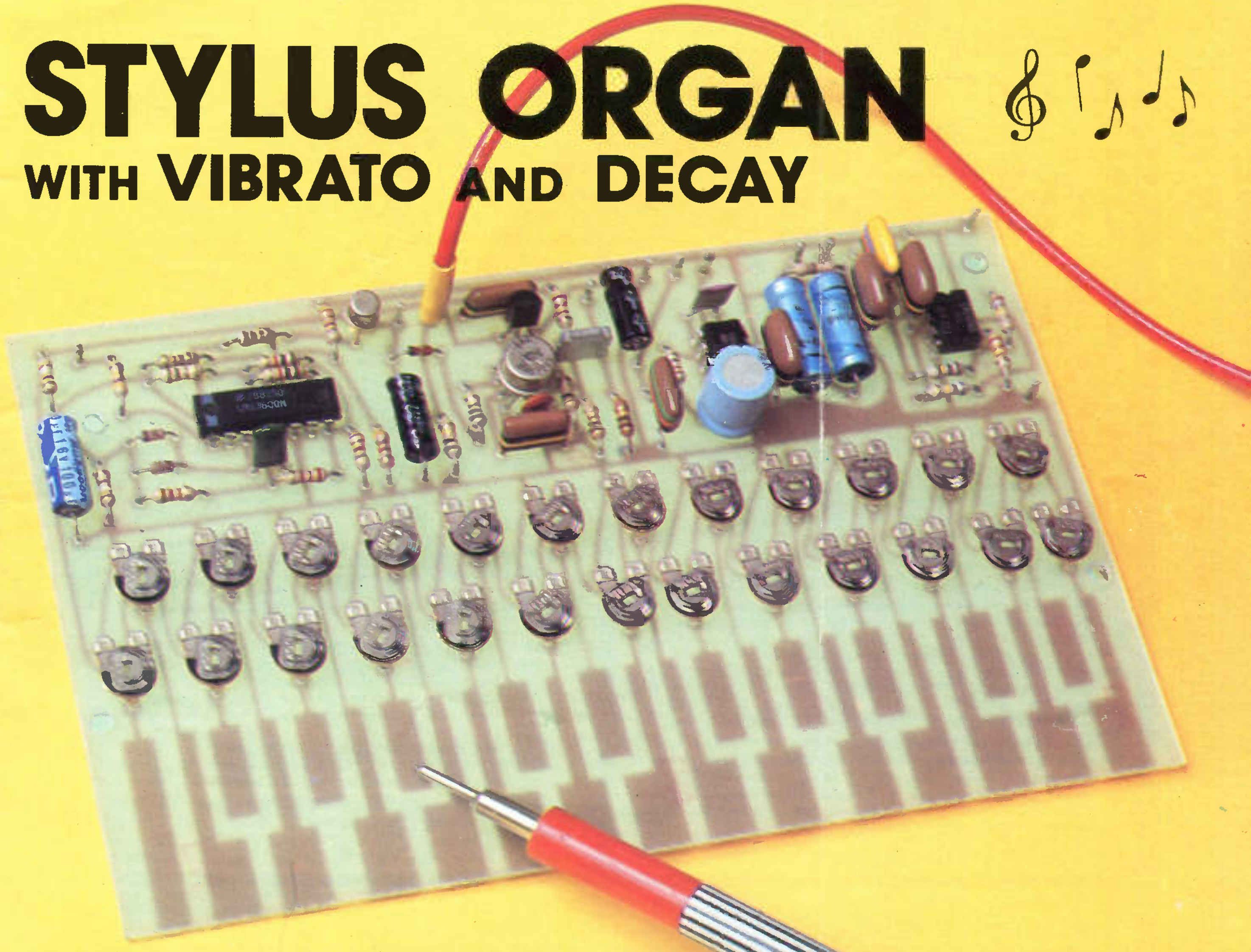
EVERYDAY ELECTRONICS and computer PROJECTS

SEPTEMBER 1983 85p

STYLUS ORGAN
WITH VIBRATO AND DECAY



A TO D CONVERTER FOR RM380Z COMPUTER
VOLTAGE DUALISER
DISTRESS BEACON FOR YACHTSMEN, FELL WALKERS AND MOUNTAINEERS

Australia $1.50 New Zealand $1.60 Malaysia $4.95 IR £1.23 (inc. VAT) electronize **AUTO-ELECTRONIC PRODUCTS**

KITS OR READY BUILT

TOTAL ENERGY DISCHARGE ELECTRONIC IGNITION

IS YOUR CAR AS GOOD AS IT COULD BE?

SPECIAL OFFER

★ Is it **EASY TO START** in the cold and the damp? Total Energy Discharge will give the most powerful spark and maintain full output even with a near flat battery.

★ Is it **ECONOMICAL** or does it "go off" between services as the ignition performance deteriorates? Total Energy Discharge gives much more output and maintains it from service to service.

★ Has it **PEAK PERFORMANCE** or is it flat at high and low revs. where the ignition output is marginal? Total Energy Discharge gives a more powerful spark from idle to the engines maximum (even with 8 cylinders).

★ Is the **PERFORMANCE SMOOTH.** The more powerful spark of Total Energy Discharge eliminates the "near misfires" whilst an electronic filter smoothes out the effects of contact bounce etc.

★ Do the **PLUGS and POINTS** always need changing to bring the engine back to its best? Total Energy Discharge eliminates contact arcing and erosion by removing the heavy electrical load. The timing stays "spot on" and the contact condition doesn't affect the performance either. Larger plug gaps can be used, even wet or badly fouled plugs can be fired with this system.

★ **TOTAL ENERGY DISCHARGE** is a unique system and the most powerful on the market - 3½ times the power of inductive systems - 3½ times the energy and 3 times the duration of ordinary capacitive systems. These are the facts:

Performance at only 6 volts (max. supply 16 volts)

SPARK POWER — 140W, SPARK ENERGY — 36mJ
SPARK DURATION — 500µS, STORED ENERGY — 135mJ
LOADED OUTPUT VOLTAGE
50pF load — 38kV, 50pF + 500k — 26kV

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

★ **All ELECTRONIZE electronic ignitions feature:** **EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, STATIC TIMING LIGHT and DESIGNED IN RELIABILITY (14 years experience and a 3 year guarantee).**

★ **IN KIT FORM** it provides a top performance system at less than half the price of comparable ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2µF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

Most **NEW CARS** already have electronic ignition. Update **YOUR CAR**

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM

★ **2000 COMBINATIONS** provided by an electronic key - a miniature jack plug containing components which must match each individual alarm system. (Not limited to a few hundred keys or a four bit code).

★ **60 SECOND ALARM PERIOD** flashes headlights and sounds horn, then resets ready to operate again if needed.

★ **10 SECOND ENTRY DELAY** allows owner to dis-arm the system, by inserting the key plug into a dashboard mounted socket, before the alarm sounds. (No holes in external bodywork, fiddly code systems or hidden switches). Re-closing the door will not cancel the alarm, before or after it sounds, the key plug must be used.

★ **INSTANT ALARM OPERATION** triggered by accessories or bonnet/boot opening.

★ **30 SECOND DELAY** when system is armed allows owner to lock doors etc.

★ **DISABLES IGNITION SYSTEM** when alarm is armed.

★ **IN KIT FORM** it provides a high level of protection at a really low cost. The kit includes everything needed, the case, fibreglass PCB, CMOS IC's, random selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

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

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

fill in the coupon and send to:

ELECTRONIZE DESIGN Dept C · Magnus Rd · Wilnecote · Tamworth · B77 5BY · tel 0827 281000

TOTAL ENERGY DISCHARGE (6 or 12 volt negative earth)

☐ Assembled ready to fit ~~£26.70~~ £19.95
☐ D.I.Y. parts kit ~~£15.90~~ £14.95

TWIN OUTPUT for cars and motor cycles with dual ignition

☐ Twin, Assembled ready to fit ~~£36.45~~ £29.95
☐ Twin, D.I.Y. parts kit ~~£24.55~~ £22.95

☐ PLEASE SEND MORE INFORMATION

Goods normally despatched within 7 days.

Prices Include VAT. P+P £1-00 (UK)

C

CAR ALARM

☐ Assembled ready to fit £37.95
☐ D.I.Y. parts kit £24.95

I enclose cheque/postal order OR debit my Access/Visa card

VISA

Name

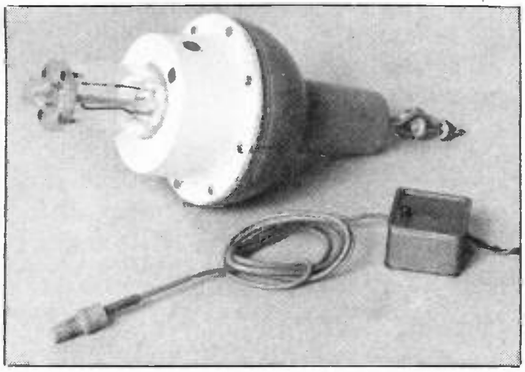
Address

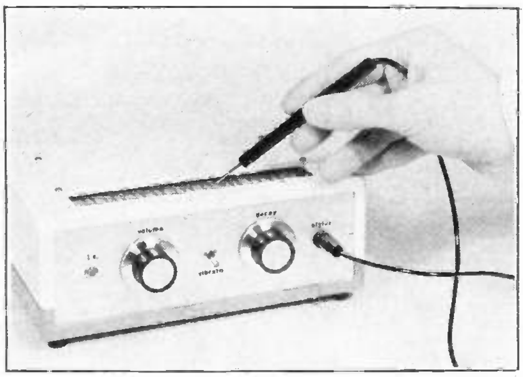
Code

VOL. 12 NO. 9 SEPTEMBER 1983

EVERYDAY ELECTRONICS and computer PROJECTS

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .





PRICE INCREASE

As from next month the cover price of Everyday Electronics will be 90p. This increase of 5p is regretted but unavoidable if we are to maintain present standards and to offer a wide range of projects each month. We are sure readers will agree that considering the wealth of detailed information for the constructor contained within EE every month, the new price of 90p represents good value.

PROJECTS

SERIES

FEATURES

Our October 1983 issue will be published on Friday, September 16. See page 589 for details.

E.E. PROJECT KITS

I.C.s TRANSISTORS CAPACITORS · TOOLS RESISTORS HARDWARE · CASES KITS PCB's

MAGENTA

Make us your No. 1 SUPPLIER OF KITS and COMPONENTS for E.E. Projects. We supply carefully selected sets of parts to enable you to construct E.E. projects. Kits include ALL THE ELECTRONICS AND HARDWARE NEEDED. Printed circuit boards (fully etched, drilled and roller tinned) or Veroboard are, of course, included as specified in the original article, we even include nuts, screws and I.C. sockets. PRICES INCLUDE CASES unless otherwise stated. BATTERIES ARE NOT INCLUDED. COMPONENT SHEET INCLUDED. If you do not have the issue of E.E. which includes the project – you will need to order the instruction reprint at an extra 50p each.
Reprints available separately 50p each + p. & p. 50p.

STORAGE SCOPE INTERFACE FOR BBC MICRO August 83 less software £13.98
PEDESTRIAN CROSSING SIMULATION BOARD August 83 no case £9.36
HIGH POWER INTERFACE BOARD August 83 no case £9.44
CAR INTRUDER ALARM August 83 £15.52
TRI BOOST GUITAR TONE CONTROLLER July 83 £7.59
AUTOMATIC GREENHOUSE WATERING SYSTEM July 83 £9.98
USER PORT I/O BOARD less cable + plug £9.54
USER PORT CONTROL BOARD July 83 less cable + plug £22.86
PULSE GENERATOR July 83 £34.97
BINARY BANDIT GAME July 83 less case £8.98
EPROM PROGRAMMER Jun. 83 less software, TRS80 £40.99 Genie £41.58
TRANSISTOR TESTER Jun. 83 £26.31
ENVELOPE SHAPER Jun. 83 less case £11.21
REAL TIME CLOCK Jun. 83 less software and cases. Apple II £30.98 BBC £35.99 less power plug
MODEL TRAIN CONTROLLER May 83 £25.17
GUITAR HEADPHONE AMPLIFIER May 83 £7.20
MW PERSONAL RADIO less case, May 83 £6.93
LABORATORY AMPLIFIER May 83 £30.98
MOISTURE DETECTOR May 83 £4.97
CAR RADIO POWER BOOSTER April 83 £10.98
FUNCTION GENERATOR April 83 £41.98
FLANGER SOUND EFFECTS April 83 £21.98
NOVELTY EGG TIMER April 83 less case £4.98
ZX SPECTRUM AMPLIFIER April 83 £8.98
DUAL POWER SUPPLY March 83 £53.98
MULTISTATION INTERCOM March 83 master + 1 slave £43.02
Extra slave £5.46
BUZZ OFF March 83 £4.10
CAR THERMOMETER March 83 £29.98
SPEECH PROCESSOR Feb. 83 £10.66
PUSH BIKE ALARM Feb. 83 £11.32
MOTOR BIKE ALARM Feb. 83 £14.46
DOUBLE DICE Jan. 83 £10.82
ELECTRONIC V/I METER Dec. 82 £11.38
ZX TAPE CONTROL Nov. 82 £6.48
PHOTO FINISH Nov. 82 £5.89
SINE WAVE GEN Oct. 82 £14.65
G. P. PRE-AMP Oct. 82 £5.64
LIGHTS ON ALERT Oct. 82 £4.25
CONTINUITY CHECKER Sept. 82 £4.97
SOUND SPLITTER Sept. 82 £15.77
SOUND RECOMBINER Sept. 82 £3.70
SCREEN WASH DELAY Sept. 82 £4.48
INSTRUMENT PRE AMP Aug. 82 £7.82
TWO TONE DOORBELL ALARM Aug. 82, less case and bell transformer £8.82
CB ROGER BLEEPER Aug. 82 £8.47
2-WAY INTERCOM July 82 no case £4.11
ELECTRONIC PITCH PIPE July 82 £4.91
REFLEX TESTER July 82 £7.07
SEAT BELT REMINDER Jun 82 £3.73
EGG TIMER June 82 £4.95
TWO TONE TRAIN HORN WITH REMOTE TRIGGER OPTION May 82 £11.26
CAR LED VOLTMETER less case. May 82 £2.89
LIGHTNING CHESS BUZZER May 82 £6.20
V.C.O. SOUND EFFECTS UNIT Apr. 82 £11.56
CAMERA OR FLASH GUN TRIGGER Mar. 82 £12.41 less tripod bushes
POCKET TIMER Mar. 82 £3.71
GUITAR TUNER Mar. 82 £15.63
SIMPLE STABILISED POWER SUPPLY Jan. 82 £24.58
MINI EGG TIMER. Jan. 82. £3.94
SIREN MODULE Jan. 82 less speaker £5.57
MODEL TRAIN CHUFFER Jan. 82 £8.27
GUITAR ADAPTER Dec. 81 £3.76
ELECTRONIC IGNITION Nov. 81 £25.98
SIMPLE INFRA RED REMOTE CONTROL Nov. 81 £16.98
PRESSURE MAT TRIGGER ALARM Nov. 81 £6.27 less mats

EXPERIMENTER CRYSTAL SET Nov. 81 less aerial £5.99
Headphones £2.98 extra
CAPACITANCE METER Oct. 81 £23.51
SUSTAIN UNIT Oct. 81 £12.76
'POPULAR DESIGNS' Oct. 81 £12.76
TAPE NOISE LIMITOR £4.57
HEADS AND TAILS GAME £2.52
CONTINUITY TESTER £3.95
PHOTO FLASH SLAVE £3.46
FUZZ BOX £7.29
OPTO ALARM £6.78
SOIL MOISTURE UNIT £5.81
ICE ALARM £7.89
0-12V POWER SUPPLY Sept. 81 £17.98
CMOS CAR SECURITY ALARM Sept. 81 £9.08
CMOS DIE Sept. 81 £7.99
CMOS METRONOME Aug. 81 £8.23
COMBINATION LOCK July 81 less case £19.58
BURGLAR ALARM SYSTEM Jun. 81 less bell, loop & Mic's £40.98
LIGHTS REMINDER AND IGNITION LOCATOR E.E. May 81 £5.66
SOIL MOISTURE INDICATOR E.E. May 81 £4.09
GUITAR HEADPHONE AMPLIFIER E.E. May 81 £4.23
PHONE BELL REPEATER/BABY ALARM E.E. May 81 £5.66
INTERCOM April 81 £22.23
SIMPLE TRANSISTOR & DIODE TESTERS Mar. 81 Ohmeter version £2.02
Led version £2.73
MINI SIREN Mar. 81 £8.04
LED DICE Mar. 81 £8.44
LED FLASHER Mar. 81 £4.29
MODULATED TONE DOORBELL Mar. 81 £6.64
POWER SUPPLY Mar. 81 £53.47
THREE CHANNEL STEREO MIXER Feb. 81 £18.69
SIGNAL TRACER Feb. 81 £8.17 less probe
Ni-Cd BATTERY CHARGER Feb. 81 £13.61
ULTRASONIC INTRUDER DETECTOR Jan. 81 less case £53.47
2 NOTE DOOR CHIME Dec. 80 £10.32
LIVE WIRE GAME Dec. 80 £11.70
GUITAR PRACTICE AMPLIFIER Nov. 80 £12.82 less case.
Standard case £3.88 High quality case £8.33
SOUND TO LIGHT Nov. 80 3 channel £21.34
TRANSISTOR TESTER Nov. 80 £11.63 inc. test leads
AUDIO EFFECTS UNIT FOR WEIRD SOUNDS Oct. 80 £13.11
BICYCLE ALARM Oct. 80 **£10.35** less mounting brackets

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

FUN WITH ELECTRONICS
Enjoyable introduction to electronics. Full of very clear full colour pictures and easy to follow text. Ideal for all beginners — children and adults. Only basic tools needed. 64 full colour pages cover all aspects — soldering — fault finding — components (identification and how they work).
Also full details of how to build 6 projects — burglar alarm, radio, games, etc. Requires soldering — 4 pages clearly show you how.
COMPONENTS SUPPLIED ALLOW ALL PROJECTS TO BE BUILT AND KEPT.
Supplied less batteries & cases.
FUN WITH ELECTRONICS, COMPONENT PACK £15.78
BOOK EXTRA £1.25.
Book available separately.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

BOOKS: ELECTRONICS & COMPUTING

First Book of Hi-Fi Loudspeaker Enclosures	95p
28 Tested Transistor Projects	£1.25
50 Projects Using IC CA3130	£1.25
A Practical Introduction to Digital IC's	£1.25
How to Build Advanced Short Wave Receivers	£1.95
Essential Theory for the Electronics Hobbyist	£1.95
50 (FET) Field Effect Transistor Projects	£1.75
How to Design and Make Your Own PCBs	£1.95
Fun with Electronics	£1.25
50 Simple L.E.D. Circuits	£1.50
How to Make Walkie-Talkies	£1.95
Projects in Opto-Electronics	£1.95
Mobile Discotheque Handbook	£1.35
Electronic Projects for Beginners	£1.95
Popular Electronic Projects	£1.95
Electronic Security Devices	£1.95
50 Circuits Using 7400 Series IC's	£1.75
Second Book of CMOS IC Projects	£1.50
Beginners Guide to Digital Techniques	95p
Transistor Radio Fault-Finding Chart	50p
Electronic Household Projects	£1.75
Electronic Test Equipment Construction	£1.75
Practical Computer Experiments	£1.75
Radio Control for Beginners	£1.75
Popular Electronic Circuits – Book 1	£1.95
Electronic Synthesiser Projects	£1.75
Electronic Projects Using Solar Cells	£1.95
International Transistor Equivalents Guide	£2.95
Simple L.E.D. Circuits – Book 2	£1.35
Easy Electronics – Crystal Set Construction	£1.75
Electronic Projects for Cars and Boats	£1.95
Popular Electronic Circuits – Book 2	£2.25
How to Identify Unmarked IC's	65p
Multi-Circuit Board Projects	£1.95
International Diode Equivalents Guide	£2.25
The Art of Programming the 1K ZX81	£1.95
The Art of Programming the 16K ZX81	£2.50
The Art of Programming the ZX Spectrum	£2.50
Semiconductor Data Book Newnes	£6.95
Basic Electronics. Theory and practice	£7.98
Microprocessors for Hobbyists	£4.75
Burglar Alarm Systems	£5.55
Electronics, Build and Learn	£3.90
Electronic Projects in Music	£3.90
Electronic Projects in Photography	£3.90
Electronic Projects for Home Security	£3.90
Questions and Answers Electronics	£2.70
Electronic Projects in the Car	£3.90
20 Solid State Projects Car and Garage	£4.80
110 Electronic Alarm Projects	£5.98
Computing is Easy	£4.25
ZX81 Users Handbook	£5.75
ZX81 Basic Book	£5.75
50 Cmos JC Projects	£1.35
52 Projects using IC741	£1.25
IC555 Projects	£1.95
IC LM3900 Projects	£1.35
Single IC Projects	£1.50
Electronic Games	£1.75
A Microprocessor Primer	£1.75
Remote Control Projects	£1.95
Electronic Music Projects	£1.75
Power Supply Projects	£1.75
VMOS Projects	£1.95
Digital IC Projects	£1.95
How to use Op-Amps	£2.25
Audio Projects	£1.95
Electronic Timer Projects	£1.95
Model Railway Projects	£1.95
IC Projects for Beginners	£1.95
Mini Matrix Board Projects	£1.95
Aerial Projects	£1.95
Modern Op-Amp Projects	£1.95
The Pre-Computer Book	£1.95
Handbook of Integrated Circuits (IC's) Equiv. & Substitutes	£1.95
Solid State Short Wave Receivers for Beginners	£1.25
Beginners Guide to Building Electronic Projects	£1.95
First Book of Transistor Equivalents and Substitutes	£1.50
Second Book of Transistor Equivalents and Substitutes	£1.75
Chart of Radio, Electronic, Semi-conductor and Logic Symbols	50p
How to Build Your Own Metal and Treasure Locators	£1.95
50 Circuits Using Germanium, Silicon and Zener Diodes	£1.50
50 Projects Using Relays, SCR's and TRIACS	£1.95
Electronic Music and Creative Tape Recordings	£1.95
Practical Electronics Calculations and Formulae	£2.95
How to Build Your Own Solid State Oscilloscope	£1.95
Practical Construction of Pre-amps, Tone Controls, Filters & Attn.	£1.45
Beginners Guide to Microprocessors and Computing	£1.75
Counter, Driver and Numeral Display Projects	£1.75
An Introduction To BASIC Programming Techniques	£1.95
30 Solderless Breadboard Projects – Book 1	£2.25
How to Get Your Electronic Projects Working	£1.95
Practical Electronic Building Blocks – Book 1	£2.25
Practical Electronic Building Blocks – Book 2	£1.95
Elementary Electronics. Sladdin. Excellent theory and 35 constructional projects. Uses S-Dec. First steps to CSE level.	£3.98
Interfacing to Microprocessors and Microcomputers	£5.75

AY3–8912 i.c. **£5.98**
ZX81 edge connector **£2.25**
ZX81 edge plug **£1.50**
ZX Spectrum edge connector **£2.55**

SINCAIR SOUND BOARD KIT AS JUNE 83 H.E. complete (less case) **£18.98**. Reprint extra **45p**.

ZX SPECTRUM AMPLIFIER

250mW output. Volume control. Internal speaker. Very simply connected using load/save lead. Puts real power even into the simplest "Beep" commands. Adds a real "zing" to musical programs and games. Requires PP3 battery — not supplied. Very low current drain.
Supplied ready built complete with demo software and instructions.

ORDER AS: ZX SPECTRUM AMPLIFIER (SAEE) £6.98

ZX SPECTRUM SUPER AMPLIFIER

250mW output. Now add synthesizer quality to those "Beep" commands. Super circuit with adjustable ATTACK, SUSTAIN and DECAY envelope controls. Plus variable ECHO. Generates a wide range of special effects. Five graduated controls. Internal speakers. Very smart case. Requires batteries — not supplied. Very low current drain.
Ready built complete with demo software and instructions.

ORDER AS: ZX SPECTRUM SUPER AMPLIFIER (SSAEE) £17.98

TEACH-IN 82

All top quality components as specified by E.E. FREE COMPONENT IDENTIFICATION SHEET. Follow this educational series and learn about electronics.
List 1 & 2 £27.98 List 3 £5.98
ALL 3 TOGETHER £33.48
WOODEN CASE KIT £11.98

INTRODUCING ELECTRONICS

INTRODUCING ELECTRONICS
6 part series E.E. Oct. 82–Mar. 83.
No soldering. Connections via screw terminal blocks. Very clear drawings showing how to connect components. Covers the basis of electronics.
Components (less batteries) parts 1–6 **£6.98**. Reprints **45p** each extra.

ADVENTURES WITH DIGITAL ELECTRONICS

Entertaining and instructive. Includes details of some digital IC's and 8 projects: shooting gallery, 2 way traffic lights, electronic adder, computer space invaders game etc. No soldering.
Adventures with Digital Electronics Book £3.25
Component pack including Breadboards £42.50 less batteries

ADVENTURES WITH MICROELECTRONICS

Similar to 'Electronics' below. Uses I.C.s. Includes dice, electronic organ, doorbell, reaction timer, radio etc. Based on Bimboard 1 bread board.
Adventures with Microelectronics **£2.98**
Component pack **£29.64** less battery.

ADVENTURES WITH ELECTRONICS by Tom Duncan

An easy to follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-Dec Breadboard. Gives clear instructions with lots of pictures. 16 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-Dec breadboard and all the components for the projects.
Adventures with Electronics **£2.85**. Component pack **£18.98** less battery.

30 SOLDERLESS BREADBOARD PROJECTS
Book 1 by R. A. Penfold
Clear verbolic layouts and circuit diagrams. Includes fuzz box, radio, metronomes, timers transistor checker, switches, etc.
Introduction gives basic information on components including resistors, capacitors, I.C.s transistors, photocells etc. Ideal for beginners as well as those with some experience.
Complete kit including verobloc, book and components (less batteries) £24.75. Less book £22.50, less verobloc £20.25. Book only £2.25.

MORE KITS AND COMPONENTS IN OUR LISTS

FREE PRICE LIST
Price list included with orders or send sae (9 × 4)
CONTAINS LOTS MORE KITS, PCBs & COMPONENTS

ELECTRONICS CATALOGUE

Illustrations, product descriptions, circuits all included. Up-to-date price list enclosed. All products are stock lines for fast delivery.
Send 80p in stamps or add 80p to order.
Free to Schools/Colleges requested on official letterhead.

MAGENTA gives you FAST DELIVERY OR QUALITY COMPONENTS & KITS. All products are stock lines and are new & full specification. We give personal service & quality products to all our customers — HAVE YOU TRIED US?

MAGENTA ELECTRONICS LTD.

EP54, 135 HUNTER ST.,
BURTON-ON-TRENT
STAFFS, DE14 2ST.
MAIL ORDER ONLY.
0283 65435, Mon-Fri 9-5.
Access/Barclaycard (Visa) by phone or post.

Add 50p p&p to all orders.
Prices include VAT.
Sae all enquiries.
Official orders welcome.
OVERSEAS: Payment must be sterling.
IRISH REPUBLIC and BFPO: UK PRICES.
EUROPE: UK PRICES plus 10%.
ELSEWHERE: write for quote.

BI-PAK BARGAINS

TRIACS – PLASTIC

4 AMP – 400v – T0202 – TAG 136G

1 OFF	10 OFF	50 OFF	100 OFF
40p	£3.75	£17.50	£30.00

8 AMP – 400v – T0220 – TAG 425

60p	£5.75	£27.50	£50.00

MINIATURE FM TRANSMITTER

Freq: 95–106MHz. Range: ¼ mile
Size: 45 × 20mm Add: 9v batt.
Not licenced in U.K.
ideal for: 007–M15–FBI–CIA–KGB etc.

ONLY £5.50

PROGRAMMABLE UNIJUNCTION TRANSISTOR

PUT case T0106 plastic MEU22 Similar to 2N6027/6028 PNPN Silicon

Price:	1–9	10–49	50–99	100 +
Each	20p	18p	15p	13p

Normal Retail Price £0.35 each.

VALUE PACKS

Pak No.	Qty	Description	Price
VP1	300	Assorted Resistors Mixed Types	£1.00
VP2	300	Carbon Resistors ½-¼ Watt Pre-Formed	£1.00
VP3	200	⅛ Watt Min Carbon Resistors Mixed	£1.00
VP4	150	½ Watt Resistors 100 ohm – 1M Mixed	£1.00
VP5	200	Assorted Capacitors All Types	£1.00
VP6	200	Ceramic Caps Miniature – Mixed	£1.00
VP7	100	Mixed Ceramics Disc. 1pf – 56pf	£1.00
VP8	100	Mixed Ceramic Disc. 68pf – .015pf	£1.00
VP9	100	Assorted Polyester/Polystyrene Caps	£1.00
VP10	60	C280 Type Caps Metal Foil Mixed	£1.00
VP11	100	Electrolytics – All Sorts	£1.00
VP12	60	Bead Type Polystyrene Min Caps	£1.00
VP13	50	Silver Mica Caps Ass. 5.6pf – 150pf	£1.00
VP14	50	Silver Mica Caps Ass. 180pf – 4700pf	£1.00
VP15	50	High Voltage Disc. Ceramic 750v – 8Kv Mixed	£1.00

VALUE PACKS

Pak No.	Qty	Description	Price
VP16	50	Wirewound Res. 9W (avg) Ass. 1 ohm – 12K	£1.00
VP17	50	Metres PVC Covered Sinlge Strand Wire Mixed Colours	£1.00
VP18	30	Metres PVC Covered Multi Strand Wire Mixed Colours	£1.00
VP19	40	Metres PVC Single/Multi Strand Hook-Up Wire Mixed	£1.00
VP20	6	Rocker Switches 5 Amp 240v	£1.00
VP21	20	Pcs. 1 – 2 & 4 mm Plugs & Sockets Matching Sizes	£1.00
VP22	200	Sq. Inches Total, Copper Clad Board Mixed Sizes	£1.00

VALUE PACKS

Pak No.	Qty	Description	Price
VP23	20	Assorted Slider Pots. Mixed Values	£1.00
VP24	10	Slider Pots. 40 mm 22K 5 × Log 5 × Lin	£1.00
VP25	10	Slider Pots. 40 mm 47K 5 × Log 5 × Lin	£1.00
VP26	20	Small .125" Red LED'S	£1.00
VP27	20	Large .2" Red LED'S	£1.00

TRANSISTOR CLEARANCE

100 All Sorts Transistors, A mixed Bag NPN–PNP Silicon & Germ. Mainly Uncoded You To Sort Pack Includes Instructions For Making Simple Transistor Tester. Super Value. Order No VP60 **£1.00**

SEMICONDUCTORS FROM AROUND THE WORLD

100 A collection of Transistors, Diodes, Rectifiers & Bridges SCR's, Triacs, I.C.'s & Opto's all of which are current every-day useable devices.

Guaranteed Value Over £10 Normal Retail Price.

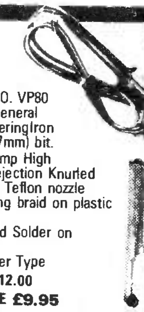
Data etc in every pack. Order No. VP56

Our Price £4.00

VALUE PACKS

Pak No.	Qty	description	Price
VP28	10	Rectangular .2" Green LED'S	£1.00
VP29	30	Ass. Zener Diodes 250mW – 2W Mixed Vlts. Coded	£1.00
VP30	10	Ass. 10W Zener Diodes Mixed Vlts. Coded	£1.00
VP31	10	5 Amp SCR's TO-66 50–400v Coded	£1.00
VP32	20	3 Amp SCR's TO-66 Up To 400v Uncoded	£1.00
VP33	200	Sil. Diodes Switching Like IN4148 DO-35	£1.00
VP34	200	Sil. Diodes Gen. Purpose Like OA200/BAX13/16	£1.00
VP35	50	1 Amp IN4000 Series Sil. Diodes Uncoded All Good	£1.00
VP36	8	Bridge Rects. 4 × 1 Amp 4 × 2 Amp Mixed Vlts. Coded	£1.00
VP37	8	Black Instrument Type Knobs With Pointer ¼" Std	£1.00
VP42	10	Black Heatsinks To Fit TO-3, TO-220 Ready Drilled	£1.00
VP43	4	Power-Fin Heatsinks 2 × TO-3 2 × TO-66 Size	£1.00
VP44	1	Large Power Heatsink 90 × 80 × 35 mm Drilled For Up To 4 TO-3 Devices	£1.00
VP45	50	BC107/8 Type NPN Transistors Good Gen. Purpose Uncoded	£1.00
VP46	50	BC177/8 Type PNP Transistors Good Gen. Purpose Uncoded	£1.00
VP47	10	Silicon Power Trans. Similar 2N3055 Uncoded	£1.50

BI-PAK SOLDER – DESOLDER KIT



Kit comprises: ORDER NO. VP80
1 High Quality 25 watt General Purpose Lightweight Soldering Iron 240v mains incl 3/16" (4.7mm) bit.
1 Quality Desoldering Pump High Suction with automatic ejection Knurled anti-corrosive casing and Teflon nozzle
1.5 metres of De-Soldering braid on plastic dispenser
2 yds (1.83m) Resin Cored Solder on Card
1 Heat Shunt tool tweezer Type
Total Retail Value over £12.00
OUR SPECIAL KIT PRICE £9.95

BI-PAK PCB ETCHANT AND DRILL KIT

Complete PCB Kit comprises
1 Expo Mini Drill 10,000RPM 12v DC incl 3 collets & 3 × Twist Bits
1 Sheet PCB Transfers 210mm × 150mm
1 Etch Resist Pen
1 ½lb pack FERRIC CHLORIDE crystals
3 sheets copper clad board
2 sheets Fibreglass copper clad board
Full instructions for making your own PCB boards
Retail Value over £15.00
OUR BI-PAK SPECIAL KIT PRICE £9.95
ORDER NO. VP81

BI-PAK'S OPTO SPECIAL

A selection of large and small sized LED's in various shapes, sizes & colours, together with 7 Segment Displays both anode & cathode plus photo transistors emitters and detectors. Cadmium Cell ORP12 and Germ. photo transistor OCP71 included. In all a total of 25 Opto pieces valued over £12 Normal Price

Order No. VP57
Our Super Value Price Just £5.00

DIGITAL VOLT METER MODULE

3 × 7 segment displays Basic Circuit. 0–2v± instructions provided to extend voltage & current ranges Operating voltage 9/12v. Typ. Power Consumption 50mA

O/No. VP99 **Once only price £9.95**

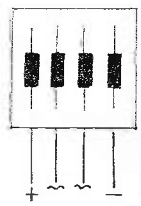
SINGLE SIDED FIBREGLASS BOARD

Order No	Pieces	Size	Sq. Ins	Price
FB1	4	9 × 2¾"	100	£1.50
FB2	3	11 × 3"	100	£1.50
FB3	4	13 × 3"	156	£2.00

DOUBLE SIDED FIBREGLASS BOARD

FB4	2	14 × 4"	110	£2.00

SILICON BRIDGE RECTIFIERS

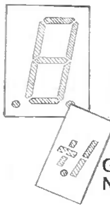


Comprising 4 × 1½ Amp rectifiers mounted on PCB.
VRM – 150 vlts
IFM – 1.5 Amps

Size: 1 inch square
10 off £1.00
50 off £4.50
100 off £7.50

ORDER NO: 4R1 B Rect.

HYBRID LED COLOUR DISPLAYS



Red, Green, Yellow – .3/.5/.6 inch Mixed types and colours NUMERIC & OVER-FLOW Common Anode/Cathode. GaAsP/GaP. Brand New, Full Data incl.

10 pieces (our mix) ..**£4.00**
Normal Retail Value Over £10.00
Order No. VP58

IC BARGAINS

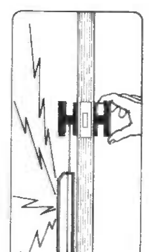
VP40	30	Assorted 74 Series TTL I.C.'s Gates, Flip-Flops & M.S.I.'s + Data Book. All New, Normal Retail Value Over £6.00. Our Price	£2.50
VP41	30	Assorted CMOS I.C.'s CD4000 Series. Pack Includes 00/09/12/14/18/21/23/25/28/30/35/44/68 AY/AE Types Plus Data Sheet Value Over £8.00. Normal retail	£2.50

YOU MAY ORDER any **ONE TYPE** of the above CMOS at £2.00 per 25 pieces. ORDER AS VP41 + type number required.

RATCHET SCREWDRIVER KIT

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

INTRUSION ALARM



The DOOR BIRD DB 2000 alerts you before your door is opened. Just hang on the inside door knob – alarm is activated as soon as the outside door knob is touched.

ONLY £3.95

OPTO 7–Segment Displays

Brand new 1st Quality
LITRONIX DL 707R 14-pin

Red 0.3" Common Anode Display 0-9 with right hand decimal point TTL compatible 5v DC Supply. Data supplied

IN PACKS OF		
	5 pieces **£3**	(60p each)
	10 pieces **£5**	(50p each)
	50 pieces **£20**	(40p each)
	100 pieces **£35**	(35p each)
	1,000 pieces **£300**	(30p each)

THE MORE YOU BUY – THE LESS YOU PAY

OUR GREAT NEW CATALOGUE

Presented with a Professional Approach and Appeal to ALL who require Quality Electronic Components, Semiconductors and other Accessories ALL at realistic prices. There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember, BI-PAK's policy has always been to sell quality components at competitive prices and THAT WE STILL DO.

We hold vast stocks "in stock" for fast immediate delivery, all items in our Catalogue are available ex stock. The Catalogue is designed for use with our 24 hours "ansaphone" service and the Visa/Access credit cards, which we accept over the telephone.

To receive your NEW 1983 BI-PAK Catalogue, send 75p PLUS 25p p&p to:-

Silicon NPN 'L' Type Transistors
TO-92 Plastic Centre Collector Like BC182L – 183L – 184L
VCBO 45 VCEO 30 IC200mA Hfe 100-400
All perfect devices – uncoded. ORDER AS SX183L

50 off	100 off	500 off	1000 off
£1.50	£2.50	£10.00	£17.00

Silicon General Purpose NPN Transistors
TO-18 Case. Lock fit leads – coded CV7644 similar to BC147 – BC107 – ZT89 ALL NEW VCE 70v IC500mA. ORDER AS CV7644

	50 off	100 off	500 off	1000 off
PRICE	£2.00	£3.80	£17.50	£30.00

Silicon General Purpose PNP Transistors
TO-5 Case. Lock fit leads coded CV9507 similar 2N2905A to BFX30 VC60 IC600mA Min HFE 50. ALL NEW. ORDER AS CV9507.

	50 off	100 off	500 off	1000 off
PRICE	£2.50	£4.00	£19.00	£25.00

VP38	100	Silicon NPN Transistors – All Perfect. Coded Mixed. Types With Data And Eqvt. Sheet No Rejects Rantastic Value	£3.00
VP39	100	Silicon PNP Transistors – All Perfect. coded Mixed. Types With Data And Eqvt. Sheet No Rejects Real Value	£3.00

2N3055 The best known Power Transistor in the world – 2N3055 NPN 115w. Our Bi-Pak Special Offer Price

10 off	50 off	100 off
£3.50	£16.00	£30.00

BD312 COMPLIMENTARY PNP POWER TRANSISTORS TO 2N3055. Equivalent MJ2955 – BD312 – T03. **Special price £0.70 ea**
10 off
£6.50

BI-PAK

Send your orders to Dept. EE9 BI-PAK PO BOX 6, WARE, HERTS. SHOP AT 3 BALDOCK ST., WARE, HERTS. TERMS: CASH WITH ORDER. SAME DAY DESPATCH. ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL (0920) 3182. GIRO 388 7006. ADD 15% VAT AND 75p PER ORDER POSTAGE AND PACKING.

Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods normally sent 2nd Class Mail.
Remember you must add VAT at 15% to your order.
Total Postage add 75p per Total order.

CRICKLEWOOD ELECTRONICS LTD.

40 Cricklewood Broadway, London NW2 3ET. Tel. 01-452 0161. Tlx. 914977.

Here's a selection from our vast stocks. Full price list free on request. Orders by 'phone quoting credit card no., or by mail order. Callers welcome. All products first grade franchised source. All in-stock items despatched same day. Official orders welcome from Govt. Depts., schools, etc. Please add 60p p&p + 15% VAT. Overseas orders no VAT but allow £2.00 min p&p. Quantity discounts negotiable.

TRY US NOW – WE'VE GOT WHAT YOU NEED.

RESISTORS

CARBON FILM 5% HI-STAR LOW NOISE 10Ω to 10MΩ
¼W E24 2p
½W E24 2½p
1W E12 6p
2W E12 12p

METAL FILM ULTRA STABLE 0.4W EXTRA LOW NOISE 10Ω to 1MΩ
2% E24 5p
1% E24 6p

LOW OHMIC GLAZE ½W 0.22Ω to 8.2Ω E24 11p

WIREWOUND ON CERAMIC E12 SERIES
2 to 3 WATT 0.22Ω to 330Ω 28p
4 to 7 WATT 0.47Ω to 6k8 33p
10 to 11 WATT 1Ω to 33K 37p

POTS & PRESETS

ROTARY POTS LOW NOISE ¼" SPINDLES E3 SERIES
4K7 to 2M LIN 32p
4K7 to 2M LOG 32p
As above with DP mains switch 79p
As above stereo (no switch) 89p

PRE-SETS PIHER (DUSTPROOF) E3 100Ω to 10MΩ
Mini Vertical 15p
Mini Hzontal 15p
Standard Vert 18p
Standard Horiz 18p

CERMET 20 TURN PRECISION PRE-SETS ¾" E3 Series 50Ω to 500K 89p

CAPACITORS

CERAMIC 100V DISC (PLATE) E12 MICRO-MINI typically ±5% 1pF to 10nF 7p

POLYCARB 5% SIEMENS 7.5mm MINI-BLOC E12 250V
1nF to 6n8 7p
8n2 to 47nF 8p
56nF to 150nF 10p
100V 100nF to 150nF 11p
180nF to 270nF 14p
330nF to 390nF 20p
470nF to 560nF 26p
680nF 30p
1μF (10mm) 35p

POLYESTER 250V RADIAL (C280)
10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF 7p
150nF, 220nF 10p
330nF, 470nF 13p
680nF 18p
1μF 22p
1μ5, 2μ2 39p

FEEDTHROUGH 1nF 500V 7p

HIGH VOLTAGE Capacitors – please enquire – many types in stock

TANT BEADS
.1/35V 14p
22/35V 14p
33/35V 14p
.47/35V 14p
.68/35V 14p
1.0/35V 14p
2.2/35V 14p
3.3/35V 18p
4.7/16V 18p
4.7/35V 20p
6.8/25V 20p
6.8/35V 21p
10/16V 18p
10/35V 27p
15/10V 22p
15/16V 30p
15/25V 32p
22/6.3V 26p
22/16V 29p
33/10V 30p
47/3V 14p
47/6.3V 34p
47/16V 39p
100/13V 32p
100/10V 55p

ELECTROLYTICS Mainly Matsushita (Panasonic) & Siemens
AXIALS (Wires each end)

μFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
μFd	V	
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end) Matsushita only

μFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	15p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

TRANSFORMERS

All 240V Primary
6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V 100mA 95p, 1A 2.65
20-0-20V 1.25A £2.65
12-0-12-0 50VA 4.35
12-0-12-0 100VA 8.95
0+6+6+9+9 1.25A 4.25
These goods are heavy send extra p&p. We will credit any difference

VEROBOARD

0.1" COPPER TRACKS
2.5 × 3.75 83p
2.5 × 5 99p
3.75 × 3.75 99p
3.75 × 5 1.14
2.5 × 17 2.99
3.75 × 17 3.85
4.79 × 17 4.93
VQ Board 1.92
Dip Board 3.90
Track Cutter 1.48
100 Pins 55p
Veroblock 3.99
Vero Wiring Pen + Spool 3.35
Spare Spool 75p
Combs 6p

PCB MATERIALS

FERRIC CHLORIDE Quick dissolving pellets (mix with 1 litre water) 1.69

ETCH RESIST TRANSFERS
1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons
9. Mixture

Any sheet of above 35p

GRADE ONE GLASS PCB Single Sided
178 × 240mm 95p
420 × 195mm 130p
420 × 245mm 195p

DALO ETCH RESIST PEN + spare nib 90p

PHOTO SENSITIVE PCB 1st Class Epoxy Glass. For better results than spraying. Expose to UV
Single sided
100 × 160 1.55
100 × 220 1.90
203 × 114 1.85
233 × 220 3.99
Double sided
100 × 160 1.65
100 × 220 2.15
203 × 114 2.21
233 × 220 4.55
Developer for above (do not use Sodium Hydroxide) 500ml 2.50

WIRE & CABLE

Prices per Metre
Solid connecting wire 5p
Mains/Speaker Cable
Twin 1 amp 14p
Twin 2½ amp 16p
3 Core 2½ amp 18p
3 Core 6 amp 31p
3 Core 13 amp 56p
Screened Cable
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p
Aerial Cable
50Ω RG58A 36p
75Ω UHF 36p
75Ω VHF 28p
300Ω Flat 14p
Rainbow Ribbon Cable — Prices per foot
8 Way 25p
10 Way 25p
16 Way 39p
20 Way 48p
24 Way 62p
30 Way 75p
32 Way 82p
40 Way 88p
64 Way 1.49

RECHARGEABLE BATTERIES

Top quality. Don't throw these batteries away they charge up to 1,000 times!
HP2 (1.2AH) 2.10
HP2 (4AH) 4.75
HP7 (½AH) 99p
HP11 (1.2AH) 2.29
PP3 4.95
Chargers
TYPE H Adjustable to 6 of any HP type above £15.59
TYPE M As above but charges 4AH batteries faster £25.95
TYPE P PP3 £5.50
TYPE A HP7 (Up to 4 at a time) £5.85

SOLDERING

ANTEX SOLDERING IRONS
C240 (15W) 4.95
XS240 (25W) 5.25
Iron stand 1.75
C240 Element 2.25
XS240 Element 2.25
Bits C240
No. 2 (Small) 85p
No. 3 (Med) 85p
No. 6 (Micro) 85p
Bits XS240
No. 50 (Small) 85p
No. 51 (Med) 85p
No. 52 (Lge) 85p
SOLDER 125gms
18 swg 2.95
22 swg 3.10

PLUGS & SOCKETS

'D' Connectors 25 Way
Solder:
Male 1.60
Female 2.09
PCB Wire Wrap
Male 1.60
Female 2.09
Covers £1.00
Phono Plugs Blk, Red, Grn, Wht or Yellow 15p
Line Skts 15p
Chas. Skt × 1 20p
Dual 30p
Quad 40p

TRANSISTORS

Britain's largest retail selection. A small sample of our vast stocks

2N930 20p
2N930A 30p
2N1893 49p
2N2102 39p
2N2217 39p
2N2218 33p
2N2218A 25p
2N2219 27p
2N2219A 28p
2N2220 22p
2N2221 22p
2N2221A 23p
2N2222 24p
2N2222A 25p
2N2223 2.60
2N2223A 4.15
2N2368 25p
2N2369 19p
2N2369A 20p
2N2904A 27p
2N2905 28p
2N2905A 29p
2N2906 25p
2N2906A 30p
2N2907 25p
2N2907A 26p
2N2920 3.47
2N2923 25p
2N2924 15p
2N2925 15p
2N2926 10p
2N3053 27p
2N3054 56p
2N3055 60p
2N3055H 120p
2N3250 36p
2N3251 36p
2N3439 98p
2N3440 80p
2N3441 1.25
2N3442 1.35
2N3442RCA 1.85
2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3468 1.00
2N3512 1.06
2N3553 2.65
2N3638 55p
2N3638A 70p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2.00
2N3713 1.38
2N3714 2.98
2N3715 3.31
2N3716 3.60
2N3773 1.99
2N3819 36p
2N3820 38p
2N3821 1.84
2N3822 90p
2N3823 45p
2N3824 1.70
2N3866 90p
2N3903 13p
2N3904 13p
2N3905 13p
2N3906 13p
2N4030 75p
2N4031 65p
2N4032 69p
2N4036 63p
2N4037 49p
2N4240 3.00
2N4347 2.26
2N4400 15p
2N4401 20p
2N4402 27p
2N4403 30p
2N4409 36p
2N4410 42p
2N4427 79p
2N4870 80p
2N4871 55p
2N4888 99p
2N4901 1.69
2N4902 1.85
2N4903 1.98
2N4904 2.15
2N4905 2.75
2N4906 2.99
2N4907 3.20
2N4908 3.15
2N4909 2.90
2N4918 65p
2N4919 75p
2N4920 85p
2N4921 55p
2N4922 69p
2N4923 99p
2N5086 36p
2N5087 39p
2N5088 37p
2N5089 37p
2N5190 68p
2N5191 70p
2N5193 90p
2N5194 79p
2N5245 37p
2N5246 40p
2N5247 45p
2N5248 46p
2N5249 48p
2N5266 2.88
2N5293 98p
2N5294 1.28
2N5295 1.37
2N5401 35p
2N5415 1.10
2N5416 1.54
2N5447 10p
2N5448 15p
2N5449 19p
2N5450 21p
2N5451 23p
2N5457 25p
2N5458 29p
2N5459 29p
2N5460 72p
2N5551 37p
2N5884 5.95
2N5886 5.95
2N6121 57p
2N6122 59p
2N6123 65p
2N6124 59p
2N6125 65p
2N6126 75p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.14
2N6134 1.36
2N6253 1.45
2N6254 1.55
2SC1306 95p
2SC2078 1.70
2SJ49 3.50
2SJ50 3.75
2SJ82 4.29
2SK134 3.50
2SK135 3.75
2SK226 4.29
3N128 1.12
3N140 1.07
3N200 6.93
3N201 2.98
40360 60p
40361 67p
40362 67p
40363 2.95
40406 1.39
40407 75p
40408 1.55
40410 1.80
40411 2.85
40412 90p
40673 83p
40822 1.80
40871 79p
40872 79p
AC125 49p
AC126 32p
AC127 32p
AC128 35p
AC132 68p
AC141K 28p
AC142K 28p
AC151 51p
AC152 45p
AC153 55p
AC153K 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 28p
AC188 25p
AC188K 40p
AF239 55p
AF240 1.00
BC107 10p
BC107A 12p
BC107B 12p
BC108 10p
BC108A 12p
BC108B 12p
BC108C 14p
BC109 10p
BC109B 12p
BC109C 12p
BC140 29p
BC141 37p
BC142 29p
BC143 30p
BC147 10p
BC147A 10p
BC147B 12p
BC147C 20p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 12p
BC149C 13p
BC152 35p
BC153 23p
BC154 27p
BC157 11p
BC157A 12p
BC157B 13p
BC158 10p
BC158A 12p
BC158B 13p
BC159 11p
BC159A 12p
BC159B 13p
BC159C 18p
BC160 42p
BC161 48p
BC167 10p
BC167A 10p
BC167B 13p
BC168 10p
BC168B 10p
BC168C 10p
BC169 10p
BC169B 10p
BC169C 10p
BC177 16p
BC177A 25p
BC177B 26p
BC178 16p
BC178A 24p
BC178B 25p
BC179 20p
BC179A 25p
BC197B 25p
BC179C 27p
BC182 10p
BC182A 12p
BC182B 13p
BC182L 10p
BC182LA 13p
BC182LB 14p
BC183 10p
BC183A 11p
BC183B 12p
BC183C 13p
BC183L 10p
BC183LA 13p
BC183LB 13p
BC183LC 14p
BC184 10p
BC184B 12p
BC184C 13p
BC184L 10p
BC194LB 13p
BC184LC 14p
BC186 24p
BC187 24p
BC212 10p
BC212A 12p
BC212B 13p
BC212L 10p
BC212LA 13p
BC212LB 14p
BC213 10p
BC213A 11p
BC213B 12p
BC213C 13p
BC213L 10p
BC213LA 13p
BC213LB 13p
BC213LC 14p
BC214 10p
BC214B 12p
BC214C 13p
BC214L 10p
BC214LB 13p
BC214LC 14p
BC237 14p
BC237A 16p
BC237B 17p
BC237C 18p
BC238 14p
BC238A 15p
BC238B 16p
BC238C 17p
BC239 16p
BC239A 16p
BC239B 17p
BC239C 18p
BC300 45p
BC301 44p
BC302 43p
BC303 47p
BC327 14p
BC328 14p
BC337 15p
BC338 15p
BC440 32p
BC441 33p
BC460 32p
BC461 33p
BC516 40p
BC517 40p
BC547 13p
BC547A 14p
BC547B 14p
BC548 12p
BC548A 13p
BC548B 14p
BC548C 15p
BC549 13p
BC549B 14p
BC549C 15p
BC550 15p
BC550C 25p
BC557 15p
BC557A 16p
BC557B 16p
BC558 14p
BC558A 15p
BC558B 16p
BC558C 17p
BC559 15p
BC559B 16p
BC559C 17p
BC560 15p
BC560C 25p
BC650 45p
BC651 46p
BCY70 16p
BCY71 16p
BCY72 19p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 39p
BD237 98p
BD238 98p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 67p
BD242A 65p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.14
BD245C 1.30
BD246A 1.20
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.46
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.20
BD530 1.30
BD535 75p
BD536 75p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 85p
BD540C 1.20
BD675 72p
BD676 77p
BD677 78p
BD678 83p
BD711 1.32
BD712 1.32
BDX14 1.30
BDX18 1.59
BDX32 3.47
BDY54 1.70
BDY55 1.75
BDY56 1.80
BDY57 5.25
BDY58 6.15
BF194 12p
BF195 12p
BF196 12p
BF197 12p
BF198 15p
BF199 15p
BF200 1.49
BF224J 32p
BF225J 35p
BF240 38p
BF241 38p
BF244A 35p
BF244B 39p
BF245A 30p
BF245B 51p
BF246 52p
BF246A 39p
BF246B 53p
BF247A 54p
BF247B 55p
BF254 39p
BF255 42p
BF256A 35p
BF256B 48p
BF256C 62p
BF257 30p
BF258 32p
BF259 35p
BF457 46p
BF458 58p
BF459 62p
BF469 86p
BF470 86p
BFR39 22p
BFR40 22p
BFR41 22p
BFR79 22p
BFR80 22p
BFR81 22p
BFR90 2.11
BFS28 2.95
BFS61 1.00
BFS98 1.10
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 22p
BSX21 40p
BU104 2.22
BU105 1.70
BU108 3.95
BU109 3.29
BU126 1.47
BU204 2.25
BU205 1.75
BU206 1.89
BU208 1.98
BU226 3.95
BU326S 2.35
BU406 1.45
BU407 1.45
BU408 1.35
BU500 2.95
BUY18S 3.95
E430 5.95
J300 48p
J310 53p
MJ802 3.99
MJ900 2.90
MJ901 3.10
MJ1000 2.50
MJ1001 3.00
MJ1800 3.60
MJ2500 2.19
MJ2501 2.25
MJ2955 1.00
MJ3000 2.19
MJ3001 2.25
MJ4502 3.99
MJ15003 4.85
MJ15004 5.55
MJ15015 2.45
MJ15016 3.34
MJE340 53p
MJE350 1.50
MJE2955 99p
MJE3055 69p
MPSA05 23p
MPSA06 25p
MPSA10 28p
MPSA12 29p
MPSA13 48p
MPSA14 46p
MPSA16 30p
MPSA18 65p
MPSA20 48p
MPSA42 49p
MPSA43 49p
MPSA55 28p
MPSA56 30p
MPSA65 40p
MPSA66 47p
MPSA70 45p
MPSA92 39p
MPSA93 39p
MPSL01 42p
MPSL51 48p
MPSU01 84p
MPSU04 1.32
MPSU05 55p
MPSU06 56p
MPSU07 75p
MPSU51 88p
MPSU55 58p
MPSU56 59p
MPSU57 1.20
OC20 2.30
OC25 2.50
OC28 1.70
OC29 2.35
OC35 2.35
OC43 70p
OC44 82p
OC70 50p
OC71 50p
OC72 50p
OC82 50p
OC83 75p
TIP29A 29p
TIP29C 38p
TIP30A 35p
TIP30C 36p
TIP31A 33p
TIP31C 34p
TIP32A 38p
TIP32C 42p
TIP33A 65p
TIP33C 78p
TIP34A 74p
TIP34C 88p
TIP35A 1.09
TIP35C 1.28
TIP36A 1.29
TIP36C 1.39
TIP41A 49p
TIP41C 55p
TIP42A 55p
TIP42C 65p
TIP49 1.20
TIP50 1.40
TIP53 1.57
TIP54 1.58
TIP110 74p
TIP112 90p
TIP115 81p
TIP117 96p
TIP120 69p
TIP122 73p
TIP125 84p
TIP127 84p
TIP130 93p
TIP132 93p
TIP135 99p
TIP137 99p
TIP140 1.04
TIP142 1.04
TIP145 1.15
TIP147 1.15
TIP162 4.95
TIP2955 77p
TIP3055 70p
TIS43 40p
TIS88A 62p
VN10KM 60p
VN46AF 84p
VN66AF 85p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 15p
ZTX311 32p
ZTX312 35p
ZTX313 36p
ZTX314 24p
ZTX320 35p
ZTX330 35p
ZTX341 28p
ZTX450 39p
ZTX500 15p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 34p
ZTX530 24p
ZTX531 25p
ZTX650 45p

DIODES

1N34A 30p
1N821 70p
1N823 92p
1N914 4p
1N916 6p
1N4001 4p
1N4002 4½p
1N4003 5p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 3p
1N4150 18p
1N4448 22p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 18p
1N5406 19p
1N5407 19p
1N5408 20p
1N5024 52p
1S44 10p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA155 15p
BA156 38p
BA157 25p
BA158 30p
BA159 32p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 25p
BA318 30p
BAV10 16p
BAV19 15p
BAV20 15p
BAX13 10p
BAX16 11p
BY126 20p
BY127 22p
BY134 52p
BY182 1.26
BY206 36p
BY207 36p
BY223 1.56
BY297 48p
BY299 55p
MZ2361 1.80
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p

SCRs, TRIACS, DIACS

THYRISTORS 4, 8 & 12 Amps Texas TO220
Suffix A 100V
B 200V
C 300V
D 400V
M 600V
TIC106A 46p
TIC106B 47p
TIC106C 48p
4A TIC106D 49p
TIC106M 68p
TIC116A 66p
TIC116B 68p
8A TIC116C 71p
TIC116D 73p
TIC116M 80p
TIC126A 72p
TIC126B 72p
2A TIC126C 73p
TIC126D 77p
TIC126M 96p

TRIACS Texas 400V TO220 Case
TIC206D(4A) 66p
TIC225D(6A) 74p
TIC226D(8A) 88p
TIC236D(12A) 1.16
TIC246D(16A) 1.22
TIC253D(20A) 1.90
TIC263D(25A) 2.11

DIACS
BR100 25p
ST2 25p

ZENER DIODES

400-500mW E24 Series 2.4-4/V 7p
1.3 Watt E24 Series 3.3-82V 14p

BRIDGE RECTIFIERS

(PIV shown in brackets)
1½ amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40

OPTO

LEDs
R Red
G Green
Y Yellow

	1+	50+
Large diffused		
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p
Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0.1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright high efficiency Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p

Rectangular Stackables LEDs
R6L 17p
G6L 18p
Y6L 19p

LINEAR ICs

AY1 5050 95p
AY3 8910 3.66
AY3 8912 4.40
CA3048 2.15
CA3059 2.80
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 39p
CA3140T 95p
HA1366W 2.40
HA1388 2.54
ICL7106 6.85
ICL7107 9.50
ICL7611 97p
ICL8038 2.95
ICL7555 80p
ICL7556 1.50
LC7120 3.20
LC7130 3.20
LC7137 3.95
LF347 1.50
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.09
LF398 4.59
LM335Z 1.19
LM348N 62p
LM349N 1.09
LM350K 4.60
LM379S 4.50
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386 88p
LM388N 2.43
LM391N60 1.70
LM391N80 1.93
LM723CH 95p
LM723CN 35p
LM725CH 3.40
LM725CN 3.19
LM733 69p
LM741CH 96p
LM741CN 15p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1871 3.25
LM1872 4.38
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.89
LM2917N8 1.89
LM387N 1.65
LM3900 49p
LM3911 1.20
LM3914 2.50
LM3915 2.50
LM3916 2.50
LM13600 95p
OM335 7.20
NE531N 1.36
NE543N 2.50
NE544N 1.95
NE555 16p
NE556 45p
NE558 1.89
NE560 3.25
NE565 1.18
NE566 1.49
NE567 1.37
NE570 4.07
NE571 3.99
NE5534A 95p
RC4136 59p
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.55
TBA530Q 2.76
TBA540 2.72
TBA540Q 2.74
TBA550 3.25
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TDA1002 3.39
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA2611A 2.50
TL061 40p
TL062 60p
TL064 99p
TL071 25p
TL072 50p
TL074 99p
TL081 25p
TL082 50p
TL084 89p
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.50
UPC1156 2.75
XR2206 2.92
ZN414 1.00
ZN419 2.25
ZN1034 1.99

74 TTL

7400 11p
7401 11p
7402 11p
7403 12p
7404 12p
7405 15p
7406 19p
7407 19p
7408 14p
7409 14p
7410 15p
7411 16p
7412 18p
7413 18p
7414 25p
7416 19p
7417 19p
7420 15p
7421 19p
7422 19p
7423 19p
7425 19p
7426 19p
7427 19p
7428 26p
7430 14p
7432 22p
7433 22p
7437 25p
7438 21p
7440 15p
7441 55p
7442 32p
7443 89p
7444 89p
7445 49p
7446 59p
7447 39p
7448 49p
7450 15p
7451 15p
7453 15p
7454 14p
7460 15p
7470 34p
7472 25p
7473 25p
7474 19p
7475 25p
7476 25p
7480 39p
7481 1.19
7482 63p
7483 38p
7484 69p
7485 60p
7486 19p
7489 1.68
7490 20p
7491 35p
7492 25p
7493 25p
7494 36p
7495 36p
7496 35p
7497 89p
74100 80p
74104 50p
74105 55p
74107 19p
74109 25p
74110 35p
74116 50p
74118 55p
74119 59p
74120 59p
74121 25p
74122 35p
74123 35p
74125 30p
74126 29p
74128 35p
74132 29p
74136 27p
74141 55p
74142 1.75
74143 1.95
74144 1.95
74145 38p
74147 89p
74148 55p
74150 49p
74151 35p
74153 35p
74154 49p
74155 40p
74156 39p
74157 29p
74159 75p
74160 59p
74161 48p
74162 39p
74163 39p
74164 39p
74165 39p
74166 48p
74170 1.25
74172 2.50
74173 59p
74174 54p
74175 49p
74176 39p
74177 45p
74178 79p
74180 40p
74181 1.15
74182 80p
74184 89p
74185 89p
74186 4.69
74188 2.50
74190 48p
74191 48p
74192 45p
74193 45p
74194 40p
74195 40p
74196 45p
74197 39p
74198 79p
74199 83p
74221 53p

74LS TTL

74LS00 11p
74LS01 11p
74LS02 11p
74LS03 12p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 15p
74LS14 24p
74LS15 13p
74LS20 13p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 13p
74LS32 13p
74LS33 14p
74LS37 14p
74LS38 15p
74LS40 13p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 18p
74LS76 19p
74LS78 19p
74LS83 36p
74LS85 41p
74LS86 16p
74LS90 24p
74LS92 29p
74LS93 24p
74LS95 39p
74LS96 93p
74LS107 35p
74LS109 23p
74LS112 22p
74LS113 19p
74LS114 22p
74LS122 32p
74LS123 36p
74LS124 89p
74LS125 24p
74LS126 25p
73LS132 29p
74LS136 24p
74LS138 24p
74LS139 28p
74LS145 69p
74LS147 99p
74LS148 75p
74LS151 37p
74LS153 39p
74LS154 79p
74LS155 29p
74LS156 36p
74LS157 24p
74LS158 29p
74LS160 31p
74LS161 35p
74LS162 35p
74LS163 35p
74LS164 40p
74LS165 49p
74LS168 84p
74LS169 85p
74LS170 69p
74LS173 49p
74LS174 34p
74LS175 34p
74LS181 88p
74LS183 1.05
74LS190 36p
74LS191 36p
74LS192 36p
74LS193 37p
74LS194 32p
74LS195 32p
74LS196 45p
74LS197 48p
74LS221 50p
74LS240 55p
74LS241 56p
74LS242 55p
74LS243 55p
74LS244 50p
74LS245 69p
74LS247 49p
74LS248 55p
74LS249 55p
74LS251 29p
74LS253 32p
74LS257 29p
74LS258 35p
74LS259 55p
74LS261 99p
74LS266 18p
74LS273 54p
74LS275 1.25
74LS279 29p
74LS280 89p
74LS283 39p
74LS289 4.70
74LS290 39p
74LS293 39p
74LS295 74p
74LS298 79p
74LS299 1.49
74LS323 1.59
74LS324 1.45
74LS325 2.96
74LS326 2.39
74LS327 2.39
74LS347 95p
74LS348 88p
74LS352 61p
74LS353 61p
74LS362 7.25
74LS365 29p
74LS366 29p
74LS367 29p
74LS368 29p
74LS373 55p
74LS378 68p
74LS386 1.14
74LS390 46p
74LS393 42p
74LS395 89p
74LS396 1.90
74LS398 2.70
74LS399 1.59
74LS445 99p
74LS490 2.20
74LS540 89p
74LS541 79p
74LS640 99p
74LS641 99p

CMOS

4000 10p
4001 10p
4002 11p
4006 49p
4007 14p
4008 32p
4009 24p
4010 24p
4011 10p
4012 15p
4013 19p
4014 46p
4015 39p
4016 19p
4017 32p
4018 45p
4019 25p
4020 42p
4021 39p
4022 39p
4023 12p
4024 32p
4025 12p
4026 79p
4027 19p
4028 39p
4029 43p
4030 14p
4031 1.19
4032 79p
4033 1.20
4034 1.29
4035 44p
4036 2.49
4037 1.13
4038 99p
4040 40p
4041 40p
4042 39p
4043 39p
4044 39p
4045 99p
4046 44p
4047 39p
4048 39p
4049 22p
4050 23p
4051 44p
4052 58p
4053 49p
4054 79p
4055 83p
4056 79p
4059 4.35
4060 42p
4063 79p
4066 22p
4067 2.39
4068 14p
4069 15p
4070 13p
4071 13p
4072 13p
4073 15p
4075 13p
4076 45p
4077 13p
4078 15p
4081 13p
4082 13p
4085 49p
4086 60p
4089 1.23
4093 19p
4094 69p
4095 71p
4096 69p
4097 2.88
4098 74p
4099 89p
4502 55p
4503 39p
4507 33p
4508 1.26
4510 45p
4511 48p
4512 48p
4514 1.13
4515 1.13
4516 55p
4518 39p
4519 29p
4520 48p
4521 88p
4526 68p
4527 62p
4528 74p
4532 69p
4534 3.96
4536 2.59
4538 78p
4539 89p
4543 68p
4553 2.25
4555 35p
4556 35p
4560 1.49
4566 1.49
4569 1.65
4584 39p
4585 59p

LOGIC

CPU's
1802 6.50
2650A 11.99
6502 3.24
6800 2.10
6802 2.40
6809 6.20
8035 3.49
8060 10.50
8080A 2.50
8085A 3.49
SCMP1 20.00
Z80A 2.98

MEMORIES
2114 (200ns) 92p
2532 2.98
2564 6.25
2764 4.25
2708 2.25
2716(5V) 2.10
4116 (200ns) 80p
4118 3 3.25
4164 3.95
5101 (450ns) 1.89
5204 7.50
6116 3.85
6514 3.30
6810 1.15
7489 1.65
74189 4.00
74LS289 3.25
74LS188 2.25
74LS287 3.05
74LS288 2.25

MISC LOGIC ICs
ADC0804 3.95
ADC0816 14.90
ADC0817 10.06
INS1671 20.80
INS1771 20.00
RO2513LC 6.50
RO2513UC 6.50
SAA5000 3.00
SAA5010 7.10
SAA5012 7.10
SAA5020 5.50
SAA5030 9.00
SAA5040 15.00
SAA5041 15.00
SAA5050 8.50
SAA5052 8.50
TMS6011 3.65
8T26 95p
8T28 1.20
8T95 85p
8T97 85p
81LS95 80p
81LS96 85p
81LS97 90p
81LS98 85p
6522 3.19
6532 5.70
8154 9.00
8155 3.50
8212 1.10
8216 99p
8224 1.10
8226 2.50
8228 2.19
Z80ACTC 2.60
Z80ADART 5.50
Z80ADMA 6.70
Z80APIO 2.70
ZN425E8 3.39

VOLTAGE REGS

– Positive –
100mA
78L05A 29p
78L12A 29p
78L15A 29p
78L24A 29p
1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
– Negative –
100mA T092
79L05 49p
79L12 49p
79L15 49p
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

Z1F SOCKET

24 Pin 4.35

SWITCHES

Toggles (Mini)
SPST 49p
SPDT 55p
DPDT 69p
DPDT C. off 85p
4PDT 2.75

EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 9 SEPTEMBER 1983

BUILDING FOR THE FUTURE

WHERE are all the girls? This was one question raised at the SEDAC '83 Presentation Ceremony last June. For although two school-girls were amongst the students of the twelve-finalist teams, no girls' school, as such, had entered this National Competition for schools sponsored by Mullard and this magazine.

Handling a soldering iron and pliers might be considered an inappropriate pursuit for girls—until one remembers their older sisters who in their thousands are employed in industry assembling electronic equipments.

Perhaps the computer has more appeal to the younger members of the fair sex? But here we discover an equally depressing situation. Girls, it is proved by national statistics, are not so eager as boys to get their fingers onto computer keyboards and four times as many boys as girls take A-level computer science. Strange again, when one considers the similarity between typewriters and computers from the users stand-point, and the overlapping that already occurs in the business office where secretaries and typists are becoming involved quite naturally with word processors and even microcomputers.

This lack of interest in computer science by girls is indeed serious and it is worrying national bodies such as the Engineering Council, the Equal Opportunities Commission and the Microelectronics Education Programme. Naturally there are exceptions to the rule, and we are pleased to show students of one London girls' school carrying out experiments with a computer, see *Computer Aided Experiments*, page 600.

Electronics and computers represent the two major growth areas in our economy—and significantly both areas are healthy despite the impoverished state of many older industries. The message for the future is there—but somehow it is not being received, or at any rate acted upon, by all those entrusted with the education of our children. It's the old story: the humanities all too often take precedence over the sciences. Many SEDAC finalists told us that the initiative to enter the Competition came from themselves and much (sometimes all) of the project work was done outside school, the school authorities taking a belated interest only when their students had won through to the final stage.

We do not have to accept passively this situation. Self-help is after all a virtue strongly advocated by our government, and it can be applied very effectively here. Wise and responsible parents do counsel their children in career matters and those who follow electronics, whether professionally or as a hobby, will appreciate the opportunities arising from electronics in general and microcomputers in particular. A home study course in electronics could initiate a youngster into the "mysteries" of the subject and infuse genuine interest leading to more extensive study.

Our twelve-part series *Teach-In 84* will meet this need very satisfactorily. We commend it to all parents, and of course to the younger people themselves. *Teach-In 84* starts next month. It could make a lot of difference to the job prospects of lots of young people due to enter the labour market in the next few years.

Fred Bennett

Readers' Enquiries
We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.
We cannot undertake to engage in discussions on the telephone.

Component Supplies
Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

Back Issues
Certain back issues of EVERYDAY ELECTRONICS are available worldwide price £1·00 inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.

Binders
Binders to hold one volume (12 issues) are available from the above address for £4·60 inclusive of postage and packing worldwide.
Please state which Volume.

Subscriptions
Annual subscription for delivery direct to any address in the UK: £12·00. Overseas: £13·00. Cheques should be made payable to IPC Magazines Ltd., and sent to Room 2613, King's Reach Tower, Stamford Street, London SE1 9LS.

STYLUS ORGAN
WITH VIBRATO AND DECAY

BY R.A. PENFOLD

THE Stylus Organ is basically a conventional instrument which covers two octaves (including sharps or flats), one octave either side of middle C. It has a switchable vibrato oscillator, the use of which gives a more "rich" and pleasant sound. An unusual feature which can further enhance the sound, is a simple envelope generator circuit, and this gives a fast attack time with a decay time which can be varied from a fraction of a second to several seconds.

With a long decay time, the envelope shaper has little effect in normal use since changes from one note to the next occur before the volume of each note decays significantly. The unit then operates as an "ordinary" stylus organ. With a fairly short decay time, the character of the sound produced changes completely, and a sort of percussive sound is obtained.

The unit has a built-in amplifier but requires an external loudspeaker having an impedance of 8 ohms or more (although there is room to fit a small internal speaker). Construction is quite simple due to the use of a single printed circuit which forms the "keyboard" and accommodates all the components apart from the controls and the battery.

SYSTEM DESCRIPTION

Fig. 1 shows the Stylus Organ in block diagram form. A voltage controlled oscillator (v.c.o.) is used to generate the basic sound, and the "keyboard" provides a series of 25 voltages which give the v.c.o. 25 different operating frequencies thus generating the required two octaves of notes. A low frequency oscillator can be used to vary the v.c.o. control voltage very slightly so that notes are modulated either side of their normal frequency, and this gives the vibrato effect.

The output of the v.c.o. is fed to the amplifier output stage via a voltage controlled amplifier (v.c.a.), and under quiescent conditions the control voltage to the v.c.a. is zero so that the v.c.o. is cut off from the amplifier. However, the stylus is connected to a pulse generator circuit which produces a brief pulse each time a new note is played, and after shaping to produce a gradual decay over the desired period of time, this pulse is fed to the control input of v.c.a.

Thus the v.c.a. couples the tone signal straight through to the amplifier at the beginning of a new note, but it then steadily reduces the amplitude of the signal during the course of each note as the control voltage diminishes. The effect of this envelope shaping can be seen by referring to the oscillograph (waveform shown on a 'scope) on page 558.

THE CIRCUIT

The circuit diagram of the Stylus Organ is shown in Fig. 2. One section of IC2, an LM13600N dual transconductance op-amp, is used as the basis of the v.c.o. A transconductance amplifier is similar in many ways to an ordinary op-amp, but there are also substantial differences. The two main differences are that the differential input voltage to the device controls the output current, and *not* the output voltage, and there is a third input to the device. This input is called the "amplifier bias" input, and the bias current fed to this input controls the gain of the device.

In this circuit, the transconductance amplifier is used as a combination of a trigger circuit and a constant current generator. C5 is charged and discharged from the transconductance op-amp in IC2a at a rate which is determined by the bias current fed to pin 1 of the device via R10. This produces a roughly triangular waveform at the output of IC2a, and the operating frequency is controlled by the bias current applied to IC2a. R10 is used in series with the amplifier bias input so that the bias current is roughly proportional to the input voltage, and the required voltage rather than current controlled operation is obtained.

The output impedance of a transconductance amplifier is generally quite high, but the LM13600N incorporates a Darlington pair emitter follower buffer stage for each section of the device, and these can be used at the output of each amplifier to give a low output impedance. R12 is the discrete load resistor for the buffer stage for IC2a.

KEYBOARD

The keyboard voltages are provided by 25 preset potentiometers (VR1 to VR25) which are connected across the supply rails. Each preset must be adjusted to give the correct note, but IC3 gives a well

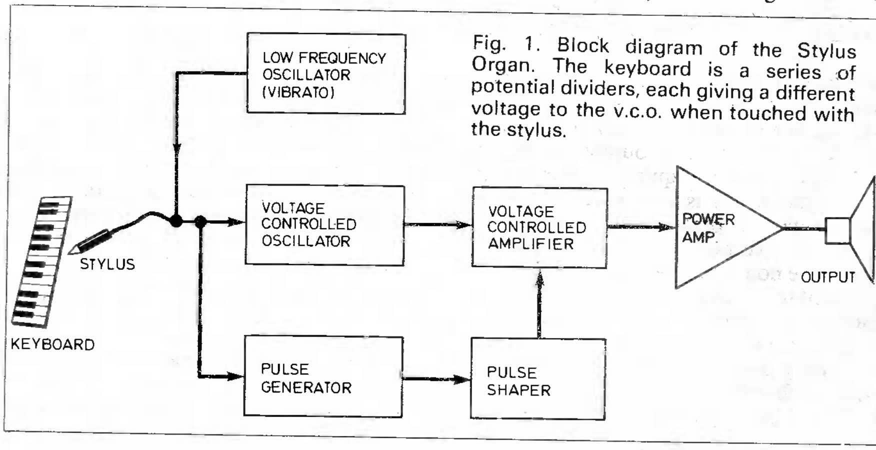
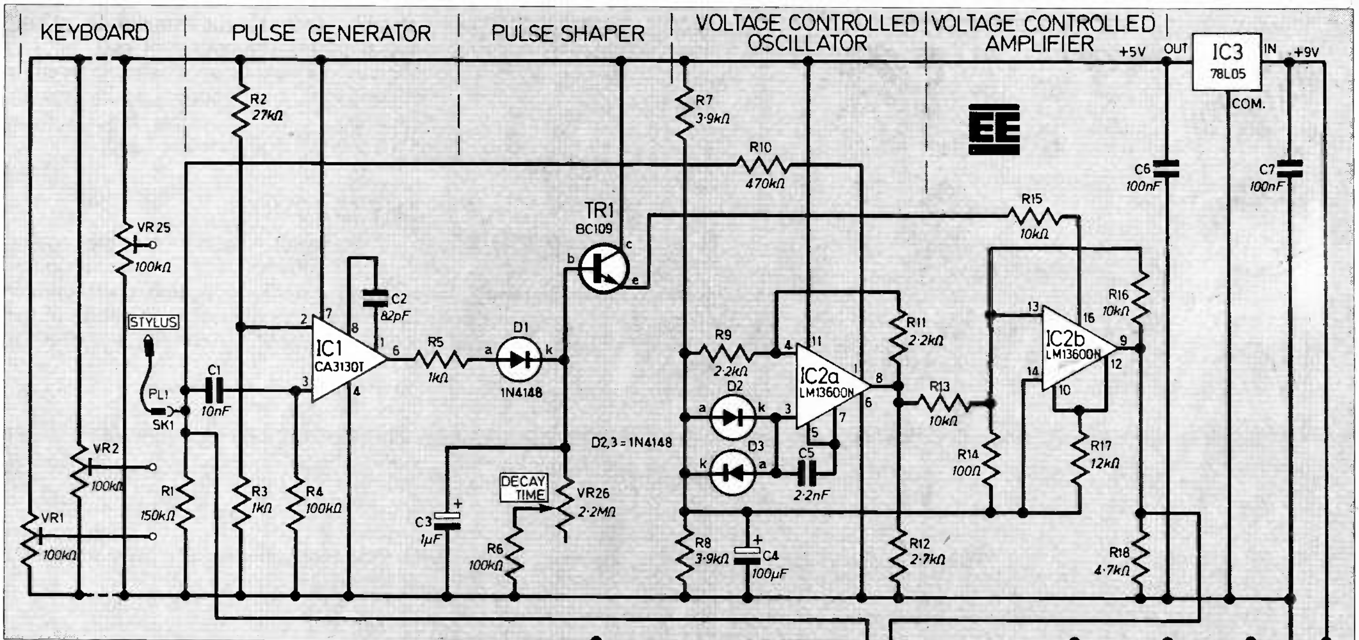


Fig. 1. Block diagram of the Stylus Organ. The keyboard is a series of potential dividers, each giving a different voltage to the v.c.o. when touched with the stylus.



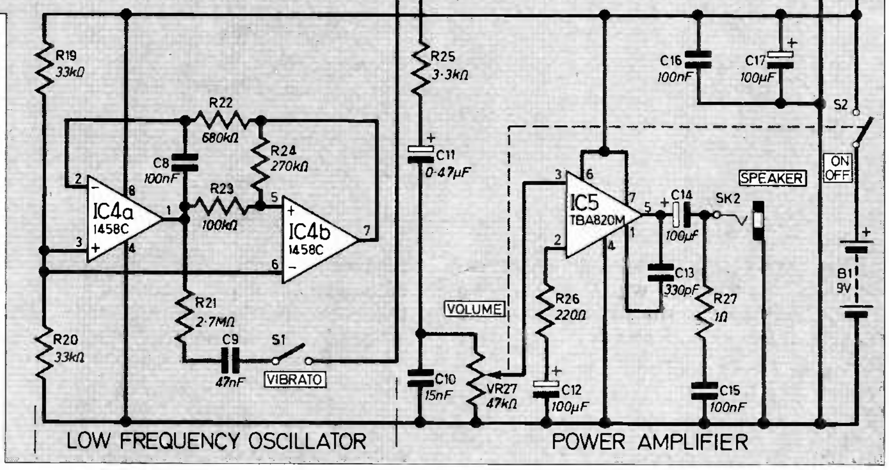


Fig. 2. The complete circuit diagram of the Stylus Organ. Note that the keyboard consists of 25 preset potentiometers (VR1 to VR25) although only three are shown.

stabilised 5V supply so that there is no discernable tuning drift, and once the unit has been initially tuned no further tuning adjustments should be required.

Transconductance operational amplifiers are also ideal for use in v.c.a. circuits, and IC2b is therefore used as the v.c.a. R13 couples the output of the v.c.o. to the inverting input of IC2b, and in conjunction with R15 this resistor also forms a negative feedback network which sets the maximum voltage gain of IC2b at unity. R17 is the output load resistor for the transconductance op-amp IC2b and R15 is used in series with the amplifier bias input to give voltage rather than current controlled operation, and it also limits the bias current to a safe level.

TR1 is used as an emitter follower buffer stage which boosts the input impedance at the control input of the v.c.a. from about 10 kilohms to several megohms. This is essential as the pulse shaper circuit has an output impedance which can be as high as a couple of megohms, and without TR1 excessive loading on the pulse shaper would occur.

IC1 is used as the pulse generator. The non-inverting input of IC1 is biased to the negative supply rail by R4, but the inverting input is given a small positive bias by R2 and R3. The output of IC1 is therefore low under quiescent conditions. When the stylus is connected to one of the keyboard presets this produces a small positive pulse which is coupled by C2 to the non-inverting input of IC1. This momentarily takes the non-inverting input to a higher potential than the inverting input so that the output briefly goes fully positive. A large but very brief pulse is therefore generated at the output of IC1 at the beginning of each note.

This pulse is fed by way of R5 and D1 to C3, and the latter is rapidly charged to almost the full supply voltage. C3 discharges more slowly since D1 prevents it from discharging through the low impedance of R5 and the output stage of IC1. Instead C3 discharges through the high resistance of VR26 and R6, and VR26 enables the decay time to be adjusted from about 0·2s at minimum resistance to around 5s at maximum resistance.

VIBRATO AND AMPLIFIER

The vibrato oscillator and output amplifier stages of the unit operate direct from the 9V battery supply and not via the 5V regulator. IC4 is a dual op-amp and this is used in the standard triangular/square-wave oscillator configuration. In this application, a triangular waveform is ideal as it gives a smooth variation in the operating frequency of the tone generator, and the square-wave output from IC4 is therefore ignored. R21 and C9 couple the triangular signal to the stylus, and S1 can be used to disconnect the oscillator when the vibrato effect is not required. If desired, the depth of the vibrato can be changed by altering the value of R21. A lower value gives increased depth, a higher value gives a weaker vibrato effect.

The amplifier uses a TBA820M audio power amplifier i.c. (IC5), and this gives an output power of up to about 500mW r.m.s. into an 8 ohm impedance loudspeaker. A high impedance loudspeaker could be used, but the maximum output power available would be substantially reduced.

VR27 is the volume control and this also acts as the input bias resistor for IC5. R25 and C10 form a simple low-pass filter which attenuate the higher harmonics on the output from the v.c.o. and give the unit a more musical sound. R26 controls the voltage gain of IC5, and the specified value gives a modest but more than adequate gain of about 28dB (25 times). C13, C15 and R27 are needed to aid good stability. S2 is the on/off switch and this is ganged with volume control VR27.

The quiescent current consumption of the circuit is about 10mA, but the current drain can rise to several times this figure when the unit is used at high volume.

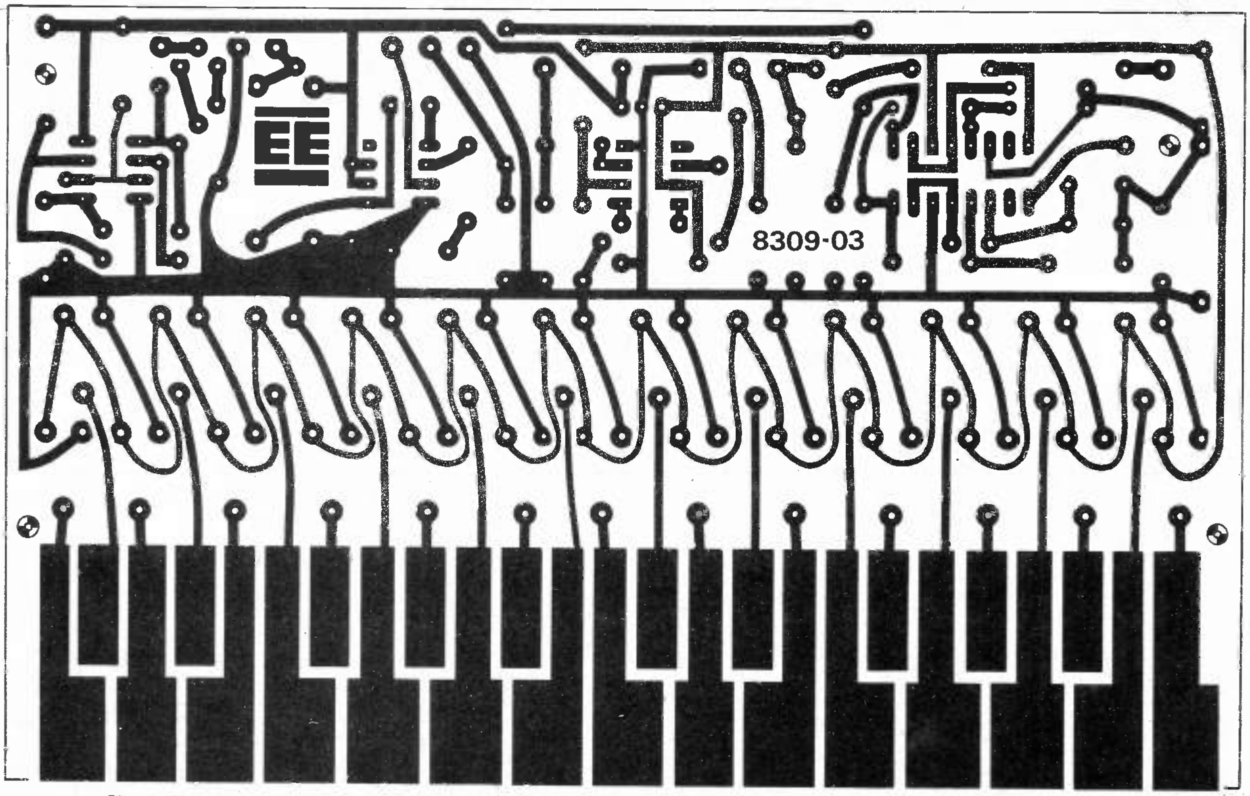


Fig. 3. The full-size artwork of the p.c.b. This board is available from the *EE PCB Service,* Order code 8309-03.

CONSTRUCTION

PRINTED CIRCUIT BOARD

Details of the printed circuit board are shown in Fig. 3, and this is constructed using the normal techniques. In order to give the completed unit a neat finish great care should be taken when applying the resist to the "keyboard" area of the board. Using rub-on transfers there should be no problems in producing good results, and reasonable results should be obtained using a resist pen if the outline of each "key" is drawn in with the aid of a ruler and then the outline is carefully filled in. In other respects the printed circuit board is straightforward. Alternatively, the board is available from the *EE PCB Service,* Order code 8309-03, see page 565.

Note that IC1 is a CMOS device and needs the normal handling precautions for MOS devices. If a CA3130E is used for IC2 this can be fitted into an 8-pin d.i.l. i.c. socket, and it should not be fitted into place until all the other components have been mounted on the board. The layout is shown in Fig. 4.

If CA3130T (TO-99 metal can) version is used, this could be soldered into place using a soldering iron having an earthed bit, and again it should be the last component to be fitted to the board and it should be handled as little as possible. Be careful to connect IC1 properly as it has the opposite orientation to IC4 and IC5, and it could be destroyed if the unit is switched on while it is connected incorrectly.

COMPONENTS

Approx. cost Guidance only **£30.00**

Resistors

R1	150kΩ
R2	27kΩ
R3,5	1kΩ (2 off)
R4,6,23	100kΩ (3 off)
R7,8	3·9kΩ (2 off)
R9,11	2·2kΩ (2 off)
R10	470kΩ
R12	2·7kΩ
R13,15,16	10kΩ (3 off)
R14	100Ω
R17	12kΩ
R18	4·7kΩ
R19,20	33kΩ (2 off)
R21	2·7MΩ
R22	680kΩ
R24	270kΩ
R25	3·3kΩ
R26	220Ω
R27	1Ω

All $\frac{1}{4}$W carbon ±5%

See **Shop Talk** page 565

Capacitors

C1	10nF polycarbonate
C2	82pF miniature plate ceramic
C3	1µF 63V axial elect.
C4,14,17	100µF 10V axial elect. (3 off)
C5	2·2nF mylar
C6,7,8, 15,16	100nF polyester (5 off)
C9	47nF polyester
C10	15nF polyester
C11	0·47µF 63V axial elect.
C12	100µF 10V radial elect.
C13	330pF ceramic

Semiconductors

D1,2,3	1N4148 silicon (3 off)
TR1	BC109 silicon *npn*
IC1	CA3130T CMOS op-amp
IC2	LM13600N dual transconductance op-amp
IC3	78L05 5V, 100mA regulator
IC4	CA1458C dual op-amp
IC5	TBA820M audio power amplifier

Miscellaneous

VR1–25	100kΩ 0·1W miniature preset horizontal mounting (25 off)
VR26	2·2MΩ lin. carbon potentiometer
VR27/S2	47kΩ log. carbon potentiometer with s.p.s.t. switch
S1	s.p.s.t. miniature toggle
SK1	4mm banana socket
SK2	3·5mm jack socket
PL1	4mm banana plug
B1	9V PP6 battery

Printed circuit board: single-sided size, 163 × 102mm, *EE PCB Service,* Order code 8309-03; Verobox size, 205 × 140 × 75mm (type 202-21035F); battery clip (same as PP3 type); control knob (2 off); test prod (for stylus); 7/0·2mm wire; mounting hardware; Veropins.

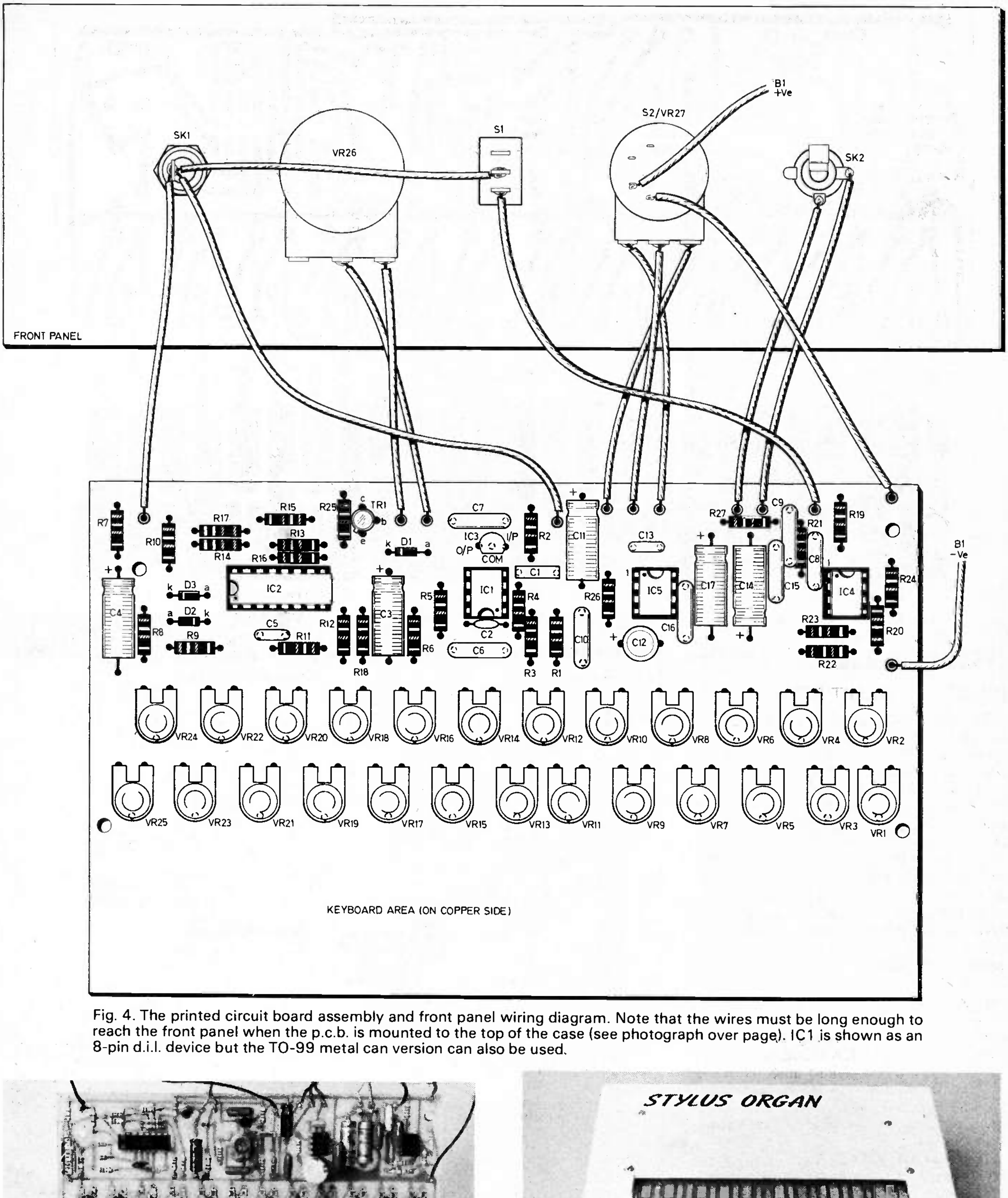
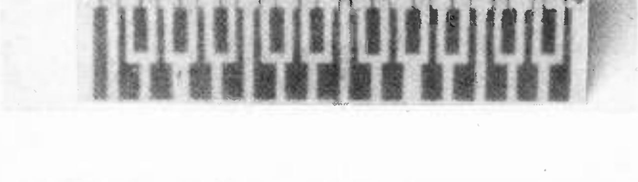
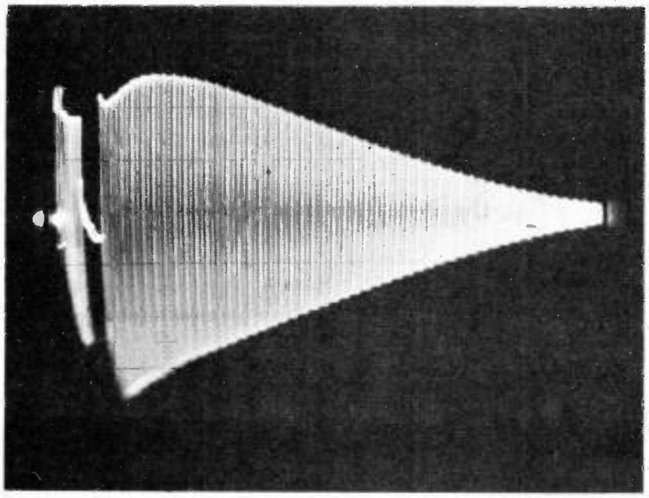
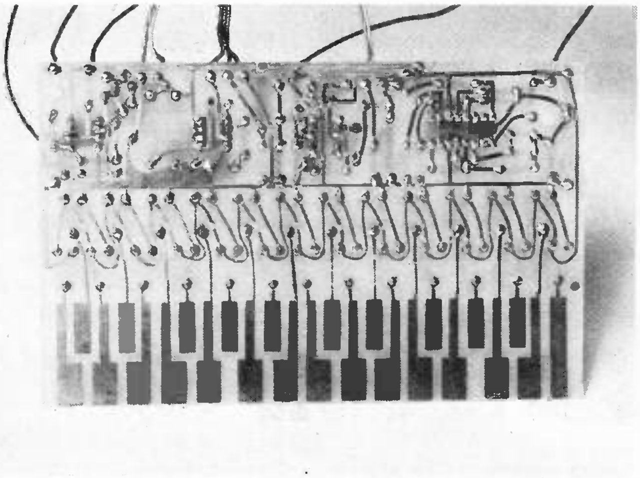


Fig. 4. The printed circuit board assembly and front panel wiring diagram. Note that the wires must be long enough to reach the front panel when the p.c.b. is mounted to the top of the case (see photograph over page). IC1 is shown as an 8-pin d.i.l. device but the TO-99 metal can version can also be used.





Oscillograph showing the rapid attack and slow decay provided by the envelope shaper. The section of the trace on the extreme left shows the rapid decay of the previous note when the stylus has been removed before the signal has decayed naturally.



The track-side of the p.c.b. showing the keyboard area. This is polished but not coated as good electrical contact is required with the probe tip.

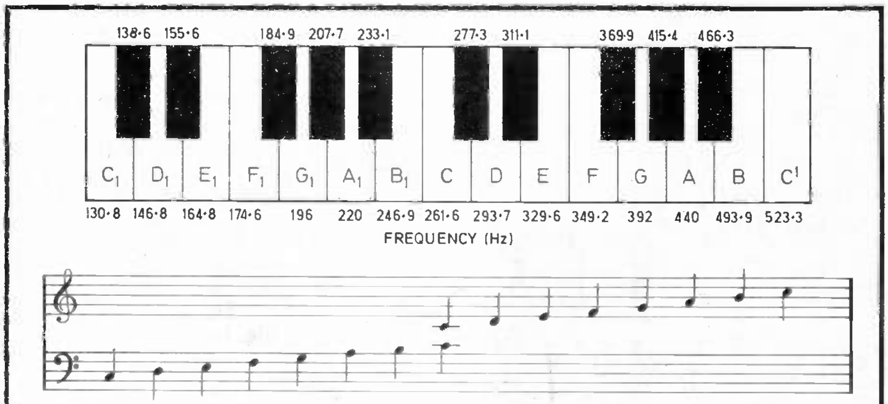


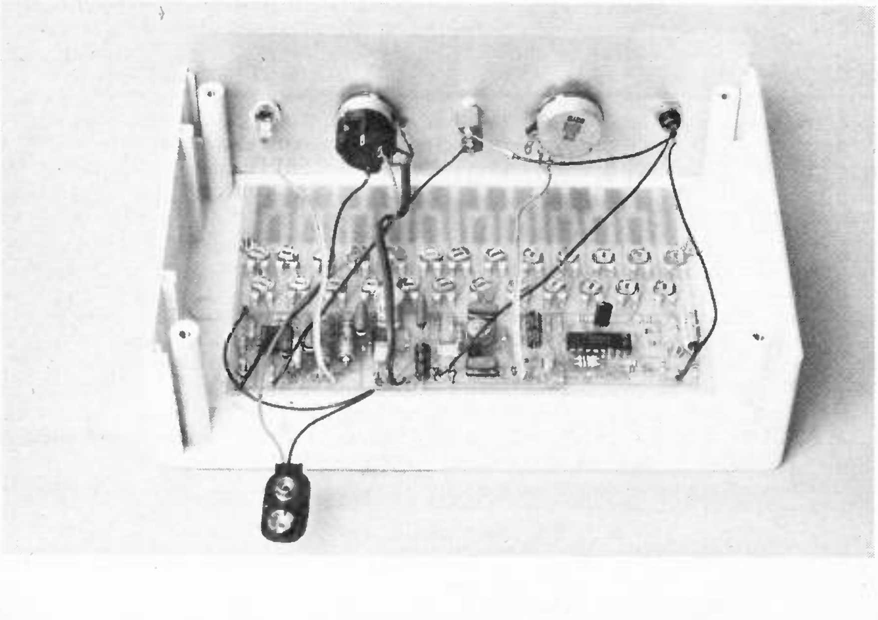
Fig. 5. Layout of the two octave keyboard. VR1 tunes note C_1 and so on to VR25 tuning C^1.

CASE

A Verocase of outside dimensions 205 × 140 × 75mm makes a convenient housing for this project. The three controls and the two sockets are mounted on the front panel, and the printed circuit board is mounted on the underside of the top panel with its copper side facing upwards. A cut-out measuring 150 × 28mm is made in the top of the case and the circuit board must be accurately mounted so that the "keyboard" is accessible through this cut-out. This cut-out can be made using a fret-saw, a coping saw, or a miniature file.

If an internal loudspeaker is required, there is sufficient space to fit a miniature type (up to 58mm in diameter) on the front panel in place of SK2, or a larger type on the base.

View inside the case top. Note that the p.c.b. is spaced slightly off the case with four additional nuts on the mounting screws.



ADJUSTMENT

The output of the Stylus Organ is coupled to any loudspeaker having an impedance of 8 ohms or more, and a fairly efficient loudspeaker (such as used with small music centres and similar equipment) is ideal. The output will also drive any normal type of earphone or headphone. A test prod is probably the best thing to use as the stylus, but it is also possible to use a small jack plug, a wander plug, or something of this nature.

The only adjustment required is to set the 25 preset potentiometers to give the appropriate notes. As mentioned earlier, the keyboard covers an octave either side of middle C, and is tuned using a piano or similar instrument to provide reference notes. The presets can be adjusted in any order. A layout of the keyboard is shown in Fig. 5 and the corresponding frequencies of the notes are given to aid tuning if using a frequency meter. When tuning the unit, adjust VR26 for maximum decay time (that is, fully clockwise) and switch out the vibrato effect.

After the instrument has been in use for some time it will probably be found that there is a noticeable change in frequency during each note, and this simply indicates that the battery voltage is becoming inadequate under maximum loading, and that a fresh battery is required. A PP6 9V battery is adequate, but if it is likely to receive a great deal of use and a low impedance loudspeaker is being used, it would probably be more economic to use a larger battery such as a PP9 type. There is plenty of space in the case to accommodate a larger battery. □

—A TO D— CONVERTER FOR RM380Z COMPUTER

BY A. A. CHANERLEY B.Sc. M.Sc.

THIS article describes the construction and use of a general purpose 8-channel, 8-bit wide Analogue-to-Digital Converter, tailored here for use with the Research Machines 380Z microcomputer. It will be used as the basis for the first six parts of our *Computer Aided Experiments* feature, see page 600.

Providing software is developed, it is possible to use this ADC with other computers fitted with a user port by connecting the appropriate cable connector.

ANALOGUE-TO-DIGITAL CONVERSION

The computer, mainframe or micro, can only respond in any meaningful fashion to digital signals which are transmitted in either serial or parallel form. The 380Z has two ports for input and output signals. One is the printer port, and the other is the input/output user port; both are sockets at the back of the 380Z.

The signals they receive are in parallel form, eight input lines, each line capable of being in either a high state (logic 1) or low state (logic 0). The collective states of the eight lines, for example, 10101111 are called the binary word or byte. The maximum value of a byte is 255 in decimal corresponding to all eight lines high (11111111) or 0 in decimal corresponding to all eight lines low (00000000). Any intermediate combination of the "bit" pattern will correspond to a number between 0 and 255; for example, 00000011 is decimal 3.

In physical situations quantities such as temperature, pressure, light intensity and sound intensity vary in a continuous manner, altering gradually in response to some external event. Before a computer can measure any of the above quantities they must first be converted into an electrical signal.

This is possible by using a transducer. A microphone is a suitable transducer for converting the changing sound intensity from a persons speech into an electrical signal which changes exactly in step with the sound intensity.

This is only the first step, however. The computer will only respond in a meaningful fashion to digital signals and therefore it is necessary to convert the gradually changing (analogue) electrical signals from the transducer into a suitable digital input for the computer to work on; this is done electronically by the Analogue-to-Digital Converter (ADC) described here. The complete set-up is illustrated in Fig. 1.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Analogue-to-Digital Converter (ADC) is given in Fig. 2. As can be seen, the component count is very low, using only two integrated circuits and a few discrete devices.

The main component, IC2, is a 7581 which is an 8-bit 8-channel memory buffered data aquisition system in CMOS. It is capable of receiving eight separate analogue signals, each signal having a maximum value of +10V per channel when used in the unipolar mode, and −5V to +5V when in bipolar mode.

The design described here is unipolar mode in order to simplify construction and keep cost to a minimum.

The 7581 i.c. has a multiplexer, digital-to-analogue converter (DAC), registers, a comparator and control logic all on the one chip. It stores each analogue channel in succession and stores the latest result in eight 8-bit RAM locations which are on-board. Each channel is then selected by software.

Each channel takes 80 clock cycles for a complete conversion, or 640 cycles for all eight channels. With a 1MHz clock, that is 80μsec per channel and 640μsec for all eight channels.

There is also a status pin (pin 12)

A. A. Chanerley is Head of Physics at La Retraite High School for Girls, London.

which goes low when a channel conversion is complete thereby giving interrupt facility for real-time applications. This function however is not included in this design and those interested in such applications should consult the technical data sheet for the 7581. The block diagram of the 7581 internal circuitry is shown in Fig. 3.

POWER SUPPLY

Requirements for this chip are +5V (supply) and −10V reference, and a 1MHz clock. The latter is provided by the two gates IC1a and IC1b with components R1, R2 and C1. IC1c acts as a buffer for this arrangement.

All power requirements are provided by the 380Z, +5V direct and −10V derived from the −12V available on the user port by means of Zener diode D1 with series limit resistor R3. When used with other computers these supplies may not be available and will need to be derived externally. Sufficient space exists in the specified case for such circuitry.

The 8-bit digital output is connected to the 380Z user port socket data-in lines DIØ to DI7 via a 25-pin D-type connector PL1 where +5V, −12V and 0V are also picked up. The user port also has eight data-out pins, DOØ to DO7. Three of these DOØ to DO2 are used in selecting the required channel with DO3 providing the necessary decoded $\overline{CS}$. The other four data-out lines are available to the user at SK9 to SK12 so that the computer may be used to control other equipment such as motors that may be required in A-to-D experiments for such purposes as transducer position and movement.

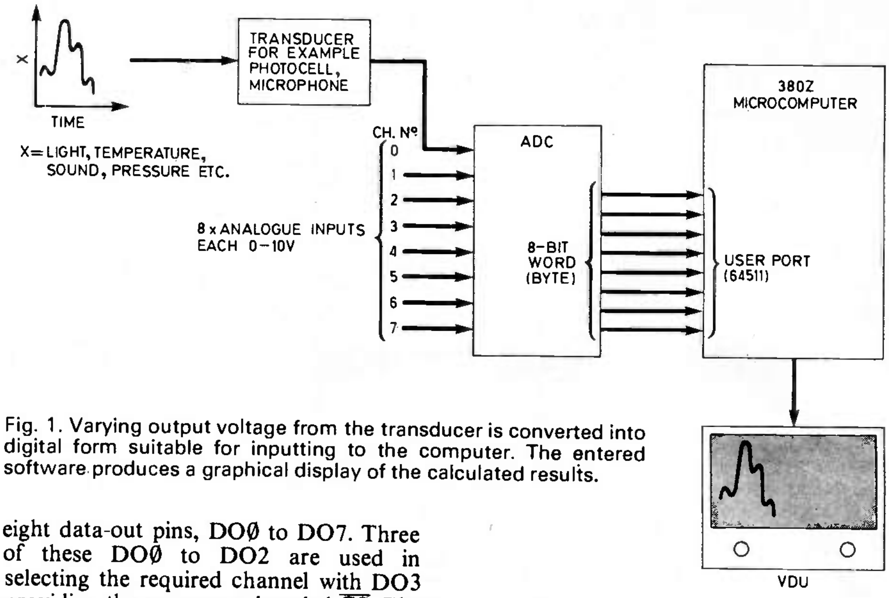
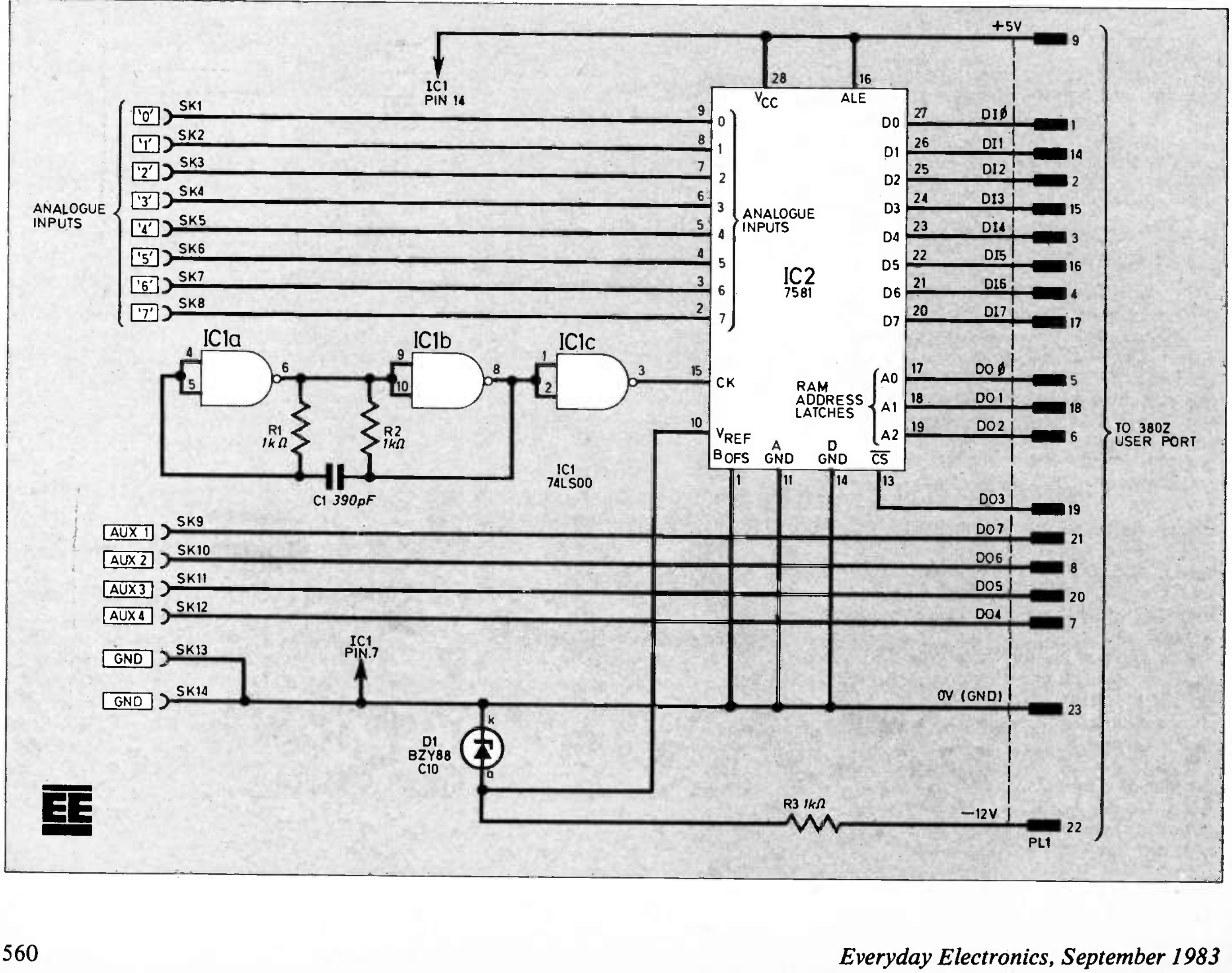


Fig. 1. Varying output voltage from the transducer is converted into digital form suitable for inputting to the computer. The entered software produces a graphical display of the calculated results.

The digital outputs may be read by the 380Z through a PEEK(64511) statement, with the data-out signals controlling A0, A1 and A2 which select the appropriate RAM location in the 7581 holding the experimental data, through a

Fig. 2. Complete circuit diagram of the 8-channel Analogue-to-Digital Converter configured for use with the RM380Z user port.



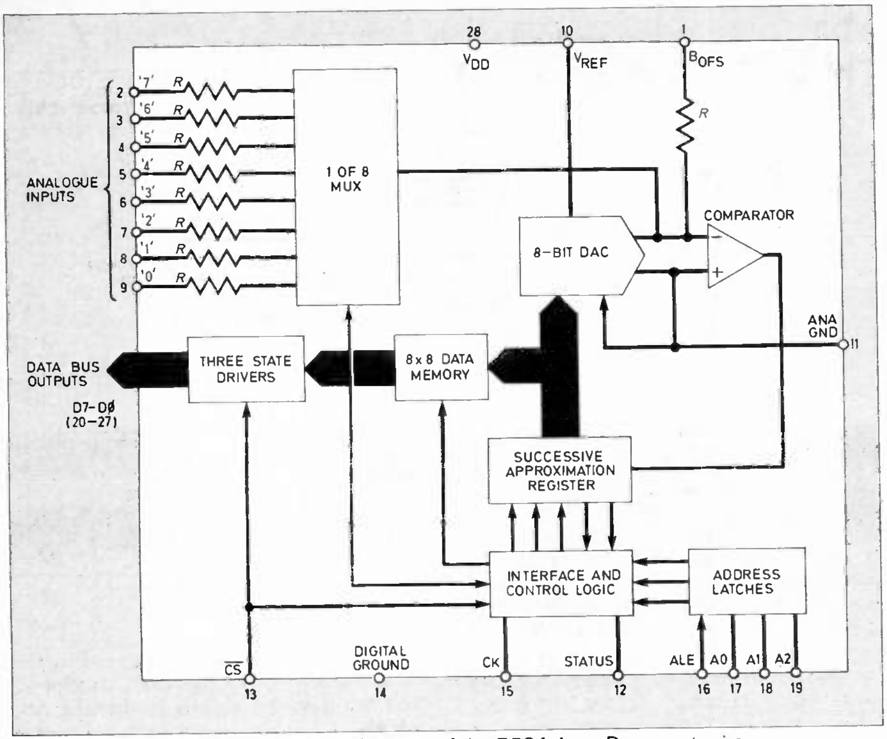


Fig. 3. Internal block diagram of the 7581 A-to-D converter i.c.

Table 2. Data-in pins on the user port

PL1 Pin No.	Data Line No.	Decimal Value
1	DØ	1
14	D1	2
2	D2	4
15	D3	8
3	D4	16
16	D5	32
4	D6	64
17	D7	128

DATA-IN

Table 2 shows the data-in pins which connect to the digital outputs of the 7581 on the circuit diagram, and constitutes the 8-bit word (byte) which corresponds to the converted analogue data. All pins high gives 255 (1 + 2 + 4 + 8 + 16 + 32 + 64 + 128); this is equivalent to the maximum analogue input of 10 volts. All pins low is of course 0 volts. Any intermediate bit pattern corresponds to intermediate analogue voltage between 0V and 10V.

These pins are read by the PEEK (64511) statement, which follows the appropriate POKE64511,XX command.

POKE64511,XX statement where XX takes on values from 0 to 7 depending on the analogue channel selected.

TEST ROUTINE

```
1Ø  POKE64511,8:REM clear data lines: GRAPH 1: GRAPH Ø
2Ø  INPUT X:REM select channel number
3Ø  POKE64511,X:REM initialize selected channel
4Ø  Y=PEEK(64511):REM read value of digital output from 7581
5Ø  PLOT 4Ø,5Ø, STR$(Y)+" ":REM print data at grid ref 4Ø,5Ø
6Ø  GOTO 3Ø:REM go back for next value of data
```

DATA-OUT

Table 1 shows the bit pattern associated with the data-out pins. Each pin is controlled by the POKE statements shown. For example, pins 5, 18, 6 are connected to A0, A1, A2 of the 7581 chip and these address the RAM locations, corresponding to the analogue inputs, inside the chip.

So that POKE64511,00 selects analogue channel 0 with pins 5, 18, 6 all low. Then the statement POKE64511,01 selects the analogue channel 01, with pin 5 high, and pins 18 and 6 low. POKE64511,03 statement selects channel 03, with pins 5 and 18 high and pin 6 low, that is, 011 in binary which is 3 in decimal, and so on.

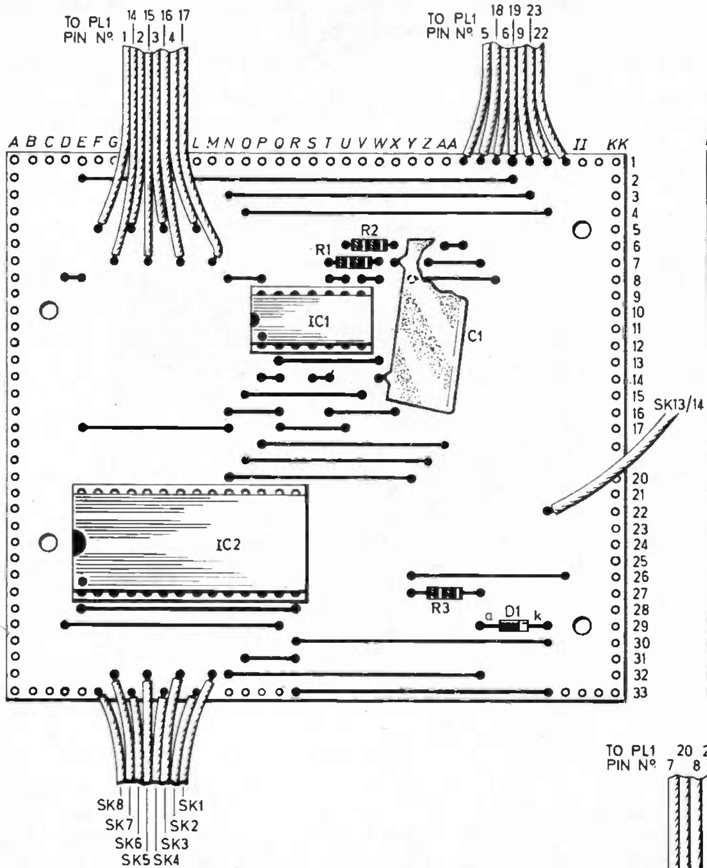
The logic levels for these pins, 6, 18 and 5 for all eight channels are: 000, 001, 010, 011, 100, 101, 110 and 111 corresponding to channels 00, 01, 02, 03, 04, 05, 06 and 07.

Pins 21, 8, 20 and 21 correspond to the auxiliary outputs on the unit marked AUX1 to AUX4. Using the appropriate POKE statement these pins can be made high (or low) to activate external circuitry.

Table 1. Data-out pins on user port

PL1 Pin No.	Data Line No.	Bit Pattern	Basic Statement	To
5	DØ	00000001	POKE64511,2^0	AØ
18	D1	00000010	POKE64511,2^1	A1
6	D2	00000100	POKE64511,2^2	A2
19	D3	00001000	POKE64511,2^3	CS
7	D4	00010000	POKE64511,2^4	AUX4
20	D5	00100000	POKE64511,2^5	AUX3
8	D6	01000000	POKE64511,2^6	AUX2
21	D7	10000000	POKE64511,2^7	AUX1

A TO D CONVERTER
RM380Z COMPUTER



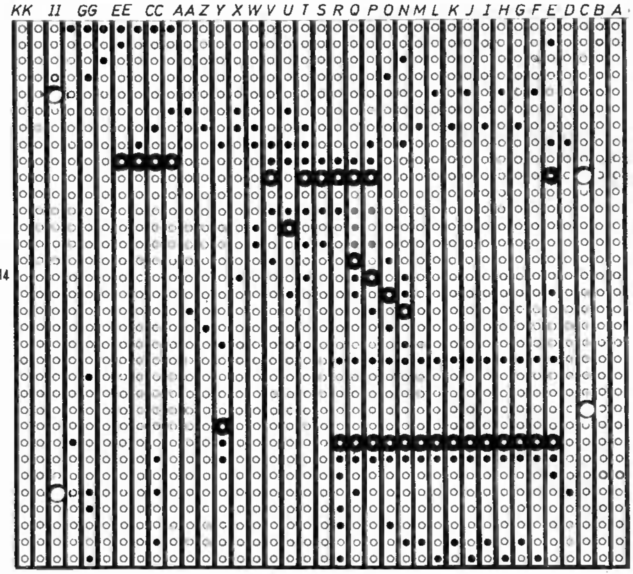


Fig. 4. Layout of the components on the topside of the stripboard with interconnection details to sockets and PL1. Above shows breaks to be made in the copper tracks on the board underside.

COMPONENTS

Resistors
R1 1kΩ
R2 1kΩ
R3 1kΩ
All ¼W carbon ±5%

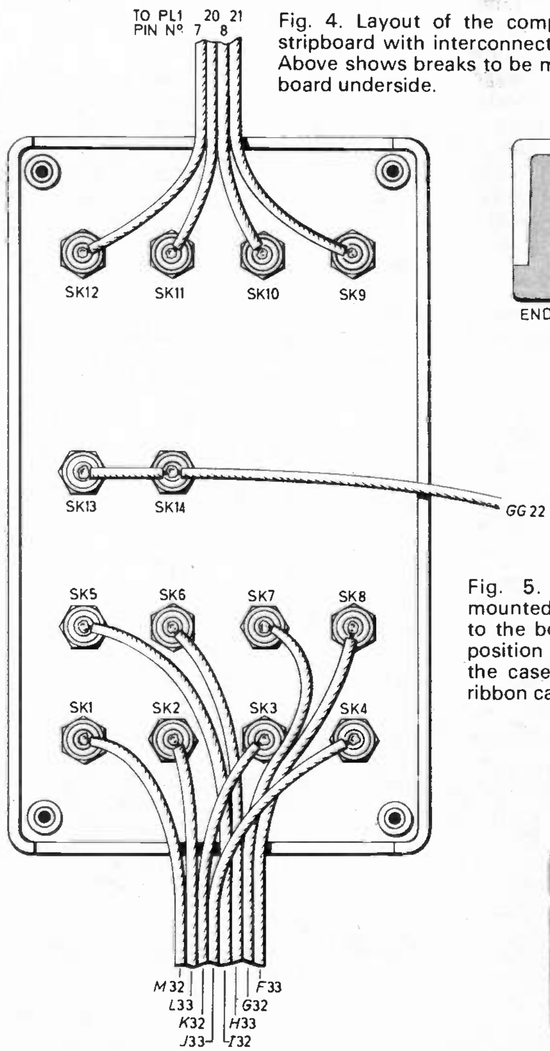
See Shop Talk page 565

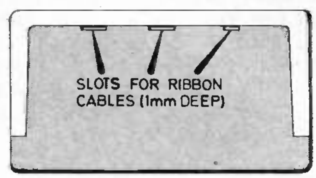
Capacitor
C1 390pF silvered mica

Semiconductors
IC1 74LS00 TTL low power Shottky quad 2-input NAND
IC2 7581 8-channel 8-bit analogue-to-digital converter i.c.
D1 BZY88C10 10V 400mW Zener diode

Miscellaneous
SK1–14 4mm insulated panel mounting sockets (8 black, 4 red, 2 green)
PL1 25-way, D-type vertical sub-miniature plug with cover

Stripboard: 0·1 inch matrix, size 37 strips x 33 holes; 20-way colour-coded ribbon cable (not i.d.c. type) length as required; Vero plastic box 202-21031G or similar, size 188 x 110 x 60mm; self-adhesive rubber feet (4 off); snap-fixing plastic stand-off pillars 6mm high (4 off); d.i.l. sockets: 28-pin, 14-pin (1 off each); wire for on-board links.

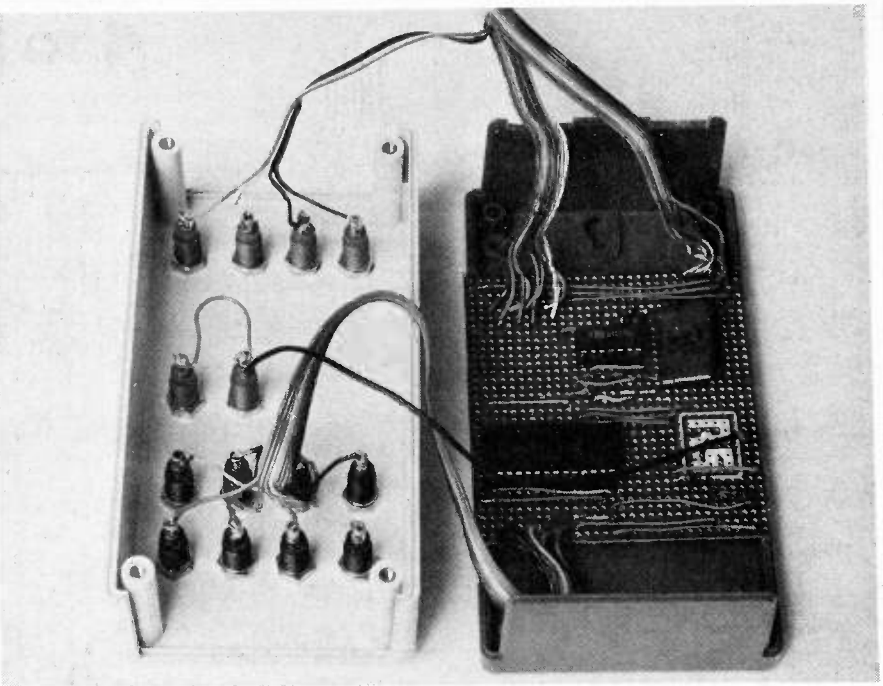




END VIEW OF BOX

Fig. 5. Position of the top panel mounted sockets and interwiring details to the board and PL1. Top right shows position of the recesses to be made in the case to allow the exit of the three ribbon cables.

COMPONENTS approximate cost £27



The completed prototype with separated case sections.

CONSTRUCTION

The Analogue-to-Digital Converter is constructed on 0·1 inch pitch stripboard, size 37 strips × 33 holes. This board size differs in strip count from that seen in the photographs as we have increased its size to provide a different board fixing method than that used in the prototype. This larger board requires a wider case than that seen and the next size up in the same style is specified in the components list.

The analogue inputs are made in 4mm panel mounting sockets. The four sockets labelled AUX are not essential. They provide access to user port signal lines DO4 to DO7 and were included by the author for work he has in mind for the future. There is space in the case for fitting further sockets or circuitry if the user so wishes, perhaps from another outlet from the 380Z that could be useful in A-to-D experiments.

The layout of the components on the topside of the stripboard is shown in Fig. 4. A number of breaks in the copper strips on the underside need to be made. Use a spot-face cutter or a small (3mm) diameter twist drill to make these breaks. Drill the four board fixing holes as shown to suit the fixing hardware. We suggest 6mm high snap-fixing plastic stand-off pillars which require a 3·8mm diameter hole in the board with a 5mm diameter hole drilled in the case. Use the drilled board as a template to drill pilot holes in the case base and then enlarge to 5mm. In this way, the two sets of fixing holes are correctly aligned and so exert minimal strain on the board.

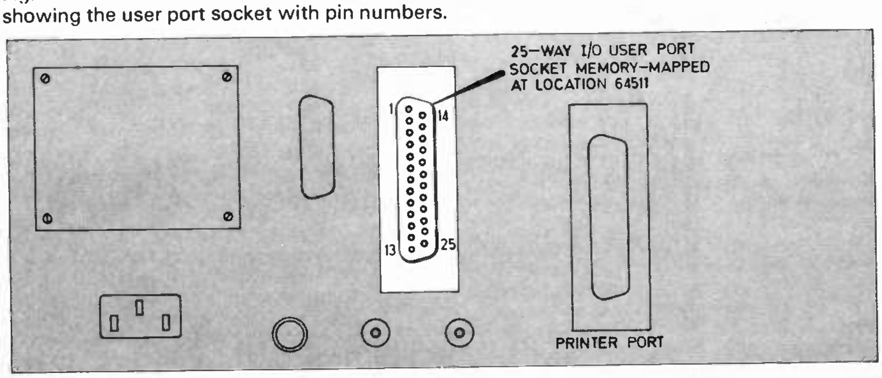
Continue by mounting the i.c. sockets followed by the numerous link wires. You should use plastic covered single core wire or tinned copper wire sleeved at positions where the conductors run close. Next solder in the resistors, capacitor and Zener diode paying attention to orientation of this device.

Table 3. 380Z user port pin assignment details

Pin No.	Function	Pin No.	Function	Pin No.	Function
1	DIØ	11	*	21	DO7
2	DI2	12	*	22	−12V
3	DI4	13	*	23	0V
4	DI6	14	DI1	24	*
5	DOØ	15	DI3	25	*
6	DO2	16	DI5		
7	DO4	17	DI7		
8	DO6	18	DO1		
9	+5V	19	DO3		
10	+12V	20	DO5		

* Not specified

Fig. 6. View of the connectors on the 380Z microcomputer rear panel (not to scale) clearly showing the user port socket with pin numbers.



CABLES

The ribbon cable connecting the board to the sockets and PL1 was soldered directly to the board tracks. Another idea is to use Veropins for this connection which will then allow the board to be positioned in the case before wiring up. Fit the Veropins now if you choose this method. Thoroughly check your construction before proceeding.

Prepare the lid of the case to accept the 4mm sockets SK1–SK14, see Fig. 5. When fitted, wire up SK1–SK8 to the board. Ribbon cable (8-way) was used for this in the prototype. Connect GND sockets to the board using stranded plastic covered wire. The easiest way to run the ribbon cables out of the case is to file three small recesses in one of the case end edges (lower section): two at 10 × 2mm and one at 5 × 2mm. When the lid is finally assembled, the lid will grip the cable firmly. It would be a good idea to fit self-adhesive ribbon cable grippers about 10mm below the recesses to align the cables with their respective outlets.

Fit the i.c.s in their sockets paying special attention to orientation and then push the board onto the plastic stand-off pillars which you have already positioned in the case.

There are two ribbon cable groups that connect the board to PL1. Solder sufficient lengths of 8-way and 7-way cable to the board and a similar length of 4-way cable from SK9–SK12 to reach the user port via PL1. Feed the cables out through their recesses after being fitted in their grippers.

Identify each of the wires and, with reference to Fig. 6 and Table 3, connect them to PL1 to complete the assembly. Screw on the lid and the unit is ready for testing.

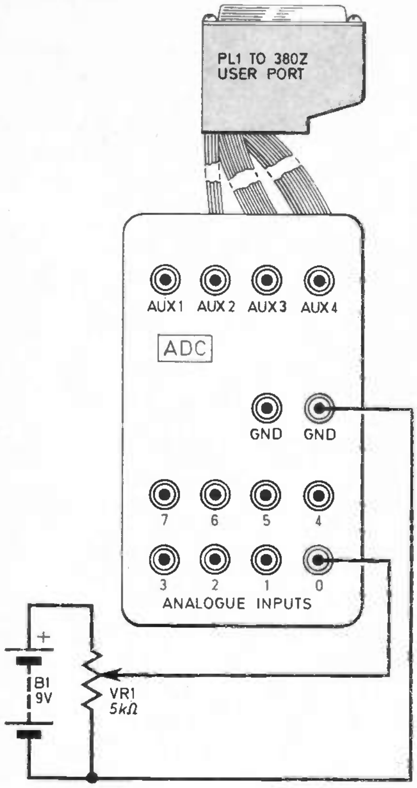


Fig. 7. Simple test circuit for checking out the ADC unit. Use the "Test Routine" software given earlier.

TEST CIRCUIT

A simple test circuit which consists of a 9V battery whose voltage is divided by a 5 kilohm potentiometer is shown in Fig. 7. By twirling the wiper and thus altering the voltage at the wiper, the value of the data byte printed at grid reference 40,50 on the v.d.u. will be seen to vary between 0 and 230, corresponding to 0V and a maximum of 9V in this case; 255 is for a maximum of 10V, so the scale factor is easily calculated (=9/230).

The equation giving the relationship between the input voltage and the binary output is:

$$V = kN$$

where V = analogue input voltage
N = 8-bit binary output
k = a constant

In this particular case

$$N = 255$$

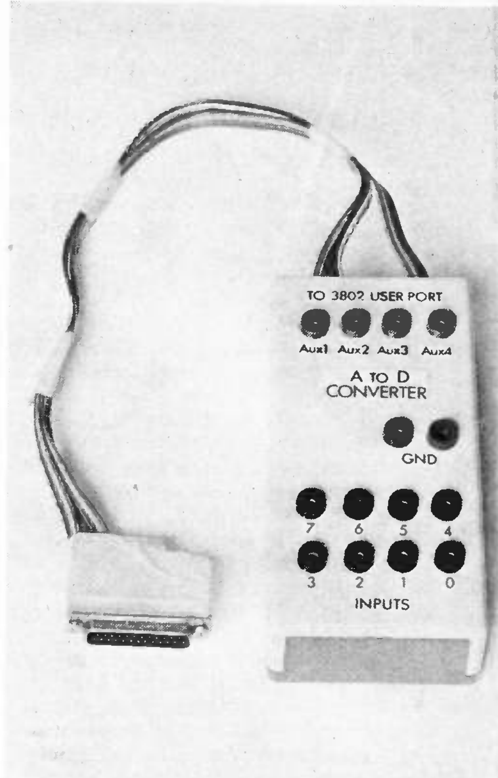
when $V = 10V$

and therefore the value of

$$k = 10/255$$

This, of course, can be written into the programme, so that the software will plot the actual value of the voltage in line 50 of the Test Routine rather than the decimal equivalent of the data byte.

If the above test was successfully carried out, you now have a useful instrument for use with a 380Z microcomputer in the science laboratory for many experiments. With suitable software, experimen-



tal results may be collected, stored, plotted and analysed. For ideas of its use see *Computer Aided Experiments*, page 600, a new series starting this month. □

COUNTER INTELLIGENCE

BY PAUL YOUNG

Ion Tonic

I would like to begin by thanking the readers who were kind enough to write to me on the subject of Ionisers (see May '83 issue). Their letters were all most enlightening, but the letter I found the most useful, came from Mr. C. Hyde of Beds.

With his letter he kindly enclosed the circuit of a simple apparatus which would give an indication as to whether the negative Ions were flowing, see Fig. 1. This could be mounted on a small piece of wood.

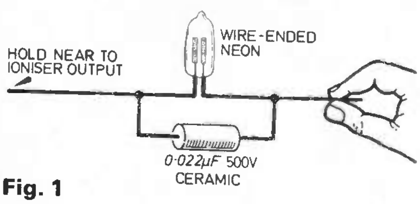


Fig. 1

The bare wire at one end is held between the thumb and index finger, and the bare wire at the other end is brought near the source of the negative Ion emission. The neon lamp will flash intermittently, and the closer it gets to the source, the faster it flashes.

It could be constructed for a few pence and is particularly useful for gauging when the needles from which the Ions flow need cleaning. I can confirm that the needles do become corroded in time and then the flow slows down. The best way to rectify this is to polish them with some fine emery cloth or sandpaper.

One reader told me that the Cockcroft Walton circuit tended to produce too much Ozone and therefore some of the commercial machines use a different circuit. I must confess I have not noticed it myself, although it always seems to be present when there is a high voltage discharge. It is a rather penetrating pungent smell which tends to irritate the membranes of the nose and throat.

Another reader successfully disposes of the "Placebo" argument by pointing out that negative Ions have been proved beneficial to animals. The thought had never struck me before, that it is useless giving a placebo to an animal.

Lastly a reader from Jersey pleads for a simple constructional article for an Ioniser. Well, Mr. Yates, I have some good news for you. I have it on the highest authority that you can expect to see such an article in EVERYDAY ELECTRONICS in the next two to three months.

Wide Interest

The other day, I was idly contemplating the difference between two contrasting professions, the Antique Dealer and the Electronic Engineer. Now before everyone starts muttering, "What on earth does old Paul Young know about Antiques?" I will have you know that my aunt had an Antique shop in North Road, Highgate Village, for many years. She also had a stall in the Caledonian Market every Friday. Now please keep this to yourselves, I wouldn't want it broadcast, but I sometimes used to look after the stall in the hope of extra cash.

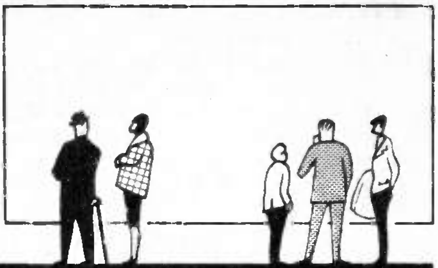
All this is by the way, but to me the interesting thing is this. The field of Antiques is fairly limited. Even so, in the case of my own relations, and no doubt this was repeated throughout the trade, they decided there was so large an area to be covered that the only satisfactory way to achieve it was by specialisation. Consequently, my aunt was an expert on China, my uncle Pictures, my cousin Furniture.

By contrast, the field of Electronics is expanding in all directions at the speed of light. I, and even colleagues who are considerably younger are almost overwhelmed by the speed of progress and the magnitude of the task of keeping abreast of modern practice.

I think all of us, have long realised, that the only hope is specialisation in a very narrow sector, and this, dare I say it, could become extremely dull and boring. I am glad to note that EVERYDAY ELECTRONICS is not proceeding along these lines, but keeping its interests wide and varied.

Long may this policy continue. All the same, there are times when I wish I had taken up Antiques.

SHOP TALK



BY DAVE BARRINGTON

Comptalk

While industry's attention has been firmly focused on "Office of the Future" systems, **Maplin Electronics** have just introduced, what they call, "Shopping of the Future" for its customers. It is now possible for orders to be placed directly with *their* computer by means of a customer's home or personal computer.

All the customer needs, apart from his home computer, is a modem kit and interface unit. A modem kit, £39.95, and a ZX81 interface, £19.95, are available now. Before long, it is hoped, that most popular microcomputer systems will be able to join the electronic shopping club.

Apart from the "interrogation" equipment, the prospective customer will need to be equipped with a Maplin catalogue product code number, a credit card number plus a conveniently sited telephone.

Having dialled directly into the Maplin computer system, the user will be able to access the stock file and place his order. The user's screen will display stock availability, the current price and total amount to be charged to the credit card account.

For more details of the Maplin Computer Shopping Service write to: **Maplin Electronic Supplies Ltd., Dept EE, PO Box 3, Rayleigh, Essex SS6 8LR.**

Constructor's Aid

Sometimes we hear from readers who, having seen an article in our pages, rush out purchase the components and then find, through one reason or another (usually lack of time), that they are unable to complete the project. Then there is the reader who has built his project but has difficulty in getting it to work.

When we receive letters from readers in this vein, we have to write back regretting that we are unable to accept and "troubleshoot" individuals models. We can only advise, from the information contained in the letter and about circuits published in EE, as best we can but this can only be in general terms as we cannot take into account the standard of construction.

Most faults are usually traced back to bad soldering, missing links or neglecting to make all the necessary cuts in copper strips. Always check the wiring against the circuit—we are not immune against errors ourselves.

We have just heard that **Webb Logic Systems** have spare capacity in their workshops and are prepared to undertake the task of sorting out readers' problems with any published design. They claim they will build, test and/or repair any partially or completed projects.

The average cost for the complete assembly of most projects is in the region of £10 to £20. But they do reserve the right to make exceptions to the costing in cases of (in their assessment), complex and poorly submitted models.

We have not seen the service in action, but feel sure that readers will welcome this facility. For more information readers should write to: **Webb Logic Systems Ltd., Dept EE, Gainsborough House, 15 High Street, Harpenden, Herts AL5 2RT.**

CONSTRUCTIONAL PROJECTS

Distress Beacon

The instrument case for the pocket version of the *Distress Beacon* is available direct from Lascar Electronics Ltd., Dept EE, Module House, Whiteparish, Salisbury, Wilts.

The NiCad PP3 equivalent batteries were obtained from Ambit. Suitable equivalent are also stocked by various advertisers.

Other components likely to prove difficult to locate are the mercury switch, Xenon tube, diac and triac. The Xenon tube and transformer, diac and triac are available from Maplin. Several advertisers stock mercury switches and it should be possible to adapt these for this design.

A/D Converter

The D-type connector for the *A/D Converter* is available from Bi-Pak, Maplin, Electrovalue, Cricklewood and Rapid Electronics.

The 8-channel 8-bit analogue-to-digital i.c., type 7581, is stocked by RS Components, Order code 303-545. RS Components will *not* supply to the general public but must be ordered through a local recognised stockist.

Stylus Organ

The semiconductor devices appear to be the only item that could cause any purchasing problems for the *Stylus Organ*.

The dual transconductance amp. type LM13600N, seems to be only listed by Cricklewood, Maplin and Rapid Electronics. However, all components for this project are stocked by Maplin.

Microcomputer Interfacing Techniques

As far as components for this month's constructional projects, for the *Microcomputer Interfacing Techniques* series, go we cannot foresee any problems for the *Signal Conditioning Amplifier*. However, the ZN449 only seems to be available from JEE Distribution Ltd., Dept EE, 43 Stathville Road, London, SW18 4QX.

Computer Aided Experiments

The photodiode, with integral amplifier, used in the *Computer Aided Experiments* was obtained from RS Components and carries the stock number, 308-067. This device is only available from a recognised RS dealer.

We do not expect any component buying problems for the *Traffic Light Simulator* and the *Voltage Dualiser* projects.

EE PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE PCB Service, see list right. These are fabricated in glass-fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Remittances should be sent to: EE PCB Service, Everyday Electronics Editorial Offices, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques should be crossed and made payable to IPC Magazines Ltd.

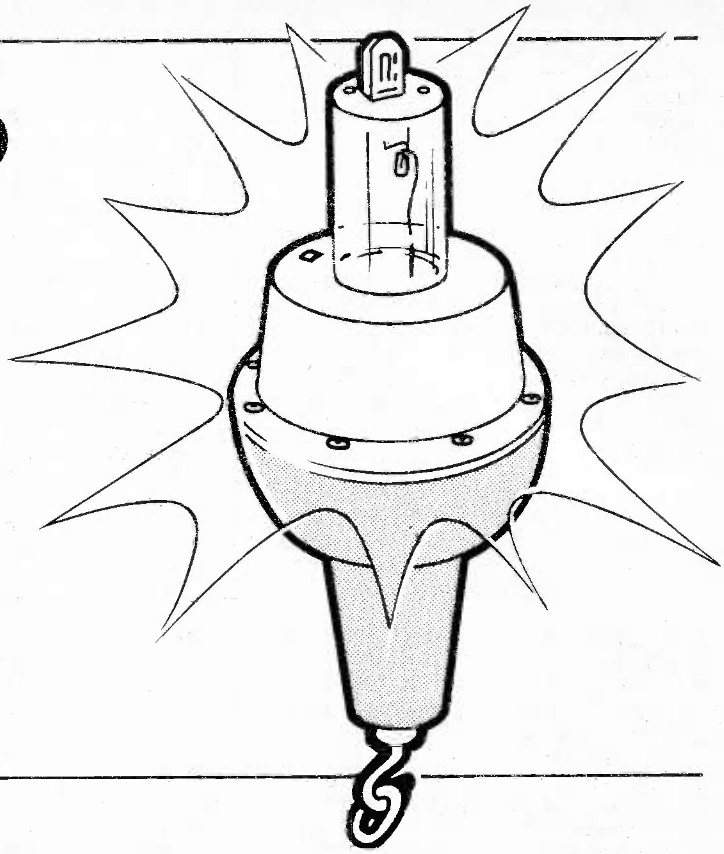
Readers are advised to check with prices appearing in current issue before ordering.

PROJECT TITLE	Order Code	Cost
Eprom Programmer, TRS-80 (June 83)	8306-01	£9.31
Eprom Programmer, Genie (June 83)	8306-02	£9.31
Eprom Programmer, TRS-80 & Genie (June 83)	8306-03	£1.98
User Port Input/Output *M.I.T. Part 1* (July 83)	8307-01	£4.82
User Port Control *M.I.T. Part 1* (July 83)	8307-02	£5.17
Storage 'Scope Interface, BBC Micro (Aug 83)	8308-01	£3.20
Car Intruder Alarm (Aug 83)	8308-02	£5.15
Electronic Die (Aug 83)	8308-03	£4.56
High Power Interface *M.I.T. Part 2* (Aug 83)	8308-04	£5.08
Pedestrian Crossing Simulation *M.I.T. Part 2* (Aug 83)	8308-05	£3.56
High Speed A-to-D Converter *M.I.T. Part 3* (Sept 83)	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Part 3* (Sept 83)	8309-02	£4.48
Stylus Organ (Sept 83)	8309-03	£6.84
Distress Beacon (Sept 83)	*8309-04	£5.36
Distress Beacon Pocket Version (Sept 83)	8309-05	£3.98

*Set of four boards.
M.I.T.—Microcomputer Interfacing Techniques, 12-Part Series.

DISTRESS BEACON

FOR MARINE USE PLUS A POCKET VERSION FOR FELL WALKERS & MOUNTAINEERS



BY P.E.HOPKINS

MAN OVERBOARD at night is a distressing experience both for crew as well as victim. Time is the essence, and quick positive action essential in order to avoid loss of life.

With the Distress Beacon mounted in an accessible position, and easily located by the small flashing light on the lamp housing, all that needs to be done is to toss it overboard. Immediately on hitting the water, the beacon is activated, emitting a powerful flash of light and providing a reference point both for swimmer and helmsman. A spiral rescue pattern working inwards to the beacon should soon effect a speedy rescue.

The beacon is totally sealed to prevent water entering, and is powered by nickel-cadmium cells, inductively charged from an external circuit, thus eliminating leakage or corrosion problems associated with connectors.

Constructors may prefer to use a casing of their own design, however, details are included of the moulding techniques as used in the original, and those that have had no previous experience in glass-fibre moulding may be delighted to discover how easy it really is using readily available moulds from off any supermarket shelf.

POCKET BEACON

For fell walkers, climbers and hikers, a pocket version of the Distress Beacon is also described. It is designed to fit into a calculator-type case and can be attached to an anorak or rucksack.

So if the user should become lost in darkness or mist, or fall injured and be unable to return, the Beacon will attract the attention of the rescue party.

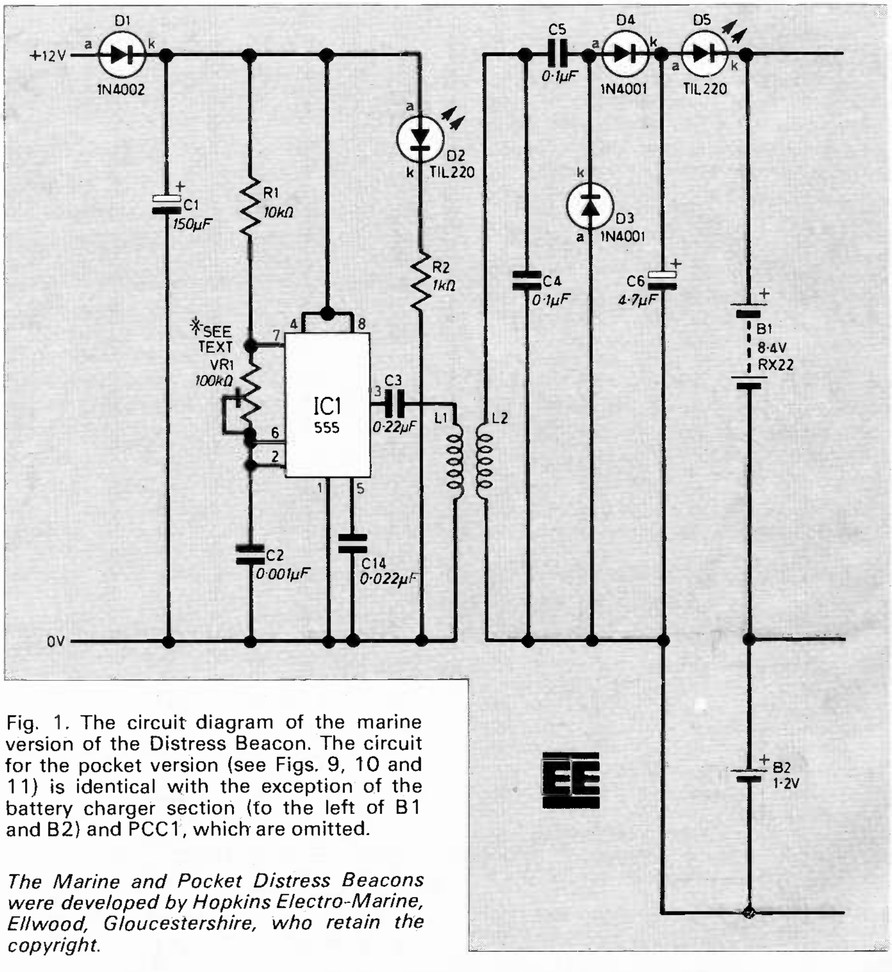


Fig. 1. The circuit diagram of the marine version of the Distress Beacon. The circuit for the pocket version (see Figs. 9, 10 and 11) is identical with the exception of the battery charger section (to the left of B1 and B2) and PCC1, which are omitted.

The Marine and Pocket Distress Beacons were developed by Hopkins Electro-Marine, Ellwood, Gloucestershire, who retain the copyright.

The circuit description for this version is identical with the exception of the battery charger section, as this is unnecessary, for the Pocket Beacon can use standard alkaline cells in place of ni-cads. The constructional details are given in a separate section.

SPECIFICATIONS

BEACON

Power Supply:	Internal ni-cad rechargeable batteries. PP3 equivalent 8·4 volts for xenon supplies, HP16 equivalent ni-cad for l.e.d. flasher supply, or button type cell if available for considerable weight saving
Current Drain:	50mA peak
Standby:	(Upright during daylight) 0·5mA
Inverted:	(Day or night) xenon supply (B1) zero mA. (B2) l.e.d. flasher supply 0·5mA
Xenon Flash rate:	Approx. every 7 seconds over a period of 2 hours on a fully charged battery
Energy Output of Light:	0·5 Joules

CHARGER

Supply:	12V d.c.
Current Drain:	60mA nominal
Frequency of operation:	6·5kHz
Charge rate:	5mA nominal
Efficiency:	10% max.

CIRCUIT DESCRIPTION

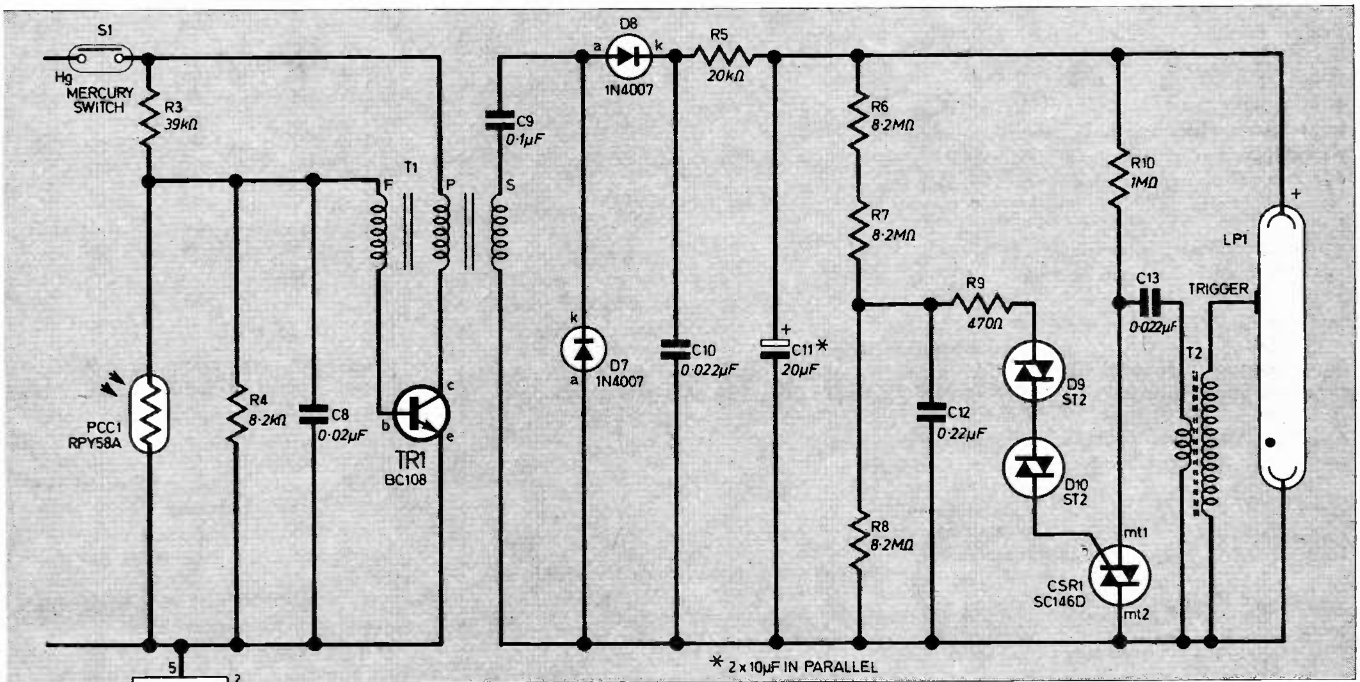
A single transistor oscillator based around TR1, working at a frequency of 20kHz converts the 8·4V battery supply via the secondary winding (S) of T1 and voltage doubler formed by D7, D8, C9 and C10 to a peak rail voltage in the order of 350V under no load conditions (see Fig. 1).

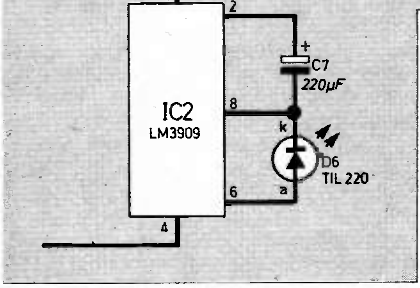
This peak voltage is, in reality, never achieved since current is constantly being bled via R5 to charge capacitor C11. At the same time, current is drawn from the h.t. supply through R6 and R7 to charge C12, and also through R10 to charge C13.

When the potential across C12 reaches a point approaching 80V (by which time C11 has charged up to 240V) the diacs (D9, D10) conduct, providing a trigger pulse to the gate of the triac, CSR1.

The triac turns on and shorts C13 to ground, and the rapid discharge through the primary of the trigger transformer (T2) induces a 3kV pulse in the secondary, which is fed to the glass envelope of the xenon tube (LP1). The normally non-conductive xenon gas is sufficiently energised by the high voltage pulse into a state of conduction, and the full charge held by C11 is able to discharge through the column of gas causing further excitation of the xenon atoms and the intense emission of light energy.

Once C11 has been discharged, the h.t. rail is reduced to zero volts, at which point the triac reverts to a non-conducting state. The charging sequence of C11, C12 and C13 begins to commence once more, and the cycle of events described repeats continuously until the power source is removed.





DAYLIGHT INHIBIT

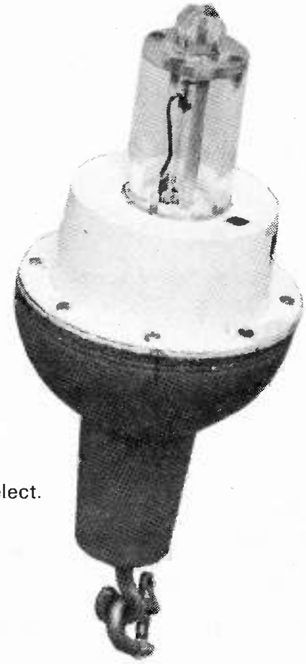
The light dependent resistor (PCC1) placed across R4 reduces the base bias of the transistor TR1 to a point where it can no longer operate under daylight conditions. To test the completed unit, it is therefore necessary to mask PCC1 with a piece of opaque tape.

When the beacon is not in use, it is hung upside-down. An l.e.d. (D6) located at the top of the lamp housing, and run by the LM3909 (IC2) produces regular flashes of light, making the beacon easy to find at night should an emergency occur. Once thrown into the water, the unit will float the correct way up and the internal mercury switch (S1) will connect the battery to the xenon flasher circuit and, providing the internal battery has been charged, flashing will commence within 20 seconds.

CHARGING THE BEACON

While the beacon is hanging in the inverted position, an energiser is placed into

COMPONENTS



See **Shop Talk** page 565

Resistors

R1	10kΩ
R2	1kΩ
R3	39kΩ
R4	8·2kΩ
R5	20kΩ
R6,7,8	8·2MΩ (3 off)
R9	470Ω
R10	1MΩ

All $\frac{1}{4}$W carbon ±5%

Capacitors

C1	150µF 16V miniature elect.
C2	0·001µF ±5% polystyrene
C3,12	0·22µF polystyrene (2 off)
C4,5,9	0·1µF polystyrene (3 off)
C6	4·7µF 35V tantalum
C7	220µF 6·3V miniature elect.
C8	0·02µF miniature ceramic
C10,13,14	0·022µF polystyrene (3 off)
C11	2 × 10µF 450V(= 20µF) miniature elect. (in parallel, see text)

Semiconductors

D1,3,4	1N4001 (3 off)
D2,5,6	TIL220 0·2in red l.e.d. (3 off)
D7,8	1N4007 (2 off)
D9,10	ST2 diac (2 off)
TR1	BC108 *npn* silicon
CSR1	SC146D triac
IC1	555 timer
IC2	LM3909 l.e.d. flasher

COMPONENTS approximate cost £18.00 excluding case

Miscellaneous

VR1	100kΩ miniature preset
LP1	xenon tube (Maplin YQ62S)
T1	see separate list
T2	trigger transformer (Maplin YQ63T)
B1	RX22 8·4V ni-cad (PP3 equivalent)
B2	1·2V ni-cad cell (see text)
S1	mercury switch
L1, L2	see separate list

Printed circuit boards: *EE PCB Service,* Order code 8309-04; raw materials for casing (see separate list); small case for charger, 35 × 35 × 20mm; battery connector; 7/0·2mm wire; small-bore aluminium tube; spacer, 15mm long; eye-hook; foam pads; silica gel in muslin bag; FX2238 ferrite core plus bobbin (for T1); silicone rubber; assorted screws (non-corrosive); 40 s.w.g., 36 s.w.g. and 30 s.w.g. enamelled copper wire.

Transformer (T1)

Windings
Primary 12 turns 30 s.w.g. enamel wire (marked P)
Feedback 3 turns 30 s.w.g. enamel wire (marked F)
Secondary 240 turns 36 s.w.g. enamel wire (marked S)

Wind first the primary and feedback windings alongside each other. Mark the start and finish of each winding, and cover this first layer with one turn of the paper tape. Next wind on the secondary. Care must be taken to lay the windings neatly, otherwise the bobbin will not enter the cores. When complete, finish off with one layer of paper tape to hold the windings in place and add fine bore plastic sleeves to the start and finish of the three windings. Assemble the bobbin and cores holding them together with a screw and nut, and immerse the transformer in hot paraffin wax.

Inductors

Energiser (L1) 250 turns 40 s.w.g. wire wound over a length of 10mm on a 20 × 6mm diameter ferrite rod (Fig. 6)

Receptor (L2) 220 turns of 36 s.w.g. wire wound over a length of 10mm on a glass-fibre tube (Fig. 7)

a receptor. In the charger, a 555 timer running at a frequency of 6·5kHz provides pulses that are fed to the energiser coil, L1, producing an alternating magnetic field.

This field induces an alternating current in the receptor coil, L2, which is rectified to produce the d.c. potential necessary for charging the ni-cads. An l.e.d. (D5) will light, indicating that charge is being transferred into the beacon.

CHARGER CIRCUIT

A 555 timer (IC1) running in the astable mode at 6·5kHz provides pulses which are fed via C3 to the energiser coil, L1. The signal from L1 passing through the beacon shell induces a resonant field in the tuned circuit formed by the receptor coil L2 and capacitor C4. The voltage produced across L2 is further increased by the doubler network formed by D3, D4, C5 and C6 to provide the charging potential required to the ni-cads B1 and B2.

The in-line l.e.d. (D5) indicates that charge is passing into the batteries, which for the cells specified will be reached in a little over 24 hours. The nominal charging rate for the ni-cads is 15mA—which is the maximum permissible current once the cells reach full charge.

Since the charger unit described here delivers well below this figure, it may be left on charge for considerable periods without risk of damage to the batteries. This ensures that the beacon is always at peak operational performance. A very slight warming of the energiser coil is normal when the charger is in use.

CONSTRUCTION

CIRCUIT CONSTRUCTION

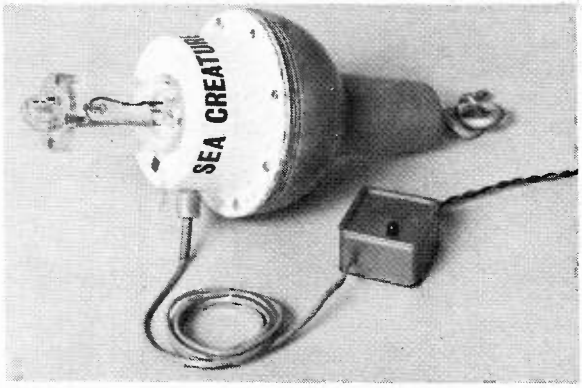
Few problems should be encountered in the circuit construction, providing miniature components are used wherever possible in order to save space and weight. Perhaps the most tedious job is cutting out two identical discs of circuit board, 65mm in diameter. A complete set of p.c.b.s for the marine version of the Distress Beacon is available from the *EE PCB Service,* Order code 8309-04.

The transformer (T1) winding details are given under the components listings, and as can be seen from the first p.c.b. layout (Fig. 2), connections into the p.c.b.1 will be found to be straightforward. The secondary windings marked G and S have to be connected to p.c.b.2 with short, well insulated leads, before the two boards are screwed together.

The two low-voltage windings are connected as follows: Feedback (finish), Primary (finish), Feedback (start), Primary (start), as viewed from left to right on the component overlay drawing.

Ensure that the mercury switch (S1) is mounted in such a way that battery, B1,

DISTRESS BEACON



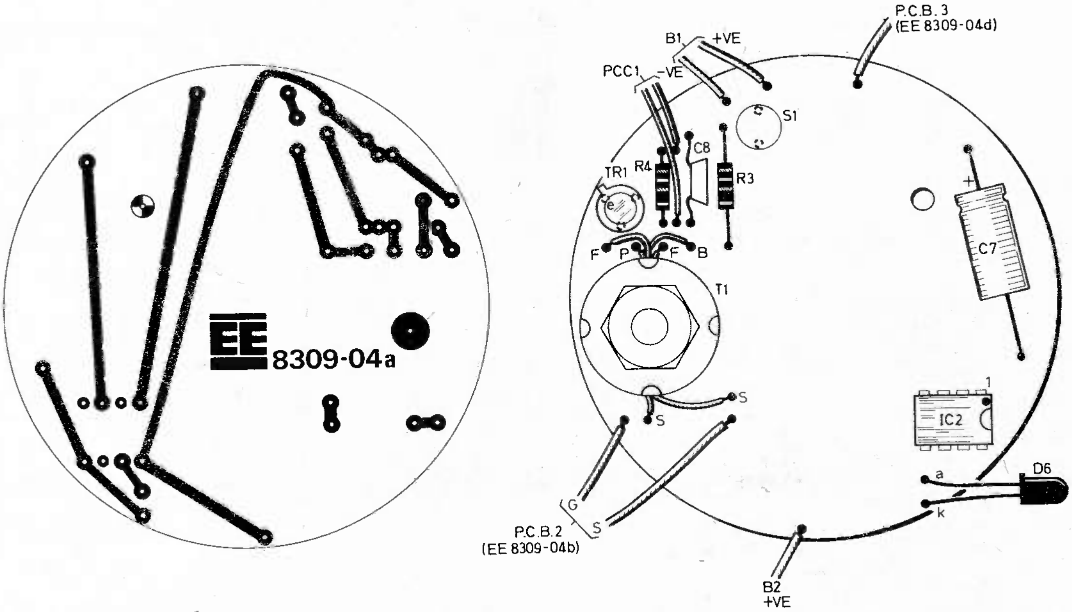
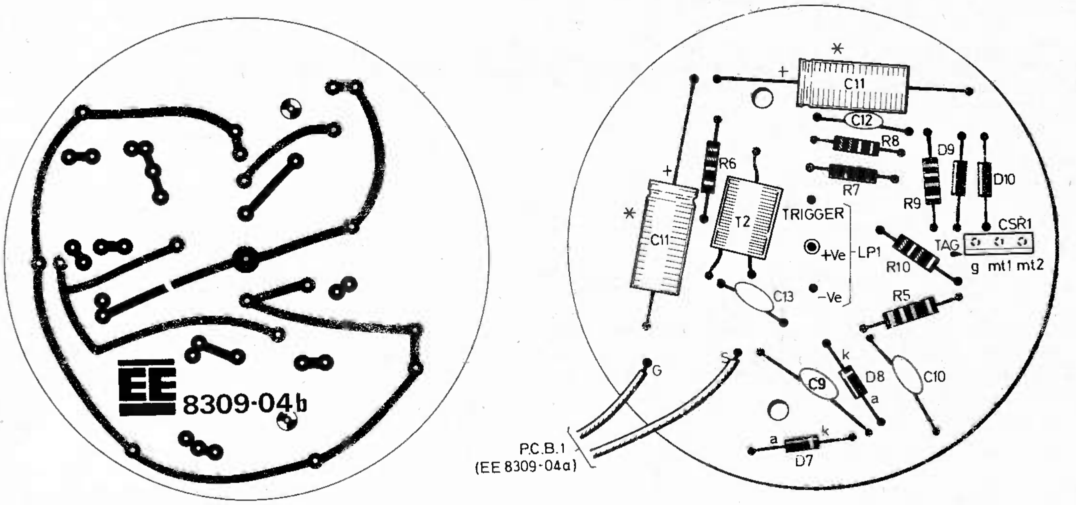


Fig. 2. The component layout and full-size artwork of p.c.b.1. Note that D6 is mounted at the top of the Beacon housing. Battery B2 is located on the space in the centre of this board.



*TO PRODUCE 20µF

Fig. 3. The component layout and full-size artwork of p.c.b.2. The xenon tube, LP1, is mounted onto stiff wire supports in the holes indicated (see also Fig. 4).

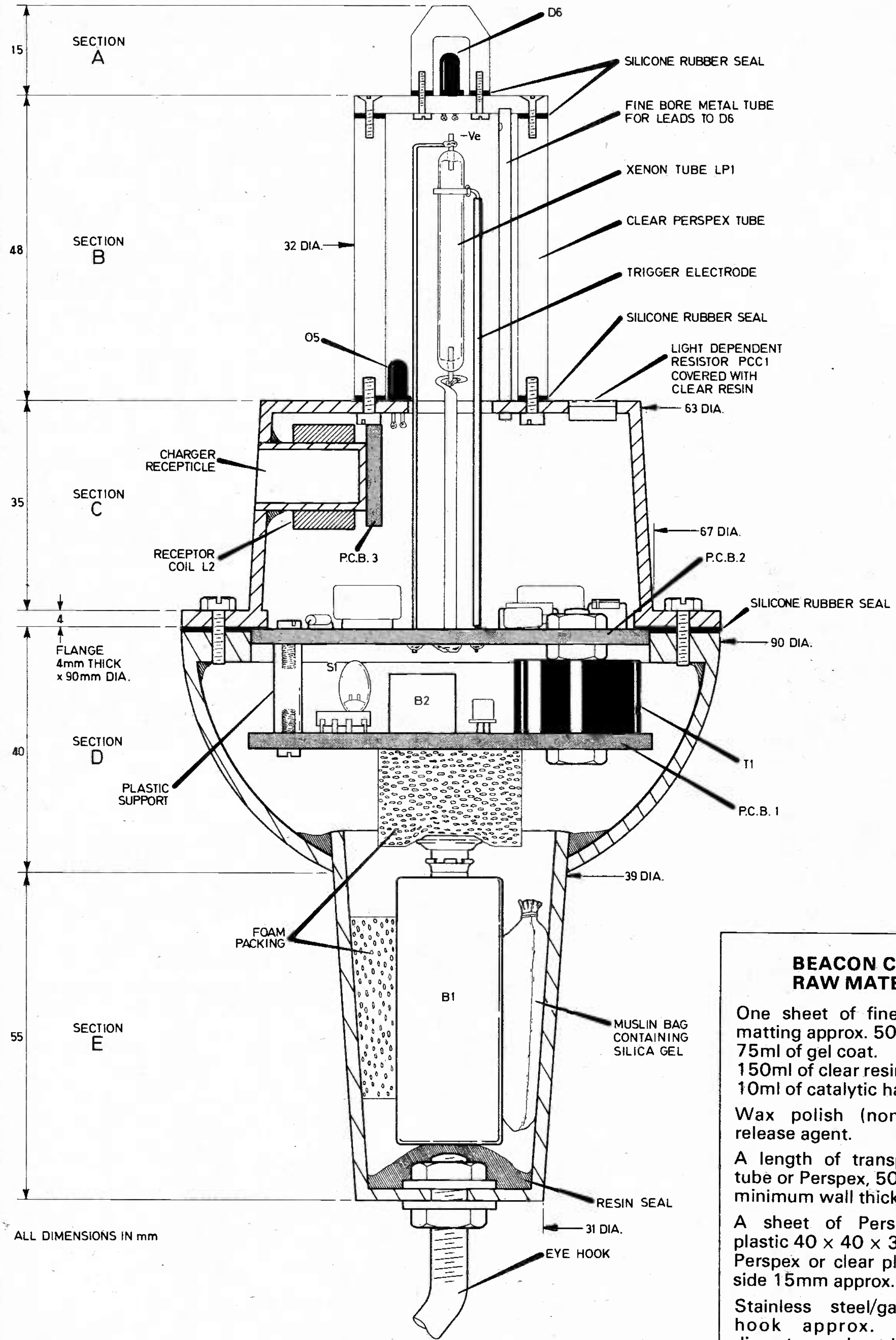


Fig. 4. A cross-section through the Distress Beacon housing giving all key dimensions and component locations. This diagram is drawn actual size.

BEACON CASING RAW MATERIALS

One sheet of fine glass strand matting approx. 500 × 500mm.
75ml of gel coat.
150ml of clear resin.
10ml of catalytic hardener.

Wax polish (non-silicone) or release agent.

A length of transparent plastic tube or Perspex, 50 × 32mm and minimum wall thickness 5mm.

A sheet of Perspex or clear plastic 40 × 40 × 3mm thick. Perspex or clear plastic block of side 15mm approx.

Stainless steel/galvanised eye hook approx. 5mm shaft diameter, and cut if necessary to a length of 40mm.

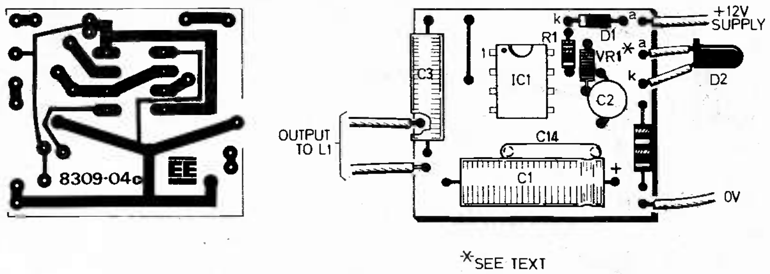


Fig. 5. The full-size artwork and component layout of the battery charger p.c.b. This fits into a small enclosure into which D2 is mounted.

is switched on only when the beacon is in the upright position. Note also that the light dependent resistor (PCC1) is not mounted on the printed circuit board, but is located as shown in Fig. 4 in the upper half of the beacon casing.

The battery, B2, that operates the l.e.d. flasher should be mounted on p.c.b.1 and soldered into position. The current consumption of IC1, the LM3909, is so low that a button-sized ni-cad may be used with a considerable weight saving.

As shown in Fig. 4, the two circuit boards are mounted on top of one another, and the screw that secures the potcore of T1 should be of sufficient length to pass through both p.c.b.s in order to bolt the two boards together. A plastic support drilled to take a self-tapping screw at each end should be positioned at a convenient place on the opposite side of the two boards in order to keep them parallel. Ensure that none of the components on p.c.b.1 are touching the printed track of p.c.b.2.

Three in-line holes at the centre of p.c.b.2 mark the position of the xenon tube supports which also serve as power connectors. A strip of brass 50mm long and 0·8mm thick was used as the central positive supply support, and a length of stiff wire cut to the correct length and with a 90 degree bend at the top end for the negative supply support. The trigger supply wire should be well insulated to minimise voltage losses en route to the glass envelope.

The l.e.d. (D6) supply which runs to the top of the lamp housing was positioned through a fine bore aluminium tube obtained from a model shop. The purpose of this tube is to keep the l.e.d. supply neatly stored away from the high voltage wires supplying the xenon.

TESTING

On completion of the circuit boards p.c.b.1 and p.c.b.2, connect up the battery, B2, and check that the l.e.d. flasher is operational. Next, with the PPC1 masked with opaque tape or temporarily disconnected, connect B1 and check that the current drain is between 40 and 50mA. Current in excess of this probably indicates a fault in the oscillator or h.t. winding of T1.

With a testmeter across C11, the voltage should steadily rise to 240V d.c., by which time the xenon should have fired. If no voltage exists across C11, disconnect R5 and check to see if there is a voltage across C10 in the order of 300V d.c. If not, check that the diodes D7 and D8 are properly positioned, and that the h.t. connections between the two boards are sound.

Should the voltage across C11 reach 240V without the xenon firing, the circuit should be switched off before the voltage rating of the capacitor is exceeded. Check the triac (CSR1) connections, trigger transformer and polarity of the xenon supplies.

CHARGER CONSTRUCTION

Construction of the charger p.c.b. is straightforward, and the layout is shown in Fig. 5. The prototype was housed in a miniature "Twinings Tea" sample caddy, reduced in height to measure 20 × 35 × 35mm. Any case of similar dimensions can be used.

Considerable care must be taken, however, in winding the coils L1 and L2 in order to minimise losses.

ENERGISER COIL

Following the dimensions given in Fig. 6, wind one turn of thin sticky paper onto a 20mm long by 6mm diameter ferrite rod. Starting 2mm from one end of the rod, wind on 250 turns of 40 s.w.g. enamelled wire in neat layers over a length of 10mm of rod.

Referring to Fig. 6A, pass the energiser feed wire through the base of a small plastic cap (as used to seal pill tubes). Slip in place a short length of plastic sheath and strip and tin the ends of the wire.

Prepare a small quantity of resin, and pour into the plastic cap as shown in Fig. 6B. When the resin has set, position the wires so that they are parallel and able to accommodate the diameter of the ferrite rod which should be placed in position by means of a further blob of resin (Fig. 6C).

When sufficient time has elapsed for the resin to harden, solder the coil ends to the feed wire, and pour a further quantity of resin into the cap to cover the first three millimetres of the ferrite (Fig. 6D).

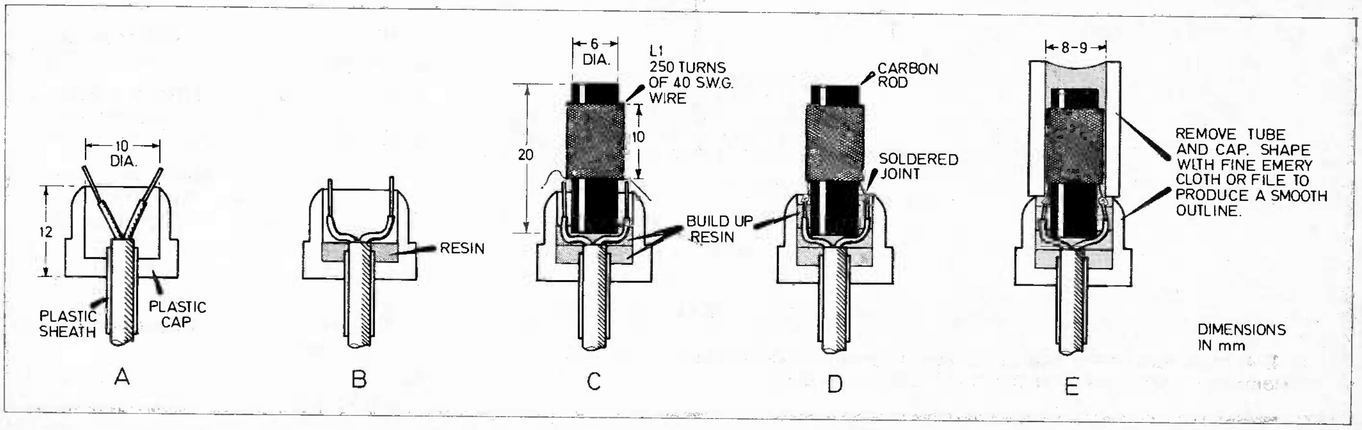
Lastly, the exposed length of ferrite and coil windings have to be covered in a regular layer of resin. One way to do this is to find a short length of plastic tube of 8 to 9mm internal diameter, coat the inside with a layer of resin, and coat the ferrite and coil.

Slip the plastic tube over the ferrite until the resin has set hard, and then carefully remove both the plastic tube and the plastic cap. The energiser coil will have a regular finish as in Fig. 6E.

RECEPTOR COIL

Find a former with an outside diameter of no more than 0·5mm greater than the

Fig. 6. The step-by-step construction of the energiser coil, L1, shown in cross-section. Note that the windings must be completely enclosed in resin.



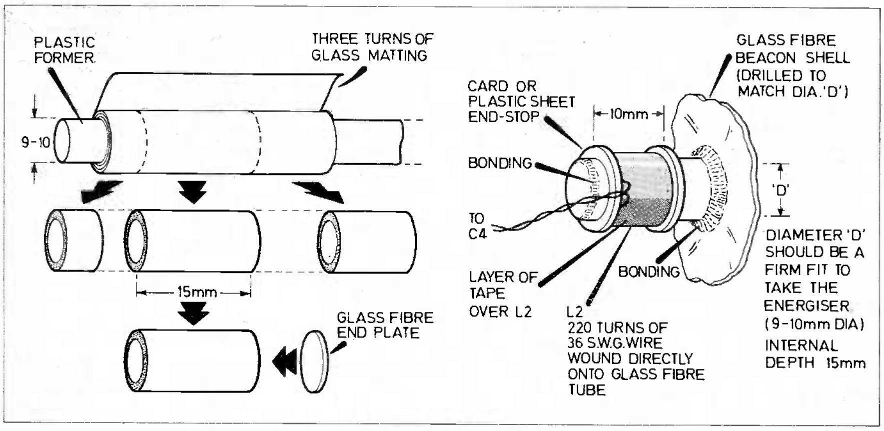


Fig. 7. The constructional details of the receptor coil, L2. Note that it should be tested before bonding to the Beacon shell.

diameter of the completed energiser (disregarding the enlarged region where the supply lead enters). Clean and polish the surface with furniture polish, and apply a thin regular layer of gel coat. When the gel has hardened, apply three turns of fine glass matting and resin (Fig. 7). When set, ease out the former and cut off the ends to form a tube 15mm in length.

Using a waste fragment of glass-fibre from the beacon casing, cap one end of the tube as shown by applying gel coat to both surfaces, thus effecting a waterproof seal.

Starting 2mm from this join, wind onto the tube 220 turns of 36 s.w.g. enamelled wire in compact layers over a distance of 10mm. Cardboard stops glued into position on the tube will locate the winding within these limits.

At this stage the coil should be checked before it is permanently bonded against a hole drilled through the beacon casing. Space inside the beacon is very limited and care should be taken to select miniature components for the receptor board which, only if space permits, should be bonded to the receptor coil, otherwise it will have to be located elsewhere inside the beacon shell. The layout of the receptor coil p.c.b. is shown in Fig. 8.

For testing purposes, temporarily link receptor coil (L2) to receptor board and link batteries B1 and B2 in circuit observing correct polarity. Place energiser coil into the receptor tube and connect charger board to a 12V d.c. supply. D5 should light indicating that charging has commenced. Check that current drawn by the charger board is between 40 and 60mA, and that the charging current into the battery is 5mA, ± 1mA.

VR1 on the charger board should be set for maximum resistance, that is, 100 kilohms. Reduce this value slightly to see if the efficiency of coupling is improved. When the best position for VR1 has been found it may be replaced by a resistor of fixed value.

Excessive currents drawn by the charger board may be trimmed by a low value resistor placed in series with the supply—typically 20 to 30 ohms. Further adjustments to compensate for the variation in the properties of the inductors L1 and L2 may be effected by slightly altering the value of the tuning capacitor C4.

BEACON CASING

Glass-fibre is not in itself waterproof, and thus the outer surface of the beacon is coated in a layer of gel coat, which is obtainable in a variety of colours. You will find that most small boat repair yards will not only be willing to supply gel coat in the small quantities required, but will also supply you with the rest of the materials for moulding the beacon, providing that you are suitably equipped with an assortment of clean jam jars.

A catalyst has to be mixed in with both gel coat and resin in order to initiate the hardening process. The catalyst contains the toxin Styrene, and should be handled with utmost care, and only used in the recommended proportions as given by the supplier. Usually mixing proportions are in the order of one part hardener to fifty parts of resin/gel coat.

Except for the lamp housing (Section B, Fig. 4), which should be made from clear Perspex or plastic tube, the rest of the beacon was moulded with the following items:

Section C—"Chambourcy" cheese-cake container.
Section D—Top cover of an "Airball" air freshener.
Section E—A "Blue Flush" W.C. treatment container.

Should any of the above be unavailable, the great variety of plastic lids and caps found on supermarket shelves should provide a near equivalent.

MOULDING

Each container should be washed, dried, and polished with wax polish. Next, a thin layer of gel coat, with hardener added, was applied using a small glue brush to the inside of the container. When the gel coat had started to harden, a second thin layer was applied on top.

Fine glass matting was then applied in small strips, each strip being firmly pressed onto the gel coat by means of a stippling action with the glue brush dipped into resin. Three layers of glass matting and resin should be sufficient to give the required strength and rigidity.

When the three sections C, D and E have been moulded, a circular hole should be cut through the centre of the base of section D, and the rim of section E bonded in place using glass matting and resin. Seal any cracks on the outside about the join with gel coat, and cover with Sellotape until cured.

A lip must be formed around the internal circumference of the top of section D, and this may be achieved by trimming an inverted "mousse" container mould, and inserting it into the glass-fibre shell to form a trough, 5mm in depth, between the mousse mould and shell. Into the formed trough, a mixture of resin and glass-fibre should be poured until it is flush with the rim of the casing. When set, the mousse mould should be removed, and the newly formed lip ground smooth using an abrasive sheet placed on a flat surface.

FLANGE

A flange has to be formed onto section C in order that it may be bolted to section D when the beacon is completed. Using two plastic or Formica sheets, apply gel coat to one surface, and when set, lay down glass matting and resin until a

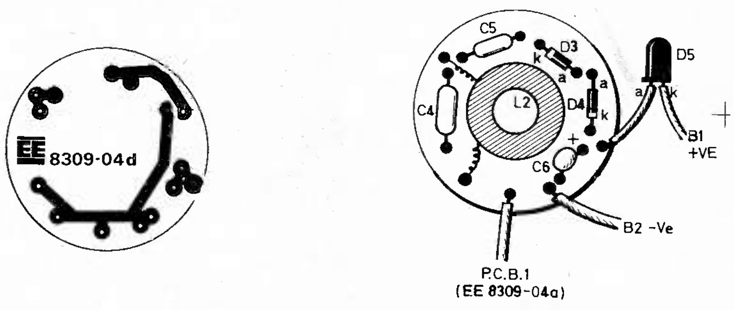


Fig. 8. The component layout and full-size artwork of the receptor coil board (p.c.b.3). Note that the components are mounted onto the track-side. D5 is remotely mounted in the Beacon as shown in Fig. 4. The receptor coil, L2, is wound onto the former as shown in Fig. 7 and connected to the position indicated.

depth of 4mm has been achieved. Apply gel coat to one surface of the second plastic/Formica sheet and place firmly, gel coat downwards, on top of the first sheet to form a gel–glass-fibre–gel sandwich.

When cured, the plastic sheets may be removed and the flat glass-fibre sheet cut with a small saw to form the flange to be bonded to section C.

Eight screw holes should be marked and drilled at equal intervals around the middle of the flange, and corresponding holes in the lip of section D.

Four holes should be drilled in the top of section C, and corresponding holes carefully drilled in the base of the clear plastic tube of the lamp housing. Four more holes are required at the other end of the lamp housing, and a small disc of Perspex or plastic cut and drilled to fit. The l.e.d. flasher (section A) is cut from a 15mm block of clear plastic, drilled to accommodate the l.e.d. and securing bolts, and polished using a 400 grade abrasive sheet followed by Brasso-type metal polish.

The base of section E should be drilled to take an eye-hook cut to a length of 40mm and with a shaft diameter of 5mm. This should be secured with a nut and washer on each side of the glass-fibre shell, the thread being first dipped in gel coat, and sealed on the inside of the beacon with a further amount of gel coat as illustrated in Fig. 4.

Assemble the complete beacon casing to ensure that a good fit has been achieved between the mating surfaces. Non-rust screws should be selected with regard to the thickness of materials through which they have to pass, and threads must be tapped with utmost care.

FINAL ASSEMBLY

During the final assembly of the beacon, all mating surfaces and screw threads are coated in silicone rubber to ensure total sealing against water.

Cut a small slot in the centre of section C just large enough for the xenon tube to pass through into the lamp housing, also a hole for the PCC1 as positioned in Fig. 4. Bond PCC1 into position using clear resin on the external surface to permit passage of light, and back with a small layer of resin and glass matting on the underside of section C to give mechanical rigidity.

Bolt section B to C, using silicone rubber to seal. Drill a 3mm diameter hole adjacent to the internal wall of the lamp tube through the top of section C. Insert a 54mm length of small-bore metal tube through this hole, so that it passes up to the top of the lamp tube.

Install D6 into the clear plastic l.e.d. housing and screw into position on the 32mm diameter plastic disc that seals the top of the lamp tube. Solder a couple of thin wires onto the l.e.d. leads, insulate the solder joints with a little plastic sleeving, and pass the two wires down the fine metal tube previously positioned within the lamp tube. Screw l.e.d. housing assembly onto the top of the lamp tube and feed through any excess wire from the l.e.d. assembly down into section C.

Drill a small hole through p.c.b.2 at any convenient position, away from parts of the circuit bearing high voltage, and pass the lead wires from the l.e.d. and PCC1 through this hole. Insert xenon through the hole in the centre of section C, solder D6 and PCC1 wires to their positions on p.c.b.1. Add small blobs of silicone rubber to the perimeter of p.c.b.2 and place the circuit board against the protruding flange of section C.

Check that B2 is connected and that D6 is operational. Connect battery B1 and place it into the base of section E, along with a small bag of silica gel to absorb any moisture that may build up inside the beacon once sealed. Add a small quantity of foam packing, if necessary, to prevent movement within the battery compartment.

Connect charger wires to the batteries, cover PCC1 and check that xenon flashes when the lamp housing is vertical. Connect up external charger circuit, insert energiser coil into the recess in the beacon shell and check that the charging l.e.d. (D5) operates.

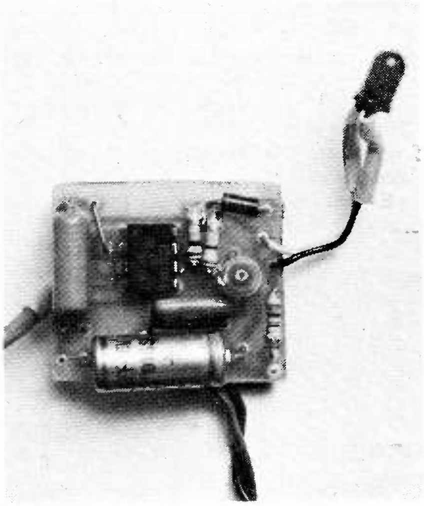
Glue a piece of foam rubber to the base of p.c.b.1 so that it helps support the circuit assembly. Smear silicone rubber onto the two mating surfaces of sections C and D, working the sealer well down into the eight screw holes, and screw the two sections together.

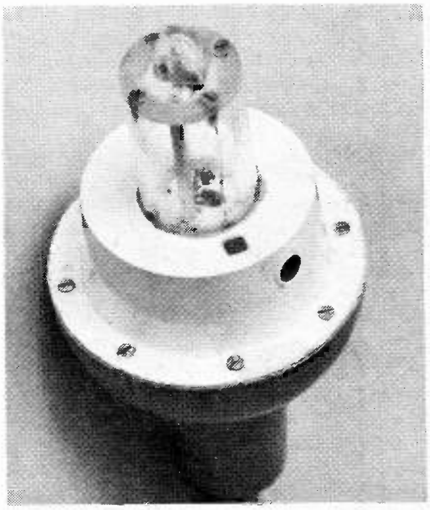
Hang the beacon in an inverted position and allow the silicone rubber seals to harden, during which time the charger may be inserted and the beacon is ready for use within 24 hours.

NOTE ON BATTERY SUPPLIES

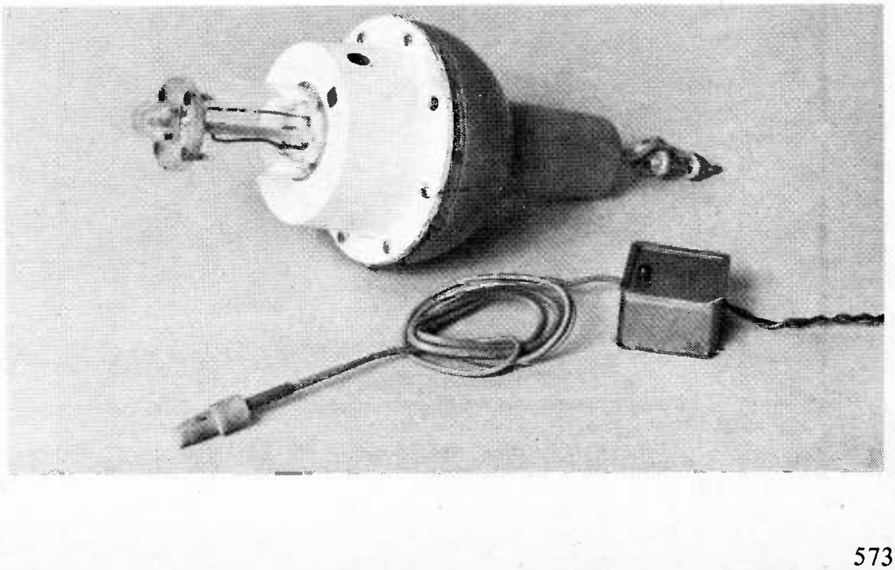
Considerable difficulty was experienced in obtaining ni-cad cells of suitable size and capacity. Varta are able to supply the 170 DK, of which eight are required (seven for xenon, one for l.e.d. flasher). However, since Varta impose a £30 small order charge, it was found to be more economical to obtain a couple of PP3 ni-cad equivalents. One "PP3" was used to power the xenon, the other was broken up and one cell* removed to power the l.e.d. flasher.

* Equivalent to Varta 100 DK0.





The charger p.c.b. (above left) is mounted into a small plastic case. The top view of the Distress Beacon (above right) shows the light dependent resistor and the recepticle for the charger coil. Below, the shape of the charger coil can be seen.



POCKET DISTRESS BEACON

THE pocket Distress Beacon is designed for non-nautical applications and as such, does not need to be in a sealed case. Therefore, the inductively coupled charger and the rechargeable batteries are not required and replaceable alkaline batteries (the Duracell type) can be used.

Referring to the main circuit diagram in Fig. 1; all the circuit to the left of the batteries B1 and B2 is omitted (that is, D1 to D5, C1 to C6, R1 and R2, L1 and L2, VR1 and IC1). S1, the mercury switch, is replaced with a normal slide switch and the light dependent resistor PCC1 is also left off. All other components are used and, for convenience, the references are unchanged on the constructional diagrams.

P.C.B. ASSEMBLY

Preparation of the printed circuit board shown in Fig. 9 is fairly straightforward, the only special precautions necessary are in the mounting of the pot-core for T1 and the two electrolytic capacitors forming C11.

These components need to be mounted in cut-outs in the p.c.b. due to the height restrictions imposed by the Lascar instrument case (as used for small hand-held instruments) employed in the design.

The pot-core of T1 is held together with a nylon screw. A nut is not used to secure the two halves together, but instead the end of the screw is passed through a spring steel clip (as used in the motor trade for securing self-tapping screws), and holding the pot-core firmly, the excess length of the nylon screw is trimmed, and the remaining stub melted over the clip with a hot iron.

The transformer was thoroughly sprayed with "Holts" ignition sealer to maintain interwinding insulation under damp conditions, and it is suggested that when complete, the whole circuit board is treated with several coats of sealer also.

Resistors, diodes and diacs should be inserted into the p.c.b. first as the capacitors will have to have their wire ends pre-formed in order that they may be mounted horizontally above neighbouring components.

The board is available from the *EE PCB Service*, Order code 8309-05.

LAMP REFLECTOR

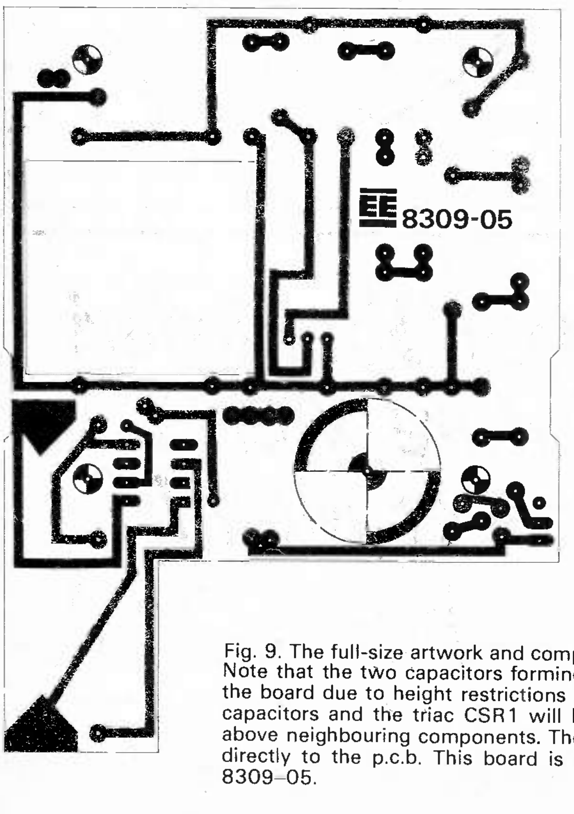
The curved reflector for the xenon tube was made from a 1mm thick sheet of plastic 70 × 40mm. This was gently heated in hot water until pliable, then set into shape by pressing over the side of a spent 55mm aerosol can.

When cool, the plastic sheet will retain its shape, and a 34mm wide strip of aluminium foil may be glued into position as shown in Fig. 10 to form the reflective surface.

Fig. 10 shows the dimensions of the xenon tube terminal supports which are passed through the reflector sheet, and glued into position. Ensure that the aluminium foil does not come into contact with the xenon tube supports otherwise the power supply to the tube may be shorted out.

POWER SUPPLIES

A 9V alkaline PP3 will fit snugly into the case in the space provided by Lascar. (Note: It was found that some makes of battery were too wide, and it was impossible to close the case completely. Allowing



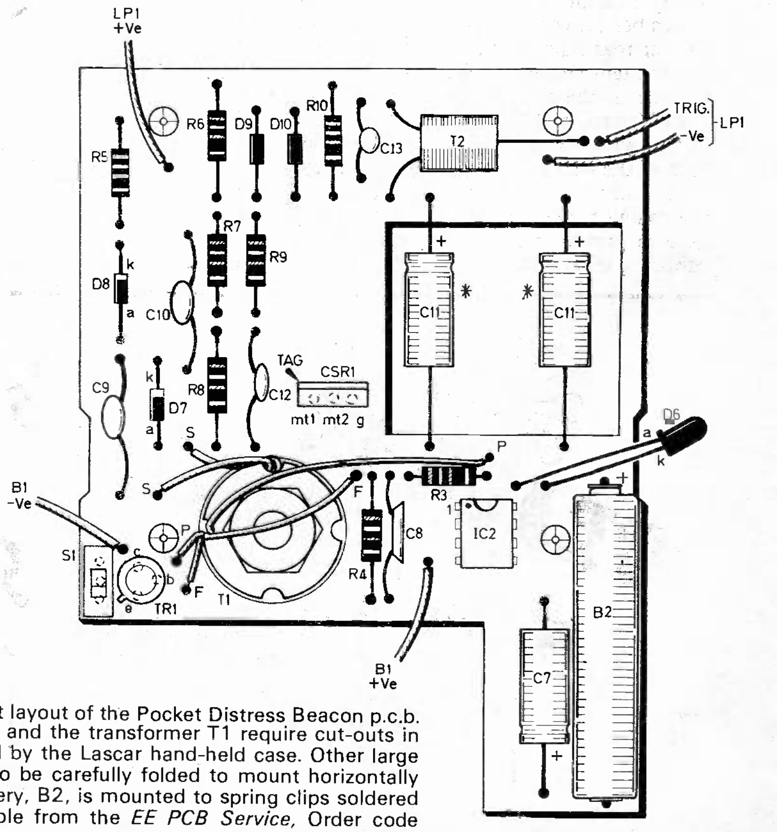


Fig. 9. The full-size artwork and component layout of the Pocket Distress Beacon p.c.b. Note that the two capacitors forming C11 and the transformer T1 require cut-outs in the board due to height restrictions placed by the Lascar hand-held case. Other large capacitors and the triac CSR1 will have to be carefully folded to mount horizontally above neighbouring components. The battery, B2, is mounted to spring clips soldered directly to the p.c.b. This board is available from the *EE PCB Service*, Order code 8309–05.

for production spreads, Duracell and Berec were found to fit well.)

The positive wire from the battery clip is soldered to a point indicated on the layout diagram, Fig. 9, and the negative to the miniature slide switch terminal is also shown.

The l.e.d. flasher is powered by a 1·5V battery (size AAA) and spring terminals should be soldered directly to the p.c.b. in order that the battery may be replaced easily.

The supply to l.e.d. D6 is taken from points located on the p.c.b. near to IC1. A small hole drilled through the mid-point of the top section of the case as shown in Fig. 11 is used to locate D6. This continuously flashing l.e.d. serves to locate the unit quickly if dropped or misplaced.

A lanyard should also be fixed to the casing, and this may be achieved by passing a length of nylon or polythene cord through a small hole drilled just below the casing catch. The end of the cord is then heated with a flame and flattened into a disc so that it will lie neatly between the battery and casing wall, and cannot be pulled out.

REFLECTIVE STRIP

A Perspex or clear plastic sheet should be cut to fit the case to protect the xenon tube. There is plenty of room to bond and seal, with silicone rubber, the window to the inside surfaces to the case. To this window, on either side of the xenon tube, reflective strips (as used on disco equipment and "custom" cars) are glued into position and act as a signal device under sunny conditions.

Amber reflective plastic sheet, as used for car rear number plates, is stuck to the upper main surface of the case. The rear surface of the pocket beacon is covered with Velcro, and the fixing patch of the fluffy nylon should be sewn to a suitable area of the wearer's anorak or rucksack.

It is advised that the mating surfaces of the casing halves are covered with sticky tape to prevent moisture entering, and a rubber gasket cut to fit over the slide switch, and positioned between the switch and internal casing.

OPERATION

In case of difficulties encountered while climbing or walking, the unit described will only be of use if used sensibly. Depending upon the quality of components used, and the care taken in winding T1, battery life will be found to be between three and five hours in the continuous flashing mode.

All walkers and climbers should always leave details of their itinerary with a friend or official so that action may be taken should they become overdue, and under such circumstances the pocket beacon used at regular intervals of time will remain usable far in excess of the three to five hours continuous running.

At temperatures below freezing, the beacon should be kept in a pocket until required to prevent the battery voltage from falling to a point where the unit would become inoperative. It is wise to carry a spare battery for your beacon at all times—as well, of course, for your conventional torch. □

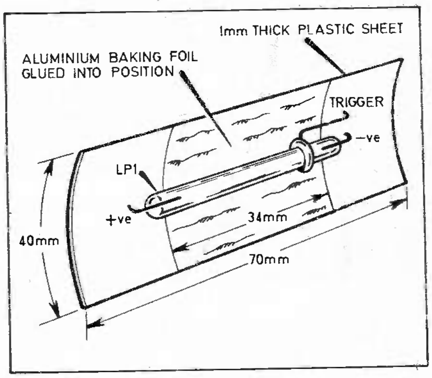
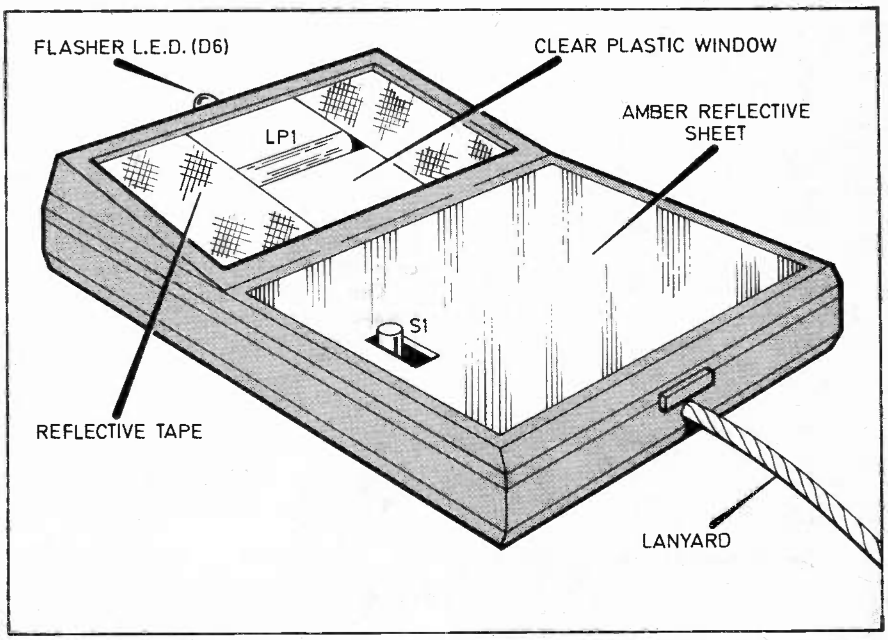
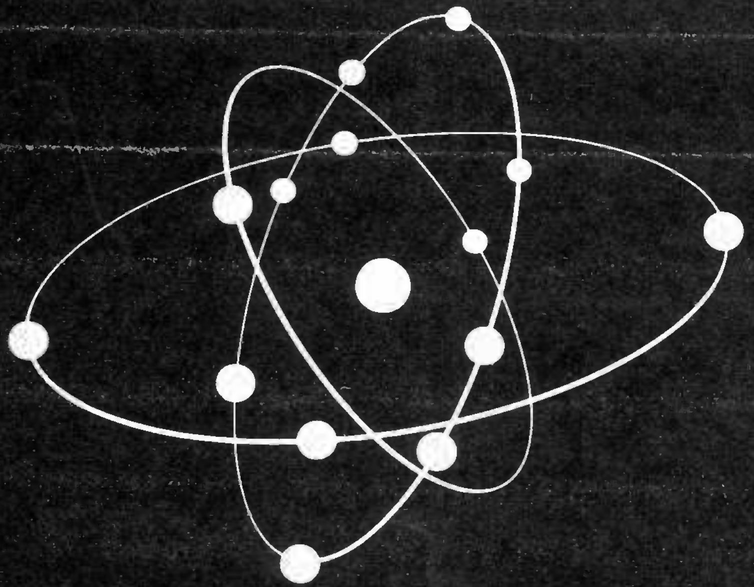


Fig. 10. Constructional details of the xenon tube reflector. The tube supports should be formed from well insulated, stiff wire.



ELECTRONICS and the ELECTRON



Part 5 DOPED SEMICONDUCTOR MATERIALS

BY J.B. DANCE

LAST month we discussed the mechanism by which conduction occurs in pure semiconductor materials. Conduction in such materials is known as "intrinsic conduction". In practical devices pure or intrinsic semiconductor materials are seldom used. Such devices employ semiconductor materials containing very small amounts of impurity elements which modify their properties considerably.

This month we shall consider how conduction occurs in semiconductor materials containing small amounts of doping elements as impurities. There are two main types of such materials, the one being known as *n*-type in which the charge carriers are the negative electrons and the other is known as *p*-type in which the charge is carried by positive holes.

N-TYPE MATERIAL

Let us first consider a silicon crystal lattice similar to the one we discussed last month but, as shown in Fig. 5.1, one of the atoms of silicon (Si) has been replaced by an atom of arsenic (As). When the arsenic has formed the four bonds to neighbouring silicon atoms, it still has an electron left over which is not taking part in the bond formation.

This extra electron present in the arsenic atom is not so firmly attached to the arsenic atom as any of the other electrons in the lattice. In other words only a small amount of thermal energy needs to be acquired by the electron to enable it to leave the arsenic atom and to wander through the crystal lattice. Thus this electron can lead to conduction in the crystal.

The conductivity of silicon can be greatly increased by the addition of very small amounts of elements such as arsenic. Even one part of arsenic in ten million parts of silicon or germanium can greatly affect the electrical properties of the material. The number of electrons provided by the impurity atoms is usually far greater than that provided by movement of electrons from the valency band to the conduction band.

The impurity atom in Fig. 5.1 provides an electron without creating a hole, since the arsenic atom has its full complement of four electrons in chemical combination after the extra electron has departed. Conduction in materials of this type is therefore almost entirely by negative electrons, the small number of holes providing a very small contribution.

Silicon doped with arsenic is known as *n*-type material, since negative charge carriers (electrons) carry the current. The arsenic atoms are known as "donor" atoms, since they donate electrons to the silicon lattice.

N-TYPE ENERGY BANDS

The energy band diagram of an *n*-type material is shown in Fig. 5.2. It should be noted that this is rather similar to the energy band diagram for a pure semiconductor material, but there are two important differences. The first is the presence of the donor band just below the conduction band.

Only a small amount of energy is required to lift an electron from the donor band into the conduction band. This results in the second difference in the energy band diagram, namely that there are many more electrons in the conduction band than in the case of the pure semiconductor material.

P-TYPE MATERIAL

Another type of semiconductor material is shown in Fig. 5.3, in which the central atom of silicon (Si) has been replaced by an impurity atom of boron (B). The boron atom has only three valency electrons as opposed to the four of silicon. There is therefore a hole or vacancy by the boron atom which can be filled by an electron from the valency band of another atom.

As shown in Fig. 5.3, an electron can move from a neighbouring silicon atom to fill the hole by the boron atom, in which case the boron atom will have four chemical bonds to neighbouring atoms instead of the three shown in Fig. 5.3. In addition, the silicon atom which donates the electron to the boron will have a hole left by it and an electron from another silicon atom can fill this hole. Thus this movement of electrons can be considered as a movement of a hole, as discussed last month.

Silicon or another semiconductor material containing atoms of an element like boron as an impurity, is known as *p*-type material, since conduction is considered to occur by the movement of positive holes (although it is actually the movement of many negative electrons which causes the conduction).

P-TYPE ENERGY BANDS

The energy band diagram of a semiconductor material containing impurity atoms such as boron, is shown in Fig. 5.4. The energy band gap of the material is essentially unchanged, but a new acceptor band has appeared just above the valency band. This acceptor band can accept electrons from the valency band and leaves holes in the latter which greatly increases the conductivity.

It should be noted that boron is only

one example of an acceptor type of impurity atom which produces *p*-type material; another example is indium. Similarly, arsenic is one example of a donor impurity atom which produces *n*-type material; others are antimony and phosphorus.

CARRIER RECOMBINATION

When electrons and holes meet in a semiconductor material, the electron normally fills the hole. Thus electrons and holes are continually being removed as fast as they are created by thermal or other energy.

If a semiconductor material contains both *p*- and *n*-type impurities, the two types produce opposite effects and more or less neutralise one another. If there are more *p*-type impurity atoms than *n*-type, the material will be *n*-type.

In a *p*-type material the number of free electrons will be far less than in the pure intrinsic material. This is because there are a large number of holes in *p*-type material and any electron moving through the material will probably combine with a hole very quickly and be removed.

Similarly, in *n*-type material the number of free electrons is large, so any hole moving through the material will quickly be removed as it meets one of the electrons. The product of the hole and the electron concentration is constant for a given semiconductor material at a given temperature, no matter what impurities are present provided that the impurity concentration is small.

SEMICONDUCTOR JUNCTIONS

A semiconductor junction device may be made by employing *p*-type material on one side of the junction and *n*-type material on the other side. However, this type of junction must be fabricated as a single crystal—it is quite useless bringing a piece of *n*-type and a piece of *p*-type material together.

As soon as a *pn* junction is formed, holes from the *p*-type material and electrons from the *n*-type material diffuse across the junction. The electrons from the *n*-type material fill some of the holes in the *p*-type near the junction, whilst the holes from the *p*-type combine with some of the electrons in the *n*-type.

This flow of charge results in the type of picture shown in Fig. 5.5. The passage of positive charges to the *n*-type and negative charges to the *p*-type, results in the *n*-type material having a positive potential with respect to the *p*-type material.

JUNCTION POTENTIAL

There is therefore a potential across the semiconductor junction. Any more positive holes from the *p*-type material which tend to approach the junction are repelled away from the junction region by the positive charge of the *n*-type. Similarly, any electrons in the *n*-type moving towards the junction are repelled back in the *n*-type region by the negative charge of the *p*-type.

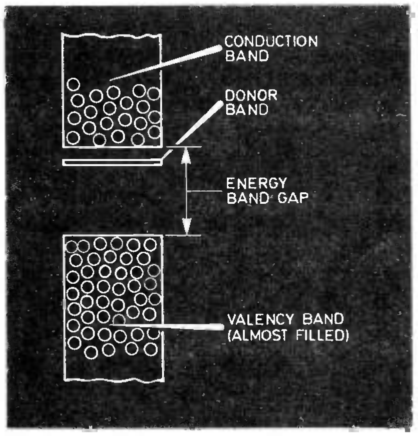


Fig. 5.2. Energy band diagram of an *n*-type semiconductor material.

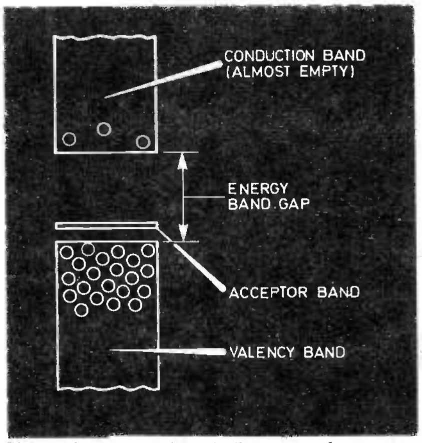


Fig. 5.4. Energy band diagram of a *p*-type semiconductor material.

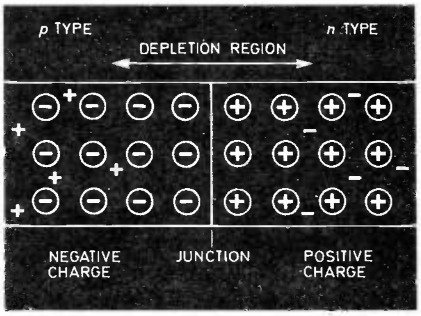


Fig. 5.5. A *pn* semiconductor junction. The charges shown encircled are fixed in position by chemical bonds, whilst the others are free to move.

Fig. 5.1. A silicon lattice containing an *n*-type impurity atom.

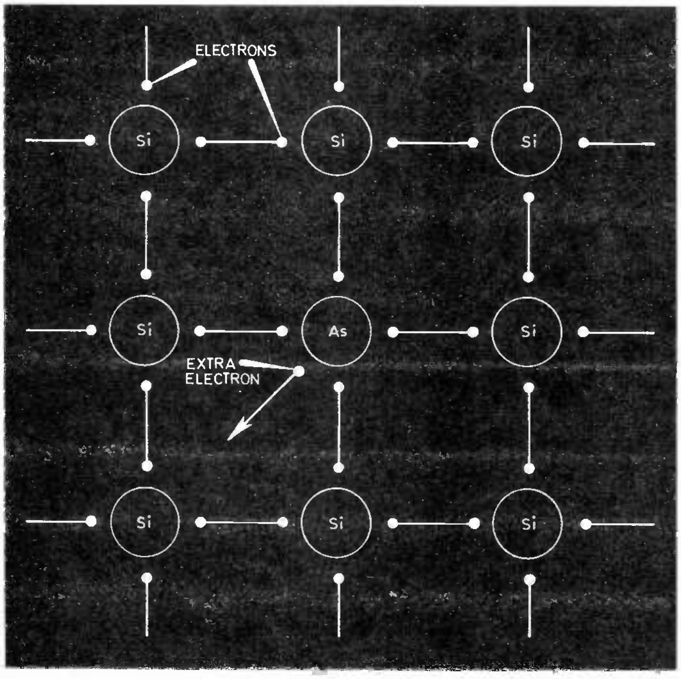
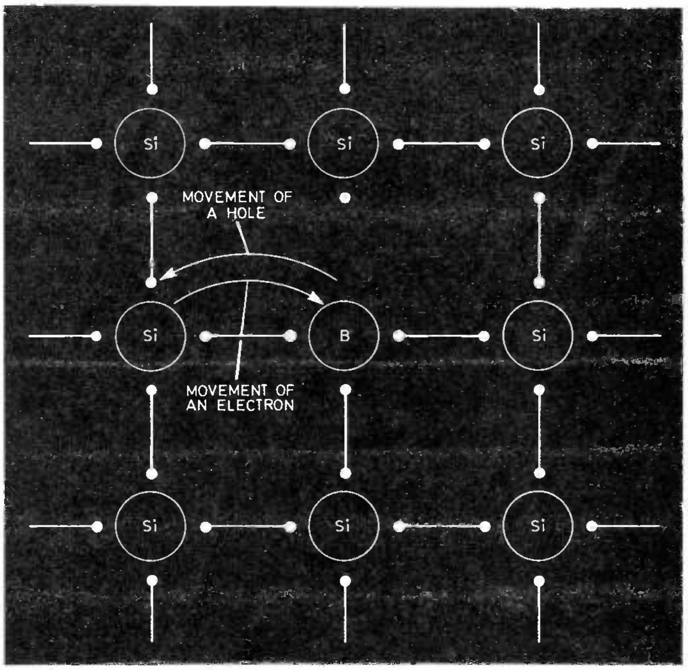


Fig. 5.3. A silicon lattice containing a *p*-type impurity atom.



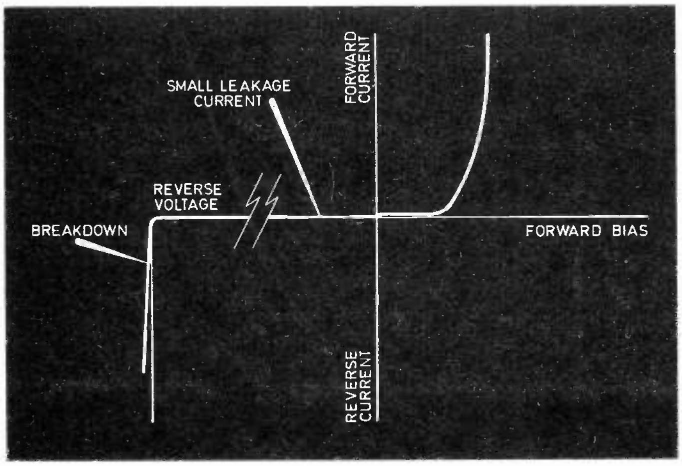


Fig. 5.6. Semiconductor junction diode characteristic showing the rapid increase of forward current with forward voltage. The reverse breakdown can be made to occur at quite high voltage.

There is therefore a region on each side of the junction which is depleted of charge carriers; this is known as the depletion region.

RECTIFICATION

If a potential is applied across the *pn* junction of Fig. 5.5 so that the *p*-type material is made more negative and the *n*-type more positive, the electrons in the *n*-type material and the holes in the *p*-type material will be repelled even further from the junction so that the depletion region is increased in depth.

As no charge carriers are present in the junction region when a voltage of this polarity is applied, no current can flow and the diode is biased in the reverse direction. Actually a very small current (known as the leakage current) flows, since the *n*-type material does contain a very low concentration of holes whilst the *p*-type material contains a small concentration of electrons.

The increase in the depth of the depletion region with reverse bias, results in a decrease in the capacitance across the junction, since the depletion region acts as an insulating region between the *p*-type and *n*-type materials, whilst these materials act as the plates of a capacitor. Thus a reverse biased junction diode can be used as a semiconductor variable capacitor the value of which is controlled by the applied reverse bias.

FORWARD BIASING

If, however, a voltage is applied to the junction diode in the other direction, that is with the *p*-type positive and the *n*-type negative, a different type of behaviour can be observed. The electrons in the *n*-type material are attracted towards the junction and the holes in the *p*-type material are attracted towards the junction also.

If the applied forward bias is not great enough to overcome the natural junction potential of the unbiased diode (about 0·55V in silicon) the diode will not conduct. When the forward voltage exceeds this value, however, the charge carriers are attracted across the junction and a forward current flows. The size of this forward current increases very rapidly with increasing voltage as shown in Fig. 5.6.

It can be seen that the reverse current remains very low until the junction undergoes breakdown, afer which the reverse current rises very rapidly with voltage.

The small reverse current which flows before the breakdown voltage is reached is due to minority carriers (that is electrons in the *p*-type and holes in the *n*-type). The concentration of these charge carriers increases rapidly with temperature and therefore the leakage current also increases rapidly with temperature. The leakage current is much smaller in silicon than in germanium diodes owing to the larger energy band gap.

OTHER DEVICES

Semiconductor junctions are present in almost all semiconductor devices. For example, two junctions are present in junction transistors (either *npn* or *pnp*), so many of the principles we have discussed can be applied to junction transistors. □

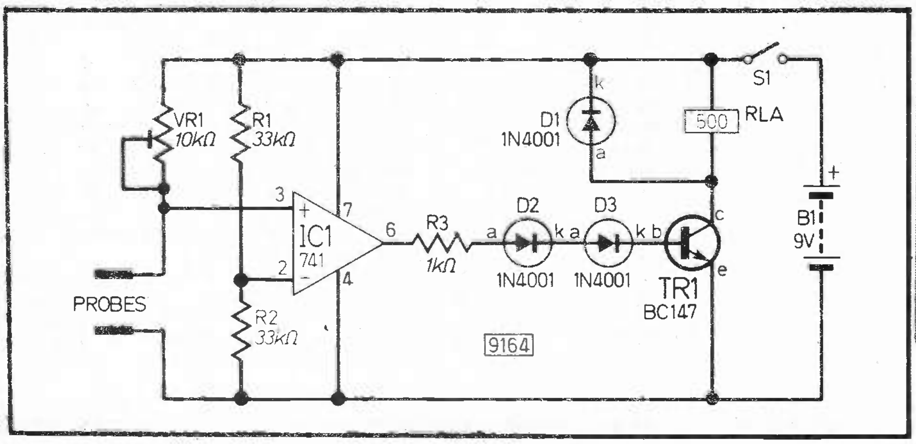
CIRCUIT EXCHANGE

AUTO WATER FEEDER

FEEDING water to plants can be automatically done using the circuit shown. When the soil moisture level falls to a pre-determined value, determined by R1, the relay RLA is turned on. The relay can be used to fire an alarm or activate an electrically-operated valve, which feeds water to the plant.

The probes are two thick wires or rods 120mm long, the upper ends of which are fixed to a piece of non-conducting board of suitable size (say, 40 × 20mm). The rods should be straight and parallel with a separation of 15mm from each other.

J. Sreekumar,
Cochin,
India.



MORE ON PAGE 611

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Video Facts

Sound is now becoming a major selling point in video. But much of what is written, and advertised, glosses over important facts. Here's what you should know if you are buying or renting a new video recorder and want good sound.

As I've previously explained, it's well nigh impossible to get genuine hi fi stereo sound from a domestic video cassette recorder. The stereo tape tracks are so narrow (around 0·25mm wide) and the tape speed so low (around 2·5cm/s, or half audio tape cassette speed) that it's a wonder that we can get anything at all.

The VHS manufacturers all use the Dolby B system, to improve signal-to-noise ratio. Some manufacturers, for instance National Panasonic, started to use the Dolby C system to cut tape hiss even further. But, unlike Dolby B, Dolby C isn't really compatible.

In other words although a Dolby B recording sounds reasonable when replayed on a machine without Dolby B circuitry, a Dolby C recording sounds distinctly odd. So Dolby C isn't finding favour.

Likewise the Sony Beta format noise reduction system, BNR or Beta Noise Reduction, isn't popular. It's more like DBX than Dolby, and thus cuts hiss quite dramatically. But like all powerful noise reduction systems, it can sometimes be heard breathing or pumping. Background hiss comes and goes with pulsating speech or sound.

It's a great pity that the Beta manufacturers, for political rather than technical reasons, wouldn't use Dolby. The inadequacy of BNR is why it's still difficult to get pre-recorded Beta video tapes with stereo sound.

Some of the software companies have been so unhappy with BNR that they've held back on Beta stereo releases. Thorn-EMI, for instance, took a decision to delay on Beta stereo releasing even though the company's catalogues had already been printed to advertise some films as available in Beta stereo.

Secretly the software companies are banking on the British launch of Beta hi fi. This system, now on sale in the US, puts genuine hi fi stereo sound into the video waveform as an f.m. signal. Expect a Beta hi fi launch in Europe later this year, or early next year, when it will give a shot in the arm to the Beta system.

Double Take

Meanwhile the VHS manufacturers have launched two-speed machines. These can run the tape at half speed to double the recording and playing time available from a single cassette.

This means that a VHS recorder can now offer up to eight hours continuous playing time from a single, standard VHS cassette. This move is, of course, meant to compete with the V2000 format, which offers up to eight hours from a single cassette, but with the need to flip it over halfway through like an audio cassette.

The half speed machine is cleverly designed. You only need to switch the speed when you are recording, and you can do so even halfway through a programme. On replay the machine senses the speed at which the tape was recorded, and automatically switches replay speed accordingly.

There's just a short break up of the picture on screen. The snag of course is that because tape speed is halved, to around one quarter the speed of audio cassette tape speed, sound quality is very poor.

Simulcasts

Anyone buying a stereo machine will eventually want to tape simulcasts with it. Because we have no stereo sound with television in Britain, and are unlikely to have it for several years, the TV stations sometimes team up with f.m. radio stations to transmit separate stereo sound and pictures.

You can record a stereo video tape of a simulcast by feeding the sound in from a stereo hi fi system while taping the picture off-air through the video recorder's own tuner. But to do this easily you need a simulcast switch, which temporarily disconnects the mono sound tuner inside the video recorder.

The VHS stereo machines sold by JVC and Ferguson have this feature, but others don't. For instance, to tape simulcasts with the Sony C9 Beta stereo recorder or the Grundig V2000 stereo recorder you need to plug and unplug extra wires before and after each recording. This is a clumsy approach, especially on the Grundig machine, where the plugs are on the rear of the machine.

Philips promise a V2000 stereo recorder late this year with a simulcast switch. It's coming late on the market because the Philips factory is having to make special models for Britain with this feature.

Teleprompting

If you thought that some politicians at the last election hustings were unusually sincere and eloquent, there's something you should know. There's a gadget, made by an American company called Q-TV, which lets a public speaker look an audience straight in the eye, while reading from a script displayed on a television screen.

The system is invisible unless you know how to spot it. Watch out for the plain glass sheet that's in front of Prime Minister Margaret Thatcher next time you see her eloquently talking into the middle distance. Actually, it's a two-way mirror that lets the audience see her, while she reads text from a video screen.

Teleprompting is an old idea. Actors have found that it's often impossible to learn a script in the short time available for a TV performance. In the early days, the words were written on idiot boards, large notices propped up around the studio.

Some actors depended entirely on this kind of help. If you remember the old Tony Hancock programmes, you may also remember seeing his eyes wander round the set until they fell on the nearest prompt board.

Then came Autocue, a clever system that lets an actor look straight at the camera, while reading a script. Peter Dimmock of the BBC was experimenting with it 30 years ago, but a commercial system was slow to arrive.

Before transmission the script is typed or written on a long roll of anti-glare paper. In a corner of the studio, or hidden back room, the paper is unrolled in front of a video camera, and this camera output fed to a TV monitor underneath the studio camera. This is shooting through a two-way mirror angled so that it sees only the scene to be televised, but an actor looking at the camera sees only a reflected image of the prompt screen.

Now, all television studios rely heavily on Autocue systems. Although actors still learn their words for drama productions, the announcers and link men and women you see on news and current affairs programmes are almost always reading their words from an Autocue screen on the camera.

Once in a while the Autocue goes wrong, for instance the roll of text jams, or the operator runs it through at the wrong speed, or there's a technical failure. That's when you'll see a look of panic in the link person's eye, while they switch to ad-libbing or try to read from a script on the desk in front of them.

Audience Contact

The Q-TV system was developed to give business speakers and politicians the equivalent of Autocue, but at public meetings where there's no life-saving TV camera with Autocue to gaze at. The script, or often just a list of crucial statistics and facts, is again typed on anti-glare paper, in an ordinary typewriter or word processor.

Behind the scenes the speaker's assistant moves from page to page to suit what's being said out front, while a closed circuit TV camera displays an image of the text pages on a TV monitor hidden underneath the speaker's table. This screen image is reflected up by a two-way mirror which is set at an angle in front of the speaker's eyes.

If the audience sees anything, it's just a plain glass plate a few feet in front of the politician's eyes. But the politician sees the prepared text running through on a television screen. So he or she can pretend to look straight at the audience, while quite literally pulling facts and figures out of the air.

The Q-TV system was developed in America, because over there they learned early about the need to simulate eye-to-eye contact with an audience. It's now used by firms like 3M, RCA, Con Edison, General Motors and Ford, to help their public speakers look more sincere.

President Reagan uses one and that's how Margaret Thatcher found out about the idea. Now an enterprising British firm is importing the system for any politician over here who sincerely wants to look sincere.

MICROCOMPUTER INTERFACING TECHNIQUES

INCLUDING MANY USEFUL CONSTRUCTIONAL PROJECTS

PART THREE: ANALOGUE-TO-DIGITAL CONVERSION

BY J. ADAMS B.Sc., M.Sc. & G.M. FEATHER B.Sc.

PHYSICAL quantities in the world outside the microcomputer are generally analogue in nature; that is, they vary in a continuous way. In the previous article electrical signals representing analogue quantities, such as light intensity, have been recognised by the microcomputer when the particular value achieves some predetermined threshold level.

If the actual magnitude of such a quantity is to be "logged" by a microcomputer then the analogue electrical signal developed by a transducer is often conditioned before being converted into a digital form which the microcomputer can accept. This is illustrated in Fig. 3.1.

TRANSDUCER

The transducer senses the magnitude of the quantity to be measured and produces a corresponding analogue electrical representation.

As an example, a temperature sensing device could be employed which produces a 0 to 1V output voltage which varies with temperature over a temperature range of say 0 to 100 degrees Celsius.

SIGNAL CONDITIONING

The analogue signal obtained from the transducer will convey the signal's information content but it may require amplification before it can be presented to an analogue-to-digital converter.

Signal conditioning circuits, often employing operational amplifiers, are generally present in data acquisition systems.

ANALOGUE-TO-DIGITAL CONVERTER

An analogue-to-digital converter (ADC) is a device which will convert a suitable analogue input into a corresponding digital output code.

SUCCESSIVE APPROXIMATION CONVERTERS

Various techniques exist for the conversion of the analogue signal obtained from a suitable transducer/conditioning circuit into a digital form which can be recognised by a microcomputer.

The successive approximation ADC offers one of the best combinations of ease of application and economy allied with speed of conversion and resolution.

The technique resembles, in some respects, the way in which many physical quantities are measured—by trial and error.

This analogy can be employed to give some understanding of the working of a successive approximation ADC.

Consider the determination of an unknown mass by comparison with known masses using a beam balance as shown in Fig. 3.2.

When the trial masses equal the unknown mass, the pointer will be at zero deflection. The trial masses are arranged to be related by powers of 2: M/2, M/4, M/8, M16, and so on.

Measurement is started by placing the largest trial mass on the left-hand pan; if $M_x > M/2$, the pointer moves towards the right and the result of this test determines whether we increase the trial mass or make another trial with the next smallest mass. In the successive approximation ADC, the test is made with a trial voltage (developed from an accurate fixed reference voltage) and the result will set a bit in a register to logic 0 or 1, depending on the result.

The trial process is continued until the scale is balanced, each decision setting a less signficant bit in the register to a 0 or 1, so building up the digital representation of the analogue quantity.

Converters offering resolution to 6, 8, 10 and 12 bits are available but 8-bit devices offer a satisfactory compromise between resolution and conversion time (the Ferranti ZN448 can perform more than 110,000 conversions per second with a resolution of 1 part in 256, or about 0·4 per cent).

All internal operations of the ADC are run sequentially by the system clock

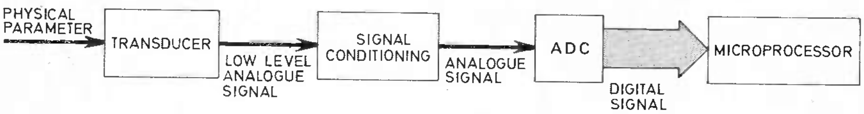


Fig. 3.1. Analogue-to-Digital Converter (ADC) and data acquisition.

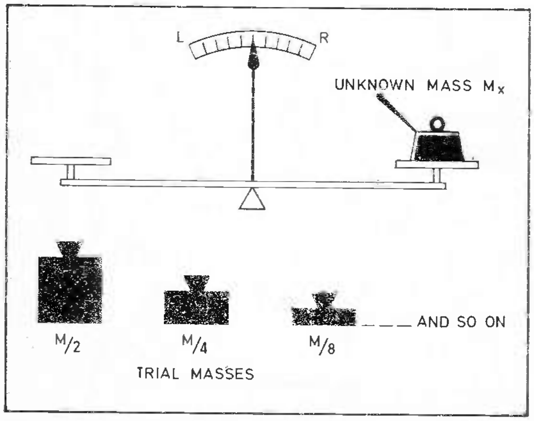


Fig. 3.2. Successive approximation balance analogy.

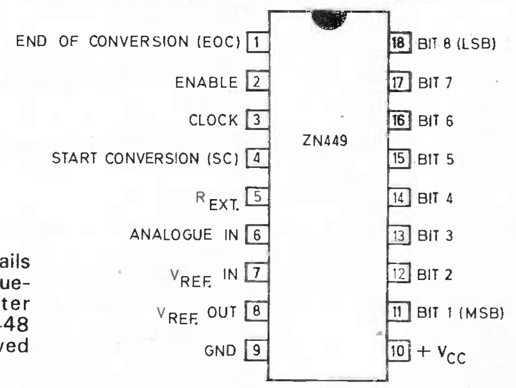


Fig. 3.3. Pin-out details for the 8-bit analogue-to-digital converter types ZN447, ZN448 and ZN449—viewed from above.

which hence determines the overall conversion time. A complete conversion occupies nine clock cycles so, for example, a ZN448 running at a clock frequency of 900kHz will give a conversion time of 10μs and therefore a conversion rate of $100{,}000s^{-1}$.

OPERATING PROTOCOL

To use any type of ADC, a precise sequence of operations must be adhered to. A simplified description of this is given below for the successive approximation type.

STEP 1 START CONVERSION

An output pulse from the microcomputer instructs the ADC to initiate a conversion. (This arrangement is sometimes referred to as "convert on command".)

STEP 2 END OF CONVERSION

An output signal from the ADC instructs the microcomputer that the conversion has been completed.

The digital representation of the analogue quantity is, at this moment, stored in the output latches of the ADC, but the actual output lines are, in many converters, tri-state configured. That is, unless instructed to do so, the ADC will not output the digital information on to its output lines—they will remain in a high impedance state, effectively disconnected from the microcomputer so as not to interfere with other signals which might be present on these lines.

This is important when the lines are required for other purposes such as channel multiplexing, software control of signal conditioning amplifier gain, and so on.

STEP 3 ENABLE TRI-STATE

An output signal from the microcomputer instructs the ADC to make available at its output lines, the data present in its output latches.

The microprocessor is now in a position to read the binary code presented by the ADC.

STEP 4 DISABLE TRI-STATE

The enable output signal from the microcomputer reverts to its original state, sending the bus lines to a high impedance state. The cycle is now complete and the ADC awaits the next start conversion pulse before repeating the sequence.

HIGH SPEED SINGLE CHANNEL BIPOLAR CONVERTER

The ADC employed in this project is a successive approximation Ferranti ZN449 device in a standard 18-pin d.i.l. package as shown in Fig. 3.3. The 8-bit binary code presented by the ADC to the microcomputer will hence allow the resolution of an input analogue voltage in 256 discrete steps. This "8-bit" resolution is simply the number of bit outputs that the ZN449 possesses and implies nothing about the accuracy of the device.

The device offers a fast conversion rate (up to approximately 110,000 conversions per second), an on-chip clock and reference voltage, tri-state outputs and +1 l.s.b. resolution.

Conversion time lasts for nine clock cycles giving the same maximum conversion rate as that for the ZN448.

CIRCUIT DESCRIPTION FOR BIPOLAR OPERATION

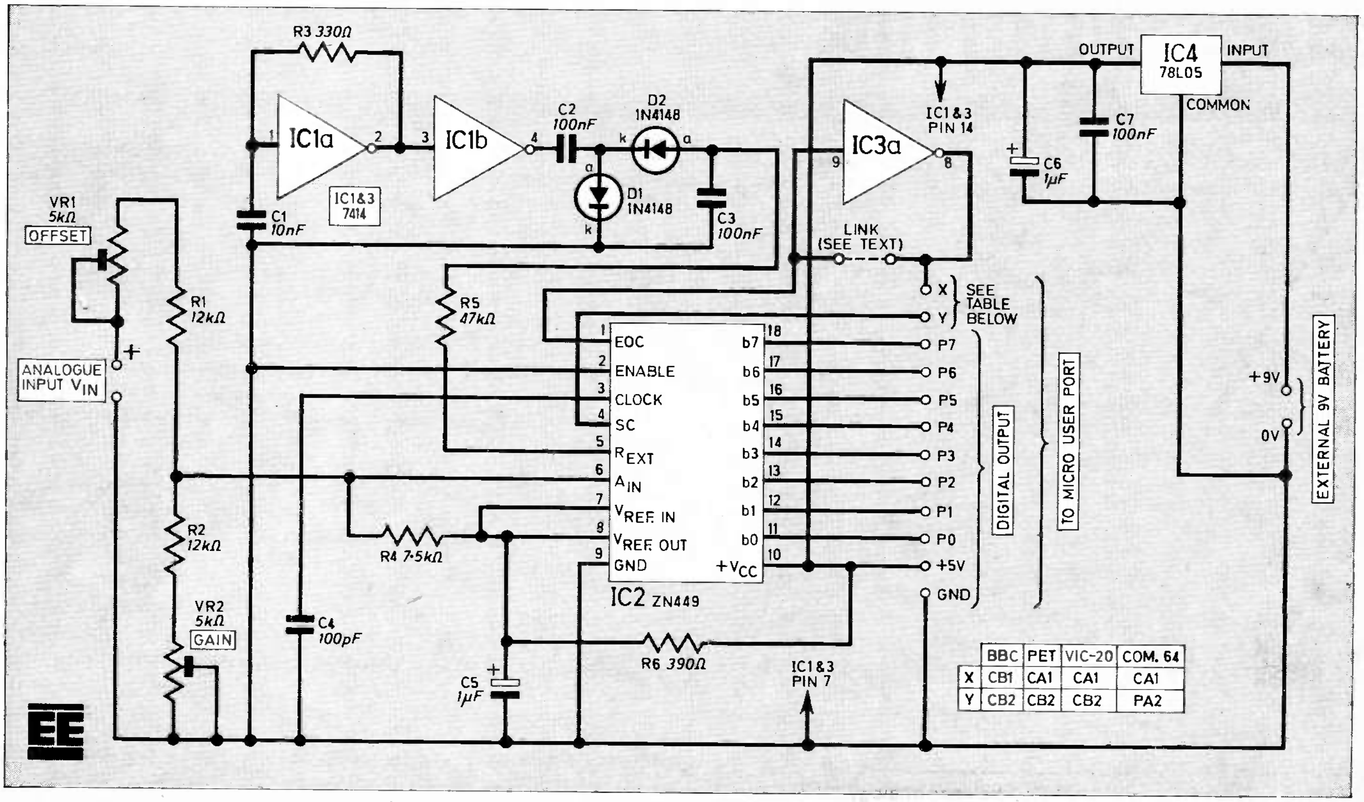
The complete circuit diagram of the High Speed Analogue-to-Digital Converter is shown in Fig. 3.4.

The A-D device, IC2, requires, in addition to the usual +5V supply, a negative rail which in the circuit given, stands at about −3·5V. This could, of course, be derived from a second battery but in the circuit, Fig. 3.4, uses IC1 as a simple multivibrator, the output of which is rectified and smoothed by the D1, D2, C2, C3 network; this provides the necessary negative supply.

ADCs may be wired to give either "unipolar" or "bipolar" operation. In the unipolar case, only positive input voltages (that is, those which make V_{IN} positive with respect to ground) will produce a digital output. The design used in the project employs the bipolar technique in which the input voltage is offset by $+V_{REF/2}$ so that the voltage at the input to the device itself will always be positive, even when V_{IN} goes down to $-V_{REF/2}$. The offset voltage is derived from $+V_{REF}$ by the resistor network R1, R2, and VR2.

Bipolar operation is useful in that it allows the converter to sample values of an alternating voltage. As both positive and negative voltage ranges are encountered it is necessary to provide a method of digital coding to represent this. The coding most widely employed is referred to as "offset" binary. The line connected to the m.s.b.—the line with the greatest "weighting"—is used to indicate the sign of the voltage. When the m.s.b. (bit 7) is set and the line goes high then the input

Fig. 3.4. Circuit diagram of a single-channel high speed Analogue-to-Digital Converter (ADC).



	BBC	PET	VIC-20	COM. 64
X	CB1	CA1	CA1	CA1
Y	CB2	CB2	CB2	PA2

voltage to the ADC is positive, whereas if the m.s.b. is clear and the line goes low then the input voltage is negative.

Table 3.1 below indicates the logic coding for bipolar operation.

VR1 and VR2 provide for adjustment of the output for inputs of plus and minus (±) full scale. A detailed description of the setting-up procedure is given. The resistor values given produce an analogue input voltage range of −5V to +5V.

Table 3.1

Analogue Input	Digital Output
+(FS − 1 l.s.b.)	11111111
+(FS − 2 l.s.b.)	1111111Ø
+1/2 FS	11ØØØØØØ
+ 1 l.s.b.	1ØØØØØØ1
Ø	1ØØØØØØØ
−1 l.s.b.	Ø1111111
−1/2 FS	Ø1ØØØØØØ
−(FS − 1 l.s.b.	ØØØØØØØ1
−FS	ØØØØØØØØ

FS = Full Scale.

In the design, the eight data lines (which are connected to PØ–P7) are used solely for the purpose of applying the output of the ADC to the user port and, although the ZN449 does have tri-state outputs, the tri-state enable pin is kept at logic 0 (ground) so that the output latches are always enabled.

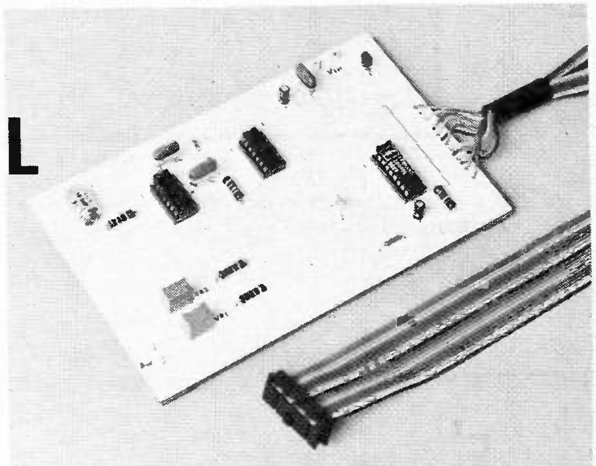
READING CONVERTED DATA

During a conversion, invalid data will thus be present on the output lines and the microcomputer must not read the data available until the conversion is complete. When operating in Basic, this does not present a problem since the conversion is completed well before the machine is ready, but for machine code operation it is necessary to employ the end of conversion (EOC) signal generated by the ADC to instruct the microcomputer to read the then valid data.

The EOC signal can be applied to the edge-sensitive handshake line as was discussed in the first article in this series. Readers should note that the Commodore 64 microcomputer requires a negative going edge-sensitive handshake and constructors intending to use this machine should include the inverter, IC3, in the EOC line. For the other machines, the LINK should be included and IC3 should not be fitted.

IC4 is a 78L05 5V regulator and need only be fitted if a 5V supply is not available at the user port. In this case, an external 9V supply for the board may be used; a PP9 battery will allow many hours of operation.

HIGH SPEED ANALOGUE-TO-DIGITAL CONVERTER BOARD CONSTRUCTION



CONSTRUCTION OF ADC

All the components are accommodated on a single-sided printed circuit board, size 150 × 95mm. The full-size master p.c.b. pattern to be etched is shown in Fig. 3.5. This p.c.b. is available through the *EE PCB Service*, Order code 8309-01; see page 565 for further details.

The layout of the components on the topside of the board is shown in Fig. 3.6. The 12 leads from the board to the user port connector are soldered directly to undrilled oval areas on the track pattern after feeding through 1·3mm diameter holes near to the board edge. This acts as a strain relief mechanism for the soldered connection.

Begin assembly by soldering in the i.c. sockets, followed by the link wire, Veropins, resistors, presets, capacitors and finally the semiconductors. Pay attention to the orientation of IC4, the two diodes and the electrolytic capacitors.

The p.c.b. has been designed to be used with the BBC Micro, PET, VIC-20 and Commodore 64 computers. The latter requires a negative going edge-sensitive handshake. This is provided by the inverter in IC3. This i.c. should not be inserted if the board is to be used with the other three machines, but a link wire must be fitted between IC3 socket positions 8 and 9. This is the "dotted" link in Fig. 3.4.

There is no +5V supply rail available on the PET computer user port, but IC4 with C6 and C7 provide a suitable +5V supply for the on-board components when a 9V battery such as a PP9 is connected. These components may be omitted if building this project for any of the other computers mentioned above.

Finally, connect the user port cable to the p.c.b. according to Figs. 3.6 and 3.7.

SETTING UP PROCEDURE

The ADC board should be connected to the microcomputer via ribbon cable and appropriate user port plug as shown in Fig. 3.7. If necessary, an exernal battery may be added.

The simple Basic program TEST, appropriate to the particular microcomputer, should now be loaded into the microcomputer. When run, the screen will display a number in the range 0 to 255. (This is the decimal value of the 8-bit binary number at the outputs of the ADC.)

It is first necessary to apply −4·98V (−5V will do) to the analogue input and adjust the offset control VR1 until the display just flickers between 0 and 1.

The input connections should now be reversed and the gain control VR2 adjusted until the display flips between 254 and 255. The first step should now be repeated.

Finally, the analogue input terminals should be short-circuited, when the display should read 128. If this is not the case, then repeat the whole procedure.

STORAGE OSCILLOSCOPE

With the very fast conversion rate offered by the ZN449 periodic waveforms of frequency up to a few kilohertz may be sampled several times per cycle and stored in immediate access memory (RAM) for subsequent display at a convenient time.

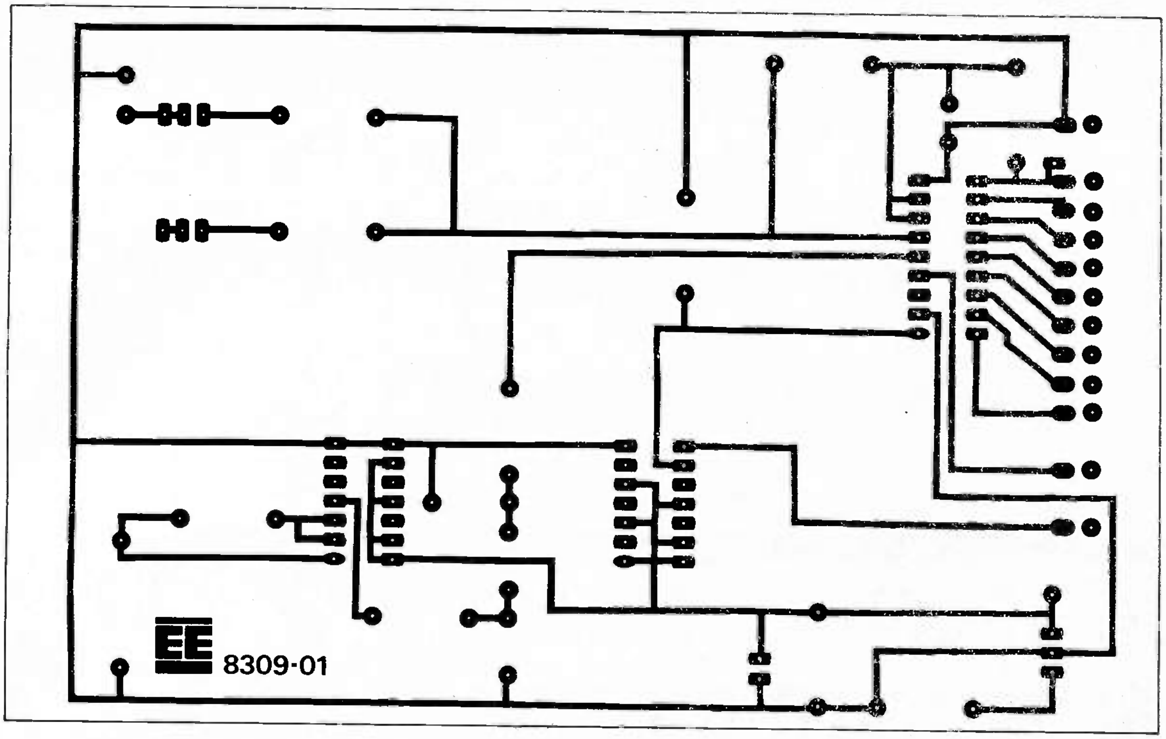


Fig. 3.5. Master pattern (actual size) to be etched for the ADC board. This board is available through the *EE PCB Service*, Order code 8309-01.

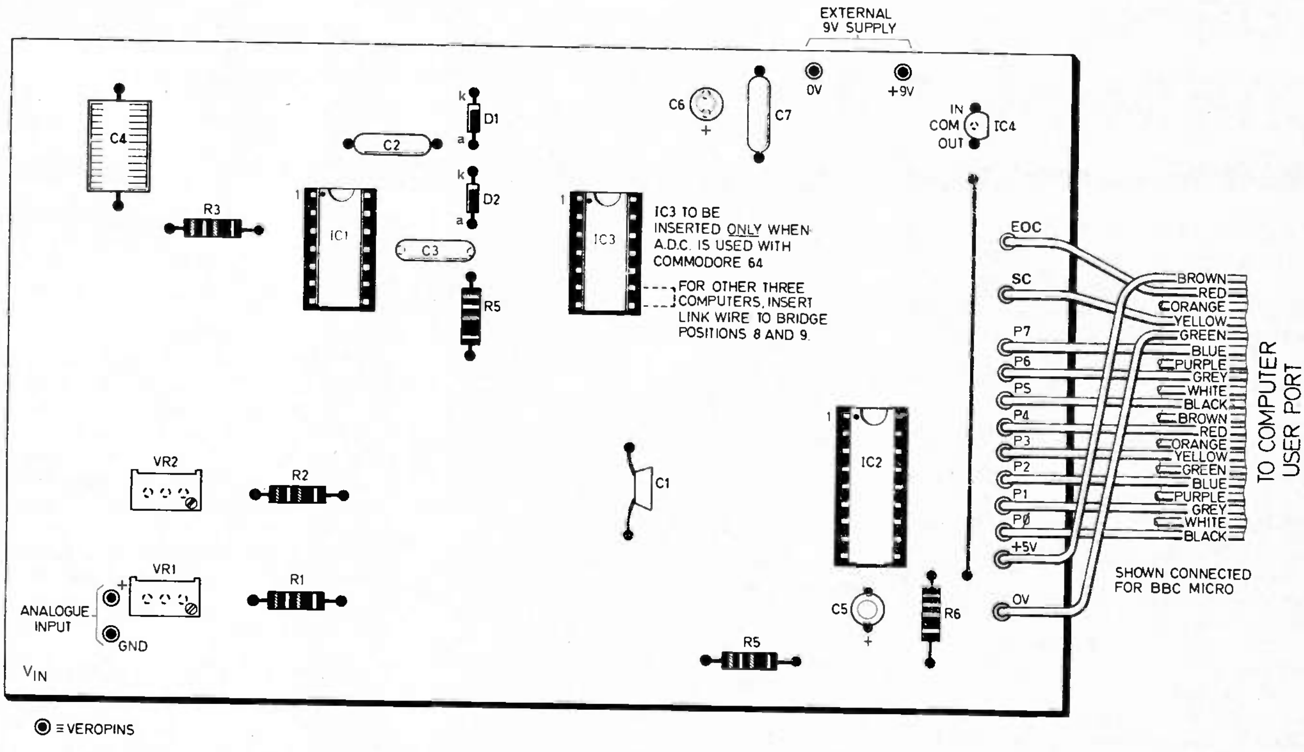


Fig. 3.6. Layout of the components on the topside of the p.c.b. with interconnection details to the user port connector.

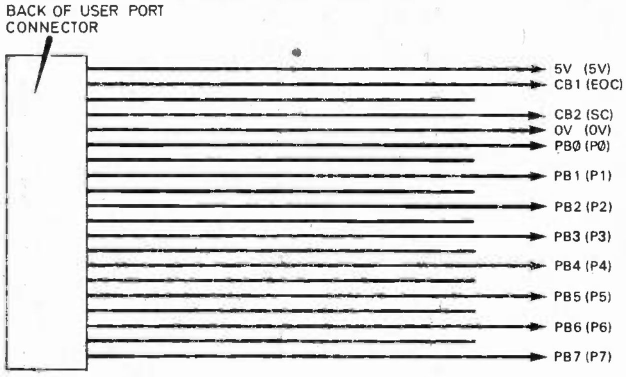
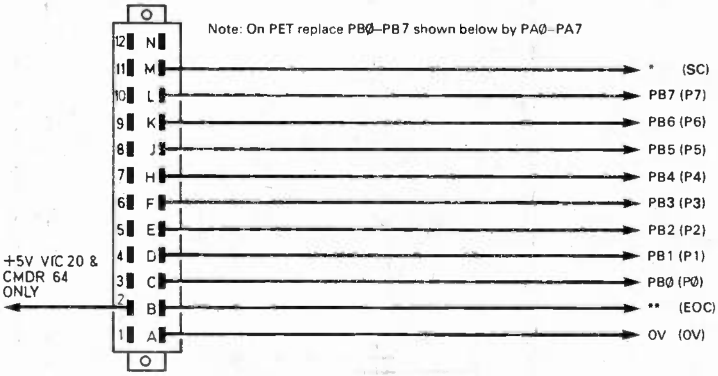


Fig. 3.7. Connection details for the user port connector cable with, in brackets, connection to ADC board. Top gives details for BBC Micro, lower for PET/VIC-20/Commodore 64. *—CB2 on VIC-20 and PET, PA2 on Commodore 64; **—CB1 on VIC-20, CA1 on PET, FLAG 2 on Commodore 64.



COMPONENTS

See Shop Talk page 565

Resistors

R1,2	12kΩ
R3	330Ω
R4	7·5kΩ
R5	47kΩ
R6	390Ω

All ¼W carbon ±5%

Capacitors

C1	10nF
C2,3	100nF polyester type C280 (2 off)
C4	100pF ceramic plate
C5,6	1µF 6V elect.
C7	100nF polyester type C280

Semiconductors

IC1	7414 TTL hex Schmitt inverter
IC2	ZN449, 448 or 447 8-bit analogue-to-digital converter
IC3	7414 TTL hex Schmitt inverter
IC4	78L05 100mA voltage regulator
D1,2	1N4148 small signal silicon

Miscellaneous

VR1,2	5kΩ cermet multiturn preset (⅜ inch square)

Printed circuit board: single-sided size, 150 x 95mm, *EE PCB Service*, Order code 8309-01; 14-pin d.i.l. sockets (2 off); 16-pin d.i.l. socket; single-sided Veropins (4 off); self-adhesive rubber feet (4 off); ribbon cable and connector to suit computer used.

Approx. cost Guidance only £13 excluding cable/connector

ADC TEST ROUTINES

```
5 REM BBC TEST PROGRAM
10 ?65122=0
20 ?65132=?65132AND160
30 ?65120=0
40 PRINT ?65120
50  GOTO 30


5 REM PET TEST PROGRAM
10 POKE 59459,0
20 POKE 59468,PEEK(59468)OR192
30 POKE 59468,PEEK(59468)OR32
40 POKE 59468,PEEK(59468)AND223
50 POKE 59468,PEEK(59468)OR32
60 PRINT PEEK(59457)
70 GOTO 30


5 REM VIC-20 TEST PROGRAM
10 POKE 37138,0
20 POKE 37147,PEEK(37147)AND227
30 POKE 37148,PEEK(37148)OR192
40 POKE 37148,PEEK(37148)OR32
50 POKE 37148,PEEK(37148)AND223
60 POKE 37148,PEEK(37148)OR32
70 PRINT PEEK(37136)
80 GOTO 40


5 REM COMMODORE 64 TEST PROGRAM
10 POKE 56579,0
20 POKE 56578,PEEK(56578)OR4
30 POKE 56576,PEEK(56576)OR4
40 POKE 56576,PEEK(56576)AND251
50 POKE 56576,PEEK(56576)OR4
60 PRINT PEEK(56577)
70 GOTO 30
```

This opens up the attractive possibility of using the system as a relatively inexpensive storage oscilloscope. For this very fast application of the ADC, machine code software is essential, and normally involves incrementing an index register and storing perhaps 256 digitised points in contiguous memory locations using indexed addressing.

Even non-periodic waveforms, such as one-shot impulses, can be sampled at great speed if the storage of results occurs only when the analogue signal exceeds a "trigger" level.

One very interesting arrangement is to connect a high output crystal/ceramic microphone to the ADC via the signal conditioning amplifier described in this article. Instantaneous values of a speech waveform can then be sampled and stored before being displayed either on a VDU or printer.

Further use of this board, including another constructional project for fast data logging, will be dealt with later in this series. Software will be available through the *EE Software Service* for those wishing to implement machine code software with their ADC board.

SIMPLE EXPERIMENTS WITH THE ADC

Joystick Potentiometer

The simple potentiometer circuit of Fig. 3.8 should be set up and the output connected to the analogue input terminals of the ADC. Rotation of the potentiometer spindle should cause the digital value displayed on the screen to vary over a range of approximately 25 to 230 corresponding to analogue inputs of −4·5V to +4·5V. It is left to the reader to devise a simple program in which this digital value of the analogue voltage can be used to control the y (or x) coordinate of a plotted point.

Optical Intensity Measurement

The circuit of Fig. 3.9 employs an ORP12 light dependent resistor (l.d.r.) in a simple potential divider arrangement. When fully illuminated, the resistance of the l.d.r. falls to a value of about 100 ohms; the output voltage from the potential divider will then be approximately equal to the supply voltage, 4·5V. When dark the l.d.r. resistance increases to approximately 100kΩ, thus decreasing the voltage across R1 to almost zero. As this transducer provides a positive analogue input to the ADC the digital output representation is limited to the range 128 to 255, inclusively.

The output voltage and optical intensity are not related linearly, but if a photometer is available, the arrangement may be calibrated. The authors have employed this technique in colorimetric applications.

Simple Temperature Measurement

In the temperature measurement application, a thermistor forms part of a potential divider arrangement, the positive output voltage of which depends upon the temperature of the thermistor. The circuit is shown in Fig. 3.10.

As with the previous case, the output voltage is not proportional to the temperature of the thermistor. A calibration curve, Fig. 3.11, is given for the particular type used, and can be held in immediate access memory (RAM) as a calibration table. The software solution to non-linearity involves searching the table until the largest input value corresponding to a particular temperature reading is found.

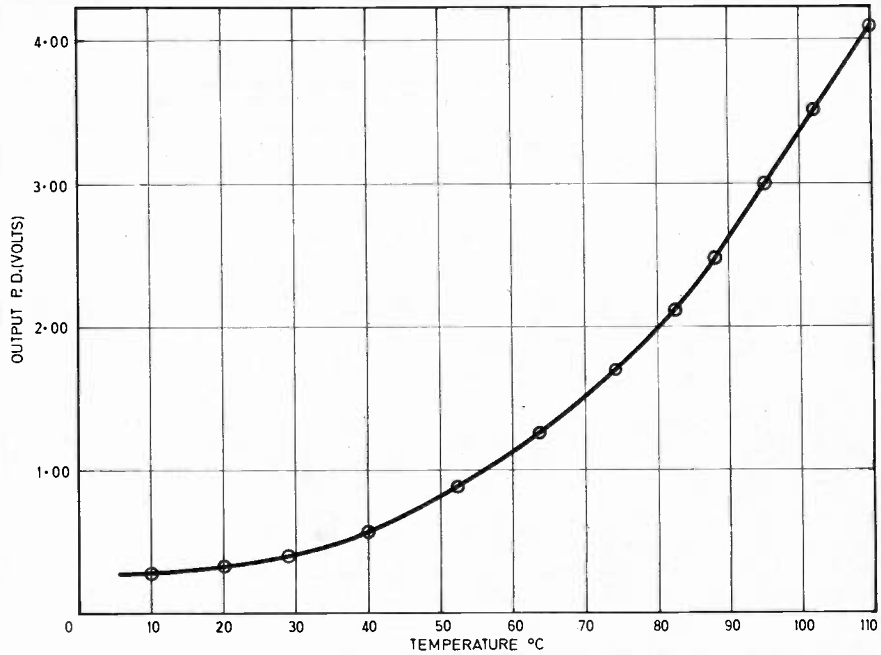


Fig. 3.11. A calibration curve constructed for the GM474 thermistor (29KO series).

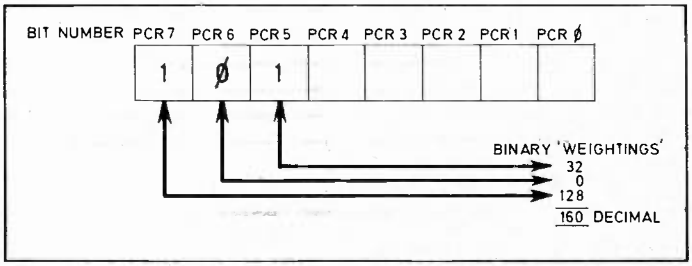


Fig. 3.13. The Peripheral Control Register (PCR) in pulse output mode. The three most significant bits control the mode of operation of the CB2 line.

SOFTWARE

The eight lines available at the user port must be configured for input if the microcomputer is to accept the eight bits of digital information from the ADC. This is achieved by clearing each bit in the data direction register for the port.

BBC Model B	VIC-20	PET	Commodore 64
?65122=Ø	POKE37138,Ø	POKE59459,Ø	POKE56579,Ø

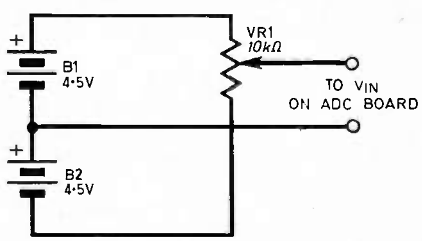


Fig. 3.8. Simple joystick for the ADC.

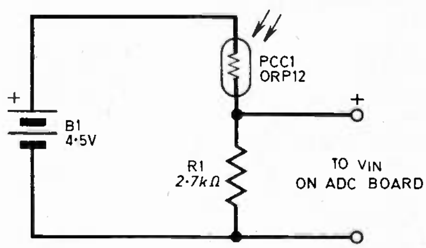


Fig. 3.9. Optical transducer for the ADC.

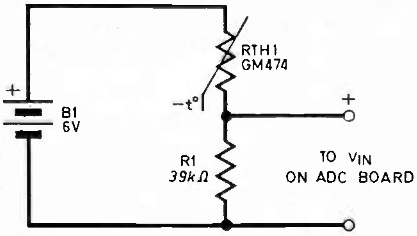


Fig. 3.10. Temperature transducer for the ADC.

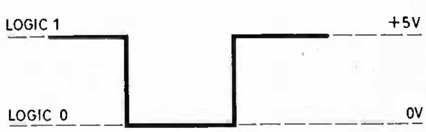


Fig. 3.12. Form of CB2 Start Conversion (SC) pulse.

The start conversion (SC) pulse, necessary to initiate the conversion process, can be obtained in a variety of ways but it is often appropriate to put the ADC entirely under microprocessor control and derive the pulse from an output line available at the microcomputer. The shape of the pulse necessary to start conversion for the ZN449 is illustrated in Fig. 3.12.

BBC Model B Microcomputer

Pin 4 (CB2) at the user port can act as an output line under program control and is ideal for sending a start conversion pulse from the microcomputer to the ADC.

The simplest way that this may be accomplished is to set up the CB2 line in pulsed output mode. This line will then go low for one cycle if the I/O register for the port is written to.

This is a "dummy" operation as the port is configured to receive information from the ADC and the eight lines will not actually output data.

To allow the CB2 line to act in pulse output mode it is necessary to use another memory-mapped register within the 6522 VIA called the Peripheral Control Register (PCR). Three bits (PCR7, PCR6 and PCR5) are used to establish any one of the eight different modes of operation of the CB2 line. In pulse output mode the bits are configured as shown in Fig. 3.13. Once this has been achieved by

```
?65132=?65132AND16Ø
```

then any write to the I/O register, for example, ?6512Ø=Ø will send a one-shot negative pulse from pin 4 to the start conversion pin of the ADC and initiate conversion.

PET

Pin M (CB2) at the user port can act in much the same way as the BBC Micro CB2 line. The three bits PCR7, PCR6, PCR5 in the Peripheral Control Register (PCR) are again used to characterise the mode of operation of the line. The register is located at memory address 59468. In this case two further modes of operation will be used to send the start conversion (SC) pulse to the ADC. Manual output mode is first selected by setting bits PCR7 and PCR6 in the PCR. This can be achieved as follows:

```
POKE59468,PEEK(59468)OR192
```

Note that the logical OR operator is used to ensure that only bits PCR7 and PCR6 are set. This must be done independently of the other bits in the register which are used for other purposes.

Once this mode has been selected, the CB2 line will reflect the state of bit PCR5, that is, if PCR5 is set then the CB2 line is held high, but if PCR5 is clear then the CB2 line is held low.

The following coding illustrates how a start conversion pulse can be fashioned by manipulating the contents of the PCR with logical operations.

```
1Ø POKE59468,PEEK(59468)OR192:REM CB2 MANUAL OUTPUT MODE
2Ø POKE59468,PEEK(59468)OR32:REM CB2 HIGH
3Ø POKE59468,PEEK(59468)AND223:REM CB2 LOW
4Ø POKE59468,PEEK(59468)OR32:REM CB2 HIGH
```

VIC-20

The start conversion pulse can again be derived from the CB2 line at pin M. The Peripheral Control Register is located at memory address 37148. For example:

```
1Ø POKE37147,PEEK(37147)AND227: REM DISABLE SHIFT REGISTER
2Ø POKE37148,PEEK(37148)OR192: REM CB2 MANUAL OUTPUT MODE
3Ø POKE37148,PEEK(37148)OR32: REM CB2 HIGH
4Ø POKE37148,PEEK(37148)AND223: REM CB2 LOW
5Ø POKE37148,PEEK(37148)OR32: REM CB2 HIGH
```

COMMODORE 64

The Commodore 64 has no CB2 line available at the user port. Bit 3 of Port A (PA2) is, however, brought out at pin M. To configure this line for output it is necessary to set the corresponding bit in the Data Direction Register for the port located at memory address 56578.

The start conversion pulse can then be derived by setting, clearing and re-setting bit 3 in the I/O register for the port. This can be achieved as follows:

```
1Ø POKE56578,PEEK(56578)OR4:REM PA2 OUTPUT
2Ø POKE56576,PEEK(56576)OR4:REM PA2 HIGH
3Ø POKE56576,PEEK(56576)AND251:REM PA2 LOW
4Ø POKE56576,PEEK(56576)OR4:REM PA2 HIGH
```

SIGNAL CONDITIONING AMPLIFIER

The electrical signals from some transducers may be too small to feed into A-to-D Converter circuitry to obtain satisfactory results. A simple signal conditioning amplifier which will give boost to the transducer signal by factors of ×10 and ×100 is shown in the circuit diagram of Fig. 3.14.

The circuit is based around a differential operational amplifier i.c., IC1, the much used 741. This is arranged in the "non-inverting" mode. R1 sets the input impedance at 75 kilohm. Negative feedback consists of R3 or R4 with R2 which sets the gain of the amplifier.

The gain is equal to:

$$\frac{R2 + R3}{R2} \text{ with S1 in upper position}$$

$$\frac{R2 + R4}{R2} \text{ with S1 in lower position}$$

Substituting in the given circuit values gives gains of 100 and 10, respectively (actually the gains are 101 and 10·1, but the rounded off figures are good enough ones to work with, bearing in mind the resistor tolerances).

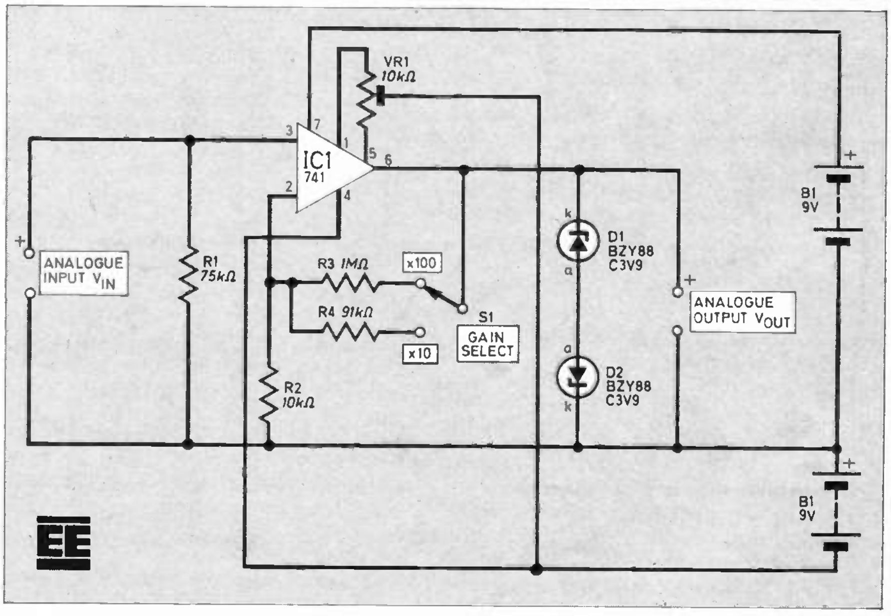


Fig. 3.14. The circuit diagram of a Signal Conditioning Amplifier for use with the ADC.

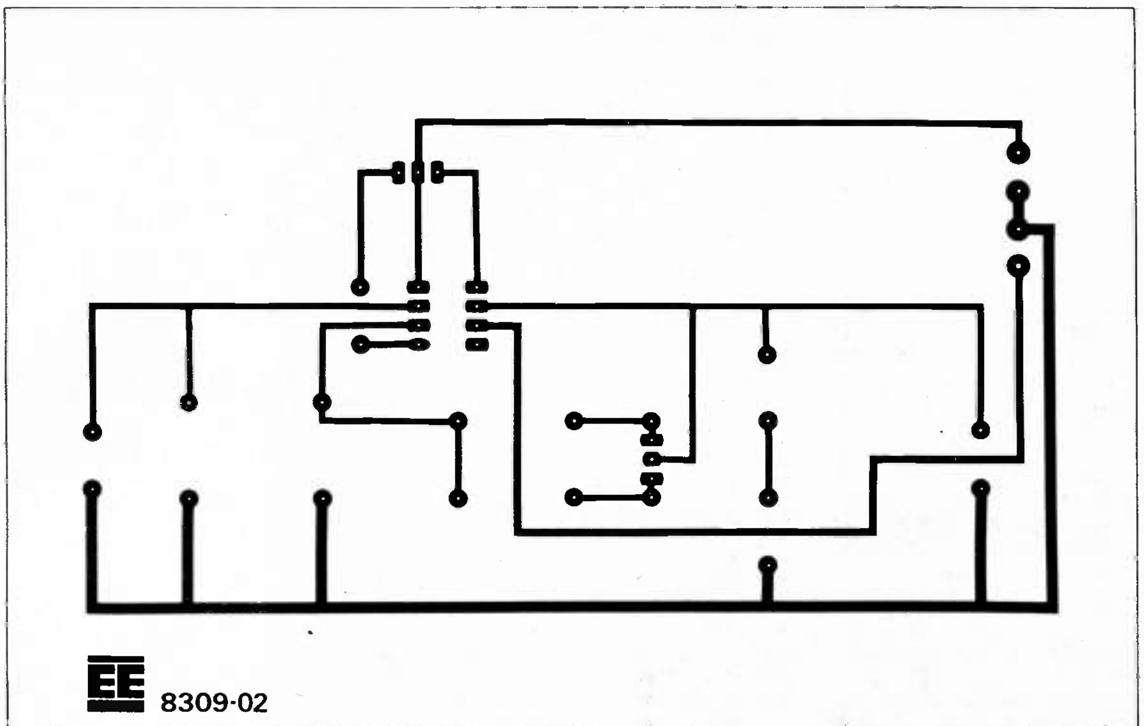
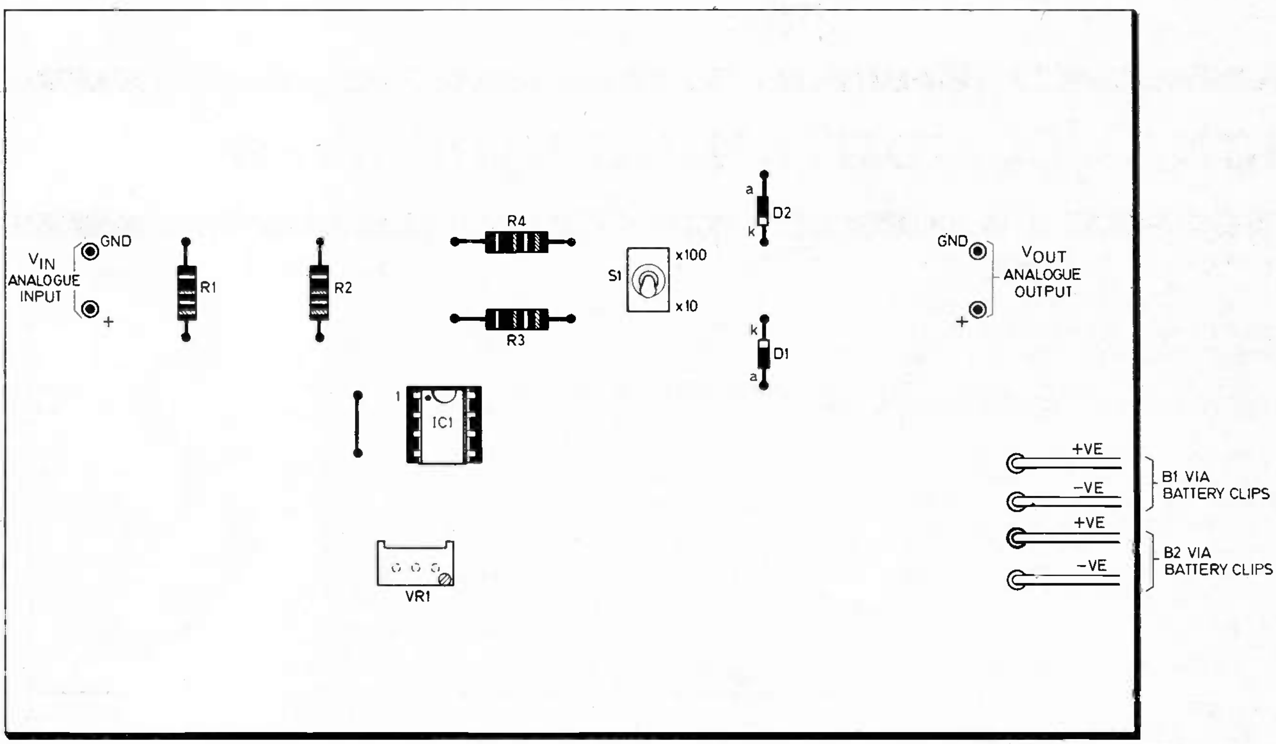


Fig. 3.15. Master pattern (actual size) to be etched for the Signal Conditioning Amplifier. This board is available through the *EE PCB Service*, Order code 8309-02.



◉ ≡ VEROPINS

Fig. 3.16. The layout of the components on the topside of the printed circuit board.

COMPONENTS

Resistors

R1	75kΩ
R2	10kΩ
R3	1MΩ
R4	91kΩ

All ¼W carbon ±5%

See **Shop Talk** page 565

Semiconductors

D1,2	BZY88C3V9 3·9V 400mW Zener diode (2 off)
IC1	741 op-amp (8-pin d.i.l.)

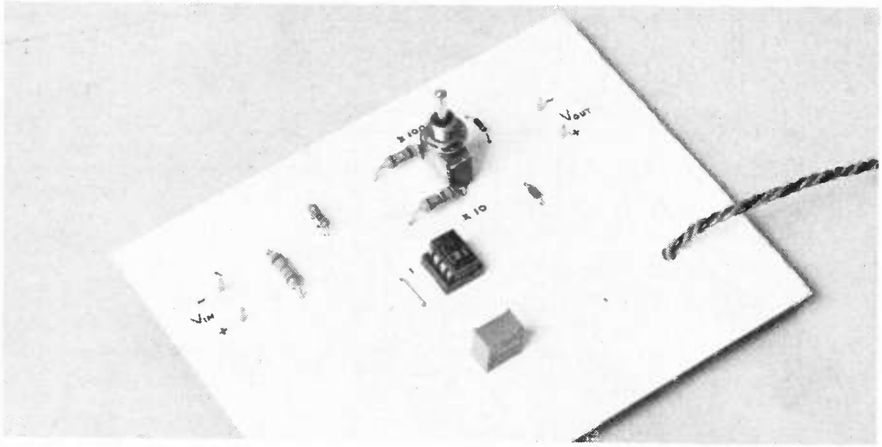
Miscellaneous

B1,2	9V type PP9 (2 off)
VR1	10kΩ cermet multiturn preset (⅜ inch square)
S1	miniature s.p.d.t. p.c.b. mounting type

Printed circuit board: single-sided size, 125 x 95mm, *EE PCB Service,* Order code 8309-02; single-sided Veropins (4 off); PP9 battery clips (2 pairs); 7/0·2mm insulated wire for batteries; 8-pin d.i.l. socket; self-adhesive rubber feet (4 off).

Approx. cost Guidance only £7.50

The input signal is applied to the "+" input of IC1 and appears amplified at its output, pin 6, the amount of amplification determined by S1 position. Zener diodes D1 and D2 limit negative and positive excursions of the amplified signal to a safe level for inputting to the ADC board. The maximum output will be ±3·9V, the value of the Zener diodes.



The power supply for the circuit needs to be a split type ranging from ±6V to ±15V; ±9V was selected as this is readily available in battery form. Two PP9 batteries will give long service.

CONSTRUCTION

The components are mounted on a single-sided printed circuit board, size 125 × 95mm; the full-size master pattern to be etched is shown in Fig. 3.15. This board is available through the *EE PCB Service,* Order code 8309-02.

The printed circuit board has been designed to accept a miniature p.c.b. mounting single-pole two-way toggle type having in-line pins. Two sets of fixing holes have been provided to allow switches with pins on a 0·1 and 0·2 inch pitch to be used.

Order of component assembly is unimportant. Check that the diodes are correctly orientated and that the i.c. is inserted the right way round in its socket. Component layout is shown in Fig. 3.16.

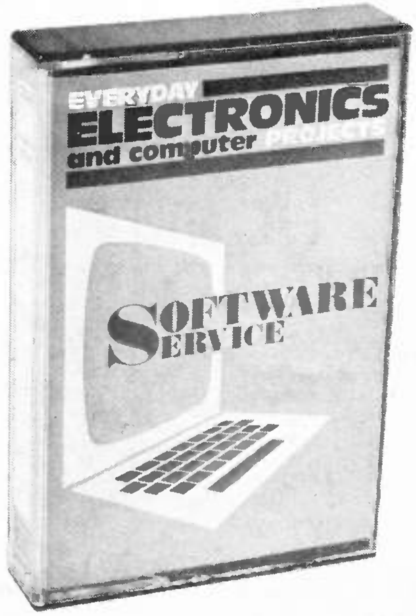
The power supply leads from the two batteries can be soldered directly to the board or via a p.c.b. screw terminal block as provision has been made for this connector to be fitted. This connection differs from that seen in the photograph which is fitted with three battery leads only.

Thoroughly check your assembly after plugging in the i.c. and when satisfied connect the two batteries and then short together the two input Veropins. Attach a voltmeter across V_{OUT} and adjust VR1 for zero deflection on the meter. Remove the shorting link and the unit is ready for use.

The sensor signal should connect to V_{IN} on the amplifier board with its V_{OUT} connected to the V_{IN} of the ADC board. Set S1 to the required gain so that the output signal is maximised without clipping (the Zener diodes are not activated). □

Next month:
Digital-to-Analogue Techniques

EVERYDAY ELECTRONICS SOFTWARE SERVICE



The EE Software Service provides an easy and reliable means of program entry for our computer-based projects. All programs have been tested by us and consist of two good quality copies of the working program on cassette tape. Certain program listings are also available.

All prices include VAT, postage and packing. Remittances should be sent to Everyday Electronics Software Service, Editorial Offices, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques should be crossed and made payable to IPC Magazines Ltd.

PROJECT TITLE	CASSETTE CODE	CASSETTE COST	LISTING CODE	LISTING COST
ZX81 SPEED COMPUTING SYSTEM (Feb 83)	T001	£2.95	L001	£2.95
REAL-TIME CLOCK (Apple) (May 83)	T002	£2.95	L002	£2.95
REAL-TIME CLOCK (BBC) (May 83)	T003	£2.95	L003	£2.95
EPROM PROGRAMMER (TRS-80 & GENIE) (June 83)*	T004	£3.95	N/A	—
STORAGE 'SCOPE INTERFACE (BBC) (Aug 83)	T005	£2.95	—	—

* Includes Command List with examples.

OCTOBER FEATURES

TEACH-IN '84

A TWELVE-PART HOME STUDY COURSE IN THE PRINCIPLES AND PRACTICE OF ELECTRONIC CIRCUITS. ESSENTIALLY PRACTICAL, EACH PART INCLUDES EXPERIMENTS TO DEMONSTRATE AND PROVE THE THEORY.

USE OF A PROPRIETARY BREADBOARD ELIMINATES NEED FOR SOLDERING AND MAKES ASSEMBLY OF CIRCUITS SIMPLE.

THE IDEAL INTRODUCTION TO THE SUBJECT FOR NEWCOMERS. ALSO A USEFUL REFRESHER COURSE FOR OTHERS.

KITS OF COMPONENTS FOR TEACH-IN '84 AVAILABLE FROM OUR REGULAR ADVERTISERS.

SPECIAL OFFER

EAGLE KEW 7S MULTIMETER AS USED IN THE TEACH-IN '84 SERIES. HANDY 2000 OHMS/V INSTRUMENT, VALUABLE ASSET FOR ALL ENTHUSIASTS.

ELECTRONIC PENDULUM

EE

THIS YEAR'S SEDAC WINNING PROJECT. A VALUABLE CONTRIBUTION TO PHYSICS STUDIES. USED IN ASSOCIATION WITH BBC MICRO.

IMMERSION HEATER TELL-TALE

An electronic aid for reducing energy costs. Feels the hot-water tank electronically at four levels and operates a corresponding display of l.e.d.s.

HOME INTERCOM

Use of i.c. audio amplifier in main station unit provides good quality reproduction. Volume control. Call facility at remote station.

SHORT WAVE RADIO

A simple t.r.f. circuit using ready-made coils covering 1·5MHz to 30MHz in three tuning ranges. Provides an inexpensive introduction to short-wave listening.

EVERYDAY ELECTRONICS and computer PROJECTS

OCTOBER 1983 ISSUE ON SALE FRIDAY, SEPTEMBER 16

SEDAC '83 RESULTS

HIGHLY SUCCESSFUL SECOND YEAR FOR NATIONAL SCHOOLS CONTEST

- ★ FINAL SWINGS TO NOTTINGHAM
- ★ NORFOLK ATTRACTS SECOND PRIZE
- ★ LANCS TEAMWORK SECURES THIRD PRIZE

Excitement and tension was almost up to Final's Day on the Centre Court at the Second Schools Electronic Design Award Competition (SEDAC), sponsored jointly by Mullard Ltd., and EVERYDAY ELECTRONICS. The final judging and presentation of prizes took place in Mullard House, London, over two days—28 and 29 June.

Schools from the length and breadth of Britain took part in the second national contest to help encourage the technologists of the future put their ideas into reality.

The three winners were selected from twelve finalists whose models were on display at Mullard House. At the presentation on 29 June, Ivor Cohen, Managing Director of Mullard and Michael Paton, Managing Director of Youth & Practical Group, IPC Magazines, shared the honour of presenting prizes to the winning teams

Opening his address at the prize-giving ceremony, Ivor Cohen made the point that "standards this year are so high that his technical judges were worried about their jobs!" This he observed was with some justification.

In his welcoming speech, Michael Paton also praised the high standard of papers and practical skills of *ALL* finalists.

However, he did voice his disappointment at the lack of "competitive spirit" shown by Girls' Schools—who failed to participate. This was despite special invitations going out to one hundred Girls' Schools throughout the country.

JUDGING PANEL

Scrutiny of Papers (Stage 1) and evaluation of working models (Stage 2) was performed by a panel of four judges representing the two sponsoring parties. The panel members were:

Andy Beer	Technical Manager, Power Control Devices, Mullard Ltd.
Terry Giles	I.C. Product Specialist, Mullard Ltd.
Fred Bennett	Editor, *Everyday Electronics*
Brian Terrell	Assistant Editor, *Everyday Electronics*

The judges wish to record their admiration for the high standards throughout, both in the written work and in the practical realisation of the designs. All students participating deserve the highest commendation and were a credit to their schools.

The proud winner of the 1983 Schools Electronic Design Award Competition, Martin Cragg of Roland Green School, receiving the SEDAC Trophy from Michael Paton of IPC Magazines with Ivor Cohen of Mullard keeping a watchful eye on the proceedings.

Winning Entries

The **first prize** of £300, the SEDAC Trophy and selection of components worth £200 were awarded to Martin Cragg (15), of Roland Green School, Welford, Nottingham, for his Electronic Pendulum.

Second prize of £200 plus components to the value of £200 was awarded to Robert Rowe (16), of Wymondham College, Norfolk, for his Digital Gauss Meter.

Third prize was won by Michael Lawrie (15) and Lorna Wilkinson (13), of Hollins High School for their Environmental Data Recorder.

The Remaining nine runners-up received component packs valued at £100. The runners-up were: Mill Hill School, London; Ousedale School, Newport Pagnell; Parkview School, Barrow-in-Furness; Princess Margaret Royal Free School, Windsor; Ridings High School, Winterbourne; Skegness Grammar School, Skegness; Skinners' School, Tunbridge Wells; Thomas Alleyne's High School, Uttoxeter; Whitecross School, Lydney.

All twelve finalists received a signed certificate to mark their achievements in reaching the finals of the 1983 SEDAC competition.

Winding up the ceremony the sponsors announced that the competition would be run again in 1984. Although it may widen its scope into other fields where electronics can be of benefit. Is this an inducement to attract the girls? Or are they too shy?

Contestants and teachers expressed their appreciation in the way the competition was organised by the joint sponsors. They were particularly grateful to Jackie Doidge, SEDAC Secretary, and Ron Powell, Mullard, for the efficient way they organised travel and accommodation for all finalists.

SEDAC TROPHY

A specially designed trophy was awarded to the winner of the Schools Electronic Design Award Competition.

As a fitting symbol of contemporary electronics this trophy is in the form of a high grade glass-fibre printed circuit board. The copper tracks are gold plated.

The p.c.b. is mounted on a polished wooden base and this carries a small brass plate engraved with name of school and title of winning project.

Martin with the SEDAC Trophy awarded to the outright winner of the schools competition.

Robert shows off the Digital Gauss Meter which won 2nd prize.

Michael and Lorna receiving their 3rd-place awards from Ivor Cohen of Mullard.

A VISITOR'S VIEW

The SEDAC 83 final was a close run event, as the standard of all the projects was high indeed.

It was interesting to note that seven out of the 12 finalists had decided to construct computer-based projects, emphasising the changing trend in schools today. Many of the competitors agreed that they were now geared towards computing rather than learning about the physical side of electronics.

The winner of SEDAC 83 was the Electronic Pendulum, entered by Martin Cragg (15) from the Roland Green School, Nottingham. The object of this project was to determine a value for "g", the acceleration due to gravity, using a pendulum linked to a BBC Microcomputer. In the three months it took to design the project a few problems were encountered by Martin, when dealing with the computer software and also the suspension of the pendulum, but these were all ironed out in time for the final. Ironically, Martin, who had hoped to get an apprenticeship in electronic engineering was turned down by Plessey at Beeston.

The runner-up of SEDAC 83 was the Digital Gauss Meter, entered by Robert Rowe (16), from Wymondham College, Norfolk. This instrument was constructed for the accurate measurement of small amounts of magnetic flux. It provides a fast and easy-to-use system at a budget price. The unit was designed specifically for an Engineering Design 'O' Level, but it was then decided to enter it for SEDAC 83. This was one of the few entries that is being turned into a commercial proposition, having been spotted by Scientific Systems Ltd., of Swindon.

The third prize winner, the Environmental Data Recorder, was entered by Michael Lawrie (15) and Lorna Wilkinson (13), from Hollins County High School, Lancashire. This was the only project amongst the finalists in which a girl participated in the technical design, and was again built especially for SEDAC 83.

The recorder was constructed for field work and is a portable, water and weatherproof unit which reads analogue information from sensors, converts these to digital form and stores the information in a memory. The results can then be graphically displayed later, back in the laboratory via a computer and television screen.

It was a stimulating experience to walk around and examine the projects and to "chat-up" all the finalists.

Nearly all the competitors seemed keen to pursue a career in the electronic or computing fields, except Lorna from Hollins County High School, who thought she would rather pursue acting on the stage!

Reaching the final of SEDAC 83 was a great event for the competitors. The two-night's accommodation in a nearby hotel at the sponsors expense made this a pleasant and memorable trip to the capital. As one teacher clearly pointed out, his pupils had never been to London before and had been thrilled at the prospect of sight-seeing in the capital.

Talking to the competitors, it became apparent that a couple of the schools involved, although eager to take credit for their pupils success, were not very eager to give financial backing, in effect limiting the competitors to what they could personally afford in the way of components. In total contrast, it is pleasing to report that the competitors from Hollins County High School were provided with pocket money by the Parent Teachers Association. It was a general feeling amongst the contestants that the schools had not been a driving force behind them to enter the competition, and it was on their own initiative that they had managed to succeed.

Many people commented on how well the competition had been organised. It was thought by one or two participants that SEDAC 83 seemed a better run event than some Government backed schools competitions that they had previously entered.

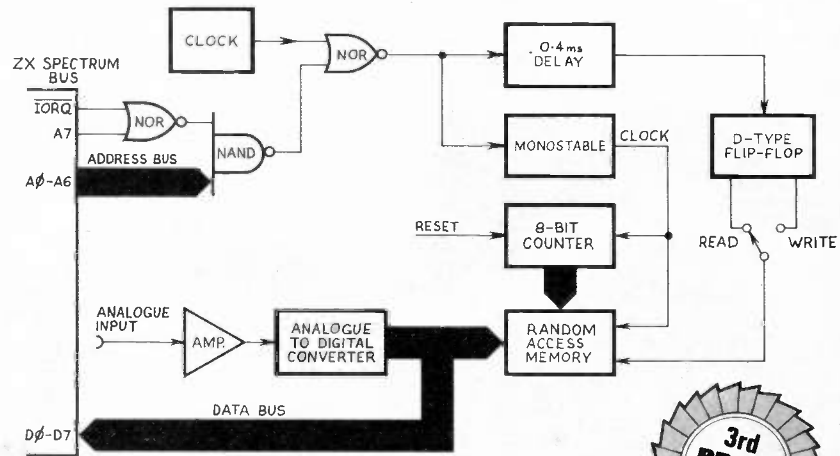
SCHOOLS Electronic Design Award COMPETITION

THE 1983 TWELVE WINNING DESIGNS

Environmental Data Recorder

Hollins High School, Accrington

Michael Lawrie (15)
Lorna Wilkinson (13)
Mr. J. S. Hagan (teacher)



Biological and environmental science studies are difficult to carry out when the quantities to be measured change slowly. Experiments may take days or weeks to be completed and when field work is being done the problems are even greater.

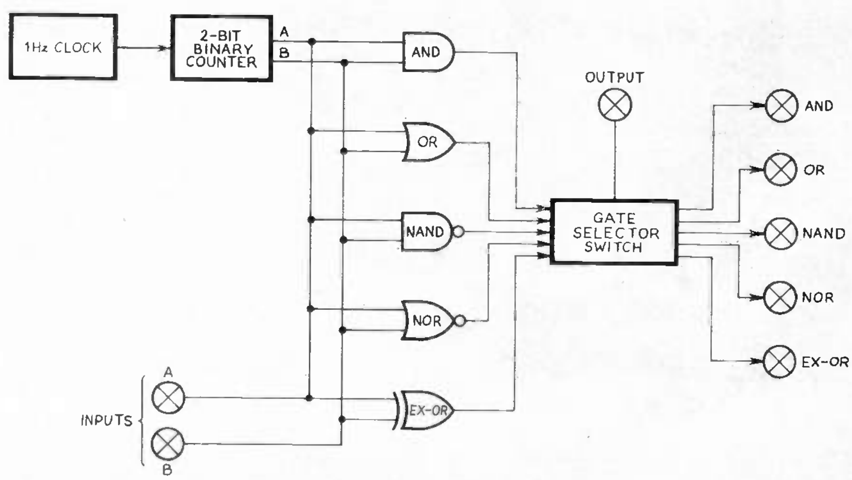
This project is a portable, water- and weather-proof unit designed to read analogue information from sensors. The unit may be used to determine temperature changes, oxygen content, light levels and may also be used with other sensors.

The data is stored digitally in a memory having already been converted from analogue-to-digital by an 8-bit converter. The results are then graphically displayed back in the laboratory via a computer and a television screen. As the project is designed as a portable unit it was decided to use rechargeable batteries as a power supply.

Logic Gate Demonstrator

Mill Hill School, London

G. Chelliah (16)
Dr. W. D. Phillips (teacher)



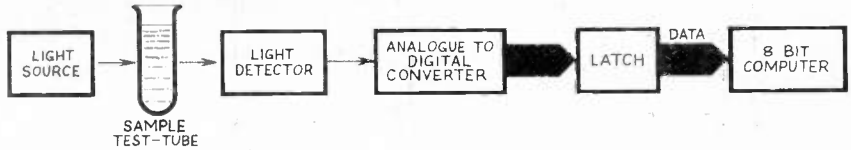
The purpose of the Logic Gate Demonstrator is to provide a visual demonstration of the operation of the five common logic gates, AND, OR, NAND, NOR and EX-OR such that the truth tables of these gates can be easily understood.

The project is intended for use in a class of about 20 pupils and therefore the display has to be of a size which will be easily visible and clear to the pupils. The display board of dimensions, 44cm by 60cm uses 6V indicating lamps.

The circuit design consists of a multivibrator producing pulses at approximately 1Hz. These pulses are then fed to a 2-bit binary counter which drives the inputs of the five logic gates. The output to be displayed is selected by means of the gate selector switch and at the same time the corresponding indicator lamp is illuminated.

Compu-Colorimeter
Ousedale School, Newport Pagnell

Mark Cole (17)
Mr. W. G. Thomas (teacher)



THE Compu-Colorimeter is designed to use a computer to record data for experiments determining rates of chemical reactions. The electronics have been kept simple, and complex Basic and Z80 Assembly language programs developed to process the data.

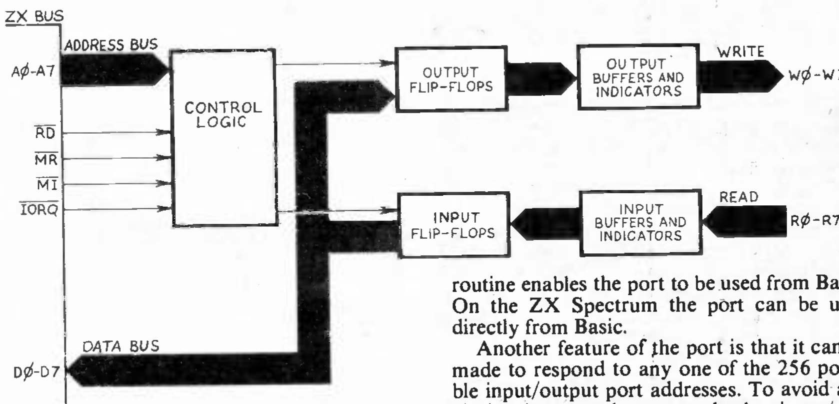
Operation consists of a light source which passes through a filter to obtain optimum wavelength and then through a test-tube containing the reacting solutions and on to a light dependent resistor. As the reaction commences, the colour of the solution changes and varying amounts of light fall on the light detector.

The equipment contains two separate compartments, optically sealed so light can only pass through the test-tube containing the reaction.

The voltage at the output of the detector is proportional to the light intensity, and is converted to a digital number and set up in a latch to be read by the computer's 8-bit input port. The software inputs data at set intervals, stores it, calculates results and displays them graphically.

ZX Input/Output Port
Parkview School, Barrow-in-Furness

M. Cowperthwaite (16)
Mr. S. J. Redding (teacher)



THIS project allows the ZX81 and ZX Spectrum to control external pieces of equipment and also to monitor external equipment. The unit provides eight input lines and eight output lines, and these may be used individually or in groups.

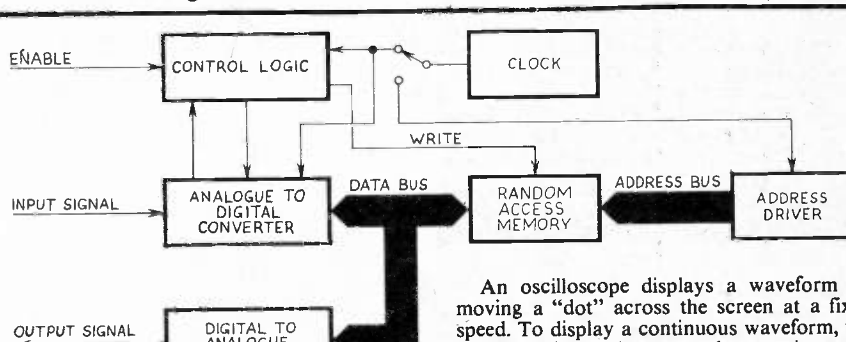
The port is input/output mapped as opposed to being memory mapped which means that the unit is compatible with any memory mapped device.

When using the ZX81, the port, being input/output mapped, cannot be used directly from Basic. However, a short machine code routine enables the port to be used from Basic. On the ZX Spectrum the port can be used directly from Basic.

Another feature of the port is that it can be made to respond to any one of the 256 possible input/output port addresses. To avoid any clashes between the port and other input/output mapped devices (ZX printer), a d.i.l. switch is built into the circuit. Hence, the port can be made compatible with virtually any other piece of hardware just by altering a few switches.

Storage Oscilloscope
Princess Margaret Royal Free School, Windsor

Ron Hejdeman (17)
Andrew Wilding (17)
Mr. G. Mort (teacher)



DURING experiments in the physics laboratory which require the measurement of waveforms lasting no longer than a few milliseconds, it occurred that it would be easier and more accurate if the waveform were frozen on the oscilloscope screen.

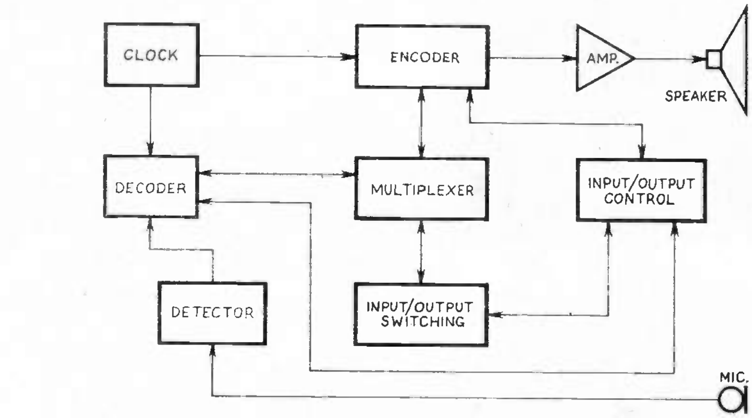
There is a type of oscilloscope which can do this, known as a storage oscilloscope, however, these are expensive, therefore an unviable proposition for schools. As a result, an alternative was designed to convert a normal oscilloscope into a storage instrument.

An oscilloscope displays a waveform by moving a "dot" across the screen at a fixed speed. To display a continuous waveform, the waveform has to be repeated many times. To do this, a memory is required, and this is the basis of this design.

To enter the waveform into the memory, it has to be converted into binary using an analogue-to-digital converter. And to convert it back to a voltage for the oscilloscope, a digital-to-analogue converter is employed. Logic is used to synchronise all functions.

Telephone Interface for Micros

The Ridings High School, Winterbourne
David Omar (16)
Julian Danton (16)
Mr. P. S. Maund (teacher)



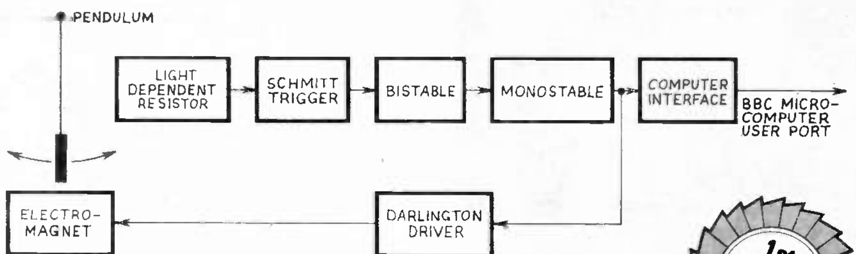
THE unit was designed as a general purpose telephone interface for any 8-bit microprocessor. The memory of the computer is converted into an audio signal, which is then passed down a telephone line and converted back to a digital signal. This signal is then stored in the memory of the receiving computer.

The main design considerations were operation, speed and synchronisation. Transmitting clock pulses was discarded as it halved the speed of data transmission, this meant an accurate clock was needed. The accurate clock pulse is provided by a crystal oscillator.

The units only requirements are a ±5V power supply, a suitable interface with two 8-bit programmable ports and suitable software.

Electronic Pendulum

Roland Green School, Wilford
Martin Cragg (15)
Mr. L. Haywood (teacher)



THE object of this project is to determine a value for "g", the acceleration due to gravity, using a pendulum linked to a BBC Microcomputer. Experimental time is reduced and a fairly accurate value of "g" may be determined. It can also be used to show how errors can be reduced by increasing the number of pendulum swings.

A pendulum is kept swinging at a constant amplitude by an electromagnet housed below the pendulum. A pulse from a light dependent resistor placed just above the electromagnet is obtained by the pendulum preventing light falling on it. This pulse is then fed into a bistable, which causes the bistable to change state and remain so, until a second pulse is supplied. As soon as the bistable has changed state a pulse is supplied to a monostable causing it to change state. The output from the monostable causes a large current to flow in two transistors wired as a Darlington pair.

After a short delay the monostable will return to its stable state and the Darlington pair will energise the electromagnet giving a kick to the pendulum. The computer keeps count of the number of pendulum swings and then calculates "g".

ALL THE WINNERS!

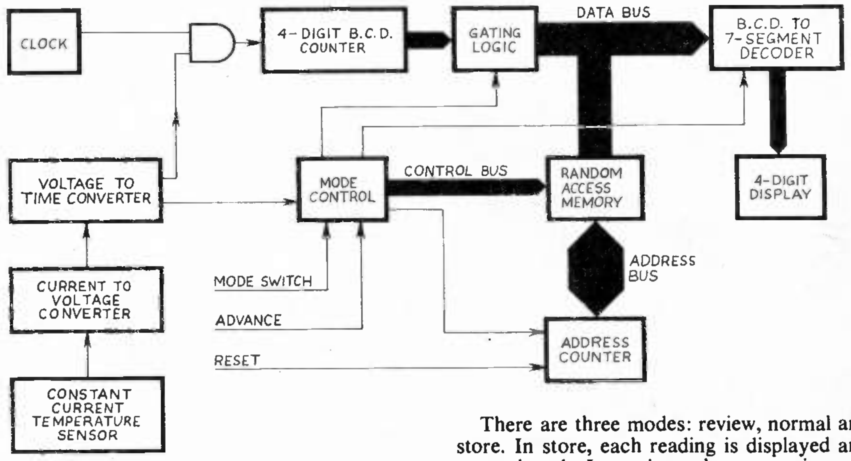
The twelve '83 finalists outside Mullard House on Presentation Day

WHO WILL BE IN THE PICTURE NEXT YEAR?

Digital Thermometer with Memory

Skegness Grammar School, Skegness

Paul Thorlby (15)
Paul Rock (16)
Mr. G. W. Payne (teacher)



THIS unit is designed to replace the mercury thermometer. Its main application will be for classroom demonstrations due to the large digital display and the ability to remember temperatures taken every $2\frac{1}{2}$ seconds.

The temperature sensor is a constant current generator whose output is directly proportional to the Kelvin temperature. This current is converted to a voltage and the next stage converts this voltage to time. The output is ANDed with the clock and the result is a number of pulses equal to the Kelvin temperature.

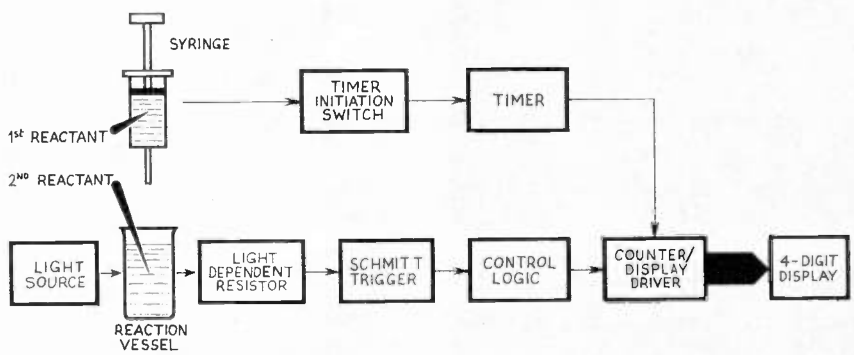
These are counted by a 4-digit b.c.d. counter. The control logic, routes each reading to and from the memory, display and counter via a data bus.

There are three modes: review, normal and store. In store, each reading is displayed and remembered. In review, the measuring apparatus is disabled and readings taken from the memory, and in normal, the memory content is safeguarded and the unit displays readings, but does not record them in the memory.

Precipitation Reaction Timer

Skinners' School, Tunbridge Wells

David Lewis (16)
Duncan Reed (17)
Mr. L. T. Goldsmith (teacher)



THE unit was designed as an aid to increasing the accuracy of experiments where a precipitate is timed as it forms. The design improves on the crude methods of timing used in schools at present and should be of value in work at all levels of chemistry. Throughout the design, emphasis has been put on the accuracy of about half a second, and the cost which schools would be able to afford.

The timer itself consists of a light shining through the reaction vessel onto a light dependent resistor (l.d.r.). As the precipitate thickens the resistance of the l.d.r. increases and this increase is used to control a switching circuit, which in turn stops a 4-decade counter timing the reaction.

The time in seconds and tenths of seconds is displayed on four 7-segment l.e.d. displays. The timer is started on the addition of the second reactant, the first having been placed in the reaction vessel. The timer is housed in a plastics case which contains all the electronics and the reaction chamber.

MULLARD and EVERYDAY ELECTRONICS are pleased to announce next year's Schools Electronic Design Award Competition—SEDAC '84.

★ Scholars and teachers are urged to give thought now to their school's participation in this challenging National Contest.

AWARDS FOR WINNERS

The SEDAC TROPHY to the outright winner

Valuable cash prizes to the first three winners

Boxes of electronic components and technical data booklets to all twelve finalists—plus a certificate and one year's subscription to Everyday Electronics

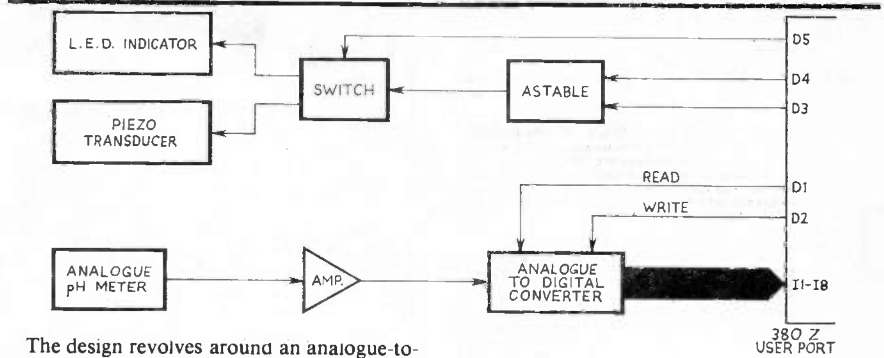
and All-Expenses-Paid Two-Day visit to London.

FULL DETAILS NEXT MONTH

Computer Interface for Analogue pH Meter

Thomas Alleyne's High School, Uttoxeter

Stephen Bailey (16)
Mr. A. H. Orme (teacher)



THIS project is intended for use in the chemistry laboratory and is a device which extends the capabilities of a pH meter by linking it to a Research Machine 380Z using Control Basic.

Precise measurements can now be carried out to a great degree of accuracy instead of using a colour change with an indicator, or a measurement on an analogue meter, as numerical representation can be given. Graph plots may also be provided by the computer during chemical reactions.

The design revolves around an analogue-to-digital converter which converts the varying analogue voltage from a normal pH meter and digitises it, so that it can be used by the 380Z. Before this stage there is a variable gain amplifier and buffer which obtains full graphical range from the 380Z.

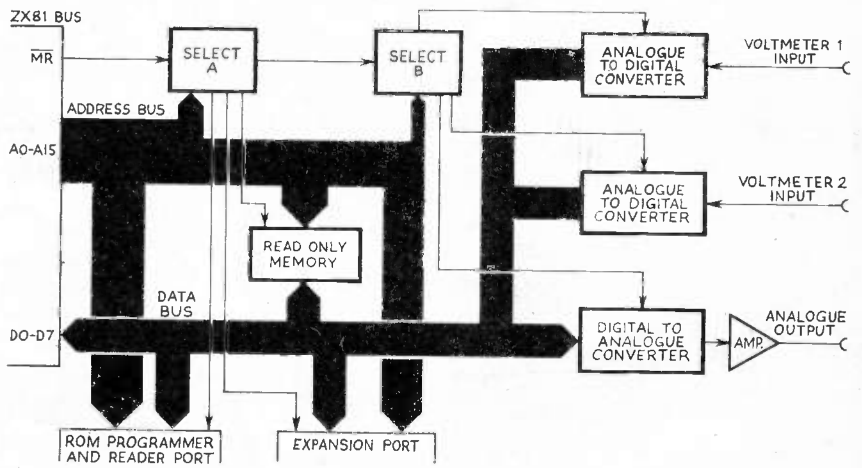
The final part of the proposed project is the audible feedback oscillator which alerts the operator that a certain pH value is about to be reached by producing two tones. A visual indicator is also provided if it is more suitable in certain conditions.

All major controls such as sampling rate and warning system switching are software based therefore maintaining the flexibility of the whole system.

ZX81 Expansion System

Whitecross School, Lydney

Peter Jarvis (14)
Katy Jarvis (18)
Mr. M. C. Jarvis (teacher)



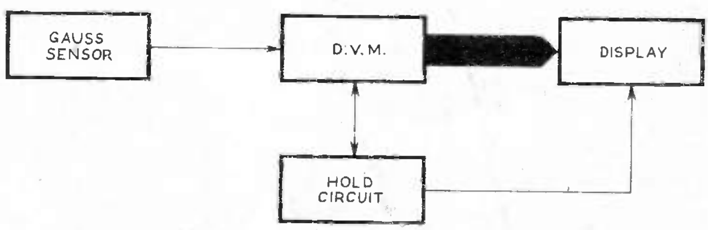
THE circuit is a complete unit for interfacing the ZX81 in a school science laboratory. The unit has its own power supply, supplying 1A to the circuit, and also the external circuitry if connected.

The circuit has seven defined parts; a selection system for selecting which part of the circuit is being used; the expansion port which enables timers and meters to be connected; analogue-to-digital and digital-to-analogue converters; a ROM port equipped with an EPROM Programmer for +5V rail EPROMS; a

Digital Gauss Meter

Wymondham College, Wymondham

Robert Rowe (16)
Mr. J. Edwards (teacher)



THIS instrument is designed for accurate measurement of small amounts of magnetic flux in the range ±2000 gauss. It provides a cheap and easy to use system, within a school's budget.

The device uses a Hall effect transducer for detection of a magnetic field, this being mounted in a probe. The sensor gives a differential output, dependent on the strength and polarity of the magnetic field. This is fed into a digital voltmeter i.c. The sensor is biased to be linear up to ±3000 gauss.

The d.v.m. gives a 3½ digit liquid crystal display of the differential voltage applied to its input. A hold feature was essential to freeze the display as small movements of the probe resulted in large changes in the magnetic field.

The 7106 d.v.m. i.c. employed in the design does not have an internal hold facility, so an external circuit was added. This uses an external clock and multiplexer, the latter necessary to prevent the display being destroyed by a constant d.c. drive voltage across it.

ADDITIONS TO OUR LIST

RADIO MOBILE CAR RADIO SPEAKERS

9" x 4" 4 ohm 5 watt – £1.70. 6" x 4½" 3 ohm 4 watt – £1.35; 6" x 4" 4 ohm 4 watt – £1.15. 6" x 4" 16 ohm 5 watt – £1.15; 5" round 8 ohm 10 watt – £2.30. 6½" round extra thin for door or back shelf. In fact these are only 1½" thick 16 ohm 5 watt – £1.75; 5" round 16 ohm 5 watt chassis size 5¼" square (approx). – £1.15; 5" round 4 ohm 5 watt chassis size 5¼" square (approx). – £1.15; 5" round 4 ohm 6 watt with built in tweeter – £1.15. 9" x 3" 8 ohm £1.15.

IMPORTANT NOTE: The speaker prices above do not include postage but 10 or more speakers are post free – otherwise add £1.50 per order.

STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) – Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% – load regulation 1% from no load to full load – or full load to no load. Complete in heavy duty case – Models available: 5v - 6A £17.25. 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

PREPARED APPLIANCE LEADS

Buy these, they will save you time and money. Prices are for small quantities but if you are buying £100 lots or more – halve the prices. Twin circular, white .5mm length 54" – 23p; 3 core circular, white 99" – 1.25mm – 57p; Twin circular black 77", .5mm – 23p; 3 core circular, black 88" .5mm – 35p; 84" .5mm 46p; Twin circular black 114" 1.25mm – 69p. Twin circular white 200" .75 fitted 2 pin continental plug one end – 57p; 3 core circular white 54" .75mm core sizes fitted continental two pin and earth plug one end and new type 3 flat pin appliance connector at other end – 75p.

MINIATURE TOGGLE SWITCHES

As used on TV cameras and other lightweight equipment. American made by the Arrow Company.
Arrow ref. TCH3E Single pole changeover, centre off – 46p.
Arrow ref. TSH3PCL Single pole changeover PCB mounting – 46p.
Arrow ref. TC6M Double pole changeover, centre off – 69p.

REED RELAY KIT

High inductance coil, moulded to take 4 reeds, operated by three volts DC or 12 ma. Could be used to close 4 circuits, or with the external magnets supplied, you could have two normally open, i.e. two changeovers. An exceptional bargain at 99p for the coil – 4 reeds and 2 magnets.

ROCKER SWITCHES

Standard size fit 11.5 x 28mm cut out. Single pole on/off – 23p; Single pole changeover 28p; Single pole changeover with centre off – 30p; Single pole on/off with neon – 46p, for double width cut out DpSt 36p, DpDT 46p.

NICAD BATTERY CHARGERS

This, although intended to charge button cells, bring leads from the contacts and then it will suit almost any Nicad battery, charge rate approximately 15mA but easy to vary.

MIXER MOTOR

If this had a case around it, it would be a complete mixer as it has a speed control switch giving three changes of main speed and it also has a gear box with two sockets for paddles. Three lower speeds are available from these sockets. £3.45 – post 60p.

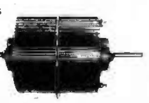
LOW VOLTAGE SWITCH

Approx 1½" diameter, the cover unscrews to enable the switch to be fixed and to keep the contacts covered, contacts look capable of up to 10 amps. 23p.

PILOT BULBS

Standard round 11mm 6.5v .3a by Philips. Box of 10 price 50p.

12 volt MOTOR BY SMITHS



Made for use in cars, etc. these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. They have a good length of ¼" spindle – **Price £3.45.**
Ditto, but double ended £4.25.
Ditto, but permanent magnet £3.75.

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £7.95 + £1.50 post.
(This is easily reversible with our reversing switch – Price £1.15).

MAINS MOTORS

We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements. Some new ones just arrived.

67 R.P.M. Motor: 1/10 hp. reversible mains operated split phase motor with gear box – shaft fitted with chain sprocket £11.50 plus £2 post.

100 R.P.M. Motor: 1/16 hp. Mains driven reversible motor with gear box, ½" shaft from gear box – Very powerful £16.50 plus £3 post.

BALANCED MOTOR: Disc or tape drive motor 1500rpm reversible – mains operated. 3" dia 2¾" long with good length 3/8" spindle £4.60 plus 80p post.

CROSSOVER NETWORKS

2-way: 4 or 8 ohm impedance – power input up to 25W, crossover frequency 2kHz with wiring dig. 87p each.
3-way: 4 or 8 ohm – power input up to 60W, crossovers at 700kHz and 3500kHz with wiring diagram. £1.15.

– BARGAIN OF THE YEAR –

The AMSTRAD Stereo Tuner.

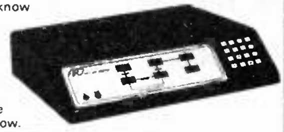
This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio – easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are: long wave band 115 – 270 KHz, medium wave band 525 – 1650KHz, FM band 87 – 108MHz, mono, stereo & AFC switchable, tuning meter to give you spot on stereo tuning, optional LED wave band indicator, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board.

Offered at a fraction of its cost: **only £6.00** + £1.50 post + insurance.

THIS MONTH'S SNIP



A PRESTEL UNIT, complete except for 6 plug-in IC's – so far as we know the unit would work once the missing IC's are fitted.
Price: £19.75 + £2.00 Post.
Contains all the items listed below.

VIEWDATA EQUIPMENT

ORACLE VB 100 PCB

This is the heart of many viewdata systems, including the Prestel Unit which we are currently selling. This board uses 25 I.C.'s, 5 transistors, 2 crystals and very many other components. It has a TV aerial input and a TV UHF modifier (AZTEC UM 1233). We offer this board, new, unused and complete except for 6 of the 25 I.C.'s at £5.75. The plug in holders for the missing I.C.'s are on the board wired ready to receive them.

MINIKEY SERIES KL

This is an American made membrane keyboard with silver contacts as used on Prestel to dial into the British Telecom phone system. It is really miniature, only 60mm x 65mm x 5mm thick. It has 16 press buttons, giving standard 0-9 numbers and ABCD facilities. There are two other buttons engraved asterisks. This is an extremely well made board. £4.60.

TELEPHONE LINE TERMINATION UNIT

As used with Prestel but undoubtedly suitable for other applications. Important components are phone line isolation transformer and 3 Clare Reed Relays. All mounted on a pcb with I.C. and other components P.C.B. size approximately 7" x 1¾" – £3.45.

VOLTAGE STABILISED POWER SUPPLY

As used with Preste' this has a mains input transformer with a 13v - 0 - 13v 20 watt mains transformer. Rectifiers and semi-conductors all mounted on P.C.B. size approximately 4¾" x 2". The stabilised DC output from this is –27v – 12v – 0 +0 +12v +27v. Price £4.60.

INSTRUMENT CASE

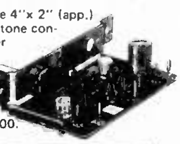
As used with the Prestel unit this comprises an ali chassis and a moulded front plastic cover secured to the chassis by self-tapping screws. Overall size approx 12"x 10" x 2½" deep. On the front is fitted the minikeyboard as described above and although originally intended for Prestel, this case should have other uses including telephone answering machine, etc. Price £5.75 + £1.50 post.

X-RAY EQUIPMENT

Beautifully made by the American GEC Company. We have a whole range of spares, all unused. **X-RAY TROLLEY** - This could be motorised, mains or battery driveb with self retractable flex lead, so it could be used for carrying other mains operated equipment which need to be manouvered easily in a relatively confined space. Switching and breaking is done from the handle and there is ample room and capacity for heavy transformers and smaller equipment. The overall size of this trolley is approx. 3' x 2' x 3'6" Price £69.
X-RAY HEAD This comprises the x-ray tube in a radiation proof housing with plug in lead connectors. The tube enclosed in the housing is a hospital size tube and unused and new. Price £69.
EHT TRANSFORMER & RECTIFIER UNIT We estimate that the output voltage of this is probably 30 or 40 KV. Completely enclosed in an oil filled container, size 13" x 14" x 15". There are four rectifier sections, each using 20 EHT rectifiers connected in series these plug in for ease of replacement. The unit is powered by a 600 cycle supply. Price £69. **600 CYCLE SUPPLY UNIT** Mains operated through a step down transformer, this contains all the electronic components to operate the equipment. Price £57.50.

MINI MONO AMP

on p.c.b., size 4"x 2" (app.)



Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 10 for £10.00.**

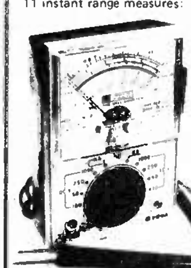
50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, multi-turn pots and notes on the 50 projects.

YOURS FOR ONLY £11.50 plus £3.00 post.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: DC volts 10, 50, 250, 1000. AC volts 10, 50, 250, 1000. DC amps 0 – 100 mA.



Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 60p post and insurance.

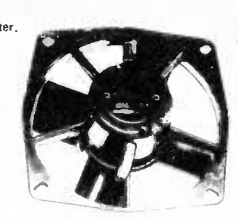
FREE Amps range kit to enable you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but if you already own a Mini-Tester and would like one, send **£2.50.**

J. BULL (Electrical) Ltd.

(Dept. EE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU. Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £12 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: write for quote. Shop open 9.00 — 5.30, mon to Fri, not Saturday.

EXTRACTOR FANS



Mains operated – ex-computer.
Woods extractor
5" – £5.75, Post £1.25
6" – £6.95, Post £1.25
5" Plannair extractor £6.50. Post £1.25.
4"x4" Muffin 115v. £4.50. Post 75p.
4"x4" Muffin 230v. £5.75. Post 75p.
9" American made £11.50, post £2.00.
12 volt 6½" extractor £6.90, post £1.50.

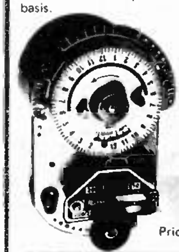
AUTO & ISOLATION TRANSFORMERS

2 KW ISOLATION TRANSFORMER 230v in 230v out with tapped primary and secondary, facilities any voltage changes that might be needed. This is a very heavy transformer, American made but not encased. The terminals are along the top on insulation board panels. Both primary and secondary are split so this sould also be used as a 2KW isolation step down transformer. £57.50. Carriage at cost depending upon the distance. This is approx half the regular price.
2 KW AUTO TRANSFORMER Similar type of transformer to the above but has only the one winding. £28.50 + carriage £3.
1 KW ISOLATED AUTO TRANSFORMER It is not generally realised that many of the American made tools intended for 115v, if used on building sites and similar damp conditions must be isolated from the mains for safety reasons, as in many cases the insulation of this equipment is not good enough for 230v. We have American made isolated auto transformers, completely enclosed in sheet metal case with carrying handle with 230v lead and 110v American type plug. Price £46.00 + £4.50 post.
300 WATT AUTO TRANSFORMER completely encased, lead for the 230v input, American type plug for the 115v output £6.90 + £1.50 post.
100 WATT AUTO TRANSFORMER not enclosed terminals, output primary with tappings for voltage adjustments. Made to rigid specification for the GPO £4.60 + £1 post.
AMERICAN 2 PIN FLAT SOCKETS for use with these auto transformers – £2.30 each.

3M FACSIMILE EQUIPMENT

– send or receive a document in 4 minutes. This equipment is used for sending letters and almost any data through the telephone system – "Mail by Phone". The machines we have are the 3M 6008B with autofeed complete with ansafonettes and connector box. We have three sets of the equipment, it is not old, in fact it was used only for about a year (1980-81), believed to be in good order and certainly in a very good condition – cost new over £10,000. We will accept £500 the lot – buyer to examine and take away on an "as seen" basis.

VENNER TIME SWITCH



Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95.** These are without case but we can supply a plastic case - **£1.75.**
Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.**

IONISER KIT

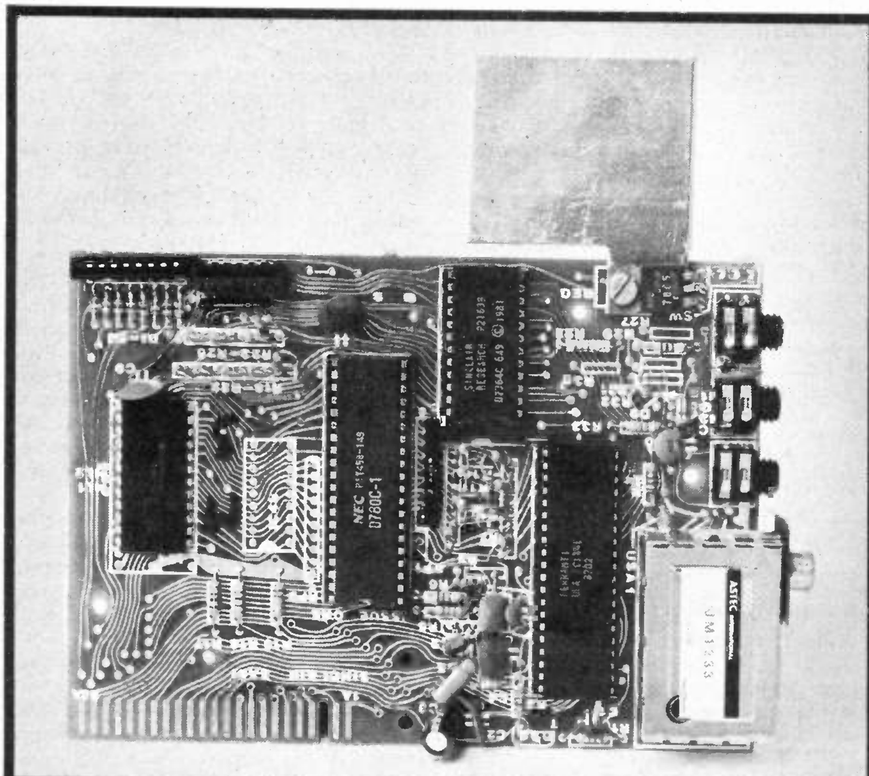
Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included.
£11.95 plus £2.00 post.

OTHER POPULAR PROJECTS

R C Bridge Kit	£9.95
3 Channel Sound to Light – with fully prepared metal case.	£14.95
Ditto – made up	£25.00
Big Ear, listen through walls	£9.50
Robot controller – receiver/transmitter	£9.50
Ignition kit – helps starting, saves petrol, improves performance	£13.95
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch – fools friends and enemies alike	£1.95
3 – 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Light Chaser – three modes	£17.50
Mullard Unilex HiFi stereo amplifier with speakers	£16.75
Radio stethoscope – fault finding aid	£4.80
Mug stop – emits piercing squark	£2.50
Morse Trainer – complete with key	£2.99
Drill control kit	£3.95
Drill control kit – made up	£6.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
FM receiver kit – for surveillance or normal FM	£3.50
Seat Belt reminder	£3.00
Car Starter Charger Kit	£14.00
Soil heater for plants and seeds	£16.50
Insulation Tester – electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio – receives Medium Wave	£2.95
Mixer Pre-amp – disco special with case	£16.00
Aerial Rotator – mains operated	£29.50
Aerial direction indicator	£5.50
40 watt amp – hifi 20hz – 20kHz	£9.50
Microvolt multiplier – measure very low currents with ordinary multitester	£3.95
Pure Sine Wave Generator	£5.75
Linear Power output meter	£11.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for one or two 115 watt amps	£17.50
Stereo Bass Booster, most items	£8.95

SPECIAL REPORT

ZX81 PERSON



(Top) The ZX81 package comes with computer, 9V power pack (excluding mains plug), programming manual and leads for TV and cassette. (Above) The p.c.b. showing the finger set to connect the printer and extra memory.

THE Sinclair ZX81 has, almost single handedly, been responsible for the boom in home computing and this familiar little "black wedge" can now be purchased for less than £40, a reduction of some 40 per cent on the original price. Still a best-seller in spite of the introduction of its big brother, the Spectrum (see *Special Report,* June '83 issue), the diminutive 1K ZX81 is as readily available from the high street chain store as it is from the computer specialist.

So what do you get for your money? The package comes complete with the computer console, a 9V mains power pack, a 1·2m long aerial lead to connect to a TV set, a pair of leads to hook up to a cassette recorder and the 210-page BASIC programming manual. Also included is a software catalogue listing all currently available Sinclair software tapes and introductory leaflet.

So all you need to supply is a 3-pin mains plug and a UHF television set (that is, one that receives BBC2 in the UK) and you can start computing.

SETTING UP

The first chapter of the manual covers the initial setting-up procedure and this is a simple matter. The television set is connected to the ZX81 via the aerial socket and the mains power pack is plugged in. The TV has to be tuned-in (using a spare channel button on push-button sets or just a little way past BBC2 on rotary controls) and this is achieved when a little "K" appears in a black square in the bottom left-hand corner of the picture.

I initially found a slightly fuzzy picture when working on a large colour TV set—as well as it being slightly inconvenient crouched on the floor in front of it. Hardly the ideal working position! However, this is a criticism of the television and not the computer for when used with a portable black and white set, the picture was pin-sharp. And a far more comfortable work station is created with the whole set-up on a table top.

The 40-key keyboard measures only 150 × 50mm and is of membrane contruction. That is, it has no moving parts, you simply touch the required key. Now this technique has recently come in for quite a lot of bad press and a whole multitude of full-size, moving-key keyboards have sprung up as add-ons.

I personally found this criticism a little unjust for, with practice, it is possible to become quite proficient with the original membrane version. It does of course mean that you have to look at the keyboard and not the screen when entering data, but how many of us can touch-type anyway?

MEMORY

One of the most important parts of a computer is the memory in which it stores data and instructions in order to carry out the programs. The unexpanded ZX81 has 1K bytes of user memory and this is known as RAM (Random Access Memory). This means that it has 1024 (1024 *and not* 1000 because 1K is equal to 2^{10} bytes in binary) memory locations for system management.

This is not a great deal by modern standards but certainly enough to introduce the user to programming techniques. It is, of course, expandable by 16K with the add-on RAM pack.

The ZX81 uses BASIC as its programming language and the central processor or "brains" of the computer (in this case, the popular Z80A processor) does not directly understand BASIC instructions. So a further memory is required to interpret the BASIC and provide instructions the processor can understand.

This additional memory is known as the ROM (Read Only Memory) and the ZX81 has 8K bytes of ROM. The contents of the ROM cannot be changed by the user whereas the RAM can be altered at will but RAM is lost when the power supply is disconnected whereas ROM is not.

PROGRAMMING

The ZX81 BASIC programming manual assumes no prior knowledge of computer programming and starts at absolute basics (excuse the pun!). Within minutes, the user is operating the ZX81 as a calculator and becoming familiar with the way to enter a problem and execute the answer.

But a simple calculator the ZX81 is not, and it very soon becomes apparent that it is capable of handling far more complex problems. The next few chapters introduce the BASIC functions, variables and strings used in programming.

By chapter eight (and it is advisable to follow chapters in numeric order) the beginner is actually running a simple program concerning the varying price of vegetables! The following chapter has you running a few more serious programs, for example extracting square roots, and it starts to fall into place.

As previously stated, the ZX81 uses Sinclair BASIC and this language uses "keywords" for all instructions. Now BASIC follows normal English as closely as possible and, for example, the language uses the PRINT command to literally "print" a result on the screen.

The ZX81 has all these keywords as single key entries and to use the same example, if the program requires a result to be displayed, the first pressing of the "P" key will give the PRINT command, without the need to spell the keyword in full. All subsequent pressings of this key will give the single character "P" until a new line of program is started.

All new lines of program are given a number and the computer will automatically place these lines in order. The normal standard is to number the lines 10, 20, 30 and so on in multiples of ten so that if an additional unforeseen line is required (and this is usually the case, even with experienced programmers), it can be added between two previous lines and the ZX81 will insert it at the correct location.

The ZX81 is not particularly fast and it can take a number of seconds, even minutes, to execute a program. However, it does have two modes of operation, FAST and SLOW. Under normal circumstances, it operates in SLOW mode and displays all operations as they happen. If the FAST mode is requested, it blanks out the screen during a program run (and as the display takes up memory space, it also takes up time) and consequently, the program runs much faster.

GRAPHICS

The display of the ZX81 has 22 lines of 32 characters making a total of 704 picture elements. Each of these picture elements is sub-divided into four portions, each known as a pixel. Each individual pixel can be addressed by its coordinates (using the PLOT command) resulting in a graphics screen area of 42 by 64 pixels. Note that the bottom two lines of the screen cannot be used for either PRINTing or PLOTting.

As such, the display is fairly low resolution and only in black and white. The standard graphics characters do, however, include a set of symbols that allow the pixels to show a kind of chequered pattern that gives the effect of a half-tone, so quite effective pictures can be generated for games.

The display can also be animated by instructing the computer PLOT and then UNPLOT pixels, giving the effect of movement.

Now, assume you have mastered the fundamentals of programming and wish to save a program. Switching off the machine will erase all that is in the RAM so the program will have to be stored on cassette tape. The ZX81 has a cassette interface to do just this and the procedure is fairly simple.

All that is required is a normal mono cassette recorder (a stereo recorder will work but better results are obtained on cheaper, mono machines) and a blank tape. The computer is connected to the recorder via the two leads supplied. These leads come with 3·5mm jack plugs at either end so if your recorder uses different connectors, a special lead will be required.

The program can now be stored with the SAVE command, or entered from tape into the memory with the LOAD command. It does not always work reliably and often requires a fair amount of experimentation with record and volume levels but once mastered, is essential for the serious user of the ZX81.

IN CONCLUSION

The final chapters of the manual go into the more serious aspects of programming, including using machine code (this is the language that the Z80A processor understands), PEEKing and POKEing and the organisation of the memory. But it still leaves you wanting for more information so as to fully exploit the capabilities of the ZX81.

I also feel that you will very soon be needing the services of the 16K RAM Pack and quite possibly, the ZX Printer so this is worth bearing in mind when considering buying. Overall, it is a very good starting point (and a very cheap one, too) and over a million users can't be a bad recommendation.

In so far as add-on extras go, it is probably one of the best computers served. With software houses offering programs on games, educational and business subjects and independent manufacturers supplying keyboards, extra memory, high resolution graphics and interfaces, the humble ZX81 could soon become the heart of a sophisticated system. □

AL COMPUTER

BY G.P. HODGSON

THIS six-part series describes experiments interfaced to the 380Z microcomputer using the Analogue-to-Digital Converter described on page 559, but could easily be adapted for use with other such devices. The software will be given for each experiment.

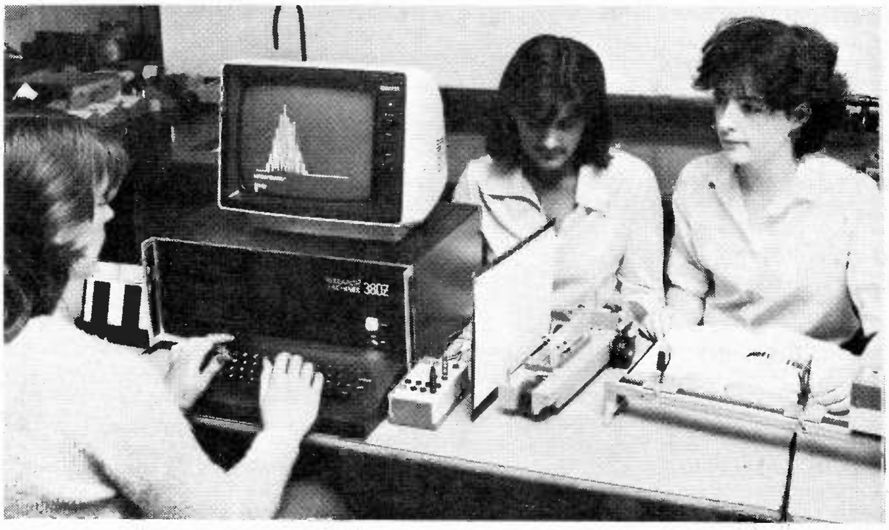
All these experiments have, at some time or other, been demonstrated in the classroom in a teaching situation and have proved very successful. These are not simulations but actual experiments performed by the teacher or pupil.

The results clearly demonstrated the advantage of supporting difficult physical ideas with almost instant experimental results, rapidly analysed and plotted. Measurable physical quantities were no longer the dreary abstract graphs which have to be learned from book or blackboard, but they actually came alive on a v.d.u. as the experiment was being performed, thus enabling the teacher to concentrate more on physical principles and interpretation of results and then in a separate experimental session to concentrate on the practical aspects of any given experiment.

COMPUTER AIDED EXPERIMENTS

USING THE RM380Z MICROCOMPUTER

BY A. A. CHANERLEY B.Sc. M.Sc.



The experiment being carried out by lower sixth form pupils at La Retraite High School for Girls, London.

1. INVESTIGATION OF DIFFRACTION PATTERNS

THIS experiment employs the 380Z microcomputer to automatically store and plot the intensity distribution of the light pattern produced as a result of diffraction/interference from single and multiple slit light sources.

An optical sensor is made to scan the interference pattern produced and the resulting analogue electrical signal developed by this transducer is fed to an analogue-to-digital converter. We are using the unit described on page 559 in this experiment, although others could of course be used. The ADC is connected to the user port of the 380Z.

Under software control the digitised data is read in by the computer and the detected intensity pattern graphically displayed on the v.d.u. wired to the 380Z.

A monochromatic light source is required for this experiment which in this case is provided by a low power helium-neon laser. As can be seen in the photograph the laser sits on a special stand which also accommodates the slit(s) and a lens. The light pattern is observed on a vertical white screen.

OPTICAL SENSOR

An integrated optical transducer is used as the sensor. It contains a high efficiency photodiode combined with a high gain low noise amplifier. The internal circuitry for this electronic sensor is shown in Fig. 1.1. It requires a split power supply of between ±2·5V and ±18V which is simply provided here by two PP1 6V batteries.

Under dark conditions there is zero output from the device. When light falls on the photodiode junction the output voltage rises, the level of the output being proportional to the intensity of the light received.

The connection details of this device are given in Fig. 1.2 where it is shown soldered to suitable lengths of plastic covered wire to be terminated in 4mm plugs to suit the specified ADC unit. Sleeving must be used, as shown, to prevent possible shorting of the pins.

Set up the experiment and connect the sensor to the ADC, and batteries, as shown in Fig. 1.3. Set the apparatus to produce a well defined image on the screen.

MOVING SENSOR

A means must be found for sweeping the sensor across the light beam. It can, and has successfully been carried out by hand, but a better method was found using the trolley normally found in the apparatus for velocity measurement. The sensor was fitted here, to the vertical metal mounting plate of a solderless breadboard system and held at the correct height with Blu-Tack. This assembly was secured to the trolley which was then pushed at an even rate across the beam. This method was used to produce the double-slit interference pattern shown in Fig. 1.4.

The software for this experiment is shown opposite under LASER. The other routines STORE, POKER and GRAPH provide the facilities described in their respective REM statements.

SAVE "LASER" will copy the typed-in program onto disc and give it the filename LASER. LOAD "LASER" will transfer the LASER routine from disc to user RAM. These routines may also be saved/loaded on/from tape using the CSAVE and CLOAD commands respectively.

The six experiments are:

1. Investigation of diffraction patterns
2. Napthalene cooling/heating curves
3. Voltage transfer characteristic of the bipolar transistor
4. Capacitor charge/discharge with variable time constant
5. Ohmic and non-ohmic resistances
6. I-V characteristic of a *pn*-junction

The theory behind this experiment is beyond the scope of EVERYDAY ELECTRONICS and readers requiring this information are referred to school and college text books on Physical Optics.

COMPUTER AIDED EXPERIMENTS SOFTWARE: EXP. 1

LASER

```
10 REM:this programme reads the light
20 REM:input from the A-to-D via the
30 REM:380Z user port relocates the
40 REM:results and plots them.
50 GRAPH1:GRAPH0
60 CALL"RESOLUTION",0,2:REM:HR-graphics
70 CALL"PLOT",0,0,3
80 FOR I = 1 TO 300
90 POKE 64511,0:REM:set channel.
100 Y=PEEK(64511):REM:read channel.
110 PLOT 70,50,STR$(Y)+"    "
120 REM LIMITS OF SCREEN ARE 318,191
130 CALL"LINE",I,Y*2,3:REM:plot results
140 POKE(&6000+I),Y:REM:relocate results
150 FOR Z=1 TO 200:NEXT Z
160 NEXT I
170 PRINT "PRESS C TO CLEAR GRAPHICS"
180 G=GET()
190 IF G >90 THEN G=G-32
200 IFG=67  THEN CALL "RESOLUTION",0,2
    SAVE "LASER"
```

STORE

```
10 REM:this programme stores the
20 REM:relocated data to disk file
30 CREATE#10,"LAS.DAT"
40 FOR V=&6000 TO (&6000+300)
50 BYTE=PEEK(V)
60 PRINT #10,V;",";BYTE
70 NEXT V
80 CLOSE#10
    SAVE "STORE"
```

POKER

```
10 REM:this programme returns
20 REM:the data to memory
30 REM:locations for replotting.
40 OPEN#10,"LAS.DAT"
50 FOR V=&6000 TO (&6000+300)
60 INPUT#10,ADDR,BYTE
70 POKE ADDR,BYTE
80 NEXT V
90 CLOSE#10
    SAVE "POKER"
```

GRAPH

```
10 REM:this programme replots the
20 REM:data returned by the previous
30 REM:programme.
40 GRAPH 1
50 CALL"RESOLUTION",0,2
60 FOR I=2 TO 300
70 Y=PEEK(&6000+I)
80 CALL "LINE",I,Y*4,3
90 NEXT I
    SAVE "GRAPH"
```

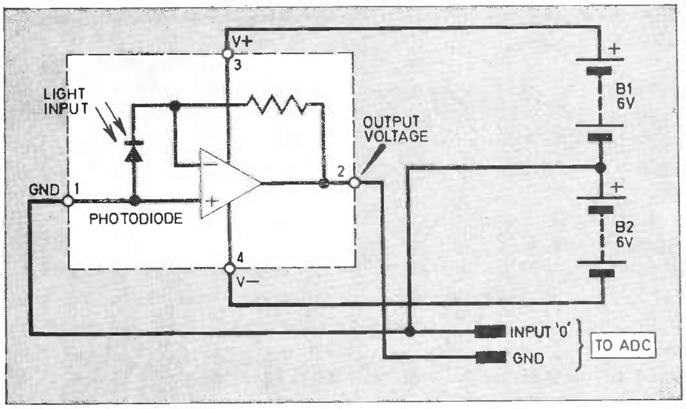
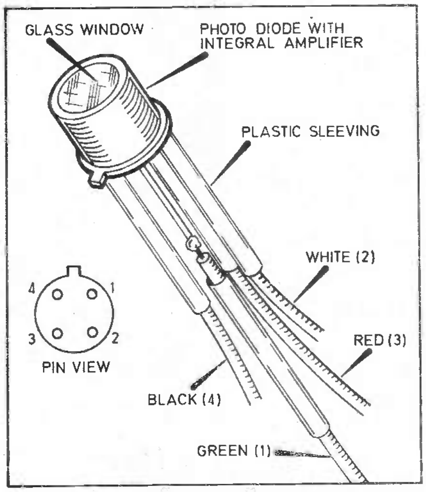


Fig. 1.1. Circuit diagram of the sensor and its battery power supply.



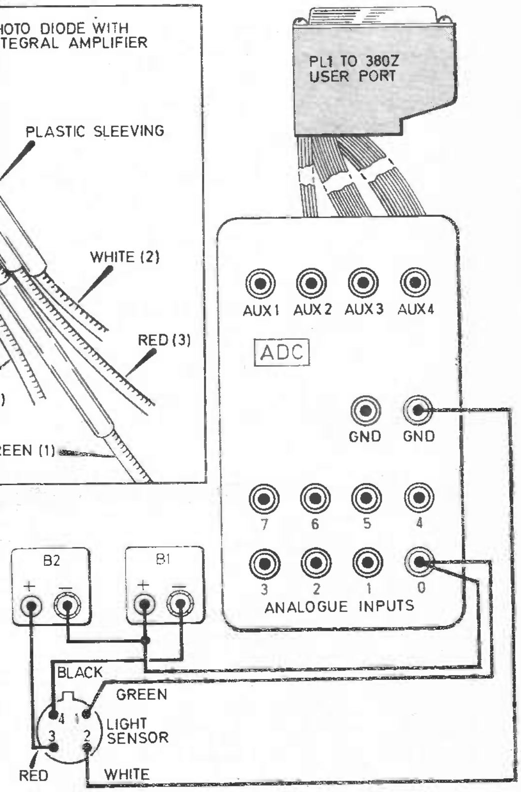
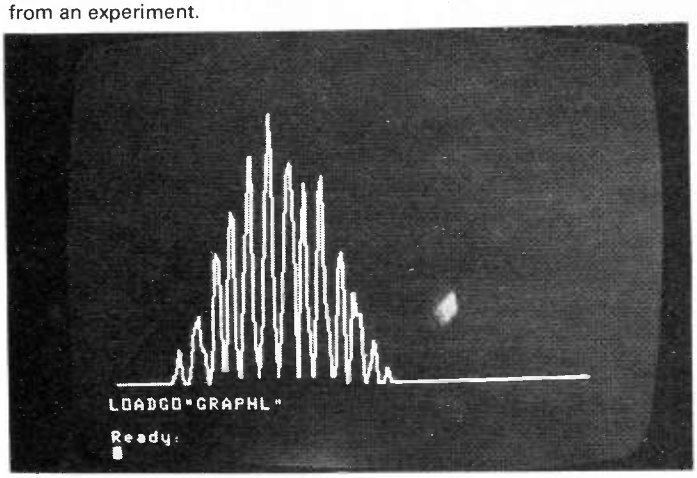
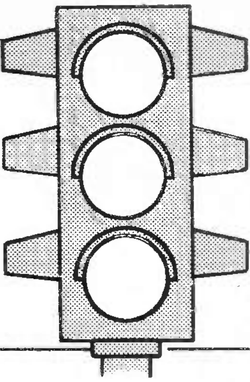


Fig. 1.2 (above). Identification of the sensor lead-outs and connection details of extension wiring. See *Shop Talk* for supplier of sensor.

Fig. 1.3. Connecting the sensor and batteries to the ADC unit.

Fig. 1.4. Photograph of a double-slit interference pattern obtained from an experiment.





TRAFFIC LIGHT SIMULATOR

BY N. P. NAUGHTON

In this project three l.e.d.s are used to simulate a set of road traffic lights. The three l.e.d.s, a red, a yellow and a green are continuously sequenced on and off, and the sequencing speed is adjustable over a wide range so that the action can be frozen by pressing the button S1. This enables a test-your-reflexes type of game where competitors freeze rapidly sequencing lights on a nominated colour.

The project may be put to a more serious use, that of teaching road safety to young children.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Traffic Light Simulator is shown in Fig. 1. The circuit uses a low power Schottky clamped TTL device and the unit will draw less than 40mA. The transistors TR1 and TR2 together with their associated components comprise a pulse generating oscillator which drives IC1. IC1 (74LS90) is a decade counter which, as shown connected, repeatedly counts incoming pulses up to ten so long as the pulses are applied.

TABLE 1

Decade Count	Binary Inputs				Outputs										Display
	D	C	B	A	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'	'8'	'9'	
0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	RED
1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	RED
2	0	0	1	0	1	1	0	1	1	1	1	1	1	1	RED
3	0	0	1	1	1	1	1	0	1	1	1	1	1	1	RED/AMBER
4	0	1	0	0	1	1	1	1	0	1	1	1	1	1	RED/AMBER
5	0	1	0	1	1	1	1	1	1	0	1	1	1	1	GREEN
6	0	1	1	0	1	1	1	1	1	1	0	1	1	1	GREEN
7	0	1	1	1	1	1	1	1	1	1	1	0	1	1	GREEN
8	1	0	0	0	1	1	1	1	1	1	1	1	0	1	AMBER
9	1	0	0	1	1	1	1	1	1	1	1	1	1	0	AMBER

The counted numbers (from 0 to 9) appear in sequence at the Q0, Q1, Q2 and Q3 outputs of IC1 as binary coded logic levels. These are then decoded into a decimal count by IC2. Table 1 shows how the ten outputs of IC2 relate to the sequence of binary inputs.

It will be seen that only one output is ever low with the remaining nine always high. In effect, the total counting time of one decade is divided into ten units, and Table 1 shows how these units of time are allocated to the l.e.d.s, D13, D14 and D15. The shorter "on" time of the amber lamp in real traffic lights is simulated but deliberately made longer for required purposes.

When IC1 is withdrawn from its holder, no l.e.d. will illuminate since IC2 recognises an open-circuit input as a logic 1, resulting in none of the outputs going low.

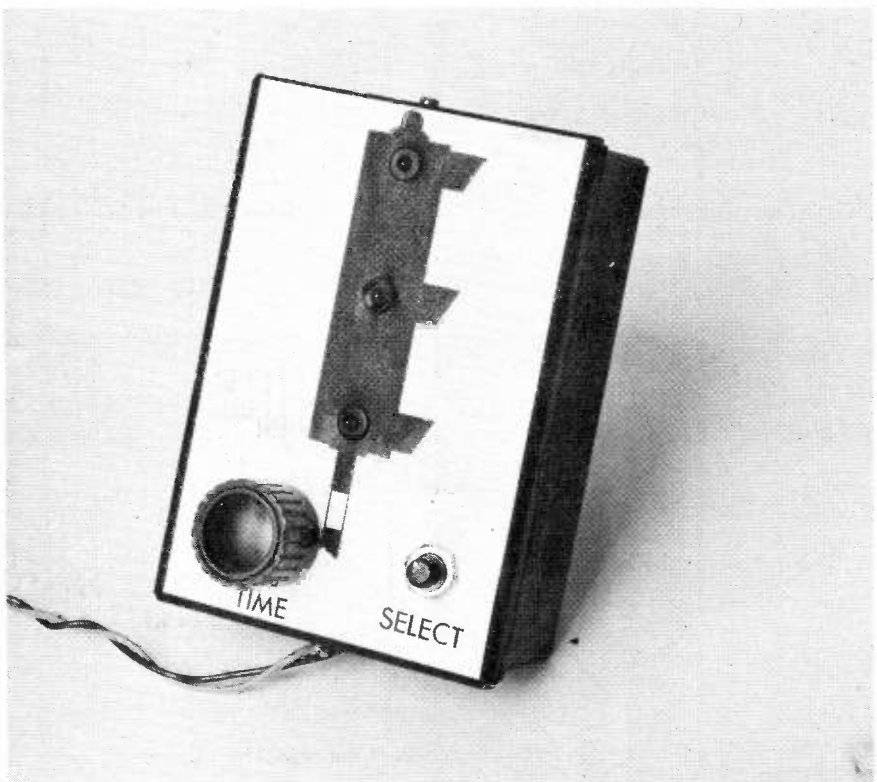
The IC2 outputs "0" to "9" are grouped via buffer diodes D1 to D10. The buffers ensure that current may only flow into, and never out of the outputs. The output which is "low" will draw current through its buffer diode, a 220 ohm limiting resistor (R5 to R7) and the relevant l.e.d. The rest of the buffers may be regarded as being reverse biased and so isolate the other outputs from the circuitry.

It might be thought that the red l.e.d. (D13) would momentarily dim when its current path is transferred from output "0" to "1", or "2" to "3". But the overall switching of the oscillator and i.c.s is much too fast for any flicker to be visible.

OSCILLATOR ACTION

In order to promote rapid switching, an oscillator which allows d.c. coupling of its output is used. This avoids capacitively loading the input of IC1.

The action begins with C1 charging via limiting resistor R1 and the base/emitter junction of TR1. The charging current alone causes TR1 to conduct so that when C1 is charged, the transistor TR1 will turn off. TR1's collector voltage



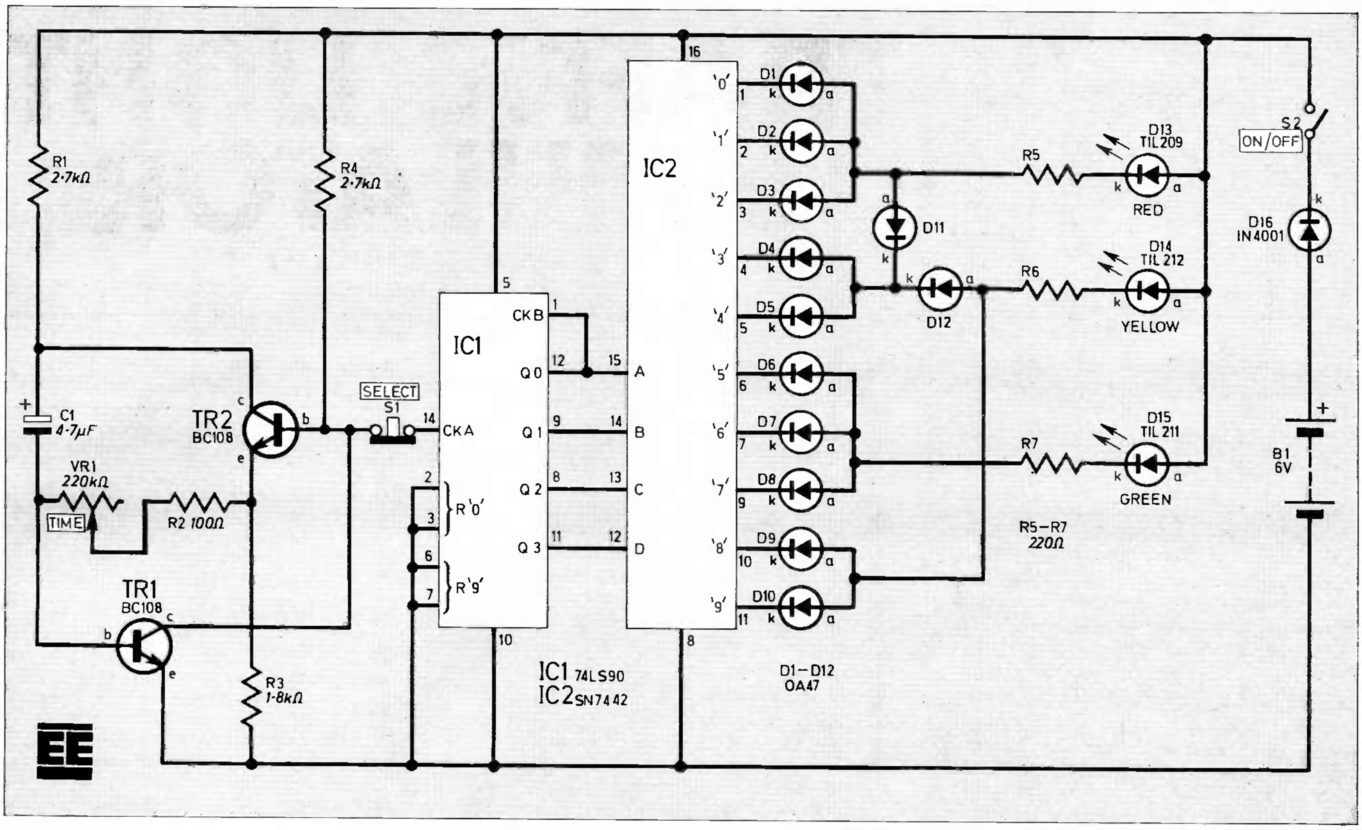


Fig. 1. The complete circuit diagram for the Traffic Light Simulator. A yellow light emitting diode (D14) is used for the "Amber" light sequencing. The circuit uses a low power TTL Schottky device (IC1) and the unit draws less than 40mA.

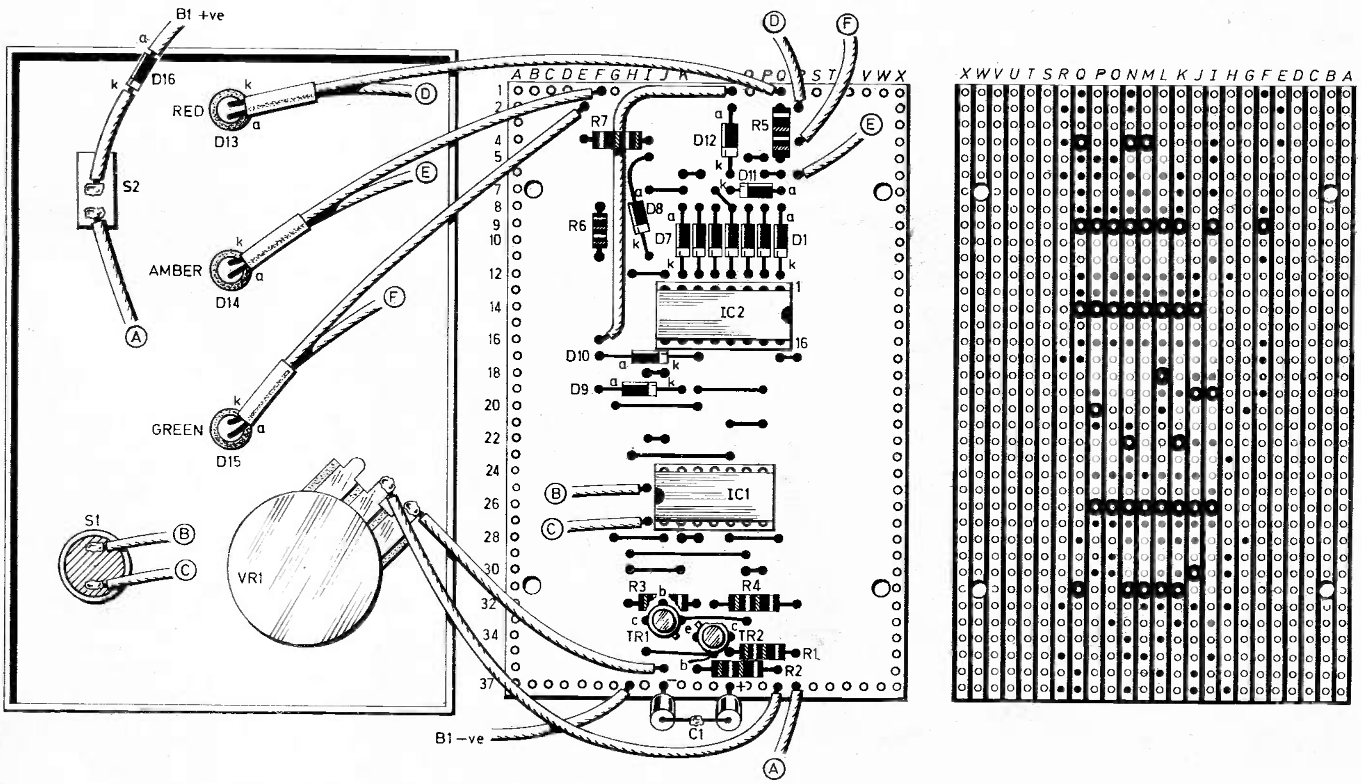
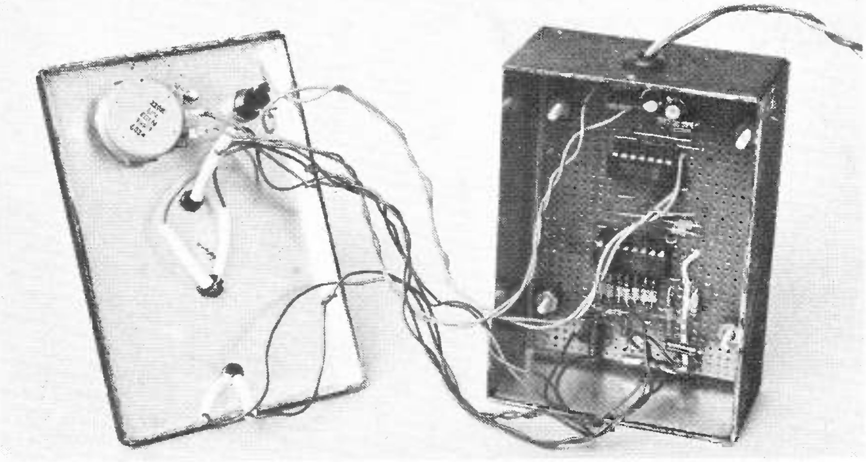


Fig. 2. Layout of components on the topside of the stripboard and interwiring to the front panel of the case. The underside of the board detailing breaks in the copper strips is shown far right.



Completed unit showing circuit board mounted on spacers in the base of the case.

therefore rises and TR2 will now conduct. The capacitor then discharges through TR2, VR1 and R2, developing a diminishing voltage across VR1 and R2 which will hold TR1 off.

A voltage of opposite polarity, developed across R3 restarts the cycle by turning TR1 on again. The charging current of C1 continues the new cycle after TR2 (and therefore the initiating voltage) turns off. VR1 controls the frequency and R2 is simply a value high enough to sustain oscillation when VR1 is at a minimum.

CONSTRUCTION

The prototype unit was constructed on a piece of 0·1 inch matrix stripboard, 24 strips by 37 holes, as shown in Fig. 2. It is helpful to mount the i.c. holders first (after all track breaks have been made), these will then act as reference points for positioning the other components.

Attach sufficient lengths of flying leads to reach the l.e.d.s to be fitted to the lid of the case. Drill the lid of the case to accept the three l.e.d.s and fit these in position and hold secure with fixing clips. The two switches and VR1 may be fitted next.

CASE

The prototype stripboard was mounted in a standard aluminium box having dimensions of 102 × 76 × 38mm. Although any case of similar dimensions should be suitable. Remember to take into account the size of a 6V battery pack when selecting the case. □

COMPONENTS

See Shop Talk page 565

Resistors

R1,4	2·7kΩ (2 off)
R2	100Ω
R3	1·8kΩ
R5,6,7	220Ω (3 off)

All ¼W carbon ±5%

Capacitor

C1	4·7µF 16V tantalum

Semiconductors

D1–12	OA47 germanium (12 off)
D13	TIL209 0·12in red l.e.d.
D14	TIL212 0·12in yellow l.e.d.
D15	TIL211 0·12in green l.e.d.
D16	1N4001 silicon
TR1,2	BC108 *npn* silicon (2 off)
IC1	74LS90 TTL low power Schottky decade counter
IC2	7442 TTL b.c.d. to decimal decoder

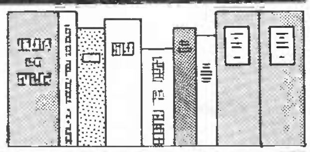
Miscellaneous

VR1	220kΩ lin. control potentiometer
B1	6V battery pack (HP7 × 4)
S1	push-to-break
S2	single pole toggle

Stripboard: 0·1 inch matrix size 24 strips by 37 holes; aluminium case, 102 × 76 × 38mm (AB8); battery clip; connecting wire.

Approx. cost Guidance only £8·00

BOOK REVIEWS



OPERATIONAL AMPLIFIER EXPERIMENTAL MANUAL

Author	G. B. Clayton
Price	£13.00 hard cover £6.95 limp
Size	220 × 145mm. 130 pages
Publisher	Butterworth & Co. Ltd.
ISBN	408 01240 4 (hard) 408 01239 0 (limp)

PRIMARILY intended as a companion to the authors text "*Operational Amplifiers, 2nd Edition" (ISBN 0 408 000370 7)*, this manual can still stand alone as a guide to operational amplifier experiments for the serious student. It is designed to give the student a broad understanding of the practical applications of operational amplifiers.

A total of 21 different experiments are listed, ranging from basic resistive feedback configurations to complex phase-sensitive detector systems, each one using the same test board, the constructional details of which are given in the introduction. An appendix suggests a method of using a personal computer to investigate op-amps.

As operational amplifiers are the most frequently used and versatile active devices in analogue electronics, an appreciation of their capabilities and limitations is essential for the designer.

G.P.H.

PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 & BOOK 2

Author	R. A. Penfold
Price	£1.95 Limp edition
Size	180 × 110mm. 94/110 pages
Publisher	Bernard Babani
ISBN	0 85934 092 9 & 0 85934 093 7

ALL electronic circuits are built in various stages and contain a distinctive base circuit. Book 1 contains three chapters dealing with Oscillators, Monostable Multivibrators and Miscellaneous Circuits.

The basic building blocks for various electronic circuits are explained with the aid of good, clear diagrams.

A book that will provide the beginner to electronics with a good insight into circuit designs.

Book 2, a continuation of Practical Electronic Building Blocks Book 1, is designed to provide a number of useful electronic circuits with which a reader may build projects.

This book deals with circuits that process signals rather than generate them. The book contains three chapters, Amplifiers, Filters and Miscellaneous Circuits.

R.A.H.

RADIO WORLD

BY PAT HAWKER G3VA

Political No-speak

Most radio amateurs are anxious to keep international politics firmly out of their hobby and like to think that freely talking to peoples of all nations plays a small but useful role in creating friendships across frontiers. But occasionally there are problems.

Several years ago, when the powerful Russian "woodpecker" radar was seriously affecting operations in some h.f. bands, a few amateur operators in North America made it clear that they would not contact amateur stations in the USSR until the interference-creating, over-the-horizon radar closed down. Most amateurs, however, recognised that no matter how much they disliked the woodpecker there was no hope that Russian amateurs would be able to influence their Defence ministries.

Indeed, the Russian amateurs were among those who suffered most from the woodpecker installations. It is as though we were to blame the Russian amateurs for the deliberate jamming of western h.f. broadcasts.

Then there was the period in the 1950s when, under the Stalin government, Russian amateurs were forbidden to talk to amateurs in western countries. A ban that disappeared early in the Khrushchev era.

Following an espionage scandal involving a serving member of the RAF, some restrictions were placed on the British Services amateur radio clubs. I am not sure to what extent these were ever enforced in seeking to limit contact with Eastern bloc stations.

My reasons for recalling these events is that it now seems that some East European amateurs have recently been declining to talk to amateurs in South Africa. Whatever one may think of a government, the idea of refusing to talk via amateur radio to its citizens seems totally against the traditions of a hobby that has always prided itself as constituting "a world-wide fellowship which knows no boundaries of race, class or creed".

MASH Millions

The three big American commercial TV networks—ABC, CBS, NBC—are continuously locked in battle over the TV ratings. Particularly with the added requirement of being able to show that despite the growth of cable they can still attract larger audiences than ever.

In the current "all-time" list of the top ten television audiences (NTI household audience estimates) half of the programmes were transmitted in the first three months of this year. On February 28 the final episode of MASH attracted an audience of over 50-million people for CBS, almost nine-million more than the previous best set by the "Who shot J.R.?" episode of Dallas in November 1980.

Four of the ten top audiences (No. 3, 4, 9, 10) were Super Bowl football games in 1983, 1982, 1980 and 1979. Part 8 of "Roots" (No. 5) gave ABC an audience of almost 36·4-million in 1977. Advertising time during Super Bowl matches can cost over £3800 *per second.*

Museum of Television

A new National Museum of Photography, Film and Television has opened in Bradford, West Yorkshire, as the first phase of a £10-million project. At present the museum exhibits are devoted mainly to photography and film, but it is planned to set up a major television gallery in 1984–85.

The museum is closely associated with the Science Museum and has been funded jointly by the London Museum and Bradford Metropolitan Council. It includes a 340-seat theatre equipped to show 70mm, 35mm and 16mm film and there are also a number of computer-controlled multi-slide projectors.

Bradford seems to have stolen a march on Alexandra Palace where for several years there has been much talk of setting up a television museum in the part of the building (which escaped the fire a few years ago) that formed the original BBC high-definition TV studios in 1936.

In March this year three of the four episodes of "The Thorn Birds" mini-series gave ABC audiences of 35·4-million (Part 2), 35·99-million (Part 3) and 35·9-million (Part 4). Thorn Birds, not yet screened in the UK, is an American-made series lasting ten hours based on Colleen McCullough's novel about family life in the outback of Australia.

To obtain on three successive nights three places (6, 7 and 8) in the all-time "top ten" ratings is a remarkable achievement that suggests that in the face of cable competition American TV production is learning the lessons of the old Hollywood film epics. And those who dismiss so much American TV as rubbish should ponder on the fact that the intelligently-made MASH should have finished its long run on such a remarkably high peak, while "60 Minutes", a CBS weekly hard-hitting current affairs programme, figures prominently in the weekly "top ten" lists.

Japanese No-code

Among the small but vocal minority of British enthusiasts who have been arguing in favour of amateur-radio h.f. licences free from the mandatory Morse test, Japan is frequently held up as an example of how international regulations can be circumscribed. The ITU's Radio Regulations insist on Morse proficiency below 50MHz but leave it to national authorities to decide if transmissions are unlikely to cause interference in other countries, and therefore escape the international rules.

For over a decade a codeless radiotelephone class licence permitting operation on h.f. bands (other than 14MHz) with a power output limit of 10 watts has been available in Japan. The result has been an enormous increase in the size of the domestic amateur radio market. Almost one million Japanese amateur operator licences have been issued: considerably more than the combined total of Europe and North America!

While this has undoubtedly enabled the Japanese communications industry to become the dominating force in the world market, the state of the hobby in Japan is less healthy than might appear from that one million figure.

High Drop-Out Rate

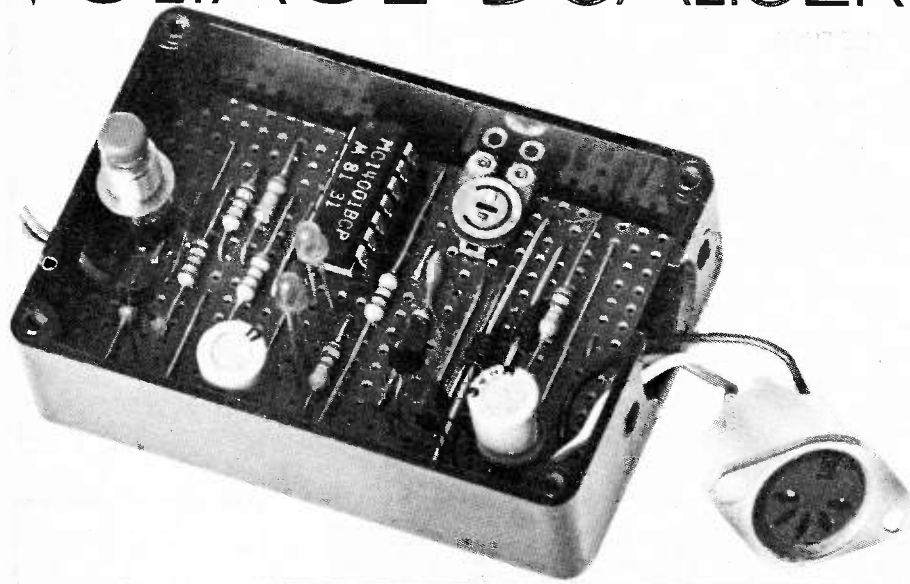
In the first place in Japan, as in the USA, a distinction is made between an "operator" licence and a "station" licence. The Japanese "operator" licence is a lifetime issue. The number of Japanese "station" licences is just over half-a-million, of which about 95 per cent are the low-power "radiophone" licences.

There is a marked tendency for newcomers to lose all interest after about a year, with far less commitment to the hobby than in other countries arising from the limited value of the h.f. facility in view of the low-power of legal transmissions and the fantastic mutual interference. In effect, Japan turned its amateur radio licence into a substitute for a Citizens Band operation, though insisting that applicants receive some technical instruction.

The core of the Japanese amateur movement has thus remained with the small minority who have the higher grades of licence requiring a Morse test. Membership of the Japanese JARL national society has a very high drop-out rate, particularly among younger members, with new members being drawn increasingly from the over-30 age group.

Japan is now creating a new form of short-range "Personal Radio Service" on 903MHz with 79 simplex f.m. channels and a transmitter power of 5 watts. Perhaps an admission that you cannot combine CB and true amateur radio licences.

VOLTAGE DUALISER



BY L.S. COOK

SOME electronic circuits demand a power source that will supply a positive and negative rail. In such a case, the circuit described here could be a useful extension to the existing power supply unit (p.s.u.), provided the latter can produce at least 135mA at 9V. The output from the Voltage Dualiser is approximately plus and minus 8V (or a total of 16V) at up to 60mA, the voltage varying a little with the current being drawn.

Electronic overload protection and indication have been incorporated into the design as a p.s.u. is unlikely to match the requirements in this respect.

Operational amplifiers frequently employ a dual supply, and voltmeter pre-amplifiers based on high input-impedance op-amps, are becoming increasingly important in view of the smaller currents encountered these days.

The Voltage Dualiser is not suitable for audio or radio frequency applications since the square-wave generated produces a high-pitched whistle at audio (and considerably more than that at radio) frequences.

CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 1 and is essentially a form of voltage doubler. When the switch (S1) is depressed momentarily, pins 2, 5 and 13 of IC1 are taken low causing IC1a and IC1b, with R2, R3 and C1 to produce a square-wave at pin 11 of IC1b.

This square-wave will then switch on TR2 and TR3, alternatively via buffers IC1c and IC1d thus steering current through l.e.d.s D1 (green) and D2 (red), and charging reservoir capacitors C2 and C3. When TR3 is off, l.e.d. D2 draws current from C2, similarly C3 supplies D1 when TR2 is switched off. Diodes D3 and D4 prevent C2 and C3 from discharging through TR2 and TR3 as well as isolating the source from the high voltage output.

With VR1 suitably set and no overloading the emitter-base potential of TR4 is sufficient to hold this transistor on and then a current is supplied from its collector to the base of TR1, via D1 which will become illuminated. TR1 is now held on. Pins 4 and 10 of IC1 are equipotential, so D2 does not illuminate.

OVERLOAD

In the event of an overload, the output voltage drops, as does the emitter-base potential of TR4. The transistor TR4 and TR1 are then cut off and D1 is extinguished.

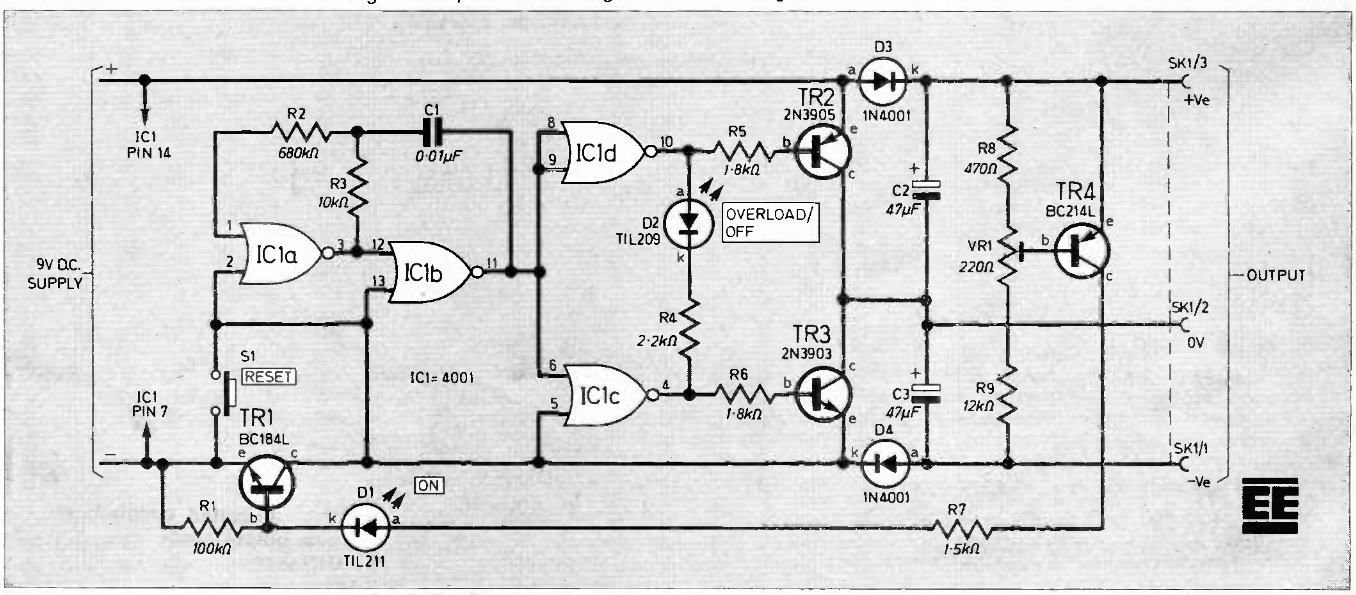
Pins 2, 5 and 13 of IC1 are taken high round the circuit resulting in the oscillator, TR2 and TR3 being switched off and D2 being illuminated. This means that pin 10 is now high and pin 4 is now low. The resistor R1 grounds the base of TR1 to stabilise this transistor.

CONSTRUCTION

CIRCUIT BOARD

All the components apart from SK1 are mounted on 0·1in matrix stripboard,

Fig. 1. Complete circuit diagram for the Voltage Dualiser.



25 strips by 17 holes, as shown in Fig. 2. The first step is to make the 13 breaks in the copper tracks as shown.

The switch S1 is soldered directly to the stripboard making sure that it will project by a suitable amount through the lid of the case. The remaining components may now be soldered to the board. Thoroughly check the positioning of all the components, making sure that the polarities of C2 and C3 are correct.

Having soldered all the components to the board, the holes in the lid of the case for S1, D1 and D2 may be determined. No specific input connector is suggested as this will depend on individual needs.

OUTPUT SOCKET

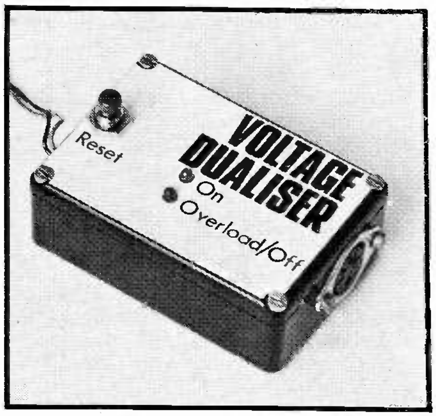
The output socket used in the prototype is a 3-pin DIN socket and is wired as shown in Fig. 2. It is not necessary to use this type of socket and may be left to personal choice.

The case chosen for this project was a Verobox measuring 72 × 50 × 24mm, although any box of similar size will be suitable.

TESTING

Connect a 9V supply to the circuit and the red l.e.d. (D2) should light but then should extinguish, the green l.e.d. (D1) should now light up. The setting of VR1, to operate the cut-out at the appropriate point is quite critical and can be carried out by placing a 120 ohm resistor across one-half of the output (test each half in turn). Adjust VR1 so that the cut-out circuitry is just, and only just, activated. With a 150 ohm resistor similarly placed the unit should remain on.

Measure the output voltages for each half, they should each be about 1V below that of the supply, the drop occurring across the semiconductors. If further tests are needed the voltages at pins 4, 10 and 11 of IC1 can be measured. With the output on they should all register about 4 to 4·5V and with the output off, pin 10 should be at just under 9V and pins 4 and 11 at zero. □



COMPONENTS

See Shop Talk page 565

Resistors

R1	100kΩ
R2	680kΩ
R3	10kΩ
R4	2·2kΩ
R5,6	1·8kΩ (2 off)
R7	1·5kΩ
R8	470Ω
R9	12kΩ

All ¼W carbon ±5%

Capacitors

C1	0·01µF ceramic
C2,3	47µF 10V elect. radial leads (2 off)

Semiconductors

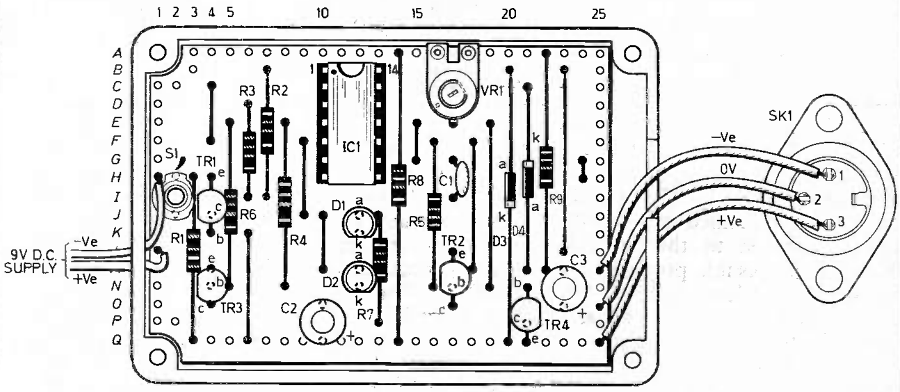
D1	TIL211 3mm green l.e.d.
D2	TIL209 3mm red l.e.d.
D3,4	1N4001 silicon diode (2 off)
TR1	BC184L *npn* silicon
TR2	2N3905 *pnp* silicon
TR3	2N3903 *npn* silicon
TR4	BC214L *pnp* silicon
IC1	4001B CMOS quad 2-input NOR gate

Miscellaneous

S1	miniature push-to-make switch
VR1	220Ω lin. miniature horizontal preset
SK1	3-pin DIN socket
PL1	3-pin DIN plug

Stripboard, 0·1 inch matrix 25 strips by 17 holes; plastics box, 72 × 50 × 24mm (Verobox 202-21024B); 14-pin d.i.l. holder; 6BA nuts, screws and washers; tinned copper wire; 7/0·2mm connecting wire.

Approx. cost Guidance only £6.00



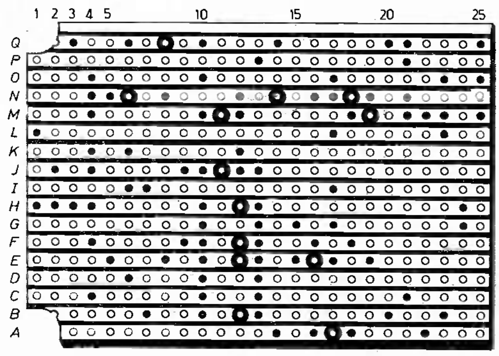
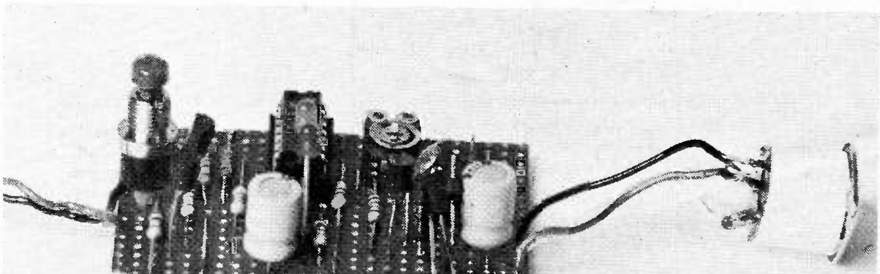


Fig. 2. The circuit board mounted in the case showing component layout and interwiring. (left): The underside of the stripboard detailing breaks in the copper tracks.



The completed circuit board with output leads wired to a DIN socket.

LETTERS

EE Excels

Sir—Many thanks for publishing my letter concerning the formation of the "National Electronics Correspondence Club". (See July issue.)

I have received a number of enquiries to date, entirely due to EVERYDAY ELECTRONICS and hope the response continues enabling me to contribute in a small way to the furtherance of the electronics hobby, as you are successfully doing in a larger way.

I wish you continued success with your publication, which, in my opinion excels to cover all of the various specialised subjects within electronics.

E. Foley,
Levenshulme,
Manchester.

Exam Time

Sir—The Walsall Education Dept. have been operating courses to sit the Amateur Radio Exam No.765 at Barr Beacon School for several years.

The examination can be taken at the school in December, March and May, and the new enrolment starts 22 September at 7.00pm.

Those with adequate education in electrical theory may also sit the December and May exam. Courses are also provided for the beginner.

The teaching technique has been modified to suit CB enthusiasts who require more facilities.

F. A. Fear G8CVR,
Aldridge,
Walsall.

Sir—The Hendon College Science and Technology is offering a part-time evening course for persons wishing to take the City & Guilds 765 Radio Amateur's course. Attendance is required on one evening per week for one year.

No special qualifications are required for admission since the course will start from basics, although candidates intending to take the examination in May 1984 will have a better chance of success if they possess some background in electricity.

Enrolment commences on 13 September at the Williams Building, The Burroughs, Hendon, NW4 4BT.

Chris Holford,
Hendon,
NW4 4BT.

Sir—No educational requirements nor is there an upper age limit for entrance to the Radio Amateurs Examination (R.A.E.) course being run by Brixton College for Further Education. The only requirement is an enthusiasm for Amateur Radio is essential.

Students attend for one evening a week from 6.30pm to 9.00pm. Students sit for the R.A.E. in the following May and the course then continues with a Morse class to the standard of the British Telecom Morse test.

Enrolment commences on 5 September at Brixton College, Ferndale Road, London, SW4 7SB.

R. McEwan Reid,
Brixton,
London.

Resist-ance

Sir—I have two questions. First, I would like to know that when a speaker is said to be 50 ohms, does it mean that if an ohmmeter is connected across the speaker leads, it will read 50 ohms?

Secondly, how do you transfer a printed circuit board layout from the page to a piece of copper clad board? Your help will be highly appreciated.

E. Ali,
Bahrain,
Iran.

To answer your first enquiry, all loudspeaker specifications quote a nominal input impedance. As a speaker contains a voice coil (that is, an inductive component) the impedance is not purely resistive and so varies considerably with frequency. A peak in the impedance occurs at the main bass resonant frequency of the speaker and the nominal quoted value of a speaker indicates the impedance at the first dip following this peak!

All this may sound a little complicated, but it is quite important when matching loudspeakers to high-quality hi fi amplifiers where the typical value is in the region of 8 ohms.

However, in the case of a 50-ohms speaker, the variation of the impedance due to the inductance of the coil will be far less and the d.c. resistance (that is, when measured with an ordinary ohmmeter) will be a good indication of the speaker impedance. So it is fairly safe to say that the ohmmeter put across the leads of a 50-ohms speaker will read about 50 ohms.

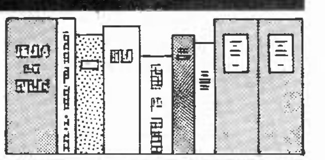
Your second enquiry requires a little more discussion. There are several methods of producing p.c.b.s from diagrams in EE. All current boards are available from the EE PCB Service *but some constructors may wish to make their own.*

In the UK, readers can purchase special kits, an example being the Electrolube CM100, to photographically reproduce the layout and transfer it to the copper. But these are expensive and I am unsure of the availability overseas.

A simple method is to lay the page over the copper clad board and mark the positions of all pad centres with a sharp point. This also helps to locate the drill when drilling the holes at a later stage. To avoid damaging the magazine pages, a photocopy of the layout can be used as the template.

The layout can then be carefully copied with an etch-resistant pen or dry-print transfers and crepe tapes. Alternatively, the track layout can be traced through using carbon paper and then the etch-resist applied. Before etching the board in ferric chloride, it is always wise to thoroughly check the layout as it is easier to take copper off than to put it back later!

BOOK REVIEWS



ELECTRICAL INSTALLATION

Authors A. O. Akintante, J. M. Hyde
Price £3.25 limp
Size 210 × 260mm. 146 pages
Publisher Macmillan Education Ltd. (Introduction to Technology series)
ISBN 0 333 34680 7

FUNDAMENTALLY, Electrical Installation is a textbook providing a theoretical introduction, with practical applications, for students taking City and Guilds courses. It meets all the needs of the major examining boards and uses SI units, I.E.E. regulations and British Standards throughout.

Many students and apprentices in allied engineering disciplines or those just interested in the generation, supply and distribution of electrical energy should also find benefit in this book. The text is presented in a clear and highly illustrated way and no previous knowledge is assumed. Examples and exercises from old exam papers are included in each section.

The nine sections cover subjects ranging from safety and workshop processes through transmission, distribution, wiring and earthing of electrical systems, to installation, maintenance and metering. The final chapter discusses contract planning and there is two appendices containing electric motor data. G.P.H.

BASIC & PASCAL IN PARALLEL

Author S. J. Wainwright
Price £1.50 Limp edition
Size 180 × 110mm. 60 pages
Publisher Bernard Babani
ISBN 0 85934 101 1

AN unusual type of computer book which deals with the two computer languages, Basic and Pascal. The book takes the two languages and develops the idea of programming in both languages simultaneously.

The book contains eight chapters, the most useful being The Development of a Computer Program. Each new topic is easily explained, with program listings in both Basic and Pascal, so that program construction may be compared.

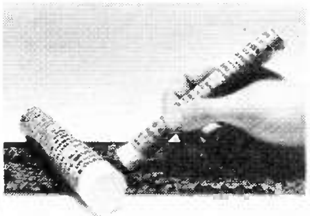
A useful book that will provide relative newcomers to computing with a useful program construction guide. R.A.H.

NEW · NEW · NEW · NEW PRODUCTS NEW · NEW · NEW · NEW

CLEANING STICK

A GLASS-FIBRE "stick", ideal for removing the protective coating found on the copper tracks of some p.c.b.s, is announced by Eraser International.

Available in both fine and coarse, the BR1 Fyberglass Cleaning Brushes are manufactured from pure spun glass and are also suitable for use on gold edge connectors, commutator cleaning and general oxidisation removal.



Further information can be obtained from:

Eraser International Ltd., Dept EE, Unit M, Portway Industrial Estate, Andover, Hants SP10 3LU.

ELECTRONIC CONTROL SOLDERING IRON

A MAINS voltage electronically controlled temperature soldering iron has just been marketed by **Light Soldering Development.**

The EC50 incorporates an electronic temperature control circuit module mounted inside the handle. This operates in response to a thermistor fitted inside the bit-mount.

Power to the 50W heating element is controlled by a triac operated by a zero-voltage switching i.c., to minimise spiking and r.f.i. The iron is fully earthed so that it may safely be used on sensitive equipment and components.

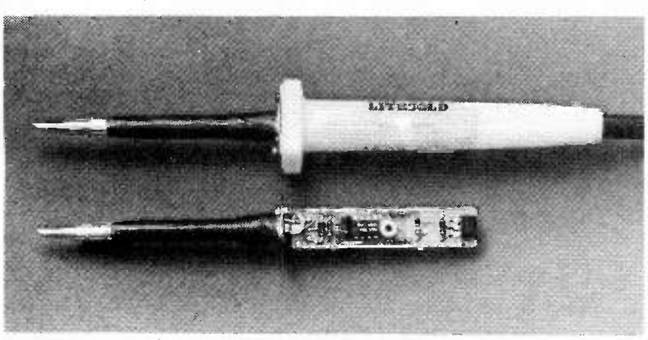
A feature of the design is that the low voltage supply for the control module is obtained by means (for which a patent is pending) which does not involve fitting a dropper resistor in or near the handle. It is claimed that this problem previously prevented a mains iron of this type being made to run with a sufficiently cool handle.

The control circuit provides a proportional control band, so that power to the heating element is only fully on or off outside a temperature band centred on a preset value. Within this proportional band, power supplied in regular pulses of equal interval but of a length which varies according to the difference between "actual" and "set" temperatures.

Access is provided to the temperature control potentiometer, and settings may be varied from approximately 280°C to 400°C. Standard setting is 370°C.

For details of prices and nearest stockists, write to:

Light Soldering Developments Ltd., Dept EE, Spencer Place, 97/99 Gloucester Road, Croydon, CR0 2DN.



MEMO PAD

A BRITISH designed electronic memo pad which can carry out the functions of a calendar, diary, address book, note pad and expense account log has been marketed in the UK by **Domicrest Ltd.** Called the Biztek Pad it will retail for £69.95.

Comprising a potential memory of 4000 characters, the Biztek Pad combines a 43-key keyboard with a large liquid crystal display with 16 alphanumeric characters, 20 numeric and clock digits and 45 special symbols.

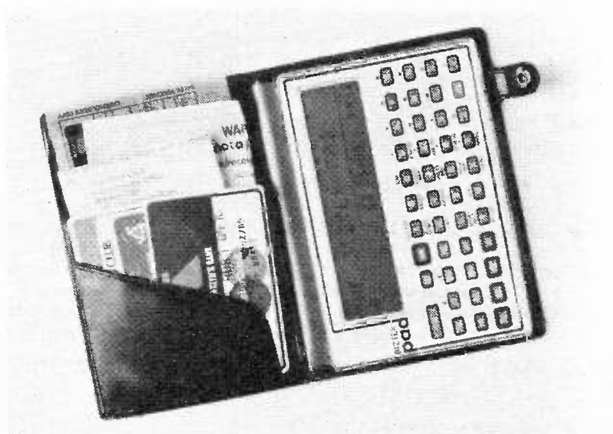
When used as a conventional note pad, the unit will record messages consisting of words and/or figures in its internal memory and display them again on demand. For example, the fluctuations of a company's share price, a shopping list or a cricket score card can be stored and recalled instantly.

As an address book it will store names and addresses and phone numbers which can be displayed simply by keying in the first few characters of the person's name and pressing the recall button.

Appointments or personal engagements such as weddings, birthdays and anniversaries may be stored and by adding a date and a time, and utilising the alarm function, the pad can be programmed to sound the alarm at the appointed time. The necessary reminder can then be recalled to appear on the screen.

For the expense account log, the user keys in the relevant wording, enters the amount and presses the appropriate key to display one of the following: Auto, Entertainment, Hotel, Meal, Mileage, Phone or Travel.

Additional functions of the "memo pad" are a calculator, stopwatch and a permanent calendar and time display. A memory save switch ensures that stored items are not "lost" when the batteries are changed.



Domicrest Ltd., Dept. EE, Domicrest House, 31–37 Hoxton Street, London, N1 6NJ.

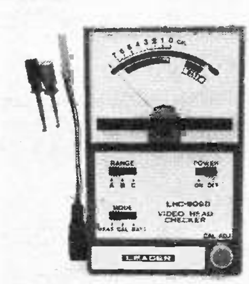
HEAD TESTER

TWO video head testers have just been introduced to the Leader range of test equipment marketed by **Thandar Electronics.**

Designated LHC-909V (VHS) and LHC-909B (Beta), the tester will measure the amount of wear in video heads. Both units are priced at £45 plus VAT.

For more information and local stockist contact:

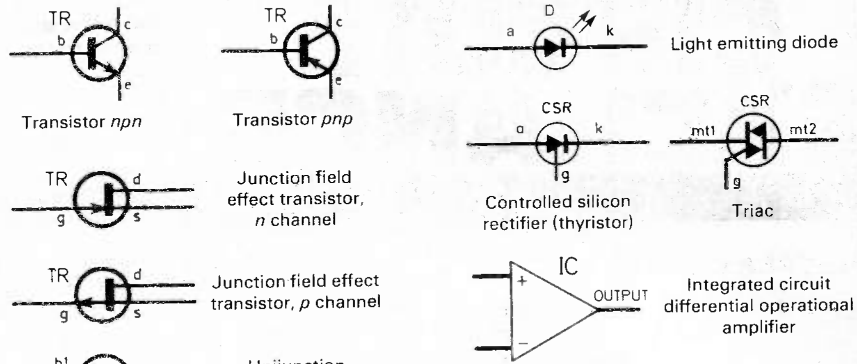
Thandar Electronics Ltd., Dept EE, London Road, St. Ives, Huntingdon, Cambs PE17 4HJ.

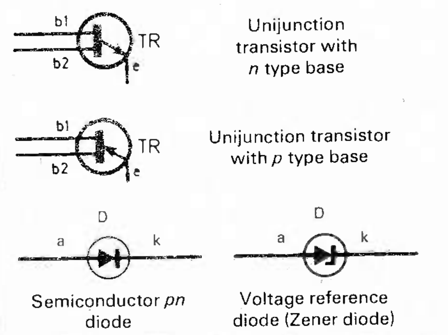


SQUARE one FOR BEGINNERS

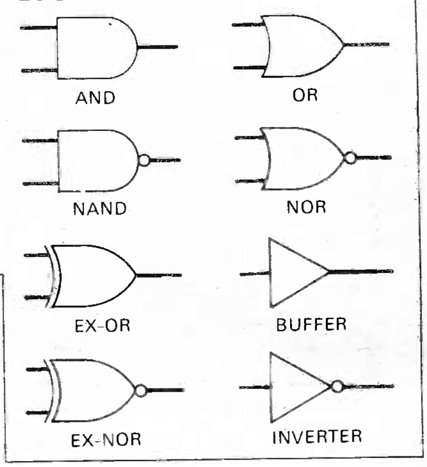
ELECTRONIC components are represented by symbols in circuit diagrams, some only differing in minute detail, such as the arrow direction on the emitter lead of bipolar transistors. The **circuit symbol** is also accompanied by a **component reference** letter(s) followed by its unique numerical position number in the circuit design (not its type number which usually follows this). Shown here are the circuit symbols and component reference for most of the components used in EE.

SEMICONDUCTORS

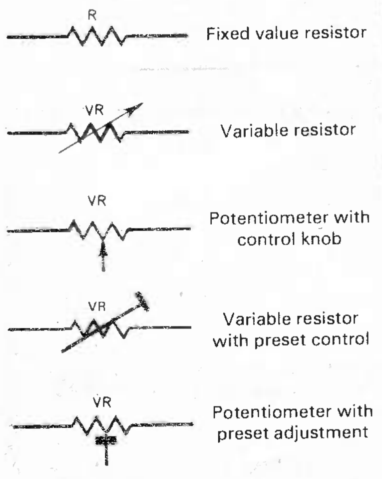




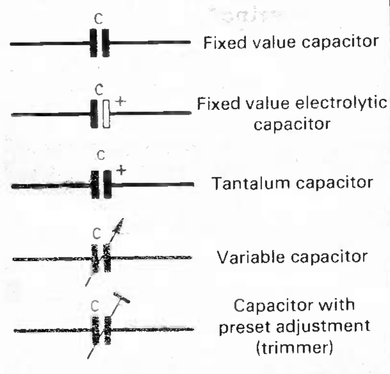
LOGIC SYMBOLS



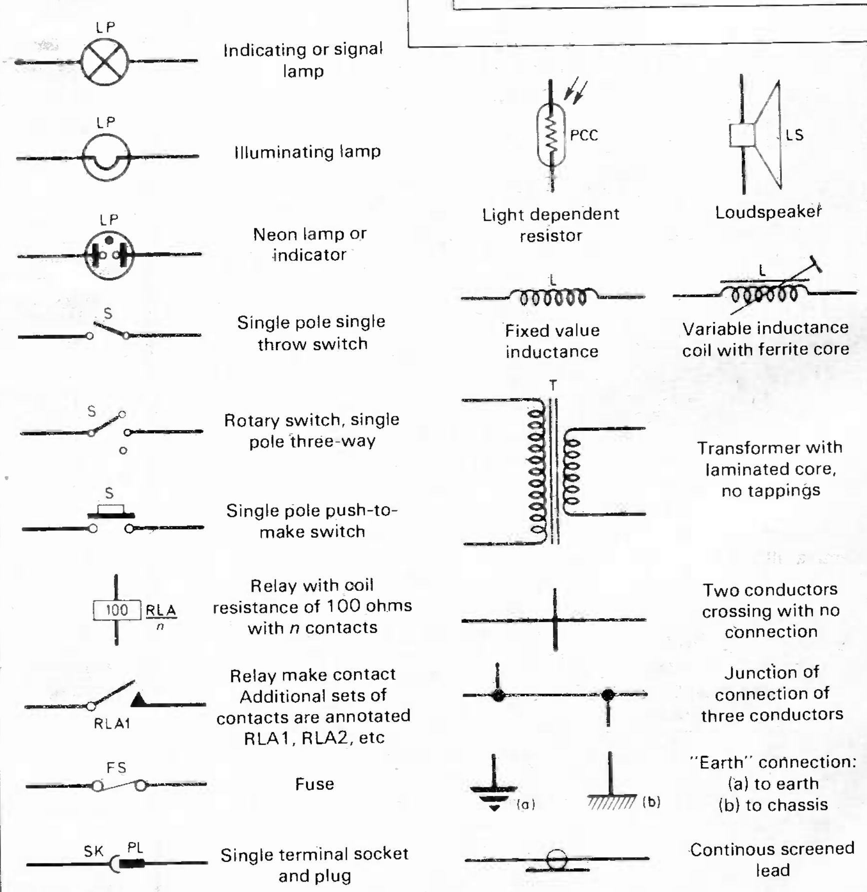
RESISTORS AND POTENTIOMETERS



CAPACITORS



MISCELLANEOUS

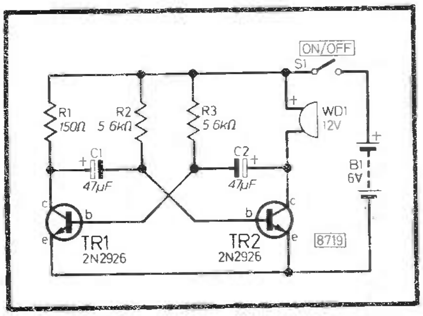


CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

BLEEPER CIRCUIT

This circuit is simply two transistors TR1, TR2 switching each other on and off; but with the bleeper WD1 in circuit you do not notice this action as the capacitors C1, C2 keep the bleeper on until the power is pulsed to the opposite transistor.



The transistors can be almost an *npn* silicon type like BFY51, 2N2926, BC108, BC107 and BC109. The circuit can work on 3–6 volts and the bleeper is a *Bleeptone* 12V type. It can be used as a burglar alarm or a siren. (The bleeper tone can be changed by fitting a capacitor of a few hundred microfarads across the output to the bleeper.)

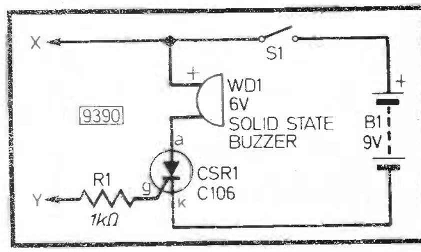
Martin Gill,
Romford,
Essex.

ALARM CIRCUIT

I have designed a simple, but nevertheless, very effective alarm circuit based upon the operation of the thyristor or SCR. When the two probes "X" and "Y" are connected the gate of CSR1 is made positive with respect to the cathode, and this in turn switches it on.

The thyristor now behaves like a common-place silicon diode. Even if the gate current is removed CSR1 will still remain on until the so-called "holding current" is reduced below a certain level. This can be attained by disconnecting the power supply (that is, a PP3 9V battery), using S1. The warning device used was a 6V solid state buzzer.

S. D. Stares,
Totton,
Hampshire.



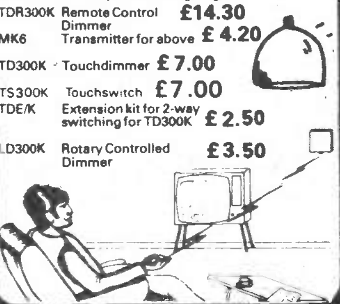
XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.00**

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TS300K	Touchswitch	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.50
LD300K	Rotary Controlled Dimmer	£ 3.50



DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (−50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week

Price £15.50

NOW available in stock THE JUPITER ACE MICROCOMPUTER

uses FORTH which executes about 10 times faster and requires less program memory than a comparable program using basic. Features 8K ROM, 3K RAM, built in speaker, 40 key keyboard and a 32 × 24 line-flicker free display on TV. Comes supplied complete with leads, mains adaptor, a comprehensive easy-to-follow manual on Forth programming + FREE cassette containing 5 sample programs.

ONLY £75.00 (+ £2.00 carriage + VAT)

JUPITER ACE SOFTWARE

J3	SPACE INVADERS	£3.90
J4	SWAMP MONSTERS	£3.90
J5	DOT MAN	£3.90
J14	ASTRO & FLYTRAP	£4.35

DRAGON 32 £143 + £7 carriage

ORIC 1 (48K RAM) £143 + £2.50 carriage

COMPONENT PACKS

- PACK 1 650 Resistors 47 ohm to 10 Mohm – 10 per value £4.00
- PACK 2 40 × 16V Electrolytic Capacitors 10μF to 1000μF – 5 per value £3.25
- PACK 3 60 Polyester Capacitors 0.01 to 1μF/250V – 5 per value £5.55
- PACK 4 45 Sub-miniature Presets 100 ohm to 1 Mohm – 5 per value £2.90
- PACK 5 30 Low Profile IC Sockets 8, 14 and 16 – pin – 10 of each £2.40
- PACK 6 25 Red LEDs (5mm dia.) £1.25

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102.

£5.00

Have you got our **FREE GREEN** CATALOGUE yet?

NO?! Send S.A.E. 6" × 9" TODAY!!

It's packed with details of all our KITS plus large range of SEMICONDUCTORS including CMOS, LS TTL, linear, microprocessors and memories; full range of LEDs, capacitors, resistors, hardware, relays, switches etc. We also stock VERO and Antex products as well as books from Texas Instruments, Babani and Elektor.

ALL AT VERY COMPETITIVE PRICES.

ORDERING IS EVEN EASIER – JUST RING THE NUMBER YOU CAN'T FORGET FOR PRICES YOU CAN'T RESIST.

5-6-7 8-9-10

Answering service evngs & weekends

and give us your Access or Barclaycard No. or write enclosing cheque or postal order. Official orders accepted from schools, etc.

LCD 3½ DIGIT MULTIMETER

16 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155x88x31 mm. Requires PP3 9v battery. Test leads included **ONLY £29.00**

ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a pre-wired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15V d.c. at 40uA. Output: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied. **ONLY £10.50**

Electric lock mechanisms for use with latch locks and above kit **£13.50**

DISCO LIGHTING KITS

DL 1000K
This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DLZ100K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1 Allowing audio ("beat") —light response. **60p**

DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply & lamps. (1Kw/Channel) **Only £11.95**

FAST SERVICE · TOP QUALITY · LOW LOW PRICES

No circuit is complete without a call to –

TK ELECTRONICS
11 Boston Road
London W7 3SJ

VISA · ACCESS and BARCLAYCARD welcome

Add 65p postage & packing +15% VAT to total
Overseas Customers;
Add £2.50 (Europe), £6.00 (elsewhere) for p&p
Send S.A.E. for further STOCK DETAILS
Goods by return subject to availability.

OPEN 9am to 5pm (Mon to Fri) 10am to 4pm (Sat)

ALL PRICES EXCLUDE VAT

TEL: 01-567 8910 ORDERS
01-579 9794 ENQUIRIES
01-579 2842 TECHNICAL AFTER 3PM

EE

NORTHERN PRACTICAL WOOD WORKING EXHIBITION

Sponsored by Practical Woodworking Magazine

Belle Vue, Manchester September 7-10, 1983

September 7-9, 10am-7pm September 10 (Saturday) 10am-6pm

Features included in price of admission

- ★ **Machinery and demonstrations for the woodworking enthusiasts and newcomers**
- ★ **Craft Market Place**
- ★ **A FREE Sotheby's valuation on your interesting wooden possessions**
- ★ **Major display of carving by T. H. Kendall**

Admission prices: Adults £2.00
Children under 16 and Senior Citizens £1.50
Party rates: Adults £1.50 Children £1.00
(Group of 20 or more *Plus 1 free ticket for teacher or organiser).

See August and September issues of Practical Woodworking Magazine for 50p reduction voucher

For further information contact the Exhibition Manager, Northern Practical Woodworking Exhibition, Reed Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ.

HOW DARE THEY!

If you see an advertisement in the press, in print, on posters or a cinema commercial which makes you angry, write to us at the address below. (TV and radio commercials are dealt with by the I.B.A.)

The Advertising Standards Authority.
If an advertisement is wrong, we're here to put it right.
ASA Ltd, Brook House, Torrington Place, London WC1E 7HN

TITAN TRANSFORMERS
DUNCOMBE STREET, GRIMSBY, SOUTH HUMBERSIDE DN32 7EG.

INVERTERS
12/24 volt DC input from car battery to 240 volt AC output at 100, 250, 500 and 1000 VA.
Plus, powerlift, autocharger, powersaver, powermonitor, autochangeover and battery isolator as optional extras.

TRANSFORMERS
12/24 volt } Range
30/60 volt }
Autotransformers, safety isolating equipment P.C.B's etc.

BATTERY CHARGERS – 2 volt.

ADAPTORS
6 volt to 7·5 volt to 9 volt switchable. 300MA regulated
6 volt to 7·5 volt to 9 volt switchable. 250MA unregulated

Send SAE for prices and info. by return.
Mail Order Prompt Service

Receivers & Components

TURN YOUR SURPLUS capacitors, transistors etc., into cash. Contact Coles Harding & Co., 103 South Brink Wisbech. Cambs. 0945-584188. Immediate settlement.

PCB's

PRINTED CIRCUIT BOARDS manufactured to order from your own actual size artwork. Economic rates and quantity discounts. One off's a speciality. SAE plese for details or SAE and full size artwork for quote by return.

ROBINSON PCB'S,
62 Moor Road,
Orrell, Wigan, Lancs WN5 8RR.

NEW COMPONENTS. Electrolytics 4.7μF 63V 6p, 10μF 22μF 47μF 16V 6p, 100μF 25V 9p, 220μF 16V 10p, 470μF 16V 13p, 470μF 25V 19p, 1000μF 25V 30p. Polyester 0.01μF to 0.1μF 6p, 0.15μF 0.22μF 8p, 0.33μF 0.47μF 11p. Polystyrene 10pF to 0.01μF 6p. Ceramics 1.8pF to 0.047μF 3p, 1N4148 2p, 1N4001/2/3/4 4p, 1N4007 6p, 1N5402 11p, 1N5404 14p. 400mW Zeners 6p. 5mm LEDs Red 8p, yell/green 9p. Clips 2p, ¼W resistors 1p. BC109C 10p, 2N3055 40p, 555 16p, 741 15p, 4001B 10p, 4011B 10p, 7400 10p. DIL Sockets 8 pin 7p, 14/16 pin 9p, 18 pin 12p. VAT inclusive. Postage 30p. Lots more. Send for quote: G. Stone, 22 Mailers Lane, Manuden, Bishops Stortford CM23 1DP.

300 SMALL COMPONENTS, including transistors, diodes £2·20; 7lbs assorted components £6·00; fifty 74 series I.Cs on panel £2·20; post paid. List 25p refundable. J.W.B. RADIO, 2 Barnfield Crescent, Sale, Cheshire, M33 1NL.

AERIAL BOOSTERS

Next to the set fitting

B45H/G-UHF TV, gain about 20dbs, Tunable over the complete UHF TV band. **PRICE £8.70.**
BII-VHF/FM RADIO, gain about 14dbs, when on the off position connects the aerial direct to the radio. **£7.70.**
All Boosters we make work off a PP3/006p/6F22 type battery or 8v to 18v DC. **P&P 30p PER ORDER.**
ELECTRONIC MAILORDER LTD, 62 Bridge St, Ramsbottom, Lancs BL0 9AG. Tel (070682) 3036
Access/Visa Cards Welcome — SAE Leaflets

ELECTRONIC COMPONENTS MERSEYSIDE, Myca Electronics, 2 Victoria Place, Seacombe Ferry, Wallasey, L44 6NR. 051-638 8647.

NOW OPEN IN NEWCASTLE
For the best in Electronic Components, Test Equipment and Accessories.
MARLBOROUGH ELECTRONIC COMPONENTS
15 Waterloo Street, Newcastle NE1 4DE
Tel. 618377
Open 9am-6pm Mon-Sat - Easy Parking
Stockists of:
Transistors, Resistors, Capacitors, I.C. Diodes, Electronic Books, Etc.

SPECIAL OFFER of unmarked transistors. (Each type of transistor supplied in separate, marked bag. BC338, BC237B, BC239B, BC115, BC173B, BC182B, BC238B). Only 50p for 10 (plus VAT). Access & Barclaycard accepted. Van Gelder Ltd., P.O. Box 10, South Road, Southend-on-Sea, SS2 6QG. Add 25p P&P.

BUMPER BOX OF BITS

WOW!!! We've got so many components in stock, we can't possibly list them all!! – So buy a box, in it you'll find resistors, capacitors, displays, switches, panels with transistors, diodes, IC's etc, coils, pots . . . and so on. All modern parts – guaranteed at least 1000 items, minimum weight 10lbs. ONLY £8.50 inc.

"JUST OUT! 40 page catalogue ONLY 50p."

ELECTRONICS WORLD
1d Dews Road, Salisbury, Wilts, SP2 7SN
(Prop: Westbrough Ltd)

EVERYDAY ELECTRONICS and computer PROJECTS

Reach effectively and economically to-days enthusiasts anxious to know of your products and services through our semi-display and classified pages. Semi-display spaces may be booked at £7·80 per single column centimetre (minimum 2·5cm). The prepaid rate for classified advertisements is 33 pence per word (minimum 12 words), box number 60p extra. All cheques, postal orders, etc., to be made payable to

Security

ALARMS ADE

FREE CATALOGUE!

OUR GREAT NEW ILLUSTRATED CATALOGUE IS PACKED WITH INFORMATION ON SUPERB QUALITY, PROFESSIONAL BURGLAR ALARM EQUIPMENT

AT UNBEATABLE PRICES!

SEND SAE OR PHONE **NOW** FOR YOUR COPY

THIEFCHECK BURGLAR ALARM D·I·Y SYSTEM — MAIN DISTRIBUTOR

A D ELECTRONICS
DEPT EE
217 WARBECK MOOR
AINTREE LIVERPOOL
19 0HU/051 523 8440

When replying to Classified Advertisements please ensure:

(A) That you have clearly stated your requirements.
(B) That you have enclosed the right remittance.
(C) That your name and address is written in block capitals, and
(D) That your letter is correctly addressed to the advertiser.

This will assist advertisers in processing and despatching orders with the minimum of delay.

BURGLAR ALARM EQUIPMENT. Free catalogue. C.W.A.S. Ltd., 0274-308920, showrooms open 9-5, Mon-Sat.

SECURITY Alarm Systems

FREE COMPREHENSIVE CATALOGUE!

- *LOWEST DISCOUNT PRICES*
- *HIGHEST QUALITY EQUIPMENT*
- *FREE DIY DESIGN GUIDE*
- *FULLY ILLUSTRATED*
- *MICROCHIP CIRCUITRY*
- *QUICK DESPATCH SERVICE*
- *FULL INSTRUCTIONS*

SEND SAE OR PHONE

C-TEC SECURITY, Dept EE,
60 Market St, Wigan WN1 1HX
Telephone (0942) 42444

Trade Enquires Welcome

Stock Clearance

COMPONENT STOCK CLEARANCE. Bags of Components (approx. 300 items) worth £5 retail. Resistors, Capacitors, Diodes, Zeners, Leds, Pots etc., all mixed values. £1.20 per bag. 5 bags for £5. ELECTRONIKA (J. Shaw), 65 Queen Court, John St., Rochester, Kent ME1 1YU.

LIQUIDATED STOCK from Bankrupt Customer; includes Assorted Pots Log/Lin, Jack Sockets, Chokes, Bulgin Plugs/Sockets, Bulgin Illuminated Switches, Fuse Holders, Bulbs, Dome LES Mini Lampholders and more; Limited Quantities Available; Bargain Prices. SAE for lists to Robinson Pcb's, 62 Moor Road, Orrell, Wigan, Lancs, WN5 8RR.

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next available issue of **Everyday Electronics** for ....Insertions. I enclose Cheque/P.O. for £..............................
(Cheques and Postal Orders should be crossed Lloyds Bank Ltd. and made payable to Everyday Electronics)

NAME ....
ADDRESS ....
....
....

EVERYDAY ELECTRONICS
Classified Advertisement Dept., Room 2612,
King's Reach Tower, Stamford Street, London SE1 9LS
Telephone 01-261 5942
Rate:
33p per word, minimum 12 words. Box No. **60p** extra

Company registered in England. Registered No. 53626. Registered Office: King's Reach Tower, Stamford Street, London SE1 9LS. 9/83

AT YOUR SERVICE

Everyday Electronics and Computer Projects and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Department, Everyday Electronics and Computer Projects, Room 2612, IPC Magazines Limited, King's Reach Tower, Stamford St, London SE1 9LS. (Telephone 01-261 5942).

Service Sheets

BELL'S TELEVISION SERVICE for service sheets on Radio, TV etc. £1.25 plus SAE. Service Manuals on Colour TV and Video Recorders, prices on request. SAE with enquiries to: BTS, 190 King's Road, Harrogate, N. Yorkshire. Tel: 0423 55885.

COMPLETE, FULL-SIZE SETS ANY PUBLISHED service sheets £2 & lsae, except CTVs/Music Centres from £3 & lsae. Manuals from 1930 to latest. Quotations, free 50p magazine, price lists, unique technical publications for lsae. Repair data/circs almost any named TV/VCR £8.50 by return. T.I.S.E.E., 76 Church Street, Larkhall, Lanarks, ML9 1HE, Phone (0698) 883334.

Miscellaneous

DIGITAL WATCH REPLACEMENT PARTS. Batteries, displays, backlights, etc. Also reports, publications, charts. SAE for full list. PROFORDS, Copners Drive, Holmer Green, Bucks HP15 6SGA.

THE SCIENTIFIC WIRE COMPANY
811 Forest Road, London E17. Telephone 01-531 1568

SWG	1 lb	8 oz	4 oz	2 oz
ENAMELLED COPPER WIRE				
8 to 34	3.63	2.09	1.10	0.88
35 to 39	3.82	2.31	1.27	0.93
40 to 43	6.00	3.20	2.25	1.61
44 to 47	8.67	5.80	3.49	2.75
48	15.96	9.58	6.38	3.69
SILVER PLATED COPPER WIRE				
14 to 30	9.09	5.20	2.93	1.97
TINNED COPPER WIRE				
14 to 30	3.97	2.41	1.39	0.94
Fluxcore Solder	5.90	3.25	1.82	0.94

Prices include P&P VAT. Orders under £2 add 20p.
SAE for list of copper and resistance wire.
Dealer enquiries welcome.

PROBLEMS WITH THAT PROJECT?
We will – * BUILD
* TEST
* REPAIR
All your Electronic Kits and Projects. Prices from only **£5.00.**
★ Call us now for a quote. ★
WEB LOGIC SYSTEMS LTD.,
15 High Street, Harpenden, Herts.
05827-62119

LEARN
ELECTRONICS WITHOUT SOLDER

Build electronic circuits without solder on a Roden S-Dec. This has built-in contacts and holes into which you plug your components. Suitable for all ages. Can be used time after time. Ideal gift for students or experimenters. Full instructions and 2 circuit diagrams with each S-Dec.
Send cheque or P.O. to:-
Roden Products, Dep EE
High March, Daventry,
Northants, NN11 4QE.
£4.99 including p & p

Courses

CONQUER THE CHIP—master modern electronics the practical way by seeing and doing in your own home. Write for your free colour brochure now to BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL, Dept C3, Reading, Berks RG1 1BR.

COURSE FOR CITY AND GUILDS, Radio Amateurs Examination. Pass this important examination and obtain your licence, with an RRC Home Study Course. For details of this and other courses (GCE career, professional examinations etc.) write or phone – The Rapid Results College, Dept. JR3, Tuition House, London SW19 4DS. Tel: 01-947 7272 (9am-5pm) or use our 24 hr Recordacall Service: 01-946 1102 quoting Dept. JR3.

INDEX TO ADVERTISERS

★ BAKER ★
GROUP P.A. DISCO AMPLIFIERS post £2

150 watt Output, 4 input Mixer pre-amp. Illustrated £99
150 watt Output, Slave 500 mv. Input 3 Speaker Outputs £80
150+150w Stereo, 300w Mono Slave 500 mv. Inputs £125
150w P.A. Vocal, 8 inputs High/Low Mixer Echo Socket £129
100 watt Valve Model, 4 inputs, 5 Outputs Heavy duty £125
60 watt Valve Model, 4 inputs. Low imp and 100v line output £69
60 watt Mobile 240v AC and 12v DC. 4 inputs £89

BAKER LOUDSPEAKERS Post £2 each

Make	Model	Size	Watts	Ohms	Price
Baker Hi-Fi	Major	12in	30	4/8/16	£16.00
Baker Hi-Fi	Superb	12in	30	8/16	£26.00
Baker P.A.	Group 45	12in	45	4/8/16	£16.00
Baker Hi-Fi	Auditorium	12in	45	8/16	£24.00
Baker Hi-Fi	Auditorium	15in	60	8/16	£37.00
Baker P.A.	DG75	12in	75	4/8/16	£20.00
Baker P.A.	Group 100	12in	100	8/16	£26.00
Baker P.A.	Disco 100	12in	100	8/16	£26.00
Baker P.A.	Group 100	15in	100	8/16	£35.00
Baker P.A.	Disco 100	15in	100	8/16	£35.00

DRILL SPEED CONTROLLER LIGHT DIMMER KIT. Easy to build kit. Control up to 800 watts AC mains with plastic case 4 × 3 × 1½ in. **£5** less case **£4.**

STEREO PRE-AMP KIT. All parts to build this pre-amp. 3 inputs for high, medium or low gain per channel, with volume control and P.C. Board. Can be ganged to make multi-way stereo mixers. **£3.50.** Post 65p.

RCS SOUND TO LIGHT CONTROL BOX MK II
Complete kit of parts, printed circuit. Cabinet. Mains transformer. 3 channels. Up to 1,000 watts each. Will operate from 200MV to 100 watts signal. Suitable for home Hi-Fi or Disco. **£19.** Post £1.
OR COMPLETE READY BUILT IN CABINET **£27.**

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw **75p** each or **6 for £4** or 12 **for £7.50.** Post £1.50 per six.

MAINS TRANSFORMERS Primary 240V A.C

	Price	Post
250-0-250V 80mA. 6·3V 3·5A 1A	£6.00	£2
350-0-350V 250A. 6·3V 6 Amp C.T.	£12.00	£2
220V 25ma. 6V 1A £2. 220V 45ma. 6V 2A	£4.00	£1
250V 60ma 6·3V 2A	£4.75	£1
General purpose tapped outputs voltages available.		
2 amps 3,4,5,6,8,9,10,12,15,18,25 and 30V	£6.00	£2
1 amp 6,8,10,12,16,18,20,24,30,36,40,48,60	£6.00	£2
2 amp 6,8,10,12,16,18,20,24,30,36,40,48,60	£10.50	£2
3 amp 6,8,10,12,16,18,20,24,30,36,40,48,60	£12.50	£2
5 amp 6,8,10,12,16,18,20,24,30,36,40,48,60	£16.00	£2

	Price	Post		Price	Post
5-8-10-16V ½a	£3.00	£1	12-0-12V 2a	£4.50	£1
6V ½a	£2.00	£1	15-0-15V 2a	£4.50	£1
6-0-6V 1½a	£3.50	£1	20V 1a	£4.00	£1
9V 250ma	£1.50	£1	20V 3a	£4.50	£1
9V 3a	£4.00	£1	20-0-20V 1a	£4.50	£1
9-0-9V 50ma	£1.50	£1	20-40-60V 1a	£4.50	£2
10-0-10V 2a	£4.00	£1	25-0-25V 2a	£4.50	£2
10-30-40 2a	£4.50	£1	28V 1a Twice	£6.00	£2
12V 100ma	£1.50	£1	30V 1½a	£4.50	£1
12V 750ma	£2.50	£1	30V 5a	£5.50	£2
12V 3a	£4.50	£1	34-0-34V 6a	£12.00	£2
12V 2a	£4.00	£1	35V 2a	£4.50	£1

TOROIDAL 30-0-30V 4 Amp+20-0-20V ½ Amp £10.00 £2

CHARGER TRANSFORMERS RECTIFIERS

	Price	Post		Price	Post
6-12V 3a	£4.00	£2	6-12V 2a	£1.00	80p
6-12V 4a	£6.50	£2	6-12V 4a	£2.00	80p

LOUDSPEAKER BARGAINS. MANY OTHERS
4 ohm. 6 × 4in., 7 × 4in. **£2.50.** 8 × 5in. 6½in. **£3.** 6½in. 20w **£7.50.** 8in. **£4.50.** 10in. **£5.** 8 ohm. 2¼. 2½. 2¾in. **£2.** 3in., 5 × 3in. **£2.50.** 8in. **£4.50.** 10in. **£5.** 12in **£6.** 16 ohm. 3½in. 6 × 4in **£2.50.** 8in **£4.50.** 10 × 6in. **£4.** 25 ohm. 3½ in. 35 ohm. 3in. **£2.50.** Many others in stock.
Speaker Covering Material Samples **32p.** Stamps.

R.C.S. LOW VOLTAGE STABILIZED POWER PACK KITS 90-100 mA Post 75p **£3.95**
All parts and instructions with Zener diode printed circuit, rectifiers and double wound mains transformer input 200-240 a.c. Output voltages available 6 or 7·5 or 9 or 12V d.c. up to 100mA. State voltage required.
PP BATTERY ELIMINATOR. BRITISH MADE
Mains Transformer Rectifier 9 volt 400ma. Post £1 **£5**
Stabilised, with overload cutout. Plastic case size 5 × 5½ × 2½. Suitable Radio/Cassettes. Fully Isolated and Smoothed.

THE "INSTANT" BULK TAPE ERASER
Suitable for cassettes and all size of tape reels.
A.C. 200/240V (120V to order).
Ideal Computer. Recorder. Post £1 **£10.50**
Tapes, Discs, Cassettes.
HEAD DEMAGNETISER PROBE **£5.00**

ALUMINIUM CHASSIS 18 s.w.g. Undrilled, 4 sides, riveted corners: 6 × 4 × 2½in. **£1.75;** 8 × 6 × 2½in. **£2.20;** 10 × 7 × 2½in. **£2.75;** 14 × 9 × 2½in **£3.60;** 16 × 6 × 2½in. **£3;** 12 × 3 × 2½in. **£1.80;** 12 × 8 × 2½in. **£3.20;** 16 × 10 × 2½in. **£3.80.**
ALI ANGLE BRACKET 6 × ¾ × ¾in. **30p.**
ALUMINIUM PANELS 18 s.w.g. 12 × 12in **£1.80;** 14 × 9in. **£1.75;** 6 × 4in. **55p;** 12 × 8in. **£1.30;** 10 × 7in **96p;** 8 × 6in. **90p;** 14 × 3in. **72p;** 12 × 5in. **90p;** 16 × 10in. **£2.10;** 16 × 6in. **£1.30** up.
ALUMINIUM BOXES. MANY OTHER SIZES IN STOCK.
4 × 2½ × 2in. **£1.00;** 3 × 2 × 1in. **80p;** 6 × 4 × 2in **£1.60;** 8 × 6 × 3 in. **£2.50;** 12 × 5 × 3in. **£2.75;** 6 × 4 × 3in. **£1.80;** 10 × 7 × 3in **£3.**

HIGH VOLTAGE ELECTROLYTICS

8/450V	45p	50/450V	95p	32+32/350V	50p
32/350V	45p	8+16/450V	75p	32+32/500V	£2
32/500V	95p	16+16/350V	75p	32+32+32/350V	50p
				16+32+32/500V	£2

SINGLE PLAY RECORD DECKS.

Make	Model	Cartridge	Price
BSR	P170	Ceramic	£20
BSR	P232	Ceramic	£24
GARRARD	6200	Ceramic	£22
AUTOCHANGERS 240 VOLT			
BSR	Budget	Ceramic	£16
BSR	Delux	Ceramic	£18
BSR	C142	Magnetic	£26

Large Turntables 240 volt AC. Post £2

RADIO COMPONENT SPECIALISTS

Dept 4, 337, WHITEHORSE ROAD, CROYDON SURREY, U.K. TEL: 01-684 1665
Post 65p Minimum. Callers Welcome. Closed Wed. Same day despatch. Access-Barclay-Visa. Lists 32p
PHONE YOUR ORDER

Worth more than just a look in '83

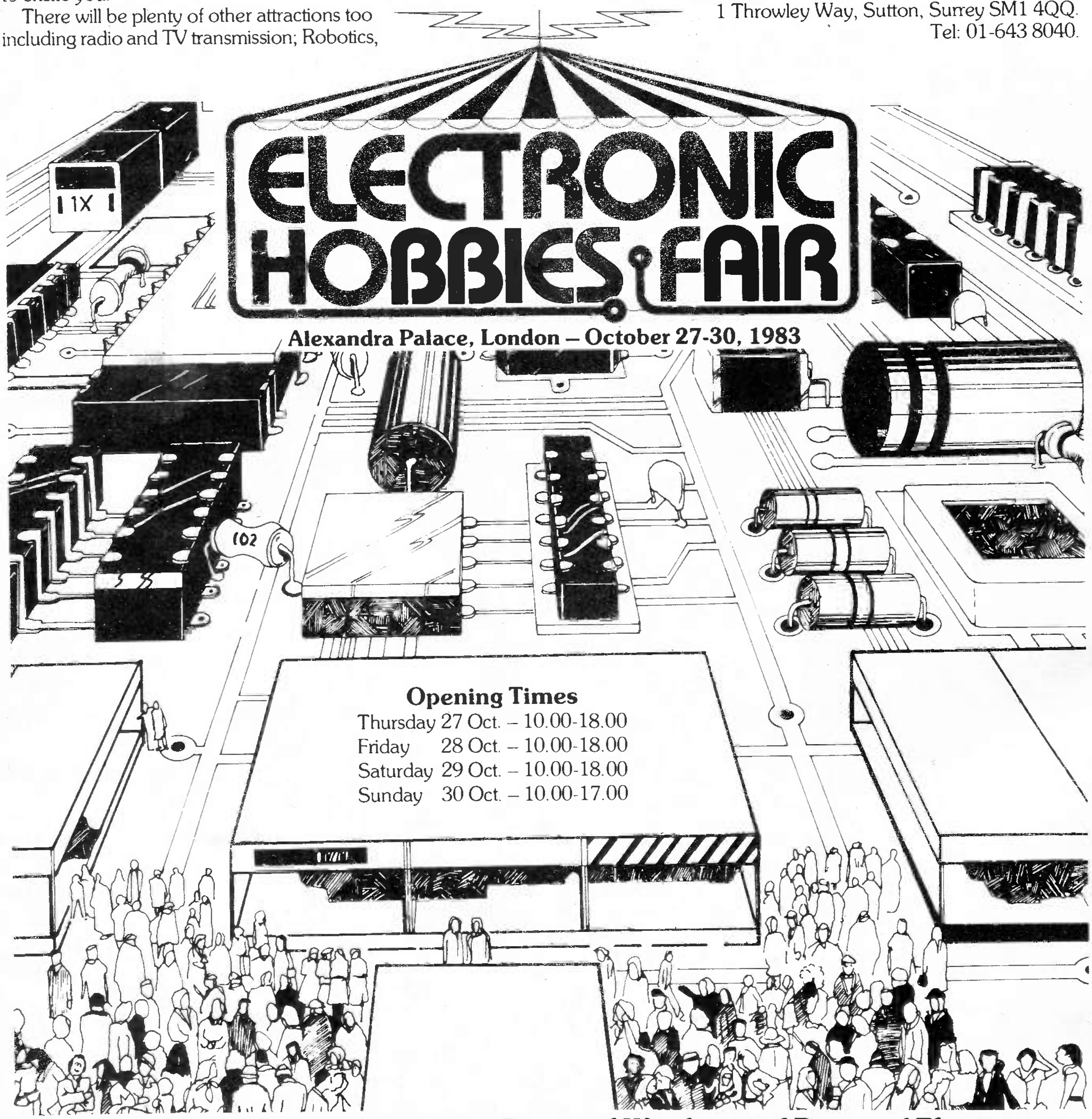
1982 saw the first Electronic Hobbies Fair and immediately established itself as the foremost consumer electronics exhibition – the biggest attendance and the largest number of exhibitors.

The 1983 Fair will be bigger and even more exciting – offering visitors everything from resistors, I C's to home computers, transmitting and receiving units, and peripheral equipment, video games, musical instruments, radio control models. . . . In fact, whatever your particular electronic hobby you'll find this show will have something to excite you.

There will be plenty of other attractions too including radio and TV transmission; Robotics, radio controlled models and demonstrations by local and national organisations. Again British Rail will be offering cheap-rate rail fares from all major stations in the country direct to the Alexandra Palace – a special bus will be waiting to ferry you direct to the show. Your ticket also includes admission to the Exhibition.

Alternatively, for those wishing to travel independently ticket prices at the door are £2.00 for Adults, £1.00 for children. Party rates are available on request (minimum 20 people).

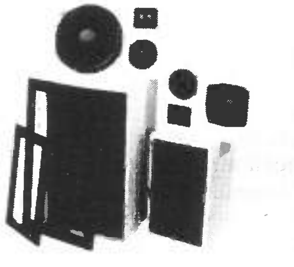
For more information contact the Exhibition Manager, Electronic Hobbies Fair, Reed Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ. Tel: 01-643 8040.



Sponsored by Everyday Electronics, Practical Wireless and Practical Electronics

Published approximately the third Friday of each month by IPC Magazines Ltd., Kings Reach Tower, Stamford St., London SE1 9LS. Printed in England by Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Subscriptions: Inland £12.00, Overseas £13.00 per annum payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex. Everyday Electronics is sold subject to the following conditions namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.

8" 40W system — recommended cabinet size 240 × 216 × 445mm
Price £14.90 each + £2.00 P & P.

5" 30W system — recommended cabinet size 160 × 175 × 295mm
Price £13.90 each + £1.50 P & P.

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

OMP 80 LOUDSPEAKER

The very best in quality and value.

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

Price: **£49.00 each**
£90 per pair
Carriage: **£5 each £7 per pair**

BK ELECTRONICS

Prompt Deliveries
VAT inclusive prices
Audio Equipment
Test Equipment
by
Thandar
and
Leader

PANTEC

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

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 5 x 46 x 14mm (9 volt) **Price: £7.99p**

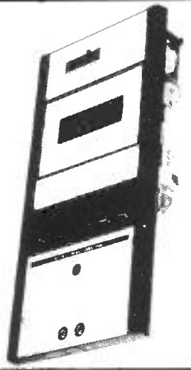
DIGITAL THERMOMETER −9.9 C to +99.9 C. LED display. Complete with sensor. 70 x 70 mm (9 volt) **Price: £27.60p**

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled, professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) **Price: £12.49p**

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

3 watt FM Transmitter

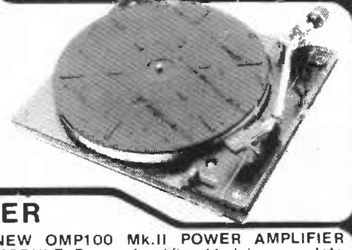
STEREO CASSETTE TAPE DECK MODULE



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

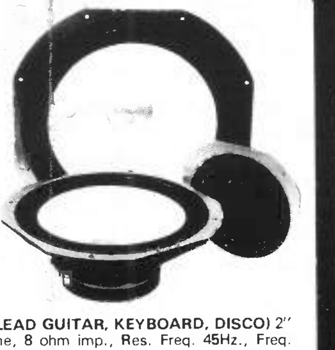
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5½in × 11½in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

BSR P256 TURNTABLE



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

LOUDSPEAKERS



THREE QUALITY POWER LOUDSPEAKERS (15", 12" and 8" See Photo). **Ideal for both Hi-Fi and Disco applications.** All units have attractive cast aluminium (ground finish) fixing escutcheons.

Specification and Prices.

15" 100 watt R.M.S. Impedance 8 ohms. 50 oz magnet. 2" aluminium voice coil. Res. Freq. 20 Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. Price £34.00 each + £3.00 P&P

12" 100 watt R.M.S. Impedance 8 ohms. 50 oz magnet. 2" aluminium voice coil. Res. Freq. 25Hz. Freq. Resp. to 4 KHz. Sens. 95dB. Price: £24.50 each + £3.00 P&P

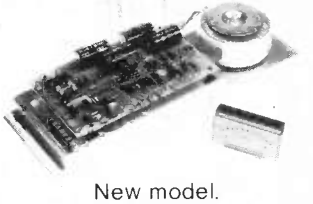
8" 50 watt R.M.S. Impedance 8 ohms. 20 oz. magnet. 1½" aluminium voice coil. Res. Freq. 40Hz. Freq. Resp to 6 KHz. Sens. 92dB. Black Cone. Price. £9.50 each. Also available with black protective grille Price: £9.99 each. P&P £1.50.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £22.00** + £3 carriage.

12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. **Price £22** + £3 carriage.

15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. **Price: £47** + £4 carriage.

OMP POWER AMPLIFIER MODULE



New model.
Improved specification

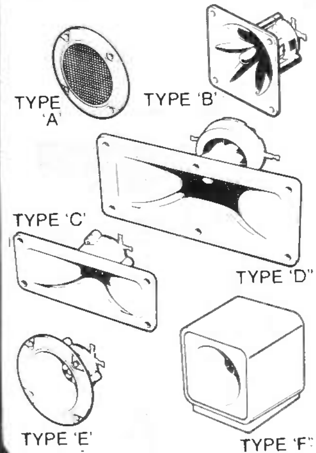
NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module **complete** with integral heat sink, toroidal transformer power supply and glass fibre p.c.b. assembly. Incorporates drive circuit to power a compatible LED Vu meter. New **improved** *specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.*

SPECIFICATION
Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16 ohms.
Frequency Response:— 15Hz - 30KHz -3dB.
T.H.D.:— 0.01%.
S.N.R. (Unweighted):— -118dB ±3.5dB
Sensitivity for Max Output:— 500mV @ 10K.
Size:— 360 x 115 x 72 mm Price:— £31.99 + £2.00 P&P. Vu Meter Price:— £7.00 + 50p P&P.

O.E.M.'s CONTACT BARRY PEARNE Tel. 0702 52752

PIEZO ELECTRIC TWEETERS – MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.29 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.99 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.99 each.**

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £7.99 each.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.99 each.**

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each**

P&P 20p ea. (or SAE for Piezo leaflets).

HOME PROTECTION SYSTEM

Better to be **'Alarmed'** then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable **FULLY GUARANTEED.**

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.

Indoor alarm — Electronic swept freq. siren 104dB output.

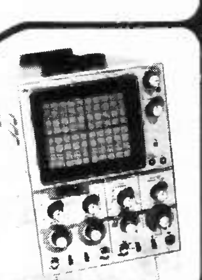
Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE £128 Usual price £228.85

BKE's PRICE £99.p&p£4
SAE for colour brochure

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



FREE SECURICOR DELIVERY

B.K. ELECTRONICS

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX, SS2 6TR

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Sales Counter. ★
★ All items packed where applicable in special energy absorbing PU foam. ★ Please phone 0702 527572 ★