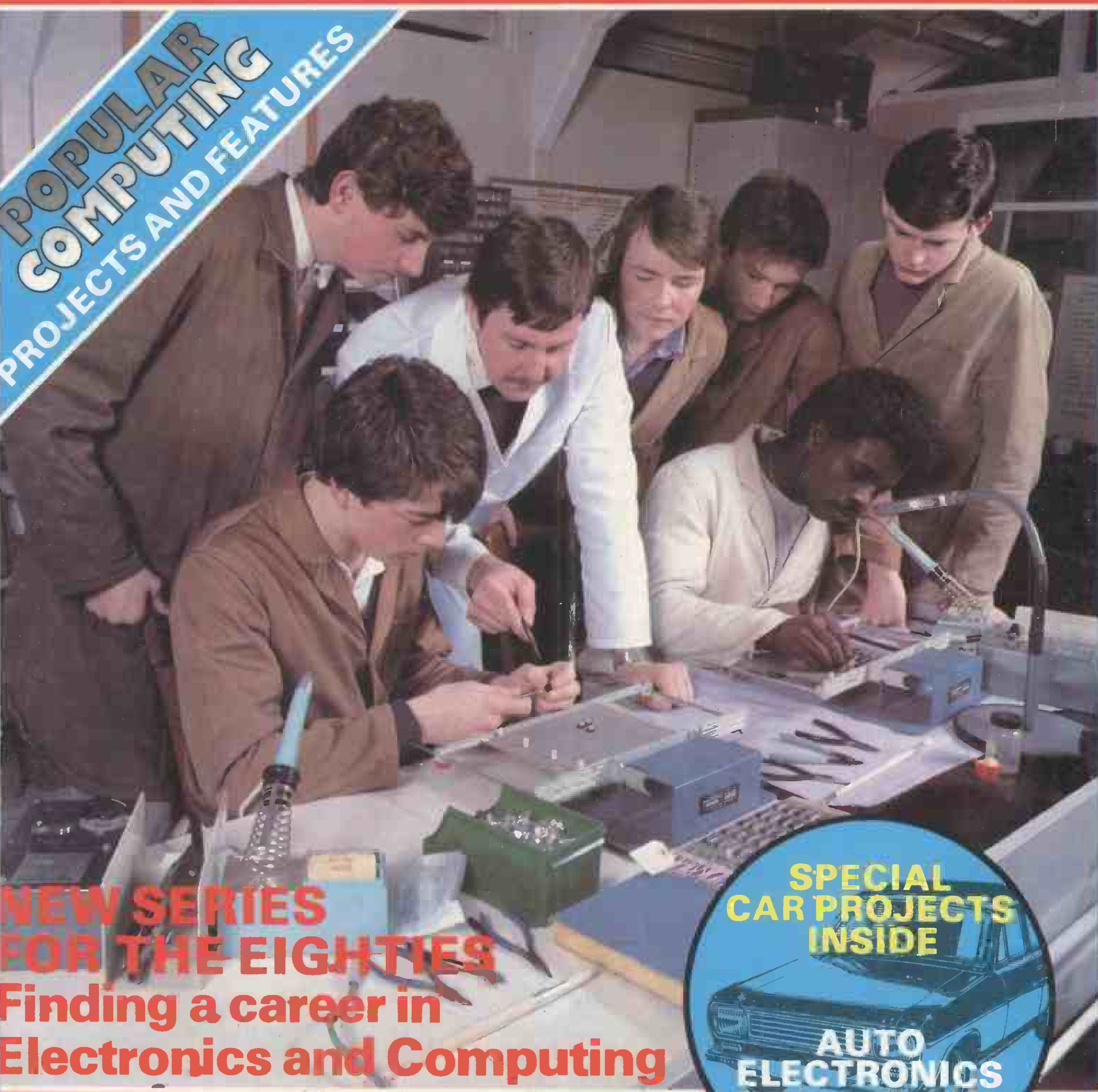
# Hobby Electronics

AN ARGUS SPECIALIST PUBLICATION

MAY 1983
80p

Project Electronics For Everyone



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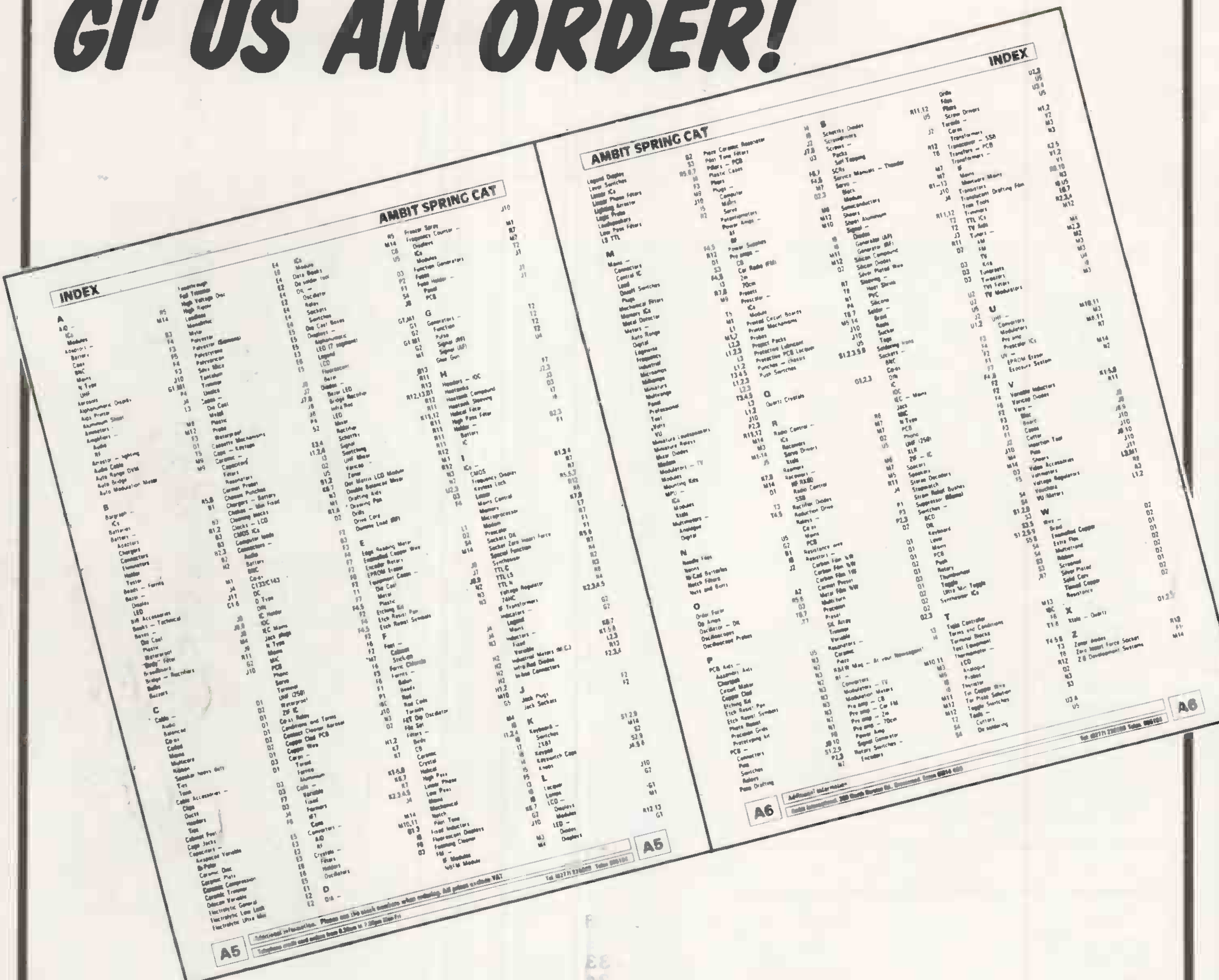


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MAY 1983
Vol 5 No 5

# Hobby Electronics

## PROJECTS



## FEATURES



## SPECIALS



## REGULARS



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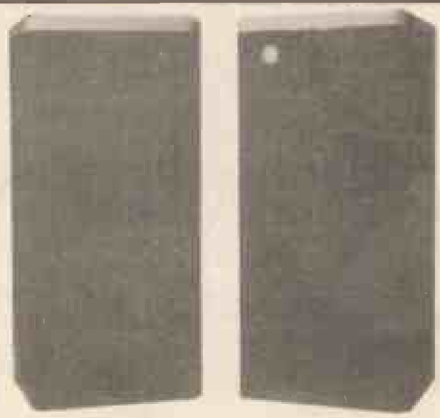

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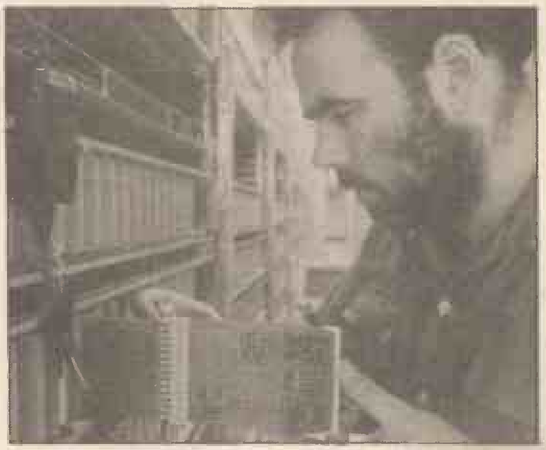

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## LINEAR

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LM339 | 45 | LM3911 | 120 | NE566 | 140 | TL064 | 96 |
| | | | | LM348 | 60 | LM3914 | 175 | ▶NE567 | 100 | TL071 | 30 |
| | | | | LM358 | 50 | LM3915 | 195 | ▶NE570 | 370 | TL072 | 50 |
| 555CMOS | 80 | ICL7106 | 790 | LM377 | 170 | LM13600 | 105 | NE571 | 370 | TL074 | 95 |
| 556CMOS | 150 | ICL7611 | 95 | ▶LM380 | 65 | MC1496 | 68 | ▶RC4136 | 55 | ▶TL081 | 25 |
| 709 | 25 | ICL7621 | 180 | ▶LM381 | 120 | MC3340 | 135 | ▶RC4558 | 60 | TL082 | 45 |
| ▶741 | 18 | ICL7622 | 180 | LM382 | 120 | ▶MF10CN | 350 | SL480 | 170 | TL084 | 95 |
| 748 | 35 | ICL8038 | 295 | LM384 | 130 | ML922 | 400 | SL490 | 250 | TL170 | 50 |
| 9400CJ | 350 | ICL8211A | 200 | LM386 | 65 | ML924 | 195 | SL76018 | 150 | UA2240 | 120 |
| AY-3-1270 | 720 | ICM7224 | 785 | LM387 | 120 | ML925 | 210 | ▶SN76477 | 380 | ULN2003 | 85 |
| AY-3-8910 | 370 | ICM7555 | 80 | LM393 | 100 | ML926 | 140 | SP8629 | 250 | ULN2004 | 90 |
| AY-3-8912 | 540 | ▶LF351 | 45 | LM709 | 25 | ML927 | 140 | TBA120S | 70 | XR2206 | 290 |
| CA3046 | 60 | LF353 | 85 | LM711 | 60 | ML928 | 140 | TBA800 | 75 | ZN414 | 100 |
| ▶CA3080 | 65 | LF356 | 90 | LM725 | 350 | ML929 | 140 | TBA810 | 96 | ZN423 | 135 |
| CA3089 | 190 | LM10 | 360 | LM733 | 75 | MM5387A | 465 | TBA820 | 70 | ZN424 | 135 |
| CA3090AQ | 375 | LM301A | 25 | LM741 | 14 | NE529 | 225 | TBA950 | 220 | ZN425E | 350 |
| CA3130E | 85 | LM311 | 70 | LM747 | 60 | NE531 | 150 | TDA1008 | 320 | ZN426E | 330 |
| ▶CA3140E | 36 | LM318 | 120 | LM1458 | 40 | NE544 | 205 | ▶TDA1022 | 490 | ZN427E | 650 |
| CA3161E | 100 | LM324 | 40 | LM2917 | 200 | ▶NE555 | 16 | TDA1024 | 125 | ZN428E | 480 |
| CA3189 | 290 | LM334Z | 100 | LM3900 | 45 | ▶NE556 | 45 | TL061 | 40 | ZN459 | 285 |
| ▶CA3240E | 110 | LM335Z | 125 | ▶LM3909 | 70 | NE565 | 110 | TL062 | 60 | ZN1034E | 200 |

## TRANSISTORS

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | BC517 | 40 | BF337 | 40 | MPSU56 | 60 | ZTX108 | 8 | 2N3055 | 50 |
| | | | | BC547 | 7 | BFR40 | 23 | TIP29A | 30 | ZTX109 | 12 | 2N3442 | 120 |
| | | | | 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 | 10 | 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 | 10 | 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 | 45 |
| 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 |
| 8C141 | 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 | | |
| 8C148 | 8 | BC479 | 30 | BF259 | 35 | MPSU55 | 60 | ZTX107 | 8 | 2N3054 | 55 | | |

## 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 |
| 10 way gery ribbon | 38p/m |
| 20 way grey ribbon | 80p/m |

## 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 |

## CAPACITORS

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

## 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 | 560 |

## 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.

## TRIACS

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

## DIODES

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

## 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

## 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.

## 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 |

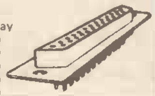
## TRANSFORMERS

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)

## MIN. D CONNECTORS

| | 9 way | 15 way | 25 way | 37 way |
|---|---|---|---|---|
| Plugs solder lugs | 60p | 85p | 125p | 170p |
| Right angle | 120p | 180p | 240p | 350p |
| Sockets lugs | 90p | 130p | 195p | 290p |
| Right angle | 160p | 210p | 290p | 440p |
| Covers | 100p | 90p | 100p | 110p |



## 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 |

## 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 resistant pen | 100 |
| Fibre glass board 3.75 x 8" | 80 |
| Fibre glass board 8 x 12" | 200 |
| Ferric Chloride crystals | 100 |

## BOXES

| | | | |
|---|---|---|---|
| | | Aluminium | |
| | | 3 x 2 x 1" | 65 |
| Plastic with lid | | 4 x 2¾ x 1½" | 95 |
| & screws | | 4 x 2½ x 2" | 95 |
| 3 x 2 x 1" | 55 | 6 x 4 x 2" | 120 |
| 4½ x 3 x 1½" | 88 | 7 x 5 x 2½" | 165 |
| 7 x 4 x 2" | 160 | 8 x 6 x 3" | 205 |

## CONNECTORS

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

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SD239 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 |

## SCRs

| | |
|---|---|
| ▶C106D | 30 |
| 400V 8A | 70 |
| 400V 12A | 95 |

## 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 |

## 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 |

## CMOS

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 | 225 | 4094 | 68 | 4511 | 40 | 4549 | 360 |
| 4007 | 14 | 4023 | 16 | 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 | | |

## 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 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

## MICRO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 6116P3 | 365 | 6852 | 240 | 8228 | 220 |
| | | 6502CPU | 325 | 6875 | 495 | 8251 | 250 |
| | | 6522VIA | 295 | 6880 | 100 | 8253 | 390 |
| | | 6532 | 570 | 81LS95 | 85 | 8255 | 225 |
| | | 6551 ACIA | 650 | 81LS96 | 85 | 8259 | 390 |
| 2114L2 | 75 | 6800CPU | 220 | 81LS97 | 85 | MC1488 | 55 |
| 2716 | 205 | 6802CPU | 250 | 8080A | 250 | MC1489 | 55 |
| 2532 | 290 | 6809CPU | 620 | 8085AC | 340 | Z80ACPU | 290 |
| 2732 | 290 | 6810RAM | 115 | 8156 | 350 | Z80APIO | 260 |
| 2764 | 540 | 6821 PIA | 110 | 8212 | 110 | Z80ACTC | 260 |
| 4116P20 | 70 | 6840 | 360 | 8216 | 100 | Z80ASIO | 900 |
| 5101L-1 | 220 | 6850 | 110 | 8224 | 120 | Z80ADMA | 1150 |

## 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 | | |

## 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 | 98p |

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) . . . 530
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. | |

## 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 | | |

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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.

# MONITOR

## Will The Last Person To Leave The House Kindly Put It On Standby . . .

The futurist's dream (one of them anyway): your house at your command. You describe the environment you want, and the computer does the rest. Eventually, not even a computer like the micros we're playing with now, but a little machine totally dedicated to controlling your habitat at the press of a button, nay, at a spoken word. We're not quite there yet, but the incidence of units either specifically designed for controlling household processes, or readily adaptable as such, is definitely increasing. Here are two:

First, from **Electronic and Computer Workshop**, a Universal Microprocessor Timer. Developed originally for industrial and lab use, it comes in kit form suitable for hobbyists. Applications specifically mentioned by ECW include control of house lighting, TV/audio gear, and automatic plant watering.

The timer is based on a preprogrammed TMS 1000 microprocessor, and has a 24-hour clock with four independent relay-controlled outputs. There are 20 daily/weekly functions, entered via a keyboard, and the timer can be set to control any one of the four relay outputs.

Timer functions are set out clearly and simply in the manual, and completed steps are indicated by LEDs and a 12mm seven-segment LED display.

The unit's power supply is stabilised on a separate PCB, and one output control relay is supplied. A total of four relays can be accommodated and relays can be easily obtained.

The kit comes complete with printed panel, to be installed as either a built-in or free standing unit. Price is £58.06 (complete with wooden housing) plus 15% VAT plus £1.50 p&p. Orders and enquiries to **Electronic and Computer Workshop Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 62149.**

Secondly, **Superswitch Electric Appliances** ("Total control at your Fingertips") has come up with the Command Centre, a 'revolutionary' new remote control unit for all kinds of electrical appliance.

By transmitting high frequency signals along AC mains wiring the Command Centre is capable of remotely operating up to sixteen different appliances. Remote control can be done either manually or programmed to take place automatically up to seven days ahead, with a maximum of 24 automatic programs at one time.

The signals sent by the Command console are received by plug-in modules, designed either for appliances or for portable lamps, which are plugged into the ordinary 13 amp household sockets. The two types of module are a safety feature, as one kind is rated for loads up to 13 amps and the lighting one for tungsten lighting up to 400W.

A major feature of the Centre is its ability to check and indicate whether an appliance in another room is on or off when asked. Other features include an 'energy save' key to bring on lamps at one of three brightness levers; manual dimming of lamps; ability to turn on all lamps simultaneously; simple programming on a keyboard that gives tone to tell you that entries have been correctly made; choice of 12 or 24 hour digital clock; simple reviewing and alteration of programs; 9V battery to save programs in case of power failure; ability to turn off up to twelve moduels simultaneously; filter modules available in case of any interference to the Command Centre from some TV sets; manual override on all modules, and last but not least you can use it as an alarm clock.

The price for a 'starter pack' with the Command Centre, and one of each module, is £139.95 inc VAT, no p&p. Contact **Superswitch Electric Appliances Ltd., 7 Station Trading Estate, Blackwater, Camberley, Surrey GU17 9AH. Tel: (0276) 34556.** Superswitch, incidentally, do all kinds of domestic and light industrial timer controllers, dimmer and time delay switches, remote control switches and units, fan controls and security switches.

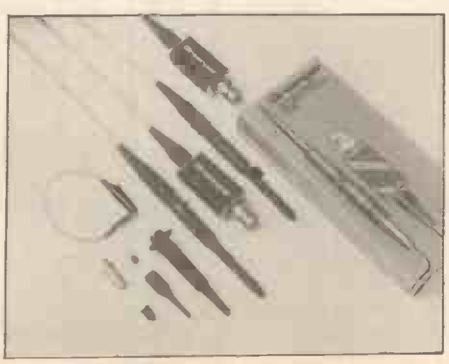

## Slick Scope Probes

More closely resembling a super executive non-slip-grip-fibretip pen than a conventional scope probe, **Greenpar Connectors'** new range of Posiscan inexpensive miniature oscilloscope probes have been designed for easy and accurate handling on crowded PCBs. The probes come supplied with seven accessories: a BNC adaptor for signal aquisition from a co-ax socket, an IC test tip, a tip insulator, detachable earth lead, spring hook, trimmer tool and a spare probe tip in case of accidental damage to the hardwearing original. 1.5 metres of cable is supplied.

The probes are compatible with Hewlett-Packard, Philips and Tektronix accessories. Two types are available: No. 99025, with 10:1 fixed attentuation, and No. 99125, with attenuation switchable from 10:1 to 1:1.

The specifications give, for the 10:1 probe (both models): bandwidth more than 250MHz giving useful bandwidth from 100 to 140MHz with typical 100 to 150MHz scopes; risetime 1.5ns max.; compensation range for scopes of 15 to 50pF input resistance; input capacitance 15pF nominal (17pF for the 99125); input resistance 10MR ±1% with scopes of 1MR resistance; for the 1:1 probe (99125 only), bandwidth 5MHz; risetime 70ns; input capacitance 100pF; input resistance equal to scope.

The probes come packed in a new-style card carton with the specification printed on the back. Prices are around £18.00 and £20.00. For further information contact **Greenpar Connectors Ltd., Studlands Park Avenue, Newmarket, Suffolk CB8 7EA. Tel: (0638) 668081.**



## Status Quo Fans Please Note

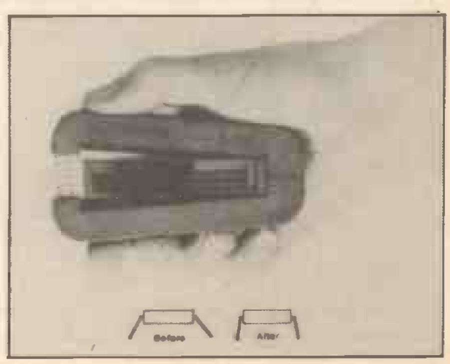
If you use any number of ICs and find that they come out of their packaging with their legs splayed out, so that they do not match standard IC plugs or rub-down PCB marks, **Aries Electronics** have a tool which will restore proper alignment.

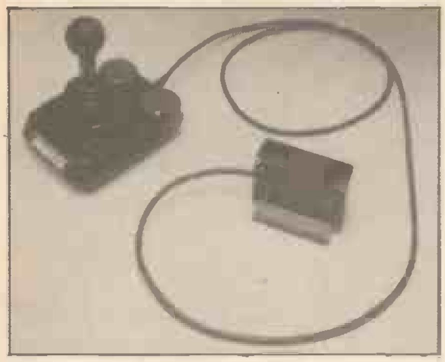
The Dip-R-Sizer T-516 is designed to take ICs with both .003 or .006 centres. The IC is simply mounted on one side or another of a metal block between a pair of sprung jaws, and the legs squeezed back into specification.

It doesn't look as if the tool would be much help if your 'carpet crawler' has been trodden on or squashed right out of shape, other than giving the legs a final adjustment to the right pitch after a workout with the pliers.

Most useful if you're sharing a workshop or lab, at school for instance, or if you are cannibalising a lot of stuff from old boards. Price is £10.50 inc. VAT and p&p.

**Aries Electronics (Europe), Eastways, Witham, Essex CM8 3YQ. Tel. (0376) 519318.**





## Spectrum Joystick

A self-centering joystick, called the Competition-Pro, is now available for the ZX Spectrum from **Kemston Micro Electronics.** The compact unit has eight direction commands and two large fire buttons for ease of play without wearing out your hands too quickly. Furthermore a number of software houses are developing games for use with a joystick, and others are on the way. It should also be possible to convert any BASIC program to work with the joystick and a short program is included to show you how to do this.

The joystick has a boxed interface which simply plugs into the expansion port of the Spectrum, with or without the printer.

Price is £25.00 plus £1.00 p&p. Enquire **Kempston (Micro) Electronics, 180a Bedford Road, Kempston, Bedford MK42 8BL.**

## Memories Of A Camel

More memory modules from **Camel Products:** for the ZX81, a new 64K RAM expansion modules. This comes with a link option to disable RAM in the 0 to 16K range of the ZX81's memory (for use by peripheral cards) and is therefore able to accept an EPROM as an alternative in that part of the map. A 28 pin IC socket can accomodate not only the popular 2716/2732 EPROMs but also the newer 2764 and 27218 devices. These latter give the user 8K and 16K of non-volatile memory respectively.

The cost per byte of the 2764 is already nearly as low as the smaller EPROMs and they are seen as an important trend for ZX81 program storage. Another link option allows slow (450ns) EPROMs to be used with a slightly higher power dissipation.

The unit, named DREAM 81, comes in an ABS case with LED-power indicator and costs £69.95 plus VAT.

Secondly, Camel have introduced a 4K version alongside their 2K MEMIC L CMOS RAM unit. The new MEMIC L 2 offers as much memory as the 2732 and 2532 Eproms (See HE March '83). These units use the latest True CMOS static RAMS which take only a fraction of a uA of current to retain data. An integral lithium battery supplies the standby power for ten years or so and the current drain is so small that no battery on/off switch is needed.

The use of fast (200ns) RAMs extends system capability by providing a user-definable ROM which can run without wait states in most systems and yet can be reprogrammed at will. This is useful as a soft character generator, for extending language interpreters and operating systems, etc.

The MEMIC unit comes in a moulded black AMS case with a flip-open window for a 24 pin cable connector, the far end of which plugs into the host system's 2716/32 or 2516/32 socket.

Price is £35.95 plus VAT. For information contact **Cambridge Microelectronics Ltd., 1, Milton Road, Cambridge. Tel: (0223) 31814.**

## Never Mind The Voltage, Feel The Heat

Anyone who has access to a digital multimeter can now use it as a wide range temperature measuring instrument using standard type K thermocouples, by adding **Graham Bell Instrumentations'** DVM/TC Interface Unit.

At considerably lower cost than a dedicated unit, this device has a temperature range of −50° to 1100°C and incorporates automatic cold junction compensation. Thermocouples are attached via a miniature compensated socket. A basic thermocouple and mating plug are supplied as standard with the instrument.

The output of 1mV per degree centigrade is via a 0.75mm coiled lead fitted with 4mm plugs. Long term stability is excellent and the low battery drain allows it to be used for continous monitoring if necessary. Since the accuracy is not affected by the output loading, it may also be used to interface low output impedance instruments such as chart recorders.

Price is £36.00 plus VAT. For more information and p&p charges contact **Graham Bell Instrumentation, PO Box 230, 39 Derbyshire Lane, Sheffield S8 0TH. Tel: (0742) 582370.**

## A Bit More Scope

The **Philips** 15MHz PM3207 oscilloscope now incorporates a new CR tube which (like so many advances) is simpler in design yet more reliable than earlier tubes, and gives a sharper and brighter picture. Using their renowned colour TV experience, Philips have used simple internally-mounted permanent magnets to manipulate the electron beam, rather than the conventional electrostatic systems, and two permanently-magnetised wire rings are fitted in the electron gun, giving greater, and better calibrated, deflection sensitivity, more accurate beam centring, stigmatic focussing and more accurate scanning; a higher acceleraton voltage is possible than usual in this class of scope, giving a brighter picture.

The choice of display modes includes A+B vertical channel display with separate B channel inversion, and X deflection through the A vertical input channel, for maximum input sensitivity in the X-Y display mode. Automatic triggering is standard; a separate peak-level control ensures a stable picture and the integral TV triggering facility provides automatic changeover from line to frame. Sensitivity is high (5mV), and there is double insulation between line and scope to avoid ground loop problems. The display screen is 8 x 10 cm, weight is 5kg and dimensions are 300 x 130 x 37mm (12 x 5¼ x 14⅝in). The PM3207 is advertised as meeting all the environmental requirements of a heavy-duty workshop oscilloscope, to standard VDE 0411 (a European standard).

Price is £372.00 from retail outlets, or contact **Pye Unicam Ltd., York St., Cambridge CB1 2PX. Tel: (0223) 358866.**

# MONITOR

## Shorts

**Stotron** are now supplying soldering equipment by Greenwood: this includes a high quality 24V 50W soldering station, a cordless Iso-Tip iron powered by long life NiCad batteries (a real boon to anyone who indulges in modifications to their car or bike electrics), which automatically recharges itself overnight in its own, plug-in stand, and accessories including solder-suckers, de-soldering braid and iron-coated long-life soldering tips.

For information on both these ranges contact **Inge Abraham, Stotron Ltd., 72 Blackheath Rd., Greenwich, London SE10 8DA. Tel: 01 691 2031.**

**OK Machine and Tool** are doing a range of PC board guides and brackets in moulded black plastic, to accommodate boards from 1.02 to 2.55mm (0.040 to 0.100in) thick with an overall length of 106mm (4.12in). Snap-in buttons ensure easy assembly to rack or brackets. The guides give a unique spring action which dampens shock and vibration. The support brackets feature a stabilizing post which permits secure mounting with only one screw. The guides can be bought as a kit (TRs-2) which includes two guides and two mounting brackets. Enquire **OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. Tel: (0703) 610944.**

The **Tangerine Users Group** has moved to new premises near Bristol. This goes with an increase in staff, the formation of a new R & D team to extend the Microtan system support, and the eventual setting-up of a monthly meeting centre for members.

By the time you read this, TUG should be well settled in and the disruption caused by the move should be settling down, but if anyone has written and not received a reply, this is the cause.

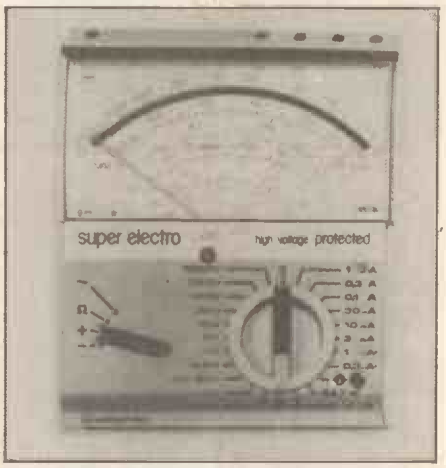
The new centre is a few miles south of Bristol with easy access to the M4 and M5, and hopefully will make a better meeting place for members.

The new address is: **Tangerine Users Group, 1 Marlborough Drive, Worle, Avon BS22 0DQ. Tel: (0934) 21315.**

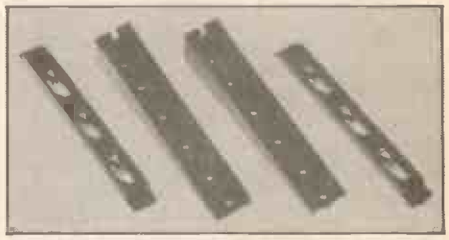
The radio wristwatch shown in our picture uses a **Ferranti Electronics** ZX414Z tuned frequency circuit. The watch is made by **Advance Products UK Ltd., 8A Hornsey St., London N7. Tel: 01 609 0061.** Well, it's a change from the personalised stereo suitcases seen and heard so oft upon our streets . . .

The Super Electro analogue multimeter from **Elemic** of Italy is now being supplied by **Black Star**. Voltage can be measured to 1000VAC and DC, and current to 30ADC and AC, as well as resistance and capacitance. The Super Electro also provides phase sequence detection for three phase systems and a mains and insulation tester. It is based on a high precision moving-coil ammeter, and has coloured scales, an antiparallax mirror and comes complete with a lined protective case, fused test leads and one year guarantee. Sensitivity is 20kR/VDC, accuracy is 1.5% fsd, and there is 50,000V protection on all ranges.

The Super Electro costs £39.95 plus VAT from **Black Star Ltd., 9A Crown St., St. Ives, Huntingdon, Cambs PE17 4EB. Tel: (0480) 62440.**




**Sinclair Research** is marketing its popular ZX Spectrum micro through a wider chain of retail outlets from mid-February. Selected branches of Boots, Curry's, Greens and John Menzies will join the former sole distributor, W.H. Smith, and Sinclair's UK distributor, Prism Microproducts, will be distributing to John Lewis, House of Fraser, Rank Xerox and many smaller stores.



Sinclair expects to be selling twelve to fifteen thousand Spectrums a week in the UK by Easter, and claims sales of its established favourite, the ZX81, of 30,000 a week. Production of the Spectrum is now claimed to be over 50,000 a month and rising, which should cover demand and remove the likelihood of further distribution problems such as Sinclair suffered in 1982.

Enquiries about the Spectrum, ZX80 and ZX81 to your local dealer or to **Sinclair Research Ltd., 25 Willis Rd., Cambridge CB1 2AQ. Tel: (0223) 353204.**

All-round tool suppliers **Toolmail** have now issued their new catalogue with prices from February to December 1983. The 128 page catalogue costs £1.00, including postage, and is colour illustrated with over 2000 items, details and prices. Delivery is free and goods are normally despatched from stock within 48 hours. Toolmail prefer to buy British tools where possible, and offer a 'no quibble' guarantee on all their lines. The new catalogues each include three £1.00 vouchers redeemable against orders.

Contact **Toolmail (1983) Ltd., P O Box 46, Maidstone, Kent ME15 8EQ. Tel: (0622) 682861.**

Hardware and heatsink suppliers Dau (UK) Ltd. and specialist in passive components Church House Components Ltd., of Bognor Regis, have combined operations to become **Dau Components Ltd.**, and the address to contact is **70-74 Barnham Rd., Barnham, W. Sussex, PO22 0ES. Tel: Yapton (0243) 553031.**

## Look Sharp

**Sharp Electronics** have announced a series of new products which they will show at the 'Which Computer' show at the NEC, Birmingham in January 1983.

They are launching a pocket computer, the PC1252, at the show itself. Running a version of BASIC extended from the PC-1211, including twodimensional arrays and full string handling commands, it has a capacity of 24k ROM and 4.2k RAM. The memory is protected by a battery backup when the machine is switched off, and the PC-1251 works for up to 300 hours on one battery. It has a QWERTY keypad and 24 character LCD, and measures in at approximately 131 x 19 x 9 mm. (5¼ x 2¾ x ⅜").

Also available for this new computer is the CE-125 integrated printer microcassette recorder: the two machines stacked together are only as large as a one-inch thick A5 paperback.

For the future, Sharp will also be showing their hand-held micro, the PC-1500, for the first time with the new RS232 interface, which will allow the PC-1500 to communicate with other computers either directly or across telephone lines with an acoustic coupler.

The PC-1500 runs BASIC and incorporates 16k bytes of ROM with 3.5k RAM expandable to 11.5k. Optional is an add-on four colour printer cassette interace which offers automatic program, data and calculation printing.

Another Sharp preview will be an innovative ink jet colour printer, capable of printing in seven colours to produce an image of 120 dots per inch, suitable for printouts from high-resolution colour monitors. Futher details from **Sharp Electronics (UK) Ltd.**, Sharp House, Thorp Rd., Manchester M10 9BE. Tel: 061 205 2333.

## Read and Write

Cassandras among us predict a major and possibly terminal (ouch) conflict between the Printed Word and the Data Store as our main source of ready reference in the future. New software house **Ramsoft**, however, is backing both horses. It's producing software with full listings published as conventional books.

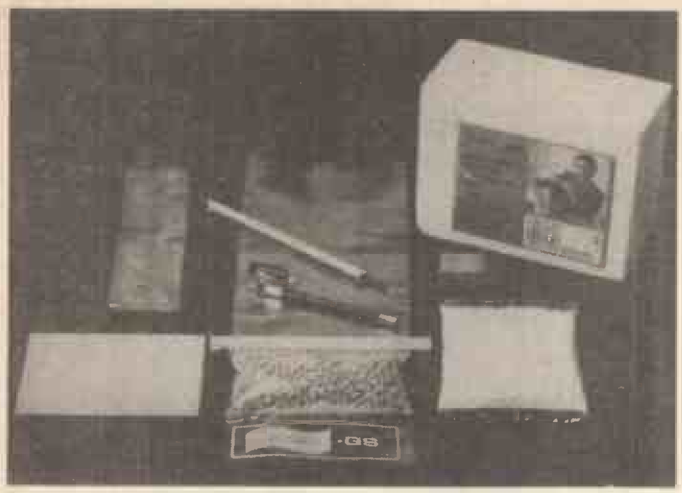
Ramsoft argue that "you need book length documentation in order to explain the intracacies . . ." (one thing is certain — editors won't go out of fashion while the printed word survives, if only in press releases) ". . . of the code and to provide sufficient discussion to enable the reader to take their own programming further. And if you are in the least bit lazy you'll welcome the fact that you can run the programs without laboriously typing in lines and lines of code."

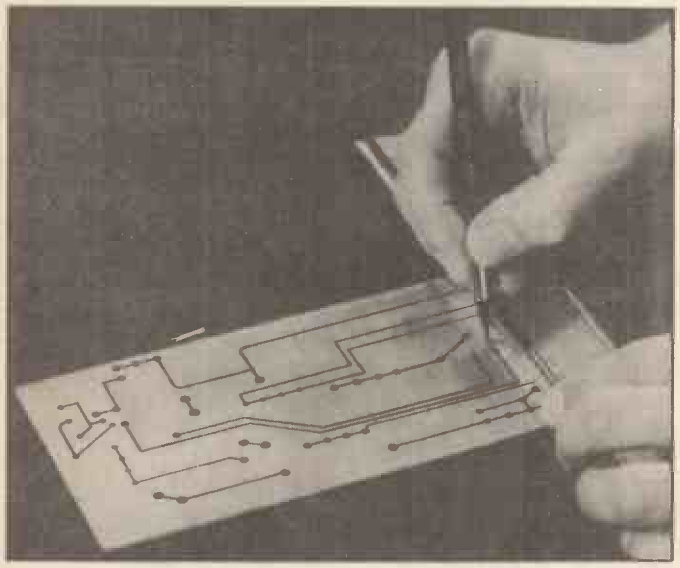
You can't say fairer than that. So far, Ramsoft does tapes to go with the following books: *'The Art of Programming the 1k ZX81'*, *'The Art of Programming the 16k ZX81'* (both by Mike James and S M Gee and published by Babani) and *'The Spectrum Book of Games'* (by Mike James, S M Gee and Kay Ewbank), published by Granada, with more titles for the Spectrum, Dragon and BBC Micros coming up from the same publishers in the future.

For more information, contact Ramsoft, **P O Box 6, Richmond, N. Yorkshire DL10 4HL.**

**HE**

## SPECIAL OFFER TO HOBBY ELECTRONICS READERS





# PCB Etch Kit for HE PCBS now available in 1983 at the 1982 price.

*Seno GS PCB Etching Kit
*Etch Resist Pen
*Polyfix Cleaning Block
*Two 6" × 4" single-sided copper-clad boards

## ALL FOR £9.50*!!

### No mess, no fuss.

The Seno GS printed circuit board etching system provides a high level of safety, convenience and efficiency for making one-off PCBs at home or at school. It is unique in allowing the etching process to be carried out in a sealed bag, eliminating the danger and mess associated with open tanks or baths.

The Seno GS kit consists of a sealable etching bag, granulated etch chemicals, leak-proof box and neutraliser. As a special bonus, this offer (available only through Hobby Electronics) includes an etch-resist pen that allows you to draw foil patterns directly onto the copper surface; a polyfix block for cleaning the copper both before and after etching; and, to get you started quickly and with minimum bother, two 6" × 4" single-sided copper-clad boards.

### Make the most of the projects in Hobby Electronics by making your own printed circuit boards!

*Price includes VAT and postage and packaging; please allow 28 days for delivery.

**To: HE PCB Kit Offer, Argus Specialist Publications Ltd, 145 Charing Cross Road, London WC2H 0EE.**

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Address . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
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. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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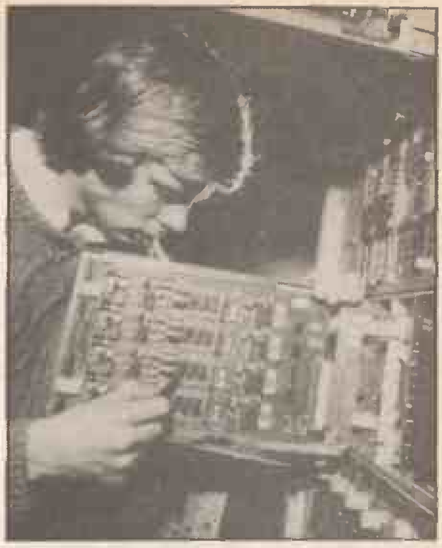
# CAREERS IN ELECTRONICS '83



Charles Harvey

## It takes study, but not a higher degree, to work in the high-flying industry of the eighties.

ALTHOUGH electronics is now taught as a subject in many schools, the real courses of electronic education do not properly begin until after leaving school. And then you will find there are a confusingly large number of courses available! Before deciding which one to choose, then, you should ask yourself two very important questions:

What qualifications am I likely to have after leaving school?

Do I want to be a full time student or would it be better to work, and study part time?

The importance of the first question is fairly obvious: the course you will be able to take will depend largely on the qualifications, if any, that you carry away from the school years. But even if you leave with very few formal grades, all is not lost.

Entry to one of the ITECs (Information Technology Centres), set up by the government to teach young people the essentials of electronics and micro-computing, requires no formal qualifications — just an interest and willingness to learn. The courses last up to a year and provide, at the least, a basic understanding of the subject — what you do with it then is up to you!

If you want to find out about ITECs in your area, the information is available from your local Careers Office, who will have all the details at their fingertips — if there is an ITEC nearby.

Young people who are leaving school before reaching the grand old age of 18 should also consider the government's Youth Training Scheme. This starts officially in September 1983, but some schemes are being set up as early as April. They will offer the equivalent of at least three months full-time training, and up to nine months of relevant work experience; for example, a person might spend a quarter of his or her time at a local college or industrial training centre and the remainder working with an electronics firm in the neighbourhood. Once more, your future after completing the course is left in your own hands.

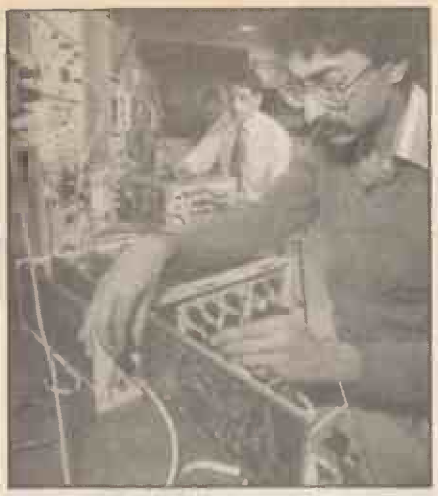
The Youth Training Scheme organisers hope that they have learned from the experience gained on the Youth Opportunities Programme, and that the new scheme will offer better quality training; however it *is* new, so we will just have to wait and see if it is successful.

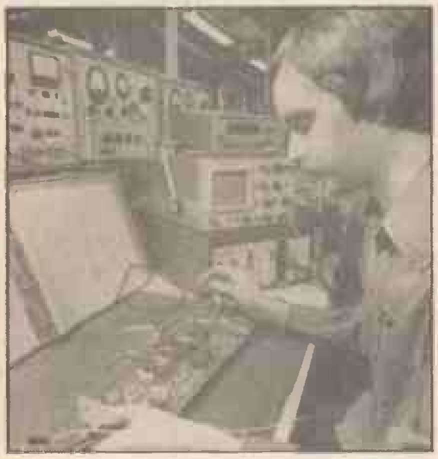
### Gilt Edged Certificates

Those who leave school with a reasonable range of CSEs (or who pass college selection, in Scotland) could normally aim for a course leading to a City and Guilds Certificate.

The City and Guilds of London Institute, to give it its full title, is an organisation over 100 years old that awards a qualification to crafts men and women in many different industries — catering, building, engineering and needle trades, to mention a few. Their certificates in electronics can be taken full time at many colleges, though most people attend part time on day or block release from a job.

This is where the answer to the second question is needed: full time education is expensive (as every parent knows), but finding an employer who will offer you day or block release from the job will depend on the employment situation in your area. Given the national employment situation, this is likely to be difficult.





There is no quick and easy solution to the problem, either, unless full time study is a realistic option. Financial assistance is available for some courses, and a few of the options are briefly summarised in **Table 1**. Many people would prefer employment of any kind, even if not in the electronics industry, to no employment at all — but it's worth considering that any job in an electronics industry (even if its sweeping the floor!) *could* allow you to undertake a City and Guilds course, perhaps leading to a brighter future. Of course the educational qualifications must be met, and entry into the business in this way would be most unusual — but always worth a try if all else fails!

The City and Guilds qualification most relevant to electronics work is the '224 Certificate'. All those who take this course do a 'Part I', which takes about 300 college hours and covers the fundamental knowledge needed (safety, electronic units and systems, transmission, wave forms, electrical supplies and circuits, resistance, magnetism and electrostatics, capacitance and inductance, heat, sound and light, the use of tools and instruments, and a heaped helping of maths, including binary arithmetic). Part II usually takes about 600 hours and contains core subjects which are taken by all students, but then allows the option of specialisation in either Radio/TV or Industrial Electronics. It is also possible to carry on to the Advanced Level (Part III), a specialist option covering TV in greater depth, including video recording systems, information technology, AM/FM radio and audio systems, microcomputer systems, electronic measurement and control systems.

Electronic work is also covered in two other City and Guilds Certificates; the '225', Maintenance Craft Studies in Instrumentation and Control covers the installation, maintenance and repair of instruments used in industrial plants, while Electronic Craft Studies ('232') is for those working in industry and building services, and covers applications of heavy duty electrical engineering as well.

## TEChnician Training

As with City and Guilds, part-time study on release from full-time employment is the most common way to gain TEC (Technical Education Council) or SCOTEC (Scottish Technical Education Council) qualifications. The minimum entry level for a TEC course is grade three CSEs in English, Maths and a science subject (or, in Scotland, being able to pass college selection), though some may demand higher entry qualifications. Relevant O-level/O-grade passes in, for example, Maths, Physics or English, usually permit exemptions from Level 1 courses, proceeding directly to Level 2 and finishing the course more quickly.

TEC/SCOTEC Diplomas are usually taken by full-time study and reach the same level, but in a wider range of subjects. Generally if you start at level 1, a TEC/SCOTEC Certificate takes three years part-time, and a Diploma takes two years full time — but there are exceptions in both cases.

Older readers may remember the Ordinary National Certificate and Diploma courses (ONC and OND); these have now been superseded by the TEC/SCOTEC qualifications and, broadly but not exactly, they are the modern equivalents.

Just as TEC/SCOTEC Certificate and Diploma have replaced the old ONC/OND, so the old Higher National Certificate and Diploma courses (HNC/HND) have been replaced by the TEC/SCOTEC Higher Certificate and Diploma. The usual entry requirements for the higher courses are either a TEC/SCOTEC Certificate of Diploma pass, or an A-level pass together with an attempt at another relevant A-level subject such as Maths, Physics, Electronic Systems etc; two 'highers' or a SCOTEC Certificate or Diploma are usually required in Scotland.

## Degrees Of Learning

Again, the usual way of completing a Higher Certificate is by part-time study, while the Higher Diploma is usually taken full-time.

One feature of these qualifications is that they are made up of self-contained units which are devised by the colleges themselves, though approved by the Technical Education Council. As a result, there are often differences between the courses run by different colleges. The TEC recommends that a course should contain some maths, physical science and industrial skills, plus electronic systems, digital techniques, general and communication studies; the range of specialist options usually cover radio, TV and telecommunications subjects. At the higher levels, there are further specialist units dealing in advanced radio/TV, radar, measurement techniques and fault diagnosis, etc. There is even more diversity at the upper levels because the TEC does not lay down such firm guidelines, and colleges are free to develop courses appropriate to the needs of local industry.

For those with two or three good A-levels (or three or four H-levels in Scotland), there are degree courses at Universities, Polytechnics and Scottish Central Institutions. In England and Wales, degree courses last three years normally (four years in Scotland) but 'sandwich' courses, with industrial experience included as part of the degree, will last four years.

For those who do well at degree level — and this means either a First or Second class degree — there is a chance for higher scholastic honours, usually a Master of Science (MSc) or Doctor of Philosophy (PhD) degree. However, competition for the limited number of grants supporting higher degree study is limited, so that even a good degree is not sufficient, alone, to guarantee grant approval.

Another question which every school leaver — indeed, every person in training — will want answered is: what

**Table 1**

| Course | Grants & Finance |
|---|---|
| ITECs<br>Youth Training Scheme | Government allowance, currently £25.00 pw and fares in exess of £4.00. |
| Full time City & Guilds and TEC courses | Free tuition if under 18. Only a few authorities (eg Sheffield, ILEA) pay maintenance grants. Fees are payable for over 18s. You may be able to get a discretionary grant from your local authority but it depends where you live. Ask the advice of your local Careers Service, or your local authority's grants department. |
| Full time Higher TEC Certs/Dips Degree | You can usually get a mandatory grant from your local authority (Scottish Education Dept. in Scotland) regardless of where you live. This covers tuition and is supposed to cover living expenses, though most students find it hard to live on! It is "means tested" — how much you get depends on how much your parents earn; they are expected to make up the difference. There are different rules for mature students. |

**Table 2**

| ENTRY | COURSE | AT | COMMENTS | POSSIBLE JOBS |
|---|---|---|---|---|
| No formal qualifications required | ITEC | ITEC | Practical experience in micro computing and electronics. | Hi-fi servicing, electronic assembly. |
| No formal qualifications | New "Youth Training" | Further education | Starts Sept '83. Exact details still uncertain but probably includes at least 3 months full training plus relevant work experience. | Not known yet. |
| Sometimes no formal qualifications but generally CSEs | City & Guilds Cert. | Further educa- College | Full time course (usually takes two years) or part time, day or block release, usually lasting three years for those in employment; leads to craft certificates. | Hifi servicing, alarm systems installation, etc. |
| College Selection (Scotland) or grade three CSEs | TEC/SCOTEC Cert./Dip. | FE College | Full time course, usually two-three years, often taken part time by those in employment. | Radio/VTR technician. |
| TEC/SCOTEC Cert./Dip. At least one A-level pass or two Highers (Scotland) | TEC/SCOTEC Higher Cert./Dip. | FE College or Polytechnic | Full time course usually lasting two years. Often taken part time by those in employment. | Computer service engineer; control & instrumentation engineer. |
| Two/three good A-levels three/four Highers | Degree | Polytechnic or University or Central Inst. or, occasionally, FE Colleges. | Three years for full time course, four years for sandwich course; four years in Scotland. | Design engineer. |

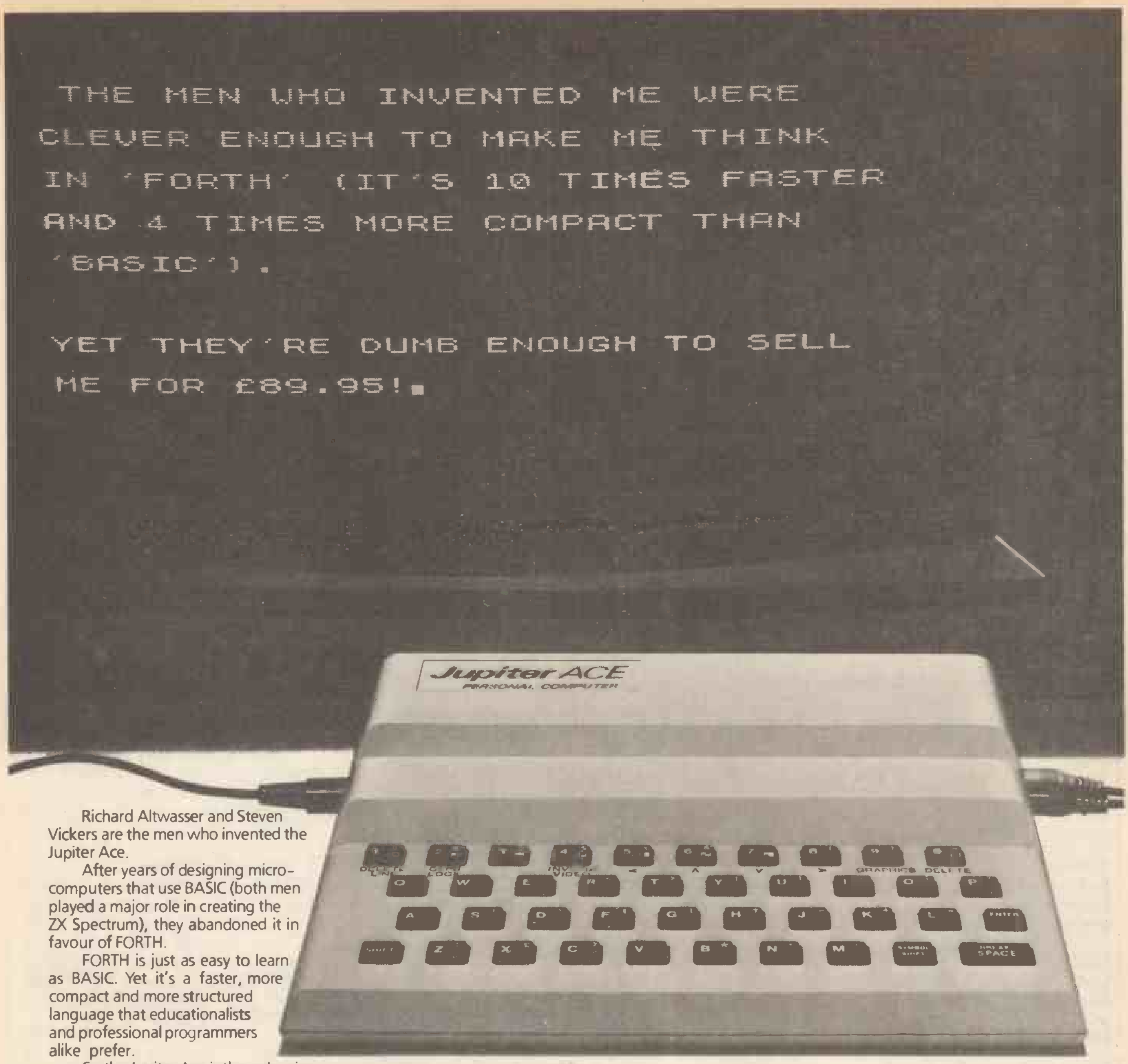
sort of job will my training lead to?

## Jobs For The Boys

An attempt to answer this question, in general terms, is made in Table 2, which summarises the various courses mentioned in this article and describes, very roughly, the type of employment which could result. Naturally, whether a job is actually available for you depends on the competition, both locally and nationally; generally electronics graduates and holders of Higher TEC/SCOTEC qualifications will do better in the hunt for jobs than those without. Below this level the number of jobs available is not so great, compared with the number of people seeking employment, so the competition is much tougher.

## Don't Need No Education

You might, by now, have the impression from all this verbage that the only way into employment in electronics is through a more-or-less specialist course of training. However many employers look rather for a good all-round education in relevant subjects. Some prefer to recruit young people with, say, four O-levels or O-grades, including Maths, Physics and English; or with Math and Physics at A-level or higher levels in Scotland. As mentioned earlier, it is now possible to study electronics at O- or A-level in many schools, in courses including electronic systems and microcomputers, and any study at school will naturally be advantageous when you later come to select a career in electronics. **HE**




Richard Altwasser and Steven Vickers are the men who invented the Jupiter Ace.

After years of designing microcomputers that use BASIC (both men played a major role in creating the ZX Spectrum), they abandoned it in favour of FORTH.

FORTH is just as easy to learn as BASIC. Yet it's a faster, more compact and more structured language that educationalists and professional programmers alike prefer.

So the Jupiter Ace is the only microcomputer you can buy that is designed around FORTH.

Using it, there's little fear of accidentally 'crashing' programs halfway through and having to start all over again (a common fault with BASIC). The Jupiter Ace's comprehensive error checking sees to that.

The Jupiter Ace has a full-size keyboard, high resolution graphics, sound, floating point arithmetic, a fast, reliable cassette interface, 3K of RAM and a full 12 month warranty.

You get all that for £89.95. Plus a mains adaptor, all the leads needed to connect most cassette recorders and T.V.'s, a software catalogue (35 cassettes available, soon to be 50), the Jupiter Ace manual and a free demonstration cassette of 5 programs

The Jupiter Ace manual is a complete introduction to personal computing and a simple-to-follow course in FORTH, from first principles to confident programming.

Plug-on 16K and 48K memory expansions are also available, at very competitive prices. (There'll be a plug-on printer interface available soon, too.)

It'll take you no time at all to realise how clever Richard and Steven were to design the Jupiter Ace around FORTH. And even less time to realise what a silly price £89.95 is to charge for it.

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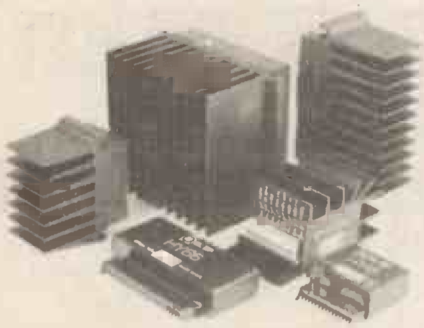


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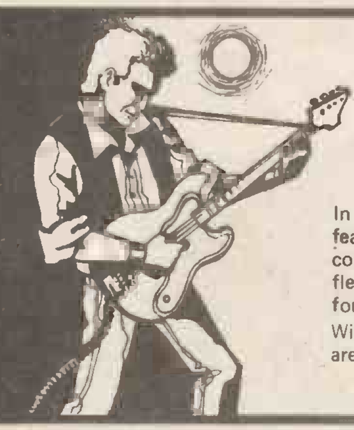

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| Module Number | Output Power Watts rms | Load Impedance Ω | DISTORTION T.H.D. Typ at 1KHz | I.M.D. 60Hz/ 7KHz 4:1 | Supply Voltage Typ | Size mm | WT gms | Price inc. VAT |
|---|---|---|---|---|---|---|---|---|
| HY30 | 15 | 4-8 | 0.015% | <0.006% | ± 18 | 76 x 68 x 40 | 240 | £8.40 |
| HY60 | 30 | 4-8 | 0.015% | <0.006% | ± 25 | 76 x 68 x 40 | 240 | £9.55 |
| HY6060 | 30 + 30 | 4-8 | 0.015% | <0.006% | ± 25 | 120 x 78 x 40 | 420 | £18.69 |
| HY124 | 60 | 4 | 0.01% | <0.006% | ± 26 | 120 x 78 x 40 | 410 | £20.75 |
| HY128 | 60 | 8 | 0.01% | <0.006% | ± 35 | 120 x 78 x 40 | 410 | £20.75 |
| HY244 | 120 | 4 | 0.01% | <0.006% | ± 35 | 120 x 78 x 50 | 520 | £25.47 |
| HY248 | 120 | 8 | 0.01% | <0.006% | ± 50 | 120 x 78 x 50 | 520 | £25.47 |
| HY364 | 180 | 4 | 0.01% | <0.006% | ± 45 | 120 x 78 x 100 | 1030 | £38.41 |
| HY368 | 180 | 8 | 0.01% | <0.006% | ± 60 | 120 x 78 x 100 | 1030 | £38.41 |

Protection: Full load line. Slew Rate: 15v/µs. Risetime: 5µs. S/N ratio: 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity: 500mV rms.
Input Impedance: 100K Ω. Damping factor: 100Hz >400.

### PRE-AMP SYSTEMS

| Module Number | Module | Functions | Current Required | Price inc. VAT |
|---|---|---|---|---|
| HY6 | Mono pre amp | Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble | 10mA | £7.60 |
| HY66 | Stereo pre amp | Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance | 20mA | £14.32 |
| HY73 | Guitar pre amp | Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix | 20mA | £15.36 |
| HY78 | Stereo pre amp | As HY66 less tone controls | 20mA | £14.20 |

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the B6 for modules HY6–HY13 £1.05 (inc. VAT) and the B66 for modules HY66–HY78 £1.29 (inc. VAT).

### MOSFET MODULES

| Module Number | Output Power Watts rms | Load Impedance Ω | DISTORTION T.H.D. Typ at 1KHz | I.M.D. 60Hz/ 7KHz 4:1 | Supply Voltage Typ | Size mm | WT gms | Price inc. VAT |
|---|---|---|---|---|---|---|---|---|
| MOS 128 | 60 | 4-8 | <0.005% | <0.006% | ± 45 | 120 x 78 x 40 | 420 | £30.41 |
| MOS 248 | 120 | 4-8 | <0.005% | <0.006% | ± 55 | 120 x 78 x 80 | 850 | £39.86 |
| MOS 364 | 180 | 4 | <0.005% | <0.006% | ± 55 | 120 x 78 x 100 | 1025 | £45.54 |

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/µs. Rise time: 3µs. S/N ratio: 100db
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| PSU 42X | 1 x HY128 | £15.90 |
| PSU 43X | 1 x MOS128 | £16.70 |
| PSU 51X | 2 x HY128, 1 x HY244 | £17.07 |

| Model Number | For Use With | Price inc. VAT |
|---|---|---|
| PSU 52X | 2 x HY124 | £17.07 |
| PSU 53X | 2 x MOS128 | £17.86 |
| PSU 54X | 1 x HY248 | £17.86 |
| PSU 55X | 1 x MOS248 | £19.52 |
| PSU 71X | 2 x HY244 | £21.75 |

| Model Number | For Use With | Price inc. VAT |
|---|---|---|
| PSU 72X | 2 x HY248 | £22.54 |
| PSU 73X | 1 x HY364 | £22.54 |
| PSU 74X | 1 x HY368 | £24.20 |
| PSU 75X | 2 x MOS248, 1 x MOS368 | £24.20 |

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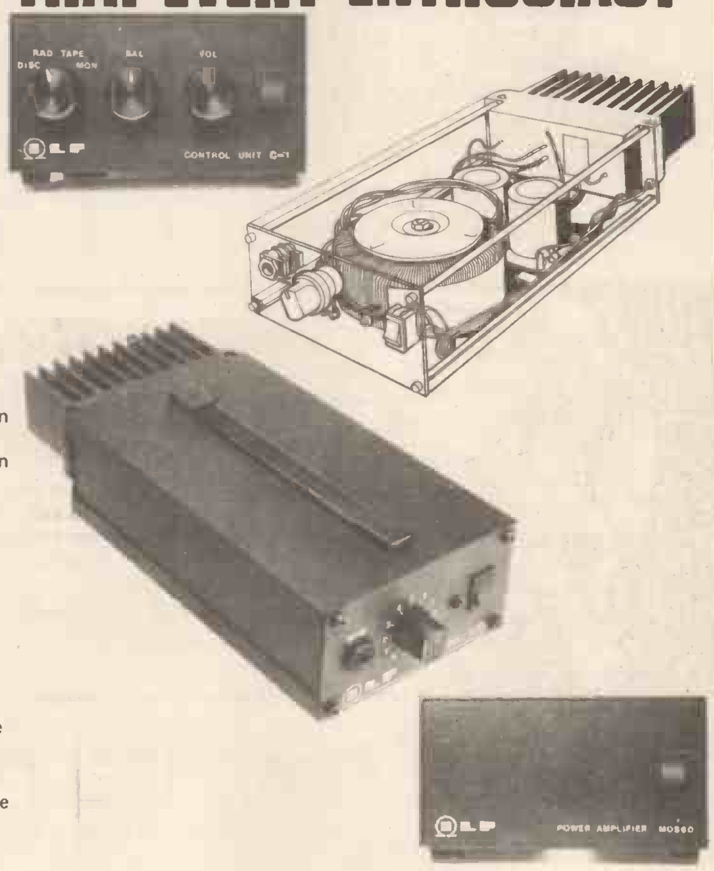


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UNICASES

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| 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 |
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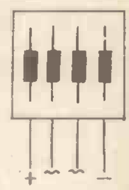

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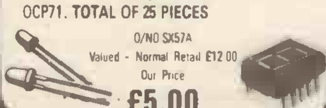

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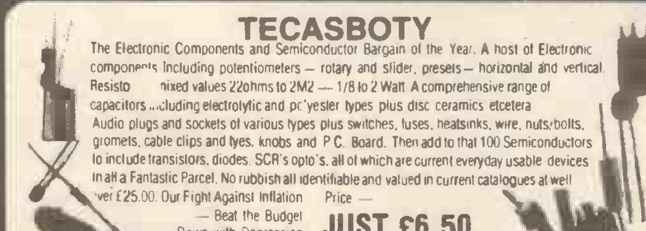

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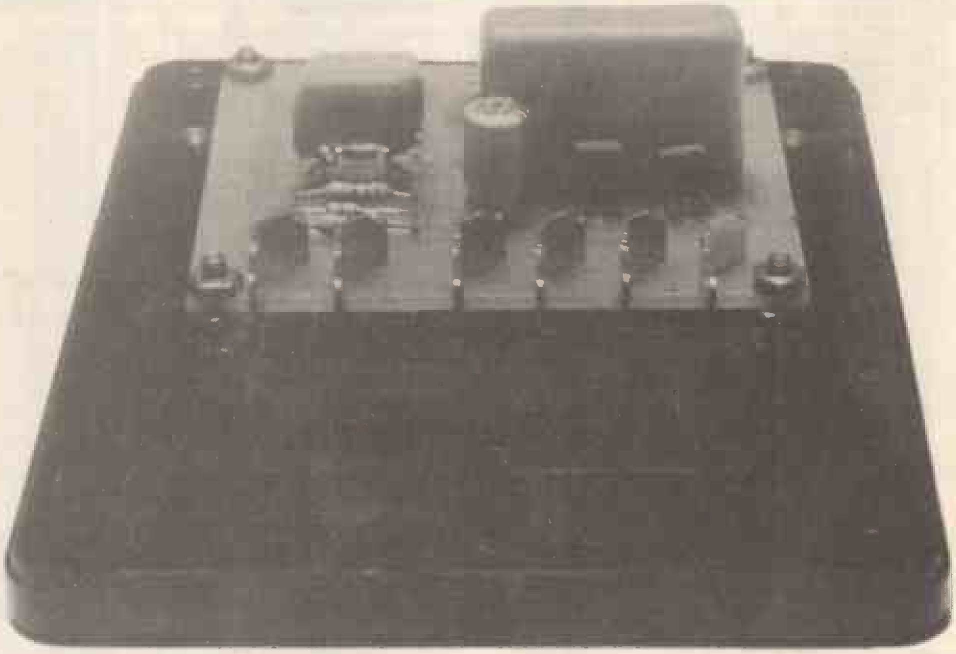
# Stall-Thief

Andy Armstrong

## Our 'invisible', noiseless anti-theft device simulates an ignition fault, frustrating a thief in his attempt to make off with your motor.



THIS is a gadget which should discourage any thief in his right mind from stealing your car! Sure, you may say, but a thief can get around any disabling device in a few minutes. This one, however, doesn't appear to be an anti-theft device; instead, it makes the *car* seem to be at fault.

When the car engine is started (possibly not at the first try) it will run for a few seconds, and then cough and die. Further attempts at starting will be met with the same results.

This particular system has the added advantage that it is automatically reset when the ignition is switched off, and that the method of deactivating it is very unusual. Thus, you cannot forget to protect your car, and any prospective thief has little chance of bypassing the system.

Obviously, the device can simply be removed, so it needs to be installed where it won't easily be found — there are some suggestions about this further on. The unit does its job by periodically shorting the contact breaker, and preventing a spark from being generated. Typically, it is shorted out for about two seconds in every ten seconds; this is adequate to stop a cold engine, though one could probably continue driving if the car was thoroughly warmed up and moving reasonably fast.

This brings us to a WARNING: though the circuit is designed not to bring the car to a halt on a fast road, it is preferable to avoid even the slightest risk of this. Therefore, the anti-theft unit — and, indeed, anything which could stop the ignition system from working — must be built and fitted with reliability in mind (the same applies to commercial devices like electronic ignitions).

## The Circuit

IC1a and b form a bistable which always powers up with pin 4 high and pin 3 low; this occurs because CI takes longer to charge than C2. Resistors R4 and R5, in series with pins 6 and 1 respectively, are to prevent the capacitor's discharge currents from damaging the CMOS input protection diodes (built into the chip) when the unit is switched off, ie when the ignition is switched off.

IC1c and d form an oscillator, which is enabled while pin 13 is held high. This oscillation has an uneven mark to space ratio, so that the engine is allowed to function most of the time, but is periodically halted. The timing has been chosen so that someone trying to restart the engine immediately after it has stopped would meet with (temporary) success.

The oscillator works in the following manner: when the power is switched on both C3 and C4 are uncharged; therefore at the moment of switch-on, pin 12 will be at logic 0. This causes pin 11 to be at logic 1 and hence pin 10 to be at logic 0. This state persists while the lower end of C4 charges towards logic 1 via R9.

This same voltage will appear on pin 12 via R8, so that after it passes about half the power supply voltage, pin 11 falls towards logic 0, causing pin 10 to rise to logic 1.

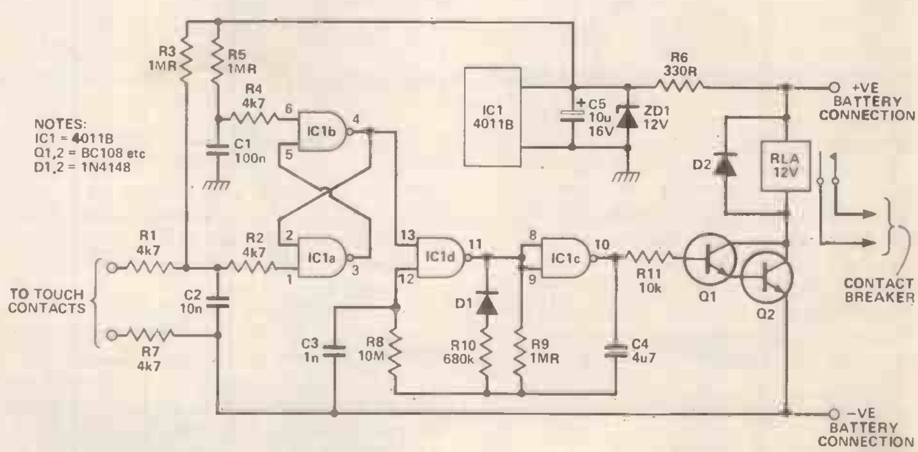


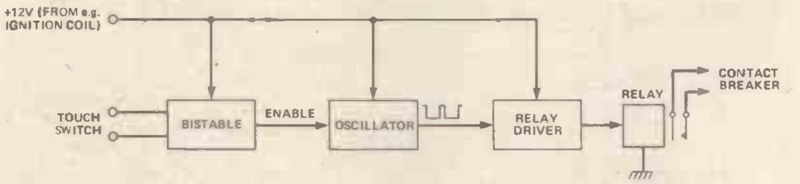

Figure 1. The Stall-Thief circuit; Vcc connects to pin 14 of the IC and 0V goes to pin 8.

## How It Works

The Stall Thief is powered from a point in the car's electrical system which is switched on by the ignition switch. When power is applied, the bistable output is at logic 0 and 1 this enables the oscillator, which is set up to produce an asymmetric waveform. The waveform is 'low' for most of the oscillator period, so that the relay driver is turned off and the car may be started — briefly!

However, when the oscillator output is 'high' (for about two seconds in every ten), the relay is energised so that the contacts short out the ignition coil contact breaker, effectively simulating a fault in the ignition system.

The Stall Thief is disabled by touching the concealed switch contacts; this takes the bistable output to logic 0, disabling the oscillator and preventing the relay from operating.



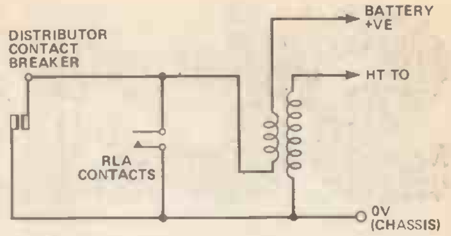




**Figure 2. The circuit of a typical ignition system; the Stall-Thief relay contacts short out the distributor contact breaker intermittently, interrupting the ignition timing.**

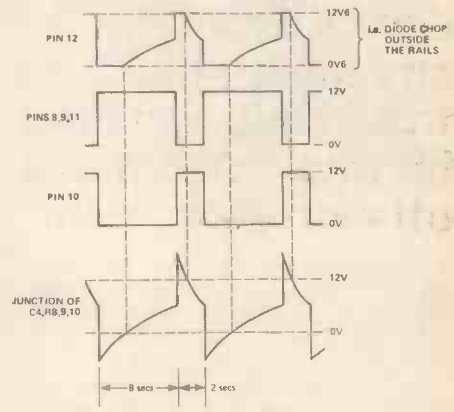



**Figure 3. Waveforms produced at various points in the Stall-Thief circuit when the oscillator consisting of IC1d,c is enabled (logic '1' on pin 13).**

In this condition, transistors Q1 and Q2, which form a Darlington pair, are turned on, thus closing the relay and preventing the enging from functioning.

You will observe, now, that the voltage on the lower end of C4 is about half the supply voltage higher than the top end, which has just been raised virtually to the full supply voltage. The voltage on C4 is thus outside the limit of the supply rails and will therefore discharge, partly via R8 and the input protection diodes on IC1d pin 12, but mostly via R9 and R10/D1. This is why R8 is such a high value — so that this discharge current is small enough to be ignored, compared with the current through R9 and R10.

The voltage on C4 therefore discharges into IC1d pin 11, towards logic 0, with a time constant given approximately (neglecting R8) by C4, and R9 in parallel with R10 (since D1 is conducting in this condition). This time constant is about 25% of the charging time constant set by C4, R9 because R9 in parallel with R10 is approximately 520k.

When the voltage on pin 12 falls below half the supply voltage, the logic gates switch into the state they had when first switched on, thus taking the voltage on the lower end of C4 outside the supply rails in the other direction, until it charges back up to half supply via R9 (see Figure 2).

This cycle repeats until the owner of the vehicle touches both of the "touch plates"; this switches the flip-flop (IC1a and IC1b) into the other state, setting pin 4 at logic 0. This disables the oscillator, causing pin 11 to go to logic 1 and pin 10 to logic 0. Thus the relay is permanently de-energised and the engine runs normally.

### Spiking the Noise

The purpose of C3 may not be immediately obvious; it's there to prevent stray noise pick-up onto the high impedance of pin 12, from causing spurious operation of the gate. The time constant of R8 and C3 is much shorter than that of R9, R10 and C4, so that C3 has no appreciable effect on the oscillator frequency.

Since car electrical systems may have substantial voltage spikes on them, the CMOS power supply is protected by R6, D2 and C5; were these components omitted from the design, the delicate CMOS would probably fail at an inconvenient moment!

Some constructors may wonder at the use of a Darlington pair of transistors to drive the relay — so a word of explanation. Even buffered CMOS cannot properly be asked to source much more than 1mA (hence the value of R11), and a transistor in saturation cannot be assumed to have a gain greater than ten. Therefore if only one transistor were used, a current of only 10mA would be available to drive the relay if the transistor were saturated. What would happen, in practice, would be that some unlucky constructors would find that the relay did not pull in, or that the transistor burned out because it was not properly switched on and thus was dissipating too much power.

### Construction

The construction of the board is simply a matter of following the overlay. The CMOS IC should be installed last, after a visual inspection to check that the rest of the components have been installed correctly.

Veropins can be used for the connections to the board, though the 0.25in push-on connector blades used on the prototype are to be preferred.

The relay is separate from the board for two reasons: the first is that, while a particular PCB mounting relay may not be hard to obtain, many people may have a 12V relay in their junkboxes. The second reason is that

## Parts List

**RESISTORS**
(All ¼ watt 5% carbon)

| | |
|---|---|
| R1,2,7 | 4k7 |
| R3,5,9 | 1MR |
| R6 | 330R |
| R8 | 10M |
| R10 | 680k |
| R11 | 10k |

**CAPACITORS**
(All polyester unless noted)

| | |
|---|---|
| C1 | 100n |
| C2 | 10n |
| C3 | 1n ceramic |
| C4 | 4u7 |
| C5 | 10u 16VDC radial electro |

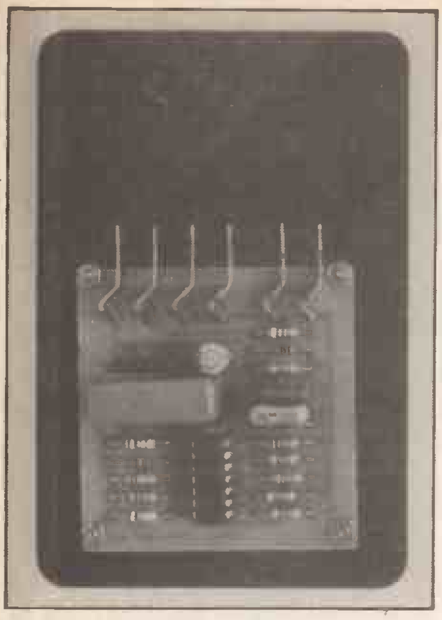
**SEMICONDUCTORS**

| | |
|---|---|
| IC1 | CD4011B quad-NAND |
| Q1,2 | BC108 or similar |
| D1,2 | 1N4148 or similar |
| ZD1 | BCY88C12V |

**MISCELLANEOUS**

RLA .................... see Buylines
PCB; case (see text); 6 x ¼" PCB-mounting connector blades; wire, solder, nuts and bolts etc.

**BUYLINES** .................. page 34



it may, under some circumstances, be preferable to mount the relay near to the distributor or coil, and mount the rest of the works elsewhere, for example behind the dashboard.

The choice of relay is, to some extent, important. The contacts need to be rated for the current (at least 5A), and also need to open, when de-energised, to at least as wide as the contact breaker gap, to avoid breakdown. Some suitable types are described in *Buylines*.

Once the unit is built it should be tested before installation. Connect up the relay and then connect the board to a 12V power supply. The relay should switch on for about two seconds out of each ten. If it does not do so, check the voltage across the relay coil; if this reaches at least 10V for the two seconds and still the relay does not switch, then it is unsuitable.

If there is no voltage on the relay at all, check the logic levels (after switch-on, before operating the touch contacts!). A wrong or indeterminate logic level should point to the short circuit, wrong component etc.

Once the relay has been made to switch, slightly moisten your finger and place it briefly across the two blades waiting to be connected to the touch terminals: the relay should switch no more. Finally, it is a good idea to varnish the board to avoid condensation problems.

## Installation

Many of the details of installation may be left to the individual constructor, as the space available in different cars needs different methods.

The first decision to make is whether to mount the relay separately or not. If there is little concealment for the whole unit under the bonnet, it is preferable to mount the relay near the wiring channels, and connect it to the contact breaker in as unobtrusive a way as possible. In this case, a small plastic box just large enough to take the PCB and push-on connectors is required. This may be mounted in a convenient place behind the dashboard and wires run to the relay. If the area under the bonnet is sufficiently untidy, so that an extra plastic box would not be noticed, then the whole thing can be mounted in one place, with twisted wires leading to the touch contacts. For this option, a larger plastic box would be required.

In any event, the PCB should be mounted to the lid by four 6BA or M2.5 bolts, and a slot cut in the box to allow cable entry. If the relay is mounted separately, it must be securely bolted down; if it is mounted in the plastic box it may be easier to use double-sided adhesive pads on two faces to mount the relay. (Note: for a reliable fixing, the surfaces must be thoroughly clean.)

Since the wires from the relay to the ignition system must be soldered at the relay end, special care should be taken; these connections should be sleeved, preferably with heatshrink sleeving (a 2kW electric fan heater shrinks it a treat!). These wires should also be fixed in place using self-adhesive aluminium cable clamps, readily available from car accessory shops.

The wiring to the contact breaker should be kept short to reduce the amount of extra ignition interference radiated, and on grounds of reliability. Depending on circumstances, a "piggy back" connector to the coil or distributor, or a tap-in connector to the wire between the two, should be used. Take care not to put tension on the wiring, to avoid the risk of it pulling off while you are driving!

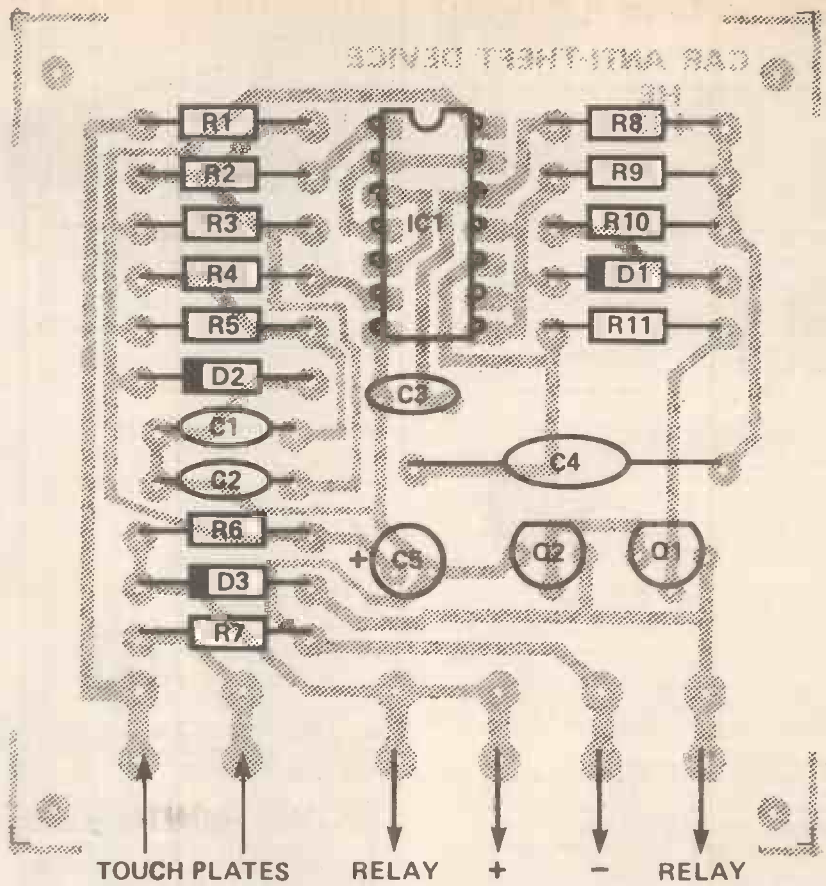



**Figure 4. The component overlay; 1mm PCB connector pins may be used instead of the push-on connectors, but are not as secure.**

## Touch contacts

The suggested techique for making these is to use plastic washers, of the type used for transistor mounting, to put two bolts into the underside of the dashboard, but insulated from it. If these bolts are more than a few inches apart, it is most unlikely that any one would touch both at once by chance, so your secret Stall Thief would be safe.

When the unit is fixed in place and connected to its touch contacts, it should be wired up to the battery. Assuming a negative earth, the -ve terminal should be connected to chassis and the +ve terminal to any positive supply which is switched off by the ignition switch (eg the +ve terminal of the coil). For +ve earth cars, this procedure must, of course, be reversed.

## Operation

Simple! Switch on the ignition, then touch both bolts without touching any other metalwork (if your hands are exceptionally dry you may need to lick your fingers but normally there should be no problems). The car can then be started and driven as usual.

Your local tea-leaf, on the other hand, will not know about this and will be stalled in his attempt to steal your motor.

**HE**

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**GOING FOR A SONG** – Are you a buyer for a factory, school, shop, club, etc? If so, please telephone or write for our sale list – over 1,000 tons of stock is being sold off at much below cost, simply because we must clear our big store this year. You will be amazed at the very low prices. Here are two examples:

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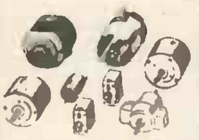

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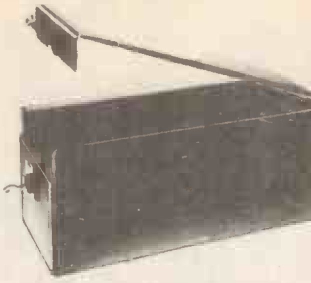
| Transmitter Surveillance Kit | £2.30 |
| Radio Mike | £6.90 |
| FM receiver kit – for surveillance or normal FM transmissions | £3.50 |
| Seat Belt Reminder | £3.00 |
| Car Starter Charger Kit | £14.00 |
| Soil heater for plants or seeds | £16.50 |
| Insulation Tester electronic megger | £7.95 |
| Battery Shaver or Fluorescent from 12v | £6.90 |
| Matchbox Radio – receives Medium Wave | £2.95 |
| Mixer Pre-amp – disco special with case | £16.00 |
| Aerial Rotator – mains operated | £29.50 |
| Aerial direction indicator | £5.50 |
| 40 watt amp hi-fi 20hz 20KHz | £9.50 |
| Microvolt multiplier – measure very low currents with ordinary multitester | £3.95 |
| Pure Sine Wave Generator | £5.75 |
| Linear Power output meter | £11.50 |
| 115 Watt Amplifier 5hz – 25KHz | £13.50 |
| Power Supply for one or two 115 watt amps | £17.50 |
| Stereo Bass Booster, most items | £8.95 |

## INSTRUMENT BOX



Instrument box with key. Very strongly made (plywood sides with hard board top and bottom). With black grained effect, vinyl covered, giving a very pleasing appearance. Internal dimensions 12½" long, 4¼" wide, 6" deep. Ideal for carrying your multi range meter and small tools and for keeping them in a safe place. £2.30. Post paid if ordered with other goods, otherwise add £1.

## LIGHTING & POWER CABLES

Copper clad, PVC sheathed. Made by Volex to BSS.

| | | |
|---|---|---|
| 1.5mm single | per 100 metres | £2.30 |
| 1.5mm flat twin | per 100 metres | £4.50 |
| 1.5mm flat 3 core & E | per 100 metres | £5.50 |
| 4mm single | per 100 metres | £3.45 |
| 6mm flat 3 core | per 100 metres | £32.00 |
| 16mm flat twin & E | per 100 metres | £54.00 |

If not collecting, add 50% carriage.

## SUB MINIATURE MOVING COIL SPEAKER OR MICROPHONE

Beautifully made permanent magnet type, this is only 0.8" dia. and 0.4" thick (approx). Impedance approximately 350 ohms, voice coil sealed with dust cover. Ex-equipment. £1.15 each, or 10 for £10.

# THIS MONTH'S SNIP

## SUPER BARGAIN JUST ARRIVED: The AMSTRAD Stereo Tuner.

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

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

Some of the features are: long wave band 115 – 270 KHz, medium wave band 525 – 1650KHz, FM band 87 – 108MHz, mono, stereo switch, AFC switch, tuning meter to give you spot on stereo tuning, optional LED wave band indicator, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board. This comes packed in a special container, which you can use as a temporary case if you want to make it quickly into a carry about personal stereo.

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

## TANGENTIAL BLOW HEATER

2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95. post £1.50.

## MINI-MULTI TESTER

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

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

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

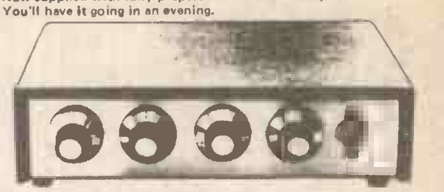
# J. BULL (Electrical) Ltd.

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

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £10 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: write for quote. Delivery by return. Shop open 9.00 — 5.30, mon to Fri, not Saturday.

## 3 CHANNEL SOUND TO LIGHT

Now supplied with fully prepared metal work and p.c.b. You'll have it going in an evening.

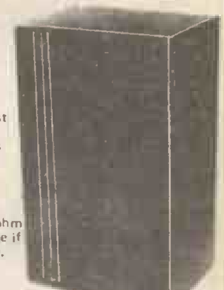


Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio 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.

## PANEL METERS & INSTRUMENTS

| | |
|---|---|
| Singal meter, 200VA | £1.15 |
| Volt meter 0 - 200 volts, 2½" round | £1.75 |
| Milli-amp meter, 500ma 2½" round | £1.15 |
| –amp meter, hot wire scaled, 0 - 9 amps | £2.30 |
| Ammeter, 2½" round, centre zero, 500ma | £1.75 |
| Charger panel meters, 1¾" dia. scaled 3 amp | .75 |
| Panel meter, 1 5/8" square, scaled Vu | £1.15 |
| Panel meter, Amstrad, 40mm sq. centre zero, scaled 1, 2, 3. | .75 |
| Edgeways panel, 3". 0 - 25ma, ex-GPO | £2.30 |

## SUPER HI-FI SPEAKER CABINETS



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.

## GOODMANS SPEAKERS

6½" 8 ohm 25 watt £4.50. 2½" 8 ohm tweeter. £2.50. No extra for postage if ordered with cabinets. Xover £1.50.

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

## VENNER TIME SWITCH

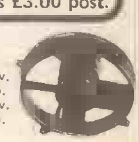
Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are without case but we can supply a plastic base £1.75 or metal case £2.95. Also available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

## 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.

**YOURS FOR ONLY £11.50 plus £3.00 post.**

## EXTRACTOR FANS



Mains operated – ex-computer.
Woods extractor
5" – £5.75, Post £1.25
6" – £6.95, Post £1.25
5" Plannair extractor £6.50. Post £1.25.
4"x4" Muffin 115v. £4.50. Post 75p.
4"x4" Muffin 230v. £5.75. Post 75p.

## ROTARY WAFER SWITCHES

5 amp silver plated contacts. ¼" shaft. 1" dia. wafer.
Single wafer types, 29p each, as follows:

| | | |
|---|---|---|
| 1 pole 12 way | 2 pole 6 way | 3 pole 4 way |
| 4 pole 3 way | 6 pole 2 way | 4 pole 3 way |

Two wafer type, 59p each, as follows

| | | |
|---|---|---|
| 2 pole 12 way | 4 pole 5 way | 4 pole 6 way |
| 6 pole 2 way | 8 pole 3 way | 12 pole 2 way |

3 wafer types 99p each.

| | | |
|---|---|---|
| 9 pole 4 way | 6 pole 5 way | 6 pole 6 way |
| | 12p 3 way | 18p 2 way |

## EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post.
(This is easily reversible with our reversing switch - Price £1.15).

## MINI MONO AMP

on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.

# Charles Proteus Steinmetz

Ian Sinclair

## An experimentor and teacher who took the guesswork out of electrical design.

YOU CAN BE FORGIVEN if you've never heard of Charles Steinmetz, because neither his name nor his achievements are well known on this side of the Big Pond. Nevertheless, his contribution to electricity, and hence to electronics, has had a profound influence on us all, making possible advances that we now take for granted. Of all the Famous Names we have looked at so far, that of Steinmetz seems at first glance least connected with modern electronics, because most of his work was concerned with large electric motors, but, as often happens, a piece of research which expands useful knowledge often affects work which is carried out years later, and in an entirely different field.

Steinmetz was born in Breslau, Germany, in 1865 (the town is now called Wroclaw, and has been part of Poland since the occupation of Eastern Europe by the USSR after the Second World War). He was christened Karl August Rudolf, and was handicapped from birth by a severe spinal deformity, which may have had the effect of turning him to academic studies at times when his classmates were playing football. His education progressed to the Technical High School in Berlin — a type of institution which never became rooted in this country — and from there, in 1892, to University, where he started to make a name for himself as a brilliant researcher and equally as a committed Social Democrat. It was this second activity which drew him to the attentions of the ruling authorities, and it's ironic to think that if he were active in his home town right now, the Polish authorities would probably take the same line.

After several brushes with the Government, he emigrated, like so many others at the time, to the USA to find freedom of expression and action. Shortly after arriving, he anglicised his names to Charles Proteus — Proteus having been a college nickname.

His reputation as a researcher had preceded him, and he was employed almost at once by the firm of Eickemeyer and Osterheld, an electrical manufacturing company with interests in electric motors, transformers and power transmission. Once established, he founded a small research laboratory which soon became very well known in the industry. It was at this laboratory that he discovered the effect of magnetic hysteresis.

### Hysteresis Lesson

Now magnetic hysteresis isn't a subject you learn about nowadays unless you have specialised interests. It was once included as a topic in A Level physics courses, but was dropped several years ago because it didn't fit in with the new methods of teaching physics, and in particular with the modern system of units. This is a pity, because it deprives a lot of students of their first glimpse of real-life physics, as distinct from the neat and tidy world of theory. Let me explain the subject in outline.

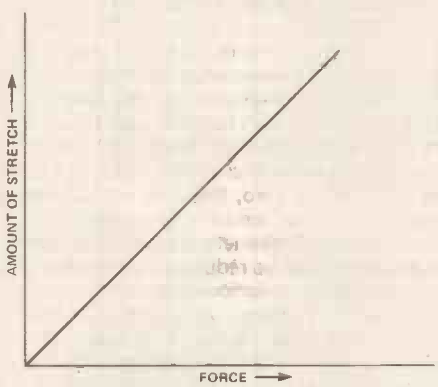



**Figure 1. The graph for stretching a spring — providing you don't overstretch it!**

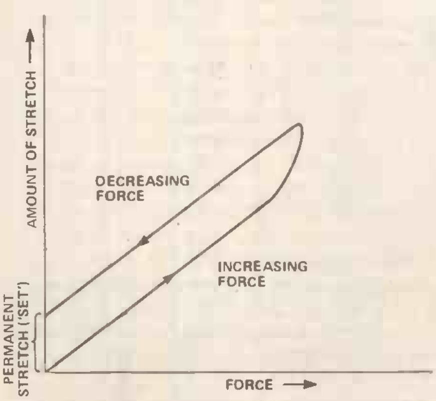



**Figure 2. The 'hysteresis' graph shape that results from overstretching.**

When you stretch a spring, its length increases, and the amount of force that you need to keep the spring stretched depends on how far you have stretched it. Unless you stretch the spring too far, it will always return to its original length when you release it. This simple fact was discovered by Hooke in the seventeenth century, and is called Hooke's Law. A lot of laws in physics are like this one — one quantity is proportional to another, so that a graph of the extension of a spring for example, plotted against the stretching force, is a straight line (**Figure 1**). This type of relationship is called linear.

If you over-stretch the spring, however, its length is permanently changed, and the graph of extension plotted against force looks more complicated. The graph now has two lines, one for increasing force, the other for decreasing force (**Figure 2**). A shape of this type is called a 'hysteresis' curve, and it implies, in this example, that the spring does not return to its original length.

Until Steinmetz investigated the magnetization of iron, everyone assumed that when a coil of insulated wire was wrapped round a piece of iron, and an electric current passed through the wire, then the magnetism of the iron would depend on the amount of current through the wire, and the relationship would be linear, or almost so. They expected, in other words, that a graph of magnetic strength plotted against current would be a straight line. By the late 1880s, it was becoming obvious that this assumption just could not be sustained. There was, for example, no way in which the performance of an electric motor could be predicted using these simple ideas about magnetism, and the magnetism of the iron in the motor was the only missing link in the theory. The only way that a manufacturer could get data on the likely performance of a new electric motor design was to build a prototype and test it! At a time when the uses of electricity, and in particular the uses of electric motors, were expanding rapidly, this was unsatisfactory, rapidly becoming intolerable because the use of AC in power transmission, strongly urged by many engineers, demanded the use of transformers — and there was no theory

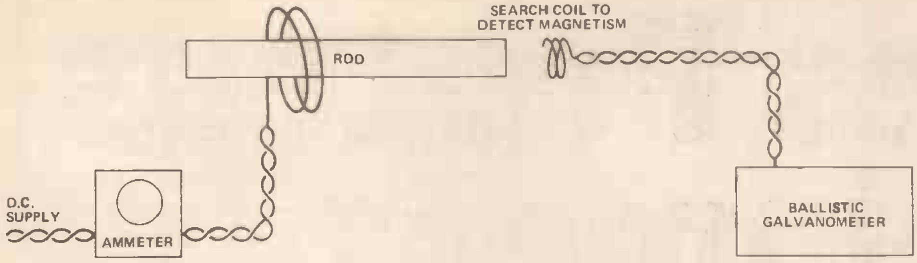



**Figure 3.** The Steinmetz apparatus, simplified. The rod was magnetized by the current flowing in the large coil, and the amount of magnetism detected by the smaller coil in conjunction with a ballistic galvanometer.

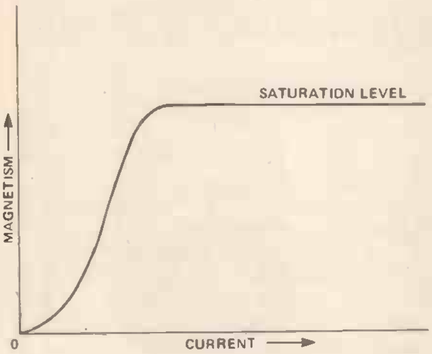



**Figure 4.** The first part of the magnetizing curve for iron.

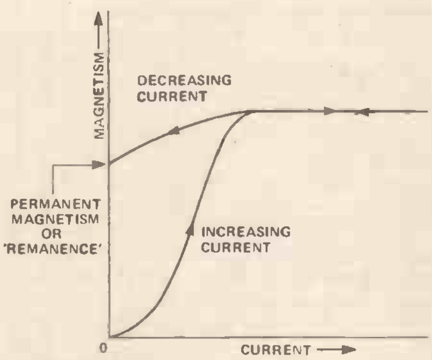



**Figure 5.** The hysteresis effect — as current is reduced from the saturation level, a different curve is traced, and with zero current, the iron remains magnetized.

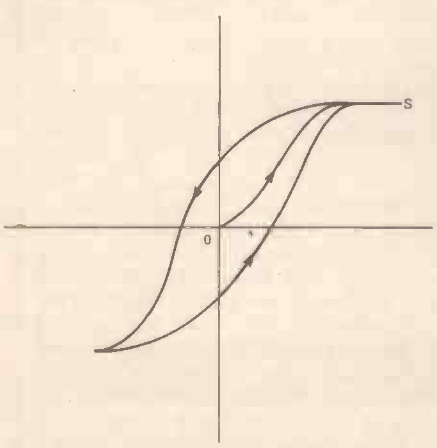



**Figure 6.** The complete hysteresis loop — the first part, marked OS, is seen only when starting with completely demagnetized material and is never traced again in the course of a measurement of this kind.

governing the design of the most important part of a transformer, its magnetic core.

## Round the Bend

Steinmetz set to work investigating the magnetism of iron and its alloys, using the type of equipment illustrated in **Figure 3**. The details have been omitted, but the principle was that a measured current was passed through the coil surrounding the magnetic specimen, and the strength of the magnetism measured (by a system which Steinmetz had devised). The measurements enabled him to draw a graph of magnetic strength (what we would now call the flux density) against the current flowing in the coil (proportional to what we now call magnetizing force). He started with completely demagnetized iron, and found that as the current increased, the magnetic strength also increased, following a curved graph line shaped rather like an 'S', to a maximum magnetic strength, which he termed 'magnetic saturation' (**Figure 4**). When the current was reduced, however, a different set of graph points was obtained, so that the graph for decreasing current followed a different path. This path (**Figure 5**) showed that when the current was reduced to zero, the iron remained magnetized (the amount is called the 'remanence'). Steinmetz found that the magnetism could be reduced to zero only by reversing the direction of the current in the coil and holding it at some definite value, called the 'coercive force'. By taking the value of the reversed current to the amount that caused the magnetism to saturate again he produced the now-familiar hysteresis curve for iron (**Figure 6**).

The consequences of this work were enormous. The area inside the loop-shaped curve is proportional to the amount of energy that has to be used to magnetize and demagnetize the material, and this energy causes the iron to become hot. Previously, it had been thought that the heating of electric motors and transformers was due only to the current flowing through the wires (and to eddy currents), but Steinmetz's work clearly showed that the magnetic material was as much to blame. He went on to show that the shape and size (area) of the hysteresis curve could be greatly affected by the composition of an iron alloy, and, even more importantly, on its previous treatment, such as heating, previous magnetization, mechanical strain, and so on.

For the first time, electric motors could be designed and perform to specification, and transformers could be wound which would not overheat. The way was open for the invention of magnetic recording by Poulsen, and subsequent research which led to the discovery of ferrite materials such as are now used for coil cores and for aerials in pocket radios. Even if Steinmetz had done nothing more on this work, he would have deserved to be remembered, and his classic paper of 1892 is well worth reading in reprint form.

## It Doesn't Add Up . . .

He contributed much more, however. When he arrived in the USA, he was amazed and dismayed to find that engineers, brought up in the British tradition, were almost incapable of making elementary calculations on alternating current circuits, and he undertook, virtually singlehanded, to raise the level of mathematical education to the standard which by then was common on the European continent, Britain excepted. He invented a new method of expressing AC calculations (the j-vector method) which is still in use, and, finding that engineers didn't understand it or even appreciate its advantages, he set about writing, in 1897, a textbook of Engineering Mathematics which did more to improve the education of engineers than any other single step in the decade.

Steinmetz's reputation by that time was such that when General Electric purchased the firm of Eickemeyer and Osterheld, Steinmetz was regarded as the main asset, and the most valuable single part of the deal. His work for GE included a new theory of transients (voltage pulses) which resulted in greatly improved ways of protecting transmission lines against switching surges and lightning strikes. The same theory was later used by the early workers on radar to predict the action of pulses in their circuits. Always an experimenter as well as a brilliant theorist, Steinmetz designed a pulse generator, for testing lines, which would even nowadays be regarded as something special — 100kV at 10kA for 1ns! This giant insulation-cracker was used to test lines for transient behaviour — and one nanosecond is as transient as you can get.

He continued working for GE, living in their bachelor accommodation surrounded by dozens of pet small animals of every kind, and a hothouse full of his special joy, orchids. He appears to have been idolised by his fellow-workers as that very rare type, a near-genius who was at the same time a very warm and friendly personality, and who would help anyone to the best of his ability. He died in 1923, having amassed no fortune, won few of the glittering prizes that most academics covet, and not even honoured by having his name used for a unit or a device. The admiration of his colleagues, and the increasing value of his contributions to electrical science were reward enough for Charles Steinmetz, and perhaps this article may serve to make his well-deserved US reputation rather better known over here.

**HE**

# Aerial Without Wings

Andy Armstrong

## A novel device that converts a rear-window demister into an effective car radio aerial for medium or longwave reception.

ARE YOU fed up with car aerials that corrode and won't work properly, or which are broken off by vandals? Or perhaps you simply dislike the idea of drilling rust-trapping holes in your beautiful bodywork!

If you listen to long or medium wave radio in your car, then your troubles may be over. This simple gadget will transform a rear window demister into a long and medium wave aerial; it will also work for FM reception, though not so well because of directional effects.

### Circuit, What Circuit?

All you need to build the device is a couple of capacitors and a bifilar wound coil. The circuit, such as it is, is shown in **Figure 1**.

The demister, like any length of wire, straight or not, will act as an aerial, but normally the radio frequency voltages induced in the wire are shorted to earth, either directly or through the battery (which presents virtually zero impedance to high frequencies).

The effective part of the circuit is the bifilar-wound coil, L1, which presents a high impedance to radio frequency signals, allowing them to be tapped off to the car radio aerial input via C1. The 1n capacitor, C2, is there to bypass to earth any transients (spikes) which are often present on a car's electrical system.

But what, you ask, is a "bifilar coil"? Well, it is simply two coils (like a 'pair' of scissors, there must be two 'halves') wound on a common former for the same number of turns with the same gauge wire, and *in the same direction*. The dots at the ends of the coil, in the circuit, indicate either the start or the finish of each winding; it doesn't matter which, as long as both ends are the same (this is the so-called 'dot convention' which is the standard way of indicating the polarity of transformers etc.).

### Saturation Tactics

Whenever a current flows in a coil (or in any wire, for that matter), a magnetic field is set up around the conductor. If the current is DC, however, and if the coil is wound on an iron or ferrite core, the magnetic flux rapidly reaches 'saturation', beyond which further increases in current have very little effect.

Therefore the high frequency AC will have no effect, either, and since inductance is largely dependent on variations in the magnetic flux density, DC flowing through an iron or ferrite-cored inductor has a drastic and undesirable effect on the inductance.

Bifilar-wound coils prevent this; since the coils, when connected as shown in **Figure 1**, are passing the same DC in opposite directions, the magnetic fields in each half are of opposite polarity and therefore cancel out. Thus only the flux due to the AC has any real presence, and the value of the inductance can be accurately predicted.

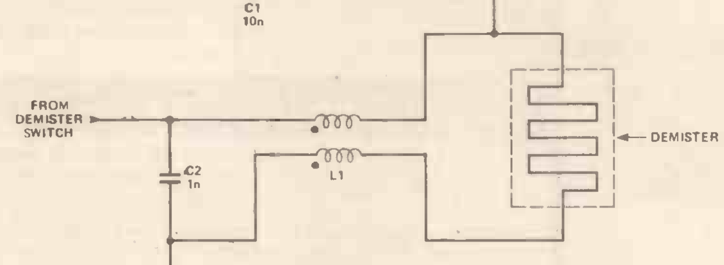



**Figure 1. The Circuit: dots signify the starting points of the two windings.**

### Construction and Installation

To make the coil, you simply need to wind two strands of thick wire (preferably 1.2mm$^2$ enamelled copper wire, but ordinary 13A household cable will do) on a toroid or pot former for between 13-20 turns, taking care to wind them together and in the same direction. Obviously the number of turns is not too critical within this range, so there is some room for experiment here! C2 can be soldered across the ends of the coil but the other capacitor cannot be so conveniently mounted, so after soldering to the appropriate coil-end, it must be securely fixed to part of the car body using a plastic cable tie. Alternatively, it could be strapped across the body of the toroid or pot former with a longer plastic cable clip, which can also be used to secure the whole assembly to the car chassis.

As with all constructions to be used in a motor, the soldered connections must be very secure lest they vibrate themselves loose, and all bare wires should be covered with insulating sleeving, preferably of the heat-shrinking variety.

The completed device should be installed as close as possible to the demister, to avoid interference pickup, and is connected to the radio aerial input via a long length of low capacitance car aerial cable, available from most good motor accessory shops. Do not be tempted to use ordinary co-ax, as the high inherent capacitance of this type of cable will prevent correct operation.

Next the car radio aerial trimmer must be adjusted for best reception; this can usually be done without dismantling the radio, and the location of the trimmer will be explained in the car radio installation instructions. And, finally, it may be necessary to improve the interference suppression, either by replacing the existing suppression components or adding extra ones (again, these should be available from an accessory shop). So here's wishing you happy motoring, and easy listening pleasure. Your car aerial is now off the wing!

HE

### Parts List

**CAPACITORS**
(polyester)

| | |
|---|---|
| C1 | 10n |
| C2 | 1n |

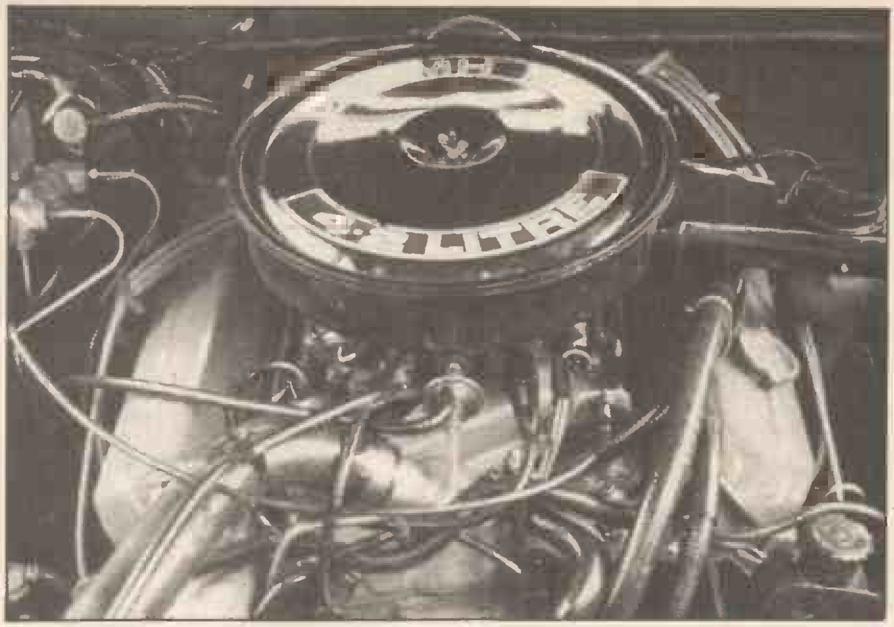
**MISCELLANEOUS**

| | |
|---|---|
| L1 | see text |

Pot core or toroid (see Buylines); 1.2mm$^2$ wire; car aerial cable; motor car with rear window demister and car radio.

**BUYLINES** ............page 34

**This handy little test gadget will help you sort out all those little things that go wrong in automotive electrics. With this, you can check voltage drops, on and off charge battery voltages and resistances.**



# HE Auto Tester

Graeme Teesdale

BUDDING MECHANICS are very often bamboozled by the electrics of a modern motor vehicle. An automotive or electronic type multimeter, with its combination scales all crammed together, simply adds to the confusion. This project was developed to make fault-finding a little easier by providing simple LED indication of 'set' points in voltage or resistance.

In a vehicle, voltage drop in cables of more than 0V5 can bring problems. The Auto Tester provides a clear indication of voltage drops less or greater than 0V5. The battery system, to perform up to scratch, must deliver at least 12V on load and the battery should have a terminal voltage of more than 13V5 when charging.

Resistances encountered in vehicles tend to have fairly well defined limits. Many devices have resistances under 10 ohms, a few range up to 150 ohms. Thus the first resistance 'set' point is at about 150 ohms. Much higher resistances are encountered in HT suppressors, etc. Generally, these are around 10k or 15k. Trouble can occur if they go faulty and exhibit a high resistance, generally greater than 50k. Thus, two other 'set' points for resistance are at 10k and 50k.

The unit was housed in a small, conveniently-sized box; the PCB designed for the unit will just fit comfortably into several different types on the market. Four indicator LEDs are provided: a POLARITY indicator, followed by one for each of the three set points in voltage and resistance. Two pushbuttons select which 'mode' you wish to use — VOLTS or OHMS.

Where battery polarity is unknown, or in instances where the Auto Tester may be incorrectly connected, the POLARITY LED will light when the red, or positive, input lead is connected to the battery negative.

Protection against input overvoltage damage has been incorporated, so that voltage inputs of greater than 15V are clamped to avoid damaging the IC.


HE Auto Tester showing the front panel and crocodile clips.

The Auto Tester, unlike most multimeters, will not be damaged if a DC voltage is applied to the input when it is being used in the resistance mode.

The unit is powered from a PP3 9V battery and the circuit is based around the commonly available, low cost LM324 or uA324 quad op-amp. The battery will likely last its shelf life (probably a year or more) as consumption is only ever momentary, when you take a reading!

## Auto Testing

The clearest way of seeing how this circuit works is to break it down into simplified sections. The Auto Tester performs three main functions: voltage drop measurement, 12/13.8V measurement and resistance measurement. In addition, an indication of reverse polarity connection is provided along with input overvoltage protection.

The whole circuit is built around an LM324 (or uA324) quad op-amp, IC1. Three op-amps from this are arranged as comparators and one as an amplifier. Let's look at the voltage drop measurement stage first. This portion of the circuit is shown in **Figure 1** (only the relevant components are included).

When PB1 is pressed, power is supplied to IC1 via D3 (note that R1, LED1, R2 and ZD2 play no part here). RV1, R3 and R4 form a voltage divider across the input of IC1a, which is arranged as an amplifier, while IC1d is set up as a comparator.

If the input leads are then

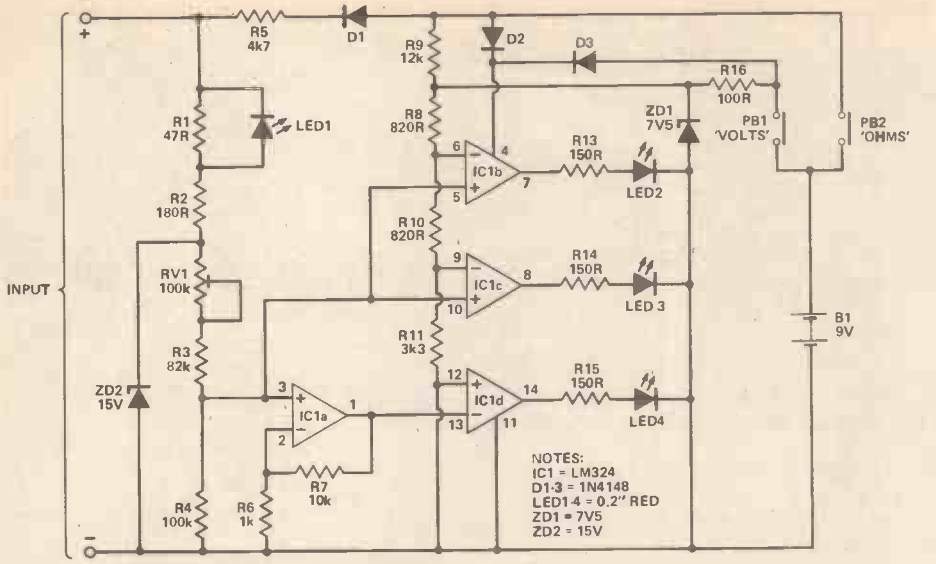



**Figure 1. The Auto Tester circuit.**

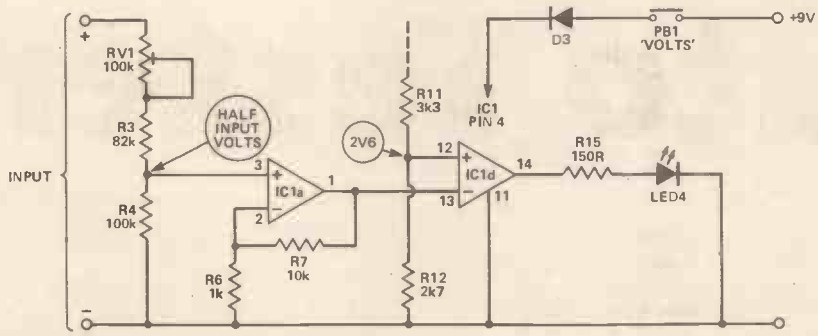



**Figure 2. Voltage drop measurement.**

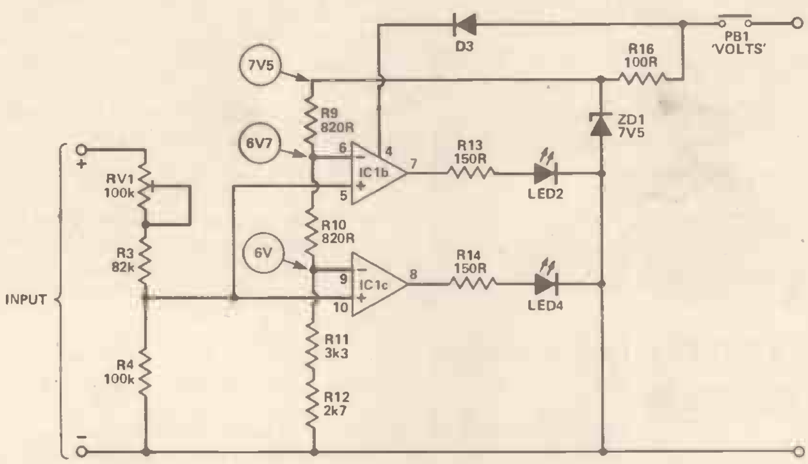



**Figure 3. 12V and 13V8 measurement.**

connected across a cable having a voltage drop of less than half a volt, say 0V2, the voltage appearing at the non-inverting input of IC1a will be about 0V1 (half the input volts) due to the divider action of RV1, R3 and R4. RV1 is set to provide this division ratio of about two, while IC1a provides a gain of 10, and thus the output will be 1V. This is lower than the 2V6 on the non-inverting input of IC1d and thus its output will be driven high, lighting LED4.

If the voltage drop on the cable you have connected the input leads across reaches a little over a half a volt, say 0V55, the voltage on the non-inverting input of IC1a will be 0V275. The voltage on the output of IC1a, and thus the inverting input of IC1d, will be 2V75 which exceeds the 2V6 on IC1d's non-inverting input. The output of IC1d will thus go low and LED4 will extinguish, warning you of excessive voltage drop in the cable.

Note that, when performing voltage drop measurements, the positive lead must be connected at the end of the cable closest to the positive terminal of the vehicle battery!

When the input leads are open circuit and PB1 is pressed, D1 will be forward biased as it is connected to the 7V5 rail (from ZD1) via R8. Thus, something a little under 7V will appear at the 'top' of RV1, and about 3V5 at pins 3, 5 and 10 of IC1. This will drive the output of IC1d low, and LED4 will be unlit. It won't change the condition of either IC1c or IC1d, so LEDs 2 and 3 will also be unlit. Thus, nothing happens if you press PB1 ('VOLTS') when the leads are not connected to anything.

Let us look at the other voltage measurements now. This section of the circuitry is shown in **Figure 2**, where IC1b and IC1c are connected as comparators. Each has its inverting input connected to the voltage divider R9, 10, 11 and 12. This voltage divider is supplied from a regulated 7V5, derived by ZD1 and R16, thus battery voltage variations will not affect circuit operation, provided the battery voltage doesn't fall to 8V or less.

IC1b and IC1c have their non-inverting inputs connected together and these are attached to the input voltage divider. When PB1 is pressed, power is supplied to IC1 via D3, as before. With no input voltage, the outputs of IC1b and c will both be low and LEDs 2 and 3 will be unlit. When the input leads are connected to a voltage a little over 12V, the voltage on pin 10 of IC1c will be a little over 6V. This will drive the output of IC1c high, lighting LED3. When the input voltage rises above about 13V5, the voltage on the pin 5 of IC1b will be a little over 6V7, driving the output of IC1b high, now lighting LED2 also.

## Resistance

Look at resistance measurement now (for this explanation, refer to the complete circuit diagram, **Figure 3**). As before, R1, LED1, R2 and ZD2 play no part here.

When PB2 is pressed, power is supplied to IC1 via D2; some current is also supplied to the resistive divider network, R9, 10, 11, 12, by R8. This establishes a different set of voltages on the three comparator inputs. Pin 6, IC1b will now have about 3V8 on it, pin 9, IC1c about 3V on it and pin 12, IC1d about 1V3 on it.

When the leads are connected to a resistance, current will be supplied to the resistance via D1 and R5. Say the resistance is 100 ohms; about 1mA8 will be driven through it because there is about 8V5 on the cathode of D1 and 8.5 divided by 4800 ohms gives about 1mA8. Thus, there will be a voltage drop across the 100 ohms of resistance of about 0V18. About 0V09 will appear on pin 3, IC1a, and the output of IC1a will drive the inverting input of IC1d to about 0V9 which is less than the 1V2 on IC1d's non-inverting input. Thus the output of IC1d will be high, lighting LED4. If the resistance across the input is, say, 180 ohms, the voltage across the input leads will be about 0V32. About 0V16 appears on pin 3, IC1a and 1V6 on pin 13, IC1d. The output of IC1d will therefore go low, and LED4 will not light.

If the resistance across the input terminals is between 150 ohms and 10k, say 5000 ohms or so, then the voltage across it will be about 4V. The voltage on pin 10, IC1c will be about 2V, which is less than that on pin 9 and the output of IC1c will be low and LED3 will be unlit. If the resistance across the input leads is about 15k, say (such as a spark plug suppressor resistor), then the voltage across the input will be about 6V4 and the voltage presented to pin 10, IC1c will be about 3V2. This is above the 3V on pin 9 and the output will thus go high, turning on LED3.

If the resistance across the input leads is about 50k, then the voltage across the input will be about 7V8. The voltage on pin 5, IC1b will be about 3V9 and the output of IC1b will therefore be high, turning LED2 on. Note that LED3 will also be on as the voltage on pin 10, IC1c is above that on pin 9 and IC1's output will be high also. Thus, for all resistances above 50k (including an open circuit) LED2 and LED3 will light.

## Parts List

**RESISTORS**
(All ¼ watt 5% carbon)

- R1 .......... 47R
- R2 .......... 180R
- R3 .......... 82k
- R4 .......... 100k
- R5,12 .......... 4k7
- R6 .......... 1k
- R7 .......... 10k
- R8 .......... 12k
- R9,10 .......... 820R
- R11 .......... 3k3
- R13,14,15 .......... 150R
- R16 .......... 100R

**POTENTIOMETERS**

- RV1 .......... 100k min. trimpot

**SEMICONDUCTORS**

- IC1 .......... LM324 quad-op amp
- LED1,2,3,4 .......... 0.2" red LEDs
- D1, 2, 3 .......... 1N4148 etc.
- ZD1 .......... 7V5 Zener
- ZD2 .......... 15V Zener

**MISCELLANEOUS**

- PB1,2 .......... push-to-make switches

PCB; box approx. 52 × 30 × 100mm; PP3 battery plus clip; 2 x alligator clips and leads; wire, solder, nuts and bolts etc.

**BUYLINES** .......... page 34

## Poles Apart

Followed that so far? Alright, let's look at the reverse polarity indication. The relevant portion of the circuit is shown in **Figure 4**.

If the input leads are transposed while trying to measure voltage, ZD2 will conduct as a diode in the forward direction (as shown by the arrow), passing current through LED1, which will turn on. It will also pass some current through R1, but that's immaterial. R1 is there so that current can pass to RV1 when the leads are correctly connected, otherwise no current would pass through LED1 as it would appear as a reverse-biased diode.

If you reverse the input leads while attempting to measure voltage drop, LED1 will only come on if the voltage drop is above about 1V3 or so. Thus, it is important to watch lead polarity when measuring voltage drop in cables.

Overvoltage protection is provided by ZD2. Why have it? Well, if a battery cable comes adrift and you're attempting to measure voltages while the motor is running, the generator/alternator can quite easily deliver outputs of 20V or so; this can possibly destroy the LM324. In addition, it is not unusual to get inductively-produced voltage 'spikes' on the supply lines in a vehicle, which can also destroy the IC. If a voltage of greater than 15V appears on the input leads to the Auto Tester, ZD2 will ensure that the voltage delivered to the LM324 does not exceed 15V.

The various voltages and resistances given here can vary by ± 10% or so without grossly affecting your interpretation of readings. What you are after, after all, is a 'ballpark' measurement which will indicate if all is well, or not.

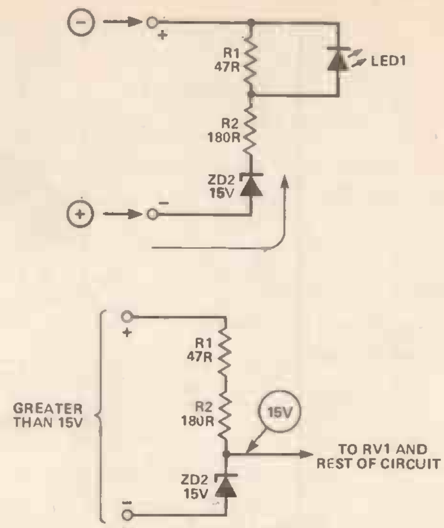



**Figure 4 (top). Reverse polarity indication.**
**Figure 5 (bottom). Overvoltage protection.**

## Construction

The project PCB has been designed to fit into almost any of the small general purpose boxes available. These are generally all-plastic or plastic cases with a light gauge aluminium 'lid'. The design will suit those boxes measuring 52 x 100mm or a little larger.

Before assembling the components to the board, check that it has no

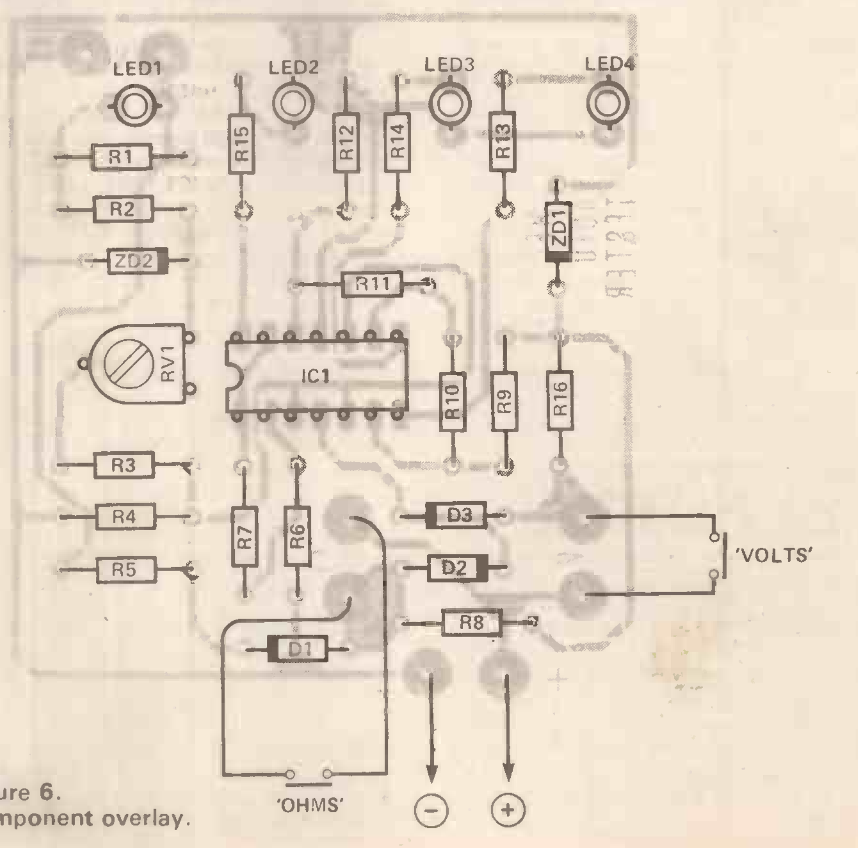



**Figure 6. Component overlay.**

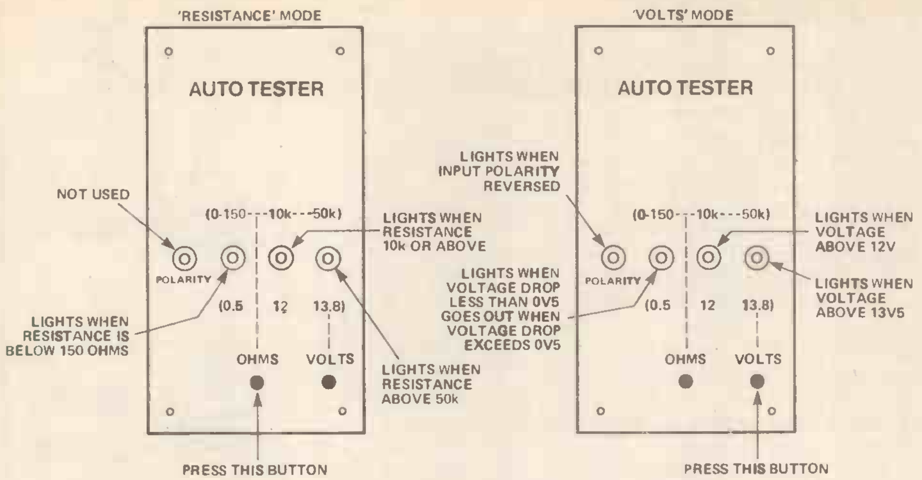



**Figure 7. Operating the Auto Tester in Resistance and Voltage modes.**

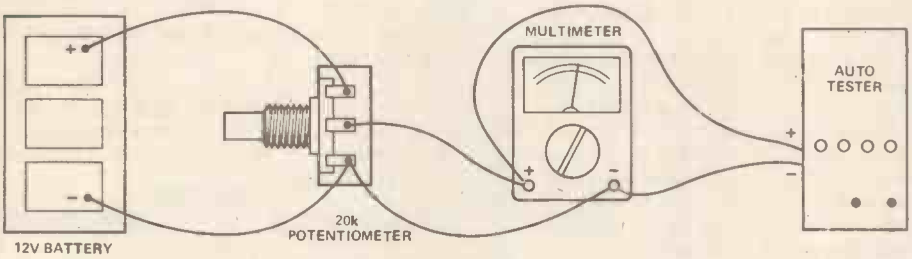



**Figure 8. Test setup for calibrating the Auto Tester.**

breaks or shorts between tracks, particularly between the IC pins. Also check that components like RV1, the Zener diodes and LEDs have the correct lead hole sizes drilled. The board can be mounted by soldering the two pushbutton switches directly to the board and letting the board hang from their leads — it's quite a robust arrangement. If you're going to do this, see that the holes for PB1 and PB2 are drilled the right size.

Next, check that the board fits inside the box. Make sure you orient the board correctly when you do this. If the board doesn't fit in without jamming you may have to carefully trim a little off one or both sides with a file until it fits properly. If it doesn't fit at all, get a bigger box.

Mark out and drill the front panel, or lid, of the box and fit the four LED mounts. Once the board is ready to go, commence assembly by soldering all the resistors in place, then the diodes D1, 2 and 3, followed by the two Zener diodes (make sure you get all the diodes in the correct way round).

If you're mounting the board to PB1 and PB2, solder these in place now, making sure their mounting 'shoulders' are level. Insert the four LEDs next, but don't solder them in place; make sure you orient them correctly and don't trim off their leads. Temporarily mount the board to the front panel of the case, push the LEDs into position and then solder and trim their leads. De-mount the board from the panel and fit IC1, RV1, the battery clip lead and the two input leads. Now you're ready for testing. But first, check *everything* carefully. See that the IC, all diodes and LEDs are correctly orientated, according to the component overlay.

## Testing the Unit

Fit a 9V, PP3 battery, short the input clips together and press the VOLTS button: the 0V5 LED should come on. If not, check component orientations, then resistor values. Fix any faults, and once you have that corrected, try again. When you get the 0V5 LED to light, unclip the input leads and it should go out.

To calibrate the unit, you'll need to get hold of a multimeter, a well charged 12V battery and a 20k potentiometer. Hookup the circuit shown here and adjust the potentiometer to give a 12V reading on the multimeter. Press the VOLTS button and adjust RV1 so that the '12V' LED just lights. Then, reset the potentiometer to get a 0V5 reading, or a little more, on the multimeter. The '0V5' LED should just light; if it doesn't, vary the potentiometer slightly until it lights. If the '0V5' LED lights when the multimeter reads more than ±0V1 from 0V5, then you may have to change the value of R12. Increase it if the voltage is low, decrease it if the voltage is high. Just take the next highest or next lowest resistor value; you're only after a rough indication, after all.

Set the potentiometer fully 'up' (fully clockwise); if the battery is well charged, then the multimeter should read 13V5 or above and the '13V8' LED should turn on, along with the '12V' LED. Now, reverse the Auto Tester input leads. The POLARITY LED should come on.

If you can't get the proper indications, check with the multimeter that you are getting 7V5 (within ±0V3) across ZD1 when you press the VOLTS button. Also check the voltages on pins 6, 9 and 12 of IC1 when you press the VOLTS button and see they are close to those given in the circuit description.

If all is well, proceed with testing the OHMS mode. Disconnect the 12V battery, then set the multimeter to read resistance (should be the X1 scale). Adjust the potentiometer until the multimeter reads about 100 ohms. Press the OHMS button and the '0-150' LED should come on. Turn the potentiometer until that LED goes out and keep turning till the '10k' LED turns on; it should turn on when the multimeter reads somewhere in the vicinity of 10k.

With the Auto Tester leads open circuit, both the '10k' and '50k' LEDs should turn on.

You are now ready for use. Happy fault-finding!

## 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 | 56p |
| 74142 | 175p |
| 74143 | 200p |
| 74144 | 200p |
| 74145 | 40p |
| 74147 | 75p |
| 74148 | 60p |
| 74150 | 50p |
| 74151A | 36p |
| 74153 | 36p |
| 74154 | 50p |
| 74155 | 38p |
| 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 | 56p |
| 74251 | 45p |
| 74273 | 120p |
| 74278 | 140p |
| 74279 | 40p |
| 74283 | 50p |
| 74284 | 160p |
| 74290 | 75p |
| 74293 | 80p |
| 74298 | 100p |
| 74351 | 150p |
| 74365 | 30p |
| 74366 | 35p |
| 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 |
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| 74LS21 | 13p |
| 74LS22 | 13p |
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| 74LS27 | 13p |
| 74LS28 | 14p |
| 74LS30 | 13p |
| 74LS32 | 13p |
| 74LS37 | 14p |
| 74LS38 | 14p |
| 74LS40 | 12p |
| 74LS42 | 30p |
| 74LS47 | 36p |
| 74LS51 | 14p |
| 74LS55 | 14p |
| 74LS73 | 18p |
| 74LS74 | 16p |
| 74LS75 | 18p |
| 74LS76 | 18p |
| 74LS83 | 36p |
| 74LS85 | 40p |
| 74LS86 | 16p |
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| 74LS241 | 55p |
| 74LS242 | 56p |
| 74LS243 | 55p |
| 74LS244 | 50p |
| 74LS245 | 70p |
| 74LS251 | 30p |
| 74LS253 | 30p |
| 74LS256 | 150p |
| 74LS257 | 30p |
| 74LS258 | 35p |
| 74LS259 | 55p |
| 74LS260 | 22p |
| 74LS261 | 50p |
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| 74LS299 | 150p |
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| 74LS323 | 160p |
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| 74LS363 | 140p |
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| 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 |
| 74LS626 | 150p |
| 74LS628 | 150p |
| 74LS670 | 120p |
| 74LS687 | 400p |

## 4000 SERIES

| | |
|---|---|
| 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 | 46p |
| 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 | 30p |
| 4044 | 40p |
| 4076 | 48p |
| 4077 | 18p |
| 4078 | 16p |
| 4081 | 14p |
| 4082 | 15p |
| 4086 | 40p |
| 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 | 45p |
| 4514 | 110p |
| 4515 | 110p |
| 4516 | 55p |
| 4518 | 40p |
| 4520 | 50p |
| 4521 | 90p |
| 4526 | 60p |
| 4527 | 60p |
| 4528 | 50p |
| 4532 | 60p |
| 4534 | 400p |
| 4536 | 270p |
| 4538 | 90p |
| 4539 | 70p |
| 4543 | 75p |
| 4553 | 246p |
| 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 |
| 40175 | 50p |
| 40193 | 60p |
| 14495 | 300p |
| 40244 | 60p |
| 40245 | 180p |
| 40373 | 160p |
| 40374 | 160p |

## LINEAR ICs

| | |
|---|---|
| AD7581 | 1150p |
| LC7137 | 270p |
| AN103 | 200p |
| AY1-0212 | 600p |
| AY1-1320 | 225p |
| AY1-5060 | 99p |
| AY3-1350 | 350p |
| AY3-8910 | 550p |
| AY3-8900 | 380p |
| AY3-8912 | 625p |
| AY5-4007D | £6 |
| CA3028A5 | 120p |
| CA3019 | 80p |
| CA3046 | 70p |
| CA3048 | 220p |
| CA3059 | 285p |
| CA3060E | 350p |
| CA3080E | 70p |
| CA3086 | 48p |
| CA3089 | 200p |
| CA3090AQ | 400p |
| CA3130E | 90p |
| CA3140E | 40p |
| CA3140T | 90p |
| CA3160E | 100p |
| CA3161E | 150p |
| CA3162E | 450p |
| CA3189E | 300p |
| CA3240E | 110p |
| CA3280G | 200p |
| D7002C | 480p |
| DAC1408-8 | £2 |
| DAC0800 | 200p |
| DAC0808 | 200p |
| RA1366 | 195p |
| HA1388 | 250p |
| ICL7106 | 700p |
| ICM72156B | £18 |
| ICM7217 | 750p |
| ICM7555 | 80p |
| LC7120 | 300p |
| LC7130 | 325p |
| LF347 | 150p |
| LF351 | 48p |
| LF353 | 95p |
| LF356P | 95p |
| LF357 | 110p |
| LM10C | 325p |
| LM301A | 25p |
| LM307 | 45p |
| LM308 | 45p |
| LM308N | 75p |
| 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 |
| LM1011 | 400p |
| 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 |
| MC1310P | 150p |
| MC1445 | 250p |
| MC1458 | 36p |
| MC1495L | 350p |
| MC1496 | 70p |
| MC3340P | 120p |
| MC3403 | 65p |
| MF10 | 250p |
| MK50398 | £7 |
| ML920 | 800p |
| MN57160 | 620p |
| MN6221A | 600p |
| NE531 | 140p |
| NE532 | 130p |
| NE533 | 140p |
| NE555 | 16p |
| NE556 | 45p |
| NE564 | 420p |
| NE565 | 120p |
| NE566 | 155p |
| NE567 | 140p |
| NE570 | 410p |
| NE571 | 400p |
| NE5534A | 125p |
| PLL02A | 500p |
| RC4136 | 60p |
| S566B | 256p |
| SAA1900 | £16 |
| SAD1024A | £9 |
| SFF9634 | 800p |
| SN76477 | 450p |
| SN76488 | 450p |
| SN76495 | 400p |
| SP0256AL2 | £10 |
| SP8515 | 750p |
| TA7120 | 150p |
| TA7204 | 150p |
| TA7205 | 250p |
| TA7222 | 150p |
| TA7310 | 150p |
| TBA641BX1 | £4 |
| TBA800 | 80p |
| TBA810 | 100p |
| TBA820 | 80p |
| TBA950 | 225p |
| TCA220 | 350p |
| TCA940 | 175p |
| TDA1004A | 300p |
| TDA1008 | 320p |
| TDA1010 | 200p |
| TDA1022 | 500p |
| TDA1024 | 120p |
| TDA1170 | 300p |
| TDA2006 | 350p |
| TDA2020 | 320p |
| TL061CP | 40p |
| TL062 | 60p |
| TL064 | 95p |
| TL071/81 | 25p |
| TL072/82 | 45p |
| TL074 | 100p |
| TL084 | 90p |
| TL094 | 200p |
| TL170 | 50p |
| TL430C | 70p |
| UA2240 | 120p |
| UAA170 | 170p |
| ULN2003 | 100p |
| ULN2004 | 75p |
| ULN2068 | 290p |
| ULN2802 | 200p |
| UPC575 | 275p |
| UPC592H | 275p |
| UPC1156H | 300p |
| UPC1185 | £5 |
| XR2206 | 300p |
| XR2207 | 375p |
| XR2211 | 575p |
| XR2216 | 675p |
| ZN414 | 80p |
| ZN419C | 190p |
| ZN423E | 130p |
| ZN424E | 130p |
| ZN426E | 300p |
| ZN427E | 580p |
| ZN428E | 400p |
| ZN1034E | 200p |
| ZN1040E | 670p |
| 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 | 36p |
| BC547B | 12p |
| BC548C | 9p |
| BC549C | 12p |
| BC557B | 18p |
| BC559C | 16p |
| BCY70 | 20p |
| BCY71 | 20p |
| BD135/6 | 40p |
| BD139 | 40p |
| BD189 | 60p |
| BD232 | 95p |
| BD235 | 75p |
| BD236 | 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 |
| MJE3305 | 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 | 56p |
| MPSU07 | 60p |
| MPSU45 | 90p |
| MPSU65 | 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 | 56p |
| TIP42A | 50p |
| TIP42C | 60p |
| TIP54 | 160p |
| TIP120 | 50p |
| TIP121 | 70p |
| TIP122 | 60p |
| TIP142 | 110p |
| TIP147 | 120p |
| TIP2955 | 60p |
| ZTX | 10p |
| ZTX300 | 13p |
| ZTX452 | 46p |
| ZTX500 | 13p |
| ZTX502 | 15p |
| ZTX504 | 30p |
| ZTX552 | 55p |
| ZTX652 | 60p |
| ZTX752 | 70p |
| VN10KM | 56p |
| VN66 | 80p |
| 2N697 | 20p |
| 2N698 | 40p |
| 2N706A | 18p |
| 2N708 | 18p |
| 2N918 | 36p |
| 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 | 56p |
| 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 | 15p |
| 2N4037 | 65p |
| 2N4124 | 27p |
| 2N4126 | 27p |
| 2N4401/3 | 25p |
| 2N4427 | 90p |
| 2N4871 | 50p |
| 2N5062 | 36p |
| 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 |
| OA200 | 8p |
| 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 |
| DCP71 | 180p |
| ORP12 | 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 | 56p |
| 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 |
| NS85881 | 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" x 5" | 95p |
| 2.5" x 3.75" | 86p |
| 2.5" x 17" | 330p |
| 3.75" x 3.75" | 95p |
| Vero Block | 410p |
| 3.75" x 5" | 90p |
| 3.75" x 17" | 410p |
| 4.75" x 7.9" | 630p |
| 2.5" x 1" | 110p |
| Spot Face Cutter | 130p |

## SWITCHES

TOGGLE SWITCHES
Subminiature
SPST £60p, SPDT 65p.
DPDT 70p
Rotary Switches
IP120w, 2P6w, 3P4w, 4P3w 56p
DIGITAST SWITCHES lxP
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.

Ready Built Unit . . . . . . . . £145 + £5.00 carr.
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AS DESCRIBED IN JUNE/JULY/AUGUST ISSUE

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Complete Kit £64.00 + £1.00 p&p
8V 1.8A PSU £7.00 + 70p p&p
1802 Ref. £7.00
IDEAL for HOBBYISTS — learn and explore the workings of microprocessors and unravel the mystical field of computers.
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INEXPENSIVE — a truly low cost teaching aid — in fact a short step towards developing new ideas and systems.

# BBC

## MICRO COMPUTER OFFICIAL DEALER

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BBC Model B £399
(incl VAT) Carr £8/unit
Model A to Model B upgrade kit £50
Fitting charge £15

**Individual upgrades also available**
**WORD PROCESSOR 'VIEW' 16k FROM £52**
**TELETEXT ADAPTOR £195**
**PRESTEL ADAPTOR £90**
**SECOND PROCESSOR 6502 £170**
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ACORN SOFT/BBC SOFT/ GAMES PADDLES IN STOCK

## FLOPPY DISC INTERFACE

inc. 1.2 O.S. £95 + £20 installation

## BBC FLOPPY DISC DRIVES

Single drive 5¼" 100K £235 + £6 carr.
Dual drive 5¼" 800K £799 + £8 carr.

## BBC COMPATIBLE DRIVES

These are drives with TEAC FD50 mechanism and are complete with power supply
SINGLE: 100K £190; 200K £260; 400K £340
DUAL: 200K £360; 400K £490; 800K £610
**Drive Cables: Single £8 Dual £12**

## 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

Further details on request
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PSU .......... £7.00 + 70p p&p
Construction details supplied

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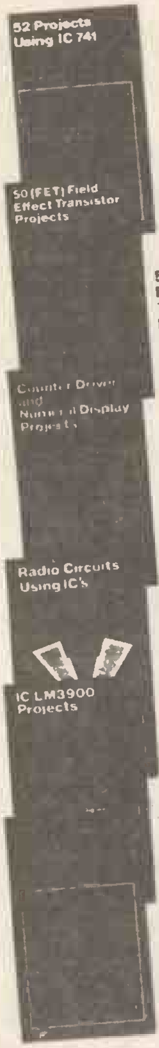


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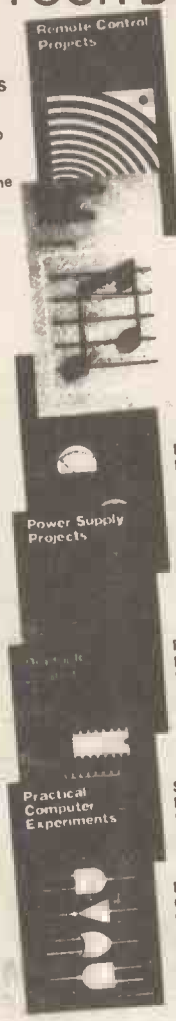


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# BUYLINES

## BBC/HEBOT Interface

A complete kit of parts and components for the project is being supplied for £24.00 by **Kelan (Hobbyboard) Ltd.**, North Works, Hookstone Park, Harrogate, North Yorkshire. The PCB is available separately from our PCB Service—see page 71.

## Aerial Without Wings

A suitable toroid for this project is available from **Neosid Small Orders** 1982, PO Box 86, Welwyn Garden City, Herts AL7 1AS, for just £1.10, including P&P.

## Stall Thief

The 0.25" PCB-mounting push-on connector blades used on the prototype are not absolutely necessary, but they do give a firmer, more reliable connection. They are not stock items and will have to be ordered specially; identification is easy if you quote the RS Components stock number—533-229. Alternatively, 0.1" PCB pins may be used, but make sure your soldering is secure!

The relay is not critical, as long as it is a 12V type, 200R coil with contacts rated at 5A or better; the open-contact gap should be wider than 5mm for reliable operation.

Component cost, excluding the PCB, relay and connector blades, should be around £2.00.

### Check List

**RESISTORS**
(All ¼ watt 5% carbon)
4 x 4k7; 2 x 1MR; 1 x 10M; 1 x 680k; 1 x 2M2; 1 x 330R; 1 x 10k.

**CAPACITORS**
1 x 100n; 1 x 10n; 1 x 1n; 1 x 4u7; 1 x 10u 16V electrolytic.

**SEMICONDUCTORS**
1 x CD4011B; 2 x 1N4148; 2 x BC 108 or similar.

**MISCELLANEOUS**
1 x 12V/200R relay, contacts rated 5A or better; PCB; 6 x 0.25" connector blades or 0.1" PCB pins; optional case; wire, solder, nuts and bolts etc.

## Auto-Test

All the components and parts for this useful project are stock by most suppliers—**Greenweld Electronics**, for example. The cost ought to be under £3.00, excluding the case and PCB.

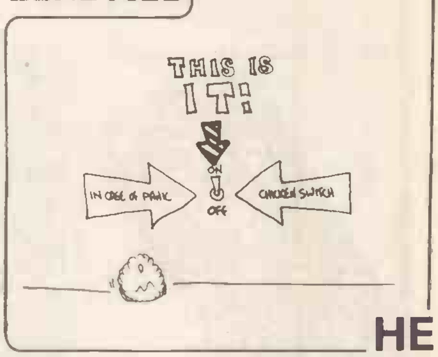
### Check List

**RESISTORS**
(All ¼ 5% carbon)
1 x 47R; 1 x 180R; 1 x 82k; 1 x 100k; 2 x 4k7; 1 x 1k; 1 x 10k; 1 x 12k; 2 x 820R; 1 x 3k3; 3 x 150R; 1 x 100R.

**POTENTIOMETERS**
1 x 100k miniature trimpot.

**SEMICONDUCTORS**
1 x LM324; 3 x 0.2" (5mm) LEDs; 3 x 1N4148 or similar; 1 x BZY88C7V5; 1 x BZY88C15V.

**MISCELLANEOUS**
2 x push-to-make switches; PCB; case; 52 x 30 x 100mm approx; PP3 battery + clip; 2 x alligator clips and leads; wire, solder, nuts and bolts etc.




HE

# POINTS OF VIEW

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

### Audio Analyser

We have received several queries about this project, which regrettably has had more than its fair share of mistakes.

The entire file has been passed back to the designer with instructions to sort it out, quickly. Meanwhile, we ask all readers who've had a problem with this project to be patient — it will be unravelled. One problem with electronics is that components can vary quite widely from their paper specification, and because of this, individual prototypes can work perfectly, when 99% of other models built to the same design will fail to work properly (or at all); conversely, sometimes a model which has been built perfectly with all the proper components will be the 1% which will never work until half the components have been changed . . . the electron is still a mysterious animal, despite the confidence with which we shunt it around.

Apropos of that, let me add that the Telephone Timer (HE June/July '82), which has turned a few hairs grey, is under similar surveillance, but at present we are not sure where the author is. . . . On a more minor note, we are looking again at Big Ear (HE December '82) to find out why a few people have had minor but persistent problems with it. We haven't abandoned you, and the answer will eventually appear. Now on with the show . . .

### Missing Designer

Is Mr. Peter Walton, who sent us a Selective Caller project a few months ago, out there? We would like a word with him, but don't have his address. Please write.

### Alarm Alarm

*Dear Sir,*
*I am building your Low Cost Alarm system, from HE December '82. I have all the parts for the alarm, but I do not have PBCs and the window foil and terminals. If you do not have these components I would like to know where I can get them.*
*Yours faithfully,*
*Stephen Herron,*
*Newtownabbey,*
*Co. Antrim,*
*N. Ireland.*

Up until now there has not been a made-up PCB available for the Low Cost Alarm; but there is now. See the PCB Service page in this issue. We don't of course stock components of any kind (not now, not ever, never — we have enough trouble with ETI stealing our personal store) but the foils and switches for this project are, of course, available from the source mentioned in Buylines: in this case, Maplin Electronics.

### Siren Call

*Dear Sir,*
*Project: Low Cost Alarm system, HE December '82.*
*1) AWD. Greenweld (1982/3 catalogue) do not seem to supply the siren as described in the text, parts list and photo.*
*Could you please suggest an altern-tive supplier, and full specification, if possible? (This AWD sounds very good, with a warbling tone, only OmA75,95dB at 1m, and very compact, as per photo.)*
*2) PCB. Is this going to be available?*
*Many thanks,*
*Dr. K.D.E. Whiting,*
*Hatfield,*
*Herts.*

This AWD is on the RS components catalogue as 249-413 — ask your local dealer to order it for you. As for the PCB, it's now available, as from this month.

### Projects From The Past

*Dear Sir or Madam,*
*I have two problems I wish you could solve for me:*
*1) HE September '79 page 23 Starburst. I bought your ETI Print made PCB, fitted components, wired up, tested and got no result. The ICs are working, and so are the LEDs (tested before wiring boards together, ie LEDs). Somebody made a hash of component layout on page 26, they even managed to get the power supplies back to front. Did they make a mistake in values for R7 to R11?*
*2) HE October '81 Pages 51 and 52 Touch Lamp. As is my practice, I am trying to fit this lot into a small box, could you tell me what relay you used, name and shop or agent?*
*Yours faithfully,*
*V. Hogg,*
*Hayes,*
*Middx.*

Yes, the 0V and +9V notation should be swapped around on the PCB layout on page 26 — an easily-spotted error.

The values for R7 to R11 should produce reliable switching provided you are using the specified transistor. However, if you think this is the source of the problem, reduce the values to around 18k (don't go lower than 10k).

A relay was not specified for the Touch Switch but any 6 to 12V, 100R coil relay with single changeover contacts rated at 10A or so will suit; just be careful with the counting and wiring. Such relays are available from almost any mail order supplier advertising in HE.

This also seems a good time to remind all our readers that technical enquiries such as this one cannot be answered personally unless an SAE is enclosed, and although we try to be prompt, especially with enquiries about projects under construction, your Hobby Electronics has to come first — so you may have a long wait. But don't feel you are alone — designers have all the problems constructors have, and then some . . .

### Shed A Little Light

*Dear Sir,*
*I have been working on a light sensitive switch project based on one of your circuits but have a problem with operation during daylight.*
*I want the switch to operate on artificial light, eg car head-lights, but not daylight. Is there a light sensitive component suitable and if so where can it be obtained?*
*F S Roberton,*
*Kelso,*
*Scotland.*

You could attack this problem in one of three ways: a) you could mount your light receptor in a recess or cowling so that it would get a minimum of normal daylight but would pick up a headlight beam pointed at it b) you could use a logic circuit of some kind which would pick up a simple pattern of flashes from the headlights c) you could opt for a commercial infra-red or ultra-sonic remote control and sensor combination — which would do the job, but is of course a completely different solution from using a light-sensitive switch.

We don't know of any light receptor which will distinguish between headlights and daylight without the kind of help described here. Does anybody else have any suggestions?

### Not Beaten Yet

Dear Sir,
In HE December '81 you had a DIY Drum Synthesiser. Have you any of the aforementioned drum synth circuit boards left, and if so could you please quote me a price?

S Hallam,
Horsley Woodhouse,
Derbyshire.

All our projects are DIY unless you can con a friend or relation in building them for you! Perhaps one day we'll design a robot that builds itself . . .

Unfortunately we don't do a PCB for the drum synth, but you can try contacting Bewbush Audio, 26 Hastings Road, Pound Hill, Crawley, Sussex and asking for information.

## Getting Into Phase

*Dear Sir,*
*Could you please send me your latest price list and catalogue on the HE Phase One unit and any other musical effects.*
*A Brandon,*
*Winsford,*
*Cheshire.*

I think you mean Phase Four, the HE Phaser Unit. If not, you're in the wrong store! There is no kit for Phase Four, but the PCB is still available from our PCB Service. For other effects, consult the Cumulative Index in HE January '83 — we can always supply back issues or copy articles of old projects, but we can only supply the PCBs as listed in the most recent issue, ie this one. Any help? Phase Four, for anyone else who wants to check it out, is in HE December '82, and features a custom-designed case supplied by Newrad Instruments.

## Time To Switch On

*Dear Sir,*
*AS a regular reader of HE, I wonder if you could publish a timer project for switching mains appliances on and off. The application I have in mind is to switch my hi-fi on to record a certain radio programme while I'm out. When the programme is over, the timer should also switch the system off. A repeat function for recording the same programme each day (holidays, etc.) would also be useful, and a smart case and digital display would make the unit fit in well with hi-fi equipment, etc.*

*Great mag, keep up the good work.*
*J. Jezard,*
*Tonbridge,*
*Kent.*

There are a number of timers already on the market which will switch a mains socket on and off at preset times. However, these are relatively expensive and do not include the extra facilities you mention. So we have started work on a design for such a timer and hope to publish one in the future. In the meantime, you might like to take a look at your central heating switch — some have an external mains outlet socket which is switched on and off with the heating. Of course, you'd have to switch off the heating system first to avoid wasting energy by warming an empty house!

## Raiders Of The Lost Hobby . . .

*Dear Sirs,*
*Having been a keen reader of HE for some time I have noticed how back numbers of the magazine soon become objects of great demand among friends and colleagues, and this leads to permanent gaps in one's collection! I am in fact in need of issues from November and December 1980 and February 1981 or more specifically the excellent articles in the series on Digital Electronics by Ian Sinclair.*

*Could you please advise me how to obtain these if they are still available?*
*J P Sheppard,*
*Cheltenham,*
*Gloucestershire.*

Yes indeed. Shall I refer this reader once again to our Backnumbers page, "not in every Hobby, but in most of them"? We can't always supply the whole magazine, glossy cover and all, but we can always supply copies of the articles.

Another award-winning idea! Introduce your friends and colleagues to our Backnumbers page. And our Cumulative Index (HE January '83). Then they can see not only what they've been missing, but how to get their hands on it without raiding *your* collection . . .

## Batteries In The Breeze

*Dear Sir,*
*I have been an avid reader of your magazine for some months. In November I leave for Kimbali which is in the Pacific. For some time now I have been trying to find out how I can use a normal car alternator driven by a form of windmill to top up a 12V storage battery during the day and possibly run limited lighting at night.*

*I would be grateful if you could help me on this subject in any way.*
*M J Maddison,*
*Cleethorps,*
*S. Humberside.*

This is essentially a mechanical problem which we can't really advise on but the basic answer is something like this: bearing in mind that car alternators are negatively earthed, if you can take the negative line from the metalwork of the alternator, or whatever it is mounted on, and the positive from one of the larger tags on the back of the unit, you can connect up the battery.

You will then have to calculate how fast the alternator needs to turn to charge the battery. A tickover speed, in a normal car engine, the alternator will only just be charging the battery, if at all. You can calculate the tickover speed of the alternator by physically measuring the diameter of the pulley wheel on the alternator, and the one one the engine, dividing the engine pulley by the alternator pulley and multiplying the lot by the number of revs per minute at which the car engine ticks over. Then triple this figure and you will have the RPM needed from the alternator to charge the battery at a reasonable rate.

The alternator can be driven by a simple pulley and belt drive straight from the wind vane, but the gear ratio between the pulleys will have to be such that the alternator is not turning too slowly to charge, or so fast that the act of charging slows down the windvane to the point of uselessness.

You would have to discover this by experimentation, as much depends on the speed and strength of the wind. It is best if you use the battery for the experimenting, with an ammeter on it to show how fast (or not) it is charging.

## Into Electronics — Minus!

*Dear Sir,*
*I would be obliged if you could let me know if you have a copy of 'Into Electronics Plus' from 1979, and if so the price.*
*K Edwards,*
*Barrow-in-Furnace,*
*Cumbria.*

Sorry! IEP really is out of print now. However, if you're eager, you could consult our wonderful Cumulative Index (HE January '83) and obtain copies of all the Into Electronics articles. See the Backnumbers page for further details . . .

## Microtrainer Manual

*Dear Sir,*
*Ref: Hobby Electronics Vol. 4, No. 6, June 1982: HE Microtrainer, page 62. In the above article you refer to RCA's 'User Manual for the CDP1802 COSMAC Microprocessor'. Can you supply me with the address to write to for this publication, please? Your assistance would be much appreciated.*
*Many thanks.*
*P V Haviland,*
*Lichfield,*
*Staffs.*

The supplier of this manual at the time was none other than Technomatic Ltd., of 17 Burnley Rd., London NW10 1ED, who supplied the HE Microtrainer. Try them.

## Component Copies

*Dear HE,*
*I would like to know how much it would cost to obtain photocopies of your series of articles 'Into Electronic Components', which I think started in August '81. I would like to know the cost of the whole series except for parts 8 and 9.*
*C K Williams,*
*Bracknell,*
*Berks.*

'Into Electronic Components' did indeed begin in HE August '81. As for copies, if you inspect page 68 of this issue, you'll find our Backnumbers service. If the back issue isn't available, we can supply a photocopy; they like the Backnumbers, cost £1.25 each. HE

# Clever Dick

## As the month of May rolls around again Clever Dick, who is himself usually quite merry, is rolling around, still.

The CD I-Spy award of the month goes to an observant reader in Glasgow. And who said there are no more surprises in the world?

*Dear CD,*
*First of all, this is a neatly written, amusing, original letter (November, page 53).*

*I have written to help you with your material problem (you mean you didn't know you have a material problem?)! I refer, of course, to the letter from D.C. Holmes (September page 31 AND November page 21) and the letter from R. Einstein (November page 53 AND December page 51). Is there any reason for this? Perhaps they are relatives of someone in the HE offices?*

*Although I considered writing to the editor about his Points of View, where one duplicate appeared, he seems to give out very few (none) of those famous blue and gold delights that are the dream of every HE reader.*

*I like HE very much, but how about more Veroboard projects? Keep up the good work.*
*Steve Morton,*
*Glasgow.*
*PS Any reader following this letter without the aid of the issues mentioned may wonder what I'm going on about.*

At first I wondered what you were going on about, too . . . but your report is entirely accurate. Those letters were duplicated, much to our editor's horror. When I mentioned it to him he put his head in his hands and sobbed loudly for two minutes (he does this at least once a day), then promised to look into it. In the meantime one of those fabled "blue and gold delights" is winging its way towards you courtesy of the editor and High Speed British Post.

And who said the age of miracles was past?

Since we have been presenting more practical projects in HE, we have adopted a policy of putting most projects on PCB, since this makes construction much more reliable and, in general, PCB layouts are not as vulnerable to the dreaded 'gremlins'. However, projects will continue to be developed on Veroboard where this medium is appropriate — that is, not too complicated and difficult to build up correctly.

Now here's a man with a problem or three . . . .

*Dear Clever Dick,*
*I have been taking your excellent magazine for a number of years and although electronics is a subject I find fascinating, I have never tried building one of your projects. However, necessity seems to be driving me to do so. Let me explain.*

*Since I have lived at my present address about twelve years, I have suspected that the television signal from the Mendip hills is somewhat weak, due to the position of a hill between it and me. However, I have been able to run three monochrome TV sets reasonably well off three separate aerials on the roof. The pictures have been a bit snowy, but not too bad.*

*Last week I thought I'd spoil myself and buy a colour portable set for the bedroom, but when I got it home it would not work on its own set-top aerial. When connected to one of the rooftop aerials it worked, but hardly satisfactorily. So, I removed one of my aerials from the roof and connected it by a short lead directly to the set, pointing the aerial out the window in the direction of the transmitter. This produced the best picture yet.*

*From the above experiments I conclude that the signal is very weak indeed and that the long lead is very noisy, so I have a poor signal-to-noise ratio, as it were. I propose to build the TV Masthead Amplifier (February '82 issue) and put up a higher mast also, but all this raises a few questions in my mind:*

*If I put up two aerials side by side, and connect them together, will this improve my signal-to-noise ratio?*

*Will the Masthead Amplifier drive four TV sets, or can the output from one amp be fed to the input of another?*

*Can I simply join the serials together by soldering the inner wires together, and the outer braids together? If not, what is the best way to runs three sets from one lead?*

*The Masthead Amp is said to amplify the signal by 18 times and to run from any voltage between 10V and 24V; does it give best amplification on the higher voltage?*

*Is it worth making a power supply? If not, what batteries would you suggest? What is the current consumption?*

*Can you suggest a book that would explain about fitting aerials?*

*Since my colour set isn't yet working, do I need a colour license?*

*What's a binder?*
*G.H. Wakefield,*
*Weston-super-Mare.*
*PS The hill that weakens my signal is called Bleadon Hill. I think the name is quite fitting, don't you?*

If you pronounce the words "Bleadon Hill" slightly differently, it also describes my reaction to this letter, which raises a few questions in my mind, too. Like, why does he need four TV sets, for example? Never mind, some questions are better not answered (ignorance is quite pleasant) and I suspect this is one of them.

Yes, you can connect two aerials side by side (better one on top of the other), provided they are accurately positioned and linked by what is called a 'phasing harness'. The precise positioning of the aerials and the matching harness are both to ensure that the signals are in phase so that they add, rather than subtract.

If you are determined to run four TV sets you can do so from a single aerial using a suitable distribution system. Rather than the methods you propose (you can't simply connect aerials together and hope for the best) you can use four separate Masthead Amplifiers connected to the one aerial by appropriate impedance matching transformers.

The amplification provided by the OM355 device, which is at the heart of the Masthead Amplifier, is dependent on the supply voltage and the gain will be higher (27dB) at 24V than at 12V (23dB). Typically, the device will draw about 35mA from the supply and if you really do want four of them (!) you may as well build a 24VDC power supply capable of supplying around half an amp or so.

A suitable book, which will answer all your questions in detail, is "Long Distance Television Reception (TV-DX) For the Enthusiast" by Roger W. Bunney. It is published by Bernard Babani (Publishing) Ltd. and is available through the Hobby Electronics Bookshelf. The principles of long-distance reception are equally applicable to fringe area reception.

Finally, I cannot comment on your legal position but if you need information on this or further answers to your ten thousand questions, contact the Engineering Information Service, Broadcasting House, London W1A 1AA.

**HE**

# RADIO RULES

Helen Armstrong

## Just one more step before you launch into space—the Radio Amateur's Examination!

By the time you read this you should, thanks to Radio Rules, be well on your way to being your own radio expert, which means that you will be nearly ready to face the final hurdle in becoming a radio amateur — the Radio Amateur's Examination, better known as the RAE.

Radio amateurs have a far wider choice of wavebands, and far more range and power to play around with, than CBers (who, until recently, weren't even legal) and the idea that members of the public should be allowed to transmit anything at all without a mass of official controls is a very recent one in the UK. CB radio has been around in some other countries, notably the USA, for a long time. But even in these places, the amateur has to pay for his greater freedom in what and where he transmits by proving that he or she is capable of running a station without interfering with other transmissions. So radio amateurs have to pass a fairly demanding exam.

The original justification for licensing amateurs to transmit was to encourage them to train themselves as radio technicians and operators in case they were needed in times of emergency or war, and the license states to this day that an amateur radio station is 'part of the self-training of the Licensee in communication by wireless telegraphy'. This is also a tribute to the development work done on radio by amateurs in its early days, as you will doubtless remember from "The Birth of Broadcasting" (HE February '83).

Amateur radio is more a pastime for people who are interested in radio and its whys and wherefores, than for those who simply want to communicate with friends without finding a callbox. That said, the RAE, although it aims to establish that the would-be amateur is competent to operate a station, is a straightforward examination for anyone reasonably familiar with the subject. The change, three years ago, from straight essay-type examination to multiple-choice questions has, despite initial grumbles and teething troubles, produced much the same percentage of passes as before.

This has sometimes led to complaints from the old school that today's amateurs can hardly hold a screwdriver, let alone construct their own transceivers — but amateur radio is more likely to encourage a lively interest in radio if people can enter it at a level where, once they understand the principles and can keep their hardware properly tuned, they can get out on the airwaves and learn the rest 'live'. Indeed, the arrival of CB, far from rendering the amateur obsolete as had been glumly forecast in some quarters, has given more people than ever a taste of radio; as CB is very limited, many of these then go on to extend their knowledge and mastery of radio and become amateurs — the number of people sitting the RAE and joining the Radio Society of Great Britain (RSGB) is increasing dramatically year by year.

### Terms and Conditions

But it's not enough to know about radio. The first part of the RAE deals with the conditions governing amateur radio licenses, and if you fail this, you fail completely. You have to know the rules before you'll be let loose. Although phrased in legalistic lingo which may be puzzling even to people used to reading paragraphs of equations, the radio rules are fairly straightforward and largely a matter of commonsense.

Cast your mind back to the first part of "Radio Rules" back in HE April '82, and you will recall that Amateur License A is the full radio licence which allows you to use amateur bands below 144MHz, as well as those above, and to transmit Morse Code (CW). Not many people opt for Morse now. A separate Post Office examination has to be taken for this. Most amateurs hold Licence B.

Your transmitter, receiver, test equipment and log are in fact a radio station, which is licensed to be set up permanently at a named address, or in any other 'temporary location'; longer-term removals have to be notified as

### Finding Out

For information about the RAE, you should contact the **Home Office Amateur Radio Licencing Division, Waterloo Bridge House, Waterloo Rd., London SE1 8UA** for a free copy of their booklet *How to Become A Radio Amateur*, which will tell you the up to date licence conditions along with a lot of other useful information. For full details of the exam, and sample questions, write to the **City and Guilds of London Institute** (who actually run the exam) at **76 Portland Place, London WC1N 4AA.**

To get hold of the *Radio Amateurs' Examination Manual*, which contains all (or most of) the technical background and information needed to take the extra (although it ought to be used as a basis for wider study if you are going to master the subject properly, and not just as the sole source), contact the **Radio Society of Great Britain at Alma House, Cranbourne Rd., Potter's Bar, Herts EN6 3JW, tel. (0707) 59015**. They will also take applications to sit the RAE. The exams are usually held twice a year, in May and December, but there have been so many applications that there may be three sittings in 1983. Membership of the RSGB currently stands at around 38,000 after rising a lot in the last five years. They publish a monthly magazine, will help members with technical queries and publish a range of useful textbooks which are, of course, cheaper to members than non-members. You don't have to be a member to take the RAE, but it pays somebody starting out in the hobby to be in touch with the main meeting-point for amateurs.

The RAE is like most other exams — to pass it, you learn the radio rules. Once you have passed and been certified safe to be let out on your own, the door is open to the real spirit of amateur radio.

'alternative premises'. The station can be operated by a pedestrian (colloquially known as portable operation) or from a private vehicle (colloquially and officially known as mobile operation — although I have yet to see one being operated from a bicycle, and operators using a hand-held mike while driving have occasionally been stopped by the police for illegally driving with one hand!). Mobile operation is increasingly popular, and there are many transceivers and aerials designed specifically for use from a car.

You must not, however, use the station in a sea-going area (at sea or in an estuary, dock or harbour) or from an aircraft or public transport vehicle (although special aircraft and mobile licenses are obtainable where appropriate).

Section 1 of the license states that you are licensed to send in radio telegraphy (which covers both voice transmissions and Morse, although voice transmissions are also called telephony) personal messages in plain language about things in which you or your contact are personally involved, but you may not discuss business or exchange messages on anyone else's behalf. This is designed to prevent the amateur bands from being used for commerce or propaganda rather than stop you from sending greetings on behalf of a friend. The RAE Manual's section on operating procedures states "It should be a golden rule never to discuss religion, politics or any other matter which may offend the person to whom one is talking or anyone who may be listening" — but this is only a guideline, not, as some people think, a statement of law. You are definitely not allowed to transmit "grossly offensive, indecent or obscene" messages, however.

License the also permits the transmission of facsimile signals (radio-encoded pictures), radio teleprinter signals, video (amateur television) and test and other signals relating directly to these and not in any secret code. This doesn't of course preclude the 'codes' and abbreviations once common in radio, especially in Morse, where they were used for the sake of brevity and extra clarity, and especially to get around any language barriers in international calls.

## Emergency Services

Amateur operators may be (and often are) called out to help the police or other emergency services. In parts of the country groups exist which practice working as a team or network—this is known as a Raynet group—and they hold communications exercises as well as taking part in real emergency work.

Generally the only person permitted to use a station was the license-holder or another licensee under his supervision. Now a pre-war custom, the sending of greetings messages by non-licensed people under occasional conditions, is being revived after long agitation by the RSGB, but this has not yet been incorporated in the licensing rules.


**QSL cards are exchanged by amateurs as a record of contacts made. These two are from Yugoslavia and Mallorca, with their national code letters.**

Transmission by anyone using a false license number is likely to be promptly spotted and reported by another station! No kind of recording may be transmitted except for certain test messages and tones, and nothing that infringes copyright (which means, in effect, anything published, or otherwise copyrighted) or anything misleading — jokes on the air are alright, but not if they could remotely be mistaken for a distress call.

It's also a requirement of the license that you should be able to receive on the same wavebands on which you are transmitting, so that messages can be returned. On the other hand, listening in to the wrong thing is out: under Section 5 of the Wireless Telegraphy Act, it is an offence to deliberately receive unauthorised messages, and disclosing anything about them to 'unauthorised persons' is an offense under the Official Secrets Act. This includes police transmissions, so don't tell me your hifi amplifier picks them up!

Some of the most important license conditions concern the prevention of interference and keeping broadcasts within the right frequency bands. Section 3 states that a satisfactory method of frequency stabilisation must be used, and that there must be equipment on hand capable of checking that the station is operating correctly. And Section 4 makes it clear that the maintenance of the radio and morse equipment in a state which doesn't interfere with other transmissions is an absolute requirement of the license, not just a social duty. The Notes to the license give examples of when aerials may give rise to interference, or (another kind of interference entirely) when they may be in danger of fouling aircraft, or power lines, and the limitations imposed.

Sections 10, 11 and the footnotes say that the station must be available for inspection at all reasonable times, and that it can be closed down at any time. This is normally only done in a case of national emergency, but the license itself can be revoked (and the operator prosecuted) if the terms of the license are broken.

To further aid keeping track of transmissions, you must keep a detailed log of calls and contacts made. This comprises, basically, the date of the call, opening and closing of operation and the address of any temporary premises (or the geographical location, for mobile operation), the times, frequencies and call-signs of each contact made and classes of emission, including those used for CQ and test calls. The log must be signed by any other amateur using the station.

## Signing On

The license is specific about the use of a callsign. It must be broadcast at the beginning and end of each period of sending, and every 15 minutes otherwise. Extra identification letters

## Safety in

Don't give a new meaning to the old expression 'over and out'! Consult the Radio Society of Great Britain's safety recommendations for amateur radio stations. A serious amateur radio station usually consists of several pieces of equipment, very often in various stages of construction, modification, testing or repair. Any piece of electrical equipment carries some danger from electric shock, but doubly so when it's being connected and re-connected. Following this comprehensive list of safety precautions will effectively remove the danger of serious shocks. Here is a summary of them:

Equipment should be turned on and off from one master switch; everything should be connected to a good, tested earth (not, as formerly, a water mains, as many now have plastic sections); wire and terminals should be thoroughly insulated (there is often a temptation to leave temporary terminals open and live); capacitors of more than 0.01uF (100n) should have a bleeder resistor across their terminals that will ensure rapid discharge; capacitors with low leakage should be stored with their terminals short-circuited, as they can otherwise build up a static charge (you can get a serious shock from a large capacitor) and better, capacitors in use should be discharged with a 'wandering earth lead', an insulated lead with some bare strands at the end, connected to a permanent earth; all equipment should have conspicuous indicator lamps to show that it is live (apart from the safety factor, it does equipment no good ot leave it switched on when not in use and unattended); double-poled switches should be used for are prescribed for mobile, temporary or pedestrian use, and for the main geographical areas of the British Isles — GW for Wales, GM for Scotland, and so on. At a temporary location, a brief address must be included.

Probably the most familiar aspect of non-broadcast radio to people who know nothing at all about it is the 'phonetic alphabet', where letters of the alphabet are replaced by distinctive words beginning with the same letter. The alphabet published by the RSGB is recommended rather than prescribed, and there are common variants, but the examiners will want the versions published! The phonetic alphabet is used to make important messages clearer in bad reception conditions, and it's generally better if you can stick to well-known versions, otherwise the point is lost. In any case, it's stated that the words used must not be "objectional or facetious". The alphabet as given in the Radio Regulations, Geneva, 1976, is printed in the footnotes to the license.


**QSL cards from Poland and France.**

Sections 12, 13 and 14 and 15 summarise the terms under which the license is issued, the most important being that the licensee shall pay up every year, and that the terms of the license may be a varied by the Secretary of State in a general announcement in the press or via the BBC.

Section 16c and the following notes contain information about how the rest of the rules should be interpreted and various other important information, such as the correspondence address at the Home Office. It also harks back to Section 2, which briefly draws our attention to the fact that radio rules are international, in effect, whatever the local variations. It refers to the International Telecommunications Convention of 1973 and various other sets of international regulations. The Government in its turn has to abide by radio rules when broadcasting at home or overseas.

## Practical Procedure

Apart from the Home Office license conditions, the RSGB issues its own advice for operators as to proper operating procedure, to ensure clear and trouble-free communication.

Quite a large chunk of the advice is for Morse operators, including a detailed list of 'Q' codes, and calling patterns for establishing a contact, making, and ending a transmission, and an RST code table, giving the standard notations for describing the quality of a transmission. The use of the Q and RST codes, as well as the phonetic alphabet, has spilled over into voice radio. The original purpose of codes was to increase both the brevity and the clarity of transmissions, but brevity is not generally important in voice radio and the use of abbreviations has become more a matter of jargon than necessity.

Amateur jargon can be quite incomprehensible to the non-initiated (although never as colourful and obscure as CB jargon). The RSGB is tending to discourage the use of jargon and CW codes, but it would be a pity if jargon disappeared altogether as the use of patter is one of the charms of radio.

## Contacting other Stations

When trying to establish a contact with another station — known as 'calling' — it is important to get your call out as quickly and as clearly as possible. Give the callsign of the station you are calling once or twice, depending on conditions, and then your own callsign at least twice, using the phonetic alphabet. If there is no response from the station you are calling, call again, putting the emphasis on your own callsign, but don't keep calling continuously. Leave it till later or (if you are mobile) until you are closer to the station.

Likewise, CQ (general) calls can be repeated several times, giving your callsign clearly, but no information is needed other than 'calling and standing by', and you should listen for a few moments between each call. Don't keep on and on calling CQ on the same channel if you get no response in a reasonable time — either listen around to see if another exchange is about to finish, or try another channel.

Once the contact is made, the stations should spell out their callsigns until they are sure that both have been received correctly. After that, callsigns only need to be given every fifteen minutes, so that in good operating conditions a normal telephone-style conversation can be held; if reception is down a bit the words 'break' or 'over' give an additional signal when one operator has finished talking. Give both callsigns again in phonetic alphabet when signing off; this also helps other stations listening in, who may wish to call.

Incidentally, if you have trouble remembering callsigns, write your contact's callsign down at the beginning of the exchange if you can; this saves a repeated 'What was your callsign again?' and 'G3 Yankee what was it?' every time callsigns are exchanged, which is all too common.

When transmitting to a group or 'net' give your callsign at the beginning of each transmission, to let the group and other listeners know who is talking. You can also pass the call on to the next person to speak, if you are taking turns.

It is not necessary to continually list the other callsigns in the group, but some groups have the practice of letting one member act as 'master of ceremonies', repeating the callsign when one member has finished and passing the call on to another member of the group.

It is helpful also to say briefly what you are about to do if you are changing channel, have just arrived on a channel or are signing off for the time being.

An important part of any exchange, especially long distance ones, where the signal strength of either operator is likely to be below maximum, is to give a signal strength report. In CW, a code known as the RST code (readability/signal strength/tone) is used. There are

## ne Shack

switching mains on and off, and the correct fuses should be installed on the equipment side of the switches.

A mains circuit breaker, such as a micro-switch, should be used to switch off metal-cased equipment automatically when the lid or other service hatch is opened; test probes and lamps should be insulated; a rubber mat should be used on the floor if the floor is at all damp.

Equipment should be switched off before adjusting, and insulated tools used. If any adjustments must be made while the gear is live, one hand only should be used, and the other hand kept in a pocket; headphones should never be worn while adjusting live equipment, and metal-cased gear like microphones and morse keys need to be properly earthed; meters with metal adjustment screws are not safe to use on high-voltage equipment.

A check needs to be kept for unexpected live projections from equipment, especially where metal screws are used on control knobs; aerials should never be connected to the mains or any other high voltage source; where they are connected through a capacitor, an RF choke should be provided.

The full recommendations are given in detail in the RAE Manual.

five levels of readability, from unreadable to perfectly readable, and nine levels each for signal strength and tone from one to nine. For operating proficiency certificates and awards given by the RSGB the minimum signal report needed is RST339, or RS33, which are the minimum practical signals.

In other parts of the world, sections of the amateur bands are reserved for certain classes of operator using particular modes of transmission (eg CW or radio teleprinter (RTTY). There, it is illegal to fail to observe these restrictions; not so from the UK, but we should still adhere to them at all times as a courtesy — this is only common sense, as are most of the rules of procedure.

It is only common sense not to attempt to call a station which is clearly trying to establish a call elsewhere, for instance, no matter how badly you want to make a contact with a station in that particular location; not to call CQ continuously if you are getting no reply; not to interrupt an established exchange; not to hold conversations on channels such as S20 (145.5MHz) which are so normally used for calling.

If you contact somebody on a channel which he has been working, move off again once the exchange is finished; don't use long-distance bands (DX) for local calls while they are open for long-distance communication, and when conditions are unusually good for long-distance contacts, keep your calls short — there will be queues of other operators hoping to pick up some rare QSL cards, waiting to speak to the same stations you are speaking to.

## Repeaters and Satellites

Over the last ten years, a number of unmanned transceivers, mounted on masts at high geographical points, have been set up. These receive VHF or UHF transmissions from portable or mobile stations on an input channel and re-transmit them on a different output frequency within the same band, but with greater power. Thus the range of low-powered equipment can be doubled or better.

QSL cards from Finland and the USSR.

These relay stations are known as repeaters and have their own call signs (eg GB3PI near Peterborough, the 'Cambridge repeater', one of the first to be opened). They can more than double the range of low-powered equipment without the use of extra power or better aerials. To prevent continuous operation of the repeater by one caller, or when not in use, the repeater is usually designed to be switched on and off remotely: on by means of a 1750Hz tone (toneburst) transmitted by the caller, or by the user's carrier on the input channel at the beginning of each transmission, and off automatically after, say, one minute — a limit known as 'time out'.

Repeaters only respond to an accurate FM signal and if the accessing signal becomes inadequate, the repeater will switch itself off. After each over, the repeater will wait for a minute or two, and then broadcast a signal in Morse to show that it is free for use.

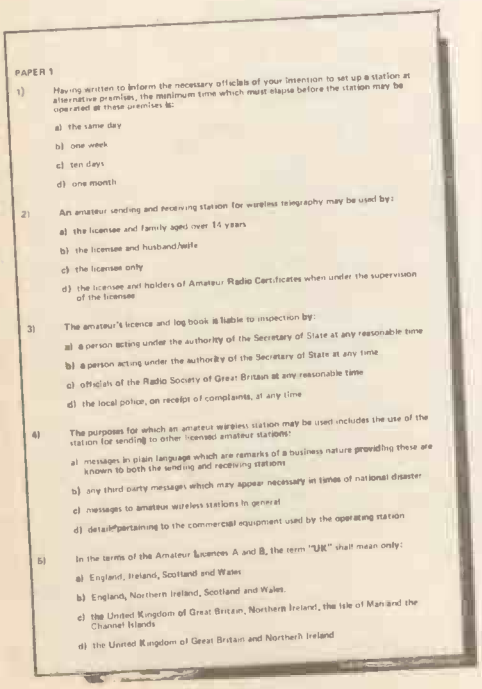
There are also satellites for amateur use which play a similar role to repeaters, only at a greater power and over a longer distance. The first one was launched in 1961 and others have gone up periodically since. They are known as OSCARs (for Orbiting Satellite Carrying Amateur Radio), each with its own own code number. They are transponders, which accept single sideband, radio teleprinter or Morse signals (for preference, although any mode is acceptable) over certain wavebands, and retransmit them on another band. At the moment they can transpond from 432 to 144MHz, 144 to 432MHz and 144 to 28MHz. Unlike repeaters, the satellites are continuously operational and require no special signal to access them.

To transmit to the satellites, a power level of 80 to 100W ERP is needed, normally provided by a transmitter of 10 to 15W output with antenna gain of 10dB, and the antenna must be in line of sight with the transmitter and, for best results, capable of following it.

## Alright on the Night

There are a number of ways to learn enough about radio to take the Radio Amateurs Examination successfully. The only essential rules are: know what is in the syllabus (it helps to be familiar with the Radio Amateur's Examination Manual), and make sure you both learn the theory and get as much practical

**Below: a set of RAE-style papers. Samples can be obtained from the Home Office.**


PAPER 1

1) Having written to inform the necessary officials of your intention to set up a station at alternative premises, the minimum time which must elapse before the station may be operated at these premises is:

a) the same day

b) one week

c) ten days

d) one month

2) An amateur sending and receiving station for wireless telegraphy may be used by:

a) the licensee and family aged over 14 years

b) the licensee and husband/wife

c) the licensee only

d) the licensee and holders of Amateur Radio Certificates when under the supervision of the licensee

3) The amateur's licence and log book is liable to inspection by:

a) a person acting under the authority of the Secretary of State at any reasonable time

b) a person acting under the authority of the Secretary of State at any time

c) officials of the Radio Society of Great Britain at any reasonable time

d) the local police, on receipt of complaints, at any time

4) The purposes for which an amateur wireless station may be used includes the use of the station for sending to other licensed amateur stations:

a) messages in plain language which are remarks of a business nature providing these are known to both the sending and receiving stations

b) any third party messages which may appear necessary in times of national disaster

c) messages to amateur wireless stations in general

d) details pertaining to the commercial equipment used by the operating station

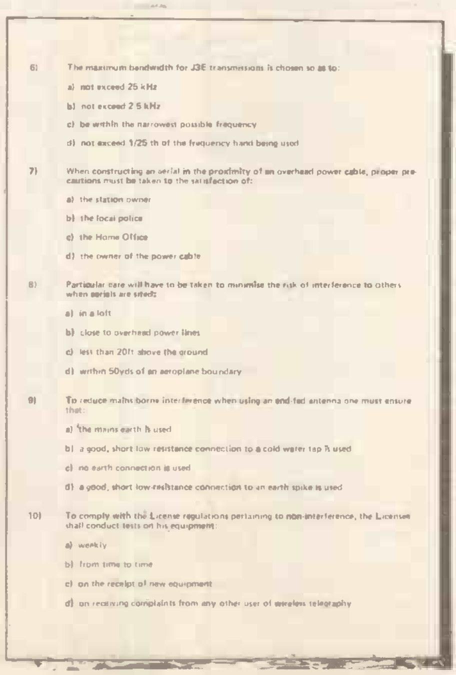
5) In the terms of the Amateur Licences A and B, the term "UK" shall mean only:

a) England, Ireland, Scotland and Wales

b) England, Northern Ireland, Scotland and Wales.

c) the United Kingdom of Great Britain, Northern Ireland, the Isle of Man and the Channel Islands

d) the United Kingdom of Great Britain and Northern Ireland


6) The maximum bandwidth for J3E transmissions is chosen so as to:

a) not exceed 25 kHz

b) not exceed 2.5 kHz

c) be within the narrowest possible frequency

d) not exceed 1/25 th of the frequency band being used

7) When constructing an aerial in the proximity of an overhead power cable, proper precautions must be taken to the satisfaction of:

a) the station owner

b) the local police

c) the Home Office

d) the owner of the power cable

8) Particular care will have to be taken to minimise the risk of interference to others when aerials are sited:

a) in a loft

b) close to overhead power lines

c) less than 20ft above the ground

d) within 50yds of an aeroplane boundary

9) To reduce mains borne interference when using an end-fed antenna one must ensure that:

a) the mains earth is used

b) a good, short low resistance connection to a cold water tap is used

c) no earth connection is used

d) a good, short low-resistance connection to an earth spike is used

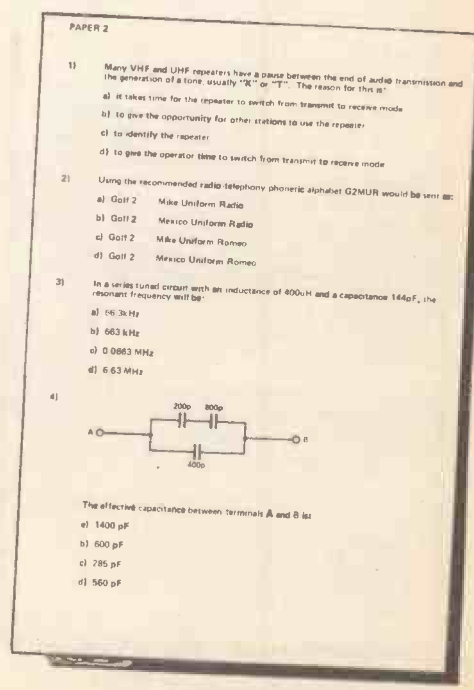
10) To comply with the License regulations pertaining to non-interference, the Licensee shall conduct tests on his equipment:

a) weekly

b) from time to time

c) on the receipt of new equipment

d) on receiving complaints from any other user of wireless telegraphy


PAPER 2

1) Many VHF and UHF repeaters have a pause between the end of audio transmission and the generation of a tone, usually "K" or "T". The reason for this is:

a) it takes time for the repeater to switch from transmit to receive mode

b) to give the opportunity for other stations to use the repeater

c) to identify the repeater

d) to give the operator time to switch from transmit to receive mode

2) Using the recommended radio-telephony phonetic alphabet G2MUR would be sent as:

a) Golf 2 Mike Uniform Radio

b) Golf 2 Mexico Uniform Radio

c) Golf 2 Mike Uniform Romeo

d) Golf 2 Mexico Uniform Romeo

3) In a series tuned circuit with an inductance of 400uH and a capacitance 144pF, the resonant frequency will be:

a) 66.3kHz

b) 663 kHz

c) 0.0663 MHz

d) 6.63 MHz

4)

200p 800p

A B

400p

The effective capacitance between terminals A and B is:

a) 1400 pF

b) 600 pF

c) 285 pF

d) 560 pF

experience as you can. One without the other is likely to leave you high and dry. You might get through on theory alone if you are very good at memorizing things, but it will be a lot harder unless you actually have 'hands on' experience of radio equipment — inside and outside the chassis.

Obviously the candidate with an electrical or electronics background has an immediate advantage in that he is already schooled in an understanding of how electronic devices work; he will still need to be thoroughly familiar with the actual syllabus to pass. But how does the complete novice with perhaps only a little physics, or not even that much to start with, get the knowledge?

Probably the best way is a structured course in a class with other candidates. In this way you will get the benefit not only of the teacher's experience but those of other hopefuls with varying experiences and see more than one approach, perhaps even with more than one teacher.

To find a local radio course, first try radio journals and popular radio magazines — the RSGB's "Radio Communication" (RadCom) for instance. Also, check with your local public library or main district library, which should have lists of activity clubs and also local institutes which do courses of various kinds. Look for local radio or electronics clubs, or local RSGB groups. Quite apart from attending club talks and meeting other amateurs, if there are enough candidates locally then you can apply to the principle of any local college to have a course set up, though you may have to find your own teacher, or an instructor that the college is satisfied with. The college year starts in September, so you will have to find this out well in advance, in time for the RAE, which is usually held twice a year, at various locations around the country.

If you cannot find any kind of local course, there are correspondence courses, and private students are also often successful. Try contacting other amateurs in the area — consult the RSGB's Amateur Radio Call Book; again, a local library might help — you are likely to find one or two who would gladly advise you and share their experience.


**QSL cards from the UK and the Faroe Islands.**

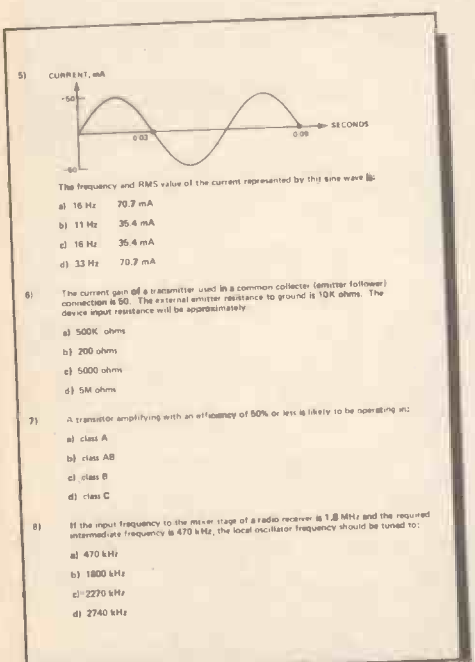
Three years ago, the RAE switched from question-and-answer to multiple choice, but do not assume that this will make the exam easy. You will still have to know your practical circuit diagrams and be able to do straightforward calculations. It is helpful and speeds things up if you have a calculator, although you can get by quite adequately on normal arithmetic as long as you have a grasp of equations (which a calculator won't help you with anyway). All the symbols used in the exam are British Standard 3939, and are laid out in the RAE Manual — you are less likely to be mislead if you know these thoroughly.

The rules of thumb for the exam are also simple: assuming you know your stuff, and even if you *don't*, do two things; read all the instructions on the paper carefully, and give yourself time to tackle all the questions. Time taken to make sure you are doing the right thing is never wasted. If you can't do a question, leave it and go on to the next. You can always come back to it. With a multiple choice exam, don't leave any question unanswered — who knows, but you might pick the right answer by accident or inspired guesswork! This compensates for the factor in the old-style exam, where some marks were allocated for part-questions finished, even if the whole answer was not right. There is always a luck factor in exams — this will never make the difference between a good and a bad candidate, but may make the difference between gaining and not gaining your licence first time around. And it costs money to take the exam, so never give up the paper while the exam is still in progress!

The RAE is not a competitive exam — you have only to reach a certain standard to pass, regardless of how many other people pass or fail.

Make sure you are familiar with everything on the syllabus. However ill prepared you may feel, make sure you have an overall acquaintance with the subject before you try swatting up on special subjects — not only are you more likely to get through the exam that way, but it will stand you in better stead afterwards.

**HE**



5) CURRENT, mA



The frequency and RMS value of the current represented by this sine wave is:

a) 16 Hz 70.7 mA
b) 11 Hz 35.4 mA
c) 16 Hz 35.4 mA
d) 33 Hz 70.7 mA

6) The current gain of a transmitter used in a common collecter (emitter follower) connection is 50. The external emitter resistance to ground is 10K ohms. The device input resistance will be approximately

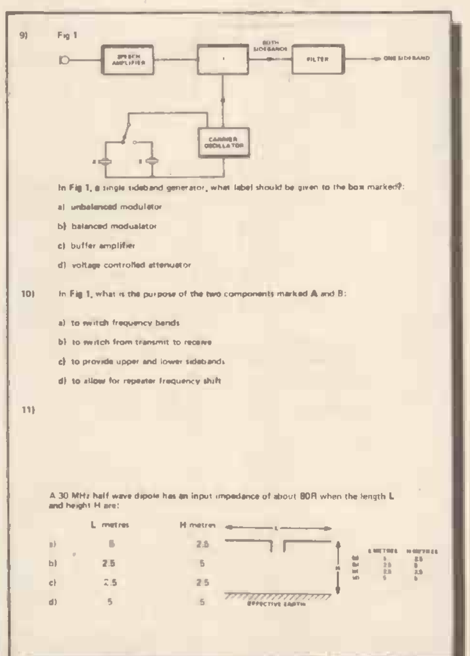
a) 500K ohms
b) 200 ohms
c) 5000 ohms
d) 5M ohms

7) A transistor amplifying with an efficiency of 50% or less is likely to be operating in:

a) class A
b) class AB
c) class B
d) class C

8) If the input frequency to the mixer stage of a radio receiver is 1.8 MHz and the required intermediate frequency is 470 kHz, the local oscillator frequency should be tuned to:

a) 470 kHz
b) 1800 kHz
c) 2270 kHz
d) 2740 kHz



9) Fig 1



In Fig 1, a single sideband generator, what label should be given to the box marked?:

a) unbalanced modulator
b) balanced modulator
c) buffer amplifier
d) voltage controlled attenuator

10) In Fig 1, what is the purpose of the two components marked A and B:

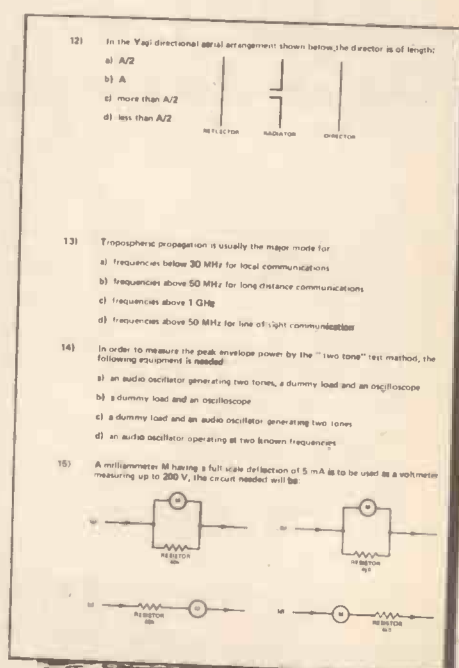
a) to switch frequency bands
b) to switch from transmit to receive
c) to provide upper and lower sidebands
d) to allow for repeater frequency shift

11)

A 30 MHz half wave dipole has an input impedance of about 80R when the length L and height H are:

| | L metres | H metres |
|---|---|---|
| a) | 5 | 2.5 |
| b) | 2.5 | 5 |
| c) | 2.5 | 2.5 |
| d) | 5 | 5 |





12) In the Yagi directional aerial arrangement shown below, the director is of length:

a) A/2
b) A
c) more than A/2
d) less than A/2



13) Tropospheric propagation is usually the major mode for

a) frequencies below 30 MHz for local communications
b) frequencies above 50 MHz for long distance communications
c) frequencies above 1 GHz
d) frequencies above 50 MHz for line of sight communication

14) In order to measure the peak envelope power by the "two tone" test method, the following equipment is needed

a) an audio oscillator generating two tones, a dummy load and an oscilloscope
b) a dummy load and an oscilloscope
c) a dummy load and an audio oscillator generating two tones
d) an audio oscillator operating at two known frequencies

15) A milliammeter M having a full scale deflection of 5 mA is to be used as a voltmeter measuring up to 200 V, the circuit needed will be:



Courtesy of Ham Radio Today.

# HIGH FLYING ACE

Mike Lord


## HE's micro-master reviews the first personal computer to use FORTH, a fast and efficient high-level language, as its 'mother tongue'.

IN INTRODUCING THE ACE, Steven Vickers and Richard Altwasser have broken away from the tradition of offering more hardware (RAM, sound, colour etc.). for your money. Instead, they have decided to innovate in terms of software by choosing FORTH for the ACE's 'natural' language rather than the various extended BASICs used by their competitors.

Because of this, any review of the ACE must begin by looking at FORTH itself, and considering its advantages and disadvantages as a programming language.

### FORTH

FORTH is not a new language. It was originally developed over ten years ago. Since then it has attracted a steadily growing band of enthusiastic supporters, most of whom use it for 'real' applications such as controlling machinery or — recently — for writing fast action moving games.

FORTH was originally developed as an alternative to machine code for use on small microcomputers with a limited amount of memory and where BASIC-like languages were often too slow for the job. The result therefore lies between machine code and BASIC in terms of both speed and ease of use.

Unlike BASIC programs, which are essentially a numbered list of commands, FORTH programs are built up by defining new commands, starting with the elementary low level operations, then using these in more complex commands, and so on until you end up with a single command that defines the whole program.

In FORTH terminology, a 'command' is known as a 'word', and consists of a descriptive name followed by a definition of what the word is to do. The definition is usually in terms of other FORTH words, although you can use a machine language routine where speed is really critical. As each word definition is entered, it is added to a 'dictionary', and that word can then be used in the definition of new words. This probably sounds confusing to someone who hasn't encountered FORTH before, but the basic principle is quite simple. If you were to enter:

```
: HI 125 100 BEEP ;
```

then the colon at the start of the line tells the computer that you are defining a new word — called HI — and the semi-colon at the end signals the end of the definition. The definition of this word is therefore:

```
125 100 BEEP
```

BEEP is a pre-defined word, one of about 140 FORTH words held permanently in the ACE's ROM, and it makes a sound using the AEC's internal loudspeaker. The two numbers define the frequency and duration of the note. Having entered the new word definition, it will be placed in the ACE's dictionary, and now the ACE will understand the word HI as an instruction to produce a short, sharp, tone. In fact, just typing in the word HI will now produce the tone, since if you enter any line that doesn't start with a colon, then FORTH assumes that you want it acted upon immediately. This is an extremely important feature that lets you test out new words as you develop them.

We could now enter a second word definition:

```
: LO 250 100 BEEP ;
```

to produce a lower note, and then play the two notes one after the other by entering:

```
HI LO
```

Having added the two words to the dictionary, we can use them in a further definition:

```
: TUNE HI HI LO LO HI ;
```

so that the new word TUNE will play a sequence of 5 notes.

In this way, a FORTH program is gradually built up by defining new words to perform ever more complex tasks, but by taking it one step at a time, you can construct your program in a logical and ordered manner.

### Looping and Choosing

To let you program for alternative courses of action, FORTH has an IF-THEN-ELSE construct similar to that found in advanced versions of BASIC. BEGIN-UNTIL and BEGIN-WHILE-REPEAT allow you to repeat actions until (or while) a particular condition is met, in much the same manner as BBC BASIC's REPEAT-UNTIL. And if you want to repeat an action a defined


**Ace comes with a power pack, cassette leads, programming manual and demonstration tape.**

number of times, FORTH provides a DO-LOOP construct which behaves like BASIC's FOR-NEXT. There is, however, no equivalent to the BASIC GOTO command. This seems at first like a serious omission to anyone used to programming in BASIC, but once you get used to FORTH you find you can always use IF-THEN-ELSE, BEGIN-UNTIL or BEGIN-WHILE-REPEAT to achieve the same result but in a much more elegant fashion.

## Stack It

One area where FORTH differs considerably from most other computer languages is in its use of a 'stack' to hold the values being worked on. Most languages use named 'variables' to hold values, so that the BASIC statement:

LET A = 27 + 33

tells the computer to add 27 to 33, then store the result in an area of memory reserved for the variable named 'A'. You can also use named variables in FORTH, but the values actually being worked on at any time will usually be held in a special area of memory known as the 'Stack'. This is best thought of as a pile of values; a new value can be added to the top of the pile — making the pile higher — or a value can be taken off the top of the pile — making it shorter. All of FORTH's fundamental operations, like addition, multiplication etc., work on the values present on the top of the stack. The '+' operator, for example, takes the top two values off the stack, adds them together, then puts the result back onto the top of the stack.

When the computer sees a number in the line you have entered, it puts that value onto the top of the stack. For example, if you look back at our definition of the word HI, what it was really telling the computer to do was to first put the value 125 onto the stack, then put the value 100 on top of that, then execute the pre-defined word BEEP, which takes the top two numbers from the stack to give the frequency and length of the note to be produced.

Similarly, the line:

27 33 +

will place the values 27 and 33 onto the stack, then replace them by the single value 60. This way of writing may seem backwards at first (and — indeed — it is known as 'reverse Polish') but you soon get used to it.

There are two main reasons why FORTH was designed around the use of a stack. The first is that it saves memory space because values are kept in RAM only as long as they are needed, and — more importantly — because the program doesn't need to contain the names of the variables (at least as long as the values are being kept on the stack). The second advantage is that your programs run more quickly because the computer doesn't have to search through a 'variables storage area' to find the one you want.

## DIY FORTH

FORTH is really a 'Do It Yourself' language. Although it has about 140 pre-defined words compared to the 90 or so keywords in most versions of BASIC, they nearly all correspond to very elementary operations, and you have to add your own definitions to do anything that is even slightly complex.

Take arrays for example. In BASIC, a simple DIM statement will set up an array so that you can then refer to an element of it by just using a subscripted variable such as A(27). But FORTH has no equivalent to the DIM statement or the subscripted variable; you have to write special words that will let you handle data in array form, or — more precisely — you have to define a routine that can be used to set up arrays, and another to let you refer to an individual element of an array. At the end of the day you will be able to handle arrays of data at least as well as you could in BASIC, but you will have taken longer to get there.

Similarly, if you want to handle strings, you must first define some string handling words.

## Fast FORTH

Where FORTH really scores is in doing fairly simple tasks very quickly. And, because it is much nearer to machine code than BASIC, you have much more control over what the computer is actually doing. Indeed, to program successfully in FORTH you need to be much more aware of how the computer works than you do with most other languages, and pay much more attention to the possible side effects of what you are doing. For example, FORTH arithmetic is usually done using 16-bit words that can take integer values from -32768 to 32767. But there is no check to see if a result has overflowed, so that it will quite happily add 30000 to 30000 and say that the result is -5536! FORTH enthusiasts will say, of course, that if you really want the + operator to check for overflow then you can easily define a new version of the word that does just that.

## ACE FORTH

There is a standard for the FORTH language, known as FORTH-79, and the version provided on the ACE sticks very close to it. The main differences are the addition of words to handle floating point numbers, plotting, the sound generator, and I/O ports. There are also some differences in the way programs are entered and edited.

## The Hardware

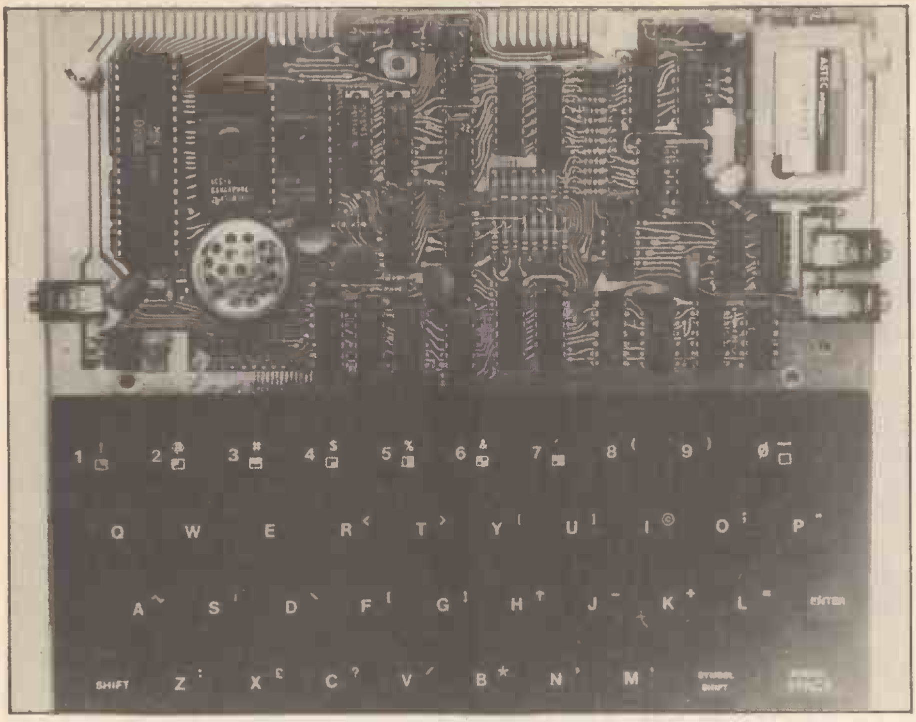
The ACE comes in a white vacuum-formed plastic box about the same width as the Spectrum but deeper, held together with plastic rivets along the sides and back. A label on the underside of the box warns that there are no 'user serviceable' parts inside, and indeed the case is fixed together in such a way that you can't take it apart without splitting the plastic. This is a pity, because I am sure that many people who would be attracted to the ACE would be enthusiastic (and knowledgeable) enough to want to get at the hardware to make minor 'improvements'.

On the model received for review, the quality of the case was poor. The edges where it had been cut from the mould were rough, there were a couple of noticeable dimples on the top surface, and the holes in the case for the TV, Ear, Mic and Power sockets did not line up properly. Worse, the bottom part of the case was bowed so that it flexed whenever you pressed on a key, and the keytops sometimes caught underneath the case top. Hopefully these were just teething problems with the first models.

Two PC board edge connectors are provided at the back for add-ons. One of these is to take memory extension and/or I/O ports. It is believed that the other is for a possible colour display add-on.

The keyboard has the same layout as on the Spectrum, even having the same awkwardly positioned Symbol Shift key, and also lacks a proper space bar. But, because FORTH doesn't use keywords in the same way that Spectrum BASIC does, there is a blessed simplicity about the key legends. Generally, each key is only used to give upper or lower case characters — governed by using the SHIFT key, or a special symbol such as '<', which is obtained with the Symbol Shift key. The keys are black with easily read white markings.

As on the Spectrum, the keytops are all formed from a single rubber moulding which collapses as you press on a key, but the ACE's keys feel much



**The view inside the ACE; the chip count totals around 30 ICs!**

firmer and need to be pressed much more deliberately. You can't type quickly on the ACE — the keyboard just won't let you — so the auto-repeat feature is useful.

## On Screen

The TV display is crisp and stable but is in black and white only. There are 24 lines of 32 characters each, and in typical fashion the bottom line is reserved for use as an input buffer. Characters are normally displayed in white on a black background, although you can make any character appear in black on white. Both upper and lower case letters are available, as well as 16 'chunky' graphics characters. The character codes used are basically ASCII with a few additions such as the copyright symbol and '£' as well as '$' and ' # '.

As is common practice for most low cost computers, the characters are formed from an 8 x 8 array of pixels. The dot patterns for the whole character set are held in a special area of RAM (they are copied from ROM into the RAM when power is applied), which means that you can re-define any or all of them to make your own shapes in much the same way as you can on the Spectrum or the BBC computer. A PLOT command uses the chunky graphics characters to give a low resolution (64 x 46) plotting capability similar to that on the ZX81. Because you can define your own characters, each as an 8 x 8 pixel array, you can theoretically draw shapes with an overall resolution of 256 x 192 pixels, but in practice you wouldn't use this facility for drawing shapes larger than the space of a few characters on the screen. There is no equivalent to the high resolution plotting modes available on the Spectrum, Dragon or BBC machines.

The ACE has an internal loudspeaker, and a BEEP command to drive it, but you are limited to one note at a time and can only vary the pitch and duration.

The cassette tape interface works at a respectable 1500 baud (about 6 seconds for 1K bytes). You can save to tape either the dictionary of new word definotions that you have entered, which is effectively your program, or a defined area of memory. A VERIFY command lets you see if what is on tape is the same as what is in memory. On the model under test, a very high level was needed from the recorder when loading; reminiscent of the old ZX81, but otherwise the system worked reliably.

## Internal Matters

Inside the case is a bit of a shock to anyone used to Sinclair's 'The fewer parts the better' philosophy; almost 30 ICs have been packed in. Obviously in starting up a new company from scratch Vickers and Altwasser could not afford the time or cost of developing a custom integrated circuit like the ULA used to replace handfuls of TTL chips in the Spectrum, just as they didn't invest in the tooling for an injection moulded case.

The central processor is, of course, the one we can't seem to get away from: the Z80A. The Operating System software, FORTH, and the standard character set dot patterns have all been squeezed into an 8K byte ROM. 3K bytes of RAM have been fitted, which may seem a lot compared to the 1K of the ZX81, but 1K is used to hold the dot patterns when the machine is running, and almost the whole of another 1K is used for the TV display file, and yet more for working space, stacks, and System Variables, so you are left with well under 1K bytes to hold your program and data. Some form of memory expan-

## ACE BOUNCER

This program was written as an exercise in using FORTH and to get some idea of how fast a FORTH program will run. It moves a star around the screen, bouncing it off the four edges.

Similar programs written in BASIC will make a complete circuit of the screen in about one or two seconds. This FORTH version runs at about the same speed, but only because it has been deliberately slowed down by the **100 5 BEEP** command in the word **GO**. Without this restraint, the star moves so fast that you can only see momentary glimpses of it as it flashes around the screen!

```
10 VARIABLE HPOS
10 VARIABLE VPOS
1 VARIABLE HVEL
-1 VARIABLE VVEL
: NEWPOS HPOS @ DUP 0= IF 1
HVEL ! THEN DUP 31 = IF -1 HVEL !
THEN HVEL @ + HPOS ! VPOS
DUP 0= IF 1 VVEL ! THEN DUP 22 =
IF -1 VVEL ! THEN VVEL @ + VPOS !
;
: WIPE VPOS @ HPOS @ AT
SPACE:
: PRINTNEW VPOS @ HPOS AT
42 EMIT ;
: GO CLS BEGIN 100 5 BEEP WIPE
NEWPOS PRINTNEW 0 UNTIL ;
```

sion is essential for any but the simplest application.

The 181 page manual provided with the ACE is excellent, both as an introduction to FORTH and as a guide to using the ACE. It was written by Steven Vickers, and is in the same light but very informative style as his previous Sinclair manuals. One interesting chapter, *Extending the ACE*, gives much more information on how to add I/O ports or memory than is usual in a computer manual, including the circuit for a simple I/O port and examples of software to drive it.

## In Conclusion

The ACE represents a brave attempt to get away from the cliche of colour — BASIC — games machine personal computers, but in the long term will probably suffer from the lack of investment in a professional looking case and the absence of colour or true high resolution graphics. Now that FORTH is becoming available as an optional language for other computers such as the Spectrum and ORIC, many people may prefer to spend the extra to get the more powerful and flexible machines. The ACE will probably appeal most to those who have a limited budget and are interested in programming simple control type applications. But even these potential buyers might prefer the combination of a ZX81 with a cheap 16K RAM pack and FORTH on cassette, which adds up to about the same as an ACE.

**HE**

# D.I.Y.

Barry Foster

## With self-assembly lou... for your money wit...

THERE IS NOT much doubt that English-made loudspeakers are the finest in the world — without any disrespect to our American cousins or the latter-day Samurai. When it comes to "Zen and the Art of Loudspeaker Construction", the British speak little but work marvels. But not on the cheap. A really first class pair of 'speakers almost requires a mortgage, and even a decent pair won't leave much change from a month's pay. You will therefore understand my interest when I was offered the chance to review a pair of self-assembly 'speakers from Wilmslow Audio!

The range offered by Wilmslow is very large. Almost every major British manufacturer is represented, including top names such as Kef, Celestion, Chartwell, and Jordan Watts. In the High Street, prices for such 'speakers range from the barely affordable to "Oh my god", so the great attraction of self-assembly 'speakers has to be the opportunity to acquire a good set at an equally good price.

### Hifi Hype

It's always easy to buy an argument, amongst hifi buffs, as to which components of a hifi system are the most critical; it depends really on who you talk to and on the degree of difficulty involved in engineering particular elements.

Amplifiers, for example, are no longer much of a challenge in the normal line of hifi equipment, so that any manufacturer worthy of the name ought to be able to produce an amp that is capable of around 50 watts per channel with 0.1% distortion and a frequency response ruler flat from 20Hz to 20kHz. Of course, there are 'exotics' that offer class and facilities way above the norm, but in average hifi terms buying an amp comes down to "pounds per watt" — unless you are unduly impressed by an excessive number of knobs, indicators etc. and a front panel as glossy as the advertising brochure!

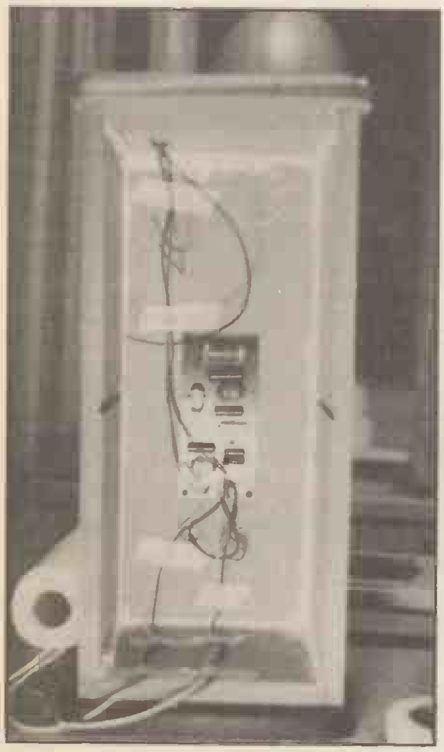
Similar arguments apply to hifi tuners, and as for cassette decks — if your budget stretches to a Nakamichi then well and good. Otherwise you'll have to be satisfied with less than best.

The argument starts to warm up when discussion turns to loudspeakers, turntables, tone-arms and cartridges. In recent years, computer-aided design and analysis has taken much of the 'magic' out of the engineering of these components; actually, it always was (is?) a case of juggling thousands of variables, partly by mathematics and partly by inspired guess-work. Computer techniques, with the capability for handling all these variables easily, have simply removed most of the guess-work!

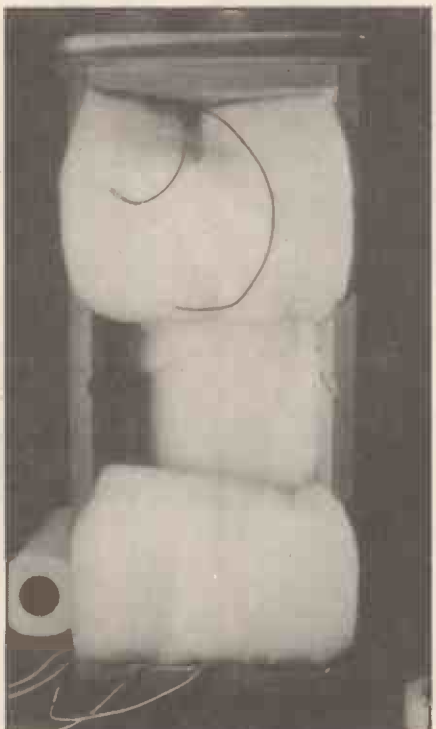
However, appreciation of the virtues of different 'speaker or turntable designs remains mostly subjective; what you like depends on what you hear. On the other hand, what you like to hear will decide where you will spend most of your hifi budget.

Briefly, the quality of the turntable, arm etc. will determine the bottom limit of distortion and the upper limit of frequency response (assuming that the amplifier is up to the mark). The 'speakers may also contribute to distortion but, more importantly, set the bottom limit of the frequency response.

So if, like me, you are a person who puts more store by meaty, beefy bass than in crisp clean highs at the upper limit of hearing, the loudspeaker becomes the most important element in the hifi system. Thus a self-assembly kit provides the means to spread your budget to the best advantage, while at the same time allowing you to acquire a first class set of 'speakers at a moderate



At this stage the cabinet has been assembled (note the lines of bathroom sealant around the inside of the joints). The crossover board has been screwed to the rear panel and the leads taped out of the way.



The two sections of acoustic wadding are rolled up and placed inside the cabinet, then teased out to fill the entire space.

# HIFI

## eakers you get more
## t sacrificing quality.

price and leaving cash in hand to outlay on other items.

### Questions and Answers

Price is not all, however, if performance does not follow, so the question must be asked: how good are self assembly 'speakers?

The answer, reassuringly, is — very good indeed! The kit chosen for review was the modestly priced dB12W kit, designed for amplifiers between 15 and 75 watts, and provided the assembly instructions are followed with reasonable care, they will produce results as good as any store-bought items of comparable size and design.

### In a Nutshell

The dB12W kit is second from the top in Wilmslow's dB kit range. It is designed for amplifiers in the range 15-75 watts and is given a five star assembly rating, meaning that no woodworking or electronic skills are required. The dimensions of each cabinet are 540 × 255 × 230mm, and they are designed for stand mounting some 300mm off the floor and, ideally, at least two feet away from walls. The units are described as medium sensitivity infinite baffle 'speakers, and contain three drivers and a pre-assembled three-way crossover board (which is the only component not manufactured in the UK).

The lower driver is a specially designed 6½in 'lower bass' unit, which, together with the 6½in mid/upper-bass driver, gives a surprisingly good response for a unit of its size; the transient response is sharp, without any trace of sogginess. The treble driver is a 1in soft-domed tweeter, dilled with ferrofluid, which produces accurate highs all the way to the top.

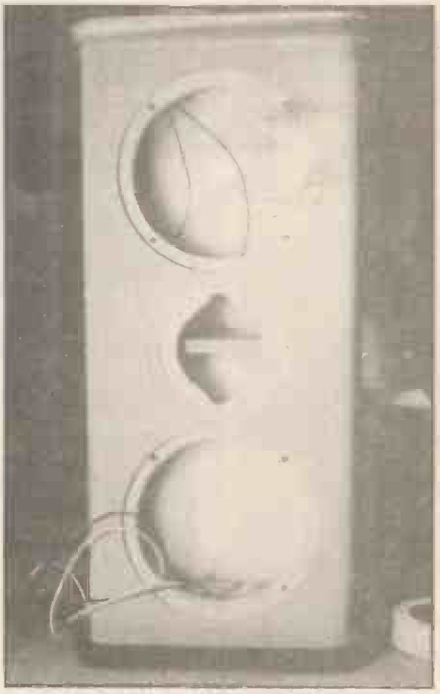
They are perhaps a little too strong on mid-range 'presence' for my taste, but a little bass and treble equalisation easily compensates. When boosted slightly, the bass is always clear and distinct, even though the speakers are floor-mounted rather than set up on stands as recommended. Likewise, the highs are crisp and clean and the stereo image, though the room does not permit ideal placement, is well separated.

The next question, of particular interest to hifi nuts who may not also be DIY buffs is: how easy are they to assemble? The answer is once more agreeable; putting together the dB12W 'speakers occupied a leisurely Saturday afternoon, with plenty of time to watch "World of Sport" while the glue dried!

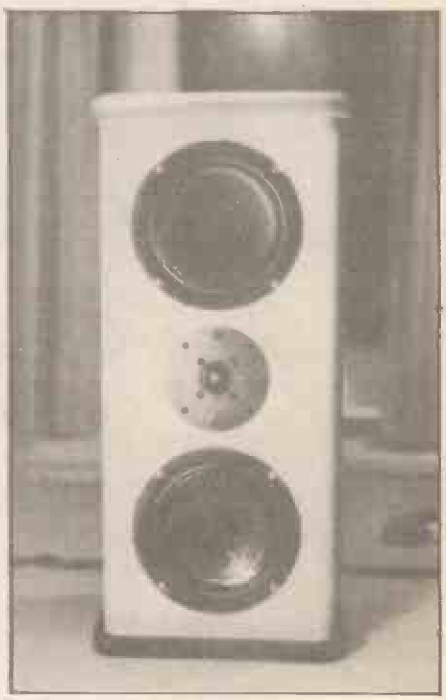
The cabinets are constructed from a material described as 'MDF', which looks like very high density chipboard to me; in any event, it certainly lives up to the makers claim that "It machines cleanly and accurately without the ragged edges associated with chipboard components". The side and top panels are prefinished solid African Walnut which, together with the simple but reliable construction method described later, give the finished units a solid appearance, not at all like a 'homemade' unit.

### Doing It Yourself

The speakers arrived, in bits, in two weighty cardboard boxes, and when unpacked formed an impressive if confusing array of high-density chipboard panels, foam-shrouded driver units, printed circuit boards, black acoustic foam, white wadding, and glossy brown African walnut panels. The instructions were roughly copied and seemed not altogether comprehensive, though in the end they proved adequate (remember the Golden Rule — when in doubt read the instructions!).



The central 'shelf' (visible through the tweeter opening) is installed next, then the front baffle-board is glued into place. The wires are led out through the openings, ready to connect up to the driver units.



Nearly complete, the driver units have been screwed into place. The bass and mid-upper units are physically very similar, and must be checked carefully to make sure they go in the right openings (bass at the bottom).

Tools required to assemble the kit are minimal: a pair of cross-head screwdrivers, a tube of woodworking glue, a roll of masking tape, a damp cloth to remove excess glue, a small power or hand drill with a ⅛in bit and a small hammer.

My initial doubts about the instructions were soon resolved. These said, in effect, "apply glue to the relevant surfaces, slap the panels together and hold them in place with masking tape while they dry". What? No screws, clamps or wood presses? No, not one; the panels are so finely and accurately machined that the box can be assembled virtually free-standing, the precision joints providing sufficient rigidity to hold the whole thing in place. The masking tape gives a slightly tighter and more securely sealed joint, but mostly seems to be for insurance (and assurance for the doubting constructor).

The remainder of the construction is equally simple, as illustrated by the accompanying photographs; there are one or two points worth noting, though.

One of the secrets of obtaining good clean bass response is to ensure that the cabinets are completely airtight; the slightest leak and your prized 'speakers will wheeze like a bagpipe with a hole in it —and sound almost as appealing! The trick I used was to seal the inside of each joint with a liberal bead of ordinary bathroom waterproof sealant, of the type sold in most DIY shops. This ensures that the panels are completely airtight (watertight, too). The front baffle-board cannot be sealed this way, however, so I applied a thin line of glue to the outside of the joint, carefully wiping off the excess with the damp cloth. These steps are perhaps not necessary if you take due care to secure the joints, but the cost and effort is minimal for a guaranteed result!

The pre-assembled crossover board can be mounted anywhere within the cabinet, as long as the leads will reach from the PCB to the drivers. I found it odd that these mounting holes were not pre-drilled, as this would have simplified the construction considerably, but apparently Wilmslow have found that people have different ideas about locating the crossover board within the cabinet. Personally, I don't see that it matters.

I had some slight difficulty with the construction at two stages only: the foam gasket in which the mid-range and bass drivers sit has to be cut up and re-arranged around the flange to clear the bolt holes; then I found that the tweeter did not want to sit firmly in its milled rebate, apparently because the centrally mounted shelf was blocking it. Fortunately, the glue had not yet dried so I was able to move the shelf backwards, secure the tweeter, then gently knock the shelf forward into position.

The only items with which I was just slightly unhappy were the banana sockets supplied for connecting up the 'speakers to the amplifier. While they have proved adequate, so far, I would have preferred solid spring-clip connectors for that extra measure of security.

Finally, though, when the dB12W kit was completed and booming out "The Wall" at top volume (the neighbours had been warned!), minor problems and quibbles were blasted into insignificance.

There is one other cautionary note which, however, applies to most makes of 'speakers, rather than the dB12W kit in particular. Like most modern loudspeakers, the dB12Ws are fronted by an acoustically transparent foam grille, which nicely complements the polished woodwork and looks at home in most decorative schemes. But the family cat seems to find the foam totally irresistable, preferring it to all other scratching posts!

*The dB12W kit is priced at £108 including VAT, with postage and insurance £4.50 extra. Other self-assembly kits in the range go from the dB4C, at £35.95, up to the Jordan System 4, which is priced at £330 and requires considerable woodworking skills (or, as Wilmslow put it, "Built any good sideboards lately?"). There are many types in between and it is worth checking the Wilmslow catalogue before coming to a decision.*

*Write to* ***Wilmslow Audio Ltd, 35/39 Church Street, Wilmslow, Cheshire SK9 1AS,*** *or telephone* ***Wilmslow (0625) 529599.***

**HE**

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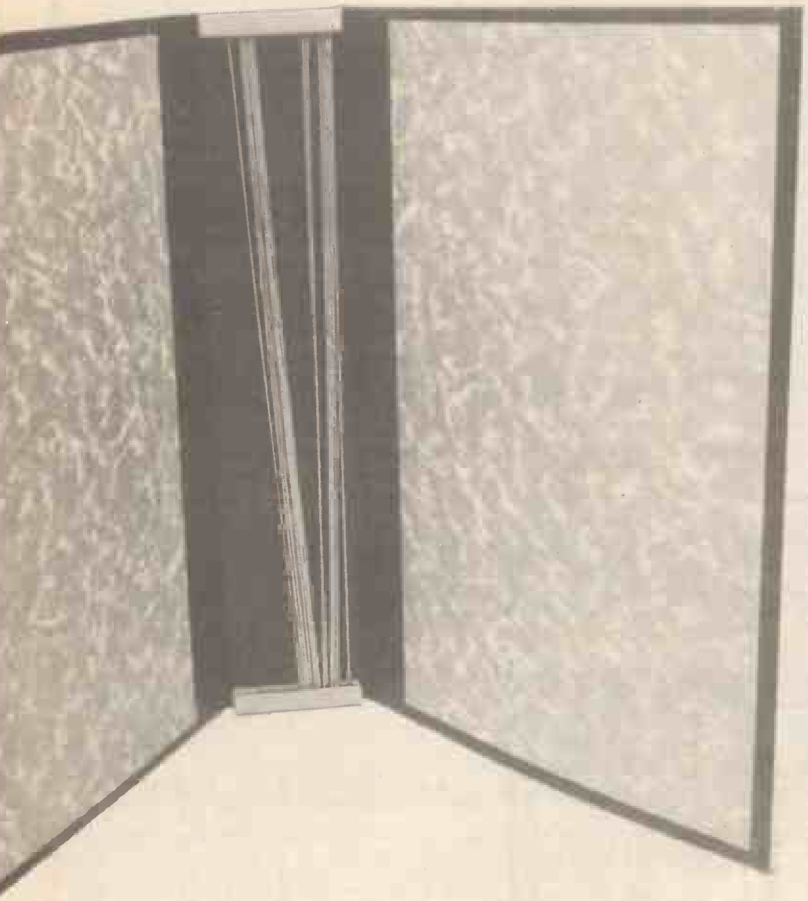

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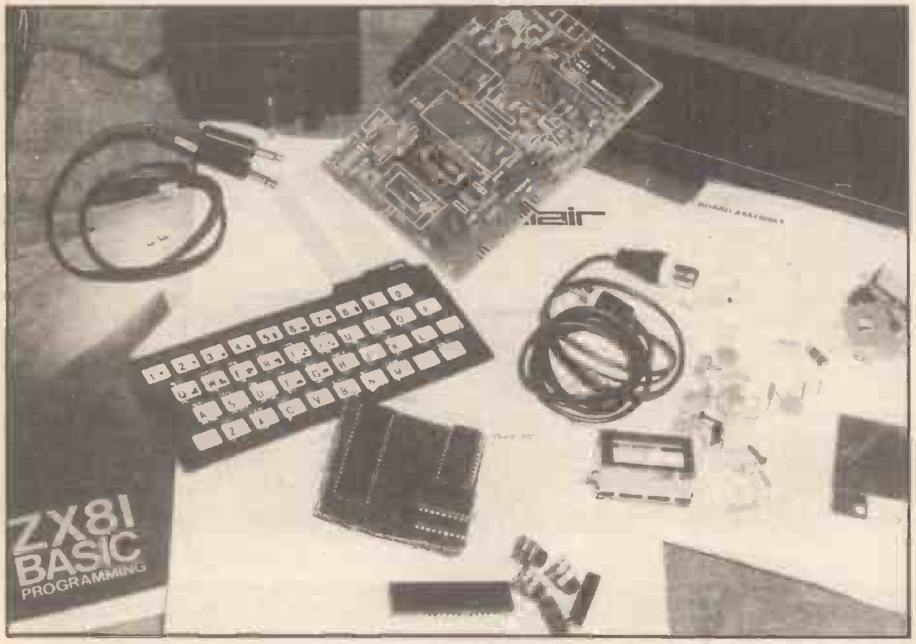
# THE ELECTRONIC REVOLUTION: THE ELECTRONIC AGE

**For better or for worse, the Atomic Age began on 16th July, 1945. The Electronic Age dawned just two years later with less of a bang, though with equally significant after-effects.**

John Biggins




IT IS VERY RARELY indeed that the birth of a new era can be located exactly on a particular day. The explosion of the first atomic bomb on 16th July 1945 at Almagordo, New Mexico is the twentieth century's most obvious candidate for the title of a day which changed the world for ever. But there have been a few others, and the events of 23rd December 1947 at the Bell Laboratories certainly give that date a strong claim to be one of history's great turning points. On that day the world's first transistor was made to work.

Some inventions creep up upon the world rather than burst upon it. Faraday's magnetic induction demonstration in August 1831 took a good half-century to turn into even the beginnings of an electric power industry while wireless dawned so gradually that we cannot even say with any certainty who transmitted the first signal. Some inventions like television were eagerly awaited for decades before anyone could produce a workable system, while other like radio-telephony lay around for years before anybody realised what could be done with them.

But the transistor fell into none of these categories. Its birth that day represented the pinnacle of nearly thirty years' concentrated research by some of the most talented physicists in the world, all labouring with the conscious aim of constructing a solid-state analogue of the wireless valve. And over the previous three years, Bell Labs alone had invested several million dollars and some of its best researchers in the project. Nor were the implications of the event lost on those present. No one had much idea of the sort of world that the transistor would have produced thirty-five years later but all those who were there seem to have been conscious that something out of the ordinary had happened and that things would never be the same again. In the event it took a decade for the transistor to be perfected and built into electronic technology, but when this happened it pushed the science of electronics into an age of exponential growth which has done more to change the world in the last generation than steam did in the two centuries before that.

Like its near-contemporary the atom bomb, the transistor is a classic case of development not by technological push, but by demand-pull. The state wanted the bomb and the corporations wanted the transistor for their own purposes, and both were prepared, whether the project turned out to be feasible or not, to invest any amount of money and time and research talent towards achieving it.

The idea of a solid-state transducer was almost as old as wireless itself. In fact, wireless wave detection began with a primitive semi-conductor, the coherer, and continued for many years afterwards with another form of the semi-conductor in the shape of the crystal detector. Looking back, you might almost see the half-century of thermionic valve development following Fleming's diode of 1904 as a blind alley in electronics history. Valves came in largely to make up for the deficiences of the crystal detector: its fragility, its need for constant delicate adjustment and above all its puny current output. Valve manufacture began by having access to all the resources and experience of the light-bulb industry out of which it had accidentally sprung, and the valve's versatility as oscillator, detector or amplifier led to its dominating radio from about 1919 onwards.

## Closing the Valve

Valve design became remarkably sophisticated between the Wars in the hands of specialists like Philips of Eindhoven and the Second World War produced great advances in miniaturisation. But even in the 1930s it was beginning to be apparent that the law of diminishing returns applied to valve development as to everything else. Research and development could reduce some of the valve's many drawbacks, but could never abolish them: its size, its fragility, the expense of its manufacture, its large power requirement, its need for cooling (40 gallons of water per minute for some of the giant transmitter valves of the mid-1920s) and its highly unpredictable life-span. For these reasons interest in semi-conductors never died away, despite the apparent death of the crystal receiver some time after 1930. For one thing, pure undirected speculative research went its own sweet way during the 1920s and 1930s. Physicists like Pohl at Göttingen University carried on a long pre-1914 tradition of research into the electrical properties of crystals, though this was sometimes more by accident than by design: as in Pohl's case, where Germany's ruined economy in the years after 1918 prevented him from getting hold of liquid oxygen to study gas conductivity and obliged him to look at solids instead.

Most of this research was quite innocent of any immediate practical application but, at the back of it, the idea of a solid-state analogue to the valve was never far away. One Lilienfeld patented a crystal amplifier in Germany in 1925, though none was ever built and argument goes on to this day as to whether the thing would ever have worked if it had been. All experimenters had to grapple with terrifying problems in getting crystals pure enough to experiment with, but gradually some substances began to emerge as front-runners. Copper oxide was in common use as a rectifier during the early 1930s, and in 1935 Oskar Heil attempted to build a field-effect amplifier by passing a current through a slab of the stuff forming one side of a capacitator: an idea which was to be taken up again by Bell after 1945, but which was eventually beaten by electron retention at the slab's surface. Embedding an electrode in a crystal to modulate the current passing through it was the obvious next step, and in 1938 Pohl and Hilsch in Germany announced that they were confident of soon being able to use this technique with a potassium bromide crystal to produce the long-sought successor to the triode valve.

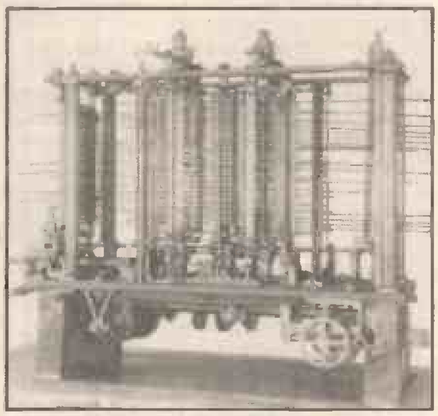
## Enter Germanium . . .

The war which broke out the following year brought most German research to a halt. But in the end it was the war's demands which forced development of the transistor ahead once more, and in particular the development by the Allies, circa 1942, of centimetric radar. Ordinary wireless valves had too high a capacitance to detect the returning signal, so the crystal detector was brought out of retirement: this time in the form of a silicon crystal touched by a tungsten cat's whisker. It worked, but not very well. So germanium was investigated as a substitute. The Massachusetts Institute of Technology and about forty other US research institutions got to work on the problem, and by late 1943 germanium detectors were available which could handle up to 150 volts.

When the war ended the research team at Bell Labs, Brattain, Barden and Shockley, were tinkering once more with the field-effect transistor, though this time as part of a vast programme aimed at producing reliable solid-state equivalents of the valve. The field-effect approach was eventually defeated by the surface retention which had beaten Heil a decade earlier. But point-contacts with a germanium crystal turned out to be far more promising. It was a semi-conductor of this type, soon to be christened the transistor, which was successfully tested at Bell Labs two days before Christmas 1947. The more familiar junction transistor followed soon afterwards and the first public demonstration was given at the end of June 1948.

Contrary to later legend, Bell was anxious from the very first to get the transistor as widely used as possible as soon as possible. To this end it was prepared to grant manufacturing rights at very favourable terms. For the first few years, though, there were few takers. Up until the spring of 1953 in fact the main optant was the hearing-aid manufacturer Raytheon which was not too concerned about sound quality so long as it could get miniature, low-power amplifiers. Wireless, television, the telephone manufacturers and (strangely enough) the military showed very little interest at first. True, apart from its size and its low power requirement the transistor offered few immediate advantages over valves. The first generation were noisy, expensive (about eight times the price of an equivalent valve in 1950), limited in the voltages they could tolerate and limited in their frequency response. Manufacturing methods were often astonishingly haphazard by the standards of a generation later, not so much designing a batch of transistors to fit a desired range of characteristics but rather making the batch and then sifting out those transistors which measured up to the requirements. And there was always the problem of minute traces of impurity left in the crystals, known collectively as 'suddendeathnium', and the reason for the failure of many early semi-conductors. But above all these difficulties there was the attitude of the industry itself. Though interested in solid-state devices, the engineers of the great American and European electronics firms were men who had grown up with valves from their earliest youth. For this reason they tended to regard the transistor as a mere valve-substitute until well into the 1950s, by which time it was establishing itself as a technology in its own right and developing the sub-technology of small-scale integrated circuitry which was to lead to the micro-chip in the early 1970s. This conservatism may have had a great deal to do with the electronics industry's great migration to the Far East from the late 1950s onwards.

The thing that really made the transistor's fortunes, though, was the providential development, at about the same time, of the digital computer. But unlike the transistor the computer was not propelled into an eagerly waiting world by a massive research programme. Instead it crept up on the human race almost unawares.



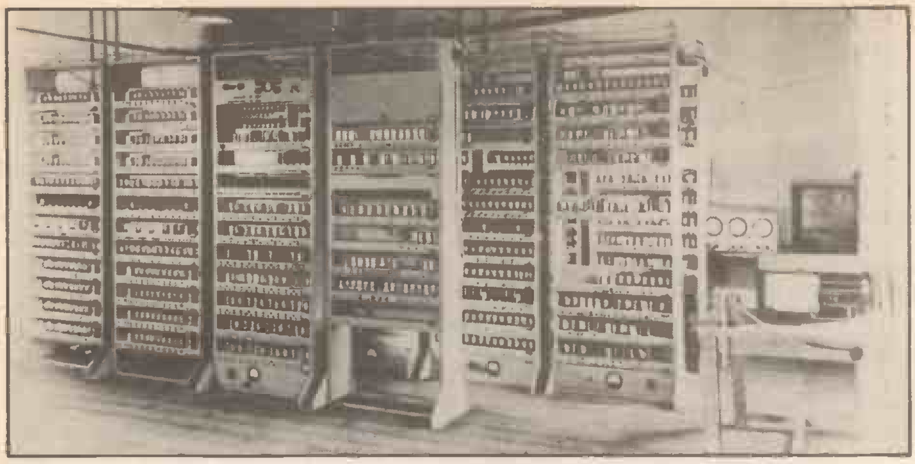
Babbage's "Analytical Engine" was perhaps the earliest computer — a machine designed specifically for performing mathematical calculations.
(British Crown Copyright, Science Museum, London.)

The idea of calculating by machine was scarcely a new one in the late 1940s when the electronic computer began to dawn upon the public consciousness. The abacus, Napier's bones, the slide rule (remember the slide rule?), Pascal's calculator and the Burroughs comptometer were all attempts — more or less unsatisfactory — to rid calculation of some of that mind-numbing drudgery involved in projects like the one, about 1840, which had an entire company of Prussian army engineers scribbling away for six months to calculate the curvature of a single lens. In 1833 the mathematician Charles Babbage had designed (but not built) his Analytical Engine: the world's first project for an analogue computer with input, output and some sort of memory. At the very end of the nineteenth century the increasing demands of each successive US census had produced a number of increasingly elaborate card-processing machines to deal with the returns. But true computers required an accuracy far beyond the reach of even early twentieth century precision engineering, and in the mid-1930s the valve began to be built into electronic analogue calculating machines at Harvard University and Bell Labs.

As with the transistor, the demands of the Second World War pushed development forward and began the transition from calculator to true computer. Not only the Manhattan atomic bomb project but also ballistics trials required calculations of an unheard-of complexity, far beyond the capacity of human beings working unaided. And in this area the Harvard Mark 1 electronic calculator was able to score a notable triumph in 1942 when it predicted — correctly, as it turned out — that the German army would never get anywhere with the electrically powered long-range gun which it was trying to build. Meanwhile, across the Atlantic, the Enigma code-breaking operation required the building of a succession of increasingly powerful electronic cipher-machines at Bletchley Park. On a more mundane level, the vast complexity of modern armed forces led to the development of electronic personnel selectors in an effort to sort out the right man for the job from among the millions available. Evelyn Waugh's novel *Sword of Honour* mentions one of these latter contraptions installed in a War Department office in London circa 1943. And beyond the strictly technical considerations of electronic systems design, the war led to the first concentrated, systematic study of operational logic, information flow and decision-making: all areas essential to the creation of artificial intelligences after the war was over.

## . . . And the Computer

The value of electronic calculation was so evident by the time the war ended that the US Government was keen to sponsor the building of the first true electronic analogue computer ENIAC at the University of Pennsylvania in 1946. The previous year John von Neumann had suggested the use of the binary system for electronic calculation, and after Cambridge University's EDSAC in 1947 all computers went over to digital operation. Meanwhile Pennsylvania University was building ENIAC's successor EDVAC with the first magnetic core memory, and computers were moving outside the field of strictly scientific calculation with the US Air Force's Whirlwind flight-simulator. Likewise the universities and government departments lost their monopoly of computer ownership in 1952 when GEC ac-



More than a hundred years after Babbage, the ESDAC I computer was built in Cambridge. It was no smaller, but a lot faster!

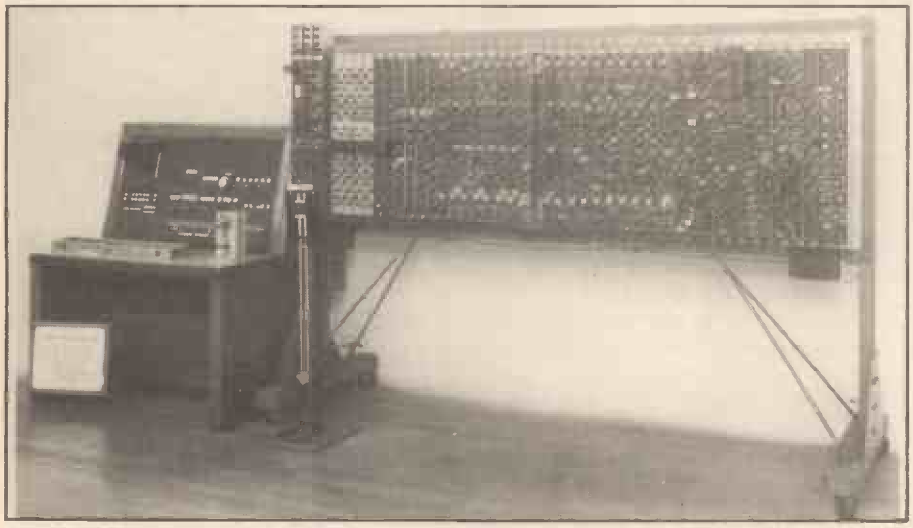
quired its Univac I, the first computer in the world to be owned by a private firm.

The trouble with these early computers was their sheer size and unreliability. Bell's Model V in 1944 contained over 9,000 valve relays and fifty pieces of teletype equipment. It weighed ten tons and took up over a thousand square feet of floor-space. Heat dispersal from these forests of valves was a major problem and power requirements were vast. ENIAC used 130kW and is said to have dimmed lights over half of Philadelphia when it was switched on. Above all, down-time was huge, given the number of valves, their unreliability and the difficulty of getting at them to replace them. When it arrived on the scene at the end of the 1940s the transistor was the answer to the computer builder's prayers, with its miniscule size, cool operation, low power requirement and — post 1953 or thereabouts — long life. From about 1955 onwards the valve began to be ousted by the transistor in computer construction, and as the transistor took over the computer began to move out into the world.

At the end of the 1940s the experts had confidently predicted that a country like Britain would never need more than two or three computers to serve all its needs while the USA itself would only require a hundred at most. But as is the way with these things, the increase in supply created its own demand. As the computer became smaller and cheaper it was found that more and more previously manual administration jobs could be handed over to the machine: not just censuses and scientific calculation, but banking and payrolls and stock control and police records. From then on it began to affect the lives of every one of us. Computer and transistor were the twin foundations of the post-1945 electronic age, and neither could really have existed without the other.

The miniaturization of electronics made possible by the semi-conductors, and the durability and low power consumption which they brought with them, caused another great leap forward (or upward) in the second half of the 1950s. After all, where would space exploration be if it relied upon valves? The nasty blow dealt to American prestige by the launching of the Sputnik in October 1957 led directly to the race to the Moon. But so far as this century is concerned its most important consequence may turn out to have been the birth of space communications. As early as 1928 the German rocket pioneer Hans Oberth had suggested space relay stations in geosynchronous orbit 22,300 miles above the Earth, though in this case he proposed beaming messages up and down by heliograph because of the limited power available from the transmitters of the day. And this idea was taken up again by Arthur C. Clarke in 1945. But it was not until the late 1950s that the idea came anywhere near realisation when the United States launched its first Echo communications relay satellites.

These were passive reflectors: mere balloons of metallised PVC which were supposed to act as mirrors for microwave signals. They were not particularly successful and it was not until July 1962 that the first active relay satellite, Telstar I, was put into orbit, powered by solar cells and capable of redirecting TV signals for that part of the day when it was above the horizon. Geosynchronous orbit followed with the Syncom series of satellites launched from February 1963 onwards. By 1980, upwards of fifty communications satellites were in orbit with a further fifty planned. The tariffs demanded by the international Intelsat corporation were too high at first for more than a minimal amount of direct TV broadcasting via satellite, but from the mid-1970s onwards US television networks and Third World governments alike began to see the advantages of a satellite-based TV system. And not only the advantages of satellite TV but also the benefits of secure telephone communications and computer data links of a hitherto unimaginable speed and purity. Again, once the transistor made it possible people began to think of needs they had never felt before.

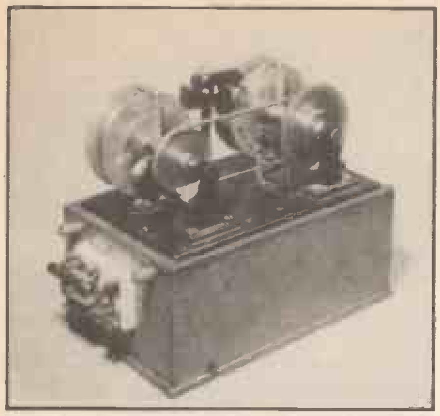


The ACE computer, built in 1950, still used valves, though less of them than its predecessor ESDAC.

(Lent to the Science Museum by National Physical Laboratories)

## Getting Taped

This kind of self-sustaining growth, with new developments creating demand and demand calling forth new developments, has been particularly noticeable in the world of home entertainment over the past eight-odd years. Wireless and television we all know about, of course. But what about recorded music? After all, one of radio's first and greatest conquests in the late 1920s was its absorption, for a time at any rate, of the gramophone: previously a scratchy, faint-sounding, clockwork instrument, but transformed by the valve, the wireless loudspeaker and electric drive into a robust, reliable means of entertainment. The great success story of the age, however, was the tape recorder. The idea of recording sound on magnetic steel wire had been suggested as far back as 1888. But it was ten years before the Danish inventor Valdemar Poulsen took out a US patent on his Telegraphone. This operated by means of clockwork-driven spools passing wire through a magnetising/de-magnetising coil at a rate of 7 feet per second. It was hailed as a major new discovery when it appeared on the market and Poulsen set up the American Telegraphone Company to sell it, but in the end the idea came to nothing. The machine's frequency response was too poor for use as anything except an office dictaphone and the wire suffered from an incurable tendency to twist and stretch — as well as occasionally snapping and slashing around at high speed until the spools



**Poulsen's "Telegraphone" was patented in the US in 1898 and used mainly as a dictaphone. "Hifi" had yet to be invented!**

(British Crown Copyright, Science Museum, London.)

could be stopped. (Wire recording was eventually used for aircraft flight recorders, because of its robustness, but it was decidedly not bound for the entertainment industry.) All the same, interest never died away completely and post-1918 AEG, Bell, 3-M and the US Naval Research Laboratories were all looking into the idea.

In 1928 the German researcher Pflumer abandoned wire in favour of paper tape coated with iron oxide. Meanwhile the Magnetophon company, also in Germany, worked on plastic-based tape. The Blattner system — used by the BBC for studio recording from 1934 onwards — favoured steel tape which had the disadvantage of having to be cut with shears and spot-welded into splices which went through the heads with a deafening clatter. But during the early 1930s magnetic tape recording was upstaged by the photo-optical system developed for the talking films.

Interest picked up once more during World War II, and the German Magnetophon system began to pull ahead of its nearest American rival Brush. It was strongly sponsored by the German Propaganda Ministry, who found its acoustic accuracy and the portability of the tapes very useful for broadcasting speeches by the Nazi leadership at times and places which would puzzle Allied intelligence. The result was that by 1945 Magnetophon tape recorders were way ahead of anything that the Allies could produce, with a frequency response of up to 10kHz. American scientists were highly impressed by German recorders captured at the end of the war, and after several years' work to perfect tape-coatings tape recorders began to appear on the US domestic entertainment market. Meanwhile, small battery-powered tape recorders came to replace wax-disc machines in radio outside broadcasting, doing away with the need for a technician to sit beside the machine while it was recording with a camel hair brush to get rid of the swarf thrown up by the needle. The only technological developments which stood between the tape recorder and a mass pre-recorded music market were the compact cassette to do away with the need for threading the tape (introduced by Philips in 1963), and $CrO_2$ tape (launched by DuPont five years later). Once these were achieved, hifi came to be a feature of most households with any pretensions to civilisation.

**The modern tape recorder was developed in Germany during World War II, when it was used to replay and broadcast speeches by the Nazi leaders.**

(Photo, Science Museum, London.)


**The "Walkman" and similar cassette players probably represent the ultimate in personal hifi.**

Once sound recording on magnetic tape had become an established technology it was only natural that people should begin to think of some better means of recording TV programmes than merely pointing a cine-camera at the screen. It is odd to remember, though, that video recording is an idea as old as television itself. In 1930 the Baird Television Company had tried to market shellac video discs with its 'Televisor' receivers: no great problem in theory, since all the disc had to do was to vary the output of a neon lamp shining through a Nipkow disc onto the back of a ground glass screen. The Baird discs turned out to be even less of a success than the Televisor itself and sank without trace after a few months. It was not until 1951 that the Crosby Laboratories developed a video recorder which could register a TV signal magnetically: in this case along the length of a tape running past at over eight feet per second. This method gave tolerable picture quality but was so greedy of tape — something like three miles for a half-hour programme — that the idea never made it outside the laboratory. The first commercially usable video system came in 1956 when the American Ampex Corporation brought out a recorder which entered each picture frame transversely on a two-inch-wide tape. A similar system was taken up by the BBC under the acronym VERA in the same year, and between them these two video systems dominated broadcast TV for the next twenty years, even though they were both about the dimensions of two wardrobes stuck together, and used tape spools the size of bicycle wheels. They gave a very good picture, but they and the later, smaller, versions of the studio VTR were clearly out of the question for the home user.

Helical scanning was developed by Sony in the mid-1960s as a compromise between tape width, speed and picture quality. It opened the way to a consumer video market but for some reason — perhaps because people were still absorbing hifi sound recording — it failed to catch on until the late 1970s when TV addicts in the USA began to appreciate the domestic VTR's time-shifting capabilities. Suddenly the market exploded as it became profitable for the Japanese electronics industry to tool up for mass production of domestic video recorders. The American film industry began its belated shift towards producing for TV and video first and the traditional movie theatre second. Meanwhile cable TV, satellite TV and the prospect of fibre-optic cable TV were starting to follow the way cut by the VTR in fragmenting TV audiences to the point where people now speak of 'narrowcasting' as the dominant home entertainment form of the 1980s.

It is only just over a century and a half since Faraday made his historic demonstration of electro-magnetic induction and only just over a century since Britain got its first public electricity supply. During that time electricity has advanced from being a barely understood and not particularly useful scientific freak to a point where it is the lifeblood of our civilisation. A great many of its innovations have merely helped us to cope with difficulties which we would never have had in the first place without those same innovations — the pocket calculator and the photocopier are the two examples which come readiest to mind — but good thing or not, the technology was there, and so it happened. The only safe prediction now, in Anno Domini 1982, is that we are only seeing the beginning.

**A PAM transistor radio dating from 1956. As today, the physical size was determined by the need for a relatively large loudspeaker.**

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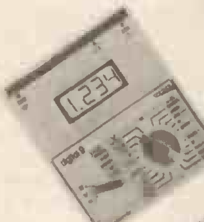

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# BBC Micro/ HEBOT Interface

Owen Bishop

**Hobby Electronics' maestro of the micros describes a versatile interface which joins the HEBOT II to the BBC Microcomputer, Model A or Model B, or which can be used for any other imaginable purpose!**

UNTIL NOW, the only way to command our friendly robot has been by using a ZX81 computer. Now we add to the list of the controllers of HEBOT, by publishing another interface; this one lets you operate HEBOT from the keyboard of the BBC Microcomputer. The interface plugs into the 1MHz socket, which is found on both Model A and Model B.

The interface has exactly the same facilities as that published in November 1982, for the ZX81. It has an eight-bit data output for controlling the motors, the pen, the lights and the horn, and it has a 4-bit data input for reading the touch sensors. It also supplies the power needed for operating the circuitry of HEBOT, including its motors and solenoid. The ZX81 supplied 10V (or thereabouts), this being the output from the ZX mains adaptor, while the BBC Microcomputer has a nominal 12V output which can supply up to 1A25, and this is more than enough for HEBOT. Readers who already have HEBOT need not worry that the power supply from this interface is 12V, rather than the 10V which little HEBOT has been used to receiving from the ZX81. Powertran Ltd. who supply the HEBOT II kit, assure me that the motors and solenoid are in fact rated for 12V operation, though they work just as well on 10V. You might find that HEBOT nips around the room a little faster when connected to the BBC Microcomputer! The other components in HEBOT are able to work just as well with a 12V supply as with a 10V supply, though his eyes may glow that bit brighter and his voice may become that bit stronger. So it looks as if an invigorated HEBOT will soon be evident!

It is worth noting that this interface could also be used to control any other device instead, provided it works with an eight-bit TTL input and a four-bit TTL output.

## HEBOT Meets The Micro

The interface provides an eight-bit data output and a four-bit data input, and consists of three parts: the Decoder, which decodes signals on the address and to the control lines; the Latches, in which data from the computer is temporarily stored in send on to HEBOT; and the input Data Buffers, which receive data from HEBOT and pass it on to the micro when asked.

The BBC micro, in common with most others, has 16 address lines; the upper 8 of these are decoded internally to produce an output which goes by the remarkable name of FRED. Normally the voltage level on FRED is 'high', but when any of the 256 addresses in the range &FC00 to &FCFF is written to or read from, FRED stops feeling 'high' and feels rather 'low' instead. This leaves only the lower 8 lines (A0 to A7) to be decoded at the interface. The circuit diagram, **Figure 1**, shows how these are decoded by a number of simple logic gates. The address allotted to HEBOT is &FCF0, which is '1111 1100 1111 0000' in binary; FRED takes care of the '1111 1100' and the interface takes care of the '1111 0000'.

## Writing Home to HEBOT

The final gates in the chain take the state of the Read/Write (R/$\overline{W}$) line into account. When the micro wants

**Figure 1. The full circuit of the BBC/ HEBOT Interface.**

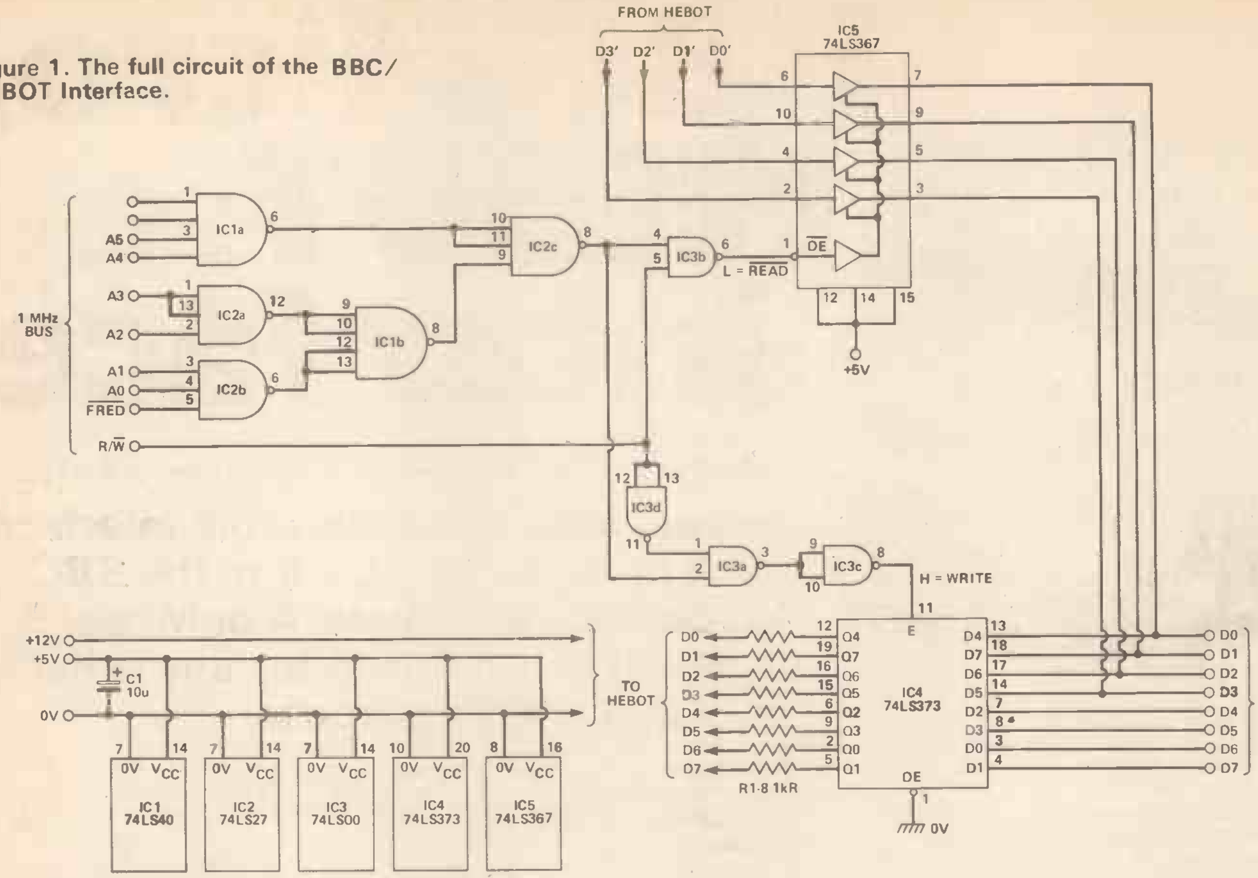
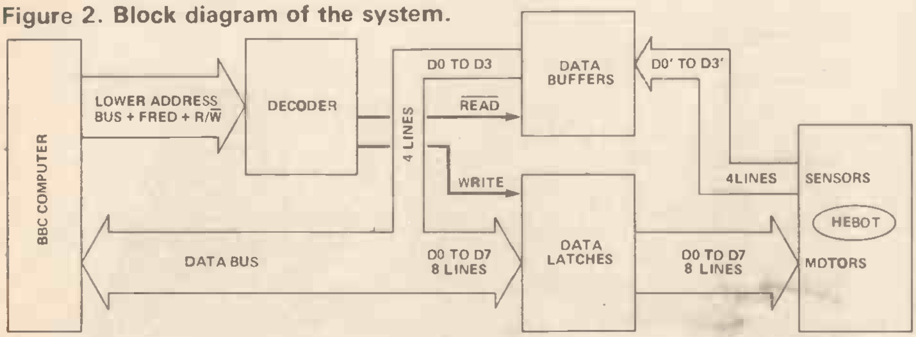



**Figure 2. Block diagram of the system.**




to write to HEBOT, this line is taken low, consequently the output at pin 8 of IC3 (which we have called 'WRITE') goes 'high'. It is not possible to detect this high pulse by using a voltmeter, for it lasts only a fraction of a microsecond, however it is long enough to trigger the latches of IC4. The output of each latch assumes the state which is present on its data input line at the instant that WRITE goes high, and this output level is fed to HEBOT through resistors R1 to R8. Once latched, the output remains unchanged, even though the data itself is no longer present on the data bus. Indeed, the micro may be writing different data to other parts of its memory but HEBOT's data remains held at the latches, giving HEBOT plenty of time to respond, and it remains unchanged until a new set of data is written to the latches.

When the micro wants to read data from HEBOT's sensors, it addresses HEBOT at &FCF0, as before, but this time the R/W line is taken 'high'. The result is that the output of IC3 at pin 6 goes low. We call this line 'READ', and when READ goes low, it enables the data buffers of IC5. In their disabled state these buffers have what is called a 'high impedance output'; in other words, there is a very high resistance (several hundred thousand ohms) between the buffer output terminal and the data line. In effect, then, the buffer is disconnected from the data line and cannot supply data to it.

When the buffers are enabled, they have normal TTL output characteristics; if a buffer is receiving a high input from one of the sensor circuits of HEBOT, the corresponding line of the data bus is made high; if the sensor circuit has a low output, that line is low. There are only four sensor outputs from HEBOT, so only the lower four lines of the data bus are connected to the buffer IC. A hex buffer (74LS367) was chosen in preference to a quadruple IC (74LS125) since it has only one enable input shared between the four buffers we are using, whereas the 74LS125 has a separate enable input for each buffer, making the wiring more complicated.

It is feasible to wire up the other two buffers to provide a six-bit data input to the micro, if you like. If you are thinking of giving HEBOT one or two additional sensors, take their outputs to pins 12 and 14 of IC5, connect the buffer outputs (pins 11 and 13) to D4 and D5 and join the other enable input (pin 15) to pin 1. You will also need to remove the track which at present connects pins 12, 14 and 15 to the +5V rail.

## Construction

The interface is built on a double-sided PCB; most of the wiring is on the under side of the board, but the power rails and a few linking tracks are on the upper side.

If you are making your own board, take special care that the two designs are exactly registered with each other on opposite surfaces of the board. There are some 'tight squeezes' in certain parts of the board; also there are 28 points at which the tracks on the upper and lower surfaces must be connected and pads are provided in the design where these connections are to be made. Drill a hole through the board in the centre of one of the pads; if registration is correct, the drill should pass through the centre of the pad on the opposite surface. Pass a 1mm terminal pin through the hole and solder it to the pads on both surfaces of the board. If you want to make a more professional job of the board, you can use the special 'through-PCB' pins which are obtainable from some suppliers, but you need three proper terminal pins at the points where the power supply cable is to be connected.

The ICS can be soldered directly to the board, thus saving cost, though it is advisable to use sockets since it is often useful to be able to remove an IC when tracing faults. Do not insert the ICs until all the wiring has been completed and the preliminary wiring checks described below have been undertaken.

## Connections To The Board

The interface is joined to the micro by a 34-way ribbon cable. At the micro end, the cable is terminated in a 34-way Speedbloc connector, which must have a central key in order to mate with the socket on the micro. Speedbloc connectors are of the insulation-displacement type and are very quick to attach to the cable, but a vice is essential for this. You also need an adaptor tool (which is inexpensive) but if you lack the equipment, it is far simpler to purchase the cable with the connector already attached to one end (see *Buylines*).

Note that the diagrams of the 1MHz bus in the BBC Microcomputer System User's Guide are incorrect — at least, those in my copy (issued late 1982) are! The diagram of the various sockets on pg. 499 suggests that the 1MHz bus has 26 pins, yet a simple count shows it to have 34. The diagram on pg. 503 shows 34 pins, provided that one ignores the rather odd 0V and +5V pins which do not exist on the 1MHz socket itself. The next error is that the numbering of pins in the two drawings is inconsistent; in this article we adopt the numbering shown on pg. 503, beginning with pin 1 at the bottom (a 0V line) and ending with pin 34 at the top (address line A7). Once again, we ignore the spurious 0V and +5V pins. On this reckoning the pin numbering on pg. 499 is wrong in orientation, as well as in magnitude, and should be as shown on the diagram we publish here. (*We have now learned that recent issues of the Guide have been corrected*—Ed.) It is essential to understand the pin numbering system before you attach the Speedbloc plug and solder the cable to the interface board.

**Table 1** shows that HEBOT uses only 18 of the 34 lines available at the 1MHz bus port. Certain of the lines may be cut short at the interface end of the cable, as shown in **Figure 4** but make sure that the cuts are clean, so that there are no thin filaments of wire protruding from the cut insulation to cause a short-circuit with an adjacent wire. The same consideration applies when you solder the wires to the board; make certain that all the strands of each wire *go through* the hole. Examine your work with a lens when you have finished, looking for single strands lying on the top surface of the board and pull off any that you see.

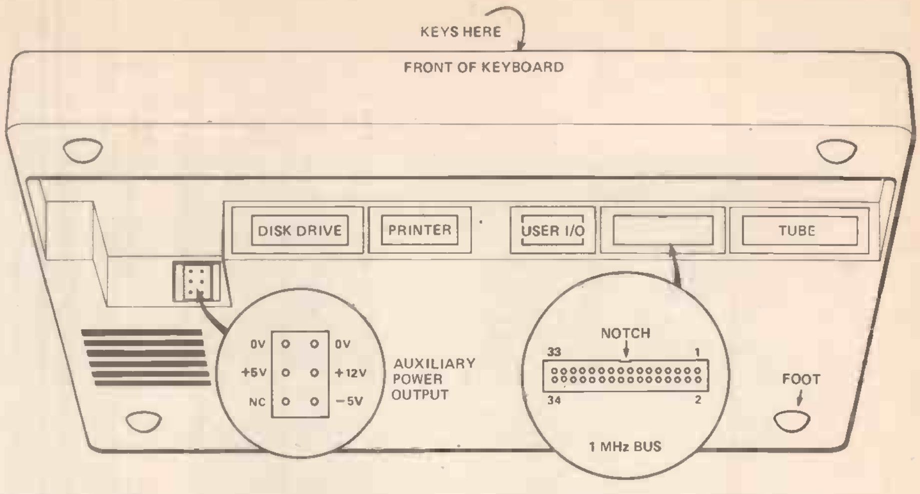



**Figure 3. Schematic view of the connectors underneath the BBC Micro.**

Table 1
CONNECTIONS OF THE 1MHz BUS

| Line no. | Name | Function | • = used for HEBOT |
|---|---|---|---|
| 1 | 0V | | |
| 2 | R/W̄ | Read/write strobe | • |
| 3 | 0V | | |
| 4 | 1MHzE | 1MHz clock | |
| 5 | 0V | | |
| 6 | NMI | Non-maskable interrupt | |
| 7 | 0V | | |
| 8 | IRQ | Interrupt request | |
| 9 | 0V | | |
| 10 | FRED | Negative strobe FC00-FCFF | • |
| 11 | 0V | | |
| 12 | JIM | Negative strobe FD00-FDFF | |
| 13 | 0V | | |
| 14 | RST | System reset | |
| 15 | 0V | | |
| 16 | ANALOG IN | Analogue input | |
| 17 | 0V | | |
| 18 | D0 | Data bus, least sig. bit | • |
| 19 | D1 | Data bus | • |
| 20 | D2 | Data bus | • |
| 21 | D3 | Data bus | • |
| 22 | D4 | Data bus | • |
| 23 | D5 | Data bus | • |
| 24 | D6 | Data bus | • |
| 25 | D7 | Data bus, most sig. bit | • |
| 26 | 0V | | |
| 27 | A0 | Address bus, least sig. bit | • |
| 28 | A1 | Address bus | • |
| 29 | A2 | Address bus | • |
| 30 | A3 | Address bus | • |
| 31 | A4 | Address bus | • |
| 32 | A5 | Address bus | • |
| 33 | A6 | Address bus | • |
| 34 | A7 | Address bus, most sig. bit of lower byte | • |

**Table 1. Correct pin numbering and function for the 1MHz bus.**

Table 2

| BBC 1 MHz BUS LINE | FUNCTION | HEBOT CABLE | | POWER LINES | |
|---|---|---|---|---|---|
| 2 | R/W̄ | BLACK | D4 | BLUE | 0V |
| 10 | FRED | BROWN | D2 | RED | +5V |
| 18 | D0 | RED | D3 | GREY | +12V |
| 19 | D1 | ORANGE | D7 | | |
| 20 | D2 | YELLOW | D6 | | |
| 21 | D3 | GREEN | +12V | | |
| 22 | D4 | BLUE | +12V | | |
| 23 | D5 | VIOLET | 0V | | |
| 24 | D6 | GREY | 0V | | |
| 25 | D7 | WHITE | D5 | | |
| | | BLACK | D3' | | |
| 27 | A0 | BROWN | D0' | | |
| 28 | A1 | RED | D2' | | |
| 29 | A2 | ORANGE | D1' | | |
| 30 | A3 | YELLOW | D1 | | |
| 31 | A4 | GREEN | D0 | | |
| 32 | A5 | | | | |
| 33 | A6 | | | | |
| 34 | A7 | | | | |

**Table 2. Summary of the input and output connections of the Interface.**

## Power Supplied

The power supply for the interface and for HEBOT is provided from an outlet on the underside of the keyboard. This is marked 'Auxiliary Power Output' and has a special six-way socket normally used to provide power to the disk drive. The drawing shows which pins to connect, so make sure that you get the orientation correct. You need a three-way cable of about the same length as the ribbon cable; connect the other ends of the wires to the three terminal pins marked 0V, +5V and +12V on the interface board.

The board also provides connections for the 16-way cable that goes to HEBOT, and this has the same order of pins as in the ZX81 version. If you already have a HEBOT tethered to the

# PARTS LIST

**RESISTORS**
(All ¼ watt 5% carbon)
R1-R8 . . . . . . . . . . . . . . . . . . . . . . 1k

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

**SEMICONDUCTORS**
IC1 . . . . . . . . . . . . . . . . . . . . 74LS40
dual 4-input NAND gate
IC2 . . . . . . . . . . . . . . . . . . . . 74LS27
triple 3-input NOR gate
IC3 . . . . . . . . . . . . . . . . . . . . 74LS00
quad 2-input NAND gate
IC4 . . . . . . . . . . . . . . . . . . 74LS373
octal D-type latch
IC5 . . . . . . . . . . . . . . . . . . 74LS367
hex bus driver, three-state output

**MISCELLANEOUS**
PCB; 3 × 14-pin IC sockets, 1 × 16 pin IC socket; 1 x 20-pin IC socket; 3 x 1mm terminal pins; 25 x through-PCB pins, or 1 mm terminal pins; ABS case, approx 150mm × 80mm x 5mm; 34-way Speedbloc cable-mounting socket; 34-way ribbon cable, approx 60cm; 16-way ribbon cable, at least 1m; wire, solder, nuts and bolts etc.

**BUYLINES**
A complete kit of components and parts for the BBC-HEBOT Interface is available from Kelan (Hobby-board) Ltd., North Works, Hookstone Park, Harrogate, North Yorkshire for £24.00.

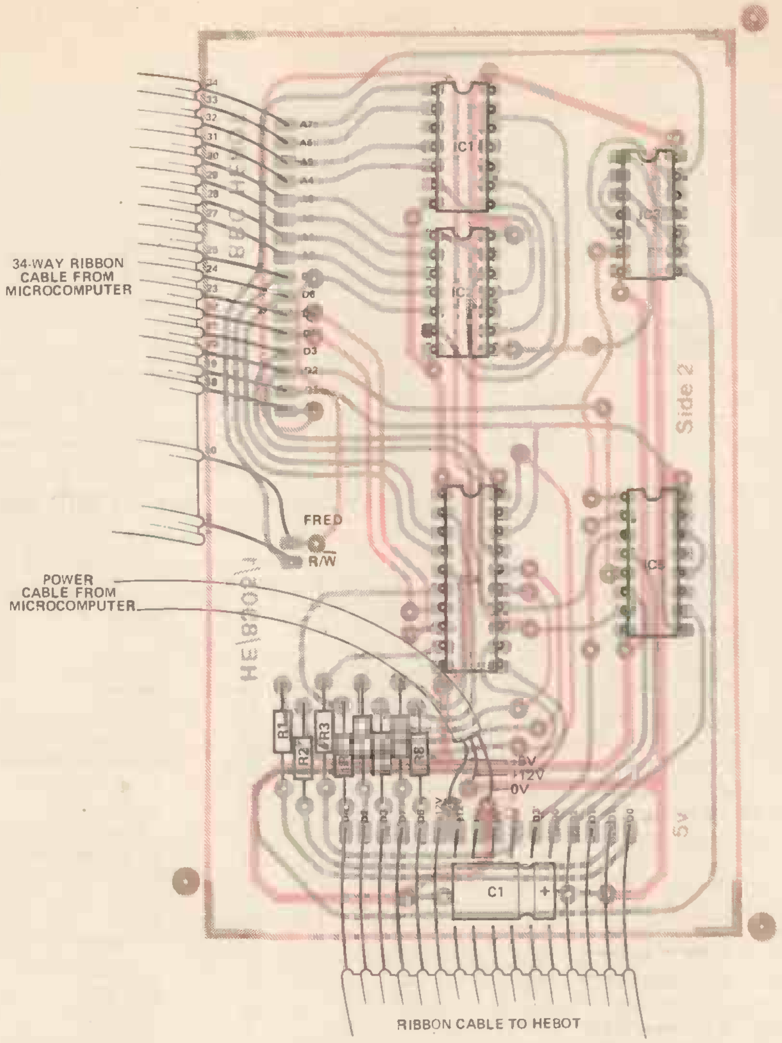



**Figure 4. The component overlay; the component-side tracks of the double-sided board are shown in red.**

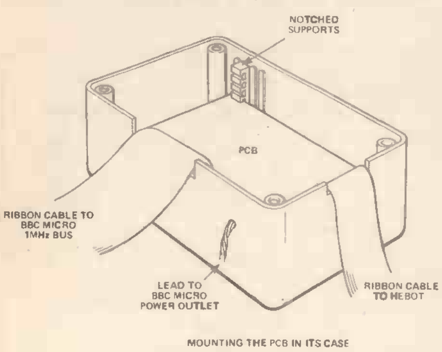



**Figure 5. The PCB fits neatly into a standard case, but slots must be cut and filed for the ribbon cables.**

other end of the cable, do not connect the it until the wiring has been tested as described in the next section. If you are beginning with a new cable, solder this to the interface board and strip its wires at the other end, *but do not solder it to HEBOT* until testing is complete.

There are many ways of enclosing the interface; the simplest method is to mount it in an ABS box of convenient size. Certain types of box have notched strips which slide in grooves on the inner side of the walls, and this board is of the correct size to slip easily into one of these boxes. Before putting the board in the box, though, cut slots for the cables, as shown in the drawing, and bore a hole for the power cable.

## Checking The Wiring

There are only five ICs but there are many connections between them, the micro and HEBOT, so it is well worth while making a systematic check for short-circuits and faulty joints before you attempt to plug the interface into the micro. Use a multimeter to check that there are no short circuits between adjacent wires of the micro cable, working your way along the row of pads where the cable is soldered to the board. Similarly, test for short-circuits where the HEBOT cable is joined to the board.

(Alternatively, a variety of PCB-interconnecting plug and socket systems are available which will result in a much neater and safer project. However, they have not been specified for the Interface for reasons of cost, so we'll leave this detail in the hands of the dedicated constructor.

Next, insert the ICs in their sockets then, using the multimeter as before, check all the connections from the input cable to the terminal pins of the ICs and all connections between the ICs themselves. You are a maestro of the soldering iron if you do not discover at least *one* dry joint which could ruin the operation of the interface. Similarly, check the power connections and, finally, check that there is no short-circuit between the 0V and +5V line (the interface takes only 45mA at +5V, so this is well within the capability of the micro's power output rating).

## Testing On The Micro

Insert the Speedbloc plug into the 1MHz socket on the underside of the micro and insert the power plug into the power output socket; have a multimeter handy, set to a voltage scale to read up to +5V. Temporarily connect the negative probe of the meter to the 0V line of the interface — the pin to which the 0V supply line is soldered will do. Arrange the further end of the HEBOT cable on the table so that the bared ends are spread widely apart, with no chance of them touching each other! If you have not yet soldered the HEBOT cable to the board, it will not be as easy to perform the tests, but you should be able to manage by making connections as required to the far ends of resistors R1 to R8, or to the pads for D0' to D3'.

When all is ready, switch on the TV set or monitor, then switch on the micro. If it fails to display its customary legend on the screen ("BBC Computer. . .") or the usual bleep from the loudspeaker is not heard, switch off immediately; you have probably still got a short to one of the address or data lines. Go back and retest the interface, but *thoroughly* this time!

As explained in the section on addressing, the interface is placed at address &FCF0 (64752 in decimal), and we treat the interface as a single byte in memory, writing data into it or reading data from it. To test output to the interface, first type:

```
H = &FCO
```

then press 'Return'. This sets variable H to the address of the interface (better to refer to it as the address of HEBOT, since eventually HEBOT will be attached to the interface). Next type:

```
?H = &FF
```

then press 'Return'. This command uses the Indirection Operator, '?', as explained on pg. 409 of the User's Manual, to write 'FF' into HEBOT's address. In binary, 'FF' is '1111 1111', so we shall expect that all 8 outputs of the latch IC will now be 'high'. Use the testmeter to measure the voltage at the HEBOT cable end for all of lines

D0 to D7, but do not expect to read +5V, even though we often equate 'high' with this voltage. In practice, anything over +2V is 'high' to a TTL IC! Now key in:

?H = &0

then press 'Return'. There is no need to repeat 'M = &FCFO' unless you have switched off the micro or inadvertently pressed 'Break'. After this, all the outputs D0 to D7 should be low, (less than 0V8). If any line fails to go 'high' on the first command and 'low' on the second, switch everything off and re-examine the board for faults, concentrating particularly on the faulty line.

For a final check on output, try writing other values to the HEBOT address. For example, if you key '?H =&AA' you are sending the bit pattern '1010 1010', ie the even numbered data outputs are 'low' while the odd-numbered ones are 'high'. Now to test the input side. The command for this is:

PRINT ?H

then press 'Return'. It is handy to set up one of the user-defined function keys to do this. The command causes a decimal number representing the input state of all eight data lines to be printed on the screen. Thus the values printed normally range from 0 (0000 0000, all lines 'low') to 255 (1111 1111, all lines 'high').

However the output from HEBOT is present on only the lower four data lines so when reading from HEBOT, there is nothing connected to the upper four data lines. A line with no input reads as 'high' so D7 to D4 always produce '1111'. Thus the range of values obtained by testing HEBOT lies between 240 (1111 0000) and 255. If all of the lines D0' to D3' are left unconnected, then all lines are effectively high, and '255' appears on the screen. Now connect line D0' to the 0V rail and key the command again. You should see '254' this time, for the data input is '1111 1110'. Try various other input combinations, grounding one or more lines of D0'-D3'! If you convert the number on the screen to its binary form, the '0's correspond with a grounded data input.

## Interference

You may find that sometimes the value you get on the screen is lower than expected. In particular, it may be 16 less than expected. This is due to a 'low' appearing on data line D4. Now, this cannot be coming from the interface in the normal way, for the interface has no *output* to line D4 or any of the upper lines.

This 'low' is due to electromagnetic interference between adjacent wires in the cable, and becomes more evident the longer the cable; it would have improved matters if the 1MHz bus had had grounded (0V) lines alternating with each data line and address line. The diagram on pg. 505 of the BBC Manual shows that there are such grounded lines on part of the bus (between lines carrying control signals), but not on the part carrying data and addresses. Grounded lines would have shielded wires from this interference and though the lack of shielding does not matter normally (for most interfaces would be sending firm data along every line of the bus), with this interface the upper four lines are left 'floating' and prone to pick up any interference which is around.

Fortunately it is no problem to program the micro to ignore the upper four data lines completely, as in line 90 of Program 1. In transmission of data *to* the interface, interference does not occur, for none of the lines are 'floating'.

If, in the tests above, you find that any combination of the lower four data inputs does not produce the corresponding figure on the screen (ignoring odd effects of interference on the upper four lines), switch off and re-examine the interface board, especially the line which is giving trouble. Assuming that all now appears to be in working order, switch off, and make the connections to HEBOT.

PROGRAM 1: "Walk and Avoid"

```
 10 REM ** HEBOT's MOVE **
 20 HEBOT = &FCF0:REM HEBOT's address
 30 Collision = FALSE: REM Not colliding yet
 40 Motion = 5: REM forward
 50 ?HEBOT = Motion: REM HEBOT to move
 60 PROCdelay(.2): REM move for .2 secs
 70 ?HEBOT = Motion + 16: REM move and flash lights
 80 PROCdelay(.2):REM for .2 secs
 90 Sensors = ?HEBOT AND 15: REM test sensors
100 IF Sensors <> 0 THEN 140: REM in collision!
110 IF Collision = TRUE THEN 180
120 Emergency = INKEY(50): REM any key pressed?
130 IF Emergency >0 THEN ?HEBOT = 0: STOP: ELSE 50
140 IF Sensors > 6 THEN 190
150 Motion = 10 + 64:REM to back and sound horn
160 Collision = TRUE: REM in collision
170 GOTO 50: REM to move back
180 Collision = FALSE: REM reset flag
190 ?HEBOT = 8: REM turn left
200 PROCdelay(1):REM turn for 1 sec
210 GOTO 40: REM to move forward again
300 DEF PROCdelay(secs)
310 TIME = 0
320 REPEAT
330 UNTIL TIME = secs * 100
340 ENDPROC
```

PROGRAM 2: "Recorded Moves"

```
 10 REM ** Recorded moves **
 20 HEBOT = &FCF0: REM HEBOT's address
 30 ?&D8 = 32:REM set 'Caps lock' mode
 40 data = 0: REM HEBOT stopped
 50 ?HEBOT = data
 60 motion$ = "S"
 70 last motion$ = "S"
 80 INPUT"How many moves",moves
 90 DIMmoves(moves)
100 DIMtimes(moves)
110 PRINT:PRINT"HEBOT is under your control."
120 PRINT"Use keys F, B, R, L, or S."
130 FOR J = 1 TO moves
140 TIME = 0
150 PRINT"Key move no. ";J
160 motion$ = GET$:REM wait for key
170 IF motion$ = last motion$ THEN 160:REM no change of key
180 IF motion$ = "S" THEN data = 0:GOTO 240: REM stop
190 IF motion$ = "F" THEN data = 5:GOTO 240: REM forward
200 IF motion$ = "B" THEN data = 10:GOTO 240: REM back
210 IF motion$ = "L" THEN data = 9:GOTO 240: REM left
220 IF motion$ = "R" THEN data = 6:GOTO 240: REM right
230 GOTO 160:REM invalid key pressed
240 ?HEBOT = data: REM instruct HEBOT
250 moves(J) = data: REM store move
260 times(J+1) = TIME:REM store time
270 last motion$ = motion$
280 NEXT J
290 PRINT"Press S to stop HEBOT"
300 IF GET$<>"S" THEN 290
310 ?HEBOT = 0: REM stop HEBOT
320 times(moves) = TIME
330 PRINT:INPUT"How many repeats",repeats
340 FOR K = 1 TO repeats
350 PRINT"Repetition no. ";K
360 FOR J = 1 TO moves
370 PRINTTAB(18)"Move no. ";J
380 TIME = 0
390 ?HEBOT = moves(J)
400 REPEAT
410 UNTIL TIME = times(J)
420 NEXT J
430 NEXT K
440 PRINT:PRINT"That's all!"
450 END
```

**Two HEBOT programs in BBC BASIC.**

## Programming HEBOT

The tables on pg. 11 of the November 1982 issue of HE summarises the ways of commanding HEBOT and reading from the sensors, and exactly the same arrangement of data lines is used in this interface. The programs in that issue are in Sinclair BASIC; here we list equivalent programs in the BBC BASIC, which differs in a number of respects from Sinclair BASIC. The first program is the 'walk and avoid' routine, in which HEBOT moves forward, eyes flashing menacingly until it runs into an obstacle. Muttering under its breath (or rather, tooting vociferously on its speaker) it backs away, turns left and then procedes in a forward direction again. Those of you who have seen the pond animal, *Paramecium* (or any of its relatives), alive under the microscope, will know just how HEBOT behaves with this program.

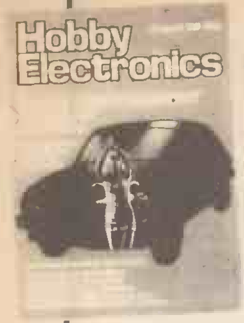
The second program allows you to type in a sequence of commands and then run the program so that HEBOT carries them out in order; the micro has plenty of memory to spare so a very large number of movements can be programmed if you wish. You can use a variant of this program to make HEBOT draw a pattern on a sheet of paper, or with a little ingenuity, you could program HEBOT to dance to music produced by the micro's sound generators. The routine can be repeated or not, as selected by your entry at the beginning of the second phase.

With the 16K of the Model A or the 32K of the Model B at your disposal, there is massive scope for programming HEBOT. It can learn how to run a maze. Or it can be allowed to wander around the room at random, bumping into objects and memorising their positions; this information, stored in the computer can be used to build up a map of the room, for display on the screen. Another project is to program HEBOT to write its own signature on a large sheet of paper. It can learn to write too; you type a message in at the keyboard and HEBOT writes it out on paper. These are only a few suggestions of things that HEBOT can be programmed to do.

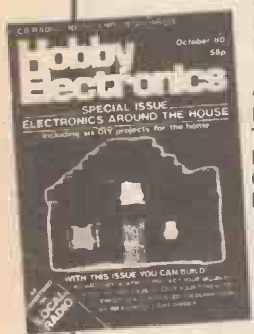
On pg. 435 of the User's manual, Aunty Beeb takes on her most severely admonitory tone and threatens dire results if we 'insist' on addressing HEBOT directly, instead of using Aunty's OSBYTE calls. Sorry, Aunty, but this programmer *insists* (as you put it) on addressing HEBOT directly. As you point out in an afterthought, the required OSBYTE routine is not available before ROM release 1.0, so many of our readers have no other option but direct addressing! And those lucky few who eventually use the Tube would really not find it all that difficult to modify their program accordingly.

*Apple owners take heart – we will shortly be publishing an interface for you!*

**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.

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

**August 1981**
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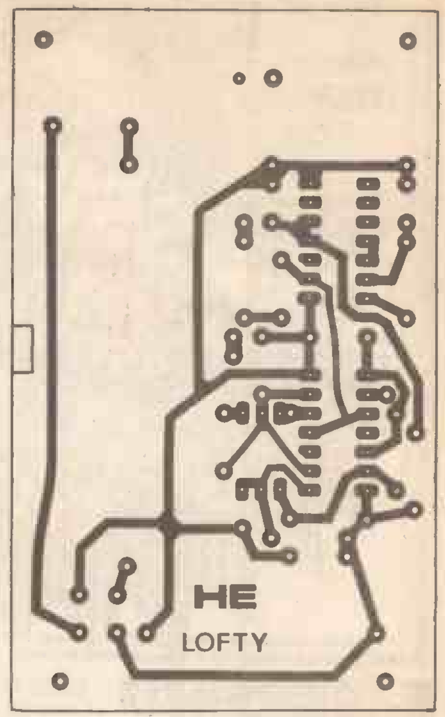


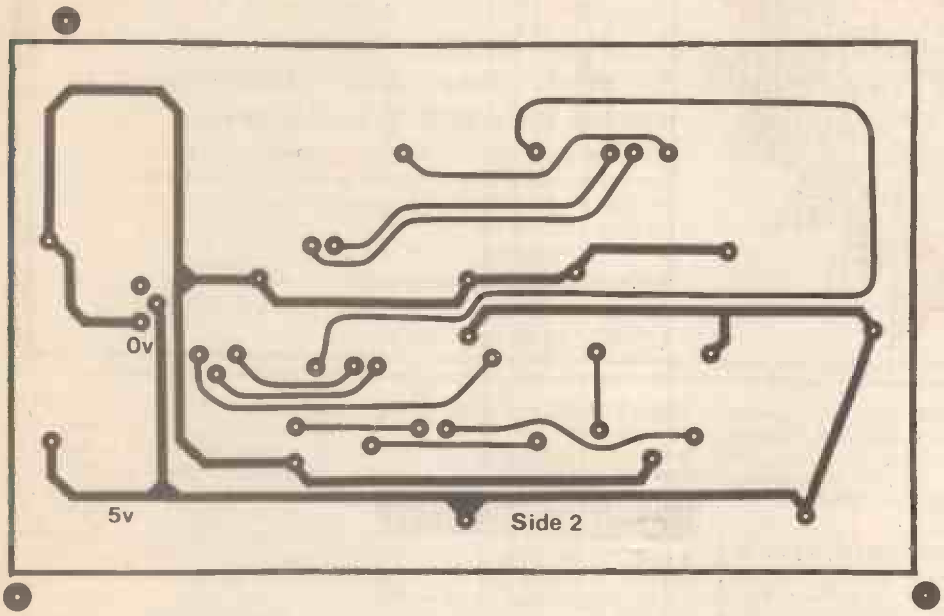


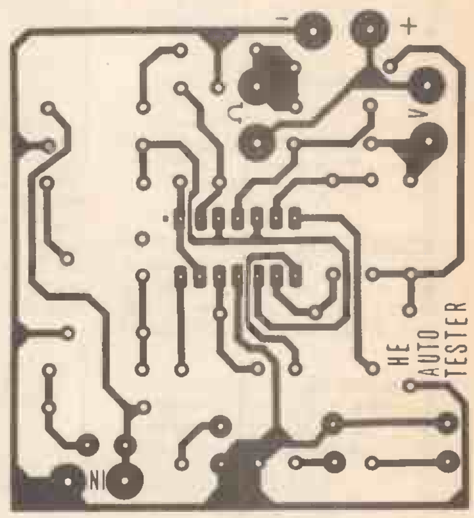


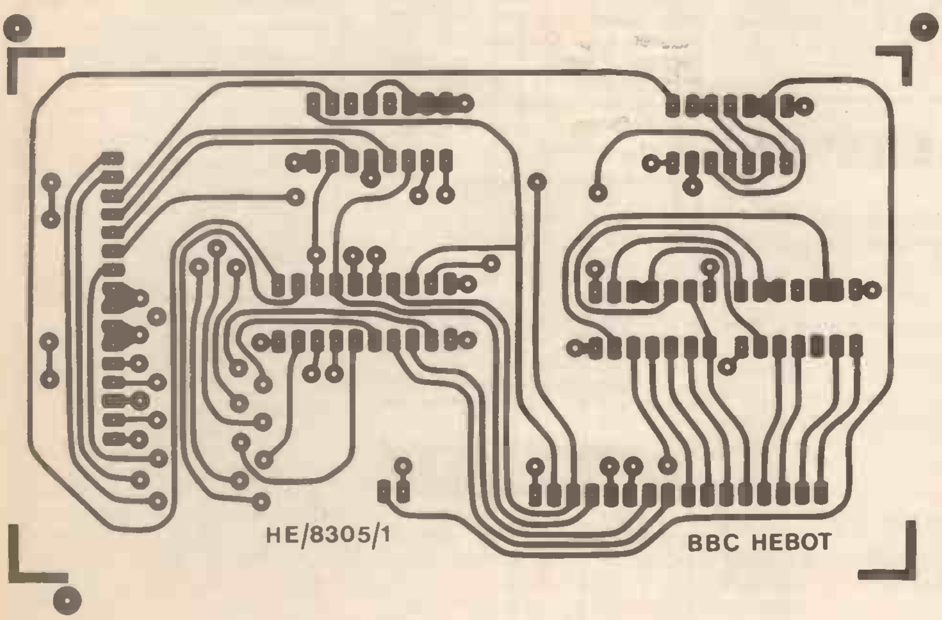


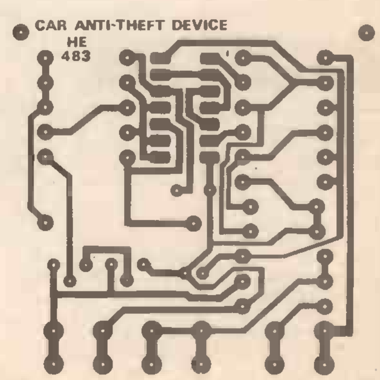


Top right; the HE Lofty' PCB, which was not published with the project.
Middle right; the Auto-Tester PCB.
Bottom right; the foil pattern for the Stall-Thief.
Above top; the component side tracks for the BBC/HEBOT Interface.
Above, the main foil pattern.

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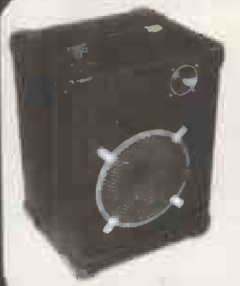
## OMP 80 LOUDSPEAKER



The very best in quality and value. Ported tuned cabinet in hardwearing black vynide with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz 20KHz; Size: 20in x 15in x 12in; Weight: 30 pounds.
Price: £49.00 each. £90 per pair
Carriage: £5 each. £7 per pair

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- Easy snap in fixing through panel/cabinet cut out
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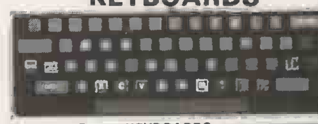
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

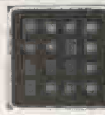
Innumerable applications in industry, the home, and discos theatres etc.

Price: £11.70 each + 50p P&P
(Any quantity)

## KEYBOARDS



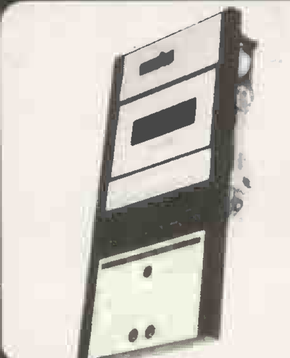
**MEMBRANE KEYBOARDS** manufactured from a tough poly-carbonate film mounted on 1mm glass fibre printed circuit board assembly incorporating silver plated contacts.



**16 way numeric keyboard** Standard keyboard providing 0-9 and A-F functions.
Size: 100mm × 100mm × 2mm. Price: £5.9у + 35p p&p

**Alpha Numeric Keyboard** Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm × 100mm × 2mm. Price: £13.99 + 50p p&p

## STEREO CASSETTE TAPE DECK MODULE.



Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
**Features:** Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5¼in × 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
**Price £26.70 + £2.50** postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.50.

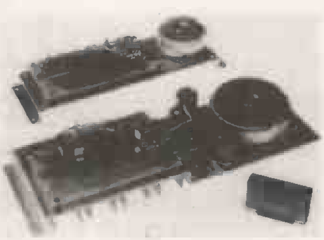
## BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price: £31.35 + £2.50 P&P

## LOUDSPEAKERS

**15" 100 watt R.M.S. (HI-FI, P.A., DISCO, BASS GUITAR)** Die cast chassis, 2" aluminim voice coil, white cone with aluminium centre dome. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 2.5KHz., Sens. 97dB (As photograph). Price: £32.00 + £3 carriage.
**12" 100 watt R.M.S. (HI-FI)** Die cast chassis. 2" aluminium voice coil. Black cone. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 4.5KHz. Sens. 95dB. (As photograph). Price: £23.50 + £3 carriage.
**8" 50 watt R.M.S. (HI-FI, P.A.)** 1½" aluminium voice coil. White cone. 8 ohm imp. Res. Freq. 40Hz., Freq. Resp. to 6KHz. Sens. 92dB. Also available with black cone fitted with black metal protective grille. (As photograph). Price: White Cone £8.90, Black cone/grille £9.50 P&P £1.25.
**12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO)** 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £22.00** + £3 carriage.
**12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO)** 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. Price £22 + £3 carriage.
**15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.)** 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. Price: £47 + £4 carriage.

## OMP POWER AMPLIFIER MODULES

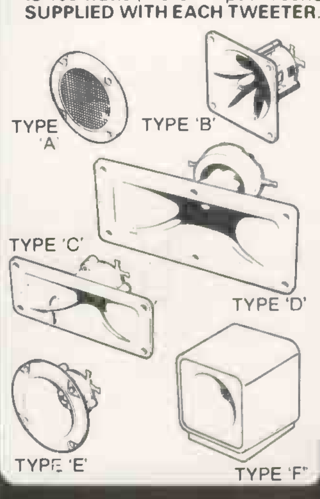


**100 WATT R.M.S. AND 300 WATT R.M.S. MODULES**
Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

**SPECIFICATION:**
**Max Output Power:** 110 watts R.M.S. (OMP 100)
310 watts R.M.S. (OMP 300)
**Loads:** Open and short circuit proof. 4-16 ohms.
**Frequency Response:** 20Hz — 25KHz ±3dB.
**Sensitivity for Max. Output:** 500mV at 10K (OMP 100) 1V at 10K (OMP 300)
**T.H.D.:** Less than 0.1%
**Supply:** 240V 50Hz
**Sizes:** OMP 100 360 × 115 × 72mm
OMP 300 460 × 153 × 66mm
**Prices:** OMP 100 £31.50 each + £2.00 P&P
OMP 300 £89.00 each + £3.00 P&P
Vu Meter £6.50 each + 50p P&P

## PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**




**TYPE 'A' (KSN2036A)** 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £4.29 each.
**TYPE 'B' (KSN1005A)** 3½" super horn. For general purpose speakers, disco and P.A. systems etc. Price £4.99 each.
**TYPE 'C' (KSN6016A)** 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £5.99 each.
**TYPE 'D' (KSN1025A)** 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. Price £7.99 each.
**TYPE 'E' (KSN1038A)** 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £4.99 each.
**TYPE 'F' (KSN1057A)** Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. Price £10.75 each.
**P&P 20p ea. (or SAE for Piezo leaflets).**

## Matching 3-way loudspeakers and crossover

Build a quality 60watt RMS system 8ohms
Build a quality 60 watt R.M.S. system.

- ★ 10" Woofer 35Hz-4.5KHz
- ★ 3" Tweeter 2.5KHz-19KHz
- ★ 5" Mid Range 600Hz-8KHz
- ★ 3-way crossover 6dB/oct 1.3 and 6KHz

Recommended Cab-size 26" × 13" × 13"

Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling. Can be mounted directly on to baffle with or without conventional speaker fabrics. All three units have aluminium centre domes and rolled foam surround. Crossover combines spring-loaded loudspeaker terminals and recessed mounting panel.
**Price £22.00 per kit** + £2.50 postage and packing. Available separately, prices on request.

## 12" 80 watt R.M.S. loudspeaker.

A superb general purpose twin cone loudspeaker. 50 oz. magnet. 2" aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. **Attractive blue cone with aluminium centre dome.**
Price £18.49 each + £3.00 P&P.

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Don't buy a T.V. game! Buy an Atari 400 personal computer and a game cartridge and that's all you'll need. Later on you can buy the Basic Programming cartridge (£35) and try your hand at programming using the easy to learn BASIC language. Or if you are interested in business applications, you can buy the Atari 800 + Disk Drive + Printer together with a selection of business packages.

Silica Shop have put together a full catalogue and price list giving details of all the peripherals as well as the extensive range of software that is now available for the Atari 400/800. The Atari is now one of the best supported personal computers. Send NOW for Silica Shop's catalogue and price list as well as details on our users club.

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