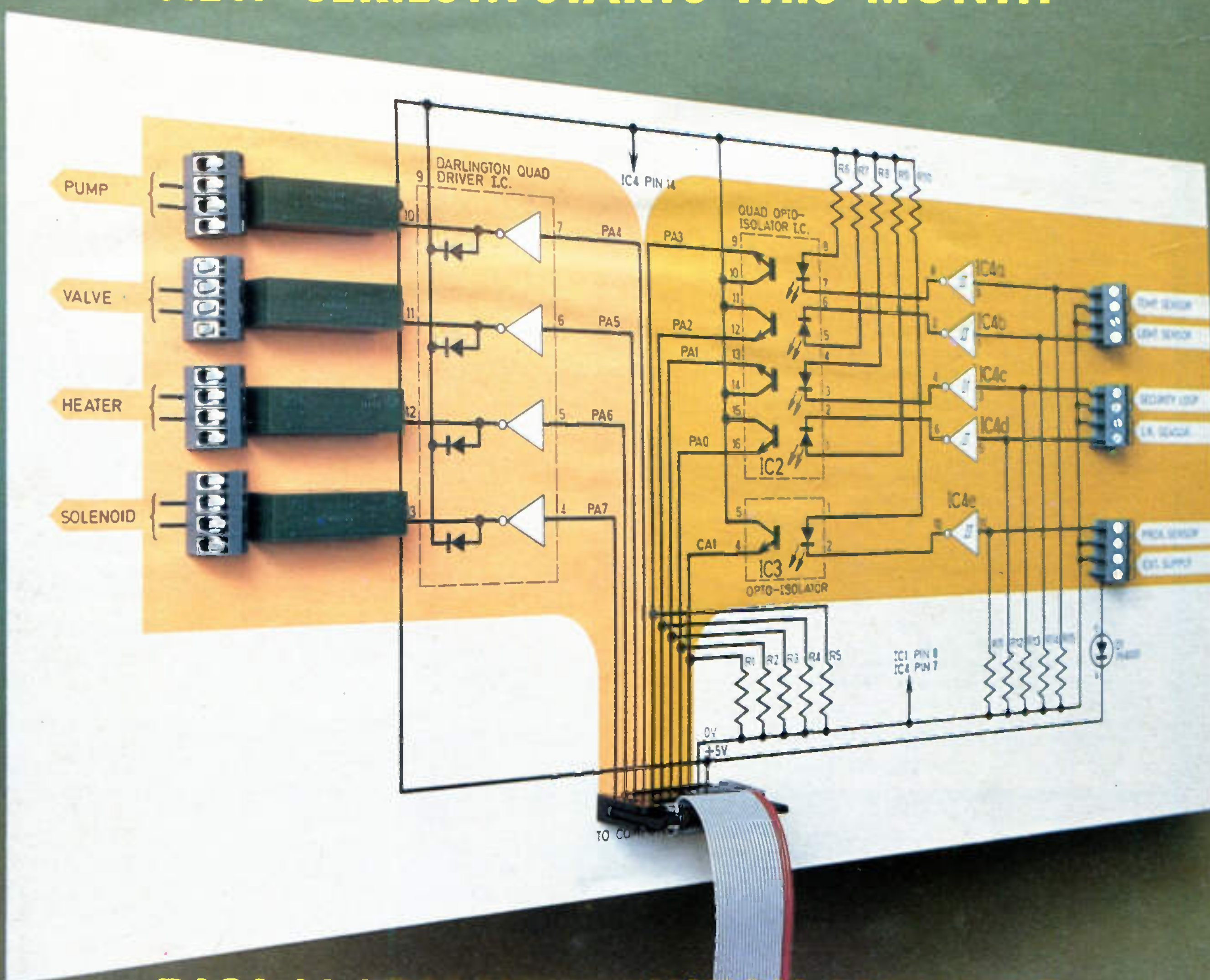
EVERYDAY ELECTRONICS and computer PROJECTS

JULY 1983

85p

MICROCOMPUTER INTERFACING TECHNIQUES

NEW SERIES... STARTS THIS MONTH



DIGI ALARM WRISTWATCH AMPLIFIER

AUTOMATIC GREENHOUSE WATERING SYSTEM

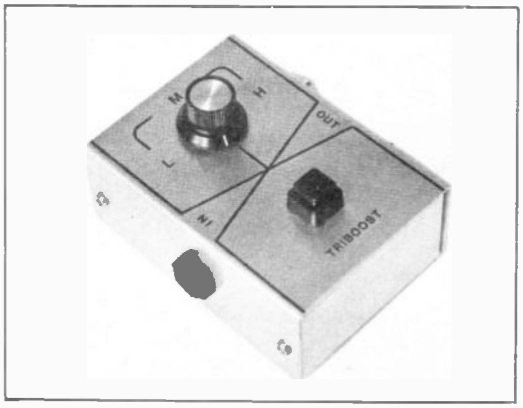
TRI BOOST GUITAR TONE CONTROLLER

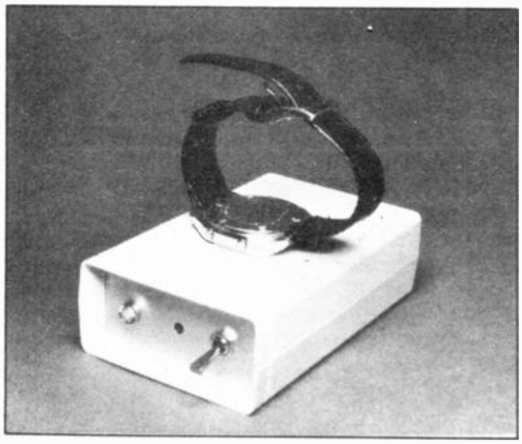
Australia $1.50 New Zealand $1.60 Malaysia $4.95 IR £1.23 (inc V.A.T.)

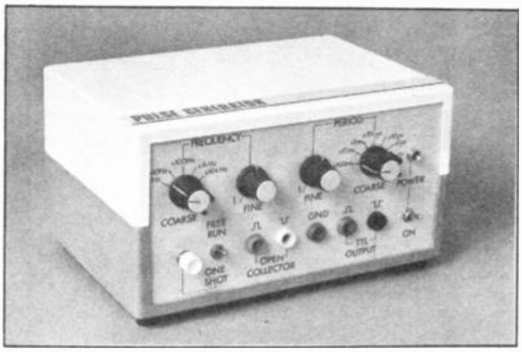
EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 7 JULY 1983

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







PROJECTS

SERIES

FEATURES

Our August 1983 issue will be published on Friday, July 15. *See page 441 for details.*

CRICKLEWOOD ELECTRONICS LTD.

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

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

TRY US NOW — WE'VE GOT WHAT YOU NEED.

RESISTORS

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

METAL FILM ULTRA STABLE 0.4 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 6k8 33p
10 to 11 WATT 1Ω to 33K 37p

POTS & PRESETS

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

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

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

CAPACITORS

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

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

POLYESTER 250V RADIAL (C280)
10nF 15nF 22nF 33nF 47nF 68nF
100 7p
150 220nF 10p
330 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 47p
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
4.7 450 30p
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 78p
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 2.90
20.0 20V
1.25A £2.90
12.0 12.0
50VA 4.35
12.0 12.0
100VA 8.95
0-6-6-9-9
1.25A 4.25
These goods are heavy send extra p&p. We will credit any difference

VEROBOARD

0.1" COPPER TRACKS
2.5 × 3.75 80p
2.5 × 5 90p
3.75 × 3.75 90p
3.75 × 5 103p
2.5 × 17 280p
3.75 × 17 355p
4.79 × 17 466p
VQ Board 180p
Dip Board 3.50
Track Cutter 159p
100 Pins 49p
Veroblock 3.95
Vero Wiring Pen + Spool 3.35
Spare Spool 75p
Combs 6p

PCB MATERIALS

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

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

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

DALO ETCH RESIST PEN + spare nib 90p

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

WIRE & CABLE

Prices per Metre
Solid connecting wire 5p
Mains Speaker Cable
Twin 1 amp 14p
Twin 2½ amp 16p
3 Core 2½ amp 18p
3 Core 6 amp 31p
3 Core 13 amp 56p
Screened Cable
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p
Aerial Cable
50Ω RG58A 36p
75Ω UHF 36p
75Ω VHF 28p
300Ω Flat 14p
Rainbow Ribbon Cable Prices per foot
8 Way 19p
10 Way 21p
16 Way 30p
20 Way 38p
24 Way 47p
30 Way 55p
32 Way 57p
40 Way 72p

RECHARGEABLE BATTERIES

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

SOLDERING

ANTEX SOLDERING IRONS
C240 (15W) 4.59
X25 (25W) 4.99
Iron stand 1.65
C240 Element 1.99
X25 Element 2.05
Bits C240
No. 2 (Small) 65p
No. 3 (Med) 65p
No. 6 (Micro) 65p
Bits X25
No. 50 (Small) 65p
No. 51 (Med) 65p
No. 52 (Lge) 65p
SOLDER 125gms
18 swg 2.95
22 swg 3.10

PLUGS & SOCKETS

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

TRANSISTORS

Britain's largest retail selection
A small sample of our vast stocks
2N930 20p
2N930A 30p
2N1893 30p
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 18p
2N2904A 27p
2N2905 28p
2N2905A 29p
2N2906 25p
2N2906A 30p
2N2907 25p
2N2907A 26p
2N2920 3.47
2N2923 25p
2N2924 15p
2N2925 15p
2N2926 10p
2N3053 27p
2N3054 56p
2N3055 60p
2N3055H 120p
2N3250 36p
2N3251 36p
2N3439 98p
2N3440 80p
2N3441 1.25
2N3442 1.35
2N3442RCA 1.85
2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3468 1.00
2N3512 1.06
2N3553 2.30
2N3638 55p
2N3638A 67p
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 25p
2N3820 48p
2N3821 1.84
2N3822 90p
2N3823 45p
2N3824 1.20
2N3866 90p
2N3903 15p
2N3904 15p
2N3905 15p
2N3906 15p
2N4030 66p
2N4031 55p
2N4032 65p
2N4036 58p
2N4037 43p
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 92p
2N4901 1.69
2N4902 3.52
2N4903 3.24
2N4904 2.75
2N4905 3.25
2N4906 3.42
2N4907 3.20
2N4908 3.70
2N4909 2.90
2N4918 95p
2N4919 1.28
2N4920 1.34
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
2N6121 54p
2N6122 56p
2N6123 59p
2N6124 56p
2N6125 59p
2N6126 71p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.14
2N6134 1.36
2N6253 1.45
2N6254 1.55
2SC1306 95p
2SC2078 1.90
2SJ49 3.50
2SJ50 3.75
2SJ82 4.29
2SK134 3.50
2SK135 3.75
2SK226 4.29
3N128 1.12
3N140 2.37
3N200 6.93
3N201 2.98
40360 60p
40361 67p
40362 67p
40363 2.22
40406 1.39
40407 75p
40408 1.58
40410 1.80
40411 2.85
40412 90p
40673 83p
40822 1.80
40871 89p
40872 89p
AC125 35p
AC126 25p
AC127 25p
AC128 25p
AC132 39p
AC141K 28p
AC142K 28p
AC151 51p
AC152 45p
AC153 55p
AC153L 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 28p
AC188 25p
AC188K 40p
AF239 55p
AF240 1.00
AL102 3.49
AU110 2.20
AU113 3.67
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 34p
BC147 10p
BC147A 12p
BC147B 10p
BC147C 20p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 12p
BC149C 13p
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BC238B 16p
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BC441 33p
BC460 32p
BC461 33p
BC516 40p
BC517 40p
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BC547A 14p
BC547B 14p
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BC558B 16p
BC558C 17p
BC559 15p
BC559B 16p
BC559C 17p
BC560 32p
BC560C 34p
BC650 45p
BC651 46p
BCY70 16p
BCY71 16p
BCY72 15p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 39p
BD237 98p
BD238 96p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 67p
BD242A 65p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.14
BD245C 1.30
BD246A 1.20
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.46
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.20
BD530 1.30
BD535 75p
BD536 75p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 85p
BD540C 1.20
BD675 72p
BD676 72p
BD677 78p
BD678 83p
BD711 1.32
BD712 1.32
BDX14 1.30
BDX18 1.59
BDX32 3.47
BDY54 1.70
BDY55 1.75
BDY56 1.80
BDY57 5.25
BDY58 6.15
BF194 12p
BF196 12p
BF197 12p
BF198 15p
BF199 15p
BF200 1.49
BF224J 32p
BF225J 35p
BF240 38p
BF241 38p
BF244A 35p
BF244B 39p
BF245A 30p
BF245B 35p
BF246 52p
BF246A 79p
BF246B 53p
BF247A 54p
BF247B 55p
BF254 39p
BF255 42p
BF256A 25p
BF256B 62p
BF256C 62p
BF257 30p
BF258 32p
BF259 35p
BF457 46p
BF458 58p
BF459 62p
BF469 85p
BF470 85p
BFR39 25p
BFR40 25p
BFR41 25p
BFR79 25p
BFR80 25p
BFR81 25p
BFR90 2.11
BFS28 2.95
BFS61 1.50
BFS98 1.70
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 24p
BSX21 28p
BU104 2.22
BU105 1.70
BU108 2.95
BU109 3.29
BU126 1.47
BU204 2.25
BU205 1.75
BU206 1.89
BU208 1.98
BU226 3.25
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
MPSU02 1.32
MPSU05 55p
MPSU06 56p
MPSU07 75p
MPSU51 88p
MPSU55 58p
MPSU56 59p
MPSU57 1.20
OC20 2.30
OC25 2.50
OC28 1.70
OC29 2.35
OC35 2.35
OC43 70p
OC44 82p
OC45 60p
OC70 50p
OC71 50p
OC72 50p
OC82 50p
OC83 75p
TIP29A 32p
TIP29C 38p
TIP30A 35p
TIP30C 38p
TIP31A 38p
TIP31C 39p
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
TIP111 90p
TIP115 81p
TIP117 96p
TIP120 69p
TIP122 73p
TIP125 84p
TIP127 84p
TIP130 93p
TIP132 93p
TIP135 99p
TIP137 99p
TIP140 1.04
TIP142 1.04
TIP145 1.15
TIP147 1.15
TIP162 4.95
TIP2955 77p
TIP3055 70p
TIS43 40p
TIS88A 62p
VN10KM 60p
VN46AF 84p
VN66AF 85p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 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 34p
ZTX530 24p
ZTX531 25p
ZTX650 45p

DIODES

1N34A 30p
1N821 70p
1N823 92p
1N914 8p
1N916 10p
1N4001 4p
1N4002 4½p
1N4003 5½p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 6p
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
BAX16 11p
BY126 20p
BY127 22p
BY134 52p
BY182 1.26
BY206 36p
BY207 36p
BY223 1.58
BY297 40p
BY299 55p
MZ2361 1.80
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p

SCRs, TRIACS, DIACS

THYRISTORS 4, 8 & 12 Amps Texas TO220
Suffix A = 100V
B = 200V
C = 300V
D = 400V
M = 600V
TIC106A 46p
TIC106B 47p
TIC106C 48p
4A TIC106D 49p
TIC106M 68p
TIC116A 66p
TIC116B 68p
8A TIC116C 71p
TIC116D 73p
TIC116M 80p
TIC126A 72p
TIC126B 72p
12A TIC126C 73p
TIC126D 77p
TIC126M 95p

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 40p
ST2 25p

ZENER DIODES

400-500mW E24 Series 2.4-47V 7p
1.3 Watt E24 Series 3.3-82V 14p

BRIDGE RECTIFIERS

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

OPTO

LEDs
R = Red
G = Green
Y = Yellow
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
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright high efficiency Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Rectangular Stackables LEDs
R6L 17p
G6L 18p
Y6L 19p

LINEAR ICs

AY1-5050 95p
AY3-8910 5.39
AY3-8912 5.59
CA3048 2.99
CA3059 2.80
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 39p
CA3140T 95p
HA1366W 2.40
HA1388 2.54
ICL7106 7.50
ICL7107 9.75
ICL7611 97p
ICL7660 1.95
ICL8038 2.95
ICL7555 80p
ICL7556 1.50
LC7120 3.20
LC7130 3.20
LC7137 3.85
LF347 1.40
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.09
LF398 4.59
LM335Z 1.19
LM348N 62p
LM349N 1.16
LM350K 4.60
LM379S 4.50
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386 88p
LM388N 2.43
LM391N60 1.70
LM391N80 1.93
LM723CH 1.21
LM723CN 40p
LM725CH 3.40
LM725CN 3.19
LM733 69p
LM741CH 98p
LM741CN 15p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1871 4.39
LM1872 4.38
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.89
LM2917N8 1.89
LM3900 49p
LM3911 1.91
LM3914 2.00
LM3915 2.00
LM3916 2.50
LM13600 1.10
OM335 7.20
NE531N 1.36
NE543N 2.50
NE544N 1.80
NE555 16p
NE556 45p
NE558 1.89
NE560 3.25
NE565 1.18
NE566 1.49
NE567 1.37
NE570 3.75
NE571 3.75
NE5534A 95p
PLL02A 4.95
PLL03A 12.75
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
TCA910 2.19
TCA940 1.99
TDA1002 3.39
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA1024 1.19
TDA2610 3.90
TDA2611A 2.50
UAA170 1.59
UAA180 1.69
ULN2003 85p
UPC575C2 2.50
UPC1156 2.75
XR2206 2.92
ZN414 79p
ZN419 1.90
ZN1034 1.90
ZN1040 6.75

74 TTL

7400 11p
7401 11p
7402 11p
7403 12p
7404 12p
7405 15p
7406 16p
7407 16p
7408 14p
7409 14p
7410 15p
7411 18p
7412 16p
7413 16p
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7423 20p
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7430 14p
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7438 19p
7440 15p
7441 65p
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7443 65p
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7445 46p
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7450 15p
7451 15p
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7497 85p
74100 80p
74104 50p
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74116 50p
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74119 57p
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74199 77p
74221 53p

74LS TTL

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74LS42 28p
74LS47 35p
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74LS145 70p
74LS147 99p
74LS148 69p
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74LS298 79p
74LS299 1.55
74LS323 1.55
74LS324 1.45
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74LS326 2.30
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74LS348 88p
74LS352 79p
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74LS362 7.25
74LS365 29p
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74LS368 29p
74LS373 59p
74LS378 58p
74LS386 1.14
74LS390 46p
74LS383 42p
74LS395 89p
74LS396 1.90
74LS398 2.70
74LS399 1.59
74LS445 99p
74LS490 2.20
74LS540 1.60
74LS541 99p
74LS640 1.69
74LS641 1.69

CMOS

4000 10p
4001 10p
4002 11p
4006 49p
4007 15p
4008 32p
4009 24p
4010 24p
4011 10p
4012 15p
4013 20p
4014 46p
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4089 1.00
4093 20p
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4515 1.10
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4527 59p
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4532 69p
4534 4.29
4536 2.59
4538 65p
4539 99p
4543 65p
4553 2.25
4555 35p
4556 35p
4560 1.40
4566 1.40
4569 1.59
4584 39p
4585 79p

LOGIC

CPU's
1802 7.00
2650A 11.99
6502 3.47
6800 2.25
6802 2.45
6809 6.24
8035 3.49
8060 10.90
8080A 2.30
8085A 3.49
SCMP1 17.06
Z80A 2.95

MEMORIES
2114 (200ns) 93p
2532 3.60
2564 11.95
2764 7.75
2708 2.25
2716(5V) 2.10
4116 (200ns) 77p
4118-3 3.25
4164 3.95
5101 (450ns) 1.89
5204 7.50
6116 3.85
6514 3.30
6810 1.15
7489 4.20
74189 4.00
74LS289 3.25
74LS188 2.25
74LS287 3.05
74LS288 2.25

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ADC0817 10.06
AY5 2376 5.90
INS1671 20.80
INS1771 20.00
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RO2513UC 7.50
SAA5000 3.00
SAA5010 7.10
SAA5012 7.10
SAA5020 5.50
SAA5030 9.00
SAA5040 15.00
SAA5041 15.00
SAA5050 8.50
SAA5052 8.50
TMS6011 3.65
8T26 95p
8T28 1.20
8T95 85p
8T97 85p
81LS95 90p
81LS96 1.20
81LS97 90p
81LS98 1.20
6522 3.19
6532 6.95
8154 9.42
8155 3.50
8212 1.10
8216 99p
8224 1.05
8226 2.47
8228 2.20
Z80ACTC 2.60
Z80ADART 5.50
Z80ADMA 6.70
Z80APIO 2.69
ZN425E8 3.39

VOLTAGE REGS

Positive 100mA
78L05A 26p
78L12A 26p
78L15A 26p
78L24A 30p
1 Amp TO220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
Negative 100mA TO92
79L05 59p
79L12 59p
79L15 59p
1 Amp TO220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZIF SOCKET

24 Pin 4.35

SWITCHES

Toggles (Mini)
SPST 49p
SPDT 58p
DPDT 69p
DPDT C off 85p
4PDT 2.75

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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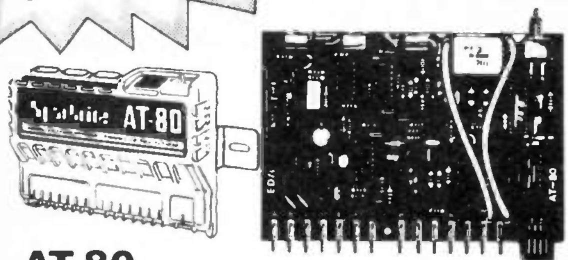

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- Over 250 components to assemble

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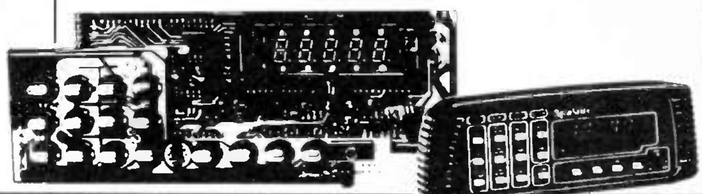
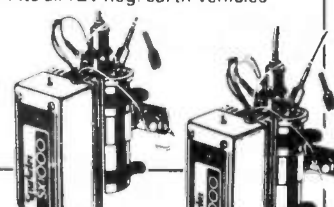
● A most sophisticated accessory ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd ● Affords 12 functions centred on Fuel, Speed, Distance and Time ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on ● Facility to operate LOG and TRIP functions independently or synchronously ● Large 10mm high 400ft-L fluorescent display with auto intensity ● Unique speed and fuel transducers giving a programmed accuracy of + or − 1% ● Large LOG & TRIP memories 2,000 miles 180 gallons 100 hours ● Full Imperial and Metric calibrations ● Over 300 components to assemble
A real challenge for the electronics enthusiast!



SX1000
Electronic Ignition

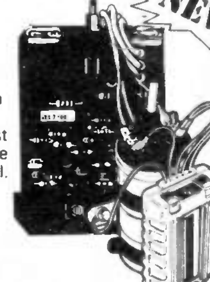
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

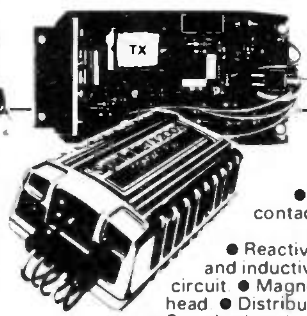


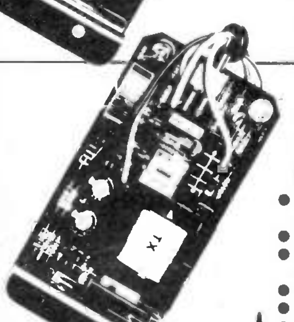
TX1002
Electronic Ignition

NEW

● Contactless or contact triggered
● Extended coil energy storage circuit
● Inductive Discharge ● Three position changeover switch ● Distributor triggerhead adaptors included ● Die cast weatherproof case ● Clip-to-coil or remote mounting facility ● Fits majority of 4 & 6 cyl. 12V. neg. earth vehicles ● Over 145 components to assemble.







SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless ● Three position switch with Auxiliary back-up inductive circuit. ● Reactive Discharge. Combined capacitive and inductive. ● Extended coil energy storage circuit. ● Magnetic contactless distributor trigger head ● Distributor triggerhead adaptors included ● Can also be triggered by existing contact breakers ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg earth vehicles ● Over 150 components to assemble

All SPARKRITE products and designs are fully covered by one or more World Patents

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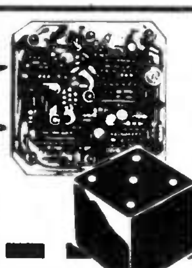

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Electronic Dice

- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand over dice
- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
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- Hours of continuous use from PP7 battery
- Over 100 components to assemble

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EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 12 NO. 7 JULY 1983

A NEW WORLD TO EXPLORE

THE personal computer boom in Britain is extraordinary considering the general economic situation and is unparalleled elsewhere except perhaps in the United States. It is reckoned that over a million of these machines are in private hands in our country and demand is by no means falling. Indeed one hears of waiting lists for certain models. Many users having acquired experience with a low priced machine are moving "up market" and buying more powerful machines that will give them greater scope now that they have taken the first hurdle and are on reasonably familiar terms with computing techniques and the handling of software.

Application wise, games may still predominate over other uses for the personal computer, but it is still early days and a sizeable minority of personal computer users is likely to be taking a more serious view of computing in its wider sense. Young users in particular will realise the necessity of acquiring computer skills which will help them in their future careers.

Considering the present practical applications of personal computers, one thing becomes very clear. There is in general a lack of awareness of the potentialities of these machines beyond their conventional function, such as their application in association with other electronic equipment and external devices like transducers and various kinds of electrically operated mechanisms. Awaiting exploration is a whole new world that should excite the imagination of those with an inventive bent, whether of the artistic, scientific or engineering nature. Above all this is an area of direct interest for the electronics enthusiast. For to bring all this about requires electronic circuitry between the computer and the external devices. The design and construction of such interfacing circuits promises to become a most rewarding activity for the hobbyist.

The nature of the electronics required as intermediary between computer and outside world is the subject of our new series launched this month. *Microcomputer Interfacing Techniques* will treat the subject in an entirely practical way with the electronic hardware presented in our usual fashion as detailed constructional projects. The series will provide a thorough grounding in the techniques required to extend the usefulness of the personal computer, in countless ways.

The steady growth in personal computer sales indicates that more and more readers of this magazine are likely to become involved with computers in the near future. Our new series will be a valuable preparation for such readers and indeed required reading for all who take a lively interest in electronic developments in general. This "new world" is going to be fun and exciting to explore. Watch these pages!

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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MICROCOMPUTER INTERFACING TECHNIQUES

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PART ONE: THE MICROPROCESSOR AND USER PORTS

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

This series has been prepared to explain and demonstrate how personal computers may be interfaced with the outside world for use in monitoring and control applications via the user port. Although the circuitry and hardware designs have been specifically tailored to suit the BBC Micro, VIC-20, PET and Commodore 64 computers, the users of other computers that are equipped with an on-board or external user port can make full use of the interfacing techniques discussed, and the circuit and hardware designs and applications. Software will be given for these four machines.

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THE sudden emergence of a wide range of relatively inexpensive microcomputers in this country is one of the more obvious indications of the developing interest in home computing. Indeed, there is little doubt that Britain has proportionately more microcomputer hobbyists than any other country. This rapid expansion has opened up exciting new areas for the computer-conscious constructor.

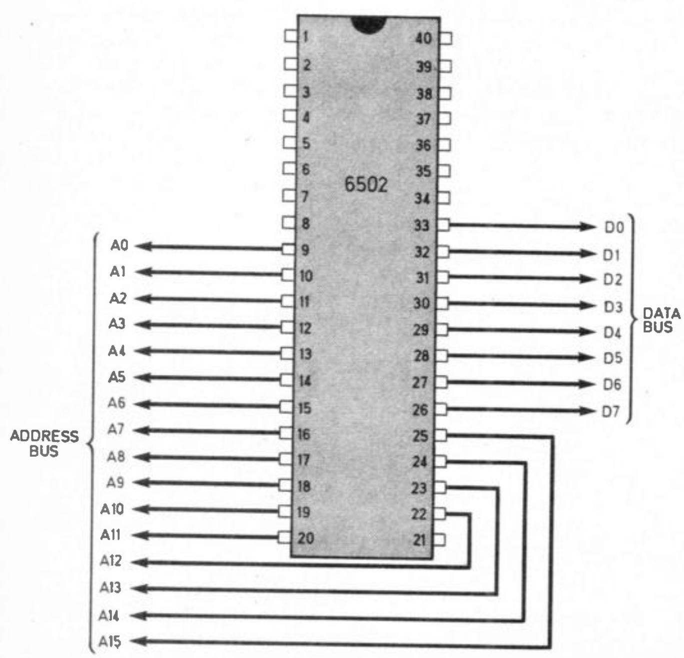
Microcomputers have many applictions because they are good at listening to questions, evaluating the appropriate responses and communicating the results. If external circuitry is added to the microcomputer system then a whole new range of tasks becomes possible.

Input, which allows the entry of information (in an acceptable coded form) into the computer's main memory, may be supplied by a switch closure rather than the more familiar keyboard. Output can be directed to perform an external task such as switching a relay rather than supplying a VDU.

This is the first part of a series of articles intended to help the electronic experimenter to build and use a range of simple peripheral devices which can be interfaced to various microcomputers.

THE MICROPROCESSOR

Processing of the data, supplied by the peripheral device, takes place in the Central Processing Unit (CPU). The principal



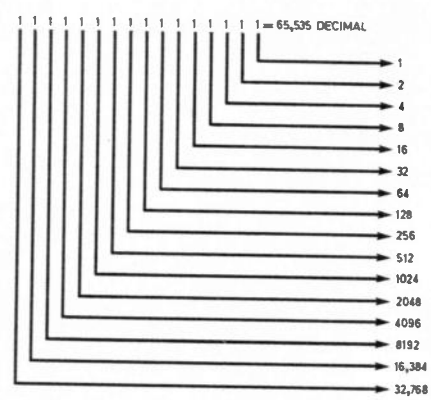


Fig. 1.2. Illustrates the binary number systems, showing how binary is weighted.

Fig. 1.1. (left). The 6502 microprocessor showing the sixteen address lines and eight data lines used to transfer binary information to and from the microprocessor.

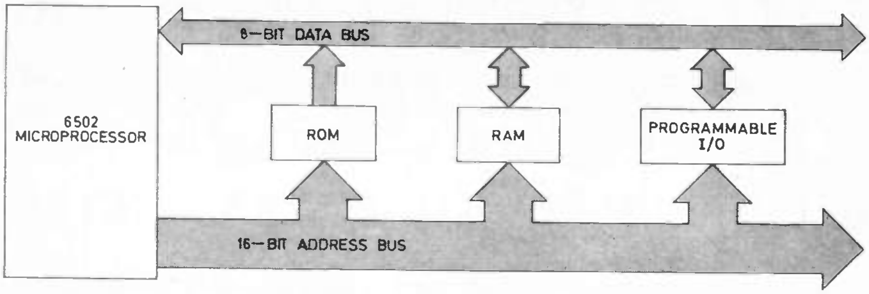


Fig. 1.4. Shows how the main memory of a microcomputer system may be divided.

component at the heart of the CPU circuitry is a microprocessor which can manipulate the data in response to instructions. One of the most common microprocessors is the 6502 microprocessor which is a single large-scale integrated circuit in a 40-pin package. This chip, which is incorporated in such computers as the BBC, VIC-20 PET and Commodore 64, may be conveniently regarded with a black box approach.

The Commodore 64 in fact contains a 6510 microprocessor. This chip incorporates a 6502 coupled with a CIA (Complex Interface Adapter) in the same package. This however will make no difference to our applications.

Fig. 1.1 shows how the sixteen Address pins and eight Data pins can be used to form two groups of lines used to transfer binary information.

These parallel paths are called the Address Bus (A0 to A15) and the Data Bus (D0 to D7).

Digital electronics has only two defined states, for example, a switch is off or on; a relay is open or closed. These states are distinguished in logic (TTL) as low (0V) or high (>3·25V).

The binary number system is ideally suited to represent these states, for example, when all 16 address lines (A0–A15) are logic high then the maximum binary output from the address bus is 1111111111111111. Since each binary digit or bit is "weighted" by assuming that the value "1" doubles for each successive digit to the left, the microprocessor can access 65,536 separate memory locations each having a unique address (0 to 65 535), see Fig. 1.2.

The binary value placed on the address bus constitutes a 16-bit address which can be interrogated for the purpose of reading data from or writing data to a particular memory location. The data bus has eight lines which can serve as both outputs or inputs as the CPU dictates. The relationship between the address bus and data bus illustrated in the memory map diagram, Fig. 1.3.

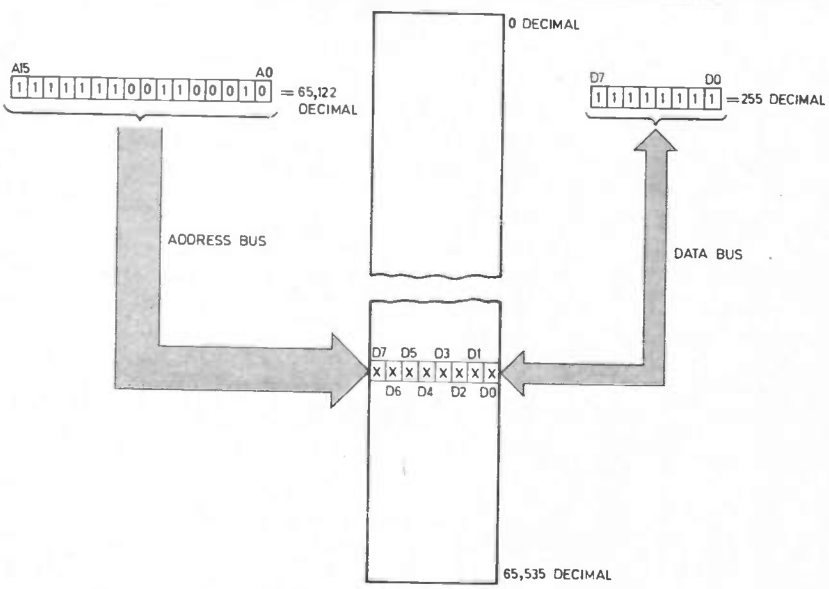


Fig. 1.3. The memory map of an 8-bit microprocessor showing the relationship between the address and data buses.

MEMORY

Main memory can be divided into three types as shown in Fig. 1.4: (i) Read Only Memory (ROM); (ii) Random Access Memory (RAM); (iii) Input/Output (I/O).

READ ONLY MEMORY (ROM)

Read Only Memory is an area of memory loaded with data and instructions which must be permanently stored. As its name implies the microprocessor cannot write data into ROM memory but can only read the contents of these locations.

RANDOM ACCESS MEMORY (RAM)

Random Access Memory is an area of memory used to store user programs and data. This type of memory allows the microprocessor both to read and write and is sometimes called R/W memory.

INPUT/OUTPUT (I/O)

Memory mapped I/O regions can be written to or read from in a similar way to RAM and allow the use of specialised instructions to handle input/output devices.

THE USER PORT

Many 6502-based microcomputers have another powerful internal integrated circuit called a 6522 Versatile Interface Adapter (VIA). This chip provides sixteen memory mapped registers which can perform a variety of useful I/O functions. One of the most useful aspects of the VIA is the provision of an external port which can be connected to the outside world.

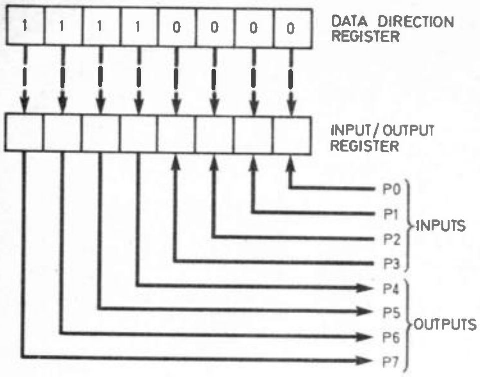


Fig. 1.9. Shows the relationship between each bit in the DDR and the user port lines PØ to P7. A 'O' sets the line up as an input, whereas a '1' sets it up to be an output.

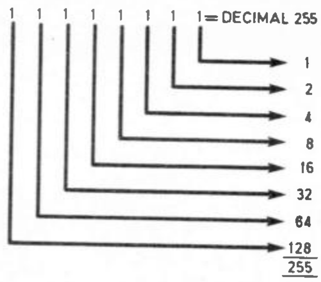


Fig. 1.10. The eight bits forming the data bus showing binary weighting.

Table 1.1

	BBC	VIC-20	PET	Commodore 64
Data direction register	65122	37138	59459	56579
Input/Output register	6512Ø	37136	59457	56577

Since the VIA is designed to provide two ports, known as the A port (PA) and the B port (PB), the microcomputer user port may be derived from either PA or PB depending on the make of microcomputer. Eight parallel lines are available to the user at the port each of which can be individually programmed to be either an output or an input. The user port location and pin identification diagrams for the four machines considered here are shown in Figs. 1.5 to 1.8.

A Data Direction Register (DDR) in the VIA is used to control whether the I/O lines available at the user port are used for input or output. For each signal line there is an associated bit in the DDR. If a bit in DDR is set to 1 the corresponding line from the user port will be an output. If a bit in the DDR is 0, the corresponding line from the user port will be an input.

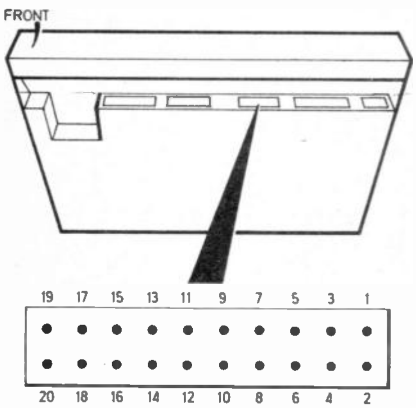
Fig. 1.9 shows the relationship between each bit in the DDR and the signal lines P0 to P7. It should be noted that a second register, the I/O register, for the port is also required to control the eight lines.

OUTPUT

It has been noted that two bit-programmable registers allow the control

Fig. 1.5. Location and pin identification for BBC Micro User Port.

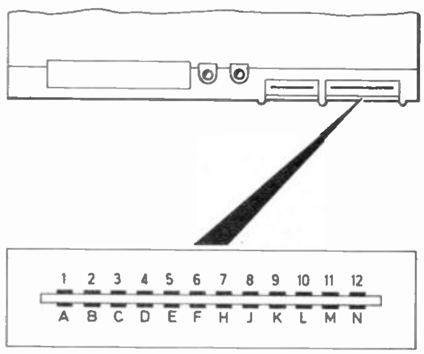
BBC MICRO MODEL B



Pin Identification	Signal (label)
1,3	+5V
5,7,9,11,13,15,17,19	GND
2	CB1 (C1)
4	CB2
6	PBØ (PØ)
8	PB1 (P1)
10	PB2 (P2)
12	PB3 (P3)
14	PB4 (P4)
16	PB5 (P5)
18	PB6 (P6)
20	PB7 (P7)

Fig. 1.6. Location and pin identification for VIC-20 User Port.

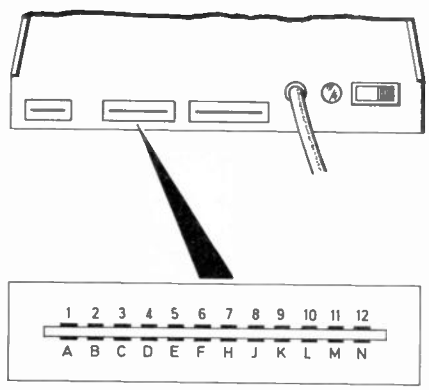
VIC-2Ø



Pin Identification	Signal (label)
A	GND
B	CB1 (C1)
C	PBØ (PØ)
D	PB1 (P1)
E	PB2 (P2)
F	PB3 (P3)
H	PB4 (P4)
J	PB5 (P5)
K	PB6 (P6)
L	PB7 (P7)
M	CB2
N	GND
2	+5V

Fig. 1.7. Location and pin identification for PET User Port.

PET MICROCOMPUTER



Pin Identification	Signal (label)
A	GND
B	CA1 (C1)
C	PAØ (PØ)
D	PA1 (P1)
E	PA2 (P2)
F	PA3 (P3)
H	PA4 (P4)
J	PA5 (P5)
K	PA6 (P6)
L	PA7 (P7)
M	CB2
N	GND

of the eight lines available at the user port. Table 1.1 indicates the addresses of the locations for four popular microcomputers.

If all the lines at the user port are to be configured for output it is necessary to set every bit in the data direction register. This is because each bit in this register acts like a minute toggle switch. If the switch is set to 1 then the corresponding line at the port is free to act as an output line.

As there are eight bits in the data direction register the sum of the binary weightings for each bit set is as shown in Fig. 1.10.

In Commodore BASIC a POKE command allows the replacement of a particular bit pattern, in either RAM or I/O memory, with another. A similar task is accomplished in BBC BASIC using the byte indirection operator "?". Table 1.2 shows how to place the bit pattern 11111111 in the data direction register for the four microcomputers.

Once the data direction register has been set up for output then it is necessary for a particular bit in the I/O register to

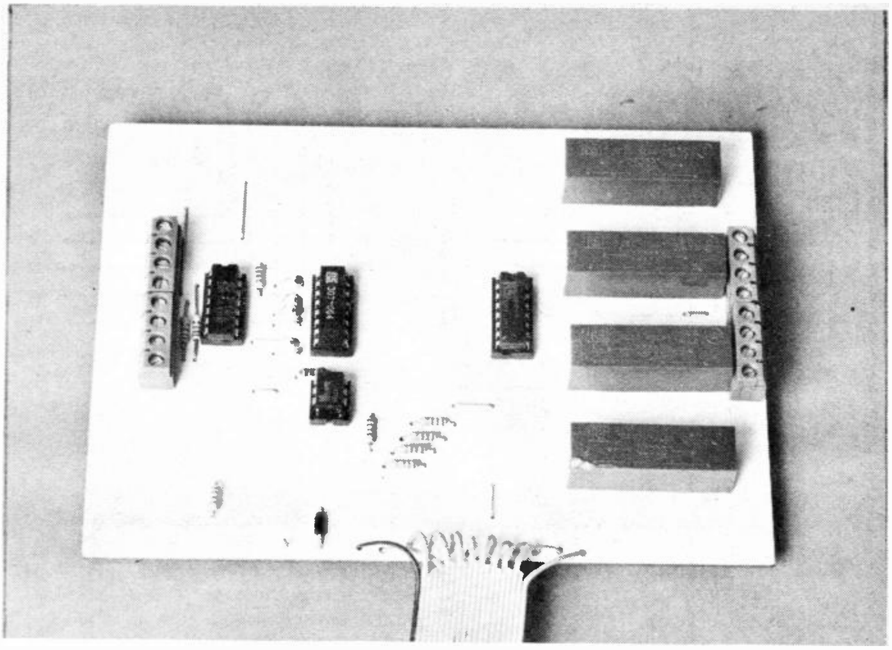
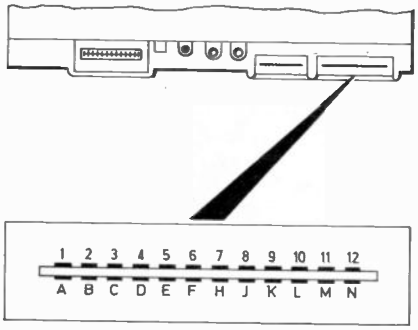


Fig. 1.8. Location and pin identification for Commodore User Port.

COMMODORE 64



Pin Identification	Signal (label)
A	GND
B	FLAG2 (C1)
C	PBØ (PØ)
D	PB1 (P1)
E	PB2 (P2)
F	PB3 (P3)
H	PB4 (P4)
J	PB5 (P5)
K	PB6 (P6
L	PB7 (P7)
M	PA2
N	GND
2	+5V

Line	BBC	VIC-20	PET	Commodore 64
10	?65122=255	POKE37138,255	POKE59459,255	POKE56579,255
20	<————————— INPUT X —————————>			
30	<———————IF X < Ø OR X > 255 THEN END ———————>			
40	?6512Ø=X	POKE37136,X	POKE59457,X	POKE56577,X
50	<————————— GOTO 2Ø —————————>			

Table 1.2

Microcomputer	Command
BBC	?65122=255
VIC-20	POKE37138,255
PET	POKE59459,255
Commodore 64	POKE56579,255

be set before the corresponding output line goes to logic high. This is achieved in much the same way as a bit pattern was introduced into the data direction register. These concepts are best investigated by replacing bit patterns in the I/O register and watching the corresponding changes on a l.e.d. array, see Fig. 1.15. This can be achieved with the following program:

INPUT

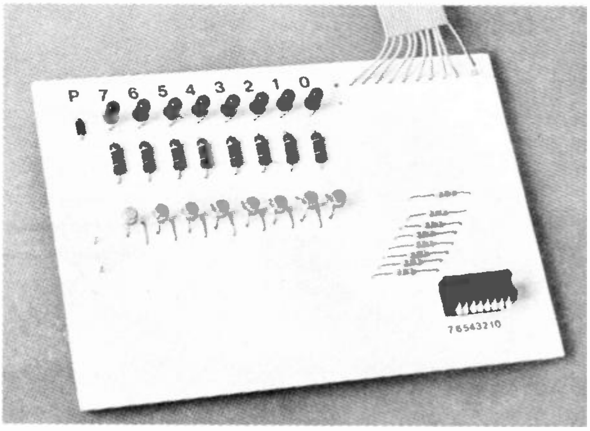
To allow the eight lines at the user port to act as inputs it is initially necessary to clear all bits in the data direction register. When this has been accomplished the bits in the I/O register will indicate the state of the input lines. If an input switch is closed the corresponding input signal line will go low and the requisite bit in the I/O register will be cleared.

In Commodore BASIC a PEEK command computes the decimal value of the contents of a particular memory location whereas BBC BASIC again uses the indirection operator "?".

The following program reinforces the concept of binary weighting by continuously monitoring the state of the eight input switches.

Line	BBC	VIC-20	PET	Commodore 64
1Ø	?65122=Ø	POKE37138,Ø	POKE59459,Ø	POKE56579,Ø
2Ø	PRINT?6512Ø	PRINTPEEK(37136)	PRINTPEEK(59457)	PRINTPEEK(56577)
3Ø	<————————— GOTO 1Ø —————————>			

USER PORT INPUT/OUTPUT BOARD CONSTRUCTION



INPUT/OUTPUT BOARD

In order to investigate the facilities of the user port, a simple input/output board is needed. The circuit diagram for such a device is shown in Fig. 1.11.

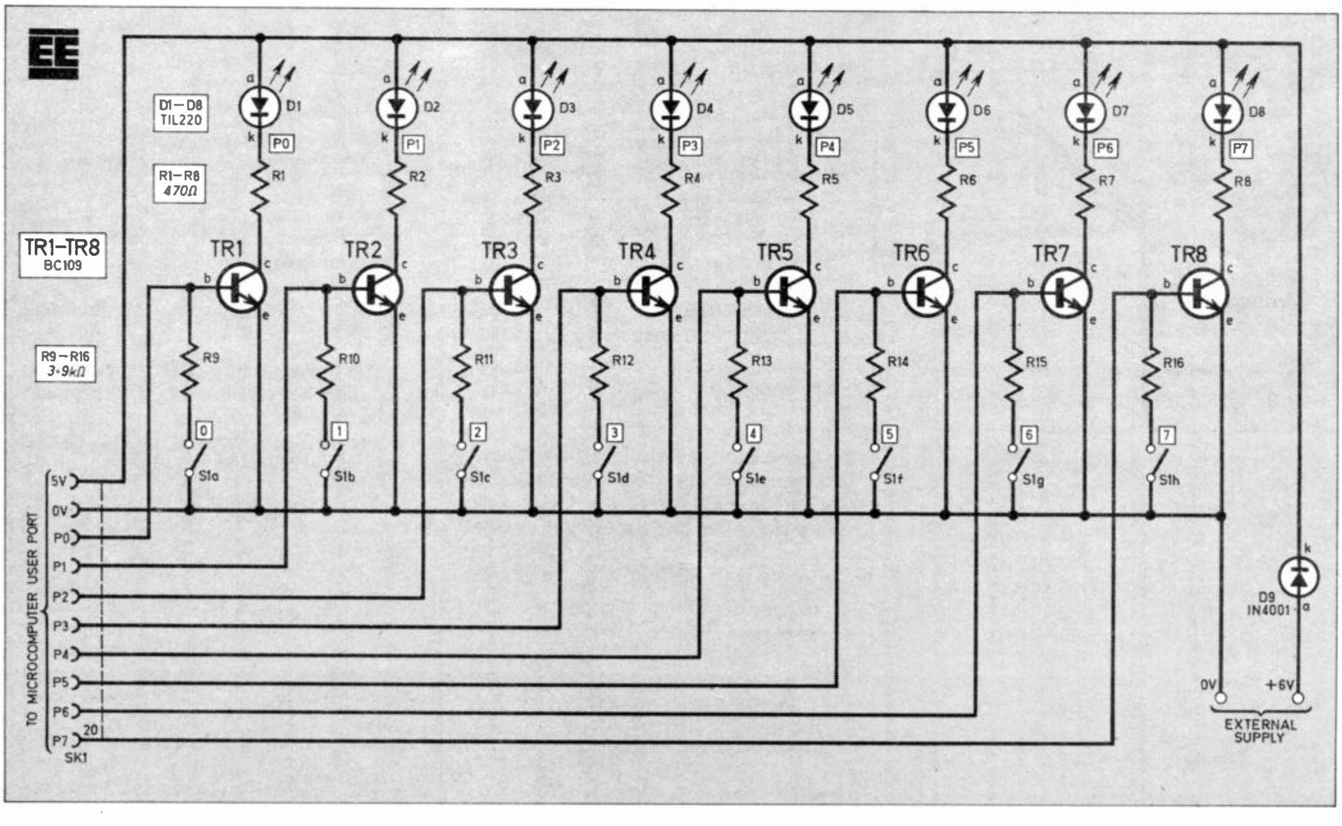
The design described here uses l.e.d.s D1 to D8 to indicate the states of lines used as outputs, an "on" l.e.d. indicating that the line is at logic 1 (TTL level >3·25V). Logic 0 or 1 switching of lines used as inputs is achieved by manual operation of appropriate switches. An 8-way sub-miniature d.i.l. switch, S1, is used for this purpose. The board is connected to the user port via a ribbon cable and an appropriate user port plug.

Power supply for the board (+5V at approximately 40mA) can, with some microcomputers, be derived from the user port. For machines not possessing this facility, provision has been made for the connection of an external 6V battery to the board (a PP6 is suitable).

For lines used as inputs, switches S1a to S1h enable the lines to be set at logic 0 (0V) or logic 1 (+5V) by closing the switch and connecting them to 0V or opening the switch and allowing them to float up to +5V (if lines are unconnected, the VIA pulls them up to +5V).

When configured as outputs, logic signals appearing on the lines turn on or off the transistors, with their associated l.e.d.s indicating the status of the line. It should be noted that if a line is to be configured as output, then the corresponding input switch S1a to S1h should be kept open (off). If this is not done, then the line will be held at logic 0 and the output signal from the user port will not be able to pull it up to logic 1.

Fig. 1.11. The circuit diagram for the User Port Input/Output board to investigate the facilities of a user port. Note: P0–P7 lines should not go directly to the bases of TR1–8 but instead to the junctions of R9/S1a and so on.



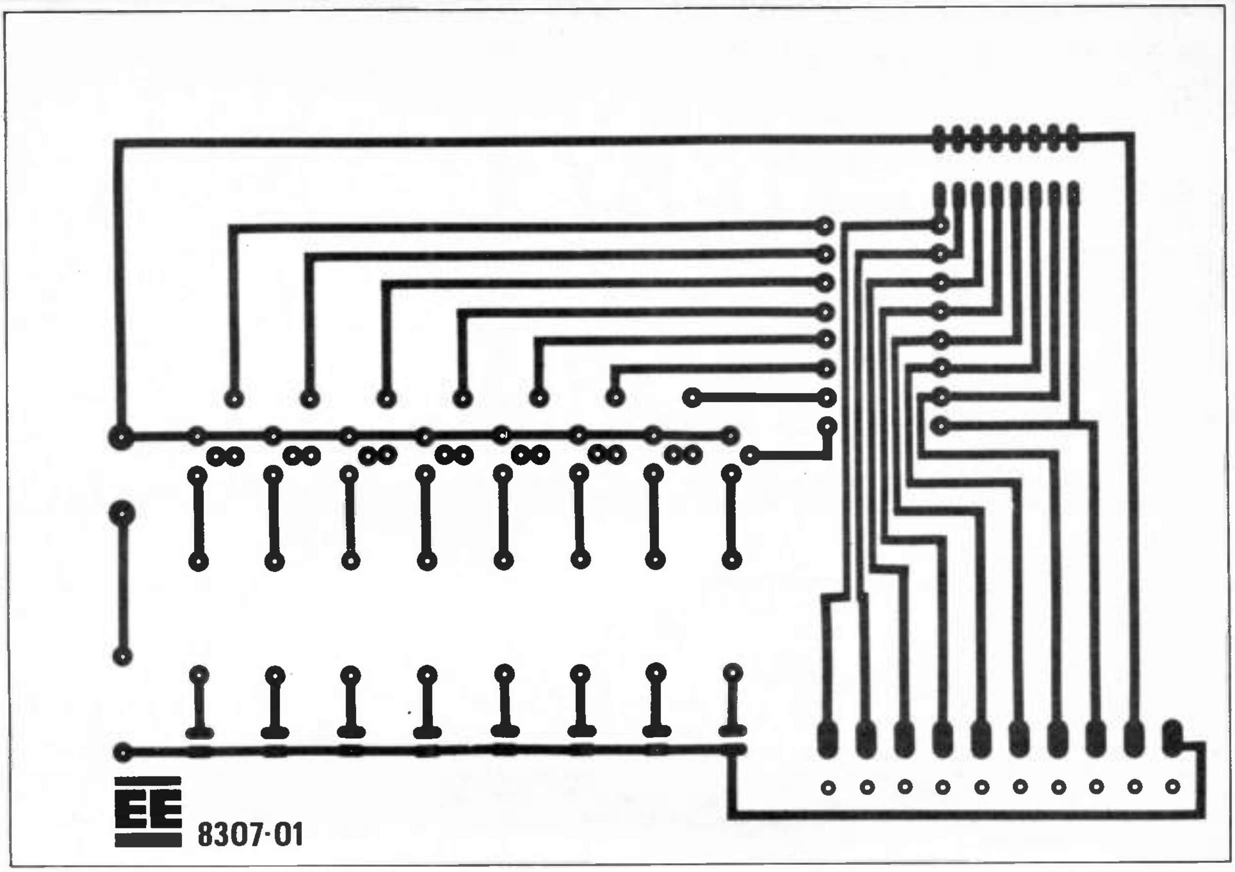


Fig. 1.12. The full size master printed circuit pattern to be etched. The black areas represent the copper tracks remaining after etching. (This board is available through the *EE PCB Service*, Order code 8307-01.)

COMPONENTS

Resistors

R1–R8	470Ω (8 off)
R9–R16	3·9kΩ (8 off)

All $\frac{1}{4}$W carbon ±5%

Semiconductors

TR1–TR8	BC109 silicon *npn* (8 off)
D1–D8	TIL220 red l.e.d. (8 off)
D9	1N4001 silicon rectifier

Miscellaneous

S1	8-s.p.s.t. 16-pin d.i.l. lever type
SK1	socket to suit user port of micro being used

Printed circuit board: single-sided size 164 × 114mm, *EE PCB Service* Order code 8307-01, 22 s.w.g. tinned copper wire (for board topside links); 16-pin d.i.l. socket for S1; cable to connect user port connector to p.c.b.; Veropins (2 off).

Guidance only Approx. cost **£8.50** excluding SK1 and cable

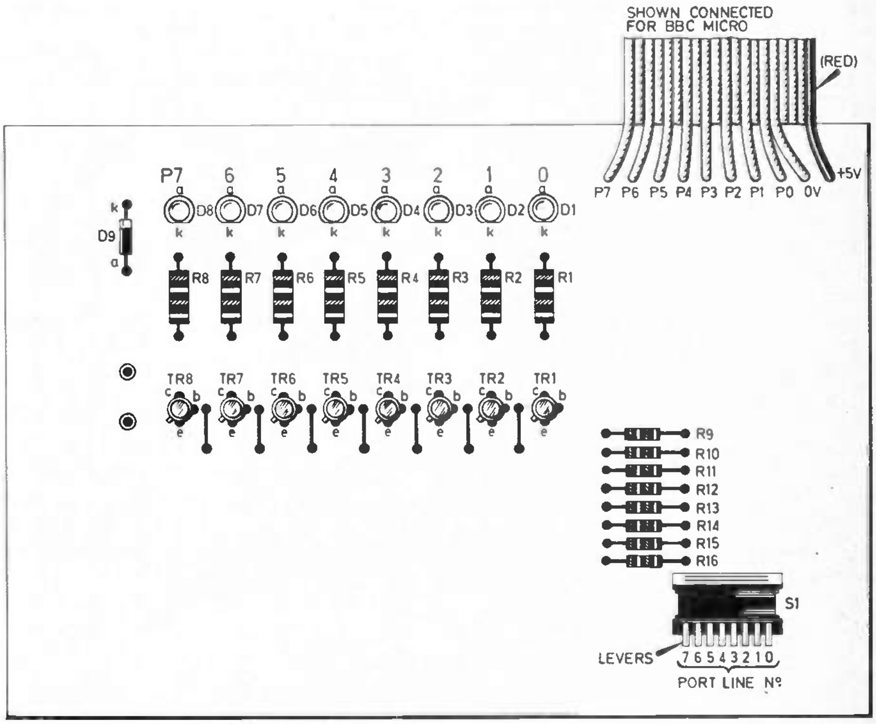
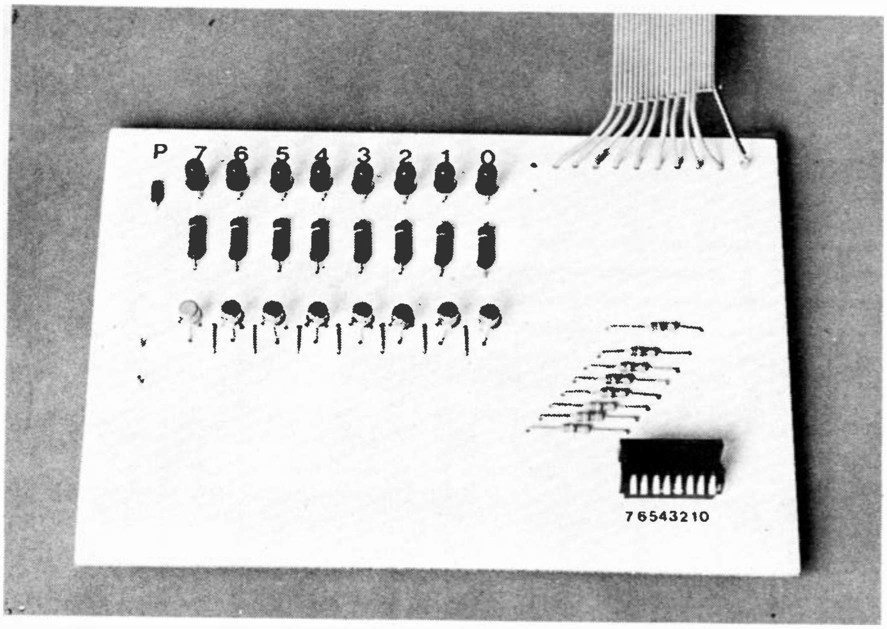


Fig. 1.13. The layout of the components on the topside of the printed circuit board. The ribbon cable from the board is drawn to suit the BBC Micro version. Note the d.i.l. switch S1 sits in a d.i.l. socket. The layout of the components here differs slightly from that shown in the photographs which is an improvement on the original.



PRINTED CIRCUIT BOARD

All the components in the circuit of Fig. 1.11 are mounted on a single-sided printed circuit board size 164 × 114mm. The full-size master of the pattern to be etched is shown in Fig. 1.12. This board may be obtained from the EE PCB Service, Order code 8307-01.

The layout of the components on the p.c.b. topside is shown in Fig. 1.13. Begin by fitting the d.i.l. socket for S1 followed by the resistors and l.e.d.s. Pay attention to the polarity of the latter, there is a flat on the body adjacent to the cathode (k) lead-out. Next fit the eight link wires in the vicinity of the transistor positions and then solder in the transistors themselves paying attention to orientation. Note that there is a body tag nearest the emitter lead-out. Finally insert the Veropins which will form the input for the external power supply. Insert the d.i.l. switch, the right way round, in its socket to complete the component assembly.

It only remains to connect the ribbon cable to the p.c.b. to suit the machine/connector it is to be used with, see Fig. 1.14. Note that the cable wires pass through large holes (insulation too) before being soldered to the board pads on the underside. This acts as a strain-relief mechanism for the cable. Self adhesive rubber feet were fitted at the underside corners to keep the connections clear of the surface on which the board stands. These are recommended. □

CONNECTING THE I/O BOARD TO THE USER PORT

THE BBC MICROCOMPUTER

The BBC user port comprises a 20-way male connector; the appropriate socket being a 20-way insulation displacement type.

Made up socket/ribbon cable arrangements are available and if one of these is to be used, the diagram of Fig. 1.14a should be consulted. (Readers should note that the pin numbering system adopted is that on the user port plug itself and not that appearing in the BBC User Manual.)

Note that, numbering from the RED (+5V) line, only lines 1,2,5,6,8,10, 12,14,16,18 and 20 are used. Other lines are either unused inputs or extra 0V/+5V connections. Cut back unwanted lines at the board end.

THE PET MICROCOMPUTER

A 10-way ribbon cable and the PET user port connector are employed for connection to the PET. Note that there is no +5V supply available at the PET user port. In this case, the I/O board derives power from an external 6V battery (a PP6 is ideal).

VIC-20/COMMODORE 64

The VIC-20 and Commodore 64 machines have identical user port connections and employ the same plug as the PET. The arrangement of port lines P0 to P7 is the same as that for the PET, but there is also a +5V supply available at pin 2. This extra connection is shown dotted in the figure. Needless to say, no external power supply is necessary when using the I/O board with these machines.

The reader should note that the current available at user port +5V lines is very limited; all interface boards described in this series of articles can be used safely, but no attempt should be made to draw any more current from these +5V lines.

SET THE DDR

Each port has a data direction register (DDR) for specifying whether each line acts as input or output. To allow a particular line to act as input then the corresponding bit in the DDR must be cleared, whereas to configure a line for output the requisite bit must be set. The input/output (I/O) register will then either:

(a) allow the lines to be programmed so that the voltage on the peripheral output lines is controlled by the corresponding bit in the I/O register.

(b) indicate the state of the voltages on the peripheral input lines by the status of bits in the I/O register.

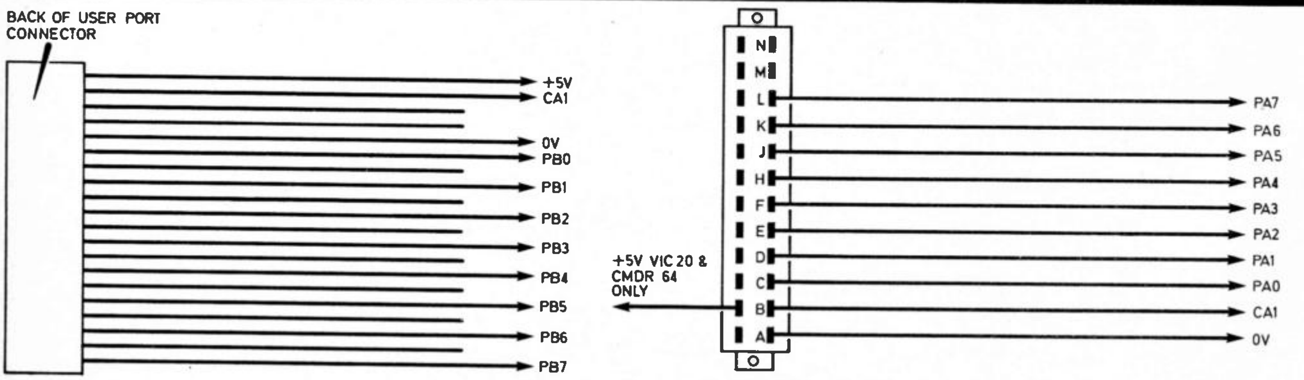
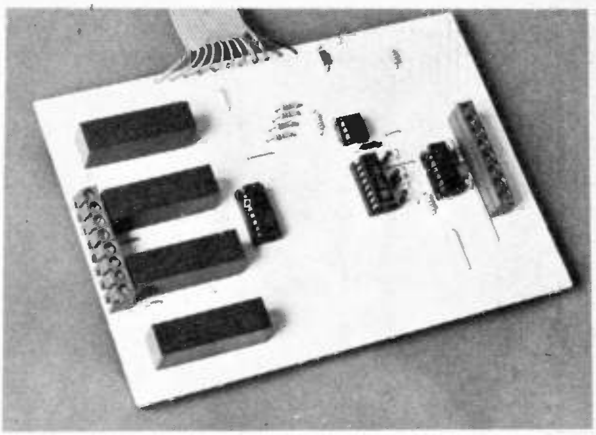


Fig. 1.14(a). Indentification of the signal lines from the BBC Micro, with its insulation displacement socket connected and viewed from the rear. Cut back the unrequired signal wires. Note that CA1 is not used on the Input/Output Port Board.

Fig. 1.14(b). Identification of the signal leads from the PET, VIC-20 and Commodore 64 when fitted to the user port cable connector for these machines. Here we are looking at the soldered connection side of the connector. Note that the +5V supply is not available at the user port for the PET. An external supply will be required for the Port boards described.

USER PORT CONTROL BOARD CONSTRUCTION



The circuit diagram for an Input/Output Control board which may be used with many of the popular microcomputers is shown in Fig. 1.15.

The User Port Control provides four opto-isolated input lines (Input 0 to Input 3) and four relay switched output lines (Output A to D). All lines may be used quite independently of each other.

Output relay sequencing and timing can be controlled by software whilst input signals can initiate and/or halt the execution of the program. Input signals can be provided by manual switching, reed switches, opto-electronic devices and so on, thus offering a wide range of control possibilities.

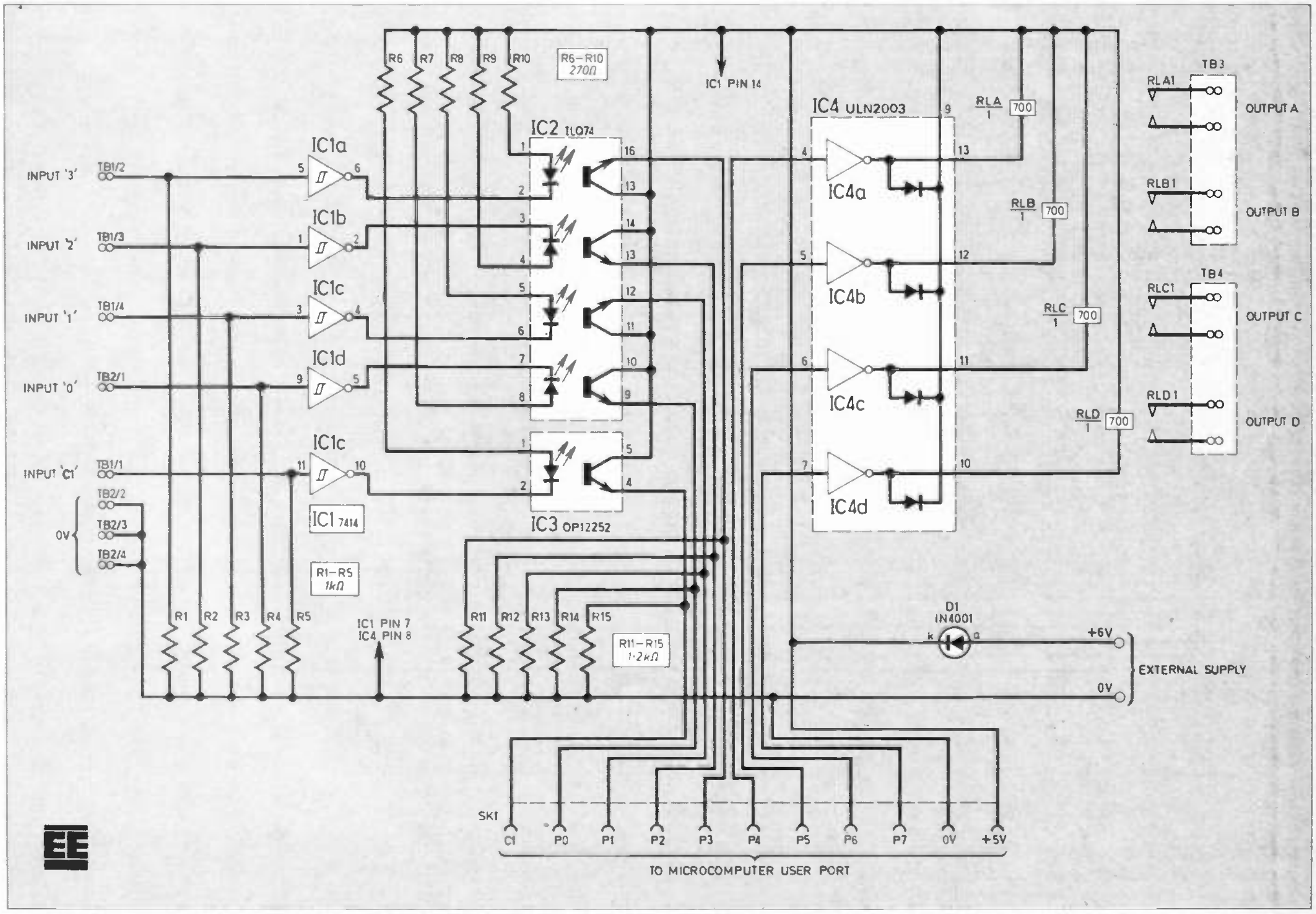
A fifth input line (Input CA1) which is a standard edge-sensitive handshake, is also provided. This is discussed later in the text together with other experimental applications.

The circuit divides basically into two sections; input and output. These are described separately.

INPUT

Input signals (at TTL logic 0 and 1; that is, <3·25V and >3·25V, respectively) are applied to the inputs of the 7414 Schmitt trigger IC1. This is an inverting Schmitt trigger, so a logic 1 input will cause the

Fig. 1.15. Circuit diagram of the User Port Control Board. There are five inputs and four relay outputs.



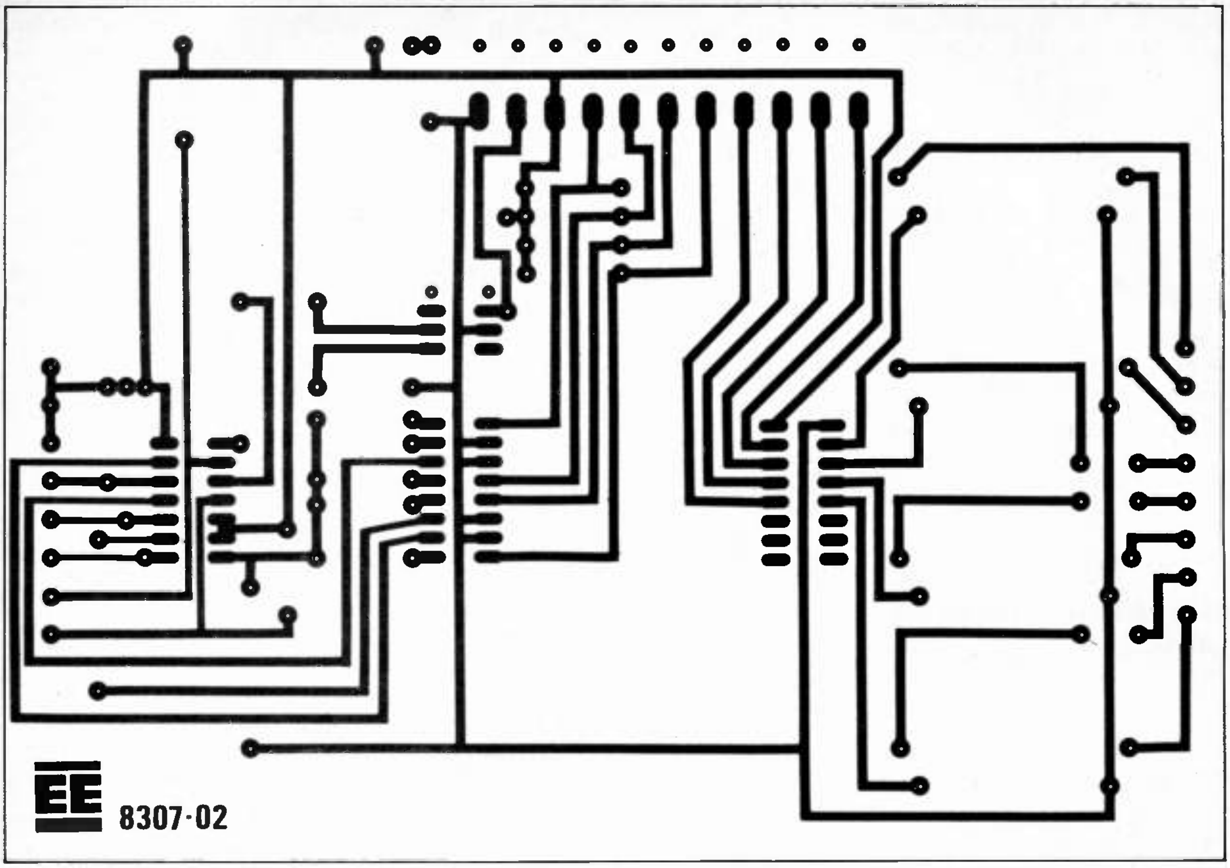


Fig. 1.16. The master pattern, actual size, to be etched. The black areas represent the copper tracks to remain after etching. (This board is available from the *EE PCB Service,* Order code 8307-02.)

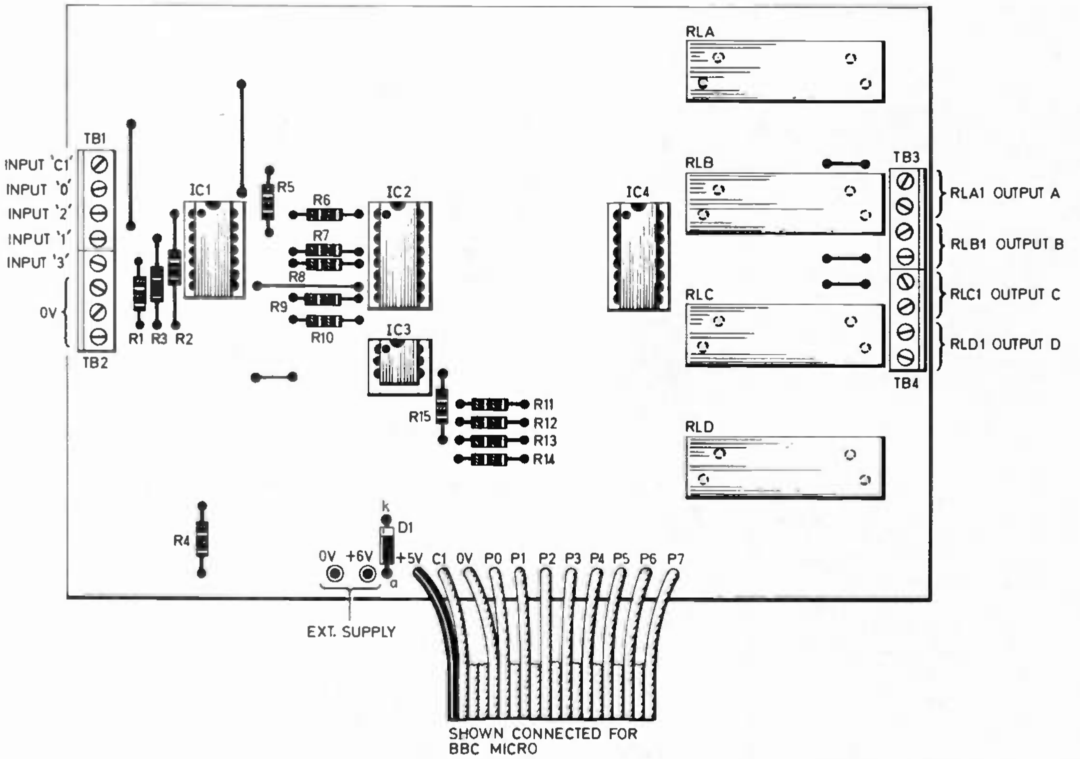


Fig. 1.17. The layout of the components on the topside of the User Port Control Board. The ribbon cable from the board to the computer is drawn here for the BBC Micro. Note that CA1 is used on this board, and forms the fifth input. The p.c.b. layout shown is an improved version of the original seen in the photographs.

associated output to go to logic 0. Resistors R1 to R5 pull the input down to 0V (=logic 0) in the absence of input signals.

A logic 0 output at the Schmitt will cause the cathode of the appropriate l.e.d. in the quad opto-isolator IC2 to go low, so turning the l.e.d. on. This turns on the associated photo-transistor in the isolator and its emitter goes high (due to the p.d. across R11–R15). The logic levels at these emitters are connected directly to P0–P3, which must be configured as inputs.

The Schmitt input circuitry ensures precise triggering, whilst the use of opto-isolation obviates the possibility of damage to the microcomputer in the event of excessive input voltages being applied to the board.

The edge-sensitive input circuitry is similar, a separate single opto-isolator IC3 being used to handle this signal.

COMPONENTS

Resistors

R1–R5	1kΩ (5 off)
R6–R10	470Ω (5 off)
R11–R15	1·2kΩ (5 off)

All ¼W carbon ±5%

Semiconductors

IC1	7414 TTL hex Schmitt inverter
IC2	ILQ74 quad opto-isolator 16-pin d.i.l.
IC3	OP12252 single opto-isolator 6-pin d.i.l.
IC4	ULN2003 7-stage Darlington driver
D1	1N4001 silicon rectifier

See Shop Talk page 427

Miscellaneous

RLA, RLB, RLC, RLD	p.c.b.-type encapsulated reed relay, 6–9V 700 ohm coil, single-pole n.o. 500mA contacts (4 off)
TB1–TB4	p.c.b.-type 4-way terminal blocks (4 off)
SK1	socket to suit user port of micro being used

Printed circuit board: single-sided size 164 × 114mm, *EE PCB Service* Order code 8307-02; d.i.l. sockets: 16-pin (2 off), 14-pin (1 off), 8-pin (1 off); 22 s.w.g. tinned copper wire (for board topside links); cable to connect user port connector to p.c.b.; Veropins (2 off).

Guidance only Approx. cost £16 excluding SK1 and cable

OUTPUT

Output signals at the user port can be set at logic 0 or logic 1 by software control. The available current is very small and, in order to control lamps, motors and so on, some form of interface circuitry is necessary.

The user port control board employs Darlington driver/relay circuitry (IC4) and enables loads of up to 0·5A to be switched. The power for these must be derived externally from, for example, appropriate batteries.

The user port lines P4 to P7 are taken to four of the inputs of IC4—a 7-stage Darlington driver (the remaining stages are unused). A logic 1 on any line turns on the associated driver and actuates the relay to which it is connected. No back e.m.f. protection diodes are necessary, as they are included in IC4.

RLA to RLD are single pole/single throw, normally open relays. The devices specified have contacts capable of switching about 0·5A which should be suitable for small lamps, motors, and so on. Larger relays could be used, but the coil resistance should not be less than about 300 ohms if the current drawn from the user port +5V supply is to remain within its capability.

D1 provides a voltage drop of about 0·6V. So that if an external 6V battery is used, the supply to the board will be about 5·4V, which is suitable.

PRINTED CIRCUIT BOARD

The circuitry is assembled on a single-sided p.c.b. The master pattern to be etched on the board is shown full size in Fig. 1.16, with the components to be mounted on the topside as indicated in Fig. 1.17. This board is available from the *EE Printed Circuit Board Service*, Order code 8307-02.

Beginning with the etched and drilled printed circuit board, begin by assembling the components according to Fig. 1.17 starting with the link wires, then the i.c. sockets, resistors, diode, terminal blocks, and finally the relays. Veropins were fitted to the p.c.b. to receive the external supply (+6V). They may be replaced with some other form of connector if preferred. All components should be soldered in carefully and a close inspection made for the presence of dry joints and solder bridges.

The ribbon cable should be connected to the board in accordance with the information given in Fig. 1.17 and Fig. 1.14.

Integrated circuits should now be inserted carefully into their sockets, noting the orientation of the i.c. Note that IC3 is a 6-pin device to be located in an 8-pin socket. Make sure that it sits at the right end of the socket. □

LOGICAL OPERATORS

It has been noted that the application demands the capability to control individual signal lines at the user port without changing the status of other signal lines. This can be achieved by using the logical operators AND or OR.

The only way to light the lamp in Fig. 1.18 is to close both switches A and B. No other combination of on and off will allow power to reach the lamp. This can be summarised in a truth table:

SWITCH A	SWITCH B	LAMP
OFF	OFF	OFF
OFF	ON	OFF
ON	OFF	OFF
ON	ON	ON

If the binary bit 0 is assigned to the off state, bit 1 to the on state and the lamp is called the output, the truth table becomes:

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

The switches in the AND circuit can be rearranged to make a simple OR circuit as shown in Fig. 1.19. The lamp will light when either A OR B are closed. The various switch combinations can be summarised in a truth table as before:

SWITCH A	SWITCH B	LAMP
OFF	OFF	OFF
OFF	ON	ON
ON	OFF	ON
ON	ON	ON

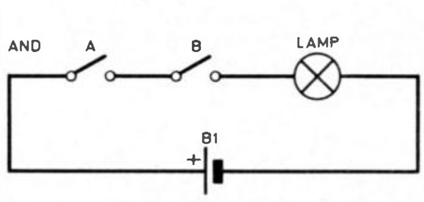


Fig. 1.18. A simple switch/lamp circuit to illustrate the logical AND operator.

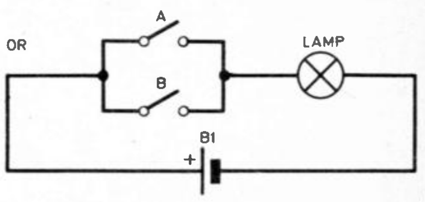


Fig. 1.19. A simple switch/lamp circuit to illustrate the logical OR operator.

This table can then be converted to the more familiar binary version shown below:

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

It is possible to send a particular bit from a logical low state (0) to a logical high state (1) using the BASIC binary logical operator OR, for example:

```
10 PRINT 0 OR 1
RUN
1
```

If a particular bit is already set high (1) then the BASIC binary logical operator AND may be used to clear it (0), for example:

```
10 PRINT 1 AND 0
RUN
0
```

These logical operations are performed in bit-wise fashion which means that each bit of the result is obtained from the corresponding bits of those being manipulated. Thus it is possible to change single bits in a particular memory location without changing the status of other bits. These techniques allow the programmer to control individual lines provided at the user port.

Line 10 in each program sets up the data direction register so that the user port signal lines are mixed inputs and outputs for the control board.

HANDSHAKING

Many microcomputers have an edge-sensitive handshake line available at the user port. This signal line, which functions as input only, is used to allow the efficient transfer of data between the computer and an external device. Control of this function within the VIA is accomplished primarily through the use of two additional registers, the Peripheral Control Register (PCR) and the Interrupt Flag Register (IFR). It is not possible to check the logic state of this handshake line but a logic signal change can be detected.

The PCR controls the mode of operation of the input handshake line. If a positive transition (low to high) is to be detected on this line then a single bit must be set in the PCR. This same bit must be cleared to allow the detection of a negative transition (high to low). The fact that an active transition has occurred on the edge-sensitive line will be signalled by the setting of a flag in the IFR.

The relationship between the PCR and IFR is summarised in Fig. 1.20.

If the binary value 1 is placed in the correct bit position in the PCR the flag in the IFR will be set on an active positive transition on the handshake line. (To detect an active negative transition it is

Example 1

Set bit 7 in the I/O register and hence switch a relay on P7 without affecting the status of other output lines.

Use logical operator OR.

BIT NUMBER	7	6	5	4	3	2	1	0
ARGUMENT 1	0	0	1	0	0	0	0	0
ARGUMENT 2	1	0	0	0	0	0	0	0
RESULT	1	0	1	0	0	0	0	0

BBC Model B microcomputer:

```
10 ?65122=240
20 ?65120=?65120OR128
```

VIC-20 microcomputer:

```
10 POKE37138,240
20 POKE37136,PEEK(37136)OR128
```

PET microcomputer:

```
10 POKE59459,240
20 POKE59457,PEEK(56457)OR128
```

Commodore 64 microcomputer:

```
10 POKE56579,240
20 POKE56577,PEEK(56577)OR128
```

Example 2

Clear bit 6 in the I/O register and hence close a relay on line 6 without affecting the status of other output lines.

Use logical operator AND.

BIT NUMBER	7	6	5	4	3	2	1	0
ARGUMENT 1	1	1	1	1	0	0	0	0
ARGUMENT 2	1	0	1	1	1	1	1	1
RESULT	1	0	1	1	0	0	0	0

BBC Model B microcomputer:

```
10 ?65122=240
20 ?65120=?65120AND191
```

VIC-20 microcomputer:

```
10 POKE37138,240
20 POKE37136,PEEK(37136)AND191
```

PET microcomputer:

```
10 POKE59459,240
20 POKE59457,PEEK(56457)AND191
```

Commodore 64 microcomputer:

```
10 POKE56579,240
20 POKE56577,PEEK(56577)AND191
```

Example 3

Check whether bit 1 in the I/O register is set and hence decide whether the P1 input line is logic high.

Use logical operator AND.

BIT NUMBER	7	6	5	4	3	2	1	0
ARGUMENT 1	0	1	0	0	1	0	1	0
ARGUMENT 2	0	0	0	0	0	0	1	0
RESULT	0	0	0	0	0	0	1	0

BBC Model B microcomputer:

```
10 ?65122=240
20 IF?65120AND2THEN40
30 GOTO 20
40 PRINT"LOGIC HIGH"
50 END
```

VIC-20 microcomputer:

```
10 POKE37138,240
20 IFPEEK(37136)AND2THEN40
30 GOTO 20
40 PRINT"LOGIC HIGH"
50 END
```

PET microcomputer:

```
10 POKE59459,240
20 IFPEEK(59457)AND2THEN40
30 GOTO 20
40 PRINT"LOGIC HIGH"
50 END
```

Commodore 64 microcomputer:

```
10 POKE56579,240
20 IFPEEK(56577)AND2THEN40
30 GOTO20
40 PRINT"LOGIC HIGH"
50 END
```

BBC MICROCOMPUTER

```
1Ø ?65122=24Ø
2Ø ?65132=?65132OR16
3Ø IF?65133AND16THEN5Ø
4Ø GOTO3Ø
5Ø PRINT"FLAG SET"
6Ø ?6512Ø=Ø
7Ø END
```

VIC-20 MICROCOMPUTER

```
1Ø POKE37138,24Ø
2Ø POKE37148,PEEK(37148)OR16
3Ø IFPEEK(37149)AND16THEN5Ø
4Ø GOTO3Ø
5Ø PRINT"FLAG SET"
6Ø POKE37136,Ø
7Ø END
```

PET MICROCOMPUTER

```
1Ø POKE59459,24Ø
2Ø POKE59468,PEEK(59468)OR1
3Ø IFPEEK(59469)AND2THEN5Ø
4Ø GOTO3Ø
5Ø PRINT"FLAG SET"
6Ø POKE59457,Ø
7Ø END
```

The corresponding program for the **Commodore 64 Microcomputer** will be published later in the series.

---

necessary to clear the correct bit position in the PCR.)

The Commodore 64 has a Complex Interface Adapter (CIA) rather than the VIA that has been discussed. The edge sensitive handshake line will set bit 4 in the Interrupt Control Register (memory location 56589) on a negative transition on the Flag 2 line.

The programs listed below show how the handshake line might be used to detect an active transition:

LINE 10—sets up the data direction register so that the user port signal lines are mixed inputs and outputs (P7–P4 outputs, P3–P0 inputs).

LINE 20—determines the nature of the active transition which will trigger the handshake flag using the peripheral control register.

LINE 30—starts a loop to check whether the handshake flag in the interrupt flag register has been set.

LINE 60—writes a "dummy" variable to the I/O register which clears the handshake flag in the IFR.

It must be stressed that once the flag in the IFR has been set it will remain so unless some operation clears it. This can be achieved by explicitly clearing the correct bit in the interrupt flag register or a dummy read or write to the I/O register as shown above.

ZX81 users can follow this series by adding an I/O User Port to their machine. Such a device will be the subject of our *Special Report* next month.

Next month: **Experiments with the User Port Control Board.**

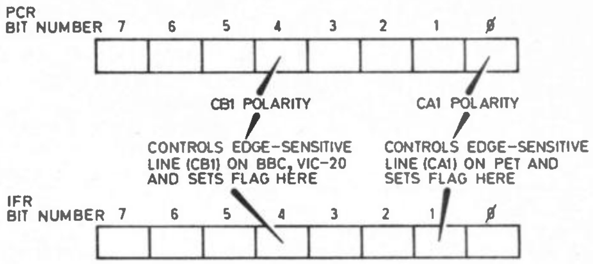
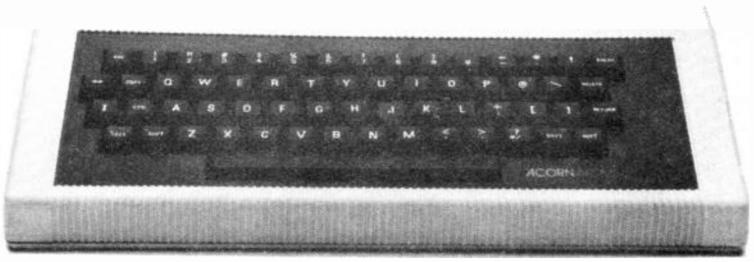


Fig. 1.20. The relationship between the PCR (Peripheral Control Register) and the IFR (Interrupt Flag Register).

CYCLIC REDUNDANCY CHECK for the ACORN ATOM



BY R.A. HALL

What is CRC? The initials CRC stand for Cyclic Redundancy Check. What does it do? There is no short answer to that question but it is possible to explain it as follows.

Consider any part of the memory in a linear way, for example a piece of tape on which is printed a series of 0's and 1's (binary digits or bits). Each of these bits are used in blocks of eight (known as a byte). Imagine that the tape is passing in front of you from right to left and that you are looking through a window such that you can see only two bytes (16 bits) at a time. As the tape moves to the left, a time will come when a 1 will appear at the left side of the window.

When this occurs the right-hand side 8-bits are Ex-ORed with #2D. At the instant that the end of the tape is reached the number that is remaining in the window is a unique number for that particular piece of tape—or area of memory. It is this uniqueness that prompts the choice of the word "signature"—once a signature for a program has been obtained, if so much as one bit is subsequently in error, its presence will be indicated by a different signature.

In practice locations #A0, #A1 are used as the window and the accumulator is used to put the next 8-bits of memory into the window so the memory itself remains undisturbed. Locations #90 and #91 are used to "point" to the memory area being looked at and #92 and #93 hold the "end" address.

WHY DO ATOM USERS NEED CRC?

Normal named files (programs) have a sum error check but this is not infallible as occasions have frequently arisen where one error cancels another one out, hence a real error has slipped through and the program crashes when RUN is executed. This presents no problem if the offending error is in a PRINT statement for example, but when it occurs in an operational instruction the consequences are fatal.

Many machines use a true CRC check as the program is transferred from tape to memory—the Atom has one built in if you are fortunate enough to be a disc user.

The reason for the Atom failing with the checksum is this: the program tape-header stores a number (mod 256) that is the sum of all the bytes in the block. Each byte of course has its own hex value. Therefore it is similar to the following sum where the result is the same but the string of figures giving the result is not.

$$3+5+7+9+1+1+3 = 29$$
$$3+5+9+9+1+1+1 = 29$$

The result, 29 represents the "checksum" and the other numbers represent the individual bytes.

The only disadvantage with the Atom CRC is that it is lost when you switch off the power to the computer. I have found also that a couple of games' programs wish to be resident in part of the same area of memory and as a result the CRC gets shunted about a little when the main program is run.

In machines with "built in CRC" it is contained in the ROM, but Atom users will have to be content to store their CRC in a little used RAM area.

Most programs reside in the area #2900 to #3BFF in the expanded version. For many reasons we often need to know if the program we've just dumped to tape is a good copy, that is, will it reload satisfactorily? The only way to do this is to reload it and RUN it, but if the reloaded program is faulty we've just written over the original—and lost it!

On many other machines such as the BBC for example, you could dump your known good program to tape and *LOAD. The program enters the computer (it will not actually be kept), and a CRC is done and any loading errors will be indicated—no errors means a good load, that is, there is a good copy on tape. If any errors are indicated we still have the original program and can save it again.

You can, with the program given here, do this with the Atom. It's not quite so easy as the direct ROM-type CRC obviously but you are now able to carry out such a check and ensure that you have a good copy.

The procedure is:

1. Load the CRC program.
2. Write/load a program into #2900 to #3BFF.
3. Make sure it is a good working program.
4. Save the program.
5. *Load the program into the area commencing at #8200 (graphics area).
6. Obtain a CRC signature for both programs.

If the signatures are the same then so are the programs—down to the last bit. However do not be led to believe that if the signatures happen to be one hex digit different then the program error consists of only one byte—not true.

If the signatures and hence the programs are not identical the possible causes are:

1. Correct save to tape but bad reload.
2. Correct save and reload but the indicated error is in fact caused by a RAM fault; this is very unlikely but not impossible.
3. Bad save to tape caused by (usually) poor tape or tape-recorder mis-match.

It is now your task to decide exactly what the cause is. CRC will tell you if there is an error but, sadly, will give no indication as to where the error is. If the error happens to be situated where it does not matter (for example, in a PRINT statement) so much the better—otherwise it is possible to repeatedly bisect the program and check each half until the error is located.

WHERE DO WE STORE THE CRC?

It seems that the area #3CA to #3FC is free to store the CRC, except possibly for disc systems—but then you're not interested in CRC anyway. Also #21C to #23F is free and it is in these areas that the two parts of the CRC are stored.

THE PROGRAM

The program uses ROM routines and it can best begin by typing in the "Source" program shown right.

This program is in BASIC and can be saved in the usual way, after having RUN it. After running the program the machine code will be located from #21C to #3CA. As there is a considerable area between the two machine code blocks that is unwanted you may choose whether to *SAVE #21C to #3FF (30 seconds at 300 baud) or SAVE the two separate blocks #21C to #23F and #3CA to #3FF. Furthermore you may choose to save these as named or unnamed programs. I used CRC at 1200 baud in one block and it takes just five seconds to load. I keep it at the front of a tape, hence it is easy to find.

Keying <BREAK> will not destroy it—that is only done by switching off the power.

Having loaded the program you use it by typing LINK#3CA. An "S" (for start of area) will appear and you type in, omitting the # prefix, the location you wish to start at, press <RETURN> and an "E" will appear. Here, type in the memory location you wish to finish at, press <RETURN> and after a few seconds up pops the signature. Try S=C000, E=CFFF and you should get D67D—quick isn't it?

If you have a DISATOM chip fitted then type !#180=#3CA and instead of LINK#3CA you can use <SHIFT> X to use the check.

```
 20P.$21
 25!£180=£3CA
 30P=£3CA;[
 40LDA@£53
 50JSR£CD0F
 60LDY@£00
 70LDX@£90
 80JSR£F893
 90LDA@£45
100JSR£CD0F
110LDY@£00
120LDX@£92
130JSR£F893
140LDY@£00
150STY£A0
160STY£A1
170JSR£021C
180LDX@£90
190JSR£FA08
200BNE£03E8
210JSR£021C
220LDX@£A0
230JSR£F7F1
240JMP£C55B;]
260P=£21C;[
270LDX@£08
280CLC
290LDA(£90),Y
300LSR A
310ROL£A0
320ROL£A1
330BCC£0230
340PHA
350LDA£A0
360EOR@£2D
370STA£A0
380PLA
390DEX
400BNE£0221
410RTS
415]
420P.$6
430END
```

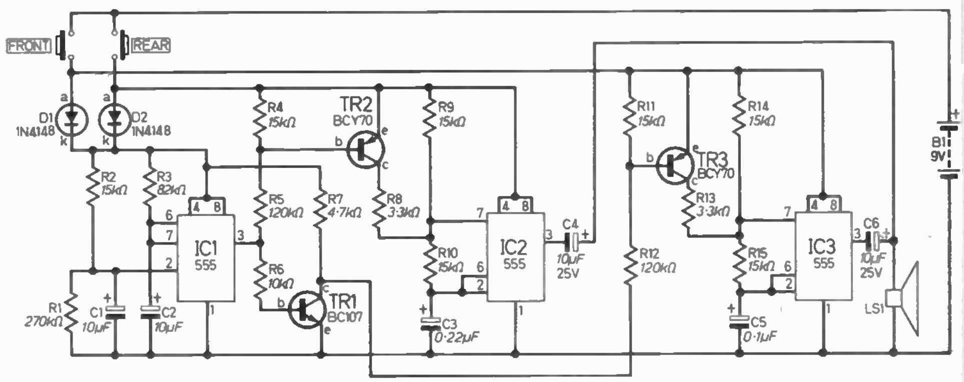
```
d021C A2 08      LDX@£08
d021E 18         CLC
d021F B1 90      LDA(£90),Y
d0221 4A         LSR A
d0222 26 A0      ROL £A0
d0224 26 A1      ROL £A1
d0226 90 08      BCC £0230
d0228 48         PHA
d0229 A5 A0      LDA £A0
d022B 49 2D      EOR@£2D .-
d022D 85 A0      STA £A0
d022F 68         PLA
d0230 CA         DEX
d0231 D0 EE      BNE £0221
d0233 60         RTS

d03CA A9 53      LDA@£53 .S
d03CC 20 0F CD   JSR £CD0F
d03CF A0 00      LDY@£00
d03D1 A2 90      LDX@£90
d03D3 20 93 F8   JSR £F893
d03D6 A9 45      LDA@£45 .E
d03D8 20 0F CD   JSR £CD0F
d03DB A0 00      LDY@£00
d03DD A2 92      LDX@£92
d03DF 20 93 F8   JSR £F893
d03E2 A0 00      LDY@£00
d03E4 84 A0      STY £A0
d03E6 84 A1      STY £A1
d03E8 20 1C 02   JSR £021C
d03EB A2 90      LDX@£90
d03ED 20 08 FA   JSR £FA08
d03F0 D0 F6      BNE £03E8
d03F2 20 1C 02   JSR £021C
d03F5 A2 A0      LDX@£A0
d03F7 20 F1 F7   JSR £F7F1
d03FA 4C 5B C5   JMP £C55B
```

Acknowledgements for the thinking behind this program must go to J. C. Rockett and J. R. Stevenson, these are genuine people of Procyon Ltd. who have allowed me to pick their brains, unravel some of the delectable mysteries of the Acorn Atom and appreciate what an excellent micro it really is. □

CIRCUIT EXCHANGE

TWO-WAY DOORBELL

Most doorbells sound exactly the same whether front or back door buttons are pressed. This can cause all sorts of problems; which door do you answer when you hear the bell ring? The circuit given here solves this problem; the front produces a "ding-dong" sound, whilst the back door produces a "dong-ding". The circuit consists of two 555 astable oscillators, IC1, 2, and one 555 monostable, IC3. When the front button is pressed, D1 conducts and C1 is charged through R1, setting the monostable, which produces a half-second pulse.



Oscillator IC2 produces a high frequency note, which is lowered when TR2 is switched off by the monostable. Hence the note produced will be a "ding-dong" sound. The back doorbell works in a similar way, but this time the monostable output is inverted by TR3 to produce the opposite effect — a "dong-ding".

Tony Johns,
E. Grinstead,
Sussex.

MORE ON PAGE 435

AUTOMATIC GREENHOUSE WATERING SYSTEM

BY J. LEWIS

A MAJOR problem of greenhouse or conservatory cultivation is that of ensuring adequate watering, especially when the owner is away on holiday.

Commercial watering systems are far from cheap and usually supply drips of water at regular intervals regardless of the weather conditions. Thus on hot days the plants may be underwatered but on cool days they receive too much water. The automatic system described here allows the plants to take as much water as they need and enables them to be left for a long time with a minimum of attention.

UNIT DESCRIPTION

The greenhouse plants should be in plastic pots in large shallow gravel trays lined with capillary matting. This is readily available in rolls from garden centres and is easily cut to size. The matting must overhang the edge of the bench and dip into a trough of plastic rainwater gutter which is fixed on the edge of the bench, as shown in Fig. 1.

The gutter contains water and this is drawn up by capillary action so that the matting on the trays is always wet. The compost of all the plants will then be kept at the correct moisture level.

The main water reservoir is a large bucket or dustbin full of water. A probe detects the water level in the gutter and an electronic circuit controls an electric windscreen washer pump which refills the gutter from the main reservoir. A probe in the main water reservoir detects when it is empty and this prevents the pump from operating. If this were not included then the pump would operate continuously if the main water reservoir ran dry.

CIRCUIT DESCRIPTION

Transistors TR2 and TR4 are connected as a high gain Darlington pair as shown in Fig. 2. When the probes (across TB1/1 and TB1/2) in the gutter are wet, sufficient current flows in the base of TR2 to turn on the transistors and produce a logic 0 at pins 1 and 2 of IC1a; a logic 1 is produced on these pins when the probes are dry.

The probes across TB1/3 and TB1/4 in the main water reservoir are connected to transistors TR1 and TR3. These transistors are connected as a Darlington pair in the emitter follower mode. Water connecting the probes produces a logic 1 at pins 4 and 5 of IC1a, while lack of water produces a logic 0 on these pins.

IC1a is a TTL 4-input NAND gate with a Schmitt trigger action which ensures a very reliable switching action as the water level changes. When the main water reservoir is sufficiently full and the gutter water level has fallen to below the probe, all the inputs to IC1a are at logic 1 and the output on pin 6 is at logic 0. After inversion by IC1b, a logic 1 is produced on pin 8 and this logic state causes the pump to be switched on to restore the water level in the gutter.

When the gutter probes are once more wet, pin 8 goes to a logic 0 which switches off the pump. If the water level in the main water reservoir falls to uncover the probes this also puts a logic 0 on pin 8 which prevents the pump from operating regardless of the state of the gutter probes.

No damage will be caused to the cir-

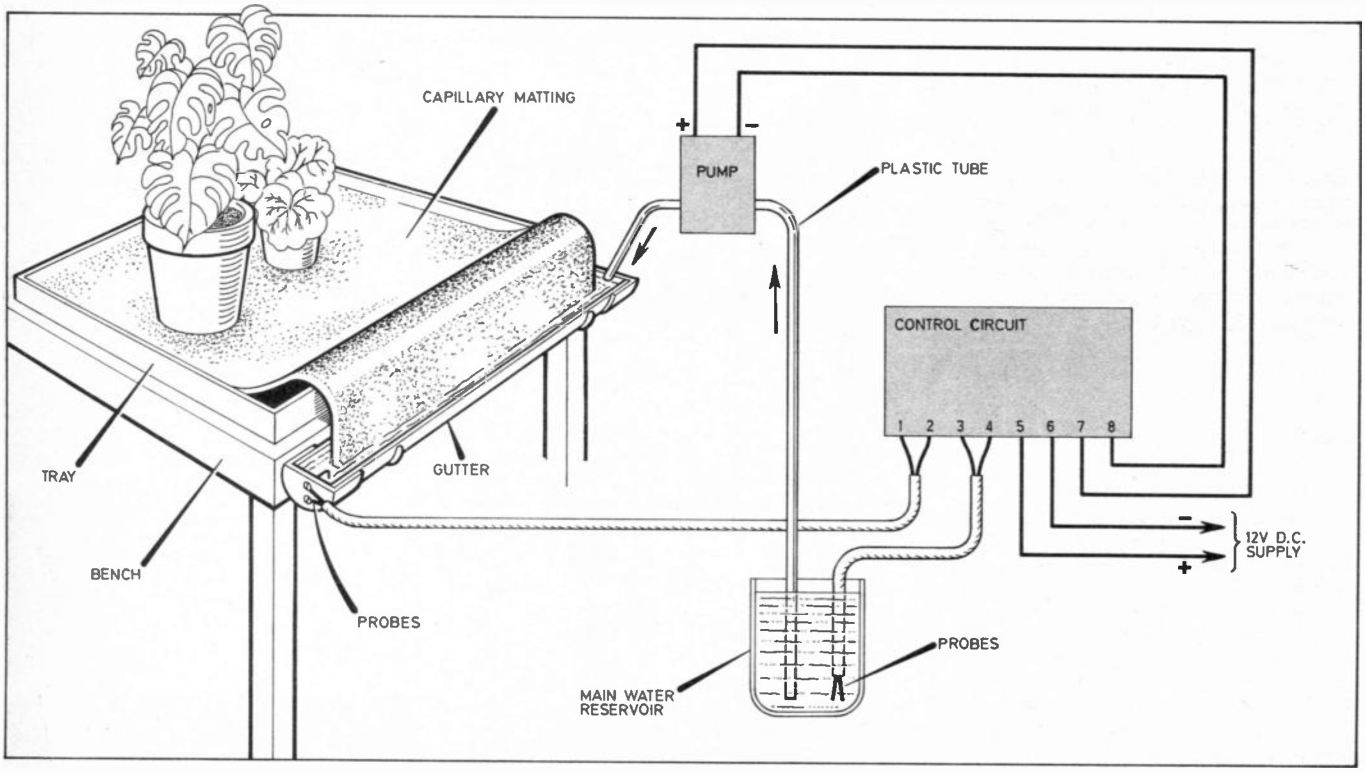


Fig. 1. Complete installation diagram for the Automatic Greenhouse Watering System showing the positioning of the capillary matting.

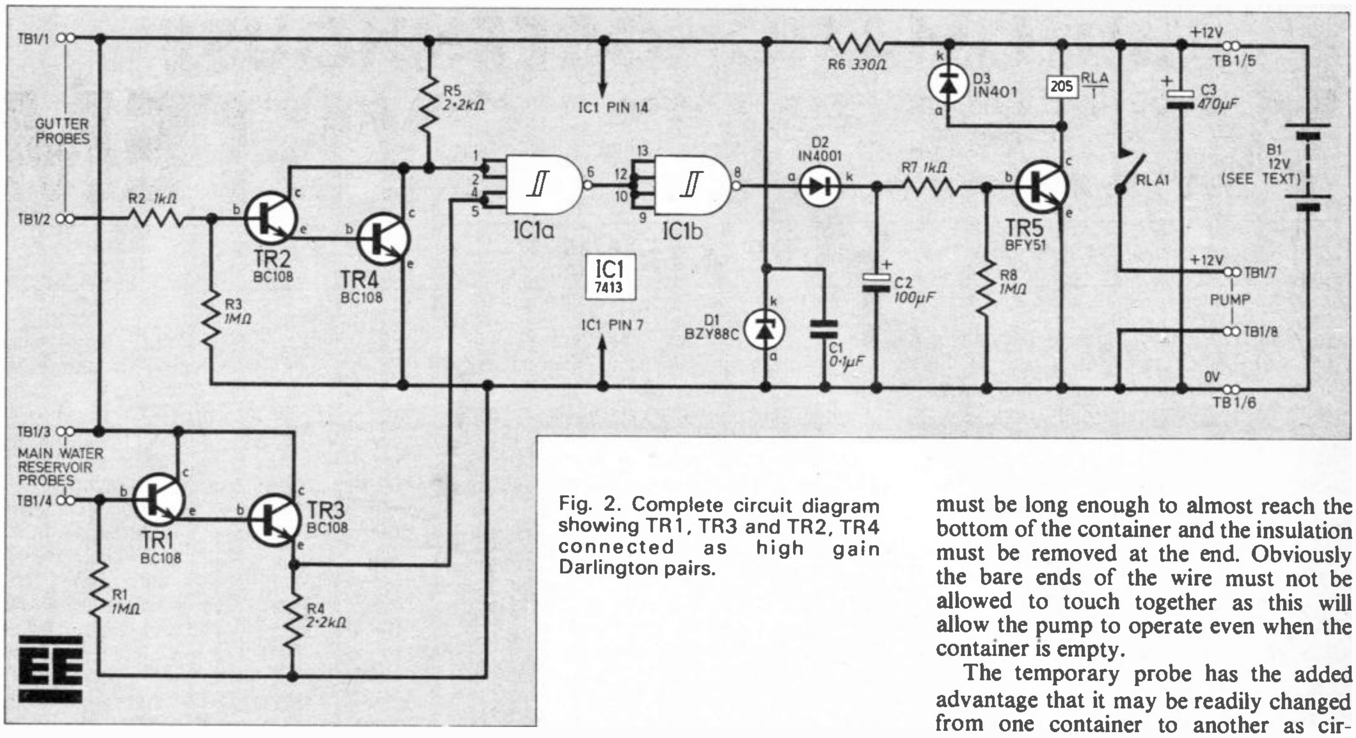


Fig. 2. Complete circuit diagram showing TR1, TR3 and TR2, TR4 connected as high gain Darlington pairs.

cuit if the probes are accidentally short-circuited.

The output from IC1b on pin 8 switches on transistor TR5 which controls the current through the relay RLA. The relay contacts are normally open, and close to connect the pump (connected across TB1/7 and TB1/8) to the 12V supply. The charge stored in capacitor C2 keeps the pump switched on for a few seconds after the gutter probes are wet. This reduces the frequency of on-off operations of the pump.

Diode D3 prevents damage to transistor TR5 as the current through the relay coil is switched off. Resistor R6 and Zener diode D1 produce a stable 5V supply from the main 12V supply for IC1 which is a TTL integrated circuit. C1 removes any noise spikes from the 5V supply line and C3 helps to smooth the main 12V supply. This supply is connected via TB1/5 and TB1/6.

CONSTRUCTION

COMPONENT BOARD

The components are laid out on a piece of 0·1 inch matrix stripboard which is 16 strips by 51 holes and the layout is shown in Fig. 3. A 14-pin d.i.l. socket is recommended for the integrated circuit which should only be inserted when all the soldering is completed. Care should be taken not to overheat the transistors and diodes while soldering them into position. The integrated circuit is a TTL device and so it can be handled without worrying about static electricity.

Note that the diodes and electrolytic capacitors must only be connected one way round. Incorrect connection will result in damage to the components. When the circuit is operating satisfactorily a coat of waterproof varnish will help to prevent ill-effects from moisture. It should also be fitted into a moisture-proof box with the terminal block (TB1) on the outside. The terminal block connections are shown in Fig. 4.

GUTTER PROBE

The lower probe is simply a one inch long 2BA bolt which is bolted firmly at the bottom of the end section of the gutter. A washer is required on both sides of the plastic section and a solder tag gives a good electrical connection.

The upper probe is made from thick copper wire, one end of which is bolted to the end section of the gutter. The other end of the copper wire is sharply pointed and touches the water surface at right angles (Fig. 5).

The correct water level must be determined by experiment. If it is too low then capillary action will not be strong enough and the mat will be too dry. Too high a water level will make the mat far too wet; a vertical rise of about 75mm should be about right. The weight of water in the gutter could be substantial and enough support clips should be used.

MAIN RESERVOIR PROBE

Two bolts may be fitted low down on the main reservoir although this may be left until the choice of container has been finalised.

A temporary probe may be made from twin core cable secured at the top of the reservoir by a bulldog clip. The cable must be long enough to almost reach the bottom of the container and the insulation must be removed at the end. Obviously the bare ends of the wire must not be allowed to touch together as this will allow the pump to operate even when the container is empty.

The temporary probe has the added advantage that it may be readily changed from one container to another as circumstances dictate.

COMPONENTS

Resistors

R1,3,8	1MΩ (3 off)
R2,7	1kΩ (2 off)
R4,5	2·2kΩ (2 off)
R6	330Ω 1W

All $\frac{1}{8}$W carbon ±5% unless otherwise stated

Capacitors

C1	0·1µF ceramic
C2	100µF 25V elect.
C3	470µF 25V elect.

Semiconductors

D1	BZY88C 5·1V 400mA Zener diode
D2,3	1N4001 rectifier (2 off)
TR1,2,3,4	BC108 *npn* silicon (4 off)
TR5	BFY51 *npn* silicon
IC1	7413 TTL dual 4-input Schmitt trigger NAND gate

Miscellaneous

RLA	Miniature high power relay, 12V, 120–205Ω coil, contacts rated at 12V, 7A

Case, 135 × 50 × 46mm (A8S case type 2005); 0·1 inch matrix stripboard 16 strips by 51 holes; 8-way terminal block; connecting wire.

Approx. cost Guidance only £10.00

see SHOPTALK page 427

POWER SUPPLY

A 12V d.c. supply capable of providing about 4A is required. Obviously, a greenhouse is a difficult place to use mains electricity and great care must be taken to ensure complete safety. This means the use of an earth leakage circuit breaker and a top quality electrical system.

The power supply could be situated in a garage or similar building near the greenhouse and the 12V supply could be fed to the greenhouse through a suitable heavy duty cable.

If a suitable supply is not available then a fully charged car battery should give enough power for a week or so. Obviously the owner should check this before going on holiday. Dry batteries are unlikely to supply the heavy current drawn by the pump for any length of time.

PUMP

The pump is a car windscreen washer pump which can be purchased from any car accessory shop. Care must be taken to connect it the right way round, this should be clearly marked on it.

The end of the tubing in the reservoir should be covered with a filter to prevent damage to the pump caused by dirt. It may be necessary to also weight this end of the tube to prevent if from lifting out of the water.

At the gutter end of the tubing it is important that the water is not pumped in too close to the probe to prevent erratic switching.

CASE

As previously mentioned it is advisable to mount the component board in a moisture-proof box, and any box with dimensions 135 × 50 × 46mm should be suitable. □

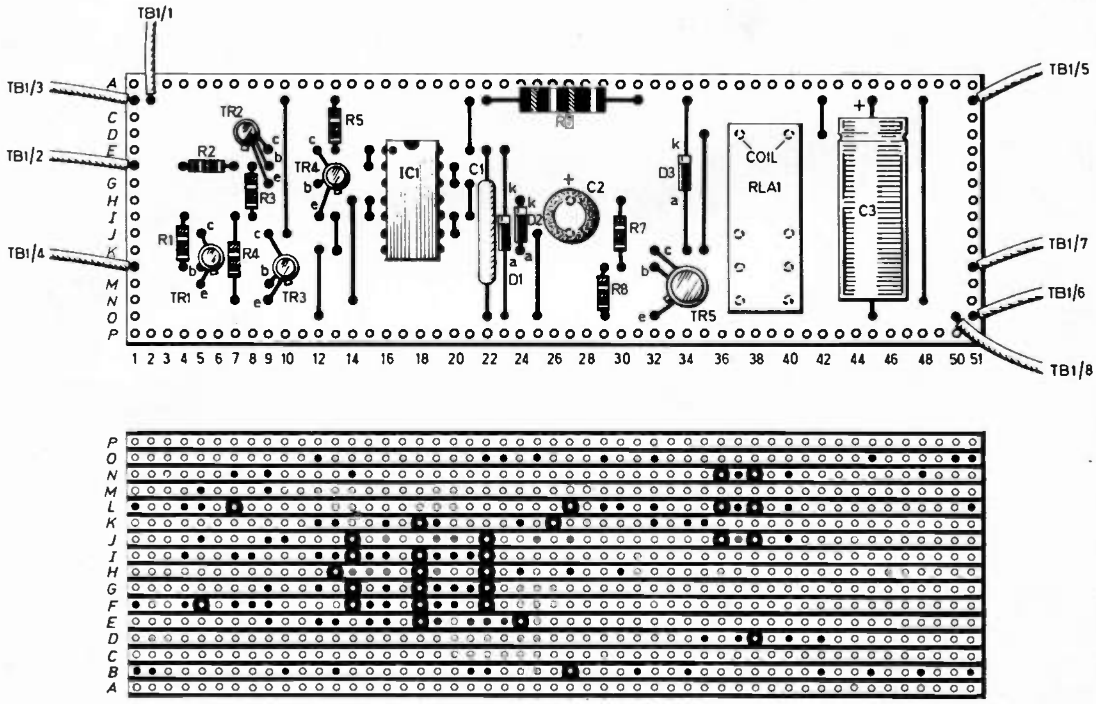


Fig. 3. The layout of the components on the topside of the board with the breaks in the copper strips shown on the underside.

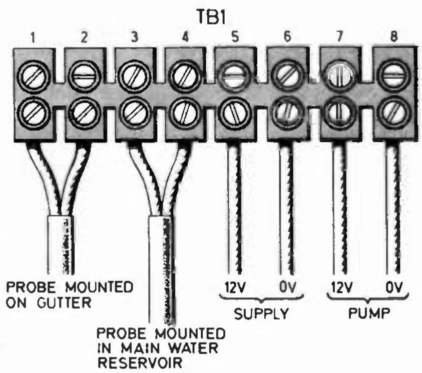


Fig. 4. Terminal block connections.

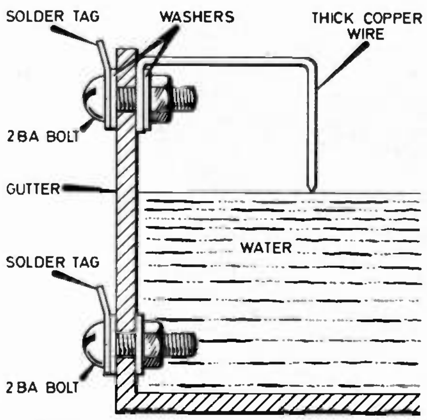
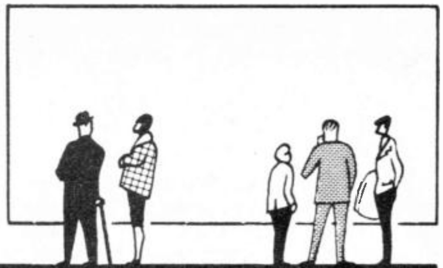


Fig. 5. Suggested mounting arrangements for the gutter probes.

SHOP TALK



BY DAVE BARRINGTON

Soldering Kit

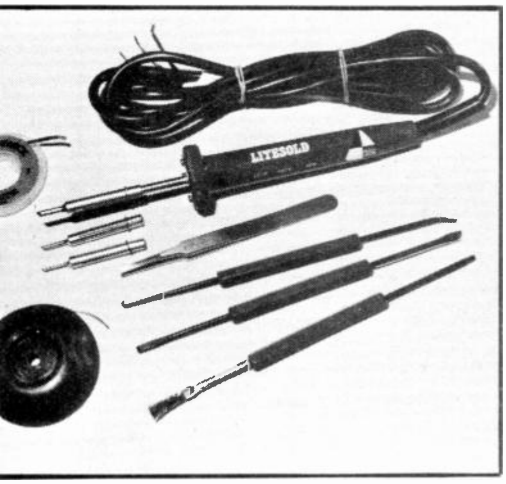
A new soldering kit that provides all that is necessary for soldering and desoldering of most electronic projects, and is ideal for beginner and expert alike, has just been put together by **Light Soldering Developments.**

Designated the SK18, the kit is centred around their high efficiency 18W mains iron, which won a Design Centre Award. The iron is fitted with a 3·2mm "slide-on" copper bit. Two alternative, 1·6mm and 2·4mm, bits are included.

Also provided are a 3 metres reel of 18 s.w.g. flux-cored solder, stainless steel tweezers, three double-ended soldering aid tools and a reel of desoldering braid. The desoldering braid acts like a wick and when immersed in molten solder around a connection draws the liquid solder away from the joint, allowing removal of the suspect component.

The SK18 comes in a clear p.v.c. wallet and is available direct from Litesold at a special mail-order price of £14.55, including postage and VAT. Further details and order forms can be obtained from: **Light Soldering Developments Ltd., Dept EE, 97/99 Gloucester Road, Croydon, Surrey CR0 2DN.**

The SK18 Soldering Kit from Light Soldering Developments.



CONSTRUCTIONAL PROJECTS

Greenhouse Watering System

The relay used in the *Greenhouse Watering System* prototype was a miniature mains relay with 5A contacts. This was obtained from Maplin, order code YX98G. It is quite in order to use other relays provided the contacts are rated at 5A or above, and the coil resistance is approximately 120 to 300 ohms.

The pump used to circulate the water was a Unipart car windscreen washer pump suitable for a Mini. Many of the motor spares shops carry windscreen washer pump kits and these may be worth further investigation.

Pulse Generator

The mains transformer used in the *Pulse Generator*—Test Gear '83 Series—is a printed circuit board mounting type. The prototype used a 6VA PC Mounting (3VA per sec.) obtained from Verospeed, order code 89-21542A. This transformer has two 9V secondary windings.

The Siemens type capacitors are stocked by Electrovalue, Ambit, Cricklewood and Rapid Electronics. The semiconductors should be available from Cricklewood, Rapid, Magenta and Circuit Board Components.

Digi Alarm Wristwatch Amplifier

The Electret microphone insert for the *Digi Alarm* is available from most Tandy stores and carries the catalogue number: 270-092A. Several of our advertisers stock similar devices and these can be used in this circuit. However, they have not been bench tested.

The reed relay is a 6 to 9V type (RS 249 092A) and the 3 to 16V audible warning device (RS 249 794) should be ordered through your local RS Components stockist.

Tri Boost Guitar Tone Controller

As the circuit board for the *Tri Boost* is supported by the "range" control VR1, it is important to use a p.c.b. mounting potentiometer. These are stocked by most of our component advertisers.

Inductors with values of up to 4 Henrys are readily available from Maplin, but a useful alternative to keep in mind is that miniature p.c.b. type transformers, such as the LT700, can be used as inductors. These can be bought fairly cheaply, or, of course, salvaged from old transistor radios.

The actual value of their inductance need not be known since it is just a matter of "trial by ear" to combine the right values of capacitors to give the desired effect.

Binary Bandit Game

The press switches used in the prototype *Binary Bandit* are the types stocked by multistores for light switches. However, any suitable switch may be used here.

Be sure to obtain the press-to-break and press-to-make types. It may be wise to order from one of our advertisers as they will understand what is required when purchasing.

Microcomputer Interfacing Techniques

Most of the components used in the *Microcomputer Interfacing Techniques* projects are listed by RS Components and can be ordered through any *bona fide* trader. They will not supply to the general public.

A similar d.i.l. switch, RS code 335-801, for the *User Port I/O* board is also available from Maplin: order code XX27E.

The i.d.c. ribbon cable for connecting the boards to the computer is now stocked by most advertisers. The connector at one end of the cable will have to match the computer used and readers should consult their manual and computer supplier.

The p.c.b. 0·2in terminal blocks used in the *User Port Control* board are made by Bulgin and available through RS stockists.

Any relay that is capable of working from 5V and has a coil resistance greater than 300 ohms will suffice. The type used in our model was a p.c.b. reed relay stocked by RS and should be ordered as: 348 970 form A code Green.

The p.c.b. has been designed around the RS relay and if an alternative type is used "flying" leads may need to be attached to the relays and then wired to the board.

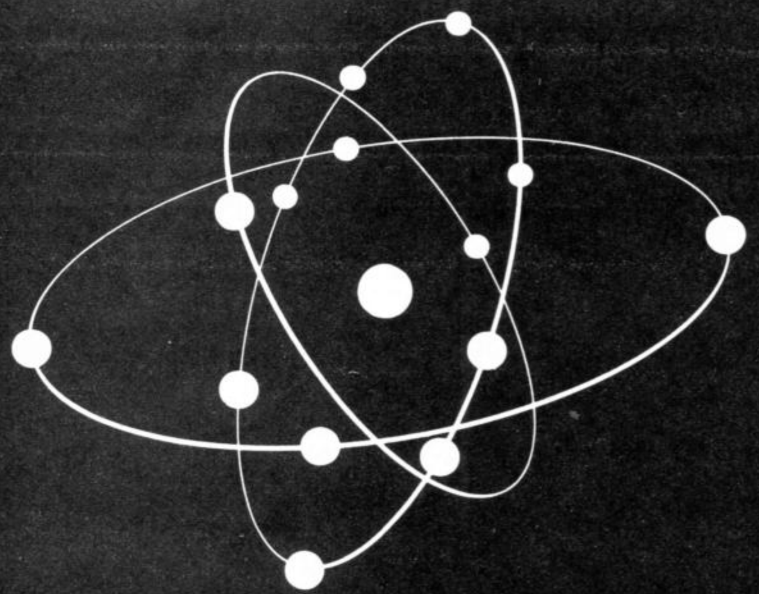
The ULN2003 7-stage Darlington driver appears to be only available from RS and Cricklewood Electronics. The OP12252 opto-isolator may be substituted with the IL74. Both the IL74 and the ILQ74 opto-isolators are available from Bi-Pak.

EE PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE PCB Service. These are fabricated in fibre-glass, 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.

PROJECT TITLE	Order Code	Cost
Eprom Programmer (TRS-80)	8306-01	£6.95
Eprom Programmer (Genie)	8306-02	£6.95
Eprom Programmer (TRS-80 & Genie)	8306-03	£1.50
Microcomputer Interfacing Techniques		
User Port Input/Output	8307-01	£2.65
User Port Control	8307-02	£2.85

ELECTRONICS and the ELECTRON



Part 3 CONDUCTION IN VARIOUS MATERIALS

BY J.B. DANCE

LAST month we reviewed the basic ideas of conduction in various materials. We will now look a little deeper into this matter.

CURRENTS IN METALS

When a current flows in a metal, the negatively charged electrons have to make their way amongst the atoms in the material towards the positive connection. If the temperature of the metal rises, the atoms are agitated to a greater extent by the heat energy and tend to get in the way of the electrons proceeding towards the anode.

Thus the resistance of a metal increases with rising temperature and the mobility of the electrons falls as their frequency of collision with the atoms increases. The rate of increase of the resistance of a metal with temperature is not very great. An increase of resistance is, of course, the same as a fall in the conductivity.

Let us now try to look more closely at the electrons in a metal. First of all let us assume that no voltage is applied across the metal. The heat energy in the metal causes the electrons to move rapidly in random motion, rather like a swarm of bees in an enclosed box, but there is no general trend for them to move in any particular direction. This random motion occurs with all small particles and is known as the *Brownian movement*.

The random movement can be stopped only by cooling the material to the absolute zero of temperature. The speed at which the electrons move in their random motion is very high—something like 100,000m/sec or 224,000 miles per hour or 62 miles/second. However, the electrons seldom move more than one hundred millionth of a centimetre (about the diameter of an atom) before they undergo a collision.

NOISE

The random movements we have been describing constitute electric currents, although we do not often notice such current, since on an average the flow of an electron in one direction is usually balanced by the flow of another one in the opposite direction.

These minute randomly directed electric currents in the input circuits of high gain amplifiers do appear as "noise" in the loudspeaker to which the amplifier is connected. However, this is not the only cause of noise. The frequency of the noise generated by the random currents extends over an extremely wide frequency bandwidth; it is known as "white noise" because, like white light, it consists of a mixture of all frequencies. Such noise is heard as a hiss, since the high frequencies are heard more prominently than the low frequencies.

STEADY CURRENTS

We will now consider the flow of electrons in a metal under an applied voltage. A single electron carries a charge of $1{\cdot}6 \times 10^{-19}$ coulomb; thus the number of electrons carrying a charge of 1C is $1/1{\cdot}6 \times 10^{-19} = 6{\cdot}25 \times 10^{18}$ (= 6,250,000,000,-000,000,000) electrons. This enormous number of electrons is required because the charge of an individual electron is so very small.

A current of 1 amp flows when 1 coulomb of charge flows past any point in the circuit each second. Thus this current consists of a flow of $6{\cdot}25 \times 10^{18}$ electrons per second.

SPEED

There are an enormous number of free electrons in a piece of copper—about 10^{23} electrons per cm^3. If we assume they all move under an applied voltage, the

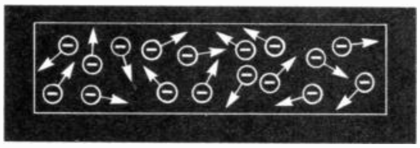


Fig. 3.1. The random motion of electrons in a piece of metal; this random movement is due to the heat energy agitating the electrons.

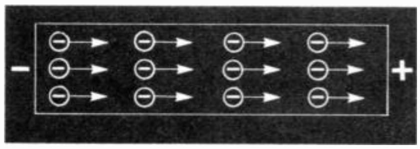


Fig. 3.2. The steady movement of electrons towards the anode. The random motion superimposed on this steady motion is not shown here.

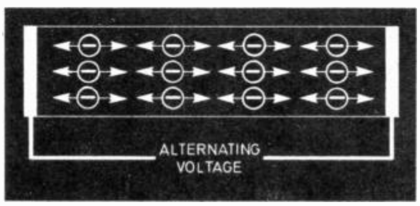


Fig. 3.3. The to and fro motion of electrons in a wire under an alternating voltage. The random motion is not shown.

speed at which the electrons move towards the positive connection in a block of metal of 1sq cm in cross section will be about $6 \cdot 25 \times 10^{18}/10^{23}$ or roughly 0·00006cm/sec when current is 1 amp.

In the case of a wire of small diameter, the rate at which the electrons flow at the same current of 1 amp will be much greater. For example, in a wire of cross sectional area $0 \cdot 1\text{mm}^2$, the mean rate of flow will be roughly 0·06cm/sec, but this velocity is still quite small.

Superimposed on the general tendency of the electrons to flow in the direction of the applied field is the far faster random motion we have discussed previously. The electron cloud moves forward very slowly as a whole, whilst the individual electrons are "buzzing around like flies" at a high speed.

ALTERNATING CURRENTS

If one considers an electron flowing in a wire which carries a current at the normal 50Hz mains frequency, it will have a slow "to and fro" motion imposed on top of its random thermal motion. It moves in one direction for only 1/100 second before it moves in the opposite direction for the same time. The distance it moves in each direction in a wire of cross section $0 \cdot 1\text{mm}^2$ is only about $0 \cdot 06 \times 1/100 =$ 0·0006cm when the current is 1 amp.

In the case of an electron in the coaxial lead from an f.m. radio aerial operating at about 100MHz, the amount of movement in each directon is far smaller still. The current flowing may be of the order of

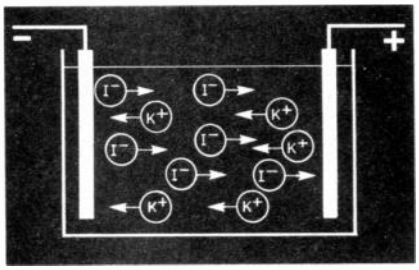


Fig. 3.4. The passage of a current through potassium iodide either as the molten salt or in aqueous solution. (Potassium ions are shown as K^+ and iodine ions as I^-.)

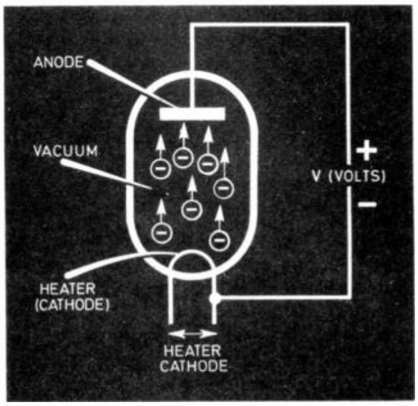


Fig. 3.5. The passage of electrons from a heated cathode to the positive anode in a vacuum tube or thermionic valve.

10µA or 1/100,000 amp. Thus the distance through which an electron moves backwards and forwards during each half cycle is 0·06cm divided by 100,000 and also divided by 200,000,000 (this last factor allows for the 100MHz frequency) if the effective cross sectional area of the lead is $0 \cdot 1\text{mm}^2$.

Thus the electron moves backwards and forwards a distance of only about 0·000,000,000,000,003cm. This is far, far smaller than the diameter of an atom and even much smaller than the diameter of the nucleus of an atom.

Although the electrons move so slowly under electric potentials in metals, the "push" exerted when a voltage is applied across a wire travels very rapidly indeed—nearly at the speed of light if the wire is away from most other materials. Thus signals can travel extremely rapidly in a wire, but it is amazing to think that these signals are being carried along by particles which are themselves undergoing rapid random thermal motion with a very slow general movement under the influence of the applied potential.

Is not truth stranger and more beautiful than science fiction?

CONDUCTION IN LIQUIDS

If one takes a salt, such as potassium iodide or sodium chloride, and tries to pass an electric current through the solid material, one will find that no appreciable current will flow. The material is a good insulator, since although enormous numbers of positive and negative charges are present, these charges are all held firmly in position and are not free to move under the influence of the applied electric field. It is electrostatic forces which hold them.

If, however, the solid salt is melted, it will be found to become conducting. Let us consider the case of potassium iodide. The melting of this solid will free the positively charged potassium ions and the negatively charged iodine ions so that they can move through the material. Any sudden separation of the two kinds of charged ion is out of the question, since if even a small fraction of the ions of either charge came together in one part of the solid, enormous voltages would be developed.

However, when electrodes are put in the liquid and a voltage applied to these electrodes, the positively charged potassium ions move slowly towards the negative electrode and the negatively charged iodine ions move slowly towards the positive electrode. When the iodine ions reach the anode, they give up an electron to the anode and form iodine which is a violet vapour at the temperature of the molten salt. Similarly, potassium metal can be liberated at the cathode.

SOLUTIONS

Pure water contains very few ions and is therefore a very poor conductor of electricity. If some substances such as sugar or alcohol are dissolved in the water, these materials do not form ions and the water remains a very poor conductor.

If, however, a salt such as potassium iodide is dissolved in the water, the presence of the water will reduce the electrostatic forces between the potassium and iodine ions. Both types of ion therefore become free to move towards one of the electrodes. Thus the solution is a conductor of electricity.

We can summarise by saying that salts become conductors when they are either melted or dissolved in water. In addition, solutions of acids or alkalis in water are conductors, but pure water is a very poor conductor. In water which has been exposed to air, even the carbon dioxide of the air increases the conductivity of the water, since it dissolves to form a weak acid (carbonic acid).

When a current is passed through a liquid, chemical changes usually occur. For example, iodine is liberated when a current is passed through a solution of potassium iodide or through this salt in the molten state. An exception is the passage of a current through mercury or any other molten metal where the current is carried by electrons without any chemical change.

The flow of current through an aqueous solution of copper sulphate containing copper electrodes does not produce any net chemical change, but separate chemical changes occur at each of the electrodes with the net result that copper moves from anode to cathode.

ELECTRONS IN A VACUUM

The thermionic valves found in old radio receivers contain a heated cathode in an evacuated tube. The cathode emits electrons; one can think of the electrons as being "boiled off" by the high temperature in much the same way water molecules can be boiled off liquid water.

In a radio valve, X-ray tube, cathode ray tube or other type of electronic tube the emitted electrons are attracted to the anode by the positive potential which is normally applied to the latter. As an electron moves to the anode, it is accelerated and travels faster and faster in the same way that an object falling under gravity.

The speed with which the electron strikes the anode is dependent only on the voltage between the anode and the cathode. If this voltage is V volts the speed at which the electron hits the anode is about $590{,}000\sqrt{V}$ m/sec or $370\sqrt{V}$ miles per second. If the anode to cathode potential is only a modest 100V, the electrons strike the anode with a velocity of 3,700 miles per second.

At very high voltages (above about 10kV) the speed of the electrons arriving at the anode is no longer proportional to the square root of the applied voltage or otherwise they would be moving at speeds greater than that of light when the voltage reaches about 250kV. Einstein's relativity theory shows that neither electrons nor any other type of known particle can move faster than light.

Next month we shall consider the flow of current in semiconductor materials.

DIGI ALARM
WRISTWATCH AMPLIFIER

BY D. E. SMITH

MANY people own a digital watch with a built-in alarm. However, one only needs to have a late night, followed by an important meeting early the next morning, to realise the acoustical inadequacy of the watch's transducer when attempting to wake you.

By setting the alarm on your watch and placing it on top of the Digi Alarm, you are awakened the following morning by a far louder audio signal (80dB at 1 metre), which should awaken even the soundest of sleepers. An l.e.d. is also mounted on the front panel to enable the Digi Alarm to be located in the dark.

CIRCUIT DESCRIPTION

The circuit consists of three main stages: a.f. amplifier, rectifier and relay driver. The digital watch alarm signal is acoustically coupled to the electret microphone insert. The signal then travels via C2 to the base of TR1, which forms an a.f. amplifier. See Fig. 1.

By feeding the amplified signal through C3 to the diodes D1 and D2 the signal is rectified, converting it into a positive voltage. This voltage is used to turn on TR2, which then operates the relay RLA1. When the relay contacts close, a voltage is fed to the audio warning device (WD1) and l.e.d. (D4).

WARNING DEVICE

The time constants of C4 and R4 have been chosen so that WD1 bleeps in time with the digital watch signal. If it is found that WD1 latches on and sounds continuously, changing C4 or R4 to a slightly lower value will cure the problem.

However, should you require the facility for a continuous tone (when triggered by the watch), slightly increase the values of R4 and C4. As the current consumption in the standby mode is only 0·1mA the battery life should be considerable.

PRINTED CIRCUIT BOARD

The components are mounted on a single-sided p.c.b. of approximate dimensions 56 × 50mm as shown in Fig. 3. All components other interconnections are shown in Fig. 2.

The case chosen for this project was a Verobox measuring 110 × 68 × 33mm and has an aluminium front panel. The warning device should be mounted onto the front panel using double-sided adhesive tape. You will notice that a small 3·5mm hole has been drilled in the front panel for WD1. This hole is small but will not stop any of the sound from WD1.

The microphone is fixed to the top half of the Vero case by first drilling a 10·7mm hole in the casing, then whilst holding the microphone in position, running a quick-setting epoxy resin around the circumference of the microphone. Make sure that the microphone is flush with the top of the case. This ensures that when a digital watch is placed on top of the case, both microphone and watch make close contact with each other.

Take care when positioning the relay RLA1, as there is little room between the relay and WD1 on the front panel. □

COMPONENTS

See Shop Talk page 427

Resistors

R1	3·3MΩ
R2	10kΩ
R3	470Ω
R4	330kΩ
R5	330Ω

All $\frac{1}{4}$W carbon ±5%

Capacitors

C1	100µF 25V elect.
C2	2·2µF 10V elect.
C3,4	1µF 10V elect. (2 off)

Semiconductors

D1,2,3	1N4148 silicon signal diode (3 off)
D4	TIL220 3mm red l.e.d.
TR1,2	BC109 silicon *npn* (2 off)

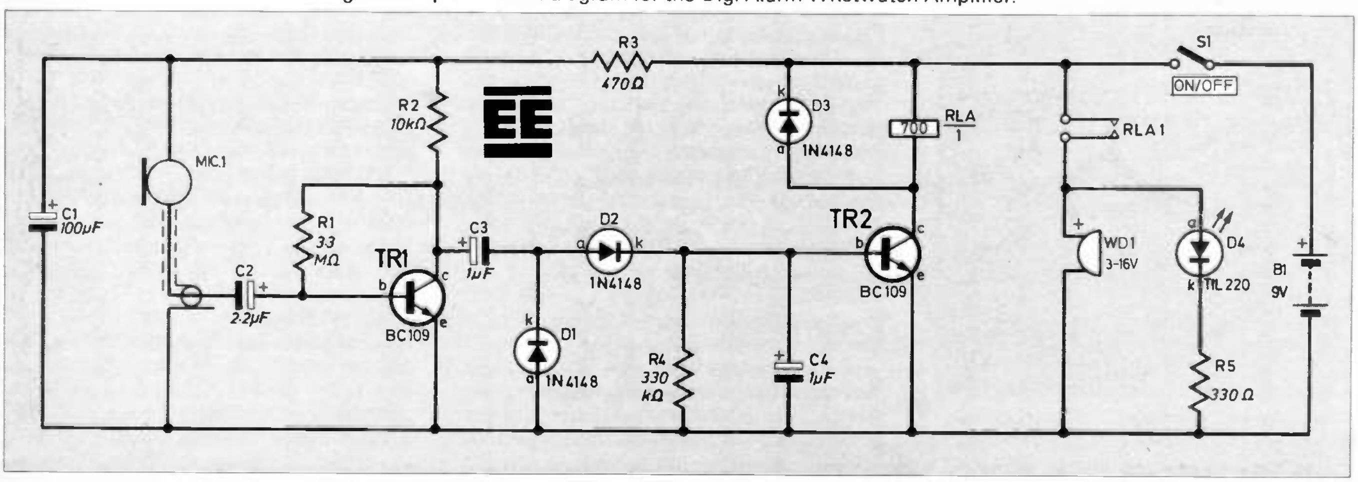
Miscellaneous

S1	on/off miniature toggle
RLA	reed relay, 6–9V, 700Ω coil with 500mA rated n.o. contacts
MIC1	Electret microphone insert
WD1	3–16V miniature piezo-electric transducer

Verobox (type 65-2036H), 110 × 68 × 33mm; single-sided p.c.b. 56 × 50mm; PP3 battery and connector; l.e.d. mounting bezel; 7/0·2mm wire.

Approx. cost Guidance only £11.00

Fig. 1. Complete circuit diagram for the Digi Alarm Wristwatch Amplifier.



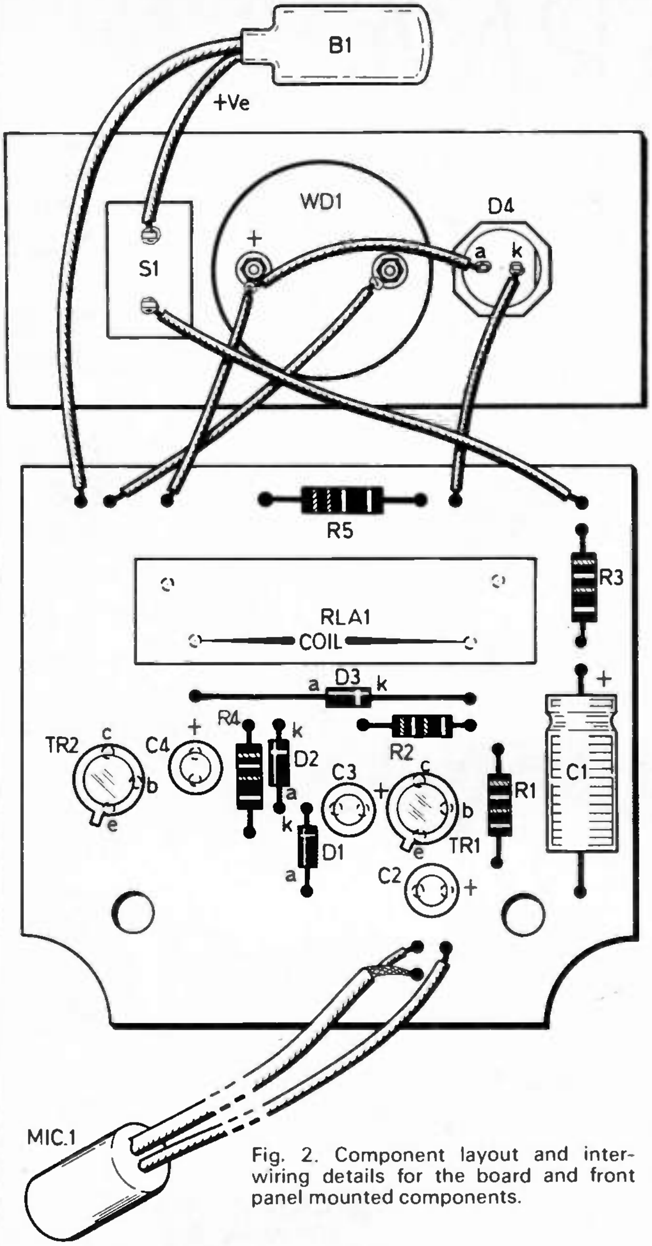
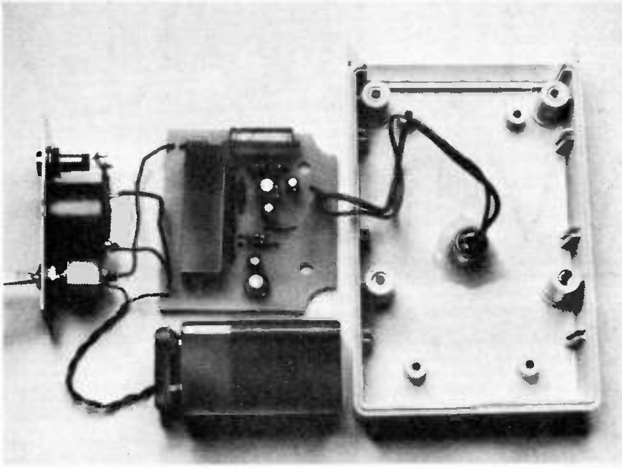
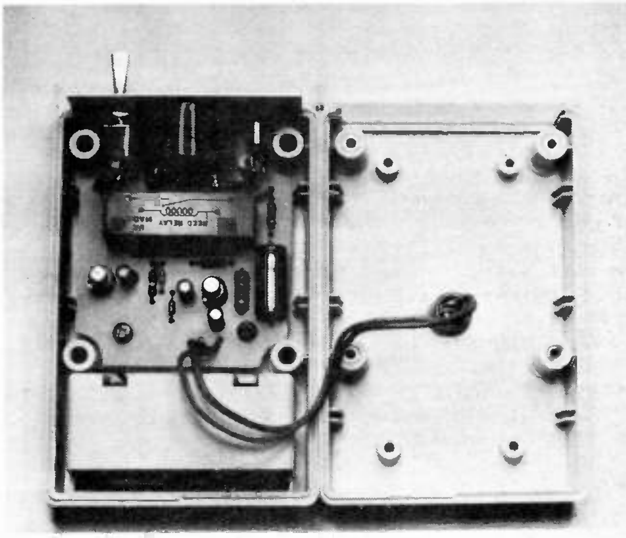


Fig. 2. Component layout and inter-wiring details for the board and front panel mounted components.

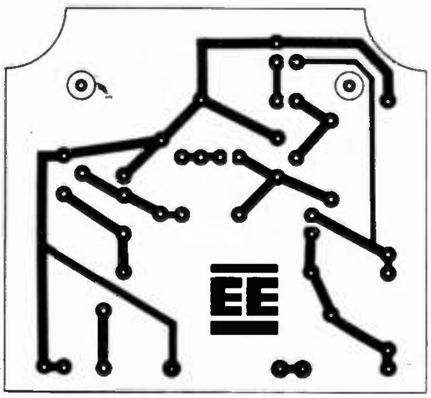


Completed front panel (containing l.e.d., audio warning device and on-off switch) and circuit board wiring prior to inserting in the case. The microphone sensor is glued in the case lid.



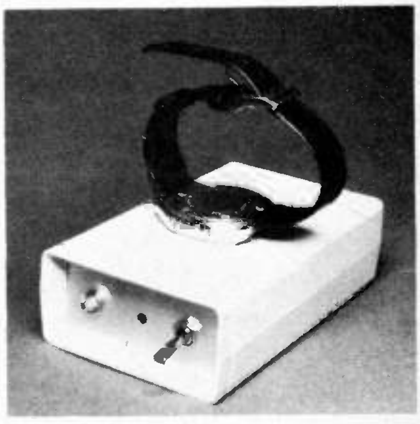
Location of the microphone insert in the lid and the printed circuit board in the base of the case.

Fig. 3. Full size printed circuit board master.



Front view of the completed prototype and position of the microphone insert.

Prototype unit ready for use with a wristwatch mounted over the microphone insert.



TRI BOOST
GUITAR TONE CONTROLLER

BY J. D. ROGERS

CONSIDER the following points: the most commonly required tonal corrections to electronic instruments and amplifiers are "not enough" types, that is, not enough treble, not enough middle or not enough bass. Guitarists tend to use the boost halves of tone controls in preference to the cut, and still sometimes need more. Boosts of low, mid or high frequencies may be needed temporarily, just for a solo break for example.

This project takes all these points into account and provides, in a compact unit, the facility to add extra gain in either the low, middle or high parts of the audio range. It is, in effect, a quality treble booster, mid booster and bass booster all rolled into one. The type of boost can be preselected on the rotary control and is switched in and out by the foot switch.

FILTER

There is a particular region of response where a cut rather than a boost can be usefully applied in many situations with the benefit of more clarity. This is the area between *real* bass and mid, the area that often causes boominess. Therefore, as well as the boosts the Tri Boost also has a switchable output filter which cuts into the above mentioned area.

The unit is easy to construct with Veroboard, it uses two transistors, a simple s.p.s.t. foot switch and a handful of other components, all of which are readily available.

Input impedance suits all instruments and the unit runs on a single 9V battery which is switched on by inserting a jack into the input socket. Drain is very low at less than 2mA so a small PP3 type can be used.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. TR1 is fed with the audio input through d.c. blocking capacitor C1 and biased via R4 from potential divider R2/R3. C2 ensures that there is no noise in the bias supply. Since TR1 has equal value emitter and collector resistors (R5 and R6), the gain at the collector will be near unity, and so the unit will normally give an output identical in volume to the input.

Any decrease in the impedance from the emitter to earth however, will increase the gain at the collector. The top of S1 (the foot switch) is a.c. coupled to the emitter and can therefore be regarded as a "boost point". Any impedance, whether it be resistive, capacitive or otherwise, between here and signal earth will increase the gain of TR1 (but cannot upset the d.c. conditions because of the presence of C3).

So, a resistor added from the boost point to earth would give a flat gain increase, equal at all audio frequencies, a small capacitance would increase gain only at high frequencies, while an inductor would give extra gain only at low frequencies since its impedance is greater towards higher frequencies.

In the unit, VR1 the RANGE potentiometer, is arranged so that when set fully clockwise, L1 is shorted out and has no effect, but C6 is left directly across the boost point and earth, resulting in treble boost. Fully anti-clockwise, C6 is shorted out and L1 is now across boost point and earth, so the result is bass boost.

Halfway, L1 and C6 are in series between the boost point and earth and form a resonant circuit. A property of the latter is that it has least impedance at resonance so the result is that mid frequencies are boosted in preference to highs and lows.

TR2 is an emitter follower, directly biased from the collector of TR1. It adds no gain itself, but it ensures correct operation of TR1 by providing a buffering action and also provides a low impedance drive to the output and the filter.

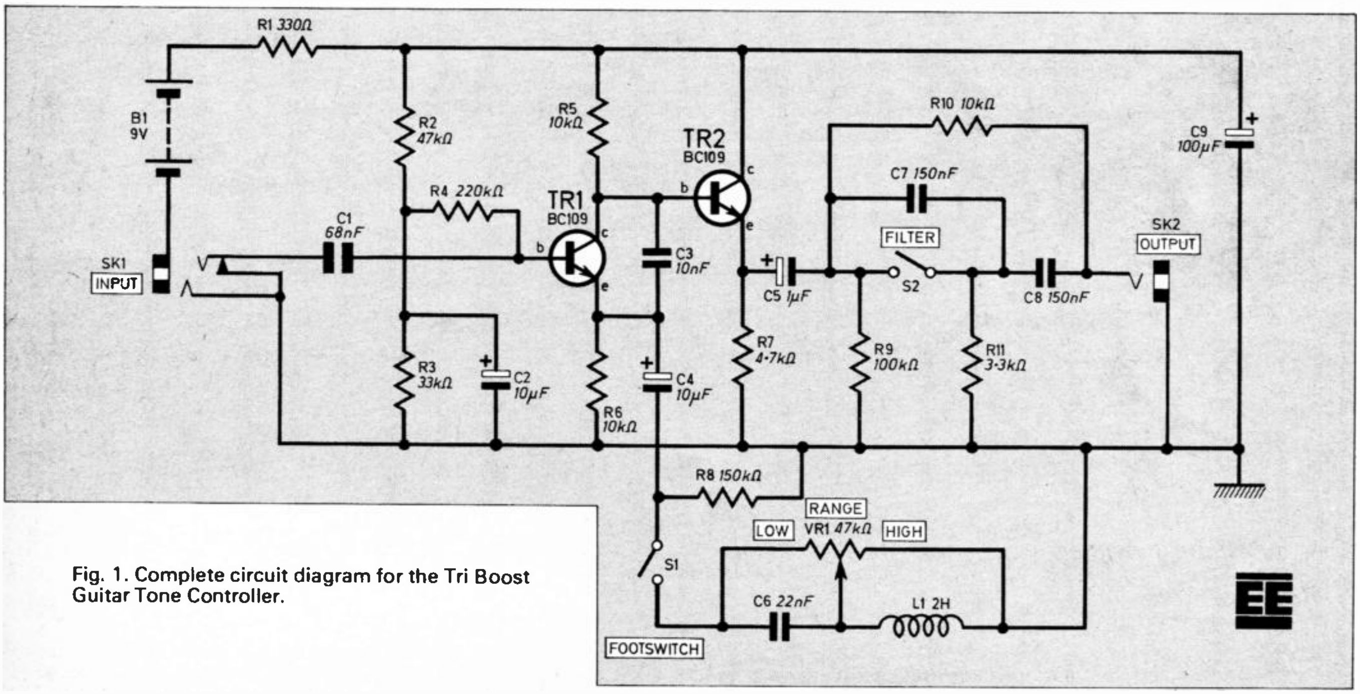
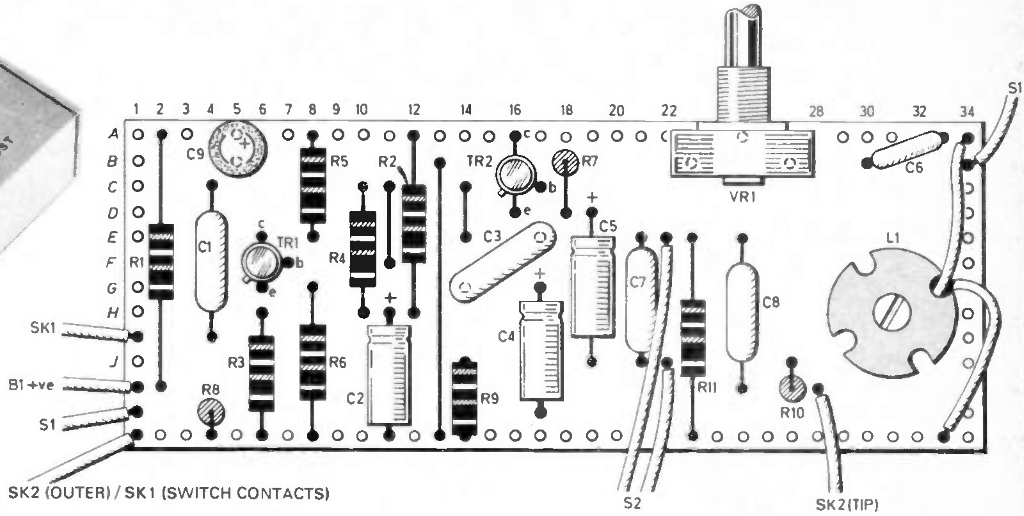


Fig. 1. Complete circuit diagram for the Tri Boost Guitar Tone Controller.

Topside of finished prototype showing the positioning of foot switch.



Note: The link from 11c to 11f can be replaced with a 100µH r.f. choke if the user's guitar or amplifier normally suffer from radio interference (taxis, and so on).

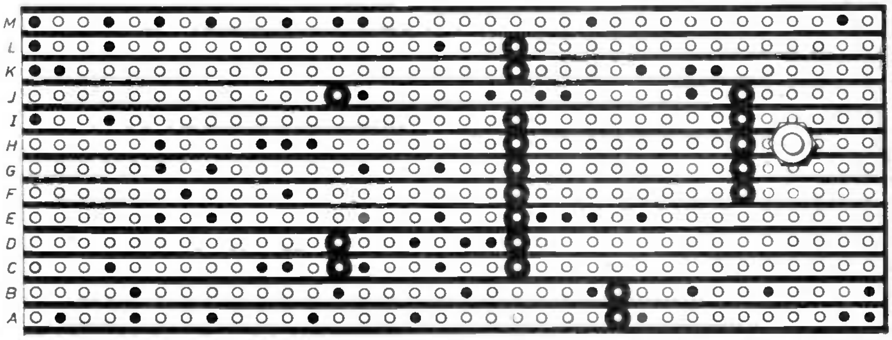


Fig. 3. Component board showing the position of VR1, which is a p.c.b.-mounted type, and underside of board showing breaks to be made in the copper strips.

COMPONENTS

Resistors

R1	330Ω
R2	47kΩ
R3	33kΩ
R4	220kΩ
R5,6,10	10kΩ (3 off)
R7	4·7kΩ
R8	150kΩ
R9	100kΩ
R11	3·3kΩ

All ¼W carbon ±5%

See Shop Talk page 427

Capacitors

C1	68nF polyester
C2,4	10µF axial elect. (2 off)
C3	10nF polyester
C5	1µF axial elect.
C6	22nF polyester
C7,8	150nF polyester (2 off)
C9	100µF axial elect.

Semiconductors

TR1,2	BC109C *npn* silicon (2 off)

Miscellaneous

S1	s.p.s.t. push-button foot switch
S2	s.p.s.t. miniature toggle
SK1	0·25in stereo jack with switched contacts
SK2	0·25in mono jack
VR1	47kΩ linear potentiometer, p.c.b. mounting
L1	2H high inductance wound core
B1	9V PP3 battery

Aluminium case, 102 x 70 x 38mm (Maplin AB9); 0·1in matrix stripboard, 13 strips by 34 holes; control knob; battery clip; 7/0·2mm equipment wire; rubber feet (4 off).

Approx. cost Guidance only £8.00

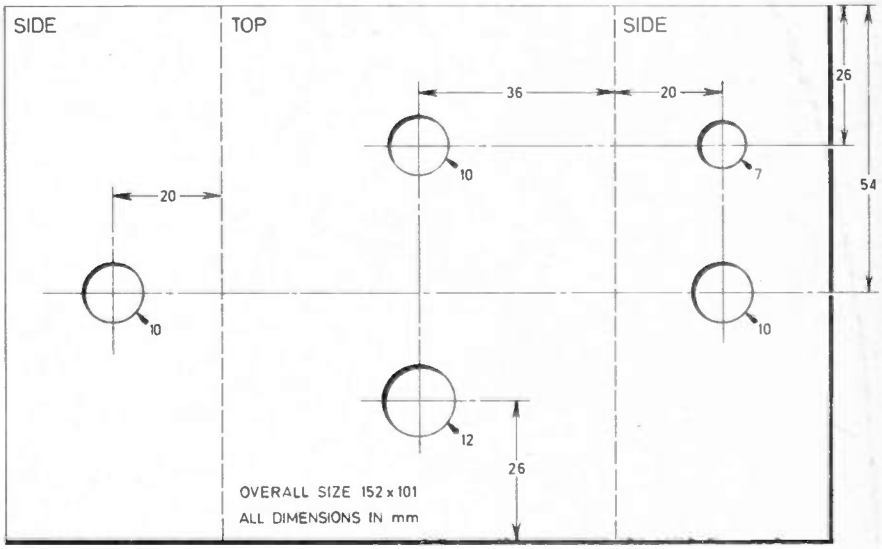


Fig. 2. Drilling information for the case showing the positioning of the five holes.

The output filter has no effect when S2 is closed, but when open it gives cut of low-mid, without sacrificing real bass which is free to pass via R10. The function of R1 and C9 are to smooth the battery supply. R8 is to earth-reference the boost point side of C3 and so make all boost controls scratch/click free by ensuring that no d.c. level is present. R9 does the same job for the output filter.

CONSTRUCTION

ASSEMBLY

The Veroboard design uses direct mounting of the potentiometer VR1 to reduce interwiring and also conveniently hold the board in position in the case. Using the recommended case it may appear to be a close fit, but so long as the given dimensions and instructions are followed everything will fall easily and neatly into place.

Construction is made much easier if operations are carried out in the following order:

1. Drill the five holes in the case, following the dimensions given in Fig. 2 as closely as possible.

2. Clean the case before lettering with rub-down transfers such as Letraset. Spray with a clear varnish such as Letraset 101 aerosol to fix the lettering.

3. Cut the Veroboard to size, 13 strips by 34 holes and make the breaks in the copper strips as shown in Fig. 3, and drill the small hole to mount L1.

4. Solder all components except VR1 onto the board, not forgetting the three links. It is easiest to do these first, followed by the resistors, capacitors then the transistors and finally L1.

5. VR1 must be of the p.c.b.-mounting type, such as those supplied by Maplin. Cut its spindle to length, then bend the centre pin so that this will fall on the *next* row of holes on the Veroboard to the outside two pins. Veroboard holes are slightly too small for these pins and so the three holes where VR1 fits (see Fig. 3) must be *slightly* enlarged using a spike or small drill. VR1 can now be soldered onto the board. "Tin" VR1's pins first and use a reasonable amount of solder to make these joints since VR1 physically supports the board. This completes the circuit board assembly.

6. Mount into the case the two jack sockets, the foot switch and toggle switch. Bend back the two contacts of the metal jack socket so that these will not come too close to the circuit board when this is installed. This can be seen in the photographs.

7. With the case lying on its back and the completed circuit board resting "North" of it on the bench, wire all components, using a 7/0·2mm wire as shown in Fig. 4. The reason for wiring up in this position is to ensure that should the board need any attention, its leads will have enough slack to allow it to be lifted clear of the case to work on.

8. Mount the board by inserting VR1 after first placing two or three spacing washers on the potentiometer. The board is designed to fit diagonally across the case, see photograph and diagram.

9. Tidy up the routing of all wires, fix the knob onto VR1, connect fresh battery and screw the case together. Finally, put four stick-on rubber feet under the case.

IN USE

The bass and treble boosts at either end of VR1's range may be too much for some tastes, so in these cases it is best to slightly back off VR1 from extreme positions.

A typical use of the filter switch is to improve the quality of acoustic guitar with a microphone, as the filter can reduce the boomy feedback that plagues this type of set up.

OPTIONS

The previously mentioned concept of a "boost point" means that the main circuit (all above S1 in Fig. 1) can in fact be used as a fool-proof "base" on which to form *any* type of booster. The constructor need not stick to the "Tri" arrangement of the prototype unit, but may experiment to obtain whatever best suits the particular instruments.

These may range from the person who only requires say a fixed amount of mild lift above certain frequencies, to another who may require a more flexible system offering variable boost.

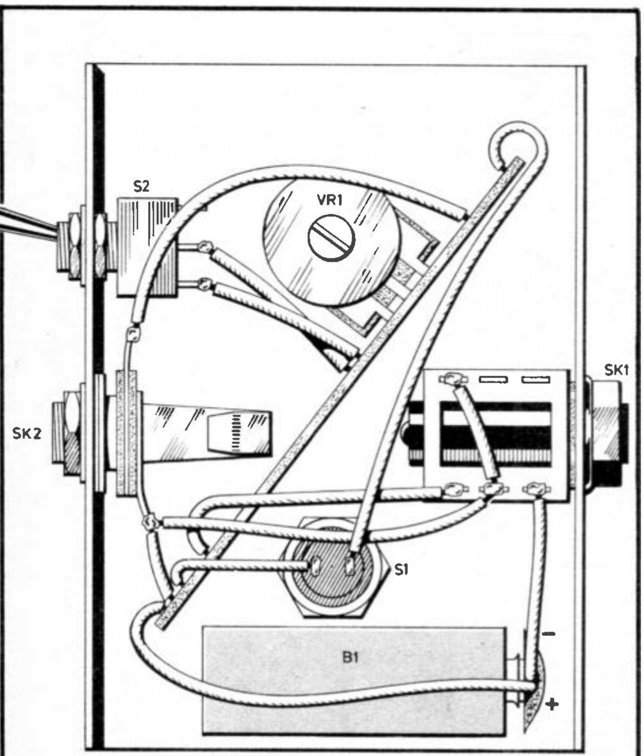
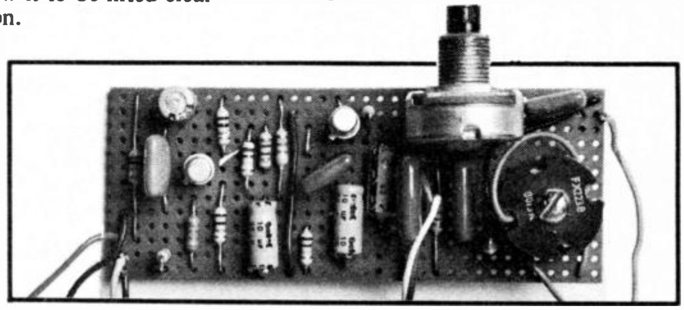
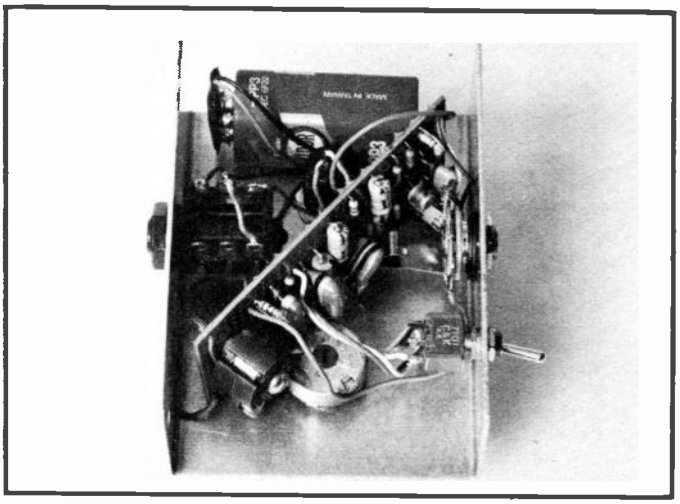


Fig. 4. Bottom of case removed showing the interwiring details of the component board and offboard components.



Component board showing the positioning of VR1.



Bottom of case removed showing the positioning of components inside the case.

It is an easy matter to try out other arrangements by simply building the whole Tri Boost as described, but leaving out VR1, C9 and L1. Two leads are then temporarily brought out, one from boost point and the other from earth.

The constructor is then free to experiment with any combinations of capacitors, resistors, inductors, potentiometers and switches of any type between these two points to give any desired boosts or control configurations.

No harm can be done by *any* arrangements here, and there are no "rules" so anything goes, the only limits are imagination and what components are available. Some tried and tested examples are given in Fig. 5 (a to g) to indicate general principles.

Use of a breadboard would make it easier to try out ideas. Having found your custom sound, or most useful control arrangement, the components can then be permanently installed in the case.

It doesn't matter whether these "amateur-derived" boost networks are technically correct, worked out mathematically or are conventional, if it *sounds* right to the individual then really that is the only valid criterion on which to judge. □

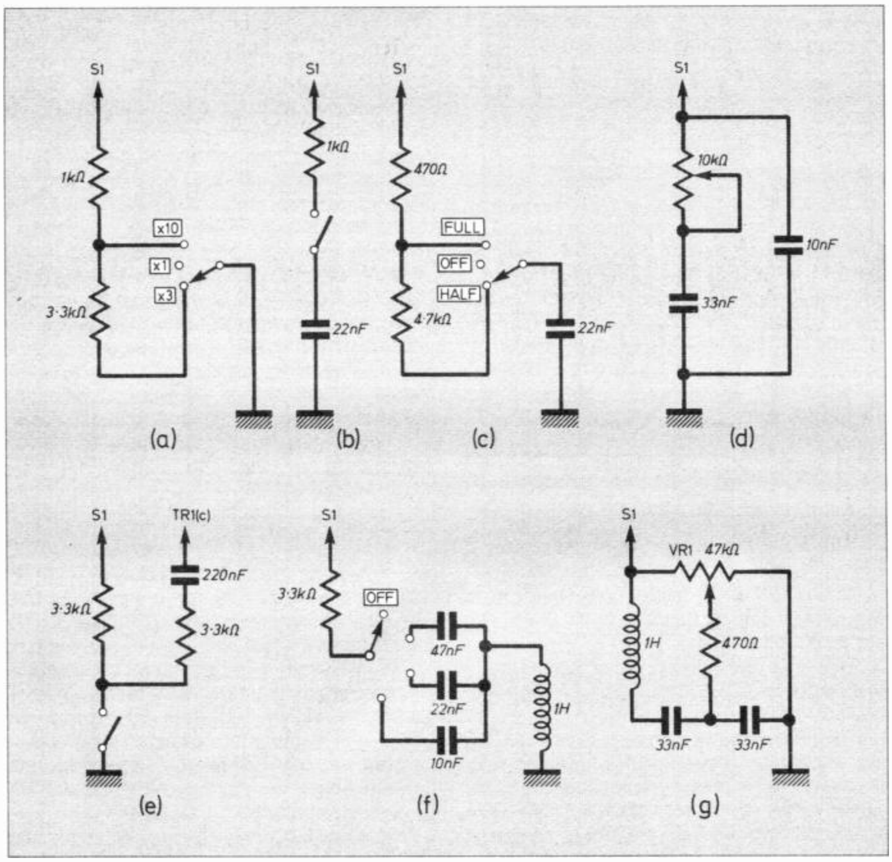


Fig. 5. Examples of boost or control configurations constructed with various components (a) Plain Gain Boost (b) Simple Fixed Boost (c) Two Level Boost (d) Variable Boost (e) Bass Boost without an Inductor (f) Switchable Frequency Band Boost and (g) shows an add-on for more variations, leaving C6/L1 connected as in Fig. 1.

CIRCUIT EXCHANGE

CAR CIRCUIT TESTER

This circuit was designed to be a very simple and cheap fault-finding aid for car electrics. The few components allow it to be packaged in, say, an old clear ball point pen tube. The probe could be fashioned from a brass screw, and the complete tester is small enough to be carried around in the car tool-kit.

The advantage of this circuit is that it gives a positive indication of both parts that are live and parts that are at chassis potential—as opposed to being isolated.

With 12 volts applied to the circuit from a pair of wires with battery clips attached to the car battery, no current flows because the battery potential will be insufficient to overcome the two Zener voltages, and the forward bias voltage drops of the two l.e.d.s.

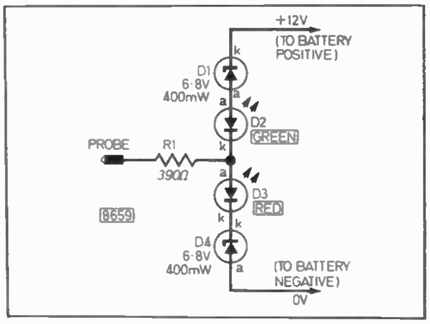
When the probe is touched to a "live" (+12V or near potential) part, the 12 volts are applied across R1, D3, D4 which causes the RED l.e.d. D3 to light.

When the probe is touched to a part at chassis potential, 12 volts are applied across D1, D2 and R1 and the GREEN l.e.d. lights.

If the connections to the battery should be inadvertently reversed no damage will occur, the l.e.d.s simply remaining extinguished.

The two colours of l.e.d.s would be swapped for positive earthed vehicles.

C. Fancourt,
Charvil,
Reading,
Berks.



MORE ON PAGE 439

MEASUREMENT OF AUDIO AMPLIFIER PARAMETERS

BY E. A. RULE*

DURING the past few years, EVERYDAY ELECTRONICS has published a considerable number of articles on audio equipment and also various items of related test equipment. These have ranged from very simple bench amplifiers to complicated FM stereo tuner amplifiers, such as the EE2020 published in December 1978, and the 50 watts Public Address System (May–August 1982).

As a result of these articles there have been a number of requests for an article on making measurements on audio equipment built by the home constructor so that comparisons may be made with similar commercial equipment.

Most manufacturers publish very full technical specifications for their equipment and there are many arguments as to the methods used to obtain the performance figures published. However, it is not intended to get involved with arguments of that nature here, but to show how the basic specification parameters may be measured with the use of equipment that is available to many home constructors.

BASIC TEST EQUIPMENT

The minimum test equipment required is a **signal generator** covering the range of 20Hz to 20kHz and preferably having an attenuator to control its output amplitude, and an **output meter** which will measure the output voltage expected from the amplifier over at least the audio frequencies involved.

Other desirable items are an **oscilloscope (c.r.o.)** and a **harmonic distortion measuring set**. A **dummy load** is also required.

The dummy load should be of a value of 8 ohms and of suitable wattage rating to withstand the full expected output of the amplifier under test. For up to 25 watts the CGS type HSA25 or the Welwyn type WH25 would be suitable. (IMPORTANT. Do not use resistance wire from fire elements as these sometimes contain iron and this can cause very high distortion at high frequencies and give misleading results.)

The load resistors should be within 2 per cent of 8 ohms and be mounted on suitable heatsinks such as the RS type 401–403, one for each load (two for stereo amplifiers).

SIGNAL GENERATOR

A simple signal generator will suffice for measuring power output, but if it is intended to measure distortion and frequency response the generator will have to have very low distortion and also a level output over its frequency range. An instrument which also has a square-wave output would be useful for certain tests.

The harmonic distortion content of the signal generator should be at least ten times better than the level expected from the amplifier if accurate and meaningful measurements are to be made. This means of course that if an amplifier is rated at 0·1 per cent total distortion, then ideally the generator should be less than 0·01 per cent and these are not cheap. However it is possible to get useful measurements with generators which have a distortion content of around 0·05 per cent or so.

The same can be said of output level; if you are expecting the amplifier to have a frequency response within plus or minus 1dB the generator should be level to within 0·1dB. It is possible to overcome this particular problem by first measuring the actual output from the generator over its frequency range and then comparing this with the output from the amplifier when using the same generator and output meter, the difference between the two would be the response of the amplifier. More about this aspect later.

OUTPUT METER

The output meter should have a level response over the audio frequency range to be measured and if possible have a dB scale as well as the normal voltage scales. It will need to cover the a.c. voltage range of from around 25 volts maximum (78 watts across 8 ohms) down to 25 millivolts minimum (—60dB); actually a wider range than this is to be preferred.

The general specification of the output meter should be ten times better than the specification you expect from the amplifier undergoing test. Any errors in the test equipment are compounded and can lead to large overall errors.

For example, when measuring a 50 watts output, if the load and meter are accurate to 2 per cent each, the 50 watts output could read either 53·08 watts (resistor low, meter high) or 47·01 watts (resistor high, meter low). A total variation of 6·07 watts or over 12 per cent error in power measurement. So be warned, do not read more into your measurements than the accuracy of your equipment will allow.

OSCILLOSCOPE

A simple oscilloscope (c.r.o.) will be satisfactory for most audio work as it will be used mostly to indicate clipping points at maximum power. However, a c.r.o. with a wide bandwidth is required if square-wave tests are to be made, and for audio work a minimum bandwidth of 5MHz is required. A double beam c.r.o. would be very helpful, but is not vital as simple switching can be used for checking stereo equipment.

HARMONIC MEASURING SET

Instruments to measure harmonic content take many forms and can be quite expensive, but one suitable for our needs is the Audio Test Set described by F. C. Judd in the May and June 1981 issues of EVERYDAY ELECTRONICS. This has a fixed frequency (1kHz) very low distortion oscillator, a wide range audio millivolt meter, and a harmonic measuring set which will read down to 0·05 per cent total harmonic distortion. The oscillator has a distortion of around 0·02 per cent so reasonably accurate measurements can be made using this Audio Test Set on amplifiers of around 0·2 per cent (or lower with a little care).

TEST SET-UP

Fig. 1 shows a typical test set-up for measuring the power output and distortion of an amplifier using the EE Audio Test Set mentioned above. Full details of how to make the measurements with this test set were given in the June 1981 issue of EVERYDAY ELECTRONICS and it is not proposed to repeat them here, however a few general tips will be given.

First of all, connect the output of the oscillator directly to the input of the distortion measuring set and take a measurement of the actual distortion of the test set-up. This reading is the best you will obtain even if the amplifier you test is perfect and has no distortion at all! In other words, it sets your limits and in practice you should only attempt to measure to around two to three times the figure

*T. & T. Electronics.

obtained if you want to be reasonably accurate.

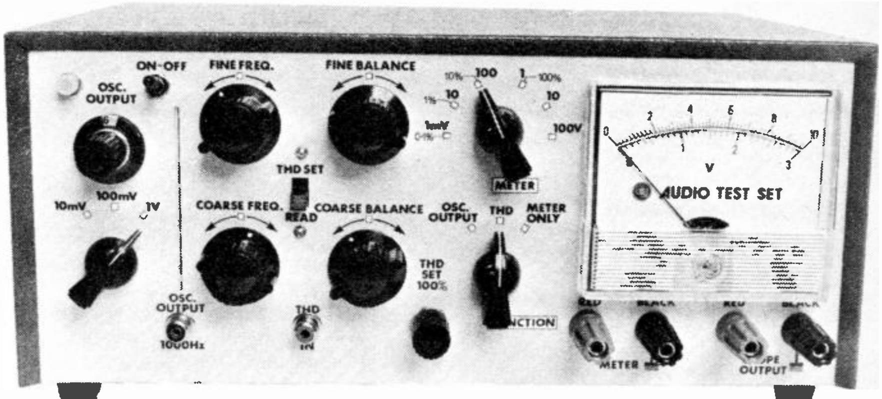
As a rough guide, if you add the possible error in dBs of all the test equipment together, you will have some indication of the accuracy that you can obtain with the equipment being used. Don't be surprised at the result! An overall figure within 2 or 3dB is quite reasonable for the type of equipment the average home constructor is likely to have. Overall test figures to within 1dB call for very expensive equipment and to measure to the best commercial standard calls for a second mortgage!

The reason that attention has been drawn to this question of overall accuracy is that it is all to easy to worry about small variations in performance between amplifiers, which are in fact less than the variations in the actual test equipment itself.

POWER OUTPUT

It is most likely that power output will be the first measurement you will want to take. Fig. 2 shows the normal set up for this. If possible the power amplifier should be tested first on its own, that is without any control unit in circuit.

With many amplifiers the tape monitor input connects directly to the power amplifier and by-passes the earlier stages. However, if this is not possible, simply set any tone controls to their "flat" position and switch any filters out. Use either a aux or tuner input, although any input which has a flat frequency response will do. Do not use the disc input for this test.



The EVERYDAY ELECTRONICS Audio Test Set.

Set the signal generator to 1kHz and its attenuator to minimum output voltage. Make sure that you have the dummy load connected across the amplifier output (both channels if stereo).

Inject a 1kHz sine-wave signal into one channel and connect the output meter and c.r.o. across the output on the same channel.

Switch the amplifier on and turn any volume control to maximum, then slowly increase the output from the generator until an output is obtained on the meter and/or c.r.o. Increase the level of signal until the peaks of the waveform start to "flatten". Reduce the signal to a point where this "flattening" is only just visible.

Note the voltage on the meter. The power output is calculated by this voltage squared divided by the load resistance. For example, if the maximum output voltage is 13·5 volts, then

$$\frac{13{\cdot}5 \times 13{\cdot}5}{8} = 22{\cdot}78 \text{ watts}$$

A fair rating for the amplifier in this case would be 20 watts.

Repeat the measurement on the other channel. You now have the output for each channel in turn. Now feed the signal into both channels at the same time and check the voltage across each output. It will now be lower. This is the power output with both channels driven. For example, if you now get 12·5 volts across each output, the power will be

$$\frac{12{\cdot}5 \times 12{\cdot}5}{8} = 19{\cdot}53 \text{ watts each}$$

so again a fair rating for this amplifier would be 20 plus 20 watts.

To compare this rating with a commercial design you must first pre-condition the amplifier by running it at one third of its maximum power for one hour, and then take the full power measurement. This will test the amplifier when it is quite hot and give the worse case measurement. Often the output will be less after this preconditioning period. However, for normal domestic use this pre-conditioning is not required, a simple measurement is enough.

FREQUENCY RESPONSE

The set-up for frequency response measurement is the same as in the power test except that all measurements are taken at a power output of less than 1 watt. The signal generator must now have a variable frequency output which at least covers the range of 20Hz to 20kHz. If possible the power amplifier should again be checked without any control unit in circuit or if this is not possible with any tone controls set for a flat response.

First, set the input frequency to 1kHz, and adjust the input signal to set the indication on the output meter to a suitable reading which will now be our reference level for 0dB. If the meter has a dB scale this can be used with the meter range switch on the 3-volt range (or a lower range); the main thing is to keep the

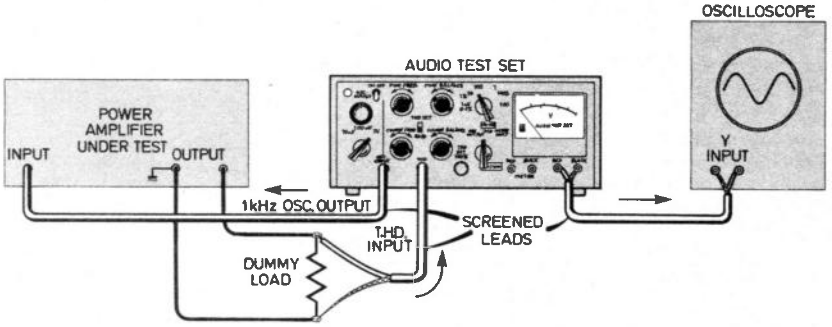


Fig. 1. Test set-up for measuring power output and distortion of an amplifier using the EE Audio Test Set.

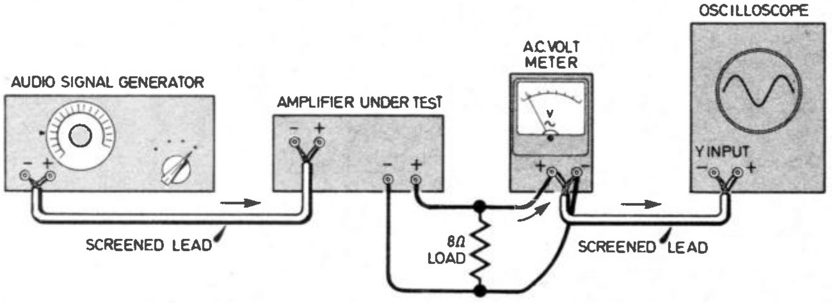


Fig. 2. Showing normal set-up when using separate test instruments. This set-up is used for power and frequency response measurements.

power output as low as practical while taking frequency measurements.

Having noted our reference level, change the input frequency over the range to be measured and note any change in output level; this change in dBs is the frequency response of the amplifier section being tested. The same method is now used for each input, and with the tone controls in each position, and then repeated again with any filters switched in. This way each of these items can be checked in turn to see what its effect is on the frequency response.

DISC EQUALISING

The disc equalising can also be checked in the same way but due to the very wide amplitude change at the very low and very high frequencies and the very sensitive input, special precautions are needed to avoid hum and enable accurate results to be obtained.

First make up an attenuator so that the output from the generator is reduced to one tenth or better still one hundredth of its normal output. Fig. 3 shows a suitable network. Set the generator to 1kHz as before and adjust its output to give our reference level on the meter when feeding into the disc input.

Change the frequency from 1kHz to 20kHz and plot the readings obtained on graph paper. It may require the meter range to be changed while doing this as the output will fall about 20dB (ten times) as the frequency is increased.

Reset to 1kHz, reduce the input amplitude so that the meter indicates −20dB, that is ten times lower than before. This is now our 0dB reference.

Change the input frequency from 1kHz to 20Hz and plot the readings as before but this time the readings will increase 20dB as the frequency is lowered and again it may require the meter range to be changed.

RIAA EQUALISING

A better way to check the RIAA equalising on the disc input would be to make the circuit up shown in Fig. 4. This

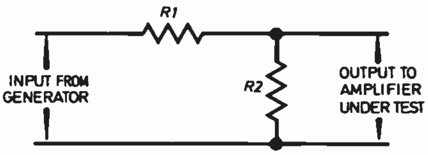


Fig. 3. Two networks which can be used to reduce the output from the generator to a suitable level for the disc input and avoid hum problems.

Network A, reduction 10 times (20dB). R1 = 10kΩ R2 = 1kΩ

Network B, reduction 100 times (40dB). R1 = 100kΩ R2 = 1kΩ

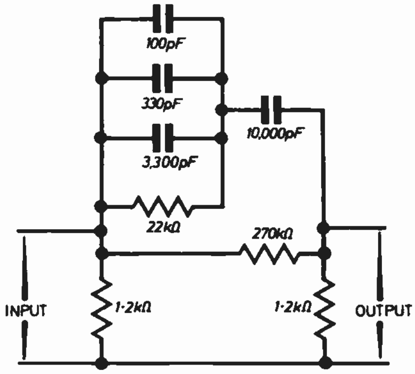


Fig. 4. Circuit for obtaining an inverse RIAA recording curve. By feeding the signal from the generator through this network to the disc input of the amplifier, the overall frequency response should be "flat". Accuracy of network is plus or minus 0·5dB 20Hz to 20kHz. Components should all be 5 per cent or better.

converts the generator output to the inverse RIAA curve and if the signal is fed via this into the disc input and the RIAA correction in the amplifier is correct, the output will remain flat over the audio range 20Hz to 20kHz. This makes it much easier to read on the meter and avoids errors due to changing ranges.

Many amplifiers have a rumble filter built into the RIAA equalising curve and this may show a fall off in response at the lower frequencies and a response 3dB down at around 20Hz is fairly normal.

SIGNAL-TO-NOISE

The amount of noise present in any amplifying system is one of the more important parameters and measuring this is fairly simple. The simplest way is to relate the amount of noise present relative to the power output of the amplifier.

To do this, first decide which input you are going to measure. Inject a signal and adjust its level until the amplifier indicates maximum power on the output meter. This is a reference point and we will make this equal to 0dB.

The volume control should be at maximum and any other controls set for a overall flat response. Remove the input signal and put a short circuit across the input terminals. The amount the output falls on the meter will be the signal-to-noise ratio.

For example, if our maximum output reading was 13·5 volts, and when the signal was removed and the input shorted out, the reading fell to 13·5 millivolts (1000 times less), then the signal-to-noise ratio is 1000 times or −60dB.

However, this method of measurement with the volume at maximum will not give a true figure of the noise present in practice when the volume control is used at a lower setting. To measure the more practical signal-to-noise ratio, set the input signal as before then reduce the *volume control* until the output has dropped by 20dB (ten times). Remove the input signal and note how far the output drops relative to the reading on the output meter, so the new reading with the volume turned down by 20dB becomes our new reference of 0dB.

On many amplifiers the results will be worse with the volume control turned down than when it is at maximum and this method gives a result more in keeping with the normal practical use of the system.

In fact the frequency response could also be checked with the volume control turned down as sometimes there is a fall off in the high frequency response compared with it at maximum.

RIAA* REPLAY CURVE

Frequency Hz	dB	Frequency Hz	dB
20	−18·6	1,500	+1·4
30	−17·8	2,000	+2·6
50	−17·0	3,000	+4·7
60	−16·1	4,000	+6·6
70	−15·3	5,000	+8·2
80	−14·5	6,000	+9·6
100	−13·1	7,000	+10·7
150	−10·2	8,000	+11·9
200	−8·3	10,000	+13·7
400	−3·8	12,000	+15·3
500	−2·6	14,000	+16·6
700	−1·2	16,000	+17·7
1,000	0·0	18,000	+18·7
		20,000	+19·6

This is the standard replay curve used in all modern hi fi amplifiers and is also covered by British Standard 1928–1955.

*Record Industry Association of America.

OTHER MEASUREMENTS

There are many other measurements that could be made and a few will be suggested here with a brief description on how to measure them.

Cross-talk. This is measured by putting the output meter on one channel while driving the other one to the full power reference level. The reading obtained relative to the full output from the other channel is the cross-talk.

For example: Full power channel A equals 13·5 volts, output from undriven channel equals 0·135 volt, cross-talk is 40dB down (100 times). This should be checked at various frequencies.

Power Bandwidth. Measured in the same way as power output but by using different frequencies find the point where the power is down to half (−3dB).

For example, if the power output is down to half power at 50Hz and 15kHz, the power bandwidth is 50Hz to 15kHz. This could also be measured for a given distortion level. Thus a specification could read: Power bandwidth 20Hz to 20kHz, 25 watts at 0·5 per cent total harmonic distortion (THD). In other words the amplifier will give a minimum of 25 watts over that range with less than 0·5 per cent distortion.

Damping Factor. This is the ratio of effective output impedance relative to the rated output impedance. For example, if the rated output impedance is 8 ohms and the actual output impedance is 0·1 ohm then the damping factor is 80. To measure, inject a signal at 50Hz and with the dummy load *removed* measure the voltage across the output, set for a convenient reading on the meter, say 10 volts. Then connect the dummy load and note the drop in reading. For example, 0·2 volt drop, divide the original reading (10 volts) by the drop (0·2 volt), 10/0·2 = 50, this is the damping factor. This can also be checked at different frequencies.

Input Sensitivity. This is the level of signal required at the particular input which will provide full power at the output of the amplifier under test.

Overload Factor. This is the maximum input that can be applied to the input under test without causing distortion to rise above a reference level. The volume control is reduced as the input is increased to prevent overloading of the power output stages.

Stability. Normally checked by feeding a square-wave signal to the input and looking at the c.r.o. to see if there is any sign of oscillation with various types of output loads.

For example: With no load; with 2μF and 8 ohms; with 2μF on its own; and so on.

There are many more tests that may be made and a good book on this subject is the *Audio Technician's Bench Manual* by John Earl. Amplifier testing is a skilled job and a full day can often be spent just taking the basic measurements. Quite expensive equipment is required if you wish to obtain accurate results comparable with commercial practice but it is hoped that this article will at least enable you to make basic measurements on your home constructed equipment with test gear that is generally available to the home constructor. □

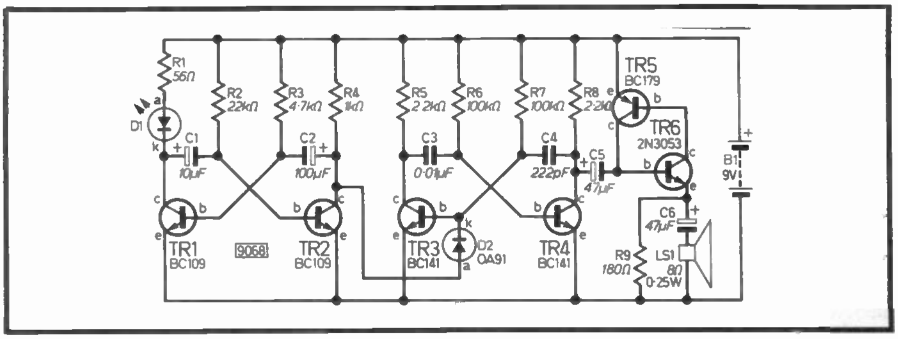
CIRCUIT EXCHANGE

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.

FLASHING LIGHT BLEEPING SIREN

THIS is an all transistor circuit. TR1 and TR2 form a slow speed oscillator which gates a higher-frequency oscillator comprising of TR3, TR4 and related passive components. Capacitor C5 couples the audio signal to a Darlington amplifier TR5 and TR6, and the output is taken from the low impedance emitter across a 180 ohm resistor. The l.e.d. flashes D1 on and off in accordance with the bleep pulses.

Toh Eng Kiong,
Singapore.

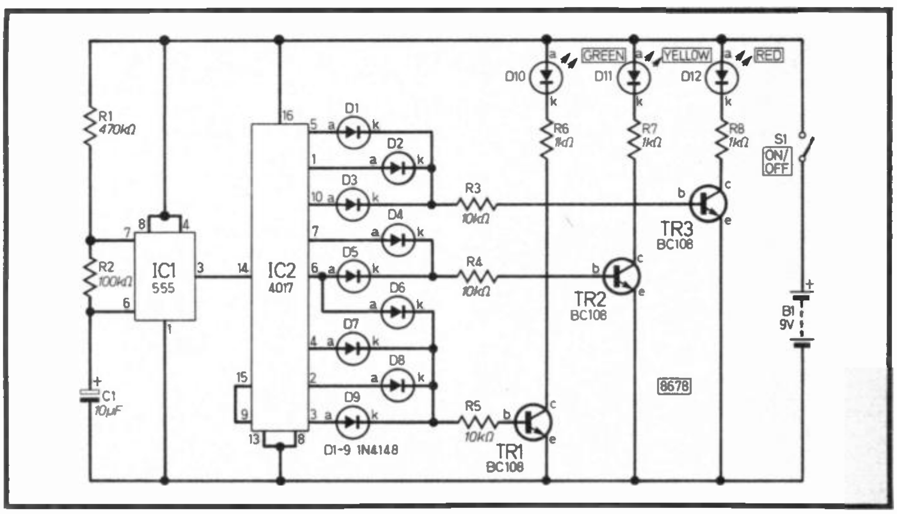


MODEL TRAFFIC LIGHTS

THIS circuit is ideal for model railways, being used to simulate red traffic lights. The 555 timer and associated components provide an oscillator with a time constant of five seconds, which can be altered by changing C1.

The output of the 555 (IC1) is taken to the 4017BE (IC2), which switches each of its eight outputs in turn. D1–9 directs the outputs to one of the three transistors, with each one controlling one of the three l.e.d.s. These simulate the traffic light colours and should be 0·125 inch dia. l.e.d.s for a "00" scale layout.

D. Pritchard,
Clanfield,
Hants.



MORE ON PAGE 450

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Wrong Line

Do you want to buy a new, legal telephone? I did, about two months ago, and found out first hand what a mess the whole liberalisation policy is still in.

Thanks to laws enacted by the Department of Industry I should be able to tell at a glance whether any phones on sale in the shops are authorised or not; authorised phones have to be marked with a green circle and unauthorised phones labelled with a red triangle. But in London I found many shops well stocked, with unauthorised phones, sometimes unmarked.

The salesmen often tried hard to sell me unauthorised equipment. They gave completely wrong advice. For instance, one told me that authorised phones are available only from British Telecom. But of course the whole point of the Government's liberalisation policy is to create competition for British Telecom.

I asked the Department of Industry what it was doing about shops that broke the law, didn't mark phones correctly and told "fibs" to customers. The answer was very vague. The DI says it writes to shops that break the telephone marking law. It could prosecute but it hasn't. The spokesman didn't even ask me where I'd seen unmarked phones. Doubtless this explains why so many shops are still breaking the law.

I wanted a wall telephone and found one shop that had an approved model made in England. But although it's designed as a wall phone the shop couldn't sell me a wall bracket. "They haven't yet been designed," I was told.

Not believing the shop, I telephoned British Telecom's sales office for my area. It took me three calls to reach the right office. First the operator put me through to the wrong sales office for my area. Then that office referred me to another office which also turned out to be wrong. Finally through to the right office, a BT salesperson said yes, they had the phones in stock. But wall brackets wouldn't be available until "around June".

Washing Up Time

As I write this, Leyland workers have just finished their strike over washing up time, that's to say the right to knock off a few minutes early every day to wash. Over the last ten years I have visited factories all round the world and in the most successful countries (Germany and Japan) have noted a quite different approach to working hours.

In those countries everyone arrives ahead of start time and are already at their desks or production line posts as the clock strikes the beginning of a working day. They leave only after the clock has struck the end of the day. In Japan the workers then gather together for what they call quality control circles, to discuss how they can improve production.

In Britain, and most other Western countries, we expect to arrive as the clock strikes and then get ready for work. At the end of the day we start getting ready early to leave as the clock strikes.

In the electronics factories now run by the Japanese in Britain, such as National Panasonic, Sony and Toshiba, the first thing the staff have to learn is that working hours mean working hours. Anyone arriving even a minute late stands to have their pay docked and risks the sack. So how can Japanese electronics companies in Britain implement rules like this, while British Leyland risks a strike? There's a very simple answer.

The Japanese Way

When the Japanese open a new factory in Britain, or take over an existing plant, they start from scratch and employ workers only on the clear understanding that they know and understand the Japanese rules. It needs a very clever management to change the rules while a factory is still running the old way.

The Toshiba TV factory in Plymouth was originally owned by Rank-Bush-Murphy. It didn't make money and in 1978 Rank joined forces with Toshiba on the same premises. That also didn't make money. So two years ago Toshiba bought Rank out. Now the factory is making money, Toshiba is taking on more workers and pushing up production to 160,000 colour TV sets a year with a shop-floor workforce of 340.

Compare that to the GEC-Hitachi joint venture: In 1977 Hitachi planned to build its own TV factory in Britain. But the other British manufacturers objected and Hitachi bought a half share in GEC's existing factory. It's been losing money ever since. Recently the workforce went on strike because their pay was frozen for the third year running and bonuses were cut.

After 800 redundancies last year the GEC-Hitachi factory in South Wales has a shop-floor workforce of 1,200 producing around the same number of sets a year as Toshiba plans to produce with a shop-floor workforce of 340.

Clear Of Fog

There's a delightful end tag to my previous story (March 1983) on how British Leyland is leaving out fog-light wires from Metro cars, even though they are shown in the circuit diagram, because it saves BL a few pence. The customer then has to pay a garage pounds to fit the wire.

It took me literally months to get a straight answer from the BL management, and a scrappy Xeroxed sheet showing me where the missing wire should be fitted to the printed circuit board. But I was still stymied because I needed a special connector to clip the wire to the p.c.b.

They then gave me a part number so that I could order the vital connector from an authorised BL dealer. But the dealer couldn't get one because the part number didn't exist. Finally, three and a half months after my initial query, BL sent me the vital tiny connector clip in an envelope.

So after three and a half months of correspondence and phone calls I was finally able to make the wiring of my new Metro car match the circuit diagram and switch on my fog lights. By then the fog season had passed! At times like these it's not hard to see why the BL workforce are at odds with their management.

Isolate Your Problems

Anyone into home computing with a cassette save and load system will soon find out the disadvantages of relying on domestic tape as a storage medium. There are the obvious problems, like the time it takes. It is also not easy to find a cassette recorder that has an adequate frequency response, runs reliably at the right speed and has the right range of output and input signal levels.

Less obvious, there's the hidden problem of mains-borne interference. If someone in the house switches on a light, or electric fire, or if the central heating or refrigerator thermostat kicks in while you are transferring data to or from tape, you will end up with a glitch in the program.

If the spike is bad enough you may even end up with a glitch in the data temporarily stored in the computer RAM. You then unwittingly transfer that to tape for storage, and are stuck with a corrupt program for the future.

The answer is very simple, all you do is buy a mains-isolating transformer to put in circuit with the computer and tape recorder.

In an isolating transformer the primary and secondary coils are quite separate, not joined together as in an auto transformer. You feed 240 volts into the primary and get 240 volts out of the secondary. But interference spikes can't get through, because the transformer acts as a giant choke. Incidentally, an isolating transformer also makes equipment safer, because there is less risk of a shock from live mains running down to earth through your body.

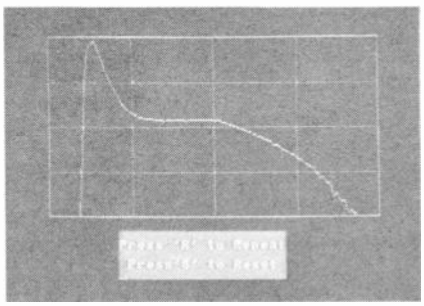
Transformers of this type are expensive because they have to handle high power, but fortunately the drain from a small computer and tape recorder is very low, often a total of no more than 25 watts.

AUGUST ISSUE

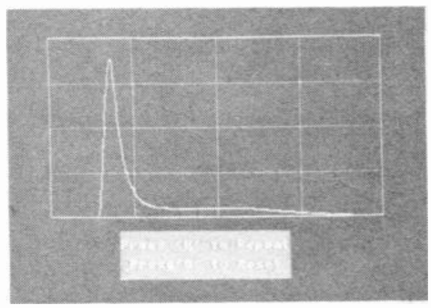
POWER CONTROLLER

A HEAVY DUTY A.C. MAINS POWER CONTROLLER DESIGNED ESPECIALLY FOR DIMMING LARGE FILAMENT LAMPS OF THE KIND USED FOR STAGE LIGHTING. ALSO SUITABLE FOR CERTAIN OTHER TYPES OF LOAD UP TO 1kW.

Your BBC Micro becomes a Storage 'scope with this Interface



PROVIDES A LOW-FREQUENCY STORAGE OSCILLOSCOPE FACILITY WHICH WILL BE FOUND USEFUL WHEN EXPERIMENTING WITH SOUND EFFECT, SYNTHESISER AND OTHER SOUND GENERATOR CIRCUITS. DISPLAYS AMPLITUDE ENVELOPE ON LIN. AND LOG. SCALES WHEN USED WITH SOFTWARE PROVIDED. SAMPLING RATE: 100/SEC.



ALSO

INTERFACING TECHNIQUES Part 2

HOME SYSTEMS MONITOR

CAR INTRUDER ALARM

EVERYDAY ELECTRONICS and computer PROJECTS

AUGUST 1983 ISSUE ON SALE FRIDAY, JULY 15

EVERYDAY news ... from the world o

WANDERER MAKES FIRST LEGAL CLAIM

April saw the launch of Britain's first legal cordless telephone, approved by both the Home Office and British Telecom. Called the Fidelity Wanderer, and manufactured by Fidelity Radio PLC of London NW10, it does not require a licence and is simply installed with a standard British Telecom socket and a mains outlet.

The Wanderer is a result of research undertaken at British Telecom's laboratories at Martlesham, Suffolk, and the portable handset, which incorporates the push button dialling and ringing tone, can be used at up to 200m away from the base unit. It is likely to retail at around £170 and is expected to find popularity with both business user and consumer alike.

Initially, the cordless telephone is being supplied to 200 selected customers, including a number of disabled and elderly subscribers, and is expected to go on sale to the general public this month and be fully available on a nationwide basis by early autumn. Calls are charged at the rate applicable.

In use, the Wanderer sounds no different from a conventional fixed telephone and is operated in the same way. The cordless handset runs from rechargeable batteries which are charged (probably overnight) by the base unit and can give up to five hours continuous use from a fully charged set of Ni-Cad batteries.

Frequencies

Operating on frequencies of 47·46/47·54MHz from handset to base and 1·642/1·728MHz from base to handset, it also has a unique built-in Securitron system of digital coding which prevents unauthorised dialling from other handsets in the same locality. There are in fact over 20,000 different electronic "signatures", one assigned to each handset/base unit pair, thus the odds of any two units in the same area operating on the same code are quite high.

In the US and Canada, where cordless telephones have been on sale for 14 years with considerably fewer channels, neither interference nor poaching have manifested themselves as a problem.

Other Features

Additional features include a re-dial facility which automatically calls a number should it be engaged at the first attempt and a novel "scratch pad" memory into which the user can enter a number during a call and then dial it when the line is cleared. A call button is positioned on the base unit to page the handset user.

The Wanderer will be available from many retail outlets including Boots, Comet, Dixons, John Lewis, Rumbelows and from the Micro Equipment Centre, Bath. The telephone point must be installed by British Telecom.

COMING EVENTS

The Leeds Electronics Show takes place from 5 to 7 July 1983 at the University of Leeds.

A seminar programme will be organised by The Institution of Electrical Engineers and The Institution of Electronic and Radio Engineers.

* * * *

CAST '83

The UK's cable and satellite industry are getting a double boost in 1983. The impending publication of HM Government's White Paper, and the International Cable & Satellite Television Exhibition and Conference at the National Exhibition Centre, Birmingham between 11 to 14 September are certain to strengthen Britain's involvement in this new field.

Britain is represented by British Telecom, Thorn EMI, GEC, Mullard (Philips), Racal, British Aerospace and Rediffusion, among many others. A strong contingent of overseas manufacturers have also bought space.

* * * *

The British Amateur Electronics Club is to hold its annual Exhibition in Penarth, Wales, on 16 to 24 July.

For more details contact: The Secretary, Mr. J. G. Margetts, 113 South Road, Horndean, Hants PO8 0ER.

High Street Sales

Many more High-Street outlets are now stocking Britain's top selling home computer, the Sinclair ZX Spectrum..

Joining W H Smith's, which is currently selling several thousand Spectrums per week, are selected branches of Boots, Currys, Greens—Debenham's in-store subsidiary—and John Menzies.

At the same time John Lewis, House of Fraser, Rank Xerox and many smaller retailers and computer stores will be supplied by Sinclair's UK distributor, Prism Microproducts.

Because of a large number of enquiries from the public about the Telecommunications Bill, the Radio Regulatory Department of the Home Office has produced an addition to its series of CB information sheets which explains the Bill's wireless telegraphy provisions.

The world-beating computerised cargo system developed by British Telecom, currently used in the control of 30 per cent of the UK's overseas trade, is to go on sale round the world.

COMPLAINT

Zilog Inc has filed a complaint against Nippon Electric Company Ltd for patent and copyright infringement, unfair competition and trademark violation involving Zilog's Z80 8-bit microprocessor integrated circuits.

Also named in this complaint are two American subsidiaries of the Japanese company, NEC Electronics (USA) Inc and NEC Home Electronics (USA) Inc. The complaint was filed in the United States District Court for the Northern District of California in San Francisco, California.

CAN YOU TAKE THE PAICC?

Forsaken by Prestel and desperately short of dealers, the Penwith Area of Cornwall now has an up and running computer club. PAICC (Penwith Area Independent Computer Club) hopes to change all that neglect. The Club is non-profit making, non-aligned for both the professional and amateur user. It aims to promote computer literacy in the area and to stimulate the use of computers in local education.

The PAICC Founding Committee includes a representative for women; for local industry; for education; for business applications; for home users and for under 18s.

The club is at present meeting every Friday in a well-equipped room above the Penzance Micro Centre who have allowed the club access to some of their equipment and use of a part of their premises, at least initially.

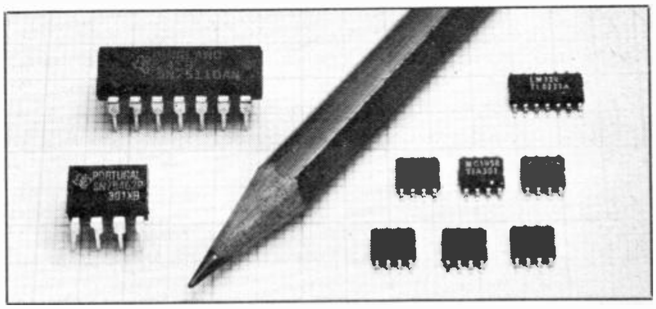
PAICC is fully affiliated to the ACC and prospective members should phone one of the following: Steven Ericsson Zenith on Hayle 754845, Paul Whitehead on Penzance 66336 or Miss Hillage on Sennen 500. These cover the full Penwith Area so phone your local number.

Down to Earth

British Telecom announced it had submitted planning applications for two alternative sites for its third Earth satellite station.

The first site is on the former aerodrome at Henstridge in Somerset, and the second at Benjafield Farm in the village of Milton on Stour, three miles north of Gillingham in Dorset.

Surface Mounted I.C.s



The fast growing components distribution specialists, United Components Ltd has just signed an agreement with Texas, for the distribution of surface-mounted components.

These include a range of low-power Schottky, memories and microprocessor chip carriers and now a range of linear devices. Included in the range will be equivalents to the 555 timer and 741 op-amp.

The new devices take up roughly one third of the board area of their dual-in-line equivalents.

TELEMATICS GRANT

The University of Essex is to receive a grant of more than £500,000 from British Telecom over the next five years to fund telecommunications studies.

British Telecom has been supporting work at Essex since 1967, both financially and through technical co-operation. The new grant extends the corporation's support for telematics and will also finance post-graduate studies in the field of teletraffic engineering. This post-graduate scheme will be the first at a British university designed to train teletraffic engineering specialists.

Teletex Research

ORACLE has been conducting a major research study into teletext usage in Great Britain since the service was launched as an advertising medium late in 1981.

The latest results, just released, show that at the beginning of 1982 the national teletext set count stood at 300,000. By the end of the year the number had more than doubled to 800,000 and the growth particularly accelerated in the last quarter of 1982. RSGB's survey confirms this with 71 per cent of owners sampled having had their set for one year or less and 48 per cent for less than six months.

Alas Poor Oric . . .

A lot of confusion has arisen recently concerning the 16K Oric home computer's availability to mail order customers. Well, for those who have previously ordered one, they should now "know him well" (with apologies to the Bard!) as the first stocks of the 16K version were ready for despatch during early May.

Customers who were supplied with the 48K machine on loan in place of their ordered 16K are being notified that the manufacturers are now in a position to supply the 16K or alternatively, they can purchase the 48K they have been using at a 25 per cent discount.

Overseas demand for the 16K Oric has been enormous and once existing mail order commitments have been met, most available units will be shipped to wholesalers abroad. This means that retail stocks of the 16K will not be available in the UK until July at a price still to be discussed.

However, since Oric Products' own mail order operation has stopped accepting orders, the 48K version is now available in the high street, backed by a £50,000 advertising campaign and full colour point-of-sale displays. Amongst those stocking the Oric are W H Smith, Dixons, Greens, Laskeys and most major specialist outlets.

In addition, Oric are announcing their first batch of specially commissioned software also to be available from dealers. There are five titles in the series, all requiring the 48K machine.

They include: Multigames, a compendium of family games; Flight, an aircraft simulation; and Zodiac, a role playing adventure. These three will retail at £7.95 each. For slightly more, at £9.99 each, comes the Chess tape with five levels of play, and Oric Base, a data management program. Following shortly is a Forth tape and user manual costing £17.95.

Aladdin's Cave

EMOS Ltd the newly-formed member of the Grenson Electronics Group has just opened a large warehouse in Daventry, dedicated to the sale of components to all types of electronic hobbyists.

"Our policy is to buy high quality components and re-sell at extremely competitive prices," says Managing Director, Stuart Taylor. "We have already put into stock over 5000 different types of component, with a value approaching half a million pounds."

The warehouse, which is open from 9a.m. to 4p.m. Monday to Saturday, complements the EMOS Mail Order operation which has now been operating successfully for the last six months.

"We believe that our service is unique to this part of the Midlands, and we have already had satisfied customers travelling many miles to visit us," continued Taylor. "The place is like an Aladdin's cave for the enthusiast."

The Story of a School Radio Club

by D.J. Fry B.Ed. G4JSZ

As a follow-up to *Forming an Electronics Club* (EE April 1982), readers and school teachers in particular may be interested in the story of our Club nine years after formation.

I joined the staff of this school in 1973; it was one of the first purpose-built comprehensive schools in the County, and now it is the largest. The response to starting an "Electronics Club" was very modest, in fact only two boys were interested, one of whom now works for the local police force repairing communications equipment; while the other, at the time of writing, is believed to be somewhere in the South Atlantic!

For the first two years we were very "electronics" orientated. We had £6 from School Funds which we used to buy two soldering irons (and we still have them!). Most of our activities involved constructing simple magazine projects, and studying basic theory. However, it soon became obvious that something more was needed, and that a dynamic approach would provoke more interest.

During the following two years we embarked on visits to a local MEB sub-station, a BBC transmitting station and some of the most popular amateur radio rallies. We are most fortunate in having two mini-buses, which we were able to put to good use. The PTA gave us a grant to buy some tools and a communications receiver, and in return for these gifts, we helped to sell tickets for their social events, cleared up after these and even washed up for them! We began a Club project to build a robot using washing machine parts, but after the control equipment was built interest died off, and the project was a failure.

Parents' Evenings

In the next two years we started putting on demonstrations during Parents' Evenings, to give them an idea what the Club was all about. Many of the boys (most of the interest is shown by boys, although we have had three competent young lady members), were reaching an excellent standard in home-built equipment and our reputation as an active and successful Club was growing. We were given the use of a small room, "the shack", and with the support of the Headmaster things began to take off.

Most of our activities take place at lunch-time; each day we concentrate on an interest such as construction, morse code practice, time "on the air", and theory. It became necessary to separate the beginners from the more experienced members in these theory sessions, in order to concentrate on the basics, although the one essential feature of the Club is that membership includes the full age range.

Half way through this phase in our development, our interests became more orientated towards amateur radio. Acquiring an amateur licence has since become the main aim of all members. We rebuilt my own 2-metre valve transmitter and converted it from AM to FM, so that we could communicate with other radio hams. Interest in amateur repeaters and in operating transmitters grew and eventually two boys (and one of the fathers!) achieved success in the Radio Amateurs Exam.

Membership always seems to hover around the even dozen mark, although one year ago after the vast amount of publicity given to CB, I was faced with nearly forty beginners! Luckily this number thinned down to *six* when it became obvious that electronics and radio involved more than calling "one four, for a copy"!

Outside Activities

During the last three years our involvement in activities outside the School has grown. We put on a display of home-built electronics gadgets and an amateur station at the Schools Science Fair in Hereford, and although we did not win any prizes, all those who took part found it an enjoyable experience with plenty to see and learn. We have developed strong ties with Worcester and District Amateur Radio Club to which many of the boys belong; and the school provides the venue for the Radio Rally which has been held here for the last two years.

Cutbacks within the education service have obviously affected our resources so I have had to find other ways of raising money. The Worcester Club has helped us to purchase a 2-metre transceiver and power supply. I had some badges made and the sale of these has enabled us to buy an aerial and posters.

A direct appeal to parents raised enough money to buy the case hardware and component lists 1 and 2 for the *EE Minilab*. We spent the winter building this, and it now stands as the basis of learning for both beginners and amateurs in the Club. I have been able to raise money by lending out our equipment in return for "donations" to Club funds, although this does not amount to much it keeps us going in batteries and the occasional catalogue.

Our Club has now produced six licenced amateurs; the seventh is awaiting his call-sign. What sort of people are they? In my experience they are slightly introverted, honest, absolutely dedicated, often eccentric, but always loyal!

Current Interests

And what of the future? Well, although I wholeheartedly agree with T. T. de Vaux-Balbirnie that broad aims are essential, it is apparent that with different personalities and new technology these change. Currently our interests are divided between Electronics, Amateur Radio and Computers. The "glue" that always seems to hold everyone together is a mutual interest in experimenting of any sort, and regular "doses" of formal theory sessions. We find that Everyday Electronics provides a varied diet to support this interest, and articles such as *Square One* always appeal to the newcomers.

Buying complete kits of components has proved to be very much more successful than obtaining the bits separately, and the slightly higher cost of doing this far outweighs the extra time taken to find different components from various suppliers. It can also save postage!

We have no formal structure of organising the Club. People seem to drop in to find out what we do, as casually as they drop out for some reason. We have a rota for tasks such as switching off the power, tidying up and locking up, and occasionally we have a purge to clean the place out. If we need specialised equipment such as oscilloscopes, labpacks and the like the Science Department is usually willing to lend us these.

Our goals are made in the context of the next piece of equipment we need; currently this includes a digital readout kit for our receiver, and a 2-metre aerial.

The Radio Club as it is known does tend to "take me over" and here in our school it has become more of an institution over the years!

LETTERS

Computer Bandwagon

Sir—I first bought your journal 10 years ago, two years before I retired, and have enjoyed it until recently.

You have now decided to join all the other available journals on the computer band wagon. I regret that you have not managed to be the only journal with very little or no computer articles. I have therefore cancelled my regular order.

In my opinion the computer projects are too advanced for readers at which EE was directed. No doubt you suffer from marketing managers as I used to do. I only wish they had been correct occasionally.

F. G. R. Rice,
Sidmouth,
Devon.

I am truly sorry to learn that we are now apparently losing a reader of some ten years' standing. I appreciate that you are not interested in computers, but I consider we have maintained the right balance with our contents and computer projects which we are now featuring, have not been included at the expense of other designs having perhaps a wider or more general appeal. For example, our June and July issues each contain five projects apart from the computer ones.

I do not know your own particular interests but these varied projects demonstrate that this magazine continues to be very broad in its outlook and that we continue to cover all aspects of applied electronics.

We of course continue with such items as Square One and in the Autumn we shall be commencing our latest Teach-In series. This will run for twelve months and will cater for beginners and also those who wish to brush up on their knowledge of electronics in general.

I trust you will continue to derive pleasure from this hobby, whether or not you do decide to discontinue reading this magazine.—Ed.

Short-Wave Reception

Sir—Can you please tell me how I can receive broadcasts from various stations around the world on the short-wave band? I'd like to know what times they are on the air and the best times I can tune in from here in Malta.

I tried to receive Radio Australia, but without any luck, so can you help me please? Thank you for now, and keep up the good work of EVERYDAY ELECTRONICS. It's very educational, and I'd recommend it to all students of electronics.

Charles Fenech,
Zurrieq,
Malta.

Pat Hawker replies:

Consistent reception of programmes from distant countries on short-waves usually requires a good deal of information about programme and frequency schedules (that is at what local time are programmes beamed on suitable frequencies towards your country). On short-wave, optimum frequencies change with the time of day and the season (and more gradually with the 11-year sunspot cycle).

It also requires a receiver that can be tuned accurately to a specific frequency—often not possible on many receivers not intended specifically for short-wave reception. There can also be the problem of interference from other stations due either to the overcrowding of the 49, 41, 31, 25, 19, 17 and 15-metre bands, or to the deliberate jamming that often wipes out large sections of the bands. Perhaps the need for information and some experience is why so many short-wave listeners become more interested in just seeking to identify and "log" distant stations and do not worry much about the programmes.

For information on stations, times and frequencies "World Radio TV Handbook" is an excellent source. Most broadcasters will provide information on their own schedules, frequencies and guidance by letter or "over-the-air": the BBC, for example, has a weekly "Waveguide" programme that goes out four times each week: Mondays 0915; Tuesdays 0100; Wednesdays 0430 and 1735—all times in GMT (UT) on the "World Service". Radio Australia provides a daily programme beamed to Europe and should not be difficult to find around 9570kHz (31-metre band) in the European morning.

Diminished Pleasure

Sir—As a regular reader and with an interest in computers I was initially pleased to see the greater emphasis on the latter in the May issue of your magazine, especially the electronic details of the "Real Time Clock". Owning a UK101 already (including several project-built interfaces), yours looked very interesting and relatively easy to adapt to any other 6502-based machine, although the two p.c.b.'s described were specific for the BBC and APPLE II machines. However, my pleasure diminished when I found that the software even for testing the interface was only available on cassette for the two machines.

Having read your Editorial I appreciated both the concept of covering a range of currently popular machines and the fact that you can supply the software in a convenient and tested form. But it means that readers not using the specific machines have no access to the software even if they are prepared to modify circuits suited to their own machines. As you state, many of the designs will be capable of wider application, but there does not appear to be any way of obtaining the necessary programs unless you publish them either in the article concerned or make them available as a separate listing in addition to the cassettes.

Software for testing such interfaces as VIA's and PIA's is difficult enough especially when unknown chips such as the MM58174 or other new ones are involved and this would put off many prospective builders even when they are capable of the relevant electronic changes.

I realise that in many instances the extended/non-standard BASIC or machine code vectors of many machines would make a quick conversion difficult and I am not asking that you become involved in such an exercise, however, the availability of REMed/labelled copies of the cassette programs in LISTed form would be a convenient guide as it has been over the years with other magazine programs.

For the convenience value and the fact that a cassette cost is involved, the prices of your cassette program appears to be very reasonable and yet there may be readers who prefer to enter their own and so obtain a better grasp of the program, also finances may dictate this even in this affluent age. Apart from this, when a reader has purchased a magazine I think that he expects the essential Listings to always be available, and if it is too long to include in the article, to follow the usual practice of being made available on receipt of a SAE to the Editorial Office.

If this practice is to continue I personally would seriously think of giving up the magazine but I would be interested in other readers' points of view.

N. L. Smith,
Stoke-on-Trent, Staffs.

Dealing with these queries in paragraph order:

(1) The TEST routine part of the CLOCK program could have appeared in the article as it was not unduly long, but this alone would have been of minimal use without the INITIALISATION and SETTING UP routines. To include these would have taken considerable page space which is in contention with our software policies.

(2) If the listing does not appear in the article, due to its length, it may be purchased through the EE Software Service. This is in addition to the cassette version.

(3) We believe sufficient information was provided in the article to allow the user to address, set-up and read the special chips used in this design.

(4) Such listings are now available as mentioned in (2).

(5) A reader can expect to find very long listings in a "software" magazine. Everyday Electronics *has no intention of becoming such a magazine. It is chiefly concerned with "hardware" and detailed circuit and construction details. Free listings would short-circuit the software service. We believe the charge for this service is very reasonable, considering the convenience to the user in relieving him/her of the laborious task of entering long programs via the keyboard.—Ed.*

Correspondence Club

Sir—I am writing to inform your readers of the formation of the "National Electronics Correspondence Club".

Primarily the club is to be of use to the hobbyist who is remote from any local club facilities (especially our disabled counterparts), by providing a communications link between members sharing similar interests within the electronics hobby. Members will receive a bi-monthly newsletter containing hints and tips on project construction, topical features, points of view, circuit ideas and members' advertisements, plus special offers on components, tools, etc, and each member will be at liberty to correspond with the club and other members for help or advice on most aspects of electronics.

Membership is £4.50 per annum, which includes the newsletter, administration and postage costs.

Interested parties should write enclosing 25 pence for full details and membership application. (Refundable on membership.)

Mr. E. Foley (Secretary),
95 Albert Road,
Levenshulme,
Manchester M19 2FU.

RADIO WORLD

BY PAT HAWKER G3VA

RTTY And The Legal Maze

Last November I noted the legal maze that surrounds so many aspects of consumer electronics, including the provisions of the Wireless Telegraphy Acts in respect of radio transmissions other than those of "authorised broadcasting stations for general reception and from licensed amateur stations".

For many years the television licence set this out in detail, the full schedule, including the statement: "If any message, other than a message for the receipt of which the use of the apparatus is authorised, is unintentionally received no person shall make known its contents, origin, destination or existence, or the fact of its receipt, to any person other than a duly authorised officer of Her Majesty's Government, a person acting under the authority of the Secretary of State or a competent legal tribunal, and shall not reproduce in writing, copy, or make any use of such message or allow it to be reproduced in writing, copies or made use of". With such a schedule, the owner of any h.f. receiver is clearly in danger of committing an offence almost every time he switches it on! On the other hand, American listeners are simply forbidden (under their 1934 Communications Act) from divulging the contents of any non-broadcast radio transmission they receive.

Unnoticed by the media, the current television licence has been greatly simplified and no longer contains any reminder of the formidable "Schedule" (though of course listeners are still bound by the same Wireless Telegraphy Acts): it now permits you "to install and use . . . television receiving equipment"—no mention of radio or messages but a reminder that "this licence permits you to do only what is stated on the licence".

RTTY Guide

Where does this leave, for example, the growing number of home computer enthusiasts, who have discovered that with the aid of a stable receiver, a "terminal unit", a home computer and suitable software, it is possible to display on a TV screen radio-teleprinter (rtty) transmissions, not only from radio amateurs but from the many commercial point-to-point transmissions, including press traffic. It would be difficult to argue that such reception was "accidental" or "unintentional" or even that any of the messages were broadcast for general reception. Yet it is surely legal for non-amateurs to receive rtty transmissions from licensed amateurs.

Recently Gilfer Associates (52 Park Avenue, PO Box 239, Park Ridge, N.J., 07656, USA) has published the second edition of Oliver P. Ferrell's "Guide to RTTY Frequencies," a 192-page book priced $9.95, listing the frequency, callsign, location, power speed and shift, plus a schedule of over 5,000 RTTY stations and frequencies in use; divided into listing by frequency and reverse listing by callsign.

The lists include weather, press, coast stations, aeronautical, commercial traffic and some military and embassy stations and nets. The book also provides some useful short articles on RTTY reception. Interesting to read but illegal to use?

Teletext

An entirely legal form of high-speed "Electronic-RTTY" now in use in a million British homes is teletext, as provided by the Oracle and Ceefax services on all four television programme services. It is now just over ten years since the development of the original system and it was in 1974 that a unified British teletext specification was drawn up, although several years passed before television receivers with reasonably-priced teletext decoders were available.

The system got off to a rather slow start but times have changed and in 1982 alone some 571,000 teletext-type sets were delivered to the trade, an increase of 168 per cent on 1981, including 200,000 in the final quarter of the year. The British Radio and Electronic Equipment Manufacturers' Association states: "The progress of teletext in the UK and Western Europe continues to give great satisfaction with some 2-million teletext receivers supplied".

BBC and IBA engineers have recently been jointly awarded a 1983 "Queen's Award for Technological Achievement," acknowledging the support given by ITV, industry and Government in what is becoming an important British contribution to broadcasting.

I must admit that at first I was a little uncertain as to how many viewers would want a continuous news and information service but I now find the service increasingly useful, the more so as one finds out all the various facilities offered by the current remote-control units not all of them fully explained in the instruction leaflets issued by manufacturers.

Fading

For listeners on h.f. there can be few more difficult problems than the degree of fading, including the distortion associated with selective fading, experienced on so many signals. Basically most fading is caused by the simultaneous reception of two or more signals coming along more than one path and consequently changing in and out of phase—although there are other causes, including the rotation of polarisation of signals during their passage through the ionosphere.

Many listeners find that fading is considerably more pronounced on signals coming from transmitters hundreds rather than thousands of miles away. Sometimes, as other writers have noted, it is as though a black hole has suddenly opened in the ionosphere as signals zoom down from S9 plus 50dB to barely readable.

In using the new "WRAC-band" of 10·1MHz, I have noticed how much more fading there is on low-power European signals than on either the 7MHz or 14MHz bands, whereas when long-distance signals are coming through they tend to be consistent for long periods at a time. But, despite the fading, 10·1MHz is a most welcome addition for the c.w. operator. Being only 50kHz wide, efforts are being made to discourage s.s.b. phone operation in this band, though not always successful.

Some different-sounding British amateur callsigns are likely to be heard before long on both h.f. and v.h.f. bands. The Home Office is to issue G0 (G-zero) callsigns to new Class A licensees when the G4 sequence is exhausted. Even sooner G1 (G-one) callsigns will be popping up on v.h.f. as the present G6 sequence for Class B licences is almost finished.

Vintage Form-filling

Douglas Byrne, G3KPO, the honorary curator of the *Wireless Museum* at Ryde, Isle of Wight, recently sent me a most interesting copy of an application form of the type used in 1921 in order to apply for "Authority to use Sending Apparatus" under the terms of the original Wireless Telegraphy Act of 1904. No mention of any examinations, although you were expected to disclose among other things whether you had scientific qualifications or experience in working wireless sending apparatus.

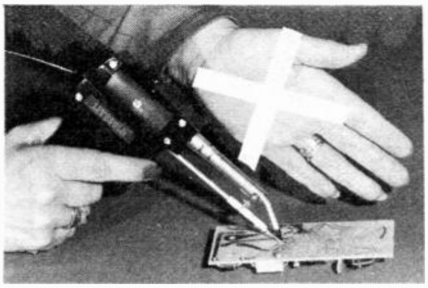
Also you were expected to declare particulars of any radiotelegraphy proficiency certificates you held, speed of your sending and receiving, the power you intended to use for spark and/or valve, the full address of each station "to which it is proposed to transmit" including names and addresses, sketch of the aerial which you desired to use, and diagrams of apparatus both for transmission and reception.

Later, in the 1930s, I recall that there was a printed rather than a duplicated form with some different requirements of which perhaps the most tricky was having to explain in detail just what scientific experiments you intended to carry out to justify your need for an "experimental" transmitting licence. If you were unwise enough, for example, to suggest only that you wished to develop improved transmitting equipment, the licensing authority (then the Post Office) would cunningly reply that such work could be carried out satisfactorily on an "artificial aerial" and would proceed to issue only an "artificial aerial licence." These had a three-letter callsign but no "G" prefix.

I held an AA licence for a year or two since you had to be 16 years old in order to qualify for a radiating licence. My call was 2BUH, until I got my radiating licence in 1938.

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

SELF-FEED SOLDERING GUN



THE need for a third hand for those tricky soldering jobs has been eliminated with the introduction of the Hakko MG Self-Feed Soldering Gun from **Litesold.** At the squeeze of the trigger, it feeds a controlled length of solder to the joint every time. The length of solder fed to the joint is adjustable and can also be varied by control of the trigger movement.

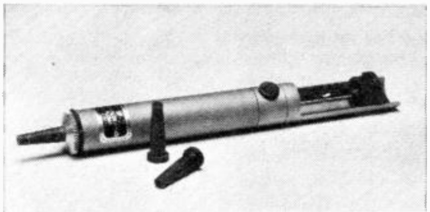
Solder may be fed from standard reels, mounted or hung on the bench, or an optional spool holder can be loaded with a suitable quantity, and mounted on the gun. Pushing the trigger upwards releases the solder feed for quick replacement.

Both the heating element and the long life soldering tip are easily replaceable when required. The gun is supplied with two solder feed nozzles one for 0·8–1·2mm solder and one for 2·0–2·3mm solder.

Two models are available; a 40W iron with a 4mm diameter tip priced at £22.04 and a 60W iron with a 6mm tip priced at £22.56. Full details from:

Light Soldering Developments Ltd., Dept EE, Spencer Place, 97-99 Gloucester Road, Croydon, CR0 2DN.

ANTISTATIC DESOLDER PUMP



A NEW antistatic desolder pump is now available from **OK Industries UK Ltd.** The desolder pump has a tip made of a special bronze alloy composition designed for long life. Moreover, static discharges automatically through the hand of the earthed operator making the DP-2 suitable for removing sensitive CMOS components.

Suction is regulated to prevent damage to delicate circuitry and the tool, which is self cleaning on each stroke, offers full industrial performance and reliability.

Full details of the Antistatic Desolder Pump, which is priced at £13.91 excluding carriage and VAT, are available from:

OK Industries UK Ltd., Dept EE, Dutton Lane, Eastleigh, Hants SO5 4AA.

HAND TOOLS

A NEW range of hand tools for the electronics industry is now available from **Eraser International** and are manufactured by their Rush Wire Stripping and Wybar Lead Forming Division.

Hand tools are available for both cutting and stripping wires and cables and for cutting and forming of the lead legs of electronic components. A new 4-page brochure is available free to engineers within the industry.

A number 6 wire stripper which is self adjusting is priced at around £12.50 and a hand cable stripper PSC-1 is priced at £15.15. For further details and prices contact:

Eraser International Ltd., Dept EE, Unit M, Portway Industrial Estate, Andover, Hants SP10 3LU.

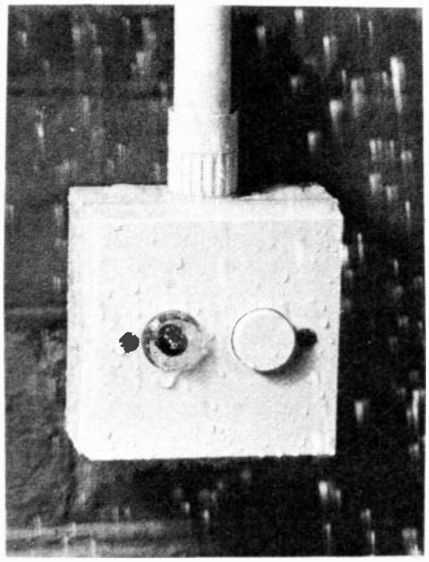
INFRA RED OPERATED SWITCH

A SPLASHPROOF, outdoor remote or manual light switch has been added to the range of remote control switches from **Superswitch Electric Appliances.**

The splashproof version, model 2715, is a surface mounting type with the infra red sensor and manual switching button located on the front panel. The hand-held infra red transmitter will trigger the switch from a distance of up to 50ft and will operate through glass. Coming home at night, in the rain, a driver can turn on the outside lights without having to leave the car or open the window.

The switch will handle tungsten lamps or resistive loads up to 5A maximum, with a maximum of 2·5A for fluorescent or inductive loads. It is claimed that it may be mounted with conduit entry above, below or at the side of the switch box, with no danger of seepage from rainwater.

It can be installed in one- or two-way switching circuits, has three modes of operation, set up by an internal switch during installation. The options are: switched on by infra red beam, off manually; switched on as long as either infra red or manual switch is pressed, but goes off when released; switched on and subsequently off by either infra red transmitter or manual switch. Further information and details of local stockists can be obtained from:



Superswitch Electric Appliances Ltd., Dept EE, Station Trading Estate, Camberley, Surrey GU17 9AH.

SLIM-LINE SPEAKER

TWO new miniature loudspeakers just announced by Mullard are claimed to be the thinnest ever offered. Both are only 5mm in depth, the smallest (AD01980) has a 34mm diameter cone whilst the larger (AD01985) has a 38mm cone.

The loudspeakers can handle 300mW r.m.s. and have a 400Hz to 3kHz frequency range. Each is offered with impedances of 8 ohms, 15 ohms and 25 ohms.

Applications cover a wide range of professional and semi-professional equipment. One idea could be their use as earphones in rally driving helmets for driver/co-driver communications.

Addresses of nearest stockists can be obtained from:

Mullard Ltd., Dept EE, Mullard House, Torrington Place, London WC1E 7HD.

SQUARE one FOR BEGINNERS

THE semiconductor diode is basically a *p-n* junction. This means it is constructed from two types of semiconductor, an *n-type* and a *p-type* material. This creates a junction between the two types of semiconductor material and at this junction, a **depletion layer** is formed. The depletion layer, under normal circumstances, cannot pass a current and therefore forms an insulator.

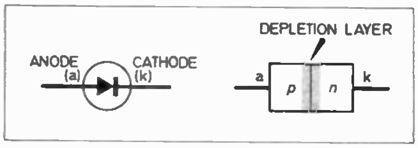


Fig. 1. The circuit symbol and basic construction of a *p-n* junction diode.

Fig. 1 shows this and the general circuit symbol for a semiconductor diode. Note that the *p-type* semiconductor forms the anode (a) and the *n-type* is the cathode (k).

FORWARD BIASING

If an electric potential is applied to the junction with the positive to the anode *(p-type)*, then the depletion layer is reduced and a current will flow. In this condition, the diode is said to be **forward biased.**

If the potential on the diode is reversed, that is, with the positive on the cathode (*n-type*), the depletion layer is increased and no current can flow. The diode is now said to be **reverse biased.**

In this way, the semiconductor diode can be thought of as a valve, only allowing a current to flow in one direction. There is, in fact, a small leakage current that flows when the diode is reverse biased but this will normally be negligible.

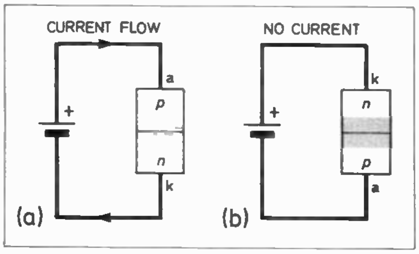


Fig. 2. Diagram showing (a), a forward biased diode and (b), a reverse biased diode. Note the difference in the width of the depletion layer (shaded).

The diagrams shown in Figs. 2(a) and 2(b) give these two basic configurations. Note that when the diode is conducting in the forward biased condition, there will be a potential difference across it, known as the forward voltage drop.

TYPES OF DIODE

There are two main categories of diode: **rectifier** and **signal diodes.** The rectifier diode is used in power supply applications to produce d.c. from a.c. and can carry large currents and work at high voltages. However, they can only operate at low frequencies, that is, in the order of the mains frequency of 50 or 60Hz.

On the other hand, the signal diode functions at very high frequencies and finds its application in logic elements and r.f. circuits. They are physically smaller than rectifier diodes and can only work at much lower voltages and currents.

These two types of diode are made from either **Germanium** or **Silicon** and each material has its own particular properties. Germanium diodes have a low forward voltage drop in the region of 0·2V and a maximum junction temperature limit of 75°C and find favour in radio frequency detectors and demodulators.

Silicon diodes have a higher forward voltage drop of about 1V but the limit for the junction temperature is 200°C making this type ideally suited for power applications and rectifiers.

SPECIALISED DEVICES

In addition to the two main types of diode, there are many specialised diode devices which the constructor will come into contact with. A brief description of some of these devices is given below.

Zener diode. As previously stated, when a diode is reverse biased, a small leakage current flows. If the reverse voltage is increased, a point will be reached when breakdown occurs and a large current will flow. For normal diodes, this breakdown voltage will be very high.

Zener diodes, however, are manufactured to have a predictably low breakdown voltage, typically in the range 2·7V to 75V. This is achieved by making the *p-n* junction with a deliberately narrow depletion layer. This characteristic makes the Zener diode suitable for reference voltage devices in power supply regulators.

Varicap diode. The depletion layer in a reverse biased *p-n* junction displays a capacitive effect and the varicap diode (also known as a *varactor diode*) makes use of this property. As the reverse voltage across the device is varied, so the width of the depletion layer varies and the capacitance changes in proportion.

For a 5V change in reverse bias voltage, a typical varicap diode will change in capacitance from 10pF to 50pF. This capacitive effect is utilised in radio and TV tuning circuits.

Light emitting diode. This type of diode, usually abbreviated to l.e.d., will behave as a normal diode but with the ex-

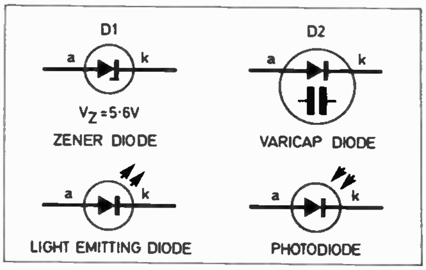


Fig. 3. Semiconductor diode circuit symbols. Note the Zener voltage (V_Z) is quoted for the Zener diode.

ception that it emits light when forward biased. They are still *p-n* junction devices but made from different semiconductor materials (see *Square One*, January '83) and are available in red, green, orange/yellow and more recently, in blue.

The l.e.d. has a high forward voltage drop, in the range 1·5 to 2·5V (depending on the colour) and will emit light with forward currents of between 5 and 30mA. Some care must be taken when using l.e.d.s to ensure this current is not exceeded so in almost all cases, a series resistor must be included.

As most l.e.d.s are used as indicators, they are packaged in lamp-like plastic cases and with the aid of a special clip, can be front panel mounted.

Photodiode. When in darkness, the only current flowing in a reverse biased photodiode will be the very small leakage current of about 10μA. However, when the photodiode is illuminated, this current increases by a factor of ten. The response to changes in light level in a photodiode is linear and very fast, making it ideal for high speed detection circuits and light level metering.

It will conduct normally when forward biased. The circuit symbols for this device and the other special types of diode discussed are shown in Fig. 3.

MARKINGS

With the exception of the l.e.d., photodiode and some high power diodes, most devices are axial components (that is, similar in appearance to a resistor). The cathode end is usually indicated with a broad band.

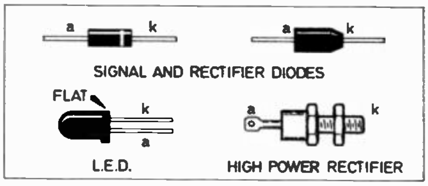


Fig. 4. Typical diode outline drawings.

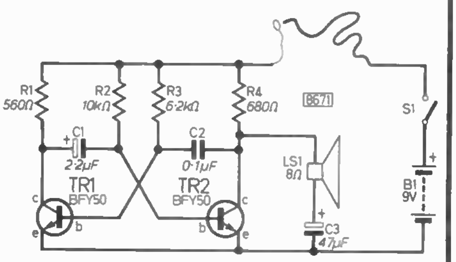
An alternative way of indicating the cathode, is a slight tapering of the component body at the appropriate lead. This is shown in Fig. 4.

One other convention for marking the cathode, particularly on circuit diagrams and component layout drawings, is with a positive (+) sign. The reason for this is that, with conventional current flow (from positive to negative), the cathode is the end from which the current flows out on a forward biased diode.

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.

SHAKY HAND GAME



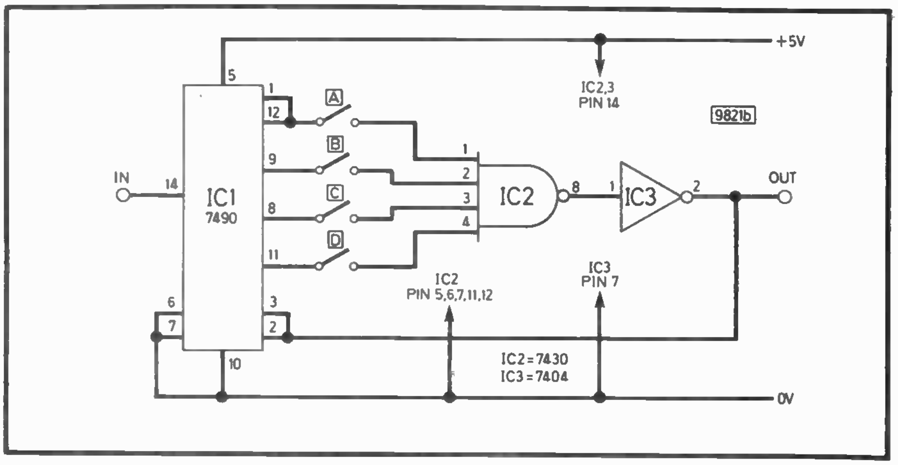
TRANSISTORS TR1 and TR2 form an astable multivibrator and a loudspeaker is connected in the collector circuit of TR2. The positive side of the battery supply is completed via a length of uninsulated wire, suitably bent; and a loop of bare wire is manoeuvred along the bent wire. If contact is made, the circuit is brought in operation and an audible sound produced.

David Smith,
Treeton,
S. Yorkshire.

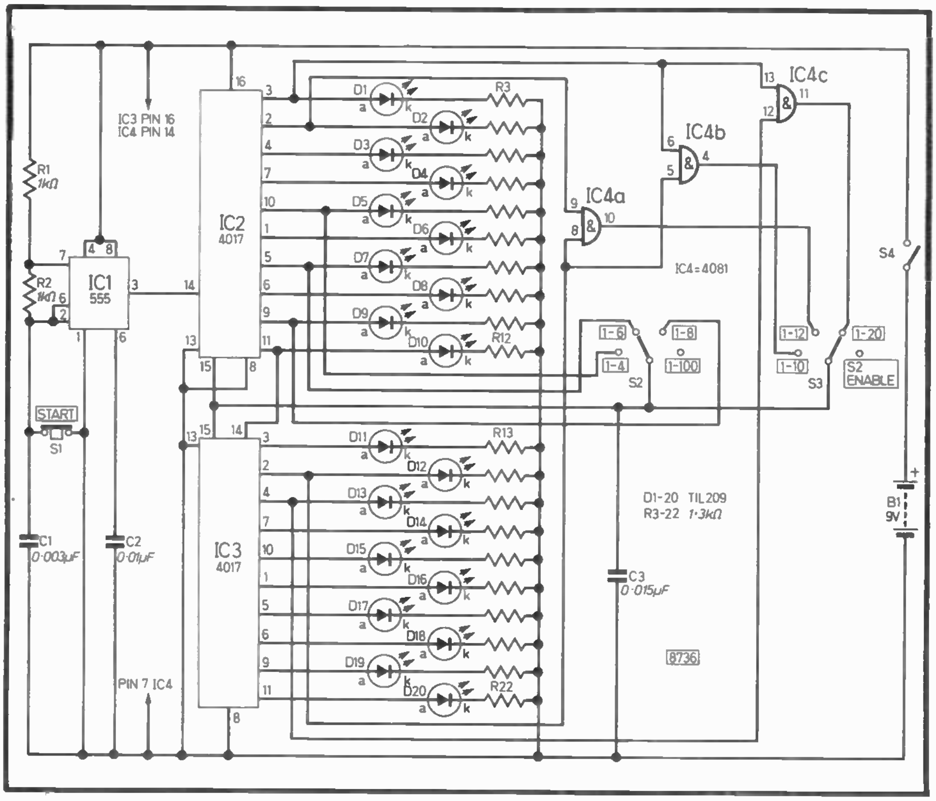
PROGRAMMABLE DIVIDER

THIS circuit is extremely useful for the digital experimenter, and can divide the incoming digital signal by any whole number between two and ten. When all inputs are at a logic "1" the output becomes "0", is inverted and becomes the output pulse and resets the counter to zero. To operate: for example, if division by six is required (6 = 0110 in b.c.d.) switches B and C are closed. The A and D inputs are floating, that is, at logic "0" and when B and C ouputs become logic "1" the counter is reset.

M. Betts, Lewes, Sussex.



ELECTRONIC DICE GENERATOR



THIS circuit generates numbers as follows: 1–4, 1–6, 1–8, 1–10, 1–12, 1–20, 1–100, for use in such games as TSR's *Dungeons* and *Dragons*, etc. The l.e.d.s driven by IC2 are units, arranged 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. The l.e.d.s driven by IC3 are tens arranged thus 0–9. Thus if pins 10 of IC2, 3 are high, "45" will be displayed.

IC4 and switches S2, S3 co-ordinate reset pulses to the counters (IC2,3) for differing ranges. The circuit is totally random; on the 1–100 range each number is displayed 1600 times a second! IC1 clocks the circuit and is allowed to function when S1 is depressed. (S1 is a push-to-break, non-locking mini switch.)

Thomas Haine,
Earley,
Berks.

MORE ON PAGE 462

COMPUTER PROJECTS
PUBLISHED OVER THE PAST 12 MONTHS

2K RAM PACK FOR SINCLAIR ZX81 — ***April 1982***
Also: Capacitance/Frequency Meter; Magnetic Lock; V.C.O. Sound Effects Unit; In-Car P.S.U.; Light Activated Switch.

KEYBOARD SOUNDER FOR SINCLAIR ZX81 — ***June 1982***
Also: C.B. Power Supply; Nightlight; Seat Belt Reminder; Public Address System (pt 2); Egg Timer.

TEMPERATURE INTERFACE FOR TANDY TRS-80 — ***Aug/Sept 1982***
Also: (Aug) C. B. Roger Bleeper; Two-Tone Doorbell; Quiz Master; Instrument Pre-Amp; Public Address System (pt 4). (Sept) Sound Splitter; C.B. Battery Charger; Screen Washer Delay; Monthly Planner; Continuity Tester.

EXPANSION SYSTEM FOR SINCLAIR ZX81 — ***October 1982***
Also: Sine Wave Generator; General Purpose Pre-Amp; Optical Tachometer; Lights On Alert; Simple S.W. Radio.

TAPE CONTROLLER FOR SINCLAIR ZX81 AND SPECTRUM — ***November 1982***
Also: Combination Lock; Digital Metronome; Oscilloscope Companion; Photo Finish; Beat The Relay.

EXTRA RAM FOR SINCLAIR ZX81 — ***December 1982***
Also: Security Vari-Light; Car Indicator Alarm; Velocity Measurer; Electric V/I Meter; 5V Regulated Supply.

A TO D CONVERTER FOR PET — ***January 1983***
Also: Personal LS Amplifier; Coulomb Meter; Opto Repeater; Double Dice.

SPEED COMPUTING SYSTEM FOR SINCLAIR ZX81 — ***February 1983***
Also: Pushbike/Motorbike Alarm; Beehive Temperature Meter; Short Interval Timer; Speech Processor.

EPROM PROGRAMMER FOR ACORN ATOM — ***Feb/March 1983***
Also: (March) Multi-Station Intercom; Car Thermometer; Buzz Off!; Dual Power Supply.

EXPANDED ADD-ON KEYBOARD FOR SINCLAIR ZX81 — ***March/April 1983***

AMPLIFIER FOR SINCLAIR SPECTRUM — ***April 1983***
Also: (April) Function Generator; Novelty Egg Timer; Flanger Sound Effect; Neon Nightlight; Car Radio Booster.

REAL-TIME CLOCK FOR APPLE II and BBC MICRO
TEMPERATURE SENSOR FOR PET and VIC 20 — ***May 1983***
Also: Guitar Headphone Amplifier; MW Personal Radio; Laboratory Amplifier; Model Train Controller; Moisture Detector.

EPROM PROGRAMMER FOR TRS-80 and GENIE — ***June 1983***
Also: Push Button Combination Lock; Caravan Power Supply; Caravan Fridge Alarm; Transistor Tester; Envelope Shaper for Bass Guitar.

All the above are fully illustrated, detailed constructional articles. Back numbers £1.00 (inclusive of p&p) per copy currently available from: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

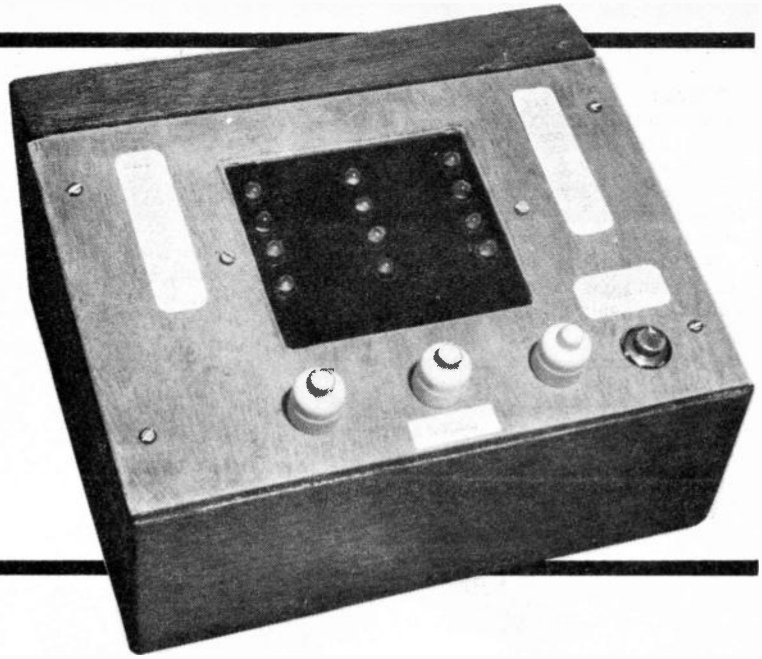
Stocks of back issues are limited. In the event of non-availability a photocopy of the relevant article will be supplied.

Please enclose appropriate remittance and specify month of issue and title of article required.

EVERYDAY ELECTRONICS and computer PROJECTS

BINARY BANDIT GAME

BY F. G. RAYER



INSTEAD of the usual fruits and other symbols, there are three vertical rows of four l.e.d.s used in this game. The control of each vertical row is separate from that of the others, and the columns change at different speeds. All change under a SPIN control, but any may be retained by means of separate HOLD controls.

Various *wins* arise from the matching or part matching of the columns in the horizontal direction, in a similar way to that of the mechanical one-armed bandit machine.

The way in which the circuit operates will become clear from Fig. 1. Here, the left hand section of the three sections is shown in detail. As the middle section *B* and right hand section *C* duplicate the circuit, they are not repeated.

DISPLAY

This display (circuit *A*) consists of the four light emitting diodes as shown in Fig. 1. These are mounted vertically one above the other, and form the left hand column of the display. IC1 is a decimal divider which receives pulses at pin 14, and provides a binary output at pins 11, 9, 8, 12 and 1. The four l.e.d.s light and are extinguished in the same sequence for each 10 pulses at pin 14. The l.e.d.s may be all the same colour, or altered to red, green and yellow.

MULTIVIBRATOR

Transistors TR1 and TR2 form the multivibrator, and pulses for IC1 are from the collector of TR2. The HOLD switch is of a type normally closed. The SPIN switch is normally open. Current is available at the positive and negative lines shown, so long as the game is being played.

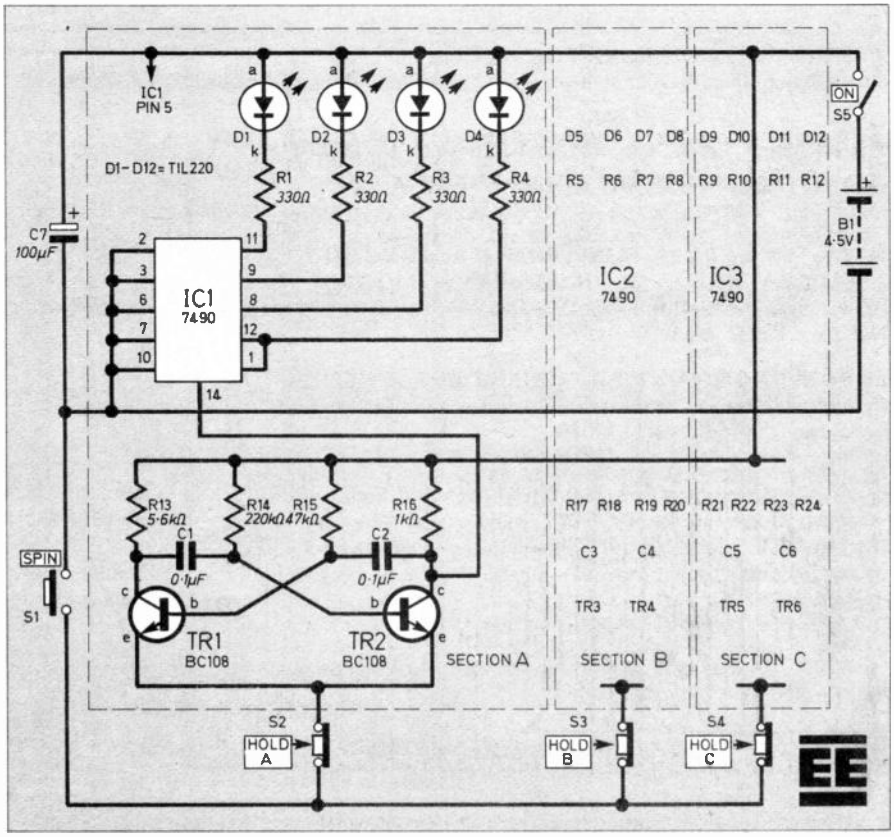
When the SPIN push switch S1 is pressed, TR1 and TR2 generate pulses, and IC1 provides a binary output from these, so that the l.e.d.s change rapidly. When the spin switch is released, pulses from the multivibrator cease, so the display depends on the last state of IC1. This remains showing until the SPIN switch is again closed.

To give the player rather better chances, the HOLD switch can be pressed before operating the SPIN switch. So the voltage does not reach TR1/TR2, and this display remains unchanged. However, the other displays (unless interrupted by a HOLD) will change.

Values from 180Ω upwards were tried for R1–12, 330Ω gives a good compromise between brightness, current drawn, and power passed by IC1.

The capacitors C1 and C2 need not be of the same value, and 30V 0·1μF disc ceramics were used for convenience. The resistors R13, 14, 15, can be modified considerably, but R16 needs to be about 1kΩ to drive IC1.

Fig. 1. Circuit diagram for one reel or vertical column of the Binary Bandit Game. The circuit is repeated for the other columns but certain component values differ as indicated in the Components List.



REPEATED CIRCUITRY

Circuit *B* is repeated in the same way, except that some of the multivibrator values are modified, so that the l.e.d.s change at a different rate. It has its own HOLD push-to-break switch S3, which allows any display here to be retained while the others operate.

Again, circuit *C* duplicates the earlier circuits, and has its own HOLD switch S4. Values are again modified, for a different running rate.

The Hold switches (S2, 3, 4) are, of course, to allow a good column to be retained while the others are changed, or to let the player keep two matching columns displayed, while playing to get the third correct. They considerably increase winning chances.

The three circuits are constructed together on a single board. This is a complete, working assembly, including the l.e.d.s which project through holes in the case, or in a panel drilled for the purpose.

Current drain is about 120mA, which makes running from a dry battery possible. The large capacitor C7 is not duplicated, only one being used for the whole board.

MOMENTUM CAPACITORS

It is easy to add an effect similar to that of mechanical momentum to any or all sections, but the capacitors for this are too large to fit the board very easily. A capacitor to provide this effect is connected from the positive line to emitters of TR1 and TR2. A quite large value is required, 3300µF to 4700µF is suitable. When a section is fitted with such a capacitor, changing of the display does not halt immediately the SPIN button is released.

HOW IT WORKS

Three multivibrators, operating at different speeds, provide pulses for three decade counters giving binary output. The outputs are displayed on three columns each having four l.e.d.s.

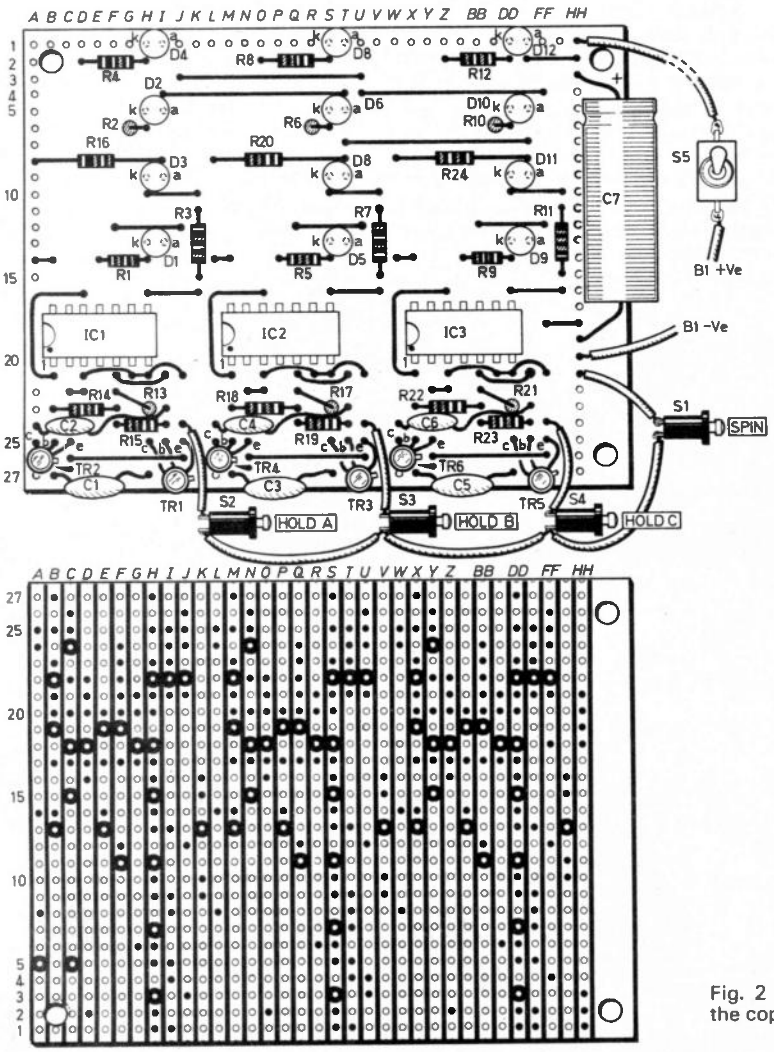
Various combinations provide a *win* and it is possible to hold any vertical column while further attempts change the other columns.

The display for any one column may be 0–9 as follows:

0	X	0	X	0	X	0	X	0	X
0	0	X	X	0	0	X	X	0	0
0	0	0	0	X	X	X	X	0	0
0	0	0	0	0	0	0	0	X	X

Here, 0 denotes an illuminated l.e.d. Pay out rates (toy money, sweets) for 1 unit per attempt can be:

```
000 pays 1      000            000
                000 pays 4     000
                               000 pays 9
000
000                   0 0
000                    0    pays 7
000  pays 15          0 0   (2,5,2)
```



COMPONENTS

Resistors

R1–12	330Ω (12 off)
R13,17,21	5.6kΩ (3 off)
R14	220kΩ
R15	47kΩ
R16,20,24	1kΩ (3 off)
R18	820kΩ
R19	56kΩ
R22	1MΩ
R23	68kΩ

All ¼W carbon ±5%

See Shop Talk page 427

Capacitors

C1–6	0·1µF ceramic (6 off)
C7	100µF 10V elect.

Semiconductors

D1–12	5·5mm l.e.d. (12 off)
TR1–6	BC108 silicon *npn* (6 off)
IC1,2,3	7490 decade counter

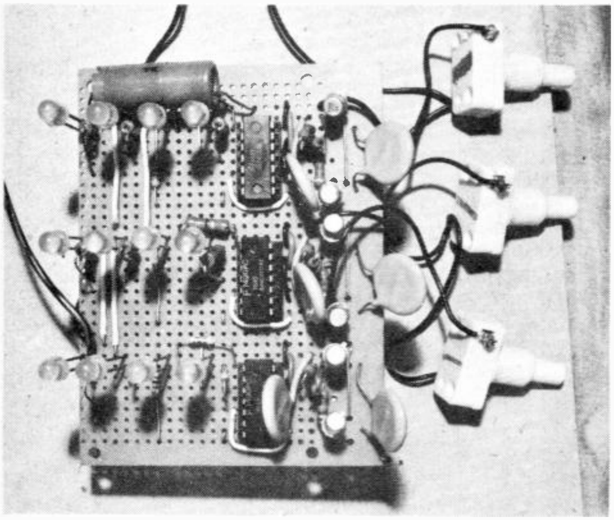
Miscellaneous

S1	press-to-make
S2,3,4	press-to-break
S5	on-off toggle

0·1in matrix stripboard, 34 strips by 27 holes; case, 165 × 139 × 63·5mm (front) × 89mm (rear) (see text);
14-pin d.i.l. holder (3 off).

Approx. cost Guidance only £10.50

Fig. 2 (left). Circuit board component layout, breaks in the copper strips (underside) and interwiring details.



Spin push-switches wired to the completed circuit board.

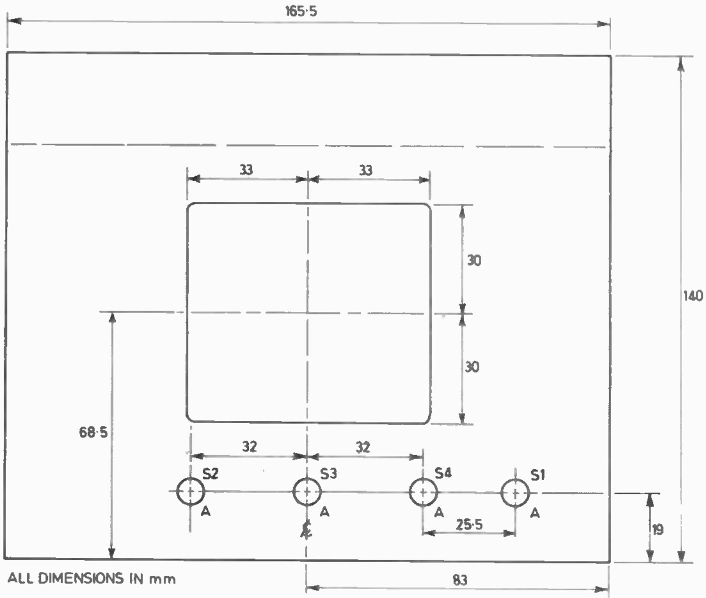


Fig. 3. Suggested drilling and measurements for a suitable front panel.

COMPONENT BOARD

The component board is a piece of 0·1in matrix stripboard having 34 strips by 27 holes. Fig. 2 is the whole of the component board. First establish correct polarity for the l.e.d.s then fit these as shown, making sure that you space and position them accurately before soldering.

Note that all the breaks in the stripboard are shown in Fig. 2. Holders are used for the i.c.s with the pin connections being made under the board. Pins 2, 3, 6, and 7 on each of the i.c.s are connected under the board.

After completing the left hand section, connect the positive and negative supply lines to a 4·5V supply. Run a flexible lead from S1 to the negative line, the l.e.d.s should change rapidly, and remain lit with S1 disconnected.

Circuit *B* and circuit *C* can be completed, by copying the board for circuit *A*. Difficulties seem unlikely, if it is remembered that each of the three circuits are separate from each other.

CASE

The case is made from thin wood, 165 × 139 × 63·3mm (front) × 89mm (rear), although any case of similar dimensions would be suitable.

Twelve holes for the l.e.d.s were drilled in thin s.r.b.p. 102 × 76mm. The sheet is then fitted over the l.e.d.s and is held in place by four 1½in 6BA bolts. Two 8BA bolts may then be used to secure the assembly behind the 66 × 60mm aperture cut into the case as shown in Fig. 3. □

BOOK REVIEWS

ELECTRONICS FOR TECHNICIANS

Author G. D. Bishop
Price £4.95 Limp edition
Size 232 × 203mm. 136 pages
Publisher Macmillan Press
ISBN 0-333-34027-2

As the name sugests "Electronics For Technicians" is a book devoted to giving trainee technicians a thorough grounding in electronics. The book contains ten chapters starting with semiconductor diodes which defines the role of the conductor and insulator in electronic theory.

The remaining chapters deal with transistors, amplifiers, power amps, noise, feedback, waveform, generators and switches, integrated circuits, stabilised power supplies and finally logic elements and circuits.

Every chapter is defined with an easy explanation and is accompanied by a set of questions with which you may test your learning power. There are plenty of diagrams to help you understand the theory in each chapter and also to aid you in constructing your own circuit diagrams. Overall, a very useful book which would benefit any newcomer to electronics.

R.A.H.

THE BBC RADIOPHONIC WORKSHOP

Author D. Briscoe/R. C. Bramwell
Price £7.75 Limp edition
Size 246 × 180mm. 175 pages
Publisher British Broadcasting Corporation
ISBN 0-563-20150-9

Formed in 1958 the BBC's Radiophonic Workshop has for many years been producing weird and wonderful sounds. Perhaps the most well known television show that the Workshop has designed sounds for is "Doctor Who".

The book gives a very detailed account of how the Workshop was originally started by a group of music enthusiasts and then later began to change the listening habits of millions of people.

The book contains twelve chapters on the history of the Workshop and how talent such as D. Briscoe, one of the pioneers of new sounds, helped to establish it. For anyone interested in sound this book gives you a true insight into the trials and tribulations of producing sound for broadcasting.

R.A.H.

Books in Brief

V.H.F./U.H.F. Manual Edited by G. R. Jessop (Radio Society of Great Britain). Hardback £8.50 (£10.31 by post from RSGB Worldwide). This is the fully revised and expanded fourth edition of a well established reference work covering all aspects of the spectrum above 30MHz. The theory of propagation, aerials, and a wealth of practical designs for receiving and transmitting equipment, and much more is included in the 528 pages.

Introducing Computers by Malcolm Peltu (The National Computing Centre, Manchester). Limp £5.50. A comprehensive but concise guide to computing, and other information technologies. Ideal for the non-technical reader wishing to obtain a good grounding in the subject.

TEST GEAR 83 PULSE GENERATOR

UNIT FIVE

BY J. R.W. BARNES

THE TEST GEAR 83 SERIES CONSISTS OF:
DUAL POWER SUPPLY ● FUNCTION GENERATOR ● TRANSISTOR TESTER PULSE GENERATOR ● LABORATORY AMPLIFIER ● FREQUENCY METER

DESPITE living in an essentially analogue world, a large proportion of electronic projects use digital circuitry. Widely available integrated circuits offer the designer a range of building blocks from simple gates to complex counters and shift registers, often for the price of a few transistors. In order to design and test digital circuits, a pulse generator is required. The unit described here will satisfy the needs of the home constructor at a reasonable cost.

The unit provides both TTL and open collector (for use with CMOS logic) complementary outputs. Facilities are provided to generate either a single pulse or a continuous stream. The pulse repetition frequency can be varied between 1Hz and 100kHz and the pulse duration from 0·1μs to 2s.

As with the Function Generator, maximum benefit will be gained when the unit is used with an oscilloscope. Simple tests can be carried out at low speeds with a logic probe.

In line with the other instruments in the *Test Gear 83* series (except the Transistor Tester), the Pulse Generator is mains powered.

CIRCUIT DESCRIPTION

The circuit diagram of the unit is shown in Fig. 1. The circuit can be split into sections. The power supply will be considered first.

The circuit is very conventional, based around the 7805 three terminal regulator integrated circuit, IC5. The a.c. input is provided by the transformer and is rectified and smoothed by the bridge rectifier D1–D4, and the capacitor C18, respectively. The capacitors C19 and C20 are to prevent high frequency oscillations. Capacitors C1 and C17 provide distributed decoupling close to the i.c.s.

SPECIFICATIONS

Operational modes:	single pulse or continuous stream.
Pulse repetition frequency:	variable between 1Hz and 100kHz.
Pulse duration:	variable between 0·1μs and 2s.
Output conditions:	TTL (buffered) and open collector (for CMOS logic)

PULSE GENERATOR

The Pulse Generator section is centred around a monostable multivibrator, the 74121 (IC3). The width of the output pulse is controlled by an R-C network connected to pins 11 and 10. Coarse period control is provided by S3 and capacitors C9–C15. Fine period control is by VR2.

OUTPUTS

The TTL outputs are buffered by inverters, IC4. The open collector outputs are implemented in transistors TR1 and TR2. When using the Pulse Generator with CMOS logic, the open collector outputs should be used. The desired output is connected to the input and a pull-up resistor of between 1 and 10 kilohms should be wired from the input to the positive supply.

This ensures that the signals are not only of the correct level, but that an input is not applied to the CMOS input with no supply connected, a potentially destructive situation.

TRIGGERING

Two methods are provided for triggering the monostable multivibrator. For a continuous stream of pulses a 555 timer (IC1) is used in the astable mode. The pulse repetition frequency (p.r.f.), is determined by an R-C network. Coarse frequency control is provided by switching the timing capacitor, S1 and C2–C7. Fine adjustment of the frequency is accomplished by VR1. Care should be taken when using the Pulse Generator not to set a period greater than the p.r.f. will allow.

The frequency of operation is given by:

$$\text{p.r.f.} = \frac{1\cdot 44}{(R1 + VR1 + 2\,R2) \times C_t}\ \text{Hz}$$

One-shot operation allows the Pulse Generator to provide a single pulse of controllable duration at a manually determined rate. The switch is debounced by two NAND gates (IC2a and b) connected as a bistable. A third NAND gate (IC2c) is used as a monostable to provide the narrow triggering pulses required by the main monostable multivibrator, IC3.

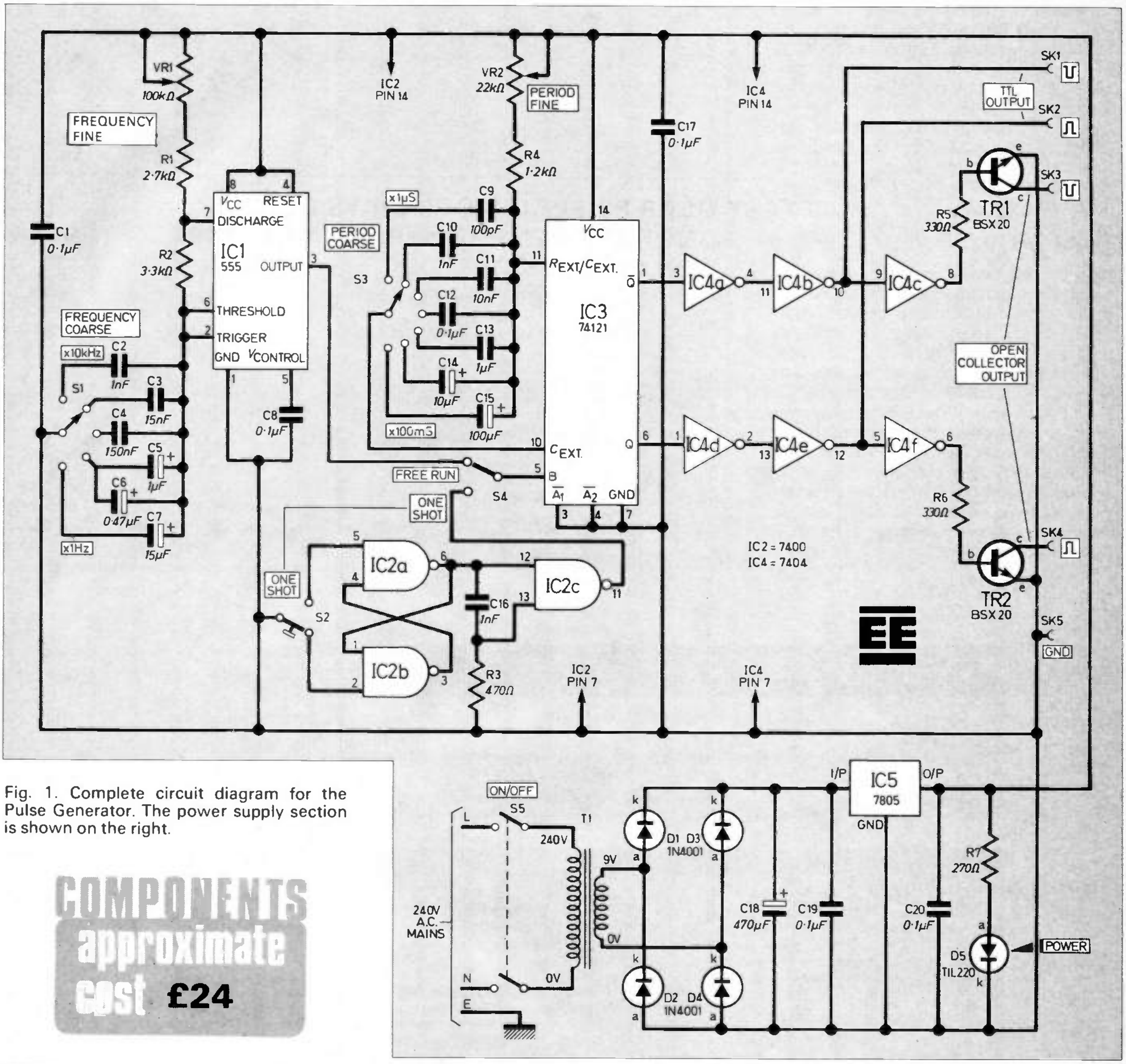
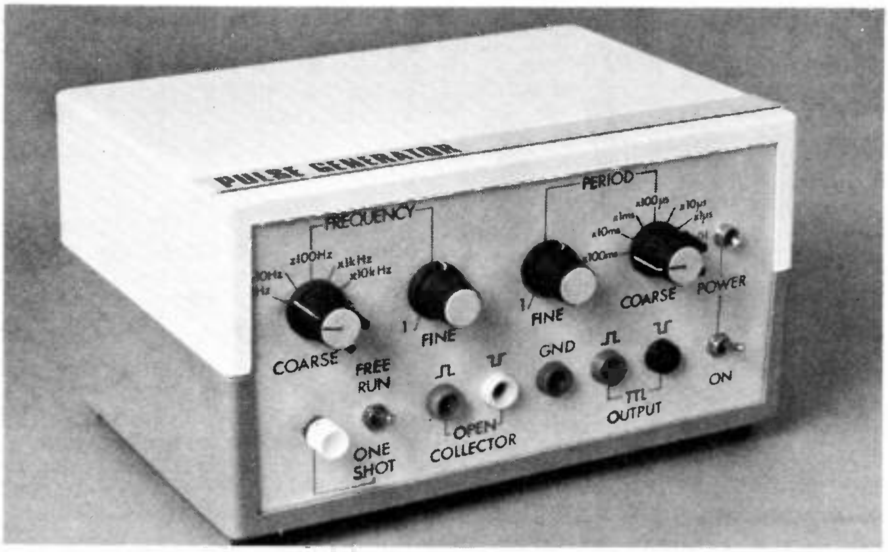


Fig. 1. Complete circuit diagram for the Pulse Generator. The power supply section is shown on the right.

COMPONENTS approximate cost £24



CONSTRUCTION

CIRCUIT BOARD

Begin construction with the circuit board. When etching the board, pay special attention to the positioning of the mounting holes, as they are designed to align with the moulded pillars in the base of the case. It may be necessary to change the mounting holes for the mains transformer, according to the one purchased. So it is advisable to check this prior to making the board.

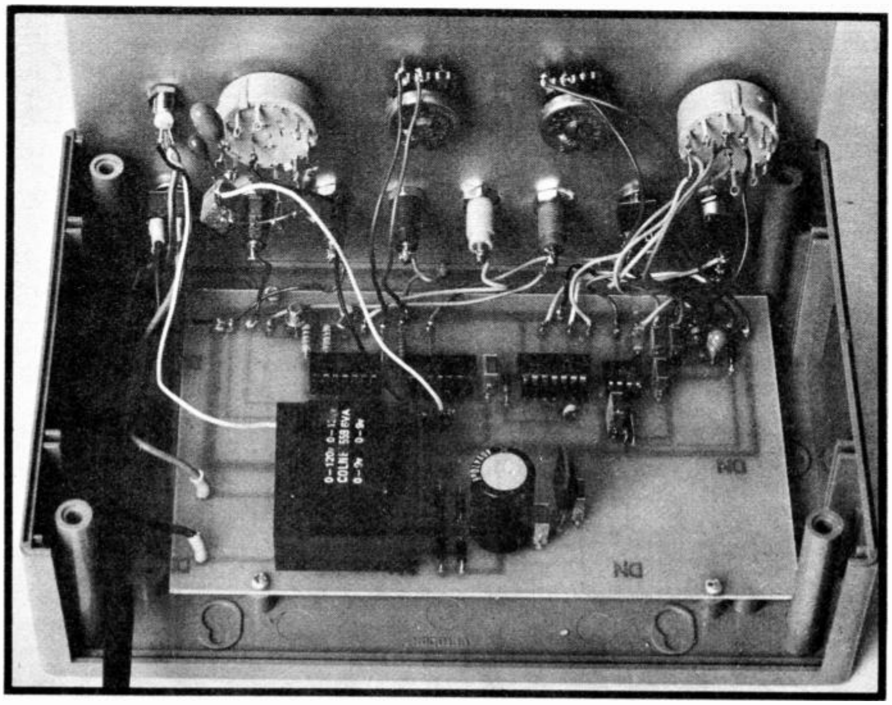
The prototype boards were laid out with etch-resistant dry transfers. The p.c.b. artwork and component layout diagram is shown in Fig. 2.

All the components with the exceptions of C9 to C15 are mounted on the board. The components should be soldered to the board in the normal manner beginning with the passive components and the wire links, working through to the semiconductors. It is recommended that d.i.l. sockets are used for the integrated circuits. It will be found helpful if Veropins are inserted in the board where the flying leads leave it.

CASE

Once the circuit board is complete, preparation of the case can begin. The prototype was housed in a Verocase type 202-21036C. This should be available through normal Vero distributors. Separate the two halves of the case and remove the front and rear panels. To assist marking out and to protect the panels from scratching, it is advisable to fasten a piece of graph paper with double-sided tape to the front panel.

Mark the centres of the holes in accordance with Fig. 3 and then lightly centre-punch them. For the large holes it is better to drill a small pilot hole (about 3mm) first.


The completed prototype with top removed to show wiring to front panel components and positioning of circuit board.

COMPONENTS

Resistors

R1	2·7kΩ	R5	330Ω
R2	3·3kΩ	R6	330Ω
R3	470Ω	R7	270Ω
R4	1·2kΩ		All ¼W carbon ±5%

Capacitors

C1	0·1μF Siemens	C11	10nF Siemens
C2	1nF Siemens	C12	0·1μF Siemens
C3	15nF Siemens	C13	1μF Siemens
C4	150nF Siemens	C14	10μF 25V tantalum
C5	1μF 35V tantalum	C15	100μF 25V tantalum
C6	0·47μF 35V tantalum	C16	1nF miniature plate ceramic
C7	15μF 35V tantalum	C17	0·1μF Siemens
C8	0·1μF Siemens	C18	470μF 40V elect.
C9	100pF polystyrene	C19	0·1μF Siemens
C10	1nF Siemens	C20	0·1μF Siemens

Semiconductors

D1–4	1N4001 silicon rectifier (4 off)
D5	TIL220 0·2in red l.e.d.
TR1, 2	BSX20 *npn* silicon fast switching (2 off)
IC1	555 timer
IC2	7400 TTL quad 2-input NAND gate
IC3	74121 TTL monostable multivibrator
IC4	7404 TTL hex inverter
IC5	7805 5V, 1A regulator

See Shop Talk page 427

Miscellaneous

T1	6VA mains transformer with two 9V secondaries, p.c.b. mounting
S1,3	s.p. 12-way midget rotary with adjustable stop
S2	s.p.d.t. miniature push-button
S4	s.p.d.t. miniature toggle
S5	d.p.d.t. miniature mains toggle
VR1	100kΩ control potentiometer
VR2	22kΩ control potentiometer
SK1–5	4mm insulated banana sockets (5 off—colours to suit)

Verocase type 202-21036C; single-sided p.c.b. size 100 × 160mm (Eurocard); control knob with pointer (4 off); 8-pin d.i.l. holder; 14-pin d.i.l. holder (3 off); grommet; P-clip; mains cable; 7/0·2mm wire; 14/0·2mm wire; mounting screws; l.e.d. chrome bezel; Veropins.

Only one hole is required on the rear panel, for the mains lead grommet.

FINAL ASSEMBLY

The p.c.b. should be screwed to the pillars in the bottom of the case with self-tapping screws. Attach sufficient lengths of wire to the Veropins. 7/0·2mm wire should be used for all connections except the mains wiring which should be 14/0·2mm.

Before mounting the front panel components, it is a good idea to apply the dry transfer lettering. A thin coat of protective lacquer will help to prevent the lettering from being scratched off. See photograph for front panel markings.

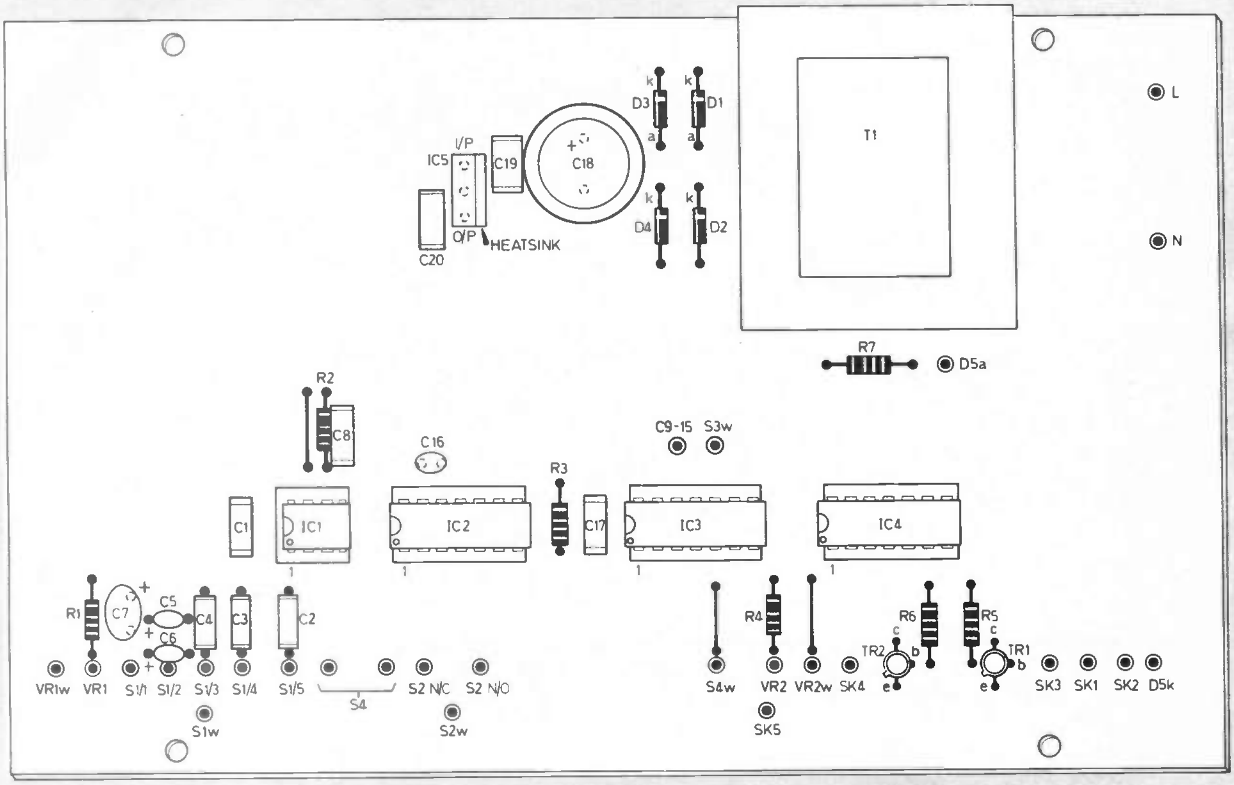
When the lacquer is thoroughly dry the components can be bolted to the panel and the wiring completed in accordance with Fig. 4. The capacitors C9 to C15 are soldered directly to the terminals of S3 as shown. The leads must be carefully preformed to avoid damage to the component and a piece of solid wire is used as a common connection.

IN USE

Most digital circuits have a clock generator. It may be simple such as a digital dice or as complicated as a microprocessor, but the Pulse Generator can be used to replace this clock and either run the circuit faster or slower than is normally intended.

For example, a digital clock is constructed and it would be desirable to observe the entire 24-hour period in a few minutes. This can be accomplished by replacing the clock's timing generator, normally derived from a crystal oscillator or the a.c. mains, with the Pulse

PULSE GENERATOR



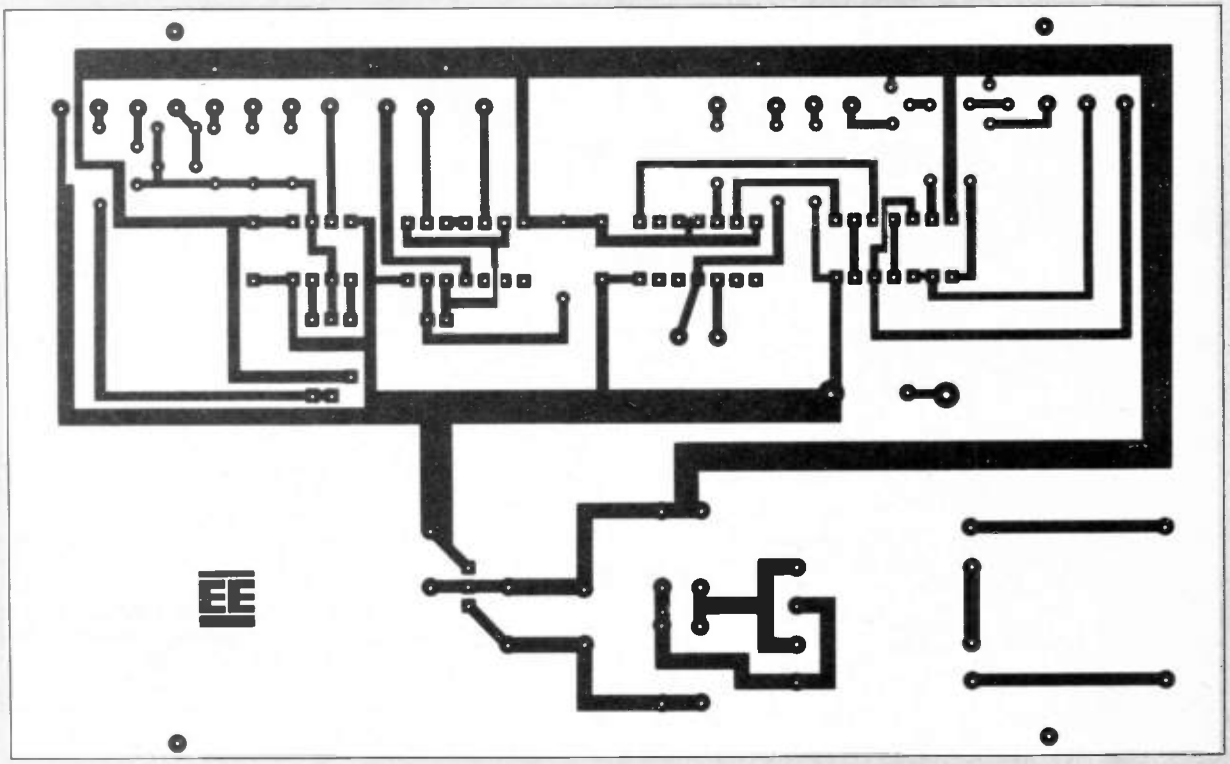


Fig. 2. Component layout and full-size printed circuit board master.

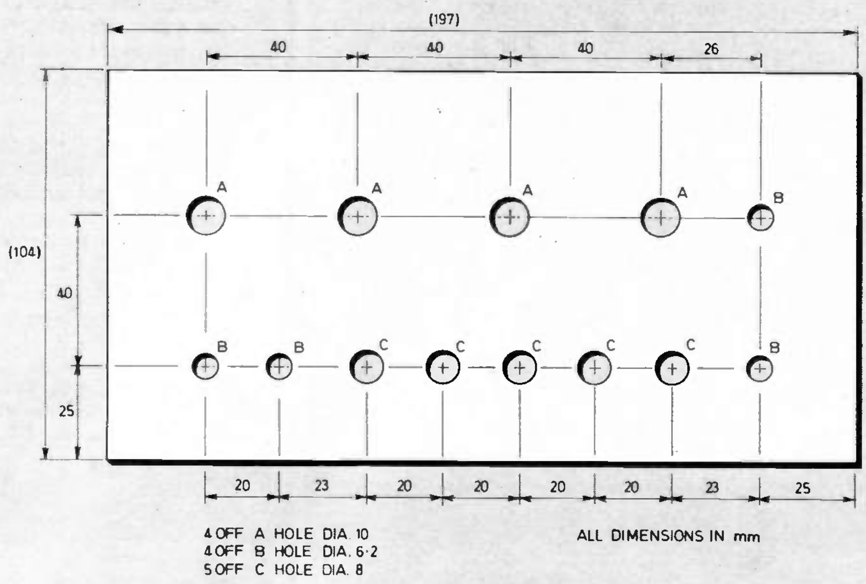


Fig. 3. Front panel dimensions and drilling details.

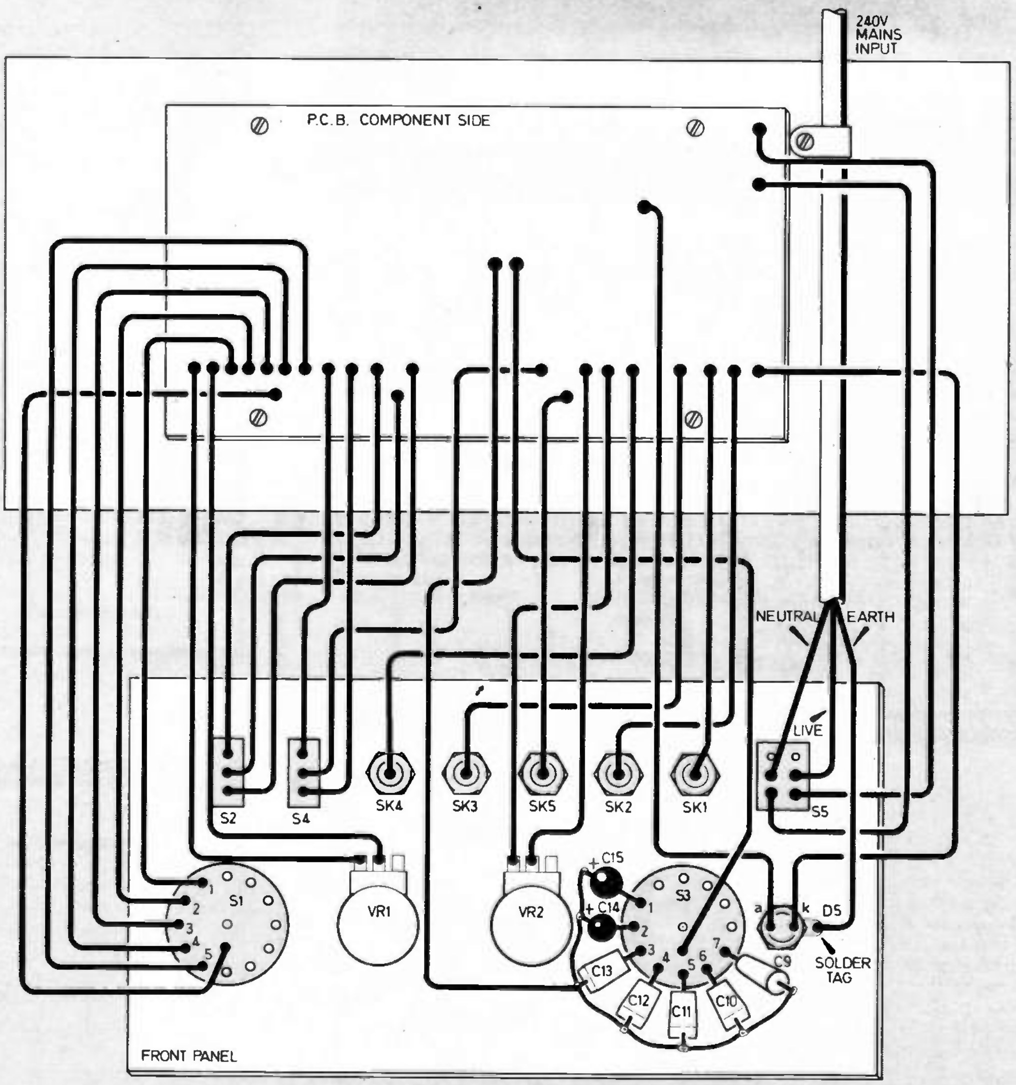
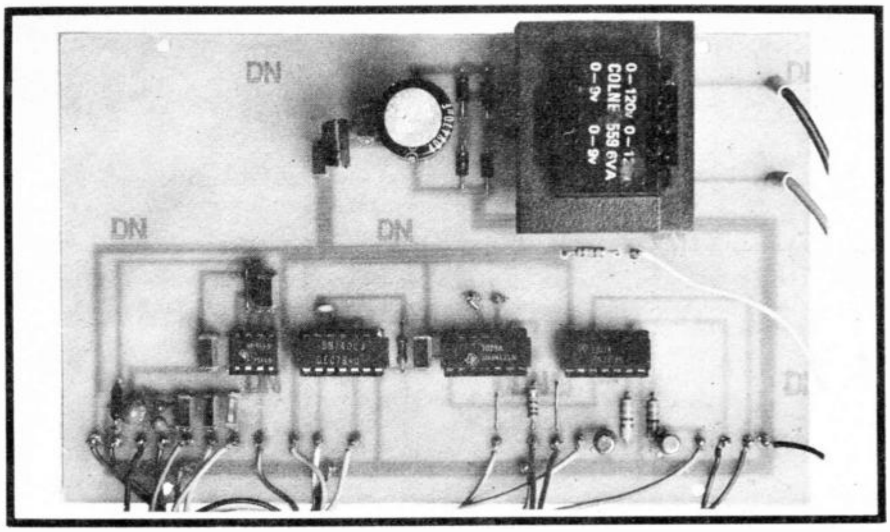


Fig. 4. Interwiring details to the front panel and circuit board.



The completed circuit board ready for wiring to the front panel.

Generator. The speed can be changed at will. In its simplest terms, the Pulse Generator should be considered as a square-wave oscillator whose frequency and mark-to-space ratio can be varied over a wide range.

No facilities are provided to calibrate the generator, this was not thought to be a disadvantage since in critical applications, the output is set with an oscilloscope.

As previously stated, the period (pulse width) of each pulse must not be set so as to be greater than the p.r.f. allows. For example, if the Pulse Generator is set to a frequency of 10Hz, the duration of one cycle will be 100ms, therefore a period of greater than this figure will not work.

Similarly, for a frequency of 100kHz, the period must not exceed 10µs. The maximum time of one cycle can be calculated by t (time) $= 1/f$, where $f =$ frequency. □

COUNTER INTELLIGENCE

BY PAUL YOUNG

Counter Attractions

I must confess that I am puzzled by one thing and that is, the apparent decline in amateur construction. I am not unduly depressed by it because I am sure it is only a passing phase but out of curiosity I thought I would investigate the reasons for it. The most obvious reason is that the constructor has been wooed away by another hobby or even another facet of electronics.

I decided that this probably began with the arrival of the metal detector. Many designs appeared and I have no doubt that many were made. Then our constructor would try it out on some treasure seeking exercise and even if he didn't hit the jackpot, he might have decided it was so fascinating that he abandoned all his other pursuits.

The next set-back might have been the arrival of Citizens Band Radio when the thought of becoming a broadcaster and speaking to the world was irresistible. Unfortunately not many constructional kits were available, and after the initial set-backs and confusion over the choice of a.m. or f.m., sales of ready made sets slumped so disastrously that some first class new equipment could be picked up for a song.

Finally along came the micro computer and with it the TV games, that must have accounted for quite a few defectors.

I will freely admit that all this is conjecture but what led me to this conclusion was the following: Last October *Everyday Electronics* published a project for making a simple short wave receiver. Normally I would have expected at least fifty to have been made. It so happened that a friend of mine had the entire supply of the coils which were stipulated in the design, so I could make a reasonable check on the number constructed. It was ten!!

I know my findings may be wrong, but even if they are correct I will wager that those that have strayed from the path of one of the most fascinating hobbies, namely electronic constructing, will sooner or later return to the fold.

Doom and Gloom Merchants

Anyone who reads the popular press may well be dismayed by the predictions of the Doom and Gloom merchants. You know the sort of thing they talk about. They say that even if we are not annihilated, pollution or atomic radiation will finish us off and even if that fails, with the population explosion we shall starve to death. For good measure they add that by the year 2050 we shall have run out of coal, oil, and electrical energy. No cars, no transport, and the unemployed running into billions.

Now what I want to know is, how is electronics going to help, in other words is "Electronics" on the side of the angels, that is of course, you and me?

Working backwards through the list we start with unemployment. In the short term I think electronics will create more jobs, but in the long term it must have the reverse effect so that the only cure will be job sharing or a shorter working week. Coal and oil will be replaced by nuclear energy which will produce the electricity. There are many people who are against the use of nuclear reactors and this is understandable on the grounds of safety but they can be made perfectly safe as witness the Canadian system called "Can Do" and already the French obtain over 80 per cent of their electrical needs from nuclear power.

Fallacies

It was during my research that I came across a book that I can recommend to the pessimists, it is called, "How to get to the Future, Before it gets to You" by Shepherd Mead published by Michael Joseph. The author points out many fallacies in the forecasts of the "D" and "G" merchants. For a start, the expected pollution is wrong because the increase is worked out exponentially while the remedies are shown as linear!!

Shepherd Mead paints a rosy picture of an all electronic future, with the wife doing all her shopping with a computer and a video screen and the husband always working from home, by means of computers and videos wired directly to his office.

This is the only point on which I disagree with him. It is already possible for many thousands to work from home, using computers, but a recent survey shows that the majority of people prefer to go to work, they like the change of scenery and the company. As so often happens in these matters, the experts overlook the human factor. We are a gregarious lot on the whole.

PLEASE TAKE NOTE

Real Time Clock, Apple *(May 1983)*

There is a labelling error on the circuit diagram (Fig. 2) and the component layout diagram (Fig. 4). In Fig. 2, the Apple contact labelled 38 should in fact read 40. In Fig. 4, the lead from IC1 pin 25 should go to edge contact 40, and not 38 as shown.

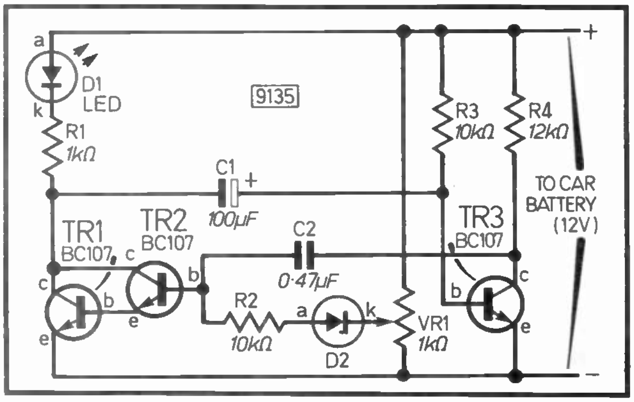
CIRCUIT EXCHANGE

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 VOLTAGE MONITOR

THIS circuit is designed for monitoring the 12V batteries of motor cars. All the three battery states are indicated by a single l.e.d., D1. The l.e.d. is on when there is sufficient voltage, it starts flashing as the voltage falls to a preset value (determined by VR1) and it is off for still smaller battery voltages.

The heart of the circuit is a multivibrator. Transistor TR1 gets the required base current when there is sufficient supply voltage. So the circuit starts to oscillate very fast and D1 seems to illuminate continuously rather than to blink. When the voltage falls to the preset value, D2 shows a high impedance. So the oscillation frequency falls and D1 appears to blink.



For still smaller voltages the frequency of oscillation falls, as the impedance of D2 increases. For very low voltages D1 is extinguished.

J. Sreekumar,
Cochin,
India.

OP-AMP TESTER

THIS Op-Amp Tester checks the important parameters and has a l.e.d. to indicate the condition of the op-amp.

The parameters which are checked by the tester are gain, stability, input offset voltage and input bias current. The tester, which itself uses two op-amps, can test internally compensated op-amps such as 741 and uncompensated op-amps such as the 709 and 748. Both 8-pin and 14-pin sockets are provided.

IC1 is used as a square-wave generator and the op-amp being tested is used as an inverting amplifier with gain of 100. The output of IC1 is applied to both IC2 and (through voltage divider R4 and R5) to the unit being tested. The output of the latter is applied as a second input to IC2 which is used as a summing amplifier.

If the op-amp being tested is good, its output is exactly equal the squarewave applied to IC2 through R11. When these two signals cancel, there is zero output from IC2 and l.e.d. D1 will not light.

If the op-amp being tested is faulty, the two inputs to IC2 will not cancel and D1 lights. Before D1 turns on, however, the output of IC2 must not exceed the threshold determined by the forward voltage-drops of two of the bridge diodes and D1. Assuming a failure, this threshold will be exceeded if the op-amp has a gain of less than 60, an input offset voltage greater than 30mV or an input bias current greater than 3 microamps.

Any of the IC op-amps should have parameter values better than these. Similarly the l.e.d. turns on if the op-amp is unstable in the test circuit or has any short or open circuitry.

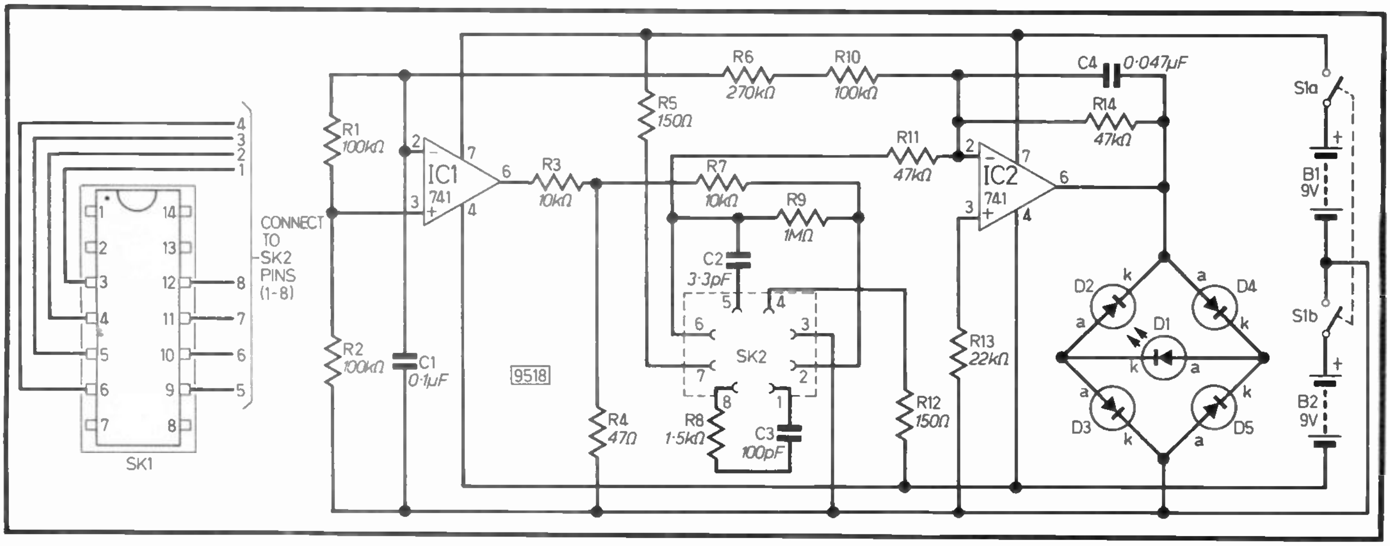
Operation. With no op-amp in either test socket, depress S1. The l.e.d. should flash on and off, indicating that the circuit is working properly.

To test an op-amp, plug it into the appropriate test socket and operate S1. If the op-amp is good the l.e.d. will not flash.

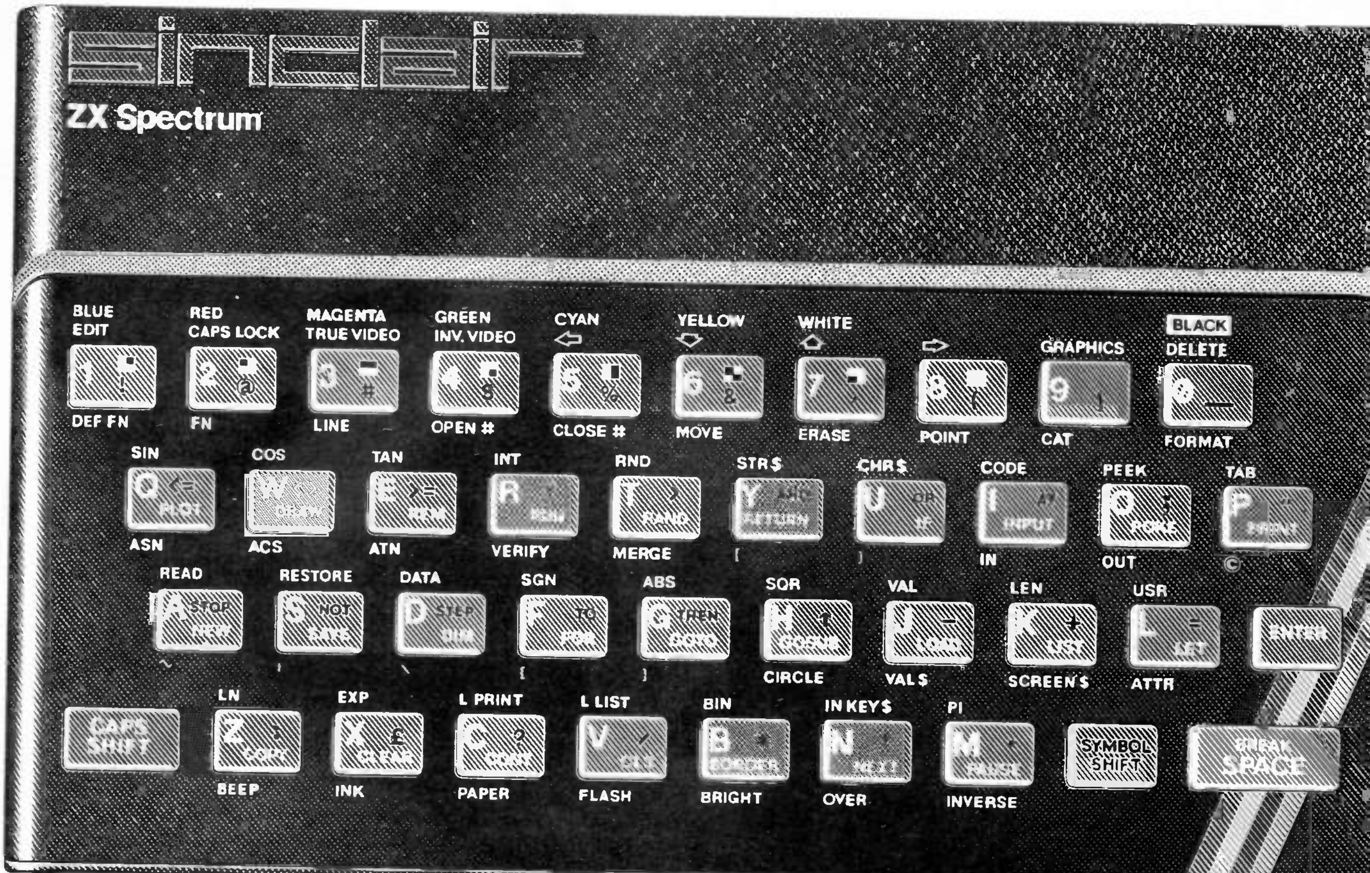
Any of the i.c. op-amps with the same pin configuration as the 709 can be checked, including 101, 301, 740, 741 and 748; units with other pin configurations such as dual op-amps, can also be tested if extra test sockets are wired in parallel with existing sockets.

Since different op-amps have different specifications, a good indication does not necessarily guarantee that the op-amp meets all of the requirements. However, for nearly all practical applications, the tester will provide a valuable go/no-go decision. The tester will be particularly useful for sorting through bargain, untested op-amps and for quickly isolating the trouble in an op-amp circuit that doesn't work.

Hamid Reza Nameri,
Tehran, Iran.



Sinclair ZX Spec



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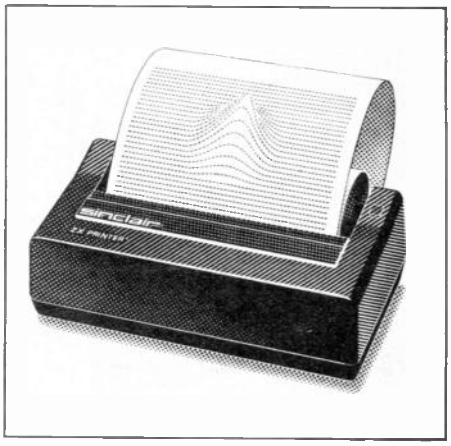

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This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 11¾" x 8½" x 3¼".

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

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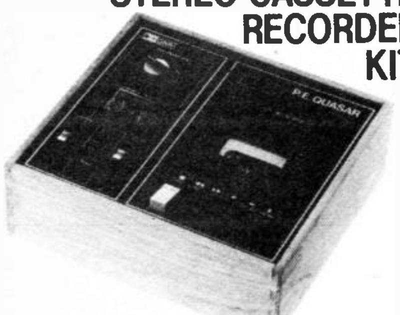

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Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up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

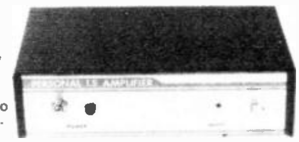
Featured in April issue P.E. Reprint 50p. Free with kit.

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

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

PERSONAL LS AMP KIT

Amplifier for your personal stereo cassette player as featured in January issue of Everyday Electronics. Turn your personal stereo into a mains powered home unit.



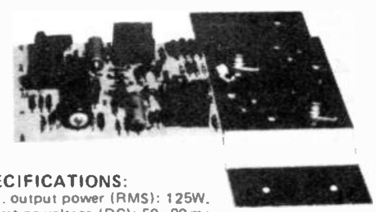
Parts: Stereo power amp PCB with all components, £3.50 + 75p p&p. Power supply unit, £1.95 + £1.50 p&p. Pair of 4½" eliptical speakers, £1.50 the pair, + £1.00 p&p. Input & output sockets & plugs, £1.50. Recommended case (for the power supply and amp only), £2.95 + 80p p&p.
P&P inclusive price of £1.75 for two or more articles.

125W HIGH POWER AMP MODULES

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

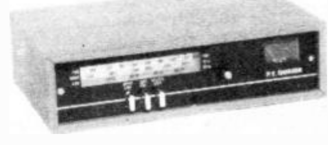
The power amp kit is a module for high power applications disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously 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.

VHF STEREO TUNER KIT



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.

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Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼" x 8½" x 3¼".
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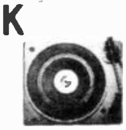

Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco.
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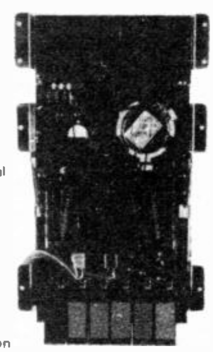

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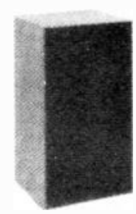

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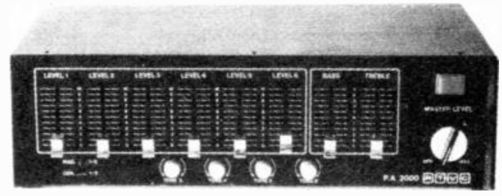

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