461

EVERYDAY ELECTRONICS and computer PROJECTS

DECEMBER 1983 90p

XMAS IDEAS

MAGIC CANDLE

CHILDRENS DISCO LIGHTS

NOVEL EGG TIMER

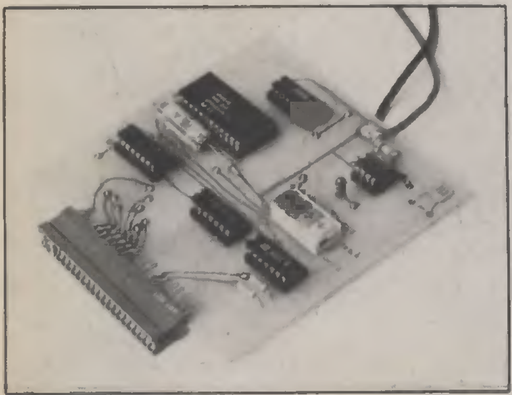
ENVIRONMENTAL DATA RECORDER

Australia $1.60 New Zealand $1.60 Malaysia $4.95 IR £1.38 (inc V.A.T.)

EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 12 DECEMBER 1983

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



PROJECTS

SERIES

FEATURES

Our January 1984 issue will be published on Friday, December 16. See page 825 for details.

CRICKLEWOOD ELECTRONICS LTD.

40 Cricklewood Broadway London NW2 3ET Tel 01-452 0161 01 450 0995 Tlx 914977

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

Stocking parts other stores cannot reach!

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

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

LOW OHMIC GLAZE ¼W 0.22Ω to 8.2Ω E24 11p

WIREWOUND ON CERAMIC E12 SERIES
2 to 3 WATT 0.22Ω to 330Ω 28p
4 to 7 WATT 0.47Ω to 8k8 33p
10 to 11 WATT 1Ω to 33K 37p

POTS & PRESETS
ROTARY POTS LOW NOISE ¼" SPINDLES E3 SERIES
4K7 to 2M LIN 40p
4K7 to 2M LOG 40p
As above with DP mains switch 90p
As above stereo (no switch) 1.00

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

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

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

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

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

FEEDTHROUGH 1nF 500V 7p

HIGH VOLTAGE Capacitors please enquire many types in stock

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

ELECTROLYTICS Mainly Matsushita (Panasonic) & Siemens
AXIALS (Wires each end)
µFd V
47 63 8p
47 100 9p
47 350 30p
1 63 8p
1 100 9p
1 500 40p
2.2 75 8p
2.2 63 9p
2.2 100 11p
2.2 350 30p
3.3 25 10p
3.3 40 11p
3.3 63 12p
4.7 16 8p
4.7 25 9p
4.7 40 11p
4.7 63 12p
4.7 100 14p
10 25 8p
10 40 12p
10 63 14p
10 100 16p
µFd V
22 25 11p
22 40 14p
22 63 16p
22 100 21p
47 25 14p
47 40 17p
47 63 26p
47 100 28p
100 16 14p
100 25 16p
100 40 22p
100 63 25p
100 100 30p
220 10 16p
220 16 17p
220 25 22p
220 40 25p
220 63 30p
220 100 40p
470 16 22p
470 25 28p
470 40 33p
470 63 43p
470 100 60p
1000 16 30p
1000 25 38p
1000 40 46p
1000 63 65p
2200 16 40p
2200 25 63p
2200 40 70p
2200 63 134p
4700 16 75p
4700 25 89p

RADIALS (PCB wires one end) Matsushita only
µFd V
10 16 6p
22 10 6p
22 16 7p
47 10 7p
47 16 8p
100 10 9p
100 16 10p
220 10 11p
220 16 12p
470 10 17p
470 16 18p
1000 10 20p
1000 16 24p
2200 10 34p
2200 16 44p

TRANSFORMERS
All 240V Primary
6 0 6V, 9 0 9V
12 0 12V
15 0 15V 100mA 95p 1A 2.65
20 0 20V
12 0 12 1.25A £2.65
12 0 12 50VA 5.25
12 0 12 0 100VA 9.50
0-6-6-9-9 1.25A 4.25
These goods are heavy send extra p&p. We will credit any difference

VERO
0.1" COPPER TRACKS
2.5 × 3.75 83p
2.5 × 5 99p
3.75 × 3.75 99p
3.75 × 5 1.14
2.5 × 17 2.99
3.75 × 17 3.85
4.75 × 17 4.93
VQ Board 1.92
Dip Board 3.90
Track Cutter 1.48
100 Pins 55p
Veroblock 3.99
Vero Wiring Pen + Spool 3.35
Spare Spool 75p
Combs 6p

PCB MATS
FERRIC CHLORIDE Quick dissolving pellets (mix with 1 litre water) 1.80

ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots + holes
8 0.1" edge conns
9 Mixture
Any sheet of above 35p

GRADE ONE GLASS PCB Single Sided
178 × 240mm 1.50
420 × 195mm 1.95
420 × 245mm 2.95

DALO ETCH RESIST PEN + spare nib 1.20

PHOTO SENSITIVE PCB 1st Class Epoxy Glass. For better results than spraying. Expose to UV
Single sided
100 × 160 1.55
100 × 220 1.90
203 × 114 1.86
233 × 220 3.99
Double sided
100 × 160 1.65
100 × 220 2.15
203 × 114 2.21
233 × 220 4.55
Developer for above (do not use Sodium Hydroxide) 500ml 2.50

WIRE
Prices per Metre
Solid connecting wire 5p
Mains/Speaker Cable
Twin 1 amp 14p
Twin 2½ amp 16p
3 Core 2½ amp 18p
3 Core 6 amp 31p
3 Core 13 amp 56p
Screened Cable
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p
Aerial Cable
50Ω RG58A 36p
75Ω UHF 36p
75Ω VHF 28p
300Ω Flat 14p
Rainbow Ribbon Cable
Prices per foot
8 Way 25p
10 Way 29p
16 Way 39p
20 Way 48p
24 Way 62p
30 Way 75p
32 Way 82p
40 Way 88p
64 Way 1.49

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

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

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

TRANSISTORS
A small sample of our vast stocks
2N930 20p
2N930A 30p
2N1893 49p
2N2102 39p
2N2217 39p
2N2218 33p
2N2218A 25p
2N2219 27p
2N2219A 28p
2N2220 22p
2N2221 22p
2N2221A 23p
2N2222 24p
2N2222A 25p
2N2223 2.60
2N2223A 4.15
2N2368 25p
2N2369 19p
2N2369A 20p
2N2904A 27p
2N2905 28p
2N2905A 29p
2N2906 25p
2N2906A 30p
2N2907 25p
2N2907A 26p
2N2920 8.50
2N2923 25p
2N2924 15p
2N2925 15p
2N2926 10p
2N3053 27p
2N3054 56p
2N3055 60p
2N3055H 120p
2N3250 36p
2N3251 36p
2N3439 98p
2N3440 80p
2N3441 1.25
2N3442 1.35
2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3468 1.00
2N3512 1.06
2N3553 2.65
2N3638 55p
2N3638A 70p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2.00
2N3713 1.38
2N3714 2.98
2N3715 3.31
2N3716 3.60
2N3773 1.99
2N3819 36p
2N3820 38p
2N3821 1.84
2N3822 90p
2N3823 45p
2N3824 1.70
2N3866 90p
2N3903 13p
2N3904 13p
2N3905 13p
2N3906 13p
2N4030 75p
2N4031 65p
2N4032 69p
2N4036 63p
2N4037 49p
2N4240 3.00
2N4347 2.26
2N4400 15p
2N4401 27p
2N4402 30p
2N4403 30p
2N4409 36p
2N4410 42p
2N4427 79p
2N4870 80p
2N4871 55p
2N4888 99p
2N4901 1.69
2N4902 1.85
2N4903 1.98
2N4904 2.15
2N4905 2.75
2N4906 2.99
2N4907 3.20
2N4908 3.15
2N4909 2.90
2N4918 65p
2N4919 75p
2N4920 85p
2N4921 55p
2N4922 69p
2N4923 99p
2N5086 36p
2N5087 39p
2N5088 37p
2N5089 37p
2N5190 68p
2N5191 70p
2N5193 90p
2N5194 79p
2N5245 37p
2N5246 40p
2N5247 45p
2N5248 46p
2N5249 48p
2N5266 2.88
2N5293 98p
2N5294 1.28
2N5295 1.37
2N5401 35p
2N5415 1.10
2N5416 1.54
2N5447 16p
2N5448 19p
2N5449 21p
2N5450 23p
2N5451 25p
2N5457 29p
2N5458 29p
2N5459 29p
2N5460 72p
2N5551 37p
2N5884 5.95
2N5886 5.95
2N6083 17.95
2N6121 57p
2N6122 59p
2N6123 65p
2N6124 59p
2N6125 65p
2N6126 75p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.14
2N6134 1.36
2N6253 1.45
2N6254 1.55
2SC1306 95p
2SC2078 1.70
2SJ49 3.50
2SJ50 3.75
2SJ82 4.29
2SK134 3.50
2SK135 3.75
2SK226 4.29
3N128 1.12
3N140 1.07
3N200 6.93
3N201 2.98
40360 60p
40361 67p
40362 67p
40363 2.95
40406 1.39
40407 75p
40408 1.58
40410 1.80
40411 2.85
40412 90p
40673 83p
40822 1.80
40871 79p
40872 79p
AC125 49p
AC126 32p
AC127 32p
AC128 35p
AC132 68p
AC141K 28p
AC142K 28p
AC151 51p
AC152 45p
AC153 55p
AC153K 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 28p
AC188 25p
AC188K 40p
AF239 55p
AF240 1.00
BC107 10p
BC107A 12p
BC107B 12p
BC108 10p
BC108A 12p
BC108B 12p
BC108C 14p
BC109 10p
BC109B 12p
BC109C 12p
BC140 29p
BC141 37p
BC142 29p
BC143 30p
BC147 10p
BC147A 10p
BC147B 10p
BC147C 20p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 12p
BC149C 13p
BC152 35p
BC153 23p
BC154 27p
BC157 11p
BC157A 12p
BC157B 13p
BC158 10p
BC158A 12p
BC158B 13p
BC159 11p
BC159A 12p
BC159B 13p
BC159C 18p
BC160 42p
BC161 48p
BC167 10p
BC167A 10p
BC167B 13p
BC168 10p
BC168B 10p
BC168C 10p
BC169 10p
BC169B 10p
BC169C 10p
BC177 16p
BC177A 25p
BC177B 26p
BC178 16p
BC178A 24p
BC178B 25p
BC179 20p
BC179A 25p
BC197B 25p
BC179C 27p
BC182 10p
BC182A 12p
BC182B 13p
BC182L 10p
BC182LA 13p
BC182LB 14p
BC183 10p
BC183A 11p
BC183B 12p
BC183C 13p
BC183L 10p
BC183LA 13p
BC183LB 13p
BC183LC 14p
BC184 10p
BC184B 12p
BC184C 13p
BC184L 10p
BC194LB 13p
BC184LC 14p
BC186 24p
BC187 24p
BC212 10p
BC212A 12p
BC212B 13p
BC212L 10p
BC212LA 13p
BC212LB 14p
BC213 10p
BC213A 11p
BC213B 12p
BC213C 13p
BC213L 10p
BC213LA 13p
BC213LB 13p
BC213LC 14p
BC214 10p
BC214B 12p
BC214C 13p
BC214L 10p
BC214LB 13p
BC214LC 14p
BC237 14p
BC237A 16p
BC237B 17p
BC237C 18p
BC238 14p
BC238A 15p
BC238B 16p
BC238C 17p
BC239 15p
BC239A 16p
BC239B 17p
BC239C 18p
BC300 45p
BC301 44p
BC302 43p
BC303 47p
BC327 14p
BC328 14p
BC337 15p
BC338 15p
BC440 32p
BC441 33p
BC460 32p
BC461 33p
BC516 40p
BC517 40p
BC547 13p
BC546B 15p
BC556B 16p
BC547A 14p
BC547B 14p
BC548 12p
BC548A 13p
BC548B 14p
BC548C 15p
BC549 13p
BC549B 14p
BC549C 15p
BC550 15p
BC550C 25p
BC557 15p
BC557A 16p
BC557B 16p
BC558 14p
BC558A 15p
BC558B 16p
BC558C 17p
BC559 15p
BC559B 16p
BC559C 17p
BC560 15p
BC560C 25p
BC650 45p
BC651 46p
BCY70 16p
BCY71 16p
BCY72 19p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 39p
BD237 98p
BD238 98p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 67p
BD242A 65p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.14
BD245C 1.30
BD246A 1.20
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.46
BD419 1.29
BD420 1.37
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.20
BD530 1.30
BD535 75p
BD536 75p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 85p
BD540C 1.20
BD675 72p
BD676 77p
BD677 78p
BD678 83p
BD711 1.32
BD712 1.32
BDX32 3.47
BDX66B 5.95
BDX67B 5.95
BDY54 1.70
BDY55 1.75
BDY56 1.80
BDY57 5.25
BDY58 6.15
BF194 12p
BF195 12p
BF196 12p
BF197 12p
BF198 15p
BF199 15p
BF200 1.49
BF224J 32p
BF225J 35p
BF244A 35p
BF244B 39p
BF245A 30p
BF245B 51p
BF246 52p
BF246A 39p
BF246B 53p
BF247A 54p
BF247B 55p
BF254 39p
BF255 42p
BF256A 35p
BF256B 48p
BF256C 62p
BF257 30p
BF258 32p
BF259 35p
BF457 46p
BF458 58p
BF459 62p
BF469 86p
BF470 86p
BFR39 22p
BFR40 22p
BFR41 22p
BFR79 22p
BFR80 22p
BFR81 22p
BFR90 2.11
BFS28 2.95
BFS61 1.00
BFS98 1.10
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 24p
BSX21 40p
BU104 2.22
BU105 1.70
BU108 3.95
BU109 3.29
BU126 1.47
BU204 2.25
BU205 1.75
BU206 1.89
BU208 1.98
BU226 3.96
BU326S 2.35
BU406 1.45
BU407 1.45
BU408 1.35
BU500 2.95
BUY18S 3.95
E430 5.95
J300 48p
J310 53p
MJ802 3.99
MJ900 2.90
MJ901 3.10
MJ1000 2.50
MJ1001 3.00
MJ1800 3.60
MJ2500 2.19
MJ2501 2.25
MJ2955 1.00
MJ3000 2.19
MJ3001 2.25
MJ4502 3.99
MJ15003 4.85
MJ15004 5.55
MJ15015 2.45
MJ15016 3.34
MJE340 53p
MJE350 1.50
MJE2955 99p
MJE3055 69p
MPSA05 23p
MPSA06 25p
MPSA10 28p
MPSA12 29p
MPSA13 48p
MPSA14 46p
MPSA16 30p
MPSA18 65p
MPSA20 48p
MPSA42 49p
MPSA43 49p
MPSA55 28p
MPSA56 30p
MPSA65 40p
MPSA66 47p
MPSA70 45p
MPSA92 39p
MPSA93 39p
MPSL01 42p
MPSL51 48p
MPSU01 84p
MPSU04 1.32
MPSU05 55p
MPSU06 56p
MPSU07 75p
MPSU51 88p
MPSU55 58p
MPSU56 59p
MPSU57 1.20

JUST RELEASED
NEW ILLUSTRATED CATALOGUE
£1.00 inc. p&p

TIP29A 29p
TIP29C 38p
TIP30A 35p
TIP30C 36p
TIP31A 33p
TIP31C 34p
TIP32A 38p
TIP32C 42p
TIP33A 65p
TIP33C 78p
TIP34A 74p
TIP34C 88p
TIP35A 1.09
TIP35C 1.28
TIP36A 1.29
TIP36C 1.39
TIP41A 49p
TIP41C 55p
TIP42A 55p
TIP42C 65p
TIP49 1.20
TIP50 1.40
TIP53 1.57
TIP54 1.58
TIP110 74p
TIP117 90p
TIP115 81p
TIP117 96p
TIP120 69p
TIP122 73p
TIP125 84p
TIP127 84p
TIP130 93p
TIP132 93p
TIP135 99p
TIP137 99p
TIP140 1.04
TIP142 1.04
TIP145 1.15
TIP147 1.15
TIP162 4.95
TIP2955 77p
TIP3055 70p
TIS43 40p
TIS88A 62p
VN10KM 60p
VN46AF 84p
VN66AF 99p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 35p
ZTX311 32p
ZTX312 35p
ZTX313 36p
ZTX314 24p
ZTX320 35p
ZTX330 35p
ZTX341 28p
ZTX450 39p
ZTX500 14p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 24p
ZTX530 24p
ZTX531 25p
ZTX650 45p

DIODES
1N34A 30p
1N821 70p
1N823 92p
1N914 4p
1N916 6p
1N4001 4p
1N4002 4½p
1N4003 5p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 3p
1N4150 18p
1N4448 22p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 18p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1S44 10p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA155 15p
BA156 38p
BA157 25p
BA158 30p
BA159 32p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 25p
BA318 30p
BAV10 16p
BAV19 15p
BAV20 15p
BAX13 10p
BB109G 65p
BY126 20p
BY127 22p
BY134 52p

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

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

DIACS
BR100 25p
ST2 25p

ZENER'S
400 500mW E24 Series 2.4 47V 7p
1.3 Watt E24 Series 3.3 82V 14p

BRIDGE
(PIV shown in brackets)
1½ amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40
BYW64 3.95
35A 400V 3.95

OPTO
LEDs
R = Red
G = Green
Y = Yellow
Large diffused 1+ 50+
R5D 9p 7p
G5D 15p 12p
Y5D 15p 12p
Small diffused
R2D 8p 6p
G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 25p 22p
G1D 27p 25p
Y1D 27p 25p
Large clear
R5E 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright high efficiency Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Rectangular Stackables LEDs
R6L 17p
G6L 18p
Y6L 19p

LIN ICS
AY1-5050 95p
AY3 8910 3.66
AY3 8912 4.40
CA3048 2.15
CA3059 2.80
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 39p
CA3140T 95p
HA1366W 2.40
HA1388 2.54
ICL7106 6.85
ICL7107 9.50
ICL7611 97p
ICL8038 2.95
ICL7555 80p
ICL7556 1.50
LC7120 3.20
LC7130 3.20
LC7137 3.95
LF347 1.50
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.[illegible]
LF398 4.59
LM335Z 1.19
LM348N 62p
LM349N 1.09
LM350K 4.60
LM379S 4.50
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.50
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386 88p
LM388N 2.43
LM391N60 1.70
LM391N80 1.93
LM723CH 95p
LM723CN 35p
LM725CH 3.40
LM725CN 3.19
LM741CH 96p
LM741CN 18p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1871 3.25
LM1872 4.38
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.89
LM2917N8 1.89
LM3877NC 1.65
LM3900 49p
LM3911 1.20
LM3914 2.50
LM3915 2.50
LM3916 2.50
LM13600 95p
MF10 3.50
OM335 7.20
NE531N 1.38
NE543N 2.50
NE544N 1.95
NE555 16p
NE556 45p
NE558 1.89
NE560 3.25
NE565 1.18
NE566 1.49
NE567 1.37
NE570 4.07
NE571 3.95
NE5534A 95p
RC4136 59p
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.55
TBA530Q 2.76
TBA540 2.72
TBA540Q 2.74
TBA550 3.25
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TDA1002 3.39
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA2611A 2.50
TL061 40p
TL062 60p
TL064 99p
TL071 34p
TL072 50p
TL074 99p
TL081 29p
TL082 50p
TL084 89p
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.50
UPC1156 2.75
XR2206 2.92
ZN409 2.25
ZN414 1.00
ZN1034 1.99
TDA7000 3.45

74TTL
7400 16p
7401 16p
7402 16p
7403 16p
7404 16p
7405 16p
7408 14p
7409 14p
7410 15p
7411 16p
7412 18p
7413 18p
7414 25p
7416 19p
7417 19p
7420 15p
7421 19p
7422 19p
7423 19p
7425 19p
7426 19p
7427 19p
7428 26p
7430 19p
7432 22p
7433 22p
7437 25p
7438 21p
7440 19p
7441 55p
7442 32p
7443 89p
7444 89p
7445 49p
7446 59p
7447 39p
7448 49p
7450 15p
7451 15p
7453 15p
7454 14p
7460 15p
7470 34p
7472 25p
7473 25p
7474 55p
7475 55p
7476 35p
7480 39p
7481 1.19
7482 63p
7483 38p
7484 69p
7485 60p
7486 19p
7489 1.68
7490 20p
7491 35p
7492 25p
7493 25p
7494 36p
7495 36p
7496 35p
7497 89p
74100 80p
74104 50p
74105 55p
74107 19p
74109 25p
74110 35p
74116 50p
74118 55p
74119 59p
74120 59p
74121 25p
74122 35p
74123 35p
74125 30p
74126 29p
74128 35p
74132 29p
74136 27p
74141 55p
74142 1.75
74143 1.95
74144 1.95
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74159 75p
74160 59p
74161 48p
74162 39p
74163 39p
74164 39p
74165 39p
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74170 1.25
74172 2.50
74173 59p
74174 54p
74175 49p
74176 39p
74177 45p
74178 79p
74180 40p
74181 1.15
74182 80p
74184 89p
74185 89p
74186 4.69
74188 2.80
74190 48p
74191 48p
74192 45p
74193 45p
74194 40p
74195 40p
74196 45p
74197 39p
74198 79p
74199 83p
74221 53p

74LS TTL
74LS00 15p
74LS01 15p
74LS02 15p
74LS03 15p
74LS04 15p
74LS05 15p
74LS08 15p
74LS10 15p
74LS11 15p
74LS12 15p
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74LS289 4.70
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74LS293 39p
74LS295 74p
74LS298 79p
74LS299 1.49
74LS323 1.59
74LS324 1.46
74LS325 2.96
74LS326 2.39
74LS327 2.39
74LS347 95p
74LS348 89p
74LS352 61p
74LS353 61p
74LS362 7.25
74LS365 29p
74LS366 29p
74LS367 29p
74LS368 29p
74LS373 55p
74LS378 68p
74LS386 1.14
74LS390 46p
74LS393 42p
74LS395 89p
74LS396 1.90
74LS398 2.70
74LS399 1.59
74LS445 99p
74LS490 2.20
74LS540 89p
74LS541 1.20
74LS640 99p
74LS641 99p

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4000 16p
4001 16p
4002 16p
4006 49p
4007 19p
4008 32p
4009 24p
4010 24p
4011 16p
4012 19p
4013 19p
4014 46p
4015 39p
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4032 79p
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4035 44p
4036 2.49
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4045 99p
4046 44p
4047 69p
4048 39p
4049 22p
4050 23p
4051 44p
4052 58p
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4072 19p
4073 19p
4075 19p
4076 45p
4077 19p
4078 19p
4081 19p
4082 19p
4085 49p
4086 60p
4089 1.23
4093 19p
4094 69p
4095 71p
4096 69p
4097 2.88
4098 74p
4099 89p
4502 55p
4503 39p
4507 33p
4508 1.26
4510 45p
4511 48p
4512 48p
4514 1.13
4515 1.13
4516 55p
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4519 29p
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4521 88p
4526 68p
4527 62p
4528 74p
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4534 3.96
4536 2.59
4538 78p
4539 89p
4543 68p
4553 2.25
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4566 1.49
4569 1.66
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8T97 85p
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81LS97 90p
81LS98 85p
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6532 5.70
8154 9.00
8155 3.50
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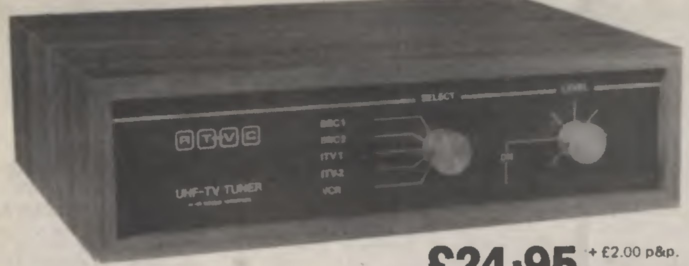
8216 99p
8224 1.10
8226 2.50
8228 2.19
Z80ACTC 2.60
Z80ADART 5.50
Z80ADMA 6.40
Z80APIO 2.70
ZN425E8 3.39

V REGS
– Positive –
100mA
78L05A 29p
78L12A 29p
78L15A 29p
78L24A 29p
1 Amp TO220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
– Negative –
100mA T092
79L05 49p
79L12 49p
79L15 49p
1 Amp TO220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZIF SOCKET
24 Pin 4.35

SWITCHES
Toggles (Mini)
SPST 49p
SPDT 55p
DPDT 69p
DPDT C off 85p
4PDT 2.78

T.V. SOUND TUNER BUILT AND TESTED



£24·95 + £2.00 p&p.

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound.

Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. The unit is mains operated.

This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 11¾" x 8½" x 3¼".

E.T.I. kit version of above without chassis, case and hardware. £12.95 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

£32.95 + £2.75 p&p.

• NOISE REDUCTION SYSTEM • AUTO STOP • TAPE COUNTER • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS • TWIN V.U. METER • WOW & FLUTTER 0.1% • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TAPES.

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up wire.

Featured in April issue P.E. Reprint 50p. Free with kit.

SPECIAL OFFER! £31.00 plus £2.75 p&p Complete with case.

Self assembly simulated wood sleeve – £4.50 + £1.50 p&p.

MONO MIXER AMP

Ideal for Church halls & Club houses. **£45.00** + £2.00 p&p.

50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic. and aux. inputs. Size: 13¾"x6½"x3¾" app. Power output 50 watts R.M.S. (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

Matching AKG Microphone to suit (with speech and music filter). Complete with lead. ONLY £9.95 plus 75p p&p.

VHF STEREO TUNER KIT

• SPECIAL OFFER! •

£13.95 Plus £2.50 p&p.

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 Issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabalised power supply with 'C' core mains transformer. All components supplied are to strict P.E. specification, Front scale size: 10½" x 2½" approx. Complete with diagram and instructions.

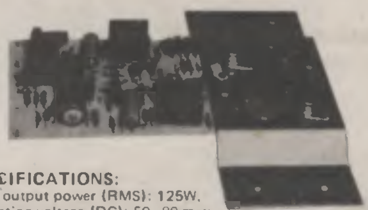
125W HIGH POWER AMP MODULES

	KIT	BUILT
	£10.50	£14.25
	+ £1.15 p&p	+ £1.15 p&p

The power amp kit is a module for high power applications – disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use.

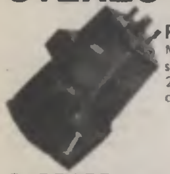
Supplied with all parts, circuit diagrams and instructions.

ACCESSORY: Stereo/mono mains power supply kit with transformer. £10.50 plus £2.00 p&p.

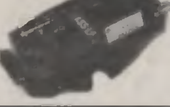


SPECIFICATIONS:
Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
Frequency response measured @ 100 watts: 25Hz - 20KHz.
Sensitivity for 100 watts: 400mV @ 47K.
Typical T.H.D. @ 50 watts, 4 ohms: 0.1%.
Dimensions: 205 x 90 and 190 x 36 mm.

STEREO CARTRIDGES



PHILIPS
Magnetic cartridge with diamond stylus. Model No. GP-397 III. Output: 2mV. Separation 22dB. Stylus 0.6mm diameter. **£3.95 each** plus 60p P&P.



GARRARD
Sonotone Garrard Ceramic cartridge. 75mV. With turnover Sapphire stylus. **£2.95** plus 60p p&p.

HI-FI TWEETER BARGAIN

GOODMANS TWEETERS
8 ohm soft dome radiator tweeter (3¾"sq.) for use in up to 40W systems; with 2 element crossover.
£3.95 each (p&p £1) or
£6.95 pair (p&p £1.50)

STEREO CASSETTE DECK

Stereo cassette tape deck transport with electronics. Manufacturer's surplus – brand new and operational – sold without warranty.

£11.95
plus £2.50 p&p.

Just requires mains transformer and input/output sockets and a volume control to complete.

Supplied with full connection details.

SPEAKER KIT 2 WAY 10 WATT

8" bass/mid range and 3¼" tweeter. Complete with screws, wire, crossover components and cabinet. Cabinet comes in flat pre-mitred D.I.Y. form. Finish - chipboard covered wood simulate. size 14½"x 8¾"x 4". PAIR for ONLY
£12.50 plus £1.75 p&p.

AUDAX 8" SPEAKER

HIGH QUALITY 40 WATTS RMS BASS/MIDRANGE

Ideal for either Hi-Fi or Disco use this speaker features an aluminium voice coil a heavy 70 mm diameter magnet.
Frequency res: 20Hz to 7KHz.
Impedance: 8 ohms.

£5.95
+£2.20 p&p

AUDAX 40W FERRO-FLUID HI-FI TWEETER

X/over on 5kHz -22kHz. 60mm square. 8 ohm. £5.50 +60p p&p

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AC128	30p	BC184	12p	MPSA56	30p	ZTX500	18p	2N1308	80p
AC132	90p	BC184B	12p	MPSU05	85p	ZTX501	18p	2N1613	36p
AC141	30p	BC184L	12p	MPSU56	60p	ZTX502	18p	2N2222A	30p
AC142	30p	BC186	30p	OC22	150p	ZTX503	18p	2N2369A	28p
AC176	30p	BC187	30p	OC23	150p	ZTX504	30p	2N2646	68p
AC187	30p	BC212A	14p	OC26	100p	ZTX531	30p	2N2904A/5A	30p
AC188	30p	BC212L	12p	OC28	200p	ZTX550	30p	2N2906A	60p
AD149	80p	BC213	12p	OC36	220p	2N696	35p	2N2907A	30p
AD161	45p	BC213B	12p	OC41	75p	2N698	45p	2N2926G	12p
AD162	45p	BC213L	12p	OC42	75p	2N699	40p	2N2926R	12p
BC107	12p	BC214	12p	OC70	60p	2N706A	26p	2N2926Y	12p
BC107A	14p	BC214B	12p	OC76	60p	2N708	30p	2N3053	30p
BC107B	14p	BC214L	14p	OC81	60p	BC237	18p	2N3054	75p
BC108	12p	BF194	14p	OC82	60p	BC238B	18p	2N3055E	60p
BC108A	14p	BF195	14p	OC84	50p	BC307	18p	2N3442	150p
BC108B	14p	BF198	14p	TIP29	30p	BC308	14p	2N3615	200p
BC108C	14p	BF199	14p	TIP29A	35p	BC327	16p	2N3702	12p
BC109	12p	BF200	35p	TIP29B	50p	BC328	16p	2N3703	12p
BC109B	14p	BF224B	20p	TIP29C	45p	BC337	16p	2N3704	12p
BC109C	14p	BF244B	35p	TIP30A	40p	BC338	16p	2N3705	12p
BC140	35p	BF256	35p	TIP30B	50p	BC441	36p	2N3706	12p
BC141	35p	BF257	35p	TIP30C	60p	BC461	36p	2N3707	12p
BC142	35p	BF258	35p	TIP31	38p	BC477	40p	2N3708	12p
BC143	35p	BF259	35p	TIP31A	40p	BC478	40p	2N3710	12p
BC147	12p	BF594	40p	TIP31B	40p	BC517	45p	2N3711	12p
BC148	12p	BF595	30p	TIP31C	45p	BC547	15p	2N3771	200p
BC157	12p	BFR39	20p	TIP32A	40p	BC548	15p	2N3772	200p
BC158	12p	BFR79	30p	TIP32C	40p	BC549	16p	2N3773	200p
BC159	12p	BFR80	30p	TIP36C	140p	BC556	20p	2N3819	25p
BC160	50p	BFX29	30p	TIP41A	50p	BC557	16p	2N3820	45p
BC161	45p	BFX84	30p	TIP41B	50p	BC558	16p	2N3823	50p
BC167	15p	BFX85	30p	TIP42A	60p	BC559	16p	2N3866	100p
BC168	12p	BFX87	30p	TIP42B	65p	BCY70	20p	2N3903	15p
BC169	12p	BFX88	30p	TIP120	85p	BCY71	20p	2N3904	15p
BC170	20p	BFY50	28p	TIP121	80p	BCY72	23p	2N3905	15p
BC171	13p	BFY51	25p	TIP142	120p	BD131	50p	2N3906	15p
BC172A	12p	BFY52	25p	TIP2955	70p	BD132	50p	2N5172	30p
BC173	13p	BFY90	80p	TIS43	36p	BD133	60p	2N5194	80p
BC177	20p	BRY39	40p	TIS44	40p	BD135	50p	2N5457	42p
BC178	20p	BSX20	30p	TIS90	30p	BD136	40p	2N5458	48p
BC179	25p	BSX29	35p	TIS91	30p	BD137	40p	3N128	85p
BC181	23p	BU105	170p	VN10KMA	75p	BD138	40p	3N140	85p
BC182	12p	BU205	200p	VN66AF	95p	BD139	45p	3N141	85p
BC182B	14p	BU208A	220p	VN88AF	110p	BD140	45p	3N163	110p
BC182L	12p	MJ2955	90p	ZTX107	12p	2N914	36p	3N201	110p
BC183	12p	MJE340	50p	ZTX108	12p	2N918	30p	3N202	125p
BC183B	12p	MJE371	90p	ZTX109	12p	2N930	30p	40406	80p
				ZTX300	15p	2N1131	30p	40407	80p
				ZTX301	18p	2N1132	30p		
				ZTX302	20p	2N1303	80p		

TTL

7400	18p	7417	28p	7447	75p	7486	35p	74119	70p	74160	65p	74190	58p
7401	18p	7420	20p	7448	55p	7489	140p	74121	35p	74161	55p	74191	71p
7402	18p	7422	28p	7450	21p	7490	37p	74122	41p	74162	46p	74192	56p
7403	18p	7425	28p	7451	20p	7491	45p	74123	41p	74163	46p	74193	55p
7404	18p	7426	28p	4753	21p	7492	40p	74126	70p	74164	46p	74194	52p
7405	18p	7427	30p	7454	21p	7493	41p	74132	65p	74165	60p	74195	52p
7406	32p	7428	30p	7460	21p	7494	41p	74135	50p	74166	60p	74196	55p
7407	32p	7430	26p	7470	25p	7495	41p	74141	51p	74167	185p	74197	56p
7408	25p	7432	26p	7472	25p	7496	41p	74144	250p	74170	195p	74198	95p
7409	25p	7433	35p	7473	30p	7497	60p	74145	575p	74173	120p	74199	95p
7410	18p	7437	30p	7474	35p	74100	95p	74147	125p	74174	65p	74221	60p
7411	25p	7438	30p	7475	40p	74104	58p	74148	65p	74175	65p	74279	60p
7412	26p	7440	23p	7476	35p	74105	58p	74150	70p	74176	46p	74284	95p
7413	26p	7441	51p	7480	30p	74107	30p	74151	46p	74177	55p	74285	95p
7414	37p	7442	40p	7481	110p	74109	30p	74153	46p	74180	50p	74366	64p
7416	28p	7443	71p	7482	70p	74110	41p	74154	81p	74181	121p	74390	325p
		7444	95p	7483	58p	74111	70p	74155	46p	74182	70p	74393	100p
		7445	71p	7484	81p	74116	70p	74156	46p	74184	105p		
		7446	71p	7485	75p	74118	65p	74157	35p	74185	105p		

LS TTL

74LS00	17p	74LS27	21p	74LS83	51p	74LS138	40p	74LS169	98p	74LS243	81p	74LS293	46p
74LS01	17p	74LS28	21p	74LS85	52p	74LS139	39p	74LS170	86p	74LS244	65p	74LS353	71p
74LS02	17p	74LS30	21p	74LS86	23p	74LS147	121p	74LS173	63p	74LS245	86p	74LS362	110p
74LS04	17p	74LS32	21p	74LS90	38p	74LS148	86p	74LS174	58p	74LS247	65p	74LS365	35p
74LS05	17p	74LS33	21p	74LS93	35p	74LS151	46p	74LS175	52p	74LS248	66p	74LS366	35p
74LS08	18p	74LS37	21p	74LS95	46p	74LS153	52p	74LS181	115p	74LS249	66p	74LS367	35p
74LS09	20p	74LS38	21p	74LS96	109p	74LS154	120p	74LS183	201p	74LS251	40p	74LS368	35p
74LS10	20p	74LS40	21p	74LS107	46p	74LS155	46p	74LS190	58p	74LS253	46p	74LS373	70p
74LS11	20p	74LS42	37p	74LS109	35p	74LS156	46p	74LS191	55p	74LS257	40p	74LS374	70p
74LS12	23p	74LS49	63p	74LS112	32p	74LS157	46p	74LS192	55p	74LS258	43p	74LS375	52p
74LS13	28p	74LS51	21p	74LS113		74LS158	40p	74LS193	55p	74LS259	67p	74LS386	130p
74LS14	32p	74LS54	21p	74LS114	32p	74LS160	40p	74LS194	52p	74LS260	30p	74LS390	55p
74LS15	21p	74LS55	21p	74LS122	46p	74LS161	40p	74LS195	52p	74LS266	32p	74LS393	55p
74LS20	21p	74LS63	138p	74LS123	46p	74LS162	40p	74LS196	52p	74LS273	63p	74LS395	98p
74LS21	21p	74LS73	25p	74LS124	166p	74LS163	43p	74LS197	52p	74LS275	145p	74LS398	310p
74LS22	21p	74LS74	25p	74LS125	37p	74LS164	48p	74LS221	63p	74LS279	40p	74LS541	130p
74LS26	21p	74LS75	28p	74LS126	35p	74LS165	60p	74LS240	81p	74LS280	110p	74LS629	200p
		74LS76	25p	74LS132	41p	74LS166	81p	74LS241	75p	74LS283	46p	74LS669	160p
		74LS78	25p	74LS136	28p	74LS168	97p	74LS242	80p	74LS290	60p	74LS670	120p

CMOS

		CD4015	46p	CD4035	55p	CD4054	100p	CD4093	40p	CD4503	46p	CD4569	80p
		CD4016	30p	CD4038	125p	CD4060	80p	CD4099	140p	CD4511	52p	CD4572	80p
		CD4017	40p	CD4040	50p	CD4066	30p	CD4160	75p	CD4512	60p	CD4581	80p
CD4000	15p	CD4018	52p	CD4041	50p	CD4068	20p	CD4161	75p	CD4514	140p	CD4582	80p
CD4001	15p	CD4019	30p	CD4042	45p	CD4069	20p	CD4162	75p	CD4515	200p	CD4583	60p
CD4002	15p	CD4020	52p	CD4043	45p	CD4070	16p	CD4163	75p	CD4516	65p	CD4584	60p
CD4006	60p	CD4021	46p	CD4044	46p	CD4071	18p	CD4175	75p	CD4518	52p	CD4585	110p
CD4007	16p	CD4022	46p	CD4045	120p	CD4072	18p	CD4402	75p	CD4520	60p	CD40100	200p
CD4008	45p	CD4023	20p	CD4046	55p	CD4075	25p	CD4412	75p	CD4528	81p	CD40106	80p
CD4009	30p	CD4024	40p	CD4047	46p	CD4076	60p	CD4419	75p	CD4538	100p	CD40109	100p
CD4010	35p	CD4025	18p	CD4048	45p	CD4077	30p	CD4445	75p	CD4539	78p	CD40114	200p
CD4011	15p	CD4026	100p	CD4049	30p	CD4078	25p	CD4446	75p	CD4541	100p	CD40174	80p
CD4012	20p	CD4027	25p	CD4050	30p	CD4081	25p	CD4449	75p	CD4555	60p		
CD4013	25p	CD4028	45p	CD4052	70p	CD4082	25p	CD4501	35p	CD4561	110p		
CD4014	55p	CD4029	55p	CD4053	60p	CD4085	72p	CD4502	70p	CD4568	80p		

RIBBON CABLE

(Priced per 33cm)

WAYS	COLOUR
10	26p
20	53p
26	76p
34	100p

D CONNECTORS

	PLUGS	SOCKETS
9 way	90p	125p
15 way	125p	190p
25 way	190p	230p

DIODES

AA119	15p	OA200	9p	1N5060	18p
AA215	16p	OA202	9p	1N5062	20p
BAX13	10p	1N823	5p	1N5400	11p
BY100	30p	1N914	5p	1N5401	12p
BY127	18p	1N916	6p	1N5402	14p
BY133	20p	1N4000	5p	1N5403	15p
BY206	30p	1N4001	5p	1N5404	16p
BY207	30p	1N4002	5p	1N5405	17p
BY299	40p	1N4003	6p	1N5406	18p
BYX10	18p	1N4004	6p	1N5407	22p
OA47	10p	1N4005	7p	1N5408	25p
OA90	8p	1N4006	7p	1S44	5p
OA91	8p	1N4007	8p	1S921	7p
OA95	8p	1N4148	5p	1S922	7p
		1N4448	6p	1S923	7p

LINEAR

		CA3090	415p	LM339	80p	LM3911	140p	SAA5020		TDA1008	347p	TL074	117p
		CA3130	105p	LM348	90p	LM3914	285p	SN76013N	295p	TDA1022	570p	TL081	40p
CA1310E	185p	CA3140	52p	LM358	62p	LM3915	285p	TAA621A	290p	TDA1024	120p	TL082	65p
CA1350E	90p	CA3240	125p	LM380	85p	LM3916	285p	TAA661B	175p	TDA2002	150p	TL083	92p
CA3020	230p	ICM7555	105p	LM381	170p	MC1458	70p	TBA120B	70p	TDA2003	345p	TL084	65p
CA3028	110p	ICM7556	200p	LM382	130p	MC1488	80p	TBA120S	68p	TDA2020	350p	UA748	40p
CA3035	270p	LF347	200p	LM384	160p	MC1489	90p	TBA120U	98p	TDA2030	340p	ZN414	95p
CA3043	305p	LF351N	55p	LM386	100p	NE555	20p	TBA540Q	161p	TDA2102		ZN424	150p
CA3055	85p	LF353N	100p	LM387	140p	NE556	55p	TBA651		TDA2522		ZN425	400p
CA3065	150p	LM224	150p	LM389	110p	NE564	405p	TBA800	95p	TDA9400		ZN426	345p
CA3080	80p	LM301	30p	LM732	55p	NE566	173p	TBA810S	110p	TL061	50p	ZN427	715p
CA3081	225p	LM308	100p	LM747	75p	NE567	161p	TBA820	81p	TL062	75p	ZN1034	230p
CA3085	145p	LM311N	81p	LM1458	45p	NE570	391p	TBA920Q	175p	TL064	150p	ZN1040	750p
CA3086	65p	LM318N		LM3900	70p	NE571	387p	TCA270S	171p	TL071	50p		
CA3089	230p	LM324	50p	LM3909	92p	SAA5010		TDA1004	345p	TL072	60p		

I.C. SOCKETS

LOW PROFILE D.I.L Type	Price	TURNED PIN D.I.L. Type	Price
8 pin	10p	8 pin	35p
14 pin	12p	14 pin	50p
16 pin	14p	16 pin	60p
18 pin	18p	18 pin	65p
20 pin	24p	22 pin	75p
22 pin	25p	24 pin	80p
24 pin	30p	28 pin	100p
28 pin	32p	40 pin	150p
40 pin	35p		

RECHARGEABLE BATTERIES

HP2, 1.2v, 4.0AH	£3.95
HP2, 1.2v, 1.2AH	£2.70
HP11, 1.2v, 1.2AH	£2.45
HP7, 1.25v, 500mAH	£1.00
AAA, 1.2v, 180mAH	30p
PP3, 8.4v, 110mAH	£4.50

ZENER DIODES

BZX61C/1.4 watt: 3V3, 3V6, 3V9, 4V7, 5V6, 6V2, 7V5, 8V2, 10V, 11V, 12V, 13V, 15V, 18V, 20V, 22V, 24V, 27V, 30V, 33V, 36V, 39V, 43V, 47V, 56V, 68V, 75V, 82V, 100V, 180V, 200V **16p each**

BZY88C/0.4 watt: 1V3, 2V7, 3V, 3V3, 3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 15V, 16V, 18V, 22V, 24V, 27V, 30V, 33V, 36V **10p each**

LEDs

5mm:	Red	10p	113:	Red	
	Green	13p		Red	20p
	Yellow	13p		Green	25p
3mm:	Red	10p		Yellow	25p
	Green	13p	323:	Tri.	
	Yellow	13p		Red	20p
CQX21:	Red			Green	25p
	flashing	65p		Yellow	25p
251:	Rect/stack		503:	Square	
	Red	20p		Red	20p
	Green	25p		Green	25p
	Yellow	25p		Yellow	25p

REGULATORS

LM304H	180p	UA723C	77p	78H12 (3A/5V)	460p
LM309H	80p	7805A	50p		
LM309K	130p	7812A	50p	78L05	35p
LM317K	350p	7812Kc	121p	78L12	35p
LM317T	130p	7815A	50p	78L15	35p
LM320/5	65p	7818A	50p	78L18	35p
LM320/12	65p	7824A	50p	78L24	35p
LM320/15	65p	7905A	55p	78L62	35p
LM320/24	65p	7912A	55p	79L05	45p
LM337T	180p	7915A	55p	79L12	45p
LM1469	324p	7918A	55p	79L15	45p
UA78P (8A/5V)	450p	7924A	55p	79L18	45p
				79L24	45p

ALUMINIUM BOXES

31⅞" × 19⅞" × 9⅞"	
80 × 50 × 25	80p
100 × 65 × 50	1.20
100 × 70 × 40	1.20
100 × 100 × 40	1.20
135 × 70 × 40	1.20
135 × 105 × 40	1.40
180 × 125 × 65	1.95
205 × 155 × 75	2.50

VERO PLASTIC BOXES

White 71 × 49 × 25	60p
Blk 71 × 49 × 25	60p
Blk 120 × 80 × 35	1.10
Blk 180 × 110 × 55	1.75

VERO BOARDS

127 × 63	1.10
95 × 63	95p
431 × 63	3.17
127 × 95	1.20
95 × 95	1.15
431 × 95	4.20
454 × 119	5.50
63 × 25	pk of 5 1.30

THYRISTORS

				600mA/200V	45p	5A/400V	60p
				1A/50V	40p	5A/600V	70p
BT101	104p	T05 1A/400V	104p	1A/100V	45p	5A/800V	80p
BT102	104p	2N1599	40p	1A/200V	50p	7A/100V	55p
BT106	104p	2N4441	170p	1A/400V	60p	7A/200V	60p
BT107	132p	2N4444	150p	1A/600V	75p	7A/400V	70p
BT108	143p	2N5060	36p	1A/800V	90p	7A/600V	80p
TIC44	20p	2N5061	33p	3A/50V	46p	7A/800V	90p
TIC106D	40p	2N5062	42p	3A/100V	53p	10A/50V	55p
TIC106M	77p	2N5063	47p	3A/200V	58p	10A/100V	60p
TIC126D	99p	2N5064	47p	3A/400V	71p	10A/200V	65p
TIC206D	80p	600mA/20V	21p	3A/600V	79p	10A/400V	70p
TIC226D	90p	600mA/30V	24p	3A/800V	99p	10A/600V	88p
TIC246D	130p	600mA/100V	30p	5A/50V	43p	10A/800V	115p

TRIACS

2A/200V	50p
2A/400V	60p
2A/600V	60p
4A/400V	60p
6A/100V	80p
6A/200V	80p
6A/400V	90p
8A/400V	80p
10A/100V	80p
10A/200V	100p
10A/400V	110p
10A/400P	100p

BRIDGE RECTIFIERS

1A/50V	30p	6A/50V	75p
1A100V	30p	6A/100V	75p
1A/200V	35p	6A/200V	80p
1A/400V	40p	6A/400V	100p
2A/50V	35p	10A/200V	200p
2A/100V	45p	10A/400V	200p
2A/200V	50p	25A/200V	250p
2A/400V	55p	25A/400V	300p

Dalo Etch resist
£1.10

SOLDER

20 swg. 3 core

500g	495p

POTENTIOMETERS

Carbon track, ¼ watt log & linear values:

Range	Price
470R-2.2MR (single track)	40p
4.7K-2.2MR (dual gang)	100p
4.7K-2.2MR (single gang D/P switch)	90p

SLIDER POTS

60mm track, log & linear values:

Range	Price
5K-500K	80p

PRESETS

Pre-set pots ¼ watt

Range	Price
50R-4.7MR (mini vert. & horiz.)	10p

RESISTORS

High stability, ¼ watt, 5%

Range	Price (1-99)	(100+)
1R-10MR	2p	1p

High stability, ½ watt, 5%

Range	Price (1-99)	(100+)
1R-10MR	3p	1.5p

CAPACITORS

CERAMIC 1pF, 2p2, 2p7, 3p3, 3p9, 4p7, 5p6, 6p8, 8p2, 10pF, 12pF, 15pF, 18pF, 22pF, 27pF, 33pF, 39pF, 47pF, 56pF, 68pF, 82pF, 100pF, 120pF, 150pF, 180pF, 220pF, 270pF, 330pF, 470pF, 560pF, 680pF, 820pF, 1000pF, 1n5, 1n8, 2n2, 3n3, 3n9, 4n7, 5n6, 6n8, 8n2, 10nF, 22nF, 47nF, 100nF 6p each

MYLAR: 100V 1nF, 2n2, 3n3, 4n7, 6n8, 10nF 7p each. 15nF, 22nF, 33nF, 47nF 9p each. 68nF, 100nF 11p each. 220nF 15p. 330nF 18p. 470nF, 20p.

POLYSTYRENE 22pF, 47pF, 68pF, 82pF, 100pF, 120pF, 150pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1000pF, 1200pF, 1500pF, 1800pF, 2000pF, 2200pF, 3300pF, 4700pF, 5600pF, 10nF 8p each

TANTALUM BEAD 3V: 100uF, 150uF, 220uF, 330uF 64p each. 470uF 110p. 680uF 160p. 6V3: 6u8, 12p. 10uF 13p. 33uF 33p. 47uF 25p. 100uF, 220uF 77p each. 470uF 160p. 10V: 15uF, 22uF 20p each. 33uF 33p. 47uF 40p. 68uF 63p. 220uF 110p. 16V: 2u2, 3u3 20p each. 4u7, 6u8 25p each. 10uF 32p. 22uF 35p. 16V; 33uF 40p. 47uF 60p. 100uF 95p. 220uF 105p. 25V: 15uF, 22uF 40p each. 47uF, 68uF 60p. 35V: 0.1uF, 0.22uF, 0.47uF 16p each. 1uF, 1u5 18p each. 2u2 25p. 3u3, 4u7 20p each. 6u8 30p. 10uF 40p. 47uF 60p.

ELECTROLYTIC Axiel or Radial 16V: 10uF, 22uF, 33uF 10p each. 47uF, 68uF, 100uF 12p each. 125uF, 220uF 14p each. 330uF 18p. 470uF 24p. 680uF 36p. 1000uF 30p. 1500uF 40p. 2200uF 50p. 25V: 1uF, 10uF, 22uF, 47uF 10p each. 100uF 12p. 220uF 20p. 470uF 30p. 1000uF 40p. 2200uF 55p. 4700uF 115p. 35V: 120uF, 250uF 20p each. 40V: 6u8 10p. 470uF 30p. 1000uF 45p. 50V: 0.47uF, 1uF 8p each. 1uF (small) 12p. 220uF 35p. 63V: 1uF, 2u2, 4u7 7p each. 10uF, 22uF 10 each. 47uF 12p. 100uF 20p. 220uF 30p. 100V: 4.7F 48p. 160V: 10MF 32p. 250V: 0.01uF, 0.047uF, 0.1uF 10p each. 0.22uF 11p. 0.47uF 12p. 1uF 18p. 2u2 26p. 10uF 23p. 100uF 35p. 400V: 0.47uF 35p. 600V: 0.022uF, 0.047uF 30p each. 0.22uF, 67p. 1000V: 0.0022uF 27p. 0.022uF, 0.1uF 39p each.

POLYESTER C280 250V .01, .022, .033, .068, .1 8p. .15, .22, .33 10p. .47 12p. .68 20p. 1uF 26p. 2.2 50p.

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EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 12 DECEMBER 1983

QUITE SIMPLE

SMALL is beautiful. This adage has relevance to our hobby. Experienced constructors will agree that satisfaction derived from one's efforts is not directly proportional to the component count nor to the overall complexity of the design. A simple circuit using few, if indeed any, i.c.s can provide much enjoyment during its construction and this enjoyment is compounded when the completed project is seen to give pleasure (however simple and innocent) to others.

Computer projects apart, our complement of designs in this final issue for the year is unashamedly biased towards the simple and novel—in particular to projects having a part to play over the Christmas period. In this age of video and computer games, and other kinds of sophisticated electronic toys, it may be questioned whether interest can be aroused in so modest a device as a *Magic Candle*; or whether children will be attracted and excited by a flashing light display emitting merely a watt or two of illuminance. But surely it will be a sad state of affairs if over-exposure to high-technology-based consumer products jades our ability to be enthralled and amused by unpretentious objects. And this applies most especially in the case of young children.

At this time, Christmas presents are uppermost in our minds and suggestions are always welcome. Well here's one. Egg-timers are not exactly a rarity, but this month's design is novel in that it generates a reasonable imitation of a clucking chicken. Perhaps a useful and amusing gift to make for ma or the wife?

ANOTHER SCHOOLS WINNER

The *Environmental Data Recorder* featured in this issue won for its schoolgirl and schoolboy designers the third prize in this year's Schools Electronic Design Award Competition. It provides yet another fine example of the enterprise and technical ability that exists amongst scholars in our secondary schools. Though conceived and designed with science department studies in mind, the Environmental Data Recorder is likely to find many uses amongst personal computer owners.

It is hoped that the appearance of this article will also act as a reminder—and a stimulant—to scholars throughout the UK who have produced an interesting piece of electronic equipment to enter this year's SEDAC. Schools please note that Registration should be made by November 30, 1983.

Fred Bennett

Readers' Enquiries

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

We cannot undertake to engage in discussions on the telephone.

Component Supplies

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

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

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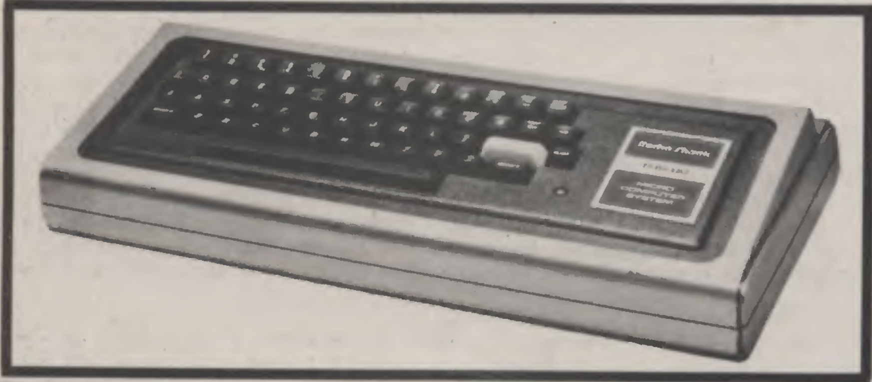
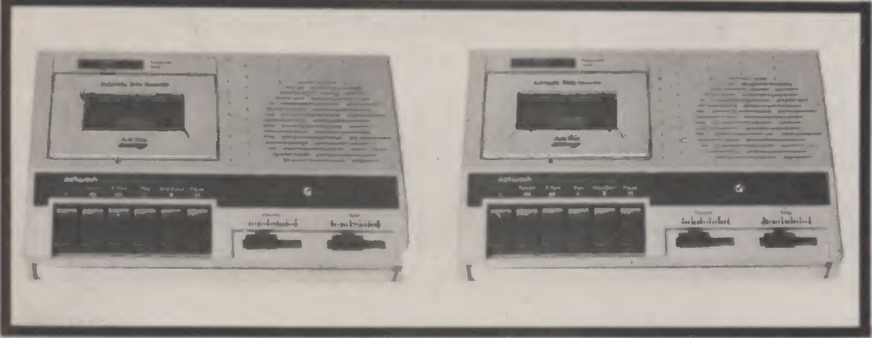
TRS-80 TWIN CASSETTE INTERFACE





BY S. RAINEY

OWNERS of the TRS-80 Model I Level II Microcomputer will know that this computer has the capability of driving two cassette decks. However, with just the basic system, only one may be used, since only one I/O port is provided. On adding the expensive and now discontinued Expansion Interface, two cassette I/O ports are provided. This project provides two cassette ports for the basic system without the need for the Expansion Interface.

CIRCUIT DESCRIPTION

Before the operation of the circuit can be understood it is necessary to understand its purpose. Those familiar with Level II Basic will know that any tape I/O command may have the suffix #–1, or #–2, placed after it. A #–1 denotes that the next cassette I/O must go to cassette deck No. 1, while a #2 denotes that the I/O must go to cassette deck No. 2.

If the Basic interpreter detects a #–1, then a ØØ is written to memory location 37E4H, whereas if a #–2, is detected then FFH is written to this location. In both cases the actual I/O goes through port FFH, the cassette port on the rear of the Model I Console. All that has to be done then is to look at memory location 37E4H and use its state to select either cassette deck.

The circuit consists of four basic sections (see Fig. 1). There is an address decoder which monitors the address bus and when the value 37E4H is present it enables the data latch. The data latch monitors data line Ø and, when enabled, reads and stores the state of this data line.

The output of the data latch, which is an echo of its input, is presented to the relay driver and relays. The relays are used to switch the I/O port between the two cassette decks. Finally, there is a small power supply to power the whole circuit.

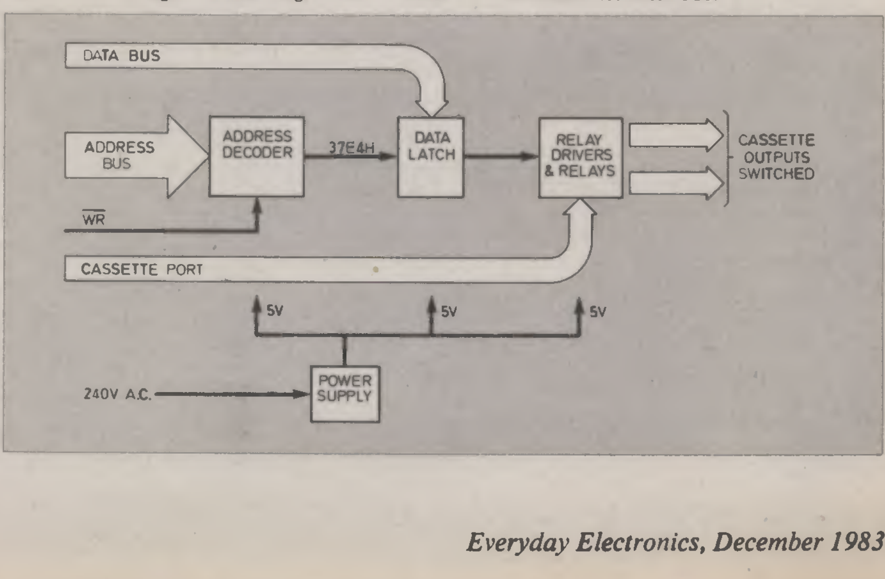
ADDRESS DECODER

The address decoder consists of IC1, IC2, IC3a, IC3b, and IC4. To understand its working we must consider the binary equivalent of 37E4H, which is what actually appears on the 16 address lines, see Fig. 2. As can be seen, when this location appears on the address bus, A2, 5, 6, 7, 8, 9, 1Ø, 12 and 13 all go high, that is, they have a potential of 5V. AØ, 1, 3, 4, 11, 14 and 15 all go low; they have a potential of 0V. IC1 and IC2 are the major components of the decoder and are 8-input NAND gates. When all eight inputs are high then the output goes low. A2, 5, 6, 7 8, 9, 1Ø and 12 are connected to the eight inputs of IC1. See Fig. 3.

As can be seen from Fig. 2, all these address lines go high when 37E4H is addressed and so the output of IC1 will go low. AØ goes low when 37E4H is addressed and this low, along with the low from the output of IC1, is applied to the inputs of the 2-input NOR gate, IC3a. The output of this NOR gate will therefore go high and is applied to one of the inputs of the other 8-input NAND gate, IC2. A1, 3, 4, 11, 14 and 15 all go low when 37E4H is addressed and these are each inverted by one of the six inverters making up IC4. The six highs from the outputs of IC4 are applied to six of the inputs of IC2. Finally, A13, which goes high when 37E4H is addressed, is applied to the last input of IC2. Since all eight inputs of IC2 are now high, the output will go low.

We have now uniquely decoded the memory address 37E4H which appears

Fig. 1. Block diagram of the TRS-80 Twin Cassette Interface.



as a low on the output of IC2. It is now necessary to decide whether or not the computer wants to write to or read from this memory location. If this was not done, the data latch may become active at the wrong time and hence remember the wrong data.

The computer tells us when it wants to write to a memory location by sending a low on its $\overline{WR}$ output. The "bar" means that this output is true when it is low and hence is normally high.

The $\overline{WR}$ signal is connected to one of the inputs of IC3b, a 2-input NOR gate. The output of IC2 (the output of the address decoder) is connected to the other input of IC3b. Since both inputs of IC3b will be low when the computer wants to write to 37E4H, the output will go high. This output is used to control the data latch, IC5.

DATA LATCH

The data latch consists of a D-type flip-flop which forms half of IC5. For

ADDRESS LINE	A15	A14	A13	A12	A11	A1Ø	A9	A8	A7	A6	A5	A4	A3	A2	A1	AØ	
STATE	Ø	Ø	1	1	Ø	1	1	1	1	1	1	Ø	Ø	1	Ø	Ø	= 37E4H

Ø = 0V 1 = 5V

Fig. 2. Binary state of the TRS-80 address bus at 37E4H.

those unfamiliar with the operation of the D-type flip-flop, a brief description is given.

This type of flip-flop has two inputs and two outputs. One input is the D, or data, input and the other is the CLK, or clock input. The two outputs are Q and $\overline{Q}$.

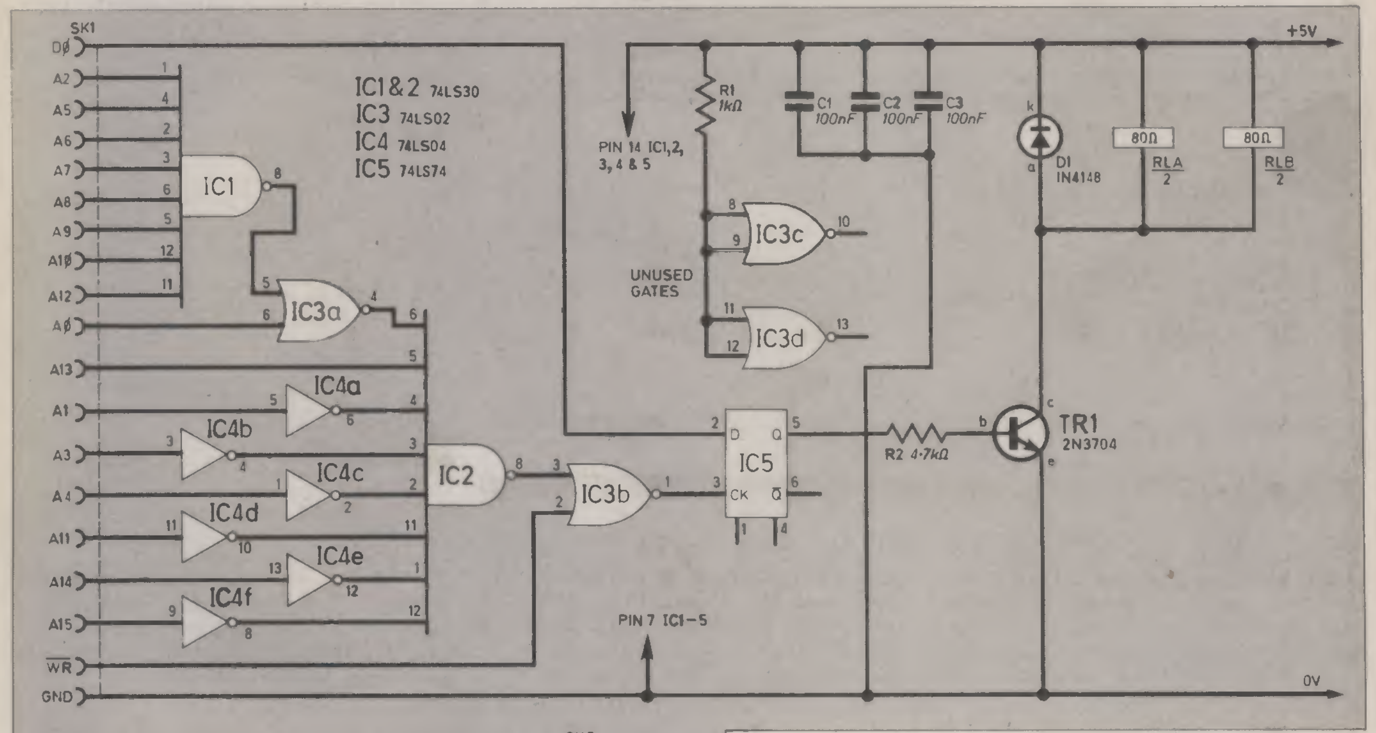
If the CLK input is kept low then the outputs remain in a constant state no matter what signal is present at the D input.

However, when the CLK input is taken high, the outputs begin to echo the signal at the D input. Q takes the same state as the D input while $\overline{Q}$ takes the opposite state. When the CLK input goes low then whatever state is present on the D input will be latched into the flip-flop and remembered until another high CLK step.

The outputs will be kept in their respective states, whatever they were when the CLK input went low.

The D input of the flip-flop IC5 is connected to the first data line of the computer, DØ. Normally this is changing state many thousand times a second as data is moved about the computer. However, since 37E4H is not being written to, the CLK input of the flip-flop will be low and so the signal at the D input will have no effect.

When 37E4H is written to, the CLK input goes high and the state of DØ is latched into the flip-flop. The timing of the computer is such that the address



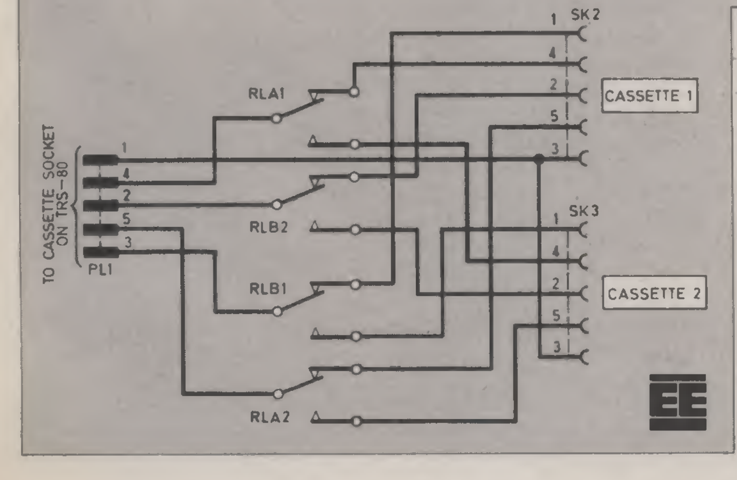
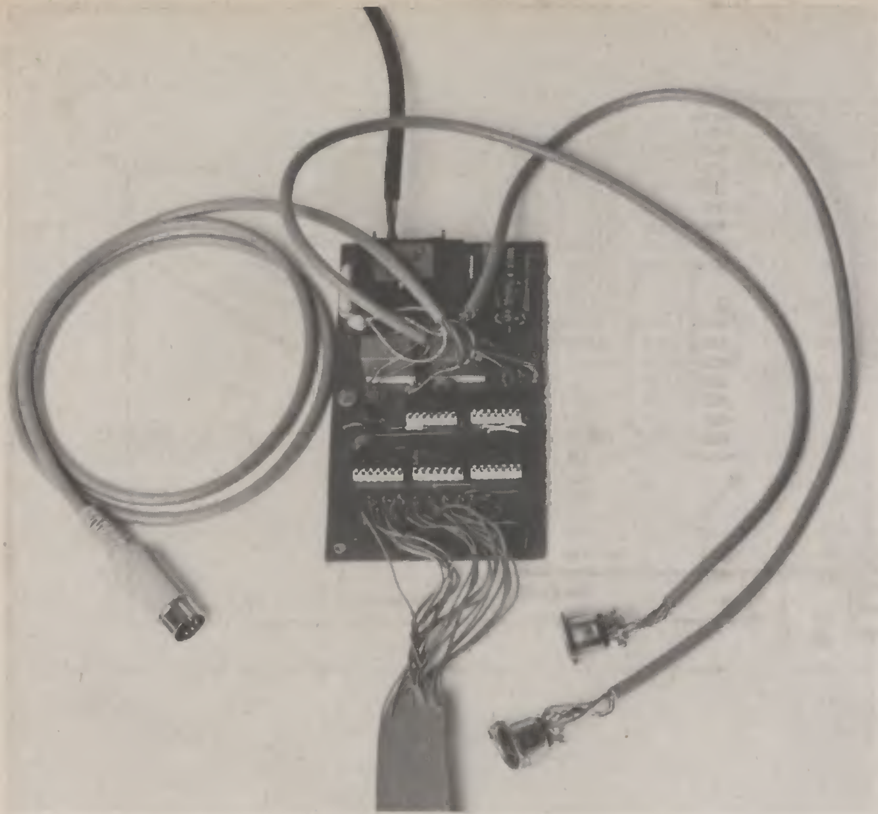


Fig. 3. The circuit diagram of the TRS-80 Twin Cassette Interface. The power supply section is shown in Fig. 4. SK1 is connected to the I/O port on the TRS-80 computer.

lines and data lines change state in synchrony and hence the data fed to the flip-flop remains constant until the CLK input goes low. The non-inverted output, Q, is fed to the relay driver.

RELAY DRIVER

The relay driver consists of a single transistor connected in the common emitter configuration. Its operation is that of a current amplifier, amplifying the 20mA available from the output of the data latch to the 125mA necessary to drive the relays. Diode D1 is reverse biased across the coils of the two relays. Its purpose is to conduct away the reverse e.m.f.



produced by the relays as they turn off, and hence protect the transistor.

The contacts of the two relays form four single-pole changeover switches. These are used to switch four of the five data routes from one cassette deck to the other. The only route not switched is the common motor switch connection. Note that it is necessary to switch the earth line as well as the signal paths since otherwise bad hum loops or even cassette malfunctions can occur.

As has already been described, a ØØ is written to 37E4H when cassette 1 is to be used and FFH is written to this location when cassette 2 is to be used. Thus the output of the data latch will be low for cassette 1 and high for cassette 2. The relays will be off for cassette 1 and on for cassette 2.

The relay contacts are wired up so as to connect cassette 1 to the cassette port when the relays are off and to connect cassette 2 to the port when the relays are on.

POWER SUPPLY

The power supply is based on the widely known 78 series of voltage regulators. The output of T1 is 6V a.c. and this is rectified by D3–D6, a bridge rectifier. Smoothing of the supply is achieved using C6, a 1000µF electrolytic capacitor. The 8·5V d.c. across C6 is applied to the input of IC6, a 5V, 500mA positive voltage regulator. The output of IC6 is +5V d.c. C4 is placed across the output of the regulator to reduce any high frequencies on the supply line. R3 and D2, an l.e.d., form an indicator to tell when the interface is on. See Fig. 4.

Finally, C1, C2 and C3 are placed around the circuit to further decouple the supply for the TTL i.c.s. IC3c and IC3d have their inputs connected to +5V via R1, a 1kΩ resistor. This is done since floating inputs are damaging to TTL i.c.s.

PRINTED CIRCUIT BOARD

It is recommended that the circuit be built on a printed circuit board since the many interconnections become difficult on stripboard. Once the p.c.b. has been made up, preferably using glass-fibre board, it should be scrutinised for bridges between the tracks.

The actual-size master printed circuit board pattern used for the prototype is shown in Fig. 5. This is available from the *EE PCB Service,* Order code 8312–03. The layout of the components on the topside of this board is also shown in Fig. 5.

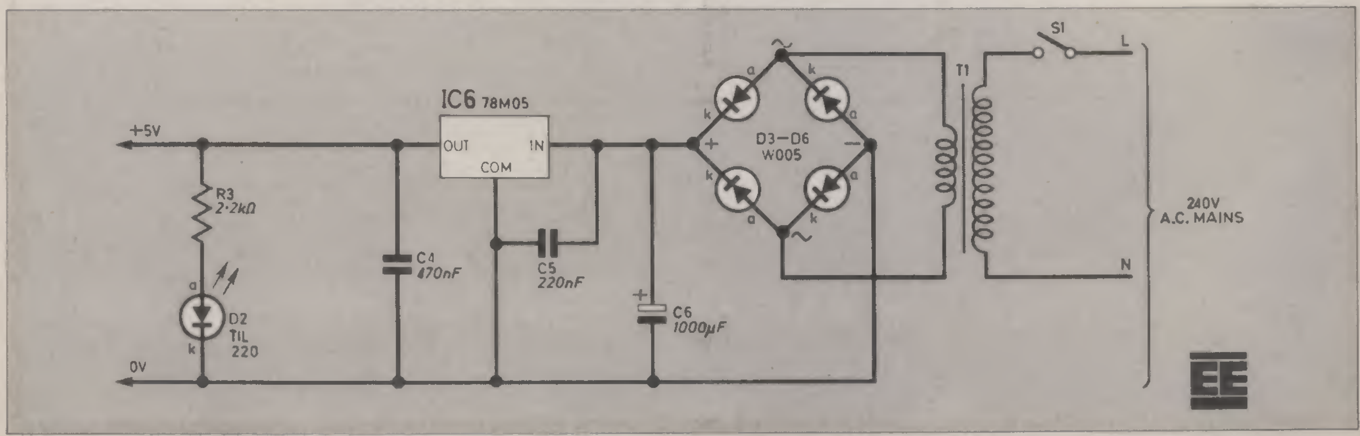
Using a fine tipped soldering iron and thin solder, construction can begin. Start by soldering in all the wire links followed by the Veropins, if these are to be used. Next, solder in the i.c. sockets. The relays are best mounted in low profile i.c. sockets, since otherwise removal will be difficult should they become faulty.

Mount the resistors and capacitors next, ensuring C6 is fitted the right way round. Now fit the transformer and finally solder in the transistor and voltage regulator. Ensure these latter components are fitted correctly.

After fitting the diode, the i.c.s may be inserted, checking their orientation is correct. Now fit the relays. The main board is now finished.

Some method of connecting the main board to the expansion socket on the Console is necessary, and a good method, especially if another peripheral is connected, is to make the header shown in Fig. 6. A double-sided p.c.b. is soldered to a 40-way edge connector and also forms an edge connector for another peripheral. Taps are taken from the appropriate lines using Veropins. Although not the neatest way of making connection, it is certainly effective.

Fig. 4. The power supply circuit diagram. Note that the mains earth is not required.



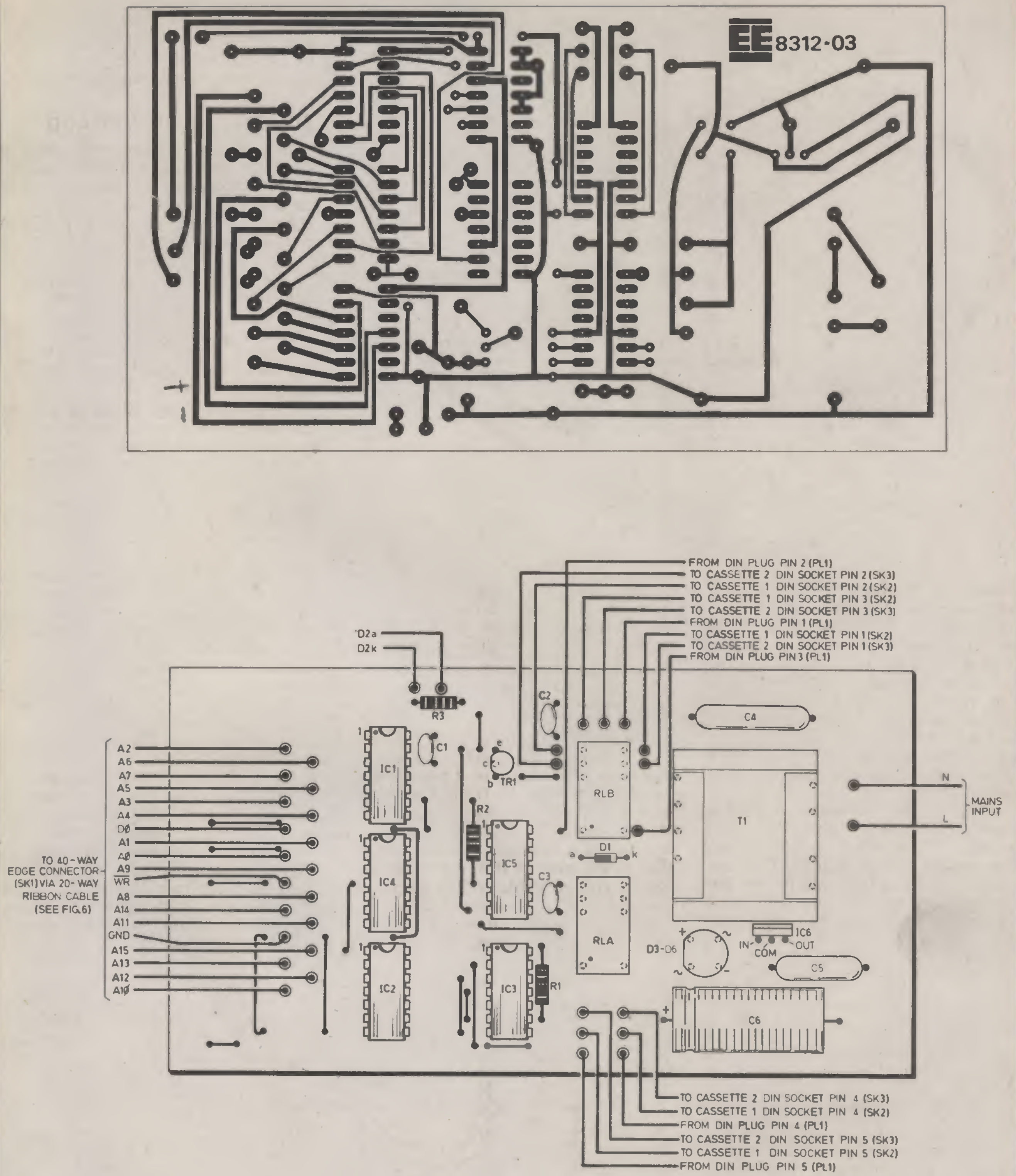


Fig. 5. The full-size p.c.b. track artwork and component layout diagram. This board is available from the *EE PCB Service*, Order code 8312-03. All wires (including the ribbon cable) must be terminated with a Veropin. Note that the mains input cable will require a clamp to act as strain relief at the point of entry on the case.

COMPONENTS

See Shop Talk page 801

Resistors

R1	1kΩ
R2	4·7kΩ
R3	2·2kΩ

All ¼W carbon ±5%

Capacitors

C1,2,3	100nF miniature ceramic
C4	470nF polyester type C280
C5	220nF polyester type C280
C6	1000µF 16V elect.

Semiconductors

D1	1N4148 silicon diode
D2	TIL220 red l.e.d.
D3–D6	W005 1A 50V bridge rectifier
TR1	2N3704 silicon *npn*
IC1,2	74LS30 TTL low power Schottky 8-input NAND gate (2 off)
IC3	74LS02 TTL low power Schottky quad 2-input NOR gate
IC4	74LS04 TTL low power Schottky hex inverter
IC5	74LS74 TTL low power Schottky dual D-type flip-flop
IC6	78M05 +5V monolithic voltage regulator

Miscellaneous

SK1	20 + 20 way double-sided card edge connector
SK2,3	5-pin DIN 180° socket
PL1,2	5-pin DIN 180° plug (2 off)
PL3,4	3·5mm jack plug (2 off)
PL5	2·5mm jack plug
S1	s.p.s.t. mains on-off toggle
T1	mains/0–6V, 0–6V 1·5VA per secondary winding, type Clairtronic 9300
RLA, RLB	Ultra miniature d.i.l. relay, 6V, coil resistance 80 ohms double-pole change-over contacts (Maplin BK48C) (2 off)

Printed circuit boards: single-sided size 135 ×75mm; *EE PCB Service,* Order code 8312–03; double-sided size 53 × 37mm, *EE PCB Service,* Order code 8312–09; single-sided Veropins (72 off); 20-way ribbon cable (1 metre); d.i.l. i.c. sockets, 14-pin (7 off); mains cable (2 metres); 4-core individual screen screened cable (2 metres); 3mm fixing hardware; plastics case, size 160 × 100 × 75mm approximately; tinned copper wire for board links.

Approx. cost Guidance only £22 excluding case

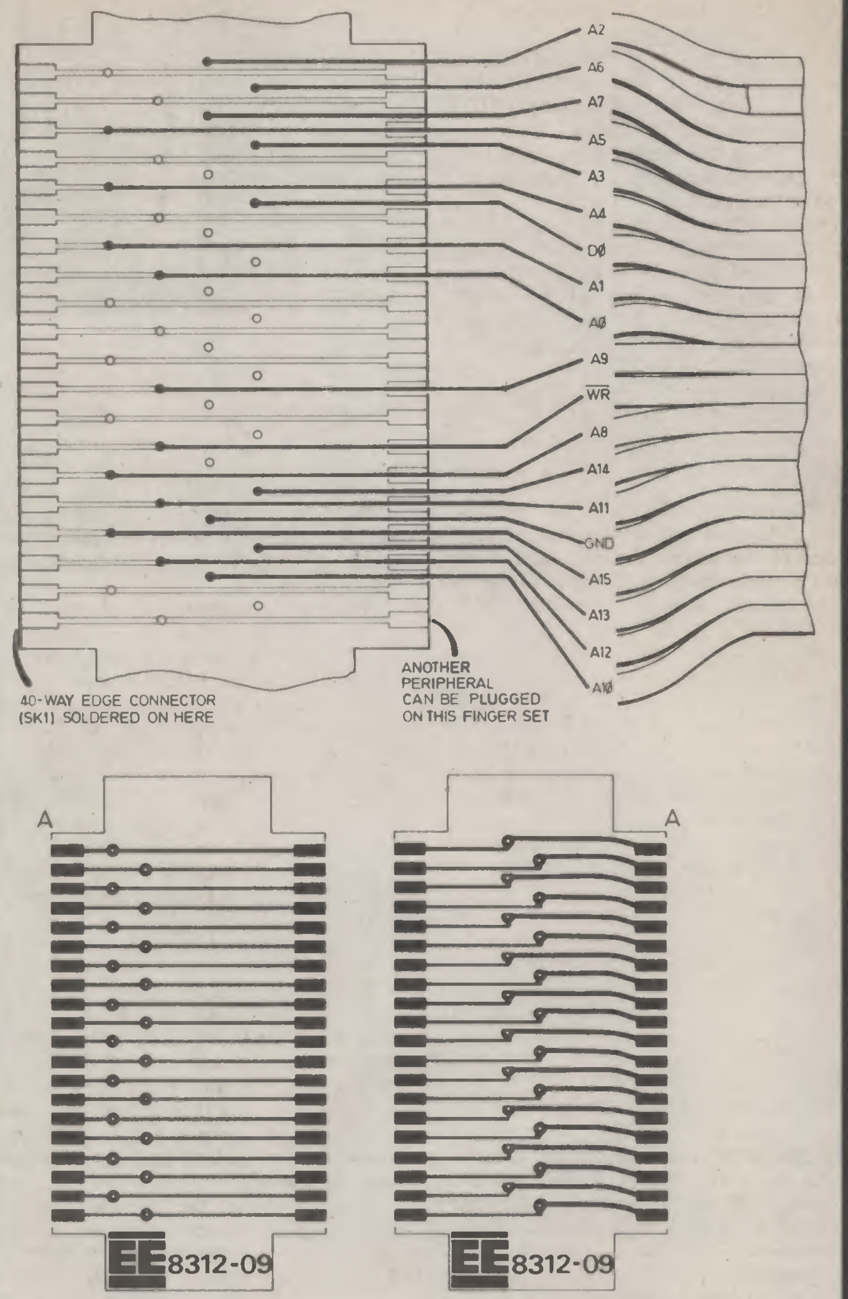


Fig. 6. Full-size track artwork of the double-sided header p.c.b. This board carries the 40-way edge connector (SK1) and also permits additional peripherals to be plugged into the TRS-80 I/O port. Top view shows the ribbon cable wiring.

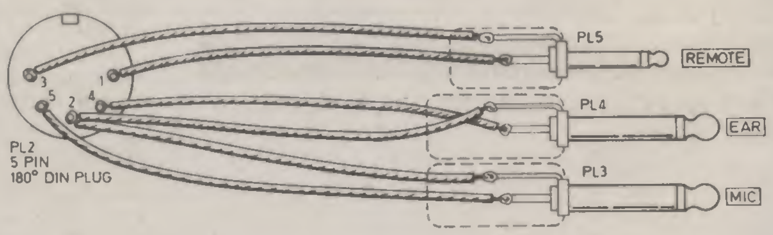


Fig. 7. Wiring of the cassette lead to connect the interface to the cassette player. If the 4-core screen cable is used, the screens must *not* be used for the REMOTE (PL5) connections.

CABLES

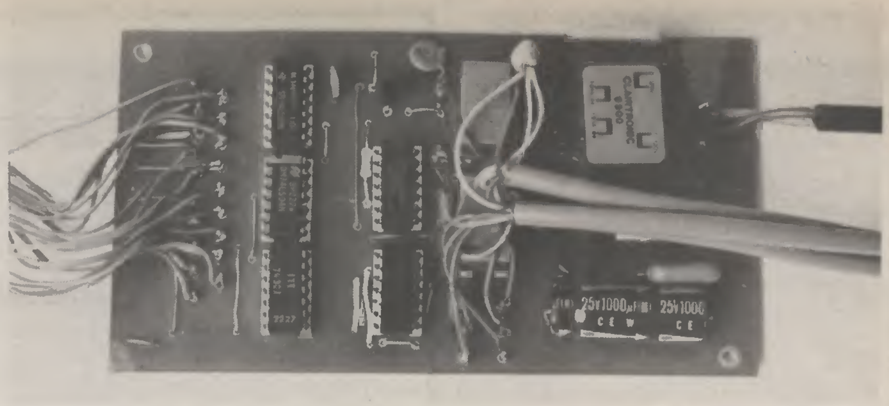
A length of 20-way ribbon cable is used to link the header to the main p.c.b., as shown in Figs. 5 and 6.

A length of four-core screened cable is used to connect the cassette port to the p.c.b. A 5-pin 180° DIN plug (PL1) should be soldered on the end of this as shown. Using the same cable, two 5-pin 180° DIN sockets (SK2 and SK3) are wired to the board.

The whole project may be fitted into a small plastic box. A metal box is not recommended since it would have to be earthed and the bodies of the DIN sockets are connected to computer ground. A slot may be cut in the end of the box to take the ribbon cable. Remember to pass the cable through this slot before soldering to the main p.c.b. The two output sockets, on/off switch and power indicator can be mounted as desired.

You should already have one cassette lead but another one is required for connection to the second cassette deck. This may be made up from a length of the 4-core screened cable. A 5-pin 180° DIN plug (PL2) is soldered to one end as shown. The other end is stripped back about 100mm and mini-jack plugs are soldered to the ends. Two of the ends have 3·5mm jack plugs (PL3 and PL4) while the third has a 2·5mm plug (PL5). A mark such as a piece of insulation tape wrapped around the plug should be made on the plug which goes to the ear socket of the cassette deck. The connections for this lead are shown in Fig. 7.

If the recommended four-core individual screen cable is used, then none of the screens should be used in the cassette motor control circuit (REMOTE). Instead, two of the insulated cores should be used.



The complete prototype printed circuit board assembly.

TESTING

First, connect the header to the expansion port of the keyboard Console. Ensure the header is the right way round. With the interface turned off and disconnected from the mains, switch on the computer. If all is well, the familiar MEMORY SIZE? will appear. Press <ENTER>. If the READY prompt appears, then all is well with the wiring. If anything unusual happens, check the connections at both ends of the ribbon cable and also check for solder bridges between tracks of both the main and header printed circuit boards.

With the computer turned off, switch on the interface. The two relays should click on. If not, check the main board for broken tracks or solder bridges. If the power light does not come on then, check out the power supply first. If the l.e.d. glows very bright, then it is probably the voltage regulator at fault. Should the relays click on, then switch on the TRS-80. All should be well, but if not it will either be IC1, IC2 or IC3 at fault.

To the MEMORY SIZE? prompt press <ENTER>. Once in Basic enter

POKE 143Ø8,Ø

The relays should switch off. If so, enter

POKE 143Ø8,255

The relays should switch on. If all is well, continue at the next paragraph. If not, it could be any one of the i.c.s at fault. Check the connections to each one in turn and ensure that no links are missing. Note that there is a link underneath one of the i.c. sockets and this may have been missed out.

Next, connect the interface to the cassette port and connect two cassette decks to the interface. Place a tape with a program on it into cassette 1 and set it to play.

Type in

CLOAD#–1

The cassette should turn on and the program should load. If not, check the wiring to the relays and the lead to the cassette port. If all this fails it is probably a fault with one of the relays.

If all is well, then insert a tape with a program on it into cassette 2.

Type in

CLOAD#–2

The cassette should turn on and the program load. If not, check out the wiring as for the first cassette. Now test the saving by loading a program and entering either

CSAVE#–1, "A" or CSAVE#–2, "A"

as appropriate.

IN USE

In use, the interface may be left turned off if only one cassette is required. However, it should not be turned on while the computer is on else the computer will probably crash. All the usual cassette I/O commands may be used, but now with the suffix #–1, or #–2. For CSAVE or CLOAD there is no need to add the suffix if the first cassette is to be used. □

BOOK REVIEWS

BASIC ELECTRICAL INSTALLATIONS 3rd EDITION

Author	M. Neidle
Price	£3.95 Limp edition
Size	254 × 229mm. 77 pages
Publisher	Macmillan Press
ISBN	0 333 34681 5

FOR students following electrical installation courses this book should provide some very useful reference material. All the material contained within has been thoroughly revised in line with new installation developments and techniques.

The book contains 13 chapters starting with basic electrical theory and finishing up with an introduction to the electrical installation industry. A welcome addition to this type of book is a chapter dealing with Care and Safety which gives advice on handling materials and equipment, tool care, safety at work, electric shock treatment, and fire protection.

The text and worked examples are approached in a clear and orderly manner and each new topic has plenty of diagrams to support the text.

R.A.H.

Books in Brief

Electronic Science Projects by O. Bishop (Bernard Babani). Limp £2.25. A different type of electronics book in that all the projects have a strong scientific bias. There are 12 projects starting with A Simple Infra-red Laser and finally a more complex electronic project called Measuring the Earth's Electric Field.

CHILDRENS DISCO LIGHTS

BY T.R. de Vaux–Balbirnie

HAVE SOME PARTY FUN WITH THE CHILDREN'S LIGHT DISPLAY

When the author's eight-year-old wanted some flashing lights for a Christmas party, some careful thought was needed. Mains-operated equipment was banned. A similar ban would also be placed on direct connections to the audio equipment.

When the problem was discussed, it appeared that any small coloured lights would be suitable just as long as they flashed in time to the music.

A circuit was devised which involves no connections to the record-player, operates from a battery and is cheap to construct. A "string" of small coloured bulbs, Christmas tree lamps for example, flash when the music plays. The sound from the audio equipment is picked up by a microphone built into the case of the project. This is interesting since the lights not only respond to music but also to other sounds in the room. Naturally, this system has limitations and is hardly suitable for serious use.

CIRCUIT DESCRIPTION

The circuit diagram for the Children's Disco Lights is shown in Fig. 1. The microphone, in reality a miniature loudspeaker, LS1 picks up the sound of the music. This gives a weak electrical signal at its terminals which is amplified by TR1 and associated components.

This amplified signal is applied through C2 to the non-inverting input (pin 3) of the operational amplifier IC1. This input also receives a steady 4·5V, approximately, due to the potential divider formed by R3 and R4. VR1, a miniature preset potentiometer, supplies a steady voltage to the inverting input of IC1 (pin 2). Before use VR1 will be adjusted so that the steady voltage at the inverting input is just above that at the non-inverting input. Under these conditions the op-amp will be off with no output at pin 6.

When the music plays there will be a small voltage superimposed on the steady one existing at pin 3. Thus, the voltage here will exceed that at pin 2 and the op-amp will switch on and off in time with the music. The light-emitting diode, D1, in the output circuit of the op-amp will then flash in sympathy. The l.e.d. is necessary to help in adjusting VR1 at the testing stage.

The output pulses need to be lengthened and smoothed to some extent to make them more suitable for operating filament lamps. This is achieved by D2 and C3. The pulses are then passed onto the Darlington lamp driver stage TR2 and TR3. This operates the bulbs in the collector circuit. VR2 is used to match the output of the op-amp to the lamp driver stage.

No input sensitivity control is included. To adjust the response of the circuit to the loudness of the music, the case is simply moved to the best distance from the record-player loudspeaker.

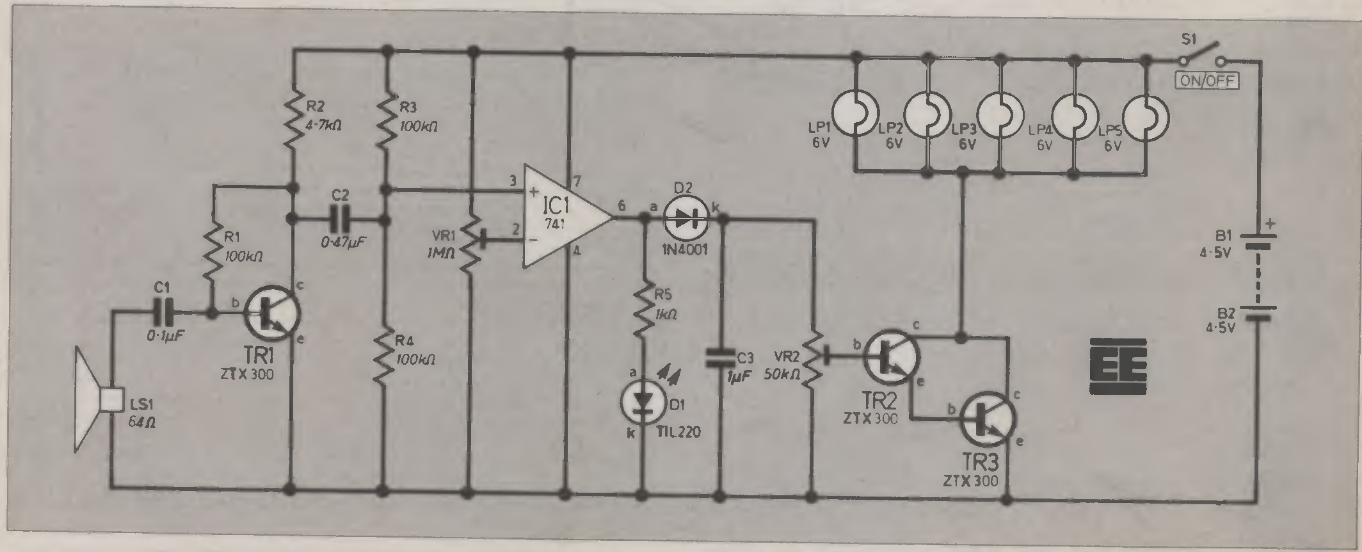
COMPONENT BOARD

The component board is a piece of 0·1in matrix stripboard having 14 strips by 29 holes and can be seen in Fig. 2. Note that all the 13 breaks in the copper track should be made in the board before any of the components are soldered in place. A holder should be used for IC1 so that damage does not occur to the i.c.

CASE

The plastics case used for the prototype measures 147 × 76 × 45mm although any case of similar size should be suitable. Prepare the case by making a

Fig. 1. The complete circuit diagram for the Children's Disco Lights.



matrix of holes for the loudspeaker, for S1 and for the battery and lamp leads. The loudspeaker is fixed in place using a quick setting epoxy resin.

LAMPS

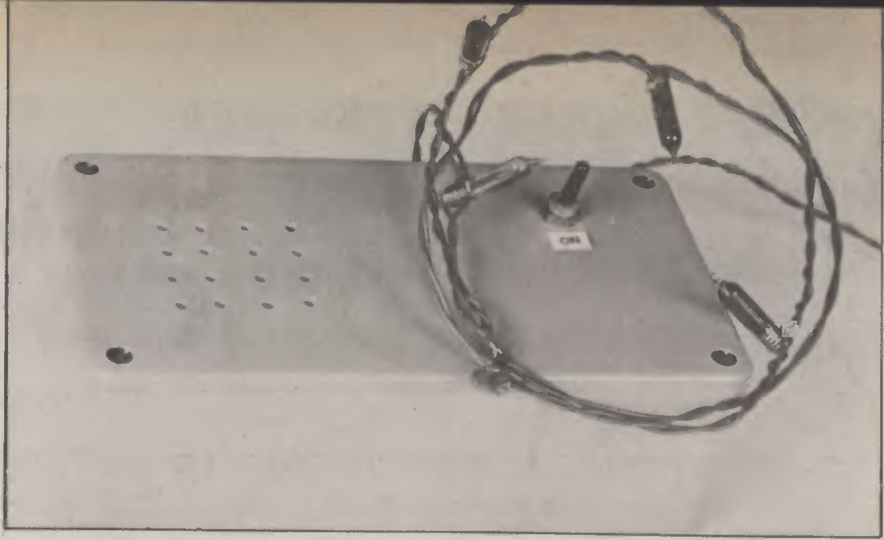
The lamp driver can handle current up to 500mA, so up to eight 6V, 0·06A lamps may be used in parallel. Alternatively, Christmas tree lights may be used as in the prototype. These must be of the 6V-type normally used in 240V, 40 lamp sets. Direct solder joints may be made to the lamps which are then connected in parallel as shown in Fig. 2.

Note: up to six Christmas tree lamps may be used but only five are shown connected on the prototype.

ADJUSTING AND TESTING

Do not place the circuit panel in the runners of the case yet. Adjust VR1 and VR2 to approximately mid-track position. Connect up the battery and switch on. Adjust VR1 until the balance point is reached where D1 is off.

Adjust VR2 so that the filament lamps glow dimly, this usually gives best results. Snap the fingers near the loudspeaker and if all is well, the l.e.d. and filament lamps will flash. The adjustment of VR1 is critical. If the slider is adjusted too far clockwise the circuit will lack sensitivity or fail to work at all.



If adjusted too far anti-clockwise, the lamps will be on continuously. VR2 may need final adjustment to obtain the most satisfactory setting. Note that the adjustment of VR2 depends on the number and type of lamps in the chain. When music is played, the lamps should flash in sympathy.

POWER SUPPLY

Depending on the number of lamps and periods of use, a small battery (a PP3 for example) will probably give poor service. It may seem tempting to house the battery inside the case but much better results are obtained by using a larger external battery. Excellent service is given from two 4·5V type 1289 batteries connected in series. Alkaline batteries or Nickel-Cadmium rechargeable batteries would also be a wise choice.

PRESENTATION

This is left to the imagination of the user. The lamps may simply be strung up. Alternatively, they may be pushed through the eyes, nose and mouth of a large mask. Another possibility is portable use with the lamps placed around a hat and the battery in a pocket. □

COMPONENTS

Resistors

R1,3,4	100kΩ (3 off)
R2	4·7kΩ
R5	1kΩ

All ¼W carbon ±5%

Capacitors

C1	0·1μF polycarbonate
C2	0·47μF polycarbonate
C3	1μF polycarbonate

Semiconductors

D1	TIL220 0·2in red l.e.d.
D2	1N4001 rectifier
TR1,2,3	ZTX300 silicon *npn* (3 off)
IC1	741 op-amp

Miscellaneous

S1	s.p.s.t. miniature toggle switch
VR1	1MΩ lin. miniature carbon preset
VR2	50kΩ lin. miniature cermet preset
LS1	miniature, 60–80Ω, 60mm dia. approx.
LP1–5	6V, 0·06A filament lamps
B1,2	See text

Stripboard: 0·1in matrix size 14 strips × 29 holes, plastic case, 147 × 76 × 45mm (ABS box 2005); 7-pin d.i.l. i.c. holder.

Approx. cost Guidance only £9.00

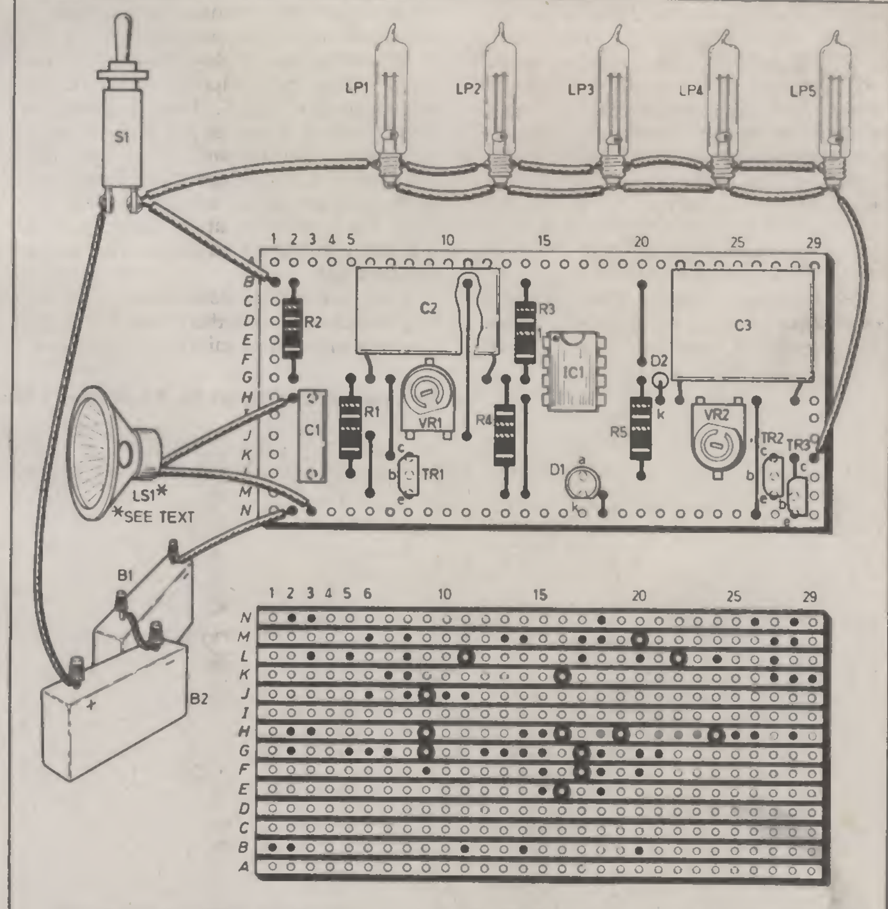


Fig. 2. The component layout and trackside view of the Disco Light's circuit board, with offboard wiring details also shown.

MAGIC CANDLE

BY T.R. de Vaux-Balbirnie

A FILAMENT LAMP "CANDLE" THAT CAN BE BLOWN OUT BUT MAGICALLY RELIGHTS

THE Magic Candle was originally intended as a Christmas novelty but it could be used as part of a conjuring routine, as a game or simply as a conversation piece at a party.

It appears as a large candle having a filament lamp instead of a flame. After switching on, the lamp may be "blown out" and after several seconds, relights itself. This gives children great delight.

CIRCUIT OPERATION

The action of this project depends on the two thermistors, RTH1 and RTH2 (see circuit diagram, Fig. 1). These components have fixed resistors, R1 and R2, respectively, "strapped" to them with thin wire "piggy-back" fashion. Since R1 and R2 are connected in parallel across the supply battery, they will become warm soon after switching on as their power rating is slightly exceeded.

This in turn will warm the thermistors. Some heat will be developed by the thermistors themselves as they are connected in series across the battery but this will be much less than that developed by the fixed resistors. Thermistors are temperature dependent resistors and RTH1 and RTH2 are negative coefficient types which reduce resistance on heating.

RTH1 and RTH2 form a potential divider and a voltage is developed at pin 3 of IC1. The value of this voltage will depend on the relative temperatures of RTH1 and RTH2. Thus, if the temperature of RTH1 becomes less than that of RTH2 the voltage will fall and vice-versa.

OPERATIONAL AMPLIFIER

The Operational Amplifier, IC1, compares the voltages at its two inputs. The voltage at pin 3 is applied to the non-inverting input (marked +) while a voltage obtained according to the setting of VR1 is applied to the inverting input (marked –). If the voltage at the non-inverting input exceeds that at the inverting input then the op-amp switches on. Otherwise it will be off. It is working as a comparator.

When on, the op-amp operates TR1 hence the filament lamp in its collector circuit. In its "normal" state, both thermistors will be warmed equally and so attain the same temperature. The voltage at pin 3 will then be approximately on half of the battery voltage, about 4·5V. One reason why this value cannot be predicted accurately is because thermistors, even of the same type, are not truly identical in performance. VR2 is adjusted so that the voltage applied to the inverting input (pin 2) is just less than that at pin 3. The lamp will then be on.

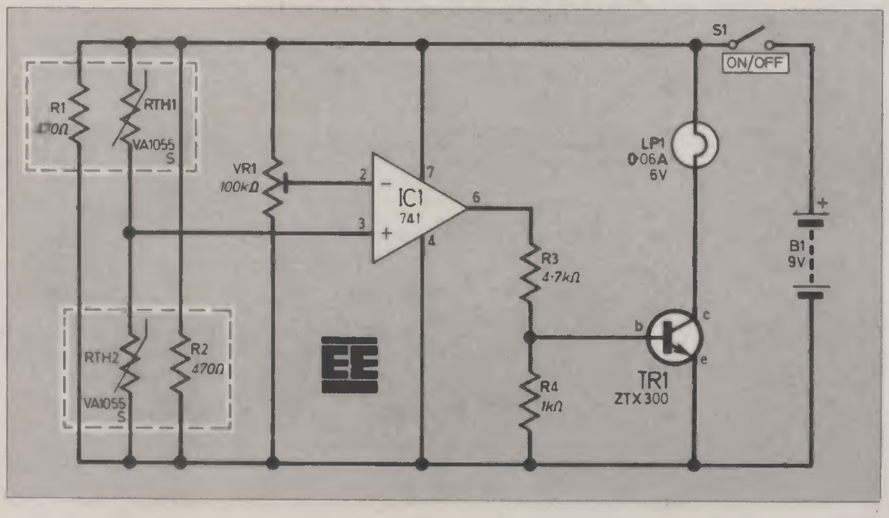
To "blow out the candle," breath is directed at RTH1. This component will be slightly cooled while the temperature of RTH2 remains unchanged. The action of the potential divider will now be upset resulting in a fall in voltage at pin 3. This is now less than that at the inverting input so TR1 and the lamp will switch off.

After a few seconds, RTH1 will regain its former temperature, its resistance will fall and the lamp switch on again.

IMMUNITY

The reason for providing *two* thermistors instead of just one and a fixed resistor, is to give some measure of temperature stability. If the project were moved to a room at a different temperature then both thermistors would be equally affected. In theory, the voltage at pin 3 would not change. How well this is realised in practice depends on the particular thermistors being used.

Fig. 1. Circuit diagram of the Magic Candle.



COMPONENTS

Resistors

R1,2	470Ω $\frac{1}{8}$W (2 off)
R3	4·7kΩ $\frac{1}{2}$W
R4	1kΩ $\frac{1}{2}$W

Semiconductors

RTH1,2	VA1055S miniature rod thermistor (2 off)
TR1	ZTX300 *npn* silicon
IC1	741 op-amp

Miscellaneous

VR1	100kΩ miniature horizontal preset
B1	PP6 9V battery
LP1	6V, 60mA m.e.s. bulb
S1	miniature toggle switch

0·1in matrix stripboard, 11 strips by 19 holes; cardboard tube (for candle body); battery clip; 8-pin d.i.l. holder; fine copper wire (see text).

Approx. cost Guidance only **£3.80**

CARDBOARD TUBE

Before constructing the circuit panel, a cardboard tube (a kitchen roll tube for example) should be chosen large enough to accommodate the circuit panel and the battery. The current requirement is about 100mA which is too high for a standard PP3 battery. If the reader intends using such a small battery, then the alkaline version (Duracell type) is strongly advised since this will give far better service.

A PP6 battery may be used but this will require a tube of greater diameter than a standard kitchen roll. It is also possible to house the battery in an ornamental base. A large battery is better where heavy use is contemplated.

SENSORS

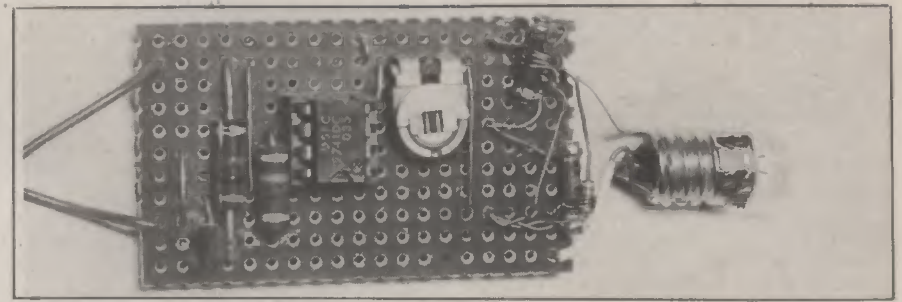
The next job is to prepare the pairs of components RTH1/R1 and RTH2/R2. These are bound together using about four turns of fine copper wire (thin fuse wire will do)—see Fig. 2.

Construct the circuit panel using a piece of 0·1in matrix stripboard, 11 strips by 19 holes as shown in Fig. 3. Although the i.c. socket should be soldered in position along with the other components, the op-amp itself should not be inserted in it until the end. Make the five breaks in the copper strips; four between the i.c. socket pins and one between the terminals of VR1 and insert the five inter-strip links.

Check all wiring and make certain that no "bridges" exist between adjacent copper tracks. Connect the lamp on two short (20mm) leads to strips *B* and *K* and two longer leads for the battery connections to strips *B* and *I*.

CHECKING

The circuit may be checked before fitting it into the candle body. Connect



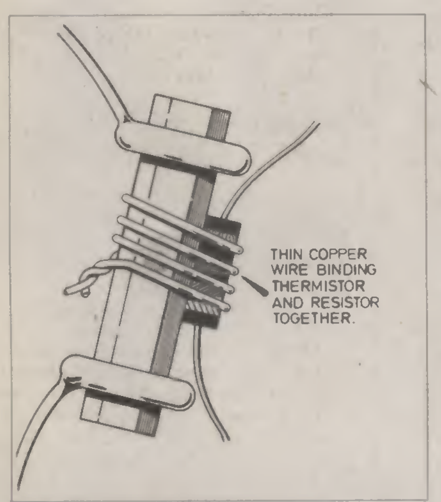
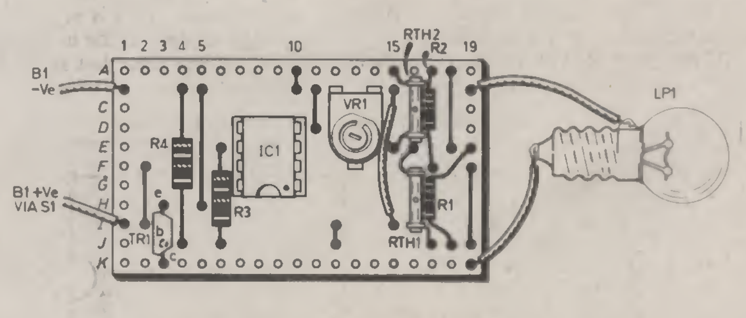


Fig. 2. The method of fixing R1 to RTH1 (and R2 to RTH2) using fuse wire. Note these resistors *must* be ¼W components.



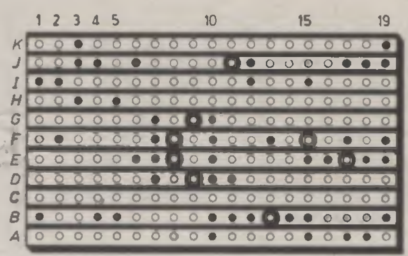


Fig. 3. The stripboard component layout and trackside view. Note that the R1/RTH1 assembly must be mounted on the board so that the stream of air reaches it but *not* the R2/RTH2 assembly (see photo above).

the battery and wait one minute for the thermistors to reach their operating temperature. Whether the lamp lights or not is unimportant at the moment. Adjust VR1 *very carefully* to the point where it can be switched on or off by small movements of the slider. Leave VR1 adjusted so that the lamp is *just* on. Using a drinking straw, blow at RTH1 but not at RTH2. The lamp should go off and after a short while come on again. Repeat and adjust VR1 for best operation.

If all is well, the "candle" body may be prepared. Here, any artistic talents the reader might have may be freely exercised. The hole in the top of the candle is made rather large on purpose (about 12mm). The real reason for this is to allow breath to reach RTH1. It will be noted that the arrangement of the circuit panel when in position is such that RTH1 will be in "direct line of fire" of breath while RTH2 is shielded.

FINAL TESTING

When finally testing the assembled project, the shielding effect of the tube may necessitate further adjustment to VR1 for best operation. It may be found necessary to make a small hole in the side of the tube to allow for adjustment of VR1. The circuit panel may be held in position using a small piece of plastic foam. The leads of RTH1 and RTH2 may be gently bent as necessary to give the correct effect.

A miniature toggle switch may be used as an on-off switch or the battery simply disconnected when the project is not in use.

Readers are advised to switch off when the project is not actually in use since the battery will soon run down otherwise.

If a base is not used it may be necessary to place a piece of "Plasticine" or similar material low down in the tube to aid stability.

VARIATIONS

A variation of the Magic Candle is to blow it on as well as off! For this, RTH2 must be accessible for breath as well as RTH1. If RTH1 is blown at then the lamp will go off. If breath is now directed at RTH2 instead, the lamp will instantly re-light! By knowing this trick, readers may make a good "magic" routine. □

CIRCUIT EXCHANGE

FOUR-DIGIT COMBINATION LOCK

THIS circuit is a 4-digit combination lock with the added feature of resetting itself if the user makes an incorrect entry, which makes it virtually "unpickable" along with the 11,880 permutations of the combination!

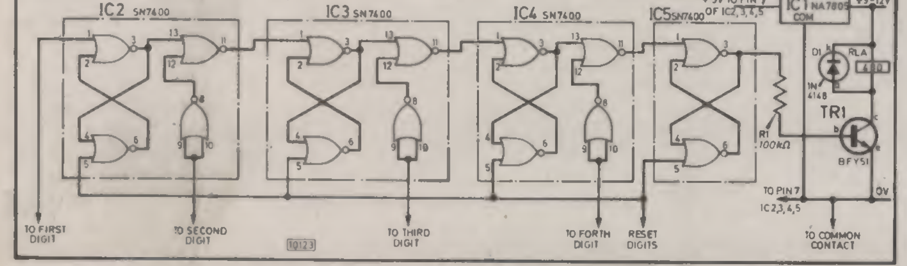
It uses four 7400 quad 2-input NAND gates (TTL) that go to make up four bistables and inverters. The keyboard used is a 12-key type with 12 contacts and 1 common contact. The inputs to the bistables are connected to the contacts on the keyboard corresponding to the digits used in the combination. All the unused contacts are connected to the reset inputs.

The final bistable, after the correct combination has been entered, drives TR1 which operates the relay. The gates are powered by the voltage regulator (5V) which runs off of the supply voltage of 9 to 12V.

Once the circuit is switched on, the bistables must be set to zero by pressing any key other than one used in the combination. After this the relay will not activate until the correct combination has been entered in the right order. The relay can be reset by pressing another key that isn't used in the combination.

The relay could operate something like an electrically-operated lock or it could be used to de-activate a larger security system. It is in these contexts that I have used the lock myself.

B. Hobson, Countesthorpe, Leicester.

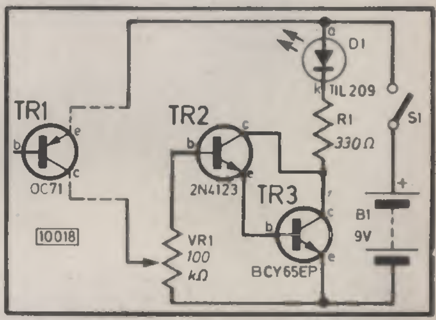


TEMPERATURE SENSOR

THE unit is very simple. It uses the fact that a germanium transistor has a varying resistance according to the temperature. It can be used as a boiling liquid alarm or for finding the temperature of a bath by putting the sensor in the water and turning the knob until the l.e.d. lights up, then reading out the temperature.

As the circuit diagram shows, the transistor collector and emitter are connected between the positive supply line and the wiper at VR1. This acts as a potential divider. The output is fed to a Darlington pair which works the alarm.

The unit reads from about 30 degrees C to 100 degrees C but this depends on the potentiometer.



David Corder,
Kirkby Stephen, Cumbria.

PLEASE TAKE NOTE

Speech Synthesiser for the BBC Micro *(November 1983)*

The circuit diagram Fig. 2 (page 699) shows two pins on IC1 labelled "27". The pin connecting to R9/C5 should be labelled "24".

The user port pin numbering on pins 8, 10, 12 and 13 of the circuit diagram are incorrect and should be renumbered 6, 8, 10, 12, respectively.

The printed circuit board is correct.

Multimod *(November 1983)*

Circuit diagram (Fig. 1, page 705) shows the bottom half of S1 drawn incorrectly; the pole should be connected to 0V not to B2 +ve as shown. Wiring diagram (Fig. 4, page 707) is correct.

SHOP TALK

BY DAVE BARRINGTON

CONSTRUCTIONAL PROJECTS

TRS-80 Twin Cassette Interface

The p.c.b. mains transformer used in the *TRS-80 Twin Cassette Interface* is available from Rapid Electronics. This should be ordered as: PCB min. mains transformer, 3VA 0-6, 0-6 at 0·25A. Price £2.87 inclusive. Other transformers may be used but this may necessitate altering the p.c.b. copper strip layout.

The miniature d.i.l. 6V 80-ohm coil relays, with double-pole changeover contacts, are available from Maplin Electronic Supplies: Order code, BK48C Ultra Min, Relay 6V (DPDT).

For those readers who do not wish to make up their own cassette lead, one may be purchased from any Tandy store; ask for a Model I CPU to audio cassette lead, Code 26-1207 (£2).

Novel Egg Timer

The 14-bit binary counter (4060B) and the CMOS dual 4-input AND gate (4082B) integrated circuits used in the *Novel Egg Timer* are available from Enfield Electronics, Rapid, Benningcross, Cricklewood and Magenta Electronics.

We have not been able to locate a "readily" available source for a 40-ohm loudspeaker. However, one of the 64-ohm, 64mm diameter range of miniature loudspeakers stocked by most of our advertisers will work in this circuit.

The final choice of housing is left to the individual, but a plastics or "soft" toy from one of the large multiple stores or toy shops would make a novel finish to this project. Also, the completed board and speaker could be housed in one of those "egg baskets" in the shape of a chicken that are very popular.

Enviromental Data Recorder

The MK5168 single channel 8-bit analogue-to-digital converter i.c. used in the *Environmental Data Recorder* may be obtained from Lock Distribution Ltd., P.O. Box L064, Neville Street, Oldham, Lancs OL9 6PY. The inclusive cost is £10.76.

Microcomputer Interfacing Techniques

The only device likely to cause any purchasing problems in this month's *Microcomputer Interfacing Techniques* is the ZN448 8-bit A-to-D Converter used in the *Digital Board*. This device is available from Magenta Electronics, Dept EE, 135 Hunter Street, Burton-on-Trent, DE14 2ST. Price £10.85 plus 50p postage.

We do not expect any component purchasing problems for the "Christmas Ideas" and the remaining constructional projects in this issue.

Teach-In 84

Readers wishing to purchase kits for the new *Teach-In 84* series may obtain them from the following advertisers. Prices appear in their relevant advertisement in this issue.

We understand that advertisers have had difficulty in obtaining the EBBO boards which has meant a delay in sending out kits. This problem has now been resolved and the back-log of orders completed.

SUPPLIERS OF KITS FOR TEACH-IN 84

Please refer to advertisement on page stated.

Greenweld Electronics *(page 846)*
43 Millbrook Road,
Southampton, SO1 0HX.

Magenta Electronics *(page 848)*
135 Hunter Street,
Burton-on-Trent, Staffs
DE14 2ST.

TK Electronics *(page 784)*
11 Boston Road,
London, W7 3SJ.

EE PRINTED CIRCUIT BOARD SERVICE

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

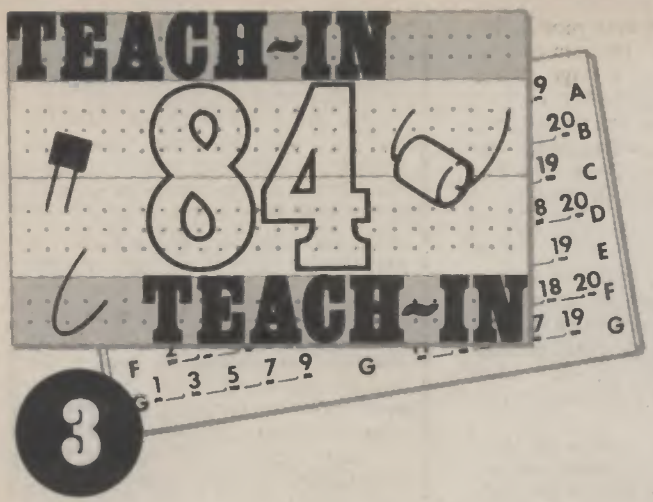
We regret that the ordering codes for the August projects have been incorrectly quoted in the Sept-Oct issues. Correct codes are given below.

Please note that when ordering it is important to give project title as well as order code.

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

PROJECT TITLE	Order Code	Cost
Eprom Programmer, TRS-80 (June 83)	8306-01	£9.31
Eprom Programmer, Genie (June 83)	8306-02	£9.31
Eprom Programmer, TRS-80 & Genie (June 83)	8306-03	£1.98
User Port Input/Output *M.I.T. Part 1* (July 83)	8307-01	£4.82
User Port Control *M.I.T. Part 1* (July 83)	8307-02	£5.17
Storage 'Scope Interface, BBC Micro (Aug 83)	8308-01	£3.20
Car Intruder Alarm (Aug 83)	8308-02	£5.15
High Power Interface *M.I.T. Part 2* (Aug 83)	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Part 2* (Aug 83)	8308-04	£3.56
Electronic Die (Aug 83)	8308-05	£4.56
High Speed A-to-D Converter *M.I.T. Part 3* (Sept 83)	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Part 3* (Sept 83)	8309-02	£4.48
Stylus Organ (Sept 83)	8309-03	£6.84
Distress Beacon (Sept 83)	*8309-04	£5.36
Distress Beacon Pocket Version (Sept 83)	8309-05	£3.98
D-to-A Converter *M.I.T. Part 4* (Oct 83)	8310-01	£5.77
High Power DAC Driver *M.I.T. Part 4* (Oct 83)	8310-02	£5.13
Electronic Pendulum (Oct 83)	8310-03	£5.43
TTL/Power Interface for Stepper Motor *M.I.T. Part 5* (Nov 83)	8311-01	£5.46
Stepper Motor Manual Controller *M.I.T. Part 5* (Nov 83)	8311-02	£5.70
Digital Gauss Meter (Nov 83)	8311-03	£4.45
Speech Synthesiser for BBC Micro (Nov 83)	8311-04	£3.93
Car On/Off Touch Switch (Nov 83)	8311-05	£3.11
4-Channel High Speed ADC (Analogue) *M.I.T. Part 6* (Dec 83)	8312-01	£5.72
4-Channel High Speed ADC (Digital) *M.I.T. Part 6* (Dec 83)	8312-02	£5.29
TRS-80 Twin Cassette Interface (Dec 83)	8312-03/09	£7.43
Environmental Data Recorder (Dec 83)	8312-04	£7.24
Touch Operated Die (Dot matrix) (Dec 83)	8312-05/06	£4.34
Touch Operated Die (7-segment) (Dec 83)	8312-05/07	£4.34
Continuity Tester (Dec 83)	8312-08	£3.41

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



A TWELVE-PART HOME STUDY COURSE IN THE PRINCIPLES AND PRACTICE OF ELECTRONIC CIRCUITS. ESSENTIALLY PRACTICAL, EACH PART INCLUDES EXPERIMENTS TO DEMONSTRATE AND PROVE THE THEORY.
USE OF A PROPRIETARY BREADBOARD ELIMINATES NEED FOR SOLDERING AND MAKES ASSEMBLY OF CIRCUITS SIMPLE.
THE IDEAL INTRODUCTION TO THE SUBJECT FOR NEWCOMERS. ALSO A USEFUL REFRESHER COURSE FOR OTHERS.

POTENTIOMETERS & TRANSISTORS

BY GEORGE HYLTON

THIS MONTH we'll start making an acquaintance with the transistor. Not before time, you may say. However, all that work you've done on resistance, voltage and current will now begin to pay off. You need just one more bit before we can really get started.

VOLTAGE DIVIDERS

Two resistances, R1 and R2, are connected in series (Fig. 3.1) across a battery. Each of these resistances "feels" the same current, and in its struggle to resist this current flow it consumes a portion of the voltage.

How big a portion? You will know from previous experiments that it depends on the relative sizes (ohmic values) of the resistances. If R1 and R2 are equal then each "drops" half of the voltage. Don't take my word for it. Try it.

Use 1kΩ resistors to keep the meter loading effect small, and remember that your resistors have a tolerance, so the voltage across R1 may not be *exactly* the same as across R2. (With 5 per cent tolerance resistors the worst that can happen is that one resistance is 5 per cent high and the other 5 per cent low. The difference in voltages can't be more than 10 per cent.)

If R1 is twice R2 then it drops twice as much voltage as the latter. If we divide our 9V into three equal parts, R1 drops two parts (two-thirds) and R2 one part (one-third), or in actual voltages, 6V and 3V, respectively. If we regard 9V as the input and 3V as the output of the circuit then the action of the circuit is to divide the input voltage by 3.

The circuit is a *voltage divider* (also called a *potential divider*). It is used a lot, because it often happens that we need to apply less than the full voltage to some part of a complex circuit.

We'll be doing it in earnest later in this article. First, however, I'd like to make the point that you can use this type of circuit to divide a voltage by any number, not just three.

What fixes the number? It's the relative sizes of the resistances. If for example R1 is eight times R2, then R1 must absorb eight times the voltage. Thus if R2 drops 1V, R1 must drop 8V. For an input of 9V, 1V comes out. The division is by 9.

Suppose we need a ten-fold reduction in voltage. If we imagine the output to be 1V, the input must be 10V. The "unwanted" 9V must be lost in R1. So for a ten-fold reduction in voltage R1 must be, not ten times R2, but nine times R2. It works like this for any required reduction. If the circuit is to divide the input voltage by 100, then R1 must be 99 times R2.

In articles on electronics you'll come across the expression: "voltage attenuation factor". Attenuation means reduction, and a factor is a number. So "voltage attenuation factor" is the number by which the voltage is divided. In our type of voltage divider R1 is greater than R2 and the number of times greater is one less than the voltage attenuation factor.

VOLUME CONTROLS

Resistances behave in the same way towards a.c. and d.c. So voltage dividers of our type can be used to reduce or attenuate a.c. signals as well as d.c. voltages. Often an adjustable form of attenuator is needed. The volume control is the most familiar type. It adjusts the voltage which goes into the audio part of a receiver, or into an audio amplifier.

To make the attenuation adjustable, a resistive track (*a-b* in Fig. 3.2) is provided with a sliding contact *c*. By moving this contact to different parts of the track, different amounts of attenuation can be obtained.

With the sliding contact at *a*, the full input voltage is passed onto the output. With *c* down at *b*, there is no output: the attenuation is infinite. So in theory a volume control can attenuate by any factor from 1 to infinity. In practice, it can't manage that very well, but 1–100 or even 1–1,000 is practicable.

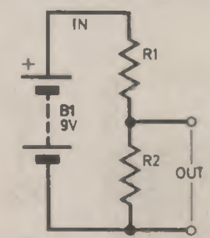


Fig. 3.1. Resistors R1 and R2 form a voltage divider across the 9V battery.

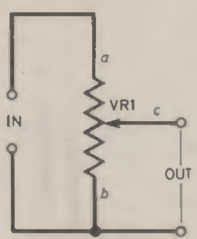


Fig. 3.2. A volume control or "potentiometer" has a resistance track *a–b* and a sliding contact *c*.

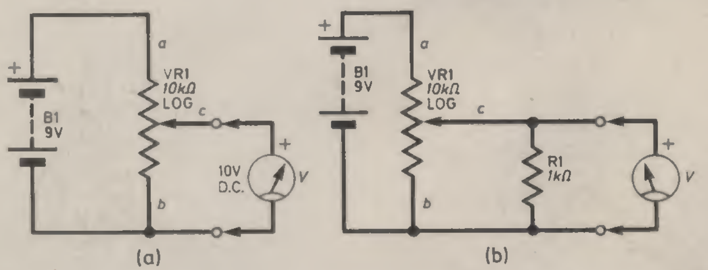


Fig. 3.3(a). How a potentiometer can "tap off' any portion of an input voltage. (Experiment 3.1); (b) Connecting R1 as a relatively low resistance "load" has a marked effect on the output voltage. (Experiment 3.2).

EXPERIMENT 3.1

PREPARING YOUR POT

Get an ordinary rotary type of volume control of the type known as a "10kΩ log. law potentiometer." Connect a length of insulated wire to each of its three tags. If you start with lengths of about 300mm (12in) they will end up about right.

To make connections without soldering, first make sure the tags are clean and bright. Then strip off about 40mm (1½in) of insulation from one end of each of these leads. Wrap this bared wire firmly round and round a tag, squeezing it from time to time with pliers to give it extra grip. When all the bared wire is wrapped, continue with a few turns of the insulated part: this helps to hold the bared wire in place. Do this for each lead.

If possible, use wire of a different colour for each lead. If not, mark the free ends of the leads in some way. You will need to strip off a few millimetres of insulation later, so don't put your markers right at the end. When all three tags are connected, twist the wires together. Finally strip off about 6mm (¼in) of insulation from the free ends, for plugging into your breadboard.

Your finished volume control should look like the one in the photograph. When the spindle is turned fully clockwise the internal sliding contact touches terminal *a*. In the fully anti-clockwise position it touches *b*.

If you connect an ohmmeter to terminals *b* and *c*, the resistance indicated increases as the spindle turnes clockwise. For *a* and *c*, anti-clockwise motion increases the resistance. (Remember to reset your meter to a voltage range immediately after making this test.)

Connect your volume control to your 9V battery (Fig. 3.3a) and measure the output voltage as shown. Note that this can be set to anything from 0V to 9V.

LOADING ERROR

When a resistance is connected across the output of a voltage divider the output voltage falls. This is because extra current flows through R1 (Fig. 3.1) or the corresponding resistance in Fig. 3.3a, which is the upper part of the track; that is, from *a* to *c*.

The amount of extra current depends on the size of the "load"; in other words, the resistance connected across the output. If this is very large, little extra current flows through R1 and the output voltage is not much reduced. But a low-resistance load pulls down the voltage seriously.

EXPERIMENT 3.2

To illustrate this, connect a 1kΩ resistor to your 10kΩ potentiometer (Fig. 3.3b). Note that if the resistor is unplugged when the slider is set at an intermediate position the voltage indicated jumps up. This loading effect is worst at the point where, in the absence of a load, the meter reads half the battery voltage.

The loading effect can be reduced by making the divider resistances small compared with the load resistance. This means wasting current in R1 and R2 (or your "potentiometer") but this is often tolerable.

CURRENT FLOW

One point which causes difficulty may as well be dealt with here. Currents are flows of electric charges. An electric charge can be positive or negative. If positive, the charge travels in the same direction as the current. If negative, it travels in the opposite direction. It so happens that most real-life currents are flows of negative charges, carried by electrons. So an electron, being negative, goes in the opposite direction to the current. To deal with this anomaly, the current, which is universally regarded as flowing from positive to negative, is sometimes called conventional current.

Only physicists and transistor designers need worry about whether currents are carried by positive or negative charges. As engineers we can forget about the nature of the charge carriers and design purely in terms of conventional flow of current from positive to negative. The arrow-like parts of the standard symbols for transistors and diodes always point in the direction of conventional current flow. All the circuits in this *Teach In* are described in terms of conventional current flow from positive to negative.

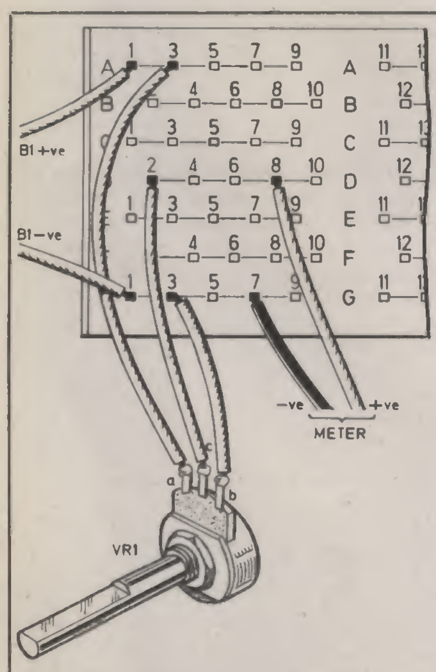


Fig. 3.4. The circuit of Fig. 3.3(a) assembled on the EBBO Block.

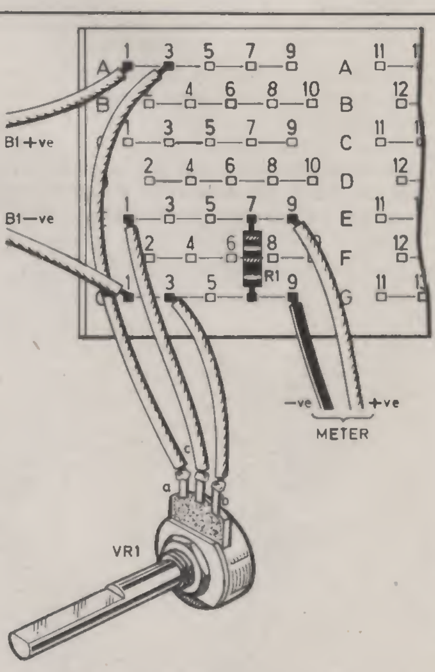


Fig. 3.5. The circuit of Fig. 3.3(b) assembled on the EBBO Block.

EXPERIMENT 3.3

TURNING ON A TRANSISTOR

Our next experiment will be to find out how much voltage is needed to "turn on" a transistor; that is, to make it pass current.

Referring to Fig. 3.6, a transistor has three terminals or "electrodes": they are, base (*b*), collector (*c*) and emitter (*e*). The main current path through a transistor lies between collector and emitter. The little arrow on the emitter (*e*) shows the permitted direction of current flow. (Transistors are one-way devices; current can flow only in permitted directions.)

To permit current to flow via the collector-emitter (*c-e*) path the transistor must be turned on by driving a small current through the base-emitter path. Our 10kΩ potentiometer allows us to adjust this current by applying any part of the battery voltage to the resistor R1. The meter (on its 2·5V range if you are using the KEW7S) measures the resulting voltage between base (*b*) and emitter (*e*). We'll call this voltage V_{BE} for short.

With the kind of transistor we are using at the moment (an *npn* transistor) the normal direction of current flow is *into* the base and *into* the collector and *out of* the emitter. Collector and base are then positive with respect to the emitter.

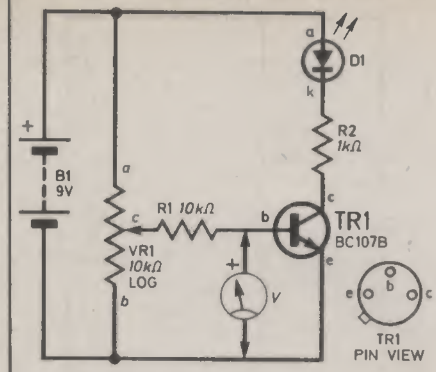
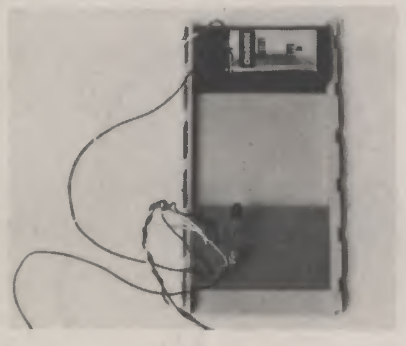


Fig. 3.6. How much base voltage is needed to turn on a transistor? (Experiment 3.3).



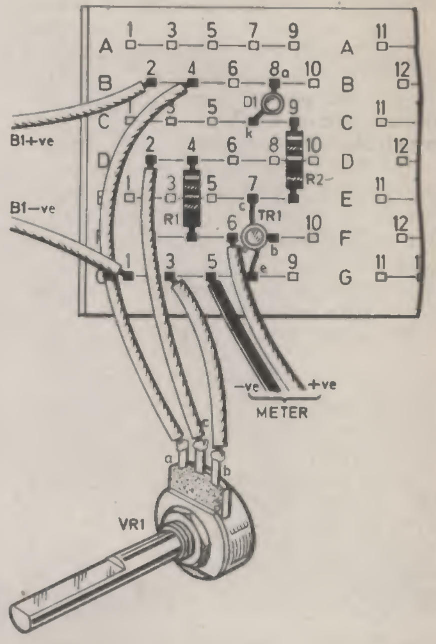


Fig. 3.7. The circuit of Fig. 3.6 assembled on the EBBO Block.

CURRENT INDICATOR

To show that collector current is flowing, connect a l.e.d. and limiting resistor as shown (Fig. 3.6), making all connections within one half of your EBBO discrete component module. Try it.

My test results were:
D1 just glowing ....$V_{BE} = 0{\cdot}65V$
D1 bright ....$V_{BE} = 0{\cdot}75V$

To pinpoint the "bright" setting of VR1, I first turned it fully up then gently back to find the point where the l.e.d. just began to dim. Transistors vary. Your voltages may be somewhat different.

The collector current with the l.e.d. bright is actually about 7mA. Assuming the "dim" current to be 1mA, we can look at our results like this:

$V_{BE} = 0{\cdot}65V$ makes 1mA flow into the collector
$V_{BE} = 0{\cdot}75V$ makes 7mA flow into the collector

From this you can see that (for my BC107B) a *change* in V_{BE} of 0·1V produced a change in collector current (I_C) of 6mA.

This ability of a change in V_{BE} to produce a corresponding change in collector current (I_C) is an important transistor characteristic. It has a name: *mutual conductance* or *transconductance,* and a symbol, gm:

gm = (Change in I_C)/(Change in V_{BE})

For small values of I_C, this is expressed in mA (of I_C) and volts (of V_{BE}). Then, gm comes out in milliamps per volt (mA/V). However, mA/V also has a name: 1mA/V = 1 milli-siemens (1mS).

My figures indicate a mutual conductance of about 60mS.

VOLTAGE AMPLIFICATION

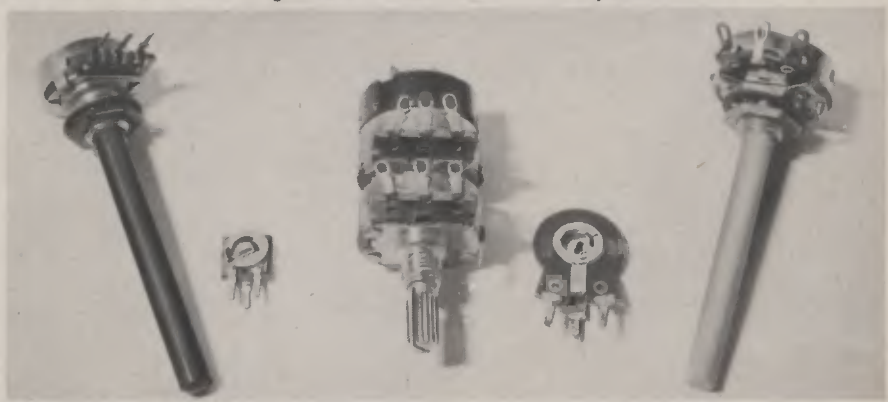
As the collector current increases, more voltage is dropped by the l.e.d. and R2. With the l.e.d. just glowing, the total drop across it and R2 is about 3V. When the l.e.d. is bright, the drop is nearly 9V. So a change of 6V in the collector part of the circuit has been produced by a change of 0·1V at the base.

If the change in V_{BE} (0·1V) is an input signal, and the change in collector voltage an output signal, then the transistor has amplified the input sixty-fold. In engineer's talk, the *voltage gain* is 60.

CURRENT AMPLIFICATION

A transistor amplifies current, too. The input is the current which flows into the base (and out at the emitter along with the main current from the collector). The output current is the collector current. It is true that for an *npn* transistor this "output" flows *into* the transistor. But we'll see in a later article how it can be taken elsewhere.

POTENTIOMETERS *(left and right)* normal panel mounting volume controls; (*centre*) twin-ganged type with mains switch at rear. The two smaller components are preset potentiometers for direct mounting on circuit boards, screwdriver adjustment.



To investigate current amplification, it is necessary to know the base current, IB. The most direct way of finding IB is to connect a current meter in the base circuit (Fig. 3.8a). In practice, this is neither practical nor safe. Meters when switched to "current" ranges are easily overloaded by accidental momentary connection across the power supply. In this particular circuit there is a design error which almost guarantees it will happen!

If VR1 slider is moved up to the top of the track (a), which is the same thing as battery +, current can flow freely from battery + through the meter, through the base and emitter and back to battery −. The transistor base-emitter "junction" offers little resistance, and the resulting large current wrecks both transistor and meter.

Some meters are protected internally against overload but it is always better to play safe and measure voltages rather than currents.

On a voltage range the meter always has a fairly high resistance. (For a KEW7S, whose sensitivity is 2kΩ/V d.c., the resistance is 2kΩ times the voltage range to which the meter is set. On the 10V d.c. range it is 2kΩ × 10 = 20kΩ.)

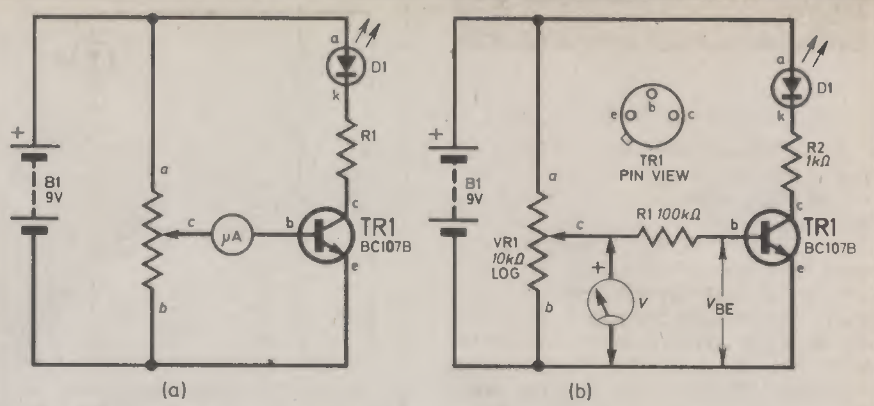


Fig. 3.8. How base current governs collector current; (a) A not very good way of finding out; (b) This way is safer, but the base current must be estimated. (Experiment 3.4).

EXPERIMENT 3.4

In any case, the base current is likely to be too small to measure on a cheap meter. We'll avoid the problem by using the circuit Fig. 3.5b. This makes use of the fact that if we know the voltage across a resistance we can find the current flowing through it.

Here, the base current sets up a voltage across R1, 100kΩ. Every volt applied to 100kΩ produces a current of 10 microamps (10µA), that is, ten-millionths of an amp or a hundredth of a milliamp.

The voltmeter doesn't measure the voltage across R1, but merely the voltage at one end. Fortunately, we can estimate the voltage at the other end. It is VBE, which is never very far from 0·7V. (The most extreme values of VBE you are likely to come across in silicon transistors are 0·4V and 1V; that is, 0·7V ± 0·3V). Let's call it 0·7V.

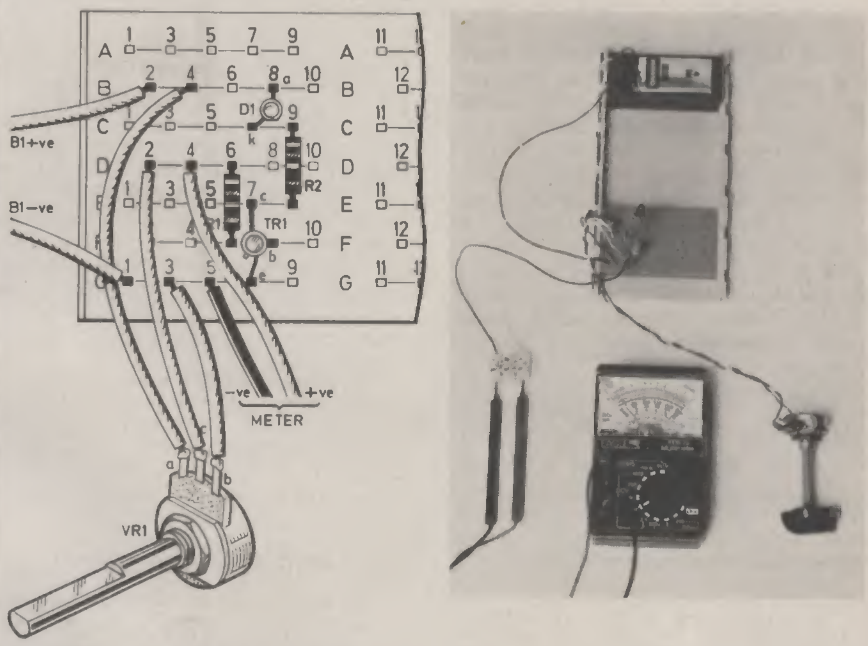
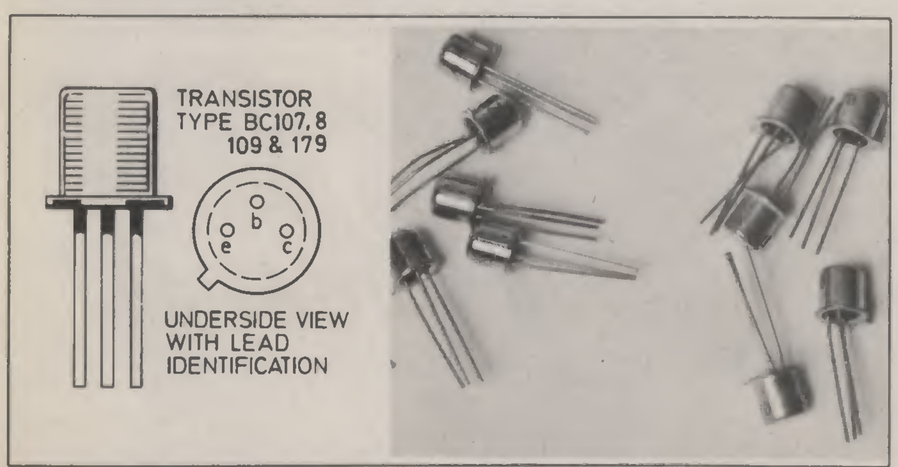


Fig. 3.9. The circuit of Fig. 3.8(b) assembled on the EBBO Block.

TRANSISTORS. High gain, small signal, metal can types as used in this series.



My voltmeter readings were:

D1 dim 1V
D1 bright 4V

Knocking off 0·7V for VBE, the voltages across R1 must have been about 0·3V and 3·3V. The corresponding base currents are 3µA and 33µA.

In the "l.e.d. dim" case, if Ic was 1mA (1,000µA) the current amplification was 1,000/3 = 333. In the "l.e.d. bright" case, if Ic was 6mA (6,000µA) my BC107B had a current gain (Ic/IB) of 180.

You may suspect that the current gain of a transistor varies with its collector current. It does. But our results are based

CHECK YOUR PROGRESS

Questions on *Teach-In 84 Part 3*
Answers next month

Q3.1 In the circuit of Fig. 3.8b, why can't the meter be connected across R1 to measure the voltage directly?

Q3.2 A transistor has a current amplification factor (h_{FE}) of 100. If its base current is 10μA what is its:
(a) collector current;
(b) emitter current.

Q3.3 The burglar alarm circuit of Fig. 3.11 makes use of the fact that the resistance of the light-dependent resistor PCC1 falls considerably when a beam of infra-red light strikes it. If the alarm bell is to sound when an intruder's body interrupts the beam how must the circuit work?

Q3.4 The collector current of a transistor is to be used to light a l.e.d. If Vcc = 6V and the current must not exceed 20mA what minimum value of current-limiting resistance is required? (The l.e.d drops 2V at 20mA.)

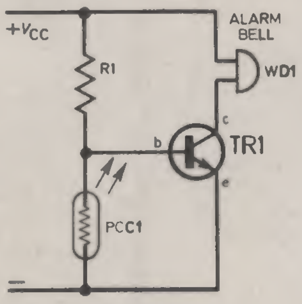


Fig. 3.11. See Q3.3.

ANSWERS TO PART 2

Q2.1 (a) 2mA; (b) 9·9V; (c) 18kΩ.

Q2.2 (a) 9kΩ; (b) 3kΩ (the lowest two resistors are short circuited); (c) 1kΩ (current can flow from X to Y via any one of the resistors so they are all in parallel).

Q2.3 3mA. There is 4V across the parallel resistors so the 2kΩ passes 2mA and the 4kΩ passes 1mA.

Q2.4 4V. The meter acts as a resistance of 10kΩ. In parallel with R2 this makes 5kΩ. The total resistance is then R1 (10kΩ) + 5kΩ = 15kΩ. 12V applied to 15kΩ drives 0·8mA, which produces 4V in flowing through the 5kΩ. So 4V appears across the meter and this is what it indicates.

on estimates and are very rough. The real value of the current gain for a BC107B is likely to be 200-500.

BIASING

Transistors are often used to amplify small voltages and currents (small signals). For example, the output from a record-player magnetic pickup may be only a thousandth of a volt (= 1 millivolt, 1mV; 1,000mV = 1V). Such a small voltage can't turn on a transistor, which, as we've seen, needs about 0·7V (= 700mV).

To make the amplification of small signals possible, the transistor is turned on, permanently, by a steady d.c. voltage or current from the power supply. The signal is added to this, so that the transistor is turned on a bit more.

In this way, a small signal can produce an increase in collector current even though, on its own, it couldn't make any collector current flow. The output signal is the increase in collector current, which can be separated from the steady current caused by the turning-on voltage or current.

This trick of turning on a transistor like this is called *biasing*. Purely by way of illustration, Fig. 3.10 illustrates how a gramophone amplifier might be set up. The voltage divider, R1, R2 sets up enough base-emitter voltage to produce a suitable collector current. This flows through a loudspeaker. Any variations in this steady current at audio frequency produces sound.

To insert these variations the magnetic pickup is connected in the base lead. Any

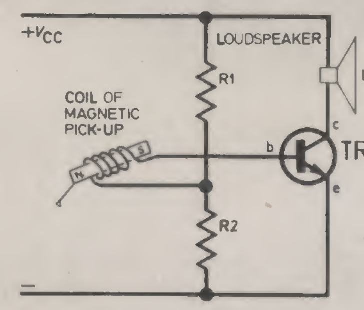


Fig. 3.10. An illustrative, but impractical, audio amplifier circuit.

voltage developed in the pickup coil then adds to or subtracts from the 700mV bias. So as the pickup generates its few millivolts of audio signal (which is a.c., not d.c.) the collector current rises and falls in sympathy. These a.c. variations superimposed on the steady d.c. produce sound in the speaker.

That, at any rate, is the theory. In practice, it won't work, because a single transistor doesn't amplify enough. Also, this circuit is badly affected by variations in the supply voltage (Vcc) and temperature, which changes the required V_{BE} of the transistor.

Next time we'll look at more practical circuits and at a useful way of separating the output signal from the steady collector current.

● If you are buying as you go along you'll need a crystal earphone and at least two 100nF (0·1μF) capacitors, 30V (minimum) working, non-polarised. Disc types with long leads are most convenient. Also a 1,000μF electrolytic capacitor, 16V (minimum).

Next month: Transistors and Capacitance

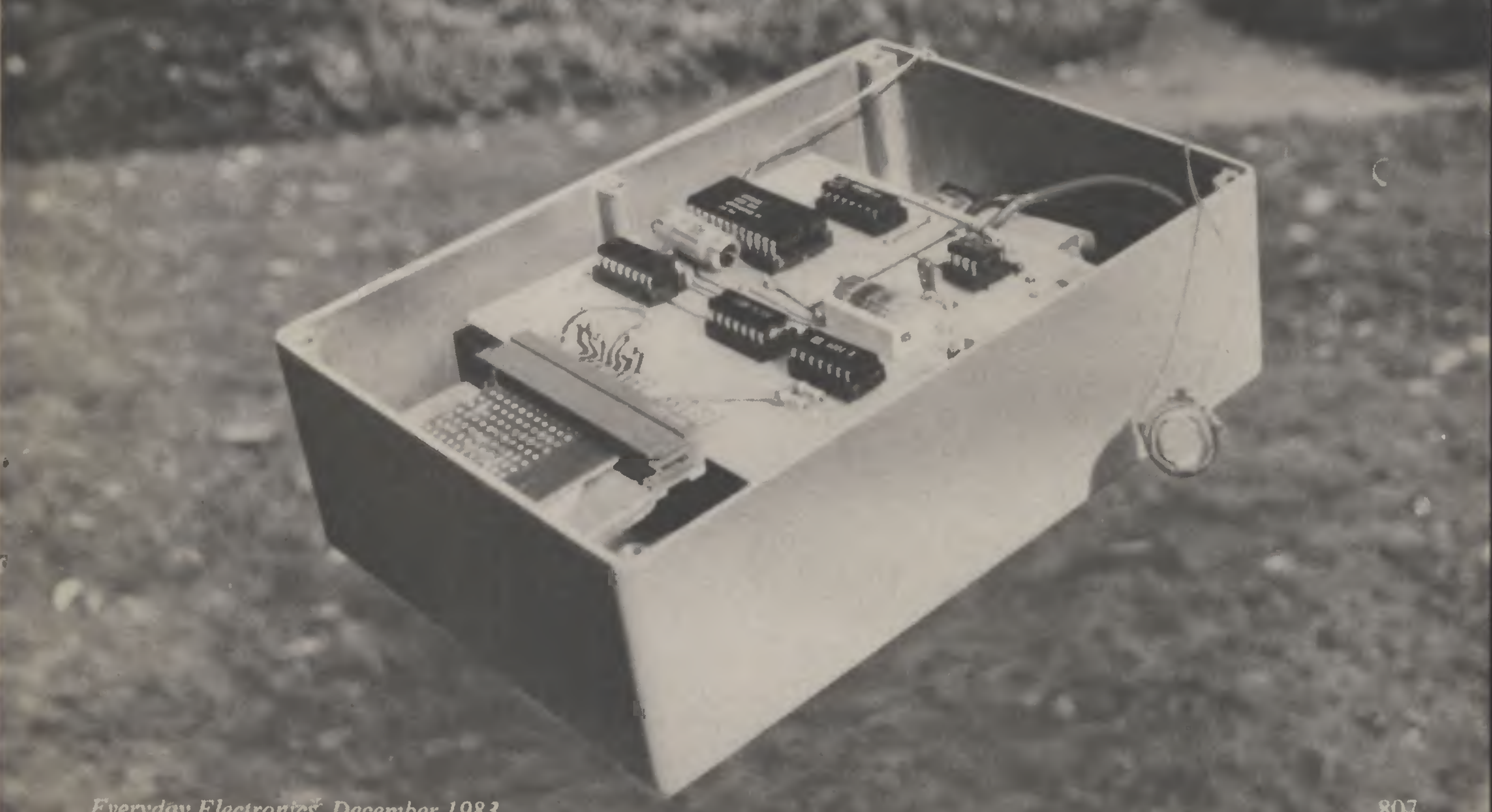
1983 SEDAC 3rd

BIOLOGICAL AND ENVIRONMENTAL SCIENCE STUDIES OFTEN REQUIRE CONSTANTLY CHANGING INFORMATION TO BE MONITORED OVER A PERIOD OF TIME. THE ENVIRONMENTAL DATA RECORDER USES EXTERNAL SENSORS TO MEASURE THESE PARAMETERS AND STORE THE RESULTS DIGITALLY IN A RANDOM ACCESS MEMORY, HAVING FIRST CONVERTED THE ANALOGUE INPUT WITH AN 8-BIT ANALOGUE-TO-DIGITAL CONVERTER. THE RESULTS CAN BE READ FROM THE MEMORY BACK IN THE LABORATORY USING THE SINCLAIR ZX SPECTRUM COMPUTER.

TOTALLY PORTABLE AND USING RECHARGEABLE BATTERIES, THIS UNIT IS IDEAL FOR FIELD WORK.

ENVIRONMENTAL DATA RECORDER

BY M. LAWRIE & L. WILKINSON



When measuring changes in biological and environmental science experiments, the quantities being measured often change very slowly. For this reason it may take days, or even weeks, to take readings of, say, pH changes in water over a length of time. If the experiments are being carried out-of-doors, then the problems of setting up the experiment and collecting the readings are far greater.

DESIGN CONSIDERATIONS

The unit described here is designed to be waterproof and weatherproof which can be left on site using its own power supply. It can be fitted with many different sensors, for example, oxygen probes, pH probes, light dependent resistors (for light) and thermistors (for heat) and with these it can measure oxygen level changes, pH level changes, light level changes and temperature changes.

The Environmental Data Recorder can take readings ranging from over 500 per second to over once per hour. The data is stored digitally in a 2K byte memory that can be read at a later date by plugging it into the expansion slot of the Sinclair ZX Spectrum. A short program is used to put the data or a graph of the results onto the screen. It is helpful to have a Sinclair ZX Printer to get a hard copy of the graph or data.

When designing the circuit, several points had to be considered because it (a) is to be portable so it must be a physically small unit, (b) should have a low power consumption, (c) must be able to be plugged into the back of the Spectrum without losing any data or crashing the computer, and (d) must be able to be used over a long period, continuously for a month if necessary.

CIRCUIT DETAILS

The unit works in one of two modes, first WRITE then READ. Switches S1 to S3 select the mode. The RESET switch (S4) resets the address counter to zero in either mode. Fig. 1 shows a block diagram of the unit in WRITE mode. Brief operating descriptions follow. The full circuit diagram is shown in Fig. 2.

The MV5516 CMOS static RAM (IC5) was used because its low power consumption when not selected ($\overline{CE}_1$ and $\overline{CE}_2$ both at logic 1) uses only about 1µA.

The MK5168 analogue-to-digital converter (IC3) was selected for its simplicity of operation. In the basic unit described here, the reference voltage (pin 4) is +5V but may be changed for other applications. To measure changes in light intensities, an ORP12 light dependent resistor (l.d.r.) was connected across the analogue input and +5V. If absolute values of intensity are needed, calibration against a standard must be carried out.

If other level changes are to be recorded, the output voltage of the sensor should be in the range of 0 to +5V, so a buffer or attenuator may be needed.

Provision for easy change of WRITE pulse times (the time between each successive sample) has not been made. The time may be changed by altering the values of R3, R4 and C1. The timing period is approximately 0·7 × R3 × C3 (R4 must be small compared with R3). With R3 = 3·3MΩ, the period is approximately 2·3 seconds times capacitance of C1 in microfarads. With a 1500µF capacitor, a reading will be recorded approximately once per hour. For all periods greater than 0·7 seconds, R4 should be 1kΩ. For periods shorter than this, R4 should be increased.

Equations for calculating the component values for a 555 timer as an astable multivibrator are given below.

Output high for

0·685 × (R3 + R4) × C1 seconds

Output low for

0·685 × R4 × C1 seconds

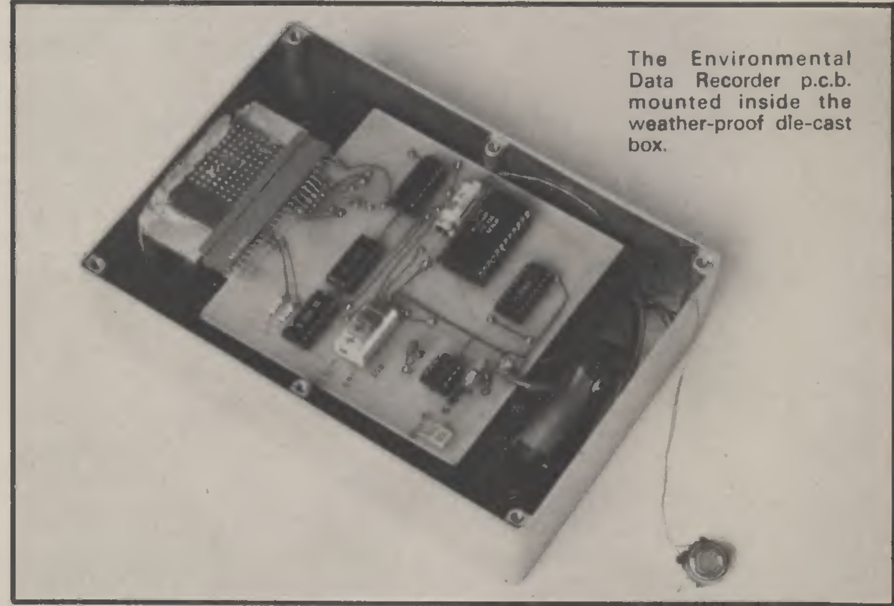
Period of one cycle

= 0·685 × (R3 + 2R4) × C1 seconds.

WRITE MODE

Data is entered into the random access memory (RAM) on the falling edge of the clock oscillator (IC4) output. On this edge, the 12-bit counter is advanced one address and the memory (IC5) and A/D converter (IC3) are also selected.

The BUSY line (pin 3, IC3) goes low when conversion is complete. This level,



The Environmental Data Recorder p.c.b. mounted inside the weather-proof die-cast box.

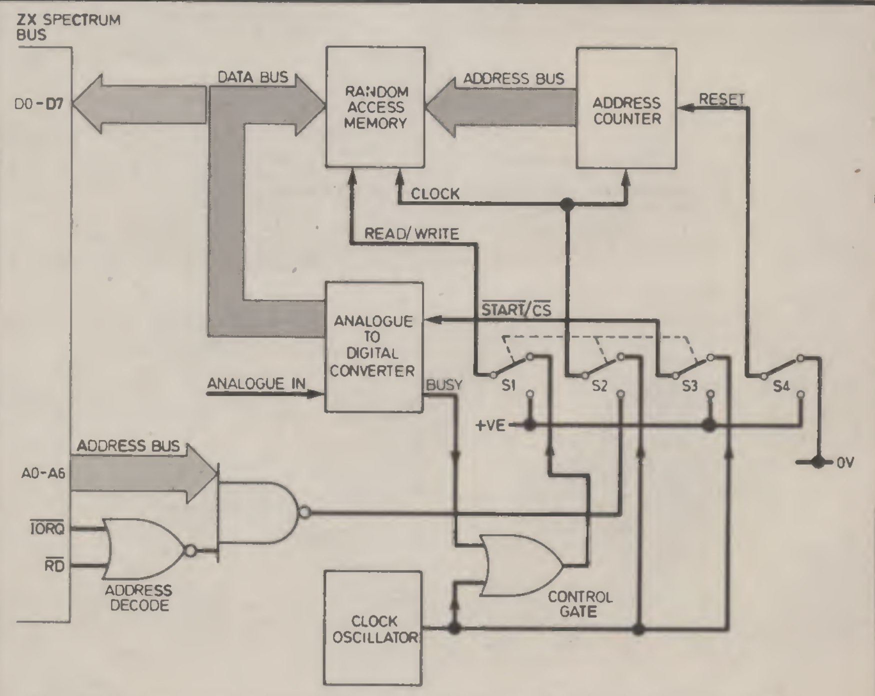


Fig. 1. Environmental Data Recorder shown with S1–S4 in the WRITE mode.

and the clock are fed to an OR gate (in the circuit, two NOR gates, IC2b and IC2c) and the output of this selects READ if high and WRITE if low.

The process repeats itself on the next falling edge from the clock oscillator. In this way, the analogue value on pin 4 of IC3 is converted to an 8-bit digital representation and written into the memory with every sample pulse.

READ MODE

When switches S1–S3 are taken to the READ position (opposite to that shown in Figs. 1 and 2), the A/D converter is turned off as the $\overline{CS}$ input (pin 5) is taken to +5V. With the unit plugged into the back of the Spectrum, IC1, an 8-input NAND gate, is switched on (as it takes its power from the computer *not* the battery pack).

The program selects ports 255 or 127 (via the command IN255 or 127) and so pulses the 12-bit address counter adding one to the memory address. Data is read from the memory after each address has been incremented.

CIRCUIT BOARD

The circuit is constructed on a double-sided p.c.b., 100 × 100mm, the track pattern and component layout of which is shown in Fig. 3. This board is available from the ***EE PCB Service***, Order code 8312-04 or can be made using the usual methods, although special care must be taken as it is double-sided, to ensure alignment of the two artworks.

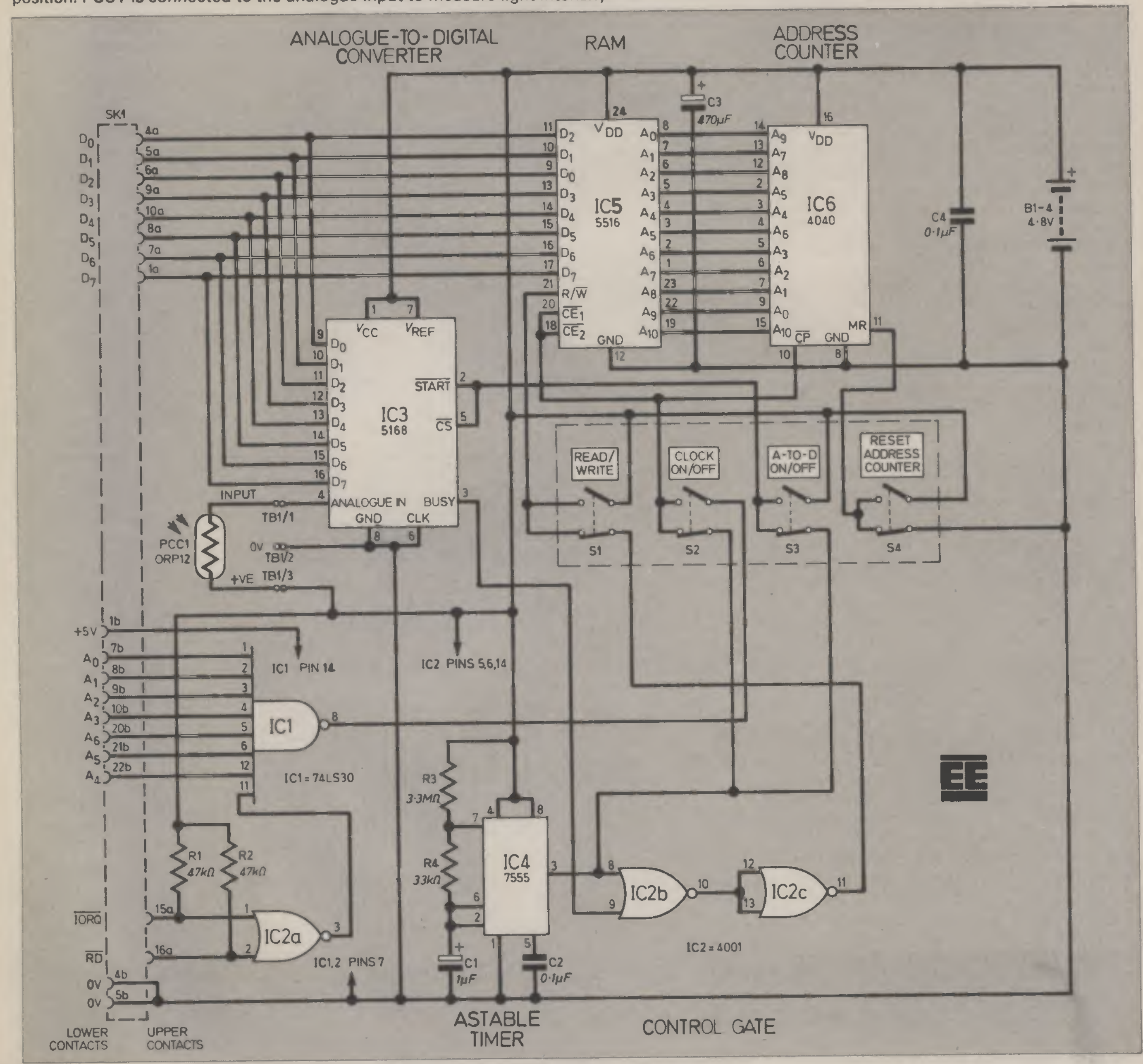
The 26 shorting pins (the links between the top and bottom tracks) must first be inserted. Note that these must be soldered on both sides. Next, the resistors and capacitors are inserted and some of the leads require soldering on both sides.

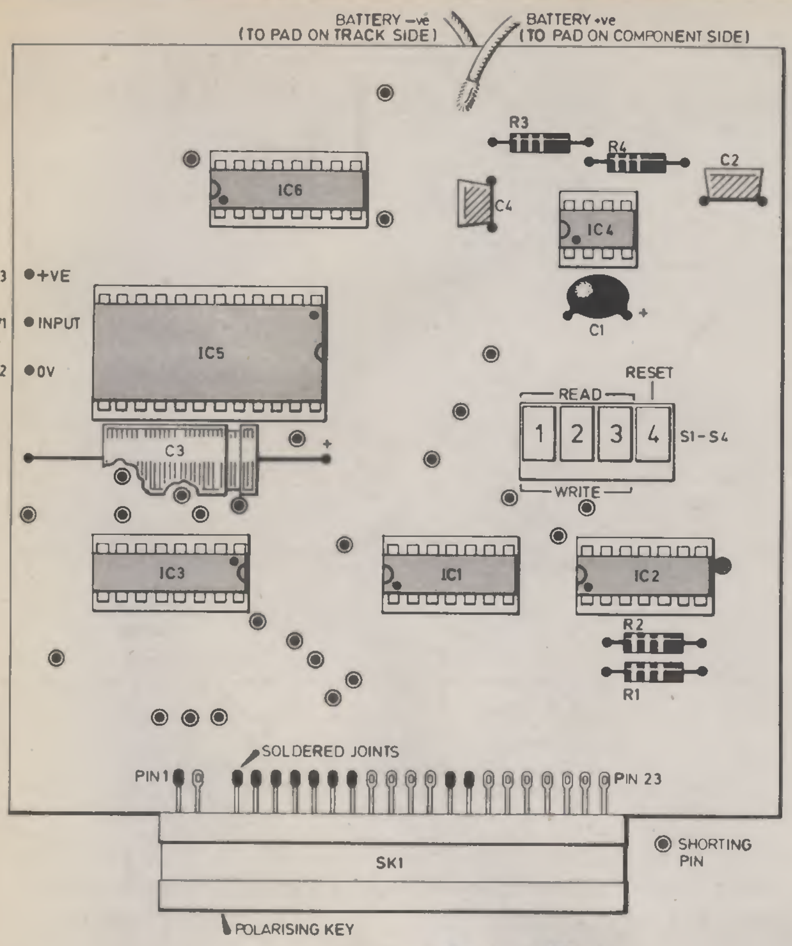
The d.i.l. i.c. holders are then soldered in place but the i.c.s are not plugged-in until later. Note that IC3 and IC5 face the opposite direction to all the other i.c.s. Finally, the d.i.l. switch (S1–S4) and the 23-way edge connector are fitted.

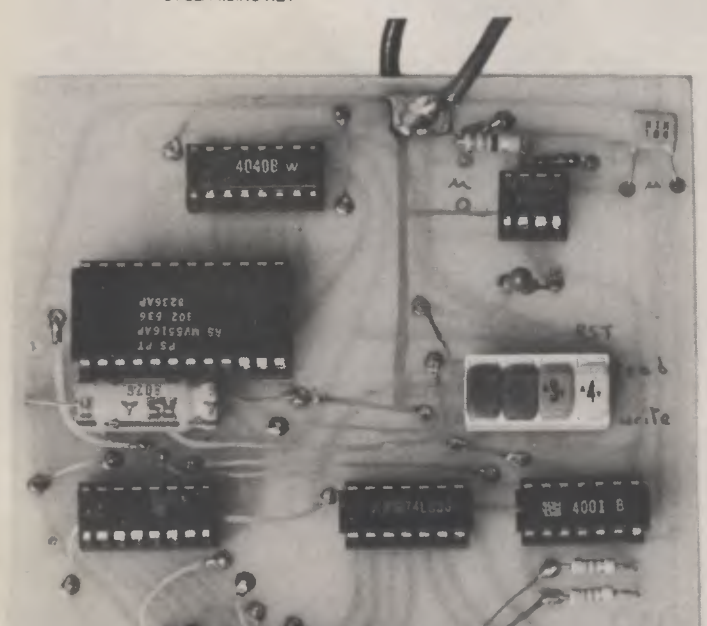
EDGE CONNECTOR

The 23-way double-sided edge connector has the polarising key fitted at position three and this is mounted to the left side when viewed from the top with the connector pointing down (as in Fig. 3).

Fig. 2. Complete circuit diagram of the Environmental Data Recorder in WRITE mode. To set to READ mode, S1–S3 are switched to opposite position. PCC1 is connected to the analogue input to measure light intensity.







The light-dependent resistor (PCC1) used for light level monitoring.

The last connections are the wires to the battery pack and to the sensor (on the prototype, a light dependent resistor, PCC1).

The battery wires should be long enough to allow the board to be withdrawn from the case to be plugged onto the Spectrum computer. Ensure that there is no short circuit on these leads as the low internal resistance of the cells compared with their high output can produce a lot of heat quickly!

When assembly is complete, the i.c.s can be inserted into their holders, observing the correct orientation shown in Fig. 3.

CASE

The Environmental Data Recorder p.c.b. is mounted into a watertight case when out in the field, which also houses the battery pack. This is a holder for four C size (HP11) ni-cad rechargeable batteries and it is held in place with double-sided adhesive tabs.

The prototype was housed in a die-cast box, 170 × 120 × 50mm with a specially fabricated bracket at one end to hold the edge connector of the board. (See photographs.) This bracket must use an insulating material (plain matrix board for example) to slot into the connector to prevent short circuits.

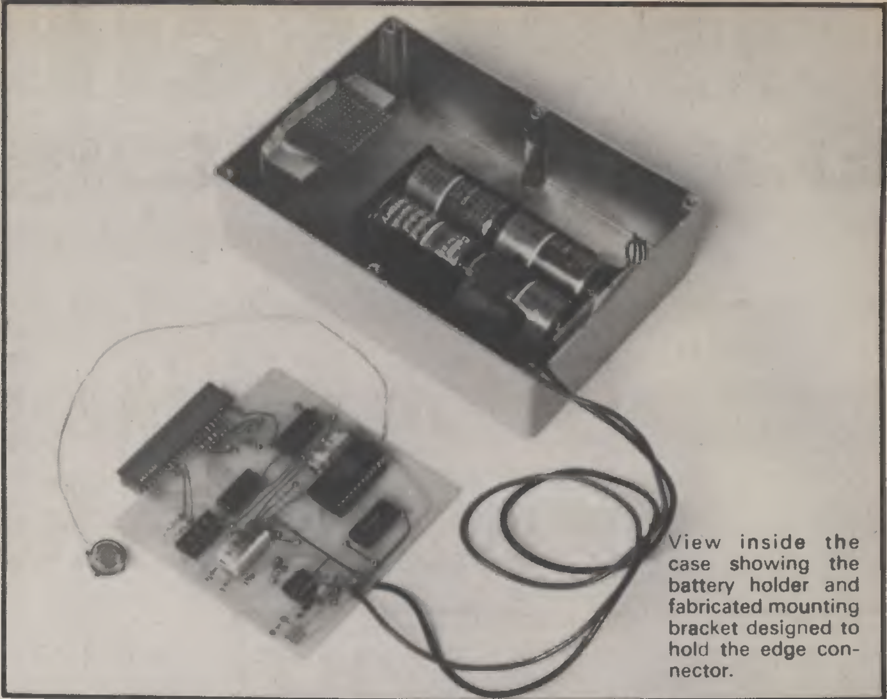
INSTRUCTIONS

To use the Data Recorder, the following set of instructions must be followed. First set up the correct sample period with the selected values of R3, R4 and C1 on the astable timer (IC4), the calculations for which are given in the circuit description.

1. Set switches S1, 2 and 3 to the down position (WRITE) and S4 to the up (RESET).
2. Place the ni-cad batteries in the holder (observing the correct polarity) to switch the unit on.
3. When ready, set S4 to the down position to begin recording.
4. Place the board onto its holder in the case and seal the lid.
5. When the readings are complete, set all the switches to the up position (S1–S3 to READ and S4 to RESET).

SOFTWARE

```
10 REM Environmental Data
       Recorder
20 REM (c) Everyday Electronics
30 REM December 1983
40 FOR n=175 TO 0 STEP −1
50 PLOT IN 255,n
60 IF n=0 THEN GO TO 80
70 NEXT n
80 PAUSE 10
90 COPY
100 CLS
110 GO TO 40
```



View inside the case showing the battery holder and fabricated mounting bracket designed to hold the edge connector.

6. Remove the module from the case (but do not disconnect batteries) and plug onto the Spectrum edge connector—with or without the ZX Printer.
7. Connect the Spectrum power supply.
8. Enter the program (listed separately) and set S4 to the down position. RUN the program.
9. When complete, remove Spectrum power supply.
10. Remove batteries from holder (to switch Data Recorder off).

CONCLUSION

Like many electronics systems, further developments can be carried out. The Environmental Data Recorder described here uses less than 2mA compared with over 8mA in the original prototype unit presented for SEDAC. The timing circuit has been completely redesigned and the selection logic simplified.

Further developments could include multi-channel A/D conversion; using switches to select the timing period and increasing the memory. A selectable voltage gain unit buffering the analogue input would be a useful feature. The prototype has been used extensively for light level comparison and no problems have been found. □

COUNTER INTELLIGENCE

BY PAUL YOUNG

Boost For CB

The other day I was idly wondering why the good people advocating a Citizen's police watch to assist the police and prevent burglaries, did not suggest that they use Citizen's Band Radio, when I spotted an intriguing piece in a national newspaper. It appears that young girls are using CB radio to lure men to their doom. My male colleagues would no doubt phrase this differently.

No, Paul Young is not leading a headlong rush to the nearest CB emporium. When you reach my mature and serene age and I sincerely hope you will, you will appreciate the wisdom of the great Groucho. When, in his eighties, he was asked if he still chased the girls, he replied: "Yes, but only downhill".

I mention all this, particularly for the benefit of my lady readers (if I have any). If your husband hints that you might like to buy him a CB radio for Christmas, I would suggest you should reply: "Of course darling, so long as I can have an extension speaker to listen in to you."

Finally, the CB jargon for a meeting of two CB enthusiasts is: "Eyeball to Eyeball". I wonder what the word spinners will dream up for this type of assignment? I could think of a few, but I fear in a respectable family magazine like ours, they would not be printable.

All At Sea

I don't often get angry, my blood pressure prevents it but I must confess to getting hot under the collar, when I read of the plight of the transatlantic yachtsman Tom McClean.

He was crossing the atlantic in a yacht just about eleven foot in length. His only communication was through British radio amateurs. Along comes two officials from the licensing department and forbids the two "Hams" to communicate with him because he has no licence.

How I would love to have the power to act like Gilbert's Mikado and make the punishment fit the crime. I would place the two bureaucrats in an eleven foot yacht in mid-atlantic, not without a paddle but without any communication.

Time Out

Hardly a week goes by without some funny story concerning digital watches. The latest concerns a small boy riding home on his bicycle wearing his sister's watch.

Suddenly the strap broke, and in order not to lose it, he put it in his mouth. Then to add to his misery, he hit a bump which caused him to swallow it.

He went along to his G.P. who was certainly a bit behind the times, and obviously not a reader of EE. "That's all right son, I will follow its progress with my stethoscope."

The final outcome was a happy one, his grandfather gave him a Silver Hunter with a tick that would have done credit to Big Ben, and, to phrase it delicately, in due course time passed.

Atomic Cars

Seeing a headline a short time ago: "New 'A' Car Craze Sweeps Britain", I immediately jumped to the wrong conclusion. "Aha!" I said, "atomic driven cars, the obvious answer", only to find they were talking about number plates. Rather a let down I'm afraid, though I am certain the day will come when we shall be driving them.

Consider for example, the Polaris submarine. The fuel container is about the size of a dustbin but the atomic contents, not only propel the vessel, it also provides all the power for heating, cooking, lighting and all ancillary equipment and even turns the sea-water into oxygen for breathing. Unbelievably, it only needs replacing every seven years. Translate that into car terms and think what it could do!!

Alas, they may not arrive in my life time, but by way of compensation I see the Wizard of Electronics, I mean of course Sir Clive Sinclair, hopes to have his Electric Car coming off the production line by the end of 1984. So, if you see me running up the road singing: "I'm Off to See the Wizard", you will know the reason why.

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PART SIX: ANALOGUE DATA MULTIPLEXING AND 4-CHANNEL ADC

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

In Part 4 of this series, the techniques of analogue-to-digital conversion were discussed and a practical single channel system, using the successive approximation type of converter, was described.

In this part, the associated techniques of analogue data multiplexing and signal conditioning will be dealt with together with the construction of a high speed four channel data acquisition system.

The first part of a series dealing with transducers for use with this (and other) systems will be published in later issues of EE.

SIGNAL CONDITIONING

The output voltage ranges of transducers to be used with ADCs will not usually be compatible with the analogue input voltage range of the converter.

As an example, a bridge network used for developing an analogue voltage which represents the deflection of a strain gauge might produce only a few millivolts, which is far too small to apply directly to the input of the ADC.

Some form of amplification is then usually necessary and circuits based upon operational amplifiers are generally employed. The simple theory of operational amplifiers with applied negative feedback is well known, but it is helpful to deal briefly with it here.

In Fig. 6.1a, the operational amplifier is used in the inverting mode, that is, the input and output signals are out of phase with each other and the voltage gain, G, of the arrangement is dependent only on the values of input resistor R_{IN} and feedback resistor R_F. The voltage gain may be obtained from the simple formula

$$G = R_F/R_{IN}$$

Note that the feedback signal is applied to the invert (–) input of the device, so giving negative feedback.

Fig. 6.1b shows a non-inverting amplifier configuration and, in this case, the voltage gain G may be calculated using the formula

$$G = 1+(R_F/R1)$$

The input impedance of this arrangement is very high indeed—a desirable feature if it is to be used to amplify analogue voltages from transducers which may themselves possess relatively high source impedances.

In the practical four-channel system described, each analogue input is applied to its own signal conditioning amplifier, the non-inverting configuration being used. The analogue signal range of each channel is 0–100mV full scale and the full scale input range of the ZN448 ADC used is 2·5V. The amplifiers are thus required to give a voltage gain of (2·5/0·1) = ×25.

Using the voltage gain formula, we see that:

$$25 = 1 + (R_F/R1)$$

and, choosing a value of 10kΩ for R1, then R_F should have a value of 240kΩ. The accuracy of the system is partly dependent upon the amplifier gains, and close tolerance resistors should be used for these components. (The channel gain is easily changed by using another value for R_F, but voltage gains of more than ×100 should not be attempted with a single operational amplifier.)

LOW-PASS FILTERING

Many transducers develop very low level signals and problems can arise with spurious signals originating from, for example, voltages induced into the system by 50Hz mains fields. Careful circuit layout and screening is helpful, but with data acquisition systems in which the signals are sampled and measured very rapidly, serious errors can arise if false signals are present.

Since most analogue quantities encountered will change fairly slowly, the corresponding electrical signals developed by the transducers will be of very low frequency and some signal conditioning circuits entail the use of low-pass filters which allow only the low frequency signal voltages to be passed onto the output, higher frequency spurious signals being heavily attenuated.

The response of a typical low-pass filter is shown in Fig. 6.2. A later article dealing with the development of a single conditioning amplifier for very low level biological signals will include a more detailed description of a typical low-pass filter.

BBC Microcomputer users will be aware that the model B already possesses a 4-channel analogue input facility. The ADC employed is a 12-bit device but its conversion time is rather slow. Transducers intended for application with the system described in this article can be employed with the BBC machine if the analogue section of the circuit is con-

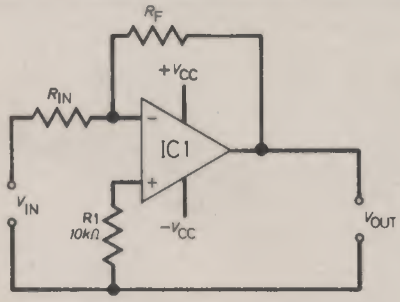


Fig. 6.1a. The operational amplifier shown is being used in the inverting mode.

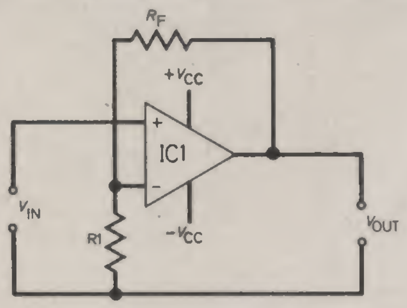


Fig. 6.1b. The configuration for a non-inverting amplifier.

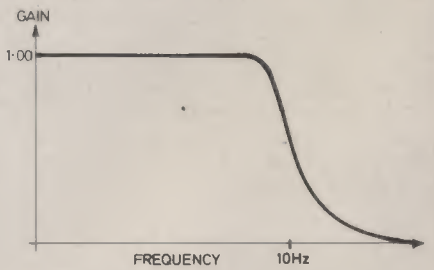


Fig. 6.2. The response for a typical low-pass filter.

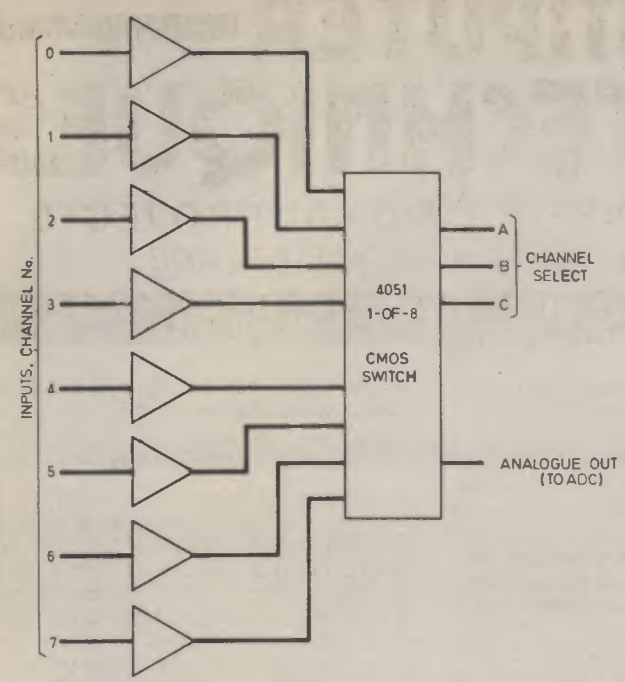
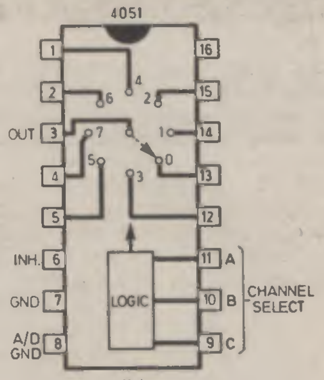


Fig. 6.3. Typical arrangement for an eight channel system.

SELECT PINS			CHANNEL SELECTED
A	B	C	
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

(a)



(b)

Fig. 6.4(a). Truth table for the 4051 analogue multiplexer; and (b) pin-out diagram.

structed and the amplifier gains are altered to an appropriate value. Details of this are given at the end of the article.

ANALOGUE MULTIPLEXING

ADCs offering multiple analogue input channels are available, for example, National Semiconductors ADC0816/ADC0817 Single Chip Data Acquisition System allows 16 analogue inputs), but Ferranti's ZN448 is a single channel device only.

In order to accommodate several channels of analogue data, some form of multiplexing technique is necessary, in which the individual channels are connected one at a time to the input of the ADC. Integrated circuit switches which can perform this function are available in both CMOS and TTL; the switching operation is usually controlled by applying binary signals to the channel select pins of the device. Fig. 6.3 shows a typical arrangement for an eight channel system.

The 4051 analogue multiplexer behaves basically as a single-pole, 8-way switch, the switch position being determined by the binary code presented to the channel select pins. Its truth table and pin-out diagram are shown in Fig. 6.4.

CHANNEL SELECT CODE

In the project described, four channels are required and a CMOS 4052 dual 4-channel multiplexer is employed.

The binary channel select code can be generated in a number of ways. A single pulse (which could be obtained from the ADC end of conversion signal, EOC) can be used to increment a three-bit binary counter and the code generated then applied to the analogue switch.

An alternative method, employed by the authors in the four channel system described, offers a "software solution" in which the appropriate code is generated by the microcomputer itself. This code is then presented at the user port and routed to the analogue multiplexer via the two least significant lines available at the user port. Clearly, these switching code signals must only be present on the port lines when the microcomputer is not engaged in a data read operation.

During the channel select period, the tri-state facility of the ZN448 output latches is utilised to effectively disconnect the ADC from the data bus lines; the tri-state enable/disable signal being generated in software.

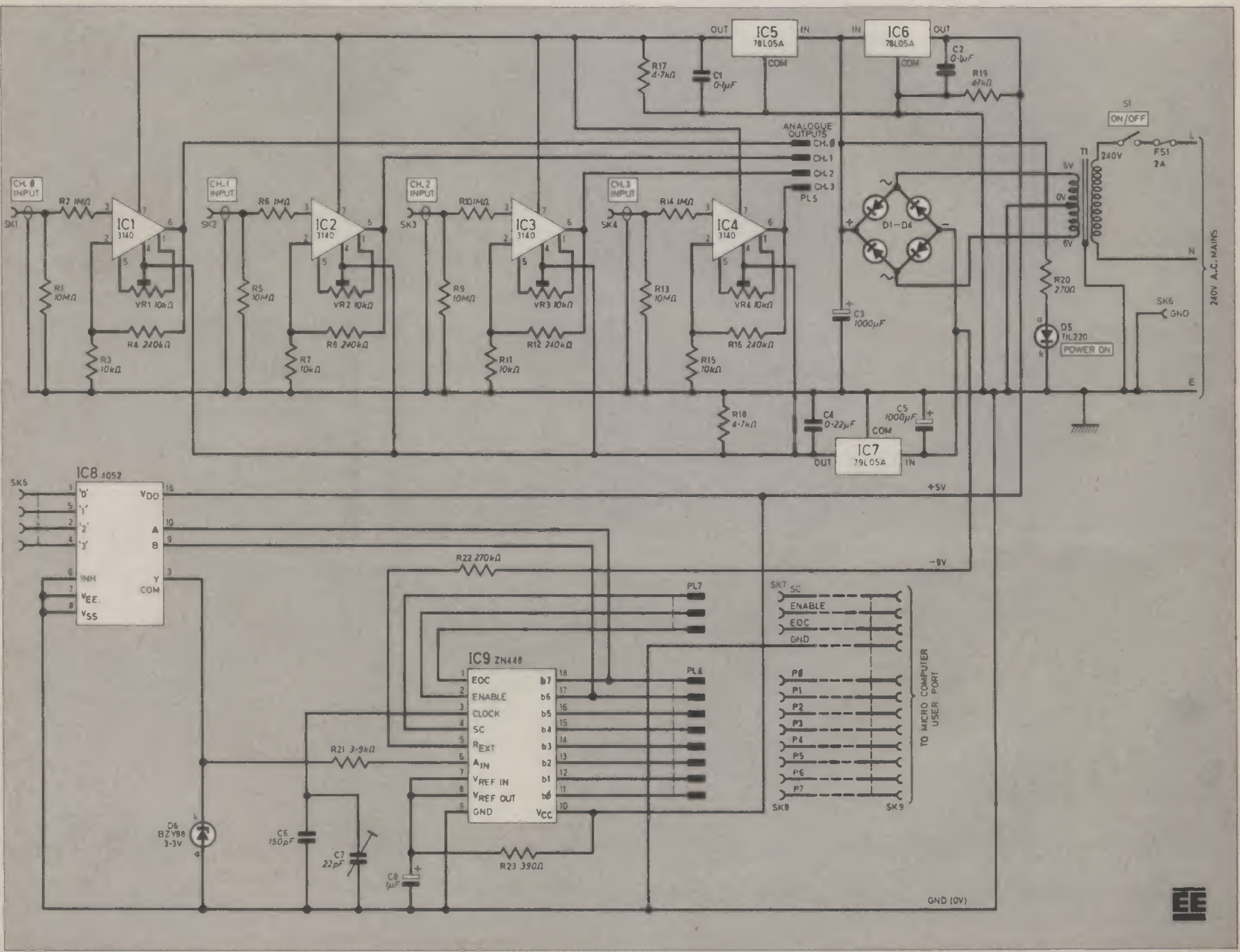
4 CHANNEL HIGH SPEED ADC

THE PRACTICAL CIRCUIT

Fig. 6.5 shows the circuit of the complete 4-Channel ADC. Each of the four analogue signals to be monitored (in the range 0–100mV) is applied to the input of its signal conditioning amplifier, IC1 to IC4, CA3140 CMOS devices are used here and offer low power consumption and extremely high input impedances. As mentioned previously, the gain of each amplifier is set at ×25 by the 240kΩ/10kΩ feedback resistor combination.

The amplifiers are situated on a separate p.c.b. to that used for the channel switching and ADC sections of the circuit, thus obviating the possibility of any interaction between the large TTL level pulses present in that part of the

Fig. 6.5. Complete circuit diagram of the 4-Channel High Speed ADC.



circuitry and the relatively low level analogue voltages present at the op-amp inputs.

The amplifier outputs are connected to the inputs of the 4052 dual, one of four CMOS switch, IC8 (only one half of the i.c. is used), and the output pin of this provides the analogue input to the ZN448 ADC. Zener diode, D6, provides protection for the ADC in the case of over range inputs by simply conducting when the p.d. across it (and the input to the ZN448) exceeds about 3V.

The ADC section of the circuit is similar to that used in the single channel converter in Part 3 except that it has been arranged for unipolar operation (that is, it can only convert input voltages which are positive with respect to ground). Transducers employed with this system should develop voltages suitable for this mode of operation.

The conversion rate has been reduced considerably (to about 30,000 per second) by increasing the size of the clock timing capacitor C6. The slower operating rate, is again, appropriate to the transducers used with the ADC.

The two channel select lines of the 4052 switch are connected directly to the PØ and P1 (two least significant bit) lines of the user port whilst the tri-state enable pin, instead of being grounded (and permanently enabling the latches) is taken, via the ribbon cable to pin M of the user port, this pin being used to output the tri-state control signals.

The power supply section of the circuitry is constructed largely on the analogue board and is quite conventional. A single +5V supply is required for the ZN448 and this is provided by the 78L05A voltage regulator IC6.

CONSTRUCTION OF THE BOARD

Printed circuit boards are used for both analogue and digital sections of the circuit and full size patterns are given for these in Figs. 6.6 and 6.8. These boards are available from the *EE PCB Service*, Order codes 8312–01 and 8312–02, respectively.

Starting with the analogue board, 8-pin d.i.l. sockets should be inserted and carefully soldered, as shown in Fig. 6.7. The five link wires should now be carefully formed and soldered into the appropriate positions. 22 s.w.g. bare tinned copper wire is used here. The seven Veropins should now be inserted, pressed home and soldered to the copper tracks.

PL5 is a 4-way inter-p.c.b. plug and this should be inserted and soldered in next.

All other components should now be inserted and soldered, particular care being taken with electrolytic capacitors and the three voltage regulators. (Readers should note that the p.c.b. appearing in the photograph is the prototype. The layout given in Fig. 6.6 is an improved version and hence differs slightly from the original.)

Construction of the digital board, Fig. 6.9, follows along similar lines and again readers should note that there are slight differences between the p.c.b. layout of original and published designs.

Connection to the microcomputer user port is via a 12-way cable and two inter-p.c.b. plugs, a 10-way and a 4-way type are employed for this purpose. Ribbon or multicore cable can be used.

An aluminium case of dimensions 27·5 × 19 × 9cm was used to house the prototype. The front panel should be drilled to accommodate the four bnc analogue input sockets (SK1–SK4), the mains switch and the power on indicator l.e.d. The rear panel needs drillings for the fuse, mains lead, and ribbon or multicore user port cable.

The mains transformer (6–0–6V at 100mA) should be mounted as shown in Fig. 6.10, which also gives the interwiring arrangement for the boards. With all of these components mounted, the boards should be fixed in place and the various interconnections completed.

SETTING UP AND TESTING THE UNIT

After switching on, power supplies to both analogue and digital boards should be checked. If either is incorrect, switch off immediately and locate the fault. If all is well, the operational amplifier offsets should be nulled.

A digital voltmeter should be connected between GND and the output

COMPONENTS

COMPONENTS approximate cost £48

See Shop Talk page 801

Resistors

R1,5,9,13	10MΩ (4 off)
R2,6,10,14	1MΩ (4 off)
R3,7,11,15	10kΩ (4 off) 1% metal film
R4,8,12,16	240kΩ (4 off) 1% metal film
R17,18,19	4·7kΩ (3 off)
R20	270Ω (2 off)
R21	3·9kΩ
R22	270kΩ
R23	390Ω

All ¼W carbon ±5% except where stated otherwise

Capacitors

C1,2	0·1μF polyester type C280 (2 off)
C3,5	1000μF 16V elect. (2 off)
C4	0·22μF polyester type C280
C6	150pF ceramic
C7	22pF compression trimmer
C8	1μF 16V elect. radial leads

Semiconductors

IC1–IC4	CA3140 f.e.t. input op-amp (4 off)
IC5,6	78L05A +5V fixed voltage regulator (2 off)
IC7	79L05A –5V fixed voltage regulator
IC8	4052 CMOS dual 4-input analogue multiplexer
IC9	ZN448 analogue-to-digital converter
D1–D4	VM28 0·9A d.i.l. bridge rectifier
D5	TIL220 red l.e.d. plus fixing bush/clip
D6	BZY88C3V3 3·3V 400mW Zener diode

Miscellaneous

SK1–SK4	bnc panel mounting socket (4 off)
SK5	4-way inter p.c.b. socket
SK6	4mm insulated panel mounting socket
SK7	4-way inter p.c.b. socket
SK8	10-way inter p.c.b. socket
SK9	Commodore user port connector 12 + 12-way double-sided card edge type, 0·156 inch pitch
PL5, 7	4-way inter p.c.b. straight plug (2 off)
PL8	8-way inter p.c.b. straight plug
T1	mains primary/6–0–6V 100mA secondary
VR1–VR4	10kΩ miniature horizontal preset (4 off)
FS1	2A 20mm type with panel mounting fuseholder

Printed circuit boards: Analogue board single-sided size 127 × 95mm, *EE PCB Service*, Order code 8312–01, Digital board single-sided size 127 × 95mm, *EE PCB Service*, Order code 8312–02; d.i.l. sockets: 8-pin (4 off), 16-pin (1 off), 18-pin (1 off); single-sided Veropins (18 off); bare tinned copper wire; 12-core cable (1m); rubber grommets (2 off); cable retaining clips (2 off); 4BA fixings (2 sets); 6BA fixings (6 sets) and 20mm spacers (4 off); metal case approx. 280 × 190 × 90mm; rubber feet for case.

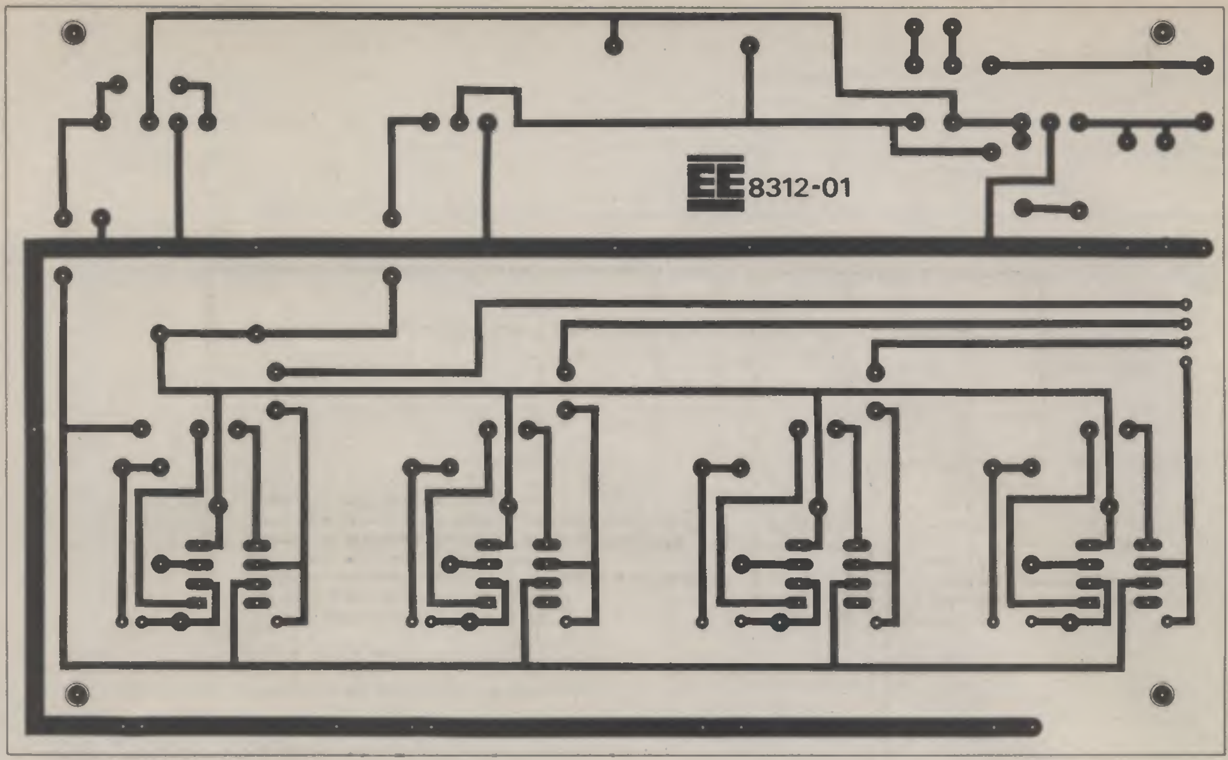


Fig. 6.6. Full-size printed circuit board master for the analogue board.

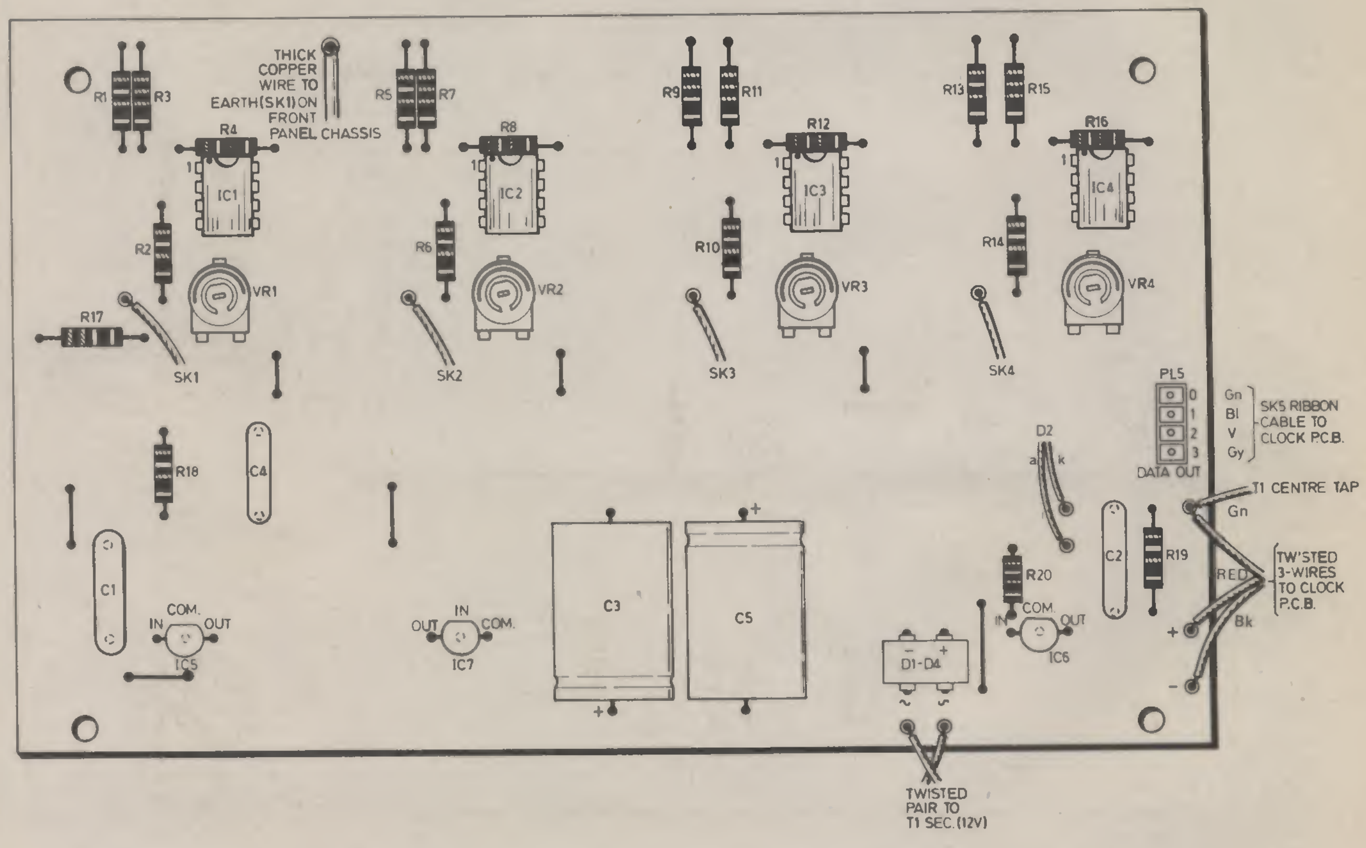


Fig. 6.7. Complete component layout for the analogue (ADC) board.

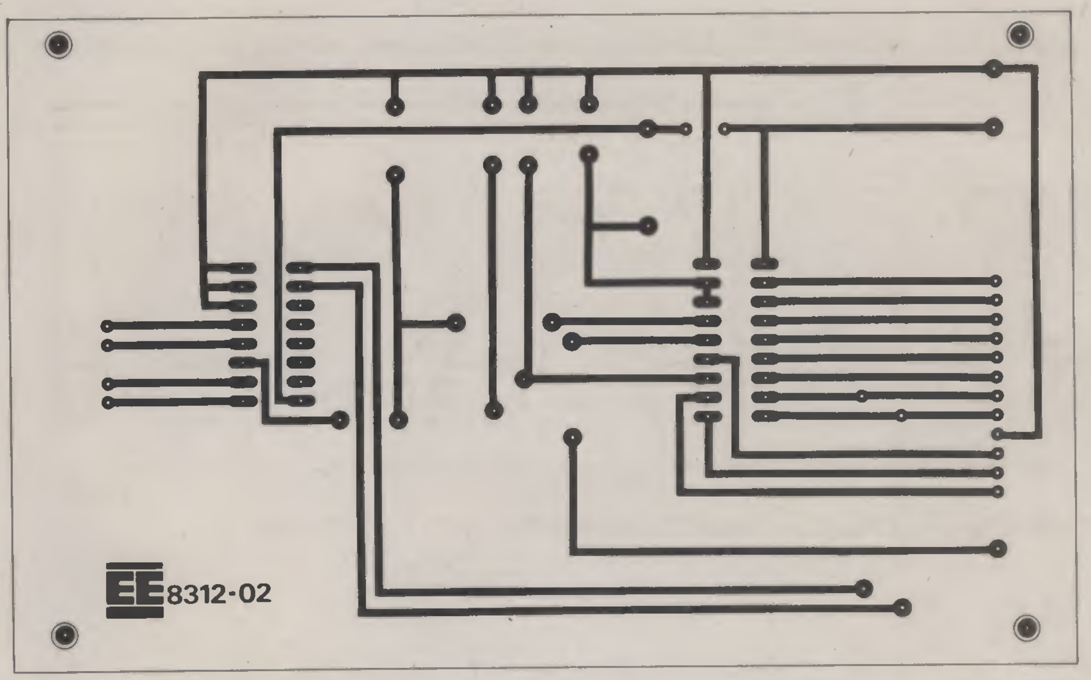


Fig. 6.8. Full-size printed circuit board master for the digital board.

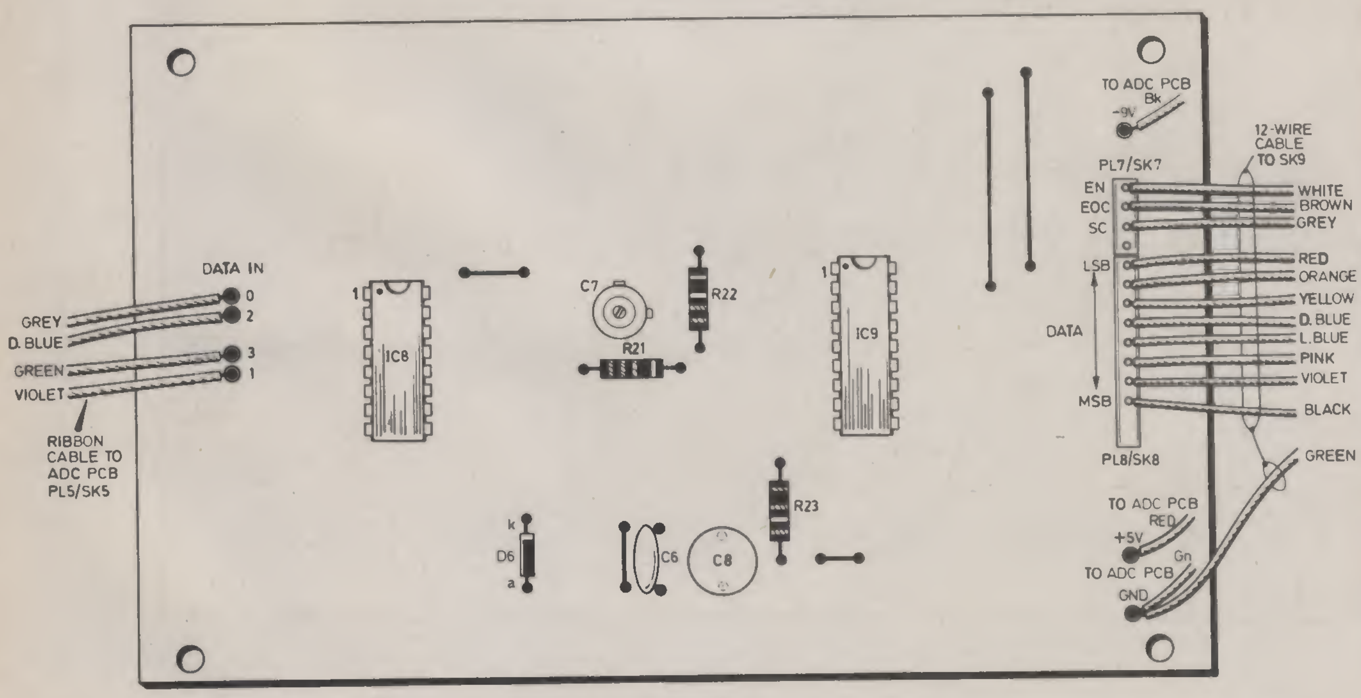


Fig. 6.9. Complete component layout for the digital (clock) board.

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4 CHANNEL HIGH SPEED ADC

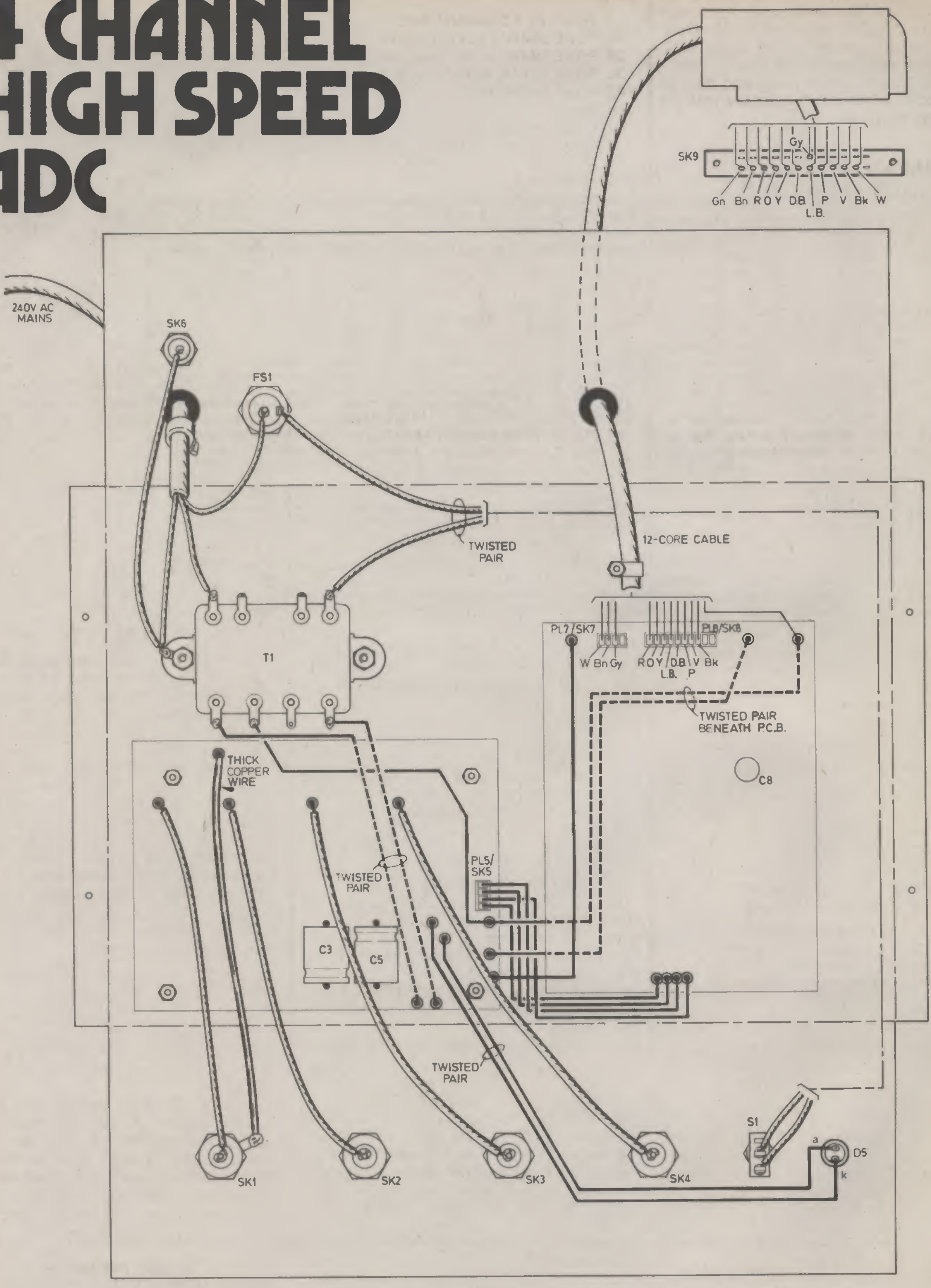


Fig. 6.10. Interwiring diagram for the two boards.

side of the 240kΩ feedback resistor in each channel; the analogue inputs should be short circuited. Rotation of the offset-null potentiometers should bring each output to zero.

The system is now ready and may be connected to the microcomputer with the appropriate plug.

COMMODORE MICROCOMPUTERS

To select one of the four analogue signals for conversion it is necessary to present the binary representation of the channel number to the channel select inputs of the 4052 (IC8). As four channels are employed in this design only two channel select lines are connected to two lower order lines (PØ and P1) available at the user port.

Initially these lines must be configured for output as the microcomputer must select the appropriate analogue input. This is accomplished by setting the requisite bits in the data direction register for the particular port. The ADC must then be instructed to initiate conversion of the selected analogue input into an eight-bit digital form.

One of the lines available at the top of the user port can be selected to provide this start conversion pulse. Pin 7 allows the same pin connections for both PET and VIC–20 microcomputers whereas pin 8 is used with the Commodore 64.

PET: Pin 7 is the cassette-write line which is automatically initialised for output. This can be used to fashion the start conversion pulse as follows:

```
POKE 59456,PEEK(59456)OR8
POKE 59456,PEEK(59456)AND247
POKE 59456,PEEK(59456)OR8
```

VIC–20: Pin 7 is derived from Port A. It is necessary to initialise this line for output by setting bit 5 in the data direction register for the port (37139) before sending the line to logic high by appropriate bit manipulation of the Port A I/O register (37151).

```
POKE 37139,PEEK(37139)OR32
POKE 37151,PEEK(37151)OR32
POKE 37151,PEEK(37151)AND223
POKE 37151,PEEK(37151)OR32
```

Commodore 64: Pin 8 is a handshaking line and allows a one-shot pulse to be output following any read or write of Port B. This is ideal for initiating conversion of the analogue input. For example:

```
POKE 56577,Ø
```

In this application Pin M at the user port is not used to fashion the start conversion pulse (unlike the single channel ADC detailed in Part 4 of this series). When the line attached to Pin M is held low the tri-state facility is enabled allowing relevant data to be read by the microcomputer.

Full software listings for collecting the data from the ADC are given below for the three Commodore machines catered for in this series.

PET

```
  5 REM PET 4 CHANNEL ADC
 1Ø POKE 59468,PEEK(59468)OR192
 2Ø POKE 59468,PEEK(59468)AND223
 3Ø POKE 59456, PEEK(59456)OR8
 4Ø POKE 59459,255
 5Ø INPUT C
 6Ø IF (C–1)*(C–3)*(C–2)
    *C=Ø THEN GOSUB 5ØØ
 7Ø GOTO 5Ø
5ØØ POKE 59471,C
51Ø POKE 59456,PEEK(59456)AND247
52Ø POKE 59456,PEEK(59456)OR8
53Ø POKE 59459,Ø
54Ø POKE 59468,PEEK(59468)AND223
55Ø PRINT PEEK(59471)
56Ø POKE 59468,PEEK(59468)OR32
57Ø POKE 59459,255
58Ø RETURN
```

VIC–20

```
  5 REM VIC–2Ø 4 CHANNEL ADC
 1Ø POKE 37147,PEEK(37147)AND227
 2Ø POKE 37148,PEEK (37148)OR192
 3Ø POKE 37148,PEEK(37148)OR32
 4Ø POKE 37139,PEEK(37139)OR32
 5Ø POKE 37151,PEEK(37151)OR32
 6Ø POKE 37138,255
 7Ø INPUT C
 8Ø IF (C–1)*(C–3)*(C–2)
    *C=Ø THEN GOSUB 5ØØ
 9Ø GOTO 7Ø
5ØØ POKE 37136,C
51Ø POKE 37151,PEEK(37151)AND223
52Ø POKE 37151,PEEK(37151)OR32
53Ø POKE 37138,Ø
54Ø POKE 37148,PEEK(37148)AND223
55Ø PRINT PEEK(37136)
56Ø POKE 37148,PEEK(37148)OR32
57Ø POKE 37138,255
58Ø RETURN
```

COMMODORE 64

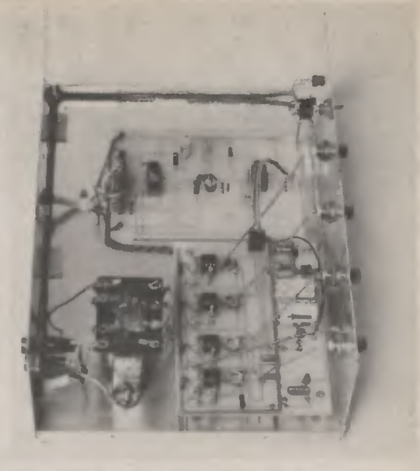
```
  5 REM COMMODORE 64 4 CHANNEL ADC
 1Ø POKE 56578,PEEK(56578)OR4
 2Ø POKE 56576,PEEK(56576)OR4
 3Ø POKE 56579,255
 4Ø INPUT C
 5Ø IF (C–1)*(C–3)*(C–2)
    *C=Ø THEN GOSUB 5ØØ
 6Ø GOTO 4Ø
5ØØ POKE 56577,C
51Ø POKE 56579,Ø
52Ø POKE 56576,PEEK(56576)AND251
53Ø PRINT PEEK(56577)
54Ø POKE 56576,PEEK(56576)OR4
55Ø POKE 56579,255
56Ø RETURN
```

BBC MODEL B

As previously mentioned, the BBC Model B Microcomputer has an internal 4-channel 12-bit ADC. The full scale analogue voltage of each channel is 1·8V and the analogue board design given can be used to give a 100mV range if the feedback network is modified slightly. The gain required is now ×18 and, using the op-amp gain equation for the non-inverting mode:

$$G = (1 + R_F/R_{IN})$$

gives a ratio of 17 for R_F/R_{IN}. Suitable resistor values for R_F and R_{IN} are 220kΩ



and 13kΩ, respectively (R_F should actually be 221kΩ, but a 220kΩ resistor is within 0·5% of this). Once again, close tolerance resistors should be employed.

The +5V regulator for the digital board supply can be omitted. Outputs from the board should be taken to the BBC analogue input via screened cable and the appropriate miniature 15-way D-type plug.

BBC MICRO SOFTWARE

The form the BASIC statement used, to extract digital information from the BBCs ADC, is

X = ADVAL(N),

where N refers to the channels numbered 1,2,3,4. The number returned is in the range 0 to 65520 in steps of 16. This may seem odd when the converter itself produces a number in the range 0 to 4095. The reason for this is to allow for future converters with higher resolutions.

It should be added that a resolution of 1 part in 256 (that is, approximately 0·4% for 8-bit resolution), is quite adequate for most applications since transducer and signal conditioning tolerances are seldom better than 1%.

The number for each channel is stored in the twelve most significant bits of two eight-bit memory locations so that the largest digital value is

111111111111ØØØØ in binary

which is 65520 in decimal. As the least significant four bits are always zero the numeric results increase in steps of 16. To obtain digital values in the range 0 to 4095 then the actual value must be divided by 16.

As the channel readings are taken sequentially on an interrupt basis every 10 milliseconds then if less than four channels are required it is sensible to disable those channels not in use so that time is not wasted converting them.

The command to accomplish this is

*FX16,N

where N is the number of channels enabled. (If N = 0 then all channels are disabled.)

Next month: Biological Amplifier with High Speed ADC

EVERYDAY news ... from the world of

NEW ELECTRONICS—*BBC puts schools on right wavelength*

BBC School Radio is breaking new ground with three innovative series designed to prepare schoolchildren for the new electronic age: (1) *Using Your Computer*, a 5-part series for 9 to 12 year olds; (2) *Junior Electronics*, a 5-part series for 9 to 12 year olds and (3) *Microtechnology*, a 10-part series for 'O' level and CSE students. These series have been prepared by the BBC with help from the Microelectronic Education Programme (MEP) and the Department of Industry.

Using Your Computer

Using Your Computer started on Nov. 1, 2.20pm on Radio 4 VHF. It is expected that this series will help teachers in primary and middle schools to introduce children to the computers supplied to schools under the DoI "computers in schools" scheme, that is the BBC Micro model B, the Sinclair Spectrum and the Link 480Z.

The series offers a completely new dimension in educational broadcasting in which recorded radio broadcasts are synchronised with specially prepared software to use the graphic, sound and "computing" abilities of these micros to provide a fully integrated audio/visual presentation. In this way the computer is given a friendly voice (it is in fact the voice of Fred Harris well known to children in the mentioned age group) which guides the children through the initial stages of the operation and application of the machine. Thus children learn to *use* a computer by *using* a computer.

Junior Electronics

Junior Electronics begins on Feb. 28, 1984, on Radio 4 VHF at 2.20pm. In this series of programmes the children are piloted through very simple practical work, learning to construct basic electrical and electronic circuits on a custom designed circuit board, which is a component in a special kit of parts, on sale from BBC Publications.

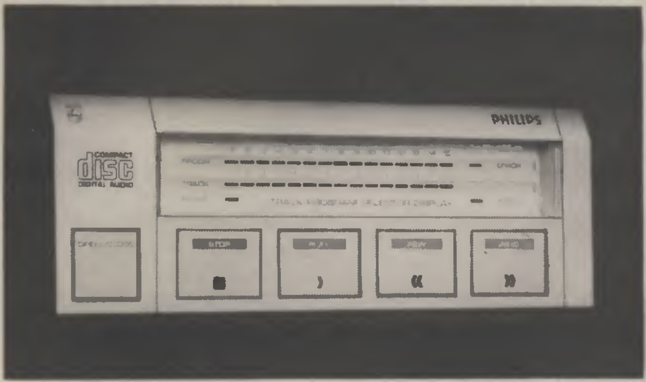
The last of the five broadcasts is a Radiovision programme in which the children are shown the relevance of the real-life applications of the circuits they have been working with, such as—why a street light automatically lights up, and how a burglar alarm works.

This and the previous series are designed so that they can be handled by teachers with little or no previous knowledge of the subjects. Comprehensive teacher's notes are provided.

Microtechnology

Microtechnology starts on Jan. 20, 1984, on Radio 4 VHF at 10.45am. It forms an introduction to basic microelectronics leading to ideas of control technology and is dependent on the medium of Radiovision associated with practical work. There is a kit of parts, film strips and software, as well as a specially developed circuit board and a "safe" power supply unit for the experiments.

electronics



DIGITAL ROUTE FINDER

SIGNS of future developments in the digital audio field were in evidence at the recent *International Audio and Video Fair* held in Berlin.

One of the items that was shown for the first time was the **Philips** In-Car Compact Disc Player. Research, it is claimed, shows that the improved sound quality is clearly noticeable in the acoustic environment of a moving car.

Also, because of the large information storage capacity, the unit is not limited to sound reproduction applications only. Future developments could include the presentation of route or touring information, for example, with a single disc replacing a number of conventional maps and guide books.

The system is based on a 12cm diameter disc, carrying up to one hour of digitally encoded programme material which is read by a focused laser beam. The prototype car player will undergo a number of changes before it finally reaches the market, probably in two years time.

FIRE PROOF

When Data Dynamics claimed that their metal cased ZIP printers would stand up well to rough industrial usage they did not have incineration in mind.

However, when a fire broke out in a warehouse the printer received extensive damage from heat and flames—see Photo. The printer was retrieved from the remains and was found to be in perfect working order.

PLAY IT AGAIN SAM

From the nostalgia of movie classics like "Casablanca" and "Hard Times" to the latest film hits such as "On Golden Pond" and "A French Lieutenant's Woman", Humphrey Bogart (alias Kenny Wymark) was on hand to launch the long awaited CED VideoDisc system and video library from RCA.

This totally new videodisc system, which the manufacturers believe will have a major effect on the market, was announced in London recently. Launched initially as a joint venture by RCA, Hitachi and GEC, the new system is claimed to provide high quality pictures and sound at around half the price of most conventional VCRs.

The CED VideoDisc player—CED stands for Capacitance Electronic Disc—works on a principle similar to that of a hi-fi turntable. The disc is contained in a caddy, rather like a long-playing record sleeve. This is inserted into the player, the caddy is then withdrawn and playing begins automatically.

This simple operation ensures the disc itself need never be touched. A stylus reads the grooves on the disc, playing them back through any black and white or colour television receiver. The signal produces both audio and visual playback.

The CED VideoDisc players are available in both mono and stereo versions and different models offer infra-red or wired remote control. The three models available include the VIP 101P, incorporating visual search, mono sound, scan and pause, which will sell for around £199.95 and the VIP 202P, which will sell for around £229.95 and which also includes stereo sound, full visual search and as an optional extra, wired remote control.

At the top of the range is the VIP 201P. This player, incorporates stereo sound, full visual search, full scan, pause and infra-red remote control. This will sell at around £259. 95.

Disc prices, and there will be 100 titles available, will be £9.95 and £12.95. RCA plan to add new releases each month, starting December.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Confusing Law

The Olympia "Great Home Entertainment Spectacular" Show typified the confusion that now exists over what electronic gadgets are, and are not, legal.

In this column we have already explained how the law now requires people who sell telephones to mark them either with a green circle, signifying official approval, or with a red triangle, to show that they are prohibited from connection to the British telephone lines. But plenty of prohibited phones are on sale, sometimes but not always marked, and you don't risk a fine or prison if you connect one to your line. What you do risk is disconnection of your service, by British Telecom, if their engineers find out and you refuse to disconnect the prohibited phone yourself.

Although CB is now legal in Britain, it is only legal on the carefully specified frequencies. Likewise cordless telephones, which use a radio link to the handset, are only legal if they operate on carefully specified frequencies. Many cordless radio phones still on sale in Britain are illegal. In this case you don't just run the risk of annoying British Telecom and losing your phone service. You also run the risk of three months in jail and/or a £1,000 fine for contravening the Wireless Telegraphy Act.

Not surprisingly the public is very confused. At the Olympia Show, one stand was manned by the British Electrotechnical Approvals Board, which runs the scheme which tests telephones. They were giving away a leaflet that reminded people that "green is for go" and "red is for no". Literally feet away, another stand was showing telephones, many of them clearly marked with a red triangle as prohibited. They also had cordless telephones marked in the same way because they operate on illegal frequencies!

Citizen's Band TV

Even more confusing was the stand across the hall which was selling what the show catalogue described as "at last—your very own portable colour TV transmitter!" This neat little gadget, which costs £1,000, works as a miniature u.h.f. TV transmitter. You plug in a video camera, or video recorder, and it broadcasts the signal to any TV set tuned to the transmitted frequency.

The unit has three watts output power which, according to the company's salesman, carries up to seven miles. But for another £600 the salesman could offer a 100-watt amplifier that carries the signal 20 to 25 miles.

"Is Citizen's Band TV on the way?" asked the Olympia Show publicity. I asked the firm demonstrating the system about the law, and they told me that they were "speaking to the Home Office".

In fact, the Home Office is no longer responsible for radio regulations. The Department of Trade and Industry took on the job soon after the last election. During the show the DTI confirmed to me that the penalty for illegal TV transmissions was still a £1,000 fine and/or three months in jail.

To be fair, the firm selling the system did say, right at the bottom of the data sheet, that "the unit is not approved for use in the UK". But that's after a suggested list of uses, including amateur TV!

For the record, I *didn't* play spoil-sport and tell the Department of Trade and Industry where they could go to catch someone red-handed breaking the Wireless Telegraphy Act.

Flat-Screen TV

Suddenly flat-screen television, or rather pocket televisions with flat TV tubes, are in the news. Sir Clive Sinclair has finally launched the set which, in February 1981, he promised would be available during 1982.

The price has risen from £50 to £80, and the f.m. radio section has been dropped. One reason for the delay was an industrial dispute at the Timex plant in Dundee earlier this year. But is it really launched, and is it really a multi-standard set as claimed by the company's publicity?

Well, although the flat-screen TV was "introduced" in September, just in time to show at the *Great Home Entertainment Spectacular* at Olympia, no-one could actually buy one. When quizzed over availability, Sir Clive hedged, and talked about going into production.

My bet is that they won't be readily available until around Christmas. But at least Sir Clive has learned from past mistakes. He isn't taking money up-front from mail orders until he is ready to supply.

This is what caused such bad feeling over his computers. People were encouraged to send money for something that wasn't actually available.

On the question of "multi-standard" operation, I don't doubt that the set will, as Sir Clive says, automatically switch between 525-line and 625-line operation and cope with the different sound and vision frequencies used in Europe. But note well that the Sinclair set receives only u.h.f. TV, whereas most television in 525-line countries like America and Japan is on v.h.f. Some Continental TV is also on v.h.f.

Later models will have a tuner which sweeps between 40MHz and 900MHz, to receive all television and f.m. radio broadcasts around the world. But that's in the future. So far the sets are u.h.f only.

And how will they work on tubes, buses, trains, cars and planes? I asked to borrow a set after the press launch, but wasn't even allowed to *buy* one to test. They weren't, I was told, ready. So I took a Sony Watchman TV to the press conference and tried one against the other.

The Sony, at three times the price, pulled in a better picture. But watch out for a low cost Watchman in the near future. It's already on sale in America.

I then took the Sony Watchman on some trips. It won't work at all on an underground train. It works reasonably well, but erratically, on overground transport, like a bus.

I can't imagine watching for pleasure, because you keep losing the picture as you turn a corner or pass a building. Remember that u.h.f. waves travel in straight lines, and don't penetrate into concrete boxes or metal cabins half as easily as long or medium wave radio transmissions.

In The Air

I then tried using the Sony on board an aircraft flying to Munich but was soon stopped by the cabin crew. The airlines are frightened that TV equipment may interfere with their navigation equipment.

I used it long enough to find out about another problem. At ground level a u.h.f. TV set picks up only local stations. That's why different transmitters around the countries can share the same frequency. But up in the air you pick up everything from hundreds of miles around. So nothing is watchable.

The Sony worked well in Germany, picking up both u.h.f. and v.h.f. TV pictures in my hotel room. But most hotels now have a TV set in each room, often colour.

So, who wants to watch a two-inch black and white picture off expensive batteries, if there is a mains-powered large screen colour set on the table? And how often do you want to watch TV while sitting in a park or sight-seeing in a foreign city? And don't forget that foreign TV programmes have foreign language sound-tracks.

Bear all this in mind before rushing out to buy a pocket TV set just for the sake of buying a pocket TV set.

Hot Memory

A few words of advice for anyone buying a memory telephone that stores strings of numbers for repertory dialling.

Some of the most powerful memories on the market are not officially approved and use a two-wire connection to the phone line. This means that the memory jangles the bell of every other phone in the house as you make a call. But approved memory phones, which use three wires and don't cause bell jangle, usually offer less memory capacity for more money.

Check also whether what you are buying has a battery back-up. The more expensive memory phones contain a string of ni-cad rechargeable cells in series across the low voltage d.c. power line.

If the power fails this battery pack keeps the memory alive. Otherwise even a short interruption of power will lose every number you have keyed into the memory.

Cheaper memory phones may not have battery back-up. It is not a condition of official approval. For instance, I bought the Ace-Telcom approved phone, which for just under £100 has a memory store of 50 numbers.

Essentially it's an approved version of a previously unapproved Lamda phone from Hong Kong. But the Ace-Telcom does not have a battery back-up. So even a brief break in the power supply loses every number you have laboriously keyed into the memory.

I solved the problem by stringing six ni-cad pen cells in series with a 50-ohm resistor, and put them across the 9V d.c. supply. The resistor limits charging current, to prevent damaging the cells, but it lets through enough current to keep the memory alive if the mains cuts out.

But far better, in the first place, to buy a memory phone with a battery back-up built in. So check this before buying.

Ace-Telcom in Britain now tell me they are thinking of making some kind of modification. What a pity they didn't think about that before starting to sell a memory phone that is prone to amnesia.

JANUARY FEATURES

Home Protection from Gas and Fire Hazards

Gas & Smoke Sentinel

This four-channel monitoring and alarm system gives early warning of gas leaks, and also of imminent danger of fire. Each of the four sensors can be installed in optimum position to detect either gas leaks or smoke in various parts of the house. The master control unit is equipped with red and green l.e.d.s which indicate status of each sensor. External 12V alarms can be connected and extended to any convenient point.

Guitar Tuner

A phase-locked loop is the basis of this tuner. Six tones corresponding to the notes from the open strings of an electric guitar are available for initial tuning and the final accurate adjustment of each string is performed with the aid of the tuning meter.

Scoreboard

Adds individual scores of between 1 and 99 and stores the totals for up to four players. Total scores are displayed on a three-digit seven-segment display. The ideal (and indisputable!) electronic scorekeeper for games where running totals are kept.

THERMOMETER for ZX MICROS

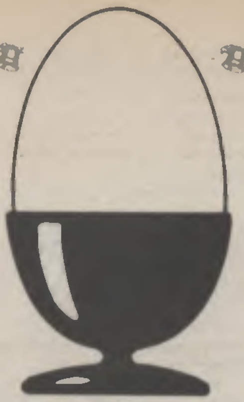
Central Heating Pump Delay Unit

Senses the temperature of the circulating water and after the boiler has been switched off at the end of the heating period, keeps the pump running until the water has fallen below a preset temperature. This allows the radiators to extract most of the stored energy and deliver it as useful room heating.

SAVE FUEL this WINTER

EVERYDAY ELECTRONICS and computer PROJECTS

JANUARY 1984 ISSUE ON SALE FRIDAY, DECEMBER 16



NOVEL EGG TIMER

BY I. HICKMAN

LET A CHICKEN TELL YOU WHEN YOUR EGG IS COOKED

UNLIKE most normal egg-timers, this project is based on an electronic circuit. The Novel Egg-Timer makes use of a deceptively simple circuit which makes a creditable imitation of a cackling chicken that has just layed an egg.

CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 1. IC1 is a 14-bit binary counter with built-in oscillator and reset facilities. R2, R3, VR1 and C2 set the oscillation frequency to about 50Hz, the exact value is adjustable by means of VR1.

When the circuit is switched on, pin 12 is momentarily carried to +9V by C1, resetting all 14 counter stages to zero. C1 charges up via R1 releasing the reset and the counter starts counting. For the first 8092 cycles the output of the 14th stage, Q_{14}, stays low (0V) and the outputs of the two 4-input AND gates therefore also remain low.

On the 8093 cycle of the built-in oscillator, after approximately three minutes, Q_{14} goes high (+9V). This enables IC2a and from then on the gates produce groups of four pulses (pin 13) and single pulses (pin 1) as shown in Fig. 3. Up until now the 555 timer IC3, which has been connected as an oscillator, has been inhibited by the low voltage on its reset pin (pin 2).

However, each time a positive-going pulse appears at pin 13 of IC2 its leading edge is differentiated by C3 and R4. This results in a narrow positive spike being applied to pin 4 of IC3, briefly enabling the oscillator.

The few cycles of oscillation that take place constitute a "cluck". On the fourth cluck the lower end of R4 is taken to +9V by the pulse at pin 1 of IC2, so pin 4 of the oscillator IC3 sees a full width pulse instead of a narrow pulse (Fig. 3).

Simultaneously, the pulse at pin 1 of IC2 turns on TR1 with the result that the voltage at pin 5 of IC3 starts to fall as C4 discharges via R6. This results in the extended fourth burst of tone having a rising pitch, the characteristic chicken's squawk following the three clucks.

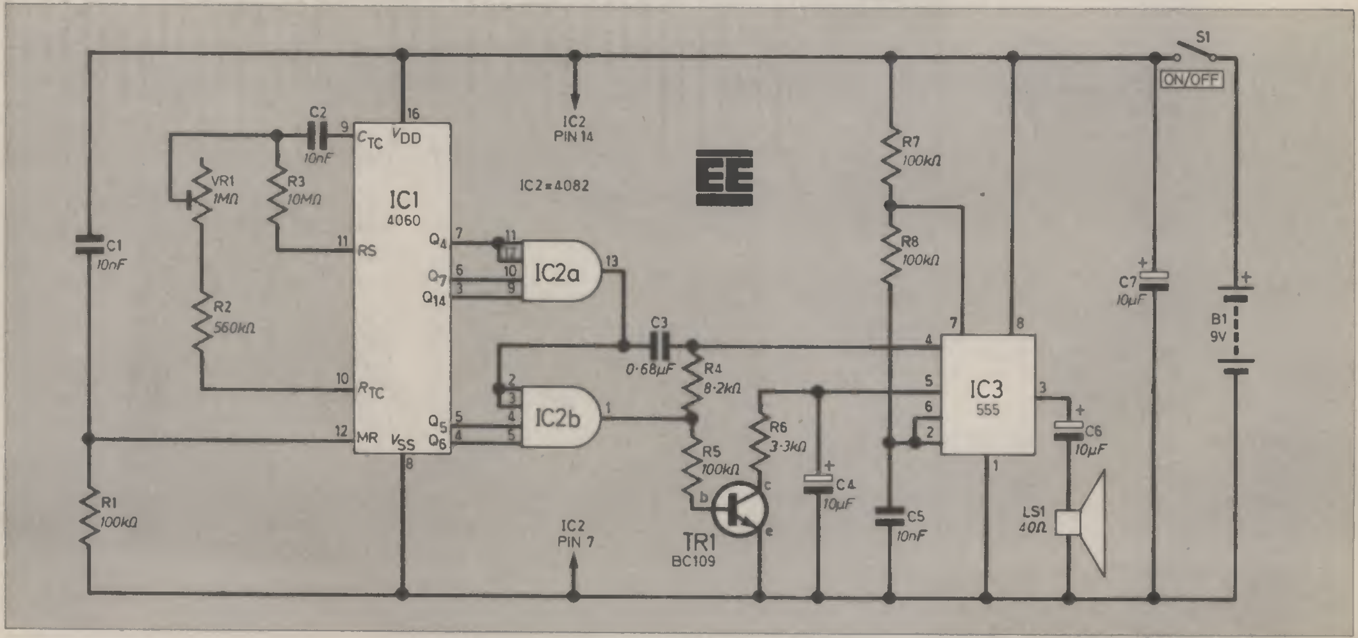
The output at pin 3 of IC3 is coupled to the loudspeaker LS1 via C6 and the egg-timer produces sufficient volume to be heard even if there is no-one in the kitchen.

COMPONENT BOARD

The components are laid out on a piece of 0·1 inch matrix stripboard which is 39 strips by 31 holes and the layout is shown in Fig. 2. The use of d.i.l. sockets is recommended for the integrated circuits which should only be inserted when all the soldering is completed. Note that the CMOS devices should be handled with care.

The power supply is provided by a 9V PP3 battery which is contained within the case. The housing used for the project is left to personal choice.

Fig. 1. The complete circuit diagram of the Novel Egg-Timer.



TESTING

Using an oscilloscope, check that groups of four pulses are obtained at pin 13 of IC2 and single pulses at pin 1 as shown in Fig. 3.

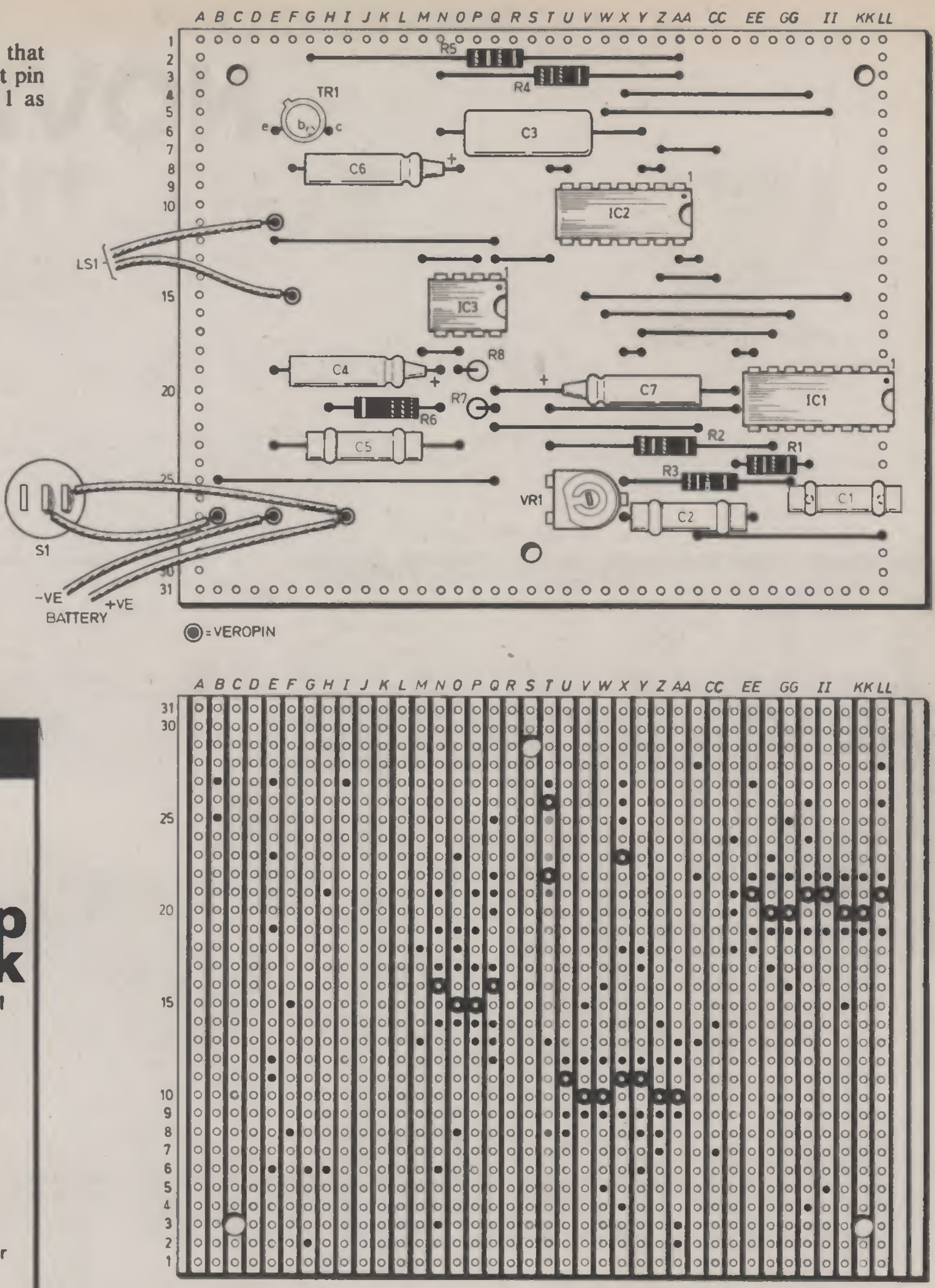


Fig. 2. The component layout and trackside view of the Egg-Timer circuit board. Note that on the prototype the author has used unfamiliar style electrolytic capacitors but any suitable type can be used.

COMPONENTS
approximate cost £7

COMPONENTS

Resistors

R1,5,7,8	100kΩ (4 off)
R2	560kΩ
R3	10MΩ
R4	8·2kΩ
R6	3·3kΩ

All ¼W carbon ±5%

See Shop Talk page 801

Capacitors

C1,2,5	10nF ceramic (3 off)
C3	0·68μF polyester
C4,6,7	10μF 16V elect. (3 off)

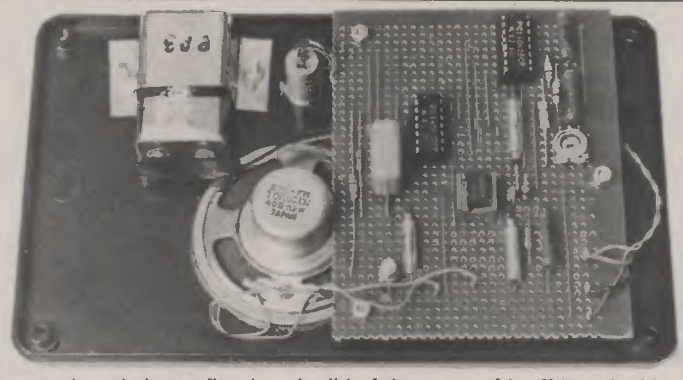
Semiconductors

TR1	BC109 silicon *npn*
IC1	4060BE CMOS 14-stage ripple counter and oscillator
IC2	4082BE CMOS dual 4-input AND gate
IC3	NE555 timer i.c.

Miscellaneous

VR1	1MΩ lin. miniature carbon preset
S1	s.p.s.t. miniature toggle
LS1	miniature, 64Ω, 60mm dia. approx.
B1	9V PP3

Stripboard: 0·1in matrix size 39 strips by 31 holes; case, 180 x 110 x 50mm; 8-pin d.i.l. i.c. holder; 7-pin d.i.l. i.c. holder; 4-pin d.i.l. i.c. holder; battery clip.



Component board shown fitted to the lid of the case, with off-board wiring details also shown.

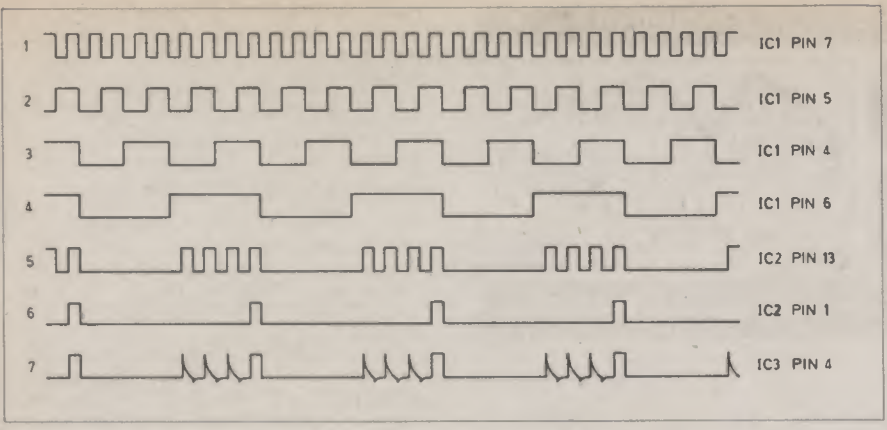


Fig. 3. Shown are the pulses that should be obtained when testing IC1, IC2 and IC3 with an oscilloscope. Note that pin 4 of the oscillator IC3 sees a full width pulse instead of a narrow pulse on the fourth count to produce the "squawk".

Switch the unit on and check that the waveforms at pins 13 and 1 of IC2 only commence after approximately three minutes. Increasing or decreasing the value of C3 will make the clucks longer or shorter. Decreasing or increasing the value of R6 will cause the final squawk to rise higher or not so high.

Reducing the value of C5 will cause the sound of a squawk to rise more rapidly. The final values of these components may be chosen to produce what sounds you like but the values shown will generally prove satisfactory.

One final note, if you leave the egg-timer switched on after it has started to sound, it will continue to do so for the set amount of time (as set by VR1). It will then fall silent for a set time and then start to sound again, this will continue indefinitely. □

BOOK REVIEWS

BEGINNER'S GUIDE TO INTEGRATED CIRCUITS SECOND EDITION

Author	I. R. Sinclair
Price	£4.35 Limp edition
Size	185 × 124mm. 194 pages
Publisher	Butterworth & Co. Ltd. (Newnes Technical)
ISBN	0-408-01301-X

As the name suggests "Beginner's Guide to Integrated Circuits" is a book intended for the comparative new-comer to electronics. The book contains nine chapters and the first deals with basic electronic theory, which gives a good grounding for the more complex chapters to come.

Many examples are given of practical i.c. circuits; and linear, digital integrated circuits are also covered. The microprocessor and associated chips are also described with comprehensive diagrams to support the text. As before Ian Sinclair has managed to produce an outstanding book for the beginner to electronics.

R.A.H.

25 SIMPLE AMATEUR BAND AERIALS

Author	E. M. Noll
Price	£1.95 Limp edition
Size	178 × 110mm. 63 pages
Publisher	Bernard Babani
ISBN	0 85934 100 3

Many radio enthusiasts construct their own aerials and "25 Simple Amateur Band Aerials" should prove a useful reference book to even the most experienced constructor.

Starting with a simple dipole aerial the book describes how to build 25 amateur band aerials, including a mini-rhombic made from four TV masts.

All the aerials described are inexpensive and easy to construct, and each new aerial has a diagram to support its introduction with clear informative text. Finally, there are a complete set of dimension tables which will help you identify an aerial on a particular frequency. Data is also provided for the spacing and cutting of phase lengths.

R.A.H.

SERVICING MONOCHROME PORTABLE TELEVISION

Author	G. R. Wilding
Price	£13.50 limp
Size	295 × 210mm. 138 pages
Publisher	Butterworth & Co. Ltd. (Newnes Technical)
ISBN	0 408 01143 2

If you are involved with, or merely interested in, the servicing of TV sets, then this book will be an invaluable addition to your library. Mr. Wilding has spent over 40 years servicing and writing about televisions and this guide presents a comprehensive insight into how current portable black and white receivers operate (which, incidently, represent the largest proportion of "second" sets throughout the world).

Covering a diversity of British, European and Japanese models, the well illustrated text discusses typical faults and their rectification with special emphasis on new and unusual circuitry. A large section of the book is given over to the reproduction of circuit diagrams and board layouts of many popular and currently available portables.

G.P.H.

Books in Brief

IBA Technical Review No 20, "Developments in Teletext" by Technical Editor Paul Gardiner (IBA). This 69-page book, with 57 illustrations, includes seven papers written by engineers working the teletext field. The Review covers the ten years of teletext development; the enhancements of additional levels including the possibility of using alpha-geometric coding; networking; integrated circuit decoders; and the NEWFOR system of teletext subtitling developed at the University of Southampton.

RADIO WORLD

BY PAT HAWKER G3VA

Where Have All The Viewers Gone

Over six years ago, in one of the broadcasting journals, I wrote an article "Broadcasting to the two-set home". In this I pointed out that if, as to me seemed likely, the number of homes with more than one TV set continued to rise (in the period 1970–75 it had doubled from only 3 per cent to about 6 per cent) this would need to be taken into account in the planning of broadcast programmes and schedules.

I began this article as follows: "Generals, it is often said, always prepare to fight the last war all over again. Broadcasters, if they are to avoid this mistake, need to be more perceptive of change; to detect the way in which the public taste and viewing patterns are gradually changing". Programmes I stressed, need to be on the basis of current public viewing habits suitable for the conditions under which the public views, the times when it views, and the sets on which it views.

Not everyone in broadcasting agreed with me. One senior administrator told me that the second set was just a passing phase—amounting to little more than keeping an old black-and-white set when buying or renting a new colour set.

Another was much upset at my suggestion that it could no longer be taken for granted that everybody sitting in a room in which there was a switched-on TV set was necessarily watching the programmes and advertisements with bated breath, but might be doing other things such as reading or even dozing, using the programme as a background accompaniment to other activities. Nor did the quote that "television is the only activity that occupies more time in the home than sleeping—though some would observe that the two pastimes are synonymous"—go down too well. The stream of television, I suggested, goes on—the mind wanders off to its own explorations or just sinks into timeless oblivion!

In the intervening six years the number of two-set homes has continued to increase—until today about a third of UK homes are in this category. But, potentially even more significant, has been the impact of almost three-million video recorders.

This enables viewers both to choose and make up their own programme schedules, either by buying or renting cassettes or by using the recorders as time-machines to view broadcast programmes at convenient times. A breach of copyright but who takes notice of this?

It now seems certain that two-set homes, and more especially video recorders, *are* affecting TV audiences, not only the head-counts of people watching top-rated programmes at the time they are transmitted, but also public attitudes to television. The old idea of programmes being "compulsive viewing" is being by-passed by the new technology.

One does not worry over much about bad programmes—more significant is that what, by any standard, are some extremely good programmes seem no longer to attract the audiences that would have watched them six years ago. And as a final straw a scientist is now suggesting that the brain rhythms of a TV viewer are almost the same as those of someone asleep!

Still Spinning

Most people believe that interest in low-definition mechanical television came to a stop in 1935 with the ending of BBC's transmissions of the 30-line Baird system, although a few European radio amateurs continued transmitting low-definition patterns up to about 1939.

Very few seem to have heard about the revival of interest in NBTV (narrow band television) in the past few years, sparked off initially in Australia. Today there is in the UK a very active *Narrow Bandwidth Television Association* made up of members interested in mechanical forms of television, though much of it is considerably more sophisticated than the old spinning Nipkow discs of the Baird era.

The NBTA under chairman D. B. Pitt (1 Burnwood Drive, Wollaton, Nottingham) publishes a quarterly newsletter that reflects a good deal of active interest in closed-circuit home-built mechanical systems and there are plans to transmit 32-line pictures on 144MHz in a bandwidth of 9·6kHz. An NBTV convention was held recently (10 September) near Manchester, and another at Nottingham last May.

One of the developments is a camera based on solar cells. The pictures may seem crude, but enthusiasm still runs high.

Happy Workers

A survey of how electronics engineers feel about their work, based on 650 replies to a questionnaire in the American "Electronics" magazine, suggests that almost 86 per cent are very or resonably satisfied with their work. Only 14 per cent unsatisfied or hardly satisfied; 72 per cent believe they are fairly paid, against 24 per cent who think the opposite.

Two-thirds would again study engineering, if they had their time over again, though some 11 per cent would switch to the medical or dental professions. Some 9 per cent would opt for pure science and 6·5 per cent for business administration.

Almost 88 per cent would encourage their children to study engineering; 28 per cent believe that what they are doing is very important to the well-being of society; 54 per cent believe their work is "fairly important", only 1·6 per cent rate it as "unimportant".

Fewer than half American engineers earn more than $40,000 per year, and average starting salary for fully qualified engineers is about $25,000. About 10 per cent top the $60,000 mark.

In the States, as in the UK, the quickest way to top earnings appears to be developing new computer-based video games. However, market-busting software tends to have a meteorite rise but an equally fast fall, often all within a single year.

Tiny TV

It is too early to predict whether Sir Clive Sinclair will succeed in making a financial as well as a technical success of his pocket TV set. I remember an earlier Sinclair model shown at Earl's Court in the 1960s that never really got going.

The flat tube in his new set represents the fulfilment of ideas first proposed in the 1950s by Denis Gabor, the man who also predicted the development of holography. Then again, the Ferranti chip used by Sir Clive succeeds in putting virtually all the basic stages of a black-and-white, multi-standard TV set onto a single chip, a remarkable feat.

Similarly, the 15-hour Polaroid lithium battery must be the first time one of these high-energy batteries has been used in British consumer electronics. It will also be interesting to see whether his mail-order-now, pay-later approach (to cover the possibility of production delays?) will succeed: it is an approach that is unlikely to prove popular with the retail trade! Walk-about audio has proved a winner but does not involve the problem of looking at a picture while watching where you are going!

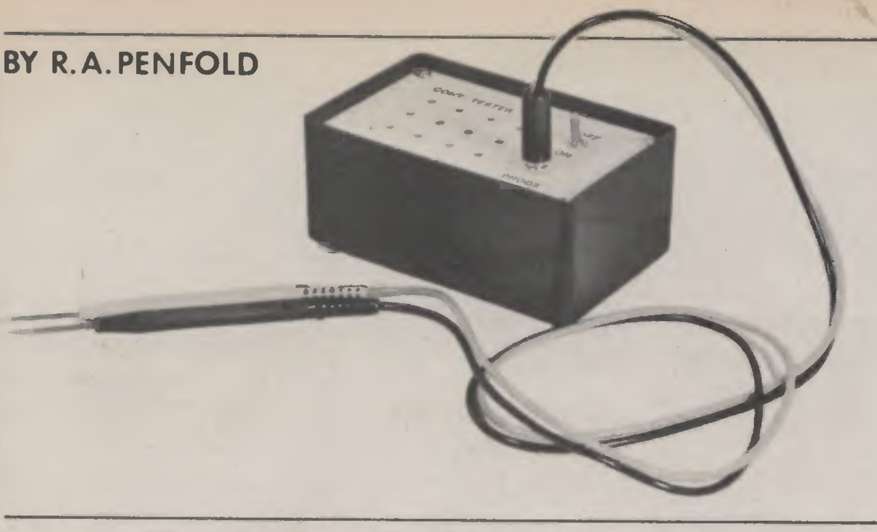
Pen Radios

For over a year I have had one of those low-cost Japanese digital watches in the stem of a ball-point pen. The watch has worked perfectly, the miniature battery seems easy to replace though this has not been necessary so far. My trouble is that I have never succeeded in finding out how to fit an ink refill! I have a compact watch but a full-size empty pen.

Now I see Mullard/Philips have marketed an integrated circuit (TDA 7000) that contains virtually all the circuitry (except for 14 tiny ceramic capacitors) needed to form a complete v.h.f./f.m. radio small enough to fit inside a pencil, wristwatch or key-ring. I suppose you could also fit a tiny earphone in the pen and then stick it in your ear.

Sounds fine, but I hope the set manufacturers make it simpler to fit those ink refills!

BY R.A.PENFOLD



CONTINUITY TESTER

DESPITE the fact that a Continuity Tester is an extremely simple piece of test equipment it can nevertheless be very useful when fault-finding on electronic equipment. Uses of continuity testers include such things as checking fuses, tracing broken wires or printed circuit tracks, checking diodes, and tracing short circuits on printed circuit boards.

An ordinary multimeter switched to a low resistance range can be utilised as a continuity tester, but this method is often inconvenient in use due to the need to look away from test prods or probes and at the meter each time a check is made.

When checking complex circuit boards, switches or something of this nature, it is often necessary to concentrate on the test prods in order to keep them in good contact with the appropriate two points. Another problem is simply that some multimeters pass quite a high current when used on a low resistance range and there is a consequent risk of damaging delicate semiconductor components.

AUDIO TONE

This simple Tri-State Continuity Tester design provides an audio tone to indicate continuity, and the maximum current that can flow through the circuit under test is only a little over 1mA. This means that there is no real risk of components being damaged while making tests using the unit. An unusual feature of the circuit is its indication of three levels of continuity rather than the usual two.

It provides a low frequency tone if a very low resistance of just a few ohms is detected, a higher tone if a higher resistance is detected, and no tone if a resistance of more than a few hundred ohms is present across the test prods.

Many continuity testers will indicate continuity if a forward biased semiconductor junction is present between the test points. This can produce misleading results when checking circuit boards for broken tracks or short circuits as there are likely to be numerous semiconductor junctions present in the circuit, bearing in mind that these junctions can be part of a transistor or integrated circuit and do not have to be present in the form of a diode.

This tester clearly differentiates between a true low resistance path, a slightly higher resistance or semiconductor junction, and a high resistance path, so that much of the ambiguity that can occur when testing circuit boards with a conventional continuity tester is avoided.

CIRCUIT DESCRIPTION

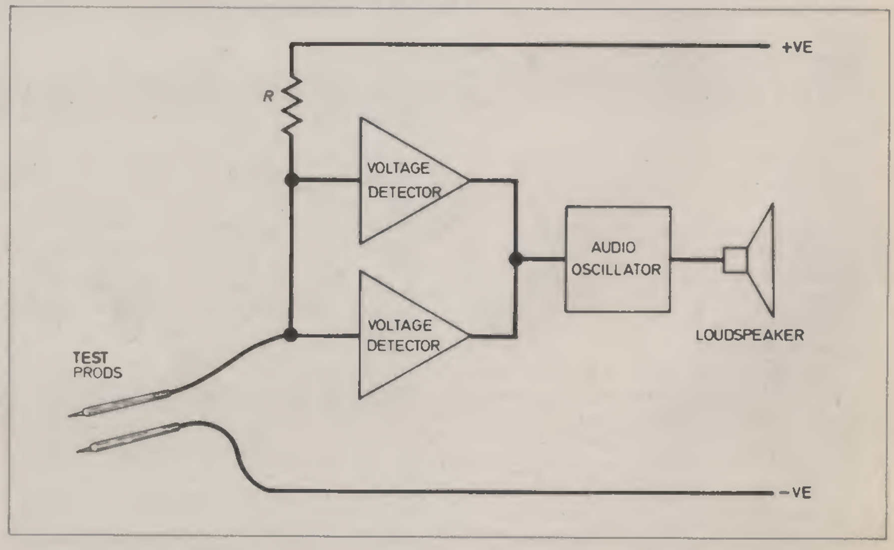
The full circuit diagram of the continuity tester is shown in Fig. 1, and the only active device used in the unit is an MC3302P quad comparator (IC1). A voltage comparator of this type has an *npn* output transistor which is used in the common emitter mode, but does not have a built-in load resistor or other form of collector load.

The output transistor is switched off if the inverting (−) input is taken to a higher voltage than the non-inverting (+) input, and is switched on if the comparative input states are reversed.

There is no built-in triggering in the comparators and they can have the output transistor partially switched on if the input voltages are balanced. It is therefore possible to use a comparator as an operational amplifier by adding a load resistor at the output and IC1c is used in this way. R10 is the load resistor and this comparator is used in what is a well-known operational amplifier oscillator configuration. The values specified for R9 and C1 set the operating frequency of the oscillator at a fairly low audio frequency of only about 100Hz.

The potential divider chain consisting of R1, R2, D1 and R3 biases the inverting input of IC1a to about 0·75V, and the inverting input of IC1b to only a few millivolts above the negative supply potential. R4 takes the non-inverting

The circuit is based on two voltage detectors and an audio oscillator. The oscillator drives a loudspeaker which then produces the audio tone and indicates continuity between the test prods. By indicating two degrees of continuity the unit eliminates the misleading results that can be produced by a simple continuity tester.



COMPONENTS

Resistors

R1	10kΩ
R2	100Ω
R3	10Ω
R4	8·2kΩ
R5	47kΩ
R6,7,8	220kΩ (3 off)
R9	100kΩ
R10	5·6kΩ
R11,12	270kΩ (2 off)
R13	470Ω

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See **Shop Talk** page 801

Capacitors

C1	10nF polyester
C2	100µF 10V elect.

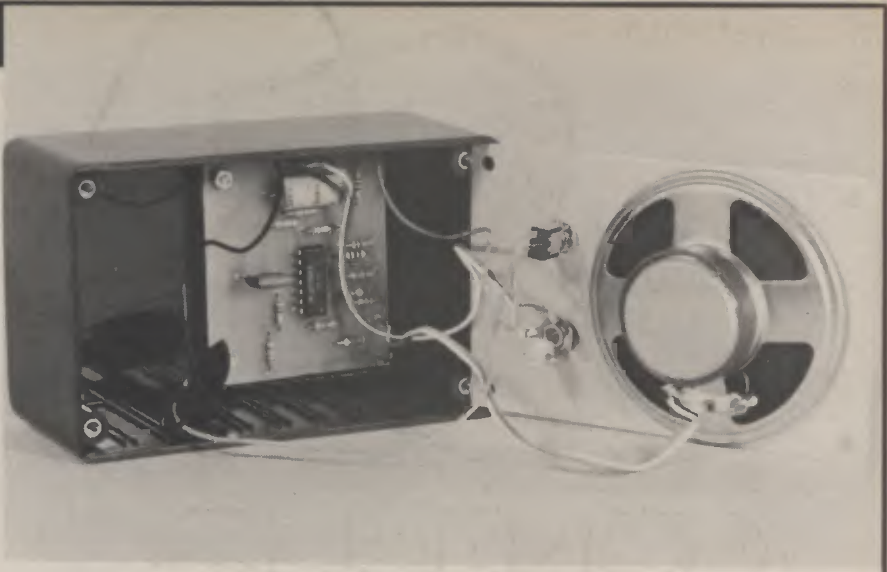
Semiconductors

D1	1N4148 silicon signal diode
IC1	MC3302P quad comparator

Miscellaneous

S1	s.p.s.t. miniature toggle
LS1	miniature, 64Ω, 66mm dia. approx.
B1	9V PP3

Printed circuit board: single-sided size, 64 x 51mm, *EE PCB Service*, Order code 8312-08; case 111 x 71 x 48mm; battery connector; 6BA fixings.



Lid removed showing the inter-wiring details inside the case.

COMPONENTS approximate cost £9.00

inputs of both IC1a and IC1b to virtually the full positive supply voltage, and the output transistors of both devices are switched on with the circuit as it stands. The output transistor of IC1a holds the input of IC1c at little more than the negative supply potential and prevents the oscillator from operating.

If a low enough resistance is connected across the test prods the non-inverting input of IC1a will be pulled down to a lower voltage than the 0·75V bias fed to the inverting input, causing IC1a's output transistor to switch off and the oscillator to operate.

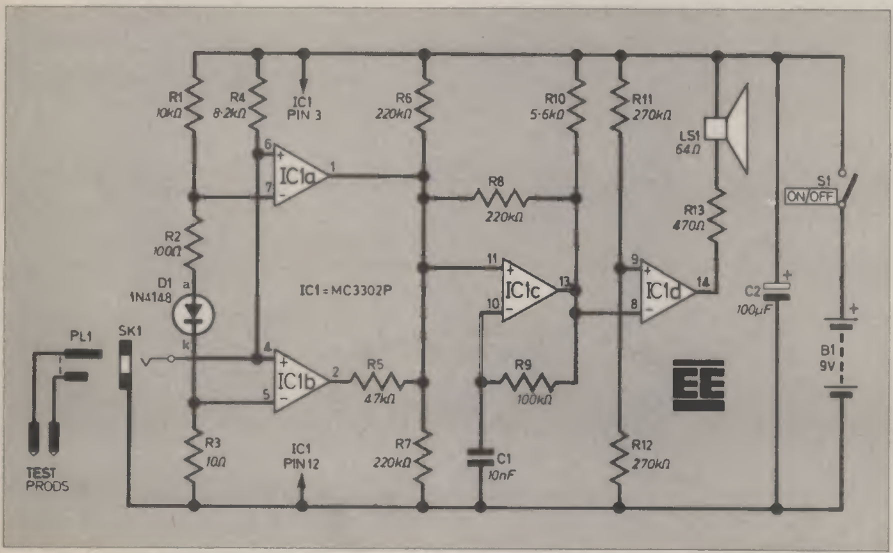
However, the oscillator will not operate normally unless a resistance of about 8 ohms or less is placed across the test prods, so that the input voltage to the non-inverting input of IC1b is taken below the minute bias voltage fed to the inverting input of this comparator. Unless this requirement is met the output transistor of IC1b effectively connects R5 in parallel with R7 so that the operating frequency of the oscillator is boosted to around 300Hz.

Thus the required tri-state indication is obtained with a high resistance giving no oscillation, a very low resistance giving low frequency oscillation, and an intermediate resistance giving a higher frequency tone. IC1c could be used to drive the loudspeaker (LS1), but its output transistor is switched on under stand-by conditions and this would result in a rather high quiescent current consumption.

The loudspeaker is therefore driven via IC1d which is used as an inverter, and this gives a quiescent current drain of only about 3mA, with the current consumption rising to about 10mA when the unit is activated. R13 ensures that the current fed to LS1 does not exceed the maximum permissible output current for comparators in the MC3302P device and this 20mA limit means that the unit does not generate a very loud tone.

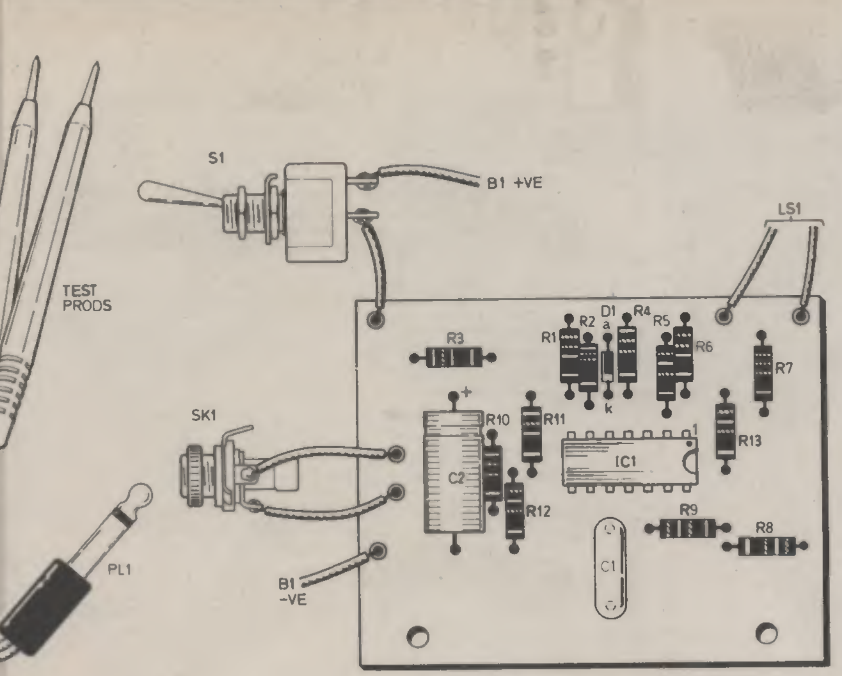
In this application high volume is not necessary and this is not of any practical importance.

Fig. 1. The complete circuit diagram of the Continuity Tester.



CASE

A plastic case having an aluminium front panel and approximate outside dimensions of 111 × 71 × 48mm is suitable for this project, and represents about the smallest case that will comfortably accommodate all the components. A matrix of holes about 3mm to 5mm in diameter are drilled in



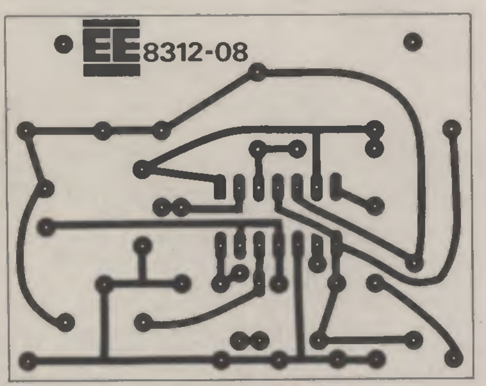
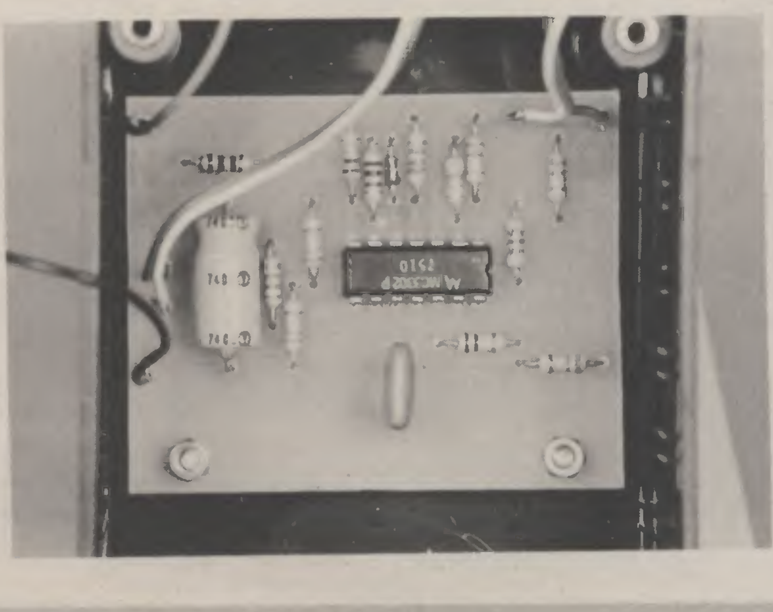


Fig. 2. The printed circuit board master, which is available from the *EE PCB Service*, Order code 8312–08. The component layout and wiring details are shown above.



the left-hand portion of the front panel to produce a speaker grille, and as miniature speakers invariably lack any provision for screw fixing it will be necessary to glue the speaker in place behind the grille using a good quality general purpose adhesive.

The test prods connect to the unit via a 3·5mm jack or any other convenient type of socket. This is mounted on the front panel on the right-hand side, beneath the ON/OFF switch.

PRINTED CIRCUIT BOARD

The components are mounted on a single-sided printed circuit board as shown in Fig. 2 measuring 64 × 51mm. The board is constructed using the usual techniques and this should be perfectly straightforward. The board is available from the *EE PCB Service*, Order code 8312-08.

The completed board is mounted on the rear panel of the case using 6BA fixings and this leaves sufficient space for the battery on the right-hand side of the case. The power source is provided by a 9V PP3 battery and after wiring the battery clip into the circuit and completing the component interwiring, the unit is then ready for testing.

TESTING

When the unit is switched on there should be no tone or other sounds from the speaker, but with the test prods touched firmly together there should be a low frequency tone of reasonable volume. Placing a resistor of between 10 ohms and 470 ohms in value across the test prods should give the higher frequency tone, and the difference in pitch should be large enough to be readily apparent. □

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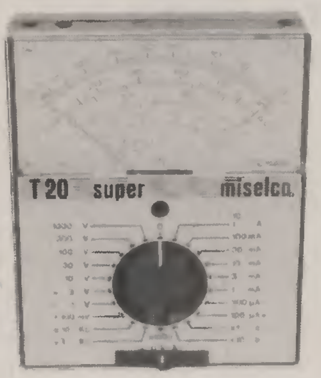

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a.c. V 10V, 30V, 100V, 300V, 1000V.
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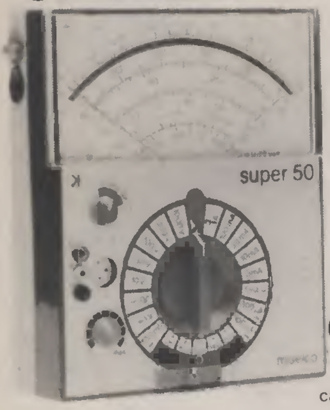

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a.c. V 10V, 30V, 100V, 300V, 1000V;
a.c. I 3mA, 10mA, 30mA, 100mA, 1A, 3A.
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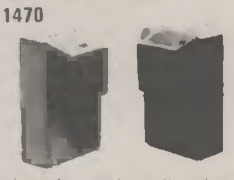

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This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size: 200 × 180 × 70mm

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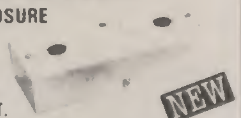
This hardware kit provides the necessary enclosure for a complete self-contained alarm system which comprises the US 5063, PS 1865, loud speaker type 3515 and key switch 3901. Attractively styled, the unit when completed, provides an effective warning system without installation problems. Size: 200 × 180 × 70mm.

ULTRASONIC MODULE ENCLOSURE



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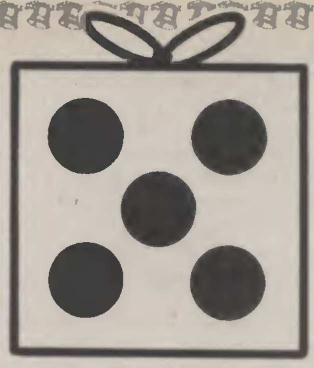


TOUCH OPERATED DIE

BY C.J.BOWES

A NOVEL ELECTRONIC DIE WITH A CHOICE OF EITHER A DOT OR NUMERIC DISPLAY

A LARGE number of games require some sort of random number generator to make decisions as the game proceeds. The most common of these devices is the cubic die which gives a random number between one and six.

There have been a number of designs published detailing how an electronic die can be made. Most use some form of counter which drives a matrix of l.e.d.s in the familiar pattern. The die described in this article is specifically designed to enable the use of two alternative displays, one the standard spot pattern and the other a numeric display using a 7-segment display.

In order to make the die simple to use, and pack away, the design incorporates a touch switch and automatically turns off after a short time.

CIRCUIT DESCRIPTION

The circuit diagrams for the die are shown in Figs. 1, 2 and 3. Fig. 1 shows the main logic circuit, which is common to both designs, whilst Figs. 2 and 3 are alternative display designs, only *one* of which is needed for each die.

The main logic circuit consists of a touch operated system which controls the number generating and display systems. In order to dispense with a mechanical switch, use is made of the fact that skin is a high resistance conductor.

TOUCH SWITCH

The touch switch, which is either laid out on the front panel as a printed circuit track or made up of commercially available pads, is in effect two conductors which can easily be bridged with a finger. One of the pads is connected to the 9V supply and the other is connected, via R1, to the base of TR1, one half of a Darlington pair with TR2.

When the tracks are bridged, a very small current passes through the finger and into the base of the transistor. The current gain of the Darlington pair is extremely high and the minute current is sufficient to make the transistors conduct, causing a current to flow both through them and R2. R1 is included as a precaution to prevent damage to the transistors in the event of a low resistance being inadvertently connected across the touch pads.

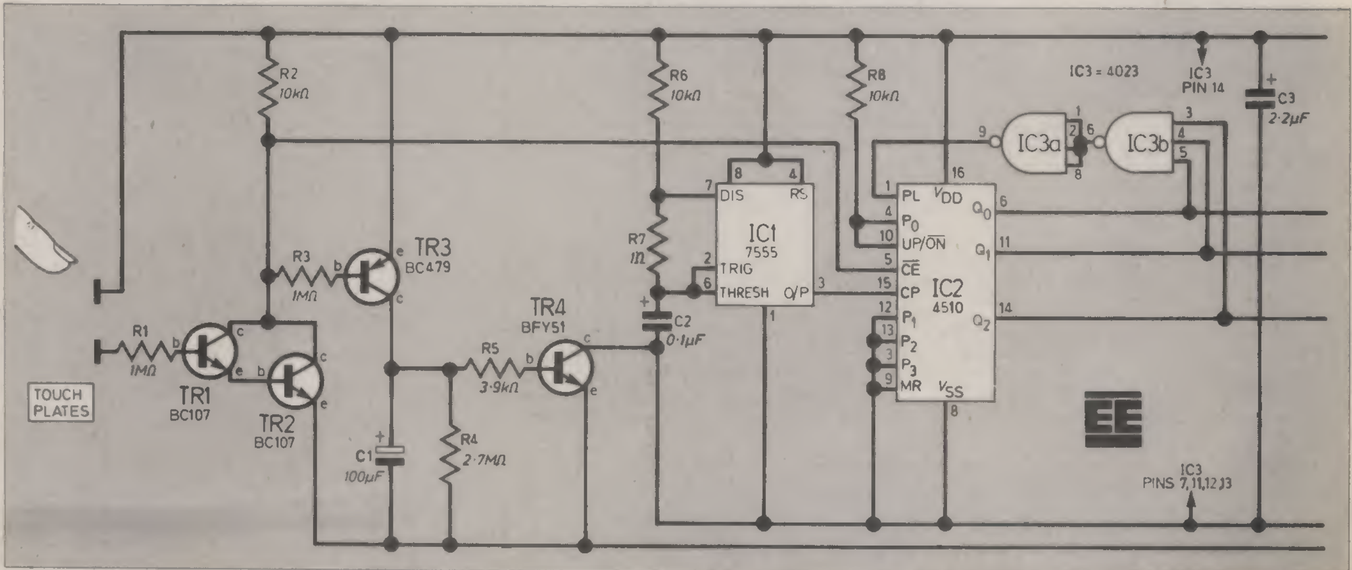
When TR1 and TR2 conduct, a voltage drop occurs across R2. This is used to operate the count enable input of IC2 and also causes a voltage difference between the base and emitter of TR3. This voltage causes TR3 to conduct, allowing C1 to charge up and TR4 to conduct. Which in turn, energises the display and counter circuits.

RANDOM NUMBER GENERATOR

IC1 is a CMOS version of the 555 timer and has been chosen for this design in preference to the standard bipolar 555 which has a rather unpleasant habit of producing spikes on the power supply lines that can upset other devices connected to the same power supply. The CMOS 555 does not suffer from this but operates in exactly the same way as the standard timer.

In the design shown, it is connected as

Fig. 1. Circuit diagram of the control logic section of the Touch Operated Die.



an astable multivibrator with a high frequency output. The output frequency is in fact set by the values of R6, R7 and C2, and is about 700Hz. The output from the timer is connected to the CP (clock pulse) input of IC2, which is a CMOS 4510 programmable up/down counter. This device is used because it has the ability to be reset to any number from 0 to 9, set on the P_0 to P_3 inputs, by a logic 1 signal to the PL (parallel load) input.

Whilst the touch pads are bridged, the input to the CE pin of IC2 is held at logic 0. This allows the output pulses from IC1 to be clocked through IC2. Pin 10 of IC2 is held at logic 1 by being connected to the 9V line via R8 causing the counter to count up. The outputs Q_0 to Q_2 are connected to the display and cause it to change so rapidly that the actual value shown is not apparent.

The outputs are also connected to IC3 which is a triple 3-input NAND gate configured so as to reset the counter by producing a logic 1 state at the PL input every time the count reaches 7. When the PL input goes to logic 1 the counter is set to the value set on the P_0 to P_3 inputs. P_0 is held at logic 1 and the other inputs are held at logic 0, so the counter is reset to 1 every time the outputs Q_0 to Q_2 are all at logic 1. This causes the counter to cycle through the numbers from one to six for as long as the touch pads are bridged.

When the user's finger is removed from the touch pads, TR1 and TR2 no longer conduct and the CE input to IC2 is pulled up to logic 1 by R2. This causes the counter gate to be disabled and the count to stop at the value it reached immediately before the finger was removed. The b.c.d. (binary coded decimal) value of this number is present on the output lines and is decoded and displayed on the chosen display system.

As soon as TR1 and TR2 stop conducting, TR3 also ceases to conduct and C1 starts to discharge through R4, but as it is also connected to the base of TR4 through R5, this causes TR4 to continue conducting for a time dependent on the values of C1, R4 and the base current of TR4.

As long as the base-emitter voltage of TR4 exceeds about 0·7V, it conducts. This enables the counter and display circuitry to remain operative for a short period after the touch pads are released. When TR4's base-emitter voltage falls below the turn on voltage, the transistor turns off and the display fades and eventually, is switched off.

DOT DISPLAY

To operate the die display it is necessary to decode the outputs from the counter to illuminate the required number of l.e.d.s which are arranged as shown in Fig. 2. Decoding of the b.c.d. information is accomplished by the use of two 2-input NAND gates and two diodes.

The standard packaging of the 2-input NAND gates in the CMOS 4011 i.c. provides four gates in one package. Advantage has been taken of this to use two of these gates as a buffer, thereby reducing the load on the outputs of the counter. The truth table for the display is shown in the table below.

No.	IC2 outputs			l.e.d. groups			
	Q_2	Q_1	Q_0	D6	D5,D7	D3,D9	D4,D8
1	0	0	1	on	off	off	off
2	0	1	0	off	on	off	off
3	0	1	1	on	on	off	off
4	1	0	0	off	on	on	off
5	1	0	1	on	on	on	off
6	1	1	0	off	on	on	on

The single l.e.d. (D6) mounted at the centre of the display is required to be on for the odd numbers (1, 3 and 5). Inspection of the truth table shows that this coincides with the presence of a logic 1 level on output Q_0. This l.e.d. can therefore be wired, through resistor R9 directly to the Q_0 output. The remaining l.e.d.s are operated as pairs in series.

When the truth table is consulted, it can be seen that l.e.d.s D3 and D9 are on only when output Q_2 is at logic 1. This pair could be connected via a suitable resistor directly to this output but as Q_2 is also used to drive other l.e.d.s they are in fact wired through the two spare gates, which are each wired as inverters. These buffer the output and reduce the load on it.

The two l.e.d.s D5 and D7 are required to be on when either output Q_1 or Q_2 are at logic 1. This could be achieved by using an OR gate but is more easily done by using the simple matrix of D1 and D2 as shown. The final pair of l.e.d.s (D4 and D8) are required to be illuminated only when both Q_1 and Q_2 are at logic 1. This is in fact the AND function which has been obtained by using a NAND gate followed by another NAND gate wired as an inverter.

The circuit diagram for the die display is shown in Fig. 2. The only component not mentioned in this description is C4 which is merely a decoupling capacitor which should be mounted as close as possible to IC5.

NUMERIC DISPLAY

The alternative display to the traditional spot pattern is to use a 7-segment display as shown in Fig. 3. This circuit is conventional and uses CMOS 4543 decoder/driver i.c. This device enables either a common anode (as used on the prototype) or a common cathode display.

If a common cathode display is used, the p.c.b. must be modified to provide the correct connections to the display and pin 6 of IC5 must be connected to the 0V line instead of the 9V line. C5 is included as a decoupling capacitor and should be mounted as close as possible to IC5.

Fig. 2. Circuit diagram of the dot matrix display.

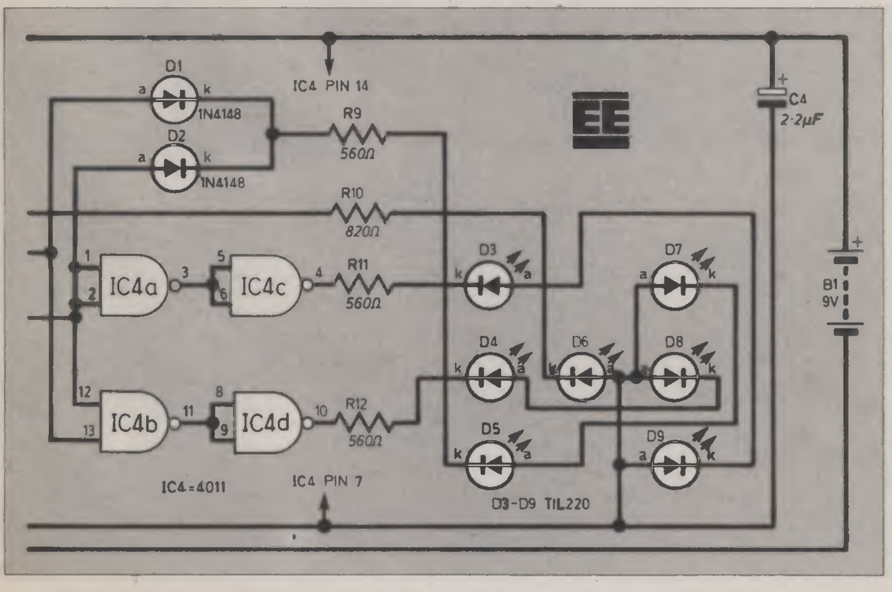
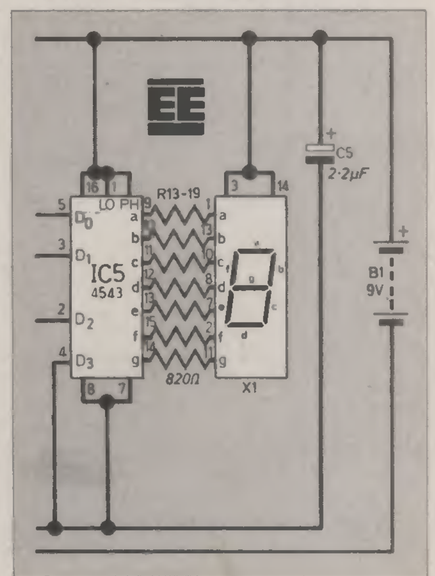


Fig. 3. The 7-segment display circuit.



CONSTRUCTION

LOGIC BOARD

The unit has been designed to fit inside the specified case, size 85 × 56 × 35mm. Other cases can be used but care should be taken to ensure that the p.c.b.s will fit. The components for the main logic circuit are mounted onto the p.c.b. as shown in Fig. 4, and the full size track layout is also shown. This can be made using conventional techniques or ordered from the *EE PCB Service*. Care should be taken wherever the tracks are closely packed or pass between the pins of the i.c.s. When the board has been etched and drilled it should be closely inspected for broken or short circuited tracks.

The components can then be mounted as shown starting with the smallest components. C1 must be left until last as it is mounted above the adjacent resistors with its leads passing between R3 and R4. Care must also be taken to ensure correct polarity of the capacitors.

The components are very closely packed on this board and it should be thoroughly inspected before attaching the battery or installing the i.c.s.

DISPLAY BOARDS

The track design for dot display board is given in Fig. 5. It is important that the cut-out in the corner, which enables the face plate mounting screw to be fitted, is made before attempting to fit any of the components. Care must be taken to ensure the correct polarity of *all* the components as incorrect orientation will produce a strange display and some extremely interesting problems in fault diagnosis!

The display board is mounted directly under the face plate and, in order to reduce the space required, IC4 is soldered directly onto the p.c.b. and not fitted into a socket. This operation should be done with care, taking precautions to avoid the risk of static electricity destroying the device. In practice, this should not present any problems providing that a buffered type of 4011 is used.

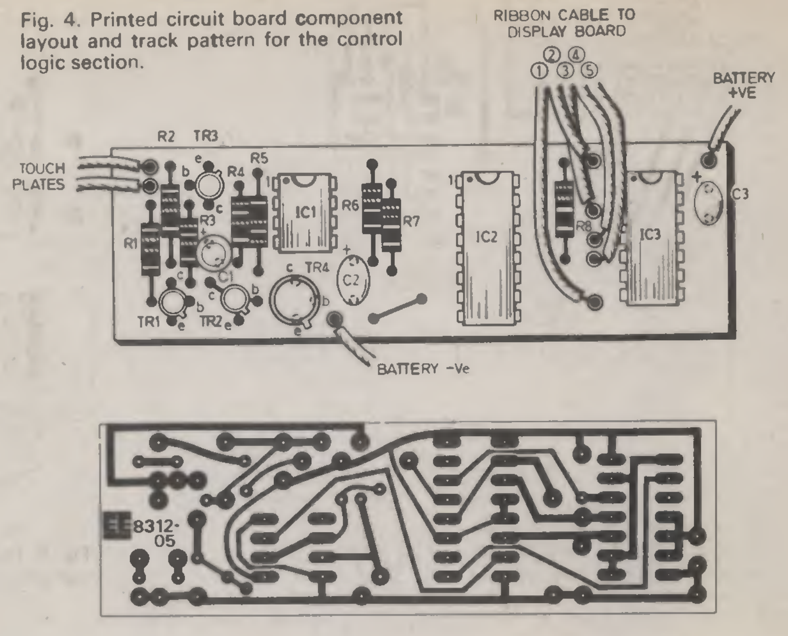
When making this board care should be taken to ensure that the resistors do not foul the holes used for mounting the board to the face plate.

7-SEGMENT DISPLAY

The 7-segment display board is constructed using the track diagram shown in Fig. 6. As with the dot display, the driver/decoder, IC5, is soldered directly to the p.c.b. and the same precautions as detailed earlier should be taken to avoid damage.

In common with the other display board, there should be no major problems but the cut-outs should be made before mounting any of the components.

Fig. 4. Printed circuit board component layout and track pattern for the control logic section.



COMPONENTS

CONTROL LOGIC

See Shop Talk page 801

Resistors

R1,3	1MΩ (2 off)
R2,6,8	10kΩ (3 off)
R4	2·7MΩ
R5	3·9kΩ
R7	1Ω

All ¼W carbon film ±5%

Capacitors

C1	100μF 10V miniature elect.
C2	0·1μF 10V tantalum bead
C3	2·2μF 10V tantalum bead

Semiconductors

TR1,2	BC107 *npn* silicon (2 off)
TR3	BC479 *pnp* silicon
TR4	BFY51 *npn* silicon
IC1	7555 CMOS timer
IC2	4510B CMOS presettable up/down counter
IC3	4023B CMOS triple 3-input NAND gate

Miscellaneous

Printed circuit board: single-sided, size 80 × 20mm, *EE PCB Service*, Order code 8312-05; moulded plastic case with internal guide slots and aluminium lid size 85 × 56 × 35mm; material for face plate size 85 × 56mm (see text); touch pads; 16-pin d.i.l. holder; 14-pin d.i.l. holder; 8-pin d.i.l. holder; battery clip; self-tapping screws; 6BA screws and nuts; ribbon cable (7-way × 150mm).

DOT MATRIX DISPLAY

Resistors

R9,11,12	560Ω (3 off)
R10	820Ω

Capacitor

C4	2·2μF 10V tantalum bead

Semiconductors

D1,2	1N4148 silicon (2 off)
D3–9	TIL220 0·2in red l.e.d. (7 off)
IC4	4011B CMOS quad 2-input NAND gate

Miscellaneous

B1	9V PP3

Printed circuit board: single-sided, size 55 × 35mm, *EE PCB Service*, Order code 8312-06.

7-SEGMENT DISPLAY

Resistors

R13–19	820Ω (7 off)

Capacitor

C5	2·2μF 10V tantalum bead

Semiconductor

X1	0·3in common anode 7-segment display
IC5	4543B CMOS b.c.d. to 7-segment decoder

Miscellaneous

B1	9V PP3

Printed circuit board: single-sided, size 73 × 32mm, *EE PCB Service*, Order code 8312-07.

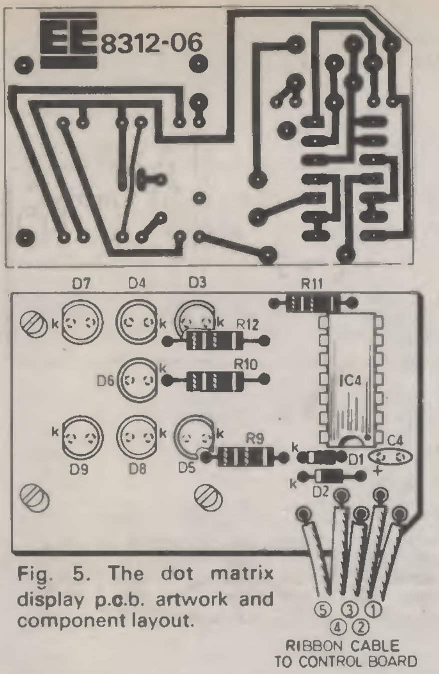


Fig. 5. The dot matrix display p.c.b. artwork and component layout.

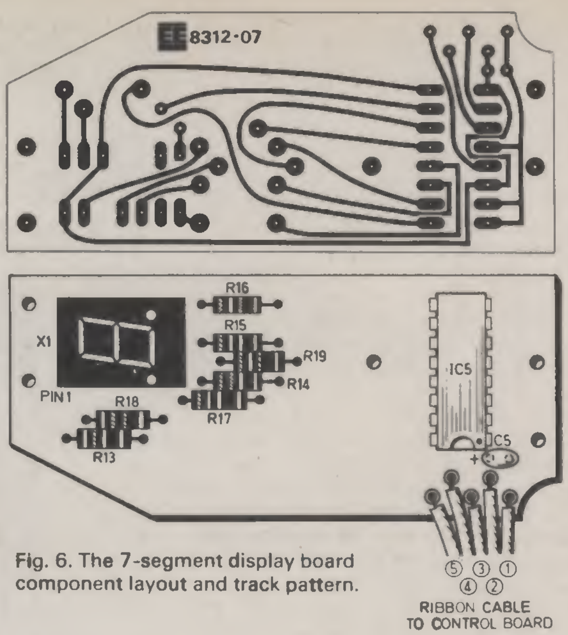


Fig. 6. The 7-segment display board component layout and track pattern.

TESTING

After both the main logic board and the display board have been constructed and checked, they should be connected together and tested. It is advisable to use ribbon cable to join the main board and display board together since this will reduce the problems of the "spaghetti" like tangle that would otherwise result every time the die is opened.

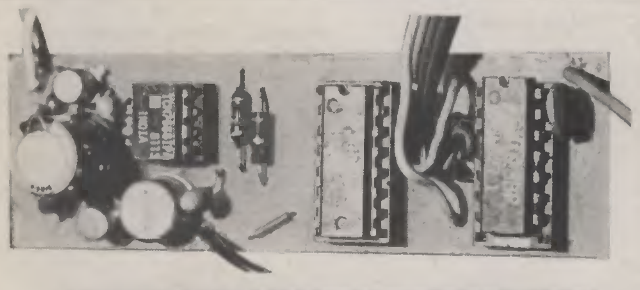
To check the boards for correct operation, the battery should be carefully inserted into its clips without either of the p.c.b.s being touched. If all is well, there should be no sign of life on the display. The touch pads should then be touched with the finger so that a current flows to the base of TR1.

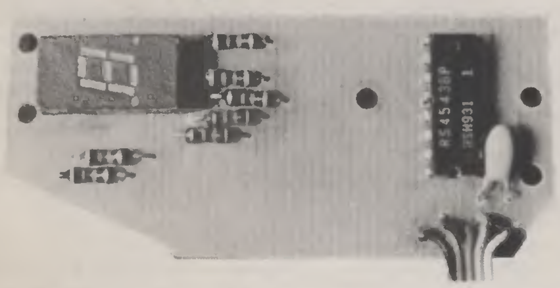
The display should immediately light, showing either the figure "eight" on the numeric display or all seven dots on the matrix display. In the latter case, l.e.d.s D4 and D8 will appear to be at low brightness. This is perfectly normal and results from the fact that as the device cycles rapidly through the numbers from one to six, these diodes are only lit for one-sixth of the cycle period.

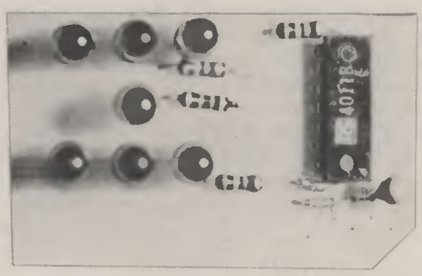
When the contact to the touch pads is released, the display should stop cycling and show a number between one and six for a short while before fading away. The test should be repeated several times in order to check that the die is not "loaded".

If it is suspected that the die does not give a random result but is biased to a particular number or set of numbers, then the operation of the number generator can be checked by temporarily connecting a 100µF capacitor across C1 and letting the die pulse slowly through the sequence from one to six. The first few numbers displayed may be random or out of the required range but after a maximum of four changes, the die should reset and start to go through the repetitive sequence from one to six.

If the time for which the die remains illuminated after the touch pads are released is incorrect, this can be adjusted by altering the value of C1. Increasing the value increases the delay time and reducing it will reduce the delay time.







COMPONENTS approximate cost £10

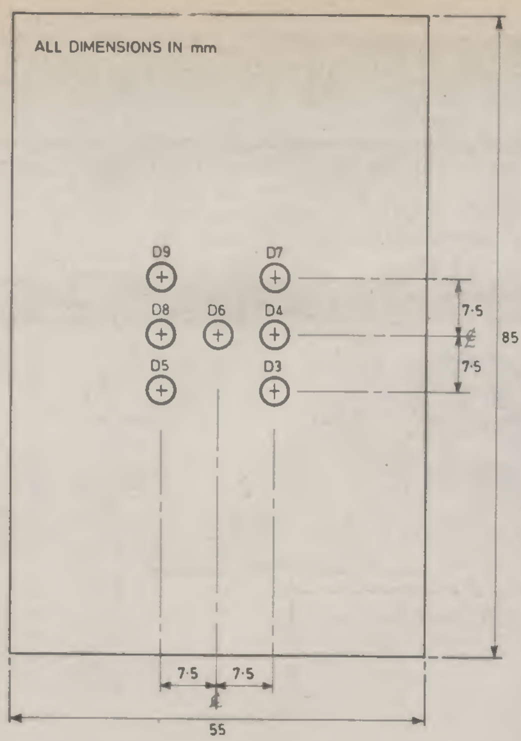


Fig. 7. The face plate drilling details. The mounting holes are positioned using the p.c.b. as a template.

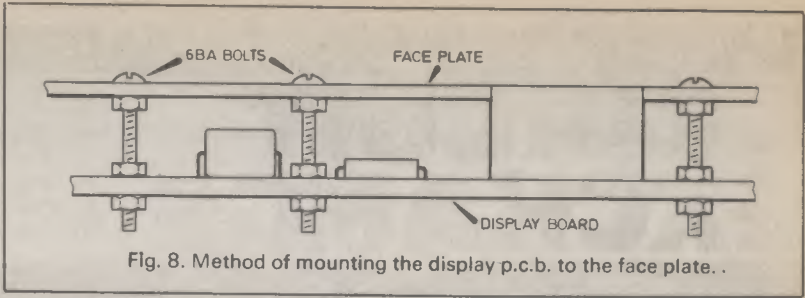
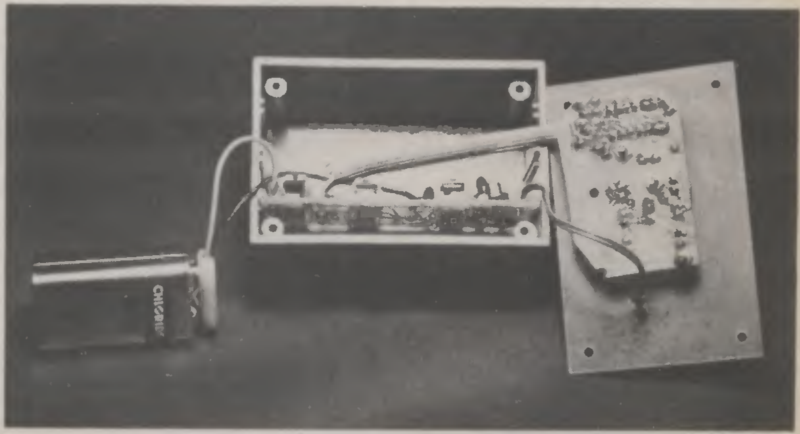


Fig. 8. Method of mounting the display p.c.b. to the face plate. .



The prototype Touch Operated Die with face plate removed to show the assembly using the dot matrix display board.

FACE PLATE

The face plate of the unit must be made of an insulating material and not the aluminium panel supplied with the case. If it is desired to make the touch plates as printed circuit tracks, this can be done by the same method as that used for making p.c.b.s. Alternatively, commercially available touch pads can be screwed through suitable material. In each case, it is important to ensure that the pads are placed at least 2mm apart and are not fouled by the display or mounting screws.

It is important to note that the face plate fits on top of the case and is not inset into the recess in the case, as is the aluminium plate supplied. The face plate must be cut to the same size as the outside of the case and appropriate mounting holes drilled through it to line up with the pillars moulded into the inside of the case.

The appropriate display board is fixed to the underside of the display panel so that the l.e.d.s protrude through the face plate or the 7-segment display fits flush into a cut-out in the face plate.

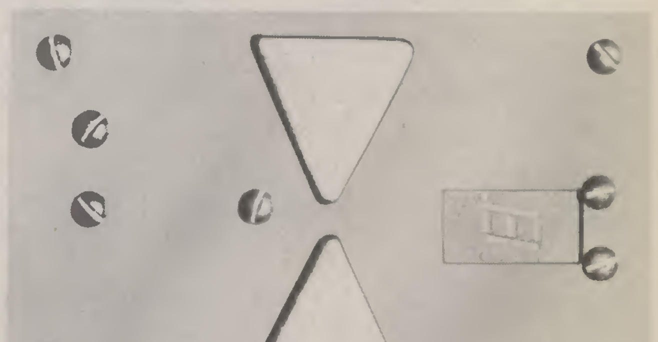
The mounting holes are then marked and drilled ready for mounting the board as shown in Fig. 7. If the 7-segment display is used, the shape should be marked out on the face plate and then carefully drilled and filed out until a good fit is obtained. The positions of the mounting holes can then be determined.

With both types of display, it is important that a dry run is conducted with the boards to ensure that they will fit into the case, leaving room for the battery, in the marked positions before committing the face plate to the attention of the cutting tools.

The face plate and display board are fixed together by using three screws, each fitted with three nuts, as shown in Fig. 8. After the holes have been drilled, the boards should be given a final check before being assembled. The control logic p.c.b. should then be fitted into place in the grooves moulded in the main case. The battery is then connected and placed in the case and the face plate fixed to the case using longer self-tapping screws than those supplied with the case. □

Face plate of the dot matrix display version made from a piece of p.c.b. material with two tracks forming the touch switch.

Face plate of the 7-segment numeric display die with the touch switch made from commercially available touch plates.



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.

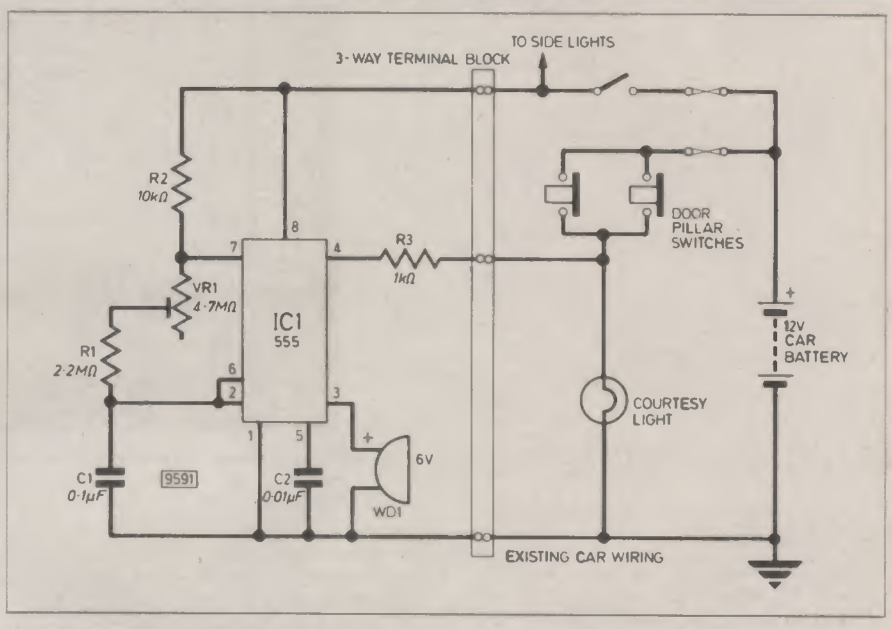
CAR LIGHTS ALARM

MY CAR is a Ford Falcon with a negative earth and as such I thought your *Car Lights Alert* (October 1982) circuit would work. The main trouble I found was with the courtesy lights. As I considered the circuit and logic behind the circuit too good not to use, I re-designed the circuit still using the same logic. I feel other readers may have had the same trouble as myself so I am offering the circuit I "designed" for my car's existing wiring.

The pillar switches are positioned between the lamp and positive. I have taken out the transistor and used the circuit, so that with the switches open, the reset of IC1 (pin 4) is held low through the lamp filament.

E. Westerman, Victoria, Australia.

Editorial note: This circuit will not work with cars having earthed door pillar switches.



TRAFFIC LIGHT SIMULATOR

THIS circuit simulates the sequence of lights at a typical cross-roads. The circuit is based upon a 16-bit counter which provides the inputs to the combinational logic gates.

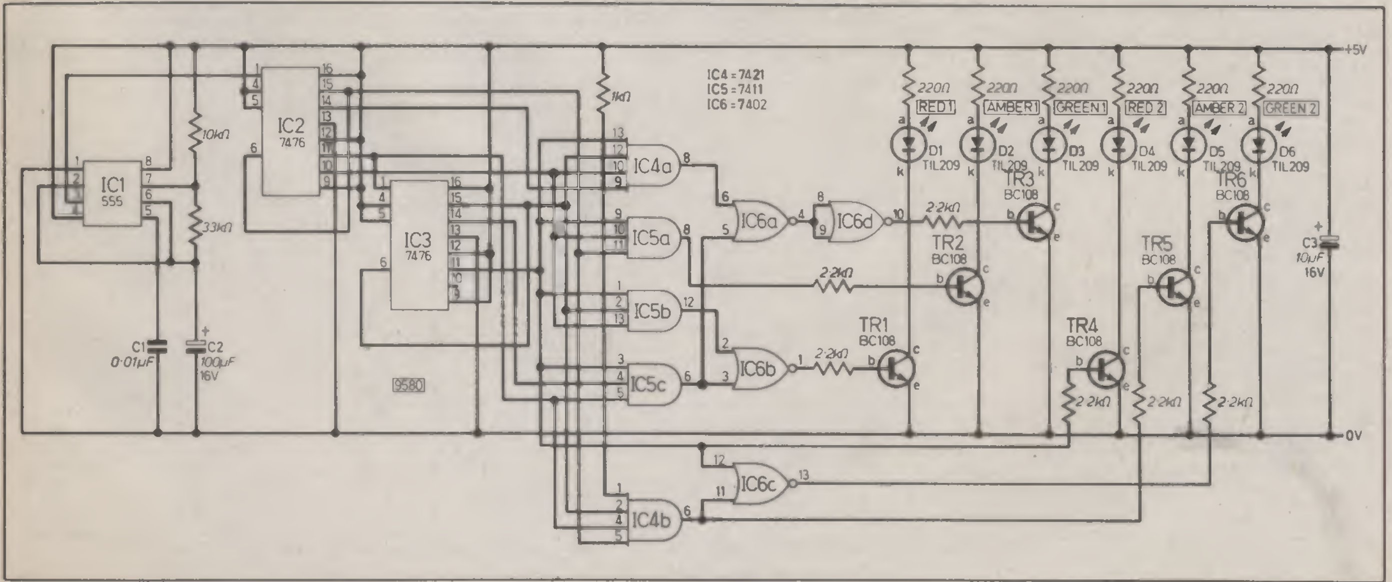
The clock for the 16-bit counter is derived from a 555 timer which is connected as an astable multivibrator. The components around the 555 are chosen so that its period of oscillation is approximately five seconds, meaning that the lights change at a realistic rate.

The 16-bit counter is based on four JK flip-flops connected in such a way that each divides the clock frequency by two.

The outputs of the 16-bit counter are used for the inputs for the logic gates which have been arranged to generate the necessary sequence of lights.

Since the logic gates are required to drive l.e.d.s, each output needs buffering. All six buffer stages are identical, except of course for the colour of the l.e.d. used. Any l.e.d. can be used but for realism it is best to use red, orange and green.

W. Barlow, Basildon, Essex.



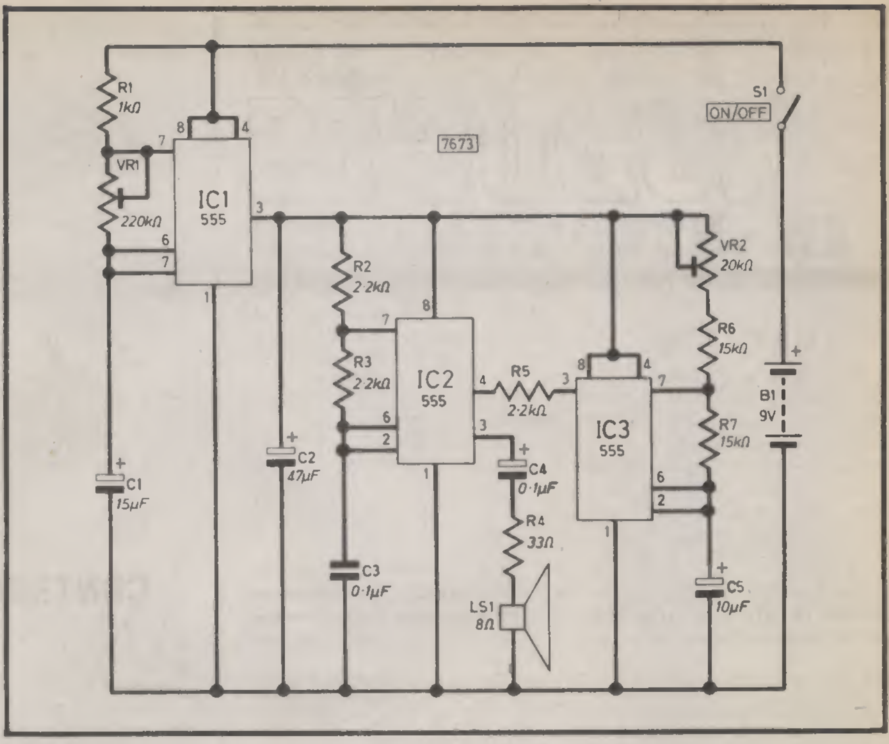
CIRCUIT EXCHANGE

TELEPHONE RING SIMULATOR

The two close-rings of a phone are provided by IC2 being switched on and off by IC3. The longish space between the two short close-rings is provided by IC1. VR1 adjusts the period between the ring-ring . . . . ring-ring, that is the long space. VR2 adjusts the space between one ring and the next, that is ring . . VR2 . . ring . . VR1 . . ring . . VR2 . . ring. The tone from IC2 is not 25Hz like a telephone bell, it is nearer perhaps 2kHz.

If a 25Hz tone is required, increase value of C3 (use an electrolytic). Note the telephone ring simulator is designed to *ring* like a phone, not *sound* like it but ring in the manner of a phone.

Brian S. Craigie,
Edinburgh,
Scotland.



FIRE ALARM—ELECTRONIC TEMPERATURE CONTROLLER

TRANSISTORS TR1 and TR2 are the master comparator pair with TR2 base, maintained at around 5·6V by the Zener, D2. Transistor TR3 regulates the current and thence the base voltage of TR2 in relation to the common emitter voltage which is also TR3 base drive.

Unlike many comparator switching circuits, my circuit latches permanently on (for example, the l.e.d. glows) once activated. In my experiment a thermistor with a rating of 30 kilohms at around 70°F was used to form a voltage divider with a 1 kilohm and 10 kilohm potentiometer in series. In practice, about 6·5V is required to trigger TR1 on, slightly raising the common emitter voltage and cutting transistor TR2 off. TR2 collector voltage rises, D3, R7 and C3 detect this rise and activate transistor TR4, thus lighting the l.e.d. D4 (setting off the alarm).

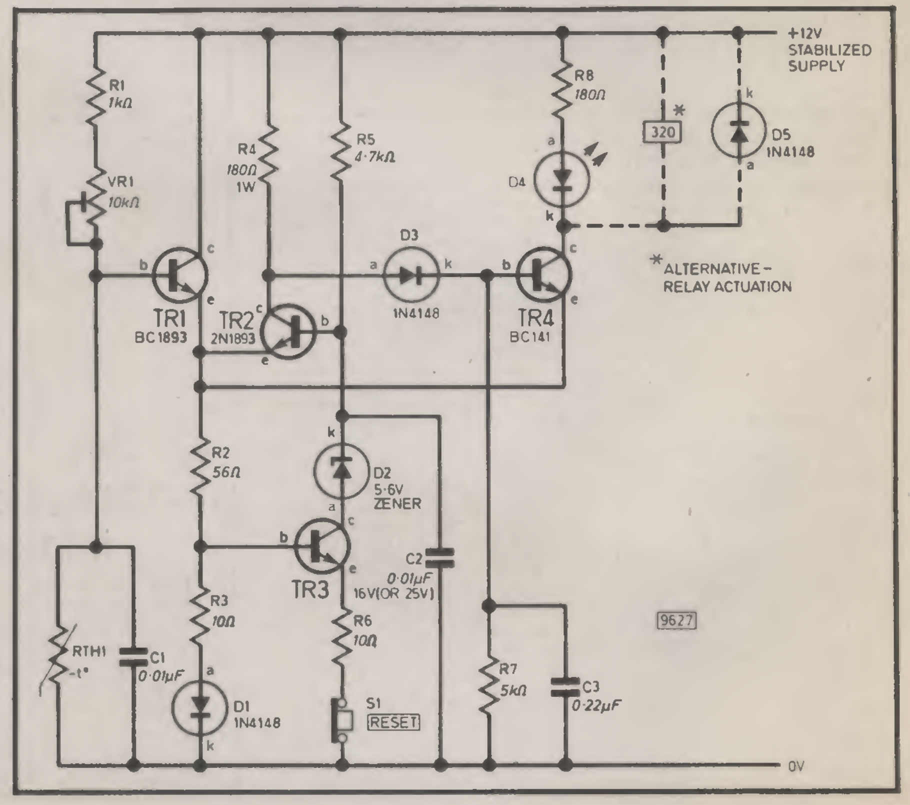
Of course, a miniature relay can take the place of the glowing l.e.d. for control applications—for instance, to switch a device on or off when a set temperature is reached. Once latched on, TR4 will continue to conduct unless reset switch S1 is depressed to open transistor TR2 base connections to 0V. The circuit is then ready to begin a new cycle.

Capacitors C1 and C2 are stabilising capacitors. Diode D1 maintains the conductive sensitivity of TR3 and thence TR2. Potentiometer VR1 is provided to set the limiting temperature which could go higher than the 70°F for this project.

The thermistor is the temperature detector and should be mounted on the object which is the temperature source, the other parts of the circuit could be placed remote from the same source. Applications are very wide, it would include the switching off of appliances such as water heaters or kettles, when the limiting temperature is reached. Besides alarm, the same circuit could be used in industrial automation and many other critical services.

I have suggested and actually used ½ watt resistors, except R4 which is 1 watt, for my experimental circuit.

Toh Eng Kiong,
Singapore.



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

FUNCTION GENERATOR

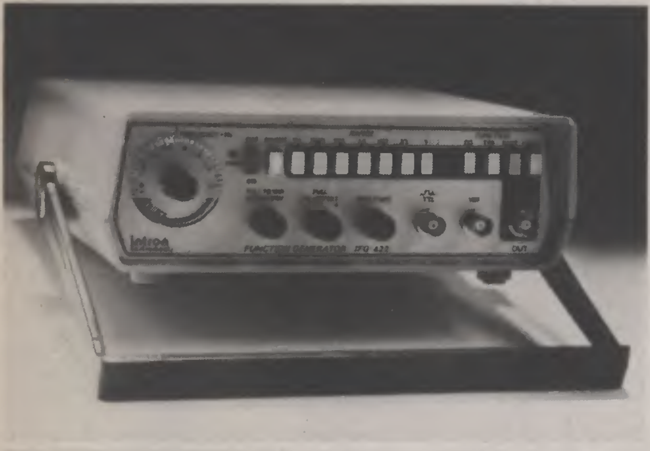
A VERSATILE function generator providing sine, square, triangle, ramp and pulse waveforms over the frequency range 0·1Hz to 2MHz in seven decade ranges has just been marketed by **House of Instruments.**

Output is continuously variable to 20V p—p from and into 50 ohms, with switchable d.c. offset available to +10V. A variable duty cycle and symmetry control enables adjustment of main, square and TTL outputs.

Other facilities include: external sweep over a 1000:1 frequency range; polarity invert and sync output.

The IFG422 Function Generator is guaranteed for one year and costs £195, excluding VAT and carriage.

House of Instruments,
Dept EE, Clifton Chambers,
62 High Street, Saffron Walden,
Essex CB10 1EE.



EPROM ERASERS

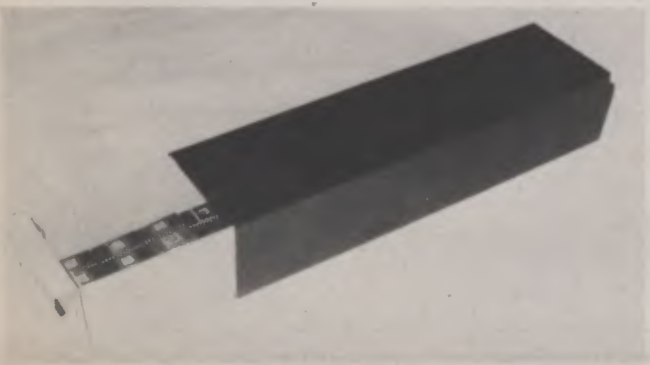
THREE new low-cost EPROM Erasers have been specifically designed by **J. P. Designs,** for use in the laboratory, classroom and by the hobbyist. All three versions use the same simple drawer construction which allows easy access.

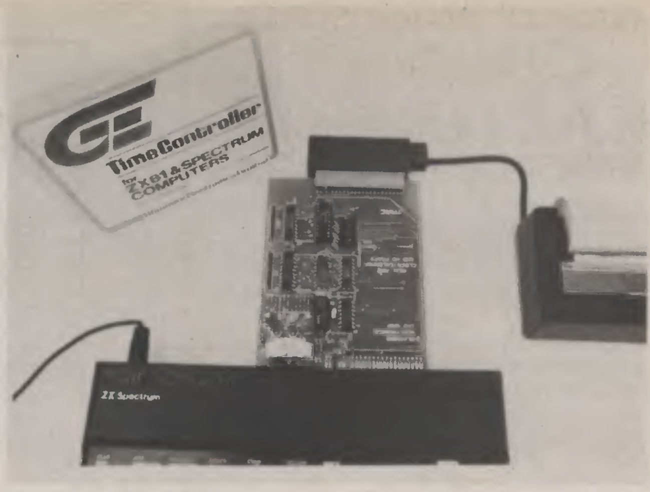
The drawer section, with antistatic foam, holds either 20 EPROMS (Model 82) or 40 EPROMS (models 84 and 84T).

A timer version, model 84T, is available to preset exposure times and safeguard against "cooking" EPROMS. The timer gives intervals of 10 and 30 minutes. An l.e.d. shows when the unit is erasing.

The price for the basic unit, Model 82, is £31.25; Model 84, £44.95; and Model 84T, with timer, £54.95.

J. P. Designs,
Dept EE, Oyster Row,
Cambridge CB5 8LJ.





TIME CONTROLLER

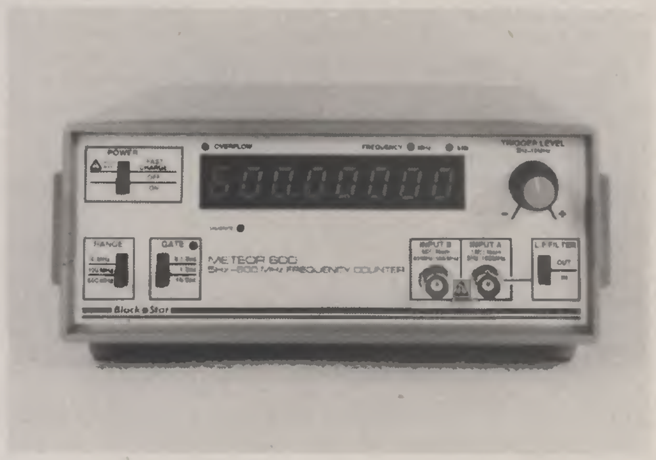
A TIME CONTROLLER for the ZX81 and Spectrum computers is now being marketed by **Glanmire Electronics.**

The timer consists of a battery back-up real time clock with eight programmable inputs and eight programmable outputs. It provides the computer with the month, day, date, hours, minutes and seconds.

The controller has its own built-in program, in PROM memory. Only a single instruction in the users program is required to read or write the time or date.

Applications include: diary with alarm; home control; burglar alarm; sound effects; games and process control. The recommended retail prices for the **Time Controller** for **ZX81** and **Spectrum** are £34.50 and £38.50 respectively.

Glanmire Electronics Ltd.,
Dept EE, Westley House,
Trinity Avenue, Bush Hill Park,
Enfield EN1 1PH.



DIGITAL FREQUENCY METER

THE launch of a new range of professional quality low-cost test instruments designed and manufactured in the UK is announced by **Black Star.**

The first products to be released come under the Meteor series and consist of three Digital Frequency Counters with a measurement range up to 100MHz, 600MHz and 1GHz.

The Meteor 600 is the first meter available and has a typical frequency range of 2Hz to 700MHz; sensitivity of about 25mV at 600MHz and resolution down to 0·1Hz. The counter also features eight ½in l.e.d. displays, three gate times, two inputs, trigger level control and an integral low-pass filter.

Black Star Ltd.,
Dept EE, 9A Crown Street,
St. Ives, Huntingdon,
Cambs PE17 4EB.

EVERYDAY ELECTRONICS and computer PROJECTS

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329–400	June	781–852	December

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

SPECIAL INSERTS AND OFFERS

NEW ITEMS FROM OUR BARGAIN LIST

Screwits enable wires to be quickly joined and insulated in one simple operation without screwdriver or pliers. Ideal for hooking up experimental circuits but quite safe to use inside metal or plastic boxes for joining mains wiring. Sample pack, 5 large, 5 small . . . £0.57

2Kw immersion heater — 10" long standard mounting . . . £2.30; 10 for £17.25

Clockwork timer — basically a 2 hr timer, very easily adaptable to 1 hr or ½ hr. Approx 2" diameter. 2 screw mounting ¼" spindle . . . £2.30; 10 for £17.25

BC to 2 Twin Adaptors for operating Christmas tree lights etc from a lamp holder . . . £0.75; 10 for £5.00

Multimeter Stand — a neat plastic adjustable holder. Ideal for pocket sized multimeter calculator etc. Makes it so much easier to read and at the same time protecting the instrument from being damaged . . . £0.69

PP3 Replacer Kit comprising plastic case transformer, rectifiers, condensors, and wiring diagram . . . £1.95

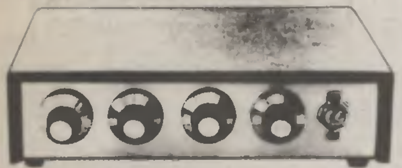
Fixing staples — always useful to have a few of these around the house. Consist of hardened pin on plastic piece shaped to take cable. Various sizes to suit wires from speaker wires, to ring main cable 100 assorted . . . £1.15

Trigger Mats — a simple and sure way of setting off a burglar alarm. Place this under the carpet at windows or doorways, directly it is walked on it will switch on the alarm. Ideal for use with our burglar alarm panel. Size 24"x18" . . . £2.30

Wall Mounting Thermostat by Danfoss has a really pretty 2 tone grey case with circular white scale and dial. Setting temperature from 0-30c 13 amp 250v contacts . . . £4.95

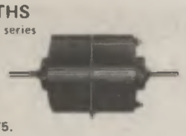
Thermo Couple Prod — when used with a suitable milli-volt meter this could be used to find the centre temperatures of say, meat or liquids . . . £3.45

3 CHANNEL SOUND TO LIGHT KIT



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.

12 volt MOTOR BY SMITHS



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

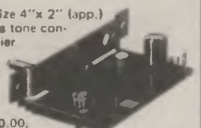
EXTRA POWERFUL 12v MOTOR

Probably develops up to ¼ h.p. so it could be used to power a go-kart or to drive a compressor, etc. £7.95 + £1.50 post.

THERMOSTAT ASSORTMENT

10 different thermostats, 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 — 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 -- however, you can have the parcel for £2.50.

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



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

— BARGAIN OF THE YEAR —

The AMSTRAD Stereo Tuner.

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

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

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

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

THIS MONTH'S SNIP

12v DRILL WITH CHUCK to take up to 2.5mm drills — miniature but very powerful. Ideal model for p.c.b. work. Wonderful present for dad or son. Only £8.50.

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

FOR SOMEONE SPECIAL

Why not make your greeting card play a tune? It could play 'Happy Birthday', 'Merry Christmas', 'Wedding March', etc, or 'Home Sweet Home', etc. Wafer thin 3 part assemblies, for making cards musical. Mini microchip speaker and battery with switch that operates as the card is opened. Please state tune when ordering. Complete, ready to work £1.25.

REEL TO REEL TAPE DECKS

Ex-Language Teaching School. Second, but we understand these are in good order; any not so would be exchanged. The deck is a standard BSR with normal record, replay facilities and an additional feature is tape rev counter. Nicely finished in teak type box. We have 30 only of these. Price £8.50 each + £3 carriage.

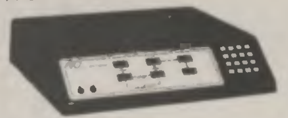
MAINS CLOCK SWITCH

Bold, easy to read clock with coupling to operate 25a switch. Made for cookers but if you throw away the switch section you can have a very neat and accurate clock at a fraction of today's cost. We are overstocked with these and are making a special offer price of 10 for £6.50 + £2 post. Or 100 for £50 carriage paid.

6v POWER SUPPLY UNIT

Mains operated fully smoothed 6v 200 ma output. Enclosed in neat plastic case only £1.15 each, but we are offering these at such a silly price because they are intended to plug into shaver sockets but it is a simple matter to remove the pins and solder on a flex lead. The 6v output termination is a 3.5 jack plug, thus making it suitable for many cassettes and radios.

A PRESTEL UNIT, brand new and complete except for 7 plug in ICs — so far as we know the unit would work once the missing ICs are fitted. Price: £19.75 + £2.00 post.



WATERPROOF HEATING WIRE

100 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with pvc. Dozens of uses — around water pipes, under grow boxes, in gloves and socks. Price: 23p per metre.

TIME SWITCH BARGAIN

Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs FOR ONLY £2.50.

ROPE LIGHT

4 sets of coloured lamps in translucent plastic tube arranged to give the appearance of a running or travelling light. With variable speed control box, ideal for disco or shop window display. Complete, made up, ready to plug into mains. £36.00 + £2 post.

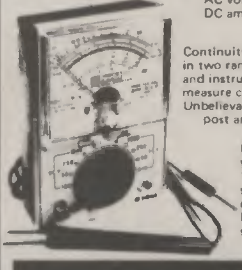
50 THINGS YOU CAN MAKE

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

YOURS FOR ONLY £11.50 plus £3.00 post.

MINI-MULTI TESTER

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



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

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

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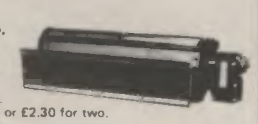
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER



by British Solartron, as used in best blow heaters. 2Kw approx 9" wide £5.95. 3Kw either 9" or 12" wide (your choice) £6.95 complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection dig. Please add post £1.50 for 1 or £2.30 for two.

2.5 Kw KIT Still available: £4.95 + £1.50 post.

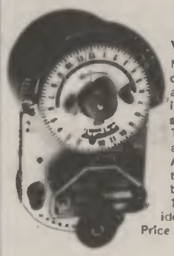
BLEEP TONE These work off 12v and have an unusual and pleasant bleep. 69p each.

CONNECTING WIRE PACK 48 lengths of connecting wire, each 1 metre long and differently colour coded, a must for those difficult interconnecting jobs. 85p the lot.

GPO PLUG & SOCKET Ideal for connecting extension telephone, Prestel and similar equipment. Socket fits onto skirting. £3.45 per pair.

RED LEDS 10 for 69p. 100 for £5.75. 1000 for £52.

IN LINE SIMMERSTAT Ideal heat controller for soldering iron and many other hand-held appliances. £2.30. 10 for £17.25.



VENNER TIME SWITCH

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

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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.

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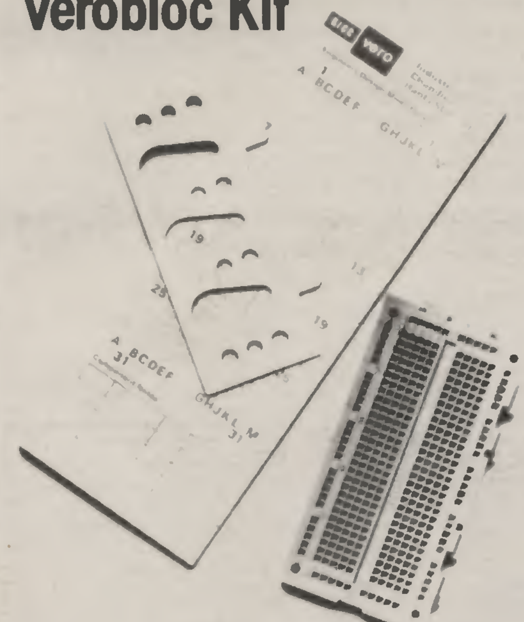
Stereo Bass Booster, most items	£8.95

Build and test your own circuit with the New Verobloc Kit



Try the new prototyping method of building and testing circuits with the British-made Verobloc kit. It consists of:

1. Verobloc. 2. A pad of design sheets for planning the circuits. 3. A component mounting panel for the larger components, i.e. switches, etc.

You can expand the circuit area by simply interlocking two or more Verobloc and, of course, with normal usage, they can be used time and time again without damaging contacts or component leads. The glass nylon material is virtually unbreakable and able to withstand temperatures from −60°C to +120°C.

So take advantage of our special price of £5 per kit (including VAT) by completing the coupon below, or telephone (04215) 62829 (24 hours). This offer closes December 31st, 1983.

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PLASTIC TWEEZERS	**69p**

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BIM 2604	483	51	210	38.5	70	13.35
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BIM 2701	178	76	210	38.5	70	9.60
BIM 2702	280	102	210	38.5	70	11.20
BIM 2703	381	102	210	38.5	70	12.40
BIM 2704	483	102	210	38.5	70	14.15

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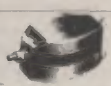

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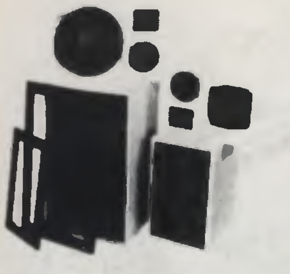
MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals.

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Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5¼in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
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HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

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3 watt FM Transmitter

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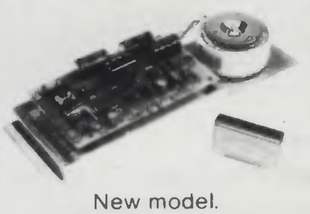
OMP POWER AMPLIFIER MODULE



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Improved specification

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Loads:— Open and short circuit proof 4/16 ohms.
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T.H.D.:— 0.01%.
S.N.R. (Unweighted):— -118dB ±3.5dB
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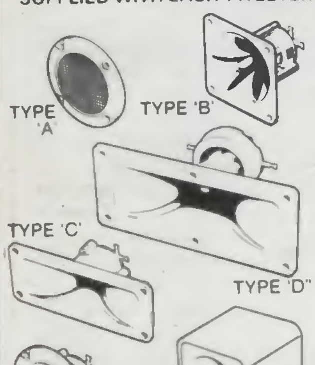

TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.29 each.**

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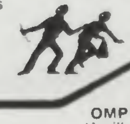
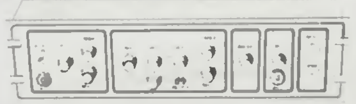


MIXERS DISCO

OMP PRO MIX MONO



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