EVERYDAY ELECTRONICS and computer PROJECTS

JUNE 1985 £1·00

COMPUTERISED SHUTTER TIMER

GRAPHIC EQUALISER

CARAVAN PSU
ELECTRONIC DOORBELL

Plus... Monostables · Bistables · Astables

Australia $1.75 New Zealand $1.95 Malaysia $4.95

BAKERS DOZEN PARCELS

All the parcels listed below are brand new components. Price per parcel is £1.00, but if you order 12 you get one extra free.

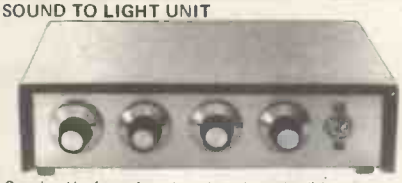
1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 25 13 amp fuses for ring mains
4 – 5 surface mounting switches suitable insulated for mains voltage
5 – 3 flush electrical switches intermediate type, will also replace 1 or 2 way switches
6 – 5 in flex line switches
7 – 4 in flex line switches with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6v 1a secondaries
10 – 2 mains transformers with 12v ⅛a secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 OCP 70 photo transistors
15 – 25 assorted germanium transistors OC45 etc
16 – 4 tape heads, 2 record, 2 erase
17 – 2 ultra sonic transmitters and 2 ditto receivers
18 – 2 15000 mfd computer grade electrollics
19 – 2 light dependent resistors similar ORP12
20 – 5 diff micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units
23 – 1 40 watt 3 way crossover unit
24 – 250 various screws and self tappers
25 – 1 of each wafer switches – 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 – 2 tape deck counters
27 – 1 6 digit counter 12v
28 – 1 6 digit counter mains voltage
29 – 1 BOAC in flight stereo unit (second hand)
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aerosol cans of ICI Dry Lubricant
34 – 96 x 1 metre lengths colour-coded connecting wire
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid dielectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – Long and Medium wave tuner kit
40 – 4 x 465 KC IF transformers
41 – 8 Rocker Switches 10 amp Mains SPST
42 – 6 Rocker Switches 10 amp Mains SPDT
43 – 5 Rocker Switches 10 amp SP.DT Centre Off
44 – 4 Rocker Switches 10 amp DPDT
45 – 1 24 hour time switch mains operated – (s.h.)
46 – 1 6 hour clockwork timeswitch
47 – 2 lever switches 4 pole changeover up and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12v DC or 24V AC 4CO relays
51 – 1 x 12v 2C 0 very sensitive relay
52 – 1 x 12v 4C 0 relay
53 – 2 mains operated relays 3 x 8 amp changeovers (secondhand)
54 – 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 – 1 locking mechanism with 2 keys)
56 – Minfature Uniselector with circuit for electric jigsaw puzzle
57 – 5 Dolls' House switches
58 – 2 telephone hand sets incorporating ear piece and mike (p)
59 – 2 flat solenoids – ideal to make current transformer etc.
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 earpieces
63 – 1 Mullard Thyristor trigger and modules
64 – 10 assorted knobs ¼ spindles
65 – 5 different thermostats, mainly bi-metal
66 – Magnetic brake – stops rotation instantly
67 – Low pressure 3 level switch
68 – Heavy duty 4 pole contactor – 24v coil
69 – 2 25 watt pots 8 ohm
70 – 2 25 watt pots 1000 ohm
71 – 5 wire wound pots – 18, 33, 50, and 100 ohm
72 – 1 1250 watt dimmer Ultra ref SE20
73 – 4 3 watt wire wound pots 50 ohm
74 – 50 1/3 watt carbon film resistors food spread 10 values
75 – 20 2 watt carbon resistors 10 values
76 – 30 1 watt carbon resistors 15 diff values
77 – 1 time reminder adjustable)-60 mins
78 – 5.5 amp stud rectifiers 400V
79 – 4 2a bridge rectifiers 400V
80 – 2 10a bridge rectifiers 30V
81 – 2 30a panel mounting slydlok fuses
82 – 4 porcelain fuse holders and fuses
83 – 1 fluorescent choke – your choice – 15, 20, 30, 40 or 65 watt
84 – 10 1 mains voltage suppressor condensors
85 – 1 malns shaded pole motor ¾" stack
86 – 2 5" all fan blades fit ¼" shaft
87 – 2 3" plastic fan blades fit ¼" shaft
88 – Malns motor suitable for above blades
89 – 1 mains motor with gear box 1 rev per 24 hours
90 – 1 malns motor with gear box 1 rev per 12 hours
91 – 2 mains motor with gear box 16 rpm
92 – 4 fluorescent starters suit 4 – 80 w tubes
93 – 4 11 pin moulded bases for relays
94 – 5 B7G valve bases
95 – 4 skirted B9A valve bases
96 – 1 thermostat for fridge
97 – 1 infra red fire element 1000 watts
98 – 1 motorised stud switch (SH)
99 – 5 assorted ferrite shapes
100 – 3 ferrite magnets
101 – 1 2½ hours delay switch
102 – 1 9v mains power supply unit
103 – 1 6v mains power supply unit
104 – 1 4½v mains power supply unit
105 – 1 5 pin flex plug and panel socket
106 – 1 12v vibrating reed bleepers
107 – 5" speaker size radio cabinet with handle
108 – 5 different multi way push switches
109 – 10 ¼" spindle type volume controls
110 – 10 slider type volume controls
111 – 2 musical boxes (less keys)
112 – 1 heating pad 200 watts
113 – 1 fm front end with tuning condensor
114 – 1 1w amplifier Mullard 1172

With most items quantity buyers get good discounts and save on postage costs.

EX-G.P.O. TELEPHONES

Black heavy type	£5.50
Lightweight 746 type	£7.50
Ex-G.P.O. plug	£1.00
Ex-G.P.O. socket	£1.00

SOUND TO LIGHT UNIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested.

CAR STARTER/CHARGER KIT

Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 or without case £15.00. post paid.

4/5A BATTERY CHARGER

Transformer and rectifier £3.95 & £1 post, 3 kits £12 post paid.

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.

PRESTEL UNITS

These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

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 - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

25A ELECTRICAL PROGRAMMER

Learn in your sleep Have radio playing and kettle boiling as you wake – switch on lights to ward off intruders – have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50.

THIS MONTH'S SNIP

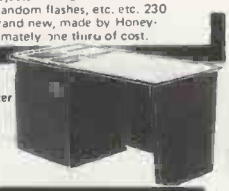
TOP OF THE POPS LIGHTING

if you use our disco switch ONLY £6.90

These have 12 x 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc. etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately one third of cost.

COMPUTER DESKS

Again available Computer desks – size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 – you must collect – hundreds supplied to schools.



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, 90% are unused componants.

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:

1 Framco motor with gear box
1 manual reversing & on/off switch
1 push to start switch
2 limit stop switches
1 circuit diag. of connections

£19.50 plus postage £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: phone for quote. Shop open 9.00 – 5.30, Mon to Fri, not Saturday.

Ex-Electricity Board. Guaranteed 12 months.

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 mine switch but you can have it for only £2.95, without case, metal case - £2.95, adaptor kit to convert this into a normal 24hr. 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.

EXTRACTOR FANS – MAINS OPERATED

Woods extractor.
5" – £5.75, Post £1.25.
6" – £6.95, Post £1.25.
5" Plannair extractor £6.50. Post £1.25
4"x 4" Muffin 115v. £4.50. 230v. £5.75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50, post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER

by British Solartron, as used in best blow heaters. 3Kw £6.95 complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £2
Still available: £4.95 + £1.50 post. or have 3 for £16 p. 2.5 Kw KIT

ROCKER SWITCHES

Standard size fit 11.5 x 28 mm cut out. Single pole on/off – 15p each 1000 for £75. Single pole changeover 20p each – 1000 for £100. Single pole changeover with centre off – 25p each – 1000 for £125. Single pole on/off with neon – 36p – 1000 for £180.

ROCKER SWITCH DP/DT

15 amp 250 volts suitable for motor reversing etc. – 46p – 100 for £34.50, 1000 for £230.

MICRO SWITCHES

V3 type all 250 10 amp SpST 20p 1000 – £100 Spdt 30p 1000 – £150, very low tongue Spdt 40p 1000 for £200.

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 – 170 KHz, medium wave band 525 – 1650 KHz. FM band 87 – 108 MHz, mono, stereo & AFC switchable, 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

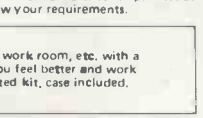
Offered at a fraction of its cost: only £6.00 + £1.50 post + Insurance

MINIATURE WAFER SWITCHES

2 pole, 2 way – 4 pole, 2 way – 3 pole, 3 way – 4 pole, 3 way – 2 pole, 4 way – 3 pole, 4 way – 2 pole, 6 way – 1 pole, 12 way.
All at 25p each or 10 for £2.00

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle – Price £3.45.
Ditto, but double ended £4.25.



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.

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	£9.9
3 Channel Sound to Light – with fully prepared metal case	£14.95
Big Ear, listen through walls	£9.50
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
Radio stethoscope – fault findlng aid	£4.80
Mug stop – emits piercing squark	£2.50
Morse Trainer – complete with key	£2.99
Drill control kit	£3.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
F M receiver kit – for surveillance or normal F M	£3.50
Insulation Tester – electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio – receives Medium Wave	£2.95
40 watt amp – hifi 20hz – 20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50

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EVERYDAY ELECTRONICS and computer PROJECTS

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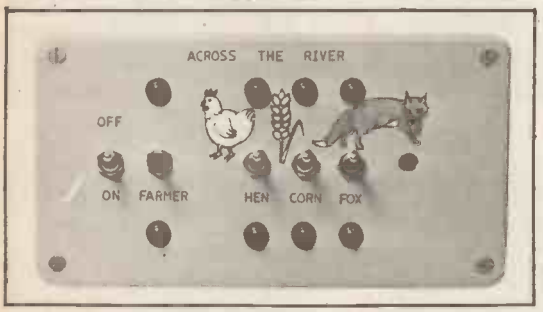
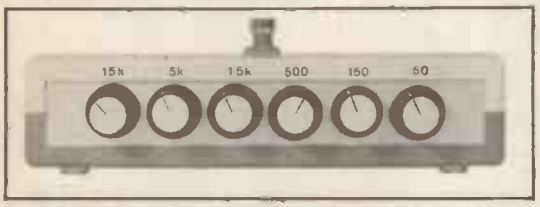
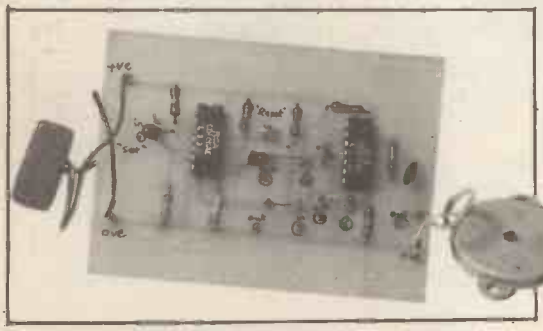
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







PROJECTS

SERIES

FEATURES

Our July 1985 issue will be published on Friday, June 21.
See page 331 for details.

NEW THIS MONTH

"SENSING & CONTROL PROJECTS FOR THE BBC MICRO"

Have you ever wondered what all those plugs and sockets on the back of the BBC micro are for? This book assumes no previous electric knowledge and no soldering is required, but guides the reader (pupil or teacher) from basic connexions of the user sockets, to quite complex projects. The author, an experienced teacher in this field, has provided lots of practical experiments, with ideas on how to follow up the basic principles. A complete kit of parts for all the experiments is also available. Book. 245×185mm 120pp **£5.95**. Kit **£29.95**.

GREENWELD

— The Pack People! —

K524 OPTO PACK – a variety of single point and seven segment LEDS (incl. dual types) of various colours and sizes, opto isolators, numicators, multi digit gas discharge displays, photo transistors, infra red emitters and receivers. 25 assorted **£3.95**; 100 **£14.95**; 250 **£36**.

K525 PRESET PACK – Big, Big variety of types and sizes – submin. min and std. MP, slider, multiturn and cermets are all included. Wide range of values from 20R to 5M. 100 assorted **£6.75**; 250 **£12.95**; 1000 **£48**.

K526 HEATSINK PACK – Lots of different sizes and shapes of heatsink for most diode and transistor case styles. A pack of 25 assorted including several large finned types – total weight over 1kg **£5.50**; 100 **£19.50**.

K528 ELECTROLYTIC PACK – All ready cropped for PCB mounting, this pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF. 6v to 100v **£3.95**; 250 **£8.95**; 1000 **£32**.

K531 PRECISION RESISTOR PACK – High quality, close tolerance R's with an extremely varied selection of values mostly ¼ and ½w tolerances from 0.1% to 2% – ideal for meters, test gear etc. 250 **£3**; 1000 **£10**.

K532 RELAYS – Wide selection of styles, voltages and contacts. 4v-240v, AC/DC, SP to 4PCO. 20 for **£6**; 100 **£25**.

K517 TRANSISTOR PACK – 50 assorted full spec marked plastic devices PNP NPN RF AF. Type numbers include BC114 117 172 182 183 198 239 251 214 255 320 BF 198 255 394 2N3904 etc. etc. Retail cost £7+; Special low price 275p.

K523 RESISTOR PACK – 1000 – yes 1000 ¼ and ½ watt 5% hi-stab carbon film resistors with pre-formed leads for PCB mounting. Enormous range of preferred values from a few ohms to a several megohms. Only 250p; 5000 **£10**; 20,000 **£36**.

K520 SWITCH PACK – 20 different assorted switches – rocker, slide, push, rotary, toggle, micro etc. Amazing value at only 200p.

K522 COPPER CLAD BOARD – All pieces too small for our etching kits. Mostly double-sized fibreglass 250g (approx 110 sq. ins.). For 100p.

K530 100 ASSORTED POLYESTER CAPS – All new modern components, radial and axial leads. All values from 0.01 to 1uf at voltages from 63 to 1000!! Super value at **£3.95**.

K518 200 DISC CERAMIC CAPS – Big variety of values and voltages from a few pF to 2.2uF; 3v to 3kv **£1.00**.

K203 100 WIREWOUND RESISTORS – From 1w to 12w, with a good range of values **£2.00**.

K505 20 ASSORTED POTENTIOMETERS – All types including single, ganged, rotary and slider **£1.70**.

W4700 PUSH BUTTON BANKS – An assortment of latching and independent switches on banks from 2 to 7 way, DPCC to 6PCO. A total of at least 40 switches for **£2.95**; 100 **£6.50**; 250 **£14.00**.

Goods normally despatched by return of post.

1984/85 CATALOGUE

84 page A4 size – Bigger, Brighter, Better – more components than ever before! With each copy there's discount vouchers, Bargain List, Wholesale Discount List, Bulk Buyers List, Order Form and Reply Paid Envelope. All for just £1.00!! Winter Supplement now out – Send large SAE for your free copy.

"TORUS"

Computer-controlled Robot built around the gearbox described below. Complete kit of parts inc PCB, program listings for BBC (other micros soon). £44.85. 20W ribbon cable (min 3m recommended – 5m better) £1.30/m. SAE for illustrated leaflet.

MOTORIZED GEARBOX

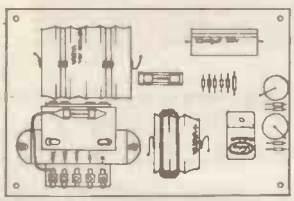
The unit has 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle, and a gearbox contained within the black ABS housing, reducing the final drive speed to approx 50rpm. Data is supplied with the unit showing various options on driving the motors.

Two new types of wheels can be supplied (the aluminium discs and smaller plastic wheels are now sold out). Type A has 7 spokes with a round black tyre and is 100mm dia. Type B is a solid heavy duty wheel 107mm dia with a flat rigid tyre 17mm wide.

PRICES: Gearbox with data sheets: **£5.95** ea

Wheel type A: **£0.70** ea

Wheel type B: **£0.90** ea



NI-CAD CHARGER PANEL

177×114mm PCB with one massive Varta Deac 57×50mm Ø rated 7.2v 1000mAH and another smaller Deac 32×35mm Ø rated 3.6v 600mA. The price of these Ni-cad stacks new is over £20. Also on the panel is a mains input charger transformer with two separate secondaries wired via bridge rectifiers, smoothing capacitors and a relay to the output tags. The panel weighs 1kgm. All this for just **£6.00**.

PCB MOUNTING NI-CADS

Much sought after 4.8V 150mA batts with PCB mntg tags on 25mm pitch. Batt size 25×16 Ø. Ideal for paralleling. 99p ea; 10+ 85p; 25+ 70p; 100+ 60p.

NI-CADS: AA 99p; C 199p; D 220p; PP3 395p.

1W AMPLIFIER

Z914 – Audio amp panel 95×65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol. control. Just connect batt. and speaker. Full details supplied. Only **£1.50**; 10 for **£12**; 25 for **£25**; 100 **£75**.

AM TUNER PANEL

Z916 – For use with mono amp above. Neat panel 60×45mm. Only **£1.50**; 10 for **£12.00**.

FIBRE OPTICS

Scoop purchase of single and twin cable. For use with visible light or infra-red. Core 1mm dia, overall 2.25mm dia. Single 50p/m; 20m coil **£6.30**. Twin 90p/m; 20m coil **£11.00**.

Our shop has enormous stock of components and is open 9-5.30 Mon-Sat. Come and see us!!

GREENWELD

All prices include VAT; just add 60p P&P. Min Access order £5.00 No min. CWO value. Official orders from schools etc. welcome – min invoice charge £10.

443L Millbrook Road
Southampton SO1 0HX
Tel (0703) 772501/783740

AA117	9	BCY42	20	BF259	18	BU100A	110	TIP42A	22	ZN 706A	22
AA119	9	BCY56	16	BF262	25	BU104	110	TIP42C	25	ZN 708	22
AAY32	9	BCY70	16	BF263	25	BU105	80	TIP47	40	ZN.914	28
AC107	28	BCY71	16	BF270	18	BU108	100	TIP48	40	2N.918	36
AC126	17	BCY72	16	BF273	15	BU110	110	TIP50	60	2N.930	18
AC127	15	BD115	50	BF311	21	BU111	140	TIP51	120	2N.1131	28
AC128	15	BD124P	50	BF324	25	BU124	60	TIP52	120	2N.1132	28
AC128K	23	BD124	10	BF336	20	BU126	70	TIP53	120	2N.1613	24
AC141K	30	BD126	35	BF337	20	BU204	75	TIP54	140	2N.1711	24
AC142K	30	BD131	25	BF338	20	BU205	70	TIP105	65	2N.2102	50
AC153L	23	BD132	25	BF355	28	BU208	75	TIP106	65	2N.2160	300
AC176	18	BD135	20	BF362	30	BU208A	80	TIP107	65	2N.2218A	24
AC176K	20	BD136	20	BF367	13	BU208D	100	TIP110	47	2N.2219	24
AC187	15	BD137	20	BF371	17	BU225	55	TIP111	50	2N.2221	23
AC187K	20	BD138	20	BF414	18	BU326	95	TIP112	40	2N.2222	23
AC188	17	BD139	20	BF420	16	BU406	85	TIP115	45	2N.2369	15
AC188K	23	BD140	20	BF421	18	BU406D	95	TIP116	45	2N.2484	20
ACY18	48	BD144	90	BF422	21	BU407	75	TIP117	50	2N.2646	40
ACY19	48	BD150	30	BF423	15	BU407D	95	TIP120	43	2N.2904	20
AD142	60	BD157	38	BF440	16	BU408	85	TIP121	45	2N.2905	20
AD149	45	BD158	38	BF451	17	BU408D	95	TIP122	47	2N.2906	18
AD161	22	BD166	30	BF455	14	BU409	95	TIP125	47	2N.2907	18
AD162	22	BD177	30	BF458	19	BU426	120	TIP126	56	2N.3026	8
AF124	25	BD179	32	BF459	19	BU500	110	TIP127	56	2N.3019	28
AF125	25	BD181	45	BF461	60	BU526	80	TIP141	90	2N.3053	18
AF126	25	BD182	60	BF462	62	BU801	95	TIP142	90	2N.3054	35
AF185	25	BD183	60	BF469	30	BU806	120	TIP145	65	2N.3055	35
AF139	22	BD201	33	BF470	28	BU807	95	TIP146	90	2N.3055H	50
AF239	22	BD202	38	BF471	28	C106D	23	TIP147	100	2N.3440	58
AL112	70	BD203	42	BF479	30	MJ2500	100	TIP2955	42	2N.3442	85
AL113	90	BD204	42	BF493	18	MJ2501	110	TIP3054	45	2N.3702	9
ASZ15	100	BD222	31	BF494	16	MJ2955	55	TIP3055	42	2N.3703	9
ASZ17	100	BD232	31	BF595	16	MJ3000	115	TIS43	45	2N.3704	9
AU110	110	BD234	32	BF596	16	MJ3001	115	TIS44	40	2N.3705	9
AY102	180	BD235	28	BF597	10	MJE2QA	30	TIS61	15	2N.3706	9
AY106	180	BD236	30	BF615	30	MJE30A	30	TIS88A	45	2N.3707	9
BA145	10	BD237	21	BF758	41	MJE340	25	TIS90	15	2N.3708	9
BA148	10	BD238	24	BF868	22	MJE350	80	TIP91	18	2N.3771	85
BA154	6	BD244	50	BF870	22	MJE520	30	TIP93	20	2N.3772	90
BA157	12	BD245	50	BF872	23	MJE2955K	58	VK1000	88	2N.3773	100
BB101	13	BD433	28	BF960	38	OC28	100	VN.10KM	60	2N.3819	29
BB103	16	BD434	30	BF963	40	OC29	80	VN.46AF	88	2N.3866	68
BB105B	18	BD435	31	BF964	38	OC35	100	VN.66AF	100	2N.3903	11
BB205B	24	BD437	28	BF965	40	OC36	120	VN.88AF	115	2N.3904	11
BC107	7	BD438	36	BFR40	25	OC45	50	VN.89AF	110	2N.3905	11
BC108	7	BD439	40	BFR51	21	OC71	30	ZTX107	11	2N.3906	11
BC109	7	BD440	40	BFR62	21	OC72	50	ZTX108	11	2N.4031	25
BC115	10	BD441	40	BFR79	25	OC200	180	ZTX109	12	2N.4036	25
BC118	11	BD442	40	BFR80	52	R2008B	100	ZTX212	27	2N.4037	25
BC140	19	BD533	50	BFR91	99	R2010B	100	ZTX300	13	2N.4058	13
BC141	19	BD534	38	BFQ29	20	TAG4443	76	ZTX301	16	2N.4443	76
BC142	19	BD535	38	BFQ64	20	TAG4444	76	ZTX302	16	2N.4444	76
BC143	19	BD536	38	BFX85	20	TIP29	15	ZTX303	24	2N.5061	20
BC147	6	BD537	40	BFX87	15	TIP29A	22	ZTX304	17	2N.5294	30
BC148	6	BD538	40	BFX88	15	TIP29C	25	ZTX320	29	2N.5296	30
BC149	6	BD675	48	BFX89	60	TIP30	25	ZTX326	29	2N.6106	40
BC157	6	BD676	40	BFY17	30	TIP30C	30	ZTX500	13	2N.6107	40
BC158	6	BD677	38	BFY18	40	TIP31A	24	ZTX501	13	2N.6109	40
BC182	6	BD678	40	BFY41	28	TIP31C	30	ZTX502	18		
BC182L	6	BD680	40	BFY50	14	TIP32	24	ZTX503	18		
BC183	6	BD679	40	BFY51	14	TIP32A	24	ZTX504	25		
BC183L	6	BD681	45	BFY52	14	TIP32C	28	ZTX550	24		
BC184	6	BD682	45	BFY56	20	TIP33	50	ZN.696	26		
BC184L	6	BDX32	100	BFY57	25	TIP34	50	ZN.697	22		
BC212	6	BDX65	80	BFY90	25	TIP41A	22	ZN.698	40		
BC212L	6	BDY92	100	BFY90	45	TIP41C	25	ZN.699	45		
BC213	6	BF180	16	BLY48	85						
BC213L	6	BF181	18	BLY49	85						
BC214	6	BF183	20	BR100	14						
BC214L	6	BF184	20	BR101	43						
BC237	7	BF185	20	BR103	37						
BC238	7	BF194	5	BSX20	15						
BC300	18	BF195	5	BSX26	18						
BC301	18	BF196	6	BSX29	19						
BC302	18	BF197	7	BT106	90						
BC303	18	BF198	7	BT109	90						
BC327	6	BF199	8	BT116	80						
BC328	6	BF200	16	BT119	100						
BC337	6	BF240	16	BT120	100						
BC338	6	BF241	10	BT138/500	60						
BCX57	6	BF255	12	BT146/750	98						
BCY32	150	BF256	18	BT151/650	58						
BCY33	150	BF257	18	BT151/800	58						
BCY34	150	BF258	18	BTY79/500	140						

BY133	8	2SB507	68
BY164	40	2SB754	80
BY176	85	2SC495	60
BY179	35	2SC1060	95
BY182	32	2SC1061	200
BY184	32	2SC1096	78
BY187	32	2SC1161	110
BY196	20	2SC1172	150
BY206	11	2SC1306	90
BY207	11	2SC1307	100
BY208	18	2SC1678	120
BY210	22	2SC1969	130
BY223	72	2SC2028	75
BY225	120	2SC2029	120
BY226	18	2SC2078	120
BY227	19		
BYZ28	32		
BYZ96	20	**LOW PROFILE SOCKETS**	
BYZ98	26	8 pin	6
BYZ99	28	14 pin	8
BYX76	90	16 pin	9
BYX10	15	18 pin	12
BYX55/350	30	20 pin	14
BYX55/600	30	22 pin	16
BYX55/800	32	24 pin	18
BYX70/300	25	28 pin	20
BYX70/500	32	40 pin	25
BYX70/800	38		
BYX71/600	80		
OA74	6	**VOLTAGE REGULATORS**	
OA90	4		
OA91	4	7805	35
OA200	7	7812	35
DA202	7	7815	35
IN.914	2	7818	35
IN.4001	4	7824	35
IN.4002	4	7905	35
IN.4003	4	7912	40
IN.4004	4	7915	40
IN.4005	4	7918	40
IN.4006	4	7924	40
IN.4007	5	78L05	28
IN.4148	2	78L12	28
IN.5400	9	78L15	28
IN.5401	10	78L18	28
IN.5402	10	78L24	28
IN.5403	11	79L05	40
IN.5404	11	79L12	45
IN.5405	12	79L15	48
IN.5406	13	LM309K	100
IN.5407	13	LM317K	220
IN.5408	13	LM317T	180
		LM323K	420
ZENERS		LM723	32
400MW BZY88 Range 2V7 to 39V 6		78HGKC	570
1.3W Zeners BZX61 Range 2V7 to 39V 12		78H05KC	520
		79GU1C	190
		79GU1C	215
		79HGKC	670
DIODES			
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BY103	32	AN-240P	150
BY126	6	AN-360	120
BY127	8		
JAPANESE TRANSISTORS			
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BC109	0.10	TIP31A	0.44
A.B.C.	0.12	TIP32A	0.42
BC147	0.09	TIP33C	0.88
BC182	0.09	TIP34A	0.72
BC182L	0.09	TIP2955	0.60
BC184	0.09	TIP3055	0.60
BC184L	0.09	TIS43	0.88
BC212	0.09	TIS88	0.40
BC212L	0.09	2N3055	0.45
BCY70	0.15	2SC1096	0.68
BDI31/2	0.34	2SC1173Y	0.82
BDI33	0.56	2SC1306	0.92
BDI35	0.32	2SC1307	0.40
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BF115	0.32	2SC2028	0.73
BF184	0.32	2SC2029	2.10
BF185	0.32	2SC2078	1.05
BF194	0.08	2SC2166	1.20
BF195	0.10	3SK88	0.65
BF196	0.10	40673	0.80
BF197	0.10		
BF200	0.38		
BF224	0.20		
BF244	0.26		
BF244A	0.28		
BF244B	0.30		
BF259	0.32		
BF262	0.30		
BF263	0.30		
BF337	0.38		
BF338	0.38		
BFX26	0.28		
BFX84	0.24		
BFX85	0.26		
BFX87	0.26		
BFY50	0.21		
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4012	0.24	4027	0.45	4043	0.42
4013	0.56	4028	0.45	4044	0.50
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IN916	0.04	AA119	0.12
IN4001	0.05	AA129	0.18
IN4004	0.06	AAY30	0.16
IN4005	0.06	BA100	0.24
IN4007	0.07	BY126	0.12
IN4148	0.05	BY127	0.10
IN4149	0.06	BY133	0.16
IN5400	0.12	BY184	0.40
IN5401	0.15	OA47	0.10
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LS03	28p
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LS05	33p
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LS09	28p
LS10	28p
LS11	28p
LS12	25p
LS13	33p
LS14	58p
LS15	25p
LS20	28p
LS21	28p
LS22	28p
LS30	33p
LS32	28p
LS37	23p
LS74	38p
LS122	70p
LS138	45p
LS139	68p
LS151	75p
LS155	50p
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BC183L	15p	LM381	180p	1N4007	7p	4024BE	48p	4081BE	28p
BC184L	16p	LM382	150p	1N4148	4p	4025BE	28p	4082BE	28p
BC212	14p	LM384	170p	1N914	5p	4026BE	110p	4085BE	59p
BC214	12p	LM387	175p	2N2219	37p	4027BE	38p	4089BE	140p
BC327	14p	LM389	150p	2N2369A	28p	4028BE	55p	4093BE	40p
BC328	14p	LM3914	380p	2N2646	90p	4029BE	60p	4094BE	110p
BC337	14p	MJ2955	115p	2N2904	32p	4031BE	130p	4098BE	85p
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BC549	12p	NE555	37p	2N3055H	105p	4035BE	65p	40109	86p
BCY70	23p	NE556	65p	2N3703	14p	4038BE	85p	40162	66p
BCY71	22p	NE565	155p	2N3704	12p	4040BE	60p	40174	72p
BD131	49p	NE566	160p	2N3705	12p	4041BE	69p	40194	79p
BD132	50p	OA200	9p	2N3706	14p	4042BE	56p	4502BE	60p
BD135	37p	OA47	21p	2N3708	12p	4043BE	60p	4503BE	55p
BD139	40p	OA90	9p	2N3711	11p	4044BE	63p	4506BE	150p
BD140	40p	OA91	10p	2N3772	195p	4045BE	115p	4510	85p
BD180	45p	SL490	320p	2N3903	16p	4046BE	75p	4511	70p
BF258	37p	TDA1022	640p	2N3904	18p	4047BE	75p	4520BE	65p
BF259	37p	TDA1024	179p	2N3905	14p	4048BE	50p	4568BE	310p
BFX29	34p	TIP122	95p	2N5458	59p	4049UBE	56p	7106	810p
BFX84	34p	TIP127	75p			4050BE	38p	7107	810p
BFX85	37p	TIP2955	95p	4000BE	23p	4051BE	60p	741	28p
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ELECTROLYTIC AXIAL TYPE
25V:10uF 8p; 22uF **10p;** 47uF **12p;** 100uF **15p;** 150uF **18p;** 220uF **17p;** 330uF 20p; 470uF **22p;** 1000uF **36p;** 2200uF 61p; 3300uF **91p**

63V:1uF **9p;** 1.5uF **11p;** 2.2uF 8p; 3.3uF 8p; 4.7uF 8p; 6.8uF **18p;** 10uF **12p;** 15uF **16p;** 22uF **17p;** 47uF **17p;** 100uF **21p;** 150uF **31p;** 220uF **29p;** 330uF **32p;** 470uF **46p;** 1000uF **78p;** 2200uF **£1.50**

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DISC CERAMIC TYPE
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100 **25p;** 150 **25p;** 220 25p; 270 **25p;** 330 **26p;** 390 **27p;** 470 **27p;** 1000 28p

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Push on/off (3A mains) 50
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1P12W 3P4W 4P3W

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4017	39	4070	18
4019	28	4071	18
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3mm red 9 5mm red 9
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3mm yellow 12 5mm yellow 12
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Rectangular, square, arrow or triangular (flat face)
Red 15 Green 18 Yellow 18
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LM348	55	TDA4290	1.98
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REGULATORS

78L05/12/15 30 7805/12/15 50
79L05/12/15 55 7905 55
Variable: LM723 40
LM338K(5A) 5.50
LM317T 85

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Based on the ICL 7126 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 0.1°C. The kit has a sensitivity of 200mV for a full scale reading automatic polarity and overload indication. Typical battery life of 2 years (PP3) £15.50

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PN13	Single Channel FM Transmitter	£9.80
PN14	Receiver for above	£15.50

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TS300K	Touch Switch	£7.75
TOE/K	2 way extension for above kits	£2.50
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MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	55p	66p	90p	150p
Right angle	90p	135p	200p	350p
Sockets solder lugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
Covers	100p	90p	100p	110p

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.

Plug chassis mounting	38p
Socket free hanging	60p
Socket with 2m lead	120p

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 15p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

27128-250 £7.50

Brand new Hitachi product. Ideal for use with the BBC Micro. Please note this price is not a misprint!!

TRANSFORMERS

3VA PCB Mounting
2x6V@0.25A;2x9V@0.15A
2x12V@0.12A;2x15V@0.1A 180p

6VA PCB Mounting
2x6V@0.5A;2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 270p

Standard. Chassis Mounting
6VA: 2x6V@0.5A; 2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 240p

12VA: 2x6V@1A; 2x9V@0.6A
2x15V@0.4A;2x20V@0.3A 350p

SOLDERING IRONS

Antex CS 17W Soldering iron	430
2.3 and 4.7mm bits to suit	85
Antex XS 25W soldering iron	530
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22 swg solder	100
0.5kg 22 swg solder	750

VERO

Verobloc	395
Veroboard Size 0.1 in matrix	
2.5 x 1	26
2.5 x 3.75	95
3.75 x 5	120
3.75 x 17	350
4.75 x 17	455
VQ board	190
Veropins per 100:	
Single sided	55
Double sided	65
Spot face cutter	145
Pin insertion tool	185
Wiring pen	375
Spare spool 75p	Combs 6

MICRO

		27128-250	750	6800	200	6522	330
		6116P3	390	6802	280	6532	520
		6264P15	2250	6809	600	6551	540
2716	310	4116P4	70	6810	140	8085A	320
2532	380	4164-15	480	6821	140	8156	380
2732 one time programmable	280	41256-15	2850	6840	360	8251	350
2732	430	Z80A CPU	290	6850	165	8253	370
2764-250	430	Z80A P10	320	6852	240	8255	320
2764 BBC	430	Z80A CTC	320	6875	500	8259	400
		Z80A S10	880	6880	100	MC1488	70
		Z80A DMA	880	6502	370	MC1489	70

CABLES

20 metre pack single core connecting cable ten different colours. 75p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way gery ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	45
LM317K	270	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	3	400mW zeners	6
		1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11

Clips to suit -3p each.

Rectangular:		TIL32	40
red	12	TIL111	60
green	17	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2N5777	45	Tri-color Led	35

Seven segment displays:

Com cathode.	Com anode.
DL704 0.3" 95	DL707 0.3" 95
FND5000.5"100	FND5070.5"100
10 bar DIL LED display, red 180	
5mm superbright LED 250mcd red 30	

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	65
▶12V Electronic buzzer	70
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	21
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

EURO CONNECTORS

Gold flashed contacts:	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

		400V 8A	65
		400V 16A	95
400V 4A	50	BR100	25

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CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p; 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p;

Tantalum bead:
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.

Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL	0.9A
1A 400V	35	200V	50

SOCKETS

	Low profile	Wire-wrap
8 pin	7p	28p
14 pin	8p	45p
16 pin	10p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	15p	75p
24 pin	17p	82p
28 pin	15p	95p
40 pin	25p	135p

Professional ZIF sockets
24 pin 430p 28 pin 480p
40 pin 595p

COMPONENT KITS

0.25W Resistor Kit. Contains 1000 0.25W 5% resistors from 4.7 ohms thru to 10M. Quantities depend upon popularity i.e. 10x10R, 30x470R, 30x10K, 25x470K. Just £7.90
Ceramic capacitor Kit. Total of 250 miniature ceramic capacitors from 22p to 0.1u. Just £6.90
Polyester capacitor Kit. Total of 110 miniature polyester capacitors from 0.01u to 0.47u. Just £6.90
Preset Kit. Total of 110 miniature preset resistors from 100R to 1M. Horizontal mounting type. Just £6.90
Radial Electrolytic Capacitor Kit. A pack containing a total of 93 miniature caps from 1u to 2200u Just £7.50
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COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 150
SPECTRUM 2 x 28 way edge connector wire wrap. 200
AMPHENOL PLUGS
24 way IEEE IDC. 450
36 way Centronix IDC 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang	Socket	Edge Conn.
10 way	70	70	70	–
16 way	75	80	80	–
20 way	90	90	95	130
26 way	105	110	115	155
34 way	115	130	130	180
40 way	140	140	145	210
50 way	165	165	170	240
60 way	195	195	200	–

LINEAR

		IC7611	98	LM358	50	LM3915	265	NE567	130
		ICL7621	190	LM377	210	LM13600	110	NE570	370
555CMOS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370
556CMOS	150	ICL8038	295	LM381	150	MC1496	70	NE5532	160
709	35	ICL8211A	220	LM382	130	MC3302	75	NE5534	105
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	85
748	35	ICM7555	80	LM386	90	MF10CN	330	RC4558	40
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250
CA3089	200	LMI0C	325	LM733	70	ML928	210	SP0256AL2	425
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	Speech data	50
CA3130E	85	LM311	45	LM747	80	NE529	225	TBA800	70
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65
CA3136	100	LM3342	85	LM2917N8	195	NE555	20	TBA950	220
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320
ICL7106	680	LM348	60	LM3914	265	NE566	140	TDA1022	490

TDA1024	115
TL061	40
TL062	65
TL064	105
TL071	38
TL072	60
TL074	110
TL081	30
TL082	50
TL084	105
TL170	50
UA2240	140
ULN2003	80
ULN2004	80
XR2206	365
ZN414	80
ZN423	135
ZN424P	130
ZN425E	350
ZN426E	300
ZN427E	600
ZN428E	450
ZN459	285
ZN1034E	200

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed.

CRYSTALS

100KHz	235	4.194MHz	150
1MHz	275	4.43MHz	100
1.8432M	200	5.008MHz	140
2.0MHz	225	6.0MHz	140
2.4576M	200	6.144MHz	150
3.276M	150	7.0MHz	150
3.579M	95	8.0MHz	140
4.0MHz	140	10.0MHz	170
		12.0MHz	170
		16.0MHz	200

BOXES

	Aluminium
	3 x 2 x 1" 65
Plastic with lid	4 x 2¾ x 1⅛" 95
& screws	4 x 2¾ x 2" 95
71x46x22mm	50 6 x 4 x 2" 120
95x71x35mm	86 7 x 5 x 2½" 165
140x90x55mm	140 8 x 6 x 3" 205

TRANSISTORS

			BC548	5	BFR40	23	2N1613	30	2N3906
			BC549	10	BFR80	23	2N2218A	45	2N4037
			BC557	10	BFR81	23	2N2219A	28	2N4058
AC125	35	BC158	11	BC558	10	BFX29	30	2N2221A	25
AC126	30	BC158	10	BCY70	16	BFX84	30	2N2222A	20
AC127	30	BC159	10	BCY71	16	BFX85	30	2N2368	25
AC128	30	BC160	40	BCY72	16	BFX86	30	2N2369	18
AC176	25	BC168C	10	BD115	55	BFX87	30	2N2484	27
AC187	25	BC169C	10	BD131	40	BFX88	30	2n2646	60
AC188	25	BC170	8	BD132	40	BFY50	27	2N2904	28
AD142	120	BC171	10	BD133	50	BFY51	27	2N2904A	28
AD161	42	BC172	8	BD135	35	BFY52	27	2N2905	28
AD162	42	BC177	16	BD136	35	BFY53	30	2N2905A	28
AF124	60	BC178	16	BD137	35	BFY55	30	2N2906	28
AF126	50	BC179	18	BD138	35	BFY56	30	2N2906A	28
AF139	40	BC182	10	BD139	35	BRY39	50	2N2907	24
AF186	70	BC182L	10	BD140	35	BSX20	22	2N2907A	24
AF239	55	BC183	10	BD204	110	BSX29	35	2N2926	10
BC107	10	BC183L	10	BD206	110	BSY95A	30	2N3053	28
BC107B	12	BC184	10	BD222	85	BU205	160	2N3054	55
BC108	10	BC184L	10	BF180	35	BU206	200	2N3055	50
BC1088	12	BC212	10	BF182	35	BU208	170	2N3442	120
BC108C	12	BC212L	10	BF184	35	MJ2955	99	2N3702	9
BC109	10	BC213	10	BF185	25	MJE340	50	2N3703	10
BC109C	12	BC213L	10	BF194	12	MJE520	50	2N3704	9
BC114	22	BC214	10	BF195	12	MJE521	90	2N3705	10
BC115	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10
BC117	22	BC237	7	BF197	12	MPF102	40	2N3707	10
BC119	35	BC238	7	BF198	15	MPF104	40	2N3708	10
BC137	40	BC308	10	BF199	18	MPSA05	23	2N3709	10
BC139	38	BC327	8	BF200	35	MPSA06	25	2N3772	170
BC140	29	BC328	8	BF244B	35	MPSA12	29	2N3773	195
BC141	30	BC337	8	BF245	35	MPSA55	30	2N3819	32
BC142	28	BC338	12	BF256B	45	MPSA56	30	2N3820	50
BC143	30	BC477	22	BF257	32	MPSU05	55	2N3823	65
BC147	10	BC478	22	BF258	30	MPSU06	55	2N3866	90
BC148	10	BC479	22	BF259	30	MPSU55	55	2N3903	10
BC149	10	BC517	30	BF337	35	MPSU56	55	2N3904	10
BC157	11	BC547	5	BFR40	35	2N118L	22	2N3905	10

2N1613	30	2N3906	10
2N2218A	45	2N4037	45
2N2219A	28	2N4058	10
2N2221A	25	2N4060	10
2N2222A	20	2N4061	10
2N2368	25	2N4062	10
2N2369	18	40360	40
2N2484	27	40361	50
2n2646	60	40362	50
2N2904	28	40408	50
2N2904A	28	2N5457	30
2N2905	28	2N5458	30
2N2905A	28	2N5459	30
2N2906	28	2n5485	35
2N2906A	28	2N5777	45
2N2907	24	2N697	20
2N2907A	24	2N698	40
2N2926	10	2N706A	20
2N3053	28	2N708	25
2N3054	55	2N918	35
2N3055	50	TIP29	35
2N3442	120	TIP29A	35
2N3702	9	TIP29B	35
2N3703	10	TIP29C	35
2N3704	9	TIP30	35
2N3705	10	TIP30A	35
2N3706	10	TIP30B	35
2N3707	10	TIP30C	40
2N3708	10	TIP31A	35
2N3709	10	TIP31B	35
2N3772	170	TIP31C	40
2N3773	195	TIP32A	35
2N3819	32	TIP32B	38
2N3820	50	TIP32C	40
2N3823	65	TIP33A	65
2N3866	90	TIP33C	75
2N3903	10	TIP34A	70
2N3904	10	TIP34C	80
2N3905	10	TIP35A	105

TIP35C	125		
TIP36A	115		
TIP36C	130		
TIP41A	45		
TIP42A	45		
TIP120	60		
TIP121	60		
TIP122	60		
TIP141	110		
TIP142	120		
TIP147	120		
TIP2955	70		
TIP3055	60		
TIS43	40		
TIS43	40		
TIS44	45		
TIS45	45		
TI590	30		
TI591	30		
VN10KM	65		
VN66AF	94		
VN66AF	110		
VN88AF	120		
ZTX107	11		
ZTX108	11		
ZTX109	11		
ZTX300	14		
ZTX301	16		
ZTX302	16		
ZTX304	20		
ZTX341	20		
ZTX500	13		
ZTX501	18		
ZTX502	18		
ZTX503	18		
ZTX504	25		

TTL

			7412	25	7440	25	7476	40	74107	40	74157	80	74180	85
			7413	36	7442	74	7480	50	74109	60	74160	90	74181	230
			7414	60	7444	105	7483	65	74121	50	74161	90	74182	85
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120
7402	25	7420	25	7448	98	7489	170	74125	50	74164	115	74192	120
7403	25	7421	30	7450	25	7490	55	74126	50	74165	90	74193	110
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80		
7411	26	7438	45	7475	55	74100	125	74154	135	74179	90		

CMOS

			4016	26	4034	145	4054	70	4081	18	4502	50	4529	80
			4017	43	4036	270	4055	70	4082	20	4503	45	4532	65
			4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	18		4019	35	4040	46	4060	70	4086	60	4508	115	4538	70
4001	18		4020	48	4041	55	4063	80	4089	120	4510	48	4543	65
4002	18		4021	55	4042	45	4066	24	4093	26	4511	50	4549	390
4006	65		4022	60	4043	45	4067	230	4094	70	4512	50	4553	215
4007	18		4023	18	4044	50	4068	18	4095	70	4514	115	4555	50
4008	50		4024	35	4046	60	4069	18	4097	260	4515	115	4556	50
4009	40		4025	18	4047	52	4070	22	4098	70	4516	48	4559	390
4010	40		4026	120	4048	50	4071	18	40106	38	4518	48	4560	110
4011	18		4027	28	4049	26	4072	18	40109	100	4520	48	4584	38
4012	18		4028	40	4050	26	4073	18	40163	75	4521	110	4585	65
4013	26		4029	45	4051	48	4075	24	40173	100	4526	70	4724	140
4014	50		4030	18	4052	48	4076	60	40175	75	4527	60		
4015	42		4031	125	4053	60	4077	24	40193	90	4528	45		

LS TTL

			LS20	22	LS75	38	LS123	70	LS161	60	LS221	78	LS365	42
			LS21	22	LS76	28	LS125	37	LS162	60	LS240	105	LS366	42
			LS22	22	LS78	28	LS126	37	LS163	60	LS241	80	LS367	42
LS00	22		LS26	22	LS83	68	LS132	53	LS164	70	LS242	80	LS368	42
LS01	22		LS27	22	LS85	82	LS136	35	LS165	95	LS243	80	LS373	80
LS02	22		LS30	22	LS86	35	LS138	48	LS166	88	LS244	80	LS374	80
LS03	22		LS32	22	LS90	40	LS139	48	LS170	120	LS245	88	LS375	55
LS04	22		LS37	22	LS92	50	LS145	92	LS173	80	LS247	77	LS377	100
LS05	22		LS38	22	LS93	45	LS147	130	LS174	60	LS251	55	LS378	88
LS08	22		LS40	22	LS95	58	LS148	115	LS175	60	LS257	55	LS390	82
LS09	22		LS42	60	LS96	120	LS151	55	LS190	75	LS258	55	LS393	82
LS10	22		LS47	78	LS107	42	LS153	80	LS191	55	LS259	90	LS399	115
LS11	22		LS48	78	LS109	42	LS154	220	LS192	75	LS266	28	LS541	115
LS12	22		LS51	22	LS112	42	LS155	55	LS193	75	LS273	80	LS670	170
LS13	35		LS55	22	LS113	32	LS157	48	LS195	60	LS279	55		
LS14	45		LS73	28	LS114	32	LS158	48	LS196	75	LS283	70		
LS15	22		LS74	28	LS122	56	LS160	60	LS197	75	LS353	85		

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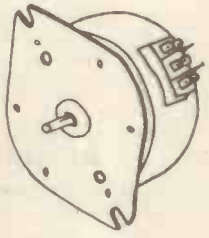

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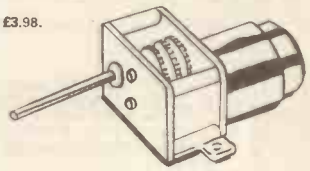

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EVERYDAY ELECTRONICS and computer PROJECTS

VOL 14 No6 JUNE '85

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We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by **a stamped self-addressed envelope** or a **self-addressed envelope and international reply coupons.**

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IDEAS

As I have said before, this is your magazine and your ideas and comments are always valued. We often get interesting views on our contents, from committed hobbyists, from advertisers and teachers and together they help to shape the future developments of the magazine.

One area where you can contribute directly to the contents is *Circuit Exchange*, this feature is for your circuit ideas. I should point out that we are looking for new ideas, not just a copy of someone else's circuit. At present we pay £40 per magazine page for any ideas published, so good ones could pay for a couple of projects. Keep them coming in—there are a few in this issue to give you the idea of just what we are after.

TEACH IN

We are continually being asked for back numbers on the last Teach-In series and unfortunately we are no longer able to supply them all. We would however like to point out that it is now only four months before the start of *Teach-In '86* which will continue the tradition of top quality beginners series established by EE over the last fourteen years. The series will be linked to a number of projects and will be backed by software for the BBC and Spectrum—although it will not be essential to use this.

ACTUALLY DOING IT

In addition to *Teach-In '86* we are about to introduce a new page giving the low-down on actually building projects for all those who are still a little hesitant to take up the soldering iron. These two items will be augmented by a building blocks series which will follow a simple systems approach to building projects of your own design around various circuit blocks. Each circuit block will be fully described and we will provide all the necessary constructional details. The series will also be helpful to AEB 'O' level students.

Whatever your level of knowledge and sophistication in electronics, EE will have something of interest.

Mike Kenward

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GRAPHIC EQUALISER

R.A.PENFOLD

PROBABLY most readers are familiar with graphic equalisers, as they are now relatively commonplace, and are sometimes incorporated in pieces of equipment such as stereo cassette radios and rack audio systems. The original purpose of a graphic equaliser was to enable any peaks or troughs in the frequency response of the overall system to be ironed out. In particular, compensation could be made to counteract any variations in the frequency response caused by the characteristics of the listening room itself. In order to do this effectively a complex circuit having a dozen or more bands is necessary, and ideally some quite sophisticated test equipment would also be used.

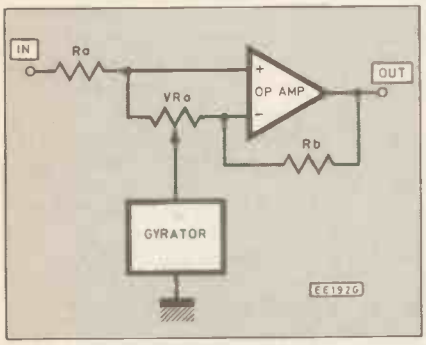


Fig. 1. The basic arrangement of frequency control.

A more recent application for a graphic equaliser is as a sort of musical effects unit. Here the idea is to adjust the controls to modify the sound of an instrument (usually an electric guitar) and give the required sound, rather than to compensate for room accoustics or other frequency response problems. For example, a graphic equaliser can easily act as a bass or treble booster, and gives excellent control over the effect produced. Better in fact, than most bass and treble booster units. Even a fairly simple graphic equaliser enables a wide range of effects to be obtained.

SPECIFICATION

This design has six equaliser controls with centre frequencies at approximately 50Hz, 150Hz, 500Hz, 1·5kHz, 5kHz, and 15kHz. With controls at the extremes of the audio spectrum and four at intermediate frequencies this gives good results with an electric guitar or other electronic instruments. With just six bands it is less than ideal for use with an audio system, but could be used as a sort of super tone control if desired, but two units would be needed for stereo operation, one to process each channel.

CIRCUIT OPERATION

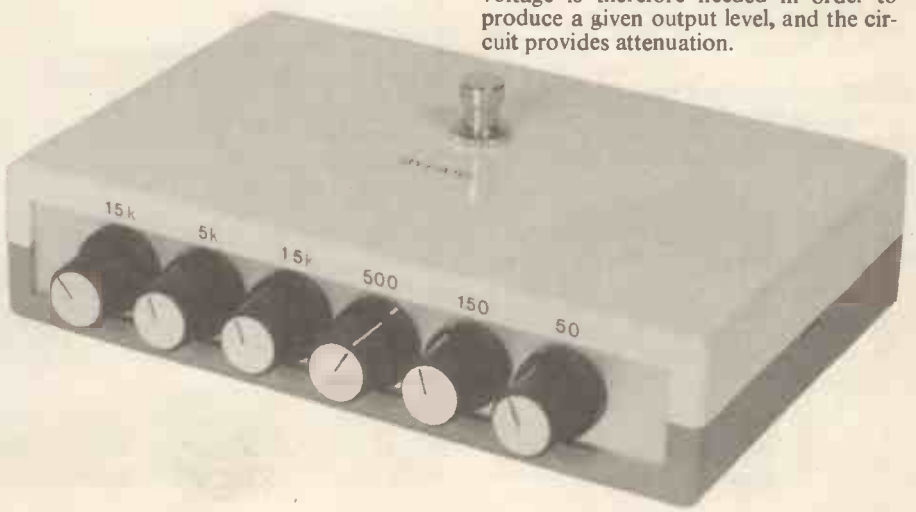
The unit has been kept as simple as possible, and is based on a totally conventional gyrator design. The basic idea is to use gyrators to simulate ordinary L-C tuned circuits, thus avoiding the need for the very large inductors that would otherwise be needed to produce bandpass filters having suitably low resonant frequencies. This gives a substantial saving in cost, as well as enabling easy to obtain components to be used throughout the design. Fig. 1 shows the basic arrangements used in the unit.

Although the operational amplifier has a rather unusual feedback arrangement, it is not very complex in operation. Ra and Rb are of equal value in a practical design, and at resonance the gyrator has a low impedance. If we consider the circuit with the slider of VRa at the centre of its track, a positive voltage applied to the input will take the non-inverting (+) input positive of the inverting (—) input. Feedback via Rb will try to counteract this in normal operational amplifier fashion, so as to maintain the two inputs at precisely the same voltage. Due to the symmetry of the circuit the output of the amplifier must go to the same potential as the input in order to maintain this balance. This is true regardless of the impedance provided by the gyrator, and it is essential to the correct operation of the circuit that there is always unity gain with the slider at the centre of its track.

With the slider moved towards the inverting input of the operational amplifier the symmetry of the circuit is upset. If we assume that the gyrator is at resonance and has a low impedance, the potential divider action across Rb and the gyrator results in only a small fraction of the output voltage reaching the inverting input. On the other hand, the coupling from the input to the non-inverting input is no worse than before, and is actually somewhat better due to the increased resistance to earth through the large portion of VRa's track and the gyrator. Accordingly, the output has to swing to a much greater potential in order to maintain the input voltage balance, and the input signal is boosted.

Of course, at frequencies where the gyrator is not at resonance and its impedance is very high it is effectively not in circuit. As VRa has a value which is low in comparison to that of Ra and Rb the symmetry of the circuit is only marginally affected, as is its voltage gain.

Moving the wiper of VRa to the other end of the track has the opposite effect. The potential divider action across Ra and the (resonant) gyrator gives a relatively poor coupling from the input to the non-inverting input of the operational amplifier. However, there is slightly reduced voltage drop from the output to the inverting input since the full track resistance of VRa is in series with the gyrator as far as this signal path is concerned. A relatively large input signal voltage is therefore needed in order to produce a given output level, and the circuit provides attenuation.



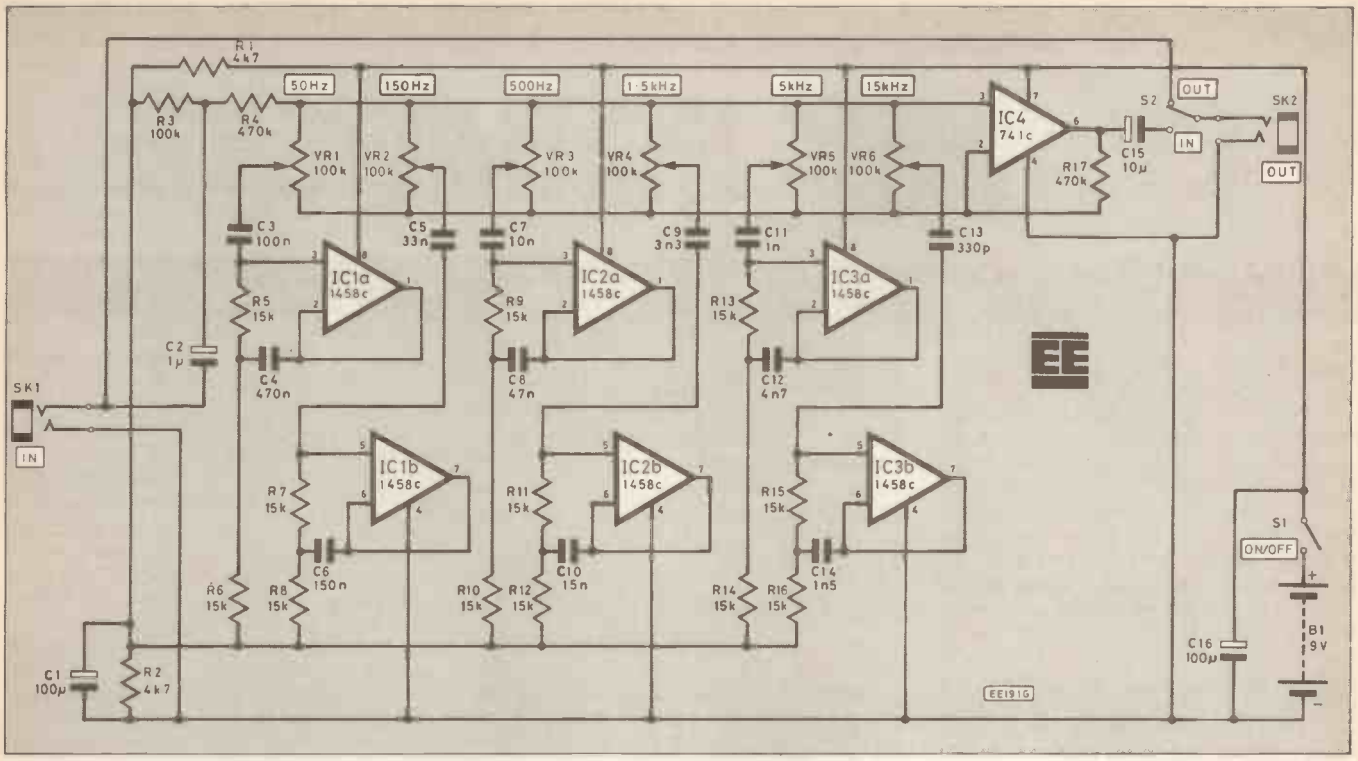


Fig. 2. The complete circuit diagram of the Graphic Equaliser.

Again, if the gyrator is off-resonance and has a high impedance it does not have any significant affect on the circuit, which consequently still has approximately unity voltage gain.

PRACTICAL CIRCUIT

The full circuit diagram of the unit appears in Fig 2, and IC4 is the operational amplifier at the heart of the unit. R4 corresponds to Ra of Fig. 1, while R17 is the practical equivalent of Rb. C2 and C15 are d.c. blocking capacitors at the input and output of the unit. R1, R2 and C1 produce a centre tap on the supply so that a single 9 volt battery supply can be used, and the need for two batteries to provide a dual balanced supply is avoided.

In Fig. 1 only a single gyrator and potentiometer are shown, but in practice several potentiometers connected in parallel (VR1 to VR6) are required, with each one having its slider feeding into a separate gyrator circuit. This produces little interaction between the various gyrator/potentiometer stages since each gyrator only has a low impedance over its own frequency band, and has a very high impedance at the centre of any other bands. Interaction is not totally absent, but out of band, each control affects the gain of the unit by a relatively small amount, and in practice this type of circuit gives excellent results.

Although each gyrator is extremely simple, using just a single operational amplifier plus two resistors and two capacitors, this type of circuit is quite complex in the way that it operates. However, the basic scheme of things is to have the operational amplifier, one capacitor, and the two resistors to simulate an inductor, which is then connected in series with the remaining capacitor. This gives what is effectively a conventional series L-C tuned circuit, which provides the required low impedance at or near resonance and a high impedance at other frequencies.

The maximum degree of boost and cut is about 15dB, and the sample frequency response of Fig. 3 was obtained using full boost at 150Hz, maximum cut at 5kHz, and the other controls set for about unity voltage gain.

S2 can be used to bypass the unit and switch out the filtering when it is not required. In practice this is a heavy duty push button type so that it can be

COMPONENTS

Resistors

R1,R2	4k7 (2 off)
R3	100k
R4,R17	470k (2 off)
R5-R16	15k (12 off)

All resistors ¼W 5% carbon film

Potentiometers

VR1-6	100k lin. carbon (6 off)

Capacitors

C1,C16	100µ 10V radial elect (2 off)
C2	1µ 63V radial elect
C3	100n carbonate
C4	470n carbonate
C5	33n carbonate
C6	150n carbonate
C7	10n carbonate
C8	47n carbonate
C9	3n3 carbonate
C10	15n carbonate
C11	1n carbonate
C12	4n7 carbonate
C13	330p ceramic plate
C14	1n5 carbonate
C15	10µ 25V radial elect

Semiconductors

IC1-3	1458C dual op amps (3 off)
IC4	741C op amp

Miscellaneous

S1	Part of SK1
S2	SPDT heavy duty push button type
SK1	Standard jack with SPST contacts (S1)
SK2	Standard jack
B1	9 volt (PP3 size)

Case, 180 by 120 by 39mm, printed circuit board EE8506–01, battery connector, small control knobs with pointer line (6 off), 8 pin d.i.l. i.c. holders (4 off), wire, solder, etc.

See Shop Talk page 312

Approx. cost Guidance only **£12**

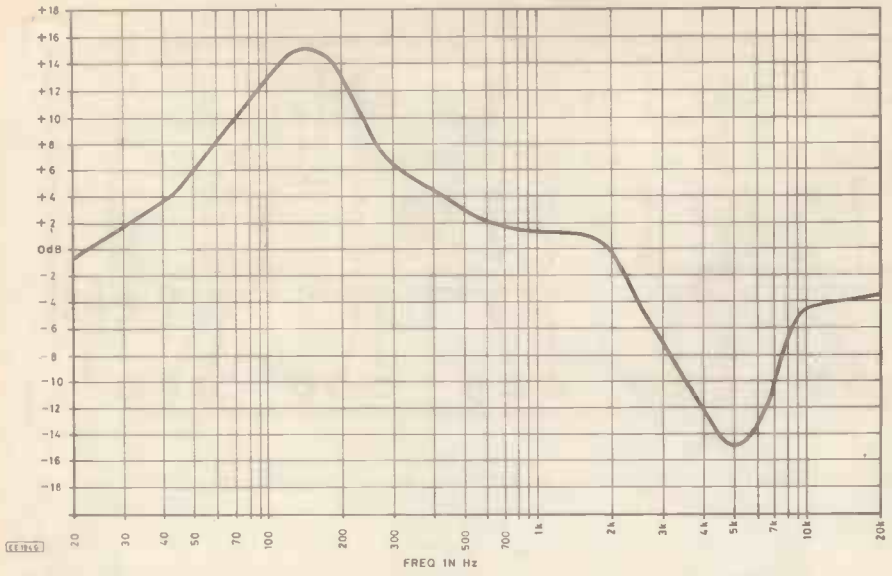


Fig. 3. A sample frequency response obtained from the Graphic Equaliser.

operated by foot. S1 is the on/off switch, and on the prototype this is a set of normally open contacts fitted to the input socket, SK1.

The unit is therefore automatically switched on when the plug is inserted into SK1, and switched off again when it is removed. Of course, S1 can be an ordinary switch such as a toggle or push button type if preferred. The current consumption of the circuit is approximately 5·5mA, and a small 9V battery is adequate as the power source.

CONSTRUCTION

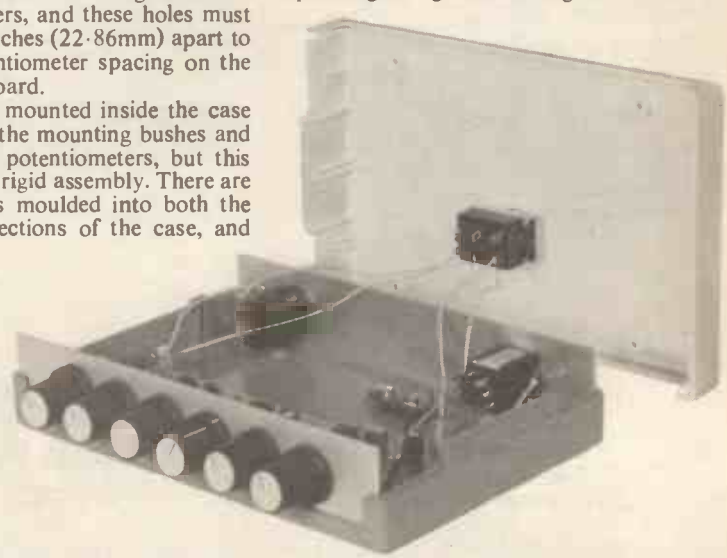
The unit is most easily constructed using printed circuit mounting rotary potentiometers as these can be mounted direct onto the printed circuit board. Details of the p.c.b. and component layout are provided in Fig. 4 and Fig. 5. An alternative is to hard wire ordinary (tag connection) rotary or slider type potentiometers to the board. If this method of construction is used it is important to keep the connecting leads reasonably short. It will be assumed here that the unit is built using rotary printed circuit mounting potentiometers, but it is obviously not difficult to modify construction to suit other types if desired.

Construction of the board is very straightforward, but make sure that each potentiometer is pushed right down into position before soldering it in place, using a generous amount of solder. Construction of the board will probably be easiest if the potentiometers are fitted last. It is advisable to use the carbonate capacitors where specified in the components list as these have a suitably close (5%) tolerance for this application, and the lead spacing on the printed circuit has been designed to suit this particular type of capacitor. The use of radial (vertical mounting) electrolytics rather than vertically mounted axial types will give a neater finish, and a board of greater resilience. Connect single-sided pins to the board at the points where connections to the sockets and switches will be made.

PLASTIC CASE

A 180 by 120 by 39mm plastic Verocase having aluminium front and rear panels makes an attractive and adequately tough housing for this application. The front panel must be drilled with six 10mm diameter mounting holes for the potentiometers, and these holes must be spaced 0.9 inches (22·86mm) apart to match the potentiometer spacing on the printed circuit board.

The board is mounted inside the case only by way of the mounting bushes and nuts of the six potentiometers, but this produces a very rigid assembly. There are mounting pillars moulded into both the top and base sections of the case, and some of these will almost certainly obstruct the potentiometers and the board. This problem can be overcome by carefully drilling away the offending mounting pillars using a drill of about 9mm in diameter. Due to the restricted height of the case it might also be necessary to trim off the ends of the potentiometer's pins, which with most components protrude well beyond the surface of the board.



Internal details of the Graphic Equaliser showing hardware mounting positions.

SOCKETS

SK1 and SK2 are fitted at opposite ends of the rear panel. S2 must obviously be mounted on the top panel of the case so that it can be foot operated. Note that this component must be a heavy duty type as an ordinary push button switch is unlikely to be physically strong enough to withstand repeated operation by foot.

It might be difficult to obtain a single pole changeover heavy duty push button switch, but one pole of a double pole type can be used if a single pole type should prove to be elusive. Be careful to position this switch over a vacant part of the case. Otherwise, due to the very limited height of the case, it will probably prove to be impossible to fit the lid into position. The unit is completed by adding the small amount of hard wiring, as detailed in Fig. 5.

IN USE

In use the unit simply fits between the guitar or whatever other instrument is being used, and the amplifier. Standard jack leads are used to carry the input and output connections. As explained earlier, the unit is automatically switched on when a plug is inserted into SK1, and switched off again when the plug is removed.

The unit can introduce large irregularities into the frequency response of a system, and experimenting with the controls should soon determine whether or not the circuit is functioning correctly. Provided the instrument producing the input signal generates signals over a reasonably wide frequency range it will be possible to considerably alter its sound. However, bear in mind that controls which operate below the fundamental frequency of the input signal can not have any significant effect on the output signal. For instance, if the instrument is generating a note at 300Hz plus harmonics throughout the part of the audio range above this frequency, the 500Hz, 1·5kHz, 5kHz and 15kHz controls will

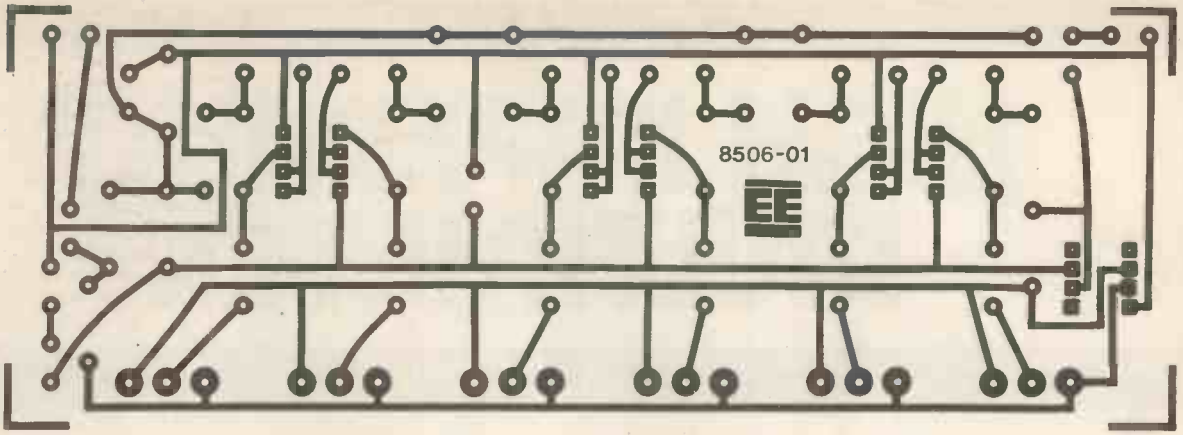


Fig. 4. The p.c.b. design of the Graphic Equaliser. This board is available from the *EE PCB Service,* code 8506-01.

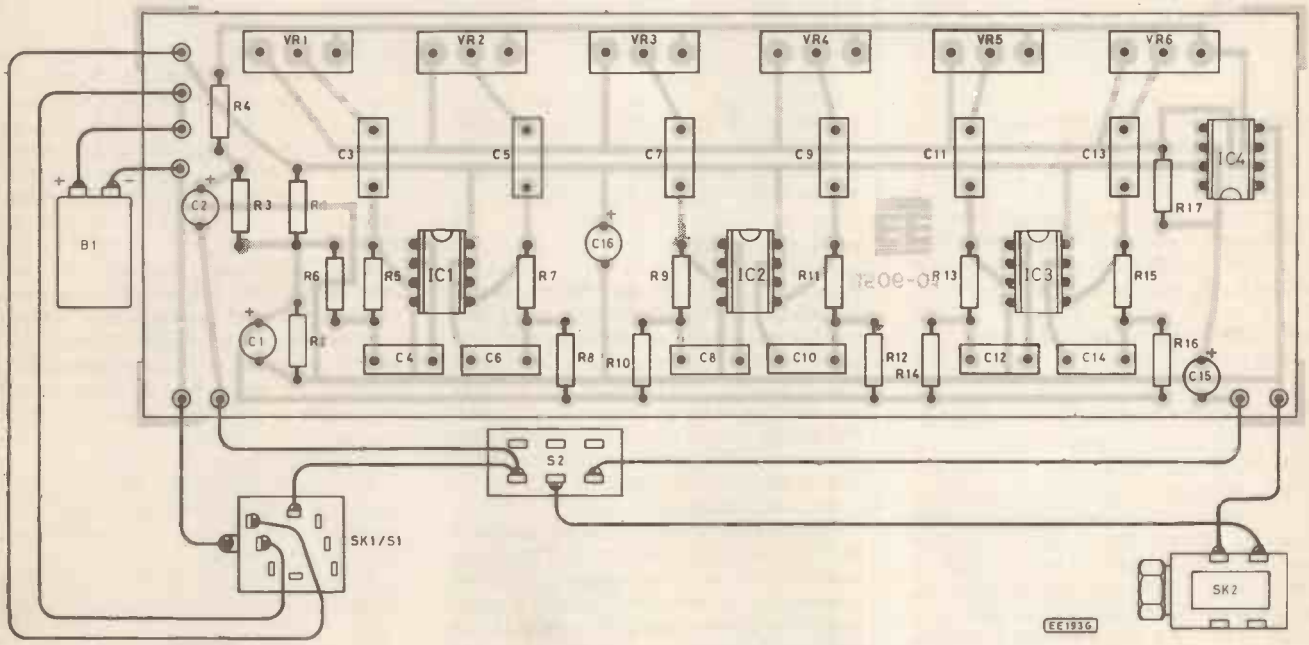
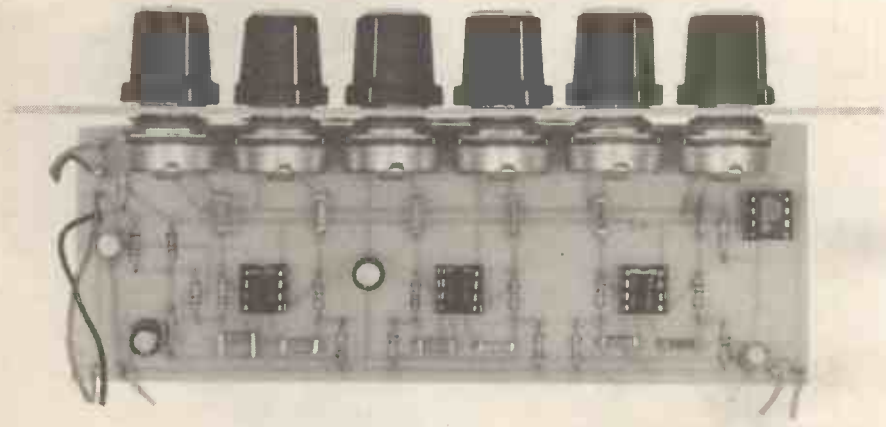


Fig. 5. Component layout and wiring diagram of the Graphic Equaliser.



Component and potentiometer mounting details.

be effective. There will be no output at frequencies below the 300Hz fundamental, rendering the 50Hz and 150Hz controls ineffective.

When using any form of high frequency tone control it is necessary to bear in mind that a large amount of boost can produce excessive powers for the tweeters in some loudspeakers. This is more likely to be a problem with hi-fi loudspeakers than with types intended for the reproduction of electronic music.

The circuit does not have a very high noise level, and an excellent signal to noise ratio will be obtained using an input level of about 200mV peak to peak or more. The maximum amplitude that can be handled without clipping occurring is about 4V peak to peak. □

HIGH IMPEDANCE MULTIMETER

L.S.COOK

WHEN measuring voltages using a conventional multimeter, the meter itself requires some current for its operation. If this is substantially greater than the current flowing in the circuit under test, the voltage levels are significantly altered when the meter is connected and a misleading reading is obtained. Even the once-popular 20kΩ/V meter requires too much current for a circuit involving just a few microamperes.

The meter featured here has an input impedance to suit almost all applications where low-level d.c. voltages and currents are to be measured. It is designed mainly for experimental work, such as investigating the characteristics of devices.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. Apart from the two highest ranges, the high impedance for voltage measurement is provided by the LF441 op-amp (IC1). This is similar to the popular 741, but has an input impedance of 1TΩ (1 Teraohm = 10^{12} ohms), and draws a much lower current, a point strongly in its favour if small batteries are used. This i.c. has JFET inputs and needs no special handling precautions unlike many MOS devices.

The meter winding, together with R26 and R27, provides a total resistance of 50kΩ so a potential of 2·5V across these produces a current of 50μA through the meter. The meter specified is a 50μA full-scale deflection type with an internal resistance of 1·4kΩ. A different type can be employed with the value of R26 and R27 modified to obtain full-scale deflection at 2·5V.

The different voltage ranges are obtained by varying the gain of IC1, which is used in the non-inverting mode; the basic arrangement for this is shown in Fig. 2. R18 to R25 (Fig. 1) constitute R_A and R_B (Fig. 2) and switch S1c taps this resistance chain at selected points to vary the gain. For example, with S1c in the position indicated, $R_B = 250\Omega$, $R_A + R_B = 25k\Omega$, so gain =

$$\frac{25000}{250} = 100$$

Therefore for an output of 2·5V the input must be 25mV, since input voltage × gain = output voltage.

Diode D1 prevents the meter attempting to swing negative which would occur if the input were incorrectly polarised or left floating. With the output taken from the cathode of D1, the calculation of gain is unaffected by the inclusion of this diode. C1 improves the stability of the circuit.

Table 1 shows the voltage ranges available, and the corresponding gains of IC1. For the 10V and 25V ranges, the input is taken to a chain of resistors totalling 100mΩ with a tap at 10mΩ providing up to 1V or 2·5V respectively at this point. The voltage is then applied to the main circuit on the 1V or 2·5V range with S1a carrying out the necessary switching. R11 prevents high currents flowing through IC1 in the event of an excessive voltage being applied at the input; this could be destructive if the polarity was reversed. Compared with the high impedance of IC1, the drop across R11 is negligible. VR1 provides a means for zero-setting as explained later.

Current measurements are made by placing shunts across the input, comprising R12 to R17. In order to keep the voltage drop to a minimum the highest gain setting is used for IC1 where practicable, this being selected by switch S1d which is brought into play by S2b. The values of R12 to R17 are chosen to provide the ranges shown in Table 2. For example, with S1b and S1d set as shown, gain =

$$\frac{25000}{25} = 1000$$

so the voltage across the input for full-scale deflection is

$$\frac{2{\cdot}5}{1000} = 2{\cdot}5\text{mV}$$

The resistance across the input is 25Ω, hence the current required for full-scale deflection is

$$\frac{2{\cdot}5}{25} \times 10^{-3} = 100\mu\text{A}$$

Table 1: Voltage ranges and op-amp gain

Range	Gain
2·5mV	1000
10mV	250
25mV	100
100mV	25
250mV	10
1V	2·5
2·5V	1
10V	2·5
25V	1

Table 2: Current measurement and voltage drop

Range	Voltage drop
10μA	2·5mV
25μA	2·5mV
100μA	2·5mV
250μA	2·5mV
1mA	2·5mV
2·5mA	2·5mV
10mA	10mV
25mA	25mV
100mA	100mV

CONSTRUCTION

Many of the resistors are mounted directly on S1, a 4-pole 9-way rotary switch. The connections to this switch are indicated in Fig. 4 with each section (pole) shown separately for clarity: the actual "Makaswitch" has two wafers each containing two poles, one each side of each wafer. It requires close scrutiny to obtain a thorough understanding of its operation, and this is essential before attempting the wiring.

Two small pieces of 0·1 inch matrix stripboard are required for the remaining

The multimeter has a JFET input to provide the very high impedance.

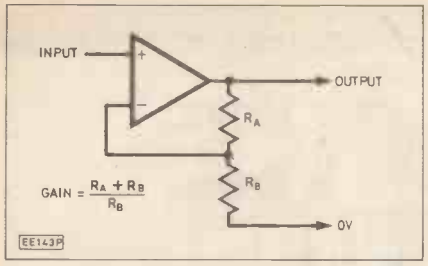


Fig. 2. Basic op-amp circuit.

small components, one of them holding the 10MΩ resistors. These are shown in Fig. 3. Attach a plug to one end of each test lead and an alligator clip to the other.

CASE

A plastic console-style case with appropriate dimensions is suitable; alternatively, a case can be made from 3mm plywood and covered with plastic fabric. The prototype, shown in the photograph, has a plywood case. Small wooden blocks glued inside the vertical corners enable a base panel to be screwed on. The circuit boards can be fixed in position using small screws and insulated spacers if necessary.

METER SCALE

The meter is likely to have a scale reading up to 50μA. This can be replaced by a scale showing markings up to 10 and 25.

Carefully remove the transparent cover and stick a piece of white card or plastic adhesive film over the scale, having first cut out an area corresponding to the position of the graduations on the original scale. Add the numbers using dry transfers.

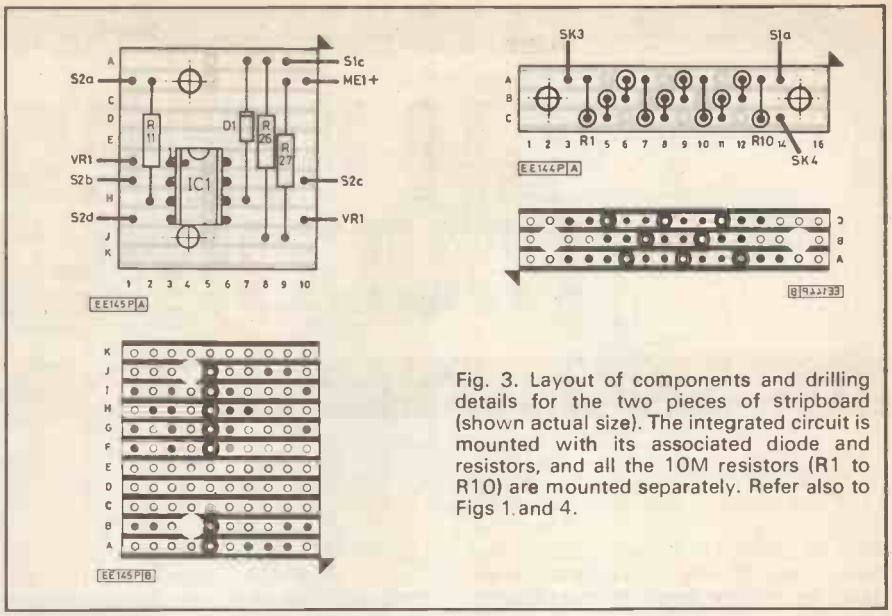


Fig. 3. Layout of components and drilling details for the two pieces of stripboard (shown actual size). The integrated circuit is mounted with its associated diode and resistors, and all the 10M resistors (R1 to R10) are mounted separately. Refer also to Figs 1 and 4.

POWER SUPPLY

A dual power supply is required: the i.c. will operate from ±3V to ±18V, but obviously the higher the supply voltage, the higher will be the meter current in the event of overload. Two PP3 batteries are ideal and can be held in place by stiff wire fastened by the meter fixing screws.

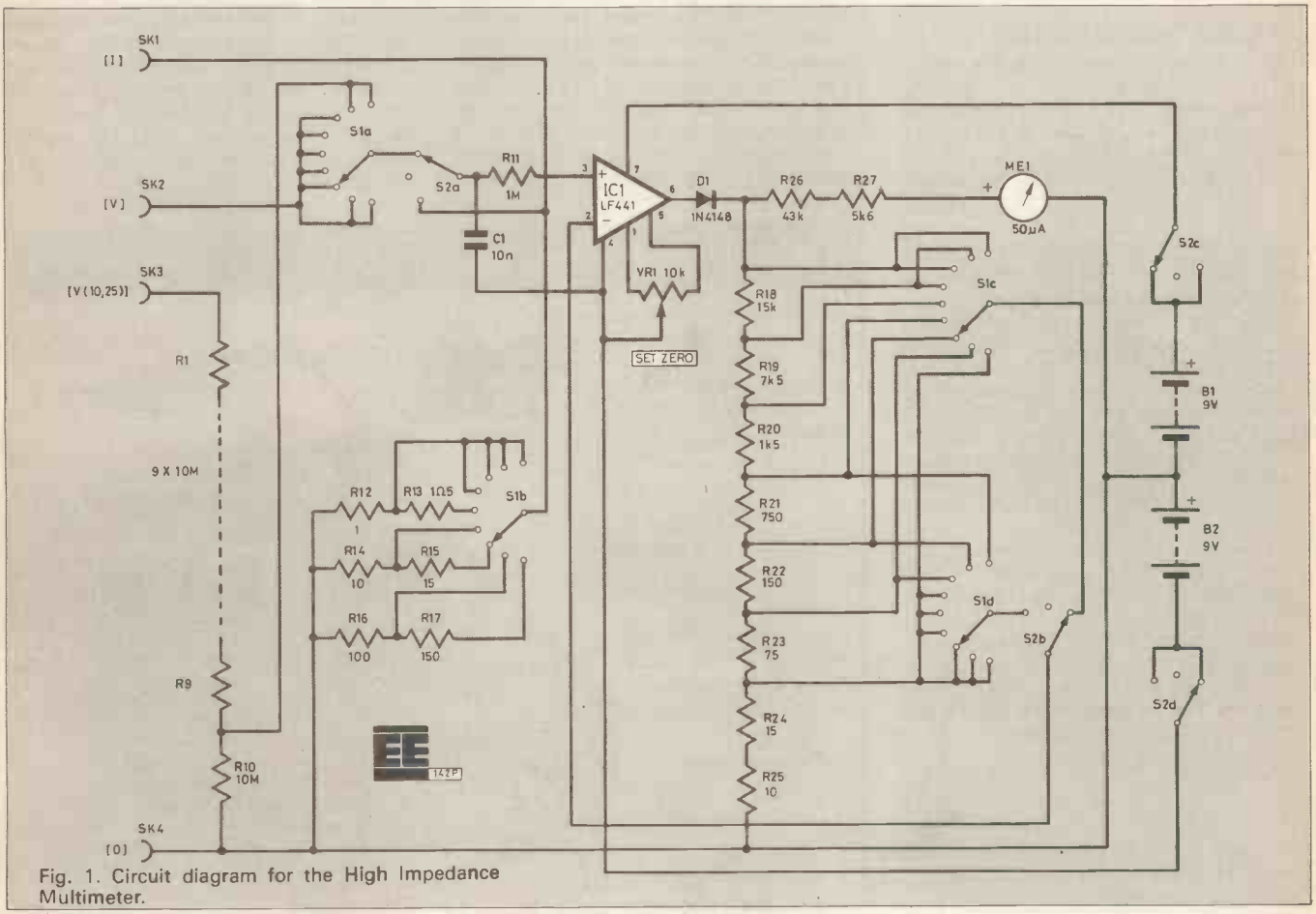
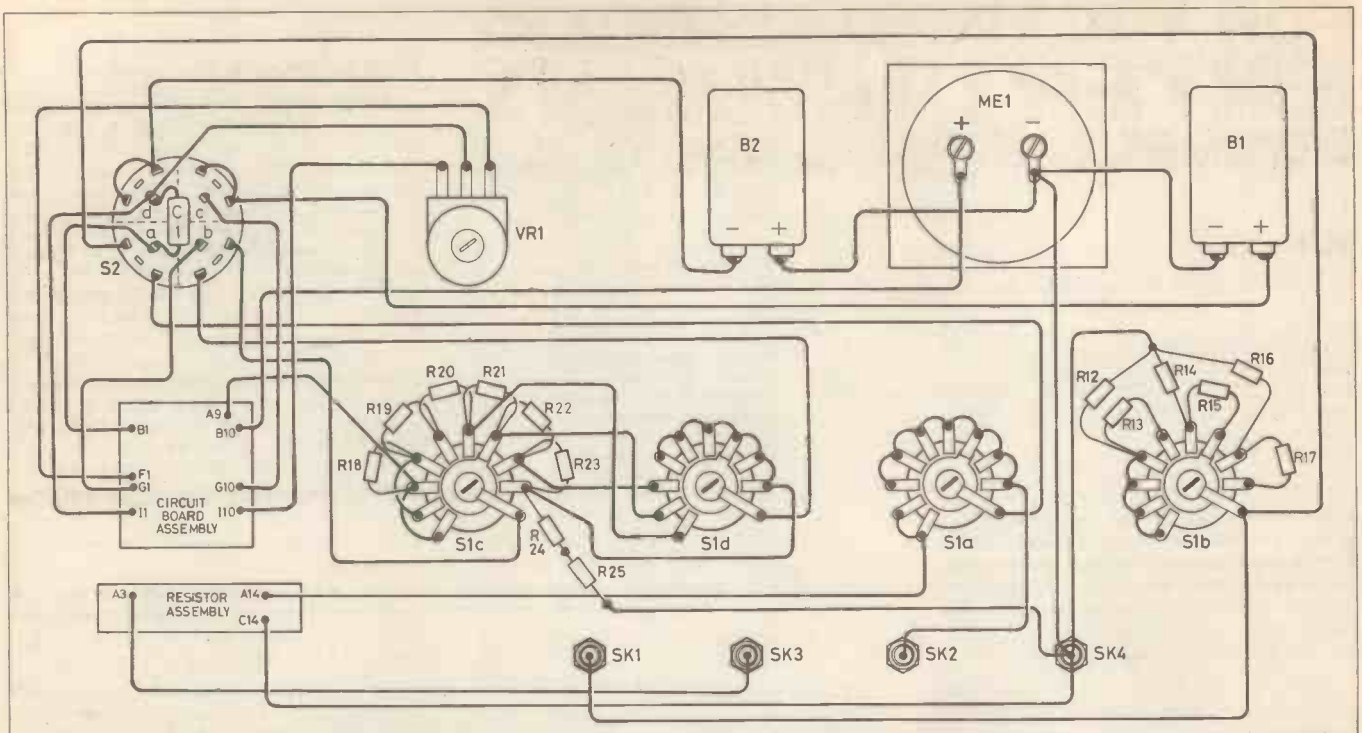


Fig. 1. Circuit diagram for the High Impedance Multimeter.



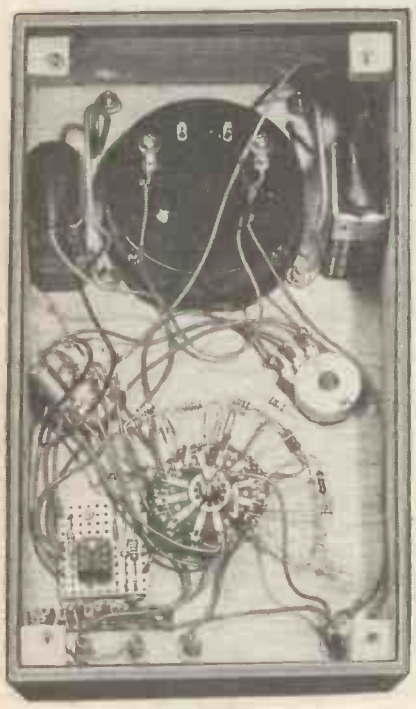
EE146P Fig. 4. Interwiring details, viewed from the back. The four poles of S1 are exploded for clarity: S1c is nearest the front (knob), and S1b is nearest to the back. The photograph below shows the interwiring of the prototype.

TESTING AND USING

Although calibration should not be necessary it is wise to check performance against an existing meter if possible. Voltage and current readings for all ranges should be checked, with the meters connected in parallel for voltage readings and in series for current. The impedance of the existing meter is of no great importance.

When using the meter try to avoid touching the positive connection as this can cause the output of the op-amp to swing to maximum. It may be advisable to switch on only when the connections have been made.

To set zero correctly, select the lowest voltage range and with the test leads plugged into the 'V' and 'O' sockets, connect both clips together. With VR1 towards the clockwise limit a reading will be shown on the meter. Turn VR1 back to the point at which a zero reading is just obtained and no further. Note that a negative reading cannot be indicated owing to the presence of D1. Accurate setting of this control is important, particularly for the lower ranges. □



COMPONENTS

See Shop Talk page 312

Resistors

R1 to R10	10M (10 off)
R11	1M
R12	1
R13	1Ω5
R14,R25	10 (2 off)
R15,R24	15 (2 off)
R16	100
R17,R22	150 (2 off)
R18	15k
R19	7k5
R20	1k5
R21	750
R23	75
R26	43k
R27	5k6

All ±1% 0·4W metal film

Potentiometer

VR1	10k linear carbon rotary

Capacitor

C1	10n polystyrene

COMPONENTS approximate cost £20

Semiconductors

D1	1N4148 silicon diode
IC1	LF441 JFET op-amp

Miscellaneous

S1	4-pole 9-way rotary
S2	4-pole 3-way rotary
ME1	50μA f.s.d. 1k4 meter
SK1 to SK3	2mm socket, red (3 off)
SK4	2mm socket, black
PL1	2mm plug, red
PL2	2mm plug, black
B1,B2	PP3 9V battery (2 off)

0·1 inch matrix stripboard, 11 strips x 10 holes and 3 strips x 16 holes; 8-pin d.i.l. holder; PP3 battery connectors (2 off); alligator clips, red and black.

Case—minimum 186mm x 110mm x 92mm high (back), 41mm (front); pointer knobs: 27mm diameter (2 off), 33mm diameter; red and black flexible leads; connecting wire; fixing screws.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Hi Fi Video

Everyone is talking about hi fi video. You can buy hi fi machines in both the Beta and VHS formats.

On a conventional machine the sound is recorded on a linear track along the edge of the tape. Quality is limited by low tape speed (under one inch a second) and the narrow track width, especially in stereo.

For hi fi video the audio is converted to f.m. and fed to extra heads mounted on the rotating video drum. These lay down f.m. signal tracks across the tape which are almost immediately over-written with video signals from the conventional video heads. Because the video signals are at higher frequency and lower drive current than the audio f.m. only the top layer of audio recording is erased and replaced with video.

The result is a two layer sandwich, with video on top and audio below. Hence the term depth multiplex recording. The audio and video heads are set at different angles or "azimuth", so that on playback the audio heads read only audio and the video heads read only video.

Both the Beta and VHS hi fi systems work in the same way in Europe, although the Beta hi fi system works rather differently in America. Over there the audio and video signals are mixed and fed to the same heads.

The hardware firms are busily advertising hi fi video and promising more and more pre-recorded cassettes in the new format. These will of course also have a conventional soundtrack for owners of conventional machines.

All the major duplicators have installed hi fi machines—except one. CBS-Fox is holding back. This is particularly surprising because in America CBS-Fox led the hi fi scramble. I asked David Harris, head of duplication at the CBS-Fox plant in Greenford, Middlesex, why he wasn't joining in.

"Hi fi has come too early," he told me. "It's a major benefit for the hardware industry which can sell at higher prices. But it's no benefit yet for software companies like us.

"Pre-recorded tapes won't sell better because they are in hi fi. We've sold 30,000 copies of *The Empire Strikes Back*. If we'd sold ten more because of hi fi we'd have been lucky."

"I don't believe hi fi quality can be achieved for the same price," he went on, "you need different mastering, different quality control standards, different technology. You can't do that for nothing. So who will pay? We've been asking that question for 18 months.

"The hardware firms should have knocked a million or so off their multi-million advertising budget for video hi fi machines, and helped pay for the duplication equipment. Sony has been markedly more helpful over providing video hi fi equipment at reasonable price than the VHS manufacturers.

"The CBS-Fox plant in America needed new equipment," Harris explained, "so it made sense to choose hi fi and launch with plenty of razzmatazz. At Greenford we've got around 800 or 900 machines, we never say exactly how many, and they don't need replacing yet.

"Hi fi machines cost more and I can't justify that extra expense. We've got some machines on test and are learning about the problems. But we are doing it without upsetting our customers. Other firms are learning publicly."

Right Approach

"What the industry needs," Harris goes on, "is a standard approach to hi fi mastering. Some duplicating houses are set up to issue hi fi tapes with the sound sourced from a digital recording sync-locked to a master video machine, but others are equipped only to source the sound from ordinary video machines with linear soundtracks.

"In America they use DBX noise reduction on the master machine, but not over here. So what happens if a film company wants to shift work from one duplicator to another with different equipment? The industry isn't even talking about a standard yet. Hi fi video in Britain won't really happen for another eighteen months."

Cable Vision

Although there is much talk about cabling Britain in the future, around six per cent of the country is already hooked up to cable. A total of 1·2 million homes get their TV programmes down wires from local "headends" or distribution points. That's in addition to people who live in blocks of flats and get their TV signals from a communal master aerial.

Ten years ago 2·5 million British homes were on cable. The number then stood still and has been falling since 1980. Cable began in Britain back in 1925, when some homes did not have mains power and could not receive radio. Enterprising companies piped in radio signals at high enough voltage to run a loudspeaker without an amplifier.

In 1950 the Home Office licensed three companies, EMI, Rediffusion and British Relay to distribute 405-line TV along cable radio lines. The systems were then upgraded to take colour TV. Around 70 per cent of these 1·2 million homes in Britain now receiving TV by cable, rely on relatively primitive twisted wire pairs of the type originally designed for radio signals.

The radio signals were distributed over long distances at 500V and reduced to 55V for home use. The TV signals run into the home at 30V on an 8·9MHz carrier. Trunk cables are coaxial and then split for home service into twisted wire pairs, with one channel per pair.

In theory it is possible to stack or multiplex (this happens in Jersey) but in practice, the losses are too serious. The higher the frequency carried, the quicker the signal is lost on a twisted wire pair. At the moment repeaters are needed every 1500 metres.

All the fuss about cabling Britain centres on the Government's enthusiasm for making the UK a wired society with high technology, two-way interactive cable links. That way homes of the future will be able to bank, shop and browse through mail order and estate agents' catalogues by cable link.

The snag is that interactive systems need cables wired in switched star configuration, not conventional tree and branch layout. Although the Government wants a wired society, it won't subsidize switched star installation.

The cable companies know there is a limited market for interactive systems. British Telecom's Prestel viewdata service still has only 50,000 subscribers, many of them business users. Only a few are domestic subscribers who use Prestel to shop and shuffle money by viewdata. So the cable companies certainly don't want to spend extra on laying a high technology system simply to offer interactivity. They would rather try to make money out of simple one-way entertainment services.

As far as I can see, no-one has yet thought seriously about a possible compromise between these two extremes; high technology switched star interaction on one hand and one way, low technology tree and branch on the other. The answer, surely, is to link cable with a telephone.

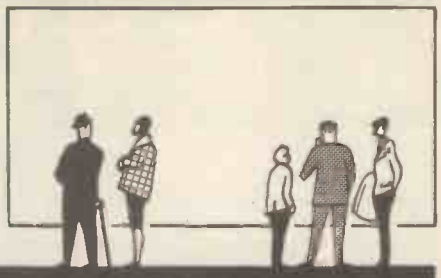
Already Oracle the commercial TV teletext service is experimenting with personalized teletext transmission. Pages of data are given address codes which means they can only be received by a set which incorporates a decoder with matching access codes.

Oracle will use this system to transmit semi-confidential information nationwide, for instance a running update on pricing for department store chains and a list of stolen credit card numbers for shops and restaurants to keep checking. Extra memory in the receiver will give rapid access to long lists of data.

If a cable system, even of the old twisted pair types, were to use addressed teletext messages, then the subscriber's conventional telephone could provide the other half of the interactive link. A simple modem would let the subscriber key instructions down the line direct into the cable teletext computer.

The use of a home computer would make the system even more flexible. This would make it possible to upgrade existing cable systems, without ripping out old wires from under the ground. But no-one seems to be seriously investigating the possibility. Could it be that no-one has thought of it?

SHOP TALK



BY MIKE ABBOTT

CATALOGUES RECEIVED

Not so much a catalogue as a bulletin received from **Midwich** concerning the company's special offering of a number of items, including IDC strip headers, low power Schottky TTL (LS series) i.c.s, low profile d.i.l. sockets and wire-wrap sockets with turned pins. Prices are too numerous to quote, but further information may be obtained from **Midwich Computer Co., Ltd., Gilray Rd., Diss, Norfolk IP22 3EU. ✆ 0379 4131.**

If you have a connector problem, STC's Five Star Connector service might be your escape route. The 1985 catalogue (Issue No. 1) is out now, and you can order using your credit card, or c.w.o. There's no minimum order charge, and if you are not an account holder with STC your first order will automatically open one. Five Star carries over 4000 lines, and the catalogue includes illustrations to assist selection: **Five Star Connectors (STC), Edinburgh Way, Harlow, Essex CM20 2DF. ✆ 0279 442851.**

Another catalogue received is that of *Rose,* whose enclosures are available in many shapes, sizes and materials, including aluminium, polyester, polycarbonate and ABS. This 52 page catalogue is rich in dimensional information, and available from **Radiatron Ltd., 76 Crown Rd., Twickenham, Middlesex TW1 3ET. ✆01-891 0156.**

Magic Washers

A revolutionary thermal jointing compound which changes state from solid to liquid when the equipment is switched on is available from **Charcroft Electronics Ltd.** Called *Crayotherm,* the compound automatically "wets" the contact area to a high level of thermal conductivity, and never hardens, no matter how many thermal cycles it undergoes—a feature contributing improved reliability.

The "no-mess" compound is available in the form of ready-coated insulating film rolls, and in sheet form, making it an ideal replacement material for power transistor mica washers. *Crayotherm* is in fact available ready-stamped into washers to suit TO-3, TO-36, TO-66, TO-220 and DO-4 devices.

If you would like free samples of the material please write to **Charcroft Electronics Ltd., Charcroft House, Sturmer, Haverhill, Suffolk CB9 7XR. ✆ 0440 705700.**

Passcards

Shown below is an example of the *'Key Facts' Passcard* 'modular' revision system for students following the AEB 'O' Level Electronics course. The card pack serves as a very quick reference for the student during revision, and for the beginner. The cards measure 75 × 125mm and fit inside a plastic wallet. Further details from: **Charles Letts & Co Ltd., Diary House, Borough Rd., London SE1 1DW.**

succession of pulses (**pulse train**) is used as the carrier wave. Of the latter type there are four main forms (**Fig. 45**):

(i) **Pulse amplitude modulation (PAM):** the amplitude of the pulses is modulated by samples of the modulating signal.

(ii) **Pulse duration modulation (PDM):** the duration of each pulse is modulated by the signal.

(iii) **Pulse position modulation (PPM):** the time of occurrence, or position of pulses is modulated by the signal.

(iv) **Pulse code modulation (PCM):** only certain values of the amplitude of the modulating signal are allowed, and each sample is assigned a numerical value. A pattern of pulses that represents this value is transmitted as a **coded pulse train.** (Morse code is an example of a pulse code.)

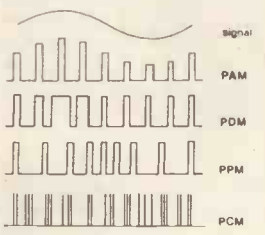


Figure 45

Information Transmission

Wherever information needs to be transmitted from one point to another, as in telecommunications, computer systems, radio and television, certain fundamental elements are required to produce an effective communication system. These elements are the **source, modulator, transmitter, propagation medium, receiver, demodulator** and **receptor** (Fig. 46).

Terrific Tori

What advantages have toroidal power transformers over their conventional stacked lamination counterparts? Toroidals are about 50 per cent lighter and smaller. They are magnetically more efficient. They radiate less electrical and audible hum.

Cotswold Electronics Ltd. stocks a "budget" range of these transformers, costing around £9 for a 30VA unit to around £25 for a unit rated at a little over 500VA, at one-off prices. Details from **Cotswold Electronics Ltd., Unit T1, Kingsville Road, Kingsditch Trading Estate, Cheltenham, Gloucester GL51 9NX. ✆0242 41313.**

CONSTRUCTIONAL PROJECTS

Across The River

The p.c.b.-mounting buzzer for *Across The River* is available from **RS Components** (RS 249-794).

Caravan PSU

Switch S2 used in the *Caravan PSU* is assumed to be the **Maplin Electronics** 4P3W slide switch, in the wiring diagram. The 317M variable voltage regulator IC1 is available from **Greenweld Electronic Components, 443 Millbrook Rd., Southampton SO1 0HX. ✆ 0703 772501.**

Electronic Doorbell

The PB2720 piezoelectric transducer used in the *Electronic Doorbell* is available from **Cirkit** (stock number 43-27201) for the princely sum of 55 pence. There should be no difficulty in procuring the remaining components. **Cirkit, Park Lane, Broxbourne, Hertfordshire EN10 7NQ. ✆ 0992 444111.**

It was mooted in the *EE* office that this project would make an ideal "pocket doorbell" for calling on houses without their own fitted. You would simply dangle it through the letter-slot, on the end of its wire, push the button and retrieve it. But is this a truly original idea?

Graphic Equaliser

There are no components in the *Graphic Equaliser* that should present any buying difficulties, although it should be pointed out that S1 is integral to SK1, which is a 0·25in. jack socket with a "make" switch. A suitable socket is available from **Electrovalue Ltd., 28 St. Judes Rd., Englefield Green, Egham, Surrey TW20 0HB.**

High Impedance Multimeter

The 50μA f.s.d. panel meter (1·4k resistance) used in the *High Impedance Multimeter* is available from Maplin (order as RX54J), for £8.95. See page 209 of the Maplin catalogue, or contact **Maplin Electronic Supplies Ltd., PO Box 3, Rayleigh, Essex SS6 8LR.**

The LF441 CMOS op. amp. can be obtained from **Macro Marketing Ltd., Burnham Lane, Slough, Berkshire SL1 6LN. ✆ 06286 4422.** If you do not have an account number with Macro, your first order will set one up.

Computerised Shutter Timer

All of the components in the *Computerised Shutter Timer* were found to be readily available when checked.

a regular feature for the Spectrum Owner...

by Mike Tooley BA

IN COMMON with most of the ready-made Spectrum interfaces, many of the projects which we shall be describing in *On Spec* will derive their power directly from the Spectrum. We shall, therefore, start this month with an important note concerning the d.c. supply rails available at the Spectrum's edge connector.

Power Supply

Whilst it would appear to be expedient to use the Spectrum's own internal supplies, the would-be experimenter should first be made fully aware of the limitations of these voltage rails. Failure to do so may not only result in unpredictable behaviour of the computer but may also cause ***permanent damage*** to the Spectrum's own internal power supply.

It should be noted that there are definite limitations to the current which may be safely drawn from the Spectrum's internal supply rails. This is particularly true in the case of the nominal +12V and −5V rails which are internally generated from a simple d.c.-to-d.c. converter, the reliability of which has been a consistent cause for concern with early issues of the Spectrum. (Sinclair have, in fact, taken steps to alleviate these problems with the introduction of a series of modifications and improvements to the circuitry around the d.c.-to-d.c. converter, TR4).

For the sake of readers who may have missed March's *On Spec* we will just summarise the power rails to which we have access at the rear connector: refer to Table 1, above.

The +9V unregulated line consists of nothing more than the unregulated d.c. input from the mains unit and, although an appreciable current may be safely drawn from this rail, the voltage may vary anywhere between 9V and 11V depending upon the mains input, load current, and particular mains unit employed.

The +5V regulated rail is derived from a single monolithic three-terminal regulator (marked REG on the p.c.b.) In early versions of the Spectrum (Issue 1 and Issue 2) this regulator was somewhat prone to overheating and, from Issue 3 onwards, was relocated to the rear of the p.c.b. and accorded the benefit of a much larger heatsink. It should be noted that, by virtue of the 7805's internal foldback over-current protection, this device will usually survive the ravages of a temporary short circuit placed on the +5V rail.

Table 1. Voltage levels available at the Spectrum rear connector

Designation	Connector Reference	Typical voltage	Max. recommended current
9V unregulated	4B	+10·5V	300mA
5V regulated	3B	+4·9V	50mA
12V	22A	+11·5V	10mA
−5V	20A	−4·5V	5mA
~12V	23A	(see Fig. 1)	do not use!

The +12V and −5V rails required by the lower 16k of RAM (IC6 to IC13) are produced by the on-board d.c.-to-d.c. converter, TR4. The +12V rail is regulated by means of d.c. feedback in the converter whilst, in later issues the −5V rail also has the benefit of an additional shunt zener diode regulator. Unfortunately, neither of these rails can deliver much in the way of current.

High-Frequency Waveform

The ~12V line is connected directly to the collector of the d.c.-to-d.c. converter, TR4, and the normal waveform at this point (shown, for the benefit of the curious, in Fig. 1) comprises a high frequency component of typically 100kHz or more, superimposed on a d.c. level of approximately 10·5V. The peak-to-peak value of this decidedly non-sinusoidal waveform is of the order of 20V or so. Permanent damage to TR4 can be caused by an inadvertent misconnection or temporary short-circuit placed on the ~12V rail and hence this particular voltage rail is best left well alone!

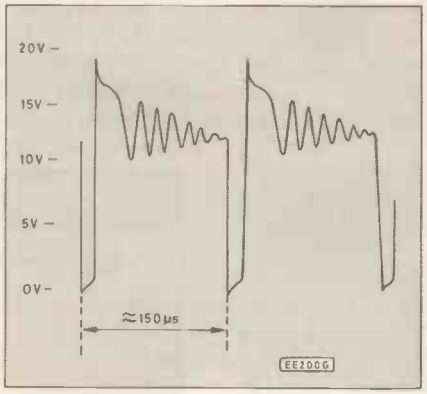


Fig. 1. Waveform at the collector of TR4

Solution

Generally the most satisfactory solution to the problem of delivering power to an external interface (at least where any appreciable current is involved) is that of providing an additional 7805 regulator within the interface unit. This, in turn, should derive its power from the unregulated 9V line. Not only is this arrangement flexible but it also helps to minimise the effects of loading on the already well-used internal supply rails of the Spectrum.

Four Channel Output Interface

Having started on a cautionary note, let's turn our attention to a simple four channel output interface. This unit has a wide variety of applications and complements the four channel input interface described in April's *On Spec*.

The complete circuit diagram of the interface is shown in Fig. 2. An eight-input NAND gate, IC1, together with the inverter formed by IC2b, provides address decoding so that the interface is selected whenever address line A6 is low and all other address lines (A0 to A7) are high. This corresponds to a decimal address of 191. If desired, the address may be changed to 255 by simply omitting IC2b and linking address line A6 directly to pin 11 of IC1.

The address decoded from IC1 is combined with the $\overline{IORQ}$ and $\overline{WR}$ lines using IC2a so that the output of IC2a (pin 6) goes high whenever the Spectrum writes to port address 191 (or 255 if IC2b is omitted). This has the effect of clocking

COMPONENTS

Resistors

R1 to R4 270(4 off)
R5 1k
All ¼W ±5%

Capacitors

C1 10µ 16V p.c. electrolytic
C2 to C4 100n polyester (3 off)

Semiconductors

D1 to D4 Red l.e.d. (4 off)
IC1 74LS30
IC2 74LS27
IC3 74LS175

Miscellaneous

14-pin low-profile d.i.l. sockets (2 off); 16-pin low-profile d.i.l. socket; 28-way open end double-sided 2.54mm pitch connector (e.g. Vero part number 838-24826A); terminal pins (12 off) or four 3-way 2.54mm pitch connectors; 2.54mm hole pitch stripboard measuring approx. 80mm x 80mm (minimum 28 strips).

Approx. cost Guidance only **£5.00**

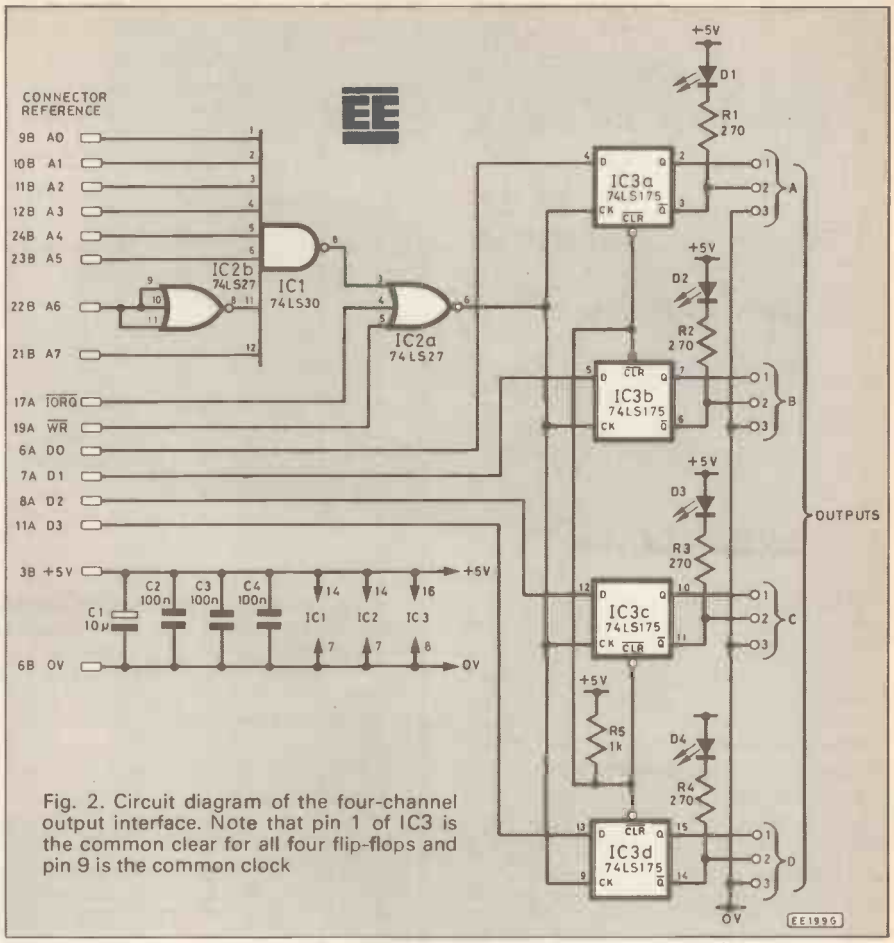


Fig. 2. Circuit diagram of the four-channel output interface. Note that pin 1 of IC3 is the common clear for all four flip-flops and pin 9 is the common clock

the data which appears on the least significant four data lines (D0 to D3) into the data latch formed by IC3. The "Q" outputs of the four latches will then retain the state of their respective data input lines until the latch is again written to.

The Q and $\overline{Q}$ outputs of each data latch (which are, of course, TTL compatible) are both made available. This not only allows an l.e.d. indicator to be connected to each channel but also permits direct connection of sensitive d.i.l. reed relays since the $\overline{Q}$ output is capable of sinking currents in the order of 15mA or so.

Construction

Construction of the four-channel output interface follows the same broad principles as that adopted for the four-channel input interface described in April's *On Spec*. The interface components are assembled on a small piece of Veroboard measuring approximately 80mm x 80mm. Whilst the precise dimensions of the board are uncritical, it must have a minimum of 28 tracks aligned in the vertical plane.

The 28-way double sided edge connector is mounted along the bottom edge of the board and will require approximately 5 rows of holes across the full width of the stripboard. The board will thus stand vertically when the connector is mated with the Spectrum.

Before soldering any of the components to the stripboard, it is important to leave some clearance for the rear "overhang" of the case. For the Spectrum this gap should correspond to 8 rows of holes (20mm approx.) whilst for the Spectrum Plus the gap should be increased to 12 rows of holes (30mm approx.).

Whilst component layout is generally uncritical, care should be taken to ensure that the supply decoupling capacitors, C2 to C4, are distributed around the board (each preferably associated with an individual integrated circuit supply). Great care should be taken to ensure that all unwanted tracks are cut (including those which link the upper and lower sides of the 28-way connector). A purpose designed "spot-face" cutter may be used for this purpose or, if such a device is not available, use can be made of a small sharp drill bit.

Links on the underside of the board are best made using appropriate lengths of miniature insulated wire of the type normally employed for wire wrapping. Readers requiring further information on the connector should refer to March *On Spec*.

When the stripboard wiring has been completed, the three integrated circuit devices should be inserted into their sockets (taking care to ensure correct orientation) and the entire board should be carefully checked before connecting to the Spectrum. Note that the Spectrum ***should always be disconnected from its supply*** before either connecting or disconnecting any interface module. If all is well, when power is re-applied, the normal copyright message should appear. If not, disconnect the power, remove the interface and check again.

Any comments, queries, or suggestions for inclusion in *On Spec* should be sent to:

Mike Tooley,
Department of Technology,
Brooklands Technical College,
Heath Road,
WEYBRIDGE,
Surrey KT13 8TT.

And don't forget to include a stamped addressed envelope if you would like a copy of our latest "Spectrum Update".

NEXT MONTH: We shall provide some example uses for the four-channel output interface.

THE LACK OF I/O facilities is undoubtedly one of the Sinclair Spectrum's weakest points. This is unfortunate since many other low-cost personal computers provide some form of parallel I/O which is available for use by the experimenter. Even with the simplest interface hardware (i.e. one which is not itself programmable) the possibilities are immense, ranging from controlling your model railway to running your domestic central heating system.

An interface, therefore, must be considered as an essential pre-requisite when connecting your Spectrum to the outside world. Happily, a few hardware suppliers are beginning to cater for this need. One such supplier, Datel Electronics (no newcomer to the field of Spectrum interface design) have recently introduced their *Robotek* interface as an addition to their existing range of 'add-ons' which includes such devices as joystick interfaces and light pens.

I/O CHANNELS

The *Robotek* interface has four output channels (labelled A to D) and eight input channels (labelled A to H). The interface is mapped to a decimal port address of 63 (address lines A6 and A7 both low). The output channels appear as relays, each of which has a single set of changeover contacts and, therefore, has three associated lines; common, normally closed, and normally open. In the non-energised state the common connection is linked to the normally closed contact whereas, in the energized state, the common connection is linked to the normally open contact. A relay may be energized by simply writing a logic 1 to the output channel concerned. It is important to note that all of the output channels have a latching action (i.e. once energised the relay will stay that way until a logic 0 is written to the channel concerned).

Besides the flexibility of relay outputs, this also provides a measure of isolation for the Spectrum controller. Each relay can switch up to 50V at 1A. It should, however, be stressed that the *Robotek* is not suitable for directly switching a.c. mains supplies. This is a task which can be easily accomplished using an appropriately rated external relay or solid-state switch. (It would have been nice to see a few hints as to how this can be done in the instructions!)

One further point to note is that the wiring of output channel D differs from that of the other channels in that the normally open contact is also used as the common ground connection for the eight input channels. The reason for this anomaly is the use of a 20-way IDC connector for terminating all the I/O lines. With three lines devoted to each relay (making a total of twelve output lines) and eight input lines devoted to inputs, the common ground connection has to be shared. Whilst in many applications this may be unimportant, it may restrict the usefulness of output channel D where a degree of isolation is required.

SOFTWARE

Software control of the output is extremely easy. Each channel is associated with a particular data line hence, to switch channel A 'on' from BASIC you need simply key:

OUT 63,8

and, to switch channel A 'off' again, you need only enter:

OUT 63,0

The eight input lines are all TTL compatible and are not isolated. The lines are internally pulled-up so that, in the absence of any external connections, they all adopt a logic 1 state. If a switch is now connected between an input line and common ground, when 'open' a logic 1 input will be sensed and when 'closed' a logic 0 will be perceived. Obviously the user is not restricted to using mechanical switches as inputs and any TTL compatible switching device (such as a TTL opto-isolator) could be employed.

DATA VALUES

Just as a data value is associated with each output channel, a value is associated with each input channel. Thus, if we had a single input switch connected to channel A (value=4) we could sense its state by keying:

PRINT IN 63

If this returns a value of 255 (all input lines high) the switch would be 'open'. If a value of 251 were to be returned we would surmise that the switch was closed (all lines EXCEPT that used by channel A are high).

The *Robotek* is neatly housed in an ABS case measuring approximately 110 × 77 × 28mm. The case is fitted with a double-sided edge connector which mates directly with the expansion connector at the rear of the Spectrum. It is important to note, however, that this case will not mate directly with the Spectrum Plus!

The external lines are terminated in a 20-way IDC connector which emerges from the upper edge of the ABS case. A matching connector (assembled on a 620mm length of 20-way colour coded ribbon cable) is supplied with the *Robotek*. Two main criticisms follow—the cable was not really long enough (they never are!) and the ribbon cable colour codes did not correctly agree with the pin assignment of the IDC connector!

The unit is supplied with two A4 pages of instructions. These explain the electrical properties of the input and output channels and provide brief details of how they can be controlled from BASIC. Also included are tables giving the values associated with each input and output channel (these are useful since the values do not follow the logical sequence of weighting) and a chart showing the ribbon cable connections. My only comment on the instructions are that a few sample programs could have been usefully included for the benefit of the inexperienced programmer. These could, for example, show how the four output channels can be controlled independently and how the status of the input lines can be repeatedly sensed.

CONCLUSION

The Datel *Robotek* offers the experimenter tremendous scope for expanding his Spectrum beyond the confines normally associated with a games/entertainment machine. The few minor criticisms voiced in this review in no way detract from the usefulness of the interface which is both competitively priced and excellent value for money. So, whether you are building a robot or intelligent security system, there are no longer any excuses; this interface will help you do it!

The *Robotek* interface costs £29.99 (post free). It is available from: **Datel Electronics**, Unit 8, Fenton Ind. Est., Dewsbury Road, Fenton, Stoke-on-Trent. (0782 273815).

ACROSS THE RIVER

W. D. PHILLIPS B Sc Ph D

THIS easy-to-build hand-held electronic game can provide fun for all the family. It is based on a very old problem in which a farmer has to cross a river to get his goods to market; the snag is that he can take only one item at a time, and he has to be selective if he is to get all three safely across.

THE PROBLEM

A farmer takes to market a hen, some corn, and a fox. On the way to town he has to cross a river. There is a boat but the farmer can take only one of the three, either the hen, the corn, or the fox, across at a time. This unlikely scenario creates a nice little problem in logic.

When the farmer is there to keep order, everything is under control but, if he leaves the hen with the corn, on either side of the river, the hen will eat the corn, while if he leaves the fox with the hen, the fox will eat the hen. The problem is how exactly does the farmer cross the river safely with all three of his possessions and continue on his way to market?

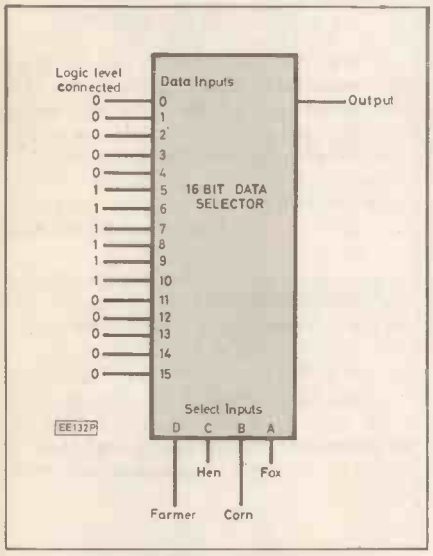


Fig. 1. 16-bit data selector.

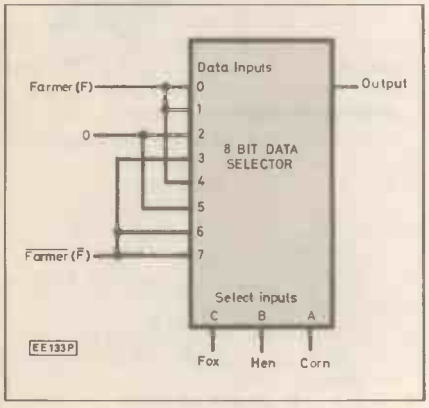


Fig. 2. 8-bit data selector.

Table 1: Truth table for the problem.

farmer D	hen C	corn B	fox A	output
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

D = 0: Farmer on first side of river.
D = 1: Farmer on second side of river.

Table 2: Truth table for an 8-bit data selector.

SELECT INPUTS			OUTPUT	OUTPUT
C (fox)	B (hen)	A (corn)	(F = 0)	(F = 1)
0	0	0	0	1
0	0	1	0	1
0	1	0	0	0
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	1	0
1	1	1	1	0

TRUTH TABLE

The first step in designing an electronic circuit to model this situation is to construct a truth table for the problem, as shown in Table 1.

In the truth table, a '0' in the *farmer* column shows the farmer on the first side of the river, while a '1' shows him on the second side. In the same way, 0's and 1's are used to represent the position of the *hen, corn,* and *fox*. In the *output* column, a 0 corresponds to a safe overall position, while a 1 indicates that either the corn or the hen, or perhaps both, are about to be eaten!

DATA SELECTOR LOGIC

The truth table is turned into a practical circuit using a simple but elegant technique called *data selector logic*. A 16-bit data selector is shown in Fig. 1. The *select inputs*, A, B, C, and D, are decoded to provide the "address" of one of the *data inputs*, numbered 0 to 15. The logic level available at the selected input is then transferred to the single *output* pin. A complete solution to the hen, corn, fox problem is obtained simply by connecting 0's and 1's to the data inputs as illustrated.

A more economical solution using an 8-bit data selector is shown in Fig. 2. In this case there are just three select inputs: these are chosen to correspond to the hen (input B), the corn (input A), and the fox (input C). By referring to the truth table of Table 1, the correct logic level to be connected to each of the data inputs can be determined and a revised truth table (Table 2) can be drawn up.

The method is as follows: consider, in Table 1, the lines for which select inputs A, B and C are all 0. In one case, select input D = 0, corresponding to the farmer on the first side of the river, and for the other D = 1. The output is 0 for the first case and 1 for the second.

For the 8-bit data selector, it is simply necessary to arrange for the *data* inputs to act as the fourth select line. Hence when A, B and C are all 0, data input 0 is routed to the output (Z): the logic level at data input 0 needs to be 0 when the farmer is on the first side of the river (F = 0) and 1 when he is on the other side (F = 1). This is achieved by switch S2, as shown in Fig. 3. The process continues similarly for the other seven possible combinations

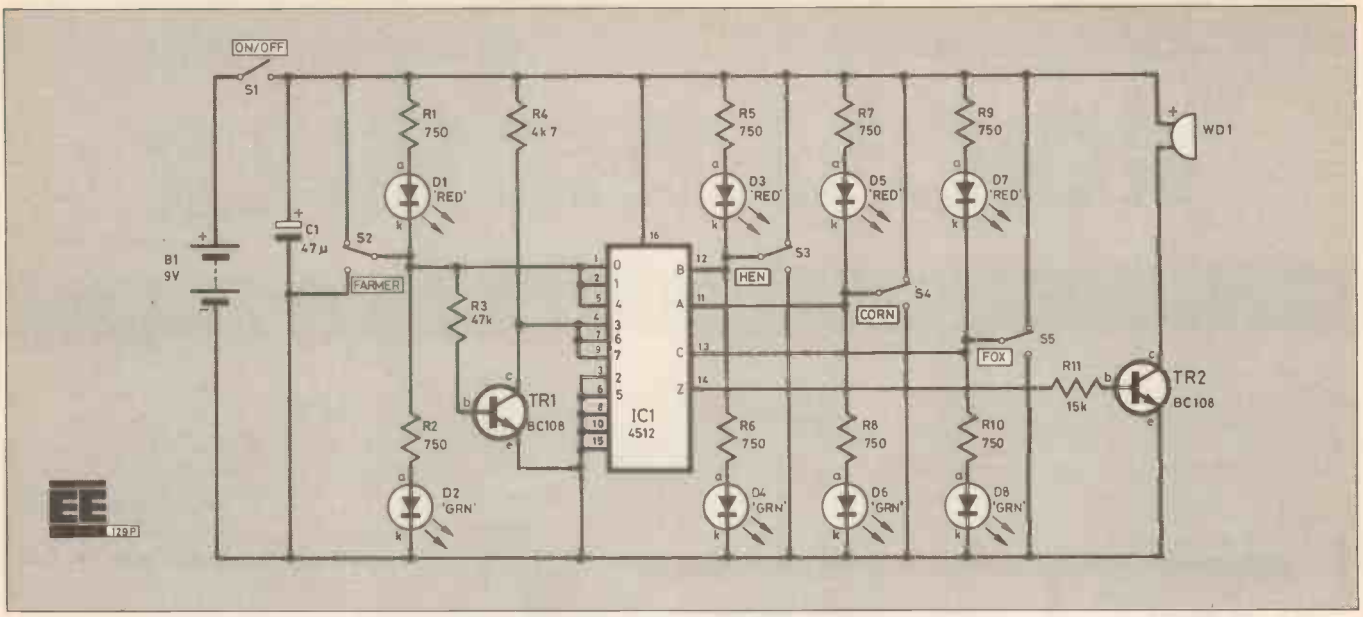


Fig. 3. Circuit diagram of the electronic game "Across the River".

of select inputs A, B and C, and is summarised in Table 2.

In the case when A, B and C are all 1, for example, in Table 1, when D = 0 the output is 1 and when D = 1 the output is 0. Hence for the 8-bit selector, the *inverse* of the input from S2 ($\overline{F}$) needs to be connected to data input 7. This is done by TR1.

The appropriate logic levels for the other data inputs are chosen in a similar way. Depending on the desired truth table, some inputs are permanently connected to logic 0, or to logic 1. The remaining data inputs will then be connected either to the logic level for the variable F, or to its inverse, $\overline{F}$. In this case, three of the inputs are connected to farmer ($\overline{F}$). In two cases (data inputs 2 and 5), the output is 0 whichever side of the river the farmer is. This corresponds to the (safe) situation in which the fox and the corn are together without supervision on either side. Hence these two data inputs can be connected directly to 0—see Figs. 2 and 3.

CIRCUIT DIAGRAM

The complete circuit diagram for the game is shown in Fig. 3. IC1 is a cmos integrated circuit, the 4512 8-bit data selector. The s.p.d.t. switches, S3, S4, and S5, represent the hen, the corn, and the fox, and each can be switched to logic 1 or logic 0, thereby providing the select inputs required by the data selector.

At the same time l.e.d.s are illuminated to indicate the current position: red on one side of the river, and green on the other. S2 represents the farmer and the logic level obtained is inverted by TR1 to provide the farmer variable connected to data inputs 3, 6, and 7. The output, pin 14 of the data selector, drives the audible warning device, WD1, via TR2.

COMPONENTS approximate cost £13.50

COMPONENTS

Resistors

R1,R2,R5 to R10	750 (8 off)
R3	47k
R4	4k7
R11	15k

All ¼W carbon film ±5%

Capacitor

C1	47µ 25V elect. axial leads

Semiconductors

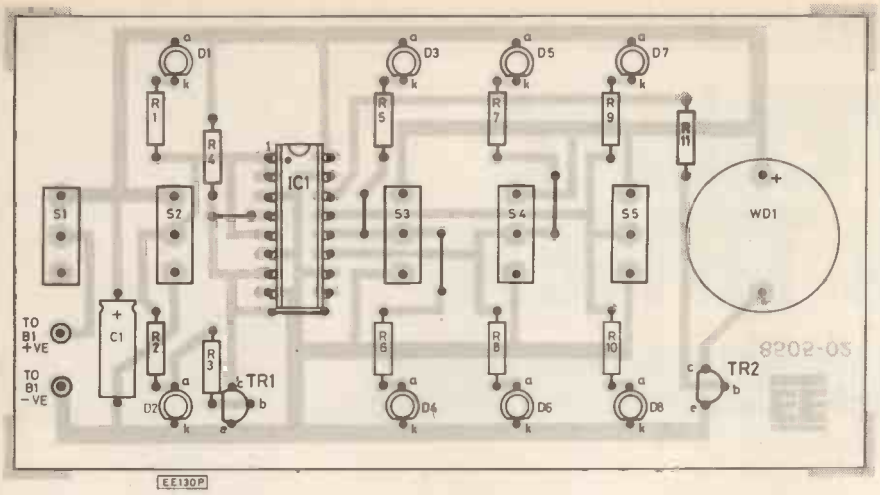
D1,D3,D5, D7	TIL 220 red l.e.d. (4 off)
D2,D4,D6, D8	TIL221 green l.e.d. (4 off)
TR1,TR2	BC108 silicon *npn* (2 off)
IC1	4512 cmos 8-bit data selector

See **Shop Talk** page 312

Miscellaneous

S1–S5	s.p.d.t. min. toggle (5 off)
WD1	p.c.b. audible warning device

Printed circuit board: single sided size 114x60mm, available from the *EE PCB Service* (order code 8505-02), ABS box, 150x80x 50mm, 16 pin d.i.l. socket, l.e.d. fixing clips (8 off), PP3 battery clip.



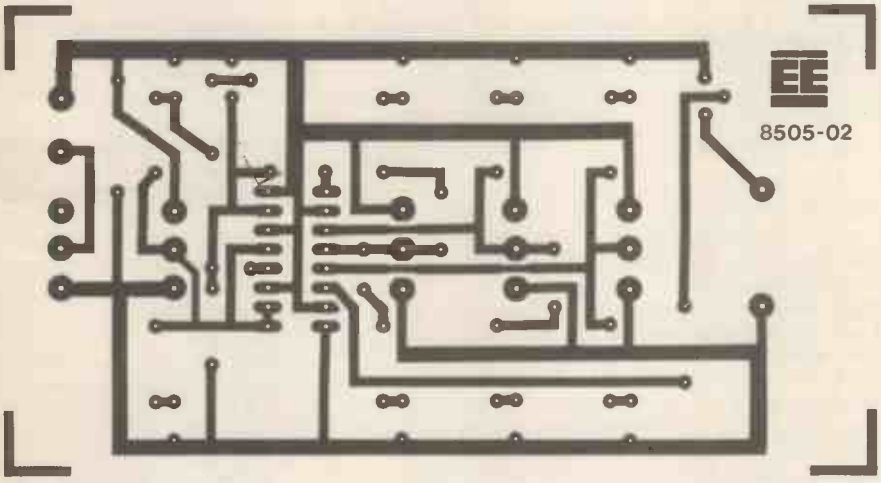
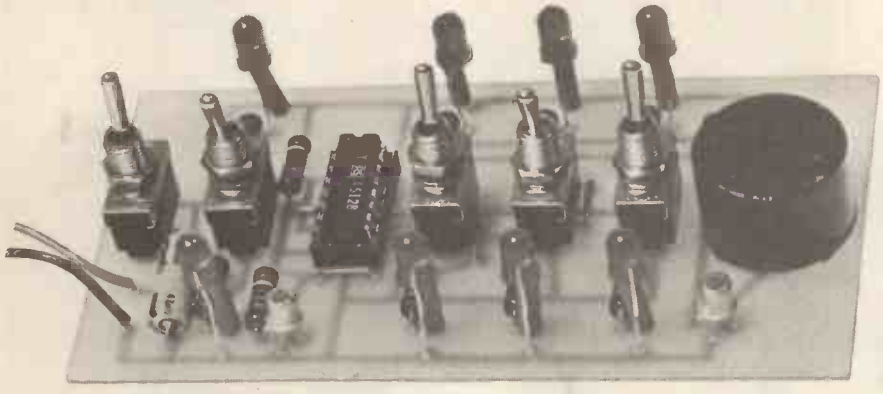


Fig. 4. Top, component layout for "Across the River". Above, actual-size p.c.b., available from the *EE PCB Service,* order code 8505–02.



The completed circuit removed from its case. Note that when completing the assembly of the unit, all components *except* the l.e.d.s should be soldered in position. The ABS case lid should have 13 quarter-inch holes drilled in it to match the positions of the switches and l.e.d.s, and one additional quarter-inch hole directly over the centre of the audible warning device WD1. The l.e.d.s should first be fixed by their clips in the case lid, and then their leads threaded through the appropriate holes in the p.c.b. Finally, the switches should be secured by their fixing nuts, and then the l.e.d.s soldered in position.

CONSTRUCTION starts here

Use of the printed circuit board available for the project is strongly recommended. This has been designed to eliminate interwiring and simplifies construction considerably. Begin by soldering all the components, as shown in Fig. 4, *with the exception of the eight l.e.d.s,* which are kept separate until later. The five s.p.d.t. switches are mounted directly on the p.c.b. and care should be taken to fix them in an exactly vertical position: switches with pins spaced at 0·2in. intervals are required.

The circuit should be tested at this stage by fitting IC1 in its socket and connecting a battery. Using S2, S3, S4, and S5, work through the complete truth table, checking that the audible warning device sounds whenever there is a 1 in the output column.

Next drill the lid of the case to accept the switches and the l.e.d.s. It is easiest to do this working in 0·1in. intervals, corresponding to the spacing of components on the p.c.b. Lettering and decoration of the case are best done at this stage.

Complete the assembly by fixing the l.e.d.s in position in their clips on the lid of the case, and then threading their connecting leads into the appropriate holes in the p.c.b. Cutting one lead on each l.e.d. slightly shorter than the other will facilitate this operation. Tighten the nuts fixing the switches and finally solder the l.e.d.s in position. This method of assembly avoids strain on the p.c.b. and produces a neat overall effect.

Table 3: Move-by-move solution.

move	farmer D	hen C	corn B	fox A	output
0	0	0	0	0	0
1	1	1	0	0	0
2	0	1	0	0	0
3	1	1	1	0	0
4	0	0	1	0	0
5	1	0	1	1	0
6	0	0	1	1	0
7	1	1	1	1	0

THE SOLUTION

It is expected that constructors will discover the solution to the problem for themselves; for. the record, the correct sequence of moves is given in truth table form in Table 3. □

COMPUTERISED SHUTTER TIMER

R.A.PENFOLD

ELECTRONIC shutter timers are much used by photographic magazines when preparing camera reviews, and are also a standard piece of test equipment in camera repair workshops. Such a unit would obviously be very useful for a camera enthusiast as well, but the cost of even a home constructed shutter timer would probably be prohibitively expensive for most camera owners. However, with the aid of a suitable home computer an accurate shutter timer can be produced for a very modest outlay, and all that is required is a simple opto-electronic interface plus suitable software.

BBC INTERFACE

This shutter timer interface was built for use with a *BBC model B* microcomputer, and it connects to the user port of this machine. The user port is basically an 8-bit input/output port plus two handshake lines, and it is provided by port B of a 6522 VIA (Versatile Interface Adaptor). In addition to the ten input/output lines it has a serial shift register and two 16-bit counter timers which can be accessed via certain of the lines. In this case it is the two timers that are of interest. These count down at a rate of 1MHz, and therefore give a resolution of one microsecond. In practice the level of accuracy this would suggest is not usually achieved, and this application is no exception, but more than adequate accuracy to permit checking of shutter times from about 1/1000th of a second to several seconds is obtained. The unit is powered from the user port of the computer and does not need any other power source.

VIC-20 INTERFACE

The *Commodore VIC-20* computer has a user port that is also provided by port B of a 6522 VIA, and which therefore offers virtually identical facilities to the equivalent port of the *BBC* machine. This timer interface has been tried with the *VIC-20* and operates perfectly well with the computer, and software plus connection details for both computers are included in this article.

Of course, although intended for use as a shutter timer this interface and (or) the method of timing suggested in this article could be used in other applications that require accurate split-second timing. Possible applications range from an ultra-accurate lap timer for a slot-car race track, to scientific experiments in schools.

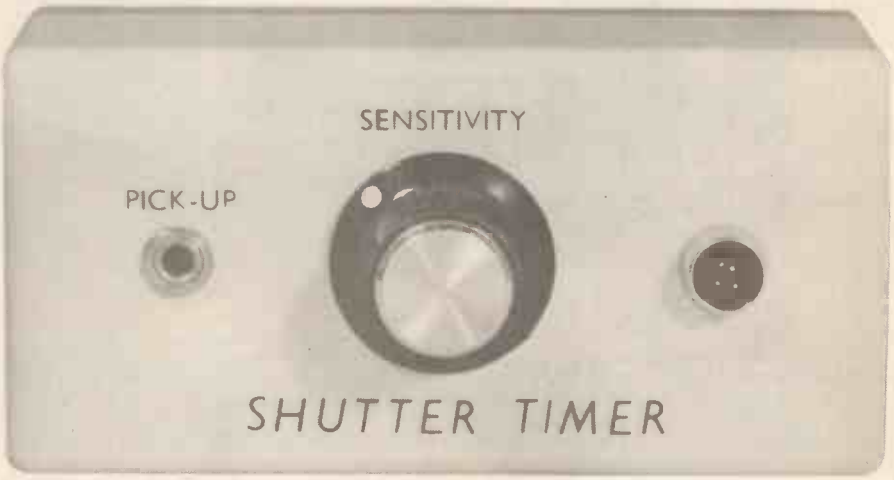
OPERATING PRINCIPLE

Fig. 1 shows the system in block diagram form. The interface consists of just the light detector and trigger circuit, while the rest of the hardware is part of the computer.

The 1MHz clock of the computer is applied to a 16-bit binary counter via some control logic. In practice the 16-bit counter is possibly better regarded as two 8-bit counters connected in series, since the 8-bit data bus of the computer means that it is only possible to read or load one half of the counter at a time. It should perhaps be explained that although the BBC computer has a 2MHz clock, this is divided by two to give a 1MHz clock signal for input/output circuits, including the 6522 VIA. The clock frequency of the VIC-20 is actually marginally more than 1MHz (1·08MHz), and although we will ignore the small error this produces in this application, if required some mathematics in the software could be used to correct it.

In the "free-running" mode the counter continuously counts down to zero, whereupon it is reloaded with the maximum value of 65535 and count down recommences. Software can be used to set the counter to any desired value and at any time. The most simple way of using the counter to time an external event is to use the two handshake lines of the user port (CB1 and CB2) as inputs to detect the beginning and end of the event. When the beginning is detected a short assembly language routine is used to load the counter with a value of 65535, and when the end is detected the counters are read by another assembly language routine. Assembly language (or machine code in the case of the VIC-20) must be used as BASIC is far too slow for this application, and would produce hopelessly inaccurate results. Of course, the number read from the counter is not the answer in microseconds as the counter is a "down" type. However, simply deducting the number from 65535 effectively inverts the counter action and gives an answer in microseconds.

A problem with this basic arrangement is that a clock frequency of 1MHz plus a maximum count of 65535 gives a maximum timing period of only about 1/15th of a second. This is sufficiently long to cover most shutter speeds, but many



cameras these days have maximum shutter times of around one to four seconds. In order to accommodate longer shutter times one section of the other counter in the 6522 VIA is used to count the overflow pulses from the first timer. The first timer can provide an output on line PB7 of the user port, and this line is toggled each time the counter reaches zero. The other counter can count input pulses on line PB6, and can therefore count the overflow pulses of the first timer if lines PB6 and PB7 are linked.

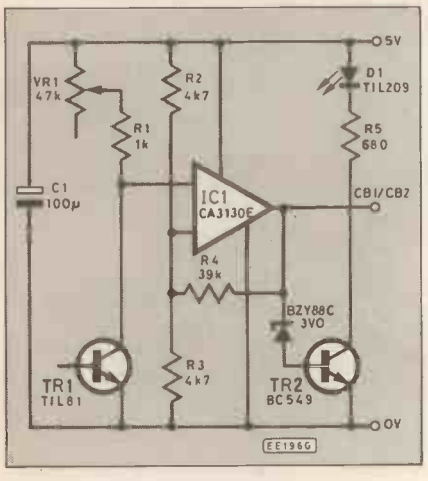
By using just the least significant bit of the second timer the maximum shutter time that can be accommodated is boosted to just over half a minute, which should be more than adequate for the present application. By also using the most significant byte the maximum timing period could actually be boosted to more than an hour if required.

The interface to drive the two handshake lines is very simple, and it merely needs to provide a positive output pulse while the shutter is open. This is accomplished by positioning a photocell behind the shutter, and having a light source in front of the camera. The latter can be provided by a torch, or even just the light from a window will often suffice. The photocell provides an output pulse while the shutter is open and it is subjected to a higher light level, but this pulse must be processed by the trigger circuit to give an output that is compatible with the handshake inputs of the user port.

THE CIRCUIT

Refer to Fig. 2 for the circuit diagram of the interface. The photocell is photo-transistor TR1, and virtually any silicon photo-transistor can be used here. The unit was found to work well using types BPY62, TIL81, BPX25, BPX29, and even the *Maplin* "low cost phototransistor" gave good results. Other types of photocell are unlikely to give usable results. Cadminium sulphide photo-resistors and photo-Darlington devices are likely to have inadequate response

Fig. 2. Circuit diagram



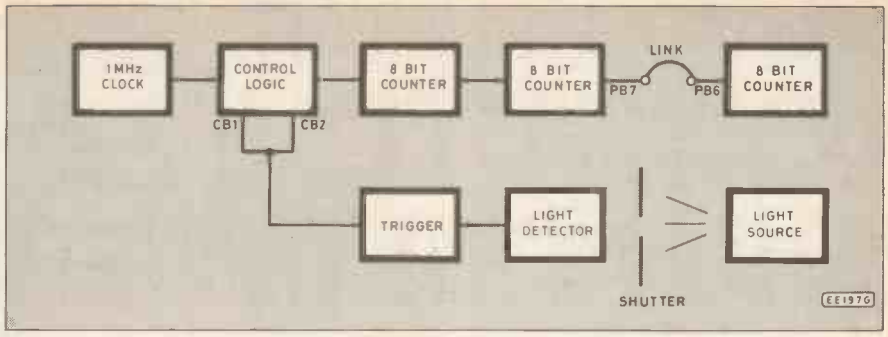


Fig. 1. Block diagram

time, and a photo-diode would almost certainly have inadequate sensitivity.

In this circuit it is the collector to emitter leakage current of TR1 that is utilized, and the base terminal is left unconnected. This leakage current is very low under dark conditions, being typically about 1µA, but it increases substantially as the light level received by the device is increased and can reach several milliamps. This results in a negative output pulse being generated from the pulse of light caused by the shutter operating. VR1 enables the sensitivity of the circuit to be adjusted so that a wide range of ambient and light pulse levels can be accommodated.

IC1 is an operational amplifier which is connected as a straightforward Schmitt trigger having hysteresis provided by R4. This helps to give a "clean" output pulse which is free from noise spikes that could give spurious results. The trigger circuit is an inverting type so that the negative output from TR1 gives the required positive output pulse from IC1. the use of a substitute for the CA3130E specified for IC1 is not recommended since few (if any) other devices would operate properly on the 5 volt supply from the user port, and would give a large enough output voltage swing to drive CB1 and CB2 of the port correctly. The CA3130E has a CMOS output stage which enables it to operate efficiently from a 5V supply and to give a large output voltage swing.

When the output of IC1 goes positive TR2 is switched on, and this in turn activates l.e.d. indicator D1. D1 plays no active role in the circuit, but is very helpful when setting up the system as it will flash on while the shutter is open if the equipment is set up correctly.

CONSTRUCTION

Most of the components fit onto a small printed circuit board, as detailed in Fig. 3. The board is constructed using the normal techniques, but note that IC1 is a MOS device and consequently requires the appropriate handling precautions. Fit this device in an 8-pin d.i.l. i.c. socket, but do not fit it into place until the board and wiring have been completed. Leave it in its protective packaging until then, and handle the device as little as possible. Fit Veropins to the board at the places where connections to off-board components will be made.

A plastic Verobox having dimensions of 100 × 50 × 40 millimetres makes a neat but tough housing for the unit. The board has been designed to fit onto the mounting pillars moulded into the base section of this case and suitable self-tapping mounting screws are supplied with the case. The board could easily be mounted in another case though, by drilling four mounting holes at suitable positions on the rear panel of the case and using M3 or 6BA fixing screws. VR1 and D1 are mounted on the front panel of the case. TR1 must be mounted off-board, and one way of arranging things would be to mount this component on the front panel of the unit. With the interface positioned behind the camera and the light source positioned in front it should then be possible to align things to give good results. An alternative method, and the one adopted for the prototype, is to fit a 3·5mm jack socket on the front panel of the unit, and to then connect TR1 to the board via this and a screened lead about 0·5 metres long and terminated with a 3·5mm jack plug. TR1 can then be easily positioned for use with any camaera shutter or in-lens shutter.

The board connects to the computer by way of a four-way lead about 0·5 to 1 metre long, and an exit hole for this is drilled in one side of the case. Connection to the BBC computer requires a 20-way IDC header socket, while a 2 × 12-way 0·156 inch pitch edge connector is required in the case of the VIC-20. In either case the terminals connecting to PB6 and PB7 must be linked. Connection details for both computers are provided in Fig. 5.

TIMERS

Timer 1 is used as the 16-bit counter fed from the machine clock, and this is controlled by bits 6 and 7 of the auxiliary control register at &FE6B (37147 in the VIC-20). Both bits are set high to give the free running mode with output on PB7 enabled. Timer 2 provides the most significant byte, and this timer is controlled by bit 5 of the auxiliary control register. This bit is set high to give the mode where input pulses on PB6 are counted. Data is written to or read from timer 1 at &FE64 and &FE65 (37140 and 37141 for the VIC-20). The

equivalent addresses for timer 2 are &FE68 and &FE69 (37144 and 37145 for the VIC-20). Note that even though the high byte of timer 2 is not used, data must still be written to this byte in order to load the low byte (which is stored in the 6522 and loaded into the counter when the high byte is loaded).

The operating mode of CB1 and CB2 is controlled by the peripheral control register at &FE6C (37148 in the VIC-20). Bit 4 controls CB1, and this bit is set high so that it is activated by a low to high transition (i.e. the leading edge of the signal from the interface). CB2 is controlled by bits 5 to 7, and of these only bit 5 is set high so that CB2 is activated by a high to low transition (i.e. the trailing edge of the pulse from the interface).

Active transitions on CB1 and CB2 set bits 4 and 3 respectively of the interrupt flag register at &FE6D (37149 in the VIC-20). Writing a 1 to each of these bits resets them.

The basic action of the software must be to first set CB1, CB2, and the two timers in the correct modes. Then the program loops until the CB1 flag is set, at which point the timers are loaded with the maximum values. The program then loops until the CB2 flag is set, after which the timers are immediately read and the figures obtained are stored in zero page addresses. The stored values are then processed and used to calculate the shutter time which is printed on-screen. After the CB1 and CB2 flags have been reset the program loops back to the point where the CB1 flag is monitored so that it is ready to take another timing. A slight improvement in timing accuracy might be obtained by disabling interrupts during each timing run, but this does not seem to be essential, and has not been included in the suggested software.

USING THE UNIT

Suitable software for the BBC model B and VIC-20 computers is provided in the form of the accompanying listings. In order to use the unit as a shutter timer it is not necessary to understand the operation of the timers in detail, and even if you do not understand the explanation given above, it is merely necessary to load and run the appropriate program for your computer. There should be no difficulty in finding a suitable light source, and aligning the shutter and photocell with this source. Any torch will provide a suitable light, and the prototype equipment even worked properly just using the light from a window. It might be necessary to adjust VR1 in order to obtain satisfactory results, and D1 (which should flash on when the shutter is open) helps to make setting up very much easier. D1 may not operate properly until the program is running and CB1/2 have been set to the correct operating mode. Until this is done D1 will probably just light up continuously.

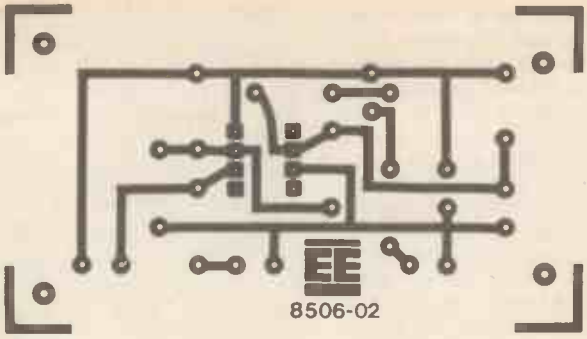


Fig. 3. P.c.b. track layout (actual size)

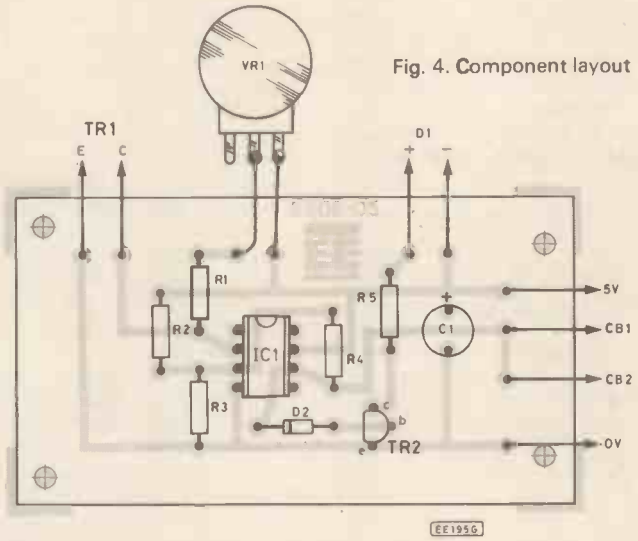
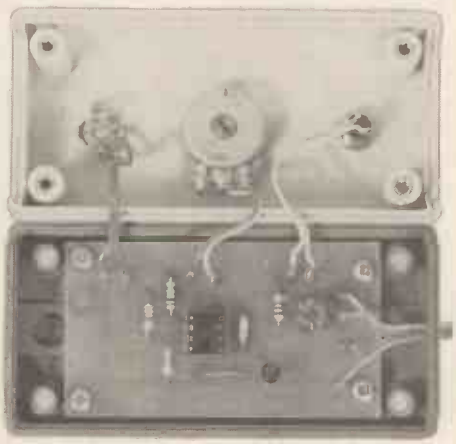


Fig. 4. Component layout

COMPONENTS

Approx. cost Guidance only **£14**



See Shop Talk page 312

Resistors

R1	1k
R2,3	4k7 (2 off)
R4	39k
R5	680
All ¼W carbon 5%	

Potentiometer

VR1	47k 1in

Capacitor

C1	100µ 10V radial elect

Semiconductors

IC1	CA3130E CMOS op amp
TR1	TIL81, BPY62, or similar npn photo-transistor
TR2	BC549
D1	TIL209 red panel l.e.d.
D2	BZY88C3V0 3 volt Zener diode

Miscellaneous

Plastic case about 100 x 50 x 40mm. Printed circuit board (available from *EE PCB Service*, order code 8506–02). 20-way IDC socket or 2 x 12-way 0·156 inch edge connector. Control knob. 8 pin d.i.l. i.c. socket. Wire, solder, etc.

If the camera has an interchangeable lens it is probably best to remove it, but this is by no means essential, and the unit seems to function perfectly well with the lens in place, or even with a large format lens having a built-in (leaf type) shutter. Something that does seem to be important is to have the photocell as close to the shutter blades or curtains as possible. This helps to keep the ambient light received by the cell to a minimum. In practice there is usually no problem in opening the back of the camera and placing the photocell close to the shutter, although the exact set-up used will obviously depend on the type of camera concerned. However, with any camera great care not to damage the delicate shutter mechanism must be taken.

It is quite likely that the shutter speeds will show significant errors, but large errors are quite tolerable (a 10% error is considered to be a commendable level of accuracy). In particular, with a focal plane shutter and speeds of about 1/500th to 1/2000th of a second the measured shutter times are likely to be significantly longer than the nominal speeds. One reason for this is simply that most cameras (even expensive types) do not seem to achieve their shortest shutter times. Another reason is that the photocell is not monitoring a single point behind the shutter, but is monitoring a small area. Due to the way in which a focal plane shutter operates this tends to slightly stretch the shutter speeds, but only to a noticeable extent on the fastest speeds. This effect can be minimised by either masking off the front end of the photocell to reduce the sensitvie area, or by using about the lowest light level that will reliably trigger the interface. □

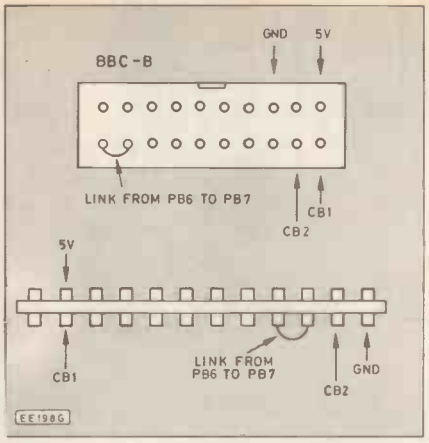


Fig. 5. *BBC* (upper) and *VIC-20* (lower) connectors.

YES!
HOME COMPUTERS
***CAN* DO SOMETHING**
USEFUL

BBC

```
 10 REM SHUTTER TIMER PROGRAM
 20 REM J.W.P 7/84
 30 *K.10 OLD:MLIST:M
 40 DIM START 100
 50 FOR I%=0 TO 2 STEP 2
 60 P%=START
 70 COPT I%
 80 LDA #16
 90 .LOOP1
100 BIT &FE6D
110 BEQ LOOP1
120 LDA #255
130 STA &FE68
140 STA &FE69
150 STA &FE64
160 STA &FE65
170 .CLKOFF
180 .LOOP
190 LDA #8
200 BIT &FE6D
210 BEQ LOOP
220 LDA &FE68
230 STA &72
240 LDA &FE65
250 STA &71
260 LDA &FE64
270 STA &70
280 .OUT
290 RTS:]
300 NEXT I%
310 ?&FE6B=224
320 ?&FE6C=48
330 PROCscreen
340 REPEAT
350 ?&FE6D=24
360 CALLSTART
370 ?&72=?&72+(?&72-255)
380 reading=?&70+256*?&71+65536*?&72
390 milliseconds=(16777216-reading)/1000
400 PROCdouble(20,9,"          ")
410 @%=&102030A
420 PROCdouble(20,9,STR$(milliseconds))
430 fraction=INT(1000/milliseconds)
440 PROCdouble(23,13,"    ")
450 @%=&20030A
460 PROCdouble(23,13,STR$(fraction))
470 UNTIL FALSE
480 END
490 DEF PROCscreen
500 CLS
510  PROCdouble(12,3,"SHUTTER TIMER")
520 PROCdouble(20,13,"1/")
530 PRINTTAB(0,9);"Milliseconds"
540 PRINTTAB(0,13);"Nearest fraction"
550 ENDPROC
560 DEF PROCdouble(x,y,screen$)
570  PRINTTAB(x-1,y);CHR$(141);screen$
580 PRINTTAB(x-1,y+1);CHR$(141);screen$
590 ENDPROC
```

VIC-20

```
  5 REM VIC SHUTTER TIMER
 10 FOR M=6144 TO 6187
 20 READ V
 30 POKE M,V
 40 NEXT M
 50 DATA 169,16,44,29,145,240,251,169,255,141,24,145,141,25,145,141,20
 60 DATA 145,141,21,145,169,8,44,29,145,240,249,173,24,145,133,89,173,21,145,1
33
 70 DATA 89,173,20,145,133,87,96
 75 POKE 55,0:POKE 56,24
 80 POKE 37147,224
 90 POKE 37148,48
100 POKE 37149,24
110 SYS 6144
120 POKE 99,PEEK(89)+(PEEK(89)-255)
130 R=PEEK(87)+256*PEEK(88)+65535*PEEK(89)
140 MS=(16777216-R)/1000
150 PRINT MS;" MILLISECONDS."
160 GOTO 100
```

COMPUTER CLUB

by Thakery

FUNdamental FACTS

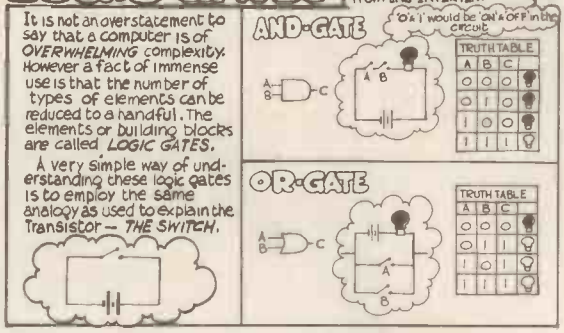
The capacity of a computer is expressed in terms of WORDS or BYTES.
eg 8K memory = $8 \times 2^{10} = 8192$ words
or it may be quoted in Kilobytes or even Megabytes
8 bits = 1 byte & 4 bytes can = 1 word.

LOGIC GATES

The AND & OR gates form the basis of all other gates apart from the INVERTER.

It is not an overstatement to say that a computer is of *OVERWHELMING* complexity. However a fact of immense use is that the number of types of elements can be reduced to a handful. The elements or building blocks are called *LOGIC GATES*.

A very simple way of understanding these logic gates is to employ the same analogy as used to explain the Transistor — *THE SWITCH*.



Computer SCIENCE

Understanding how a computer works isn't the easiest thing in the world so let's start at the very beginning with our old friends 1 & 0.

The computer has to store information before it can do anything else and it does this by using the simplest imaginable code which has only two characters 1 & 0.

So the simplest message must be one character $x = 1$ or $x = 0$
Our message carries UNIT INFORMATION called a BIT and can take the value 1 or 0 and there is a formula to tell you the number of possible messages

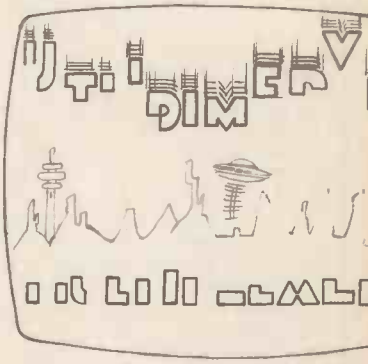
N = Number of possible messages
x = Number of bits.

$$N = 2^x$$

Let $x = 3$ then $N = 2^3 = 8$ possible messages

These messages are 000, 001, 010, 011, 100, 101, 110, 111

WORD INVADER



Join the invading segments at the top of the screen to join the segments at the bottom of the screen to form a computer related word.

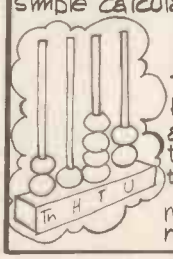
HISTORY

Early developments may be considered as starting with the first civilisations in Egypt. Their method of counting was very primitive — numbers were represented by PEBBLES arranged in heaps of ten.

the Abacus

We are all familiar with the 'Abacus' as being rows of beads sliding on medal rods but the ORIGINAL Abacus was a flat tray of sand. Marks were made in the sand with a thin sharp stick.
('Abacus' is taken from the Greek word 'Abax' meaning flat board)

The 'Abacus' as we know it is still used today and is considered by some to be faster than the modern computer for simple calculations.

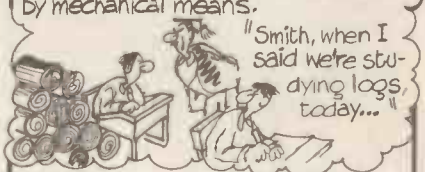


One of the most important inventions in calculations was the '0'. The Hindus invented the '0' and would be represented by an empty rod on the 'Abacus'.

The Ancient people were now able to do calculations without apparatus.

JOHN NAPIER.

Publication of a work by John Napier in 1617 showed a method of multiplying and dividing by the use of "RODS" or "BONES" — combined with the use of original data tables marks one of the historical contributions to COMPUTATION by mechanical means.



PASCAL The Frenchman Blaise Pascal built a digital calculating machine in 1642 to assist with his father's business accounts.

The machine was able to perform addition during which CARRYING

AMBUSH

The BLACK SPOT is ambushed by a horde of numbers but there is an escape route! All you have to do is find 19 circles leading to the outside of the square and they must add up to exactly 48.

3	1	2	6	2	6	9	7	2
2	9	8	14	3	2	1	8	1
6	6	3	2	1	4	2	4	3
2	1	4	9	3	6	3	7	12
6	2	3	1	●	4	1	2	4
17	3	9	2	3	4	6	2	3
8	1	2	3	2	3	9	7	7
4	4	6	4	6	7	8	4	3
9	7	2	1	2	6	2	1	4

LINK-UP

Link-up the letters to form a chain of words related to computing ⇨ start at B

	A	T	O	R	P	A	S	S	
	L	D	O	W	N	L	O	W	O
	U	N	H	E	R	A	A	D	R
	C	O	P	I	R	L	D	I	D
	L	I	B	A	E	P	O	N	F
	A	T	A	S	I	C	C	G	L
	C	G	T	N	E	M	U	D	O
R	F	N	I	G	G	U	B	E	W
A	N	I	A	M	T	R	A	H	C
M	E								

WORD	CLUE
1 B___C	Beginners...
2 _E_____L	disk drive is one
3 __CUM__TATION	may include flowchart
4 D___L__D_G.	Large to small
5 DE_____	...not if you're perfect
6 C_____TOR	Hand held
7 PA_____	...for access
8 FL__CH___	shows sequence
9 MA__F____	LARGE.

occurred by means of a gear chain arranged so that the next left wheel turned one unit when the dial exceeded '9'

"Actually, this machine doesn't count for you but it does slap your hand if you get it wrong."

LEIBNIZ In 1694 the German mathematician G.W. Leibniz completed the stepped Reckoner that could COUNT, MULTIPLY, DIVIDE and extract SQUARE ROOTS.

The major contribution was how he showed the advantages of binary over the decimal system for mechanical computers. I wonder if he realized that the binary system would be used today.

The software for "Seekers Of The Gold Seal" is continued from the last *Computer Club* below.

```
  530DEFPROCar W%=h%?Q%:T%=W%DIV19:IFV%=2 V%=SGN(T%-N%DIV19)+242
  540 IFV%=1 T%=W%-T%*19:W%=N%DIV19:V%=SGN(N%-W%*19-T%)+245
  550PROCwr:ENDPROC
  560DEFPROCtw(H%) VDU4,28,0,31,19,28:COLOUR131:CLS:COLOUR129:COLOURH%:ENDPROC
  570DEFPROCshft(B$,J$) MOVEC%,R%:PRINTB$:MOVEX%,Y%:PRINTJ$:C%=X%:R%=Y%:ENDPROC
  580DEFFNsk(X%,C%,P%,R%) LOCALY%:T%=0
  590 FORX%=X% TOC% STEP8:FORY%=P% TOR% STEP4:V%=FNpt:IFV% T%=V%
  600NEXT:NEXT:=T%
  610DEFPROCse PROChd
  620 DIMN$(7),K$(4),C$(4),H$(7),A$(5),I%(7),T%(4),x%7,y%7,B%6,L%7,D%406,h%6:E%=
&B00:G%=&B20
  630DATAGloom,Towers,Bat,Crab,Arches,Zeen,Sorah,Flent,Hidden ,Arrowed,Sealed ,S
lipped,Fallen!,"  Empty"
  640 RESTORE630:FORS%=0 TO7:READN$(S%):NEXT:FORP%=0 TO5:READA$(P%):NEXT
  650DATA1,5,9,15,21,17,25
  660 PROCz:FORP%=1 TO7:READG%?P%:NEXT
  670FORP%=1 TO26:REPEAT Q%=38+RND(26):UNTIL G%?Q%>1:G%?Q%=1:E%?P%=Q%:NEXT
  680 FORS%=0 TO4:T$="":W$=""
  690REPEATFORQ%=1 TO3:IFQ%=2T%=G%?RND(5) ELSET%=FNa
  700 IFQ%<>2ANDRND(5)<2THEN720
  710 T$=T$+CHR$(E%?T%):W$=W$+CHR$(T%+96)
  720 NEXT:UNTILLENT$>2:K$(S%)=W$:C$(S%)=T$:NEXT
  730 T$=C$(3)+C$(4):T$=T$+T$:S%=5:T%=LENT$:IFT%>9 T%=9
  740REPEATH$(S%)=H$(S%)+MID$(T$,T%,1):S%=S%+1+(S%=7)*3:T%=T%-1:UNTILT%=0
  750 S%=3:FORP%=0 TO4:H$(S%)=C$(P%):S%=(S%+1)MOD5:NEXT
  760VDU23,252,0;0,124,61438;71;23,253,64,64,64,120,60540;196;23,254,0;0;0,16,56
,16,23,255,2,7,2,3,1;0;23,239,26,58,107,75,72,72,216;23,240,0;24,126,24,24,24,25
4
  770VDU23,246,8,24,26417;49,24,8;23,245,0,17022;66,66,66,126;23,244,16,24,59020
;140,24,16;23,243,16,56,50796;16,16,124;23,242,0,17022;66,66,66,126;23,241,4220;
16,27846;56,16;
  780VDU23,238,65535;65535;65535;65535;23,237,60,50022;56319;39321;153,23,236,36
,50022;66,231,189,153;23,235,126,90,65499;65535;48615;23,234,130,43690;65278;238
,238;23,233,65278;27756;254,238,238;
  790FORP%=0 TO17:READW%:J$=J$+CHR$W%:IFP%MOD7=2 W%=0
  800 B$=B$+CHR$W%:NEXT
  810DATA18,0,1,252,253,8,8,18,0,2,254,254,8,8,18,0,3,255,5,7,12,9,14
  820FORP%=1 TO5:READB%?P%:NEXT
  830REPEATT%=0:S%=0:Q%=5500:PROCc
  840REPEATS%=S%+1:IFS%=5 Q%=2700
  850REPEATPROCc:Y%=1:FORP%=0 TOS%-1
  860 V%=ABS(x%?S%-x%?P%):W%=ABS(y%?S%-y%?P%):IFV%*V%+W%*W%<Q% Y%=0
  870 NEXT:T%=T%+1:UNTILY%=1 ORT%=300:UNTILS%=7 ORT%=300
  880 IFT%=300 UNTILFALSE ELSEUNTILTRUE
  890REPEATPRINTTAB(0,20) "Mappings in Progress":PROCl(404)
  900 PROCz:G%?0=129:G%?1=153:G%?2=231:G%?3=255:I%=10:M%=40:N%=9:S%=0
  910 REPEATI%(S%)=I%:IFS%=5 M%=32:N%=5
  920 X%=27+RND(3):Y%=19+RND(4):PROCin(M%):PROCin(N%):PROCin(X%)
  930 T%=I%:I%=I%+1:W%=0:REPEATW%=W%+RND(54)
  940 PROCin((X%-RND(7))*COSRADW%):PROCin(Y%*SINRADW%)
  950UNTILW%>309:D%?T%=I%-T%:PROCin(X%):PROCin(0)
  960 FORP%=0 TO4:REPEAT:T%=RND(64):UNTILG%?(T%+3)>1:G%?(T%+3)=1
  970 FORQ%=0 TO2:W%=G%?(T%MOD4):PROCin(W%):T%=T%DIV4:NEXT:NEXT:S%=S%+1:UNTILS%=
8
  980IFI%>380 UNTILFALSE ELSEUNTILTRUE
  990 PROCst(0):C%=8:R%=128:A%=1:PROCqt(30):ENDPROC
 1000DEFPROCz FORP%=0TO246:G%?P%=255:NEXT:ENDPROC
 1010DEFFNa LOCALQ%:REPEATT%=RND(25):W%=1:FORQ%=2 TO7:IFT%=G%?Q% W%=0
 1020 NEXT:UNTILW%=1:=T%
 1030DEFPROCqt(T%) PROCcr(0):*FX15,1
 1040 IFT%=30 PROCl(96)
 1050 PRINTTAB(1,T%) "press bar to play";:K%=GET:ENDPROC
 1060DEFPROCc x%?S%=28+RND(203):y%?S%=55+RND(163):ENDPROC
 1070DEFPROCin(V%) D%?I%=ABSV%-128*(V%<0):I%=I%+1:ENDPROC
 1080DEFPROChd VDU22,2:PROCcr(0):COLOUR129:CLS:COLOUR3:PRINTTAB(1,2) "Valley of
the Seal":PROCl(912):ENDPROC
 1090DEFPROCtab LOCALS%,Y%:PROChd
 1100 COLOUR132:COLOUR2:PRINTTAB(1,5) "Key   TEMPLE  Find":Y%=6:FORS%=0 TO4:Y%=Y
%+2
 1110 PRINTTAB(1,Y%) C$(S%) TAB(10-LENN$(S%)/2,Y%) N$(S%):PROCt(19):NEXT
 1120 PROCl(448):COLOUR128:COLOUR6:PRINTTAB(2,19) "TOMBS       Find":Y%=22:FORS%
=5TO7
 1130 PRINTTAB(2,Y%) N$(S%):PROCt(18):Y%=Y%+2:NEXT:IFa%=2 ENDPROC ELSEPROCqt(30)
 1140DEFPROCvl
 1150 PROCv19(0,1):PROCv19(1,2):PROCv19(2,4):FORP%=4 TO15:PROCv19(P%,1):NEXT
 1160 COLOUR128:CLG:F%=0:FORS%=0 TO7:IFL%?S% PROCard(S%+4,1):F%=F%+1
 1170 NEXT:VDU24,8;128;1271;1023;:K%=8:O%=104:X%=C%:Y%=R%:PROCshft(B$,J$):ENDPRO
C
```

Continued on page 345

CARAVAN PSU

T. R. de Vaux Balbirnie

ALTHOUGH portable equipment is useful to take on a caravanning holiday, it proves expensive on batteries. Assuming the caravan has a 12-volt system supplied by either an independent car battery or through a hook-up lead from the towing vehicle, items such as radios, cassette recorders, games and keyboard musical instruments may be operated at practically no cost.

This project accepts a nominal 12V input and supplies a regulated 6V, 7·5V or 9V output at up to 300mA. This suits a wide variety of battery powered equipment. Precision resistors are used to preset the output voltages so it is not necessary to have a volt meter available at the testing stage.

Special features of this circuit are switched polarity reversal of the output leads and the ability to make input connections either way to the supply. This is useful where the caravan is fitted with non-polarised sockets, or where battery clips are to be used.

Examine each piece of equipment to be powered by the unit. Check that it requires one of the above input voltages, and that it is fitted with a d.c. power-in socket. Such sockets are usually used for connecting mains operated power supplies. Although some items are fitted with 2·1mm or 2·5mm connectors, or 2·5mm or 3·5mm jack sockets, DIN or other types of socket may be found. If no such d.c. input socket is fitted it will be necessary to make direct connections in the battery compartment and the feasibility of this should be investigated before proceeding.

CIRCUIT DESCRIPTION

The circuit for the *Caravan Power Supply* unit is shown in Fig. 1. With S1 on, current flows through FS1 to the bridge rectifier REC1. Whatever the polarity of the input connections, the bridge rectifier will direct current correctly to the rest of the circuit—that is, with the positive and negative as shown. D1, a light emitting diode with current limiting resistor R1 shows that the circuit is switched on. IC1 is a voltage regulator which gives a steady output voltage whose value depends on R2 in conjunction with either R3 (9V), R3+R4 (7·5V) or R3 + R4 + R5 (for 6V) as selected by the 3-position switch S2. S3 sets the output polarity. When switched the opposite way to that indicated in the diagram the output leads will assume opposite polarity.

VOLTAGES

The output voltages are preset to approximately 90–95% of their nominal values. This allows for the precision resistors R2, R3, R4 and R5 being at the extremes of their tolerance, and for the fact that even a new battery does not produce its nominal voltage on account of its internal resistance. In the prototype, the voltages were 8·2V, 7·1V and 5·7V for 9V, 7·5V and 6V settings respectively. Tests with several pieces of portable equipment proved these to be entirely satisfactory. It will be noted that the *higher* the resistance between the adjustment and output pins of IC1, the *lower* will be the output voltage. This particular arrangement of R3, R4 and R5 was chosen so that the circuit defaults to a *low* output voltage in the event of S2 failing to make proper contact or wires detaching from its terminals.

Operates battery-powered equipment from a 12V supply

CONSTRUCTION

Since most of the circuitry is already inside IC1, construction is made very straightforward. Due to variations in size in components of the same specification, readers are advised to check their layout before buying the case. The prototype was made to take up as little space as possible but some readers will wish to use a larger box to give more working room.

IC1 becomes warm in use so must be mounted on an aluminium panel which acts as a heat sink. Begin by cutting this part from thin aluminium sheet to fit tightly in the runners of the case. Its width should be 4mm less than the height of the box to allow connecting wires to pass over the top. Cut short the centre connection and bend the tab of IC1 so that this component will lie flat on the panel. Drill a small hole and attach it using a small fixing. Note the solder tag which is secured under the nut. Cut the tag panel to fit the runners of the case tightly—there must be at least 10 tags available in two rows. Refer to Fig. 2, and solder the components in position noting the polarity of C1. It is essential to use only high quality close-tolerance resistors for R2–R5 as specified in the components list. Neglecting this could possibly result in output voltages which are too high. Prepare the case by making holes for the switches, l.e.d. indicator, fuse holder and the input and output leads. Mount the off-board components noting that it helps to place some packing under S2 and S3 to level the slides with the face of the case. This will make accidental operation less likely. Refer to Fig. 2 and complete all wiring. Take care over the connections to S2 and S3 so that the output voltages and polarity are predictable. Although S2 is a 4-pole switch only one pole is used in this circuit. Note that the connections between the adjustment pin of IC1 and R2, and between R2 and the negative supply line demand special care. ***WARNING: If any of these should become detached, the output voltage will rise to the full 12V of the supply with possible damage to external equipment.***

Tape a piece of thin cardboard to the back of the tagboard to provide insulation. Insulate any other exposed connections where they could short-circuit to the metalwork. Use 3A 2-core mains wire for the input and output leads and tie string tightly around each on the inside of the

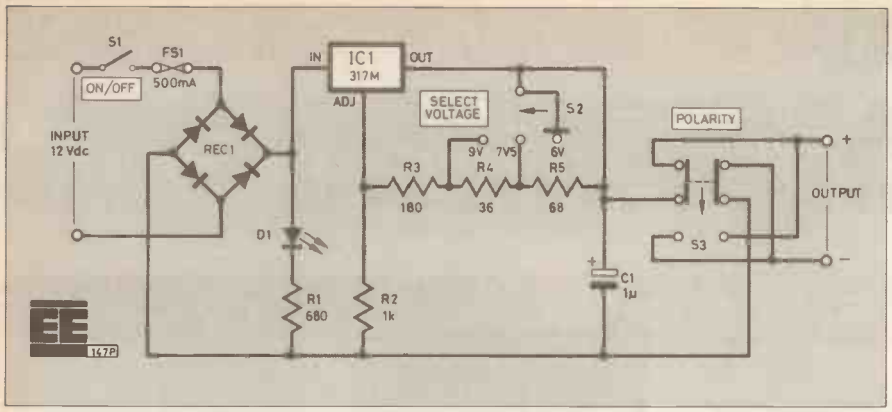


Fig. 1. Circuit diagram.

case to provide strain relief. Slit a piece of scrap insulation along its length and use it to protect the top edge of the aluminium panel. Fit appropriate connectors to the input and output leads. In the prototype, a 4-way Universal Connector was used for the output.

TESTING

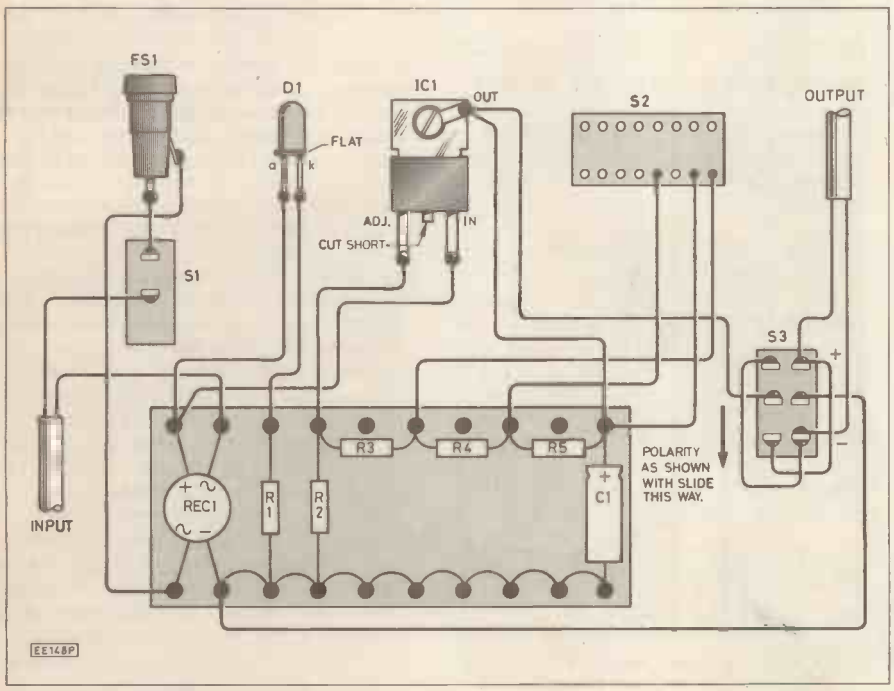
Although not essential, some readers may wish to use a multitester to check the polarity and output voltages. A simpler test can be made with a small 12V bulb. Connect this to the output lead, adjust S2 to 6V, connect the supply and switch on. The l.e.d. should light and the test bulb glow dimly. At 7·5V and 9V settings it should increase in brightness but never become as bright as it does when connected directly to the 12V supply. If there is any doubt about the polarity of the output wires, check by connecting a diode in series with the test bulb (Fig. 3). With the diode connected as shown the test bulb should light.

It only remains to label the switches and to check that they cannot be operated accidentally. Where young children are present it would be a wise precaution to tape over S2 and S3 since a higher voltage than that required, or switching to the wrong polarity could damage equipment.

USING THE UNIT

Before connecting a particular piece of equipment to the power supply, determine the operating voltage and polarity. Do not use trial and error. Always switch off S1 when the unit is not actually being used since it draws a small current (about 20mA) even with nothing connected to the output. Switch off also before changing the settings of S2 or S3. Note that it is normal for the case to become slightly warm in operation. □

Fig. 2. Tag-board layout and wiring.



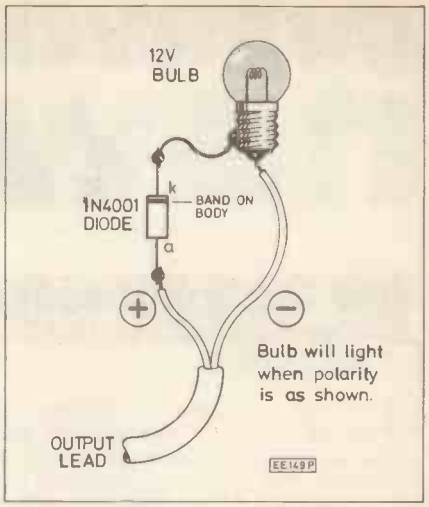


Fig. 3. Polarity tester.

COMPONENTS

See Shop Talk page 312

Resistors

R1	680
R2	1k
R3	180
R4	36
R5	68

All resistors 0·4W metal film ± 1% (R1 may be ¼W carbon ± 5%)

Capacitors

C1	1µ 15V electrolytic

Semiconductors

IC1	317M voltage regulator
REC1	W005 50V 1A bridge rectifier
D1	TIL220 5mm red l.e.d. with panel mounting clip

Miscellaneous

S1	miniature SPST rocker switch
S2	miniature 4P3W slide switch (Maplins 4-pole slide switch
S3	miniature DPDT slide switch
FS1	500mA fuse and fuseholder to suit

Sub-miniature tag board; Plastic box (see text); 3A mains type twin wire; Aluminium panel; Universal power-in connector, plugs and sockets for input and output leads as required; Fixings; Solder tag.

Approx. cost Guidance only £8.00

EVERYDAY news ... from the world o

New Laboratories for Graduates

OPENING the new Advanced Telecommunications Laboratories in the Department of Electrical and Electronic Engineering at Queen Mary College, University of London, Dr John Alvey CB FEng, Engineer-in-Chief British Telecom offered his congratulations to the Principal, Sir James Menter, FRS, on the College initiative in setting up the laboratories.

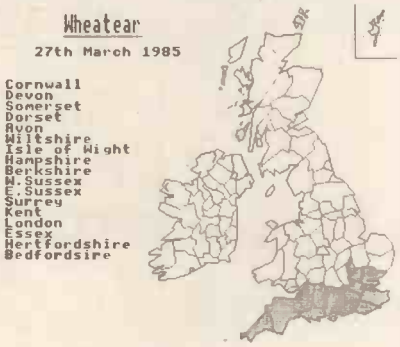
In his speech Dr Alvey referred to the increasing shortfall in the number of graduates being produced to meet the needs of the Electronics and Telecommunications Industries and spoke of the facilities at Queen Mary College as being just the sort required to provide graduates with the skills they will need to help British industry establish a leading role in the many aspects of Information Technology. These facilities are probably unique in the UK and establish the Department of Electrical and Electronic Engineering as one of the leading departments in the country.

He particularly appreciated the combination of technologies provided for undergraduates within the Department. For instance, the VLSI Design Laboratory which gives students the opportunity to design on silicon and see some of their integrated circuits made and tested. Also the provision of a range of real telecommunications systems throughout the laboratories to enable undergraduate students to experience the application of the principles they have learnt on real systems.

Dr Alvey speaking to Mr Lomer, Technical Director Racal Electronics, over the digital telephone system built by a third-year project student.

Welcoming the guests, the Head of Department, Prof. Peter Clarricoats, FEng, explained that whilst the visit was primarily concerned with undergraduate activities, the Department played a leading role in research. The current value of grants held by the Department is almost one million pounds.

COMPETITION FOR BIRDBRAINS



The advance of migrant birds across the British Isles as shown on BBC Telesoftware's high resolution maps.

YOUNG computer enthusiasts have a chance to win a microcomputer and help scientific research in a new competition launched by BBC CEEFAX and the Young Ornithologists' Club (YOC) of the Royal Society for the Protection of Birds.

The latest data on the spring migration of birds arriving in Britain is being collected by members of the YOC, who are reporting the first sightings of spring migrants throughout the country. BBC CEEFAX is displaying maps and information to show how birds are travelling across the country, on page 295 on BBC 2. More detailed information is also being transmitted through the BBC CEEFAX Telesoftware Service, which will be updated weekly until the end of this month (May).

The competition winner will be the person who makes the most imaginative and innovative use of the data transmitted by Telesoftware. The programs based on the Telesoftware data will be judged in September, and the winner will receive a BBC Microcomputer; three runners-up will receive Electron Microcomputers, and there will be consolation prizes of binoculars.

ALL AT SEA

Questions and answers will be bouncing back and forth across the Atlantic by satellite as The Times Network for Schools puts UK schools in direct touch with the *Operation Raleigh* flagship, sailing off the coast of Panama.

The *Sir Walter Raleigh* is at present in the Caribbean, acting as a base for extensive community work and diving exploration and in the cause of conservation. TTNS's representative Lakh Singh, has just joined the ship and will be sending twice-weekly bulletins to the schools network via the satellite link.

Schools in the UK will be able to ask Lakh specific questions on projects they are undertaking and he will reply via the Network. A team of scientists will also be using the *Sir Walter Raleigh* as a base.

This will provide schools with immediate access to new research information and the opportunity to question scientists as they carry out their work in the field.

Oil and gas production platforms in the North Sea will have their own satellite communications system next year. The system will be called SatStream Offshore and contracts for the provision of a permanent service to a floating production platform in June '86 have been signed by British Telecom and the North Sea Sun Oil Company.

A new satellite earth station near Aberdeen, using an 8m (26ft) diameter dish, is to be built by British Telecom.

This earth station will work to the European Communications Satellite, *EUTELSAT 1–F2*. It will offer satellite facilities to platforms in any part of the UK's offshore exploration areas.

Philips is to supply 115 million Guilders worth of colour television sets to the People's Republic of China. The contract was signed by the Consumer Electronics Division and a Chinese Purchasing Delegation.

AGREEMENT ON EDUCATION

THE City and Guilds of London Institute (CGLI) and the Scottish Vocational Education Council (SCOTVEC) have announced that they have reached agreement on the terms of a formal Memorandum of Agreement covering the establishment of equivalences between particular certificates awarded by the CGLI and particular modular programmes of study, leading to the award of the SCOTVEC National Certificate.

Announcing the agreement Mr. H. M. Neal, Chairman of CGLI, and Dr Peter Clarke, Chairman of SCOTVEC, made the following observations:

"The agreement provides the framework of procedures within which individual equivalences can be established and detailed work has now begun on taking these matters forward.

"The new agreement has been reached after careful and detailed discussions. We believe it will be mutually advantageous to both parties in assisting the establishment of the new SCOTVEC National Certificate and in making a major contribution towards the success of the 16-plus Development Programme being implemented in Scotland."

OFFSHORE DEAL

Thorn EMI Electronics has been awarded a contract by Humphreys and Glasgow on behalf of Britoil, to supply a sophisticated environmental monitoring system for the Britoil Clyde field.

The microcomputer-based equipment will display all the current weather information on a number of VDUs situated in various parts of the platform. Displays can be modified to include special customer requirements or any new legislation that might arise; further sensors can also be added if required.

The monitoring system, which can be linked to a telemetry facility and interrogated at intervals, can also be connected to a tape recorder or other data logging system to provide a permanent record. Apart from the sensors it is claimed that the system requires no maintenance.

MICRO TRENDS

Barely two thirds of UK micro suppliers have been in the market for more than a year and nearly a third are likely to withdraw before the year is out. This is one of the more startling conclusions which can be drawn from the third NCC Microsystems Centre's survey of the UK micro-market.

This survey is based on the files used to support the NCC Microsystems Directories of Hardware, Software and Training. These files are updated daily as new products are identified and old ones withdrawn, or suppliers go out of business and no-one is willing to take over the product.

Of the 629 hardware suppliers known to be active in the UK market as at March 1st, only 386 (61 per cent) had been identified as at September 1 (when the first NCC-computing survey was drawn up). However, of those active in September, 65 (14 per cent) have since withdrawn—implying an annual rate of nearly 30 per cent. Part of the reason for the rate of entry is that over two-thirds of the products on sale are imported and many new suppliers are merely agents for American organisations (over half of all systems) or Japanese (who dominate the market for most types of peripheral).

Under the terms of a deal worth £¼M, Microvitec will manufacture switched mode power supplies and colour monitors for the RM Nimbus computer which was launched recently by Research Machines.

A graphics utility package for the Amstrad CPC464 is the latest software release from Kuma.

Entitled "Artwork" (£9.95), it enables the user to draw pictures and includes the facility for circle, ellipse, line and box drawing and allows full use of available screen modes and colours.

Options for fast colour fill and complete screen scroll in all directions are included, plus the ability to load and save completed pictures to either tape or disc.

MOBILE REPAIR SERVICE

THORN EMI Electronics have recently received an £18M contract from the British Army for the supply of a number of its general purpose thermal imager repair facilities (GPTIRF).

The GPTIRF will allow the British Army to test and repair complex thermal imaging equipment in the field and in base workshops rather than returning the equipment to civilian contractors.

The contract, which was secured by the company's Electro Optics Division, is the the third major contract for thermal imagers and associated equipments to be awarded by the MoD to THORN EMI Electronics in the last eighteen months.

Pictured here (top) is an interior view of the GPTIRF container body, showing a thermal imager being tested on the optical test bench, and (bottom) an exterior view of the vehicle with a towed generator attached.

BOOK REVIEWS

MICROCOMPUTERS AND THEIR INTERFACING

Author	R. C. Holland
Price	£6.95 Flexicover, £15 Hardcover
Size	210 x 147mm. 193 pages
Publisher	Pergamon Press
ISBN	0 08 031125 3 (Pbk.)

THERE is no shortage of books on this subject, but *Microcomputers and their Interfacing* is not an unwelcome addition.

When choosing a book on this topic, an important criterion (apart from cost) is likely to be the particular microprocessor that the author has used for explanation and examples. For although the various different 8-bit microprocessors have much in common, their differences are particularly evident when it comes to interfacing, and real-time control applications using assembly-language. Mr Holland uses chiefly the 8085 and the related Z80 chip for his examples, and this is a fair choice, as they are the most popular 8-bit microprocessors for industrial use and personal computers, respectively.

The opening chapters are given over to fundamentals—binary and hexadecimal arithmetic, logic, CPU architecture and memory organisation. This approach is common, but ought by now to be assumed prior knowledge, especially for a book concerned primarily with interfacing, rather than the fundamentals of microprocessor design. It would have been better to have devoted this space to the hardware of standard programmable and non-programmable I/O devices, establishing the distinction between memory-mapped and isolated I/O.

Following his introductory chapters, Mr Holland covers, in a very general way, standard methods for interfacing microprocessors to the outside world, using both digital and analog techniques. This is well-presented, and a useful and comprehensive summary. The section on 'Special Peripherals' will be of widespread interest, as floppy discs, keyboards, and VDUs are the media used by the majority of people for communicating with their CPUs. The hardware is shown in block-diagram form, which is appropriate to the approach taken in the text—widely applicable principles rather than specific instances—and makes for clarity.

The chapter on high- and low-level languages is ill-considered; it is probably impenetrable to those not already familiar with the use of different languages, and different assemblers and compilers, and of little value to those who are.

For the engineer who wants to know how to *use* his microprocessor to monitor and control external events, the final chapters are those of real interest: the 8085, Z80, and 9980 each have their own section. This is very useful, and although the manufacturers' own literature would still need to be consulted in order to implement a real system, their data sheets can be cursory or confusing to the novice. Mr Holland provides a beneficial service in explaining the function of control and timer registers, publishing full instruction sets, and giving examples. Also valuable are the explanations of the user ports on the Apple II and BBC computers, again with examples.

This book will no doubt find its way into college libraries and onto the bookshelves of many students and engineers. But as Mr Holland himself indicates by his (excellent) bibliography, he is up against stiff competition.

D. A. B.

EXPERIMENTS WITH YOUR COMPUTER

Author	Helen Davies
Price	£4.50 hardback, £2.25 paperback
Size	240 x 170mm. 48 pages
Publisher	Usborne Publishing Ltd
ISBN	0 86020 791 9

How can a computer be educationally useful? One approach is to make use of the speed and graphics capabilities of the computer to *model* real situations, using well-established mathematical modelling techniques. These techniques can be used for the optimisation of transportation systems, for example, or for investigations into rocket flight, population growth, or the national economy.

The reason that the computer is invaluable for such investigations is two-fold. Realistic models require hundreds (or thousands) of recalculations as parameters are varied in order to give a useful result; and the results are best displayed graphically. Both these tasks are ideally suited to a computer's capabilities. Once the analytical and the graphics programs are stored, parameters can be changed, and a new display obtained, saving hours of time and eliminating mistakes in recalculation.

A related area in which a computer is invaluable is the analysis of data. Are events positively or inversely correlated? At what level are test results statistically significant? What is an "average" result? The problem with all this is that the mathematics involved is not trivial, and the programs can be tricky to write properly. The solution is *Experiments With Your Computer*. This splendid book has listings for investigations into the effects of gravity on different planets, simple transportation problems, and an excellent "Running an Airline" model. The calculations are (rightly) presented in the body of the programs without comment. This means that the situations can be investigated immediately, while those who have the inclination can follow up the mathematics if or when they wish.

There are also some elementary but useful ideas for using thermistors and light-dependent resistors to directly monitor real-world conditions. The hardware involved here is minimal, and the interfacing instructions are clear and unfussy.

This is the way books for computer users ought to be written. No specialist prior knowledge is necessary; the machine's capabilities are properly exploited to allow real-life investigations. For young children, the presentation is so good that it will be possible to work from the text with minimal supervision; for older children (and adults) it is an invaluable springboard for further development of ideas.

D.A.B.

MICROMANIA

Author	Charles Platt
Price	£7.95 Hardback
Size	235 x 142mm. 184 Pages
Publisher	Victor Gollancz
ISBN	0 575 03419 X

THIS is an excellent book, because the author fully achieves his purpose, namely, to remove the mystique surrounding the Home Computer. A "Micromaniac" himself, he skilfully pilots us through the maze of Hardware, Software and Buzz Words. He sums up the good points and the bad points of most of the well known makes of Home Computers and he pulls no punches. He even evaluates the many and varied Computer Magazines. It is not written for the expert, but for those who don't know a "Bit" from a "Byte" or a "Dot" from a "Daisy Wheel", and although after reading it, you won't be an expert on "Boolean Algebra", you will at least know how the Binary Code works. It is a "Must" for beginners, and they should not venture within ten miles of a computer shop before reading it.

Illustrated with an abundance of helpful diagrams and amusing cartoons, the author adds just that touch of humour which makes the book a pleasure to read.

A.S.

JULY FEATURES...

AMSTRAD I/O

The Amstrad CPC464 computer has proved an extremely popular machine, although it lacks a proper user port. This project provides just such a port, at a reasonable cost and with a minimum of hardware.

TRAIN SIGNAL CONTROL

All model train enthusiasts will want to build this signal controller. The red signal stops a train from entering a zone in which there is already another train. When the line is clear, the signal changes to green and the train can move.

CONTINUITY TESTER

This unit incorporates a buzzer so that short circuits can be easily and quickly detected. Diodes and the majority of electrolytic capacitors can also be checked.

Actually doing it!

Spread out before you are the following items: One magazine constructional article, a selection of small tools, a soldering iron and reel of solder, a p.c.b. and packets of electronic components. What do you do next? If you are a beginner, the answer is simple. Read this new regular column.

DOWN TO EARTH

BY GEORGE HYLTON

A TRANSISTOR is a cleverly-processed bit of semiconductor material. To make use of it, the engineer needs to know how it behaves electrically. This entails inventing an equivalent circuit, in which the electrical activity of the device is represented by an assembly of familiar elements.

ACTIVE DEVICES

Transistors are active devices. This means that in order to describe how they work, any circuit which serves as a model must contain a generator of some kind. The rest can then be made up of passive elements: resistors, capacitors, etc.

Note that I'm talking about a model for what goes on *inside* the transistor, not a complete circuit with external elements such as collector loads and base bias resistances. That comes later.

There are two kinds of models. One is concerned with the d.c. conditions in which the transistor operates. The other kind assumes that the d.c. operating conditions are satisfactory and deals only with small a.c. signals. Small means not so large that the signals interfere with the d.c. conditions.

Assuming that the transistor is operating in the common-emitter configuration (i.e. with the emitter earthed or common to both input and output) the simplest a.c. equivalent circuit is shown in Fig. 1. Here the input impedance of the device is modelled by resistance R. When an input current flows (between base, b, and emitter e), this causes a corresponding collector current to flow. Because the device amplifies, this collector current is greater than the base current. The amount by which it is greater is called the current amplification factor. It is typically 100, but very variable. For small (a.c.) signals, this number is given the symbol hfe.

If the polarity of the signal is such that current flows *into* the base, then amplified current flows *into* the collector. Of course, a.c. signals alternate between inwards and outwards, but for convenience it is usual to consider only one polarity at a time.

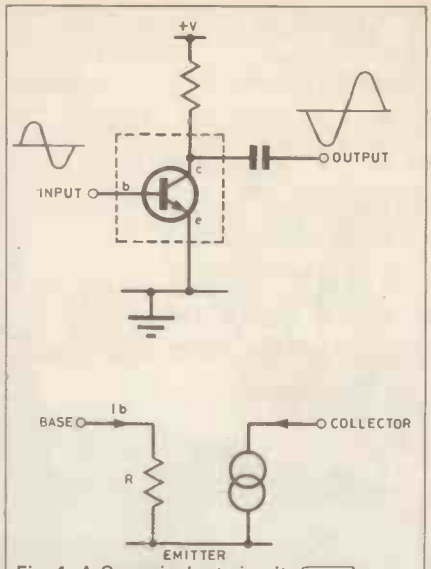


Fig. 1. A.C. equivalent circuit. EE201G

MICROPHONE AMPLIFIER

Now let's use the model in a practical situation and see (Fig. 2) what happens. Suppose we have a microphone whose internal impedance is 500Ω and which produces an audio signal of 3mV. We connect this to a transistor whose input resistance R is 2·5k. (Never mind how we know this, for now.) The transistor is given a collector load of 10k, so the current generator is driving current through 10k. If hfe=100 this current is 100 times the base current.

What's the base current? By inspecting Fig. 2 it is clear that the microphone's 3mV must drive current through its own impedance (500Ω) and R in series. We have 3mV and 3k. This gives a base current, ib, of 1μA. The collector current is therefore 100μA (0·1mA). In flowing through the 10k load this sets up a voltage of 1V (1000mV). The voltage gain, overall, is 1000/3 = 333.

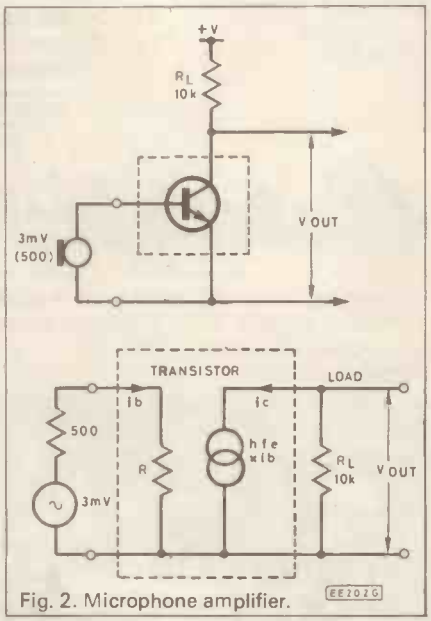


Fig. 2. Microphone amplifier. EE202G

CLOSER TO REALITY

Our model has told us the voltage gain, but of course it is not a full working circuit, with d.c. supplies, input and output coupling capacitors and so on. Never mind. It has in fact already given a vital pointer to the d.c. conditions needed. If the a.c. collector current is 100μA then in order that the a.c. will not interfere with the d.c., the d.c. collector current must be more than 100μA. How much more depends on commonsense considerations.

If the microphone gives out 3mV on an average sound, what will it give on a loud one? Maybe 10 times as much. So to handle the loudest sounds the collector current must be at least ten times 100μA, i.e. 1000μA or 1mA. We have selected one d.c. operating condition already!

INPUT IMPEDANCE

The input impedance of a transistor can be estimated. At audio frequencies, and with small d.c. collector currents, the common-emitter input resistance is approximately:

$$\left(\frac{hfe \times 25}{Ic\ (mA)}\right) \text{ ohms.}$$

In our case we have selected Ic = 1mA, and our transistor's hfe = 100. So the input resistance is roughly 25 x 100/1 = 2500Ω, or 2·5k, which is the value actually given.

All very well, but hfe is a very variable quantity, even among nominally identical transistors. What if our particular specimen had hfe = 200?

Let's see. The input resistance would then be 25 x 200/1 = 5000Ω (5k). With the microphone's 500Ω, the 3mV signal now sees a total of 5·5k. The base current reduces to 3/5·5μA = 0·545μA. This is now amplified by hfe = 200, giving ic = 109μA. This is 9 per cent more than before so the gain and output increase by a mere 9 per cent even though hfe has doubled.

Inspection of the diagrams shows why. Since the microphone impedance is small compared with R, in effect R controls the input current. As hfe increases, R also increases, reducing the input current in such a way as to keep the output current fairly constant.

SUPPLY VOLTAGE

With a d.c. collector load of 10k and current of 1mA the load drops 10V. The collector voltage must be more than this: it must be able to deliver the required output voltage. Suppose the amplifier drives a mixer whose input impedance is 10k. The amplifier "sees" 5k—the load resistance and mixer impedance in parallel. With a "loudest sound" microphone output, the output voltage into 5k (RL and the mixer) is 5V. So the d.c. supply must be at least 15V. If the microphone output is in r.m.s. volts rather than peak volts the peak output will be much more than 5V, so the supply voltage must be increased further. A fairly common voltage is 20V: you can see why.

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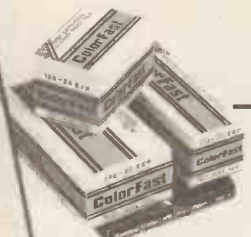

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*monostables *bistables *astables

Stephen Ibbs

No, this is not an article about various types of housing accommodation for horses, but about three building blocks that are used time and time again in electronics, and yet never fail to cause confusion in the minds of newcomers to the hobby. The stable part comes from the same root word as stability, so the three words of this article's title refer to different types of circuits dealing with electronic stability. The three, known as multivibrators, will be explained separately, and examples given with various circuits using both transistors and i.c.s. Finally a simple test-bed circuit will be described that can be built and experimented with.

All the circuits are shown using a 9V supply, but in fact the CMOS circuits will operate from approx. 5 to 15V, and the transistor circuits from approx. 3 to 12V. All the component values are only suggestions, and modifications are encouraged. None of the CMOS circuits show the supply connections (+V pin 14, and 0V pin 7), and if they are tried, don't forget to tie any spare input pins from unused gates to either supply line, as the text will explain.

MONOSTABLE (Transistor)

Any word starting with mono usually refers to something single, and similarly a monostable multivibrator is stable in one condition only, either on or off (high or low). The circuit can be forced to assume a different state but after a period of time it will revert to its original stable condition where it will remain indefinitely.

Consider the circuit in Fig. 1. Transistor TR1 is normally on, pulling its collector down close to 0V, taking with it the base of TR2, consequently keeping TR2 turned off. Also note that R3 and R5 keep both sides of C1 high so that it is fully discharged.

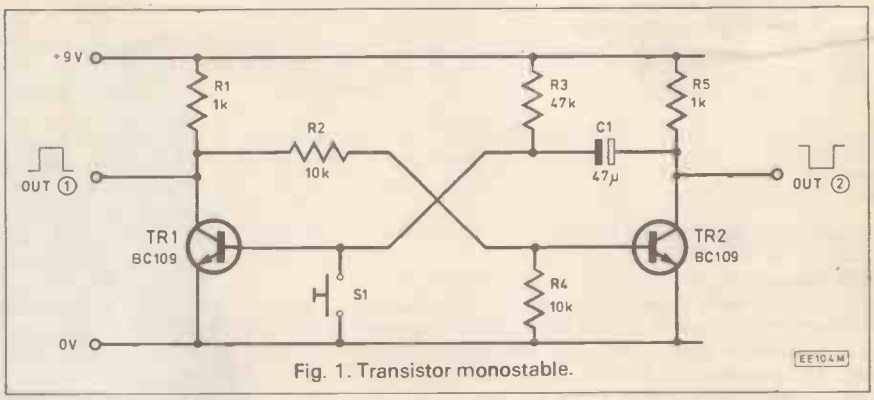


Fig. 1. Transistor monostable.

If however we temporarily short the base of TR1 to ground, this transistor will be turned off, allowing the collector voltage to rise, turning on TR2. The temporary short to base will also take with it the −ve side of C1. However after a period of time determined by the charging circuit involving C1 and R3, the base voltage of TR1 will gradually rise, and it will turn back on again, turning off TR2, and the circuit is once more stable. Note though that if the base of TR1 is held low, shorted to ground, then the outputs will remain in their changed condition until the short is removed, after which the monostable will then complete its cycle. Outputs can be taken from either collector.

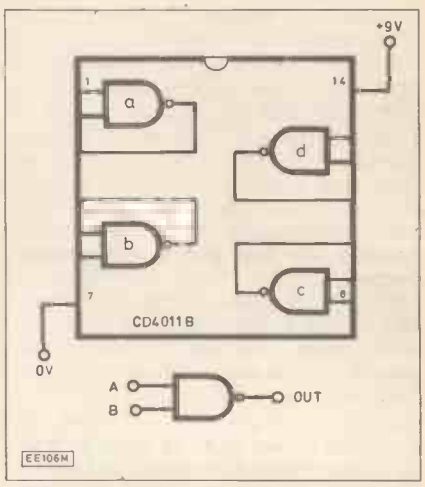


Fig. 3. CMOS 4011B pin connections.

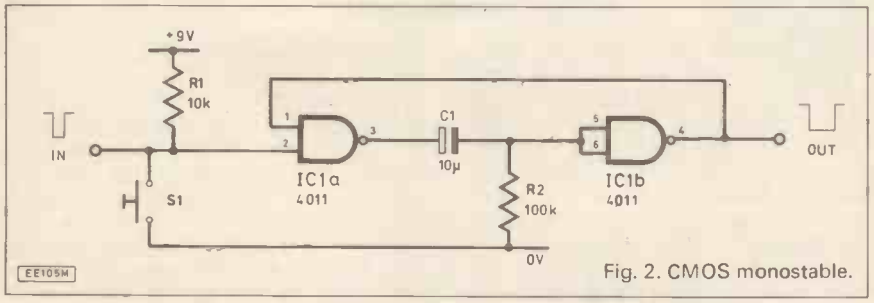


Fig. 2. CMOS monostable.

MONOSTABLE (CMOS)

Fig. 2 shows a circuit that does exactly the same job as the transistor circuit above, but this time it is performed by two gates of an i.c., the CMOS 4011 quad NAND gate. The quad means that within the i.c. are four identical circuits, symbolised by Fig. 3. The truth table is shown opposite, and these tables are extremely important for any logic circuit designer, because they show what the gate will do given certain conditions.

A logic gate can normally only assume two positions, referred to as high (1), i.e. close to the +V supply voltage, or low (0), close to 0V. The output state of the NAND gate will depend on the states of the two input pins, A and B, so that if both inputs are high, the output will be low. However if only one input is high, it doesn't matter which, then the output will be high, as it will be if both inputs are low. A final point to remember about any CMOS logic gate is that all the input pins must go somewhere; they cannot be allowed to float, i.e. not connected to anything, because the output won't know whether they should be high or low. Consequently you will read in circuit descriptions of pins being tied with resistors to +V or 0V as appropriate.

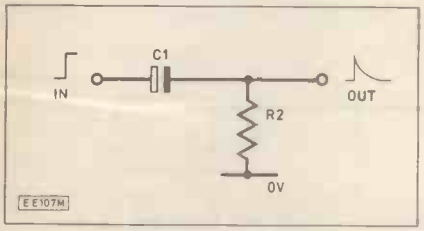


Fig. 4. Differentiator circuit.

Before we examine the circuit in more detail, it is worthwhile just looking at what happens at the junction of C1 and R2. This is called a differentiator, and if the input (the left hand side of C1 in Fig. 4) is a positive going transition, low to high, the junction of the capacitor and resistor will immediately go high, and then gradually fall to 0V via the resistor, irrespective of whether the input is still high or low.

Normally the output at pin 4 will be high. This is because R2 is pulling both IC1b inputs low. Because the output is connected to one of the inputs of another NAND gate (IC1a) and R1 is holding the other input of IC1a high, the output at pin 3 will be low, as shown by the truth table. Consequently both sides of the capacitor are low and it is fully discharged.

When a low-going trigger pulse is applied to pin 2, the output of IC1a will switch states, causing a high pulse, gradually decreasing to 0V on the two inputs pins 5 and 6, the junction of C1 and R2. Thus pin 4 goes low, taking with it pin 1. The output of IC1a will now stay high, even if the trigger pulse is removed. Eventually the decreasing voltage falls below the threshold of pins 5 and 6, and IC1b output reverts back to its original high state.

This takes pin 1 high, and assuming the trigger pulse is no longer there, the output of IC1a will return low. If however the trigger pulse is still present, then IC1a

Table 1. NAND gate truth table.

A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0

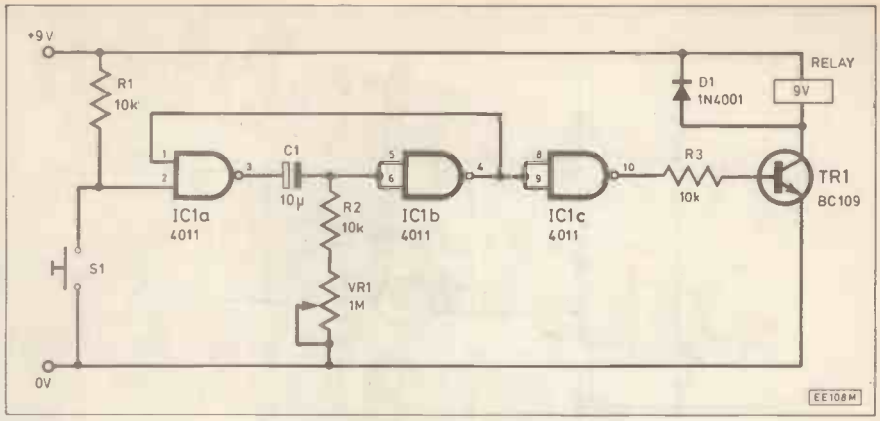


Fig. 5. Simple monostable timer.

output will stay high until it is removed. This is an important difference with the transistor circuit, namely the output (pin 4) changes back, irrespective of whether the trigger pulse has finished.

Monostable circuits are very useful as for example, simple pulse stretchers. As the name implies these lengthen a normally very short pulse to one slightly longer. Normal switches don't in fact switch over very cleanly, and produce more than one pulse, hence they are called noisy; this can totally upset logic circuits. To counteract this, pulse stretchers are used so that the monostable output lasts slightly longer than the complete switchover operation, ensuring that no extraneous pulses get through.

Another use for monostables is as a simple timer, and because of the high impedance of CMOS gates, high value resistors and capacitors can be employed to give very long time delays, a disadvantage with the transistor circuit incidentally. A practical circuit might well be based on one like Fig. 5.

The input to pins 8 and 9 is normally high, going low for the timed period. The truth table shows that the output will consequently be normally low, going high for the timed period, and thereby turning on the transistor. D1 is included to protect the transistor from back e.m.f. when the coil de-energises.

BISTABLE (Transistor)

Any word starting with "bi" normally means two, and a bistable multivibrator is one that is stable in either the high or low (the on or off or the '1' or '0' state). These types of circuits are useful as latches, i.e. sensing an input pulse, and changing the output accordingly. The advantage over normal switches is, as with the monostable above, that they can be made clean, so avoiding glitches in the circuit. The simple circuits shown here have two input pins, normally known as SET and RESET, but brief details will be given later of a specialised flip-flop i.c., the 4013.

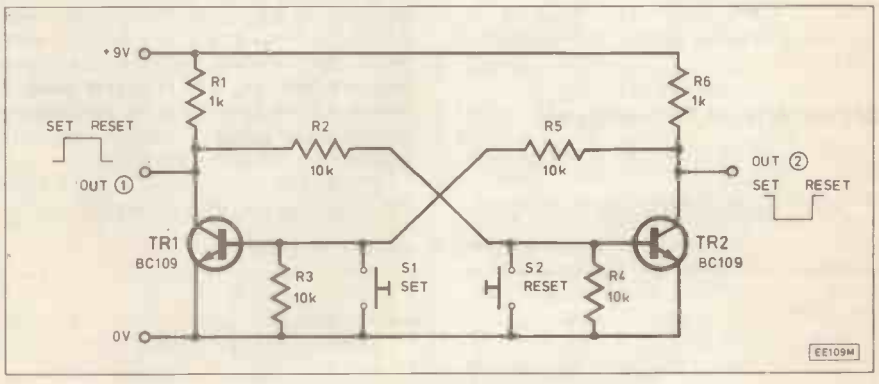


Fig. 6. Transistor bistable.

On pressing S1 the output will switch on TR1, which energises the relay. The changeover terminals can then control an appliance, turning it on or off after a predetermined length of time. Increasing the value of R2 or C1 will lengthen the time delay. You will note that an extra gate IC1c has been used. This was deliberately done rather than use a transistor to show that a 4011 gate can be used as a simple inverter.

Consider the circuit in Fig. 6, assuming that TR1 is on. The effect of this will be to pull the collector of TR1 down close to 0V, taking with it the base of TR2, turning that transistor off. If we now short the base of TR1 to earth, it will turn off, allowing its collector voltage to rise, past the point at which TR2 will turn on. This takes the TR2 collector voltage (and the TR1 base) down, thus ensuring that the base of TR1 is low, and this transistor is

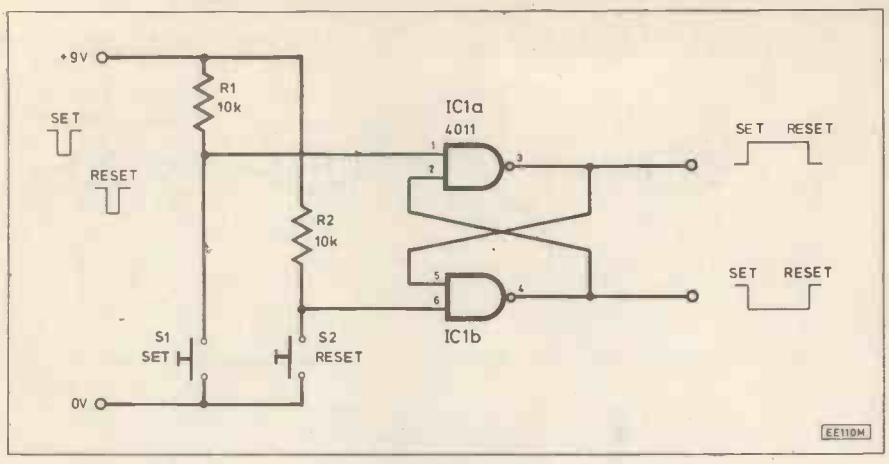


Fig. 7. CMOS bistable.

kept turned off. The circuit is now stable, but with the on and off transistors transposed. Another shorting to 0V, this time the base of TR2, will reverse the process. Outputs can be taken from either collector.

BISTABLE (CMOS)

The CMOS equivalent of the bistable circuit is shown in Fig. 7. Again two NAND gates are used, so that the same truth table applies. Assume that gate IC1a output (pin 3) is high. This means that IC1b pin 5 is high, and because pin 6 is tied high by R2, then IC1b output at pin 4 will be low, holding pin 2 low. R1 is holding pin 1 high, so IC1a output will stay high and the circuit is stable. If S2 is now closed briefly, IC1b output will switch high, taking with it pin 2. Now both IC1a inputs are high, so pin 3 will switch low, taking with it pin 5, and the circuit is once more stable, but with the outputs transposed. Closing S1 will reverse the process.

You will notice that there is no capacitor in either of the two bistable circuits. This is because capacitors normally introduce an element of timing, which is not required in this application, unlike monostables or astables. We want the switch over to be clean, and usually as fast as possible.

Fig. 8 shows a very simple application of a bistable, again using a relay which can be used to turn on household appliances, (but check the power rating!). It is a latching relay circuit, i.e. a simple pushbutton will cause the relay to turn on, and stay on. It will only turn off when the second pushbutton is pressed. Projects always look a bit more impressive with a couple of very small pushbuttons on the front panel to control something rather than a large toggle switch.

The 4013 is a more specialised CMOS dual flip-flop i.c., and a detailed description of all the possibilities available would take too long. However one of the principle advantages is that it only requires one pushbutton to set and reset. This has interesting applications in the field of frequency division, as Fig. 9 will show. Each rising edge of the input waveform will cause the output to change state. Thus it requires two input pulses to cause the output to rise and fall once, which means it has divided the input frequency by two. The 4013 has two identical circuits inside it (see Fig. 10) and the output of the first can be connected to the input of the second, which will further divide the frequency by two.

This technique is often used in simple musical instruments that need to generate frequencies for the different octaves. Usually what is involved is, creating the top octave's frequencies, then dividing them by two each time for the lower octaves.

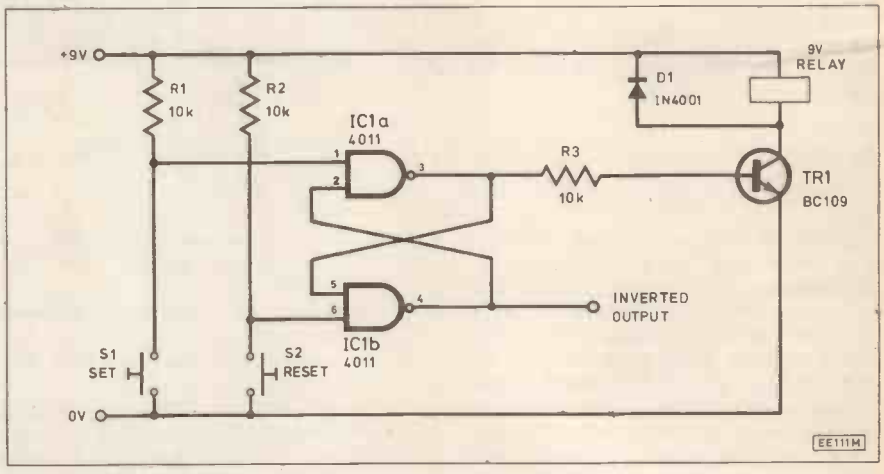
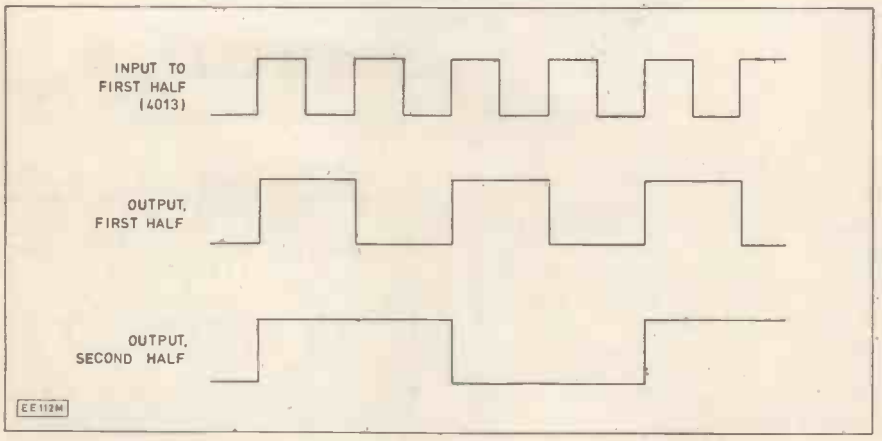


Fig. 8. Simple bistable application.

Fig. 9. Frequency division waveforms.



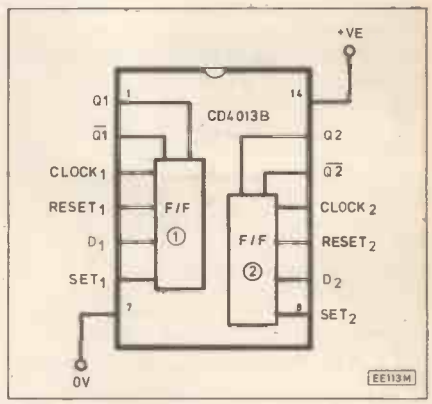


Fig. 10. CMOS 4013B pin connections.

An experimental circuit is given in Fig. 11 and consists of a sound generator, feeding into the 4013, which produces the two lower octaves. The output is fed into a piezo transducer, connected in what's known as a bridge circuit to increase the output power. This circuit can be built either on Veroboard or on a small p.c.b. Varying the resistance of VR1 will alter the pitch, and by switching in either the pure signal, or divided by 2, or 4, the dif-

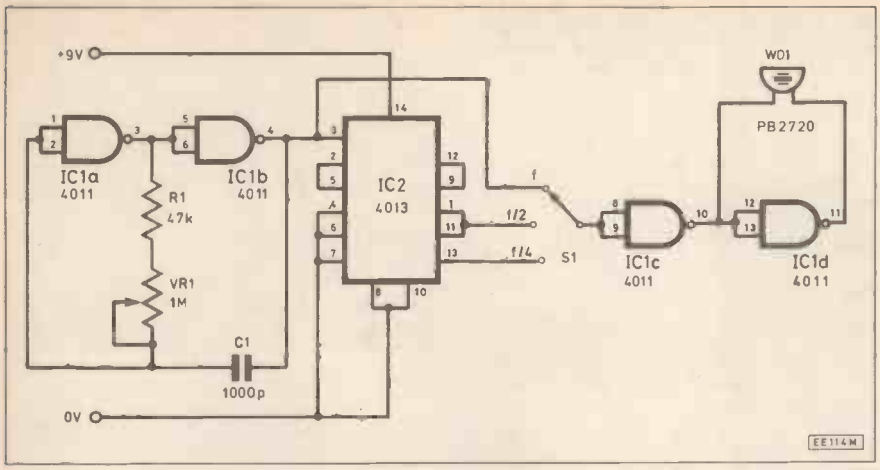


Fig. 11. Simple sound generator and frequency divider.

ferent octaves will be heard. Looking at the latter two waveforms in particular will reveal a very clean square wave with fast rising and falling edges.

ASTABLE (Transistor)

Modern music is often referred to as atonal, without tonality (sounding dischordant to many people). Similarly "astable" circuits, being without stability, are those which are deliberately designed to be unable to remain in either the on or off state. They stay in one condition for a period of time, but the operating conditions change, normally caused by rising or falling voltages due to a capacitor, and the multivibrator has to change state, when conditions again start to alter back, and the process continues ad infinitum.

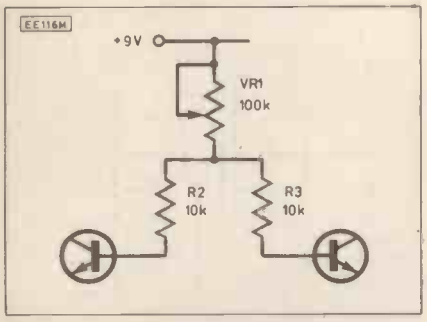


Fig. 13. Frequency alteration circuit.

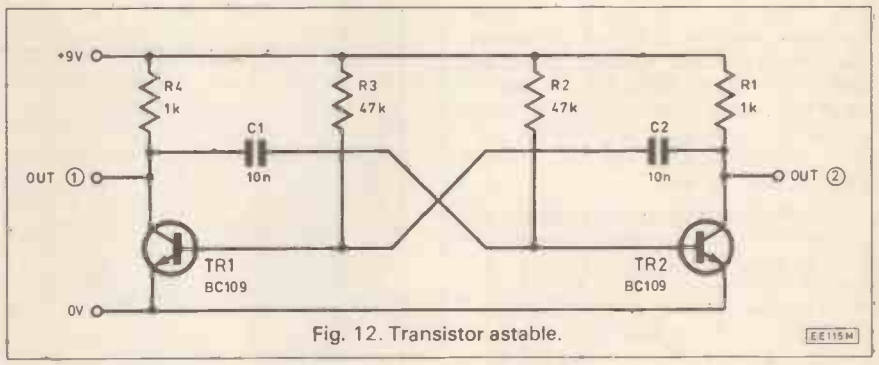


Fig. 12. Transistor astable.

The circuit in Fig. 12 bears some slight resemblance to the transistor monostable circuit and this is not surprising, because it can be considered as two monostables, working opposite to, and continually triggering, each other. For this reason there are now two capacitors in the circuit, one for each transistor. The operation is very similar, with the capacitors alternately charging and discharging, switching on each transistor in turn. The speed of switching is controlled by R2, C1, and R3, C2. If the two resistors and the two capacitors are the same value, a square wave with equal mark-space ratio (i.e. each transistor is off and on for the same amount of time) should be obtained. To make the circuit variable whilst maintaining the equal mark-space ratio requires that R2 and R3 be altered as in Fig. 13.

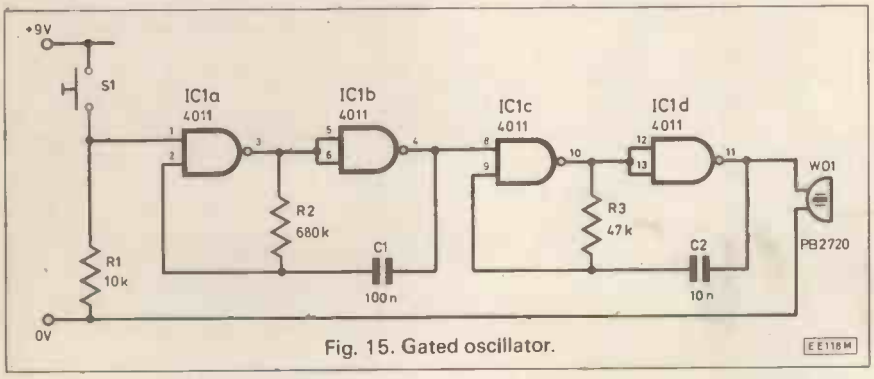


Fig. 15. Gated oscillator.

ASTABLE (CMOS)

The CMOS version of the astable circuit is shown in Fig. 14, and the explanation of how this circuit works tends to get rather complicated, involving the charging of C1 via R1, and then the discharging through the internal input protection diodes, actually contained within the i.c. Detailed explanation is outside the scope of this article, and readers should look to the various reference books on CMOS.

The really nice thing about this circuit is that it only needs two other components apart from the i.c. gates, and because the i.c. contains four identical gates, two oscillators can be built from one i.c., two resistors, and two capacitors. As a bonus one oscillator can control the other. One point to note: because the capacitor charges in both directions, only non-polarised capacitors may be used; electrolytics are not suitable. Values for the resistor can vary from a few kilohms to several megohms, and for the capacitor from a few picofarads to hundreds of microfarads; thus the operating frequency of the oscillator is vast.

If pin 1 is not joined to pin 2, but is instead tied high via a resistor, then by shorting this pin to 0V, the oscillator will stop. This is called a gated oscillator, and the pulling down to 0V can be achieved either mechanically, with a pushbutton, or with another logic circuit, as in Fig. 15.

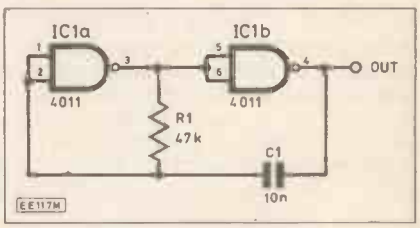


Fig. 14. CMOS astable.

If controlled by a logic circuit, then the tie-up resistor is not required, because the previous circuit element holds it high or low. Gates IC1a/b are connected as an astable multivibrator, switching high and low quite slowly. The output is connected to one of the pins of the astable using IC1c/IC1d, switching much faster (approx. 1kHz, 1000 times per second), producing an audible sound. The effect of the first astable is to keep switching off

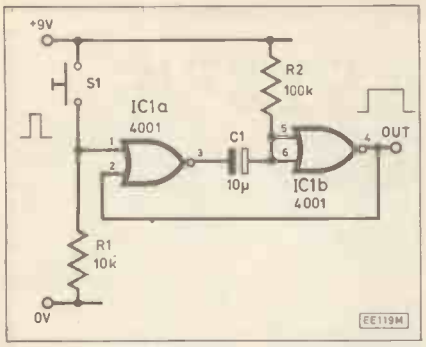


Fig. 16. Positive triggered monostable.

the second, so we hear a pulsed bleep tone, which can be speeded up by reducing the value of R2 or C1, and can be raised in pitch by reducing the value of R3 or C2.

NOR GATES

All of the CMOS circuits so far described have used the 4011 quad NAND gate, but there does also exist the 4001 quad NOR gate, the truth table of which is shown below.

Table 2. NOR gate truth table.

A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

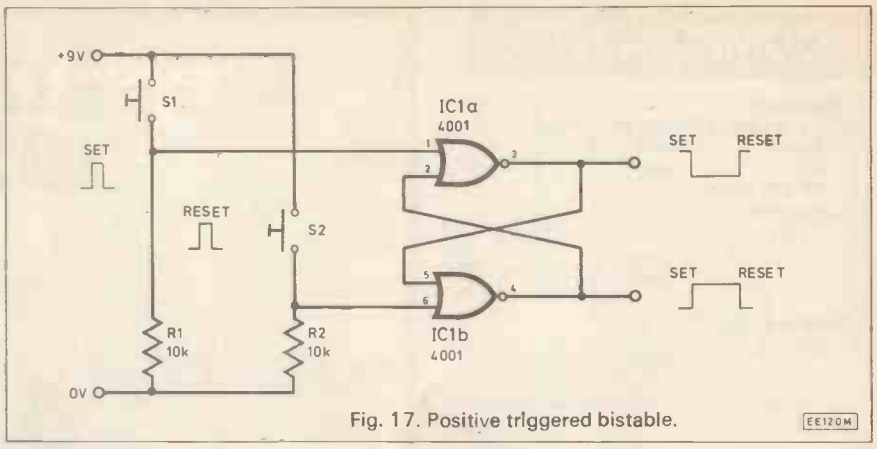


Fig. 17. Positive triggered bistable.

You will observe that the difference is a low (0) output when either input is high. All 3 types of multivibrator can be built with this i.c., but because the truth table has changed, the polarity is opposite. Also note how the drawing of the gate is different to distinguish it from a NAND gate. The variations from the NAND circuits are listed below:

a) The monostable requires a positive-going trigger pulse, and the output (pin 4) will normally be low (Fig. 16).

b) The bistable requires positive-going pulses to change the states of the outputs (Fig. 17).

c) The astable requires pin 1 to be tied high to stop the oscillator (Fig. 18).

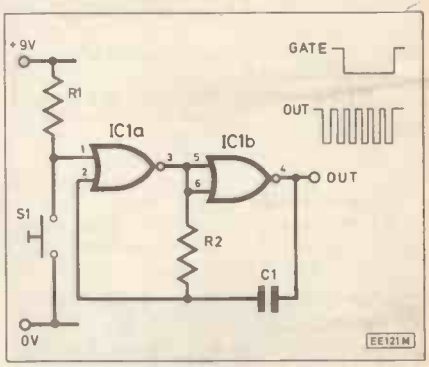


Fig. 18. Astable requiring +V to stop.

EXPERIMENTER'S TEST BED

Finally Fig. 19 shows a test-bed circuit, consisting of two monostables, with short timing periods to act as pulse stretchers, a bistable and a gated astable operating in the audio range. All the circuit elements are separate, but link positions have been provided on the p.c.b. so

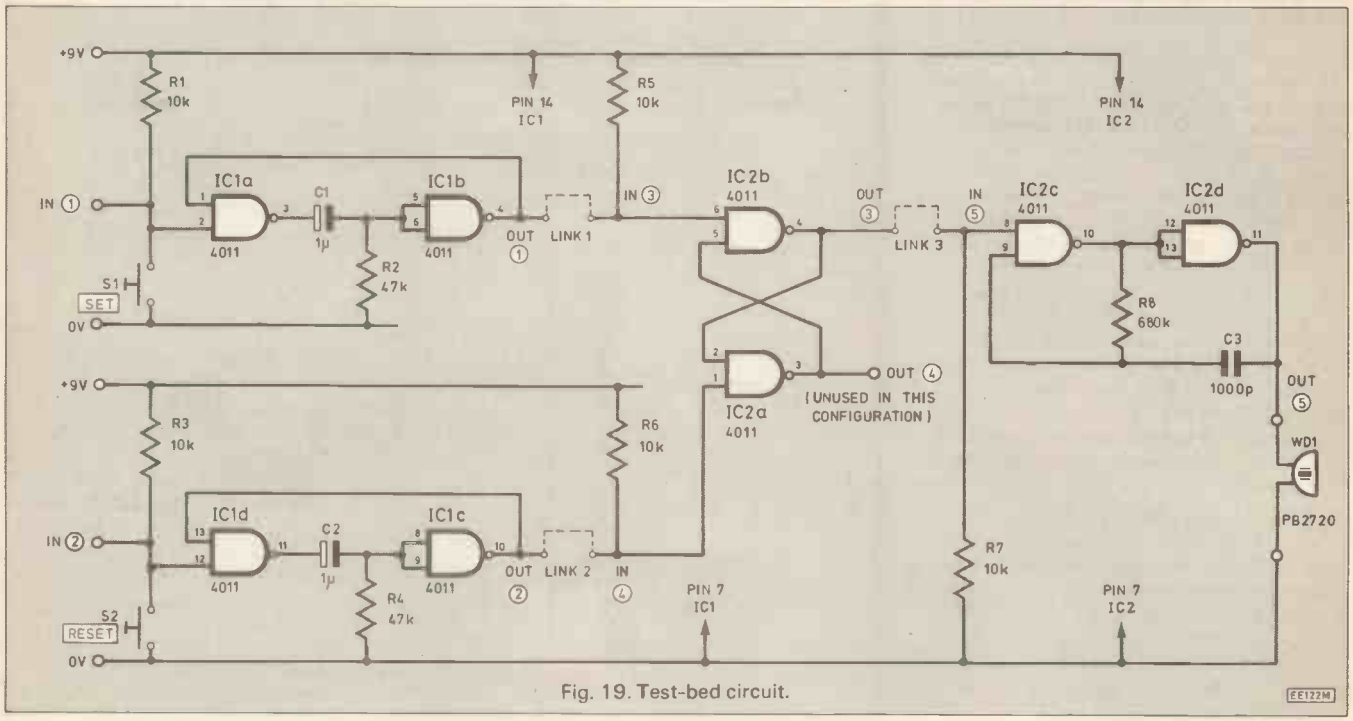


Fig. 19. Test-bed circuit.

COMPONENTS

Resistors

R1,R3,R5–R7	10k (5 off)
R2,R4	47k (2 off)
R8	680k

All ¼W carbon 5%

Capacitors

C1,C2	1µ Tant. bead 35V (2 off)
C3	1000p Disc ceramic

Semiconductors

IC1,IC2	4011 CMOS quad NAND gate (2 off)

See Shop Talk page 312

Miscellaneous

S1,S2	Push-to-make pushbutton switch (2 off)
WD1	PB2720 piezo-electric transducer

Printed circuit board: single-sided 86mm x 50mm, *EE PCB Service*, code 8506-03; Veropins; connecting wire; link wire; battery connector.

Approx. cost Guidance only **£6.00**

that they can be combined together in various ways. e.g. if the two monostables control the two trigger pins of the bistable, the output of which gates the oscillator, then S1 and S2 will turn the audio on and off. This is rather a case of over-kill but it does use all the elements!

CONSTRUCTION

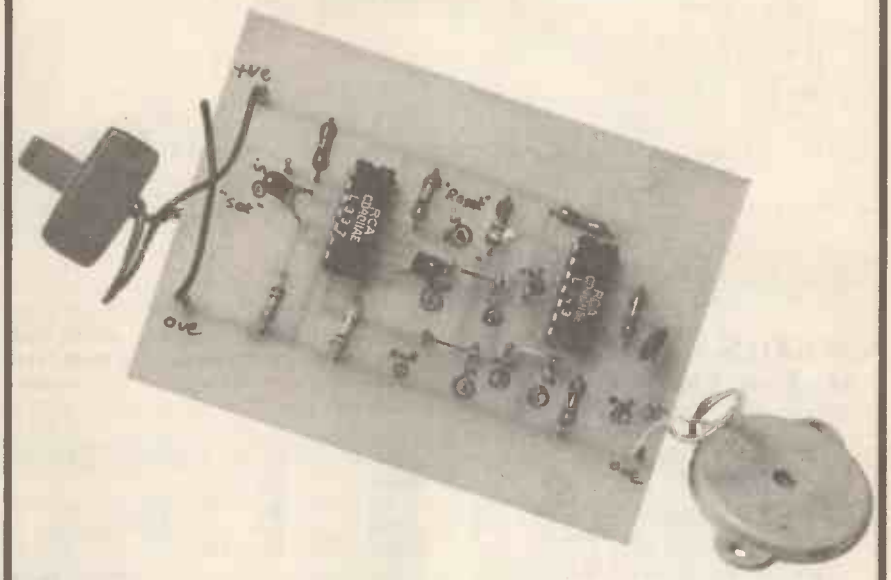
A p.c.b. design is given in Fig. 20, with the overlay in Fig. 21. Insert the resistors, capacitors, and veropins for the various link pads. CMOS i.c.s are sensitive to static, though the more recent B-series are more robust. However the legs should be handled as little as possible, and insert the i.c.s last in any p.c.b. When construction is complete, check carefully, then switch on. If connected as suggested above, then the switches should control the audio.

Try experimenting with different permutations, and different component values. R5, R6 and R7 are tie up/down resistors and in fact are unnecessary in the configuration example illustrated. Each section has been labelled in and out so that the operation can be understood more easily.

CONCLUSION

It is hoped that this article will have shown how useful the three types of multivibrators are. They crop up time and again, in various guises, and readers are well advised to read more information about them to gain a greater understanding. □

EXPERIMENTER'S TEST BED



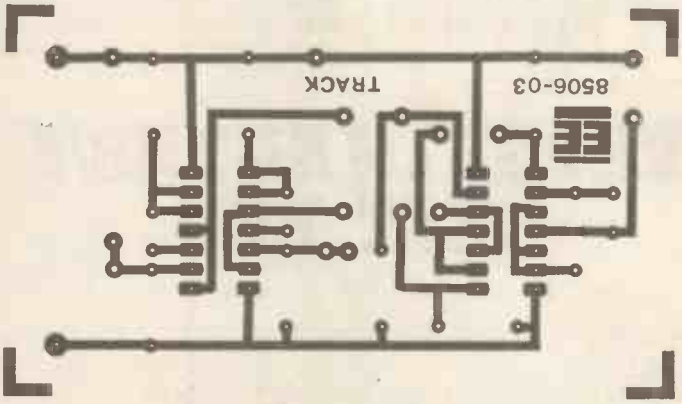


Fig. 20. P.c.b. design of the Experimenter's Test-bed.
This board is available from the *EE PCB Service*; order code 8506–03.

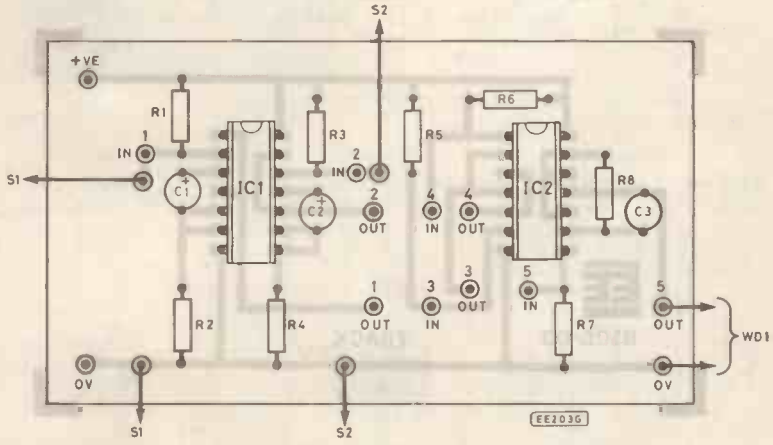


Fig. 21. Component layout of the Experimenter's Test-bed.

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.

LIGHT CHASER/SEQUENCER

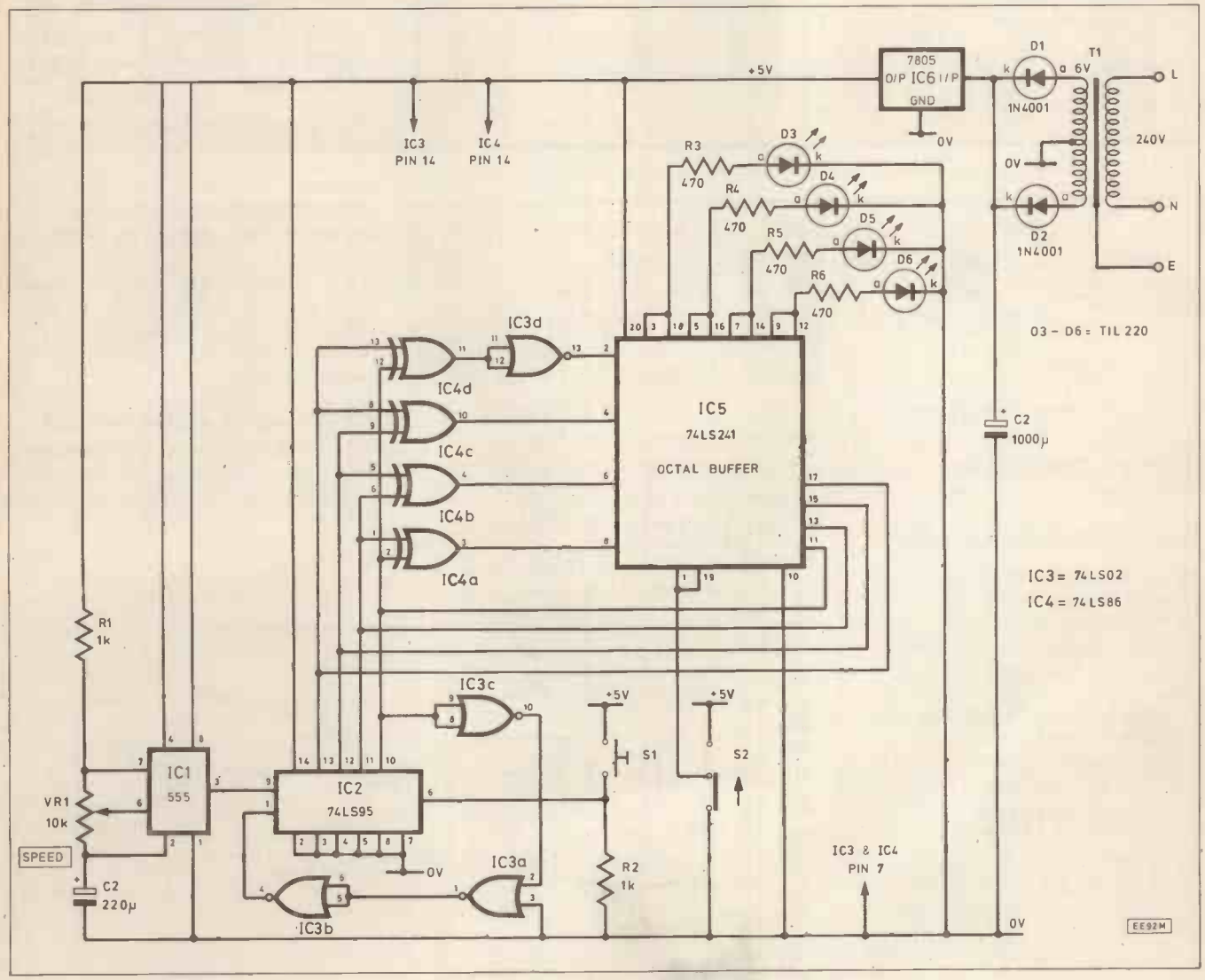
THE circuit is designed around the 4-bit shift register, 74LS95. The clock pulses are provided by the 555 timer. When S1 is depressed all the four outputs (13, 12, 11 and 10), of the shift register will go low, so that the output of IC3c will be held high; the serial data input of IC2, pin 1, will also go high. Clock pulses from the 555 timer will then successively make the outputs of IC2 go high, one after the other. When IC2 pin 10 goes high its serial data input will go low so that the next set of clock pulses will make the IC2 outputs to go low, one after another, after which the first sequence will be repeated.

Connected to the shift register outputs are four exclusive-OR gates. The output from the NOR gate, IC3d will go high only if both pins 13 and 10 of IC2 are high, or low. IC4c gives a high output only when pins 13 and 12 of IC2 are high and low or vice versa. IC4b gives a high output when pins 12 and 11 of IC2 are high and low or vice versa and IC4a output goes high when pins 11 and 10 are high and low or vice versa. These events take place sequentially so that the net result is a 1 to 4 decimal counter.

The outputs from the shift register and gates are connected to l.e.d.s. via an octal buffer. When the slider switch S2 is in its normal position the l.e.d.s. will simulate a light chaser.

The original version was interfaced with triacs to drive higher power lights.

Gerald Kotonya, Kenya



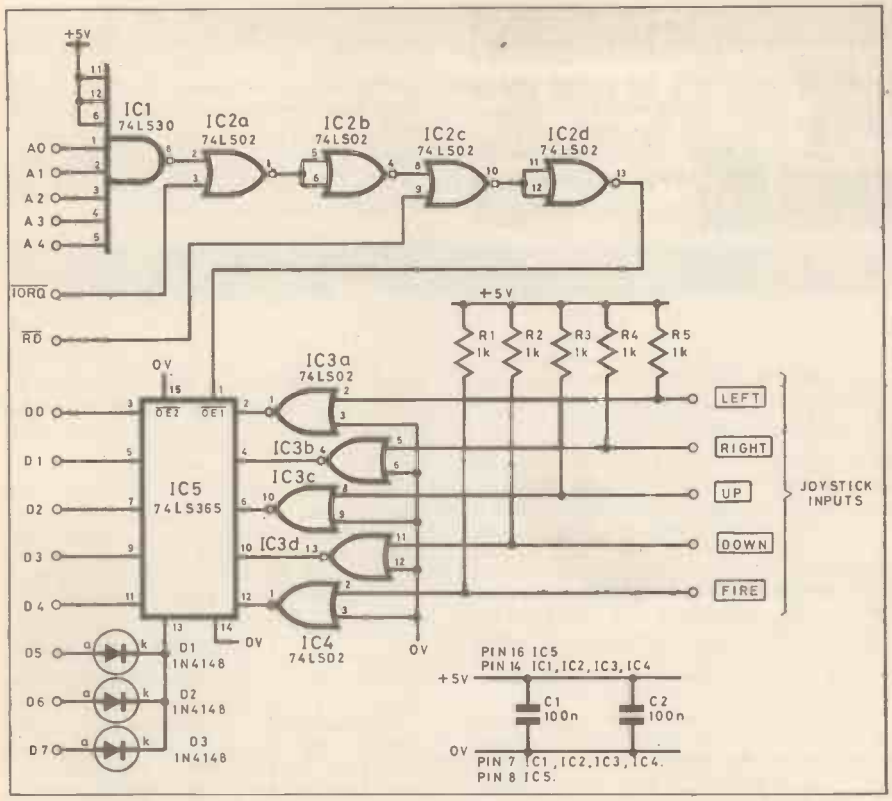
Circuit diagram of the Light Chaser/Sequencer.

ZX SPECTRUM JOYSTICK INTERFACE

THIS simple Joystick Interface for the ZX Spectrum consists of a few discrete components and five readily available i.c.s. It is addressed when A0 to A4 are at logic 1. With this condition true and the Z80 control lines, $\overline{RD}$ and $\overline{IORQ}$ low (logic 0), the hex buffer i.c., IC5 is enabled and the device is ready to transmit.

The Joystick conditions are fed to data lines, D0 to D4 and are read as left, right, up, down and fire respectively. R1 to R5 are pull up resistors and the Joystick signals should be switched to ground to provide the required voltage levels.

A. Moran,
Reading,
Berks.



For more circuit ideas for the Spectrum, see our regular feature, *On-Spec*, Page 314

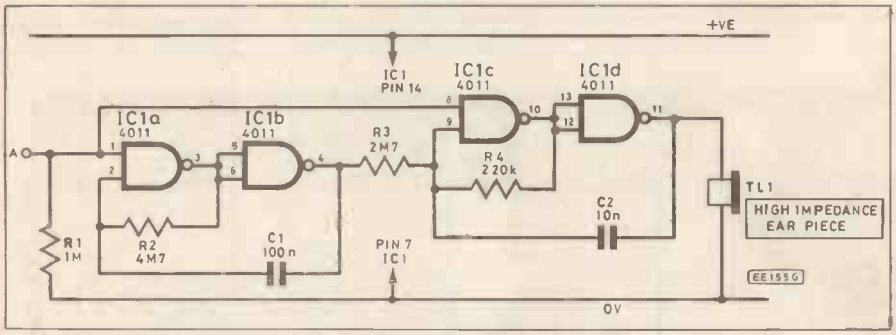
MODEL EMERGENCY VEHICLE SIREN

ONCE again we see a simple oscillator application circuit. This design is used to simulate an emergency vehicle siren for model cars or alternatively it may be used in conjunction with an amplifier to drive a burglar alarm.

IC1c and IC1d form a simple oscillator whose output is modulated with the output from the oscillator formed by IC1a and IC1b running at about 1Hz, to give an alternate high and low signal.

There is nothing new about this circuit but a useful 'switch' is provided by the input to IC1a. When 'A' is at logic 1 the circuit is on, when at logic 0 the circuit is off and it draws negligible current. This makes it ideal for use with computers or remote controlled models.

W. A. Adam,
Kettering,
Northants.



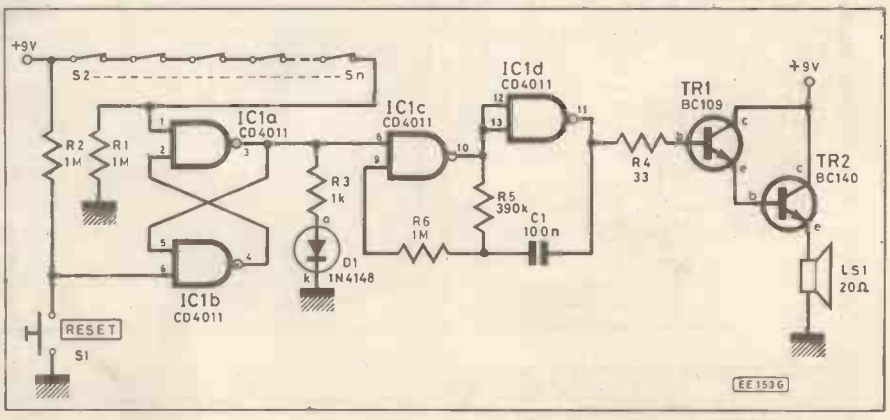
SIMPLE BURGLAR ALARM

THIS simple alarm circuit uses just one i.c. wired as a flip-flop and multivibrator. The flip-flop, IC1a and IC1b is wired to give a normally low output which is switched high whenever the loop circuit is broken, via the switches or cut wire. This will cause the l.e.d., D1 to light and the multivibrator, IC1c and IC1d to be activated.

The output from IC1d is amplified by the Darlington pair, TR1 and TR2 which supply current to drive a loudspeaker or relay.

A Reset switch S1 is provided which will reset the alarm when the loop has been re-established. The frequency of the alarm signal can be modified by changing the components associated with IC1c and IC1d.

K. A. Khiavi,
Tehran,
Iran.



COUNTER INTELLIGENCE

BY PAUL YOUNG

On Trial

Being an avid reader, the first thing I did on moving to my new district was to join the library. My previous library was the old fuddy-duddy type which issued tickets, but it had certain advantages. You were given six tickets, so if you looked in your pocket and only found five you knew you had a book to return, even old Young can count up to six.

Contrast this with my present library. You are issued with one ticket, which has a rectangle on the bottom surrounding a series of vertical lines (as used in some Supermarkets for pricing). Having selected your books, the librarian rubs a special collector across the appropriate part of your ticket, and also across a similar marking fixed to the inside cover of each book. On returning the books, they only rub the collector across the marks in the books.

It seemed to work well enough until last week, when I received a letter requesting me to return *Systematics* by John Gall. I was convinced in my own mind that I had returned it. To be certain, I turned Schloss Young inside out, though to no purpose.

Finally I went to the library and asked the lady if their electronic wonder ever made mistakes. "Oh! yes" she said, "You see it is very old". This rather surprised me as I thought they were the latest thing, so I explained my predicament and she went off to investigate. She returned beaming, and said, "I wrote to you at the beginning of the week and you came in and returned it".

"Madam" I replied, trying to appear cross, which is difficult if the recipient is an attractive young lady, "I have not returned any books this week, I returned that book a month ago, it has obviously been sculling around your library and you have only just found it."

While I was sitting at home cogitating on this fracas I fell asleep and had a dream which finished up as a nightmare. It was evidently some time in the future, and Young was in the dock charged with some dreadful crime.

The Jury consisted of twelve good computers and true, and my learned friend, the computer for the defence, was giving his final summing up speech. Unfortunately due to a bad joint on one of his chips he became thoroughly confused and thought he was the computer for the prosecution. Consequently poor old Young was sentenced to be hung. Luckily I woke up just before the sentence was carried out. It was a narrow squeak and all due to a faulty joint.

I don't wish to appear as an alarmist, but remember this could happen. To repeat myself once more, computers are wonderful, except when they go wrong.

Mature Guard

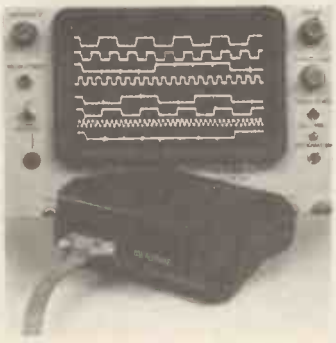
You would imagine that any firm responsible for the security of 700 million pounds worth of maturing whisky would have the latest and most sophisticated type of electronic alarm system. In the case of George Ballantyne and Sons, you would be wrong. They employ a flock of Chinese geese who patrol the barbed wire perimeter and racks of casks twentyfour hours a day. Any intruders start them cackling so loudly that they wake up the two human guards.

The geese were the idea of the late Tom Scott managing director of the company after studying Roman history. He decided that as the geese successfully aroused Rome in time to counter the Gauls offensive in 390 B.C. they could probably frighten off Bill Sykes, or perhaps I should say Mac Sykes, bearing in mind they are situated North of the border.

Apart from the minimal running costs, another advantage is, that they can reproduce themselves, something still beyond the scope of any electronic device—I always say you can't beat these old fangled ideas!

NEW · NEW · NEW · NEW PRODUCTS NEW · NEW · NEW · NEW

LOGICAL STEP



AN oscilloscope companion that will enable most scopes to have the facilities to function as a real-time eight channel logic analyser is the latest product from **Heaviside Industries.**

This relatively low-cost add-on is capable of allowing the scope to display high speed signals from d.c. to 10MHz, and is compatible with all ±5V logic. No a.c. outlet is required, the unit taking power directly from the circuit under test and drawing typically 50mA.

Allowing the scope to display up to eight simultaneous traces on the screen, the unit is supplied with 750mm eight channel probe complete with E–Z hooks for easy i.c. connection.

The Real-Time Logic Analyser (RTLA) is expected to sell for around £150, including VAT. This includes operating instructions, full one year warranty on parts, postage and packing.

For further information contact:

Heaviside Industries Ltd.,
Dept EE, 45 Woodstock Road,
London, NW11 8ES.

TRANSFERS

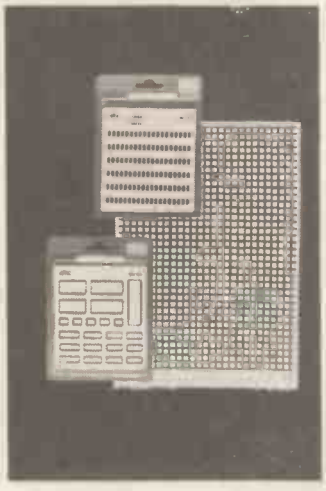
AVAILABLE to amateurs wishing to design and make their own one-off p.c.b.s, as well as for the professional, **Pelltech** are marketing a new range of ALFAC "rub-down" dry transfers.

The range includes self-adhesive black flexible crepe paper tapes with a non-reflective matt finish for quality photographic reproduction work. It is claimed that the use of a quality adhesive allows easy correction and resiting of "tracks" as necessary.

Included is a comprehensive selection of circular and d.i.l. pads, connectors and elbows, track conductors and relay symbols. A further addition is a range of solder mask symbols, component outlines and round plane grids. These are printed in inactinic transparent red (photographically opaque) which, it is claimed, permits accurate positioning in relation to the printed circuit layout.

The complete range of ALFAC Electronic draughting aids is now listed in a new free catalogue. Information on stockists and copies of the catalogue may be obtained from:

Pelltech Ltd.,
Dept EE, Station Lane,
Witney, Oxon, OX8 6YS.



CASE FOR ENCLOSURE

THE first of a new range of durable enclosures moulded in rigid polyurethane is now available from **Plastek.**

Designed as a medium sized desk console, the EC21 can be used with a range of components including key pads, meters, liquid crystal displays, and ZIF sockets to produce stylish assemblies for desk and laboratory applications.

Being moulded from polyurethane, the case lends itself to a variety of fixing arrangements such as inserts, self-tapping screws, through bolting and epoxy adhesives, and can be cut, drilled or routed using ordinary tools.

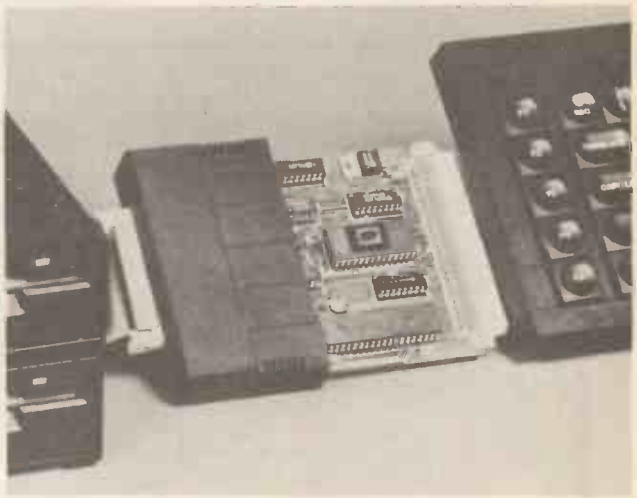
Features include a brushed aluminium mounting plate, moulded-in mounting guides for circuit boards, provision for Perspex display face, large cable entry/outlet plate and non-slip rubber feet.

The case is finished in polyamide spatter textured paint with black base and grey top and is claimed to be impervious to most forms of chemical and environmental attack. Other colours are available to special order.

For details of prices and range of cases available contact:

Plastek,
Dept EE, Units 1, 2 & 7,
The Midlands Industrial Estate,
Holt, Trowbridge,
Wilts, BA14 6RU.

DRIVE FOR SINCLAIR QL



A 3·5in floppy disc drive system to operate with the Sinclair QL is announced by **Micro Peripherals.**

The system has been designed and manufactured in the UK and is available in three separate units which can be purchased individually. The package consists of an interface module and first and second disc drives.

The two drive system has a total formated capacity of 1·44MB and provides fast file handling using the multitasking feature of the QL.

The interface which supports up to four drives on a standard multibus provides a whole host of resident utilities including a screen editor, job control as well as additional file handling commands.

The interface module has a recommended selling price of £99 and the first and second Disc Drives are available for £189 and £159 respectively (ex VAT).

For more details and addresses of nearest stockists contact:

Micro Peripherals Ltd.,
Dept EE, Unit 3 Intec,
Hassocks Wood, Wade Road,
Basingstoke, Hants, RG24 0NE.

COMPUTER CLUB ANSWERS

LINK-UP

Link-up the letters to form a chain of words related to computing ⇨ start at B

	A	T	O	R	P	A	S	S	
	L	D	O	W	N	L	O	W	O
	U	N	H	E	R	A	A	D	R
	C	O	P	I	R	L	D	I	D
	L	I	B	A	E	P	O	N	F
	A	T	A	S	I	C	C	G	L
	C	G	T	N	E	M	U	D	O
R	F	N	I	G	G	U	B	E	W
A	N	I	A	M	T	R	A	H	C
M	E								

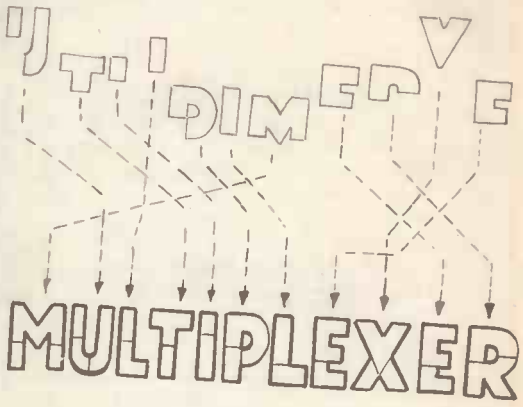
WORD	CLUE
1 BASIC	Beginners...
2 PERIPHERAL	Disk drive is one
3 DOCUMENTATION	may include flowchart
4 DOWNLOADING	Large to small
5 DEBUGGING	...not if you're perfect
6 CALCULATOR	Hand held
7 PASSWORD	...for access
8 FLOWCHART	Shows sequence
9 MAINFRAME	LARGE.

"Contact 'sales, fellas! I THINK I've found someone who hasn't got a computer!"

AMBUSH

The BLACK SPOT is ambushed by a horde of numbers but there is an escape route! All you have to do is find 19 circles leading to the outside of the square and they must add up to exactly 48.

3	1	2	6	2	6	9	7	2	
2	9	8	14	3	2	1	8	1	
6	6	3	2	1	4	2	4	3	
2	1	4	9	3	6	3	7	12	
6	2	3	1	0	4	1	2	4	
17	3	9	12	3	4	6	2	3	
8	1	2	3	2	3	9	7	7	
4	4	6	4	6	7	8	4	3	
9	7	2	1	2	6	2	1	4	




```
 1180DEFPROCt(T%) IFT%=19 W%=132 ELSEW%=128
 1190 IFL%?S% COLOURW% ELSECOLOUR135
 1200PRINTTAB(T%-LENH$(S%),Y%) H$(S%):COLOURW%:ENDPROC
 1210DEFPROCv FORP%=247 TO251:VDU23,P%,255:FORI%=I% TOI%+2:VDUD%?I%*257;:NEXT:VD
U255:NEXT:ENDPROC
 1220DEFPROCbrd(H%,M%) LOCALX%,Y%,C%:GCOLO,H%
 1230 I%=I%(S%)+M%:M=0.5:M=FNout:IFM% X%=x%?S%*5:Y%=y%?S%*4 ELSEX%=630:Y%=512:I%
=I%+1
 1240 VDU29,X%;Y%;5:MOVEFNout,0:FORP%=I% TOI%+FNout/M STEP2
 1250 DRAWFNout,FNout:NEXT:IFM%ANDS%<5MOVE-32,16:VDU233+S%
 1260VDU26,5:IFM%ENDPROC
 1270 PROCv:U%=0:M%=LENH$(S%):N%=TRUE:C%=TRUE:PROCz
 1280 GCOLO,2:FORY%=128 TO896 STEP64:X%=24:T%=TRUE
 1290REPEATREPEAT:X%=X%+4:W%=FNpt:UNTILABSW%=1:IFW%=1 T%=T%+1:T%(T%)=X%
 1300 REPEATX%=X%+4:W%=FNpt:UNTILW%<1:T%=T%+1:T%(T%)=X%
 1310UNTILW%=TRUE ORT%=3:V%=T%(1):W%=T%(2)
 1320FORX%=64 TO1216 STEP64:N%=N%+1:IFT%<3THEN1380
 1330 IFX%<V% ORX%+64>W% ORPOINT(X%,Y%-64)<2THEN1370
 1340 C%=C%+1:P%=5:REPEAT:Q%=C%MOD8%?P%:P%=P%-1:UNTILQ%=0 ORP%=0
 1350 T%=32:IFQ%=0 P%=P%+1:T%=246+P%
 1360 G%?N%=P%:MOVEX%,Y%:VDUT%:IFT%>32 GCOLO,1:VDU8,10,238:GCOLO,2
 1370 FORP%=X% TOX%+60 STEP4:IFP%>=V%ANDP%<W%:PLOT 69,P%,Y%:NEXT ELSENEXT
 1380NEXT:NEXT:C%=0:REPEATN%=0:REPEATN%=N%+1
 1390 IFG%?N%=0 C%=C%+1:IFC%MOD37=0ANDU%<M% U%=U%+1:h%?U%=N%:G%?N%=ASCMID$(H$(S%
),U%,1)
 1400UNTILN%=240:UNTILU%=M%:VDU24,32;68;1216;896;:ENDPROC
 1410DEFFNpt=POINT(X%,Y%)
 1420DEFFNout V%=D%?I%:I%=I%+1:IFV%>128 V%=128-V%
 1430=V%*M
 1440DEFPROCv19(V%,W%) VDU19,V%,W%,0;0;:ENDPROC
 1450DEFPROCl(V%) MOVE0,V%:DRAW1279,V%:ENDPROC
 1460DEFPROCcr(V%) VDU279:V%;0;0;0;:ENDPROC
>
```

CONTINUED FROM PAGE 325

ELECTRONIC DOORBELL

L.S.COOK

THE purpose of this project is to construct a doorbell with the ringing sound of the conventional electromechanical device, but taking advantage of the reliability and compactness of electronic techniques. It is battery-operated with the batteries housed in the unit, so the only external connections are those to the bell-push.

POWER

The two PP3 batteries providing the power may seem uneconomical but they minimise the physical size, and with only intermittent use they should last an acceptably long time.

The current drain is about 5mA, and just one battery could be used, but the loudness would be reduced. The supply must not exceed 18V, as this is the maximum that the i.c. can handle.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. IC1c and and IC1d, together with R3, R6, VR1 and C3 produce a square-wave at the resonant frequency of WD1, adjustable by VR1. TR2 and TR3 drive WD1 using a simple push-pull arrangement. IC1a, IC1b and associated components produce very short zero-going pulses when pin 1 of IC1a is high (bell-push pressed), which switch on TR1 and charge C4. The capacitor, prevented from discharging through IC1b by D2, gradually discharges through the base-emitter junction of TR1, thereby steadily reducing the current available to the output stage, and effectively giving rise to damped oscillations between each pulse from IC1b.

When the power is disconnected (push released), C1 maintains a supply to IC1, and with pin 1 now low, the output of IC1b is low, holding on TR1. C5 then supplies a diminishing voltage to power WD1, again simulating damped oscillations.

D3 and D5 ensure that C1 and C5 respectively discharge only along the required paths. D4 provides a voltage drop to roughly match that across D3 so that the input at pin 1, IC1, is not harmfully above the supply voltage to this i.c.

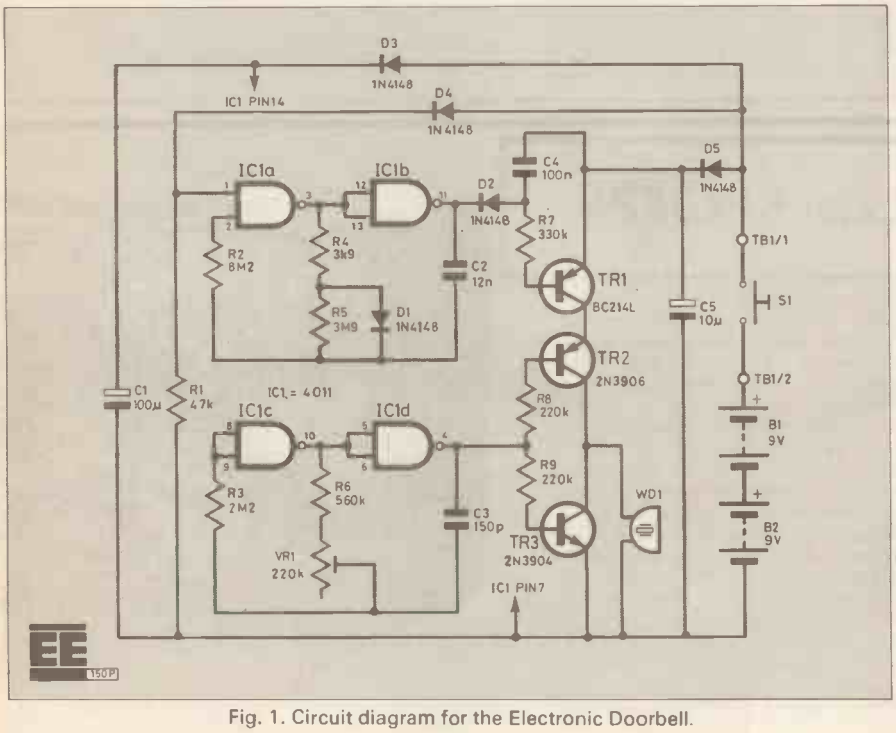


Fig. 1. Circuit diagram for the Electronic Doorbell.

CONSTRUCTION

The sixteen breaks to be made in the copper tracks of the circuit board are shown in Fig. 2. This also shows the positions of the wire links on the underside and the layout of the components and links on top of the board.

Complete the trackside first, then mount the i.c. holder, VR1, and add the links on the upper side. Solder in the remaining components leaving the semiconductors until last. Use sleeving, such as the insulation from connecting wire, on the leads of D1 to prevent electrical contact with VR1.

Attach the flying leads, battery connectors, and WD1 to the circuit board as shown. Check the orientation of C1 and C5 and ensure there is no copper or solder shorting adjacent tracks.

CASE

A box made specially (3mm plywood is suitable) enables the circuit board, batteries and terminal block to fit exactly (see photographs) so that the unit can be kept as compact as possible. WD1 is screwed to a strip of wood which is then screwed across the top of the box. The prototype, as shown in the photographs, was constructed in this way.

Alternatively, a plastic box could be utilised to give a more professional finish, with WD1 screwed to the outside of its lid, holes being made in the lid to take the leads. Holes would also be needed in one side for the leads to the bell-push. A box with dimensions 95 × 71 × 35mm is suitable.

The circuit board is screwed to the bottom of the wooden box using small-gauge screws in the positions indicated in Fig. 2 and the terminal block screwed to the side as shown. Make screw holes in the base for mounting the box, if it is to be secured in a fixed position. The two battery connector leads which are joined together are anchored on a solder-tag positioned between the terminal block and box.

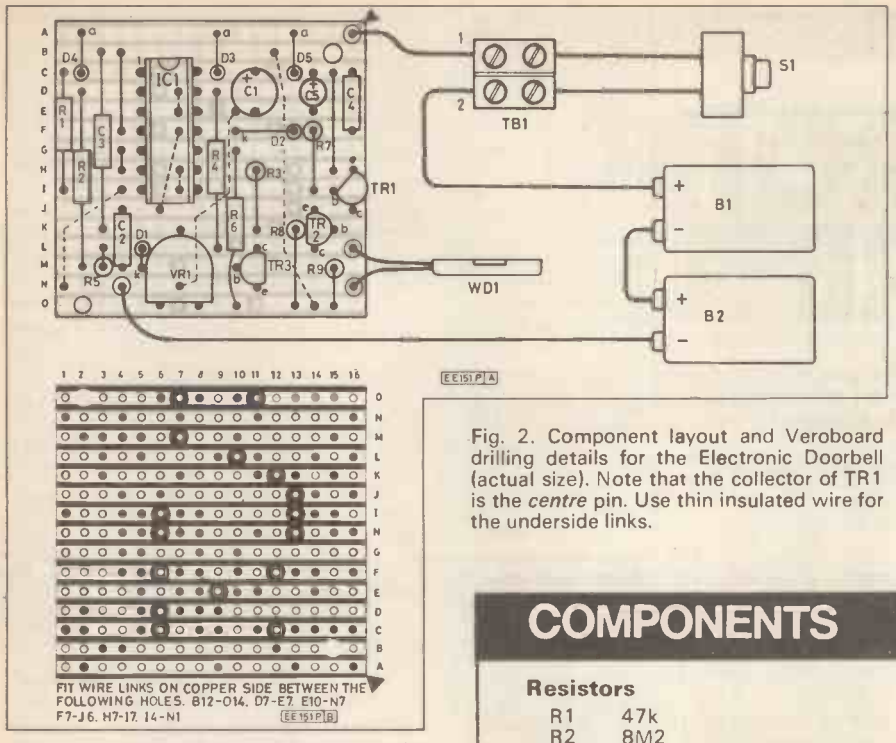


Fig. 2. Component layout and Veroboard drilling details for the Electronic Doorbell (actual size). Note that the collector of TR1 is the *centre* pin. Use thin insulated wire for the underside links.

View showing the layout of the circuit board and batteries within the case.

If required, a cover can be made for the unit. The prototype made use of an empty margarine tub, painted with silver-coloured enamel paint. A small hole (about 5mm diameter) was made in the centre of the tub, immediately above the hole in WD1, and pieces of foam rubber glued round the inside of the tub fixed the cover in position.

ADJUSTING

Insert IC1, connect the batteries and bell-push. With the device in operation, adjust VR1 to provide the best sound and loudest output.

Finally, fix the bell and push in the desired positions, with an appropriate length of twin flex connecting them. □

COMPONENTS

Approx. cost Guidance only **£5.00**

Resistors

R1	47k
R2	8M2
R3	2M2
R4	3k9
R5	3M9
R6	560k
R7	330k
R8,R9	220k (2 off)
All ¼W ±5% carbon	

See Shop Talk page 312

Potentiometer

VR1	220k min. horizontal preset

Capacitors

C1	100µ 25V radial elect.
C2	12n polycarbonate
C3	150p polystyrene
C4	100n polycarbonate
C5	10µ 25V radial elect.

Semiconductors

D1 to D5	1N4148 silicon (5 off)
TR1	BC214L *pnp* silicon
TR2	2N3906 *pnp* silicon
TR3	2N3904 *npn* silicon
IC1	4011 CMOS quad 2-input NAND gate

Miscellaneous

WD1 PB 2720 piezo-ceramic transducer
B1,B2 9V battery (PP3) (2 off)
S1 Push-to-make switch
0·1 inch matrix stripboard, 15 rows x 16 holes; 14-pin d.i.l. socket; 2A terminal block, two sections; PP3 battery connectors (2 off). Case—minimum internal dimensions 68 x 57 x 28mm; twin flex, length as required; bell-push; 6BA solder-tag; fixing screws.

P C B SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE PCB Service, see list. These are fabricated in glass-fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas air-mail. Remittances should be sent to: EE PCB Service, Everyday Electronics Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG. Cheques should be crossed and made payable to IPC Magazines Ltd.

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps. Do not send any other correspondence with your order.

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

NOTE: Please allow 28 days for delivery. We can only supply boards listed here.

PROJECT TITLE	Order Code	Cost
— JULY '83 —		
User Port Input/Output *M.I.T. Part 1*	8307-01	£4.82
User Port Control *M.I.T. Part 1*	8307-02	£5.17
— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
Car Intruder Alarm	8308-02	£5.15
High Power Interface *M.I.T. Part 2*	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Pt 2*	8308-04	£3.56
Electronic Die	8308-05	£4.56
— SEPTEMBER '83 —		
High Speed A-to-D Converter *M.I.T. Pt 3*	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Pt 3*	8309-02	£4.48
Stylus Organ	8309-03	£6.84
Distress Beacon	*8309-04	£5.36
Distress Beacon Pocket Version	8309-05	£3.98
— OCTOBER '83 —		
D-to-A Converter *M.I.T. Part 4*	8310-01	£5.77
High Power DAC Driver *M.I.T. Part 4*	8310-02	£5.13
Electronic Pendulum	8310-03	£5.43
— NOVEMBER '83 —		
TTL/Power Interface for Stepper Motor *M.I.T. Part 5*	8311-01	£5.46
Stepper Motor Manual Controller *M.I.T. Part 5*	8311-02	£5.70
Digital Gauss Meter	8311-03	£4.45
Speech Synthesiser for BBC Micro	8311-04	£3.93
Car On/Off Touch Switch	8311-05	£3.11
— DECEMBER '83 —		
4-Channel High Speed ADC (Analogue) *M.I.T. Part 6*	8312-01	£5.72
4-Channel High Speed ADC (Digital) *M.I.T. Part 6*	8312-02	£5.29
TRS-80 Twin Cassette Interface	8312-03/09	£7.43
Environmental Data Recorder	8312-04	£7.24
Touch Operated Die (Dot matrix)	8312-05/06	£4.34
Touch Operated Die (7-segment)	8312-05/07	£4.34
Continuity Tester	8312-08	£3.41
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Central Heating Pump Delay	8401-01	£3.33
Biological Amplifier *M.I.T. Part 7*	8401-02	£6.27
Temp. Measure & Control for ZX Comprs		
Analogue Thermometer Unit	8401-03	£2.35
Analogue-to-Digital Unit	8401-04	£2.56
Games Scoreboard	8401-06/07	£9.60
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Eprom Programmer/ROM Card for ZX81	**8402-01	£7.84
Oric Port Board *M.I.T. Part 8*	8402-02	£9.56
Negative Ion Generator	*8402-03	£8.95
Temp. Measure & Control for ZX Comprs Relay Driver	8402-04	£3.52
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VIC-20 Extension Port Con. *M.I.T. Part 9*	8403-03	£4.42
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Power Supply	8405-04	£4.93
— JUNE '84 —		
Infra-Red Alarm System	8406-01	£2.55
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Speech Synthesiser *M.I.T. Part 12*	8406-03	£4.85
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Electronic Code Lock		
Main board	8407-03	£2.70
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Op-Amp Power Supply	8409-01	£3.45
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—MARCH '85—		
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—APRIL '85 —		
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—MAY '85—		
Auto Phase	8505-01	£3.02
Amstrad CPC464 Amplifier		
Mains Unit	8505-02	£2.56
Micro Unit	8505-03	£2.56
Voltage Probe	8505-04	£2.67
—JUNE '85—		
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Across The River	8506–04	£2.63

*Complete set of boards. **Calibrated with C1, VR1 and IC3 fitted.
M.I.T.—Microcomputer Interfacing Techniques, 12-Part Series.

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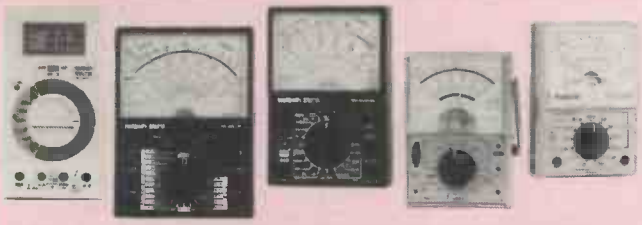

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