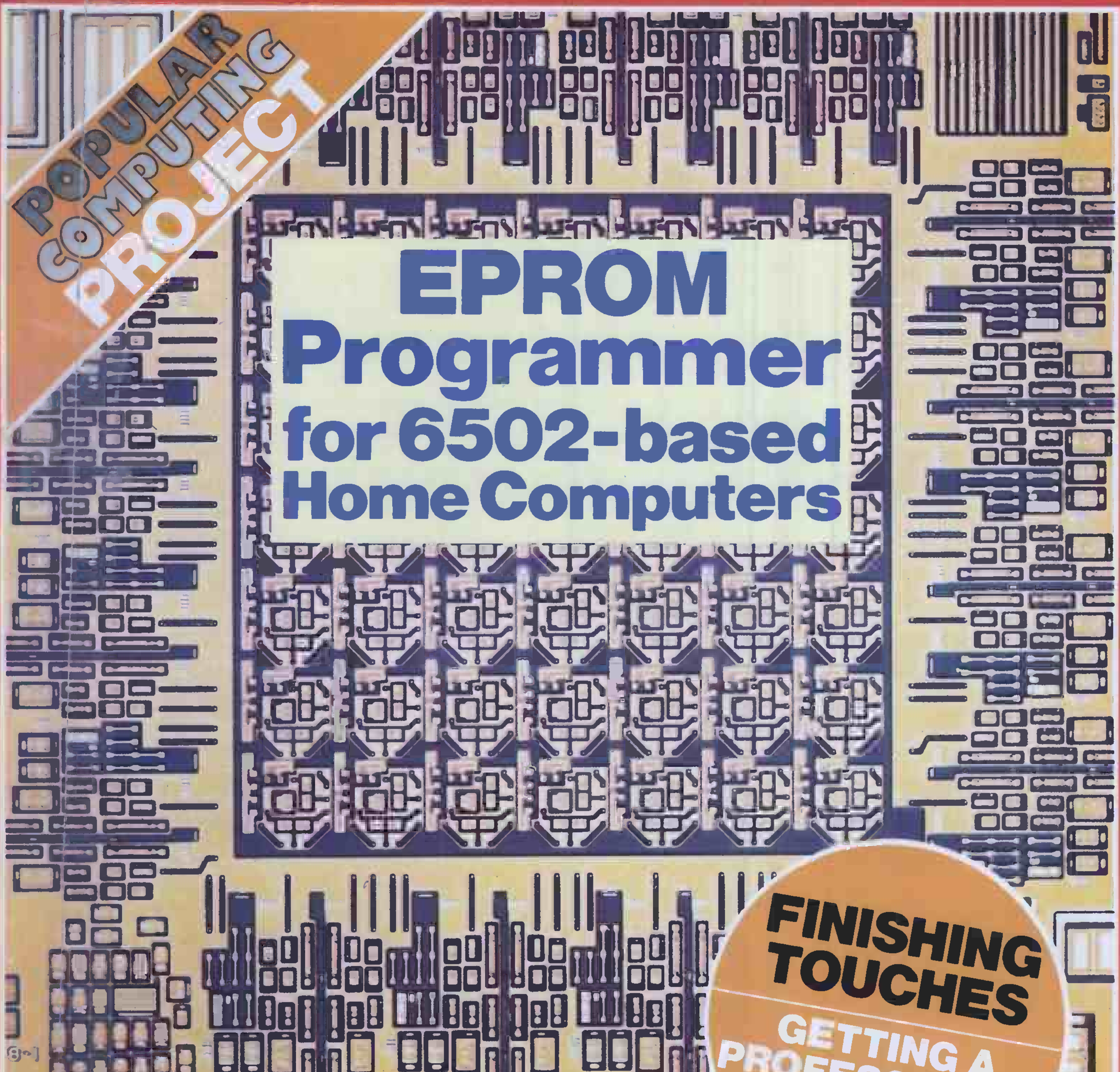
MARCH 1983
80p

Hobby Electronics

Project Electronics For Everyone



POPULAR COMPUTING PROJECT

EPROM Programmer for 6502-based Home Computers

FINISHING TOUCHES
GETTING A PROFESSIONAL FINISH AT HOME

PROTECTION PROJECTS • Signal Powered Loudspeaker Protector • Over-voltage Cut Out

Hobby Electronics

MARCH 1983
Vol 5 No 3

PROJECTS

FEATURES

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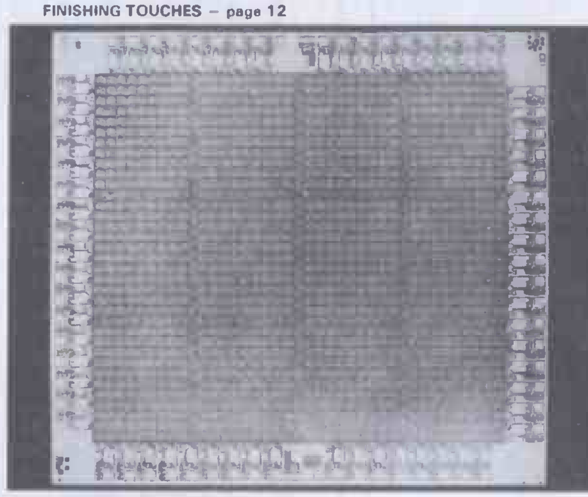
FINISHING TOUCHES – page 12



COMPONENTS FOR COMPUTING – page 16
Picture courtesy Ferranti Ltd.

THE ELECTRONIC REVOLUTION – page 40

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.
Hobby Electronics, 145 Charing Cross Road, London WC2H OEE, 01-437 1002. **Telex** No 8811896. **Published** by Argus Specialist Publications Ltd.
Design and Organisation by MM Design and Print Ltd, 145 Charing Cross Road, London WC2H OEE, 01-437 1002.
Distributed by S. M. Distribution Ltd, 16/18 Trinity Gardens, London SW9 8DX.
Printed by QB Ltd, Colchester. **Covers** printed by Alabaster Passmore.

Multicore makes soldering easy fast & reliable

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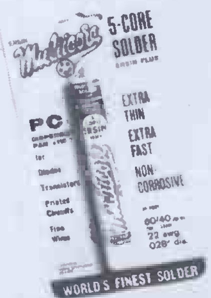
Comes in handy dispensers and tool box reels in two different alloys 40/60 tin/lead for general purpose electrical soldering and 60/40 tin/lead ideal for small components and fine wire soldering.



Size PC115 60/40 tin/lead
£1.38 Handy pack 0.028mm dia

Size 3 40/60 tin/lead
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Size 10 60/40 tin/lead
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Multicore Savbit, solder increases the life of your soldering bit by 10 times, for better soldering efficiency and economy.
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Multicore Alu-Sol, solder contains 4 cores of flux, suitable for most metals especially aluminium.
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MICRO-MINI 100V CERAMIC PLATE CAPS

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2.2/35V 22p
3.3/35V 22p
4.7/16V 22p
4.7/35V 24p
6.8/25V 26p
6.8/35V 25p
10/16V 25p
10/35V 34p
15/16V 22p
15/16V 30p
15/25V 32p
22/6.3V 26p
22/16V 32p
33/10V 38p
47/6.3V 43p
100/3V 37p

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Standard Horiz 17p
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10nF 15nF [illegible]
22nF 33nF [illegible]
47nF, 68nF [illegible]
100nF 9p
150nF, 220nF 11p
330nF, 470nF 18p
680nF, 1μF 24p
1 5μF, 2 2μF 44p

Veroboard 0 1" Copper Clad
2 5 × 3 75 72p
2 5 × 5 80p
3 75 × 3 75 80p
3 75 × 5 93p
2 5 × 17 2.50
3 75 × 17 3 30
4 75 × 17 4 20
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Guaranteed minimum 500 charges
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By Matsushita or Siemens (other good makes may be sent only in the rare event of supply difficulty)

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μFd	V	
47	63	8p
47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	[illegible]
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	10	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	26p
220	63	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	30p
470	63	43p
470	100	70p
1000	16	30p
1000	25	38p
1000	40	44p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	136p
4700	16	75p
4700	25	99p

Beautiful Mini Radial Low Voltage
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

Grade One Glass PCB
Single Sided
178 × 240mm 95p
420 × 195mm 130p
420 × 245mm 195p

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2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots + holes
8 0 1" edge cons
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1st Class Epoxy Glass For better results than spraying Expose to UV
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100 × 220 1 90
203 × 114 1 85
233 × 220 3 98
Double sided
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100 × 220 2 15
203 × 114 2 21
233 × 220 4 56
Developer for above [illegible]
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DALO ETCH RESIST PEN + spare nib 90p

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X25 (25W) 4.99
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C240 Element 1.99
X25 Element 2.06
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No6 (Lge) 65p
Bits X25
No50 (Small) 66p
No51 (Med) 66p
No52 (Lge) 66p
SOLDER 125gms
18 swg 2 96
22 swg 3 10

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Prices per metre
Solid Hook up Wire Any colour 5p
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3 Core 6 amp 31p
3 Core 13 amp 56p
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Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p
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1-2.5 amp slow 17p
1-2.5 amps quick 10p
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20 mm quick 10p

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2N2906A 30p
2N2907 25p
2N2907A 26p
2N2920 3.47
2N2923 25p
2N2924 15p
2N2925 15p
2N2926 10p
2N3019 50p
2N3053 27p
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2N3055H 1 20
2N3106 42p
2N3109 48p
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2N3442 1 35
2N3442RCA 1.85
2N3444 1 70
2N3445 4 80
2N3446 6.09
2N3447 5.72
2N3448 6.54
2N3468 1.00
2N3512 1 06
2N3553 2.30
2N3632 9.88
2N3638 35p
2N3638A 37p
2N3694 30p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2 00
2N3713 1.30
2N3714 2.38
2N3715 3.31
2N3716 3.60
2N3819 21p
2N3820 38p
2N3821 1.84
2N3822 80p
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2N3905 15p
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2N4031 56p
2N4032 65p
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2N4240 3.00
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2N4904 2 79
2N4905 3.25
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2N4907 3 30
2N4908 3 70
2N4909 2.90
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2N4919 1 28
2N4920 1.34
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2N5209 24p
2N5245 37p
2N5246 40p
2N5247 45p
2N5248 45p
2N5249 48p
2N5266 2 88
2N5293 98p
2N5294 1.28
2N5295 1 37
2N5401 35p
2N5415 1.10
2N5416 1 54
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2N5448 19p
2N5449 21p
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2N5457 29p
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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
2SC1444 2.50
2SC2078 1.70
2SJ49 3.98
2SK134 3 98
3N128 1.12
3N138 3.50
3N139 3 30
3N140 2.37
3N143 2.85
3N152 3.00
3N153 2.47
3N154 2.56
3N200 6.93
3N201 2.98
40360 60p
40361 67p
40362 67p
40363 2.22
40406 1.39
40407 75p
40408 1.59
40410 1.80
40411 2.86
40412 90p
40673 83p
40822 1.80
40871 89p
40872 89p
AC125 35p
AC126 25p
AC127 25p
AC128 25p
AC132 39p
AC141 35p
AC152 [illegible]
AC153 55p
AC153K 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 28p
AC188 26p
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AF239 1 24
AF240 1 00
AF279B 75p
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AU110 2 20
AU113 2.30
BC107 10p
BC107A 12p
BC107B 12p
BC108 10p
BC108A 12p
BC108B 12p
BC108C 12p
BC109 10p
BC109B 13p
BC109C 14p
BC140 28p
BC141 29p
BC142 28p
BC143 34p
BC147 10p
BC147A 10p
BC147B 12p
BC147C 12p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 12p
BC149C 14p
BC152 35p
BC153 24p
BC154 27p
BC157 11p
BC157A 12p
BC157B 13p
BC158 10p
BC158A 12p
BC158B 13p
BC159 11p
BC159A 12p
BC159B 13p
BC159C 13p
BC160 48p
BC161 48p
BC167 10p
BC167A 12p
BC167B 13p
BC168 10p
BC168B 13p
BC168C 13p
BC169 10p
BC169B 13p
BC169C 13p
BC177 24p
BC177A 24p
BC177B 25p
BC178 24p
BC178A 24p
BC178B 25p
BC179 26p
BC179A 28p
BC179B 28p
BC179C 27p
BC182 10p
BC182A 12p
BC182B 12p
BC182L 10p
BC182LA 13p
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BC183 10p
BC183A 12p
BC183B 12p
BC183C 12p
BC183L 10p
BC183LA 13p
BC183LB 13p
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BC184 10p
BC184B 12p
BC184C 12p
BC184L 10p
BC194LB 13p
BC184LC 14p
BC186 24p
BC187 24p
BC212 10p
BC212A 12p
BC212B 12p
BC212L 10p
BC212LA 12p
BC212LB 14p
BC213 10p
BC213A 11p
BC213B 12p
BC213C 13p
BC213L 10p
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BC237C 16p
BC238 14p
BC238A 15p
BC238B 16p
BC238C 16p
BC239 15p
BC239A 16p
BC239B 16p
BC239C 16p
BC300 45p
BC301 44p
BC302 43p
BC303 47p
BC327 16p
BC328 15p
BC337 15p
BC338 15p
BC440 32p
BC441 33p
BC460 32p
BC461 33p
BC516 40p
BC517 40p
BC547 13p
BC547A 14p
BC547B 14p
BC548 12p
BC548A 13p
BC548B 13p
BC548C 14p
BC549 13p
BC549B 14p
BC549C 15p
BC550 15p
BC550C 33p
BC557 15p
BC557A 16p
BC557B 16p
BC558 15p
BC558A 15p
BC558B 16p
BC558C 17p
BC559 15p
BC559B 16p
BC559C 17p
BC560 32p
BC560C 34p
BCY71 16p
BCY72 19p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 39p
BD237 90p
BD238 90p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 87p
BD242A 65p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.14
BD245C 1.30
BD246A 1.30
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.44
BD437 88p
BD438 88p
BD439 90p
BD440 90p
BD441 91p
BD442 93p
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BD530 1.20
BD535 75p
BD536 75p
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BD538 80p
BD539 80p
BD539C 1.10
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BD540C 1.10
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BD676 72p
BD677 76p
BD678 83p
BD711 1.32
BD712 1.32
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BDX18 1.59
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BDY54 [illegible]
BDY55 [illegible]
BDY56 [illegible]
BDY57 [illegible]
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BF196 12p
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BF225J [illegible]
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BF244A 39p
BF244B 39p
BF245A 39p
BF245B 51p
BF246 52p
BF246A 39p
BF246B 54p
BF247A 55p
BF247B 55p
BF254 42p
BF255 42p
BF256A 35p
BF256B 38p
BF256C 30p
BF257 30p
BF258 30p
BF259 35p
BC207 [illegible]
BC208 [illegible]
BF457 40p
BF458 56p
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BF470 85p
BFR39 25p
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BFR41 25p
BFR79 25p
BFR80 25p
BFR81 25p
BFR90 2.11
BFS28 2 95
BFS61 1 00
BFS98 1 10
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 24p
BSX21 [illegible]
BU104 2.22
BU105 1.70
BU109 3.29
BU126 1.47
BU204 2.25
BU205 1.75
BU206 1.89
BU208 1.98
BU326S 2.36
BU406 1.45
BU407 1.45
BU408 1.35
BU500 2.36
BUV20 11.00
BUV21 10 90
BUV23 13.60
BUV24 12.10
BUV25 15.20
BUV26 17.00
BUY18S 3.96
E430 5.60
J300 48p
J310 53p
MJ802 3.98
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
MJ3701 2.56
MJ4502 3.99
MJ15003 4.85
MJ15004 5 56
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 38p
MPSL01 42p
MPSL51 48p
MPSU01 84p
MPSU04 1.32
MPSU05 55p
MPSU06 56p
MPSU07 75p
MPSU51 88p
MPSU55 58p
MPSU56 59p
MPSU57 1.20
OC22 2.30
OC23 2.00
OC25 2.00
OC28 2.50
OC29 1.70
OC35 2.38
OC41 2.38
OC43 80p
OC44 70p
OC70 82p
OC71 60p
OC72 50p
OC82 50p
OC82D 50p
OC83 50p
TIP29A 70p
TIP30A 75p
TIP30C 32p
TIP31A 38p
TIP31C 36p
TIP32A 38p
TIP32C 38p
TIP33A 38p
TIP33C 42p
TIP34A 65p
TIP34C 78p
TIP35A 74p
TIP35C 88p
TIP36C 1.00
TIP41A 1.28
TIP41C 1.29
TIP42A 1.39
TIP42C 49p
TIP49 56p
TIP50 56p
TIP53 65p
TIP54 1 20
TIP110 1.40
TIP112 1 57
TIP115 1 59
TIP117 74p
TIP120 90p
TIP122 81p
TIP125 96p
TIP127 69p
TIP130 73p
TIP132 1.20
TIP137 1.27
TIP140 1 50
TIP142 1.60
TIP145 1.60
TIP147 [illegible]
TIP2955 1.04
TIP3055 1.04
TIS43 1.15
TIS45 1.19
TIS46 77p
TIS48 70p
TIS88A 82p

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 15p
ZTX341 28p
ZTX500 14p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 34p
ZTX530 24p
ZTX531 29p

DIODES

1N34A 30p
1N821 70p
1N823 92p
1N914 08p
1N916 10p
1N1190 1 47
1N4001 4p
1N4002 4p
1N4003 5p
1N4004 5p
1N4005 6p
1N4006 6p
1N4007 7p
1N4009 20p
1N4148 4p
1N4150 18p
1N4448 22p
1N4517 22p
1N5172 30p
1N5176 94p
1N5400 12p
1N5401 13p
1N5402 14p
1N5404 16p
1N5405 17p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1N5625 60p
1N5626 62p
1N5627 68p
1S44 10p
BA102 26p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA144 15p
BA155 15p
BA156 38p
BA157 25p
BA158 30p
BA159 32p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 26p
BA318 30p
BAV10 18p
BAV19 15p
BAV20 15p
BAV49 15p
BAX13 10p
BAX16 11p
BY126 20p
BY127 22p
BY134 52p
BY182 1.26
BY188A 65p
BY206 36p
BY207 36p
BY223 1.56
BY297 48p
BY299 55p
MZ2361 1.80
OA10 70p
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p

DIACS

BR100 40p
ST2 25p

THYRISTORS

4, 8 & 12 Amps Texas TO220
Suffix A 100V
B 200V
C 300V
D 400V
M 600V

4A
TIC106A 46p
TIC106B 47p
TIC106C 48p
TIC106D 59p
TIC106M 68p

8A
TIC116A 66p
TIC116B 68p
TIC116C 71p
TIC116D 73p
TIC116M 80p

2A
TIC126A 72p
TIC126B 72p
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

BRIDGE RECTIFIERS

(PIV shown in brackets)
1½ amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40
Proprietory Bridges
B40C1500 1.20
B80C3700 1.80
BY164 56p
BY179 92p

ZENER DIODES

400-500mW E24 Series 2.4-47V 8p
1 3 Watt E24 Series 3 3-82V 15p
2 5 Watt E24 Series 7 5-75V 1.10

NEW OPTO DEVICES

New LEDs Now in stock
R = red
G = green
Y = yellow

	1 +	50 +
Large diffused		
R5D	9p	7p
G5O	16p	12p
Y5O	15p	12p
Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0.1"		
R1D	26p	22p
G1D	27p	26p
Y1D	27p	26p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri-colour flat		
RGY8	83p	78p

LINEAR ICs

AN103 2.20
AY1.5050 95p
AY3.8910 5.39
AY3.8912 5.59
AY5.1013A 3.00
CA3048 2.99
CA3049 3.21
CA3059 2.80
CA3060 4 08
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.00
CA3140E 38p
CA3140T 85p
HA1366W 2.40
HA1388 2.54
LC7120 3.20
LC7130 3.20
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.08
LM348N 62p
LM349N 1.16
LM350K 4.80
LM379S 4.79
LM380N14 75p
LM380N8 1 50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3 40
LM384N 1.40
LM386N1 88p
LM386N8 1.20
LM388N 2 43
LM391N60 1.70
LM391N80 1.93
LM723CH 1 21
LM723CN 40p
LM725CH 3.40
LM725CN 3.19
LM733 69p
LM741CH 96p
LM741CN 15p
LM741CN14 80p
LM747CN 69p
LM748CH 1 00
LM748CN 35p
LM1303N 1.20
LM1304N 2.50
LM1305N 3.10
LM1307N 2.75
LM1310N 1.45
LM1330N 2.25
LM1871 4.39
LM1872 4.39
LM1886 7.44
LM1889 3 77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1 89
LM2917N8 1.89
NE531N 1.36
NE543N 2.60
NE544N 1.80
NE555 16p
NE556 46p
NE558 1.89
NE560 3.25
NE565 1.18
NE5661 49
NE567 1.37
NE570 3.75
NE571 3 75
NE5534A 1.25
PLL02A 4.96
PLL03A 12.75
RC4136 59p
RC4194 3.95
SL470 3.47
SL490 3.47
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.56
TBA530Q 2.78
TBA540 2.72
TBA540Q 2.74
TBA550 3.26
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.40
TCA910 2.19
TCA940 1.80
TDA1002 3.30
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA1024 1.19
TDA2610 3.90
TDA2611A 2 60
UAA170 1.69
UAA180 1.69
ULN2003 86p
UPC575C2 2.86
UPC1156 2.76
XR2206 2.92
ZN414 79p
ZN419 2.25
ZN1034 1.99
ZN1040 6 69
ZTK22 89p
ZTK33 89p

CPUs

1802 7 00
2650A 11.90
6502 3.24
6800 2.74
6802 2.80
6809 8.50
8035 3.40
8060 10 90
8080A 2 79
8085A 3.40
8900 57.75
9980 21 00
SCMP1 17.06
Z80A 2.86

LOGIC ICs including COMPUTER SUPPORT

ADC0804 .395
ADC0816 14.90
ADC0817 10.06
AY5-2376 6.90
ICM7555 80p
INS1671 20 00
INS1771 20.00
RO2513LC 6.80
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 3.05
8T26 1.35
8T28 1.35
8T95 1.35
8T97 1.35
81LS95 90p
81LS96 1 20
81LS97 90p
81LS98 1.20
6522 3.19
6532 6.96
8154 9.42
8155 3.50
Z80ACTC 2.86
Z80ADART 8.00
Z80ADMA 10.00
Z80APIO 2 80
ZN425E8 3.30

VOLTAGE REGULATORS

Positive 100mA
78L05A 30p
78L12A 30p
78L15A 30p
78L24A 30p
1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
Negative 100mA T092
79L05 58p
79L12 58p
79L15 58p
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZERO INSERTION DIL SOCKETS

24 pin 4 [illegible]
40 pin 6 30

40 CMOS

4000 10p
4001 10p
4002 11p
4006 48p
4007 15p
4008 32p
4009 24p
4010 10p
4011 10p
4012 16p
4013 20p
4014 46p
4015 58p
4016 20p
4017 32p
4018 46p
4019 26p
4020 44p
4021 39p
4022 48p
4023 12p
4024 32p
4025 12p
4026 79p
4027 20p
4028 28p
4029 29p
4030 14p
4031 1.19
4032 80p
4033 1.20
4034 1.29
4035 58p
4036 2 44
4037 1.30
4038 90p
4039 2.00
4040 46p
4041 40p
4042 39p
4043 46p
4044 41p
4045 99p
4046 44p
4047 39p
4048 39p
4049 22p
4050 23p
4051 44p
4052 48p
4053 48p
4054 79p
4055 83p
4056 89p
4059 4.36
4060 42p
4063 79p
4066 22p
4067 2.49
4068 14p
4069 13p
4070 13p
4071 13p
4072 13p
4073 13p
4075 13p
4076 46p
4077 13p
4078 13p
4081 12p
4082 12p
4085 48p
4086 53p
4089 1.50
4093 20p
4094 88p
4095 88p
4096 90p
4097 2.80
4098 74p
4099 90p

45 CMOS

4502 [illegible]
4503 29p
4507 33p
4508 1 11
4510 38p
4511 48p
4512 38p
4514 1.17
4515 1.17
4516 58p
4518 39p
4519 29p
4520 48p
4521 99p
4526 59p
4527 59p
4528 46p
4532 89p
4534 4 28
4536 2 00
4538 86p
4539 90p
4543 86p
4553 2.38
4555 38p
4556 38p
4560 1 40
4566 1 40
4569 1.50
4584 38p
4585 79p

MEMORIES

2101 4.00
2102AL2 1.36
2111-1 3.00
2114 (200ns) 80p
2532 3.80
2708 2.28
2716 (5V) 2 11
4027 3 00
4044 7 00
4060 9 50
4116 (200ns) 75p
4118-3 3.28
4164 4 50
S101 1.95
5204 7.50
6116 4 40
6514 3 30
6810 1.15
7489 4.20
74189 4 00
74LS289 3.25
74LS188 2.25
74LS287 3 06
74LS288 2 25

MINI TOGGLE SWITCHES

SPST 49p
SPDT 55p
DPDT 66p
DPDT/C. OFF 75p
4PDT 2 75

TTL

7400 10½p
7401 11p
7402 11p
7403 12p
7404 12p
7405 15p
7406 20p
7407 20p
7408 14p
7409 14p
7410 15p
7411 16p
7412 18p
7413 18p
7414 28p
7416 20p
7417 20p
7420 15p
7421 20p
7422 20p
7423 20p
7425 24p
7426 28p
7427 22p
7428 26p
7430 14p
7432 22p
7433 22p
7437 25p
7438 25p
7440 15p
7441 65p
7442 32p
7443 80p
7444 80p
7445 50p
7446 80p
7447 40p
7448 44p
7450 16p
7451 15p
7453 15p
7454 14p
7460 15p
7470 34p
7472 28p
7473 28p
7474 20p
7475 28p
7476 28p
7480 48p
7481 1.19
7482 68p
7483 38p
7484 69p
7485 80p
7486 20p
7489 2 20
7490 20p
7491 36p
7492 28p
7493 28p
7494 38p
7495 38p
7496 40p
7497 90p
74100 80p
74104 50p
74105 55p
74107 22p
74109 25p
74110 35p
74116 50p
74118 59p
74119 80p
74120 58p
74121 28p
74122 40p
74123 48p
74125 35p
74126 34p
74128 38p
74132 29p
74136 30p
74141 68p
74142 1.99
74143 2.48
74144 2.10
74145 50p
74147 89p
74148 70p
74150 48p
74151 40p
74153 40p
74154 48p
74155 40p
74156 40p
74157 30p
74159 75p
74160 60p
74161 48p
74162 48p
74163 48p
74164 48p
74165 48p
74166 48p
74170 1.25
74172 2.75
74173 60p
74174 54p
74175 49p
74176 39p
74177 46p
74178 79p
74180 40p
74181 1.15
74182 80p
74184 90p
74185 90p
74186 4 69
74188 2 50
74190 48p
74191 48p
74192 46p
74193 46p
74194 46p
74195 46p
74196 46p
74197 48p
74198 83p
74199 83p
74221 53p

74H TTL

74H00 1.45
74H01 1.46
74H04 1 55
74H05 1.55
74H10 1.46
74H11 1.45
74H20 1.45
74H21 1.45
74H30 1.45
74H40 1 55
74H51 1.75
74H53 1.65
74H54 1.45

74LS TTL

74LS00 11p
74LS01 11p
74LS02 11p
74LS03 12p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 19p
74LS14 30p
74LS15 12p
74LS20 12p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 12p
74LS32 13p
74LS33 14p
74LS37 14p
74LS38 16p
74LS40 13p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 20p
74LS76 20p
74LS78 18p
74LS80 1.20
74LS83 36p
74LS85 48p
74LS86 16p
74LS90 24p
74LS92 25p
74LS93 24p
74LS95 38p
74LS96 98p
74LS107 20p
74LS109 27p
74LS112 22p
74LS113 22p
74LS114 22p
74LS122 38p
74LS123 38p
74LS124 89p
74LS125 24p
74LS126 25p
74LS132 39p
74LS136 29p
74LS138 32p
74LS139 30p
74LS145 70p
74LS147 1.57
74LS148 75p
74LS151 38p
74LS153 38p
74LS154 79p
74LS155 29p
74LS156 38p
74LS157 27p
74LS158 29p
74LS160 36p
74LS161 35p
74LS162 35p
74LS163 35p
74LS164 40p
74LS165 59p
74LS168 84p
74LS169 86p
74LS170 70p
74LS173 56p
74LS174 46p
74LS175 39p
74LS181 99p
74LS183 1 79
74LS190 36p
74LS191 36p
74LS192 36p
74LS193 37p
74LS194 32p
74LS195 32p
74LS196 45p
74LS197 48p
74LS221 50p
74LS240 56p
74LS241 56p
74LS242 56p
74LS243 56p
74LS244 60p
74LS245 70p
74LS247 50p
74LS248 56p
74LS249 56p
74LS251 30p
74LS253 32p
74LS257 38p
74LS258 36p
74LS259 56p
74LS261 1.36
74LS266 18p
74LS273 80p
74LS275 2.25
74LS279 30p
74LS280 1.00
74LS283 40p
74LS289 4 70
74LS290 46p
74LS293 40p
74LS295 80p
74LS298 89p
74LS299 2 50
74LS323 1 79
74LS324 1.45
74LS325 2 98
74LS326 2.38
74LS327 2.38
74LS347 96p
74LS348 1 00
74LS352 70p
74LS353 70p
74LS362 7 25
74LS365 29p
74LS366 29p
74LS367 29p
74LS368 29p
74LS373 59p
74LS378 58p
74LS386 1.14
74LS390 46p
74LS393 42p
74LS395 80p
74LS396 1 90
74LS398 2.70
74LS399 1 50
74LS445 90p
74LS490 2 20
74LS540 1 60
74LS541 80p
74LS640 1 69
74LS641 1 88

MONITOR

Fourth London Computer Fair — 1983

The Fourth London Computer Fair is to be held from 14 to 16 of April at the Central Hall, Westminster. This year, the computer fair will be part of a larger London Computer Festival, which is being held to bring together all the activities organised by the Association of London Computer Clubs, and events held in London and the South East to mark Information Technology Year in 1982.

The Computer Fair is the latest of an annual event organised by the **Association of London Computer Clubs (ALCC)**, a group of some fifteen local computer clubs in the London Area. The Fair started out when the North London Hobby Computer Club invited other clubs to join them in organizing the event, and since then it has become yearly more popular, so that now it has become one of the major exhibitions for micro-based systems and projects, attracting both major UK micro companies and the smaller companies in south east England.

This year, as part of the Computer Festival, the Computer Fair is being co-sponsored by the ALCC and the GLC (with the actual running being done for the first time by a professional organisation, Goddard, Steadman and Partners).

The main aim of the ALCC and its member clubs is simply to spread knowledge about the use of micros, especially for home users, to put people with computers in touch with each other, and to run seminars, meetings and lectures to teach people what can be done with home computers. They want to establish new clubs, and help information to circulate between groups. Eventually, any kind of group with an interest in hobby computing should be able to join. There is a three-man executive committee, and the chairman and secretary from each member club will form a clubs council. There will be specialist sub-committees to deal with specific aims and projects within the ALCC, so there will be opportunities for people with particular interests to actively do something about them.

Members of associated clubs can attend each other's meetings, and newsletter is circulated to club secretaries. Information is available on Prestel, starting on page 80080, including a newsletter which is updated daily. Remember that Prestel terminals are now available for use in many public libraries. The ALCC also has various discount and bulk purchasing schemes for members.

The main clubs participating are the Croydon Micro Computer Club (01 653 3207 or 764 4043), Harrow Computer Club (01 950 7068), North London Hobby Computer Club (where the whole thing started) (01 607 8349), East London Amateur Computer Club (01 554 3288), North Kent Amateur Computer Club (Biggin Hill 71742), Richmond Computer Club (01 892 1873), South East London Micro Computer Club (01 853 5829), West London Personal Computer Club (01 997 9437), and Worcester Park Computer Club (01 337 1609), as well as in-house clubs in places like the Post Office HQ, Home Office, etc. All these clubs have regular meetings, monthly or more often, and the North London Hobby Computer Club is run from the Polytechnic of North London, where it holds structured courses on a termly basis, open to members of the public.

The London Computer Festival is being organised by a consortium of computer interests, including the National Computing Centre Micro Systems Centre, and local authority computer centres. For information on the Festival, contact the **Secretary to the Consortium, GLC Central Computer Service, Room 431, County Hall, London SE1 (01 633 3348)**.

For more information about the ALCC, contact the ALCC at **North London Hobby Computer Club, Polytechnic of North London, Holloway, London N7 8DB. Tel: (01 607 2789).**

Going Up

Many a radio amateur wants to set up a radio mast in the back garden, but, having overcome all obstacles and finally put it up and into operation, finds that he's got the thing the wrong way round, or the mast isn't quite tall enough, or it's prone to blow over — and so on. **Allweld Engineering's** Altron SP1 Swing Post is a practical way to reduce access problems on radio masts: it is basically a hinged post which can be either latched upright, or swung into a horizontal position at about waist height for adjustments. The swing post will hold a mast made of any piece of aluminium tubing, from 1¾ to 2in in diameter and up to 6m (20ft) long, and Allweld also supply 2in tubing up to 5m long at £6.50 a meter, if required.

The swing post is made of galvanised steel and simply sets into concrete, or impacted filling, in a hole in the ground (it could even double as a washing-line post, couldn't it?). The SP1 costs £49.50, inc. VAT and UK carriage.

For mobile broadcasters, the Altron PM1 portable mast is made in zinc-plated steel tube and is designed to telescope into 1.5m sections for easy carriage. Thus it can be packed into any car and easily set up, with the car as a support, at any location. An adjustable-height bracket clamps to the guttering of most car roofs, while allowing the mast to be rotated. The PM1 extends to 5.5m (18ft) and costs £40.50, VAT and UK carriage inc.

Finally, a universal aerial mounting, for television, CB, amateur radio aerials, etc. The QM1 is a pressure-bar which fits across most window openings or similar from 25 to 42in (or more with an extension) in a vertical or horizontal position. The fixing clamp takes tubes from 1½ to 2in, and no drilling or brackets are needed for fixing. For rotatable or long masts, up to 8ft long and 12lb weight, an extra support arm is available which can mount on the QM1 itself, or be set into the wall. We don't have a price for this one, but all orders and enquiries should go to **Allweld Engineering, Unit 6, 232 Selsdon Rd., S. Croydon. Tel: 01 681 6734 or 01 680 2995.**

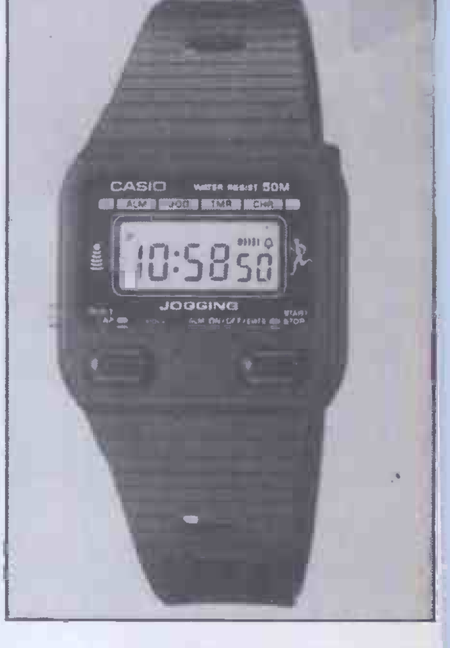
Shorts

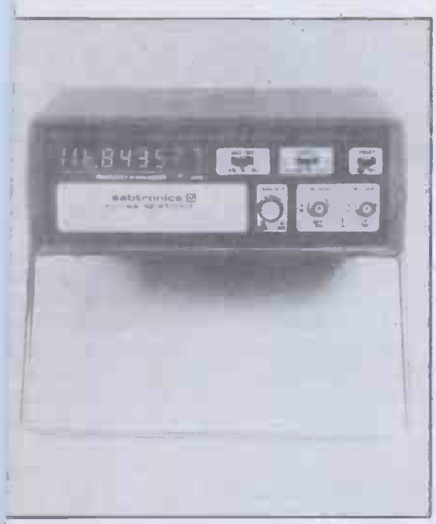
Camtec Circuits and Systems have produced four new finger heatsink designs for use with SOT32 and TO220 case plastic transistors. The heatsinks, made from high-grade black anodised aluminium, come with composite drillings to allow a variety of devices to be mounted either flat, or on legs that pass through the PCB. They are also available undrilled or with special drillings if required.

For details and prices contact **Camtec Circuits and Systems**, 5 York Rd., Bognor Regis, W. Sussex. Tel: (0243) 862911.

Electronic Hobbies have sent us a description of how to convert their 3½-digit Digital Panel Meter kit for use as a digital thermometer. The kit contians an IC, PCB, liquid crystal display, components and hardware to build a DPM on a single chip, run from a 9V battery. Extra components needed for the conversion have to be obtained in addition to the kit. Other applications mentioned are input attenuator, AC voltage meter, multi-range DVMs, current and resistance meters. Details from Caroline Stewart, **Electronics Hobbies Ltd.**, 17 Roxwell Rd., Chelmsford, Essex CM1 2LY. Tel: (0245) 62149.

Black Star are supplying the Sabtronics 8000 nine-digit frequency meter, a portable, battery or mains operated meter, capable of measuring frequencies between 1Hz and 1GHz with 'impressive accuracy'. Frequencies are covered in three ranges and three gate times are provided.





There are two BNC inputs (10Hz to 100MHz/1MR and 10MHz to 1000MHz/50R) and a sensitivity control. Sensitivity ranges from 20V to 10Hz to 35mV at 1GHz. Maximum resolution is 0.1Hz (on the 10MHz range), 1Hz (on the 100MHz range) and 10Hz (on the 1GHz range), all using a ten second gate time.

The 8000 costs £155.00 plus VAT. Specification and information from **Black Star Ltd., 9A Crown St., St. Ives, Cambs PE17 4EB. Tel: (0480) 62440.**

Stotron have added miniature relays by **National** to their catalogue, including subminiature DIP relays with single or double pole operation and very low operating power, for 12 or 24V; four pole miniature relays capable of switching 5A at 250VAC, for 24VDC or 220VAC; several kinds of low-profile relays, and various sealed terminals to give higher reliability and to prevent solder contamination.

General enquiries to **Stotron Ltd., Haywood Way, Ivyhouse Lane, Hastings, E. Sussex TN35 4PL. Tel: (0424) 442160.**

Electronic Hobbies have produced a range of 'Simplex' lightweight soldering irons. These are available for 24 or 48V, and 18 or 23W, and cost £5.00 plus £1.00 p&p, with VAT to be added to the total cost. The irons conform with international CEE11 and BS 3456 safety regulations. A wide range of iron-clad soldering bits is also available.

Order or enquire: **Electronic Hobbies Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 62149.**

Casio, who are already known for pacemaker watches for joggers and runners, have now produced a water-resistant watch (over a distance of 50 meters) for swimmers and people in training for other water sports.

One characteristic of these watches is their ability to bleep at regular, pre-set intervals, to help a runner keep his stride rate steady, important for athletic training. The water-resistant J30 also has a daily alarm, countdown timer alarm and stopwatch feature.

Price is £14.95 (RRP). For further information, contact **Casio Electronics Co. Ltd., Unit 6, 1000 North Circular Rd., London NW2 7JD. Tel: 01 450 9131.**

A New Hobby Shop

Hobbyists from South London and further afield will be interested to know of a new component and hardware shop opening in SW18, near Southfields and Earlsfield stations. **JEE Distribution**'s shop will be open usual hours plus 10 am to 4 pm on Saturdays, and will be stocking over 4000 electronics items, with the aim of providing a complete equipment source for the hobbyist. A catalogue aimed specifically at hobbyists is available for 25p, and you can write for a complete catalogue and mail-order prices to Roger Buckingham, **JEE Distribution Ltd.**, 43 Strathville Rd., London SW18 4QX. Tel: 01 870 0075 (5 lines).

Telephone Ringer

Inspired by our 'Telephone Repeater' project back in October '81, **Tutchings Electronics** have sent us information about the new 'Door Bell Repeater' they are producing. This can be set up just about anywhere that a length of wire will reach (Tutchings mention the garage and the garden, but do not say specifically that it is suitable to be mounted out of doors, so you will have to check that) and will sound a bell and flash a green light when the doorbell rings.

This is obviously useful for anyone some distance from their doorbell, or engaged in some noisy pursuit like watching the telly, and the light facility (an optional switch is available to switch off the bell when required) is especially handy when a silent alarm is wanted, or for the hard of hearing. The repeater can be set to sound as many times as you wish for each ring of the doorbell. Apparently, it doesn't work with chimes, but it might be possible to wire it in to some chime systems, so it may be worth asking.

The repeater can be powered either by PP9 battery or from an AC adaptor (which can be supplied for £3.50). The price of the Door Bell Repeater is £11.50 plus £1.50 p&p, and it is guaranteed for one year. Write to **Tutchings Electronics Ltd.**, Crest House, 3 Grange Rd., Southbourne, Bournemouth BH6 3NY. Tel: (0202) 424858.

Nellie Goes Home

Still on the subject of computers, but going back a bit in time, one of the oldest first generation computers actually to be put to regular commercial use in Britain is being returned to its makers, **STC** (who no longer make computers now), for their archives.

The computer, known as **Nellie**, is a Stantec Zebra, 'which can be described as a serial digital computer with a 33-bit word length. Operation is based entirely on a magnetic drum rotating at 100 revolutions per second, 32 words per track giving a word cycle time of about 312 microseconds. Although this sounds slow compared with modern computers, the long word length enables a high degree of arithmetical precision to be combined with a multiplicity of switching operations that could take place in one word time. For precision mathematics, the machine's efficiency is still close to that of the latest equipment available.' For comparison's sake, it takes three kW to heat up Nellie's 600 valves, and 21 fans to make sure they do not overheat. It then takes another four kW to enable her to calculate, when the high-tension circuits are switched on, and she requires a 270sq ft computer room to herself. She has the capacity of a small desk-top micro today.

Nellie has had a fairly impressive history: she was the main computer at Woolwich Polytechnic until the mid-1960s, when STC stopped making computers, which effectively made her obsolete. Later, she was acquired by a gentleman called Mr. MacRae as a backup computer for another Zebra that he was already using in his business — this was long before business computers were the commonplace they now are — and Mr. MacRae's computers were also used by a firm of sail designers, **Bruce Banks Sails Ltd.** The two computers were used together, each providing a backup for the other, but when the first machine was destroyed by fire in the early 70s, Bruce Banks Sails took over Nellie full-time (such was her reliability that she had never required the backup) and used her for all their research and development work until January 1981, when all her programs were transferred to a modern micro.

By taking a gamble and relying on Nellie at a time when she was obsolete and when there was no outside source of maintenance, Bruce Banks Sails was able to use a computing facility which they would not have been able to afford in any other form, and gain a world lead in the scientific approach to yacht sailmaking, which is today a precise science. Nellie could be said to represent the birthplace of sail technology.

Comparing the dimensions and enormous power of old computers with the tiny size of modern micros which can do the same tasks is a awe-inspiring exercise. Here's hoping that other old machines like Nellie will be preserved in museums and by private owners so that we can look back on them in the future.

Software For Sinclair

Sinclair Research have announced eighteen new software cassettes, mostly adventure games, for the Spectrum and ZX81.

The most expensive tape is *The Hobbit*, designed for the **48k Spectrum**, a fantasy game based closely on the book of the same name, and indeed the game package from **Melbourne House** publishers includes a copy of said book to give the player hints on what to do next. The game, of course, develops according to the player's decisions, and if he takes too long over them, it will develop without him! *The Hobbit* has been written to use the full potential of the 48k Spectrum, and has a built-in 500-word 'inglish' vocabulary to instruct the computer. Will Bard the Bowman miss this time? Will Smaug the Dragon eat the thirteen dwarves and re-invest his hoard? Here's your chance to find out — it costs £14.95.

There will be a review of *The Hobbit* game in a future issue of HE.

Also for the Spectrum are four adventure games: Adventure A *(Planet of Death)* Adventure B (*Inca Curse*), Adventure C (*Ship of Doom*) and Adventure D (*Espionage Island*), all published by Artic at £6.95. Sounds like a normal day's work for Harrison Ford. Then there is *Reversi*, a modern version of the late nineteenth century board game (also known as *Othello*) with nine levels of difficulty, from Games Of Skill, price £7.95, and two practical programmes from ICL, the *Collectors Pack*, which enables collectors to hold a minimum of 600 records of up to nine items on one cassette, and the *Club Record Controller*, both £9.95.

All these are for the 48k Spectrum, excepting *Reversi*, which is for the 16k version, and Adventure A, which can be played on either the 16 or the 48k model.

For **ZX81** users, the four adventure games are available for use with the 16k RAM pack, and are priced £5.95 each. *Reversi* costs £6.95 and needs 16k. Also for the 16k ZX81 is *Thro' the Wall/Scramble*, and a tape with two interactive games in machine code, *Super Glooper* and *Frogs*, both from Psion/Microgen at £4.95.

For the 1k ZX81 there is a Games Pack with eleven items (£6.00) and a new ZX81 Chess tape (£2.95) — these are both from Artic.

For the experienced ZX81 operator, there is a new ZX Toolkit (Artic, £5.95) which gives nine new functions: renumber, delete, MEM, dump, find, replace, save and append, and remkill.

Prices are all inc. VAT and the tapes are available now from **Sinclair Research, Stanhope Rd., Camberley, Surrey**, and from retail stockists.

Oric the Third — and Forth

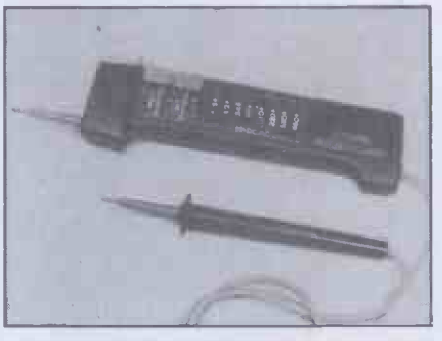
A 32k version of **Oric Products International**'s Oric I microcomputer will be available from January 1983 — it should be in the shops now. It retails at £139.95 (inc. VAT), making a trio with the 48k Oric at £169, and the 16k version (£99.95).

All the Orics run on extended BASIC, but for mail order purchasers only there is a free cassette containing FORTH as a second language with the 48k model. This cassette is to be available as an optional extra for other buyers of the 48k and 32k Orics. More information from **Oric Products International**, Coworth Park, London Rd., Ascot, Berks SL5 7SE. Tel: (0990) 27686.

OK, OK, OK

OK Machine & Tool have now issued their 1983 catalogue with "108 pages of information on tools and equipment for electronics, telecommunications, manufacturing, field services, labs, as well as schools and hobby users . . . It also features a unique product line of low cost tools and products, especially for educational and home use, and is full of useful technical and product information." Updates will be added every quarter.

Also from OK is a series of wire binding posts by **BP** which can be connected to a phono plug, banana plug, alligator clip, spade lug or wire, and plastic washers are available for complete insulation from PCB or chassis. For amateurs, these are available in packages of four (one red, one yellow, one green, one black); there are also bulk packages of 100 of any one colour.



A hand-held voltage and continuity tester, the **Steinel** Combi-Check, claims to be foolproof and fully protected against any damage to the unit (or the user) from wrong operation. Covering a voltage range of 6 to 660V AC/DC in eight increments, it is shock protected by a high input resistance, and protected against voltage surges.

The Combi-Check can be used for phase-to-ground testing, polarity, continuity in the 0 to 2MR range, and diode testing, as well as AC/DC voltage testing. Its performance and display levels can be checked on a voltage indicator before or during voltage testing, and it gives visual and audible readouts.

For further news or catalogue, contact **OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleight, Hants S05 4AA. Tel: (0703) 610944.**

Open And Closed

Open Sesame? It's not quite as simple as that, but if you are fed up with climbing out of your car on wet windy evenings and struggling with the garage keys, you could consider a remote-controlled garage door mechanism. **Slave-Dor**, long-time specialists in automatic door control, are now handling the US-made Moore O-Matic screw-driven remote-controlled garage door operator.

The newest model, called the Ultra Lift 838, costs £247.00, and is operated by remote control from inside the car. The basis of the opening mechanism is a triple-thread ¾" hollow aluminium screw and belt-drive mechanism with a microprocessor controlled circuit board (easy to replace in case of failure). The 'door open' and 'door closed' limits of the screw, and the pressure needed to stop automatic opening or closing in case of obstruction are adjustable by the owner. The whole mechanism is designed to resist interference by ice, gravel and other driveway hazards, and includes an in-garage light which comes on automatically.

Slave-Dor haven't told us whether the unit is user-installable, or whether the remote is IR or ultrasonic, but they have told us that there is a cheaper version for £181.75, and that they will be introducing a version for domestic gates, which is user-installable.

For full details, contact **Slave-Dor (UK)**, (Division of Amplite Electrical Ltd.), 1 Maidstone Rd., New Southgate, London N11 2TR. Tel: 01 881 2905.

Going Down

What lies at the bottom of Loch Ness? What lies at the bottom of the generations-old desire to know what lies at the bottom of Loch Ness? Everybody (just for once, we can use this oft-abused cliche with some accuracy) has heard of the Monster — generous time and resources have been spent on tracking it (him? her?). But the **Loch Ness Explorers Club** are taking an entirely different and down to earth track, by ignoring the palaeontology and getting on with the archaeology.

The Explorers Club are planning to survey the entire floor of Loch Ness, and record — on computer and video and any other appropriate method which is presented — the geography of the loch and any man-made remains which have sunk to the bottom during the loch's millenia-old history as a cross-country waterway (it's part of the Caledonian canal and was at one time the main route across Scotland). They have two sailing boats, video and computer equipment and, far from trying to acquire more heavy-duty gear, want the whole project (which they expect to run for about five years) to be run entirely with the ideas and assistance of hobbyists. In their own words:

"What we are looking for is hobbyists who might fancy designing and building equipment that we can use to further the survey. The hobbyists may either send their built pieces to us and we will try them out and return them with a report of their performance, or better still, they are most welcome to bring them along and try them out themselves on Loch Ness on board our research vessel. This way the hobbyists get a chance to test their ideas and their prototypes under practical conditions. The kind of equipment we need is varied indeed. It ranges from robots, capable of working in 800 feet of water, remote-controlled grabs, TV cameras, water-tight cases, low level lighting systems, sonar (tight beamed), computer recording data methods, position fixing systems . . . the list is endless! Anything that a hobbyist can dream up and wants testing. Time is plentiful, so any modifications that may be needed to someone's idea will be able to be tried out, too. No project is too small, too trivial."

Members of the club will get a quarterly progress report, opportunities to visit the site and use the equipment, and contribute any ideas, even seemingly unlikely ones, which come to them.

This sounds like a good opportunity for inventors and adventurers, as well as down to earth hobby designers, to try out their ideas in the field.

The address to contact is: **The Loch Ness Explorers Club, "John William", Foyers, Inverness-shire, IV1 2YB, Scotland.**

Prestel Editing

Continuing on the theme of computer clubs: The **Association of Computer Clubs** (ACC — not to be confused with the ALCC), acting in its role as the national body representing the computer hobbyist, has linked up with Micronet 800 to create **Club Spot 800**, a new way to involve the ordinary computer enthusiast in Prestel editing.

Club Spot 800 will be on Prestel *8008+, and will contain news and ideas about micros and micro clubs, programs, sales, wants, views etc.

The ACC is holding an editors conference on Saturday 26 February, at the Institute of Grocery Distribution, Grange Lane, Letchmore Heath, Watford, Herts. The nearest station is Watford Junction, and lifts can be arranged from there. Registration is free in advance, or £5.00 on the door, subject to space. There will be an introductory talk on Prestel editing, a hands-on session and questions and discussions.

For information, contact Rupert Steel, **ACC National Prestel Committee Secretary, St. John's College, Oxford OX1 3JP. Tel: (0865) 512811.**

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709	25	ICL7621	180	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
▶741	14	ICL7622	180	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
748	35	ICL8038	295	LM382	120	▶MF10CN	350	SL480	170	TL084	95
9400CJ	350	ICL8211A	200	LM384	130	ML922	400	SL490	250	TL170	50
AY-3-1270	720	ICM7224	785	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-8910	370	ICM7555	80	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
AY-3-8912	540	▶LF351	45	LM393	100	ML926	140	SP8629	250	ULN2004	90
CA3046	60	LF353	85	LM709	25	ML927	140	TBA120S	70	XR2206	290
▶CA3080	65	LF356	90	LM711	60	ML928	140	TBA800	75	ZN414	100
CA3089	190	LM10	360	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3090AQ	375	LM301A	25	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3130E	85	LM311	70	LM741	14	NE529	225	TBA950	220	ZN425E	350
▶CA3140E	36	LM318	20	LM747	60	NE531	150	TDA1008	320	ZN426E	330
CA3161E	100	LM324	40	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
CA3189	290	LM334Z	100	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
▶CA3240E	110	LM335Z	125	LM3900	45	▶NE556	45	TL061	40	ZN459	285
				▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

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				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	6
AC125	35	BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	9	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	9	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	48
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	65		

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		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	226	4094	68	4511	40	4549	360
4007	14	4023	14	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

		LS20	12	LS75	20	LS123	34	LS160	35	LS197	45	LS353	60
		LS21	12	LS76	17	LS125	24	LS161	35	LS221	50	LS365	28
		LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	LS26	14	LS83	35	LS132	35	LS163	35	LS241	55	LS367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	11	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	58
LS03	12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	LS390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
LS15	12	LS74	17	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

		7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
		7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 12p.
Push to make 12p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

TRANSFORMERS

Please add carriage charges to our normal post charges.

Miniature mains:
606V; 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature:
3VA 0-6, 0-6 @ 0.25A; 0-9, 0-9 @ 0.15A; 0-12, 0-12 @ 0.12A 200p each.
6VA 0-6, 0-6 @ 0.5A; 0.9, 0-9 @ 0.3A; 0-12, 0.12 @ 0.25A 270p each.
High quality. Split bobbin construction
6VA 0-6, 0.6 @ 0.5A; 0-9, 0-9 @ 0.4A; 0-12, 0-12V @ 0.3A 220p each.
12VA 0-6, 0-6 @ 1A; 0-9, 0-9 @ 0.8A, 0-12, 0-12 @ 0.5A; 0-15, 0-15 @ 0.4A 295p (plus 40p carriage).
25VA 0-6, 0-6 @ 1.5A; 0-9, 0-9 @ 1.2A; 0-12, 0-12 @ 1A; 0 15, 0-15 @ 0.8A 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1.5A. 440p each (plus 75p carriage)

VERO

VEROBLOC◀	350
Size 0.1 matrix:	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	6

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25

CONNECTORS

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

UHF (C8) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . 60p
Socket with 2m lead . . 120p

BOXES

Plastic with lid + screws		Aluminium	
		3x2x1"	70
		4x3x1½"	85
3x2x1"	55	4x3x2"	100
4½x3x1½"	88	6x4x2"	120
7x4x2	160	6x4x3"	150

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	2	400mW zen	6

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

BRIDGE RECTIFIERS

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

MULTIMETERS

HT-120 4,000 opv
A smart looking 11 range pocket sized multimeter with an impressive spec. Complete with battery, etc. 650p each.
HT-320 20,000 opv.
Highly sensitive 19 range multimeter including transistor tester. Overload protection. DC volts – 1000, AC volts – 1000; DC current 0.25A. 4 resistance ranges Complete with batteries, leads, etc. 1395p

CABLES

20 metre pack single core connecting cable ten different colours. 65p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m

NEW CATALOGUE • NEW CATALOGUE!!!!!!!
Our latest catalogue has just been released containing over 2000 stock lines all at extremely competitive prices backed by Rapid's return of post service. Stocks include Denco coils, tools, Verocases, data sheets etc. etc. Send 45p for your copy now (sent free of charge with all orders over £10).

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p, 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 180p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead.
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 63p each.
Preset submin. hor. 100 ohms -1M 7p each.
Cermet precision multiturn, 0.75W ¾" 100 ohms to 100K - 88p each.

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	LM338K	475
LM317T	120	78H05 5A	
LM323K	350	5V	550

SOLDERING IRONS

Antex CS 17W Soldering iron	460
2.3 and 4.7mm bits to suit	65
CS 17W iron: 450, element:	210
Antex XS 25W	480
3.3 and 4.7mm bits to suit	65
Solder pump desoldering tool.	480
Spare nozzle for above	70
10 metres 22swg solder	100

TOOLS

Small trimming tool	22
Small pocket screwdriver	16
Large pocket screwdriver	13
6 piece precision screwdriver set in plastic case	170
Low cost side cutters	160
High quality side cutters	650
Low cost pliers	160
High quality pliers	650
Wire strippers	120
Expo reliant drill	695
Expo Titan drill	1025
Drill stand	1200
Reduced shank drill bits for above 0.8mm, 1mm, 1.4mm	60

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100
TIL313 0.3"	115	TIL312 0.3"	115
TIL322 0.5"	115	TIL321 0.5"	115

LCD: 3½ digit 580p. 4 digit 620p.

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 1M. . . . . 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each.
¼W 1% metal film E24 series 10 ohm - 1M . . . . 6p each.

PCB MATERIALS

Alfac transfer sheets – please state type (e.g. DIL pads etc.)	45
Dalo etch resist pen	100
Fibre glass board 3.75"x8"	80
Ferric chloride 250ml bottle.	100

TRIACS

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

SOCKETS

	Low profile	Wire-wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	99p

Soldercon pins 60P/100

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices.

¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors)	480
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps)	370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps)	575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets	425

Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

The Rapid Guarantee

★ Same day despatch ★ Competitive prices
★ Top quality components ★ In-depth stocks

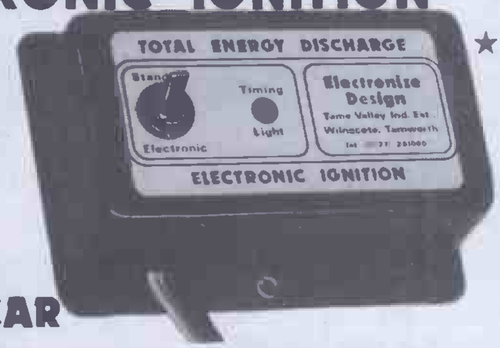
ORDERING INFO. All components brand new and full specification. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/P.O. or Access/Visa number with order. Our detailed catalogue costs 45p (free with orders over £10). Callers most welcome. Telephone orders welcome with Access or Visa. Official orders accepted from colleges, Schools, etc. . . Callers most welcome, we are open Monday to Saturday.

electronize

AUTO-ELECTRONIC PRODUCTS

KITS OR READY BUILT

ELECTRONIC IGNITION



IS YOUR CAR AS GOOD AS IT COULD BE ?

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

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

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

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

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

Most **NEW CARS** already have **ELECTRONIC IGNITION**. Update **YOUR CAR** with the most powerful system on the market - 3½ times more spark power than inductive systems - 3½ times the spark energy of ordinary capacitive systems, 3 times the spark duration.

Total Energy Discharge also features:
EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, LED STATIC TIMING LIGHT, LOW RADIO INTERFERENCE, CORRECT SPARK POLARITY and DESIGNED IN RELIABILITY.

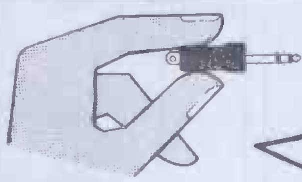
★ **IN KIT FORM** it provides a top performance system at less than half the price of competing ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2μF discharge capacitor, case, easy to follow instructions, solder and everything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

FITS ALL NEGATIVE EARTH VEHICLES
6 or 12 volt, with or without ballast.

OPERATES ALL VOLTAGE IMPULSE TACHOMETERS:
(Older current impulse types need an adaptor).

STANDARD CAR KIT	**£15·90**	PLUS P. & P. £1 (U.K.)
Assembled and Tested	**£26·70**	
TWIN OUTPUT KIT	**£24·55**	Prices include VAT
For Motor Cycles and Cars with twin ignition systems		
Assembled and Tested	**£36·45**	

PROTECT YOUR CAR WITH AN ELECTRONIZE ELECTRONIC ALARM



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

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

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

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

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

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

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

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

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

CAR ALARM KIT	**£24·95**	PLUS P. & P. £1 (U.K.)
ASSEMBLED AND TESTED	**£37·95**	Prices include VAT

VISA

Access and Visa Welcome. Write or Phone Quoting Number

ELECTRONIZE DESIGN

Dept. E · Magnus Rd · Wilnecote
Tamworth · B77 5BY
tel: 0827 281000

FINIS TOU

Keith Brindley

With patience, a few sim a home-built project can as "a bou

HOWEVER long you have been building your own electronic projects, the problem of how to house them remains a perennial one. No matter how well the project works, you won't want to show it off to the girlfriend, boyfriend, neighbour, mother-in-law, budgerigar, cat etc. unless it looks good . . . will you!

Over the next couple of pages you'll find all of the information you need to be able to put a project into a box or case and give it the high-quality appearance that it deserves. When you've finished reading this article we think that, even if you have never put a single electronics project into a case before, you will agree that housing a project is just a matter of following a few simple rules.

First things first. What sort of housing are you going to use? There are hundreds of different boxes and cases on the market — some cheap, others not so cheap. You might even make your own if you can, but the problem remains the same, whatever box you decide to put your project in: how do you make it look presentable? After all, you might argue that it doesn't matter what it looks like inside, it's what is outside that people see, so the box itself is important to the final appearance of your project.

Assuming that you have already built up your project on a printed circuit board (PCB) or piece of Veroboard and tested it to make sure it works and does everything it's supposed to, the peripheral components (called panel hardware) such as potentiometers, meters and connection sockets will be joined to the PCB by short lengths of wire.

Write a list of all these controls — sockets, meters etc. — which need to be accessed from outside the case. Other examples of controls are the volume, treble, bass and balance on a stereo amplifier, while input and output sockets are almost always needed. Now, take a few minutes and try to visualise a layout for the front panel of the project box. Some projects will have an obvious layout — for example an amplifier looks 'right' in a case having a long, thin front panel, with all controls in a straight line. Front panels of other projects could take a bit more thought.

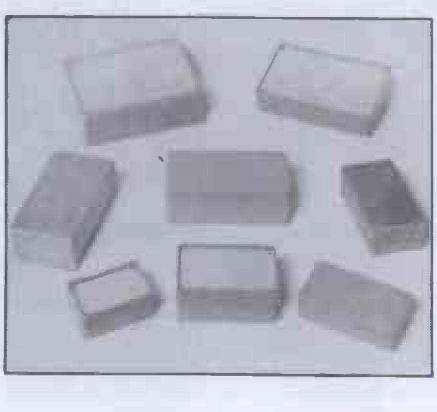
There are two ways of going about this, depending on whether you already have your box or not. If you have a box then the size and shape of the panel is fixed. However, if you haven't got a box you can decide your own front panel size and shape — but then you have the problem of finding a box to suit your requirements. Keep a few catalogues from mail-order companies handy because they will give you a good idea of what boxes you can get (and how much they cost!). Above all, don't rush this stage; take your time, perhaps draw out in pencil on paper a few rough-sketched panel layouts until you've got the one most suitable for your project.

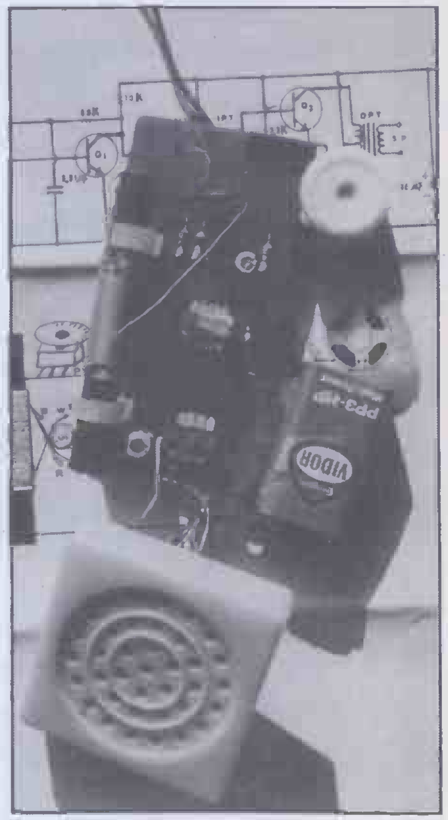
It's worthwhile remembering, while you are designing your front panel, the rule of the 'Five Ps' — Prior Planning Prevents Poor Performance. In other words, a bit of careful thought before you put your project in its box will help stop you making any mistakes. Don't make a move until you are sure you have everything planned! Don't drill a hole, don't even mark the case until you are positive you haven't missed anything out; once you've marked or drilled the case you can't go back and start again — you have ruined the case!

Centres of all holes for all panel hardware should now be marked using a hammer and punch; a punchmark will keep a drill bit in the right place and prevent it from slipping, scratching or scoring the panel. Small holes can be drilled out using a hand-drill and bit, but a power drill fitted with the correct sized bit is better still. Large holes can be a bit trickier. There are two general methods — punching, or sawing and filing. Punching gives by far the neatest and cleanest of holes, but you have to have the correct sized punch. If you want a lot of different sized holes you need a good selection of punches, and the problem here is that punches are quite expensive. If you can't afford to buy more than a couple then it's best to buy sizes which you will use most often. For example, a punch which gives a hole to suit potentiometers is a good size to buy because most projects use at least a couple of 'pots'.

Using a punch is simple. Drill a pilot hole in the panel to fit the centre bolt of the punch. Now, following the instructions which will be supplied with it, hand-tighten the parts of the punch until the cutting edge bites onto the panel. Now, using a spanner or Allan key tighten the punch until the hole is cut. It really couldn't be simpler.

The other method of making large holes is a bit more fiddly and takes more care, but is decidedly cheaper. Using a pair of dividers or compasses, mark out





Top left: the professional touch — custom metalwork for the HE TV Amp by Newrad Instruments Ltd, assembly and finish by Paul Coster.

Above: A project wired-up for testing. Later it will have to be disassembled for mounting in a case.

Left: A range of simple metal and plastic enclosures.

HING CHES

ple tools and a little skill, be made to look as good ght one".

the exact size of the hole in its correct position. Next, punch-mark and drill a number of holes around the inside of the circumference of the hole. Now, using a padsaw, or junior hacksaw, cut round the marked hole, keeping fractionally to the inside edge of the circumference, going from each small drilled hole to the next.

When you have cut all the way round, the centre will fall out. Then, using a half-round file, carefully file all round the inside edge of the hole until it is the correct size.

Take extreme care when you do any metalwork, because one slip with a drill bit, scriber, file etc. could make a scratch on the panel which you can never remove — the appearance of your project will be ruined.

The Inside Story

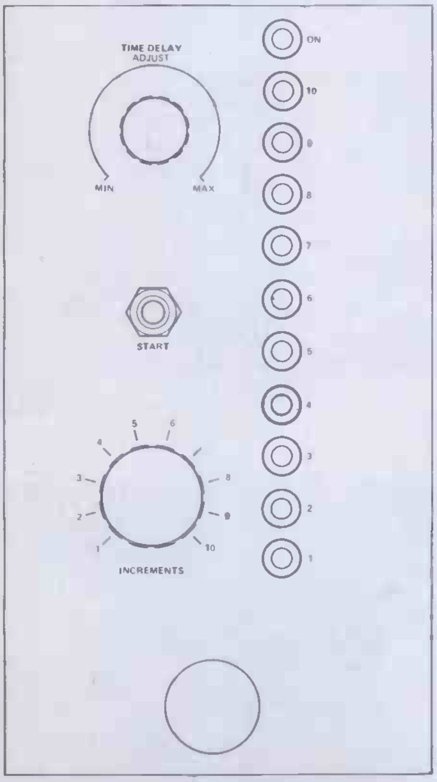
When you've made all the necessary holes in the front panel, it's time to think about how you are going to mount the project's circuit board. Plastic pillars are ideal; alternatively simple nuts, bolts and washers can be used to do the job. Whatever method you use, you will need to drill more holes to suit, but in the bottom of the case this time!

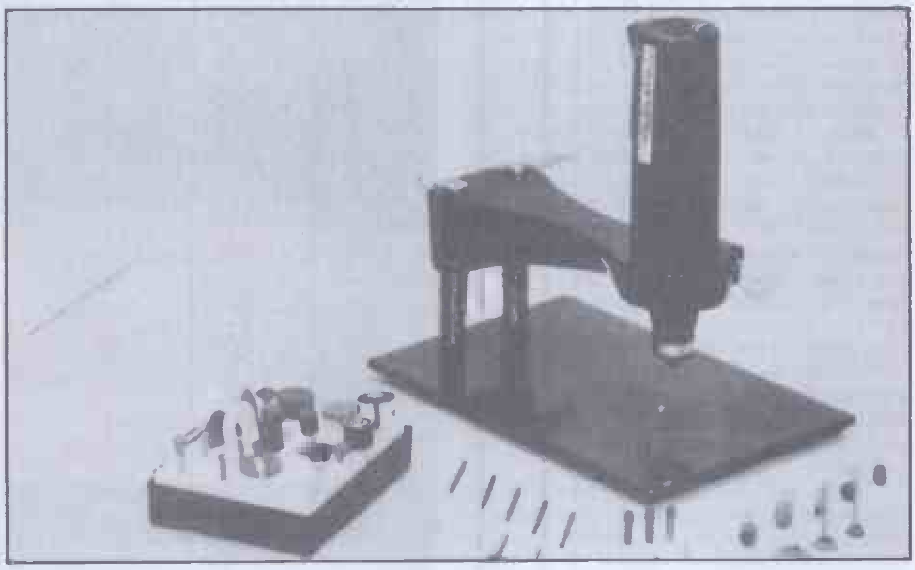
Next step on the agenda is to label the front panel so that all controls and switches etc. can be clearly identified. Rub-down transfer lettering is the best for this; there are many different makes of transfer letters but they are basically the same in use. The surface of your project must, first, be perfectly clean and free from grease — the lettering won't stick unless the panel is grease free so spend a bit of time cleaning the case. You can use a piece of rag sparingly damped with methylated spirits or, alternatively, one of the commercially available kitchen scouring creams. Make sure your hands are clean at this point!

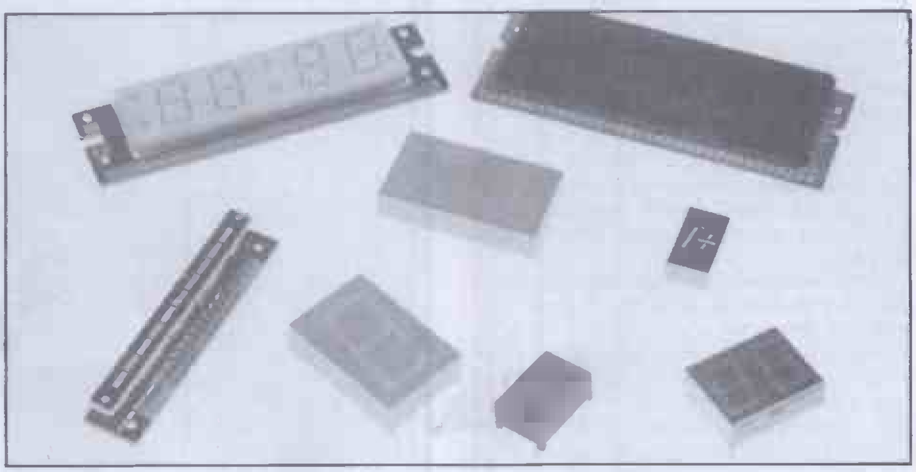
Transfer lettering is bought as a sheet with a quantity of each letter of the alphabet and the numbers '0' to '9' on it. Have a good look at the selection of styles of lettering (called 'faces') you can buy; most manufacturers produce a catalogue for the purpose. Choose a face which you like and which will suit the project. A good tip is to buy a fairly plain face (so the style will suit more than just the one project) and one which is quite small in size (so that you get more letters per sheet!).

Transferring a letter is simply done by laying the sheet ink side down over the panel, making sure the letter you want is exactly over the place you want it. Now, with a soft-leaded pencil or a ball-point pen, slowly rub over the letter so that it sticks to the panel and stays behind when you remove the sheet. There are three useful tips here:

- lightly rule a pencilled line where the label is to placed; this way, the word will be 'straight'
- where a label is to be central, above or under a definite point (such as a pot) start labelling with the middle letter; this ensures the word is not lop-sided
- make sure your spelling is correct; once you've misspelt a word, you'll have to redo it!







Above: Front panel artwork for the HE Incremental Timer, drawn up from the printed circuit board.

Top right: Even a small bench drill is suitable for drilling PCBs, plastic and light metalwork.

Right: Panel mounted displays require square or rectangular holes, made by drilling, cutting and filing as described in the text.

If you do make any mistakes, ordinary cellophane adhesive tape can be carefully used to remove the offending letters. Lay a piece of adhesive down over the error, rub it down then pull the tape off; the letters underneath the tape will be removed with it. Be careful it doesn't catch any letters you don't want removed!

Spray it Again, Sam?

Transfer letters can be easily scratched and damaged so they have to be protected from mishandling. Clear protective lacquer is available in aerosol form, and this gives a hardwearing finish to your project's front panel, preventing all but the fiercest of scratches from damaging the lettering. Most manufacturers of rub-down letters also produce their own forms of aerosol lacquer.

After you've sprayed the front panel, let the lacquer dry thoroughly. There's nothing more irritating than a messy (and irremovable) thumbprint on an otherwise perfect front panel, so allow at least the manufacturer's recommended drying time before you touch it!

When the panel is perfectly dry, the time has arrived to put the whole project into the completed case. Unsolder all connecting wires which were on the PCB for testing, and discard them. Now, mount all panel hardware and the PCB in their respective places in the case. At this stage you can put all control knobs onto any pot shafts, too. You may have to shorten the pot shaft to suit — but don't do this with the pot in the case, otherwise you might damage the case; take the pot out and, holding it in a vice, cut the shaft to the correct length using a hacksaw.

We're at the point now, where we commence final wiring-up of the project. Following the projects's circuit, cut each connecting wire to the correct length; this helps to keep the project looking neat inside. Make each connection in two steps:

1. Solder one end of the connecting lead to one point, say the PCB.
2. Take the lead around the case to the other point, cut it to length, then solder it.

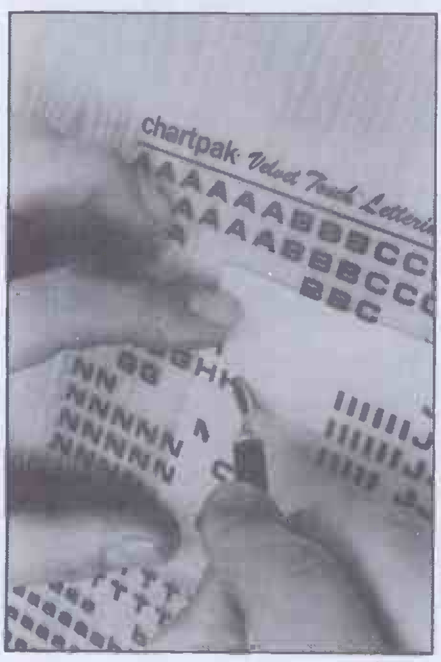
Make all connecting leads go around the case in the same fashion so that generally they group together. Then, when all connections have been made and you have checked the project, (making sure it still works), tie the group of leads together with a cable tie. Plastic cable-ties, lacing-cord or simple string can be used for this job. Forming all connecting leads into such a bunch gives a very neat appearance to the inside of your project, much better than the ''bird's nest'' appearance you get when a project is wired-up with all connecting leads simply taking the shortest distance between two points. It really is worth the extra few centimetres of wire you might use in forming the group of leads.

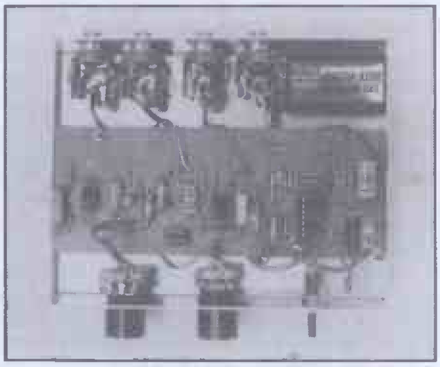
Now, the only thing to do is put the lid onto your case and then you can take a step back to admire your fully housed and completed project. Neat, isn't it!

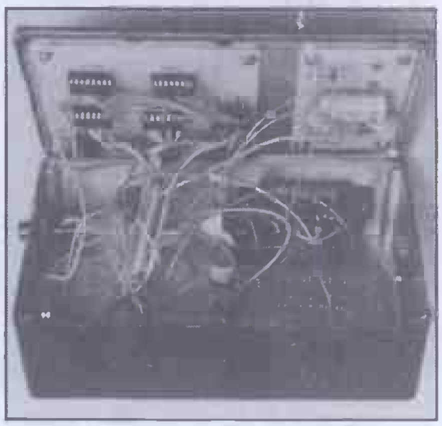
HE

Above: Plastic mounting strips simplify the problem of securing a PCB or Veroboard within a case.

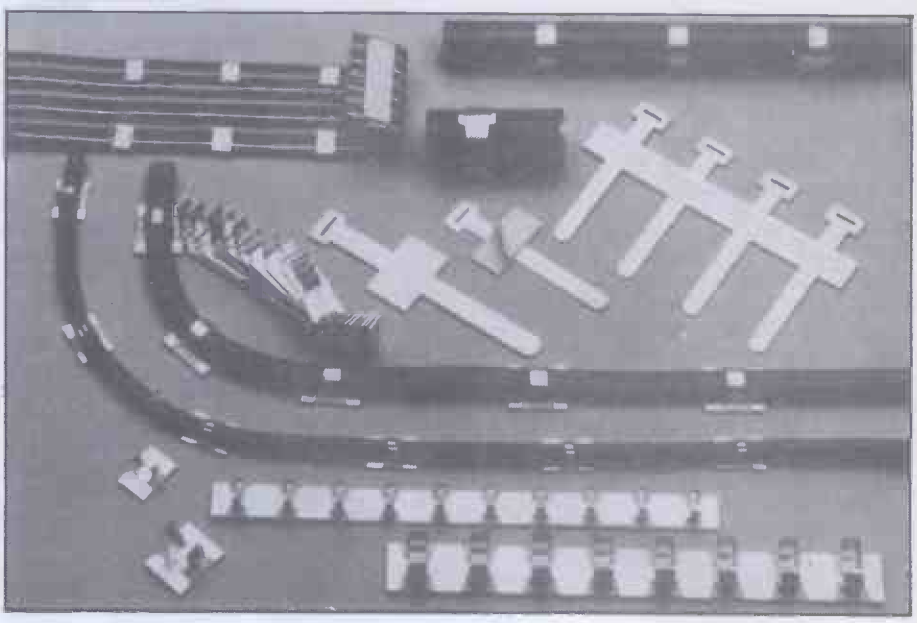
Below: Using rub-down lettering; a soft pencil will do as well as the special burnishing tool!







Above: A neatly completed Hobby Electronics project and . . . Middle: A not-so-neatly completed project; the 'birds nest' effect could have been avoided by the use of ribbon cable or . . . Below: Cable ties, such as these self-adhering types.



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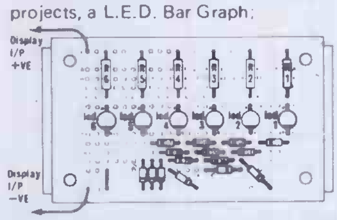

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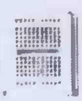

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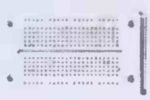

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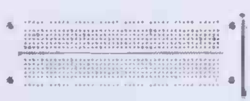
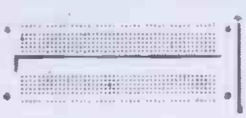


EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.



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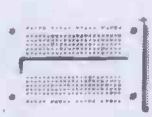

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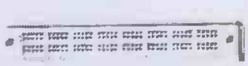

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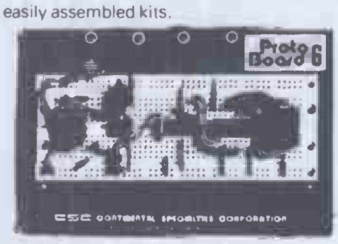

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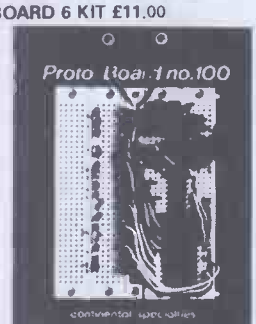

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COMPONENTS FOR COMPUTING

Pictures courtesy Ferranti Ltd.

Paul Kelly

Like elephants, ROMs never forget (unless you want them to).

Last month we outlined the different types of memory used in microcomputing systems and discussed, in detail, RAMs (Random Access Memory). We continue this month by looking at the other main memory type, ROMs (Read Only Memory). A ROM is in fact a type of random access memory (but rarely referred to as a RAM), in that it consists of a number of memory cells organised as a number of randomly addressable data words, each of one or more bits wide. The most significant difference between a ROM and a RAM is that the data stored in a RAM may be freely altered during normal operation of the device whereas in a ROM, the data is fixed at manufacture or by a programming procedure (depending on the type of device) and is unalterable in-circuit. The property enables ROMs to retain data when no power is applied to the device and is called 'non-volatility'. Such devices are of particular use in microcomputer systems where it is desirable to have the machine's operating software available immediately from power-up, whether it be a BASIC interpreter in a home microcomputer, a Disc Operating System (DOS) of a business machine or an industrial control system.

There are a huge variety of ROMs, in general use, which vary in the technologies of fabrication, in the means of data fixing and, of course, in their capacities and organisations. Most of the devices fall into one of the following broad categories: mask programmed ROMs, bipolar programmable (fusible link) ROMs, UV-Erasable ROMs (EPROM) and electrically alterable ROMs (EEPROM).

In a mask programmed ROM, the stored data is determined by the set of masks used in the manufacture of the device. It is unlikely that these devices will ever be used by hobbyists, as the manufacturer's masking charge, although steadily falling, is of the order of £2,000! Mask programmed ROMs are used widely by high volume manufacturers of microprocessor based equipment (eg microcomputers) where the overall cost per unit (over, say 10,000 devices) is very small.

EPROMS are the most popular ROMs, used almost universally by hobbyists, small volume equipment manufacturers and Research & Development departments. The popularity of these devices lies, firstly, in their field-programmability, and secondly in their ability to be erased (by ultra-violet light) and reprogrammed many times. We will be looking at these devices, in particular, in the final half of this article.

EEPROMS have only recently hit the market and are, at present, too expensive to be in general use though no doubt they will completely replace EPROMS in the long term. EEPROMS vary in type. Generally they are programmed in the same manner as EPROMs but can be erased electrically (rather than by UV), some devices one location at a time and others, all locations together.

Bipolar PROMs are almost always programmed by a method of 'blowing' fusible links within the device. The programming process is irreversible — once a data bit has been programmed (usually from '1' to '0') it cannot be reversed. The basis principle of fusible links is illustrated in **Figure 1**; when the cell is selected (addressed) by its row drive, it will pull the column output high if the link is intact — if the link is blown the column output remains low. The fuse, which is usually made of nichrome, is blown by momentarily passing a high current through the transmitter and for this, Vcc is often increased to a high voltage (although the particular programming requirements vary widely from one manu-

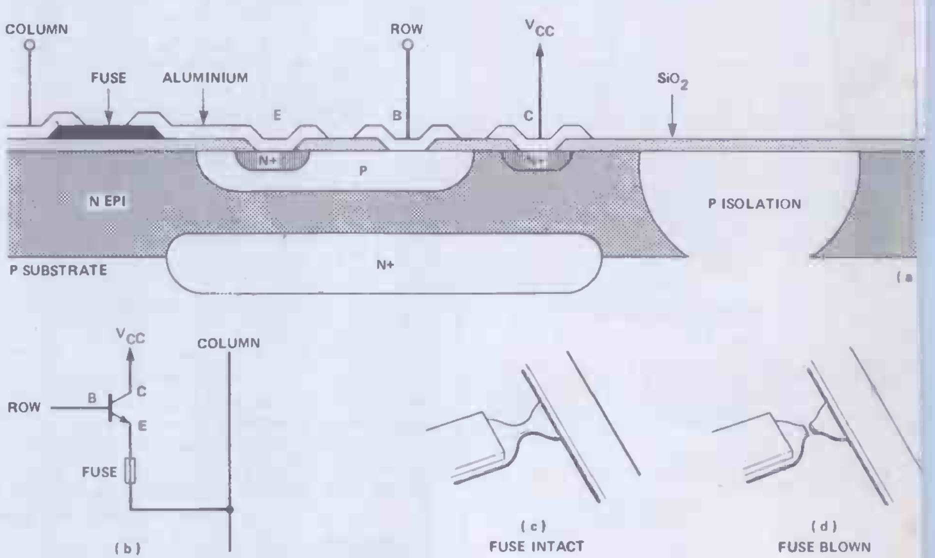

Figure 1. (a) The physical structure of a bi-polar fusible link PROM cell; (b) the circuit of a single cell; (c,d) these drawings, showing the fuse intact and then blown, were made from a pair of photomicrographs of a PROM cell.

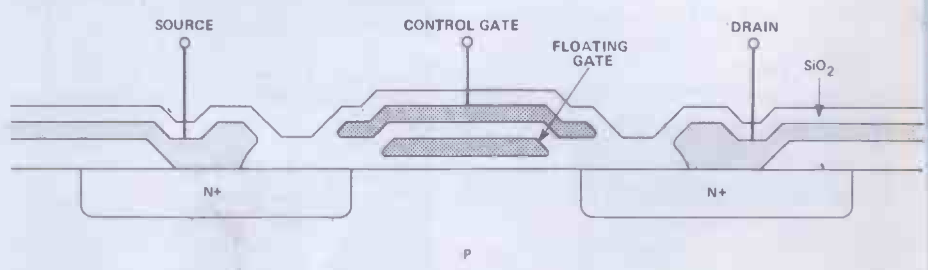

Figure 3. The structure of a UV erasable EPROM memory cell.

Table 1

TYPE	ORGANISATION	TECHNOLOGY	SUPPLY	CURRENT	PINS	COMMENTS
2708	1K × 8	NMOS	+5, +12V	65mA	24	Now obsolete.
2716	2K × 8	NMOS	+5V	100mA	24	Low cost type.
2532	4K × 8	NMOS	+5V	100mA	24	No OE pin.
2732	4K × 8	NMOS	+5V	100mA	24	Uses OE pin.
2764	8K × 8	NMOS	+5V	150mA	28	Pin compatible with 2732; expensive.
2564	8K × 8	NMOS	+5V	150mA	28	Pin compatible with 2532; expensive.

The essential characteristics of the most common EPROM types are tabulated above. As chip densities have increased low-capacity ICs such as the 2708 have become obsolete. However, the very high density chips remain expensive.

facturer to another). Bipolar PROMS offer an advantage in speed when compared with other PROMs, which are usually MOS (access time of the order of 20nS versus 200nS for MOS). Because this extra speed is not required by the average microcomputer system, and because of the high cost and difficult programming procedures, bipolar PROMs are rarely used for storing software in microcomputers. However they are used in minicomputers and mainframes, within the CPU microprogram control unit (where speed is crucial); a more frequent use is as a substitute for a logic array, as shown in **Figure 2**. Each of the PROM's outputs is a logical function of the input (address) lines; if any required function is tabulated (as in a truth table) by storing the contents of the table as data in the PROM, it will then function as an equivalent array of combinational logic

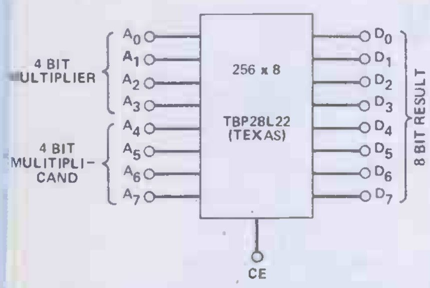

Figure 2. An EPROM can be used as a look-up table; the 8-bit result is stored at an address corresponding to the values of the 4-bit multiplier and multiplicand.

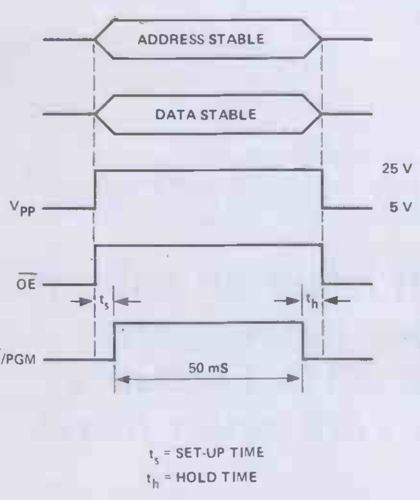

Figure 4. The timing diagram of a single program cycle for the 2716 EPROM.

which might otherwise be used to implement the function. The example given is of a 4-bit multiplier used to give an eight bit product, implemented with one ROM chip — an equivalent circuit with NAND and NOR gates would require many chips!

We return, now, to the subject of EPROMs because, as a hobbyist, this is the type you are most likely to encounter (particularly if you build the programmer presented in this issue). A profile of the 'silicon slice' of one memory cell is shown in **Figure 3**. Each cell is based on a single MOS transistor, with a 'floating gate' implanted in the silicon dioxide insulator normally placed between the transistor control gate and the drain-source conduction channel. During programming, a high potential applied between drain and control gate causes an injection of electrons into the floating gate across the SiO_2 barrier, but when the high potential is removed, a charge remains on the floating gate indefinitely. This charge on the floating gate inhibits the control gate, preventing it from turning on the transistor; thus two logical states exist for the cell, depending on whether the floating gate has been charged or not. The presence of UV light raises the conductivity of the SiO_2 sufficiently to permit a gradual leakage of charge from the floating gate. Typically, an EPROM will take 30 minutes to complete erasure using a commercial UV erasing unit. The UV light of sunlight is not strong in the required spectrum (short wavelength UV) and could take several weeks to erase an EPROM. However, erasure boxes can be purchased as cheaply as £40, these days, with tubes running at about £12 each, if you wish to DIY.

In **Table 1** we have presented some of the characteristics of most of the popular EPROMS on the market, together with their pin configurations. Most of the devices are in 24-pin DIL packages (except the larger 8k x 8) EPROMS, which are 28-pin) and have a glass 'window' at the top of the package to allow UV light to strike the exposed silicon chip. After programming, a paper label or similar must be placed over the window to prevent gradual erasure in sunlight or artificial flrouescent lighting.

We have not gone into the internal architecture of a ROM, as the interconnection of memory cells within the device is basically the same as for RAMs (see last month's installment). Externally, the devices are very similar as well; they have an address bus (the number of lines being determined by the memory capacity), a data bus (which for most devices, being intended for microcomputing applications, is eight bits wide) and a chip select line (CE) which allows many devices to connect onto the data bus (when high, the CE pin disables the data output drivers). Obvously, for a ROM, there is no R/W (Read/Write) line, and in its place a Program Voltage pin is provided.

The earlier EPROM types (eg 2708) were quite complicated to program, in that it was necessary to cycle through all address locations many times so as to avoid localised heating of the chip. Most of the modern EPROMS, though, are fairly standardised and may be programmed a byte at a time; we will consider the 2716 EPROM (probably the most popular, at £2.50 each) in particular. A programming cycle for the 2716 is illustrated by the timing diagram of **Figure 4**. With the device enabled (CE low) and the programming drive, V_{PP}, at 25V, a stable address and data word are presented to the appropriate pins of the device; the OE (Output Enable) pin is also taken high to avoid conflict with the data 'blanks' already present in the ROM. The data is then programmed by applying a high to the PGM/CE pin for a period of 50mS. It is important to note that a blank EPROM as supplied by the manufacturer has all its bits 'high' and that, during programming, the appropriate bits are forced low; it is not possible to bring a bit back from a low to a high without erasing the entire device. For a 2716, it takes about a minute and a half to program all 2048 locations on an automatic programmer and it takes at least 20 mins to erase the device. This gives the software developer a very fast turn around on modifications he makes during program development.

It is also worth mentioning some details of commercial programmers, although they are priced from 'as little' as £200! Some of the cheaper programmers are simple copiers, and therefore of limited use to software developers (but of considerable use to 'pirates', most noticeably of video games!) For manufacturers, bulk copiers (to program several EPROMS at a time) have become a cheap time-saving device — again not much use to the amateur. The 'intelligent' EPROM programmers, now beginning to flood the market, are becoming just within the reach of the amateur's pocket, and offer all the facilities he could wish. Most of these have video displays (as opposed to the earlier LEDs) and, in conjunction with an integral keyboard, allow data to be entered and manipulated as required before programming. The project presented in this issue, however, is a compromise between what one would like and what one can afford! **HE**

74 SERIES

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18pp
7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7440	15p
7441	55p
7442A	30p
7443	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74107	22p
74109	25p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	36p
74156	40p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184A	90p
74185	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74273	120p
74278	140p
74279	40p
74283	50p
74284	160p
74290	75p
74293	80p
74298	100p
74351	150p
74365	30p
74366	36p
74367	35p
74368	30p
74376	100p
74390	75p
74393	90p
74490	95p

74LS SERIES

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS06	12p
74LS07	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	13p
74LS13	15p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS22	13p
74LS26	14p
74LS27	13p
74LS28	14p
74LS30	13p
74LS32	13p
74LS37	14p
74LS38	14p
74LS40	12p
74LS42	30p
74LS47	35p
74LS51	14p
74LS55	14p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	36p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS95	40p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125	24p
74LS126	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	25p
74LS158	30p
74LS160	38p
74LS161	38p
74LS162	38p
74LS163	38p
74LS164	40p
74LS165	50p
74LS166	60p
74LS170	70p
74LS173	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	36p
74LS194	35p
74LS195	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	70p
74LS251	30p
74LS253	30p
74LS257	30p
74LS258	36p
74LS259	55p
74LS260	22p
74LS261	50p
74LS266	20p
74LS273	55p
74LS279	30p
74LS283	40p
74LS298	90p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365	30p
74LS367	30p
74LS368	30p
74LS373	55p
74LS374	55p
74LS375	45p
74LS377	70p
74LS378	70p
74LS390	45p
74LS393	45p
74LS399	160p
74LS467	90p
74LS540	90p
74LS541	80p
74LS610	£19
74LS670	120p
74LS687	400p

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4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4076	48p
4077	18p
4078	18p
4081	14p
4082	15p
4086	60p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
4500	575p
4502	60p
4503	45p
4505	400p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4532	70p
4534	400p
4536	270p
4538	45p
4539	70p
4543	75p
4553	245p
4555	35p
4556	35p
4560	120p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
40085	90p
40097	50p
40102	140p
40103	170p
40106	36p
40109	100p
40163	60p
40174	50p
40176	50p
40193	60p
14495	300p
40244	60p
40245	180p
40373	160p
40374	160p

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LC7120	300p
LC7130	325p
LF347	150p
LF351	48p
LF353	95p
LF356P	95p
LF357	110p
LM10C	325p
LM301A	25p
LM307	45p
LM308	45p
LM310	120p
LM318	150p
LM319	215p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM384	140p
LM386	90p
LM387	120p
LM389	95p
LM391	150p
LM393	100p
LM394	300p
LM709	36p
LM710	50p
LM711	70p
LM723	35p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1014	150p
LM1801	300p
LM2917	200p
LM3302	75p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
M51513L	300p
M51516L	500p
MB3712	250p
MB3730	400p
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MC1445	250p
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MC1496	70p
MC3340P	120p
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ML920	800p
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NE531	140p
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NE565	120p
NE566	155p
NE567	140p
NE570	410p
NE571	400p
NE5534A	125p
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TDA1024	120p
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TL061CP	40p
TL062	60p
TL064	95p
TL071/81	25p
TL072/82	45p
TL074	100p
TL084	90p
TL094	200p
TL170	50p
TL430C	70p
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ZN424E	130p
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ZNA134	£23
ZNA234	850p

TRANSISTORS

AD161/2	40p
BC107	14p
BC109C	14p
BC117	20p
BC169C	10p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	10p
BC187	30p
BC212/3	10p
BC214	10p
BC237	15p
BC327	16p
BC337	10p
BC338	16p
BC461	25p
BC516/7	38p
BC547B	12p
BC548C	9p
BC549C	12p
BC557B	18p
BC559C	16p
BCY70	20p
BCY71	20p
BD135/6	40p
BD139	40p
BD189	60p
BD232	95p
BD233	75p
BD235	75p
BD241	70p
BD242A	70p
BF256B	45p
BF257/8	30p
BFR39	20p
BFR40/1	20p
BFR79	20p
BFR80/1	25p
BFR96	180p
BFX30	34p
BFX86/7	25p
BFX88	25p
BFX89	150p
BFY50	24p
BFY51/2	24p
BFY56	30p
BFY90	75p
BRY39	40p
BSX19/20	20p
BU104	225p
BU105	170p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	175p
BU208	200p
BU406	145p
BUX80	400p
BUY69C	200p
J310	50p
MJ8024	£4
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	£4
MJE340	50p
MJE2955	90p
MJE3055	70p
MPF102	30p
MPF103/4	30p
MPF105	30p
MPSA12	30p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	25p
MPSA70	50p
MPSA93	50p
MPSU06	55p
MPSU07	60p
MPSU45	90p
MPSU56	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	50p
TIP32A	40p
TIP32C	45p
TIP33A	90p
TIP33C	80p
TIP34A	90p
TIP34C	80p
TIP35A	120p
TIP35C	150p
TIP36A	140p
TIP36C	160p
TIP41A	45p
TIP41C	55p
TIP42A	50p
TIP42C	60p
TIP54	160p
TIP120	50p
TIP121	70p
TIP122	60p
TIP142	110p
TIP147	120p
TIP2955	60p
ZTX	10p
ZTX300	13p
ZTX452	45p
ZTX500	13p
ZTX502	15p
ZTX504	30p
ZTX552	55p
ZTX652	60p
ZTX752	70p
VN10KM	55p
VN66	80p
2N697	20p
2N698	40p
2N706A	18p
2N708	18p
2N918	35p
2N930	18p
2N1132	24p
2N1613	30p
2N1711	25p
2N2102	70p
2N2160	295p
2N2219A	25p
2N2222A	25p
2N2369A	17p
2N2484	25p
2N2646	40p
2N2905A	25p
2N2907A	25p
2N3053	25p
2N3054	55p
2N3055	35p
2N3442	140p
2N3553	240p
2N3702/3	10p
2N3704/5	12p
2N3706/7	10p
2N3773	200p
2N3819	20p
2N3823	30p
2N3866	90p
2N3904	15p
2N3906	16p
2N4037	65p
2N4124	27p
2N4126	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5062	35p
2N5087	27p
2N5089	27p
2N5172	27p
2N5192	75p
2N5245	40p
2N5401	50p
2N5457/8	30p
2N5459	30p
2N5460	60p
2N5485	36p
2N5875	250p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES

BY127	12p
BYX36300	20p
OA47	8p
OA90/91	9p
OA95	9p
DA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	5p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
S920	9p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	380p

PCB MOUNTING RELAYS

6 or 12V DC
Coil SPDT 2A
24DC 160p
6 or 12V DC
Coil DPDT 5A
24V DC
240V AC 200p
6 or 12V DC
Coil SPDT 10A
24V DC
240V AC 225p

OPTO ELECTRONICS

2N577	40p
OCP71	180p
DRP12	120p
ORP60	120p
ORP61	120p
TIL78	55p

OPTO ISOLATORS

ILD74	130p
MCT26	100p
MCS2400	190p
MOC3020	150p
ILQ74	240p
TIL11	70p
TIL12	70p
TIL13	70p
TIL116	70p

LEDs

0.125"
TIL32 55p
TIL209 Red 9p
TIL211 12p
TIL212 Ye 14p
TIL216 Red 18p
0.2"
TIL200 Red 10p
TIL222 Gr 12p
TIL228 Ye 14p
Rectangular LEDs (R,G.Y) 30p
NSB5881 570p
TIL311 600p
TIL312/3 110p

TIL321/2	130p
TIL330	140p
7750/60	200p

DISPLAYS

31015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	90p
FND507	90p
MAN3640	175p
MAN4640	200p

DRIVERS

9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

LOW PROFILE SOCKETS BY TI

8 pin	9p
14 pin	10p
16 pin	11p
18 pin	16p
20 pin	18p
22 pin	22p
24 pin	24p
28 pin	26p
40 pin	30p

WIRE WRAP SOCKETS BY TI

8pin	25p
14 pin	35p
16 pin	40p
18 pin	50p
20 pin	60p
22 pin	65p
24 pin	70p
28 pin	90p
40 pin	100p

VERO BOARDS

2.5" × 5"	95p
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3.75" × 3.75"	95p
Vero Block	410p
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3.75" × 17"	410p
4.75" × 7.9"	530p
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DIGITAST SWITCHES)xP
Push to make (R,G,B)15p
Push to break (Black) 10p
Slide Switch DPDT 10p
Square PCB Switch 65p

RUGBY ATOMIC CLOCK

This Z80 micro controlled clock/calender receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided.

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AS DESCRIBED IN JUNE/JULY/AUGUST ISSUE

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BBC COMPATIBLE DRIVES

These are drives with TEAC FD50 mechanism and are complete with power supply
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MICRO TIMER

The programmable clock/timer is a 6502 based dedicated micro computer with memory and 4 digit 7 segment displays to form an extremely versatile timing device with following features:

- 24 hour 7 day timer
- 4 completely independent switch outputs
- 6 digit 7 segment display output to indicate real time turn-off times and reset times
- Individual outputs to day of week, switch and status LEDs
- Data entry through a simple matrix pad

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EPROMmer For 6502-Based Computers

Ian Hickman

Originally designed to operate in conjunction with a UK101 computer, the HE EPROMmer can be made to work with any computer using the 6502 MPU. Full construction details, including the PCB, component overlay and the operating program listing, will be presented in the April '83 issue of HE. Part 1: The Circuit and How It Works.

OVER the last few years the cost of PROMs (Programmable ROMs), and particularly UV Erasable Programmable Read Only Memories, has dropped sharply, while single rail 5V types have largely displaced the earlier and less convenient three-rail types. For the budget conscious home constructor, the beauty of EPROMs is that if you get it wrong, the PROM can be 'wiped' and used again, unlike a fusible link PROM, where one "burns one's boats" the first time it is programmed. To erase an EPROM, one simply exposes it to short wavelength Ultra-Violet light from, for example, a 12in 8W uncoated fluorescent tube. The "black light" tubes sold for such purposes as demonstrating the fluorescence of various minerals or rock samples are not suitable for erasing PROMs, as they only emit longer wavelength, less harmful, ultra-violet light. The author purchased an EPROM Eraser replacement tube and found that this works perfectly in a 12V transistor fluorescent ballast which, at other times, is used as a tent light run from the car's cigar lighter socket when camping. The short wavelength UV radiation from the tube will completely erase an EPROM in twenty minutes or less, but on no account look at the tube when lit as the radiation is very bad for the eyes.

This EPROM Programmer is designed to program Ultra-Violet Erasable Programmable Read Only Memories, namely 2K by 8 EPROMs such as the 2716 and 2516, and 4K by 8 2732s. The author designed it to work with his Compukit UK101, but it should work equally well with any 6502-based personal computer. The EPROM Programmer contains a 25V power supply for the programming voltage V_{PP}, but draws the small current that it needs at +5V from the host computer.

It was decided before the design was commenced that operation should be simple. Thus, the only controls on the EPROM Programmer are two toggle switches; one selects 2716 or 2732 (16K or 32K) operation whilst the other selects Read or Program. Reading, programming and verifying are all carried out under the control of a "user friendly" operating system written in BASIC. The Programmer has been in use for many months now, and has proved extremely useful and completely reliable.

Circuit Design

To cope with 2716 and 2732 EPROMs, the circuit must be able to change the functions of pins 18, 20 and 21 of the PROM socket — all other pin designations for the two devices are identical. **Table 1** shows the functions of these three pins for the two different PROMS, and it can be seen that the logic level applied to pin 18 needs to be inverted for the 2732 (relative to the 2716) in the PROGRAM mode, but *not* in the READ mode. This can be achieved by using an EXOR (Exclusive OR) gate which inverts the signal to pin 18 only when +25V is applied to pin 20. How this is arranged will shortly become clear.

Figures 1 and **2** show the complete circuit of the HE EPROM Programmer. **Figure 1** shows the circuit board, with a 40 way DIL socket J1. This socket is connected by a 40 way jumper lead to the expansion socket of the host UK101 computer, though the EPROM Programmer does not use all of the signals available. Addresses A8 — 15 are decoded to define the position of the 6821 PIA (Peripheral Interface Adapter) in the UK101's memory map. With the connections shown, this is 32768. Addresses A0 and A1 are also used by the PIA directly, to provide access to Control Register A, Peripheral Register A, Control Register B or Peripheral Register B as appropriate. For those who have not used the 6821 PIA before, **Figure 3** shows its internal structure. RS0 and RS1 are connected to address lines A0 and A1 of the host computer's address bus and route the PIA's data bus (connected to the UK101's data bus) as shown in Table 2. When RS0,

TABLE 1

EPROM	PIN	READ	PROGRAM START	PROGRAM INHIBIT
2716	18	0	1	0
2732		0	0	1
2716	20	0	1	1
2732		0	+25V	+25V
2716	21	+5V	+25V	+25V
2732		A11	A11	A11
2716	IC5a	0	0	0
2732	PIN1	0	1	1

Two switches are used to change the logic functions according to the programming operation and the type of EPROM, as shown above.

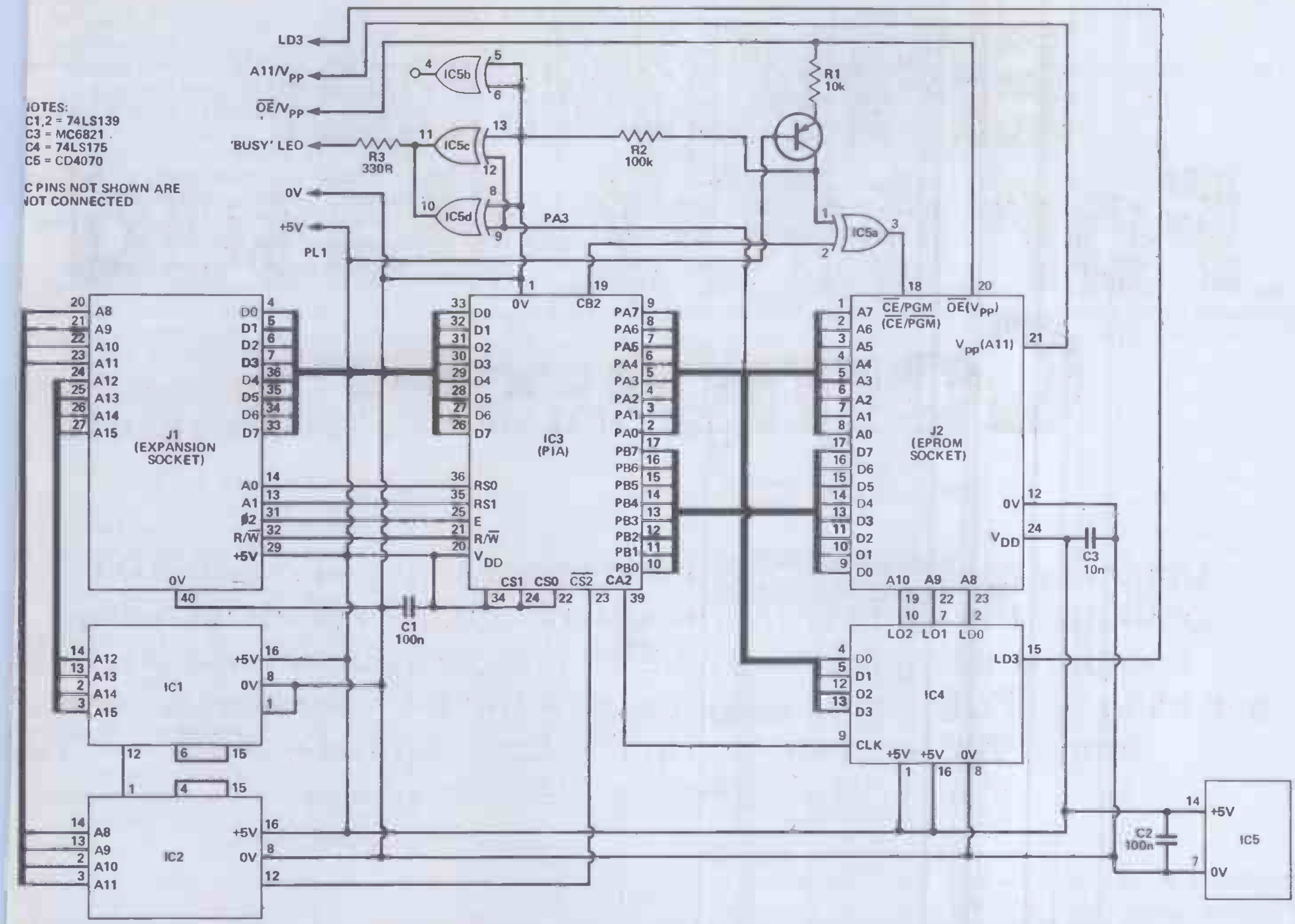


Figure 1. The main circuit board carries the sockets connecting to the host computer (J1) and to the EPROM (J2), the PIA (IC3) and its address decoders (ICs 1 and 2), plus the EPROM address latch (IC4). IC5 and Q1 are concerned with the EPROM pin functions; two spare gates are used to drive the 'Busy' LED.

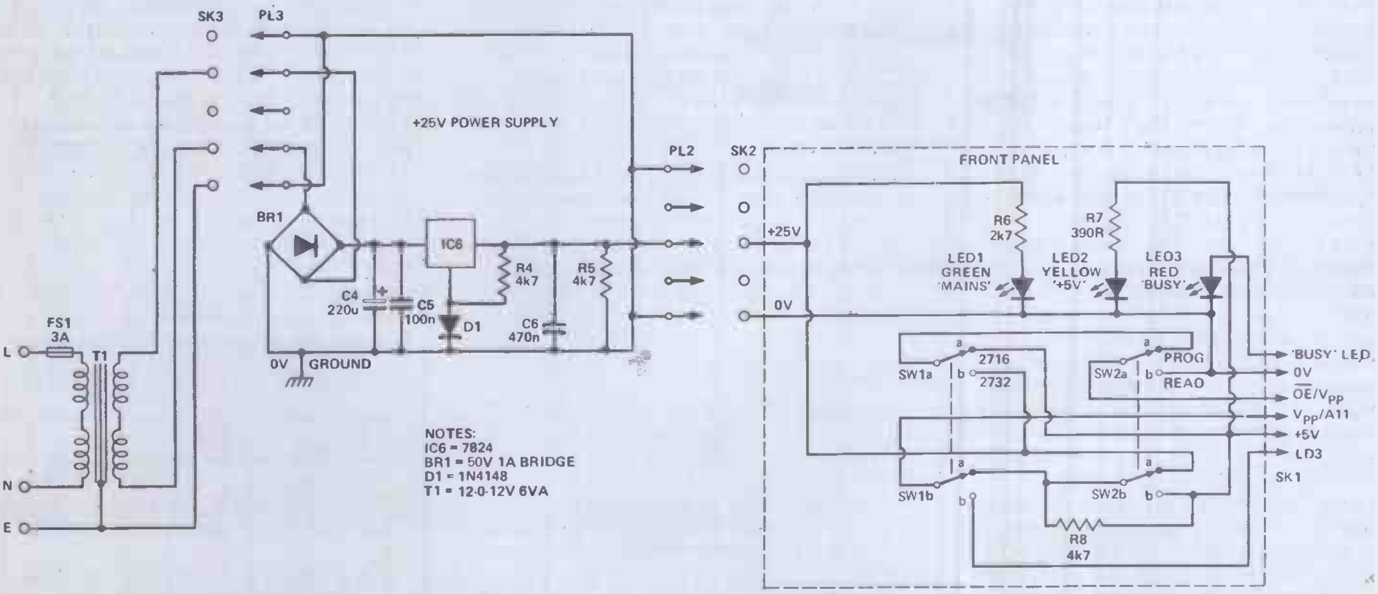


Figure 2. The power supply and pin function logic circuits are designed as separate modules.

RS1 = 1,0 respectively, access is provided to Control Register A. Then, writing a '0' in bit two of the eight bit Control Register A — CRA2 = 0 — provides access to Data Direction Register A (DDRA) if RS0, RS1 = 0,0. For each bit in DDRA which is then set to a '0', the corresponding bit in Peripheral Interface A (PA0 — 7) is set as an input, whilst a '1' sets it as an output. That is, RS0, RS1 = 0,0 accesses DDRA if CRA2 = 0, or Peripheral Interface A if CRA2 = 1. In the latter case, PA0 — 7 are all inputs if DDRA holds zero and are all outputs if DDRA holds 255. (The EPROM Programmer uses all eight lines, PA0 — 7, as all inputs or alternatively as all outputs, although under control of DDRA, any mixture of inputs and outputs can be set up).

TABLE 2

RS0	RS1	CRA2	CRB2	LOCATION SELECTED
1	0	X	X	CONTROL REGISTER A
0	0	0	X	DATA DIRECTION REGISTER A
0	0	1	X	PERIPHERAL DATA REGISTER A
1	1	X	X	CONTROL REGISTER B
0	1	X	0	DATA DIRECTION REGISTER B
0	1	X	1	PERIPHERAL DATA REGISTER B

The 6821 Register selection programming. Control signal RS1 selects either control Register A or B, while RS0 selects either the Data Direction Register or the Peripheral Data Register of the selected side.

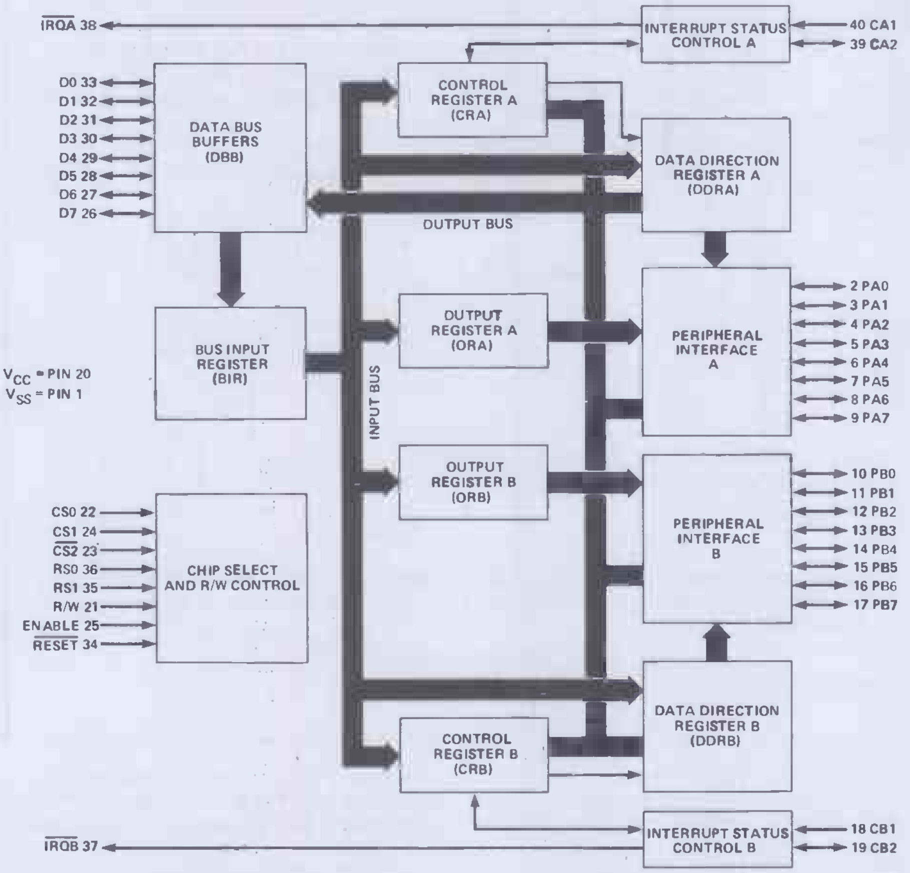


Figure 3. The internal architecture of the 6821 PIA. Not all the functions are used by the EPROMmer circuit!

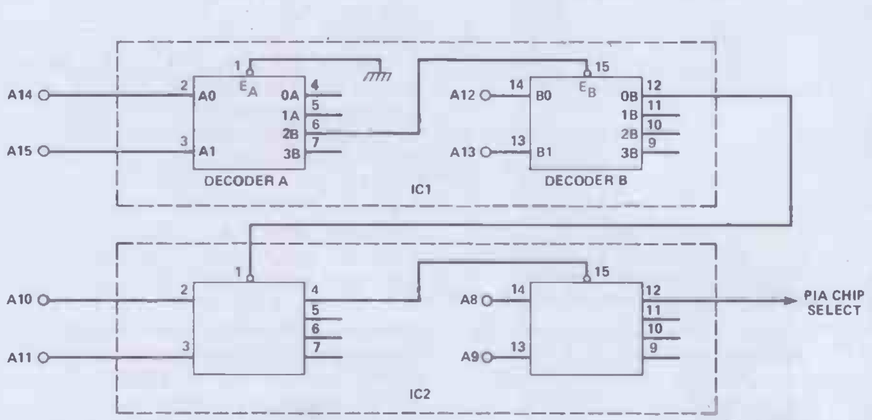


Figure 4. Detail showing the PIA address decoding circuitry. With the connections shown, this places the PIA at 32768, though other addresses can be arranged by selecting the appropriate outputs from each decoder section.

We do not use bits 0, 1, 6 or 7 of CRA, but in addition to bit 2 we also need bits 3, 4 and 5. These control line CA2, and we configure this as an output, which is set to a 0 or a 1 as appropriate by the BASIC operating system, as will be explained later.

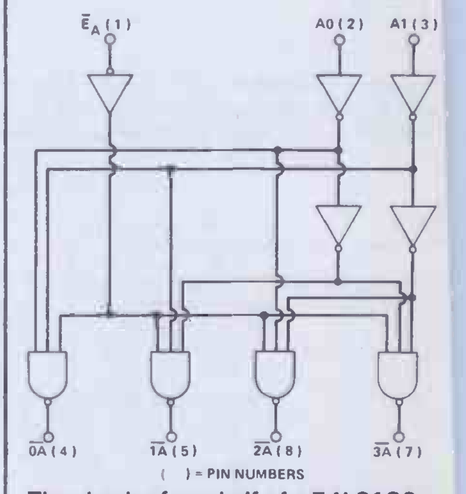
Similar comments apply to the B side of 6821, as shown in **Table 2**.

The arrangement of the 6821 thus provides access to a total of six registers whilst only occupying four consecutive memory addresses. The present circuit does not take advantage of this economy of address space since, for simplicity and economy, partial

Building Blocks

The 74LS139 is a dual 1-of-4 Decoder/Demultiplexer IC containing two independent decoders. Each decoder accepts two binary inputs and produces a single, unique active LOW output for each combination of inputs, as shown in the Truth Table. Each decoder has an active LOW ENable (E) input which forces all four outputs HIGH when it is taken HIGH itself.

In the EPROM Programmer, two 74LS139s are used to provide address decoding for the PIA as shown in **Figure 4**; when the correct address is presented on the host computer's address bus, pin 12 of IC2 goes low, ENabling the PIA.



The circuit of one half of a 74LS139.

INPUTS			OUTPUTS			
$\bar{E}$	A_0	A_1	$\bar{0}$	$\bar{1}$	$\bar{2}$	$\bar{3}$
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	H	L	H	L	H	H
L	L	H	H	H	L	H
L	H	H	H	H	H	L

H = HIGH VOLTAGE LEVEL
L = LOW VOLTAGE LEVEL

The Truth Table for the decoder; each combination of inputs produces a single unique output.

How It Works

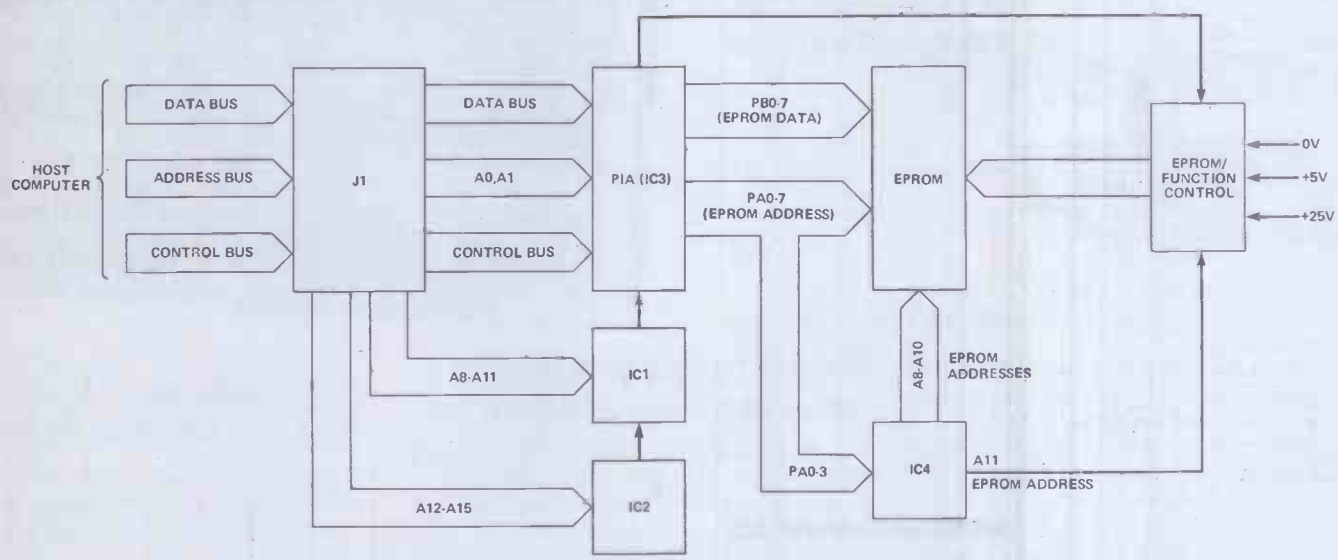
THE HEART of the Programmer circuit is the 6821 Peripheral Interface Adaptor (PIA). This contains two independent sets of DATA registers, PA0-7 and PB0-7, each controlled by separate control Registers CRA and CRB, plus a pair of Data Direction Registers DDRA and DDRB. Register PB is used to store the data to be programmed into the EPROM, while register PA is used to hold the address in the EPROM where the data is to be located. Both sets of information are transmitted via the host computer's *Data* Bus.

Thus storing a single byte of data requires two separate operations; first the EPROM address is sent to register PA, then the data to be stored in the EPROM at that address is sent to Register PB. These operations are carried out under the control of the operating software.

However, since only eight address bits are supplied, only 256 bytes of EPROM can be programmed, therefore it is necessary to increment the EPROM address after each block of 256 addresses. Before the low-order address bits are sent to Register PA, four address bits are first loaded into the four-bit latch IC4, and these are presented to the EPROM address bus at the same time as PA0-7 loads the low-order address into the EPROM. That is, programming one byte of data actually required three operations; first, EPROM addresses A8-A11 are latched into IC4; then address bits A0-A7 are presented via PA0-7, then the data is loaded via PB0-7.

Since the Programmer is designed to program both 2716 and 2732 EPROMs, which have some slightly different pin functions, the appropriate logic levels are derived from two switches and a small amount of control logic; the switching and logic circuit is described fully in the text and **Table 1**.

Finally, ICs 1 and 2, a pair of 1-of-4 line decoders, are used to ENable the PIA when the appropriate address appears on the host computer's address bus. Address lines A8-A15 are decoded by ICs 1 and 2 while A0 and A1 are applied directly to the PIA (see text and Building Blocks for further details). This system locates the PIA's Control and Data Direction Registers at 32768 — 32771. However, because address lines A2 — A7 are not decoded, the register's addresses also occur at the next four addresses, the four after that and so on.



address decoding is used. Address bits A0 and A1 are applied to the 6821 directly and, in conjunction with A8 to A15 decoded by IC1 and IC2, locate the PIA's four registers at 32768-32771. But as address bits A2 to A7 inclusive are not used, the PIA could equally well be addressed at the next four memory locations or the four after that and so on. This is satisfactory in the author's set-up as the 256 addresses following the PIA are unused, but the point must be borne in mind if you wish to relocate the PROM Programmer's PIA address, say to tuck it away in one of the odd spaces near the top of RAM.

Returning then to **Figure 1**, it can be seen that address lines 0 to 7 of the EPROM are driven by Peripheral Register A, PA0 — 7, of the PIA. Do not confuse the EPROM's address lines with the computer's address bus; the EPROM address is written into PA0 — 7 via the computer's *data* bus. The data bus also supplies the data to be stored in the EPROM, and this program data is held in Peripheral Register B, PB0 — 7, of the PIA. That would be the end of the story if the EPROM only held 256 bytes, but in fact it holds 2048 bytes (2716) or 4096 bytes (2732), so the eight address bits held in PA0 — 7 must be augmented by three or four more EPROM address lines. These extra address bits are held in four bit latch IC4. The latch inputs D1 — 4 are from the four low order outputs PA0 — 3 of Peripheral Register A; the appropriate address data is stored in Peripheral Register A and then latched in IC4 by momentarily taking PIA control output CA2 high. This extra operation only represents a tiny overhead as EPROM addresses A8 — 10 (or A8 — 11 in the case of the 2732) only need updating once for every 256 lower order addresses.

Having set up the complete EPROM address in latch IC4 and PA0 — 7 of the PIA, and with the corresponding data byte to be stored sitting in PB0 — 7, PIA control line CB2 is taken high for 50 mS. Provided V_{PP} is at +25V, this has the effect of "burning" the data into the EPROM at that address. If a 2732 is in course of being programmed, then +25V will be present at pin 20 of the PROM. This is detected by Q1, which places a '1' on pin 1 of EXOR gate IC5a, causing it to act as an inverter, as required (see **Table 1**). Under all other conditions (2732 read or verify, 2716 all operations), there will be a '0' at pin 1 of IC5a and the CB2 signal is therefore not inverted. This looks after pin 18's requirements, and the functions of pins 20 and 21 for the two types of PROM are sorted out by switches SW1 and SW2, again in accordance with Table 1.

Two of the spare EXOR gates have an input tied to PA3. Thus during reading, programming or verifying, as successive addresses are set up in Peripheral Register A, red LED1 will blink on and off, showing that it is "all happening"; PA3 was chosen as giving a suitable blink rate. A green LED driven from the +25V supply indicates that the mains supply to the EPROM Programmer is on, whilst a yellow LED powered from +5V indicates that the Programmer is indeed receiving this supply from the host computer. The +25V supply is actually more like +24V7 nominal, using as it does a 7824 regulator with the common leg propped up on a small signal silicon diode D2. **HE**

Sinclair ZX Spec

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

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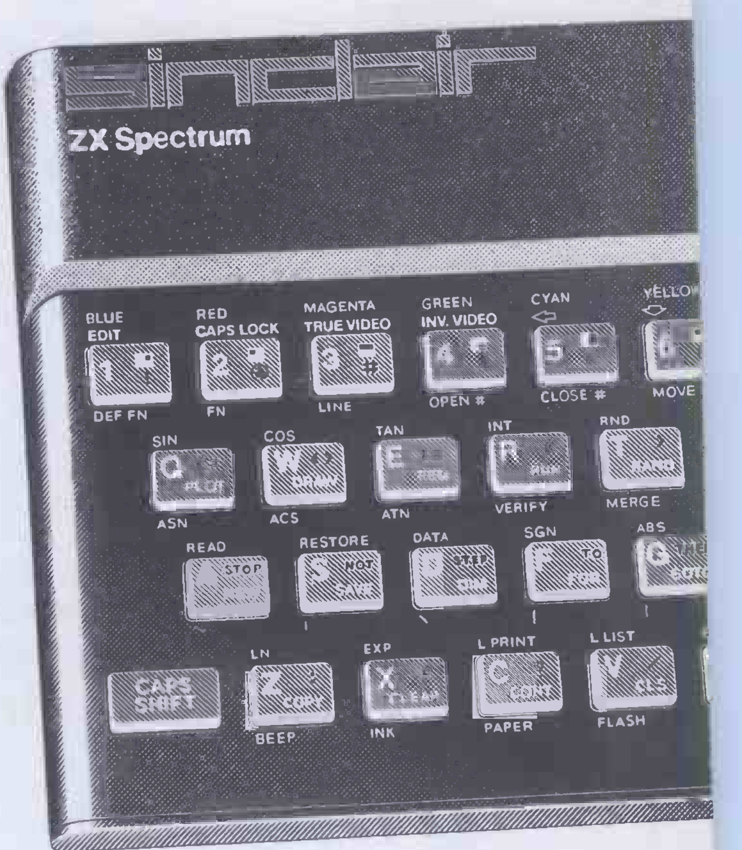


First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power– personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232/network interface board.

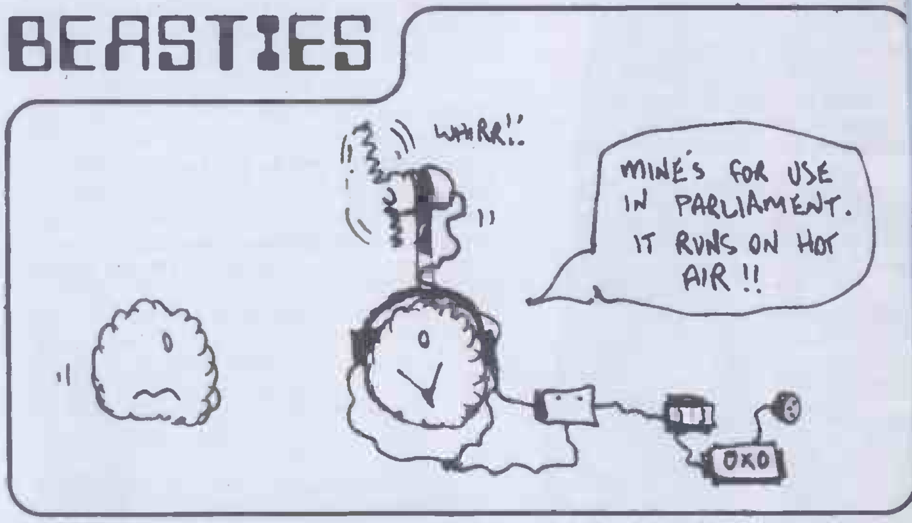
Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and bor plus flashing and brightness-inter control.
- Sound – BEEP command with vari pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – a keys at normal typewriter pitch, wi repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true hi resolution graphics.
- ASCII character set – with upper- a lower-case characters.
- Teletext-compatible – user softwar can generate 40 characters per lin or other settings.
- High speed LOAD & SAVE – 16K in 1 seconds via cassette, with VERIFY MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

POINTS OF VIEW

Feel like sounding off? Then write to the Editor stating your Point Of View!

BEASTIES



Gordon Channer Again!

Now, replies to a reader's query, from other readers:

Dear Sir,
With regard to Gordon Channer's letter (HE January '83) may I suggest he contacts Black Star Ltd., who advertise in ETI (they appear in Monitor and in our suppliers' surveys from time to time, too — Ed.). They stock a range of Crotech oscilloscopes, two of which may be operated from a 10V to 15V DC supply. I hope this information will be of use.
J.M. Oakley,
Ormskirk,
Lancs.

Thanks, J.M. — you've furthered the cause of hydro-electronics. (Anybody who doesn't understand that hasn't read their January HE properly — shame on you.)

Dear Sir (or Madam),
In answer to Gordon Channer's letter in HE January '82 about a 12VDC oscilloscope, the instrument he is looking for is obviously the superb instrument that was offered by ETI in their May '82 issue and the following couple of issues.
C. Williams,
Willenhall,
West Midlands.

This letter continued with various facetious comments concerning Clever Dick, Steven Spielberg, binders and the dotted lines on our survey sheet . . . all of which are being referred to the proper authorities, who will doubtless be round with rubber truncheons one evening quite soon. As for the query about whether ETI is actually extra-terrestrial, we can't reply to that one as we can't understand a word their editorial team says. Sorry!

Generating Some Curiosity

Dear Sir,
I have just read the 'Wireless Goes To War' article in HE January '83 and found it very interesting. Can I suggest that John Biggins writes about the wartime development of radio during World War Two, which should also make interesting reading.

The caption for Fig. 3 on page 56 states that the purpose of the 'fan (propellor)' is not known; I think the purpose is quite obvious. It is an air driven generator to provide power for the aeroplane's radio, to save the weight of battery power packs. What do other readers think?
C.M. Daw,
Flitwick,
Beds.

It's easy when you know how! We had one or two readers contact us about this propellor, and they all agree with you. Now, when will our modern electronics companies think of something similar for personal stereos? I'm sure we'd all be willing to walk a bit faster to avoid the frustration of batteries conking out in the middle of a loud bit!

Flash It Again, Please

Dear Sir,
Last year I built the circuit you published using two 555 timers and LEDs to make the 'Twinkling Star' tree decoration, and it worked perfectly. However, when I made the 'Christmas Tree Lights Flasher', neither of the 555 timers would work the relay specified. When put back into the 'Star' circuit they both functioned perfectly. Both circuits were powered by new PP3 batteries, which pulled the relay in when directly connected.
Could you offer any explanation for this, or should I boost the output of the 555 with a small transistor in order to power the relay?
Robin R. Davies,
Horley,
Surrey.

Uh oh. Deeply involved as you are in building this circuit, your description of it must seem to you all-embracing. Unfortunately, to us, with our miles of files and lengthy editorial history, it sounds pretty much like any of a dozen other circuits.

As a matter of general policy, please can you try to name the month and year of the Hobby you were working from when writing about circuits? If you send an SAE, you will get a personal reply; if you don't, you will eventually appear in POV; but if we can't work out what you're talking about, you may never get a reply which makes any sense! So please, gentle readers — name, rank and serial number when you're reporting projects for misconduct.

Ear Errata

Dear Sir,
May I point out what I think are a number of errors concerning the project 'Big Ear' in HE December '82.
1) Reference page 80 (Circuit Diagram): The volume control RV1 has the bottom end connected to OV. This would place a dead short across C5 and R6.
2) Reference page 81 (Component Layout): R2 is shown as going to Pin 2 of the IC1 (TL082). Circuit Diagram shows R2 going to Pin 3.
3) In the description of the Circuit (page 81) it is stated that "The input from the mic is fed to the non-inverting -ve input of IC1a", but the Circuit Diagram shows the input from mic to the +ve input of IC1a.
4) The article states that "The junction of the two resistors is bypassed to OV by C3", but the Circuit Diagram shows the bypass capacitor to be C5 at the junction of R3/R6.
A. Lord,
Southport,
Merseyside.

Dear Sir,
An electronics engineer has informed me that at least one error is present in the Circuit Diagram of the directional microphone published in HE December '82.
I would be grateful if you would send me a correct circuit diagram should the

statement be true. I have already purchased the components and am keen to complete the project.
P.E. Philpotts,
Brentwood,
Essex.

Well, notwithstanding what we say about feedback sometimes taking months to come through, where the errors are less subtle they come back to us pretty fast! Here are the errata from our own correction card:

a) Page 80, Fig 2: Junction of R6, C5 and RV4 should not go to 0V.

b) Page 81, Fig 3: R2 should go to pin 3 of IC1, not pin 2.

c) Page 81, Text: Input from mic is to non-inverting (+ve) input.

d) Page 81, Text: Junction R2, R3/R6 is bypassed to ground by C5, not C3.

A Bit Off The Beat

Dear Sir,
I have constructed the circuit board and components for the Metronome project in HE November '81. The accented beat is very unreliable. After a few seconds the 4017 IC breaks down and the accented beat is at random intervals. I have tried two fresh ICs, but the same fault develops after a couple of minutes. I have tried various voltages, and breakdown seems to occur soon after 7V. I am quite convinced that it is not a circuit fault.

Is it possible that there is an inate problem with the 4017 when the reset pin is connected to one of its output pins? I once used the 4017 as a divide-by-five counter, but eventually had to resort to other means because of its poor reliability. In any event my niece who was so looking forward to having the metronome is very disappointed.
C.A. Bearfield,
Sale,
Cheshire.

Unfortunately, there was more than one error in this project, so we can't correct it in a few words. Anyone who thinks or knows, that there is an error in a project they are building, send us an SAE. Mark your own envelope 'project errata' and we'll forward a correction sheet as a matter of priority. The only snag can be that some project problems are subtle and may not come to light for months after a project is published, so anyone writing for corrections too soon after publication may not find what they're looking for. It's safest to do what Mr. Bearfield has done: test out all the possibilities to see if it's a construction or a component fault, and then contact Hobby.

Faults in projects seem to be inevitable because Hobby projects are effectively production designs — they're being made up in multiple copies by different people with components from different sources in different places. Designs for commercial production can have months of strenuous testing under all sorts of conditions before they're released for cloning — if we did that, your Hobby would shoot up to about £3.00 a copy. So we rely on careful testing and — er — proofreading, and feedback from designers and readers, and cheer loudly when we get a design for publication that has been tested in the field for a year or two — not, alas, all that common, but nice if we can get it.

Heat But No Light

Dear Sir,
Some months ago you published an article on solar cells which I found very interesting. We are interested in using these solar panels to provide lighting in some of the bush missions and outstations. You mentioned one particular type of panel which appeared suitable. We would be very grateful if you could send us the name and address of the manufacturers and/or suppliers. We would also like to have an idea of the cost.

When we get your magazine (which is unfortunately very seldom) we find it very interesting and instructive. Keep up the good work.
Martin O'Neil,
Mansa,
Zambia,
Central Africa.

We have to admit that, unlike dear old England, you have no shortage of sun out there. The cells, unfortunately, might prove a problem. The cells we featured were at the time listed in the RS Components catalogue, but on checking, they no longer appear to be available. Can any reader or supplier help? If so, contact us at POV. Meanwhile, somebody had better get HE onto the Bush Telegraph double quick and make sure Mr. O'Neill gets our reply!

Seeking The Light

Dear Sir,
I am a student at East Ham College of Technology, studying my final year in a TEC Diploma Electrical Engineering course.

The class has been asked to carry out a full year project. I have therefore decided to make and research on the Light Dimmer featured in HE October '80.

Can you therefore please be kind enough to send me some information based on this project.
Ilyas Syed,
Forest Gate,
London E7.

I'm afraid we don't keep files of extra information on our projects — what we have is what we publish in the magazine. Of course, back issues are always obtainable through our back-numbers service (details in most Hobby issues — not this one, alas. Check out February or April. Cost is £1.25 per issue or article). Also, there are in London some very good libraries that have stocks of technical magazines going back many years which you can look at for reference, even if you don't live in the same local area. Try asking your local library for advice.

Microlog Mistake

Dear Sir,
HE Microlog (December '82).
Thank you for this excellent project which I am in the process of building. I think this is a good introduction into the world of analogue computing. With reference to Fig. 6, there appears to be a misprint. The top part of the secondary of T1 is taken straight to regulator IC3, instead of into the top part of BR1. Thanks for this great magazine and please keep up the good work.
H. Meidner,
Kensal Rise,
London NW10.

Yes, we caught that one, unfortunately, just too late to stop it from getting into print, but the correction was published in January's Hobby as part of Monitor, with the corrected diagram on page 72. Thank you for contacting us anyway — it might have been something no-one else had yet spotted. Just to recap, the top of T1 should go to the top of the diode bridge BR1, but not to IC1.

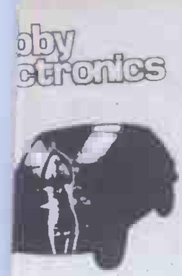
Might As Well Stay Home . . .

Dear Sir,
I read with interest both the letter from Mr. Gordon Channer (POV HE January '83) and the article 'Light and Power', both of which dealt with DC/AC inverters. I had already drafted out a letter to you on the same subject, now disposed of. I was going to state, and I do now, that I'm sure there are many people like myself who garage their car some distance from their home and would welcome such an inverter to enable them to use an electric drill, etc. That would mean something with a power capability of around 4-5000 watts. Perhaps your engineers can come up with something in the near future.

The other point I would like to raise, again for your engineers. What I would like to see is a project on a digital scoring device, like two seven segment displays that would retain their respective figures until they are updated, but only using one key-pad that could be switched (by a two-way switch) from one to the other. This could be used for many games like darts, cards, dominoes, etc.
A.W. Guy,
Forest Gate,
London E7.

As stated in the article on supplies, power in excess of around 200 watts is very difficult to realise, so it's unlikely that a more powerful supply will appear as a Hobby project, regrettably.

However, as for the scoring systems: we have something in mind, so watch this space! **HE**



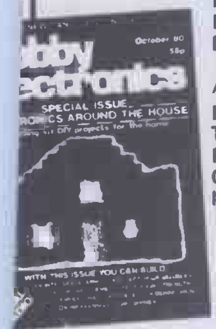
BACKNUMBERS

February 1980
Passion Meter, Win Indicator, Short Circuit Special, Kit Review Special, Into Electronics Construction Part 1.

May 1980
MiniClocks, 5080 Preamp, Model Railway Track Cleaner, 5080 Loudspeakers, Loudspeaker Crossover Design, Radio Controlled Model Survey.

June 1980
Microbe Radio Control System, Egg Timer, Two Watt Amplifier, Fog Horn, Short Circuits, LEDs and LED Displays.

July 1980
Sound-Operated Flash Trigger, 18 + 18 Car Stereo Booster, Hazard Flasher, Electronics in Photography, Electronic Espionage, Piezo Electricity.



August 1980
EquiTone Car Equaliser, Pass-The-Loop Game, Gaztec Gas Detector, OP-Amp Checker, In-Car Entertainment Survey, Introducing Microprocessors.

September 1980
MicroMixer, Reaction Tester, Guitar Phaser, Development Timer, Teletext Explained, Into Digital Electronics Part 1.

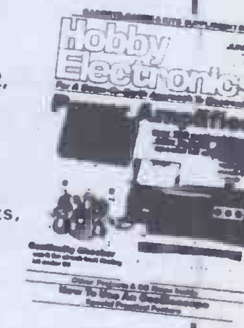
October 1980
Kitchen Timer, Tug 'o' War Game, Light Dimmer, Freezer Alarm, Intruder Alarm, Temperature-Controlled Soldering Iron.

January 1981
Car Rev-Counter, Bench Amplifier, Sound-Into-Light Converter, Chuffer, Electronic Games reviewed.

February 1981
Heartbeat Monitor, High-Impedance Voltmeter, Medium Wave Radio, Two-Tone Train Horn, Audio Signal Generator.

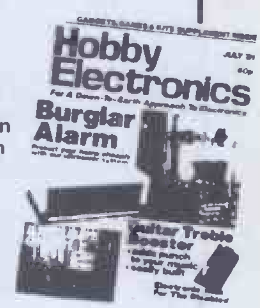
March 1981
Public Address Amplifier, Windscreen Wiper Controller, Bicycle Speedometer, Photographic Timer, Microcassettes.

April 1981
Pre-Amplifier Part 1, Super Siren, Guitar Tremolo, Russian Roulette Game, Doorbell Monitor, Anatomy of a Space Shuttle.



May 1981
Electronic Organ, Voice-Operated Switch, Infra-Red Controller, Pre-Amplifier Part 2, Audio Millivoltmeter.

June 1981
Power Amplifier Part 1, Continuity Checker, Envelope Generator, Early Radio, Gadgets, Games and Kits Supplement.



July 1981
Burglar Alarm, Doorbuzzer, Treble Booster, Electronic Aids for the Disabled, Power Amplifier Part 2.

August 1981
Electronic Ignition, Thermometer, Electronic Organ (final part), RPM Meter, Bench Power Supply, Radio Control Survey, Into Electronic Components Part 1.

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Pop Amps

Owen Bishop

Simple circuits based on operational amiplifiers

No 6: Linear Ohmmeter

BOTH of this month's Pop Amp circuits are concerned with the measurement of resistance. Like the previous circuits in this series, they are low-cost add-ons which give an inexpensive multimeter those extra facilities normally found only on the high grade models. You need only add a simple voltmeter or a multimeter switched to a DC voltage range.

Most multimeters include a circuit for measuring resistance; Usually it is powered by a cell hidden inside the case of the meter. This is wired in series with the coil of the meter and one of a set of standard resistors which can be switched into the circuit according to the range required (**Figure 1**). There are four snags to this arrangement: one is that the accuracy of the reading depends on the cell delivering the correct voltage. If it is not fresh, the reading is wrong. The second is that this circuit inevitably produces a non-linear reading. You will notice that the multimeter has a special scale for resistances; this is a non-linear scale with the lower gradations widely spaced and the higher values crowded toward the left-hand end. This highlights a third disadvantage which is that the scale reads from right to left, instead of the direction to which we are all more accustomed. Finally, there is the serious limitation that the amount of current flowing through a resistor of several megohms is usually far too small to be measured precisely with the kind of microammeter found in the average multimeter. Consequently, resistance in excess of about 1M ohms can not be measured with precision, if at all.

This circuit provides a linear reading, using the ordinary scale of a 10V voltmeter, and reads from left-to-right. Its accuracy is not affected by battery condition until the batteries are really worn out, and it gives equally precise readings on all ranges, up to 9M ohms.

Operating Amps

The op-amp is wired as a inverting amplifier, with the resistance which is to be measured (Rx, in **Figure 2**) as the feed-back resistor. The op-amp used in the prototype is a 7611 CMOS amplifier; the output of this device can swing fully between +9V and −9V, giving the maximum range of readings on one range setting.

The way the op-amp works as an inverting amplifier is explained for the benefit of readers who have missed earlier circuits in this series. The first point to note is that the amplifier has a balanced power supply of +9V and −9V, provided by the two batteries. The two inputs to the amplifier have extremely high impedance — 10^{12}ohms (one teraohm) — and for all practical purposes we can consider that no current can flow into these terminals.

The amplifier detects the potential of each input, and when they are equal, the output of the amplifier is OV. If the potential at the non-inverting input (positive) is greater than that at the inverting input (negative), the output swings to a positive voltage; if the positive input is less than that of the negative input, it swings negative. In this circuit, the positive input is wired directly to the OV line and all input voltages to the negative input are positive. Consequently the potential at the negative input is either equal to or greater than that of the positive input, so the outputs are OV or less. This is why the meter is connected with its negative terminal to the output of the amplifier and its positive terminal to the OV line; the output voltages are actually negative, but we read them as positive.

The positive input to the inverting input comes from a reference voltage source, which will be described in a moment. A current flows toward the input through a resistance, called the input resistance, RIN. In practice, this may be any one of a number of different resistances, each made up from a fixed resistor in series with a variable resistor, which can be switched into circuit. This allows changing the range of measurement. Because of the high input impedance referred to above, however, virtually no current can enter the inverting input, so the current flows along unchanged, through the test resistor, Rx to the output of the amplifier. Since this has swung to a negative voltage (for a positive input), the current flows *into* the amplifier's output.

RIN and Rx are in series and the same current flows through each, so they act as a potential divider. Think of it as a seesaw which turns around a point at a distance from its middle (**Figure 3**). The high end is at VIN (a positive voltage), and the low end is at VOUT (a negative

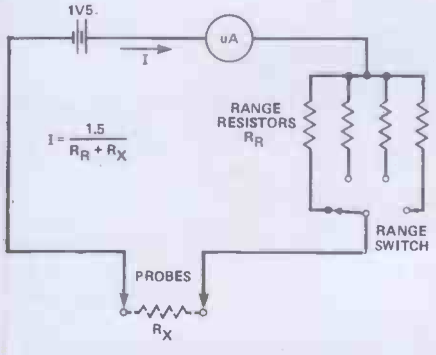


Figure 1. The resistance measuring circuit of a typical multimeter.

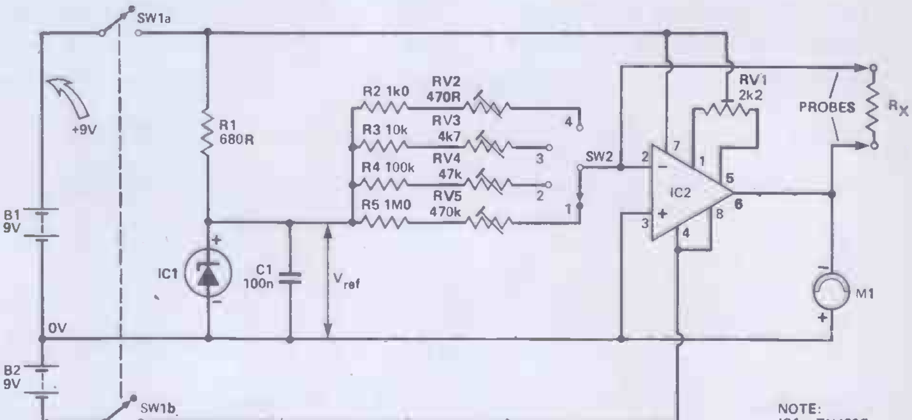


Figure 2. Figure 2. Circuit diagram of the Linear Ohmeter.

voltage), and somewhere between positive and negative there must be 0V. The amplifier adjusts VOUT until this 0V point is located exactly at the negative input, then both inputs are at 0V and the circuit becomes stable. In this condition, the voltage drop across RIN is VREF, so the current through RIN is I = VREF/RIN. Also the voltage across Rx is VOUT, so I = VOUT/Rx, and the same current, I, is flowing through both resistors, so VREF/RIN = VOUT/Rx. We already know VREF and RIN, and we can measure VOUT on the meter, so we can easily calculate Rx.

VREF is provided by a band gap reference IC (ICI) which acts in a way similar to a reverse-biased Zener diode but with much greater precision; the voltage across this is typically 1V26. If RIN is exactly 1V26R and the voltage across it is exactly 1V26, the current flowing through it is 1mA, and if Rx is exactly 9kR, it requires a voltage of 9V to make 1mA flow through it. In other words, with a 9kR resistor as the test resistor, VOUT swings to −9V, and remains there — the meter reads 9V.

If Rx is 8kR, then VOUT swings to −8V; the current through Rx is 1mA, as before, and the voltage at the negative input is 0V as before. Now the 'see-saw' is tilted less steeply, with its long arm only 8 times longer than the short one, and the meter reads 8V. The same happens for all other resistances up to 9kR; the meter reading in volts equals the resistance of Rx, in kilohms.

If we make RIN equal to 12k6, I is reduced to 100uA, so to obtain full-scale deflection of 9V, Rx must be 90k. Then the meter reading in volts equals the resistance of Rx in tens of kilohms. Table 4 shows the details of the four ranges which this circuit provides.

To obtain a 900R range we would need to make RIN equal to 126 ohms, and the current would be 10mA. The IC is not able to hold VREF steady when the current is as large as this. If you would like a lower range, make RIN 252 ohms, giving a full-scale reading equivalent to 1k8; take the scale reading, divide it by five and call it kilohms.

The only other part of the circuit which needs comment is the zero adjustment. The inputs of the amplifier behave as if there is a very small voltage difference between them, even if there is not, and when amplified, this small difference would appear as a significantly large reading on the meter. We compensate for this by setting RV1, as explained later.

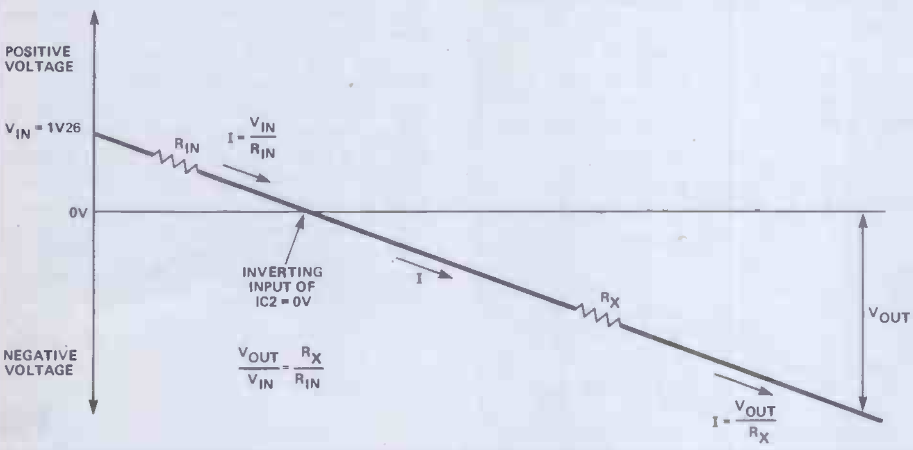


Figure 3. The voltage see-saw around an op-amp.

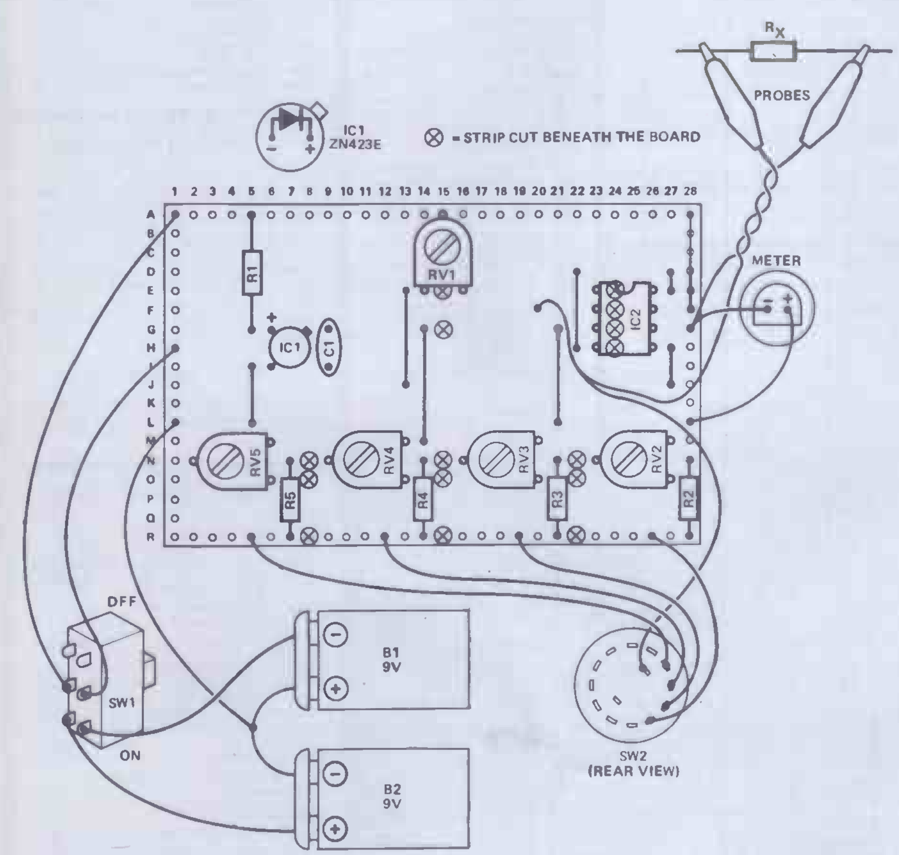


Figure 4. Component layout of the circuit board; note that the track cuts are shown viewed from the component side.

Construction

A board of the size recommended has room for four sets of fixed and preset resistors but you can leave out some of

Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1 . . . . 680R
R2 . . . . 1kR
R3 . . . . 10k
R4 . . . . 100k
R5 . . . . 1MR

POTENTIOMETERS
(All horizontal sub-miniature presets)
RV1 . . . . 2k2
RV2 . . . . 470R
RV3 . . . . 4k7
RV4 . . . . 47k
RV5 . . . . 470k

CAPACITORS
C1 . . . . 100n ceramic

SEMICONDUCTORS
IC1 . . . . ZN423 band-gap reference
IC1 . . . . 7611 CMOS op-amp

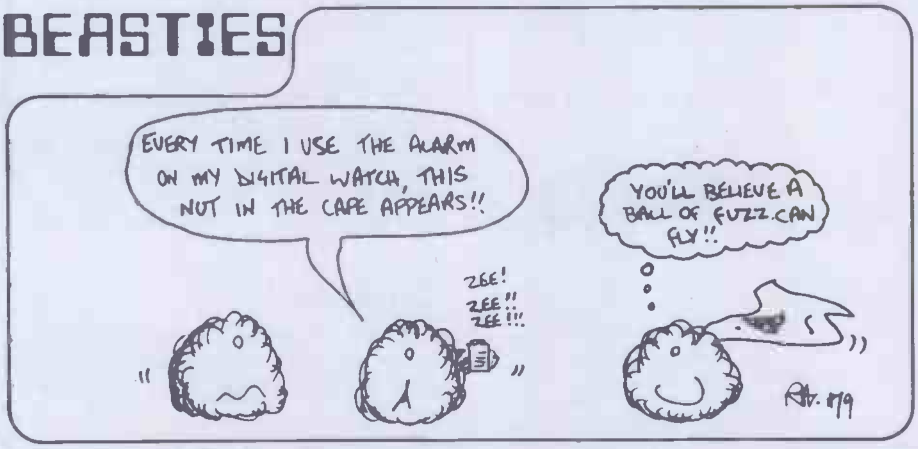
MISCELLANEOUS
SW1 . . . . DPDT toggle or slide
SW2 . . . . rotary single pole six-way
M1 . . . . 10V FSD
0.1" stripboard, 72 × 46mm (18 strips × 28 holes); 8-pin DIL socket; 9 × 1mm terminal pins; 2 × crocodile clips; case (optional); wire, solder etc.
Calibration resistors — see Buylines

BUYLINES . . . . page 34

Rin	R2-5	RV2-5	CURRENT	FULL SCALE
1k26	1kR	470R	1mA	9kR
12k6	10k	4k7	100uA	90k
126k	100k	47k	10uA	900k
1M26	1M	470k	1uA	9MR

Table 1

Table 1 shows the input resistance, the values of the input resistors and potentiometers which make up R_{IN}, the reference current I, and the full scale resistance reading for each range of the Linear Ohmeter.



these if you do not want all the ranges listed in **Table 1**. If you are unable to obtain a 2k2 preset for RV1, use a 4k7 preset instead.

Wire up the whole circuit before testing it; it can readily be powered by two PP3 batteries though you can use other types, or a mains power pack, if you prefer. Switch on the power and first check that ICI is working; the voltage across C1 should be close to 1V26.

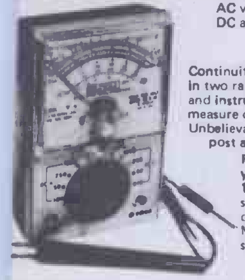
To make the offset null (set zero) adjustment, temporarily connect pins 2 and 3 of IC2 together, using a lead with crocodile clips, and adjust RV1 until the needle of the meter rests at OV. This operation requires patience, since the needle tends to swing violently to either side of zero, but it can be achieved with a little care. Then remove the connection between pins 2 and 3.

You will need a standard resistor to test each range; a 1% tolerance resistor is best. Choose a value which is near the upper end of the scale you are calibrating, attach the probe clips and select the range on SW2. Adjust the corresponding preset until the meter reading shows the value of the standard resistor; all other readings on that range will now be correct. When all the ranges have been calibrated, the circuit is ready for use.

HE

MINI-MULTI TESTER

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



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

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

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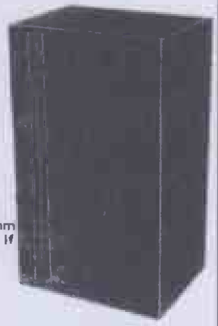

Made for an expensive Hi-Fi outfit – will suit any decor. Resonance free. Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacron. The completed unit is most pleasing. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.

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DITTO but for 8" speaker and 4" tweeter. £7.50 + £3.50.

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

50 THINGS YOU CAN MAKE

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

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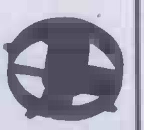

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Single wafer types, 29p each, as follows:

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6 pole 2 way	8 pole 3 way	12 pole 2 way

3 wafer types, 99p each,

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	12p 3 way	18p 2 way

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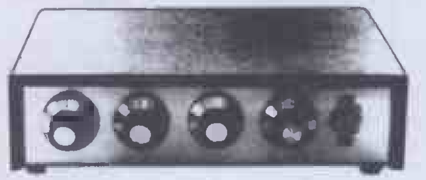
This is two kits. The 8 channel transmitter kit and the 8 channel receiver kit. Each kit comes with diagrams and notes, but no circuit boards, the component layout being left to you. The data shows how to drive, reverse and steer two or more motors. With spare channels to perform other functions. Price £9.50 for both kits.

3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested. Case & metal Chassis No. Fully punched and prepared.

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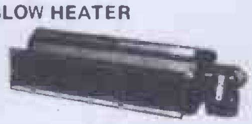

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In an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250 watt mains transformer, 40 amp bridge rectifier, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £12.50 + £3.00 post.

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	15 amp off/on	.20
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12 volt 1 amp	£1.00	12 - 0 - 12, 2 amp	£2.50
8.5 - 0 - 8.5 1 amp	£1.00	12 - 0 - 12, 1 amp	£2.00
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Mains motor with gear box	5 rev minute	£2.25
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Fan blade for above		.50
Mains motor, double ended, very powerful 1½" stack		£1.50
Mains instrument motors with gear box:	1 rev 24 hours	£1.50
	1 rev 1 hour	£1.50
	16 rev minute	£1.50
	4 rev minute	£1.50
	2 rev minute	£1.50
	1 rev minute	£1.50
Motor clockwork, set up to 1 hour		.38
Motor, clockwork set up to 1 hour with ringer		.75
Mains motor ¼ h.p. 1425 revs, ex-computer		£4.25
Vent opening motor with end stop switches		£12.50
12 volt motors, Smiths, single ended ¼" spindle		£1.50
12 volt motors, Smiths, double ended ¼" spindle		£2.00
12 volt motors, P magnet type, single ended		£1.75
1½ h.p. motor 3450 rpm 100 volt. 50Hz. New		£5.00

SPECIAL TERMS. For items in this column. Order no less than 10 of any item. Then add VAT at 15%, and 20% for carriage in the case of transformers and electric motors. All other items in this column are free post & packing.

BUYLINES

Pop Amps

We do not usually give sources of supply for the components used in these simple projects because they are generally easily available! This month though, there are several that are a little hard to get hold of. These are: the ZN423 precision voltage reference, the 7611 CMOS op-amp (used in the Linear Ohmeter, Pop Amps No.6) and the 334Z programmable current source used in the Low Range Ohmeter (Pop Amps No.7).

The calibration resistors for the Linear Ohmeter should ideally be 0.4 watt 1% tolerance metal film types, for best accuracy, and these are not stocked by every supplier either. The values required are 8k2, 82k, 820k and 8M2, though lower values in each range would do at a pinch. Fortunately, though, almost all of these components are stocked by **Rapid Electronics**.

Loudspeaker Protector

The difficult items in this project are the 1N5349B 12V/5W Zener diode and the TIP31C transistor; note that a TIP31A will not do, here! Also, the 12V PCB mounting relay and the 2k2 2.5W resistor may be somewhat hard to locate; a 5W resistor will do instead.

You may find all these at your local supplier or in your favourite catalogue but if not, try **Watford Electronics** or **MS Components**, who stock all the hard to find items. **MS Components** are at Zephyr House, Waring Street, West Norwood, London SE279LH, 'phone 01-670 4466.

Since the Protector circuits are designed to fit into the loudspeaker cabinets, cases are not required and the cost should be in the region of £6.00, excluding the price of the PCB.

CHECK LIST

RESISTORS
(All ¼ watt 5% unless noted)
1 x 47R; 1 x 2k2, 2.5W or greater; 2 x 47k; 2 x 100k; 3 x 470k; 1 x 220k; 1 x 2M2; 1 x 10M.
POTENTIOMETERS
1 x 20k miniature carbon trimpot.
CAPACITORS
1 x 1000u 25V axial electrolytic; 2 x 220n polyester.
SEMICONDUCTORS
1 x CD4050; 1 x TIP31C; 1 x 1N5349B; 4 x 1N4004; 4 x 1N914, 1N4148 etc.
MISCELLANEOUS
1 x 12VDC PCB relay; PCB, wire, solder etc.

Overvoltage Cut-Out

Once again, there are a couple of hard to get items; the 2N3904 transistor, which is however stocked by **Electro-Value**, and the 2N6403 SCR, which appears to be available only from **Ambit**. However, **Greenweld** stock a suitable substitute for the SCR (the C126M, rated at 12A and 400V PIV) and also the last awkward item, the OR47 5 watt resistor; thus they are a convienient source for all the components used in this project.

The cost of this project excluding the PCB should be about £3.50; a suitable two-part aluminium case can be had for around £1.00.

CHECK LIST

RESISTORS
(All ¼ watt 5% carbon unless noted)
1 x 2k2; 2 x 22k; 1 x 5k6; 1 x 2M2; 1 x 330R; 1 x 33OR; 1 x OR47 5W 10%.
CAPACITORS
1 x 10u 25V axial electrolytic.
SEMICONDUCTORS
1 x 2N3904; 1 x CA3140; 1 x 2N6403 or C126M; 1 x BZY88C6V8;
MISCELLANEOUS
Chassis mounting 20mm fuse holder; 20mm quickblow fuse, current rating as required; input and output terminal; optional case (as above); mounting fixings, PCB, wire, solder etc.

HE

Clever Dick

Still half full of Christmas Spirit, CD attempts to answer another motley selection of reader's letters.

Christmas comes but once a year . . . fortunately. Letters like this next one arrive more frequently, though.

Dear CD,
I am writing to ask you this question: what are the units of conductance?
If you cannot answer the question then I think that a binder would compensate me, don't you?
Yours hoping that you don't answer,
A. Sutton,
Rishton,
Lancs.
PS I'm trusting you not to consult a dictionary, nor to ask anybody else. Don't cheat!

Who needs a dictionary? The unit of conductance, as you seem to know already, is the 'mho'; that is, the inverse of resistance which is measured in 'ohms'. Get it? Good.

The author of the next letter receives the CD Bright Idea award . . . a very large raspberry.

Dear Clever Dick,
I think HE is fantastic, brilliant, clever etc. BUT your printers are chronic. Here is a solution (how about a binder?): rebuild all your projects after the designs have been mangled by the printer, ie build them from the finished article.
M. Cummings,
Chepstow,
Gwent.

Well . . . yes. It sounds like a good idea, in theory. Unfortunately, it just can't be.

First, though, any errors which occur in HE are certainly not the fault of our printers. We manage them ourselves, thank you very much! Second, the editor takes every precaution to catch errors in circuits or projects *before* the issue is sent to the printers. Last, your suggestion is impractical for the simple reason that it is far, far too late to correct errors which are found only after tens of thousands of copies of the magazine have been printed!

And if there was an award for Dumb Letter of the Month, this next one would win hands down . . .

Dear Clever Dick,
I was wondering if you could tell me whether or not it would be safe to wire a single-wired intercom, that is mains operated, through the earth of the mains socket?
Could you also please tell me where I could buy an Eagle LT700 transformer and the ZN414 silicon chip?
S. Williams,
Keighley,
West Yorks.
PS Is it true that the OC71 transistor is going out in place of the AC128?

Is this man winding me up?

On the basis of the information supplied, I can only reply — No! Better to be safe than sorry, you see. (I'm tempted to say "yes" but I do hate to lose readers!).

For the transformer, why don't you try Eagle International? Their address is: Precision Centre, Heather Park Drive, Wembley HA0 1SU. The telephone number is 01 902 8832. The ZN414 is widely available from most of the compenent suppliers advertising in Hobby Electronics . . . TK Electronics, for example.

As usual, the subject of my precious binders arises once more. Anybody would think I had thousands to spare!

Dear Clever Dick,
Would you mind telling me who I could send off to, and how much I would pay if I actually want to (wait for it . . .) BUY a HE binder!? It's all very well you sitting there with your pile of binders, carelessly discarding them in the direction of grovelling electronics enthusiasts when the whim takes you; how about telling us unfortunate and wretched beings how we can obtain these priceless gems to keep our equally priceless HEs in without grovelling to some anonymous "wit".
Incidentally, I've been buying HE regularly since February 1979 and I desperately need some binders — how about sending me one immediately (and free) so I don't have to bother to write off again?
P. Spring,
Bath,
Avon.
PS Notice the lack of scrounging, squirming, crawling, truckling, scraping and fawning (and any other nasty words of such like meaning) in this letter.

Of one thing I can assure you: my binders are never discarded "carelessly", or on a whim!

Astute readers may have noticed in last month's issue, that I have actually agreed (under considerable pressure, it must be said) to award one of my blue and gold masterpieces *free of charge* to any reader clever enough to fill out a subscription form for Hobby Electronics.

And now for something a little more exotic, to borrow a phrase.

Clever Dick Sir,
I am a guitar player in a rock group and would like to build a radio transmitter/receiver for use with my instrument, as I and many other guitarists are tied to our equipment by leads, cables etc.
Commercially I fear, those units are very expensive (hundreds of pounds) and I would be very pleased if you have any ideas or could put me in touch with anyone who has plans for such a project.
Finally, would I have to apply for a licence, as the range would only need to be approximately 100 ft?
E.C. Mountford,
Stone,
Staffs.

I felt this question required an expert answer, so I contacted Mr. Steve Stow of Martellow Sound Ltd., manufacturers of the popular 'Rello' range of radio mics.

First, a licence is required to operate any such system and will only be issued for Home Office approved equipment. This means it is most unlikely that you will ever see a radio mic system project.

Second, it is virtually impossible to design a guitar transmitter/receiver system at a reasonable price, that will satisfy all guitarists. Any inexpensive system must incorporate a limiter, making it unrealistic for those players who use a wide dynamic range (a system that did not use limiting would cost over £1000!).

However, Martello will shortly be releasing a new narrow-band system designed primarily for speech transmission. It will be shown at the annual APRS event in June '83 and will retail for approximately £299 plus VAT. Martello Sound will be able to supply individual modules at a slightly lower price to anyone who wishes to experiment. See you at the APRS?

I'm continually amazed by the poetic nature of some of my fans. Not so much by their poetry, though.

Dedicated to Seedy.

Being a nice sort of fellow
I'm sure you will oblige,
Now that I've forty issues
Down in a scruffy old drawer,
Eventually they're going to get torn,
Rendering them pretty messed up.

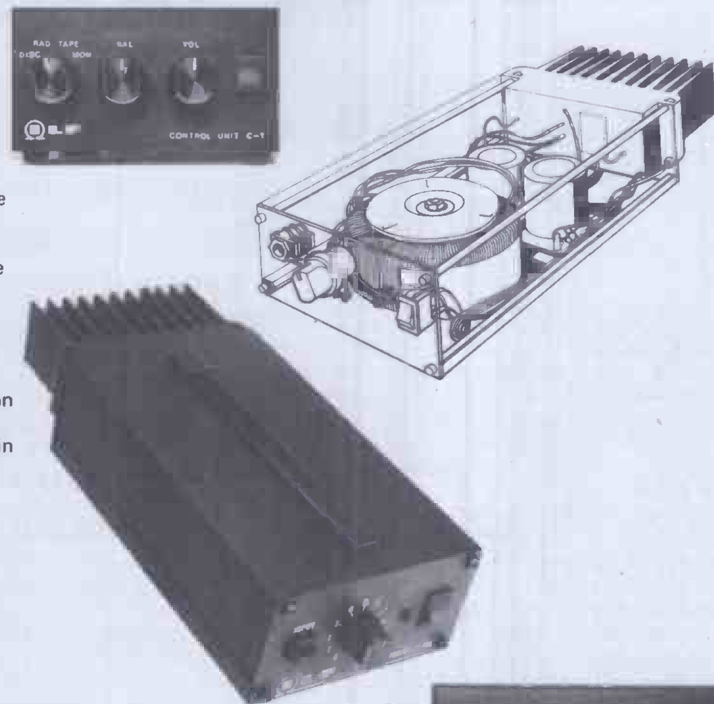
But you have just the cure,
If only you'll read from the top,
Next to the left hand side
Downwards towards the bottom,
Ending then starting again;
Read carefully and you will see
the perfect cure for me!

The Poet,
C/O S.A. Lilleyman,
Sale,
Cheshire.

I hate to be seen to encourage any more of this appalling stuff, but it *is* the cleverest letter of the month — not that that's saying very much. You win. The Binder is presently being despatched. HE

WITH A LOT OF HELP FROM ILP ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...



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Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

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Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (< 0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/ monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HIFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert 'O' in place of X for 110V, '1' In place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 Incorporate our own toroidal transformers.

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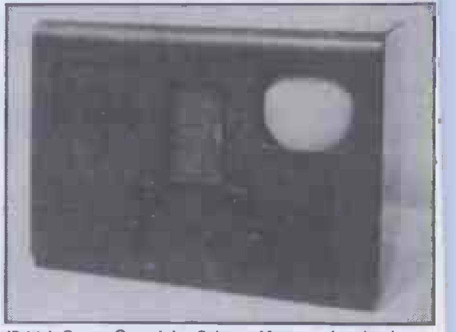
THE ELECTRONIC REVOLUTION: PICTURES FROM AFAR


(British Crown Copyright, Science Museum, London.)

John Biggins

A GREAT DEAL of the trouble with television in its early days stemmed from the fact that it came so close upon the heels of radio broadcasting. The first public-service wireless broadcasts took place in the USA late in 1920. Within ten years, the first regular mechanical-scan TV transmissions were being made and at the end of 1936, still a month short of the BBC's fourteenth birthday, the world witnessed the start of the first television service using the all-electronic system which is the direct ancestor of TV as we know it today. All in all, an astonishingly short time-scale when you consider how long it had taken public electricity supply, for instance, to get established in the mid-19th Century.

An amazingly rapid development perhaps, but it was also a remarkably difficult one when you compare it with the birth of sound broadcasting in the years immediately after the Great War. The trouble with television was quite simply that the idea existed long before anyone had much idea of how to put it into practice. With wireless broadcasting it had been the other way around, of course: the basic technology — radio telephony — had lain there virtually unnoticed for nearly two decades before the idea had dawned, some time in 1919, that there was enjoyment to be had (and perhaps money to be made) from using it to talk to a mass audience. But, once the idea of sound broadcasting was firmly established, about 1923, people naturally began to wonder why you couldn't broadcast pictures as well . . .

The problem was that in the early 1920s, no more than a tiny handful of visionaries around the world had even the remotest idea of how this was going to be put into practice. In fact, most of the Informed Opinion in the electronics world thought that if the transmission of moving pictures could be achieved at all (which was far from certain) it would take at least half a century to do it. The next fifteen years were to prove the doubters dramatically wrong, but only at the cost of one near-disastrous false start, great expense, and a legacy of bitterness and ill-feeling which was to plague television for years to come.

Early Days

The possibility of transmitting pictures electrically over long distances had been

The idea of transmitting pictures electrically over long distances had been around since the middle of the 19th Century, but it took nearly 100 years to develop the technology.

examined half-heartedly since the 1850s, when French experimenters had managed to pass a few slow, fuzzy reproductions of still pictures along telegraph wires. The idea never really caught on but it remains one of the curiosities of technological history that in the end, a reasonably fast and reliable system for telegraphing press photographs came into use in the early 1930s, only a couple of years before the start of the first high-definition TV service. In fact it was rather as if the steam engine had been invented only a few years before the aeroplane!

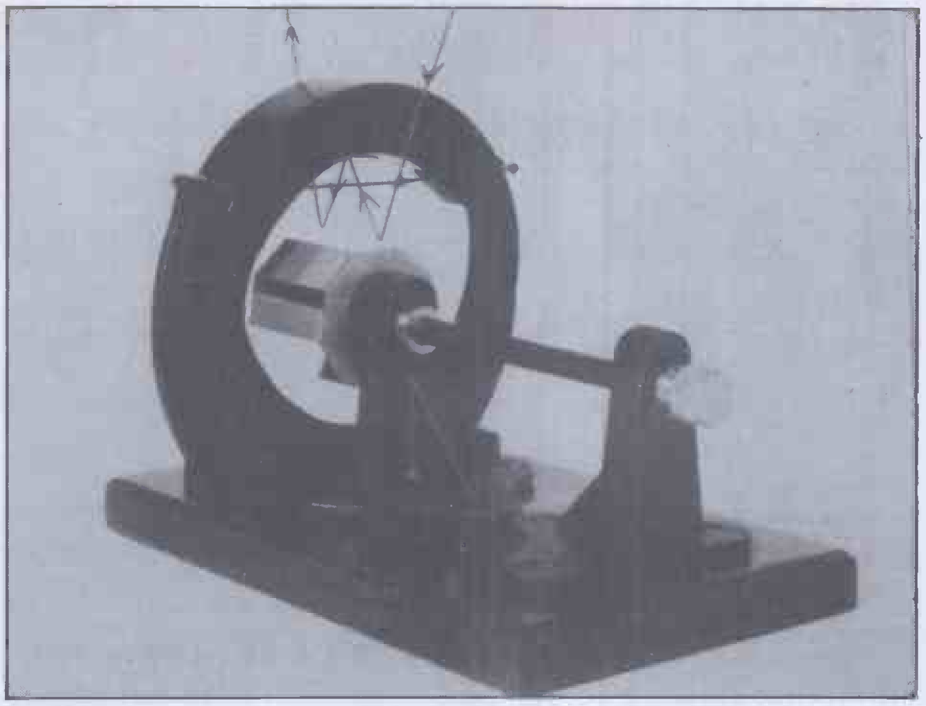
The idea of pictures-from-afar was given a major boost in 1873 with the discovery of selenium and its photoelectric properties. After a few years' research, though, this line of enquiry appeared to lead to nothing, as it was realised that the new substance was too slow in responding to light variations for it to be much use in transmitting a moving picture. In 1888 the German experimenter Nipkow achieved a major breakthrough (though it was scarcely recognised as such at the time) by cracking the problem of image dissection — how to break a picture down into separate elements capable of being transmitted over a single wire as a succession of electrical pulses. His solution was the Nipkow disc: a spinning disc with a series of holes spiralling inwards from the edge, so that as each successive hole passed between the subject and a photo-electric cell, the light reflected through the hole onto the cell would give an electrical analogue of the light/shade pattern on that part of the subject which the hole had just scanned. With this process reversed at the receiving end, a crude picture could be built up, with the number of lines corresponding to the number of holes in the disc. Although well ahead of its time — it had to wait for the invention of the valve as an effective current amplifier — this device was to form the basis of the first attempts at a working TV system.

Mechanical scanning, then, was the obvious starting-point when researchers began to think seriously about television — but it took a long time for them to begin thinking about it at all! Prior to the First World War, a few scientists had toyed with the idea as part of their researches into something else. Boris Rosing in Russia and A.A. Campbell-Swinton in Britain, for example, whose early work on cathode ray tubes had given them an inkling at least that they might one day be used in television systems, if only at the receiver-end. It is only in looking back on it, though, that we can see the beginnings of television, and in later years Campbell-Swinton used to become very annoyed when journalists described him as the 'Father of Television'. The Great War did nothing for TV, since its military value was far from clear. In fact, it set research back by a good few years when the Russian Revolution broke up Rosing's team of scientists at St. Petersburg. Then, when the War ended, attention was focussed for several years on the business of setting up sound-broadcasting in America and Europe. But as life returned to normal a few pre-War experimenters got working again.

John Logie Baird in Britain and C.F. Jenkins in the USA were pursuing the task of marrying the Nipkow scanning system to the valve-based radio transmitter, while an obscure Russian immigrant called V.K. Zworykin, an old pupil of Rosing's, was beavering away in the Westinghouse research laboratories in Pittsburg, developing the all-electronic iconoscope scanning system which was eventually to drive all before it.

Flying Spots

At the beginning of 1924 though, when Baird gave the first demonstrations of his TV system in London, it looked very much as if mechanical scanning systems would be the basis of all future work on television broadcasting. Baird's television camera in these demonstrations was really little more than an up-dating of Nipkow's apparatus. The main innovation was that the subject was scanned by a spot of light shone onto it through a Nipkow disc by a lamp mounted on the camera. The light reflected back — only a tiny percentage of that given out by the lamp — was focussed onto the photo-electric cell by lenses fitted over the successive holes in a *second* Nipkow disc, synchronised to spin with the first. The current given out by the cell modulated a medium-wave radio signal. The receiver, for its part, was a disarmingly simple contraption consisting of a neon light whose output was varied by the signal from the transmitter. It shone through another motor-driven Nipkow disc, synchronised with the camera, onto the back of a ground-glass screen. Given luck with synchronising the spin of the camera and receiver discs, the result was a postcard-sized picture made up of twenty-five curved, vertical strips of yellowish light and greyish shade in which those with a good imagination might discern the smudgy, distorted semblance of a human face or some similar-sized object.

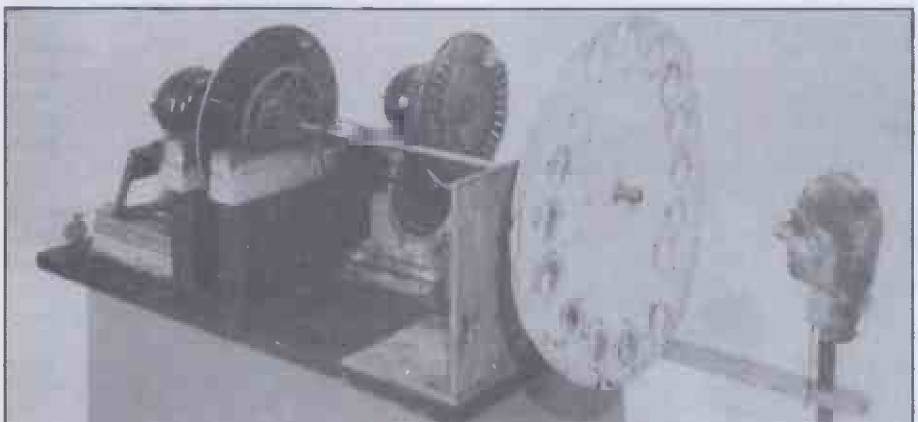


A Mihaly mirror-drum scanner, in use around 1929; the arrows show the path of the light.

(Photo. Science Museum, London.)

It was this rather unpromising system which Baird and his motley, quarrelsome crew of financial backers set out to perfect and sell to the British public during the years 1924-30. Before they could do so, however, they first had to win over the GPO and the BBC to the idea of a television service: the former so that it would grant the Baird Company a sizeable slice of the already-crowded MW band for experiments and the latter so that it would relax its statutory monopoly of broadcasting, lend a transmitter and eventually (it was hoped) take the new invention aboard as the BBC Television Service. Contrary to later legends, the Post Office and the BBC seem in fact to have been interested in the idea of television, and tolerably helpful despite the difficulty of negotiating with Baird (who was an outstandingly poor businessman) and his financial partners (some of whom were more than a little shady).

Demonstrations for the benefit of the GPO's engineers and then the BBC, in the autumn of 1928, seem to have given far from outstanding results even for an experimental system, and while the general verdict was that television was an idea well worth developing, the GPO thought that it would need to have a lot of work done on it before they could inconvenience radio users by giving it part of the medium-wave band for trial broadcasts. Baird's associates were furious and immediately began a press campaign, accusing the Post Office and "the BBC bureaucrats" of trying to strangle the new invention at birth. This lead to the Postmaster-General twisting the BBC's arm until it agreed to lend the Baird Company a transmitter at Brookman's Park in North London, for six months of the experiment, problems with the transmitter led to a typically British compromise whereby the vision and the sound were broadcast on alternate days! Once the service was working properly however, the BBC (who were producing the programmes) were quite adventurous about what they broadcast. In May 1930 they put out the world's first television play, Pirandello's "The Man With A Flower In His Mouth", undetered by the fact that the entire cast had to act seated around a four foot-wide table. In June 1931 the Derby was televised in the first outside broadcast, the Nipkow disc being replaced on this occasion by a rotating drum of mirrors, each angled slightly from the next. In the autumn of 1932 the BBC formed a television committee and agreed with the Baird Company to provide two programmes per week until the spring of 1934.



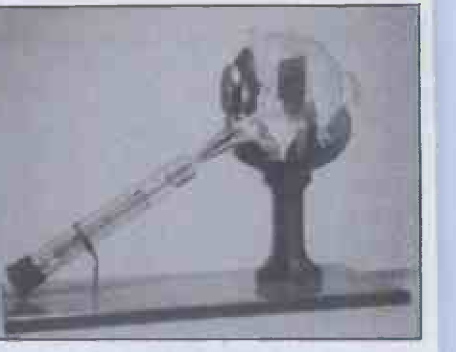
John Logie Baird's 1925 experimental TV camera.

(British Crown Copyright. Science Museum, London.)

Unfortunately public interest in the new service was minimal, however much of a stir TV demonstrations might cause on the stands at the Radiolympia exhibitions. Baird manufactured "televisors", at 25 guineas a time, to be on sale for the opening the experimental broadcasts but few of these were ever sold. Only thirty were known to exist when the broadcasts began in September 1929 and eighteen months later, only about 10,000 were in operation. True, most of these were home-built from kits of parts, since the receiver was simple enough for most radio amateurs to make for themselves. But as a public service, mechanical-scan TV failed to catch on, despite the fact that the Brookman's Park transmitter gave theoretical coverage over a large part of southern England. This was partly due to the fact, no doubt, that sound-broadcasting was only just becoming accepted as a regular public service. The main reason, certainly, was that the picture was simply not good enough.

Studio productions were very limited because the most the camera could take in was one or two people in head-and-shoulders close-up. Any larger scene or outside broadcast had to make use of the clumsy intermediate film process, which involved shooting it first with a conventional cine camera, developing the film and running it through a scanner a minute or so later. Those appearing in the studio had to be thickly painted with a coating of flat white and dead black make-up, so as

One of Baird's Televisors; the serial number on the bottom left corner of the cabinet reads "1936-647".
(British Crown Copyright. Science Museum, London.)



This exotic piece of glassware is an EMITRON camera tube, dating from 1935.
(Lent to the Science Museum by Electrical & Musical Industries Ltd.)

to get the maximum constrast from facial features. Then, sitting in the tiny blacked-out studio being scanned by a brilliant, flickering light was unpleasant for most people, and it was even said to trigger epileptic fits in some. Nor were the results particularly impressive when they arrived in the living-room: the screen was about 3in by 7in, the picture swayed up and down the whole time, it smeared and it often lost sync and dissolved into a rushing smudge of light and shade. Even when the picture was received at its best, viewers said that it compared unfavourably with the early cine-films. All in all it was something people might watch out of interest but scarcely something they would pay to watch for pleasure!

The End of the Beginning

Baird tinkered with the system for three years in an effort to achieve acceptable definition and screen-size, but the mechanics and the electrics were both against him. A larger screen meant a larger scanning disc; a larger scanning disc had to spin faster and this inevitably led to loss of synchronisation and smearing of the picture, as the photo-electric cell found itself unable to keep up with the changing light values. In any case, better definition would have meant taking up an even larger slice of the MW band. Baird was a formidably stubborn man and his backers tended to blame the BBC for not trying hard enough to make mechanical TV work. But there were other opinions to be considered: wireless-users were complaining about interference from the TV transmissions and, in the USA and Germany, RCA and Deutsche Rundfunk (using the Mihaly-Traub system) were preparing to abandon their own TV experiments at the end of 1932 as a waste of time and money. Early in 1933, then, the BBC announced to the Baird Company that it would end the broadcasts from Brookman's Park in September 1935.

While all this was going on, Zworykin had been at work in the United States, first for Westinghouse and later for the Westinghouse associate RCA. He had taken out a patent on his iconoscope TV camera as early as 1923, but it was not until 1931 that he and his growing research team had developed it to a point where its picture could be compared with mechanical-scan television. The principle of the iconoscope was that an electron beam was fired obliquely at a metal-mosaic plate, being electromagnetically deflected in the process to scan back and forth across the plate from top to bottom. The camera lens focussed the image onto the plate and as the electron beam traversed, it created a succession of tiny electron discharges corresponding to the light and shade of the image; these were amplified to modulate a VHF signal. Secondary emission of electrons was a serious problem, at first, and the haloes which it caused around the brighter parts of the picture were so persistent that at one point, late in 1932, RCA was preparing to give up its experiments with all-electronic TV and go back to mechanical scanning. But the problem was gradually overcome during the early months of 1933 to the extent that by mid-year Baird — who had once confidently said that "there is no hope for television by means of cathode ray tubes" — was sufficiently alarmed to begin his own experiments with electronic TV, borrowing the American inventor Philo T. Farnsworth's image-dissector tube (a primitive cathode-ray device) for the purpose.

Part of Baird's alarm was caused, no doubt, by the talks which were in progress between the BBC and RCA's British sister-company, EMI, following a very promising demonstration of electronic-scan TV in April 1933. The BBC was determined to try the new system in an experimental public service, but the newspapers were beating the patriotic drum about American competition with the all-British Baird system. Baird's supporters, like the journalist Sydney Moseley, had always believed that the BBC was operating a vendetta against the Company, and they had sufficient influence in Parliament and Fleet Street for the Postmaster-General to be wary of doing anything which might lead to accusations that the Government had killed off Baird's Television by favouring foreigners. The result was that, however much the BBC might be impressed by the superiority of the EMI system over Baird's, it had to allow some sort of comparison when the Corporation's television service began broadcasts on 2 November 1936.

"String and Sticky Tape"

The arrangement was that each company's system would be used in alternate weeks: the EMI 405-line, 50-scan per second transmissions going out from the Alexandra Palace in North London and the Baird 240-line, 25-scan broadcasts from Crystal Palace on the other side of town. In the event, though, it was hardly much of a competition. The Baird pictures, put out by a hastily-assembled jumble of mirror-drums, image-dissectors and intermediate filming, were so patently inferior to those from the EMI cameras that it hardly needed the bad luck of the Crystal Palace fire to bring about the Baird system's demise after only three months, in February 1937. From then on, electronic scanning was to rule the world's television systems, with only minor changes like the introduction of orthicon cameras in the late 1940s and the European switch to 625 lines in the mid-1960s.

The technical argument was over, but television took many years to live down the collapse of mechanical scanning and the bitter quarrels which followed. Development was slow during the years 1936-39, both in Britain and in the USA. In fact, by the time the Alexandra Palace transmitter was closed down abruptly at the end of a Mickey Mouse film on the morning of 1st September 1939 (it was feared that the Luftwaffe would use it as a navigation beacon), the number of sets in use had barely reached 20,000. Transmissions went out for a mere twenty hours per week and they could only be picked up within a radius of about 25 miles from Alexandra Palace. True, sets had got markedly cheaper over the three years — from around 95 guineas to 21 guineas for some of the most basic models — and they had also become noticeably less bulky, as improvements were made to the large iron-cored transformers needed to provide the 2,5000 volt anode potential. But 21 guineas was still 3-4 weeks' wages for a skilled workman in 1939 and, in any case, people were extremely reluctant to invest such a large sum in a set which might well end up as a useless relic like the 1930 televisors, if the BBC decided to abandon TV at some future date. Television excited little public interest in the last years of peace, either here or in the States, where NBC began regular broadcasts only in February 1939.

Radio was still the dominant medium and TV was regarded as a faintly crankish and unreliable experiment for years, even after it became a regular service. Indeed, there have been some historians in recent years who have said that much of the British Government's interest in television around 1936 arose from the fact that the Air Ministry needed a cover-story to explain the mass production of cathode ray tubes for use in the chain of top-secret radar stations which it was building along the South Coast!

Not a prototype Dalek, but an early EMI TV camera.

(British Crown Copyright. Science Museum, London.)

The War put paid to television services the world over. The USA's embryonic TV network was closed down by order from Washington early in 1942, to free tube-manufacturing capacity for the Navy and, by the end of 1943, the German experimental transmitters had been bombed out of existence — though for some mysterious reason the Wehrmacht was tinkering with transmissions from the Eiffel Tower right up to the liberation of Paris in 1944. The story of television begins once more on 7th June 1946, the day before the Victory Parade, when the BBC resumed television broadcasts from the Alexandra Palace. TV was back on the air, but it was there only as a rather threadbare version of the pre-War service. The number of sets in use had actually gone down as a result of the Blitz, and new manufacture was a very fitful affair as the electronics industry readjusted to peace. A few skilled enthusiasts managed to build their own sets from surplus radar equipment, but for most people a TV set was an undreamed-of luxury item; the climate of Austerity Britain was not at all favourable to expensive new services like television. It was not until 1949 that the BBC got its second TV transmitter, at Sutton Coldfield, and during 1950 set manufacture stopped altogether because of the Korean War. The actor's unions and the theatre managers were hostile while BBC radio broadcasting was reluctant to share its immense wartime prestige with this upstart newcomer.

A pre-war (1938) EKCO TV receiver; the size of the screen can be judged against the operating knobs!

(British Crown Copyright. Science Museum, London.)

Towards the Future

In spite of all these difficulties, television was busy preparing itself for its great take-off in the mid-1950s. The production teams were rapidly learning their new trade in the dingy, cluttered studios of the Ally Pally and the realisation slowly dawned, even on the BBC management, that television was a completely separate medium from radio: a process of education which was greatly helped by a disastrous attempt to put on Tommy Handley's "ITMA" programme as a simultaneous TV and radio broadcast. Scriptwriters began to cater exclusively for television and the first "personalities" began to emerge at the beginning of the 1950s: people like Gilbert Harding and MacDonald Hobley and Philip Harben. Sets were still expensive, though, and — worse than that — the populace at large still regarded TV as a slightly suspect plaything for the rich. It needed some major event to force TV in to the public consciousness.

That event came with the Coronation in June, 1953. Unlike the earlier Coronation in 1938, the BBC was allowed to televise the whole ceremony, including the scene inside Westminster Abbey. Large numbers of sets were hired for the occasion by people who would normally no more have thought of acquiring a TV set than a Rolls Royce. In the event, the whole proceeding turned out to be such an impressive spectacle that few of the sets went back to the showrooms afterwards. The number of licences had risen to two and a half million by the end of the year and, from then on, the television era had really arrived, both in Britain and in the United States where the three major networks CBS, NBC and ABC were soon able to parcel out the national TV audience among themselves much as they had shared out wireless broadcasting in the 1930s.

A Bush model TV22 9" television set from 1950; millions of viewers watched the 1953 Coronation on sets such as this.

(Photo, Science Museum, London.)

Technical improvements were few after 1950. The size and weight of sets were reduced still further as transformers were made more compact and scanning angles were increased to allow a wider screen for a given length of tube, eventually doing away with the early solution of mounting the tube vertically and placing an angled enlarging mirror over the top of it. At the studio end, the orthicon camera replaced the iconoscope and the zoom lens replaced the earlier four-lens turret, which made it necessary to cut from one camera to the other while changing focus. Video recording arrived in 1956, live satellite relay in 1962 and colour TV at the end of the 1960s. With these developments television came to cover the whole Earth and the last stimuli to the imagination were removed. TV's direct influence on the world has been small in comparison with radio's. But the era of cable, satellite, home video and high-definition digital TV can only confirm it in its undisputed position as the world's most popular pastime. **HE**

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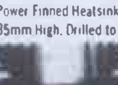

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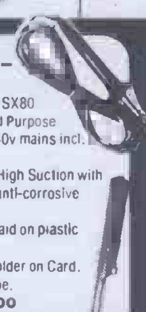

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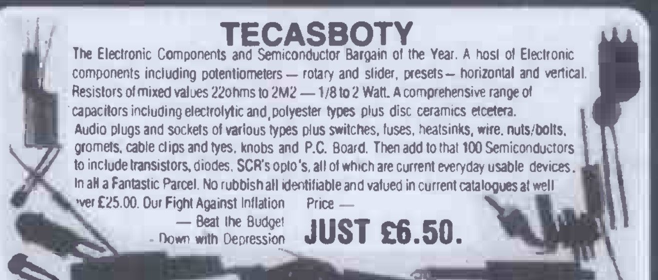

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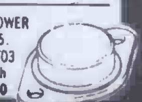

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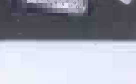

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No. 7: Low Range Ohmmeter

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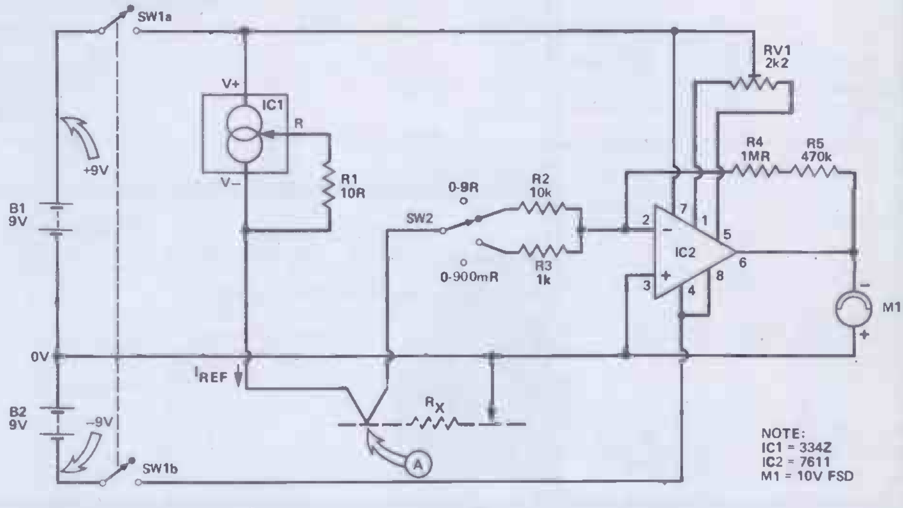

Figure 1. The Pop-Amp No. 7 circuit, a Low Range Ohmmeter.

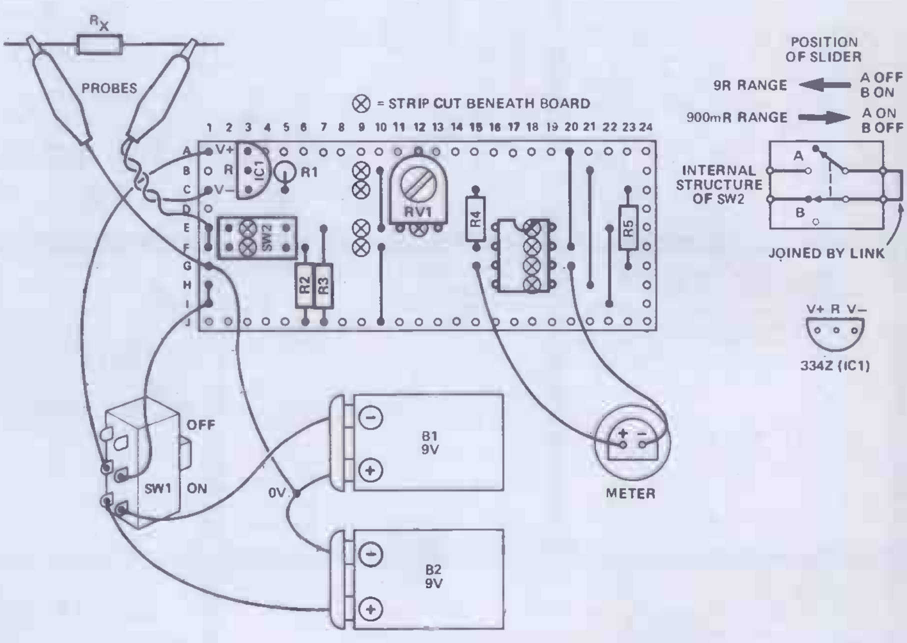

Figure 2. The stripboard component overlay, showing track cuts viewed from the top.

Low Class Circuits

As in the previous circuit, the op-amp is wired as an inverting amplifier. The amplifier works in the same way as in that project, but the input to it is derived in a slightly different way. The principle is that a known current is made to flow through the unknown resistance, Rx, and the amplifier is used to measure the voltage developed across Rx. Since RX is very low, the voltage is very low too, but this is amplified to give a voltage which is measurable by an ordinary voltmeter.

The constant current is derived from ICI, which is a programmable constant current generator. Provided that the voltage across ICI exceeds about 1V5, the current flowing from ICI remains unchanged no matter what the operating voltage may be; this means that the current is independent of the freshness of the battery. The IC is programmed by the value of R1. With R1 = 10R as in **Figure 1**, the constant current is 6m77A at 25°C. It varies in proportion to the absolute temperature but, unless you are likely to be using the circuit at sub-zero temperatures, this results in an error of less than 1% in the readings.

Suppose that Rx has the value 9R; the voltage developed across it is $9 \times 6.77 \times 10^3$ = 60m93V. If the voltage at point 'A' is 60m93V, the current flowing through R2 is 6u093A. Note that the measuring circuit draws less than a ten thousandth of the current coming from the current generator, making virtually no difference to the voltage across Rx. This current flows on through R4 and R5. Since R4 and R5 have a combined resistance 1M47, the voltage at the output must fall to $6.093 \times 10^6 \times 1.47 \times 10^6$ = 8V96.

When Rx is 9R, the meter reads 8V96, so the meter reading, in volts, is approximately equal to the resistance in ohms. To give a more precise reading it would be necessary to substitute an

Parts List

RESISTORS
(All 0.4 watt 1% metal film, unless noted)

R1	1OR OW25 5% carbon
R2	10k
R3	1k
R4	1MR
R5	470k

POTENTIOMETERS

RV1	2k2 horizontal sub-min preset

SEMICONDUCTORS

IC1	334Z programmable constant current source
IC2	7611 CMOS op-amp

MISCELLANEOUS

SW1	DPDT toggle or slide switch
SW2	SPDT toggle or slide
M1	10V FSD meter

Stripboard, 27 × 63mm (24 holes × 10 strips); 8-pin DIL socket (IC2); 7 × 1mm terminal pins; 2 × crocodile probe clips; connecting wire, solder etc. Optional case.

BUYLINES . . . . page 34

8.2 resistor and 4k7 preset for R2, but in this application it is probably not worth while.

On the other scale, which covers 0 to 900R, the voltage across Rx has a maximum value of 6m093V, which is a tenth of the maximum of the 0 to 10R range. This means that amplification must be ten times greater, so R3 has the value 1kR range. This means that amplification must be ten times greater, so R3 has the value 1kR. Then a full scale reading of 9V corresponds to a resistance of 900mR.

You will have noted in **Figure 1** that there are two wires going to point 'A'; this is to allow for a possible error due to the probe lead resistance. One wire delivers current *direct* to point 'A' — the whole current goes to this point. The other wire makes a direct connection between point 'A' and the voltage measuring circuit and the current in this lead is so small that the resistance of the wire causes negligible voltage drop at the IC.

As explained in Pop Amps No. 6, an op-amp may deliver an appreciable output voltage even when its inputs are at equal potential. This 'offset voltage' is compensated by adjusting the setting of RV1.

Construction

The circuit fits easily onto the smallest standard size of Veroboard, though you may want to use a larger board if you intend to fit trimmer presets for the two resistance ranges. The circuit requires so little current that it can be powered by two PP3 batteries. Note that the terminals of RV1 have to be slightly bent out of alignment in order to fit it into a convenient place on the board.

Complete the circuit before testing it, then clip the two probe wires together and switch on the power. The inputs of the op-amp are then joined together so they are at the same potential and the output should be zero; if not, adjust the setting of RV1 until the needle of the meter rests at OV. Unless you have decided to fit trimmer presets, no further adjustments are necessary. Clip the probes to a known resistance in the 0 to 10R range, and select the range using SW2. The voltmeter should indicate the resistance. Use two or more 1R resistors wired in parallel for testing the lower range.

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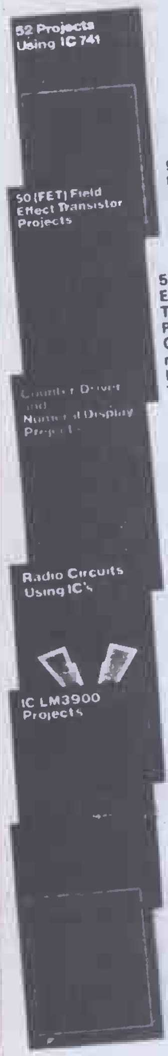

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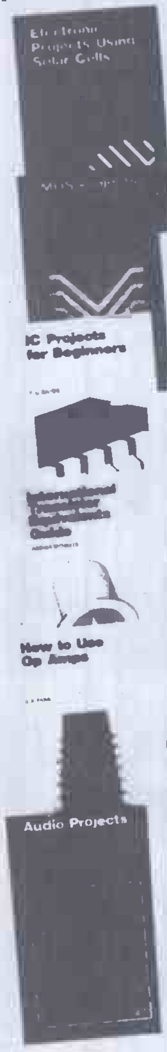

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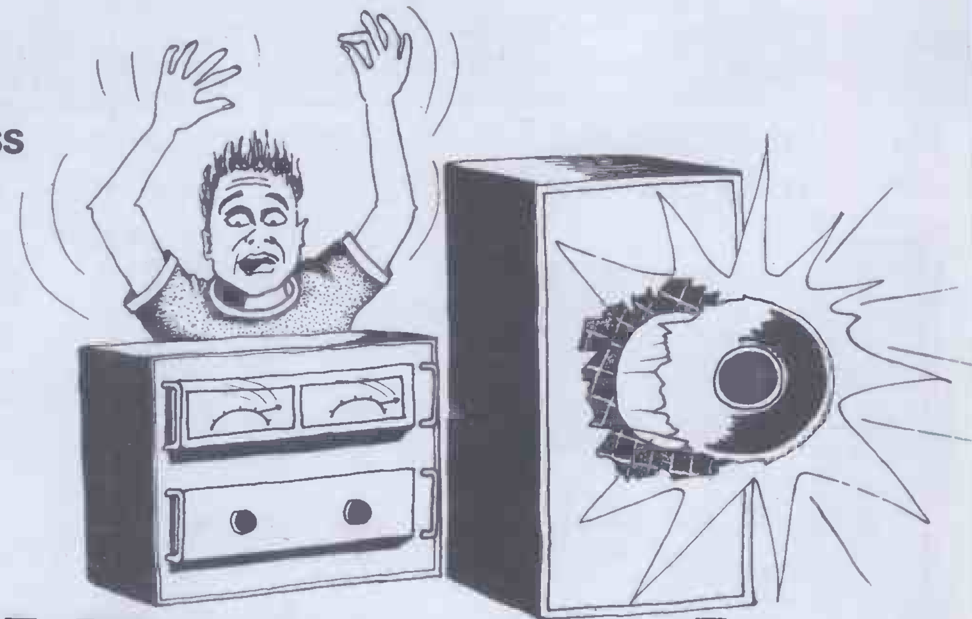
"Holy Smoke", exclaimed Robin, "that's another bass driver gone up in a puff". The Caped Crusader reached for the stereo headphones. "I warned you, Robin. You should build the HE . . .



Signal Powered Loudspeaker Protector

NOT with a bang, not even with a whimper — most loudspeakers, when subjected to intolerable strain, simply stop, cease and desist from operating. The vital signs no longer present, the hapless audiophile sits for a moment in wonder at the pallid absense of sound before filling the air himself with tones of electric blue.

Usually, the power amplifier has gone faulty and applied the full DC supply to the loudspeaker terminals. Without some form of protection, the result is at least an open circuit bass driver — or worse. A protection circuit prevents this by monitoring the loudspeaker lines for the presence of DC, opening a set of relay contacts if this occurs and disconnecting the speakers from the faulty amplifier.

However, conventional speaker protection circuits suffer from two disadvantages: first, they are active devices, and thus require a separate power supply, either from batteries or from mains. The second problem results from the type of filter used to distinguish between DC and the audio signal; a standard passive filter, set at around 10Hz, is often used, but it is possible that a large amplifier will produce sufficient energy at low frequencies to trigger the protector, even though there is not actually a fault present.

These problems are both overcome by this new circuit. The result is a particularly small, compact circuit board which can be mounted inside a loudspeaker enclosure. Thus it is not necessary to run mains power leads, or to continually check and replace batteries (the unit, while suiting all types of loudspeakers in general, is therefore very suitable for sound reinforcement systems). The solution used in this project is to power the protection circuit from the audio signal itself.

This is done by placing a full wave rectifier across the speaker lines and charging a 1000u capacitor through a 47R resistor. The worst possible load presented to the speaker lines is therefore 47 ohms — and this is only while charging the capacitor and for signal voltages in excess of 12V. This ensures that the unit has no discernable effect on audio quality but makes possible a truly 'set and forget' speaker protector that can, if required, be mounted inside the enclosure.

The second problem, that of the filter, is solved by a new design which has an almost 'brick wall' response; it enables the unit to be used with very high power amplifiers without danger of false triggering by very low frequency content.

Power Monitor

Another cause of speaker failure is the application of too much power for too long — a problem that is most often encountered in professional applications where the sound level can peak into the red and stay peaked for minutes, unless the sound engineer is alert. The Signal Powered Protector also tests for over-power, with an adjustable level control, and disconnects the speakers should the amplifier exceed the limit for more than a certain period.

This feature needs to be adjusted carefully when the unit is being used in a hifi set-up; if the trigger level is too low, the speakers will be cut out by the sudden dynamic peaks which normally occur in some types of music.

The maximum power is determined by the type of regulator transistor (Q1) used; we have specified a TIP31C for this device. It has a collector-to-emitter breakdown voltage (V_{CEO}) of 100V, and since the emitter is at 12V, the maximum voltage that can be aplied to the unit is 112V. This is equivalent to an amplifier capable of supplying approximately 784 watts into an 8R load, or 1568 watts in four ohms. If the amplifier to be used is capable of powers greater than this(!), the regulator transistor should be changed for a device with a higher V_{CEO} rating.

The relay pulls about 40mA when operated, so power dissipation in the regulator transistor will be around four watts when there is 100V across it

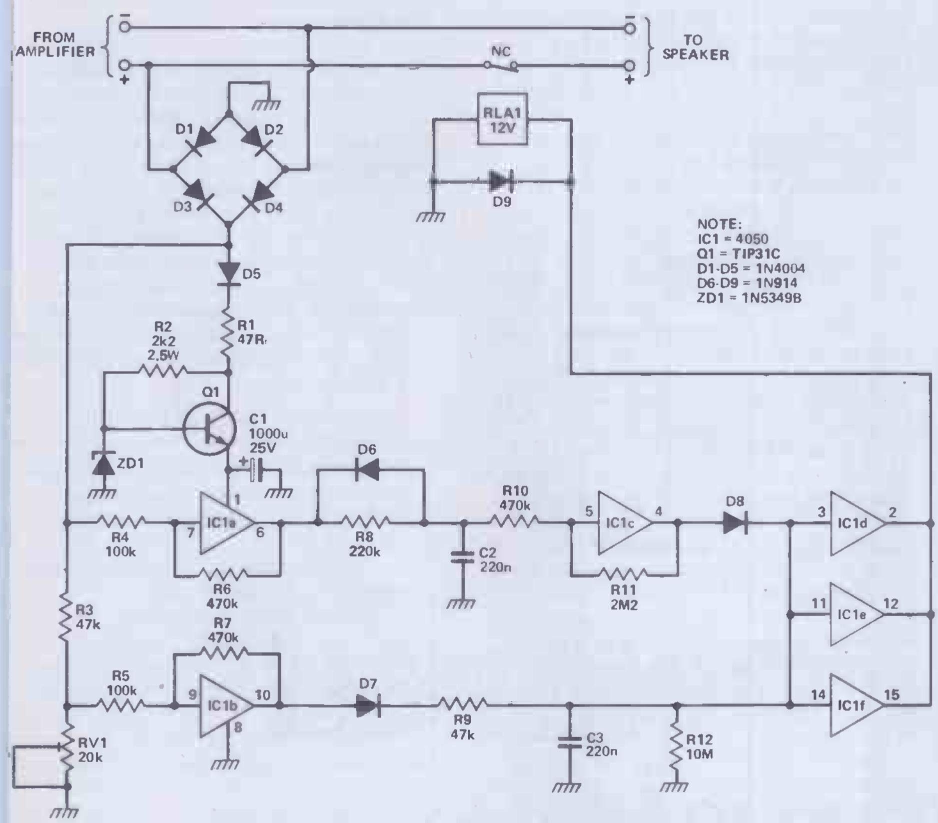


Figure 1. All there is to know about the circuit of the Signal Powered Loudspeaker Protector.

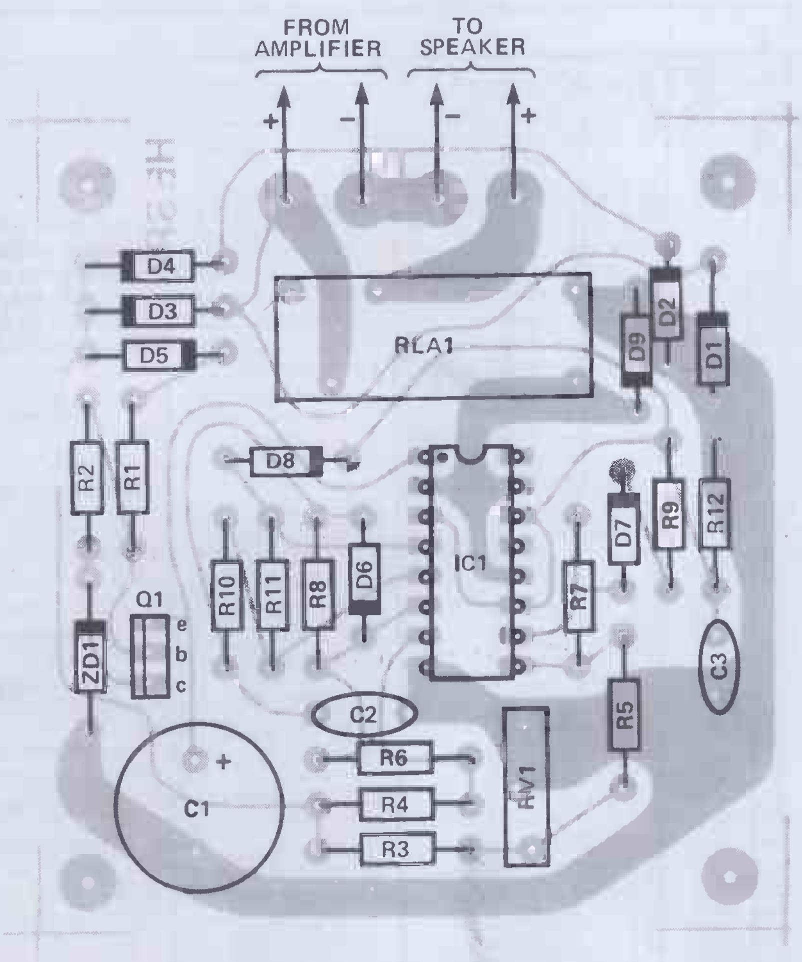


Figure 2. The component layout drawn on the PCB pattern; the full-sized foil is reproduced on the PCB Printout page.

Although this is not particularly high, it is high enough to be outside the safe operating limits of many high voltage transistors, so be careful when choosing a substitute.

Protection Circuit

The signal from the power amp is rectified by the fullwave bridge formed by D1-D4. The output from this is fed through a 12V regulator circuit formed by Q1 and the associated components, with ZD1 setting the regulated voltage. Capacitor C1 is charged to this level, and powers the remainder of the circuit. The output of the bridge rectifier also feeds the input of the DC sense circuitry and the over-power detector.

Buffers IC1a and c form the DC filter. Resistors R4, 6 with IC2a form a Schmitt trigger with a small deadband. When the signal goes above the trigger voltage, the output of IC1a swings hard to the positive supply rail, charging C2 through the 220k resistor, R6. Buffer IC1c, together with R10 and R11, form a second Schmitt trigger, monitoring the voltage across C2. If this reaches the second trigger voltage then its output goes toward the positive rail, activating IC1d, e and f, which pull in the relay and disconnect the loudspeaker lines.

It takes about 100ms to charge C2 via R8. However, the input to IC1a is fullwave rectified *unsmoothed* DC. The output, therefore, will switch between high and low as the input swings above and below the trigger voltage. With a normal audio input, then, the output of

Parts List

RESISTORS
(All ½ watt 5% unless noted)
R1 . . . . 47R
R2 . . . . 2k2, 2.5W
R3,9 . . . . 47k
R4,5 . . . . 100k
R6,7,10 . . . . 470k
R8 . . . . 220k
R11 . . . . 2M2
R12 . . . . 10M

POTENTIOMETERS
RV1 . . . . 20k min. trim pot

CAPACITORS
C1 . . . . 1000u 25V electrolytic
C2,3 . . . . 220n polyester

SEMICONDUCTORS
IC1 4050
Q1 . . . . TIP31C
ZD1 . . . . 1N5349B 12V/5W Zener diode
D1-5 . . . . 1N4004
D6-9 . . . . . . 1N914, 1N4148 etc.

MISCELLANEOUS
RLA1 . . . . 12V relay SPDT, 10A contacts
PCB, wire, solder etc.

BUYLINES . . . . page 34

IC1a will go low before C2 can charge to the second trigger level, and it will discharge rapidly into the low output via diode D6. Thus only signals which do not have a zero crossing for longer than 100ms will trigger the protector.

The over-power detector consists of a voltage divider, formed by R3 and RV1, driving a third Schmitt trigger. Whenever the voltage exceeds the trigger level, the output of IC1b will be driven high and C3 will commence to charge. If this condition persists for long enough, the output buffers will drive the relay, disconnecting the speaker lines.

Note that both the DC sense and the over-power detector charge C3 when a fault condition occurs. The circuits are decoupled from the capacitor by diodes, so that it can only discharge through R12 (the effect of the input impedance of the buffers is negligible). Together, R12 and C3 have a time constant of about one second, therefore the relay will hold on for this length of time. Thus the speaker lines are re-connected approximately one second after a fault condition has been detected.

Construction

Construction is straightforward since all of the components are mounted on the PCB. The usual precautions should be taken to ensure that all polarised components have been mounted with the correct orientation. The IC used is a CMOS type and is therefore static sensitive. Solder this last, and preferably using an earthed soldering iron. It is a wise precaution to discharge yourself before handling the device by first touching an earthed metal appliance.

It is a wise precaution, also, to space the 2.5W resistor, R2, off the PCB slightly. In the case of a high powered loudspeaker going faulty with DC this component will get quite hot, and spacing improves ventilation around the component and prevents the possibility of charring the board. If you can't obtain a 2.5 watt type then a 5 W type may be substituted.

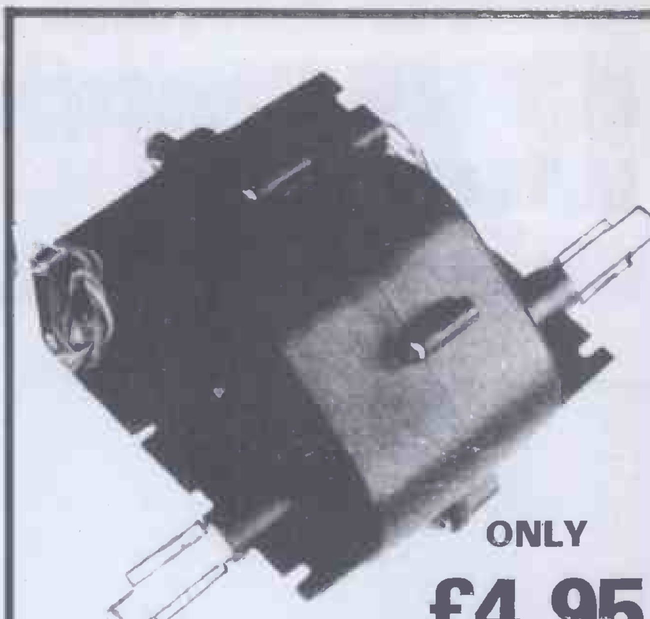
Before mounting the unit check operation by connecting around 20VDC across the speaker input terminals on the PCB. The relay should cut in after about one tenth of a second. If the protector passes this test, connect the speaker wiring. If the preset is turned fully down (turn it anticlockwise when viewing the board with the components on top and the relay to the right) the relay will cut in when the power exceeds around 20 watts for an extended period. The protector allows transients to the full supply rail to pass but will prevent a continuous 20W from being applied to the loudspeaker. To increase this, turn the preset clockwise until the desired response is achieved.

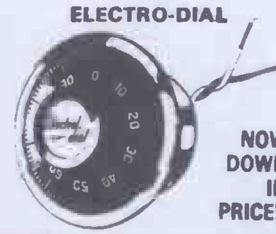
Performance

We tested the loudspeaker protector for its effect on audio performance as well as its reliability. A variety of powe amps were used to ensure that the loa represented by the protector would no affect audio performance. Even a very low power amplifier, with a comparatively small damping factor (high output impedance) could drive the unit with no degradation to the sound quality. During every test the protector worked well and cut in at the correct time to prevent damage to the loudspeakers.

NOTE. Some amplifiers are unstable when driven into an open circuit. This is particularly true of valve power amplifiers, some of which destroy themselves the moment the speaker is disconnected. Loudspeaker protectors are, however, not usually required for use with valve power amps, since the possibility of DC on the speaker lines is remote. But over-power protection may be required.

HE





RADIO RULES

Ian Sinclair

Propagation and aerials

YES, AERIALS! I know that all of the US magazines use the word antenna, but what Marconi called it is good enough for me. As you might have gathered by now, this Part is about how you get that modulated carrier winging its way from the transmitter to the receiver, which means that we're dealing with the most tricky of all electronic components, empty space.

As it happens, most of the space that we use is not exactly empty, but the presence of air makes so little difference to the way a radio wave behaves that it might as well be empty space. One of the great mysteries that baffled great brains for centuries was how light waves could reach us from the sun if there was no material between us and the sun to carry the waves. The problem was finally solved by Clark Maxwell (see Famous Names, HE May '81) who, in a brilliant piece of theoretical reasoning, showed that a wave consisting of both electrical and magnetic fields could move through empty space. In this respect, electromagnetic waves are totally unlike the more familiar waves of sound and of water.

Both electrostatics and magnetism are involved in the electromagnetic field. A varying voltage between any two points causes a magnetic field, and a varying magnetic field causes a voltage. The electric and magnetic fields chase each other along, needing no matter to contain them or be affected by them, and their speed is around 300 million metres per second. What we call 'light' is just one of the huge range of electromagnetic waves, all of which travel at the same speed in space, and which are distinguished from each other only by their different frequencies and wavelengths. These two quantities are, incidentally, related, because frequency x wavelength = speed, and the speed is constant — see Table 1. For radio waves, then, we can always find what the wavelength is for any given frequency, or the other way round, and **Figure 1** shows some examples.

Electromagnetic waves can travel in insulators, though at a lower speed than in air or in free space, but they cannot travel in their normal form through good conductors, because a good conductor will short-circuit the electric field part of the wave. Waves can travel along the surface of a metal, however, and can be reflected from conducting surfaces. For many of our purposes, the electric field component of a wave is the important one, and most of our transmission systems cause the electric field to move in one particular direction. When this is so, the wave is said to be plane-polarised. If the electric field is parallel to the surface of the Earth, the wave is horizontally polarised, and if the electric field is 90° to the surface of the earth, the wave is vertically polarised. The direction of the magnetic field is always at 90° to the direction of the electric field, and both fields are at 90° to the direction of motion (**Figure 2**).

WAVELENGTH x FREQUENCY = VELOCITY OF LIGHT
(in metres) (in Hertz) (3×10^8 m/s)

WAVELENGTH	FREQUENCY
85 m	3.5 MHz
42 m	7 MHz
30 m	10 MHz
21 m	14 MHz
14 m	21 MHz
10.7 m	28 MHz

FREQUENCY = 11.24 MHz = 11.24×10^6

$$\text{WAVELENGTH} = \frac{3 \times 10^8}{11.24 \times 10^6} = 26.69 \text{ m}$$

Table 1. Calculations on wavelength and frequency.

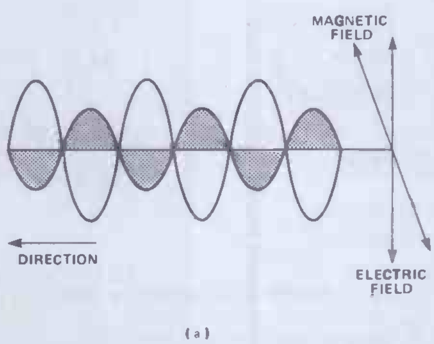


Figure 1a. The electric and the magnetic waves are at 90° to each other and also at 90° to the direction of movement.

Propagation

Propagation means the way in which a wave travels from one place to another. Over short distances, the path of a wave can be taken as a single straight line, the 'line of sight' from the transmitter to the receiver. For many of the distances we are interested in, however, the path of the wave will involve at least one reflection from the ionosphere, which is the reflecting layer above the atmosphere of the Earth (**Figure 3**). This reflecting layer is created by the action of sunlight on the low-pressure gases more than 70 miles above the surface of the Earth. The high-energy ultra-violet rays of the sun (which at that height would burn you up to a frazzle in seconds) separate the oxygen and nitrogen of the air into charged particles, called ions, so making the low-pressure gas behave like a conductor. In darkness, these particles recombine (sometimes causing a glow in the sky, hence the Northern Lights or Aurora Borealis), which is why there are such considerable differences between daytime and nightime radio ranges. There are also considerable

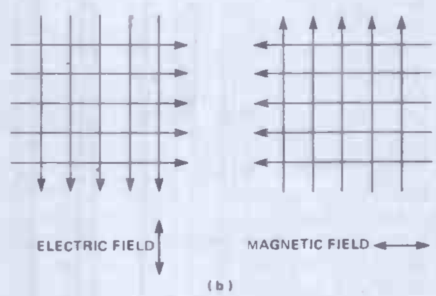


Figure 1b. Another representation of the polarisation of electromagnetic waves.

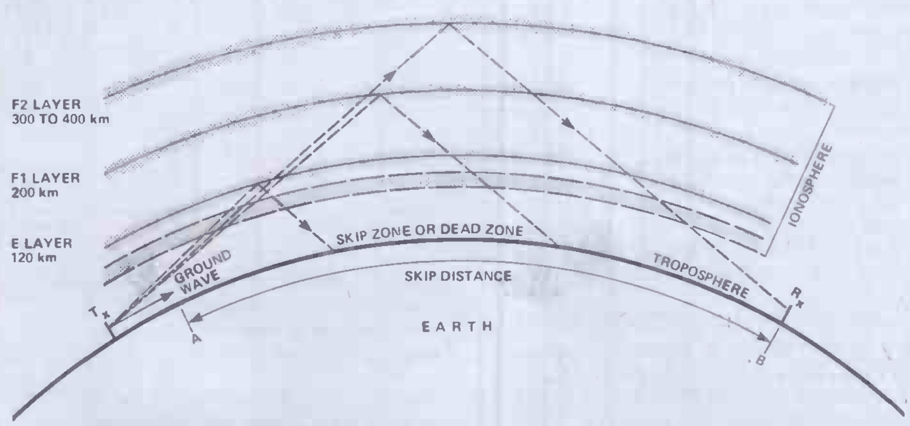


Figure 2. How waves bounce from the ionosphere for long-distance communications.

variations in the ultra-violet output from the sun, which leads to the degree of ionisation varying considerably from time to time.

The way in which radio waves travel by bouncing from the ionosphere also accounts for reception problems. Fading is caused because waves that have travelled along different paths can be received simultaneously. Because the path length is never constant as the ionosphere churns around, waves which meet at the receiver may be in phase, out of phase, or any amount of phase degrees apart, causing the amplitude of the received signal to vary considerably, right down to almost zero at times. For some reflecting conditions, the phase of the reflected wave may depend on its frequency, so that the two sidebands of the AM signal may be out of phase, causing severe distortion. This is why suppressed-carrier SSB signals are so often superior in signal quality.

Launching-Pad

An aerial is a form of launching-pad for waves, and since all of our aerials are made of metal, they create an electric field in the air around them, so that what you acutally launch is the electric-field part of the wave. Like Mary's little lamb, its magnetic field is sure to go every where with it.

Launching a wave into space (**Figure 4**) is like transferring power to anything; it needs some matching of impedance. You can't, for example, expect to transfer much power to an eight ohm loudspeaker from an amplifier with a 2k output resistance, and the same applies to aerials, so that the action of an aerial depends to a large extent on the impedance of space. What on earth do we mean by the impedance of space? Just this: a radio wave carries power, and power means volts *and* amps. When a radio wave travels through space, we can measure the volts between two points in the wave, and we can also measure the amps that are flowing. The ratio of volts to amps is called the impedance, and it is measured in ohms (R). The ratio of peak voltage to peak current in a wave is called the characteristic impedance of free space, and that's a figure which can be calculated (rather than measured) at about 377 ohms. When we put an aerial into this space, however, the aerial acts as a contact which alters the impedance to some extent, so that what we have to match is not the impedance of free space, but the impedance of aerial plus space, which is usually a lower quantity.

The most efficient aerial for transmitting purposes is one which has the maximum amount of electric field between its ends when a wave is sent to it. The shortest possible aerial of this type, called a half-wave dipole (yes, it's half a wavelength long) will also have a fairly low impedance, around 70 ohms, and is almost perfectly resistive — it dissipates power into space with no reflections. In general, an efficient aerial needs to be cut to a length which is a whole number of half-wavelengths. For example, the wavelength of a 28MHz wave in space is 10.7 metres, and if we allow for the wavelength on the wire of the aerial being about five per cent less than this, we arrive at the figure 10m. Half a wavelength is 5m, so that aerial lengths of 5m, 10m, 15m, 20m and so on would be acceptable. **Table 2** shows the half-wavelength lengths corresponding to some popular amateur bands.

The reason for preferring aerials of this half-wave length can be understood more easily if we superimpose against a drawing of the aerial a diagram of the voltage in a wave (a 'standing wave'), using the same scale. A half-wave aerial has a pattern of the type shown in **Figure 5**. The maximum voltage is at each end, so that the electric field across the aerial is large, and the maximum current is in the middle. The conditions for drawing these standing waves are that there should always be maximum voltage at the ends and maximum current in the middle — the wave cannot be stable otherwise. **Figure 6** shows the standing-wave pattern for a full-wave aerial length.

The ratio of voltage to current obviously varies from one part of an aerial to another, being very large at the ends of a half-wave aerial, and very small at the middle. Note, however, that if the aerial is correctly cut to length, there is no phase difference between current and voltage — they rise and fall in step. These standing-wave patterns are permanent on an aerial of the correct length — there will never be a time when the voltage at the centre of the half-wave aerial is large and the current small, for example.

An aerial which is cut to a number of half-waves in length is said to be resonant, and an aerial of this type works most efficiently at the frequency for which it is designed, though it may radiate at some harmonic frequencies as well, because it will also be a number of half-waves long for some harmonic frequencies. The radiation of a horizontal half-wave aerial is not equally strong in all directions; it tends to be strongest along a line at right angles to the aerial's length, following the pattern shown in **Figure 7**. Longer resonant aerials, (one-wave, one-and-a-half-wave, two-wave, etc.) radiate over a wider range, and very long resonant aerials will radiate almost in the direction of the wire, but few people, unless they live on farms, can use long resonant aerials, particularly on the lower frequency, longer wavelength bands. When the half-wave aerial is used ver-

FREQUENCY (MHz)	HALF-WAVE (metres)
1.8	74.9
3.5	39.0
7.0	20.1
14.0	10.05
21.0	6.7
28.0	5.02
70.0	1.8
144.0	0.97
430.0	0.32

Table 2. Half-wave lengths in metres for the popular amateur bands.

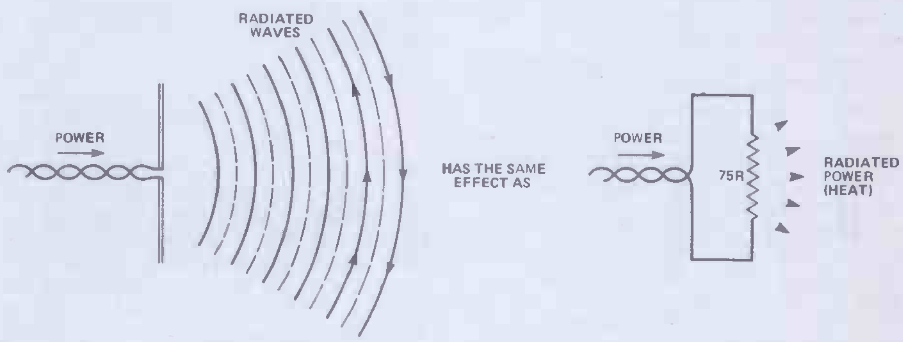


Figure 3. A half-wave dipole radiates waves, behaving as far as the transmitter is concerned like a 75 ohm resistor (which radiates heat).

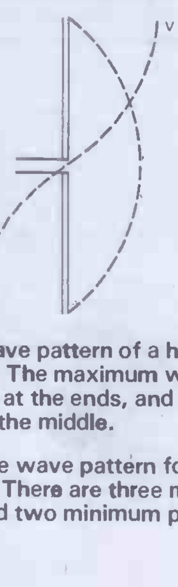


Figure 4. Wave pattern of a half-wave dipole aerial. The maximum wave voltages are at the ends, and the minimum in the middle.

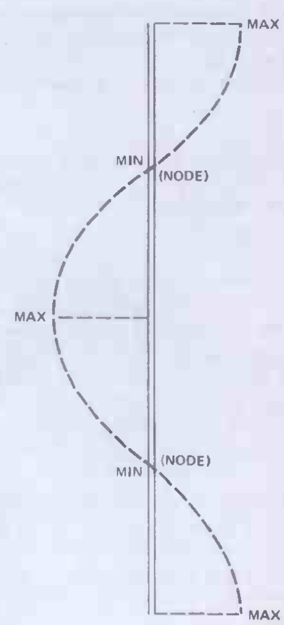


Figure 5. The wave pattern for a full-wave aerial. There are three maximum positions and two minimum positions.

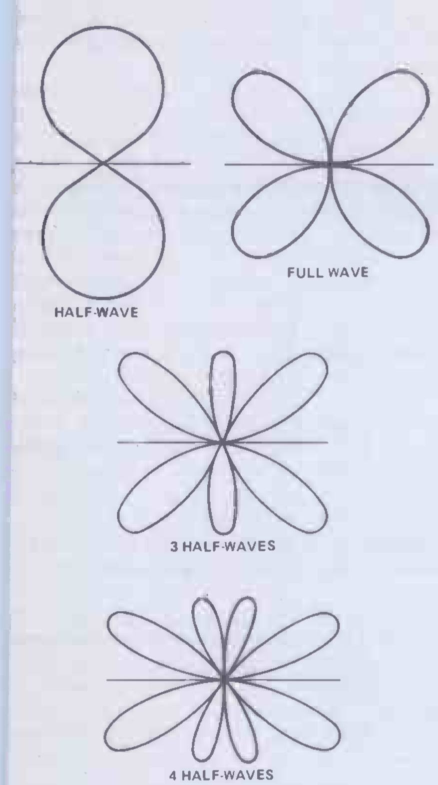


Figure 6. Theoretical radiation patterns for aerials — these show how the wave goes out in different directions.

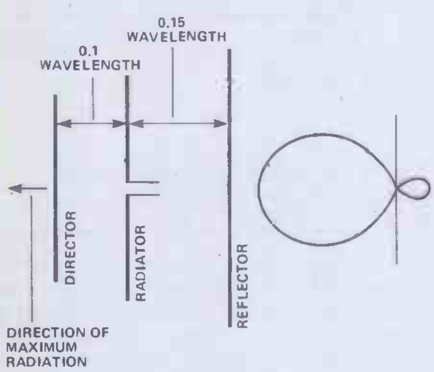


Figure 7. A three-element Yagi, made by adding a director and a reflector to the dipole. The director is shorter than the dipole, and the reflector is longer.

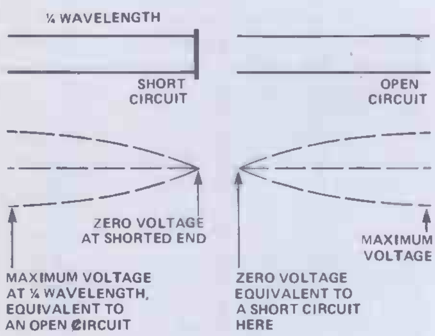


Figure 8. Quarter-wave sections. A shorted quarter-wave piece of cable acts like an open circuit; an open circuit quarter-wave section acts like a short circuit because of the wave patterns, shown here.

tically, however, its radiation pattern is omnidirectional — equal in all directions around it.

These patterns are theoretical and are found in practice only when aerials are spaced well away from the ground and any other conducting objects, but they form a reasonable guide to what we can expect. We can modify the patterns very considerably by adding 'dummy' aerials or parasitic elements parallel to the main half-wave aerial and spaced some distance away from it. One popular arrangement is the three-element Yagi of **Figure 8** in which a slightly longer element, the reflector, is set at 0.15 wavelength from the radiating aerial, and a shorter element, the director, is set at 0.1 wavelength in the opposite side. This arrangement gives a very much more directional beam, and if you want to change the direction of transmission, you will have to turn the whole assembly — just about possible for a 10m wavelength.

Feeding the Power

One of the most critical parts of radio transmission practice is the correct feeding of power from the transmitter to the aerial, and it's all a matter of wavelengths again. We get accustomed to the idea that if you have a voltage on one end of a piece of wire, you'll have exactly the same voltage on the other end. That's true of AC and DC generally when no current flows, but not when the length of the wire is something like the wavelength of the AC. When a piece of wire is some appreciable fraction of a wavelength long, like a quarter wavelength, then it can have very different voltages on its ends, simply because a wave has formed on the wire.

Normally, this effect doesn't bother us. Our electronics equipment is made so that the dimensions of conductors are all very small compared to the wavelength of the signals that they are handling. This becomes much more difficult for UHF signals, and that's why UHF is so tricky to work with. In any transmitter circuit, however, there is one piece of connecting wire which just has to be long — the wire that connects the output of the transmitter to the aerial, called the tranmission line. For best results, an aerial should be placed as far away from buildings as possible, and that means that the transmission line, or feeder, will be long, often considerably longer than one wavelength. Ideally, we want the waves to travel along this line from transmitter to aerial, but if we get things wrong, the waves may be reflected back to the transmitter, causing a loss of radiated power. The transmission line can, if not correctly designed, waste a lot of that precious power.

What happens? The line is carrying a wave and it, like the space round the aerial, has a characteristic impedance, usually of 75 ohms or 300 ohms, depending on the construction of the line. Unlike space, though, we can do things to a line, such as shorting or open-circuiting the ends. When we do such things, the line can behave very differently, as we can demonstrate by drawing wave diagrams. A shorted line one quarter wavelength long, for example, will behave like an *open* circuit for waves of that length, **(Figure 9)** and an open circuit quarter-wave line will behave like a short circuit. Pieces of line attached to the main line can therefore be made to act like transformers, or as resonant filters, making the way the waves behave work for us instead of against us.

Standing Waves and Travelling Waves

Our ideal transmitter rig would feed waves from the transmitter, up the transmission line to the aerial where they would be wholly radiated into space. The speed of the waves along the transmission line is not as high as their speed in free space, and can be taken as about 66% of free space speed in coaxial cable and 85% of free space speed in twin-line feeder. These ideal conditions are met if the transmitter output impedance, the feeder impedance and the aerial - plus -space impedance are all identical at the frequency of transmission. This is what is termed a perfectly equalised load condition, with a non-resonant feeder. Such conditions can be approached even if the equalisation is not perfect, providing that

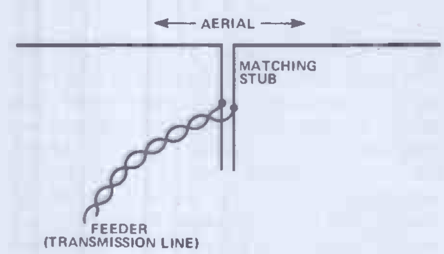


Figure 9. Using a matching stub to match an aerial to a transmission line. The stub acts like a transformer.

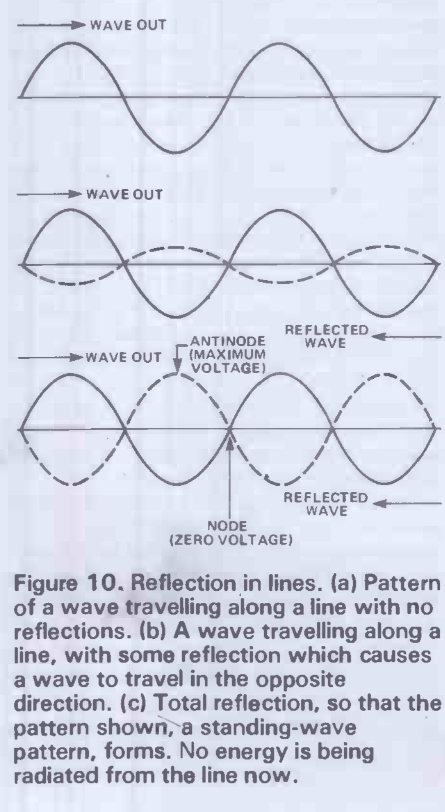


Figure 10. Reflection in lines. (a) Pattern of a wave travelling along a line with no reflections. (b) A wave travelling along a line, with some reflection which causes a wave to travel in the opposite direction. (c) Total reflection, so that the pattern shown, a standing-wave pattern, forms. No energy is being radiated from the line now.

the length of the feeder can be adjusted, or some other means of matching used. As transmitters are universally constructed nowadays to have an output impedance of 50 ohms, aerials can be constructed to a variety of impedance values, and feeders generally have an impedance of 75 ohms or of 300 ohms. We usually have to take some steps to match these different impedances to each other.

At the aerial, this is achieved by the correct shaping of the aerial, or by the addition of 'matching stubs', which are the short sections of line that behave like transformers (**Figure 10**). At the transmitter, the transmission line is matched to the output impedance of the transmitter by using a wideband variable transformer which is called an aerial tuning unit (or antenna tuning unit, if you must), shortened to ATU.

How do we know when we have achieved matching? The answer lies in the way that waves behave when a mismatch is present. The worst possible mismatches are open circuits or short circuits, and these will both cause power to be completely reflected back down the line (**Figure 11**). Even a small mismatch, however, will reflect some power, so that measuring the reflected power is a good way of measuring the closeness of the matching. When a reflection occurs, standing waves form on the line, causing some parts of the line to be permanently at higher voltages than other parts. The ratio of the amplitude of such a standing wave to the (desirable) travelling wave amplitude (the one which goes up the spout and radiates away) is another good measure of matching, and we can obtain instruments which measure this standing wave ration, SWR for short. The SWR meters use a type of bridge circuit to balance the amplitude of waves travelling up the transmission line against the amplitude of waves reflected back, and the lower the SWR reading the better is your system. The minimum possible value (because of the way the SWR is defined) is one, but it's practically impossible to obtain such a reading — if you do it's time to have the meter checked! A SWR reading of less than two is pretty good, and if the line is a low-loss type, then you work with SWR values greater than two without greatly reducing the efficiency of your system, because in such circumstances, the amount of power which you get out will not be greatly affected by the SWR value. If the line is lossy (low-grade coax, for example), then high SWR spells low power output, and there is also the danger, whenever the SWR is high, that the reflected power will damage PA stages. Valve output stages are very much less likely to be damaged in this way than transistor stages.

Note by the way that the ATU will be used to match the transmitter to the transmission line. If the aerial is not correctly matched to the line, then no amount of fiddling with the ATU will get the SWR really low.

Aerial Shapes and Sizes

One thing that will strike you when you look through magazines and books is the huge range of aerials that you will find described, and the claims that are made

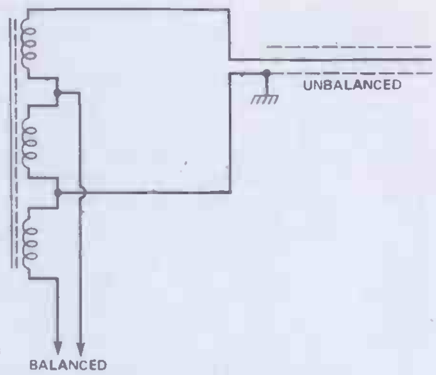


Figure 11. A balun circuit. A transformer construction is shown, but the balun can be constructed with lengths of transmission line.

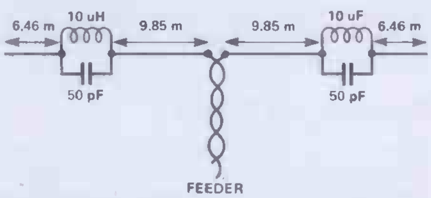


Figure 12. A trap dipole aerial. The trap is the parallel resonant circuit in each arm of the aerial.

for them. You might easily conclude that almost anything could act as an aerial — and you're quite close to the mark. Almost any piece of wire will act as an aerial for reception and for transmission anything that can be matched reasonably well will get a signal out. To get the best from the power of your transmitter, though, a correctly designed, constructed and matched aerial is essential.

The simplest type of aerial to construct is the half-wave dipole. This means a length of wire or rod equal to half a wavelength (allowing for the length of a wave on a wire being about 80 per cent of the length in free space), and cut at the centre to allow two connections. The impedance at the centre of such an arrangement is about 70 ohms, and resistive for the frequency at which the aerial is one half wavelength long, or an odd number (one, three, five, seven etc) of half-wavelengths long. An aerial of this type looks like a good impedance match for 70 ohms coaxial cable, but there is one snag — the aerial is a 'balanced' arrangement, requiring signals of opposite phase on its two arms, and arranged so that the sum of the signals is zero. Coaxial cable, by contast, is unbalanced, with all of the signal on its inner core, and the outer core earthed. To ensure correct matching of a dipole aerial with coaxial feeder, then, we need a unit which will obtain balanced signals at the end of the coaxial cable; such a unit is called a 'balun', short for balanced to unbalanced transformer (**Figure 12**). This can be constructed — it consists of tightly-coupled windings on a ferrite core — but is more easily bought. Coaxial cable is convenient because most transmitter outputs are unbalanaced, so the coax is the most obvious type of feeder to use, being comparatively cheap, and with a balun at the end it operates

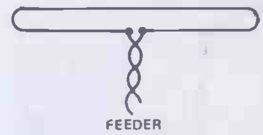


Figure 13. A folded dipole. Folding increases the impedance fourfold.

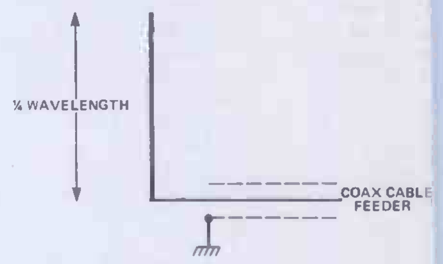


Figure 14. A simple vertical aerial. The snag is getting an efficient earth.

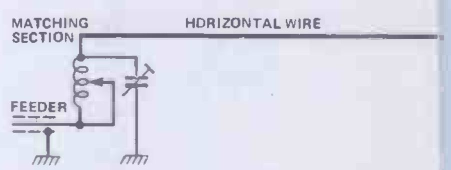


Figure 15. A horizontal (Hertz) type of aerial, and matching section.

Figure 16. A Marconi aerial, much favoured at low frequencies.

very satisfactorily. If you use a transmitter which has a balanced output, then you must use either twin line (balanced line) or the correct impedance (usually 300 ohms), and no balun at the aerial end, or you can use coax with a balun at each end of the cable. In general, the fewer devices like baluns that you need to use, the better, because each device must lose some power.

Because the simple half-wave dipole is a one-frequency (plus odd-numbered harmonics) aerial, many variations on the design attempt to extend its use to other bands. The most successful of these variations is the 'trap dipole', which uses two sections in each half of the aerial, separated by a parallel LC circuit (tuned circuit). At its resonant frequency, its impedance is so high that it completely isolates the outer sections of the aerial, so that only the inner sections radiate. **Figure 13** shows the arrangement of a trap dipole aerial that can be used at amateur frequencies ranging from 3.75MHz to 30MHz. The trap uses a 10uH coil and 50pF capacitor, making it resonant at around 7.1MHz. The inner dipole is of 9.85 m and the outer of 6.46 m. It can give SWR figures of less than 2.5 on all the amateur bands within its range.

At 7MHz, the resonant trap completely isolates the outer sections of the aerial from the inner ones, so that the inner sections are used as a straightforward 7MHz dipole. At 3.5MHz, the total length of the aerial, plus the equivalent length of the inductor of the trap, gives an aerial which will operate well at this low frequency. Above 7MHz, the end sections are not isolated but, with the operating frequency well above the resonant frequency of the traps, the traps act as capacitors which will resonate with the inductance of the outer sections of the aerial at frequencies which are odd harmonics of the fundamental frequency. At 14MHz, for example, with a wavelength of around 17m in wire, the half-way length is 8.57m, and 3/2 wavelengths (three half-waves) amount to 25.7m. The combination of the 2 × 6.45m outers with 2 × 9.75m inners, plus the capacitance of the trap, produces the same effect as this length of aerial. Similarly, it acts as a five-halfwave aerial at 21MHz, and as a seven-halfwave aerial at 28MHz. The aerial matches well to a 75 ohm line, but, like all multiband arrangements, will not have the same high performance in every band. You can't have it all ways.

A simple dipole matches to 75ohms, but if the dipole is folded, as shown in **Figure 14** then its impedance is four times as much, 300 ohms, and this arrangement can be fed by 300 ohm twin line, providing that suitable matching exists at the transmitter. A dipole can always be matched by using 'matching stubs': quarter wavelength pieces of transmission line (**Figure 10**) with the feeder attached at any point which gives the minimum SWR reading.

Dipoles can be formed into Yagi arrangements by adding reflector and director wires parallel to the dipole. A Yagi is much more directional than a plain dipole, so that it's useful mainly if you are trying to get out with maximum power in one direction only. The impedance of a dipole is considerably reduced by adding the other sections to make a Yagi but, by folding the dipole part, a reasonable match to 75ohms can usually be achieved.

Unbalanced Aerials

An aerial can be fed from one end rather than from the centre, and in such a case unbalanced coax cable is appropriate as a feeder. One form of unbalanced aerial is the vertical type, using a quarter-wavelength of vertical wire fed by 50 ohm coaxial cable (**Figure 15**). This type of aerial needs an earth under the wire, and because satisfactory low-resistance earth connections are difficult to make unless you live in a bog (I mean a peat-bog, of course), the 'ground-plane' construction, using wires a quarter of a wavelength long arranged as radii of a circle on, or just under, the ground can be used in place of an earth connection (**Figure 16**). For VHF, the roof of a car makes a good ground plane, and lower frequencies can be catered for by using a loading inductor to increase the effective length of the aerial.

Another type of unbalanced aerial is the end-fed horizontal wire of **Figure 17**, which, for best results, should be half a wavelength long. Careful matching is needed to avoid harmonic radiation, and it's usually better to use a dipole unless you are keen on experimenting. An aerial of this type for the lower amateur frequencies needs a lot of wire, and shorter lengths can be used in what is called the Marconi aerial. This one uses an inductor connected at the far end of the aerial (remote from the feeder), with an auto-transformer and capacitor at the feeder end for matching purposes (**Figure 18**). An earth directly into soil (NOT to mains earth or to a water pipe) will be needed.

In general, if you want to make your own aerial, then you must consult some of the magazines and books which are published by the RSGB (in Britain) or the ARRL (in the US). These are gold-mines of information on amateur radio, and if you are a determined constructor you will find in their pages information on every imaginable thing which has any application to amateur radio transmission and reception.

Next month: interference problems, and what to do about them.

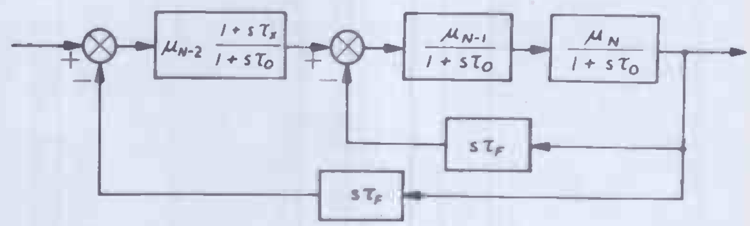
HE

NEXT MONTH

electronics today INTERNATIONAL

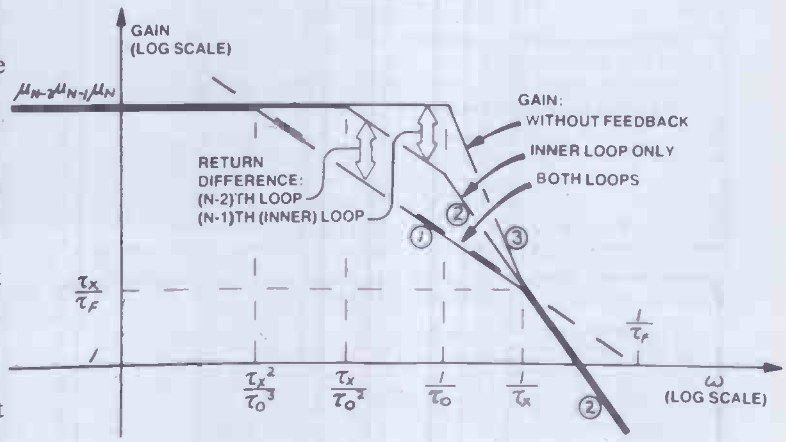
:WITCHED MODE PSUs

pecially for those interested in extending their knowledge of lectronics (which must be about 100% of you), we are eturning to the Designer's Notebook feature with not one ut two articles. As you may gather from the heading, one of hese is not a million miles away from the subject of switched node power supplies, one of the design fields often regarded s a no-go area for the hobbyist — that is, until that hobbyist eads ETI. The other Designer's Notebook will be on voltage nultipliers, so start queueing at the newsagents now.



REAL-TIME CLOCK CALENDAR

A project for all those readers with 6502-based micros that an't tell the time, or remember what day it is. If you liked the 6502 Sound/DAC card this month, you'll love this project: only in the April edition of ETI.

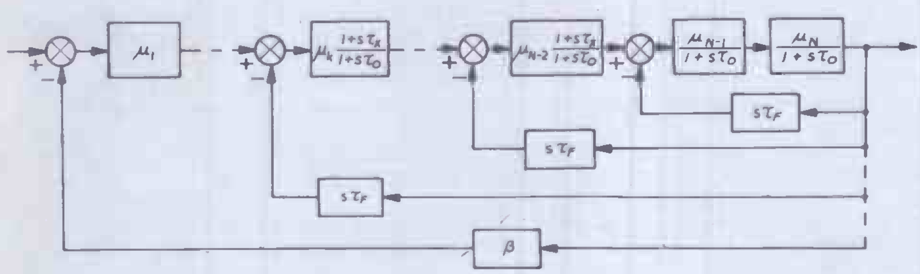


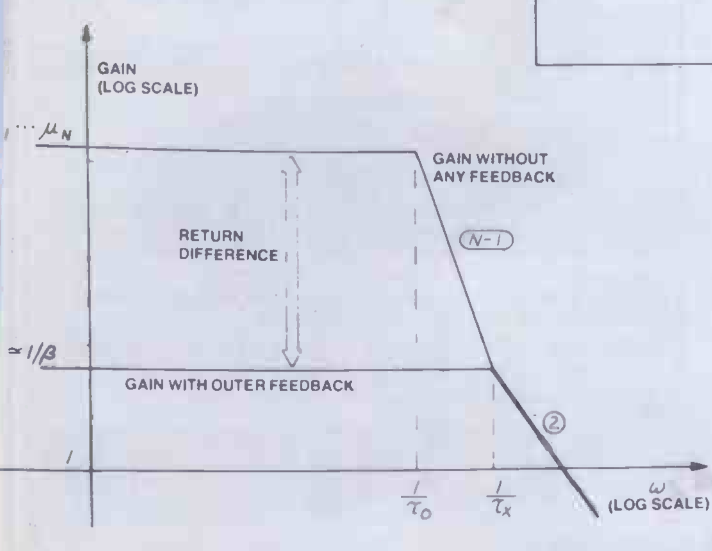
ZX81 MUSIC BOARD

This is a quite sophisticated though cost-effective music board for the ZX81. The board is capable of playing music without continuous CPU maintenance, and three notes may be played at once, each with independently variable volume. If you want more out of your micro, get next month's ETI.

NDFL

NDF what? We're afraid you'll have to wait until the next ETI is published to find out what those letters stand for, but it will culminate in an entirely new audio amplifier design. Sounds interesting. Meanwhile, here are a few clues . . .





LOOK OUT FOR THE APRIL ISSUE ON SALE MARCH 4th

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

VOYAGER CAR COMPUTER

Keith Brindley

Ex HE-Man Keith returns with a tale about a kit designed for more economical motoring.

THE Voyager kit arrives through the post, from Sparkrite, securely packed in a polystyrene foam box, which has formed spaces for each main part. Everything you need to build and fit the kit (except tools) comes with it, and that includes wire, solder, nuts & bolts, and screws. All you have to supply are the necessary tools (a small soldering iron, long-nosed pliers, wire cutters, a small screwdriver and a small cross-head screwdriver) plus a reasonable competance at soldering.

There are, apparently, over 300 parts (mechanical and electronic) in the kit (I didn't stop to count them) and it took about five hours' continuous work to get the Voyager ready for installation into a car. A very good instruction booklet takes the builder through each stage, in a clear and concise, step-by-step way. The tasks are divided into the assembly of three printed circuit boards (PCBs):

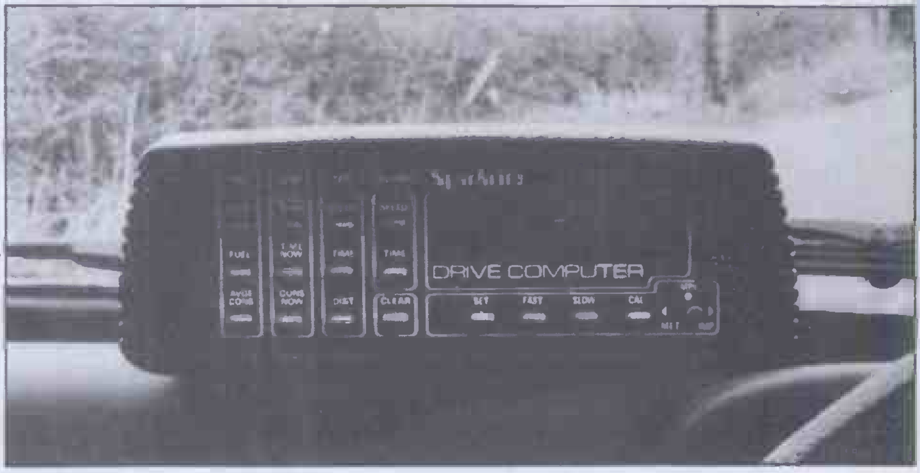
1) Ice-warning PCB
2) Main display PCB
3) Keyboard PCB

followed by instructions for fitting the ice-warning PCB into its metal housing and fitting the other two boards into the plastic Command Module housing.

Without a doubt, the most difficult board to construct is the main display board. There are about 80 electronic components to insert and solder, including a fair number of polarised components, so great care must be taken to select the correct components. This PCB holds all main integrated circuits and they all are soldered directly into the board — no IC sockets are used. But the instructions are quite clear on how to solder them in without damage. The vacuum fluorescent display also mounts onto this board, but is raised (by about 5 mm) from the board's surface.

The keyboard PCB contain sixteen push-button switches and a bank of six small bulbs (to backlight the front panel); only three other components are soldered onto this board.

These two PCBs are interconnected in a number of places but, instead of wired connections (which can mean a 'birds-nest' of leads), the connections are made by fixed PCB connector plugs and sockets. Thus, the two boards are literally pushed together and pulled apart. A thin sheet of plastic film fits between them to prevent possible short-circuits. The whole arrangement makes a neat and professional combination which fits easily into the plastic Command Module housing which is then ready for its front panel and fitting into the car.

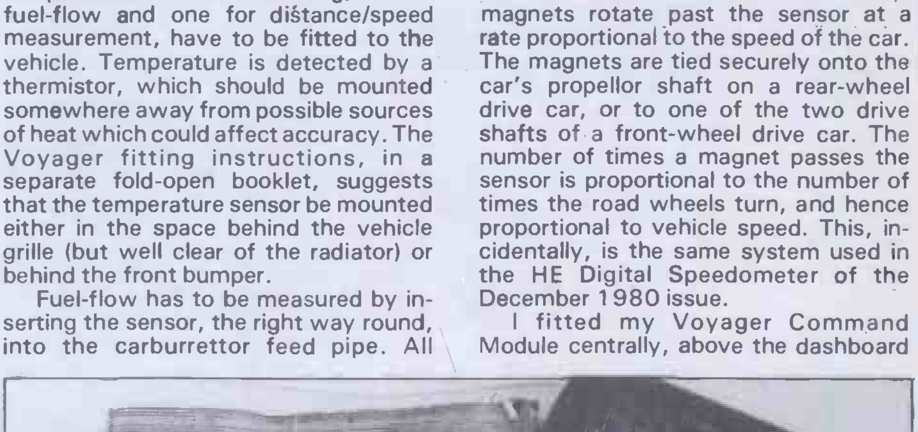


Three sensors, one to measure temperature for the ice warning, one for fuel-flow and one for distance/speed measurement, have to be fitted to the vehicle. Temperature is detected by a thermistor, which should be mounted somewhere away from possible sources of heat which could affect accuracy. The Voyager fitting instructions, in a separate fold-open booklet, suggests that the temperature sensor be mounted either in the space behind the vehicle grille (but well clear of the radiator) or behind the front bumper.

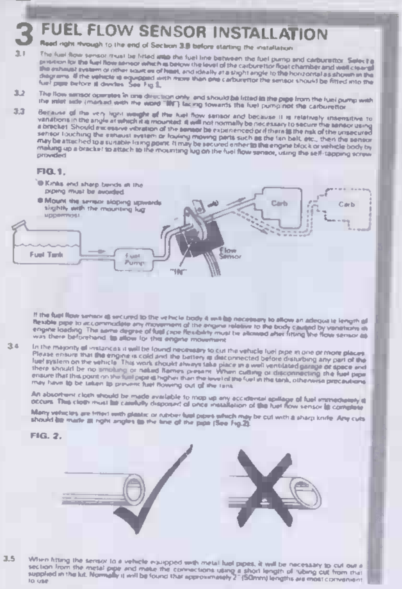
Fuel-flow has to be measured by inserting the sensor, the right way round, into the carburrettor feed pipe. All necessary clips and connection pieces, for all standard petrol-engined cars but not high-pressure fuel systems such as diesel or petrol injection), are supplied.

Next, the speed sensor and magnets have to be fitted to the vehicle so that the magnets rotate past the sensor at a rate proportional to the speed of the car. The magnets are tied securely onto the car's propellor shaft on a rear-wheel drive car, or to one of the two drive shafts of a front-wheel drive car. The number of times a magnet passes the sensor is proportional to the number of times the road wheels turn, and hence proportional to vehicle speed. This, incidentally, is the same system used in the HE Digital Speedometer of the December 1980 issue.

I fitted my Voyager Command Module centrally, above the dashboard



The collected parts of the Voyager kit.



3 FUEL FLOW SENSOR INSTALLATION

Read right through to the end of Section 3.5 before starting the installation

3.1 The fuel flow sensor must be fitted into the fuel line between the fuel pump and carburettor. Select a position for the fuel flow sensor which is below the level of the carburettor float chamber and well clear of the exhaust system or other sources of heat, and ideally at a slight angle to the horizontal as shown in the diagrams. If the vehicle is equipped with more than one carburettor the sensor should be fitted into the fuel pipe before it divides. See Fig 1.

3.2 The flow sensor operates in one direction only and should be fitted in the pipe from the fuel pump with the inlet side (marked with the word "IN") facing towards the fuel pump not the carburettor.

3.3 Because of the very light weight of the fuel flow sensor and because it is relatively insensitive to variations in the angle at which it is mounted, it will not normally be necessary to secure the sensor using a bracket. Should excessive vibration of the sensor be experienced or if there is the risk of the unsecured sensor touching the exhaust system or fouling moving parts such as the fan belt, etc., then the sensor may be attached to a suitable fixing point. It may be secured either to the engine block or vehicle body by making up a bracket to attach to the mounting lug on the fuel flow sensor, using the self-tapping screw provided.

FIG. 1.

- Kinks and sharp bends in the piping must be avoided
- Mount the sensor sloping upwards slightly with the mounting lug uppermost

If the fuel flow sensor is secured to the vehicle body it will be necessary to allow an adequate length of flexible pipe to accommodate any movement of the engine relative to the body caused by variations in engine loading. The same degree of fuel pipe flexibility must be allowed after fitting the flow sensor as was there beforehand, to allow for the engine movement.

3.4 In the majority of instances it will be found necessary to cut the vehicle fuel pipe in one or more places. Please ensure that the engine is cold and the battery is disconnected before disturbing any part of the fuel system on the vehicle. This work should always take place in a well ventilated garage or space and there should be no smoking or naked flames present. When cutting or disconnecting the fuel pipe ensure that this point on the fuel pipe is higher than the level of the fuel in the tank, otherwise precautions may have to be taken to prevent fuel flowing out of the tank.

An absorbent cloth should be made available to mop up any accidental spillage of fuel immediately it occurs. This cloth must be carefully disposed of once installation of the fuel flow sensor is complete.

Many vehicles are fitted with plastic or rubber fuel pipes which may be cut with a sharp knife. Any cuts should be made at right angles to the line of the pipe (See Fig.2).

FIG. 2.

3.5 When fitting the sensor to a vehicle equipped with metal fuel pipes, it will be necessary to cut out a section from the metal pipe and make the connections using a short length of tubing cut from that supplied in the kit. Normally it will be found that approximately 2" (50mm) lengths are most convenient to use.

The manual is well written and clearly illustrated.

of my car, using the special windscreen fitting, self-adhesive pad and short, ball-jointed connecting rod. A variety of fitting methods are supplied in the kit to enable the module to be mounted above or below the dash in most required positions.

Connections between the various sensors and the Command Module are made by joining the leads from each sensor to one end of a length of ribbon cable. The ribbon cable is fitted with a female connector to mate with the male connector in the rear of the Command Module. At the sensor end of the cable, individual plugs and sockets are used to connect to the sensor leads. Power connections are all made using fuses and the special clip-type connectors supplied. Again, easily understandable instructions make the module fitting an easy — if time-consuming — job. Voyager is, at this time, ready to test, calibrate and use.

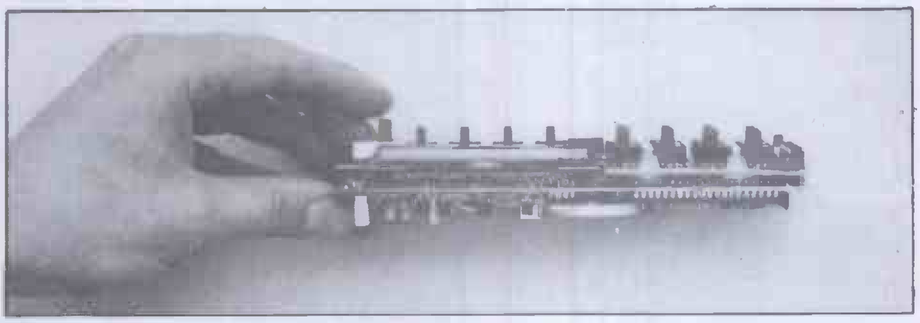
Road Test

Testing is a straighforward procedure, given in the operating handbook, to make sure all functions are up and running.

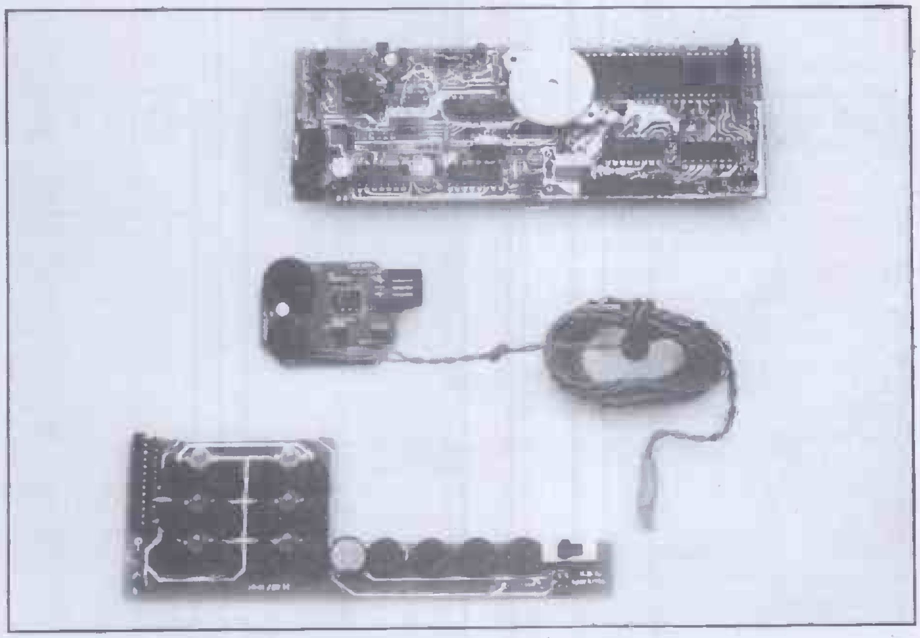
The microcomputer, within Voyager, needs to be programmed to suit the car it is fitted to. This entails driving over a measured distance and keying in that distance (to calibrate the distance/speed sensor) and then using a measured amount of fuel and keying in that amount (to calibrate the fuel sensor). At the end of this calibration period, Voyager can be programmed to provide two figures which the user should note. Then if, at some future date, Voyager is removed for any reason, or if the car battery is taken out and Voyager's internal memory is erased, the figures can simply be re-inserted, thus saving the bother of having to go through the whole calibration procedure again. The kilometre-spaced marker-posts on a motorway are a convenient measure of the distance to programme into Voyager.

Eating up the miles, my car went through about seven gallons of petrol on a motorway trip, so I was very quickly able to see Voyager fully operational.

Installation of the speed sensor.



The two PCBs are fitted back-to-back.



The assembled PCBs before installation.

One of the most amazing things you become aware of on a 'consumption now' reading ie, how many miles-per-gallon the car is doing on a second-by-second basis, is how little fuel is used cruising at high speed, and how much fuel is being guzzled around town, in lower gears. For example, at a constant 70 mph in top gear my car registered about 32 mpg, whereas in second gear the car registered no higher than 12 mpg (at any engine speed) and in third gear: 22 mpg. The most economical speed of all was about 60 mph, when the car returned over 40 mpg.

All-in-all, Voyager represents good value for money as a well presented and well produced kit. It's fun to build, and can, in fact, save you money if you watch your fuel consumption figures. If you feel that you're not capable of building it yourself, Voyager is also available from Sparkrite, (at 82 Bath Street, Walsall, West Midlands WS1 3DE) as a ready-built and working device — all you have to do is fit it to your car. **HE**

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ICM 7211	400p
ICM 7212	300p
ICM 7216B	1800p
ICM 7216C	1800p
ICM 7216D	1800p
ICM 7217C	700p
ICM 7218	700p
ICM 7235A	400p
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LF 155T	
LF 355T	100p
LF 356H	100p
LF 357T	100p
LM 310	150p
LM 311	80p

LM 319	200p
LM 324	35p
LM 339	60p
LM 380	85p
LM 1458	50p
LM 2901	80p
LM 3401	80p
LM 3900	55p
MC 1310	150p
MC 1312	
MC 1327	
MC 1349	
MC 1350	80p
MC 1357	
MC 1456	80p
MC 1488	150p
MC 1489	200p
MC 1495	320p
MC 1496	80p
MM 53100N	200p
MM 57105	200p
NE 536T	
NE 540L	
NE 543K	200p
NE 541	
NG 550	90p
NE,555	16p
NG 556	40p
NG 558	100p

NE 562	350p
NE 565	120p
NE 566	160p
NE 5018	700p
NG 5553	120p
NG 5554	120p
TBA 810P	80p
TDA 1001A	
TDA 1003A	220p
TDA 1004	300p
TDA 1008	300p
TDA 1050	250p
TDA 1071	
TDA 1170	200p
TDA 1190	200p

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BC109C	8p
BC158	6p
BC159	9p
BC167	10p
BC173	7p
BC177	10p
BC178	13p
BC179	12p
BC182	9p
BC184L	9p
BC212	9p
BC212L	9p
BC213	9p
BC213L	9p
BC214	9p
BC214L	9p
BC477	18p
BC547	7p
BC549	9p
BC557	7p
BC558	7p
BC559	13p
BD131	35p
BD132	35p
BD135 to	
BD138	27p
BD139	35p
BD140	35p
BF180	22p
BF181	7p
BF184	21p
BF185	15p
BF194	12p

BF195	9p
BF196	7p
BF197	10p
BF244C	15p
BFR39	20p
BFX87	23p
BFY50	20p
BFY52	18p
BU205	105p
BU208	115p
MJ2955	90p
OC28	50p
TIP29B	28p
TIP30	25p
TIP30B	28p
TIP34A	46p
TIP36A	127p
TIP2955	58p
ZTX300	9p
ZTX500	11p
2N1131	11p
2N1304	23p
2N2222A	15p
2N2369	14p
2N2484	18p
2N2904	17p
2N2906	17p
2N2907	17p
2N2926G	10p
2N3053	25p
2N3055	44p
2N3702 to	
2N3711	6p
2N3823	52p
2N3866	40p
2N3903	11p
2N4037	35p
2N4058 to	

2N4061	6p
2N5458	40p
2N5459	35p
2N6027	18p
3N128	20p
CMOS	
4000	11p
4001B	11p
4006B	40p
4007	10p
4008	33p
4009	28p
4010B	33p
4011B	11p
4012	15p
4013B	23p
4014	52p
4015B	40p
4016	20p
4020B	43p
4021	43p
4022	40p
4023	11p
4025	14p
4027	20p
4028	42p
4029	45p
4030	14p
4035	46p
4041	42p
4042	44p
4043	46p
4044	40p
4048	43p
4049	24p
4050B	24p
4066	25p
4068	14p
4069	11p
4070B	15p
4071	15p
4072	15p
4073	15p
4081	14p
4082	14p
4516	58p
4518	46p
TTL 'N'	
7401	11p
7403	10p
7405	11p
7406	15p
7407	18p
7408	15p
7409	13p
7410	11p
7412	15p
7413	16p
7417	16p
7420	9p

7421	22p
7423	23p
7425	21p
7426	21p
7427	16p
7428	17p
7432	17p
7433	22p
7441	58p
7442	25p
7444	72p
7445	38p
7446	57p
7447A	35p
7448	25p
7472	25p
7473	14p
7474	16p
7475	20p
7476	18p
7482	56p
7483	35p
7489	110p
7490	20p
7492	26p
7493	27p
7494	27p
7495	35p
7497	98p
74100	70p
74105	46p
74107	18p
74109	19p
74110	33p
74118	61p
74121	21p
74122	30p
74123	40p
74125	35p
74126	33p
74132	33p
74141	48p
74145	40p
74147	85p
74150	51p
74151	36p
74153	40p
74155	36p
74157	35p
74161	29p
74162	26p
74163	40p
74164	38p
74165	46p
74167	70p
74174	40p
74176	20p
74177	37p
74180	30p
74184	70p
74185	92p

74190	42p
74191	44p
74192	40p
74193	46p
74194	46p
74195	46p
74198	89p
TTL 'LS'	
LS00	10p
LS01	10p
LS02	10p
LS03	12p
LS04	13p
LS08	11p
LS10	11p
LS12	11p
LS13	22p
LS14	22p
LS20	11p
LS21	14p
LS32	13p
LS42	28p
LS47	36p
LS48	45p
LS73	20p
LS74	16p
LS75	20p
LS76	19p
LS78	20p
LS86	18p
LS90	23p
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LS95	40p
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LS279	30p
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748-8	25p
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LF356N	60p
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LM308N-8	50p
LM318H	92p
LM339N	35p
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LM382N	70p
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Herman Hollerith

Ian Sinclair

An inventor who made a fortune from...a piece of cardboard?

THE HOLLERITH CARD was a device which was widely used in the dawn of computing, but the life and work of Herman Hollerith is not as well-known as it might be, despite this major contribution to the 20th Century.

Herman Hollerith was born in 1860 in Buffalo, New York State in the USA, of German immigrant parents. He went through school with little distinction, and graduated from Columbia University School of Mining in 1879. He is, therefore, yet another example of an inventor who made his name in a field of activity for which his training was virtually irrelevant. The moral of this is, that it's a background knowledge of subjects like maths, chemistry and, especially, physics, along with that indefinable urge to solve problems which motivates the true inventor that counts, rather than what you specialise in — though it sharpens your mind to have specialised in something. Hollerith, in fact, never pursued a career in mining engineering.

Computer Challenges

One of the lecturers at Columbia at that time was William P. Trowbridge, who was placed in charge of the 1880 census by the US Government. Trowbridge found that Hollerith was interested in what he (Trowbridge) was doing, and appointed Hollerith as his assistant in the slow and laborious process of gathering and analysing statistics for the census. When most of the work was finished, Hollerith took a teaching job at the newly-founded Massachusetts Institute of Technology, and after that, for the best part of ten years, he worked for the US Patent Office in Washington as a Patent examiner. There must be something about this type of work that provokes curiousity, because this is the job that Einstein also was doing while he formulated the Laws of Relativity.

Hollerith seems to have spent most of his time outside the office in brooding over the problems of the census. The tabulation work in the 1880 census had been done by hand, and even by that time the job was clearly becoming too much, with the looming danger that the results of one census would not be analysed by the time of the next one! Hollerith realised that only an automated system could possibly cope with the information from the next census in 1890, because of the huge increase in the population of the US and the number of new headings that would have to analysed. There were, for example, several hundred new job titles to account for, and the flood immigrants to the US meant that the statistics on the origins of new citizens were expanding enormously. Hollerith set about designing a system that would cope with the expected flood, and the results of his work were the beginning of data processing, the foundations of information technology.

A Simple Idea

The idea he came up with was, like so many good ideas, basically quite simple. Each census result was tabulated by punching holes in a card, using a card of as many columns (for headings) and as many hole positions (for data under each heading) as were needed. Modern cards use ten hole positions 40 columns. Each of these columns would be used to represent some measurable quantity, such as age range, and the position of the hole punched in that column would show the answer of that particular respondant. Similarly other answers on the sex, employment, marital status, number of children and educational achievement of the people who replied could be coded into one small card by the position of the hole punched in each column. The holes were punched by a small machine, like a cash register, and the rate at which a skilled operator could prepare cards from census forms was an enormous improvement on the filling-in of tables by hand.

The Hollerith cards were made from a non-conducting material, cardboard, so that the presence of a hole in a card could be detected electrically. This meant that comparatively simple electromechanical machines, using contacts and relays (no electronics in these days!) could carry out sorting. Even nowadays, the sight of a Hollerith card sorter in operation is rather awe-inspiring, as the cards are whipped across the sorting slots and pushed into the correct piles by small solenoids. Hollerith hoped, incidentally, that letters would be sorted in the same way, but this development did not take place.

Statistical Breakthrough

Hollerith's cards, and the punches and readers that he had developed to make use of them, were just the breakthrough that statisticians needed, because methods of tabulation that depended on metal rods fitting into the cards had proved to be much too slow and cumbersome. By using electrical contacts on each side of the card, Hollerith's system ensured very rapid reading, so that the results of a census could be available in a few months. His system was ready for the 1980 census, and it proved enormously successful, drastically shortening the time that was needed to obtain results from the census. It would probably be no exaggeration to say that this prompt availability of statistics laid the foundation for the expansion of the US economy which persisted for the next 40 years. Oddly enough, though, despite the clear advantages of the system, and the undoubted success that it had, it was not widely adopted in the US outside the census office. For some curious reason, companies in the US at that time did not appear to realise the usefulness of Hollerith's data processing system.

In a strange reversal of the normal procedure, Hollerith took his invention to Europe, where it was enthusiastically taken up for statistical purposes (but not, at that time, in the conservative UK), and encouraged by this success, Hollerith returned to the US to form the Tabulating Machine Co., incorporated in New York in 1896, to manufacture tabulators of all types. This time the idea caught on, and tabulating machines bearing the Hollerith imprint started to appear in the accounts offices of organisations all over the world. The name 'Comptometer' started to be used — how many readers remember the number of job vacancies for comptometer operators in the late 40s and early 50s? The punched-card system became a world standard, and when I first started computer programming, the program had to be punched onto Hollerith-type cards. Herman Hollerith himself died in 1929 in Washington, D.C.

Whatever became of the Tabulating Machine Co.? Well, it's a fact of life that a lot of companies that start off with a few employees, and are successful, will eventually grow to be very big companies. The Tabulating Machine Co. was absorbed by one take-over after another, devoured other companies in turn, and eventually changed its name to International Business Machines, now the jolly green giant of computer manufacturers. I wonder if Acorns grow as fast? **HE**

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Overvoltage Cut-out

A super circuit protector for all mains-powered projcts.

WHEN a stabilised supply becomes faulty, this often results in a substantial increase in the output voltage, but the first indication that a fault has occurred is likely to be when the supplied equipment fails due to semiconductors or other delicate components being damaged by the excessive supply potential! The voltage difference between the unregulated and regulated supplies can be surprisingly large, incidentally, with an overload in the region of 50% being quite possible if the unregulated supply finds its way to the output.

A simple method of protecting equipment against an excessive supply voltage is to use an overvoltage cutout between the power source and the equipment concerned. The circuit described here is of the 'crowbar' type that instantly short circuits the power supply if an input potential above a certain threshold level is detected. The virtual short circuit that is placed across the supply almost instantly pulls the supply voltage down to a safe level, and limits the duration of the overload to an insignificant period of a fraction of a millisecond. A fuse, in series with the input of the cutout, then blows so that power is cut off altogether until the fault has been rectified and the fuse has been replaced.

It is possible to have a purely electronic cutout, and this 'crowbar' method may seem a little crude. However, it has the advantage of a negligible voltage drop through the fuse (which is the only component in series with the supply), so that adding a unit of this type should give no degradation of performance.

The Circuit

The circuit diagram of the Overvoltage Cutout is shown in **Figure 2**. Operational amplifier IC1 is used as the comparator, while R5 provides a small amount of positive feedback over IC1 so that the output triggers either to the high state or low state, but cannot be at an intermediate level. The output is low if the inverting input (pin 2) is at a higher voltage than the non-inverting input (pin 3), or the high state if the comparative input levels are reversed.

The inverting input is held at a stable potential of 6V8 by the simple Zener stabiliser circuit formed by R2 and ZD1. The non-inverting input is fed from the supply lines via a potential divider which is formed by R1, R2 and R3, and this divider circuit supplies a little under half the supply voltage to the non-inverting input. R1 and C1 form a simple filter which prevents transients on the supply from producing spurious triggering of the unit.

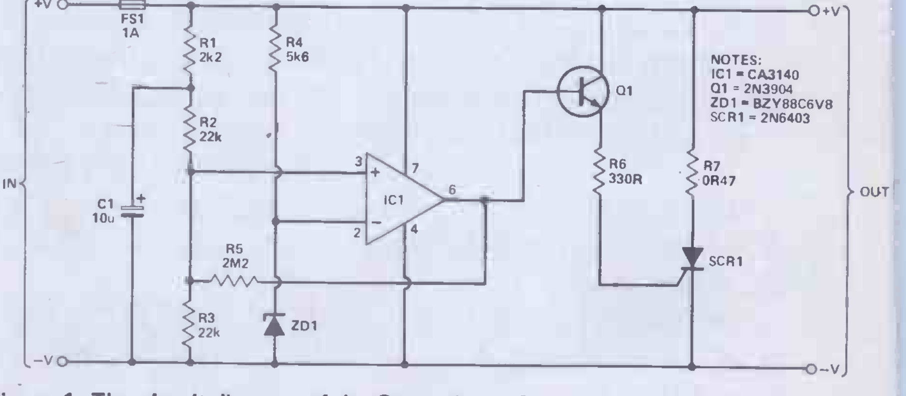


Figure 1. The circuit diagram of the Overvoltage Cut-out.

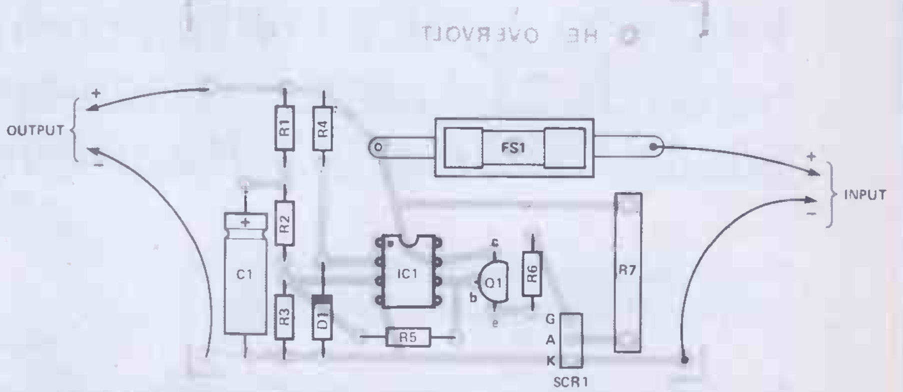


Figure 2. The PCB component overlay. The full-sized foil pattern is reproduced on the PCB Printout page.

With a nominal 12V supply (allowing for the fact that some items of equipment, such as a mains power supplies for CB transceivers, actually give about 13.8 V, and a car supply can reach a similar level), the potential fed to the non-inverting input of IC1 is still below the 6V8 reference potential applied to the inverting input. IC1's output is low, Q1 is biased off and SCR1 is switched off.

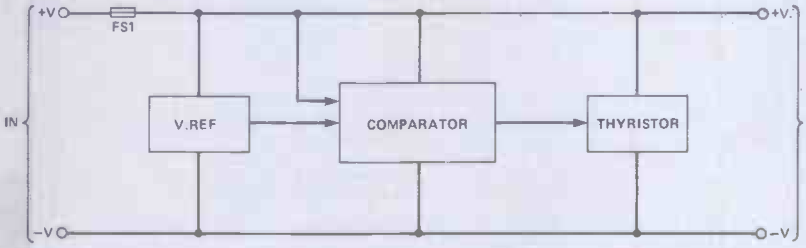
The situation is different if a fault occurs; if the supply voltage rises above about 14.3V, the non-inverting input is then the one at the higher potential. This causes the output of IC1 to be triggered to the high state, turning on Q1 and SCR1; the supply is 'crowbarred', with SCR1 effectively short circuit, and fuse FS1 blows. The output current ot IC1 is insufficient to reliably operate most thyristors, and Q1 is therefore used as an emitter follower buffer stage to produce a suitably high drive current; R6 prevents excessive gate current from flowing into SCR1. R7 gives a certain amount of current limiting when SCR1 is triggered, although this is probably not, strictly, necessary as SCR1 only has to conduct for a few milliseconds before FS1 disconnects the supply, and a considerable current overload could probably be tolerated for such a short duration.

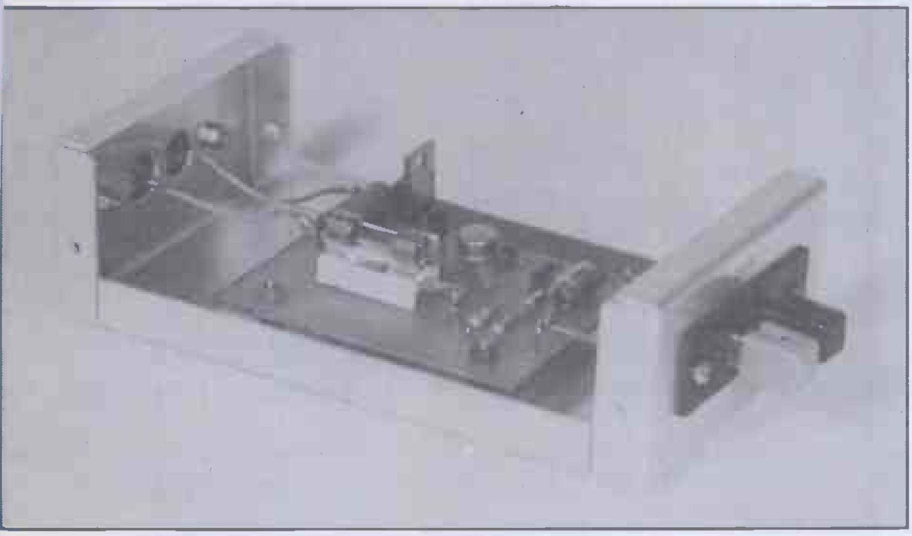
FS1 is a 1 amp fuse on the prototype, but the rating of this fuse must obviously be varied to suit the particular item of equipment fed from the output. It should have a current rating approximately equal to or a little higher than the maximum current drain of the equipment being powered. For example, a current consumption of 1.8A would require a 2A fuse, this being the nearest current rating available, but higher than the 1.8A figure.

How It Works

A COMPARATOR is used as the basis of the circuit; this compares the supply voltage with a stable reference voltage. Normally the difference between the reference potential and the supply voltage is quite small and the output of the comparator is consequently at a low voltage. The thyristor, which it drives via Q1, is therefore switched off and has no effect.

If the supply voltage rises to a high enough level the potential difference between the reference and supply voltages is sufficient to trigger the comparator to the high state and the thyristor is then switched on via Q1. It virtually short circuits the supply, so that the voltage is reduced to a low and safe level, but the high current flow causes FS1 to blow and completely cut off the supply from the output. The unit is primarily intended for use with 12 V equipment such as power supplies for mobile CB transceivers. The nominal trigger voltage is 14.3 V.





Construction

All the components (including FS1 and its chassis mounting fuseholder) are mounted on a printed circuit board which is detailed in **Figure 2**. This is constructed in the usual way, but bear in mind that IC1 has a MOS Input stage and therefore needs the standard MOS handling precautions. Both the CA3140E (which is an 8 pin DIL package) and the CA3140T (which has an 8 pin TO-99 metal package) will readily fit onto the printed circuit board. Note that SCR1 does not need a heatsink, as it conducts too briefly to heat up significantly. Any thyristor having a current rating of about 12A or more should be satisfactory in this design, and it is not essential to use a 2N6403.

The printed circuit board is small enough to fit into practically any small metal or plastic case. Pairs of spring terminals are fitted at each end of the case to provide an easy way of connecting the input and output leads to the unit, and these are colour coded red and black to indicate the polarity of the supply lines. Clearly mark which set of contacts are the input terminals and which are the outputs, and be sure to connect the unit correctly. There will be dire consequences if a mistake is made here since, if the unit is triggered, the fuse will not blow because it would be at the *output* of the unit instead of the input.

A simple way to test the unit is to use a bench power supply to provide an input voltage which is steadily increased from about 10 volts until the circuit triggers; a voltmeter is used to monitor the voltage. The current limiting facility of the supply can be used to prevent FS1 from blowing, and the circuit can then be reset by reducing the supply voltage and momentarily disconnecting the supply from the input of the unit. If necessary, the trigger voltage can be reduced slightly by decreasing the value of R2, or increased by raising the value of this resistor. **HE**

Parts List

RESISTORS
(All ¼ watt 5% unless noted)
R1 . . . . 2k2
R2,3 . . . . 22k
R4 . . . . 5k6
R5 . . . . 2M2
R6 . . . . 330R
R7 . . . . 0R47 5W 10%

CAPACITORS
C1 . . . . 10u
25V axial electrolytic

SEMICONDUCTORS
ZD1 . . . . BZY88C6V8
6V8 400mW Zener
Q1 . . . . 2N3904
IC1 . . . . CA3140
SCR1 . . . . 2N6403 or similar

MISCELLANEOUS
FS1 . . . . . . 20mm quickblow fuse current rating as required
Chassis mounting 20mm fuseholder; input and output terminals; printed circuit board; case; 6BA fixings, connecting wire, solder etc.

BUYLINES . . . . Page 34

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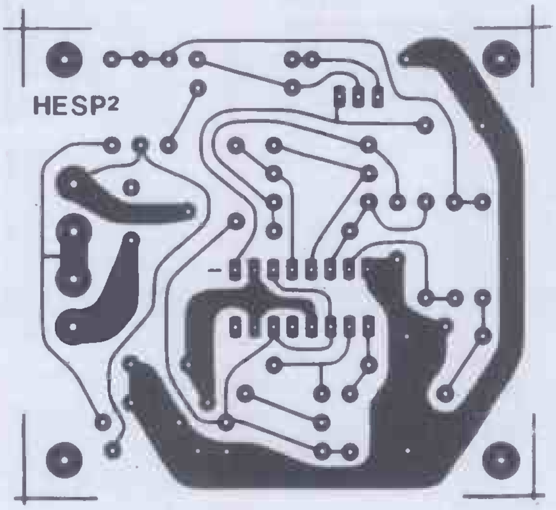
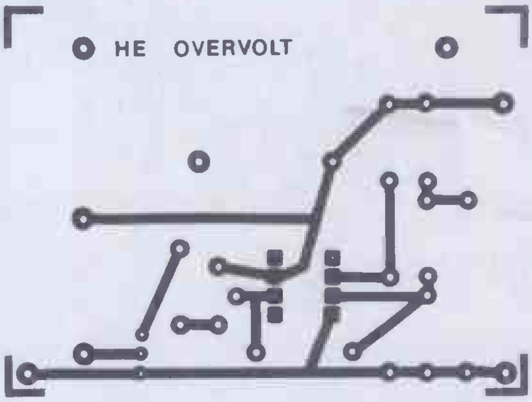
Below: The PCB foil pattern for the Signal Powered Loudspeaker Protector.



Foil pattern of the Overvolt Cut-out.



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