuden has however recognised the concern in the industry at the prospect of the mass of CD pirating that would inevitably be produced by a consumer CD-R system, particularly since a twin-deck CD-R is anticipated to cost little more than a standard normal CD player.

The company will concentrate on the areas of broadcasting, professional recording and the record industry itself, where the benefits of cheap short-run CD production could be reaped. It claims it will not exploit the consumer market until the copyright issues are resolved.

The distribution in the UK will be handled by Harman.

It is expected that a commercially viable CD-E system (repeatedly erasable discs) will not be fully developed for several years.

RENT THE SKIES

The high consumer interest in the area of satellite TV system rental has led to mass orders of equipment from the large TV rental chains.

Thorn-EMI has plumped for Grundig's equipment on the strength of 10000 positive responses to a recent customer questionnaire. Some 40000 Grundig units have been ordered.

The Granada retail and rental chain, one of the founder members or British Satellite Broadcasting, has displayed an interesting sense of loyalty by ordering equipment to receive Astra channels — BSB's deadly rivals. These orders will be filled by Finnish company Salora and Tatung of South Korea.

The Ministry of Defence has been carrying out feasibility studies on the possibilities of a European anti-ballistic missile umbrella similar to the US 'Star Wars' project.

However despite conclusions that such a system would be possible, the Defence Secretary Mr George Younger has ruled out any possibility of development along these lines.

The study was based on the use of existing technology — Sea Wolf and Starstreak missiles — rather than on new and uncertain systems as envisaged in the US.

The MoD study was commissioned and financed by the US SDI Initiative.

ON THE COUNTER

An 8-digit frequency counter with a range from 1Hz to 100MHz is available from Alpha Electronics.

The Goldstar FC7011 can use manual or automatic ranging with gate times from 0.01s to 10s and a basic input sensitivity of 10mV.

The 10MHz reference crystal has 5ppm stability — other models can provide stability better than 1ppm.

The FC7011 costs £98+VAT.

Contact Alpha Electronics, Unit 5, Linstock Trading Estate, Wigan Road, Atherton, Manchester M29 0QA. Tel: (0942) 873434.

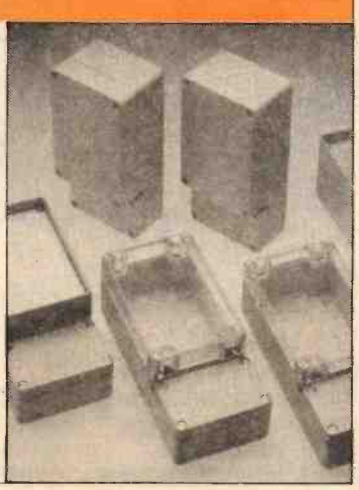
OPEN AND SHUT CASE

Two ranges of cases are now available from West Hyde.

The 'Boplast Plus' cases pictured here have separate compartments, each with a screw sealed lid, so that say power terminations could be kept isolated from the main electronic circuits allowing circuit adjustment without the danger of live terminal blocks exposed.

The 'Sentinel' range of cases are designed for housing wall-mounted sensors such as smoke, gas or fire alarms.

Details of both ranges are available from West Hyde, Unit 9, Park Street Ind. Est., Aylesbury HP20 1ET. Tel: (0296) 20441.



PILOT PILOT

A pilot electronic guidance scheme is being considered by the Government with tenders being invited from the private sector.

The proposal would initially involve the London area within the orbital M25, concentrating on radial routes from the centre to the motorway. About 1000 vehicles could be fitted with the Autoguide equipment which takes information from roadside beacons and instructs the driver of current traffic problems and alternative routes.

Both GEC and Plessey are showing interest in the scheme (as well as each other). Successful trials could lead to a public system within five years.

Next Month in

ETI ELECTRONICS TODAY INTERNATIONAL

MAYDAY!

Always one to answer to call for assistance, ETI leaps forth with the May issue to rescue all readers in need of a bit of crucial reading.

The EASi alarm blossoms forth into a complete system with the first of two groups of peripheral bits to add onto this month's control box including the entry/exit timer, panic switch and a fire and gas/smoke sensor.

The long awaited update and general modernisation of John Linsley Hood's excellent 'Audio Design' hi-fi amplifier also sees the light of day next month as does a novel, cheap super efficient guitar tuner. For those of you with an eye on the rapidly disintegrating kitchen sink, we start an indepth series on making your own PCBs with some home made equipment.

And of course there's all the other sought after snippets which go to make ETI the thinking man's electronics mag. Make May a merry month with ETI.

Help arrives on March 3rd

THE BRAIN WAVE

Bill Bains racks his brain for signs of artificial intelligence

What is Artificial Intelligence? Let's make one thing quite clear at the start. There is no such thing as *intelligence*. Come to that, AI workers have begun to doubt that there is such a thing as *artificial*, either. That has not stopped a flood of products and ideas about AI, a wealth of programs which run chemical plants and plan road networks and advise doctors and chat in reasonable English. However, they are not intelligent.

Why do AI workers suspect this? Because every time they have found a *good* definition of intelligence (as opposed to one that boils down to 'Intelligence to what I am, and you are not', they write a program which fulfills it. The sceptics then all say 'Oh, that's not what *we* mean by intelligence', and everyone starts again.

Far easier, then, to assume that intelligence does not actually exist. Working from that point, then, what is AI all about?

That depends on when you ask it. Every ten years the sceptics decide that what AI workers used to think was AI is actually just programming. You get a quite different answer every ten years. So, let's start from the beginning.

40 Years Ago

What was AI 40 years ago? Well, about then a lot of boffins (later called scientists, then electronic engineers) released from the war effort realised that they had to hand some very powerful electronics with which they could do calculations. Indeed, they were so good at it that they beat human calculations hands down and that led the boffins to ask what whether they could beat humans at anything else. Maybe they could even think?

Ah, but is thought a feature of brute machines, or is it something aetherial, beyond reproduction of cogs and valves and things? The sceptics said that there was no way that anyone could produce a thinking machine, no matter how fast it did arithmetic. To the boffins such a challenge was like a red rag to a rabbit — baffling but slightly intriguing. They put their minds to it and formulated the first theory of intelligence.

Any problem can be stated as a problem in logic. Thus any problem can be solved by a program which can manipulate the symbols of logic.

This approach eventually gave rise to the General Problem Solver (GPS) project. Its basis was the work done at the start of this century by Bertrand Russell on formulating mathematics as logic. He was concerned with such statements as 'The King of France is bald'. The difficulty with this statement is that it is neither true nor false. The King of France is not bald but neither had he any hair. The problem is that the King of France is not anything. He does not exist. However there is no way of including this in our statement.

Bert got round it by expanding the statement into one that goes 'There is a class of people called 'Kings of France' and there is a class of people who are bald, and there exists a person X and X is a member of both classes.' (I have translated slightly). Now we see where the problem lies — there does *not* exist a person X such that . . . etc. Bert considered that, with enough thought, any query such as 'Oh, why did you have to wear that ghastly jacket to dinner?' could be formulated in these terms ('There is a class of jackets . . .').

The new computers were ideally suited to manipulating such logical formulae, as each part of a formulae is either true or false and so its truth value can be represented by a single binary bit. So GPS and logicians and computer programmers struggled mightily with it for much of the 1950s until they decided that, while capable of some logical feats, it was far from General.

Out of GPS, however, sprung two lines of programs. Manipulating truth tables turned into some spreadsheet software, where columns of data are sorted and transformed on logical rather than arithmetical grounds. The other line of programs ended up performing computer algebra. All the tedious stuff about gathering all the x's on one side of an equation that we do at school can be done by computers now, as well as the expansion of such equations as

$$y = (x-1)^{101}$$

lots of deduction in trigonometry, topology and other branches of mathematical logic. This is not surprising really, because Russell's logical theories were only really successful in mathematics.

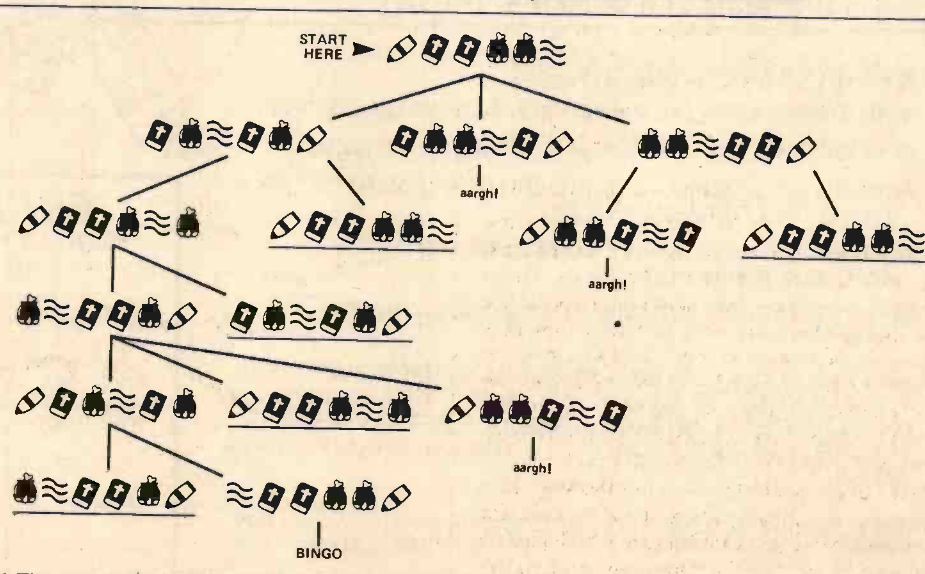


Fig. 1 The state graph of the cannibals and missionaries problem

AI

The problem was that many problems that were solved by intelligent people were not just logic-chopping games. They involved choices between alternative actions based on their likely effects. Thus the second, 1960s version of AI:

Difficult problems can be solved by breaking them down into sub-problems and then solving the sub-problems.

Search

This brings us to the theory of search. In general, 'search' means how the computer hunts for the solution to a problem through a set of sub-problems. The ultimate search problem was the game of chess and so for quite a while a 'really intelligent computer' was one that could play chess. In part this is because chess is mind-bogglingly complex. We will choose another AI classic, the missionary and cannibals problem, to explain the principles.

Two missionaries and two cannibals have to cross a river using a boat that will only hold two people. However, if the cannibals outnumber the missionaries on either bank or on the boat, the cannibals eat the missionaries. Rather than try to solve the problem by logical formulae, we break it down into a lot of sub-problems and try to solve them. Each possible state of the game is a sub-problem — the problem of what to do next. You can only get from one state to a few others.

This can be described by a *state graph*. The current state of the game is described by some symbol: we will describe each cannibal with a and each missionary with an . The ≋ represents the river, so ≋ represents one cannibal and one missionary on each side of the river. The shows where the boat is. Only missionaries can row.

The graph (or tree) connects up each state of the game by links describing how you get from one to the other (Fig. 1).

Now, this is a very simple game but shows several of the problems of more complicated ones. The tree is abbreviated because several of the states (the underlined ones) are the same as ones we have found before. To avoid getting round these again and again, the computer must remember where it has gone. We must also be able to detect when we have got to the goal and detect when we have failed too.

There are two approaches to doing this. A *breadth first* search means constructing all the possible moves on the first line, then all the ones you can make next, drawing the full width of each layer before going on to the next. The alternative is *depth first* which follows one line down to the bottom of the tree before starting another. The former is more sympathetic but takes longer. The latter is a better bet if you have some idea in which direction to head as you cut out a lot of tree-building, but it offers no advantage if you have no initial clue.

For chess, of course, a breadth first algorithm would be hopeless — the full tree for a typical game might contain 10^{120} states. So we need a depth first plan, guided by rules of thumb — heuristics. These might be that any move that takes command of the center of the board is preferable to one that commands the periphery, that trapping some pieces such as the opponent's queen is more advantageous that trapping the pawns and so on. The tree then becomes simpler (Fig. 2). And each 'state' actually encompasses a lot of moves and a lot of possible board positions.

The theory of search has been most spectacularly successful in, well, playing chess. It is also useful for any situation where a program has to reach a final state via a number of intermediate positions, such as the manouvering of a robot around a factory floor or getting at the fifth box down in a stack of boxes, very useful in automation. However, more complicated problems run across the combinatorial explosion — the way that the number of possible moves expand exponentially as the problem gets bigger.

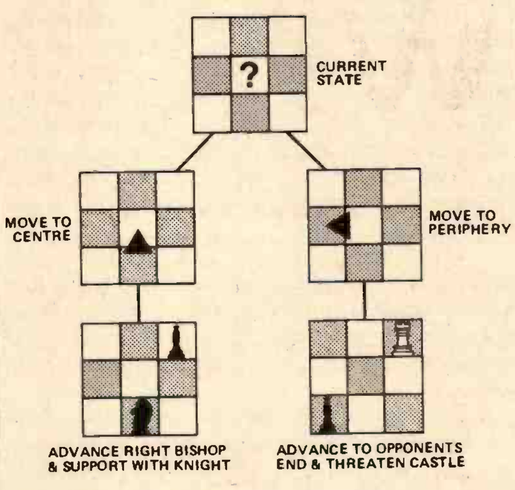


Fig. 2 Part of the state graph for chess

Chess suffered from this too but in chess there are many heuristic rules, derived by human experts from years of study, which can eliminate nearly all moves from consideration. In other problems this is not possible, as for example in the Travelling Salesmen Problem (Fig. 3).

Travelling Salesman

Here a travelling salesman has to visit each of N cities once only, visiting no city twice and returning to his starting point. What is the shortest route? Finding *a* route is easy but finding the shortest gets enormously hard because of the number of possible routes. Here a search approach could systematically try all routes, but it would take forever to do it.

Travelling salesman do this sort of thing automatically, whereas chess players have to think about their moves and so can give a coherent account of why they choose one other another. So, what we really need is something that can not only search through various options (which is what searching a state graph is doing) but can evaluate them in the light

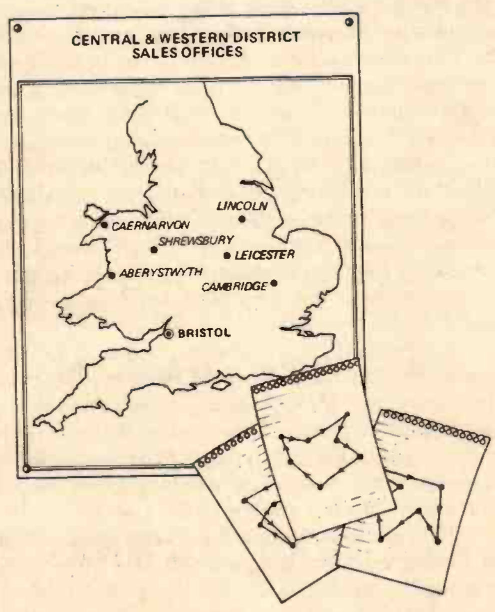


Fig. 3 The travelling salesman problem

of expertise.

Thus we arrive at the third, 1970s version of Intelligence.

Difficult problems are solved by the application of experience and expertise.

This leads us into the realm of the *expert system* and the most obviously useful of AI's results. An expert system is a program or group of programs which embodies 'expertise' in some area — its 'domain'. Expert systems applications fall into three broad areas. Advisory systems are the most spectacular, advising on medical diagnosis, taxation, pension schemes, house-buying, configuring mainframe computers and the like.

Checking systems are used in clerical and ordering roles, checking, say, that the order for four tonnes of elephant manure can be met by the number of elephants in stock at the moment. For ordering the components to make, say, a satellite this is no mean feat.

The third area is in real-time monitoring, where the system integrates a large number of inputs to produce a single advisory output, usually of the 'help' variety. This latter has been used in army in battlefield evaluation systems.

Big expert systems are remarkably good — the MYCIN system, which advises on infectious disease treatment, is as reliable as an experienced hospital intern. However, a lot of extreme cleverness in three areas is required to get to this point.

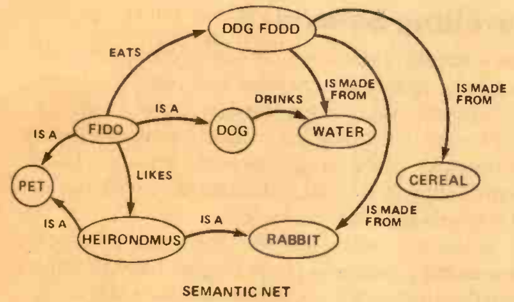


Fig. 4 A semantic net

Rules

The first is the rules base. Nearly all expert systems are rules-based systems, in that their expertise is based in some way on rules. MYCIN, one of the early successful systems, had the rules written in Lisp, the world's most unreadable 'high-level' computer language. They are of the form known as 'production rules' which are a list of conditions and an action to take if the conditions are all met. They are usually heuristic rules because they embody something that we have found to be so, not something that is logically necessary. Thus they might list the chance that a given set of symptoms are associated with infection by a particular bacterium.

Lisp stands for List Processing language, and was invented by AI pioneer John McCarthy in 1958. It has the advantage that it is enormously flexible and so any sort of knowledge can be described in Lisp using some suitable symbology (Lisp *is* meant to be a very difficult language, which is why AI researchers do not like you to mention that it is amazingly like Logo).

Recently programmers have been shifting more to Prolog as their language for this *knowledge engineering,* not because writing the rules is easier in Prolog but because making them work for you is much easier.

This brings us to the second problem, the problem of inference. Having a huge amount of data in a computer is one thing — getting anything useful out again is quite another. This is the job of the *inference engine,* the part of the system which checks to see which rules are actually true given its data and hence what conclusions it can draw. This is where Prolog scores because it is a language written around *predicate logic,* a form of logical calculus (just as Fortran is written around arithmetic, so making arithmetical calculations very easy). This means that stating logical rules in Prolog is a doddle and 'adding' them together with data is also simple.

An example? Certainly, Sir. Let us outline an expert system for finding out why your hi-fi is making no noise. This is the simple version, for people to whom IC1 is a misprint for ICI. First, the rules.

1) If the speakers are turned off then no noise will come out.

2) If there is no power then no noise will come out.

3) If it is not plugged in then there will be no power.

4) If the power supply is blown then there will be no power.

5) If the transformer is smoking then the power supply is blown.

6) If the rectifier is smoking then the power supply is blown.

7) If the fuse is blown then there will be no power.

That will do for now. To start, we observe that even our 'Saxon' CD will not produce any sound. So the initial observation is that no noise comes out. In the most common method, called *backward chaining,* the system, takes one of the possible explanations for this and then works back to check if the data actually support it.

In this case, we chose rule 1 and the system then asks

Are the speakers turned off?

> No (we reply).

So rule 1 'fails', and we have to go back to the start ('backtracking' — something easy to Prolog and LISP). The other possibility is now invoked — rule 2. Is rule 2 'true' — does it fit the facts to explain the silence? More questions: the system postulates rule 3, and then checks for data:

Is it plugged in?

>Yes.

So rule 3 fails but rule 2 might still hold, so we backtrack to rule 2, not right to the start. Keeping track of where you are among the rules is what makes Prolog clever.

>*Is the transformer smoking* (It postulates rules 4 and 5)

>No (Rule 5 fails, backtrack to rule 4)

>*Is the rectifier smoking?* (Postulate rule 6)

>Yes

>*Your power supply is shot.* (Found that rules 2, 4 and 6 apply)

and there you are, another success.

The alternative to this is *forward chaining,* which takes all the data and then filters out the rules that can apply to it. This is more systematic but often you do not know what data you need before you start reasoning.

You can incorporate uncertainty into the logic by using probabilities or *fuzzy logic* instead of a true/false dichotomy to characterise each statement. Inference becomes more complicated but can cope with statements like 'There is a *bit* of haze round the transformer . . .' which do not seem too sure. MYCIN uses probabilities in this way, using Bayes Theorem.

So far this is easy programming and you could probably do it yourself in Basic, let alone Lisp. The third problem is the big one, though. Where does that expertise come from and how do you store it?

The last part first. Rules are fine for simple diagnostic tests but are very cumbersome for dealing with more complicated subjects. Imagine a system for identifying animals. There would be a vast amount of repetition if we used rules to identify each one:

IF — It is bipedal AND it has binocular vision AND it has no feathers AND it has little hair THEN it is a human.

IF — It is bipedal AND it has binocular vision AND it has no feathers AND it has little hair AND it has claws then it is a plucked chicken.

Very wasteful, which is why a lot effort is put into identifying good database structures for all this information such that the attributes of a plucked chicken are automatically called up by asking about chickens or, conversely, that asking about biped animals that have no feathers or hair automatically generates a shortlist of humans, chickens, tyrannosauruses, etc. As there is no consensus on this one and as several of the database structures are almost exactly the same apart from the words used to describe them, let us just list them quickly.

Heirarchical databases arrange things so that there is an entry for mammals, then a sub-entry for primates that shares all the mammal entry and has a few more specific items of its own, then an entry for humans that is more specific and so on. Easy to write, but has problems with exceptions to rules.

Semantic nets (Fig. 4) are pictures a bit like the graph in Fig. 1. Each concept is linked to any other concept it is related to, so travelling down the lines automatically gets you to related subjects. Nice idea, hard to do.

Frames and Scripts (Fig. 5) are like blank forms — there is a memory form for 'Planets' with slots for 'mass, 'number of crashed space-probes' and so on into which you fill your data. This allows you to know what to expect but again copes poorly with exceptions.

Object-Orientated Programming is the latest craze — databases are oriented around objects (cats, dogs, Saturn, the GNP) rather than properties. What this means in practice is still unclear. None of them do as well as a trained gerbil.

Expertise

The other aspect of the expertise problem is putting expertise into the system. This is troublesome in two ways. Firstly, it is very difficult and boring to do. Expert systems cannot go out and get expertise — they must have it fed into them. Very sophisticated ones can find some gaps in their knowledge and request that you fill them but nothing you could buy would do this. So you must go round asking people all about infectious disease, or power amps, or budgie breeding.

Often this requires you just to watch someone doing something — mending their car, sexing their budgie or whatever, and asking them at frequent intervals why they are doing *that*. Then you must code the result in the form the database requires. After that, typing it in is a minor chore.

The second point is even worse. Much knowledge is not *explicit* knowledge, such as the definition of a disease in a medical text-book, but is *tacit* or *hidden* knowledge, such as knowing just what a 'rash' is. *I* know what it is, but I am sure that no-one ever tried to define one for me. If I told you to put your shoes and socks on, you would automatically do it in the reverse order (despite the fact that it is quite possible to put your shoes on and then put your socks on) because, well, you would look daft otherwise, wouldn't you?

TO VISIT THE ______ SHOP: PICK UP MONEY. GET INTO (CAR/BUS). GO TO ______. PICK UP BASKET. PICK UP ______. PUT IN BASKET. TAKE TO (TILL/CHECKOUT). PAY. LEAVE ______ SHOP. GET INTO (CAR/BUS). PUT DOWN BASKET. PICK UP BASKET. GET OFF (CAR/BUS). RETURN TO ______ SHOP. GIVE BACK BASKET. APOLOGISE. LEAVE.....

Fig. 5 A script

We learn these things by example and experience, and consequently often do not realise that we know them, let alone exactly *what* it is that we know.

This shows up in expert systems in two ways. First, crucial knowledge may be just missing. It works fine when it is used by an expert because, of course (ha ha), no-one in their right mind (ha ha) would ever think of trying to treat a Treponema infection with *oral* ampicillin! Ha, what a laff — until you unleash your expert system on some GP who is a little shakey on what Treponema actually *are*. Consequently, most expert systems are only really useful as prompts for other experts.

The other way this shows up is in *default reasoning*. In expert systems, tacit knowledge is often hidden as default reasoning — conclusions which are drawn if no other ones can be drawn from the rules. Quite often these defaults are not even stated as rules at all but are hidden in the mechanics of the inference engine. The programmer has assumed (maybe unconsciously) that the defaults are correct. If you are not an expert in the area or if you want to challenge the assumptions then such 'hidden knowledge' makes using the system very difficult. If my expert system on rose pruning suddenly recommends that I buy a bulldozer, I might be loath to take its advice. If it can explain its reasoning it might convince me. This is the job of the explanation system.

In theory, such a system is simple, it just keeps track of all the rules that 'fired' in coming to a particular conclusion. The result is rather like a machine-code dump of a Fortran program in its intelligability, so many expert systems have explanation systems attached which translate such 'traces' into English.

Their degree of success depends not only on the quality of their English but also on how much of the reasoning is hidden — the dreaded tacit knowledge. For example, my expert system might have built into it the assumption that if it could not decide what was wrong with your roses you should give up and try geraniums. Hence the bulldozer. Getting the explanation system to reveal this default logic is tricky.

Language

This brings us back to the problem of input, both of rules and, when it is full of rules, of queries. Many commercial expert systems claim to be able to understand English, but they cannot. They understand such formalised, stilted English as:

Query: count the samples from the location Birmingham.

rather than

So how many lorries do we have in Birmingham, then?

AI has a poor record of getting computers to understand 'natural language' (English, Russian, Scouse) as opposed to artificial languages (Fortran, Lisp and the like, which they should be able to understand as these languages are designed for computers). Because we can do this, and computers cannot, this has been one of the two 1980s definitions of AI: *An intelligent system is one that can communicate in natural language.*

It has the major advantage that it automatically includes nearly all humans and no computers at all. Yet.

One early English-language program was one called Eliza, which was a psychiatric consultation program. It would scan your sentence for key words, and then re-use them in its own sentence. Just like a half-asleep psychiatrist, in fact. When no obvious prompt suggested itself, the program invited you to 'tell me about . . .'. Thus, for example.

>I am really depressed

Why do you say that you are really depressed?

>Because my father doesn't understand me.

Tell me about your father

and so on. This could result in ludicrous problems, however:

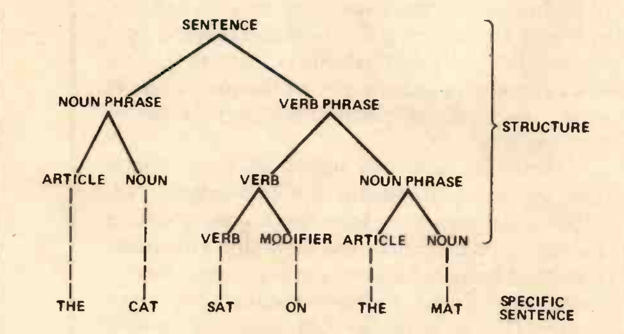


Fig. 6 Deep structure (or parts of speech)

>I have terrible heartburn.

Why do you think that is?

>I have had kippers for breakfast

Tell me about had kippers for breakfast

This approach was rapidly discontinued.

AI people thought that they had language cracked in the early 1970s. Using a variety of grammatical theories coupled with the latest in database structures, a program called Shlurdu could converse in grammatical English about a box filled with geometrical shapes. The box was displayed on the screen and the computer identified shapes and moved them around under the user's control. Thus, for example:

>Pick up the green pyramid.

Which green pyramid do you mean?

>The one on top of the red block.

(Does it) *OK.*

>Put it down on top of the red cylinder.

(Does it) *OK.*

>Is there a tower in the box?

I do not understand tower.

>A tower is any pile of two or more objects. Is there a tower here?

Yes. The green pyramid on the red cylinder.

and so on. It could keep this up for days and also explain the logic of what it was 'thinking'. However, the basis of the program was a mass of mixed theories and database structures which happened to work. When people tried to extend the program to more useful domains, they turned out not to work.

So for the last 15 years it has been back to basics, to try for a Grand Unified Theory of language, one that would be the building block of a computer comprehension system. When a computer translates a computer language into machine code, it does it by a series of rewrite rules. The symbol 'X =' is translated into 'Load contents of buffer H into memory location pointed by buffer X' (which is why sane people prefer 'X ='). Such grammars are largely 'content-free', that is what a symbol means does not depend on where in a program it lies. 'SIN(X)' always means 'calculate the sine of X'.

A human analogue of this sort of language was tried and reached its most sophisticated development with Naom Chomsky who said that behind the surface structure of every sentence is a *Deep Structure*, which represents its internal representation in our brains. The deep structure is the same for all human languages and all you need to do to get from English to Japanese, or from English to the brain's own databases, is to rearrange the sentence according to set rules (Fig. 6). Thus:

The cat sat on the mat.

is split into subject phrase ((The) cat) and verb phrase (sat on (the mat)). The verb phrase is a verb and another noun phrase, the noun phrase consists of an article (the) and a noun (mat). Getting from one structure to the other is simply a case of replacing (the mat) with (noun phrase) throughout.

Hang on, isn't this terribly complicated AI stuff just the old 'parts of speech'? Well, yes, a lot of AI natural language processing is actually parsing sentences to see what structural form they fit into.

The problem with this is that it assumes that a sentence can be parsed on the basis of its syntax alone without worrying about what it means — its semantics. It also assumes that the meaning of one bit is not affected by that of another bit, let alone by what the next sentence means. Alas, this is not true. Try saying

'I never said that he was a bad salesman'

with the stress on different words. No computer could tell what you mean from it unless it could understand the subsequent sentence which said "Rotten manager, yes, . . .". So much for context-free grammars.

Having said that, fairly unambiguous and simple English can be understood by the descendants of the AI language research projects. They are often used as 'front ends' to expert systems, allowing the user to communicate with the system in something like English. Which is where we came in.

Vision

The other big area which traditional AI has bumped on is vision. Now, a two-year-old can pick out a stylised plane from a tangled picture containing dozens of objects in about three seconds. A Cray supercomputer, programmed with the latest software, would take 10 minutes to come to the same conclusion — and might pick out a duck by mistake.

This is a great embarrassment to AI and leads to our last definition of intelligence:

An intelligent system is one that can see.

(Non-AI apologists do not usually put it like that — they usually say 'can match complex patterns, like the eye does').

The difficulty is not picking up a picture, which is done with a TV, but in identifying what is in it. You start with a digitised TV picture, usually reduced to black and white only, rather than allowing shades of grey. Discrete picture areas are identified by their edges. These are then smoothed to give shapes (Fig. 7). Surface texture gives an idea of surface orientation and stereoscopic vision can give depth information. But where then? All you have is a series of lines and planes and, with luck, their orientation in 3D space. You then have to identify the objects concerned.

How is it that we can instantly discriminate between a table and a fattish horse? Why are we not amazed when red buildings with wheels at bus stops suddenly start moving? In a nutshell, no-one knows

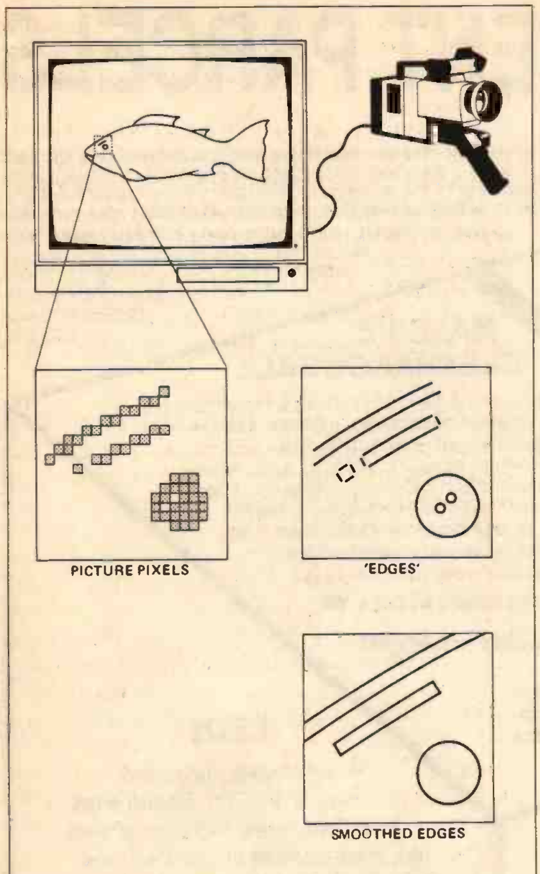


Fig. 7 Image recognition

and no-one has managed to mimic it on a conventional computer.

What they can do is apply pattern recognition techniques to a limited number of patterns and so discriminate between objects on a production line, or check the orientation of a part as it enters a machine. They can get an idea of whether a moving object is a person or a car (although a wolfhound would probably floor them). In short, like the language systems, when they are operating on a limited set of possibilities they work OK.

Minds To Come

So what of the future? The really successful applications of AI—games playing (and its serious counterparts in automation) and expert systems, are going from strength to strength. Commercial 'expert systems' often contain no more AI than a spreadsheet but this will change as research techniques in logic penetrate to the office.

The real problem is that these systems are hard to use, partly because their output is incomprehensible but mostly because inputting data into them is very tedious. WIMPS methods (themselves a spinoff from AI) are more comprehensible for output but useless for input. So the next major jump must be in input and output format, and that means language comprehension and voice recognition. Then we will be able to babble at our computers, not just program them.

It is no coincidence that the Japanese's over-ambitious 'Fifth generation computer' project concentrated on these areas. Such things as manipulating shapes in 3D and constructing fractal landscapes, while showy and wonderful television, will have less impact on most of us.

How this is going to be achieved in Lisp and Prolog is hard to see. However it is likely that massively parallel programming, especially in computers modelled on neural systems (Fig. 8) will make some major advances, especially in pattern and speech recognition. Indeed, some AI researchers are now doing work on bits of *natural* neural systems, which may be 'I' but is probably not 'A'. Neural systems will not do all that is claimed for them but as they are claimed to do everything from solve the nuclear stalemate to prove the existance of God, this is not very surprising.

Their record on pattern recognition so far is impressive. Professor Aleksander's Wisard can do the aircraft recognition trick I mentioned above about as fast as a 2-year-old.

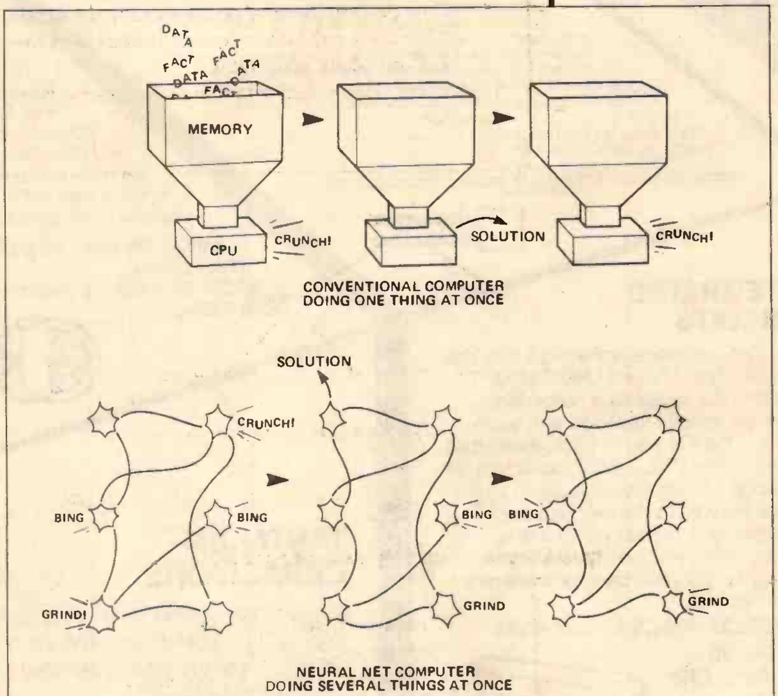


Fig. 8 Serial and parallel processing in conventional and neural net computers

The nice thing about it for the ETI reader is that it is not clever programming that makes this possible but clever hardware and some simple programming to run it. There was a theory a few years ago that all you needed to understand English, or defend the USA against nuclear attack, was a hundred mainframe computers and a program that would stretch to the moon. However, AI has taken another course and changed the rules again.

The latest test of AI (propounded by the BBC, so it must be right) is that an intelligent system can appreciate a metaphor. This really is getting a bit rarefied, considering the performance of the average Sun reader.

I prefer the definition of intelligence proposed by a disgruntled AI researcher several decades ago, when sheer number-crunching power was thought clever enough. It seems to get nearer the heart of what most people would call intelligence than anything else. See how near your micro, or even your toaster, is to this!

And mankind at last built the ultimate computer, with more connections than in all the human brains in the world. They switched it on. And they knew at once that it was truly intelligent because no matter what problem they set it, no matter how difficult or arcane the subject, no matter the gravity of human suffering held in the balance by the flip of a circuit, the damn thing always found an excuse not to bother finding the answer.

ETI

CIRCUIT THEORY

OP-AMPS

Paul Chappell resists the urge to oscillate with the low down on stabilising op-amp circuits

In last month's article I introduced some of the basic concepts of feedback theory — loop gain, return difference and so on. This month I'd like to pursue the topic a little further.

To explain the idea of loop gain, I cut the feedback loop at various points, injected a signal into the loop and looked at what came out of the other side of the cut. I didn't specify the kind of signal I was injecting but let's suppose it was a sine wave. The situation is shown in Fig. 1.

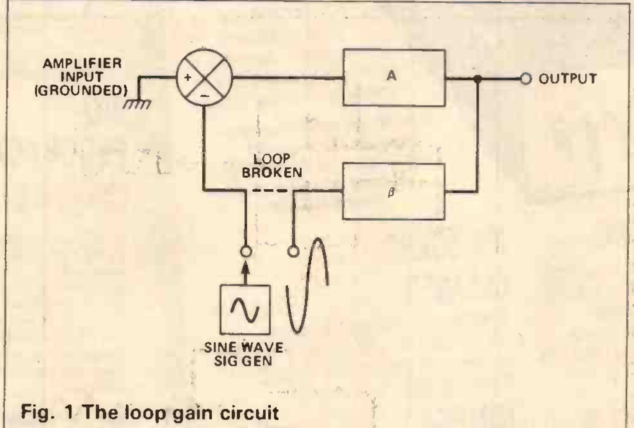


Fig. 1 The loop gain circuit

Suppose that the block A in Fig. 1 is a real op-amp. It is built only to amplify, so inside its black plastic case there are nothing but transistors and resistors. Is it reasonable to describe its operation by saying simply that it magnifies the input signal by a factor A? That is to say, can you assume that for a real (uncompensated) op-amp, it will simply amplify any old signal by an equal amount?

For low frequency inputs, the description may not be far from the truth, but at higher frequencies the limitations of components in the circuit will begin to make themselves apparent. Although no reactive components have been deliberately introduced, they exist as integral parts of the various components of the IC.

The result is that as the frequency of the signal in Fig. 1 is increased, the loop gain will start to decrease and the phase of the returned signal will change. With any signal other than a sine wave, the shape of the wave would change too but a sine has the special property of passing through any linear circuit without a change in form.

Just suppose that at some particular frequency the returned signal was reduced to exactly the same amplitude as the test signal by the fall in gain of the amplifier (Fig. 2). Why not close the switch, remove the test signal and let the circuit carry on alone? The answer is — no reason at all! But if this circuit is both a feedback amplifier and an oscillator, how do you separate the two functions? How do you make a feedback amplifier that won't oscillate?

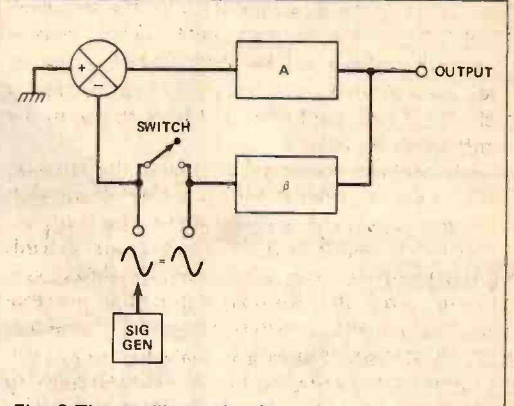


Fig. 2 The oscillator circuit

You may think there's a pretty slim chance that in any practical circuit the gain would hit unity at just the same moment the amp's phase shift was 180°, and you'd be right. But let's just think about the opposite side of the situation for a moment. If you were deliberately trying to make an oscillator, how would you go about it?

The condition for the circuit of Fig. 1 or 2 to be an oscillator is that at the frequency of oscillation, the signal emerging from a cut in the loop should be exactly the same as the one that went in. In mathematical terms, the condition is $-A\beta = 1$. (Since we're dealing with sine waves, you can think of A and β as complex numbers which represent both the gain and phase change at any particular frequency). You won't want to rely on chance to determine the frequency of oscillation, so instead of relying on A to provide the phase shift, you'll put some network in the β-box which gives 180° phase shift at the frequency you choose, well below the frequency at which the amplifier starts to add its own contributions.

Now comes the problem of making the loop gain exactly equal to one at the frequency you've chosen. Exactly one? Not even a fraction of a percent out? What happens if it's, say, just a touch less? If you have a circuit oscillating merrily away and reduce the loop gain just a little below one, the oscillations will die away. This corresponds with the intuitive notion that the signal will get smaller and smaller on each journey around the loop until it's too small to see.

Increasing the loop gain above one, on the other hand, will cause the oscillations to increase in amplitude — not to settle at a higher level but to keep increasing until something makes them stop. Banging against the power rails, perhaps.

Setting the loop gain at exactly one, without the tiniest margin for error on either side, is clearly ridiculous. Impossible. The upshot is that there's no such thing as an oscillator based on a linear circuit! The ones which look as if they are, all have gains set slightly higher than one. What happens is that the oscillations build up until circuit non-linearities come into play. The circuit then finds for itself a wave that is not quite a sine wave but will travel around the loop with exactly unity gain. The trick to designing an oscillator is to make this new wave as close to a sine wave as possible, which is most easily done by giving the circuit a gentle transition into non-linearity as amplitude increases — in other words, no sudden clipping.

Just to avoid confusion, I'm talking here about the kind of oscillator that might make an unwelcome appearance in your amplifier circuits. There is another type of oscillator, the relaxation oscillator, which uses the active circuit element as a switch. Some examples based on op-amps are shown in Fig. 3. The amplifier's linear characteristics are irrelevant to these circuits — they could equally well be made from logic gates. They are also unlikely to creep into your circuits by accident. If you want one, you have to put in the components to make it!

Returning to the amplifier circuits, the situation is this. If the amplifier produces a 180° phase shift while the gain is still unity or above, the feedback circuit will oscillate. Is there any way to ensure that this won't happen? One way to be certain is to deliberately introduce a roll-off in the gain of the op-amp so that it reaches unity before all the unwanted (but unavoidable) capacitors built into the IC make themselves felt.

Introducing a single capacitor between collector and base of one of the driver transistors in the IC is a very common way. The capacitor introduces its own phase shift but although it approaches 90° at high frequencies, it remains far from the critical 180°.

Although certain to produce stable amplifier circuits, this technique is not ideal. A single capacitor gives a gain roll-off of 20dB per decade (in other words, every time the frequency goes up by a factor of ten, the gain drops by 20dB). This roll-off rate doesn't depend on how the capacitor is connected — all you can change by altering the circuit is the frequency at which it starts.

This means that for an op-amp circuit which would begin to introduce its own phase shifts at a few hundred kHz, the frequency chosen by the IC designer for unity gain might be 1MHz. If the original circuit had a gain of 100dB, this means that the roll-off in gain must start at only 10Hz!

Some IC manufacturers go for a more subtle means of keeping the amplifier stable in an attempt to preserve more of the gain at higher frequencies. The NE5534, for example, being intended for audio use, must have useful gain at least into the tens of kHz. The compensation circuit used does exactly that but the trouble is that the op-amp produces a 180° phase shift before the gain hits unity. In other words, you can build quite ordinary two resistor feedback circuits around the IC and it will oscillate!

Let's take an example. Suppose you have an op-amp which reaches the 180° phase shift while it still has a gain of five. How can you use it? Look at the circuit of Fig. 1 again. At the 180° shift frequency (let's say it's 200kHz) the A box will have a gain of five. As long as the β box has a gain of less than $\frac{1}{5}$, the loop gain will still be less than unity, although the op-amp's own gain isn't. Remembering that the demanded gain is $1/\beta$, as long as the resistors are used to select a gain *greater* than five, the circuit won't oscillate. Try to select a gain of five or below and the loop gain will exceed unity and you'll have a 200kHz oscillator on your hands!

Preventing the circuit from oscillating spontaneously is not quite enough to make sure you end up with a well-behaved amplifier. If the loop gain is only marginally below unity at the 180° phase shift point, its transient response can still be pretty bad. If you apply a square wave, it can set up 'echoes' around the loop (like the oscillator with loop gain set just below one) which die away after a few cycles. This shows itself as 'ringing' after each transition of the square wave.

The worst effects are cleared up by making sure the loop gain is well below one when the phase hits 180° and the phase is well away from 180° when the gain is unity and above. In the jargon, you give the circuit the highest possible gain margin and phase margin.

Well, I promised many months ago to give an explanation of the capacitor in the op-amp and the reason for the roll-off in gain. At last I've got there. I hope you've found a few useful odds and ends to extract from all the theory. Don't expect an op-amp to give a gain of 1000 at 100kHz, for example! Beyond that, if you ever build an amp that turns out to be an oscillator, at least you won't be entirely baffled about the cause.

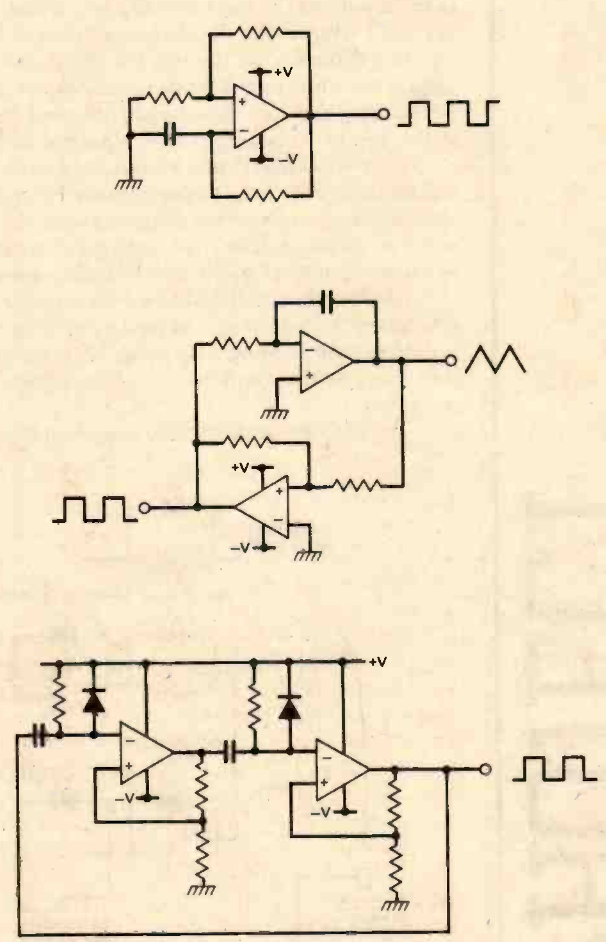
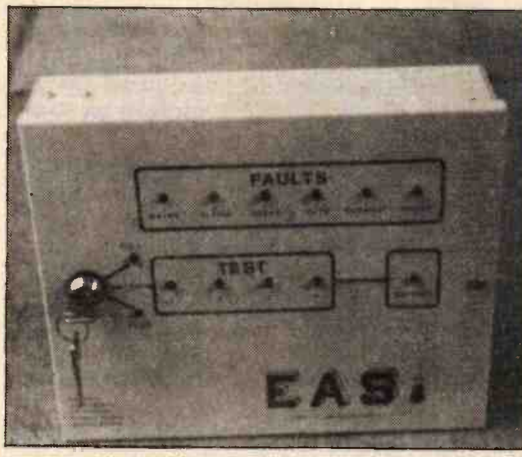


Fig. 3 Relaxation oscillators

EASi

Pat Alley presents the EASi way to the ultimate comprehensive alarm system



Wires wires wires. The problem with modern burglar alarms is the wires. Wires for sensing, wires for sounding, wires to confirm, wires to deter. A never-ending reel of 4-core cable, all of which needs carefully hiding in order to avoid 'decor pollution' and the wrath of co-residents!

So how about having a single 1mm wire connecting door and window sensors, pressure pads, ultra-sonics and infra-red devices, fire, gas, smoke and flood alarms, personal attack points and more. Does it sound a tricky problem? The answer is EASi.

EASi

EASi stands for Event Alarm System installation. Figure 1 shows the fundamental operation. A constant current is fed through the single wire loop around the house from a mains-derived power supply (with battery back-up). Across each door and window switch (normally closed) is a standard red LED.

With all switches closed the resistance of the loop will be negligable in comparison with R1 and the voltmeter will read zero. For an open switch, the LED will drop something like 1.6V and the voltmeter acts as a totaliser indicating how many switches are open.

Also the illuminated LED makes it easy to spot which switch is to blame — anyone with a loop alarm system will tell you how infuriating it is to open and shut every window and door until the alarm resets properly!

The LED also assists a very important aspect of burglar alarms, your sense of security. Every time you open a window, you see the system in operation as the LED lights — a psychologically satisfying side-effect.

Another major advantage of the EASi system stems from the fact that the alarm triggers from the *rise* in voltage rather than from the crossing of a specified alarm threshold. This means that a window can be left open at night in your bedroom without disabling the whole system, as is the case in virtually all commercial designs.

Things To Come

Before we describe the main system in detail we should give you a taster of the many units we have to offer over the next few issues that can be used with the EASi loop.

Apart from the central control and power supply, there is an entry/exit sensor, a fire sensor, a combined gas and smoke sensor, a panic switch, an ultrasonic detection system, a light detector, an intercom system, a freezer fault alarm and a moisture alert. Oops, nearly forgot the pressure mat and cupboard sensors, and the instructions for fitting side loops or for including garden sheds without jeopardising the internal security. Impressed? Now read on . . .

The Control Box

The heart of the system (from which flows all knowledge and current) is the control box, normally screwed to the wall inside the house. It is powered from the mains but uses a 12V back-up battery in case of mains failure.

The control box has a loud internal siren which can be heard throughout the premises. The unit distinguishes between three types of alarm — *hazard*, *intruder* and *event*. Hazards include fire, floods and personal attack. Intruder alerts come from windows, doors and other burglar spotting sensors. Events could be anything from your freezer turning off unexpectedly to a potentially explosive gas concentration.

A key operated switch selects between *full*, *test* and *part*. With *full* selected, all sensors are activated. The *part* option de-activates intruder alarms so that you can use your house as normal without turning off the alarm completely. *Test* prevents all alarms, checks the battery and displays the number of open sensors

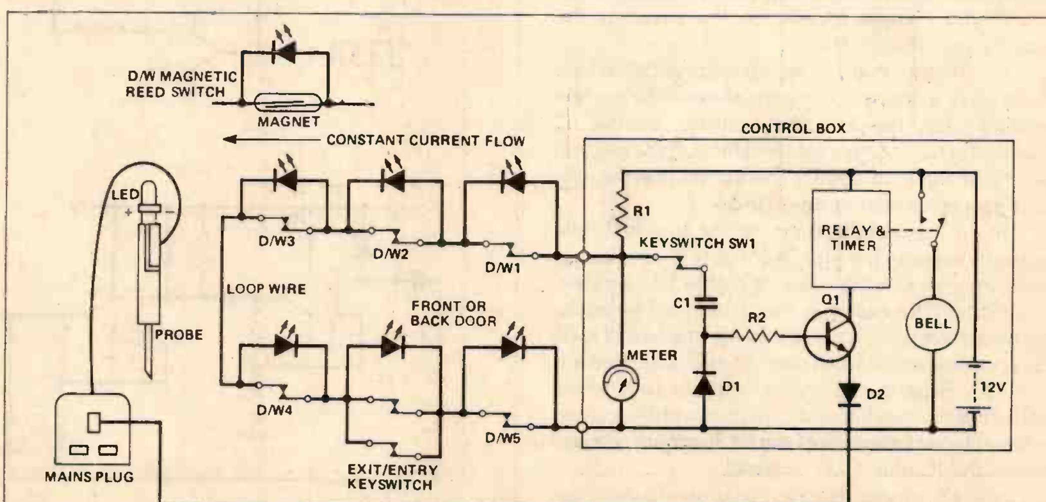


Fig. 1 Fundamental concept of the EASi system

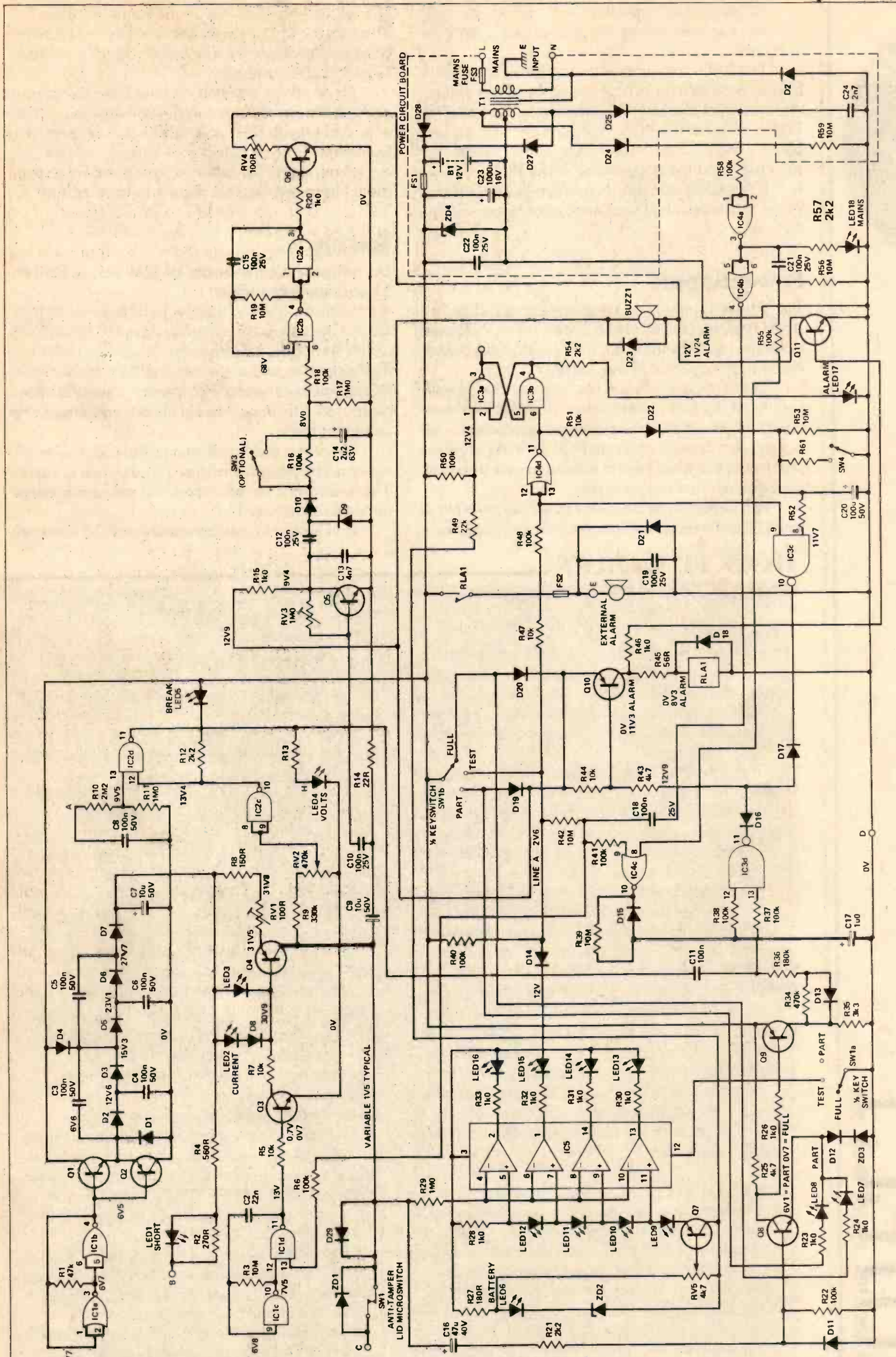
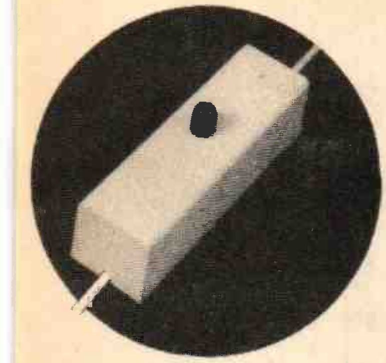


Fig. 2 Circuit diagram of the EASi control box and power supply

using the four display LEDs.

The component overlay is shown in Fig. 3. Construction is reasonably straightforward, starting with the resistors and building up through to the higher components, IC sockets and variable resistors. Leave the ICs out for the moment.



All electrolytic capacitors and LEDs have their positive terminal facing the top of the board as indicated.

The LEDs that appear on the front panel each have a space for a 6mm hole next to the solder points, through which the LED should pass, finally standing 12mm proud of the PCB. Alternatively, with a bit of careful positioning these LEDs could simply be soldered in on the copper side of the PCB.

IC sockets are highly recommended since there is plenty of room and the convenience far outweighs the cost.

Power Supply

The power supply is on a separate board (Fig. 4). Again construction is straightforward — the PCB pins to connect with the mains terminal block should stand about 8-9mm proud of the board.

The principle reason for keeping the power supply off the main board is one of safety, this way there is no chance of mains voltages appearing in the wrong place through a bridged PCB track. As a further precaution put some form of insulation over the short copper track that carries mains.

On the prototype the main circuit board was fitted to the lid of the metal case using plastic snap-on stand-offs, so that the PCB was about 10mm from the lid. This puts the LEDs in positions as shown in Fig. 5 and gives easy access to the terminal blocks for the sensor loop and alarm signals.

Once you've decided on your case layout you can join the boards together (three wires, +, − and a link between R58 and R59) and wire in the keyswitch. Ribbon cable is of sufficient gauge for everything except the battery connections. For testing, the lid microswitch SW1 should be shorted out.

Testing

Do not connect the mains power yet, we can do preliminary tests without it.

With the ICs and the fuses in place, set all pots around the middle of their range except RV2 and RV5 which should be fully anti-clockwise. Place SW5 in the 5s position and fit the terminal blocks onto each PCB if you have not done so already. Label the mains clearly on the power board's block, preferably by colouring them.

To test the system without wiring your house up, construct the breadboard test circuit shown in Fig. 6. The switches can be pieces of wire inserted or removed as required.

Run a wire to each of the six main PCB terminals

HOW IT WORKS

The circuit diagram of the EASi control box is shown in Fig. 2.

Power Supply

The specified 12-0-12V transformer of about 2VA, capable of running cool at maximum power dissipation is employed for minimum cost. It adequately supplies the equiescent current requirement of about 45mA plus sufficient charging to replenish even a discharged battery within 12-20 hours although in practice the battery normally remains in a fully charged state.

Since the battery remains permanently connected it not only dictates the rail voltage until shunted by the 13V zener diode but augments the transformer in providing the extra current for the alarm bell thus allowing it to discharge slightly on occasions, as recommended by manufacturers, so as to sustain peak condition.

Used in this way the battery life should exceed 10 years.

Battery charging current reduces as the battery voltage increases until at about 13.5V it is completely shunted out by the 13V zener diode which commences to dissipate all excess transformer current thereafter, thus providing completely automatic battery charging. Note this simple combination of battery, zener diode and transformer allows each component to compensate for the other, obviating maximum CMOS voltage being exceeded (even if the battery becomes detached) and superior to the traditional reversed diode between battery and power rail, which demands much more sophisticated circuitry to provide optimum battery charging.

Note also that without the reversed diode the battery can provide much of the smoothing, augmented by the 1000μ capacitor.

The ultimate safety device in case of zener diode breakdown creating a short circuit is the 2.5A fuse.

Main Board

All CMOS states 0 or 1 shown are for normal operation on *part* or *full*. All the DC voltages were measured with a 10M/V meter. IC1a and IC1b in the astable mode, oscillating at about 70kHz, feed into push-pull transistors Q1 and Q2 to lower the output impedance and via the following diode/capacitors boost the voltage across C7 to over 30V DC where output is about 700R.

A constant current impedance circuit feeds 5mA current into the loop via Q4 and terminal C. (LD2 + D8 are there in case LD3 fails open-circuit.) Note the DC path via D4 in case of voltage booster failure. This still ensures approximately 5mA of loop current and thus continued protection from the system, albeit at a lower potential voltage.

IC1c and IC1d in the astable mode provide the means of visually modulating the loop sensor LEDs at about 2Hz for easier viewing when keyswitch SW1 is selected to TEST and IC1d pin 13 goes high via SW1b, R42 and R6.

Q5 amplifies *event* alarms condition and if the DC output of C12-D9-D10-C14 exceeds approximately ½Vcc then CMOS astable IC2a/b oscillates and via Q6 and RV4 audio modulates the internal siren to give an *event* alarm.

IC5 is a quad voltage comparator powered only when SW1 is selected to TEST, at which point R28 passes current approximating to that of the loop through series connected LEDs 9-12 and Q7. Thus the voltage at the junction of LD9/LD10 is 1.7V and ascends 1.6V with each LED, each junction being connected to the non-inverting input of each independent comparator. Meanwhile each inverting input samples the loop voltage via R29 and output test LEDs 13-16 illuminate according to each voltage comparison.

If electronic sensors are installed the standing voltage of the loop within any open D/Ws will greatly exceed +0.7V, in which case RV5 is adjusted to bias the comparator LED voltages 9-12 upwards. This test LED datum is a once-and-for-all adjustment unless electronic sensors are added or removed from the loop.

If the voltage across ZD2 and LD6 exceeds 11V then LD6 will illuminate. This battery check is only valid if the mains if switched off for obvious reasons but given the expected life (my own battery is now eight years old) this need not be done too often.

Under quiescent conditions IC4d output is high and charges C20 via R51 and D22 placing a high on IC3c pin 8. Note D22 prevents reverse current flow when IC4d output goes low.

Q8 compares any positive going loop voltage pulse via C16 and R21, with its own V_{BE} plus D12 voltage when SW2 is on *full*, and plus ZD3 when on *part*. If exceeded and Q8 collector increases sufficiently to make Q9 conduct, IC3d pin 13 goes high so long as the loop voltage pulse lasts (about 60ms as dictated by the time constant of R34 + R36/C11.)

Consequently IC3d output goes low momentarily biasing Q10 into conduction to energise the relay and Q11 which this time applies full rail voltage to the internal siren. On RLA1 closing, full voltage is applied to the external bell which commences to ring.

It also places a high on IC3c pin 9, IC4d input and IC4c input 9. Since IC3c pin 8 is already high IC3c output goes low and latches Q10 into conduction until C20 discharges through R61 (5s alarm) or R53 (10-15 min alarm).

Meanwhile IC4d output sets the RS bistable formed by IC3a and IC3b illuminating 'Memory' LED 17, which will notify a returning occupant of the alarm. Simultaneously the high placed on IC4c pin

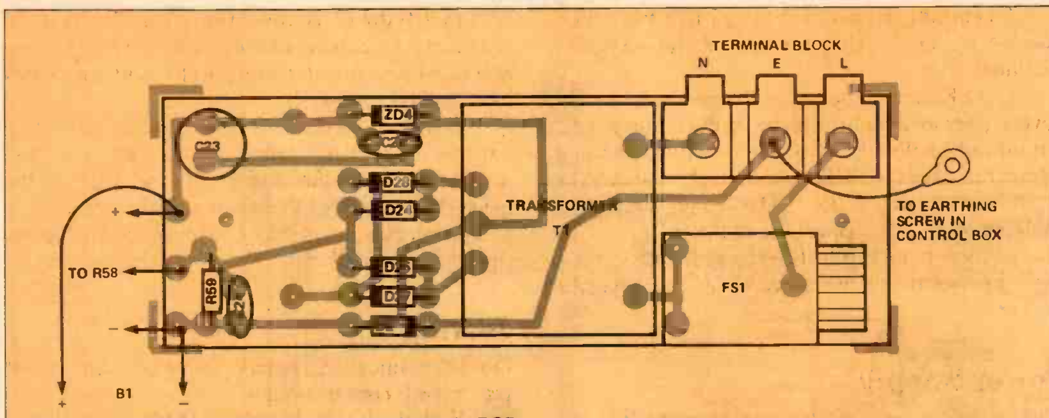


Fig. 4 Component overlay of the power supply PCB

as indicated (D and D′ are common). Leave out R60 (see Fig. 3) until after testing. Do not connect the mains! We can test quite happily using the battery.

For first tests, connect a 220R resistor and an ammeter in series with the battery to protect the circuit. If the current rises excessively — to 40mA say — then there is something amiss.

Otherwise you can proceed as follows, performing each test first with the resistor, then without.

- Set SW2 to *full*. With the limiting resistor there should be 24mA ±10mA, with no resistance this should rise to 45mA with the same tolerance. Fault LEDs 3, 7 and 18 should light.
- Set SW2 to *part*. Results as above except that LED8 is lit instead of LED7.
- Set SW2 to *test*. With 220R, current should oscillate around 18mA±5mA. With the resistor removed this should rise to 25-30mA.

If you're getting no results at all, make sure that

9 via R47, R43 and R41 sends IC4c output low, discharging C17 immediately via D15. This places a low on IC3d pin 12 sending its output high and keeps it there for the duration of the alarm period.

When C20 discharges below ½ Vcc IC3c output goes high, Q10 switches off de-energising the relay, the bell and the siren. Also IC4c pin 9 goes low and its output goes high but IC3d remains inhibited (to prevent a nuisance alarm) until C17 charges via R39. This takes 6-8 seconds, sufficient time for all circuit voltages to settle.

At this point the system continues protection. Note that R34/R36/C11 can be increased in value so as to require the alarm trigger pulse to last longer (I have had it up to 300ms). These same components, in conjunction with D13, also act as an AC rejection circuit since the decay time is much faster than the attack time (D13 + R36/C11 versus R34 + R36/C11).

Another route for an alarm is via IC2c and IC2d. If the loop voltage exceeds about 30V DC (set by RV2) due to an open circuit in the sensor loop or by the insertion of a 'cheat' resistance in an attempt to exhaust the loop voltage, then IC2c output goes low. Consequently IC2d goes high, fault LEDs 4 & 5 illuminate and IC3d momentarily outputs a high due to a positive pulse via C11 to IC3d pin 13.

As previously described this results in a timed alarm. The alarm will also be triggered via the Q8 route too, even if the loop voltage rises to maximum at a reasonably slow rate (belts and braces!).

If required an A/T loop with a voltage of 32V is provided via terminal B and returns to the control box at terminal A. Cutting this loop wire will send IC3d pin 13 low and consequently its output high, illuminating fault LED4 and causing a timed alarm as just described. Note that standard BS4737 assumes both sensor loop and A/T loop will be cut simulatneously so EASi doubly ensures the alarm will sound which is the reason it is felt the A/T loop is superfluous in EASi's case.

EASi has its own version of SABAS (Self Activating Bell Alarm System), which saves a special panel in the bell box plus additional battery and mains derived charging circuit, not to mention the multiplicity of wires and installation.

It will be noted that in normal operation LINE A voltage is kept low by virtue of the low bell resistance. Thus if the bell wire is cut, LINE A will rise to 12V via R40 and triggers IC3c pin 9, automatically sounding the remaining alarm (presently this means the internal siren but if a 2-pole relay was used an additional outside bell could be included). IC4d and IC3b/IC3a are also triggered to illuminate fault LED17.

At the end of the alarm period when C20 has discharged sufficiently for IC3c to switch off, LINE A is still high preventing C20 recharging. Subsequently fault LED17 will not extinguish when the keyswitch is selected to test.

If instead an intruder shorts the two bell wires with the intention of breaking in afterwards, then on triggering the system bell fuse FS2 will 'blow' giving exactly the same result as the cut wire case. The blown fuse is the additional clue warning the repairer he is looking for a short as opposed to an open circuit.

Without mains power IC4a input is low due to R59 thus its output is high, illuminating fault LED18 as a reminder to the user to switch on the mains. When mains power is applied, transformer dervied voltage is rectified by D24/25 and smoothed by C24 placing a high on IC4a input, consequently its output is low and LED18 is extinguished.

Certain sensors if used in the loop, such as the gas/smoke detector, various forms of light detectors and the ultrasonic transmitter rely on mains power and it is necessary to inhibit the alarm at the instant there is a mains failure and once again on restoration of the mains in order to prevent a false alarm. Protection is lost from these sensors during the period of the power cut but not from the remaining sensors such as D/W sensors, pressure mats, smoke alarm, infra-red and others.

On the mains failing IC4a goes high, illuminating fault LED18 and placing a momentary high on IC4c pin 8 which sends its output low discharging C17 quickly through D15 and inhibiting IC3d from an alarm signal. It remains inhibited for 6-8 seconds until C17 re-charges via R39.

On restoration of the mains a momentary positive pulse, this time from the output of IC4b via C18 and R41, sends the output of IC4c low and IC3d is once again inhibited for 6-8 seconds. Thus by the time IC3d is ready to accept an alarm signal everything is back to normal and LED18 extinguished.

It can be seen that when SW2 is selected to *full* red LED7 illuminates and when selected to *part* green LED8 illuminates. The reason for this is two fold. Firstly one can see at a glance from the LED's colour which mode the system is in and secondly the LED current derived from the 12V rail via R24 biases ZD3 to a more predictable voltage, offsetting the rather steep knee voltage one sometimes finds with zeners and defining the voltage pulse necessary to trigger the alarm more precisely. For example some 5V1 zener diodes pass 200µA at 3.5V and in this case the alarm would be triggered at about 4.9V instead of 6.5V.

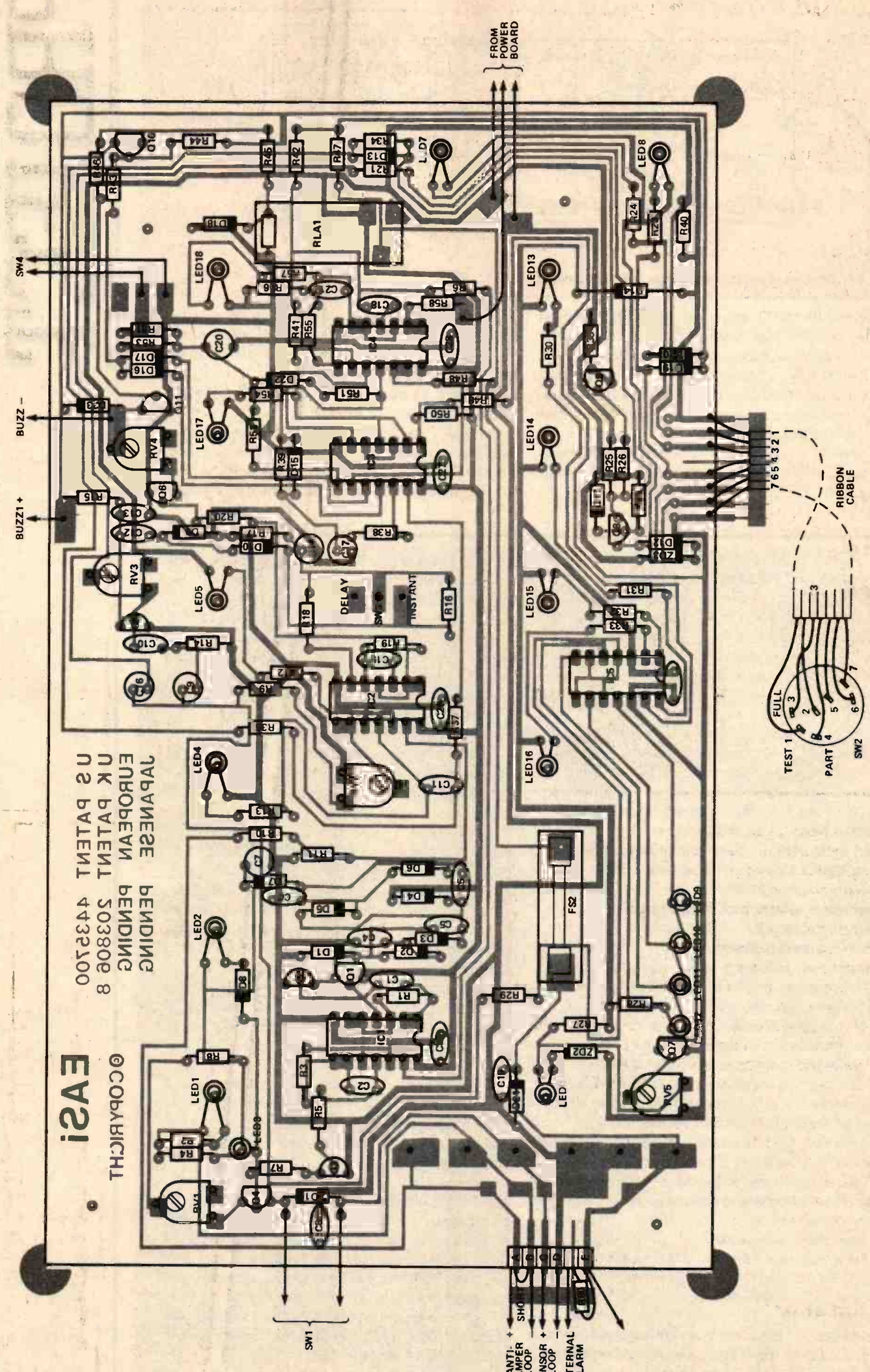


Fig. 3 Component overlay of the control box PCB

PARTS LIST — Control Box and Power Supply

RESISTORS (all ¼W 5% unless specified)	
R1,61	47k
R2	270R
R3,19,39,43,53,56,59	10M
R4	560R
R5,7,44,47,51	10k
R6,18,22,37,38,40,41,48,50,52,55,58	100k
R8	150R
R9	330k
R10	2M2
R11,17,29	1M0
R12,13,21,54,57	2k2
R14	22R
R15,20,24,26,28,30-33,46,60	1k0
R16,49	22k
R25,43	4k7
R27	180R
R34	470k
R35	3k3
R36	180k
R45	56R
RV1,4	100R
RV2	470k
RV3	1M0
RV5	4k7

CAPACITORS	
C1	56p
C2,25-29	22n
C3-6,8	100n 50V
C7,9	10µ 35V electrolytic
C10-12,15,18,19,21,22	100n 25V
C13,24	4n7
C14	2µ2 15V electrolytic
C16	47µ 35V electrolytic
C17	1µ0 50V electrolytic
C20	100µ 15V electrolytic
C23	1000µ 15V electrolytic

SEMICONDUCTORS	
IC1,3	4011
IC2	4093
IC4	4001
IC5	LM339
Q1,3,5,6,8,11	BC546
Q2,4,7,9,10	BC556
ZD1,2	9V1 400mW
ZD3	5V1 400mW
ZD4	13V 1.3W
LED1,2,4-7,13-18	red LEDs high intensity 1.9V 5mA
LED3,9-12	red LEDs low intensity 1.6V 5mA
LED8	green LED
D1-11,13-26	1N4148
D12	0A95
D27,28	1N4001

MISCELLANEOUS	
B1	12V battery
BUZZ1	internal siren
CONN1	6-way connecting block + PCB pins
CONN2	3-way connecting block + PCB pins
FS1-3	2A fuse
RLA1	12V PCB-mounting relay n/o
SW1	microswitch
SW2	2-pole 3-way
SW3,4	slide-switch 1-pole o/c
T1	transformer 12-0-12V PCB-mounting

PCBs. Fuseholders. IC sockets. Stand-offs (6). Metal case. Wire. Nuts and bolts.

you have been taking into account the 6-8 second 'alarm inhibit' period. The system prevents false alarms by automatically switching off briefly in any of the following situations:

- after initial selection of SW2 to *part* or *full*
- after mains failure
- when mains is restored
- immediately following an alarm
- with SW2 on test, all alarms are permanently inhibited.

Now hopefully we are ready to connect the mains. Remove the ammeter and resistor and make sure SW3 and 4 are fully down. Now reconnect the ammeter between battery and power board but in reverse mode so it will show a discharge. Use an ammeter scale of 500mA or more.

Now connect the mains and switch on. The ammeter should show a positive reading between 5-80mA, indicating that the battery is being charged. Switch off the mains and remove the ammeter, then switch back on.

Note that as standard policy you should avoid powering from the mains without the battery in circuit.

Calibration

Moving back to the breadboard test rig, connect the ammeter across the first switch (A) and pull out the LED. Turn SW2 to *part* and open the test rig switch. Adjust RV1 to give 5mA as the loop current, then close switch A again.

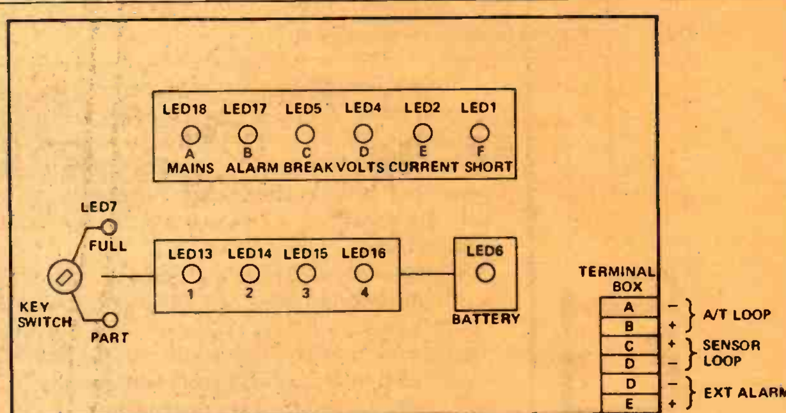


Fig. 5 Control panel layout

Next set the meter to read at least 35V FSD and open switch A again. The siren should leap into action for about 5s and then stop. The fifth LED on the breadboard should also illuminate — this is substituting for an external alarm bell.

When the alarm stops, check that the voltage is 30V or more. The alarm for this open loop circuit was triggered via Q8 (read *How It Works* for the full story) so now turn RV2 clockwise until the *break* and *volts* fault LEDs (4 and 5) illuminate.

Close breadboard switch A again, wait about 10s then open it again, making sure that the two LEDs

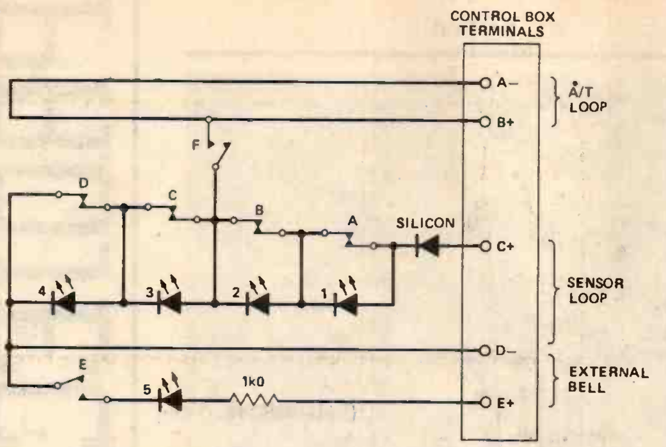


Fig. 6 The breadboard test circuit

illuminate steadily by turning RV2 clockwise while the alarm is sounding. The alarm was also triggered this time by IC2c.

Close switch A, put its LED back and take out the meter.

Playing Burglars

Switching SW2 to *test* will turn off the *alarm memory* fault indicator, LED17.

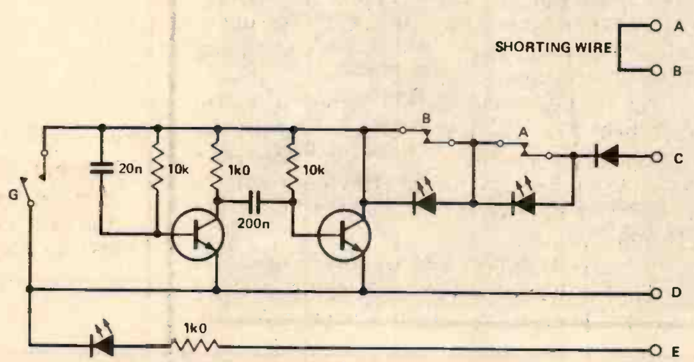


Fig. 7 The second breadboard test circuit

Now pretend you are a burglar cutting the wires to your external bell by opening switch E on the breadboard rig for a timed alarm by internal siren. Notice that when you select *test* with SW2, LED17 does not this time extinguish — alerting you to the bell's disconnection. Close switch F to reset, leaving SW2 on *test*.

Next simulate an open window or door (takes you right back to Play School doesn't it . . .) by opening switch A. Its LED will flash but more importantly the first of the test indicators (LEDs 13-17) should also have lit. Experiment with switches A-D and check you get the right responses.

To demonstrate the auto-reset, turn SW2 to *full* and open any window A-D to trigger the alarm (don't forget the 6-8s inhibit time). When the alarm has stopped open another window. The alarm triggers again despite the circuit break in the other switch.

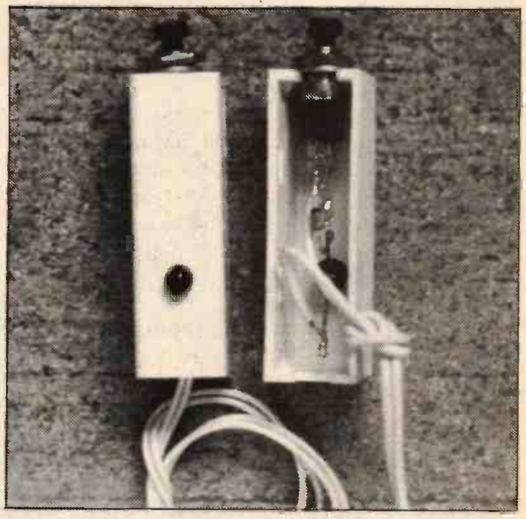
Check mains failure by turning off the power. The mains indicator LED18 should activate. The alarm should not! Restore power and check the alarm still doesn't sound.

Simulate shorting the anti-tamper loop to the sensor loop by closing switch F for a timed alarm. Note illumination of alarm, volts and short indicators (LEDs 1, 4 and 17). You will find that after the usual inhibit period the windows are still protected even though the alarm is shorted out. The fault LEDs tell you what the naughty burglar has attempted while you've been away and with SW2 on *test* you can locate the short by opening all the windows and checking the brightness of their respective LEDs!

Test Rig 2

Adapt your test rig to the circuit shown in Fig. 7.

Adjust RV3 to give 3V DC (or as close as you can



get) across R15 — next to the siren output on the circuit board. Set SW2 to *part* and open breadboard switch G to simulate an 'event' alarm. This should produce a modulated bleeping alarm, the volume of which can be varied by RV4. Note that with SW2 on *part*, the window and door alarms (A,B) are disabled.

Close switch G, set SW2 to *full* and set off the event alarm again. Do not close switch G but open switch A or B as well to give a main alarm, showing that the main alarm takes preference.

If all that has worked then congratulate yourself on producing a fully operational EASi master control. Of course, it's scattered all over your workbench at the moment, but the final product is in sight!

Assembly

In the prototype the control box top was drilled as in Fig. 8. The corner hole is to house the lid protection microswitch. A hole on the main case will also be required to earth from the power supply board. The other holes are for the internal alarm.

Resistor R60, previously ignored, should now be fitted hanging precariously between terminals D and E.

Then all that remains is the fitting into the chosen box using spacers to hold the PCBs solidly in position.

Your Choice

The position of D2 (see Fig. 2) is the result of one of those iffy questions — would the burglar be clever enough to earth an outside wire by driving a stake into the ground? This is I think unlikely but perhaps it is best to leave it to the installer.

The only disadvantage of not earthing the loop is that if you ever did have to locate an open circuit with the probe to be described later, you would have to rewire the circuit to temporarily short D2. You have the option of soldering it in, leaving it out or shorting the gap.

Another function you could remove is the 'mains inhibit' function — if you use no mains powered sensors you could remove this by omitting C18 and C21.

Switch SW3, as you'll no doubt have gathered by now, will remove the delay normally placed on event alarms for the purpose of experimentation. If you don't mind waiting the 10s that must otherwise elapse the switch could be omitted.

Wiring The House

With the completed control box screwed to the wall, you can start wiring up your house. If you are using an external bell then wire that up first with twin 7/0.2mm wire connected to terminals D and E. If you are not using such a bell, you must leave resistor R60 across the terminals.

Also if you are not using an anti-tamper loop you must short between terminals A and B.

When you start running the wire around the house, always go the easy way. Don't restructure your house just to save fifteen feet of wire, and remember to make the most of carpets, cellars and attics. It is also a sterling idea to make a simple map of the route in case you forget later.

Connect door and window sensors one at a time so that the continuity of the loop is assured and the direction of the LED will check that you are on the right path.

Take It To The Limit

The number of door and window sensors is unlimited but some of the EASi sensors to be described in forthcoming articles take power from the sensor loop, consuming something like 0.4V per sensor. To avoid the necessity of extra wires or batteries it is recommended the voltage dropped is limited to about 6V — about 15 sensors. Since such sensors are unlikely to be required in profusion (ultrasonics, light sensors, pressure mats, water sensors) this shouldn't cause a problem.

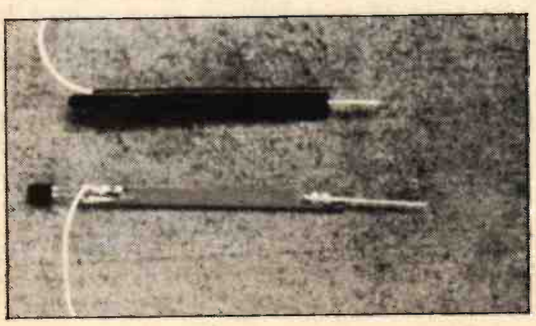
Protecting Of Outbuildings

The first of the major additions made as the prototype developed was the protection of outside premises such as garage and garden shed by extending the loop across a small module paralleled across the loop just inside the house (see Fig. 9a).

The 5V1 zener, push button and LED form the House Protector unit (HP). Pressing the button will short out the zener and light the LED if any of the outbuilding door/window switches are open, thus saving a trip out into the cold.

If the outside loop wire is broken, the main alarm will sound and hopefully the culprit will leave the scene. But even when the alarm stops the house remains fully protected by the maintenance of loop current through the HP.

For those who feel the need to tamper proof outside buildings (access could be obtained by shorting both wires) it is possible to move the HP to the end of the house loop (Fig. 9b) and earth the loop wire through any mains earth. This will in addition tamper proof the control box since removing the mains plug will break the HP circuit and sound the alarm.



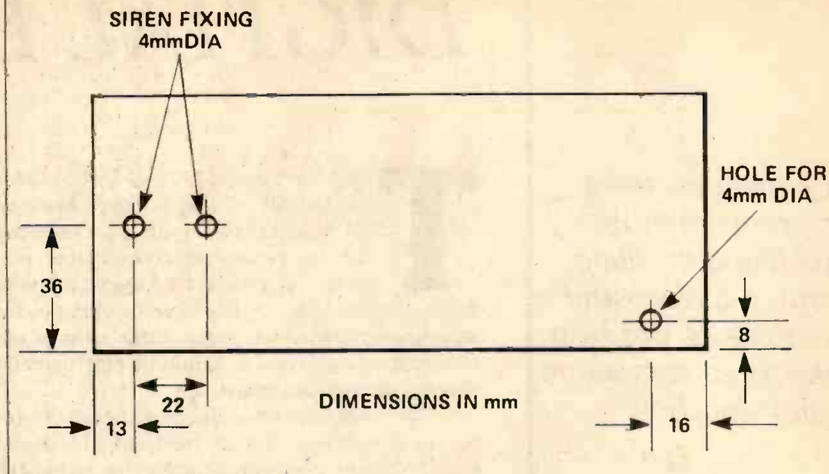


Fig. 8 Drilling of the case top

After A Break

In the unlikely event of the main house loop wire being broken, cut or eaten by rats, a positive voltage equal to the supply will set off the alarm. Thereafter the open loop circuit is unusable.

Given the length of loop wire (300m is not unusual in a large house) a quick and simple method is handy to trace the break. This is the probe shown in Fig. 1 consisting of a sewing needle on a copper-clad board in series with an LED connected to mains earth. For complete safety we should advise turning off the house mains power.

An iterative search rapidly homes in on the break. Start at the middle of the break and pierce the wire with the needle. If the break is between probe and earth, the needle provides an alternative source to earth and the LED will light. Move further down the wire and try again.

If the probe doesn't light, go back towards R1.

The length of suspect wire reduces exponentially — just eight tests take you from 300m to about 1m.

That describes the basic EASi system. The profusion of sensors and expansions will follow next month. Until then, happy wiring!

All boards and modules for the EASi alarm system are available in kit form. Full details and prices will follow in next month's article.

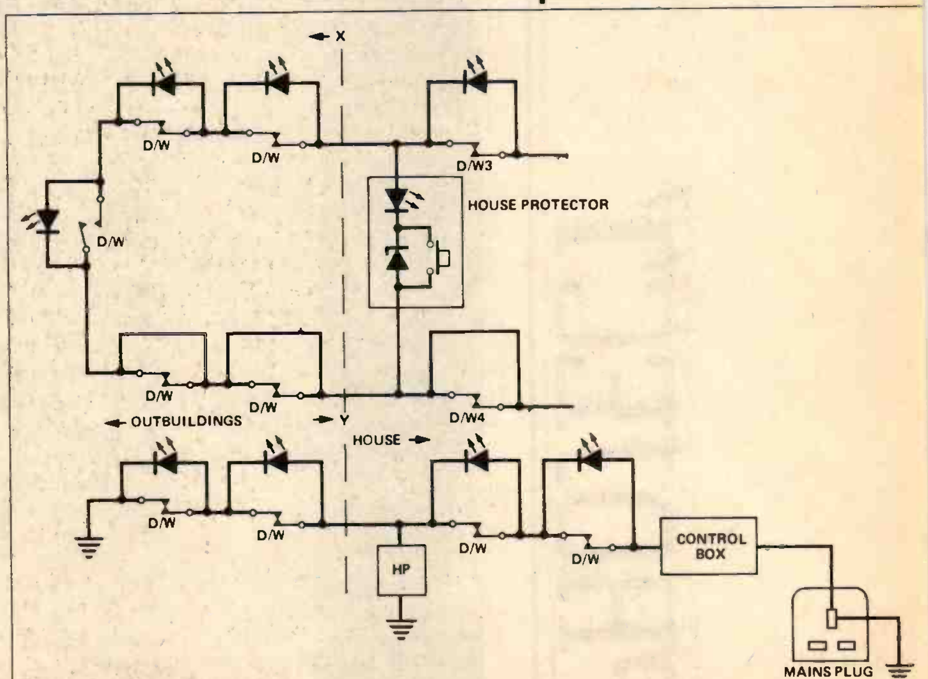


Fig. 9(a) Use of the house protector module (b) Alternative position for the module

DIGITAL DOORBELL

John Jameson's front door greets visitors with a blood curdling scream, a fanfare and the chimes of Big Ben thanks to his ingenious sampler doorbell

This project provides you with the means to have a totally unique doorbell. Almost any sound effect lasting up to three seconds can be emitted at considerable power whenever a visitor calls. If you have several doors, you could build several units and have them announce *Front Door, Back Door* or you could sample the neighbours' bloodhound and frighten the wits out of your postman.

The possibilities for such a project are limited only by your imagination. Slightly modified, the unit could even find uses in electronic music, as a simple but versatile drum effect.

To make things easy for you, the author has arranged to provide a range of sound effect ROMs, and a tape to EPROM service (see *Buylines*) so you won't need a sampler and an EPROM programmer to build the project.

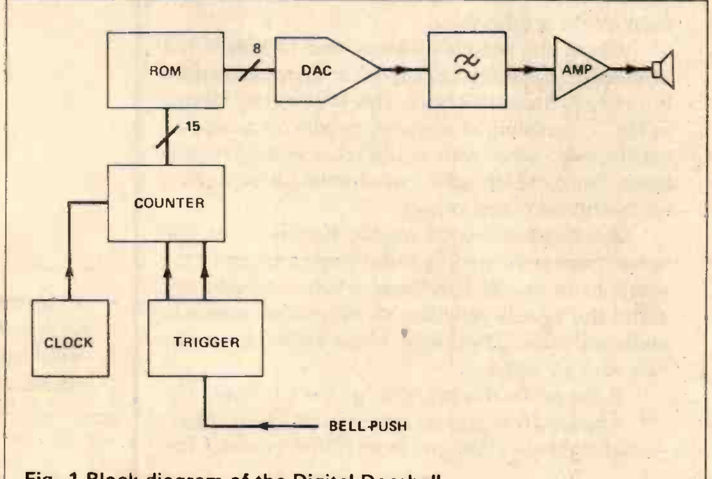
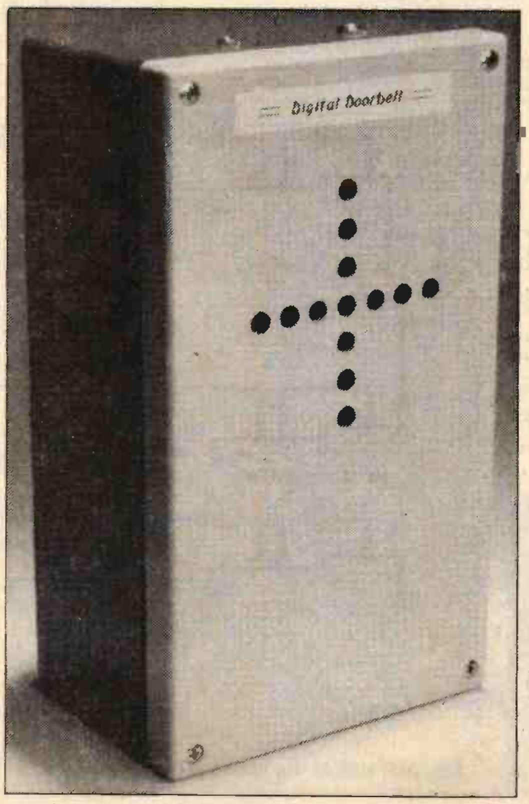


Fig. 1 Block diagram of the Digital Doorbell



Construction

The project is constructed on a 4 x 4in double sided PCB with only the loudspeaker and the power and bell push sockets mounted off the board. This design is simple enough to build up completely before testing, provided you have the proper PCB.

Start by making the through-hole connections or 'vias' first. Don't forget the ones under the EPROM. Next insert then solder in the six pins used to make the external connections and add the passive components. The ICs should go in last.

Only the EPROM need be mounted in a socket. IC3,4 and 5 will have to be soldered in as their legs make further through-hole connections. These are CMOS devices so take the usual anti-static precautions of earthing yourself and everything else in sight when doing this.

If you house the unit in the recommended box, the PCB will be glued in, so it is highly advisable to test it thoroughly and get it working on the bench. A 15V DC power supply will do just as well as AC for testing so you can use your bench supply. Initially, power the unit up without an EPROM inserted. Several simple tests can now be made.

First and foremost, check the 5V supply is present. The output from the DAC, IC6, should be at around 2.5V (it is seeing &0FF on its inputs) and the output of the LM380, pin 9, should be at about 7-8V. Switch off, insert a programmed EPROM, set the DIP switches as detailed in Table 1, set RV1 at mid range and switch on.

If all is well, the unit should emit the sample and go quiet. Triggering the unit by shorting the bell push terminals should cause it to emit the sample once and stop.

If you get nothing, use a crystal earpiece or a scope to trace the fault back down the analogue path. If nothing is coming out of the DAC, see if data is coming out of the EPROM. Failing that, check around the address counter and the clock. Highly distorted sound might simply be due to shorted address or data connections around the ROM.

Once you have a working doorbell and assuming you are using the recommended case, drill a grid of holes in the top of the case for the loudspeaker and bolt it to the top (or glue it using Araldite or something similar). Drill two more holes at one end of the box for the two jack sockets. The prototype has the 2.5mm connector for power and the 3.5mm one for the bell push, though this is not at all crucial.

If you plan to mount the unit on a wall, drill a couple of holes in the bottom of the case, and file them into keyhole shapes so you will be able to hang the unit on a couple of screws in the wall.

Put the PCB in the bottom of the box at the other end from the mounting holes (so as to avoid the screws shorting things on the underside of the board) and measure up connecting wires to go from the PCB pins to the sockets and the loudspeaker. Wire up these connections, check everything and then glue the PCB onto the bottom of the box using Araldite. Finally screw the lid onto the box and wire up cables to your bell transformer and bell push.

You will need a bell transformer with a 12V tap. Also, bear in mind that sticking a jack plug into a socket causes a momentary short, so turn the power off to the transformer while setting everything up.

PROJECT

Samples

For the benefit of those readers who want to program their own EPROMs, here is the procedure you will need to follow for the doorbell of your dreams.

Firstly, follow the normal procedure for sampling a sound on your sampler. If you want it to play back

HOW IT WORKS

The unit is in effect a self-contained, play-only sampler. The sample data is stored on a standard EPROM and the rest of the design consists of a clock, a trigger circuit, an address counter, a DAC, a 4-pole filter and a power amp. The arrangement is shown in the block diagram (Fig. 1).

The clock is (almost inevitably) a 555 timer – in this case the CMOS version. The component values have been chosen to make it oscillate at around 10kHz giving up to 3.2s sample length with a 32K EPROM (27C256).

As with all sampling systems the bandwidth is restricted to half the clock frequency and is therefore about 5kHz. This may seem low to hi-fi purists but it is equivalent to that of AM radio and quite adequate, given that the sound will emanate from a cheap 4in loudspeaker.

Pressing the bell push (SW6) triggers the monostable IC5 which resets the address counter made from IC3,4. The monostable is configured to be edge triggered and non-retriggerable which means that however long the bell push is pressed, the pulse from the monostable will only last about 20ms, after which its Q output will return low.

Once the reset pulse has ended, the address counter will start counting and data will be fed to DAC IC6 and the analogue stages causing the doorbell to burp, scream, bark or what you will.

If an 8K EPROM is in use, SW1 will be closed and SW2,3 open. This means that A13 will be connected to the clock enable of the address counter. It should be clear that when a count of 8192 is reached, A13 will go high disabling the counter and stopping the system until the counter is reset.

SW5 selects retriggerable or non-retriggerable operation. If it is open, then re-pressing the bell push will re-start the sample from the beginning. If SW5 is closed, then the monostable will be held reset until the sample has finished, thus preventing the sample being retriggered while it is playing.

The chosen filter is a fixed cut-off 4-pole Chebyshev low pass filter and is a good example of economic design. The output from the DAC ranges from 0 to 2.5V, and the overall gain of the two filter stages is just over five. It follows that if the output of the DAC were fed directly into the filter, an output swing of over 12.5V would be required. Normally you would achieve this using ±12V or 15V rails but by choosing op-amps capable of single rail, low voltage operation and by doing a few simple calculations, it is possible to power the filter from the regulated 5V rail required for the EPROM.

R11 and R12 attenuate the signal from IC6 so it will not drive the second op-amp, IC8, into overload. C4 removes the DC content from the output of the DAC and R21 in combination with R12 sets a new DC bias level for both op-amps. Bearing in mind that the DAC has an output impedance of 10k, application of simple resistors in series/parallel theory to the network shows the impedance at the node (without the filter connected) would be 8k1. R13 then makes this up to near enough 39k as required for the filter.

C9 couples the filter to the output stage, RV1 sets the volume and the LM380 provides power amplification sufficient for the purpose.

A standard 78L05 regulator circuit provides the supply for the logic and the filter while the LM380 is run off the unregulated supply, which should be about 15V from a 12V AC input.

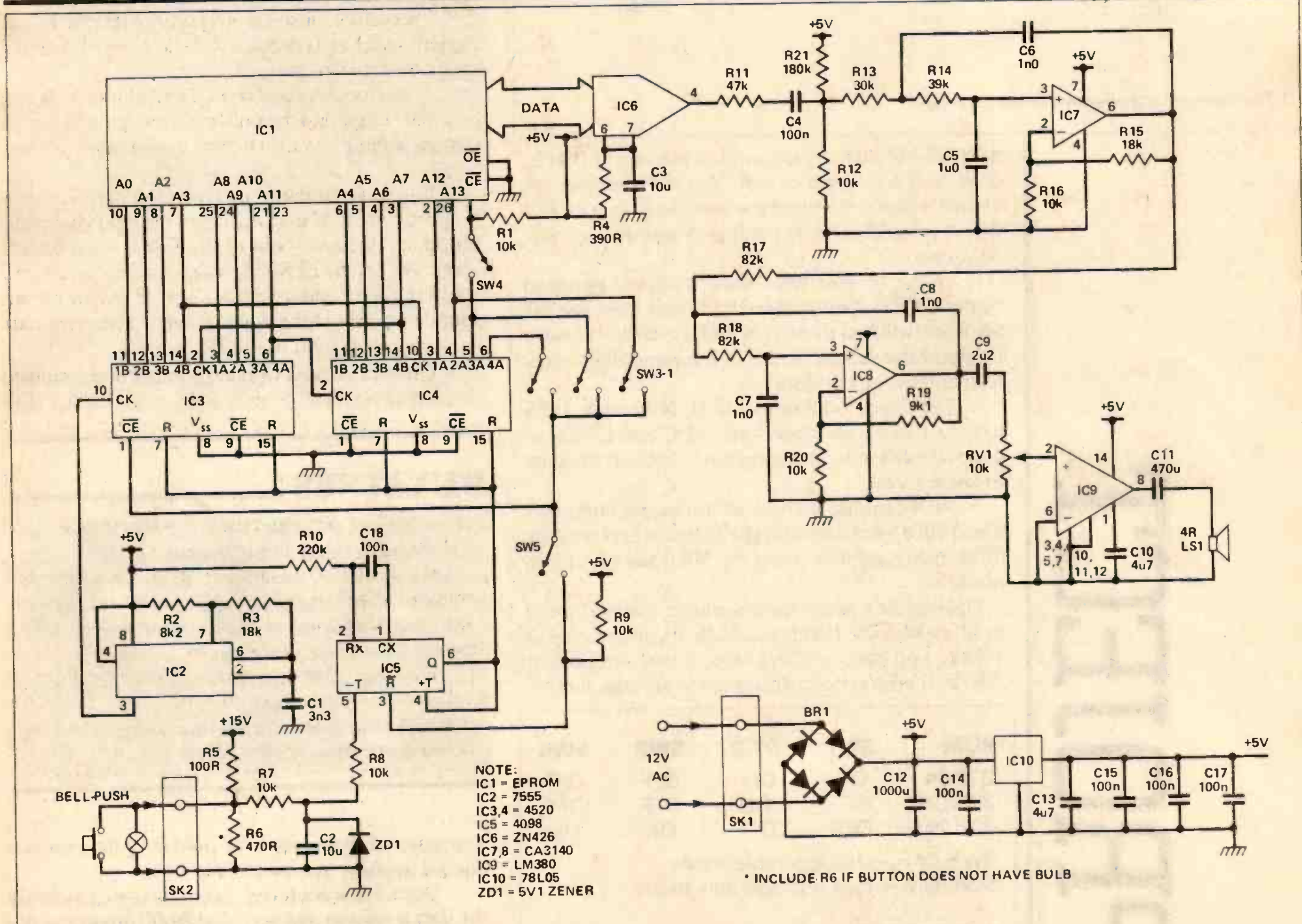


Fig. 2 The full circuit diagram of the doorbell

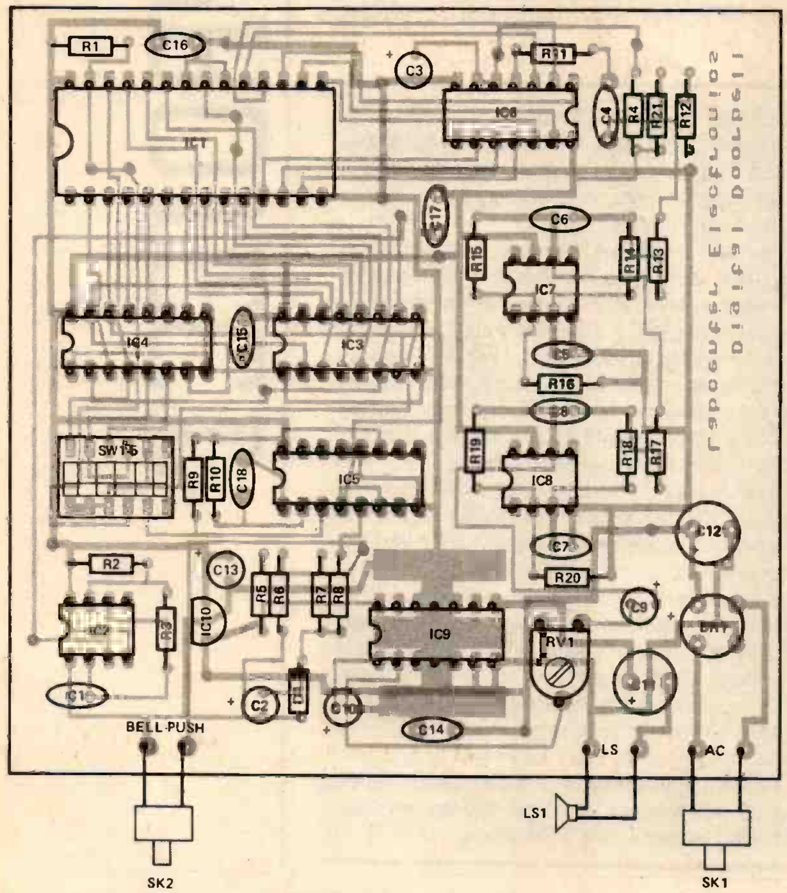


Fig. 3 The component overlay for the doorbell

at its natural pitch, try to sample it at a rate of 10kHz, or at least a multiple of that. You will then need to extract a binary dump of the sample. This is easiest if your sampler is home made and based on a home computer.

Those of you who have built my Amstrad Sampler (ETI, September 1987) and have the full software, will find that the SMP file is a direct binary dump of the sample and is in the same 8-bit linear format used by the doorbell.

The Spectrum Sampler (ETI, November 1985 to July 1986) uses logarithmic ADC and DACs, so you will need to write a program to convert the data to linear form.

MIDI sampler owners with a home computer based MIDI interface should be able to extract samples from their machines using the MIDI sample dump protocol.

Having got a linear sample dump, the next job is to adjust it for the 10kHz playback. If you sampled at 10kHz, you can omit this step. If you sampled at 20kHz, then you need a program to average successive pairs of bytes, and for 30kHz, your program should average groups of three bytes.

Once this is achieved, you now need to ensure the data is represented such that &000 represents the most negative value, &080 represents quiescent conditions, and &0FF represents the most positive

ROM	SW1	SW2	SW3	SW4
27C64	ON	OFF	OFF	OFF
27C128	OFF	ON	OFF	OFF
27C256	OFF	OFF	ON	ON

SW5 OFF — retriggerable mode
SW5 ON — non-retriggerable mode

Table 1 The DIP switch settings

PARTS LIST

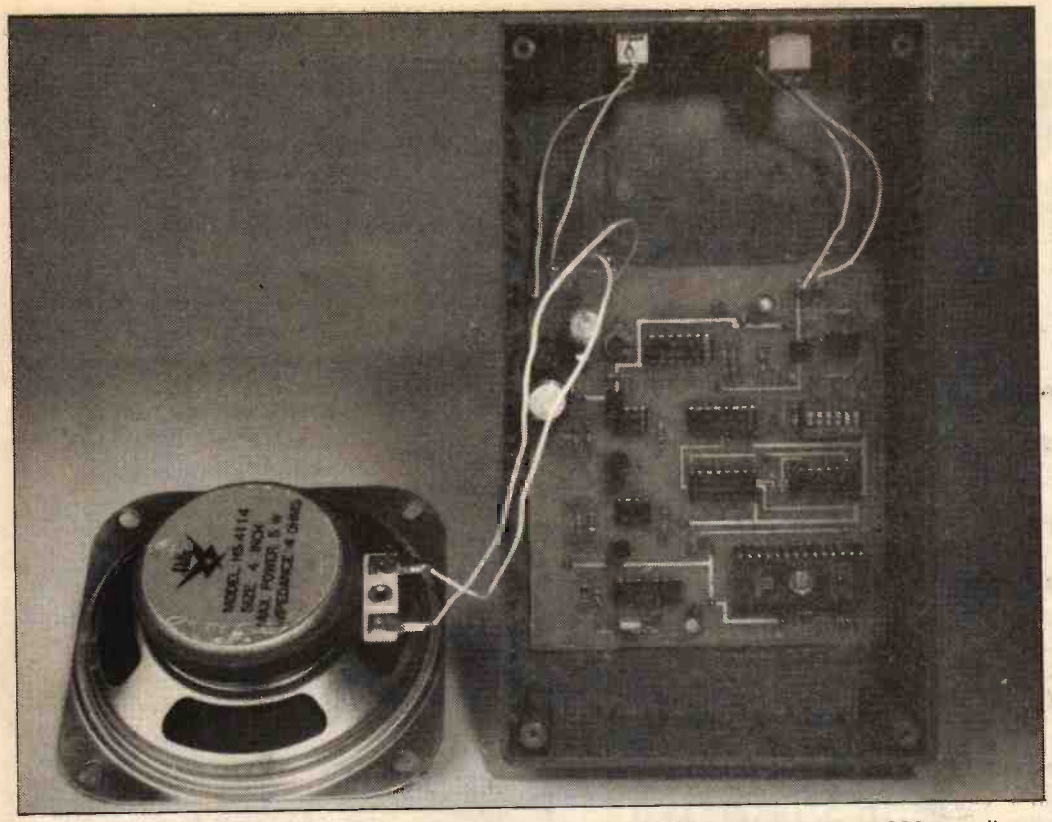
RESISTORS (all ¼W 5% unless specified)	
R1,7,8,9,12,16,20	10k
R2	8k2
R3,15	18k
R4	390R
R5	100R
R6	470R
R10	220k
R11	47k
R13	30k 1%
R14	39k
R17,18	82k
R19	9k1 1%
R21	180k
RV1	10k horiz preset
CAPACITORS	
C1	3n3 ceramic disc
C2,3	10µ 25V radial electrolytic
C4	100n polyester
C5,6,7,8	1n0 ceramic disc
C9	2µ2 63V radial electrolytic
C10,13	4µ7 63V radial electrolytic
C11	470µ 16V radial electrolytic
C12	1000µ 16V radial electrolytic
C14,15,16,17,18	100n dipped multilayer
SEMICONDUCTORS	
IC1	2764 or 27128 (see text)
IC2	7555
IC3,4	4520
IC5	4098
IC6	ZN426
IC7,8	CA3140
IC9	LM380
IC10	78L05
ZD1	5V1 zener
BR1	W005
MISCELLANEOUS	
LS1	4in 4R 2W speaker
PL1	2.5mm jack plug
PL2	3.5mm jack plug
SKT1	2.5mm jack socket
SKT2	3.5mm jack socket
SW1-5	6-way DIP switch
SW6	single pole push switch

PCB. Case 190 x 110 x 74mm. IC sockets. Wire. Glue. Nuts and bolts.

BUYLINES

All the electronic components should be readily available. The recommended case is sold by Rapid Electronics (Tel. (0206) 272730) as order code 30-0420. Alternatively, a kit including the PCB, all components, one standard sound effects ROM (8K or 16K) and the case, but not including a bell transformer is available from Labcenter Electronics, 14 Marriner's Drive, Bradford BD9 4JT. The cost is £29.95 plus 50p postage inc VAT. The PCB is available for £7.20 plus 30p postage.

Write to Labcenter for details of the Tape-to-Sample service and for a list of standard sound effect EPROMS.



value. Again, Amstrad Sampler owners need do nothing here.

Choose an EPROM type large enough to hold the data (8K, 16K or 32K) and then pad out the sample dump with &080 so as to fill the ROM. The first byte of the ROM should be &080 as well, so as to prevent a sharp click occurring at the end of the sound.

Finally, transfer the data to your EPROM programmer to blow the device.

SECURITY

SYSTEMS, MODULES, COMPONENTS

SAVE £££'s

BY INSTALLING YOURSELF

Telephone or send for free literature today

MINIATURE PASSIVE INFRA-RED SENSOR RP33

ONLY £23.95 + VAT
Quantity discounts start at 3 units

Detects Intrusion up to 12 Metres Away

Size: only 80×60×40mm. Wide 85° coverage. Switchable detection indicator.

This advanced intrusion detector operates by detecting the body heat of an intruder moving within the detection field whilst ignoring ambient changes. Easily installed in a room or hallway, the unit provides reliable detection of any intrusion. Operating from a 12V supply and requiring only 15mA, it is ideal for use with the CA 1382 or any equivalent high quality control unit. Supplied with full instructions its performance compares with detectors costing more than twice the price.

INFRA-RED SYSTEM IR 1470

Consists of a separate transmitter & receiver, the system provides an invisible modulated beam which when broken operates the built-in relay. For use with security systems, but also ideal for photographic purposes and industrial applications.
Size: 80x50x35mm.

Only **£25.61** +VAT

DIGITAL ULTRASONIC DETECTOR US 5063

This advanced module uses crystal control transmitter and digital signal processing to detect movement at distances of up to 20ft or more. With built-in timing and 12V operation, it is ideal for a wide range of security applications.

Only **£13.95** +VAT.

Suitable steel enclosure complete with necessary mounting pillars and fixings.

Only **£2.95** +VAT

LIGHTING CONTROLLER DP 3570

This versatile module provides timed switching of loads up to 3A for pre-set times between 10 secs and 5 mins, the timed period being triggered by the opening or closing of an external loop or switch. The built-in 12V 250mA power supply is available for operating external sensors.
Suitable plastic enclosure £2.85+VAT

Only **£13.95** +VAT

CPU 9000 SELF-CONTAINED ALARM SYSTEM

Immediate Security Without Installation

For Homes, Storerooms, Clubhouses, Caravans, etc.

■ Detects intruders up to 30ft. ■ Penetrating 103db Siren with auto reset ■ Compact size only 203×180×78mm ■ Easily extended for coverage of additional rooms or large areas.

This exciting new System which contains a Passive Infra-Red Sensor, Control Unit and Power Supply, together with a high output Siren all housed in the one compact steel case, provides immediate protection of a chosen area without the need for costly wiring and expensive installation costs. Operating from a standard 240V supply, provision has been made to incorporate a re-chargeable 12V battery which is capable of operating the System for up to 10 days before re-charging becomes necessary, and which is carried out by the built-in charger. Where protection of more than one room is required, additional sensors may be wired to the main unit. An external siren unit may also be fitted to warn neighbours. Supplied with 2 keys and full operating instructions, the unit is fully guaranteed for 12 months. Immediate protection for only:

Priced £67.72 +VAT

CA 1382 ADVANCED CONTROL UNIT that's simple to install and operate.

- Fully automatic siren re-set
- Audible entry/exit warning.
- Alarm sounded memory
- 2 separate loop inputs +24hr circuits.
- Built-in electronic siren driver
- Easily installed, full instructions supplied

The latest control panel provides effective and reliable control for all types of security installations. Its advanced circuitry checks the loop circuits every time it is switched on, preventing incorrect operation. Using a simple 'on/off' key switch, it is easily operated by all members of the family. In addition it provides 24hr. personal attack protection. Housed in a steel case, it is supplied with full operating instructions.

Only **£44.95** +VAT Available in kit form with fully-built electronics, £39.95+VAT.

CA 1250 LOW COST ALARM CONTROL MODULE

This tried and tested control unit represents the finest value for money in control systems, providing the following features:
• Built-in electronic siren drives 2 loudspeakers • Provides exit and entrance delays together with fixed alarm time • Battery back-up with trickle charge facility • Operates with magnetic switches, pressure pads, ultrasonic or I.R. units • Anti-tamper and panic facility • Stabilised output voltage • 2 operating modes full alarm anti tamper and panic facility • Screw connections for ease of installation • Separate relay contracts for external loads • Test loop facility.

Price **£19.95** +VAT

HW 1250–ATTRACTIVE HOUSING plus HARDWARE FOR CA 1250

An attractive steel case dsigned to house the Control Unit CA 1250 together with the appropriate LED indicators and key switch (available separately).
Supplied with the necessary pillars, fixings, and punched front panel, the unit is given a professional appearance by the adhesive silk screened label. Size 200×180×700mm.

Only **£9.50** +VAT

POWER SUPPLY & MAINS SWITCHING UNIT PS 1265

In addition to providing 12V stabilised output of 700mA, this module may be used to provide a switched 240V output for operating security lighting etc., when used in conjunction with the CA 1382, CA 1250, CPU 9000 etc.
Suitable plastic enclosure £2.85+VAT.

Priced at **£12.95** +VAT.

RiSCOMP LiMiTED

Callers by Appointment
Office hours Mon–Fri
9am–5pm

Dept. ETI 4, 51 Poppy Road,
Princes Risborough. Bucks
HP17 9DB

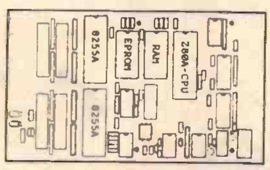
The Security Specialist

ORDER BY MAIL OR TELEPHONE

BARCLAYCARD VISA

P&P U.K. Orders 75p per order
Export add 10%
Tel: (084 44) 6326
Fax: 08444 7102

Interak 1



Bare Board
£17.50
(plus postage and VAT)

SINGLE BOARD COMPUTER "SBC-1"

A computer doesn't have to look like you'd expect a computer to look. It doesn't have to have a keyboard and a screen and floppy disks and so on.

The SBC-1 has the bare minimum of chips a Z80 computer can have and still be a computer: A 4MHz Z80A-CPU chip, an EPROM chip (up to 32K), a static RAM chip (up to 32K) and a pair of 8255A I/O (input output) chips giving 48 individual lines to waggle up and down. There are one or two additional "glue" chips included, but these are simple "74LS" or "HC" parts.

A star feature is that no special or custom chips (ie PALs, ULAs, ASICs etc) are used — and thus there are no secrets. The Z80A is the fastest and best established of all the 8-bit microprocessors — possibly the cheapest too!

Although no serial interface is included, it is easy for a Z80A to waggle one bit up or down at the appropriate rate — the cost is a few pence worth of code in the program: why buy hardware when software will do?

Applications already identified include: Magnetic Card reader, mini printer interface, printer buffer, push button keypad, LCD alphanumeric panel interface, 40-zone security system, modem interface for auto sending of security alarms, code converter (eg IBM PC keyboard codes to regular ASCII), real time clock (with plug in module), automatic horticultural irrigation controller.

By disabling the on-board Z80A-CPU this card will plug into our Interak I CP/M Plus disk-based development systems, so if you don't fancy hand-assembling Z80 machine code you don't have to!

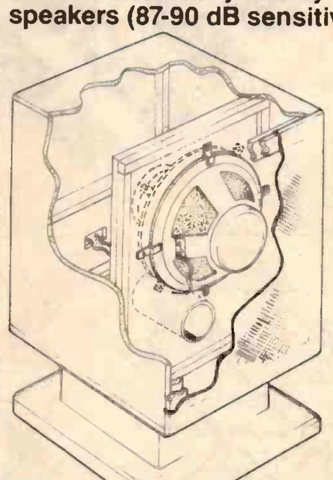
The idea is (if you are a manufacturer) you buy just one development system and then turn out the cheap SBC-1 systems by the hundred. If you are really lazy we can write the program for you and assemble the SBC-1 cards so you can get on with manufacturing your product, leaving all your control problems to us.

Greenbank

For more details write or phone us:
Greenbank Electronics, Dept. (T2E), 460 New Chester Road, Rock Ferry, Birkenhead, Merseyside L42 2AE. Tel: 051-645 3391.

£150 + £125 = £1000?

Add our £125 sub-bass unit to your £150-per-pair "Best Buys" and your system will sound as if it has LARGE (and expensive!) speakers.
Although very compact, this ingenious Push-Pull design will fill-in that missing "Bottom Octave" and can be sited almost anywhere in the room–without affecting the stereo image. It can be connected directly into systems with medium sized speakers (87-90 dB sensitivity).



The Wilmslow Audio CPP sub-bass speaker kit contains 2 10" drive units, flatpack cabinet kit (inc. stand) machined from smooth MDF for easy assembly, low pass filters, grille fabric, reflex port etc.
Dims. (inc stand): 571×366×336mm
Amp. suitability: 20-120 watts
Impedance: 8 ohms
PRICE £125 inc. VAT plus carr/ins £11
telephone credit card orders

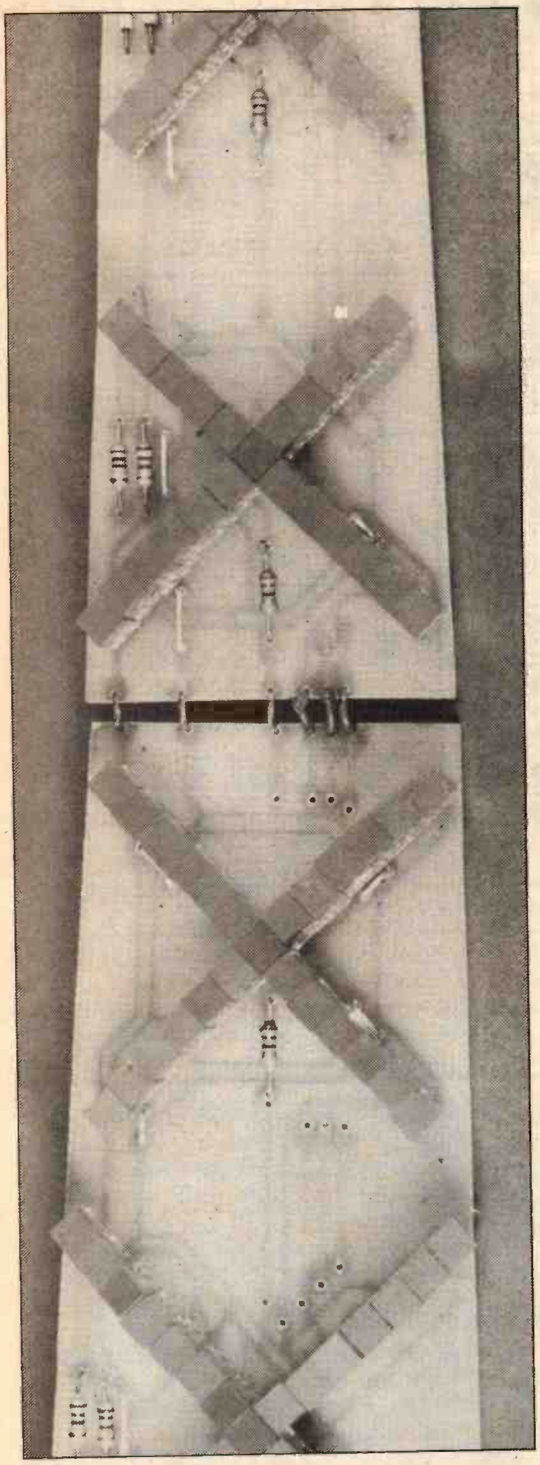
WILMSLOW AUDIO LTD.
35/39 Church Street, Wilmslow, Cheshire
SK9 1AS Tel: 0625 529599
Call and see us for a great deal on HiFi
(Closed all day Mondays)

DIY Speaker catalogue £1.50 post free (export $6)

PROJECT

KINETOTIE

Mike Bedford dons suitable garb for the foolish season with an ETI first — the truly pan-Atlantic tie



Have you ever taken a really good look at striped ties? Have you ever noticed that there is one aspect in which these ties hardly ever differ? Certainly they differ in width and the stripes also vary from the very wide to the very narrow. They may be in the colours of the regiment, the school, the company, the sports team, the university or the society and the stripes may be interspaced with emblems or coats of arms. So what is this mysterious invariant feature?

Well, if you do take a good look at a number of ties in the street, I'd be very surprised if many had the stripes running from top left to bottom right (looking towards the wearer). Yes, virtually all the stripes run along the same diagonal.

Nobody seems to know why this has come about but the strange thing is that the converse would be found if a survey of ties on the streets of Washington DC (or any other place in the US for that matter) were to be carried out.

Indeed, two separate standards have emerged and the well dressed, well informed gentlemen in either the UK or the USA would not dream of wearing a tie with the stripes running in the wrong direction, would you?

At ETI we are frankly appalled at the declining standards of dress in recent years. Although only in small numbers, American ties are making their way to this side of the Atlantic and have even been worn by otherwise perfectly attired, bowler hatted, pin stripe besuited English gentlemen!

It is felt that public awareness of this problem should be highlighted and we have considered lobbying our MP to push for a total embargo on their importation. However, such a solution would be unacceptable to the frequent trans-Atlantic traveller who doesn't wish to stand out like the proverbial sore thumb in either continent. Electronics has come to the rescue! We believe that in not too many years time an announcement like this may be commonplace on trans-Atlantic flights. "Ladies and Gentlemen. We are about to start our final approach to John F. Kennedy Airport. We would advise passengers that the local time is now 9.32 am. Gentlemen are also advised that since we are entering a North American tie zone, all neck ties should be switched accordingly."

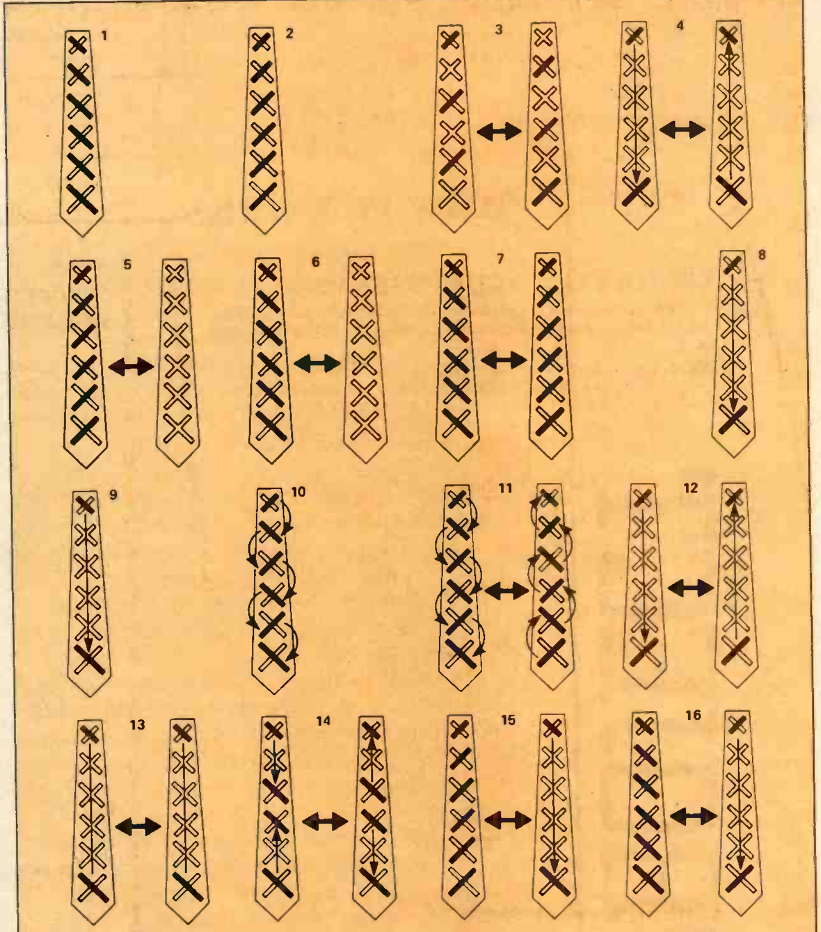


Fig. 1 The sixteen modes of the Kinetotie

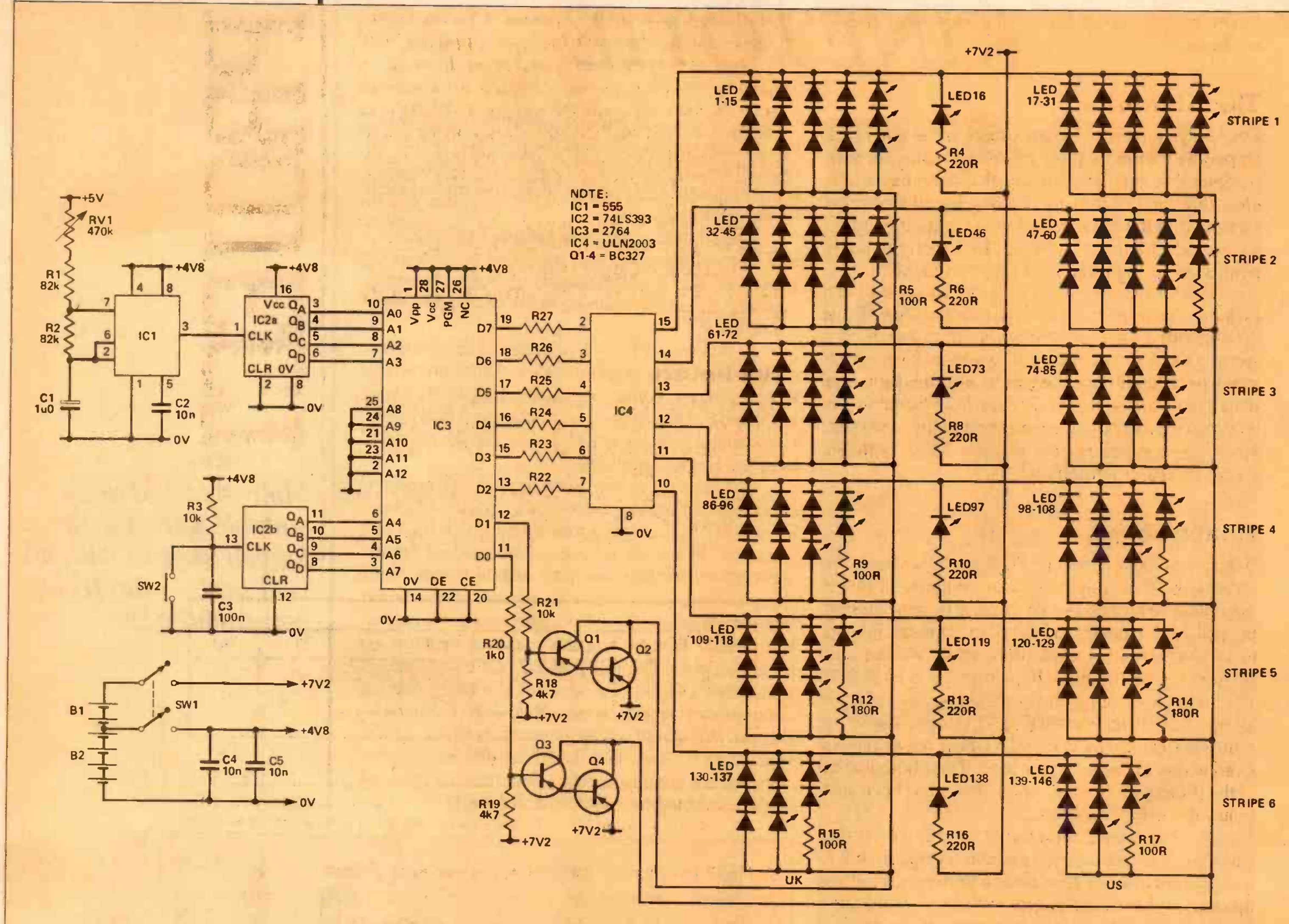


Fig. 2 The circuit diagram of the Kinetotie

PROJECT

HOW IT WORKS

To keep the cost of the tie to within reasonable limits, the number of stipes has been limited to six. Each stripe is made up of a cross of LEDs, each cross being constructed from LEDs in three different groups. These groups are those exclusively in the UK diagonal, those exclusively in the US diagonal and the one LED at the intersection which is common to both. The number of LEDs per group increases from top to bottom since the tie is tapered and can vary from as few as one (only for the common LED) to as many as 15.

The LEDs within a group are arranged in a series/parallel arrangement with groups of three in series paralleled together. Where the number in a group is not equally divisible by three the remaining one or two LEDs have a series resistor added to keep the potential across them to the 2V required.

The supply used is 7V2 which when the 2 x 0.7V drops across the two drivers (discussed later) is subtracted comes to just less than 6V — hence the triplets of LEDs.

In passing it is worth noting the resistors in series with the single common LEDs (220R) are different to that used when a single LED remains in an exclusively UK or US diagonal group (180R) because the common LEDs are hard wired to the 7V2 supply rather than through a driver and the effective supply potential is therefore 9.7V higher.

Now, for simplification let's consider each series/parallel group of LEDs as a single load so we have 18 all together arranged as a three group by six stripe matrix. Since one of the groups is always active as already mentioned, the number of drivers required is 2 + 6 = 8 which just happens to be the width of most common EPROMs — what a lucky coincidence!

The six stripes are driven from the EPROM via a ULN2003 NPN darlington driver chip to the LED cathodes whereas the US and UK groups are driven via PNP darlington pairs made from discrete BC327 transistors which switch 7V2 to the anodes. So we now have a situation whereby either the UK of the US diagonals (or both) of any combination of the six stripes may be illuminated depending on the data in the EPROM and the address inputs (Fig. 3). Only eight address inputs are used so only 256 values need programming. This means a smaller EPROM could have been used but since 2764s are so cheap this was used and A8-A12 are permanently grounded (Fig. 4).

Of the eight inputs to the EPROM, the highest order four are connected to half a 74LS393 4-bit counter which is connected to a push button on the clock input so that for each depression (assuming that A0-A3 are constant) the selected address increments by 16 (modulo 256). This give mode selection with 16 possible modes.

The capacitor C3 was thrown in rather absent mindedly as a switch de-bounce precaution. To be quite honest it's not the most reliable debouce circuit imaginable. To do the job properly would require a Schmitt trigger input and hence another DIL package. Since a slight random element to the mode switching is not inappropriate to a project like this, it hasn't been changed!

To complete the address inputs to the EPROM the least significant four bits connect to the other half of the 4-bit binary counter, the clock input of which is fed from a NE555 in its normal oscillator configuration.

So, for each mode, 16 states are selected in sequence at a frequency dictated by the period of the NE555 oscillator which in turn is controlled by RV1.

Yes, we are entering the era of the electronic multi-mode tie.

The Kinetotie

Originally conceived as just a dual mode (UK/US) striped tie for the frequent traveller, it soon became obvious that this was limiting the potential of the electronic tie. For the cost of just a handful of extra components the tie described here boasts 16 modes, each of which can cycle through 16 different states as controlled by the programming of an EPROM.

The programming information presented here includes the original UK and US modes (since all the 16 states for a particular mode can, of course, be the same) plus 14 kinetic modes. It's questionable just how many people will have the guts to wear this tie in one of its kinetic modes on the 7.45am from Surbiton but it certainly provides a conversation point at parties. How many other people do you know with an electronically programmable tie?

Construction

Before building up the main PCB, you'll have to make a decision. This board has been designed so that it may either be built up as a single piece (which is easiest but results in a totally rigid tie) or may be split into up to six sections (this takes more effort but the end product is more flexible). If the board is to be split, it should be sawn along any of the dotted lines shown on the component overlay (Fig. 2). At each split point a number of flexible wire links which act as hinges need wiring to the pads provided. The photographs of the prototype Kinetotie show that is has been split at just the centre position.

Apologies for stating the obvious but do make sure the LEDs are inserted the correct way round. It is suggested that all LEDs along a single diagonal are inserted and then the bodies of this row of components is firmly clamped in a vice prior to soldering. This gives the opportunity to ensure that the stripes are perfectly formed without gaps.

Both the anode and the cathode leads (but particularly the cathode) have 'collars' to provide stand-off from the PCB. For this project the LEDs are to be fixed as close to the board surface as possible to make the tie as thin as possible (it will still be quite a high profile tie!). If the holes in the board were made big enough for the collars to pass through there would have been virtually no pad left. This being the case, you'll have to use a file on the LED leads before positioning them on the PCB.

Now to the links. There are a number of ordinary wire links on the component side of the board and nothing more need be said about these. Because the rows of LEDs occupy the full width of the PCB, however, not all the required links could be accommodated in this way. This being so, there are a number of links which need wiring to the track side of the board. These are shown on the component overlay as letters in circles, matching pairs of which are interconnected. So, (A) to (A), (B) to (B) through to (S) to (S) should be joined using insulated wire.

Nothing else concerned with the true electronic construction need special attention. Now the inserting of the PCB into the tie. Starting at the fat end, the stitches on the back of the tie should be unpicked for the length of the main PCB so that the back may be opened up. If the tie is like the one I used, you'll find a piece of white gauze material inside which should be cut off at the point the tie has been un-stitched to. Failure to do this will cause the stripes to diffuse on illumination and hence not be well defined. Matching lengths of self adhesive Velcro tape should be stuck onto the two edges of the material at the back of the tie so that it may be firmly fastened round the PCB.

A final note on putting the tie on. It will prove totally impossible to tie the tie in the normal manner with a PCB stuffed inside it! It is suggested that the tie is first tied without the PCB and adjusted to the correct length. Now the tie should be loosened by pulling the knot so that it can be removed over the head without undoing it. Having removed the tie in this way the PCB should be inserted and the tie 'Velcroed' up before passing it back over the head and re-tightening.

The ribbon cable passes between a couple of shirt buttons so that the control box may be placed in a side trouser pocket.

The Future

The whole field of opto-electronic clothing in general and multi-mode ties in particular is in its infancy and undoubtedly new developments will follow thick and fast. So, to whet the appetite we thought we'd mention some of the possible improvements to the Kinetotie and new related projects under consideration.

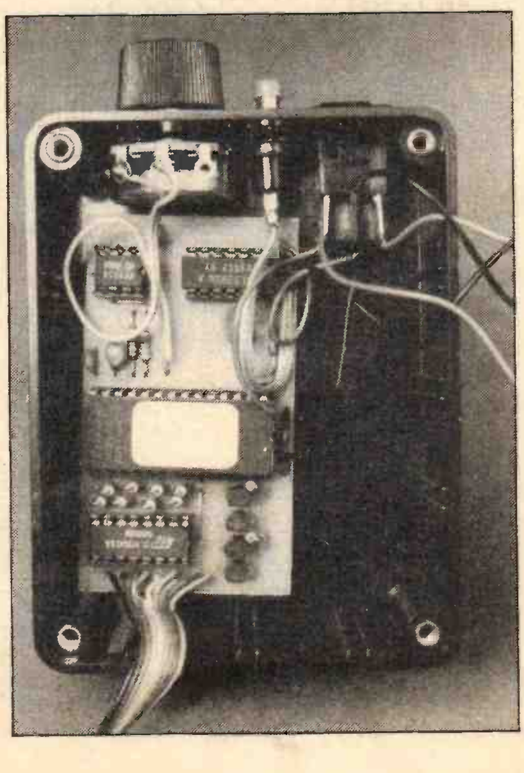
The main drawbacks of the current design result from the use of LEDs which because of their height make the tie rather thick and because of their being mounted on a PCB make it somewhat rigid. Both these limitations could be overcome by incorporating optical fibres into the actual fabric of the tie.

Power consumption also proves a problem if

MSB							LSB
D7	D6	D5	D4	D3	D2	D1	D0
Stripe 1	Stripe 2	Stripe 3	Stripe 4	Stripe 5	Stripe 6	UK Diag.	USA Diag.
←Bottom					Top→		
Code a 1 bit for stripe on						Code a 0 bit for diag. on	

NB: If 1s are coded into both D0 and D1 (ie UK and USA diagonals off), will still get a dot for any stripes enabled since the centre LED is always on.

Fig. 3 The generalised EPROM programming pattern



Address	Designation
0000-000F	Mode 1
0010-001F	Mode 2
0020-002F	Mode 3
0030-003F	Mode 4
0040-004F	Mode 5
0050-005F	Mode 6
0060-006F	Mode 7
0070-007F	Mode 8
0080-008F	Mode 9
0090-009F	Mode 10
00A0-00AF	Mode 11
00B0-00BF	Mode 12
00C0-00CF	Mode 13
00D0-00DF	Mode 14
00E0-00EF	Mode 15
00F0-00FF	Mode 16
0100-1FFF	Not used

Fig. 4 Memory map of the EPROM

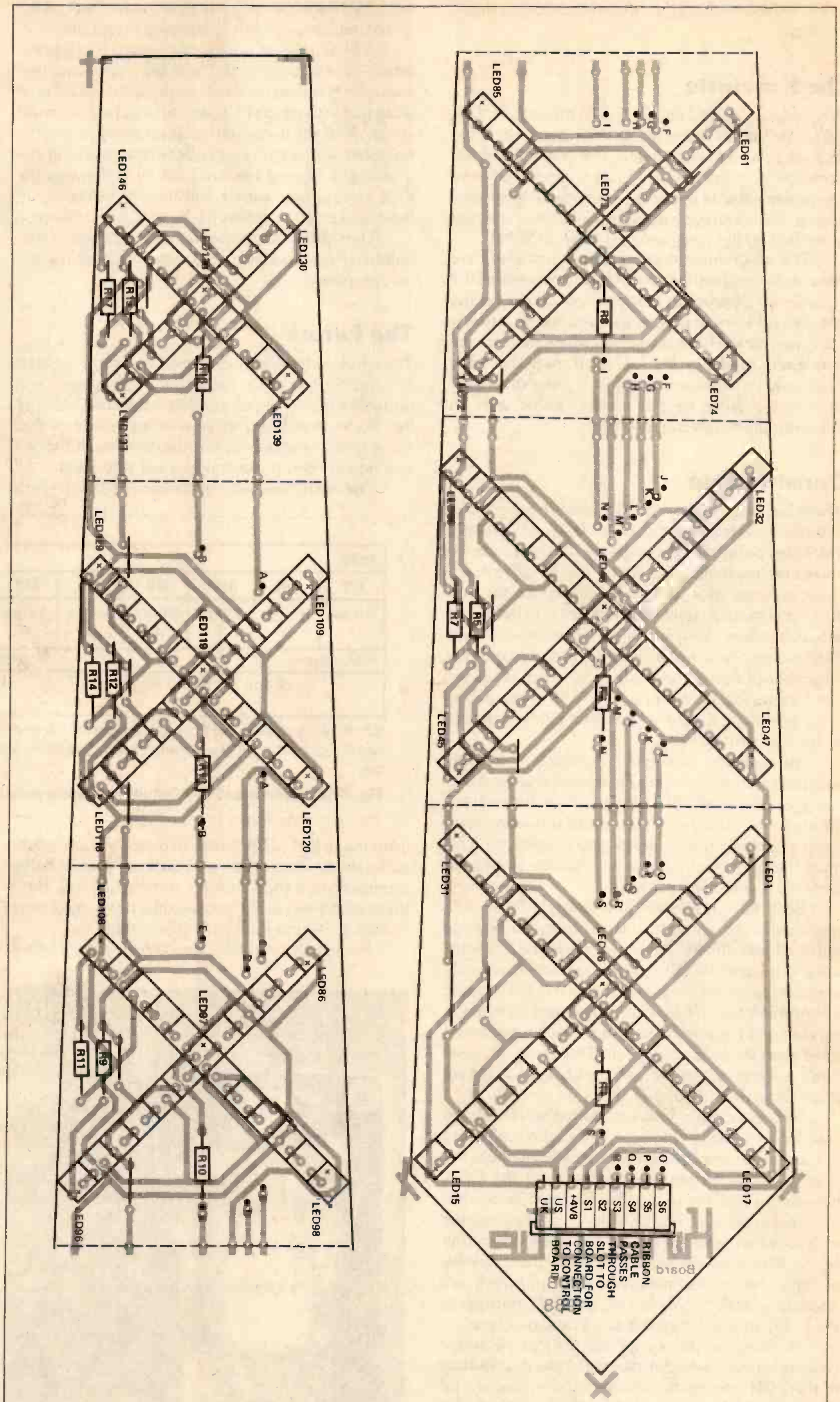


Fig. 5 Component overlay for the Kinetotie tie PCB

prolonged use is required (especially in a non-kinetic mode). Possible solutions here include high efficiency solar panels fitted into a bowler hat and a mains adapter for those instances where limited movement is acceptable (in the boardrom for instance).

Use of the tie in either the UK or the US is

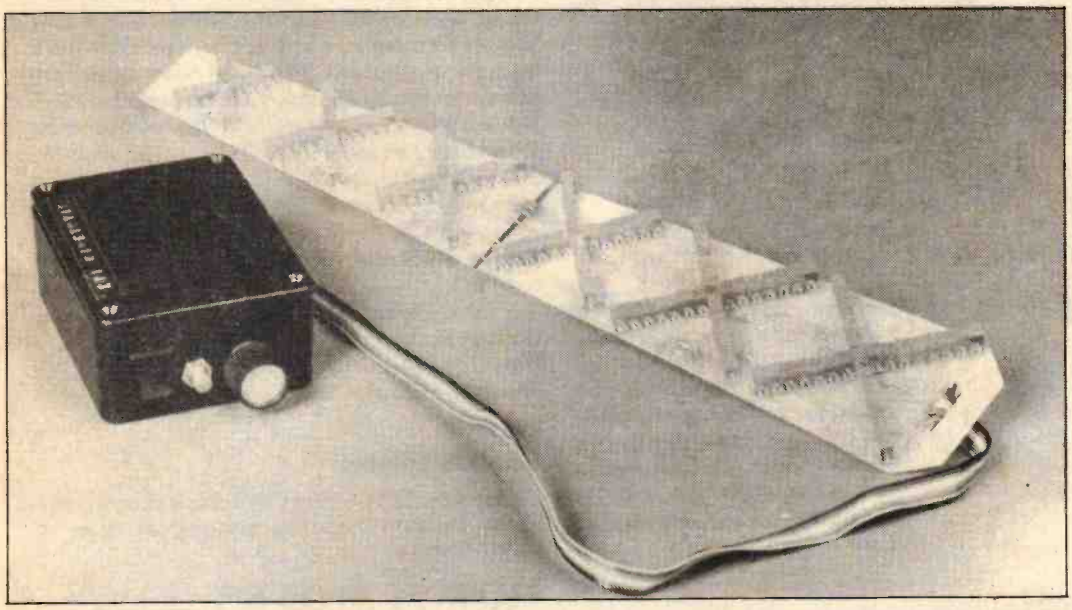
```
0000  FE FE FE FE FE FE FE FE FE FE FE FE FE FE FE FE
0010  FD FD FD FD FD FD FD FD FD FD FD FD FD FD FD FD
0020  55 A9 55 A9 55 A9 55 A9 55 A9 55 A9 55 A9 55 A9
0030. 05 09 11 21 41 81 81 81 82 42 22 12 0A 06 06 06
0040  FD FD 00 00 FD FD 00 00 FD FD 00 00 FD FD 00 00
0050  FE FE 00 00 FE FE 00 00 FE FE 00 00 FE FE 00 00
0060  FD FD FE FE FD FD FE FE FD FD FE FE FD FD FE FE
0070  05 09 11 21 41 81 00 00 05 09 11 21 41 81 00 00
0080  06 0A 12 22 42 82 00 00 06 0A 12 22 42 82 00 00
0090  05 0A 11 22 41 82 00 00 05 0A 11 22 41 82 00 00
00A0  05 0A 11 22 41 82 00 00 81 42 21 12 09 06 00 00
00B0  05 05 09 09 11 11 21 21 41 41 81 81 41 21 11 09
00C0  82 82 42 42 22 22 12 12 0A 0A 06 06 0A 12 22 42
00D0  86 4A 32 4A 86 4A 32 4A 86 4A 32 4A 86 4A 32 4A
00E0  FD FD FD FD FD FD FD FD FD FD 06 0A 12 22 42 82
00F0  FE FE FE FE FE FE FE FE FE FE 05 09 11 21 41 81
```

Listing 1 Hex dump of the used portion of the EPROM

straightforward but how many people would be able to say with confidence which mode would be appropriate in say the Cape Verde Islands? This brings us to the top of the range executive mode.

Complete with a satellite based navigational system, the latitude and longitude are passed to the on-board (on-tie, rather) computer which calculates the country and from this the required mode. In countries such as Australia where both tie modes seem to be commonly used, the mode would be selected at random.

Enough of ties, the pièce de résistance currently under consideration is the multi-tartan kilt (with optional sporran and MIDI-pipes to match). Whereas the electronics is well proven technology we are having considerable difficulty in finding weavers on the Isle of Harris with experience of incorporating fibre optics into the tweed (although one or two crofts in the Quidnish area look promising). Nevertheless, obstacles are there to be overcome so keep watching these pages — perhaps a few years yet but certainly at this time of year!



PARTS LIST

RESISTORS (all ¼W 5%)

R1,2	82k
R3,20-27	10k
R4,6,8,10,13,16	220R
R5,7,9,11,15,17	100R
R12,14	180R
R18,19	4k7
RV1	470k Lin

CAPACITORS

C1	1µ0 tantalum
C2,4,5	10n ceramic
C3	100n ceramic

SEMICONDUCTORS

IC1	555
IC2	74LS393
IC3	2764
IC4	ULN2003
Q1-4	BC327
LED1-146	square 5mm red LED

MISCELLANEOUS

B1	2V4 battery (2×AA NiCd)
B2	4V8 battery (4×AA NiCd)
SW1	Double pole rocker
SW2	Single pole push button

PCB. Battery holders. 9-way ribbon cable. Case 95×71×35mm. Red or pink tie.

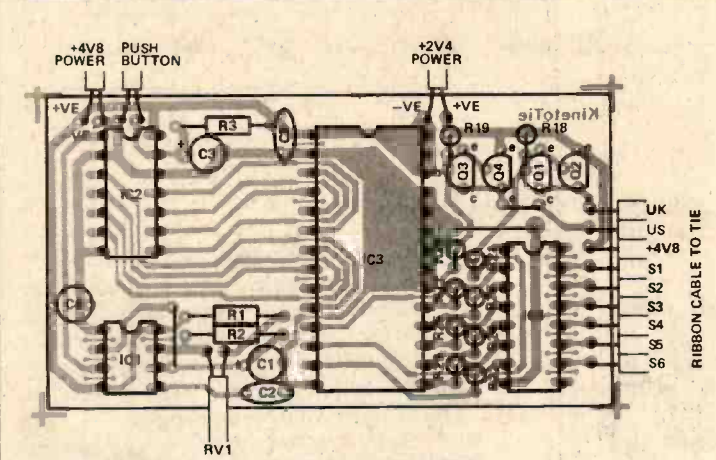


Fig. 6 Component overlay of the control box PCB

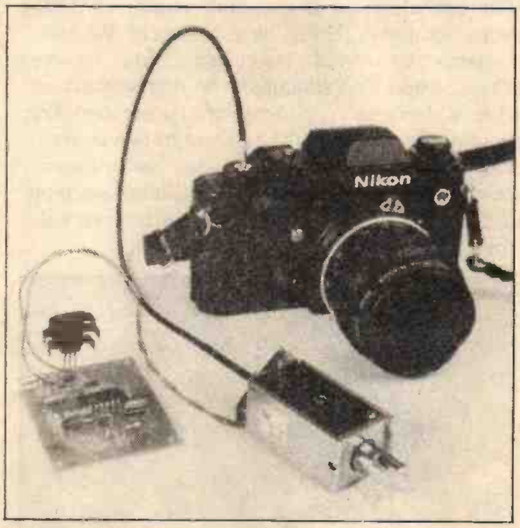
BUYLINES

Most parts are readily obtainable from the usual sources. This includes the PCBs which are available from the ETI PCB service. The LEDs used are rather specific and the only known source is Farnell Electronic Components Ltd (Tel: (0535) 636311) where the part number is V530PA. For those without a trade account, Farnell's parts may be purchased for a small commission from Trilogic (Tel: (0274) 691115). The LEDs specified are quite expensive. For those wishing to build a less expensive Kinetotie, ordinary round LEDs could be used but the stripes will then be made up of dots rather than solid.

For those without EPROM blowing facilities, a programming service is available from PLS (Tel: 01-330 6540).

CAMERA CONTROLLER

Keith Brindley builds a snappy project for beginners to turn your camera into a sophisticated remote-triggered device



To start we must make it clear that this project is not in itself a particularly useful addition to your camera gadget bag. It *can* be used to control the camera's shutter release but its *real* advantage will be found later. You see, the ETI Camera Controller acts as a multi-function, electronic shutter release interface which, in the future, can be used with other projects which allow the camera to be remotely operated in a wide variety of ways.

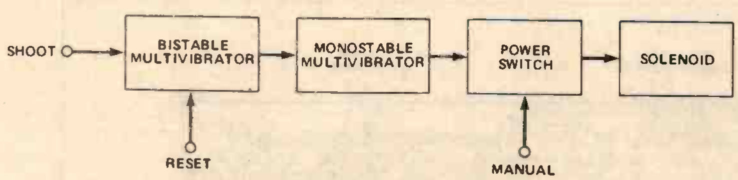


Fig. 1 Block diagram of the camera controller

The later projects (all *1st Class)* will include:

- a light-beam trigger — when someone or something interrupts an infra-red beam of light, the camera will be triggered. Ideal for candid shots of, say, birds entering or leaving a bird-house or surprise shots of intruders breaking into guarded premises
- a sound-operated trigger — to trigger the camera on the detection of a sound
- a remote trigger — to operate the camera from a distance for, say, self-portraits
- a fixed-interval timer trigger — allowing photographs to be taken at a number of fixed times, to show, say, a flower head opening up in stages through the day
- a variable-exposure time trigger — allowing the camera to be triggered for longer periods than are available on the camera's built-in exposure time mechanism

The Camera Controller links to your camera with a standard cable release, operating the cable release (with the help of a low-voltage solenoid) to trigger the camera on reception of an electronic pulse. So, quite simply, the project interfaces the mechanical shutter release of the camera to the electronics world. The camera then, effectively, has an electronically-operated shutter release. With the addition of one or more of the later projects listed here it becomes quite a sophisticated photographic tool.

The design is for battery-powered operation — if you're going to use such a device to trigger your camera outside it's hardly likely you'll have a mains power point at the camera's position. So the solenoid used is of low-voltage (12V) operation. However, the power required to operate a cable release and a camera's shutter is quite large so the solenoid is a beefy one, which requires a fair current (about 1A). Your common-or-garden dry cell isn't going to be able to provide the current needed. Instead, you should use two, PP3-sized NiCd batteries. These have two advantages. They are rechargeable and their operating voltage (8.4V, 16.8V in series) is within the maximum 18V limit for the integrated circuit used — a CMOS device. Alkaline batteries could provide a voltage of exactly 18V — too close for comfort.

Observant readers will note the use of a cheap Darlington pair transistor to ensure a low source current requirement from the CMOS chip, while providing adequate drive current for the solenoid.

Construction

Circuit of the ETI Camera Controller is shown in Fig. 2. As usual in *1st Class* projects, a choice of

HOW IT WORKS

Figure 1 shows a block diagram of the ETI Camera Controller. A bistable multivibrator (that is, a flip-flop) is used as an interface to incoming electronic shoot pulses. These pulses set (or flip) the bistable into the triggered state. Once set, the bistable cannot be re-triggered until it has been reset (flopped!).

Once set, the bistable output triggers a monostable multivibrator, with an on period of about one second. The monostable output controls a power switch which in turn controls a low-voltage solenoid. In addition to this automatic mode, the power switch can be controlled manually.

The circuit is shown in Fig. 2. Gates IC1a,b form the bistable multivibrator which is set by incoming shoot pulses and reset by incoming reset pulses. A LED is used to show when the bistable is set and to warn the user it must be reset before it will trigger the solenoid.

Gates IC1c,d form the monostable multivibrator which is triggered by the output of the bistable. Its on state is determined by the values of capacitor C5 and resistor R8, following the approximate relationship:

$$\text{Time} = 0.8 \times C5 \times R8$$

which, for the given component values, is as near as dammit 0.8 seconds.

Output of the monostable drives the power switch, formed by power Darlington transistor Q1. This directly drives the solenoid. Diode D3 is incorporated in parallel with the solenoid, to prevent the back EMF generated when the solenoid is de-energised from damaging the transistor. This is effectively shorted to the positive power supply rail through the diode.

Manual override of the power switch is provided by resistor R10, which when connected to the positive supply rail, creates a secondary base current to transistor Q1 cancelling all effects of the preceding circuit.

1st CLASS

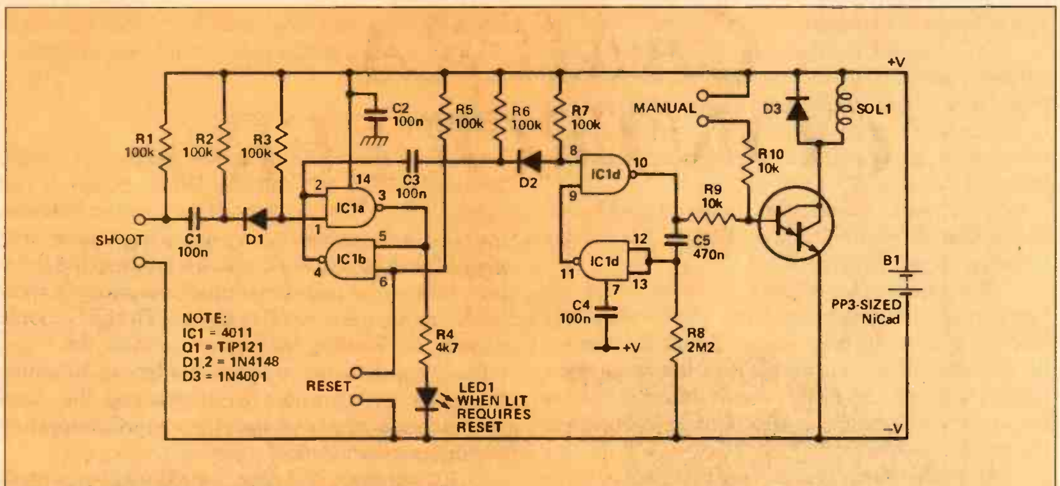


Fig. 2 Circuit diagram of the camera controller

construction techniques is offered: printed circuit board or stripboard. Both methods are straightforward and apart from a few points are more-or-less self-explanatory.

On PCB, construction doesn't need to follow any particular order, although it's probably best to leave the integrated circuit till last. PCB layout, component overlay and wiring details are shown in Fig. 3. If you aren't too sure, insert components following an imaginarily logical order of complexity. That is, insert and solder passive components first (resistors then capacitors), simple semiconductors second (diodes then the transistor) and the complex semiconductor (the integrated circuit) last.

Although a socket was used in the prototype to mount the IC, it's by no means essential, and 4011s aren't too pricey anyway, so it can be soldered directly into the PCB without worry. Nevertheless, if you're not using a socket, go easy on the heat. Solder one pin then leave the IC to cool before moving on to solder the next pin.

On stripboard, it's probably best to follow this order of inserting and soldering components pretty rigidly. The stripboard layout, component overlay and wiring details are shown in Fig. 4. Before you start, however, make all copper track cuts then insert and solder all wire links. It's far easier doing all these fiddly

PARTS LIST

RESISTORS (all ¼W 5%)	
R1,2,3,5,6,7	100k
R4	4k7
R8	2M2
R9,10	10k
CAPACITORS	
C1,2,3,4	100n polyester
C5	470n foil
SEMICONDUCTORS	
IC1	4011
Q1	TIP121
LED1	red LED
D1,2	1N4148
D3	1N4001
MISCELLANEOUS	
B1	16.4V battery (2xPP3 NiCd)
SOLI	12V DC 10W solenoid

PCB or stripboard. Battery clips. Cable release. TO220 heatsink. IC socket. Wire. Case.

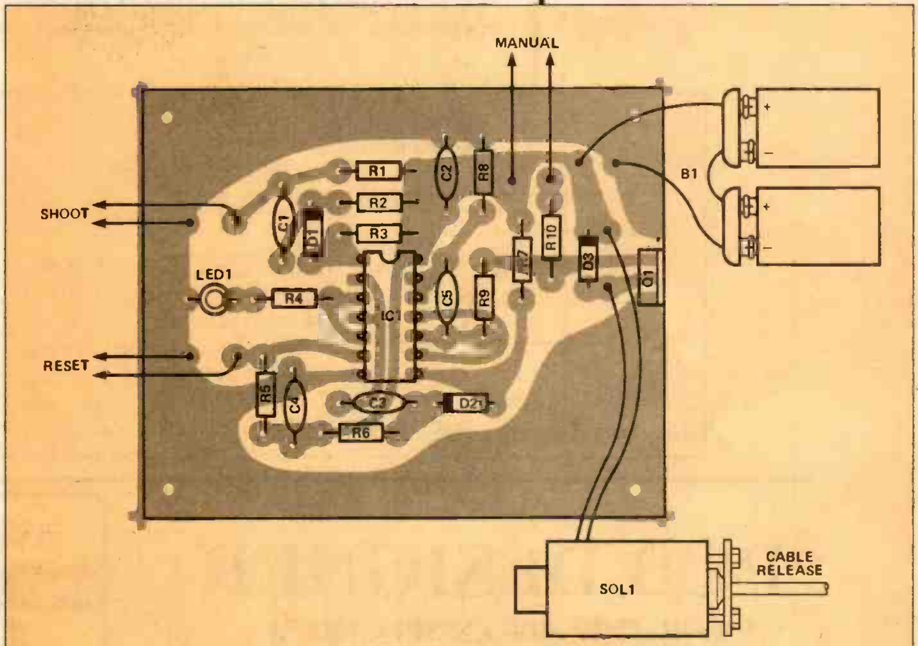


Fig. 3 The PCB component overlay

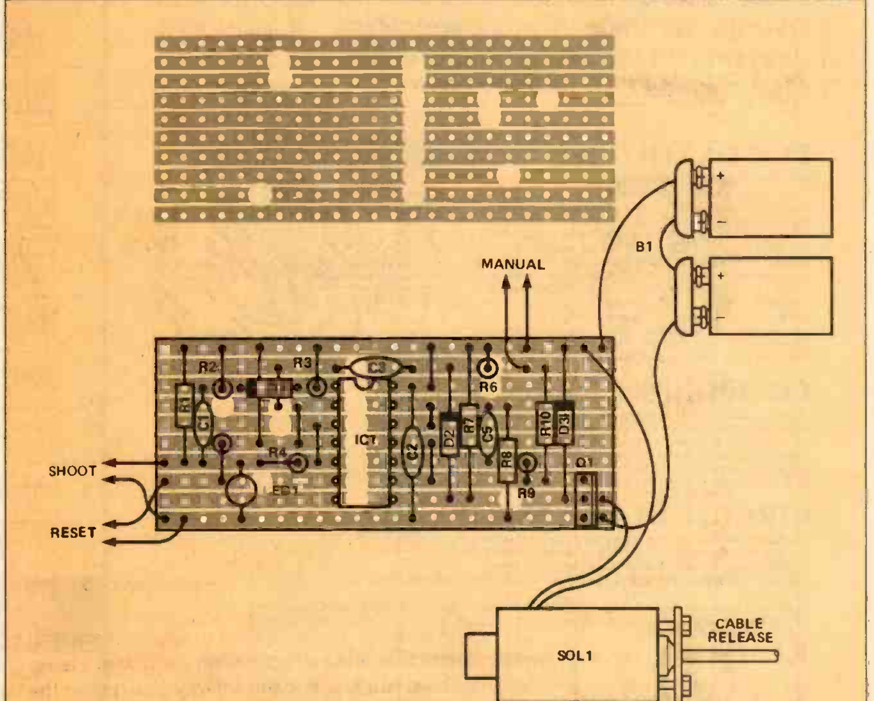


Fig. 4 The stripboard track cuts and component overlay

things before components are mounted.

On either PCB or stripboard, it's a good idea (though, again, by no means essential) to use circuit board pins where all off-board wire connections are to be made. Their use means it is simple to make a connection, particularly so after the board has been fastened down.

Whichever construction method you choose, check that no solder links or bridges are present between components or IC pins.

Although we've offered no suggestions for housing your completed project, any suitably-sized box can be used. It's here, however, that the interface between the project and the cable release takes place, using a solenoid. So this is where readers may have to use a little ingenuity to ensure the solenoid operates the release satisfactorily.

A possible method of linking the solenoid to the cable release is shown in Fig. 5. As the solenoid is energised, its plunger must push in the cable release's operating pin. The method shown couples the cable release's operating pin directly to the solenoid's plunger giving a pretty 'solid' and robust interface.

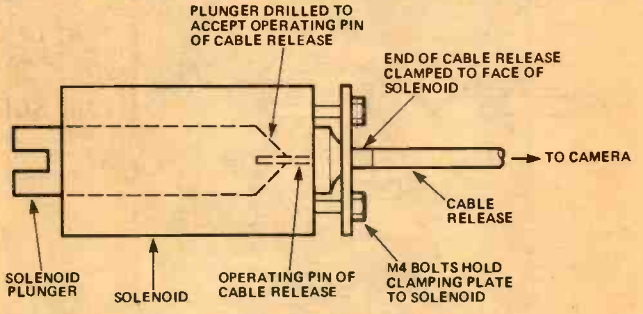


Fig. 5 Attaching the solenoid to the cable release

Setting Up

There's not a lot to do here. Test the project initially unconnected to the camera. When power is first applied, the LED may light. If so, connect between the two reset terminals (using, say, a screwdriver) and the LED will go out. Now, connect between the shoot terminals — the solenoid should energise for a short while (about one second) then stop. The LED should now be lit. Further attempts to connect the shoot terminals should *not* operate the solenoid. Resetting the project, however, by connecting the reset terminals will allow the shoot terminals' connection to energise the solenoid again.

It should be noted, here, that although we've been talking about connecting between terminals to provide shoot and reset triggers — by touching the terminals with a screwdriver — there's nothing to stop switches being used. Also, for future use, these triggers will be generated elecronically by other circuits — negative-going pulses will trigger both shoot and reset.

The shoot-then-reset operation can be effectively over-ridden by connecting the manual terminals — the solenoid should energise for as long as the manual terminals are connected.

ETI

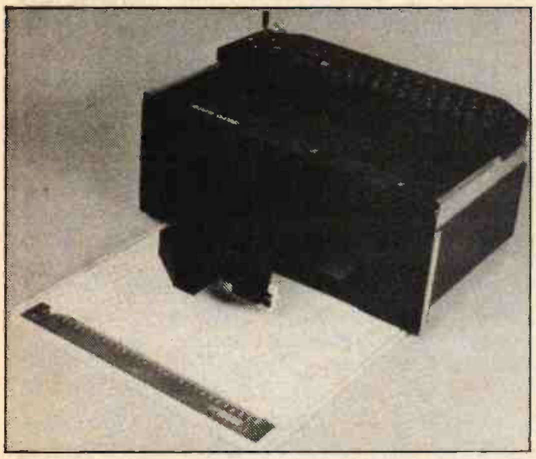
BUYLINES

The solenoid is the only difficult bit and it's available from Electromail as part 349-709. For a suitable cable release for your camera, call in at your local camera shop!

INTELLIGENT PLOTTER

PROJECT

Bob Joyce's plotting project reaches the end of the line with a look at the CPU board and software



In this final part of the Intelligent Plotter we look at the central processing board, keyboard and interface devices. A single 8-bit microprocessor is used to control all of the functions and outputs of the Plotter using three 8K EPROMs holding the program, the various look-up tables, the upper case character set and the test routine co-ordinates.

The PCB was designed to be versatile enough to be used for other interface projects and accordingly a considerable amount of external interface porting has been provided (six 8-bit ports + interrupts) together with 8K RAM and 24K ROM.

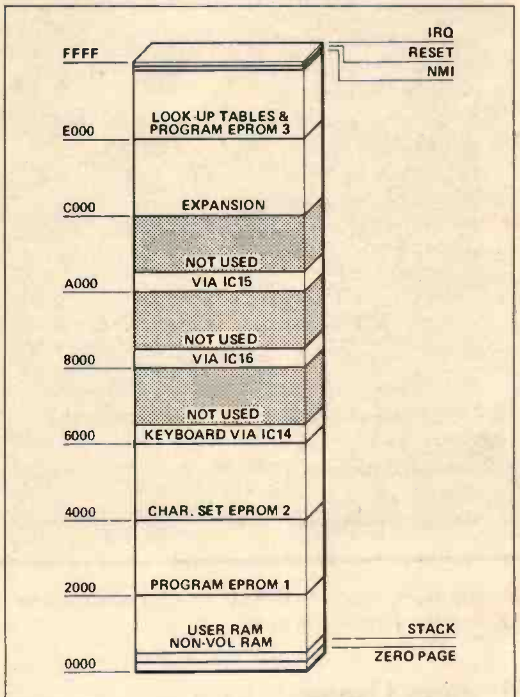


Fig. 1 The Intelligent Plotter's memory map

Battery-backed RAM can facilitate some further development if required using any suitable 6502

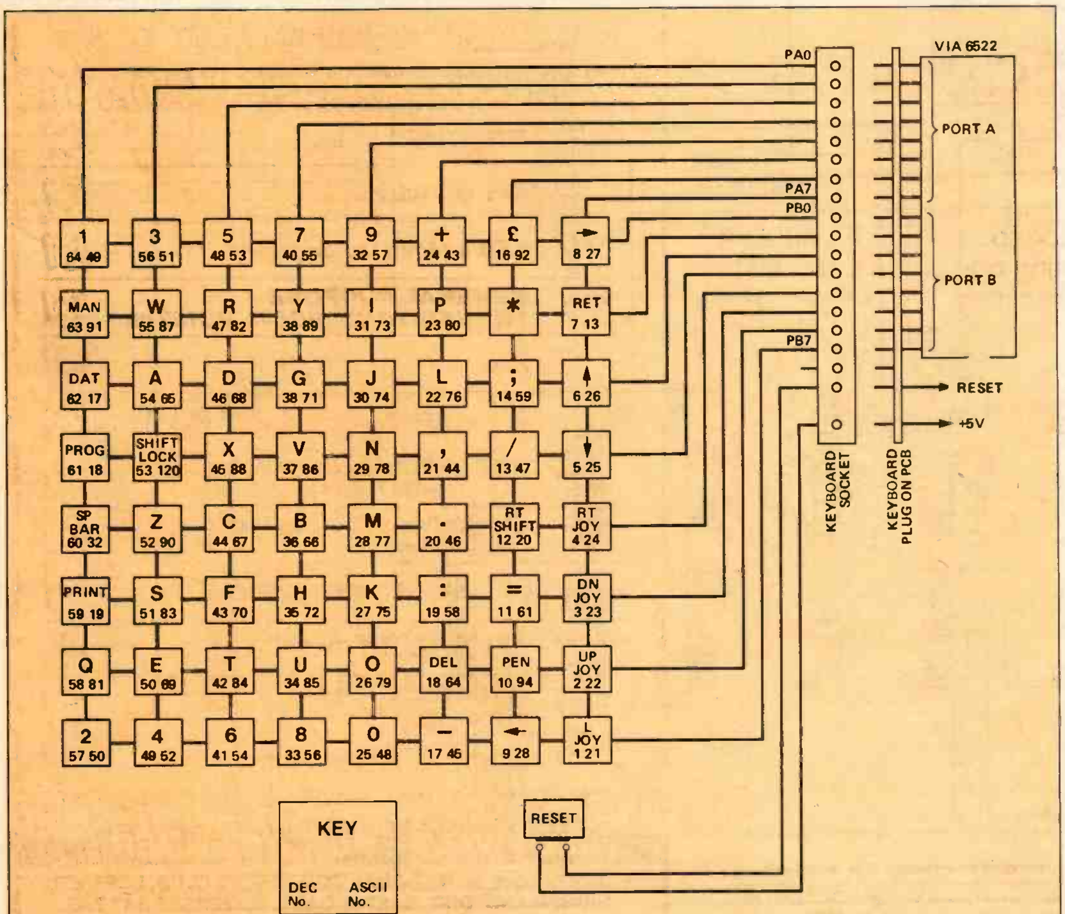
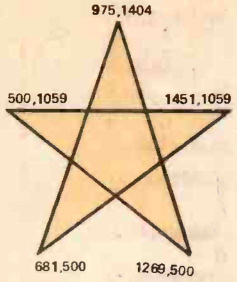


Fig. 2 Keyboard scanning of the Plotter



OPERATING INSTRUCTIONS

1. Connect the Plotter to a 240V 50Hz mains supply. The start up symbols [ ] [ ] should appear on the X and Y axis displays.

If the start up symbols do not appear then press the reset key on the keyboard to initialise the system. If the symbols still do not appear refer to the setting up procedure.

2. After reset, manual operation via the joystick is possible although the exact position will not be shown on the display until the datum procedure has been completed.

3. A keyboard test is available at this stage (before datumming) by pressing any key. The key value and also the ASCII value of the key pressed will be shown on the displays as a decimal value. Some keys are active at this stage so will not show their value.

4. Pen speed of manual and automatic modes can be changed by pressing the 'S' key. The display subsequent to pressing the 'S' key will be as follows:

__223	1__82
BASE SPEED	RAMP RATE INCREASE VALUE

To modify the base speed between its limits of 001 (slow) and 254 (fast), press key B then either + or −. The return key loads into memory.

The ramp speed is varied from 1 (slow ramp) to 8 (fast ramp) by R followed by + or −.

The maximum speed is determined by the base speed added to the increase value. This defaults at 82 and is modified by key I followed by + or −.

5. To datum the plotter and reset the display simply press the 'datum' key. The X and Y axes will move to the bottom left 0.0000, 0.0000 and the display will reset.

To optimise the speed parameters from the default values, press 'S' and 'I', reduce the increase value to 1. Press 'B' and increase the base speed until loss of step is reached then bring it back four steps to ensure stability. Then increase the max speed into its slew range, again back off by 2 when step is lost.

Lastly increase ramp rate until step is lost then reduce by 2.

Coordinate Programming

A series of coordinates may be programmed into memory to be run in order on execution. So to draw the star shown on the left the sequence of key entries would be as follows: prog, 1, return, X, 681, return, pen, Y, 500, return, prog, 2, return, X, 1451, return, Y, 1059 . . . Y, 500, return, prog, 7, return, X, 0, return, pen, Y, 0.

To plot from program 1 onwards, press the auto key twice. The speed may be adjusted by using the S key. The programmed data can be checked prior to plotting by pressing the program key followed by the program number to be checked. Pressing the shift key then displays the contents.

development system (a BBC computer was used to develop the Plotter software).

Memory Usage

The Plotter's memory is divided into eight 8K sections selected by IC6 (see Fig. 1).

The IRQ, NMI and RESET co-ordinate vectors are of course held in the top of the memory map to point the program counter in the right direction when required to do so.

A 6502 8-bit microprocessor controls the

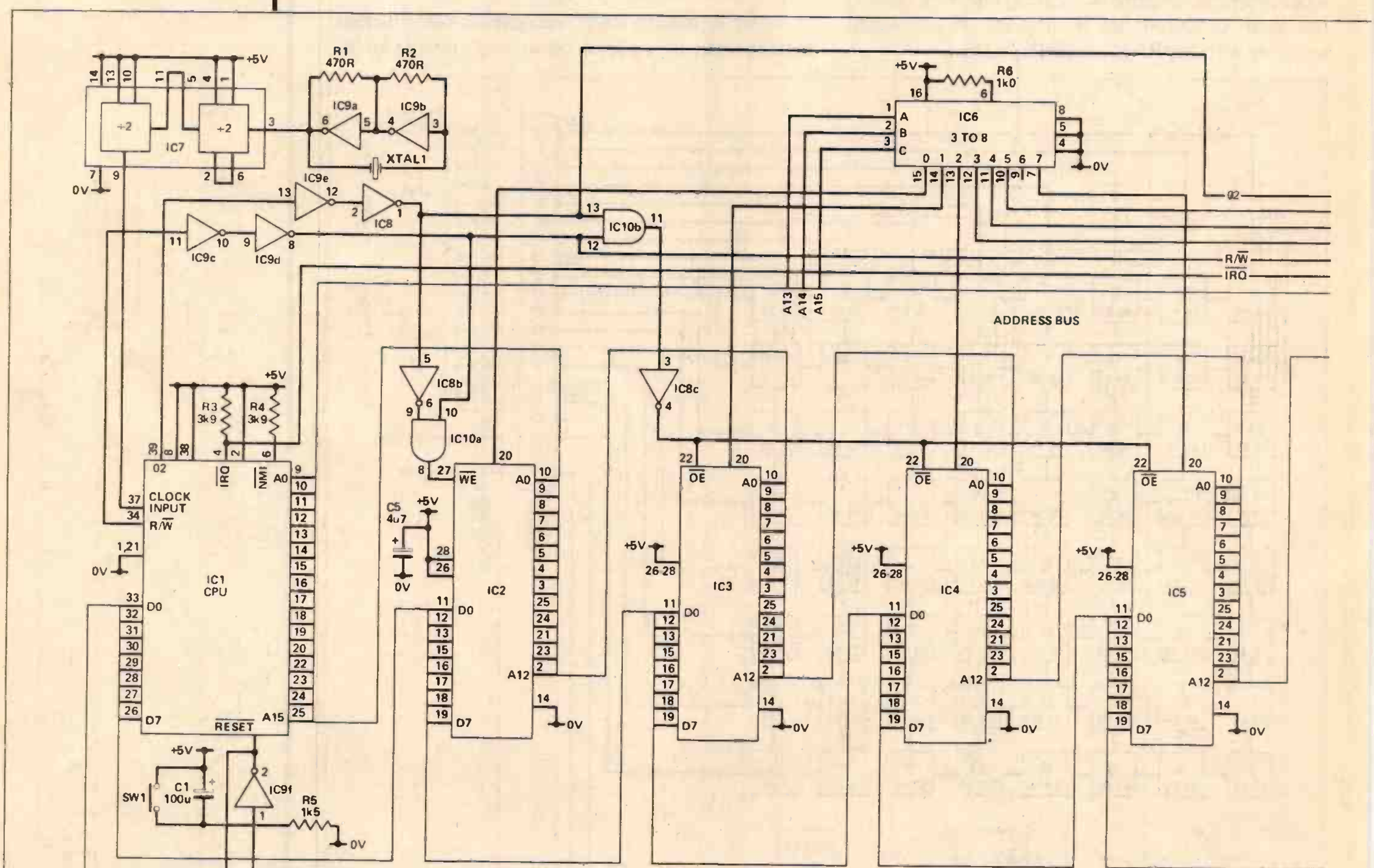


Fig. 3(a) Circuit diagram of the central processor board and power supply

HOW IT WORKS

The circuit diagram is shown in Fig. 3.

IC1 controls all the functions of the plotter. A clock signal of 4MHz derived from XTAL1 and part IC9a,b is divided twice by IC7 to provide a 1MHz clock input.

IC1 is reset on switch-on or by pressing SW1 manually. A reset can also be made from the keyboard.

IC1 NMI (non-maskable interrupt) is not used and held high by R4. IRQ (maskable interrupt) is connected to the VIAs to inform the central processor (IC1) that an interrupt has occurred. The software then interrogates the processor flags to determine the origin of the interrupt.

IC6 is a 3 to 8 decoder and is used to divide up the 64K memory into eight sections. This provides for 8K of RAM, 24K of ROM and 3 VIAs.

The top part of memory is in ROM so that the microprocessor is able to obtain the reset (&FFFC, &FFFD) and interrupt vectors (NMI &FFFA, &FFFB; IRQ &FFFE, &FFFF) during start-up and interrupt operations.

IC8, IC9 and IC10 are used to enable the RAM and ROM when appropriate during read and write cycles.

The display segments are driven by IC17 (74ls47) which uses four ports of IC16 (6522 VIA). The displays are selected by the appropriate binary code to IC11 (74ls145 decoder) using the remaining four ports of IC16's port B.

Darlington drivers IC12 and IC13 and transistors Q1 to Q8 are used to switch on the selected display. Originally dropper resistors were used to limit the current to the displays, but subsequently omitted when the software was rewritten making them redundant.

Port A of IC16 VIA controls the plotter's mechanics as follows:

PA0 .... Direction Y axis
PA1 .... Step Y axis
PA3 .... Pen control
PA4 .... Direction X axis
PA5 .... Step X axis

Initially ports A and B are both configured as outputs (by writing '1' to DDRA and DDRB).

Movement of the axes is achieved by sending a '1' to the appropriate step line for each 0.1mm movement and sending a 0 or 1 to the respective axis direction port output. There is not enough space in this article to cover in depth the programming of the VIAs but interested readers should obtain a copy of the 6522 data sheet from their usual electrical supplier.

functions and outputs of the Plotter. Address lines A0 to A3 are used to provide all the programming functions of the VIA. Address lines A13, A14 and A15 select the memory in 8K blocks.

The VIA at &8000 (IC16) drives the plotter mechanics from Port A and also the CPU display from Port B.

The Keyboard

The keyboard (Fig. 2) is a 64-key QWERTY type,

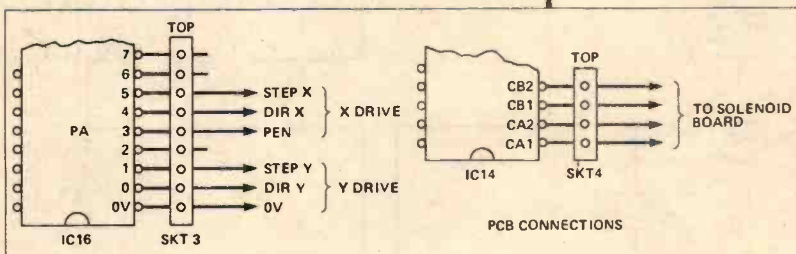
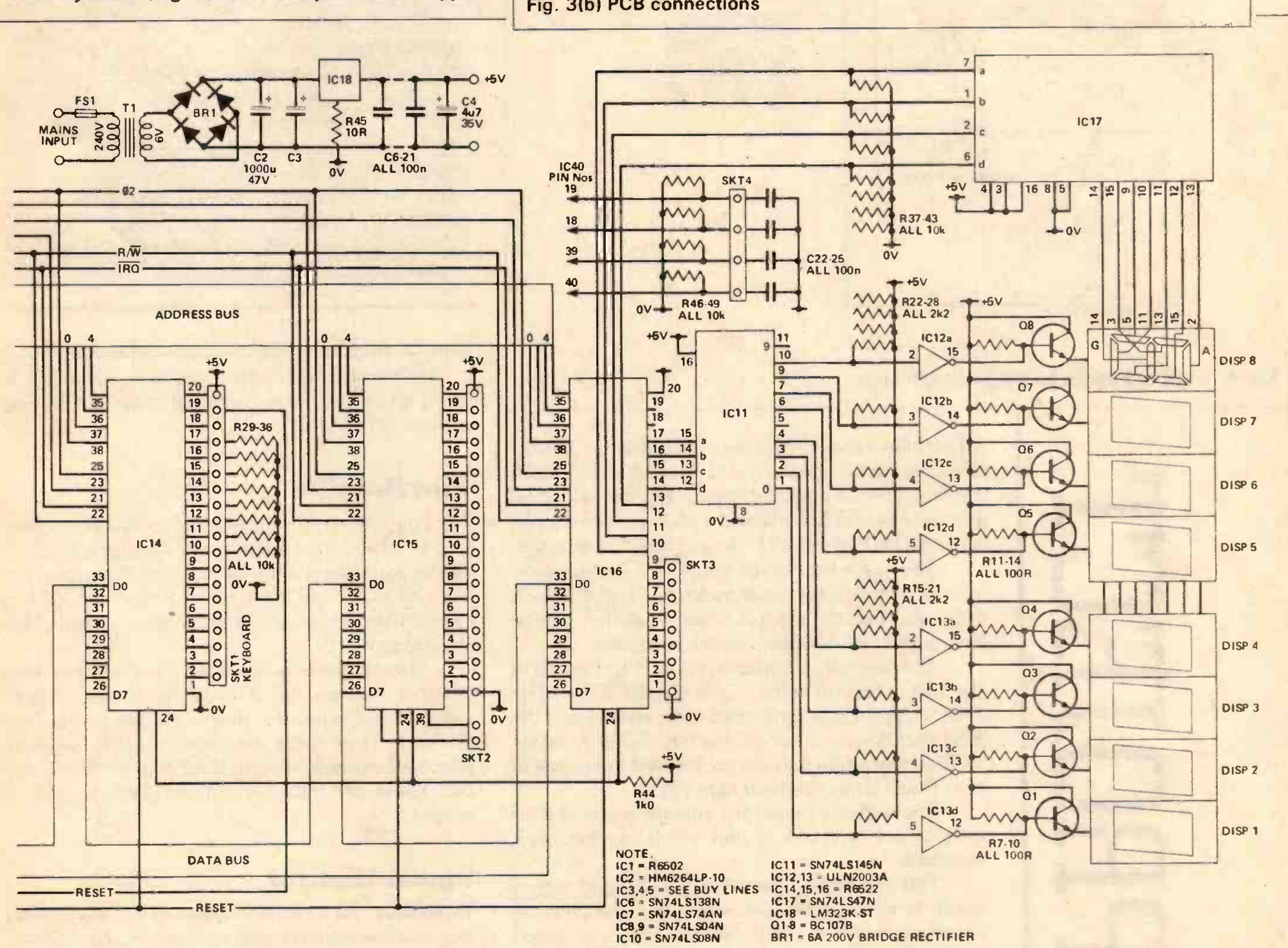


Fig. 3(b) PCB connections



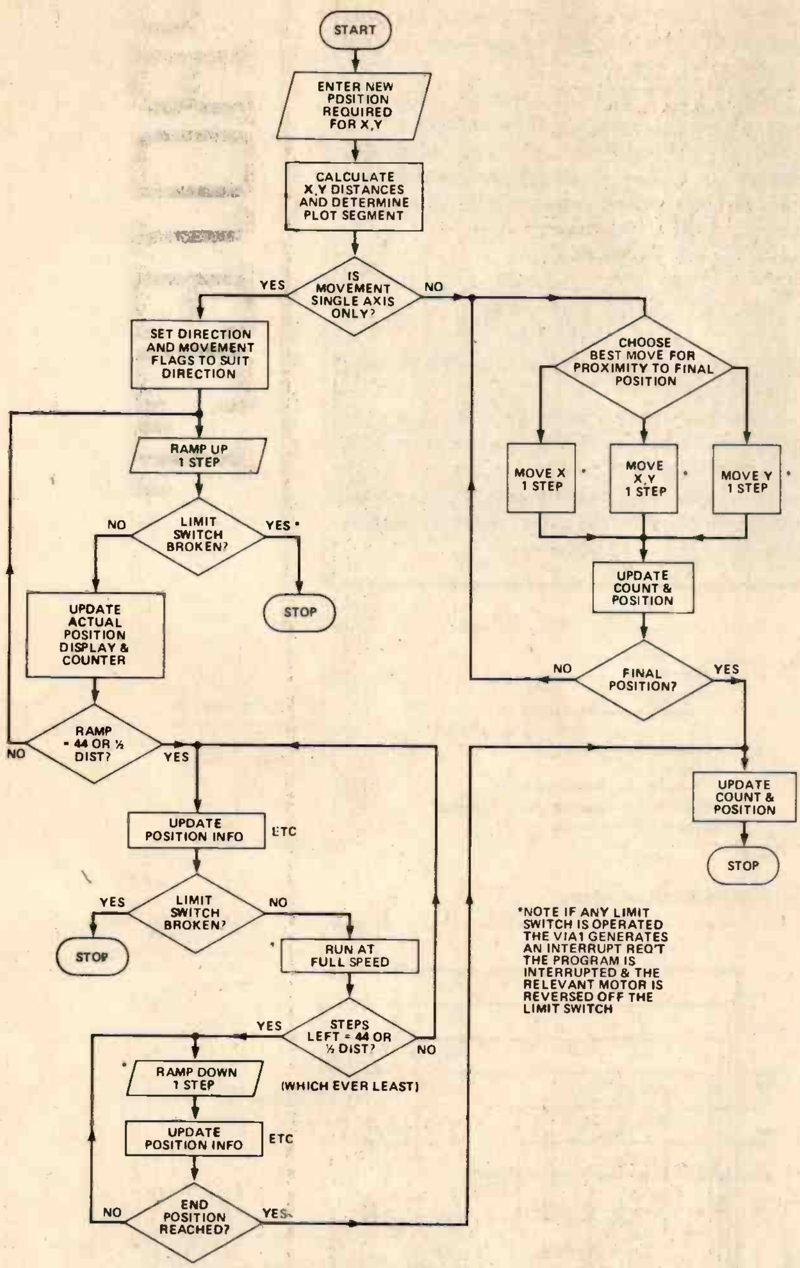


Fig. 4 The flow diagram for the plotting routine

which allows the user to type upper case text directly. The prototype used an old Commodore Vic20 keyboard from a local electronics rally, which had the bonus of two 6522 VIAs and a 6502 all socketed on its single PCB. Any 8x8 keyboard could be adapted.

The 'reset' key shown could be a spare key on your keyboard or a separate switch on the plotter itself. Note also that the manual control switches can be connected to a 4-switch joystick as shown.

The keyboard scan utilises port A and port B of the VIA at &8000 in the memory map (IC14). The 8-bit VIA port A is configured as an output and the 8-bit port B as an input. All the bits of port A are set to '0' so that when no keys are pressed the inputs to port B will always be held high (&FF).

The software looks for a change in port B then interrogates each row to find which one has been switched.

This established port A is then loaded with a single '0' which is 'walked' across the port until the column is found. A small software delay is included and the key checked once more, if the result is not the

PARTS LIST

RESISTORS (all ¼W 5% unless specified)	
R1,2	470R
R3,4	3k9
R5	1k5
R6,44,46	1k0
R45	10R
R7-14	100R ¾W
R15-21	7 commoned res. net. 2k2 ⅛W
R22-28	7 commoned res. net. 2k2 ⅛W
R29-36	8 commoned res. net. 10k ⅛W
R37-43	7 commoned res. net. 10k ⅛W
R46-49	4 commoned res. net. 10k ⅛W
CAPACITORS	
C1	100µ 16V radial electrolytic
C2	10000µ 47V electrolytic
C3,4,5	4µ7 35V tantalum
C6-25	100n submin polyester
SEMICONDUCTORS	
IC1	R6502
IC2	HM6264 LP-10 or bat/backup 175-995 (Farnell)
IC3,4,5	see Buylines
IC6	SN74LS138N
IC7	SN74LS74AN
IC8,9	SN74LS04N
IC10	SN74LS08N
IC11	SN74LS145N
IC12,13	ULN2003A
IC14,15,16	R6522
IC17	SN74LS47N
IC18	LM323K-STEEL
Q1-8	BC107B
BR1	6A 200V bridge rect.
MISCELLANEOUS	
DISP1-8	Hewlett Packard HDSP3900 0.8in 7-segment c/anode
FS1	250mA antisurge fuse
SK1-4	single row through headers
SW1	miniature PCB n/o momentary
T1	50VA primary mains: secondary 0-6V
XTAL1	4MHz

PCB. IC sockets. Joystick if required. QWERTY keyboard. Fuseholder. Heatsink (T03 type 14degC/W or alloy)

same as previously the routine is not executed.

When the key pressed has been identified an index is used to locate the ASCII value in a look-up table held in ROM.

Plot Routine

The flow diagram for the plotting routine is shown in Fig. 4. This routine was a major stumbling block — clearly you cannot simply instruct the X motor to run from X1 to X2 and the Y motor from Y1 to Y2 and expect them to run at the appropriate speeds for a straight plot.

The method finally chosen involves checking whether moving the X-axis, the Y-axis or both together will bring the plotter closest to the final position. Thus there are eight possible segment directions corresponding to N,S,E,W,NW,NE,SW and SE. These are followed until the final position is reached.

Speed Control

To achieve the optimum speed from the stepper motors some form of speed ramping must be applied.

In the software I have used a look-up table (see

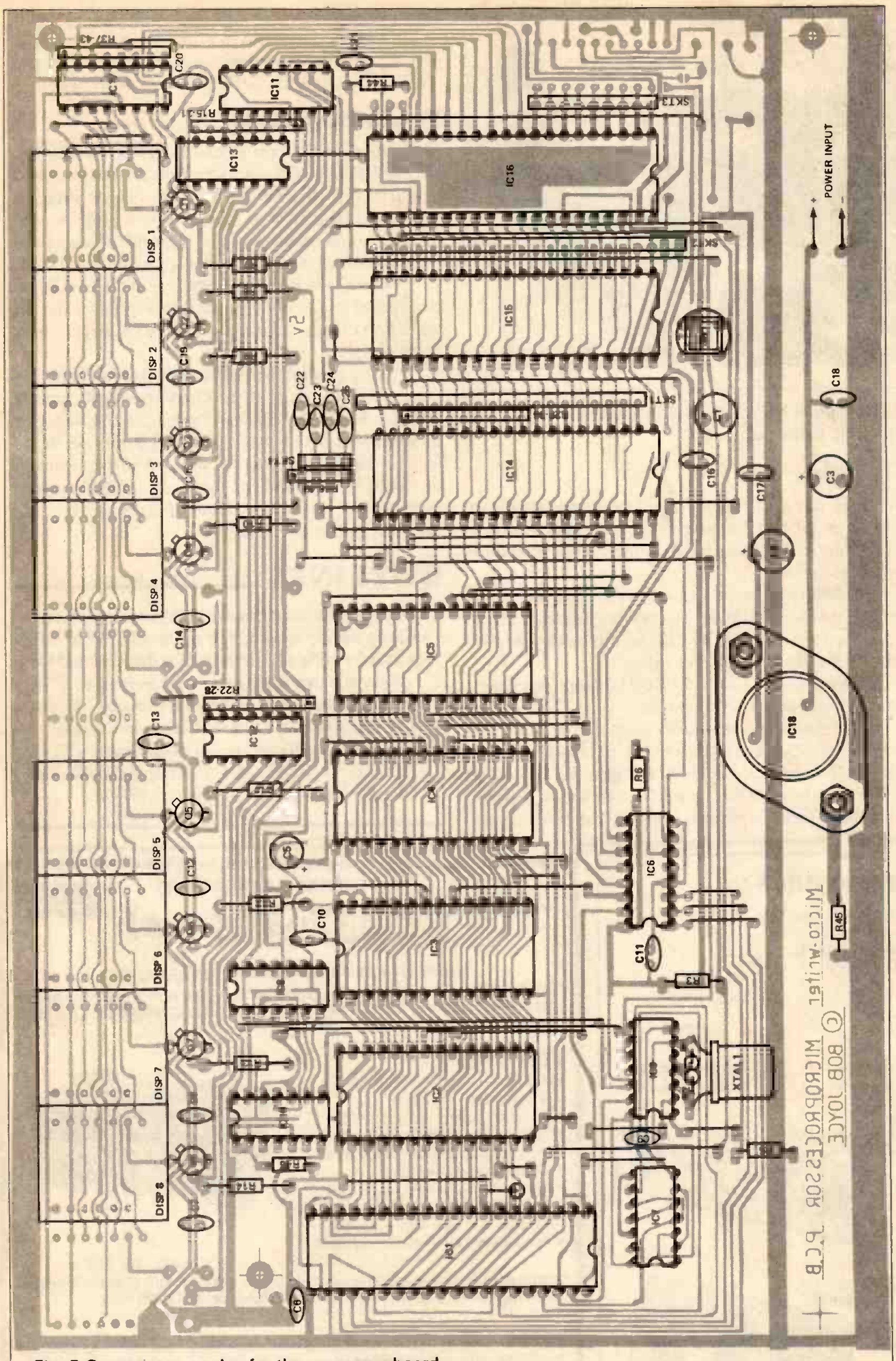


Fig. 5 Component overlay for the processor board

Fig. 1) which contains the necessary delay changes to produce a smooth ramp.

The speed can be changed using three parameters, namely base speed, top speed and ramp rate. These three parameters can be changed independently from the keyboard to produce the optimum speed parameters for a given set of mechanics and stepper motor.

Construction

The component overlay for the processor board is shown in Fig. 5. Construction should be performed with care but should hold few difficulties. Note that there a quite a few links to be made, ensure that the longer ones cannot stray to other links or components.

The displays should be fitted into strip sockets without reducing their lead length. I recommend that you socket all ICs.

You will notice that there is provision for expansion (ten displays for example), so don't panic when you realise there are unpopulated holes left at the end of construction.

Fit the voltage regulator as shown in the February

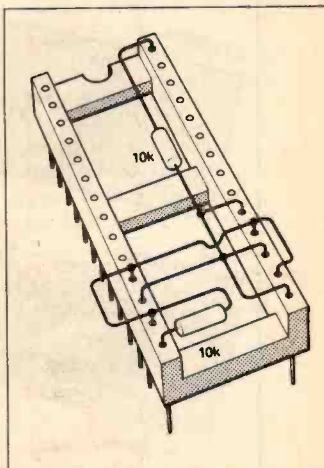
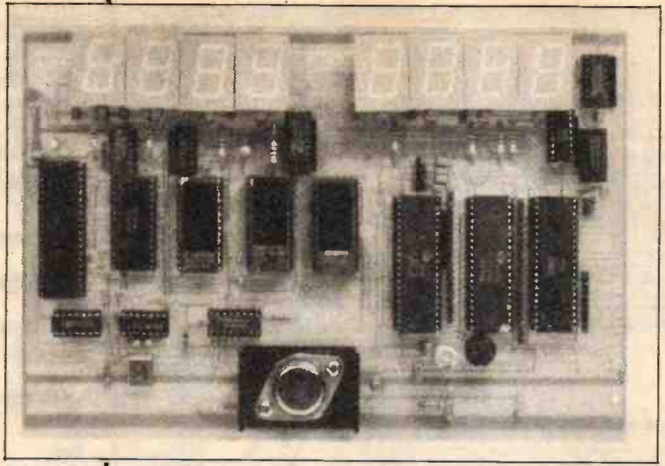


Fig. 6 Wiring of the test socket for a NOP instruction



issue (Fig. 3) and do not solder it until all the screws are fully tightened.

Testing

With all ICs *out*, check that T1 is producing 6V at 50Hz and that the power supply is giving between 5.0V and 5.2V to the PCB — this can be raised by increasing R45.

Switch off power and insert IC7 and IC9, then check that a 1MHz clean squareware appears at the clock input of IC1 (pin 37). If it isn't there check from the crystal through IC7 for faults.

Now insert ICs 1,6,7,8,9,10,11 making absolutely sure their orientation is correct.

To check the microprocessor, wire up a 28-pin turned pin socket as shown in Fig. 6. Inserting this in any of the EPROM sockets will give 10101010 in binary on the data bus — a NOP instruction. Switch on and check the address bus: A0 should have a 125kHz square wave, A1 62.5kHz, A2 31.25kHz and so on, halving the frequency each time. If this works you should have a working unit, if it doesn't then get your meter out and check for shorts and breaks.

Power Supplies

Separate power supplies have been specified for the microprocessor PCB, stepper motor drive boards and solenoid driver. These individual power supplies (including fuse holders) are not mounted on the printed circuit boards but bolted to the chassis then hard wired according to the respective circuit layout.

Note all 0V power supply feed lines should be connected to the chassis at a single point using an earth bolt to reduce voltage build up between return earth paths.

Using separate supplies allows constructors to build up and use the various parts of the project independently. Anyone deciding as an alternative to amalgamate all the power supplies from one transformer should take steps to prevent surges (caused by the inductive loads of the solenoid and stepper motors for instance) from reaching the 5V microprocessor board supply.

BUYLINES

IC3,4,5 are available ready programmed from the author for £15 each. A 40-track disc with source code for all three costs £9 from Mr R. Joyce, 104 Craythorne Ave, Handsworth Wood, Birmingham B20 1LN.

All the other components are available from Farnell on (0532) 636311. Farnell will deal only with account holders but Trilogic on (0274) 684289 can obtain Farnell components for individuals.

The following are Farnell's ref. nos for components — C3,4,5 (100-904); SKT1-4 (176-371); XTAL1 (103-878); joystick (148-212).

The T03 heatsink is from Electromail part 401-778.

ETI

REACTION TIMER

Rod Cooper beats time with a reaction timer project for quick wits

Probably the simplest method of timing human reaction is by dropping a ruler, the time being measured indirectly by the distance needed along the ruler for the subject to catch it. Most readers will be familiar with this test from their schooldays.

In practice this method suffers from a number of disadvantages. For example, it cannot be used for anything other than a visual stimulus, as it is not really feasible to incorporate an audible or touch stimulus into such a simple technique. Also, it is unreliable because of the likelihood of the operator giving the subject an inadvertant 'cue' just before dropping the ruler.

The method then becomes more of a test of a person's ability to perceive these small cues from the operator rather than a true test of reaction time. Because of these snags, most serious operators use more sophisticated methods.

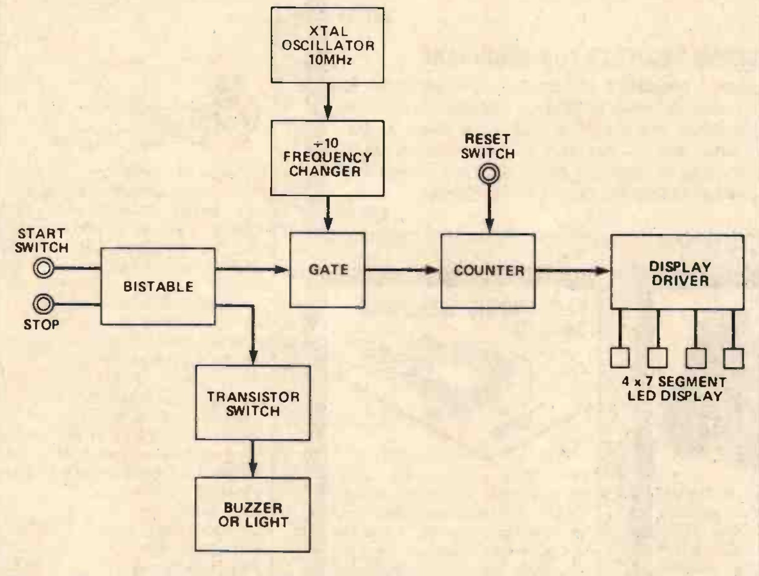


Fig. 1 Block diagram of the Reaction Timer

There are many advantages to using an electronic meter both to give the stimulus and to record the time as a direct reading in fractions of a second. Firstly, the choice of stimulus can be made very wide. Not only can visual stimuli be given but these can vary as to colour and intensity, and can be as simple as one light coming on to a complex stimulus such as recognising a pattern out of a multitude of lights.

Similarly, an audible stimulus could be just a buzzer or could vary as to pitch and amplitude or could be a pattern-recognition type. Response to touch and small electric shocks can also easily be made part of an electronic measuring system. This reaction timer is a basic meter giving one simple audible or visual cue in the form of a buzzer or a light but can easily be expanded to give more difficult stimuli by adding on extra circuitry.

A second advantage is freedom from cueing errors. The distance between the operator and the subject is only limited by the length of the flex between the operator's console and the subject's stop-button. The two could be in separate rooms to completely eliminate the error but it is more usual to have a more reasonable distance, with a screen in between.

A third advantage is that the subject can easily give the stop signal via a foot-pedal instead of by hand and this provides an alternative path for nerve impulses. It can be instructive to compare the two paths, bearing in mind that the fastest nerve impulse travels at about 80m/s.

A fourth small advantage is that the electronic method is more accurate from the timing point of view. Quartz-crystal control and a digital display gives an accuracy impossible using a mechanical technique.

Human reaction timing is used in some types of aptitude testing and also forms part of the new GCSE course in psychology. Reaction timers are available commercially but tend to be expensive, so this design provides an inexpensive alternative as well as being a good educational project.

The timer is also useful in other fields with a little adaptation. It could be used for measuring the transition time of a moving object between two points by substituting the stop-start push-buttons for either microswitches or simple opto-electronic switches. It is also possible to change the timing range, and ways of doing this are described later.

Circuit Description

The circuit is shown in block form in Fig. 1. Starting and stopping the timer depends on push-button switches but these do not operate the circuit directly because of the errors that would be introduced by the shortcomings of mechanical switches. These are well-known defects and include electrical noise and contact bounce. Clean start and stop signals can be obtained without resorting to the complexities of contactless switches simply by feeding the mechanical signals to a bistable.

The bistable opens the gate when the start signal is given and also turns a transistor switch hard on. The transistor switch gives the subject a signal via a fast-response buzzer or via an LED for visual signals. Opening the gate allows a train of pulses from the crystal oscillator to be fed to the counter, which in turn operates the display drivers. The bistable closes the gate when the stop button is pressed, this stops the

PROJECT

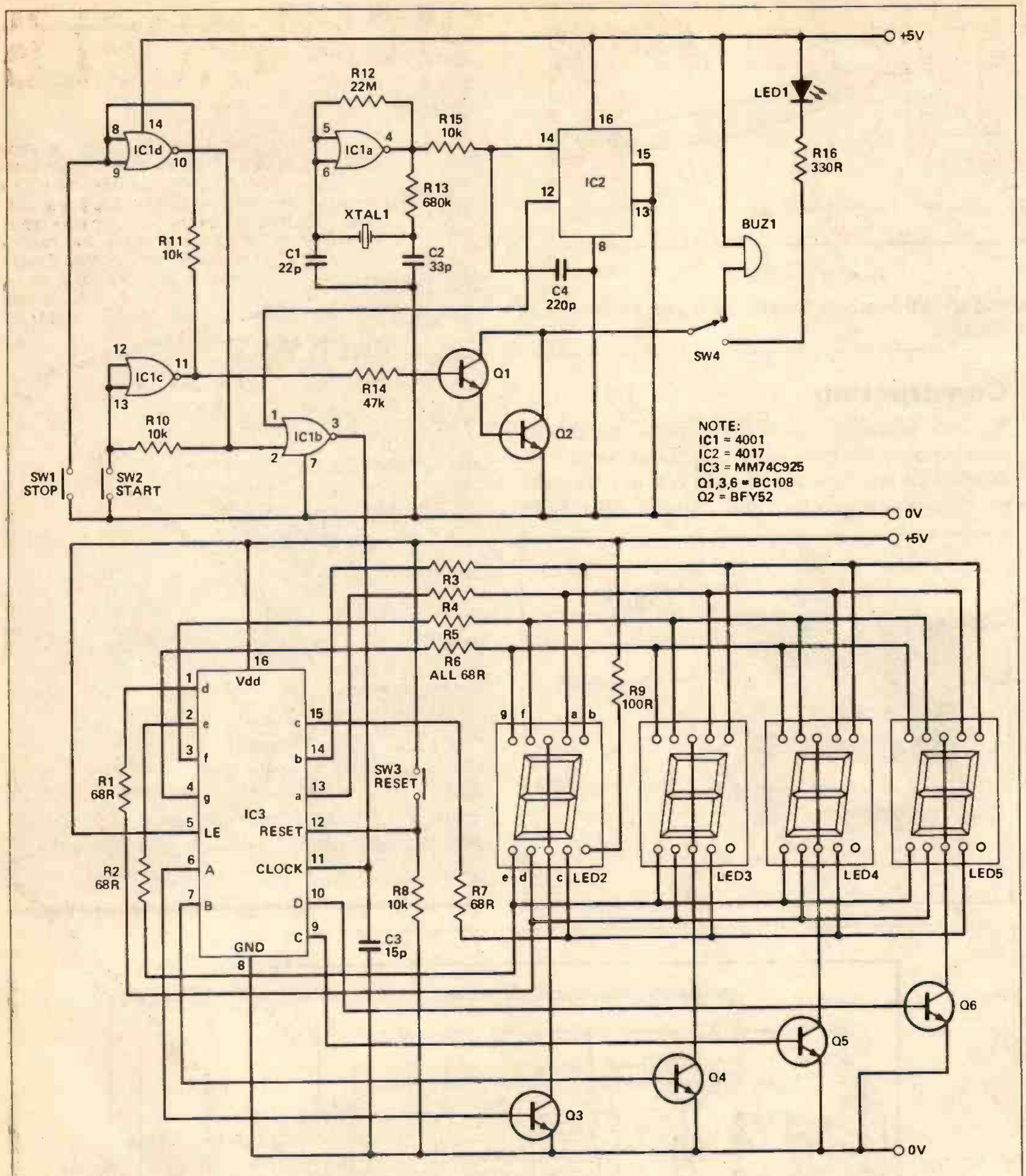


Fig. 2 The circuit diagram of the Reaction Timer

HOW IT WORKS

Figure 2 shows the circuit. IC1a forms a crystal oscillator with the crystal being used in a Pierce circuit. The crystal specified is intended for use in this type of oscillator and should not be substituted. Other crystals may work in this configuration but the accuracy will suffer. The crystal frequency is 10kHz and this is fed to a CD4017 decade divider, IC2. The 1kHz output is fed to one input of gate, IC1b. The other input is controlled by the output from the bistable IC1c,d. The bistable output goes low when the start push-button is pressed, and opens the gate, and goes high when the stop button is pressed, shutting the gate.

Transistors Q1 and Q2 form a darlington switch, the output of which is connected to the buzzer or via a limiting resistor R16 to LED1.

The counter and display-driver uses the MM74C925 which has all the necessary functions on one chip, giving a compact PCB. The MM74C925 is a CMOS 4-decade counter-driver consisting of a 4-digit counter, NPN output sourcing drivers for the standard 7-segment common cathode LED display and an internal multiplexing circuit with four outputs (A, B, C and D). These outputs switch external transistors Q3-6 at a frequency of 1kHz. The multiplexing circuit has its own on-chip oscillator which determines this frequency.

The MM74C925 also features an internal output latch, which although not used in this circuit, could be used for other applications. To operate the latch, a high or low transition on pin 5 is required to latch the number in the counter into the internal output latches.

Segment resistors R1-7 are needed to limit power dissipation in this hard-working chip. Nevertheless, good brightness is obtained using standard LED displays and this can be increased a little by reducing the value of segment resistors given (Fig. 3). It is a good idea, as the MM74C925 is not cheap by any means, to fit an IC heat sink if you do this.

Note that the decimal point is placed between the first two digits.

Power is supplied by three 1.5V dry cells. The circuit will work happily from a nominal 4.5V provided adequate decoupling capacitors are included.

buzzer or the LED and halts the counter at whatever number is reached. This number is continuously displayed until the reset button is pushed.

By choosing a simple decade of one second for the pulse frequency, in this case 1kHz, the display can read directly as fractions of a second in the narrow band into which human reaction times are likely to fall. In this design, the display can register from 0.001 seconds to 9.999 seconds which covers all the eventualities of reaction timing with generous margins. The longer times are useful for pattern-recognition timing.

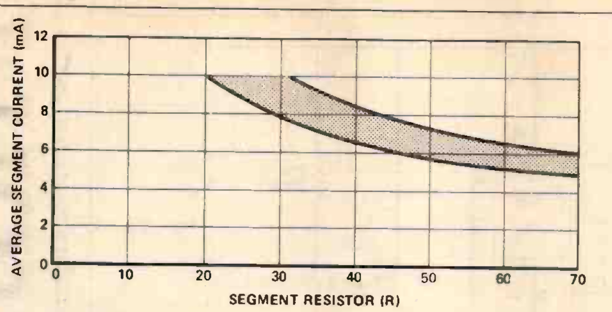
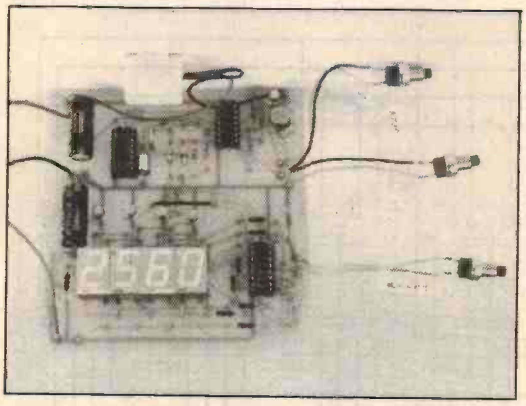


Fig. 3 Choosing an LED segment resistor for higher brightness or for different displays

Construction

A plastic box with a metal front 150×200mm was used to house the display and main components. The depth of the box depends on whether C or D size cells are chosen to power the circuit. The sounder, LED



PARTS LIST

RESISTORS (all ¼W 5%)	
R1-7	68R
R8,10,11,15	10k
R9	100R
R12	22M (or combined equivalent)
R13	680k
R14	47k
R16	330R
CAPACITORS	
C1	22p polystyrene
C2	33p polystyrene
C3	15p polystyrene
C4	220p polystyrene
C5,6	1000µ 10V axial electrolytic
SEMICONDUCTORS	
IC1	4001
IC2	4017
IC3	MM74C925
Q1,3-6	BC108
Q2	BFY52
LED1	Red LED
LED2-5	7-segment common cathode display
MISCELLANEOUS	
B1	3×1.5V batteries
BUZ1	3V DC buzzer
SW11-3	Push to make switch
SW4	SPDT switch
XTAL1	10kHz Statek CX-IV crystal

PCB. Case. Battery holder. Optional on/off switch. Wire. Nuts and bolts.

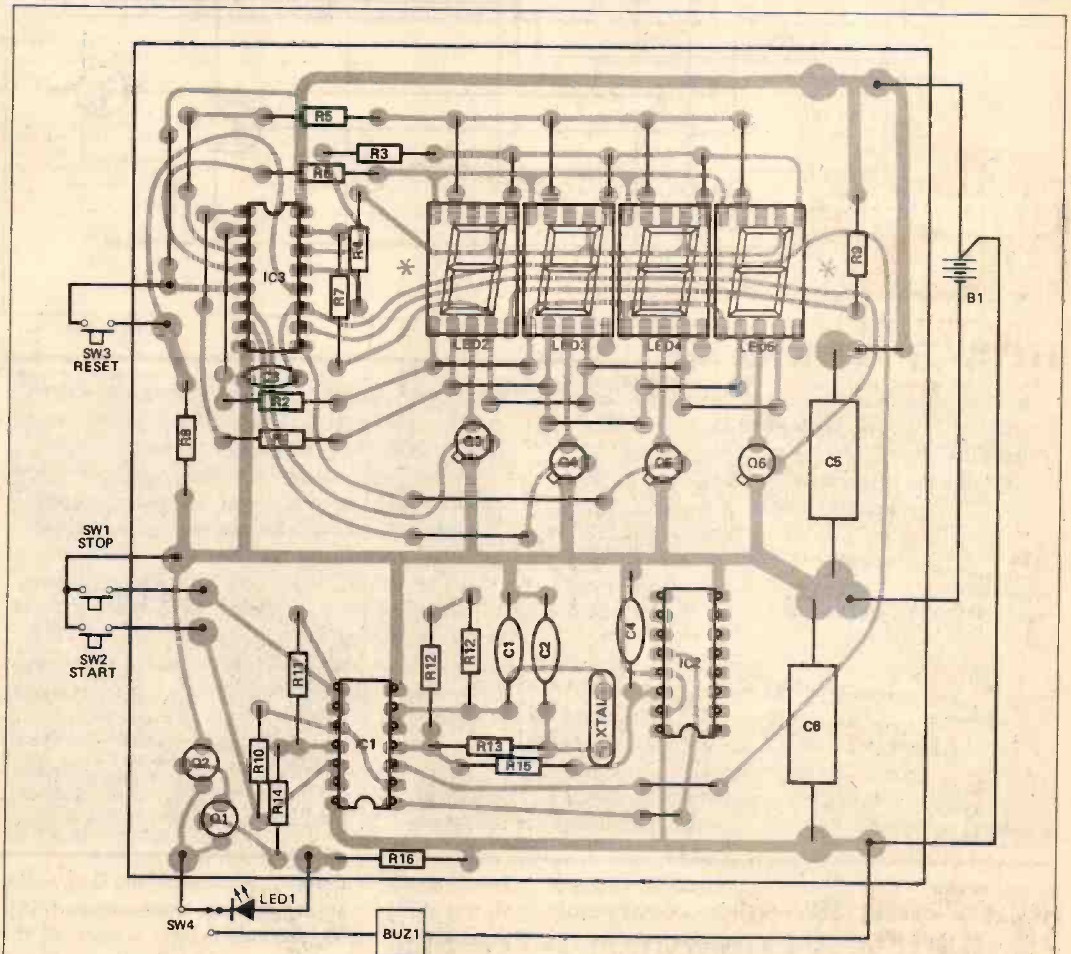
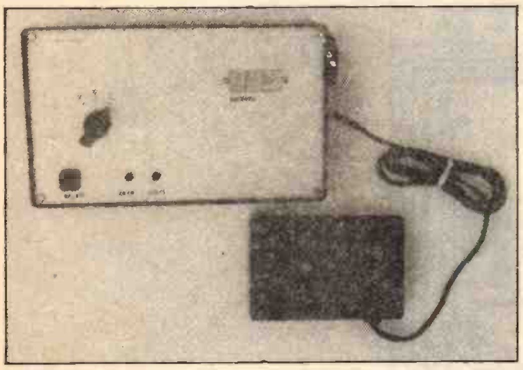


Fig. 4 The component overlay for the Reaction Timer

and stop button are housed in a smaller, all-plastic box and are joined to the main circuit by flexible multicore cable. The length of cable is of course a matter of choice.

The PCB (Fig. 4) is held onto the metal front panel by two screws, one each side of the display. The display is mounted in a holder on the PCB, not soldered direct. This is to give headroom for the other components on the board. The display is thus pressed against the rim of a rectangular hole cut in the front panel (Fig. 5). For a 4-digit display, this hole should



be 49×16mm, which gives a small overlap on the display all round the edge.

To steady the PCB a further holding screw is necessary, or alternatively if you do not want a third

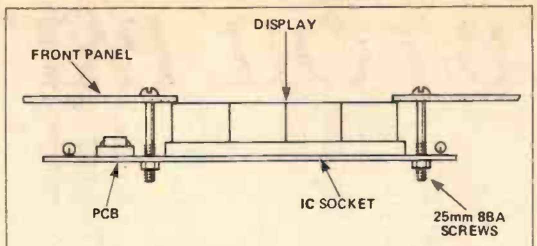


Fig. 5 Mounting the PCB and display

screw head on the front panel, one of the self-adhesive PCB clips now on the market would be better.

The battery of three cells is accommodated in cell holders screwed to the base of the main case underneath the PCB. To renew them it will then be necessary to remove the front plate. Alternatively, the cells can be held in a tubular holder which exits at the side avoiding the need for front panel removal.

The start and reset buttons can be mounted anywhere on the front panel, their position is not critical at all.

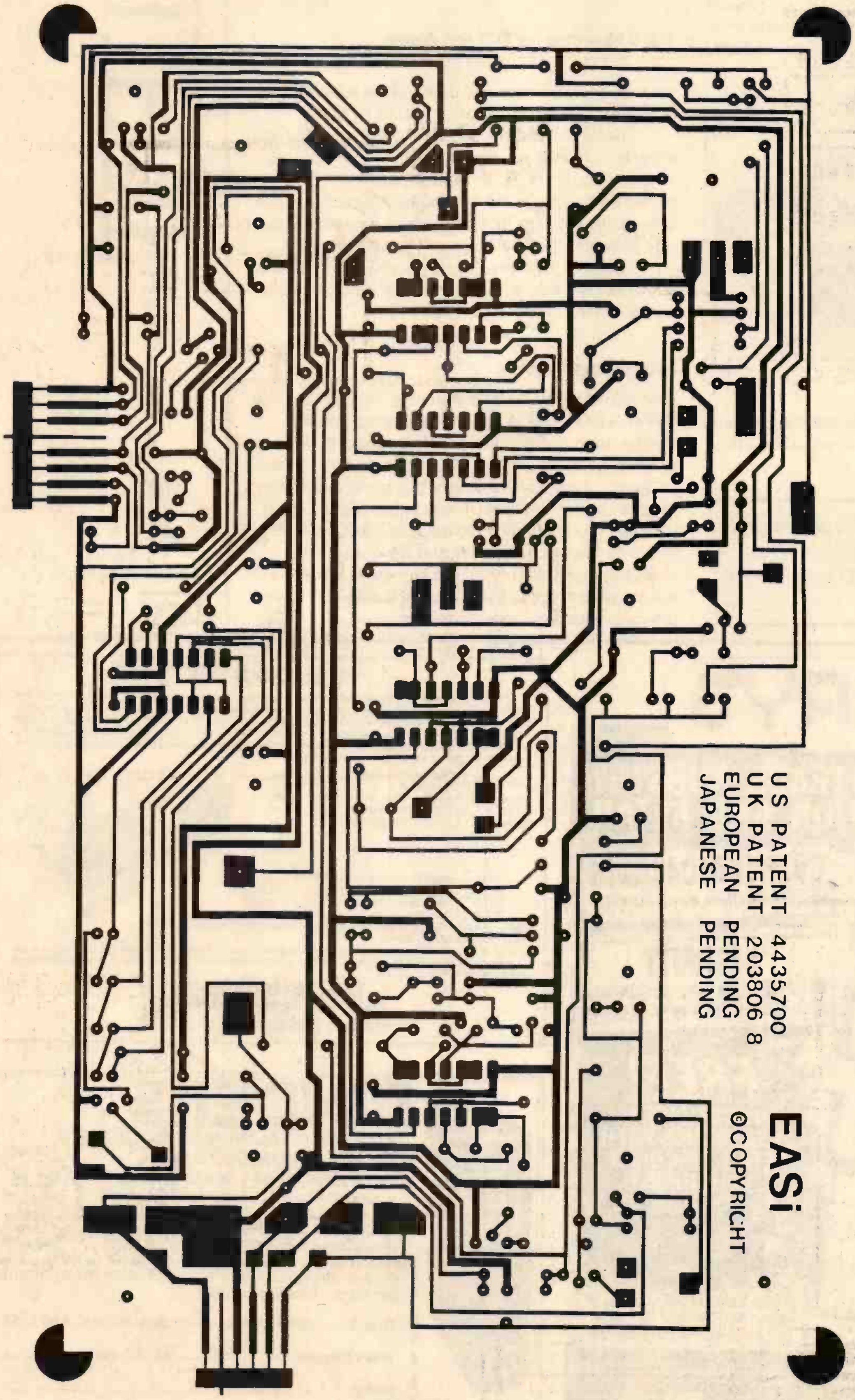
Developments

The MM74C925 has a frequency limit of around 4MHz which makes this circuit easily adapted to shorter timing periods. The frequency divider is needed because 10kHz is the lowest quartz crystal frequency easily available and this requires division to get a convenient scale. If you bypass the CD4017 then you shorten the scale to read from 0.001 to 0.999 seconds. It is possible to shorten the scale further by changing the quartz crystal to a higher frequency and this makes the circuit useful for the timing of the fast-moving objects mentioned earlier.

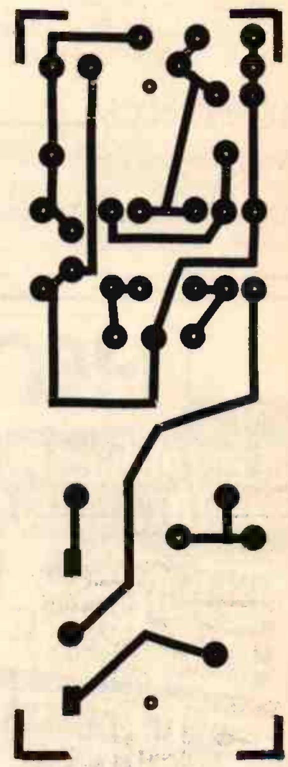
BUYLINES

A complete kit for this project is available from £36.49 including VAT from Magenta Electronics, 135 Hunter Street, Burton-on-Trent DE14 2ST. Tel: (0283) 65435. The PCB alone costs £5.75 from Magenta. Postage is £1 on either item.

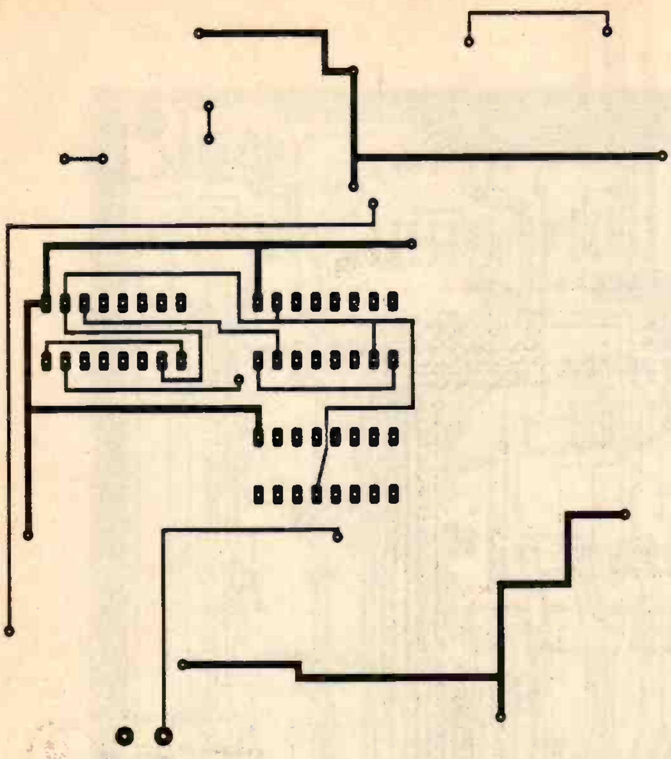
PCB FOIL PATTERNS



The EASI alarm main board foil

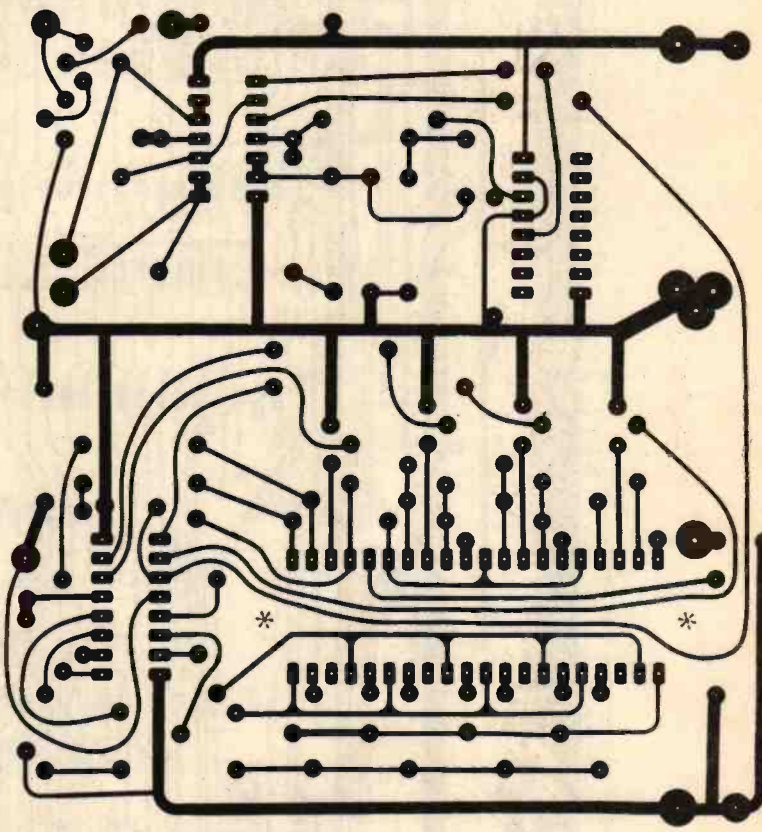


The EASI alarm PSU board

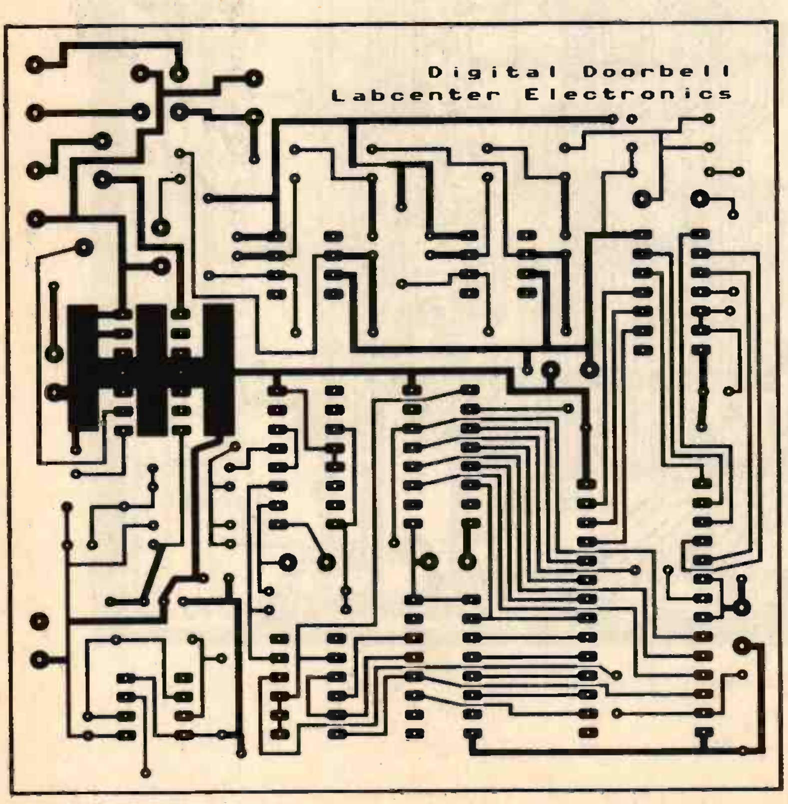


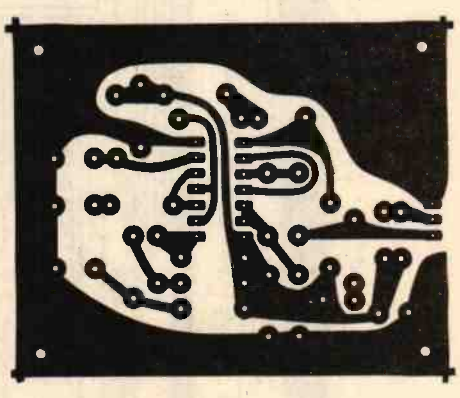
The Digital Doorbell topside foil

The reaction timer foil pattern

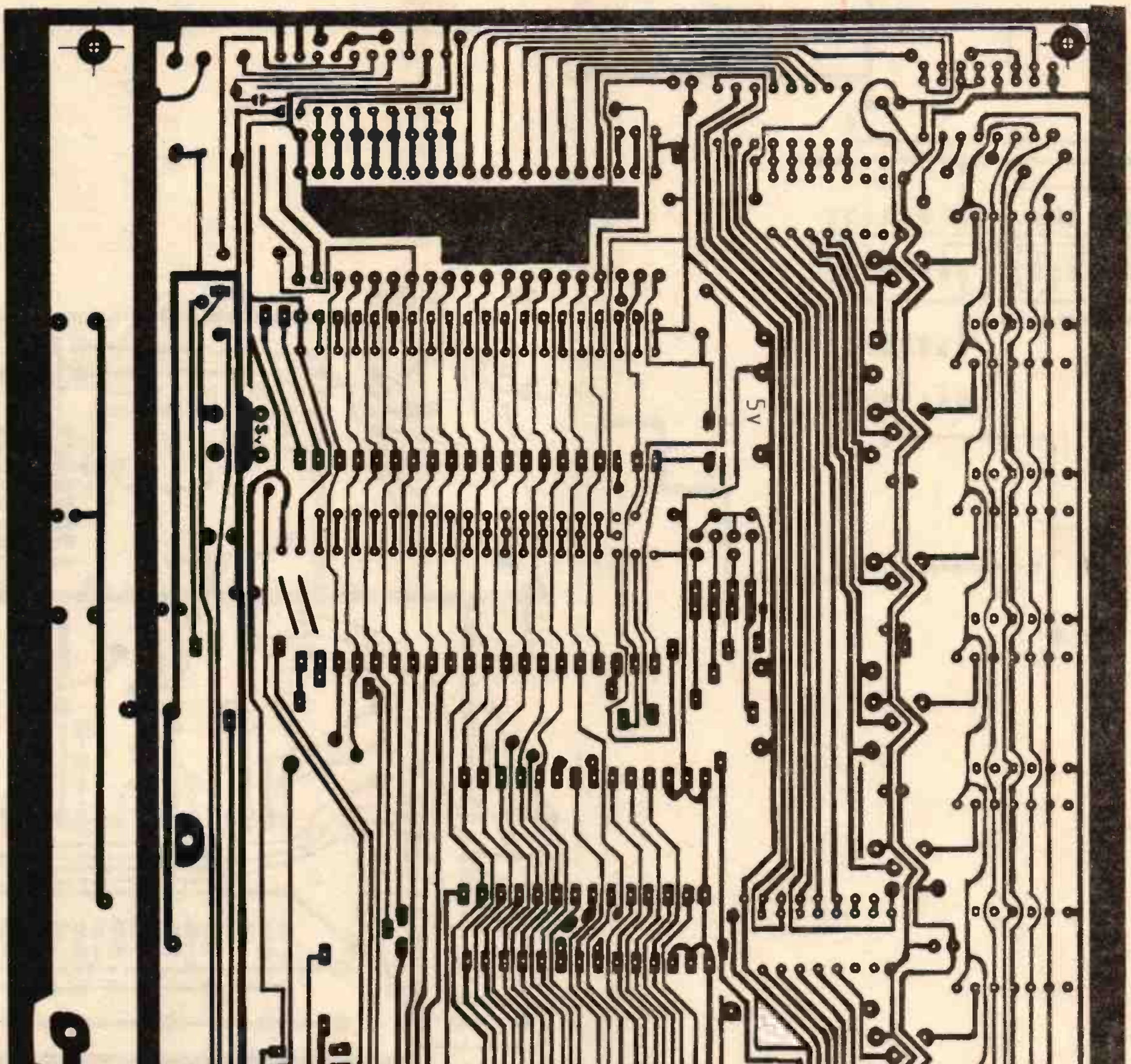


The Digital Doorbell solderside foil

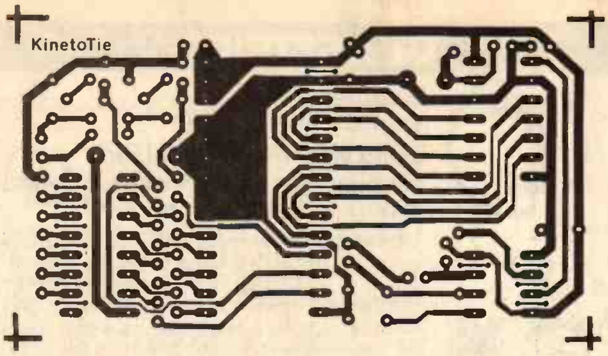




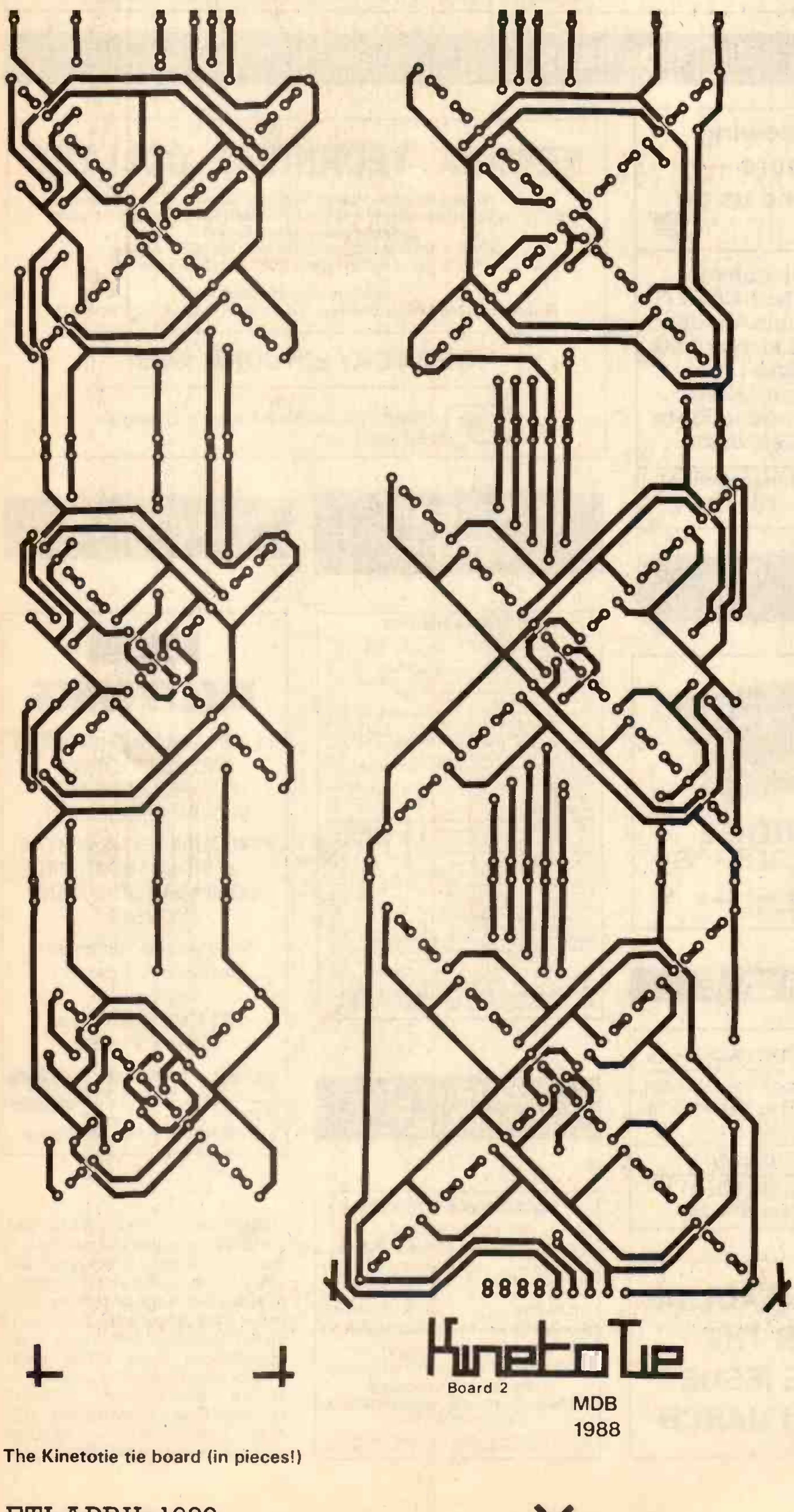
The Camera Trigger board



Intelligent Plotter Microprocessor PCB



The Kinetotie control board



The Kinetotie tie board (in pieces!)

OOPS!

Combo-Lock (April 1988)
Transistors Q1,3,5,7,8 are incorrectly given as ZTX400. The correct part number is ZTX300.

Bicycle Battery Dynamo Backup (June 1988)
C1,2 are incorrectly given as 22μ in the Parts List. The value of 220μ given on the circuit diagram (Fig. 1) is correct.

FM Stereo Decoder Update (July 1988)
R8 is given as 10R in the circuit diagram whereas the correct value is 10k as in the Parts List. R27 is missing from the circuit diagram. This connects R25 to the 12V supply.

QWL Loudspeakers (August 1988)
Some dimensions were missing from Fig. 7. The bass driver port centre should be 3¾in above the base of the baffle panel. The notches in the side of the tweeter cut-out are ½in wide. The top plate is missing from the cutout diagram (Fig. 6). This is 7×4⅝in.

EEG Monitor (September 1987)
The wiring for the switch SW1 in Fig. 5 shows all the wires for selecting Alpha and Beta waves swapped. A_1 should read B_1. A_2 should read B_2 and so on. The easiest remedy is to swap the front panel labelling shown in Fig. 6 so that the switch labelling reads Theta, Beta, Alpha.

Chronoscope (November 1988)
In the overlay diagram for the counter PCB (Fig. 3) the polarity of C12 is shown the wrong way around. SW1a-d is shown as SW1-4. In Fig. 4 the cathodes of LED 8 and 9 are the righthand and lefthand pads respectively. The cathodes for LED 6,7 are marked as the wrong pin. In the text section on Battery Operation, Q1 should read T1. In Fig. 5 SW2 is incorrectly labelled SW5.

Doppler Speed Gun (December 1988)
In Fig. 2 the labelling of pins 7 and 4 of IC2 are transposed. IC10a Pin 1 and IC9c Pin 10 should connect together and not to the 5V rail. The positive terminal of C3 should connect to the junction of R2/R3. Pin 7 of IC2 should connect to the 12V rail and not to Pin 6/R1. So the pin labelling of CONN1 runs left-right on the overlay diagram, the corresponding labelling in Fig. 2 should be 3-1-2, reading downwards. Fig. 4 is correct in all respects except for the orientation of Q2 for which the c and e labels should be transposed. In addition the extra switch to be seen in the photograph of the prototype is a hangover from a previous incarnation. Just ignore it!

Burglar Buster (December 1988)
The foil part of the component overlay for the basic alarm (Fig. 1) was printed the wrong way around. It should be rotated through 180° as in Fig. 5.

Rev-Rider (January 1989)
In the parts list RV2 is incorrectly given at 33k. It should be 22k as in the circuit diagram. A 'blob' went missing from the circuit diagram. RV2, R7, R4, C1 and D3 should all be connected.

ETI ELECTRONICS TODAY INTERNATIONAL

CLASSIFIED

Heather Wust
01-437 0699 Ext 292
Send your requirements to:
Heather Wust, ETI Classified Department, ASP Ltd., 1 Golden Square, London W1.

Lineage: 54p per word VAT inclusive (minimum 15 words)
Semi Display: (minimum 2 cms)
£12.80 per single column centimetre + VAT
Ring for information on series bookings/discounts

All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request)

COURSES

Start training now for the following courses. Send for our brochure — without obligation or Telephone us on 0626 779398

NAME ____________

- ☐ Telecomms Tech C&G 271
- ☐ Radio Amateur Licence C&G
- ☐ Micro-processor
- ☐ Introduction to Television

Radio & Telecommunications Correspondence School, 12, Moor View Drive, Teignmouth, Devon. TQ14 9UN.

NEWARK TECHNICAL COLLEGE

offers a wide range of full-time Music Industry and Technology Courses including
B/TEC National Diploma in MUSICAL INSTRUMENT ELECTRONICS — 2 years
(with recordingg studio option)
CERTIFICATE in MUSIC INDUSTRY MANAGEMENT — 1 year
DIPLOMA in MUSIC INDUSTRY STUDIES — 2 years

Details from the Principal, Newark Technical College, Chauntry Park, Newark, Notts. Tel: (0636) 705921

OPEN DAY 9th JUNE 1989

Nottinghamshire County Council Education

EQUIPMENT

WOULD YOU BUY A CAR WITHOUT A TEST DRIVE? THEN WHY BUY A MIXER WITHOUT A TEST DRIVE?

Thinking about a new project — from a small Mixer to a large studio complex — come and talk over ideas with the people who offer manufacturing and user experience at our new premises:

Unit D, 318 High Road, Benfleet, Essex SS7 5HB
TO TAKE THAT TEST DRIVE — PHONE 0268-793381
(Weekend Committee visits welcome by prior arrangement)

PARTRIDGE ELECTRONICS

Head Office. 56 Fleet Road, Benfleet, Essex SS7 5JN Telephone 0268-793256

- Series X Mixer Kits
- up to 1,000 inputs
- on-board mic input
- 6 auxiliaries
- versions for recording PA, radio, disco
- From £9.92

Send 19p for catalogue to:
K. Tek, P.O. Box 172A, Surbiton, Surrey KT6 6HN. Tel: 01-399 3990

PCB'S

PRINTED CIRCUIT BOARDS. Low cost production service: 5p per square centimetre (less for orders of 10 plus) one offs, 100 offs. Enquiries: Watling Wires, 52 Watling Street, Nuneaton, Warwickshire CV11 6JL. Telephone (0203) 382296.

FOR SALE

★ ★ RESISTOR PACKS ★ ★

¼W 5% Carbon Film, 10 of each, E12 value, 10R to 10M, total 730 resistors

£8.00 UK only.

RMOS, P.O. Box 3 Usk, Gwent NP5 2YF

COPY DEADLINE FOR THE JUNE ISSUE IS 23rd MARCH

SPECIAL OFFERS

JPG Electronics

Resistors ¼w 5% carbon (E12) .. 1p; 1% metal film (E24) .. 3p
Resistor Pack 85 different E12 values + zero ohm link, total content 1,000 resistor £8.95
LED's red or green 3mm or 5mm .. 6p each; Yellow .. 11p each
Cable ties 75mm 1p each £5.95 per 1,000, £49.50 per 10,000
Stepping motor 4 phase 12v 7.5 step 50ohms £8.95
SAA 1027 stepping motor driver chip £3.95
Miniature FM transistor kits 100-108MHz high quality sound ideal for cordless microphones or guitars etc £7.48
Computer grade capacitors with screw terminals 58000uf 60v £4; 4700uf 63v £1.50, 38000ul 20v £1.95; 87000uf 10v £1.50
7 segment C anode LED display 12mm £0.45
LM2931AT5.0 low drop out 5v regulator TO220 package . £0.65
BS250 P channel MOSFET £0.45
BC559 transistor TO92 PNP .... £3.95 per 100
74LS05 hex inverter .... £10.00 per 100
AM27S02/DC memory £1.50
Stereo LW/MW/FM tuner, pre-amp assembly complete with volume/tone control and tuning scale. Brand new in maker's carton £5.95. Faulty £1.95.
Circuit diagram, description and setting up procedure for tuner assemble described above 50p
Motor star capacitors 1.5uf 440vac £1.50
40uf 370vac .... £5.95; 4ul 250vac £1.95
LNE mains suppressor 2x5nf+100nf £0.55
5 digit 6v electromagnetic counter £1.95
Oval 8ohm speakers 136x70mm £0.60
Hour counter (used) 7 digit 240vac 50hz £0.95
LCD display 16 digit 7x5 dots dot matrix £2.50
Qwerty keyboard 58 key uncased good quality switches £5.00
CMOS TTL 74 HC 74F linear transistor kits, capacitors, resistors, tools etc, always in stock.

Please add 75p p&p per order VAT included

JPG Electronics, 276 Chatsworth Road, Chesterfield S40 2BH
Access orders (0246) 211202 — Callers welcome

COMPUTER REPAIRS

HINDLEY ELECTRONICS
FAST ★ FAST ★ FAST ★ FAST
COMPUTER REPAIRS — STANDARD CHARGES

Commodore 64	£25	Commodore 64C	£29
Commodore +4	£25	Commodore C16	£21
Commodore 128	£32	Commodore Vic 20	£18
1541 Disc Drives		£32.50 (excluding r/w head)	

Large SAE for Computer ICs and General Computer Lists.
Sinclair/Amstrad/Electron — Please ring for repairs.
All prices include VAT and postage including insurance.

HINDLEY ELECTRONICS
97 Market St, Hindley, Wigan WN2 3AA
Tel: 0942 522743

Standard charge may not apply to machines with multiple faults. 3 months warranty on repairs with average 24 hours turnaround.

SURVEILLANCE

ESKAN ELECTRONICS

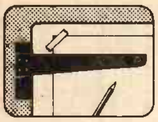
LEADING MANUFACTURERS AND SUPPLIERS OF SURVEILLANCE AND SECURITY EQUIPMENT.

MINIATURE TRANSMITTERS, TELEPHONE MONITORING EQUIPMENT, AND MANY OTHERS.

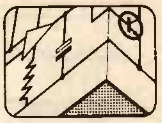
Send stamped addressed envelope for your free catalogue to:
172 Caledonian Road, London N1 0SG.
Telephone 01-278-1768

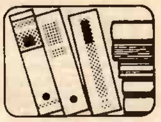
Trade Enquiries Welcome

OMICRON 2 — THE PRACTICAL surveillance solution. Less than ½ matchbox sized, shockproof unit with whisper sensitive microphone, quarter mile range on domestic FM radio, 72hr battery life and full 12 months warranty. Easy to use, many applications. Only £17.95 each. 14-day money-back guarantee — Millea Electronics, 470-472 Leymoor Road, Huddersfield, HD7 4QF. Special offer! Free COD on phoned orders (0484) 460103 24hr.



Blueprint is a service to readers to help overcome problems in projects being designed whether from scratch or by 'mix and match' of other circuits. The solutions provided here have usually not been tested although they are believed to work. Some minor modifications may be required. Blueprint is intended to provide interesting material for publication and preference is given to subjects covering several inquiries. Personal replies cannot usually be given. Send your requirements with as much detail as possible to ETI Blueprint, 1 Golden Square, W1R 3AB.





The request for a Blueprint circuit this month has come our way from Mr. J. L. Edwards of Moffat in Dumfrieshire.

I need a circuit to limit the revs on a motorcycle engine. The circuit must have an adjustable maximum RPM and I must be able to switch it on or off. It must work with normal points or with an electronic ignition.

A good place to start on a project like this is with an IC widely used in ETI projects, the LM2917. This IC contains a charge pump controlled by an input comparator. The output of the charge pump is fed to an op-amp which drives an output transistor with enough current capacity to switch any reasonable size of relay.

In the circuit shown in Fig. 1 the signal from the points is fed into the comparator via suitable filtering and protection components. Though the input signal may have interference and ringing on it, the output of the comparator will (hopefully) be a rectangular wave at the frequency of opening of the points.

Charge is transferred from C4 and C5 at this frequency and leaked away from C5 via R4. Thus the average voltage on C5 depends on the speed of the engine.

The relationship of the voltage on C5 to the speed is not linear but this does not matter. The circuit can be adjusted to switch at a suitable point, regardless of linearity.

The non-inverting input of the output op-amp is internally connected to the charge pump, leaving no obvious means of providing positive feedback to make the output switch cleanly. Once the first draft of the circuit had been produced, it was clear that inverted feedback to the inverting input (positive feedback) could be provided from the collector of the output transistor.

The relay itself must be capable of switching the maximum current which flows in the primary of the ignition coil. If the relay were simply connected in series with the ignition system its contacts would burn. The ignition coil is highly inductive and the 'condenser' in the ignition circuit is there purely to protect the points. A greater degree of protection is required for the relay because any normal relay contacts are much smaller than the points. The large capacitor used conveys another advantage. The opening of the relay contacts could induce a spark, at a time not related to the normal operation of the ignition system. The large capacitor prevents this from happening and avoids the small risk of damage it would entail.

Of course, the circuit has no means of detecting the speed of the motor when the ignition power is switched off. It might be worth experimenting with a large value resistor in position R7 to energise the points just enough to generate a small signal (of perhaps a volt) to operate the charge pump, while not providing a spark. A good starting point might be 2.5W.

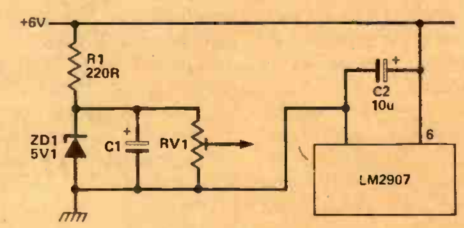


Fig. 2

David Essex demonstrates the alternative foot-down-and-don't-start-the-engine method of limiting revs.

Choices

The circuit as shown is suitable for use on a 12V electrical system with conventional ignition or with electronic ignition which uses the points. It is possible to adapt the circuit of other situations but first all there are aspects of the basic circuit to experiment with.

The voltage on C5 at any particular engine speed depends on the value of C4. The voltage should be measured using a high impedance voltmeter (such as a DVM) and if it is under 2V at the maximum speed, the value of C4 should be increased. If, however, the voltage is over 5V then the value should be decreased.

The time constant of C5 and R5 sets the hold off time — the time during which the ignition will not switch on again. The value shown is very short, but if a longer time is needed then the value of C5 may be increased. A 10μ electrolytic will give a useful fraction of a second.

The required decrease in speed to switch the ignition back on is set by R4. The value shown should work acceptably but a higher or lower value may be shown to be more appropriate as a result of experiment. This will also affect the time constant set by R5 and C5, with higher hysteresis (lower R4) giving a longer time delay.

To make the circuit work on a 6V electrical system, it is necessary to omit R6 and use the LM2907, which does not have an internal zener diode. It is also necessary to zener regulate the voltage on RV1 as shown in Fig. 2. A small local decoupling capacitor is also a good idea and this too is shown.

If the unit is to be used with an electronic ignition which does not use the points, the same input configuration should be used and should be connected to the terminal of the coil where the points would have been connected had there been any. The value of R1 may need to be increased if a capacitor discharge ignition is used, as should its voltage rating. A suitable value to try would be 47k 1W. Most 1W resistors have an adequate voltage rating.

A certain amount of experimentation is required to complete this project, but the end result should be quite reliable.

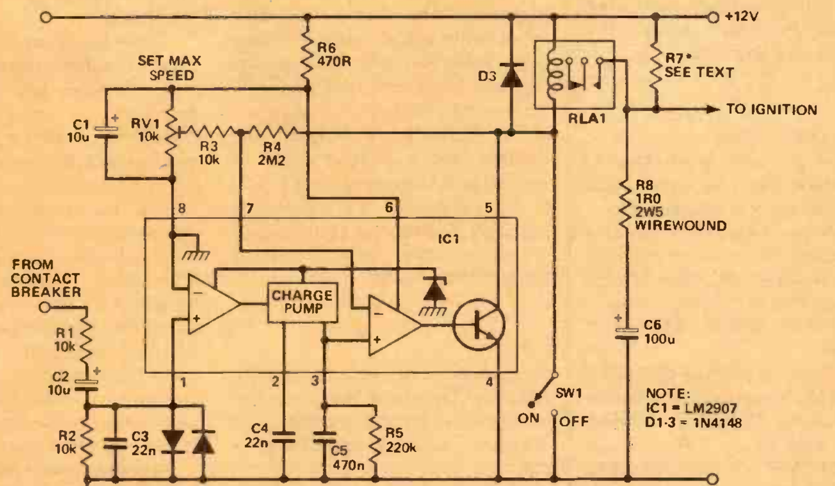
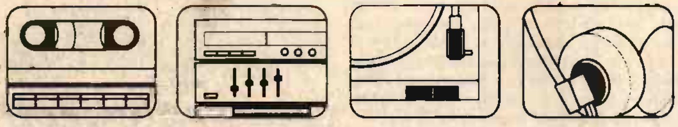


Fig. 1

Andrew Armstrong

PLAYBACK



Audio enthusiasts have been experimenting with mains filters of one kind or another for many years, the general idea being to remove as much ultrasonic garbage as is realistically possible.

Central heating systems, nearby railway lines, domestic appliances, fluorescent tubes and dimmer switches are all prime sources of RF noise — a noise that may influence the performance of a hi-fi system either via its various power supplies or via poorly screened interconnects.

Nevertheless, an elementary low-pass inductive mains filter may simply trade one set of problems for another, particularly as a large-ish coil will increase the source impedance of the mains supply. This in turn may possibly heighten any signal-dependent supply modulation that already exists between two audio components on the same ring main.

Breakthrough

Such inter-component supply modulation does occur in the domestic environment though I have measured signal breakthrough some 20-30dB higher via the P/S of two independent amplifiers at one venue for recent hi-fi exhibitions.

Here the hotel mains supply is so grossly overloaded that its source impedance simply rockets.

Noise

Back to RF noise. Now, while the benefits of a 'clean' power supply have long been appreciated it is only recently that the *subjective* effects of broad-band RF noise have been treated with any concern. One very new source of non-correlated RF noise is our friend the CD player, many machines producing a significant output between 1-10MHz quite possibly as a result of 'leaky' clocks.

Interestingly all machines based on the Philips chipset are relatively clean for it is the Sony and Burr-Brown chipsets that suffer most notably from a spurious RF output.

By contrast, the Philips' SAA7220/TDA1541 chipset is responsible for a substantial output of sampling IMD products in the stop-band from 24.1kHz — 200kHz. Typically −40dB down (relative to 0db = 2V @ 1kHz) these manifest mainly as second-order products; $yF_S \pm F$ where y = 1-4, F_S is the 44.1kHz sampling frequency and F, the audio frequency 20-20kHz.

Broadly speaking these are also representative of the better *sounding* players available, while alternative machines sound inferior despite their offering a stop-band rejection of >70dB.

Indeed, it is quite common to find a CD player with a very clean output spectrum up to 500kHz or so while its performance between 1-10MHz is comparably weak. Furthermore, it does seem that the players exhibiting an above-average RF output are also the ones that react unpredictably with different partnering amplifiers. Why should this be?

RF

So far there is some evidence to suggest that RF intermodulation distortion could be precipitated at the input of certain amplifiers, the products of which manifest in the *audio* band. However, because the RF noise is itself uncorrelated with frequency (it is random) any products of IMD will also transpire as a random noise rather than as a discrete set of signals.

Consequently the dynamic effect of RF IMD is very difficult to measure. Listening tests have indicated that a randomly fluctuating noise floor — even 90-100dB down — is subjectively undesirable if only because your brain is trying to assess the myriad S/N ratios of a dynamic music signal against some arbitrary reference (noise) that keeps shifting in level!

It has been suggested that higher-order RF IMD products are responsible for the harsh, unforgiving or superficial treble quality associated with some CD players.

Naturally, the extent to which this occurs will depend on the specific combination of amplifer and CD player (standard RC RF decoupling at the input to an amp is largely ineffectual, a small attenuation is all that can be hoped for).

This does go some way in explaining why there is a consensus concerning the sound of some CD players but not others. Another variable in this messy equation is the type of interconnect used between the CD player and amplifier.

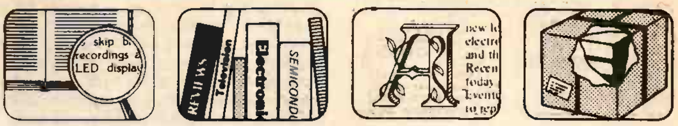
Wired For Sound

Now I am not even going to attempt to pursuade the more cynical ETI readers that bits of wire have a 'sound' all of their own. However in respect of our RF theory it is interesting to note the series resonant frequency of most cables falls around the 6MHz mark — smack in the middle of a CD player's RF band!

One way or another things will undoubtedly hot up once we enter the RF-conscious European Market. Tighter controls on RF noise are bound to follow but I for one will be more interested in the *subjective* repercussions of such a trend.

Paul Miller

BOOK LOOK



Evolution of the Intelligent Machine. A popular history of AI. by Geoff Simons.
£18.50 from NCC Publications, Oxford Road, Manchester M1 7ED. Tel: 061-228 6333.

This chunky book is an excellent chronicle of the emergence of modern robotics and cybernetics. Simons fills it with facts and figures from the ancient roots of mechanics and logic to the latest in neural net computers, taking in much territory that most programmers or engineers could regard as alien and (wrongly) irrelevant.

Simons given a wizz through the ancient world (mentioning contributions from India and China, which most writers leave out), tells us where Aristotle went wrong and then leaps on to Charles Babbage and the beginnings of modern computing. Chapters 5 to 7 then take us through the years when robots were big boxes full of relays and the invention of the transistor by, among others, the egrarious William Shockley.

In line with his general policy, Simons fills us in on the why, where and by whom as well as the how of all stages. A rather lengthy detour through the basics of AI then brings us back to methods of control and so to the sensor systems and robotics of today, with a roundup of currently emerging techniques and future directions. Throughout, the book is packed with detail including brief descriptions of the 'key' programs which most other books mention but do not explain. All in all, a great introduction to Weiner's 'cybernetics' — the study of the control of animal and mechanical devices.

Which leaves us with only two problems. The first is the title. Whatever its merits, the book is only peripherally about AI. The historical background is, until the mid 19th century, the history of mechanics, not of AI. Until the Victorians, who thought that everything could be mechanised (even space was meant to be filled with tiny wheels in Maxwell's Victorian electrical theories) no-one conceived that mind could be separate from matter.

Ideas

Now, of course, it is a commonplace (viz those TV adverts that invite you to improve or pander 'your body', as if It were a separate object like your car).

The originators of this concept were not Frege and Russel but Berkeley and Locke who started talking about 'ideas' as if they were things.

We still do it. You *have* ideas like babies, rather than *being* an idea as you might have in the 17th century. This is the crucial change that makes AI possible but Simons only mentions it in passing on page 103 in the context of Shannon's work in information theory. The automata of previous centuries and indeed many of today are meant to be mechanisms that mimic humanity, as an actor mimics a king. They were not thought of as *being* intelligent, only *looking* it, to the amusement, amazement or fear of all around.

Society Wide

The comments on the impact of AI in wider society, essential for a real history, are also almost absent, and those that are there are cliches, outdated before they were printed.

The theme of this book is to chronicle the rise of the 'intelligent' robot and for that purpose it is a mine of information. It is not a history, and it is only peripherally about AI. (And who goes down a mine for fun?)

There are a couple of other faults. No index, which in a book filled with facts is a disaster. The editor should have insisted on one. What use is it to be reminded of Margaret Boden's 'tin can' approach to AI on pages 243 and 269 when you cannot remember where you saw it explained?

Reliable

I wondered how reliable some of the information was — some seemed to have been taken almost verbatim from company handouts, like the 2½ pages on Logica's LOGOS system. This is not the most impartial source of material.

There are occasional lapses into jargon. Fascinating although 'use was made of a network of net convexivity detectors . . .' may be, a little explanation would be nice (but such an easy trap to fall into! 99/100 for not doing it more often).

Also needed is some assurance that 'net' was not meant to be 'nett' as misprints abound, sometimes to very funny effect — Chapter 16 mutates halfway through to 'Signposts to a failure' (from 'future') which is perhaps a bit more honest than even Simons wants to be. Again, a good editorial presence is called for, which is unfortunate for Simons as he seems to have been the editor too.

A slightly flawed reference book, then. Fascinating to dip into but not a history, and mostly not about AI.

Bill Bains