FREE GADGETS, GAMES & KITS SUPPLEMENT INSIDE

# Hobby Electronics

AUGUST '81

ISSN. 0142-6192

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LINEAR ICS

# THE LOWEST PRICES FOR PRIME CMOS/TTL/74C IN THE UK

TRANSISTORS

## LINEAR ICS

| | | | | | |
|---|---|---|---|---|---|
| TBA120S | 1.00 | SL1610P | 1.60 | HA11223 | 2.15 |
| L200 | 1.95 | SL1611P | 1.60 | HA11225 | 1.45 |
| U237B | 1.28 | SL1612P | 1.60 | HA12002 | 1.45 |
| U247B | 1.28 | SL1613P | 1.89 | HA12017 | 0.80 |
| U257B | 1.28 | SL1620P | 2.17 | HA12402 | 1.95 |
| U267B | 1.28 | SL1621P | 2.17 | HA12411 | 1.20 |
| LM301H | 0.67 | SL1623P | 2.44 | HA12412 | 1.55 |
| LM301N | 0.30 | SL624C | 3.28 | LF13741 | 0.33 |
| LM308TC | 0.65 | SL1625P | 2.17 | SN76660N | 0.80 |
| LM324 | 0.64 | SL1626P | 2.44 | | |
| LM339N | 0.66 | SL1630P | 1.62 | | |
| LM348N | 1.86 | SL1640P | 1.89 | | |
| LF351N | 0.49 | SL1641P | 1.89 | | |
| LF353N | 0.76 | TDA2002 | 1.25 | | |
| LM374N | 3.75 | ULN2242A | 3.05 | | |
| LM380N-14 | 1.00 | ULN2283B | 1.00 | | |
| LM380N-8 | 1.00 | CA3080E | 0.70 | | |
| LM381N | 1.81 | CA3089E | 1.84 | | |
| ZN419CE | 1.98 | CA3090AQ | 3.35 | | |
| NE544N | 1.80 | CA3123E | 1.40 | | |
| NE555N | 0.30 | CA3130E | 0.80 | | |
| NE556 | 0.50 | CA3130T | 0.90 | | |
| NE560N | 3.50 | CA3140E | 0.46 | | |
| NE562N | 4.05 | CA3189E | 2.20 | | |
| NE564N | 4.29 | CA3240 | 1.27 | | |
| NE565N | 1.00 | MC3357P | 2.85 | | |
| NE566N | 1.60 | LM3900N | 0.60 | | |
| NE570N | 3.85 | LM3909N | 0.68 | | |
| SL624 | 3.28 | LM3914N | 2.80 | | |
| TBA651 | 1.81 | LM3915N | 2.80 | | |
| uA709HC | 0.64 | KB4400 | 0.80 | | |
| uA709PC | 0.46 | KB4406 | 0.60 | | |
| uA710HC | 0.65 | KB4412 | 1.95 | | |
| uA710PC | 0.59 | KB4413 | 1.95 | | |
| uA741CH | 0.66 | KB4417 | 1.80 | | |
| uA741CN | 0.27 | KB4420B | 1.09 | | |
| uA747CN | 0.70 | TDA4420 | 2.65 | | |
| uA748CN | 0.36 | KB4423 | 2.30 | | |
| uA753 | 2.44 | KB4424 | 1.65 | | |
| uA758 | 2.35 | KB4431 | 1.95 | | |
| TBA820M | 0.78 | KB4432 | 1.95 | | |
| TCA940E | 1.80 | KB4433 | 1.52 | | |
| TDA1028 | 2.11 | KB4436 | 2.53 | | |
| TDA1029 | 2.11 | KB4437 | 1.75 | | |
| TDA1054 | 1.45 | KB4438 | 2.22 | | |
| TDA1062 | 1.95 | KB4441 | 1.35 | | |
| TDA1072 | 2.69 | KB4445 | 1.29 | | |
| TDA1074A | 5.04 | KB4446 | 2.75 | | |
| TDA1083 | 1.95 | KB4448 | 1.65 | | |
| TDA1090 | 3.05 | NE5044N | 2.26 | | |
| HA1137 | 1.20 | NE5532N | 1.85 | | |
| HA1196 | 2.00 | SD6000 | 3.75 | | |
| HA1197 | 1.00 | SL6270 | 2.03 | | |
| TDA1220 | 1.40 | SL6310 | 2.03 | | |
| LM1303 | 0.99 | SL6600 | 3.75 | | |
| LM1307 | 1.55 | SL6640 | 2.75 | | |
| MC1310P | 1.90 | SL6440 | POA | | |
| MC1330 | 1.20 | SL6690 | 3.20 | | |
| MC1350 | 1.20 | SL6700 | 2.35 | | |
| HA1370 | 1.90 | ICL8038CC | 4.50 | | |
| HA1388 | 2.75 | MSL9362 | 1.75 | | |
| TDA1490 | 1.86 | MSL9363 | 1.75 | | |
| MC1496P | 1.25 | HA11211 | 1.95 | | |

### FREQ. DISPLAY AND SYNTH. DEVICES

| | |
|---|---|
| SAA1056 | 3.75 |
| SAA1058 | 3.35 |
| SAA1059 | 3.35 |
| 11C90DC | 14.00 |
| LN1232 | 19.00 |
| LN1242 | 19.00 |
| MSL2318 | 3.84 |
| MSM5523 | 11.30 |
| MSM5524 | 11.30 |
| MSM5525 | 7.85 |
| MSM5526 | 7.85 |
| MSM5527 | 9.75 |
| MSM55271 | 9.75 |
| MSL2312 | 3.94 |
| SP8629 | 3.85 |
| SP8647 | 6.00 |
| 95H90PC | 7.80 |
| HD10551 | 2.45 |
| HD44015 | 4.45 |
| HD12009 | 6.00 |
| HD44752 | 8.00 |
| MC145151 | 12.45 |
| MC145156 | 8.75 |

### MISC

| | |
|---|---|
| ICM7106CP | 9.55 |
| ICM7107CP | 9.55 |
| ICM7216BP | 19.50 |
| ICM7555 | 0.94 |

## 4000 series

| | | | | | |
|---|---|---|---|---|---|
| 4000 | 0.13 | 4060 | 0.95 | 4566 | 1.59 |
| 4001 | 0.13 | 4063 | 1.15 | 4568 | 2.18 |
| 4002 | 0.14 | 4066 | 0.38 | 4569 | 1.95 |
| 4007 | 0.19 | 4067 | 4.30 | 4572 | 0.30 |
| 4008 | 0.70 | 4068 | 0.18 | 4582 | 0.99 |
| 4009 | 0.30 | 4069 | 0.18 | 4584 | 0.49 |
| 4010 | 0.30 | 4070 | 0.25 | 4585 | 1.00 |
| 4011 | 0.24 | 4071 | 0.22 | 4702 | 4.50 |
| 4011 | 0.15 | 4072 | 0.22 | 4703 | 4.48 |
| 4012 | 0.20 | 4073 | 0.22 | 4704 | 4.24 |
| 4013 | 0.35 | 4075 | 0.18 | 4705 | 4.24 |
| 4015 | 0.70 | 4076 | 0.60 | 4706 | 4.50 |
| 4016 | 0.30 | 4077 | 0.23 | 4720 | 4.00 |
| 4017 | 0.65 | 4078 | 0.25 | 4723 | 0.95 |
| 4019 | 0.38 | 4082 | 0.25 | 4724 | 0.95 |
| 4020 | 0.68 | 4093 | 0.45 | 4725 | 2.24 |
| 4021 | 0.75 | 4099 | 0.99 | 40014 | 0.54 |
| 4022 | 0.68 | 4175 | 1.15 | 40085 | 0.99 |
| 4023 | 0.19 | 4502 | 0.90 | 40098 | 0.54 |
| 4024 | 0.45 | 4503 | 0.55 | 40106 | 0.54 |
| 4025 | 0.18 | 4506 | 0.75 | 40160 | 0.69 |
| 4026 | 1.05 | 4507 | 0.45 | 40161 | 0.69 |
| 4028 | 0.60 | 4508 | 1.99 | 40162 | 0.69 |
| 4029 | 0.75 | 4510 | 0.70 | 40163 | 0.69 |
| 4030 | 0.35 | 4511 | 0.85 | 40174 | 0.69 |
| 4035 | 0.75 | 4512 | 0.70 | 40175 | 0.69 |
| 4040 | 0.68 | 4514 | 2.20 | 40192 | 0.75 |
| 4042 | 0.65 | 4515 | 2.50 | 40193 | 0.75 |
| 4043 | 0.68 | 4516 | 0.75 | 40194 | 0.69 |
| 4043 | 0.93 | 4518 | 0.75 | 40195 | 0.69 |
| 4044 | 0.68 | 4520 | 0.80 | | |
| 4946 | 0.69 | 4521 | 2.36 | | |
| 4047 | 0.69 | 4522 | 1.49 | | |
| 4049 | 0.30 | 4527 | 0.95 | | |
| 4050 | 0.30 | 4528 | 0.95 | | |
| 4051 | 0.65 | 4529 | 1.40 | | |
| 4052 | 0.69 | 4539 | 1.10 | | |
| 4053 | 0.69 | 4549 | 3.50 | | |
| 4054 | 1.30 | 4554 | 1.73 | | |
| 4055 | 1.30 | 4555 | 0.72 | | |
| 4056 | 1.35 | 4556 | 0.58 | | |
| | | 4560 | 2.18 | | |

## TTL 'N'

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7400 | 0.10 | 7448 | 0.56 | 74125 | 0.40 | 74190 | 0.55 | 7405 | 0.14 | 7496 | 1.20 |
| 7401 | 0.10 | 7450 | 0.14 | 74126 | 0.40 | 74191 | 0.55 | 7408 | 0.14 | 74107 | 0.25 |
| 7402 | 0.10 | 7451 | 0.14 | 74128 | 0.65 | 74192 | 0.55 | 7409 | 0.14 | 74109 | 0.25 |
| 7403 | 0.11 | 7453 | 0.14 | 74132 | 0.50 | 74193 | 0.55 | 7410 | 0.13 | 74112 | 0.25 |
| 7404 | 0.12 | 7454 | 0.14 | 74136 | 0.65 | 74194 | 0.55 | 7411 | 0.14 | 74113 | 0.25 |
| 7405 | 0.12 | 7460 | 0.14 | 74141 | 0.45 | 74195 | 0.55 | 7412 | 0.15 | 74114 | 0.25 |
| 7406 | 0.22 | 7470 | 0.28 | 74142 | 1.85 | 74196 | 0.55 | 7413 | 0.28 | 74122 | 0.40 |
| 7407 | 0.22 | 7472 | 0.27 | 74143 | 2.50 | 74197 | 0.55 | 7414 | 0.49 | 74123 | 0.55 |
| 7408 | 0.15 | 7473 | 0.28 | 74144 | 2.50 | 74198 | 0.85 | 7415 | 0.14 | 74124 | 1.80 |
| | | 7474 | 0.28 | 74145 | 0.75 | 74199 | 1.00 | 7420 | 0.13 | 74125 | 0.29 |
| | | 7475 | 0.35 | 74147 | 1.50 | 74221 | 1.00 | 7421 | 0.15 | 74126 | 0.29 |
| | | 7476 | 0.30 | 74148 | 1.09 | 74246 | 1.50 | 7422 | 0.15 | 74132 | 0.45 |
| | | 7480 | 0.26 | 74150 | 0.79 | 74247 | 1.51 | 7426 | 0.18 | 74133 | 0.30 |
| | | 7481 | 0.20 | 74151 | 0.55 | 74248 | 1.89 | 7427 | 0.14 | 74136 | 0.25 |
| | | 7482 | 0.75 | 74153 | 0.55 | 74249 | 1.89 | 7428 | 0.35 | 74138 | 0.40 |
| | | 7483 | 0.60 | 74154 | 0.55 | 74251 | 1.05 | 7430 | 0.13 | 74139 | 0.40 |
| | | 7485 | 0.75 | 74155 | 0.55 | 74265 | 0.66 | 7432 | 0.14 | 74145 | 1.20 |
| | | 7486 | 0.24 | 74156 | 0.55 | 74273 | 2.67 | 7433 | 0.17 | 74147 | 2.10 |
| | | 7489 | 1.05 | 74157 | 0.55 | 74278 | 2.49 | 7437 | 0.17 | 74148 | 1.60 |
| | | 7490 | 0.30 | 74159 | 1.90 | 74279 | 0.89 | 7438 | 0.16 | 74151 | 0.35 |
| | | 7491 | 0.55 | 74160 | 0.55 | 74283 | 1.30 | 7440 | 0.13 | 74153 | 0.35 |
| | | 7492 | 0.35 | 74161 | 0.55 | 74284 | 3.50 | 7442 | 0.40 | 74154 | 0.99 |
| | | 7493 | 0.35 | 74162 | 0.55 | 47285 | 3.50 | 7447 | 0.42 | 74155 | 0.50 |
| | | 7494 | 0.70 | 74163 | 0.55 | 74290 | 1.00 | 7448 | 0.65 | 74156 | 0.50 |
| | | 7495 | 0.60 | 74164 | 0.55 | 74293 | 1.05 | 7449 | 0.6? | 74157 | 0.36 |
| | | 7496 | 0.45 | 74165 | 0.55 | 74297 | 2.36 | 7451 | 0.14 | 74158 | 0.40 |
| | | 7497 | 1.40 | 74166 | 0.70 | 74298 | 1.85 | 7454 | 0.15 | 74160 | 0.40 |
| | | 74100 | 1.10 | 74167 | 1.25 | 74365 | 0.85 | 7455 | 0.15 | 74161 | 0.40 |
| | | 74104 | 0.62 | 74170 | 1.25 | 74366 | 0.85 | 7463 | 1.50 | 74162 | 0.40 |
| | | 74105 | 0.62 | 74173 | 1.10 | 74367 | 0.85 | 7473 | 0.21 | 74163 | 0.40 |
| | | 74107 | 0.26 | 74174 | 0.75 | 74368 | 0.85 | 7474 | 0.18 | 74164 | 0.50 |
| | | 74109 | 0.35 | 74175 | 0.75 | 74390 | 1.85 | 7475 | 0.28 | 74165 | 1.20 |
| | | 74110 | 0.54 | 74176 | 0.75 | 74393 | 1.85 | 7476 | 0.22 | 74166 | 1.75 |
| | | 74111 | 0.68 | 74177 | 0.75 | 74490 | 1.85 | 7478 | 0.24 | 74168 | 0.85 |
| | | 74112 | 1.70 | 74178 | 0.90 | | | 7483 | 0.50 | 74169 | 0.85 |
| | | 74116 | 1.98 | 74179 | 1.35 | | | 7485 | 0.70 | 74170 | 1.85 |
| | | 74118 | 0.85 | 74180 | 0.75 | | | 7486 | 0.18 | 74173 | 0.75 |
| | | 74119 | 1.20 | 74181 | 1.22 | | | 7490 | 0.32 | 74174 | 0.55 |
| | | 74120 | 0.95 | 74182 | 0.70 | | | 7491 | 1.25 | 74175 | 0.55 |
| | | 74121 | 0.35 | 74184 | 1.20 | | | 7492 | 0.39 | 74181 | 1.35 |
| | | 74122 | 0.34 | 74185 | 1.20 | | | 7493 | 0.38 | 74183 | 2.96 |
| | | 74123 | 0.40 | 74188 | 3.00 | | | 7495 | 0.48 | 74189 | 1.28 |

### 'LPSN'

| | |
|---|---|
| 7400 | 0.11 |
| 7401 | 0.11 |
| 7402 | 0.12 |
| 7403 | 0.12 |
| 7404 | 0.13 |

| | | | |
|---|---|---|---|
| 74190 | 0.60 | 74258 | 0.39 |
| 74191 | 0.60 | 74259 | 0.39 |
| 74192 | 0.68 | 74260 | 0.70 |
| 74193 | 0.68 | 74266 | 0.24 |
| 74194 | 0.42 | 74273 | 0.90 |
| 74195 | 0.42 | 74275 | 3.20 |
| 74196 | 0.65 | 74279 | 0.35 |
| 74197 | 0.65 | 74280 | 2.50 |
| 74200 | 3.45 | 74283 | 0.44 |
| 74202 | 3.45 | 74290 | 0.58 |
| 74221 | 0.60 | 74293 | 1.30 |
| 74240 | 0.99 | 74295 | 1.50 |
| 74241 | 0.99 | 74298 | 1.50 |
| 74242 | 1.65 | 74365 | 0.35 |
| 74243 | 1.65 | 74366 | 0.35 |
| 74244 | 0.83 | 74367 | 0.35 |
| 74245 | 1.50 | 74368 | 0.35 |
| 74247 | 1.35 | 74373 | 0.78 |
| 74248 | 1.35 | 74374 | 0.78 |
| 74249 | 1.35 | 74375 | 1.15 |
| 74251 | 0.46 | 74377 | 1.99 |
| 74253 | 0.46 | 74378 | 1.40 |
| 74257 | 0.55 | 74379 | 2.15 |
| | | 74384 | 2.50 |
| | | 74385 | 4.20 |
| | | 74386 | 0.29 |
| | | 74390 | 0.68 |
| | | 74393 | 0.61 |
| | | 74395 | 2.10 |
| | | 74396 | 1.99 |
| | | 74398 | 2.75 |
| | | 74399 | 2.30 |
| | | 74445 | 1.40 |
| | | 74447 | 1.95 |
| | | 74490 | 1.10 |
| | | 74668 | 1.05 |
| | | 74669 | 1.05 |
| | | 74670 | 1.70 |

## 74C CMOS

| | |
|---|---|
| 7400 | 0.20 |
| 7402 | 0.20 |
| 7404 | 0.20 |
| 7408 | 0.20 |
| 7410 | 0.20 |
| 7414 | 0.55 |
| 7420 | 0.20 |
| 7430 | 0.20 |
| 7432 | 0.20 |
| 7442 | 0.80 |
| 7448 | 1.03 |
| 7473 | 0.50 |
| 7474 | 0.50 |
| 7476 | 0.48 |
| 7483 | 0.98 |
| 7485 | 0.98 |
| 7486 | 0.26 |
| 7489 | 2.68 |
| 7490 | 0.80 |
| 7493 | 0.80 |
| 7495 | 0.94 |
| 74107 | 0.48 |
| 74151 | 1.52 |
| 74154 | 2.26 |
| 74157 | 1.52 |
| 74160 | 0.80 |
| 74161 | 0.80 |
| 74162 | 0.80 |
| 74163 | 0.80 |
| 74164 | 0.80 |
| 74165 | 0.84 |
| 74173 | 0.72 |
| 74174 | 0.72 |
| 74175 | 0.72 |
| 74192 | 0.80 |
| 74193 | 0.80 |
| 74195 | 0.80 |
| 74200 | 4.52 |
| 74221 | 1.06 |
| 74901 | 0.38 |
| 74902 | 0.38 |
| 74903 | 0.38 |
| 74904 | 0.38 |
| 74905 | 5.64 |
| 74906 | 0.38 |
| 74907 | 0.38 |
| 74908 | 0.84 |
| 74909 | 1.52 |
| 74910 | 3.62 |
| 74914 | 0.86 |
| 74918 | 0.98 |
| 74925 | 4.32 |
| 74926 | 4.32 |
| 74927 | 4.32 |

E&OE

Subject to availability

## TRANSISTORS

| | |
|---|---|
| BF194 | 18p |
| BF195 | 18p |
| BF224 | 22p |
| BF241 | 18p |
| BF274 | 18p |
| BF440 | 21p |
| BF441 | 21p |
| BF362 | 49p |
| BF395 | 18p |
| BF479 | 66p |
| BF679S | 55p |
| BFR91 | 1.33 |
| BFW92 | 60p |
| BFT95 | 99p |
| BFY90 | 90p |
| 40238 | 85p |
| BF256 | 38p |
| 2SK55 | 28p |
| 2SK168 | 35p |
| J310 | 69p |
| J176 | 65p |
| 40823 | 65p |
| 40673 | 3SK51 |
| 3SK45 | 49p |
| 3SK51 | 54p |
| 3SK60 | 58p |
| 3SK88 | 1.24 |
| MEM680 | 75p |
| BF961 | 70p |
| BC237 | 8p |
| BC238 | 8p |
| BC239 | 8p |
| BC307 | 8p |
| BC308 | 8p |
| BC309 | 8p |
| BC413 | 10p |
| BC414 | 11p |
| BC415 | 10p |
| BC416 | 11p |
| BC546 | 12p |
| BC556 | 12p |
| BC550 | 12p |
| BC560 | 12p |
| BC639 | 22p |
| BC640 | 22p |
| 2SC1775 | 18p |
| 2SA872A | 14p |
| 2SD666A | 30p |
| 2SB646A | 30p |
| 2SD668A | 40p |
| 2SB648A | 40p |
| 2SD760 | 45p |
| 2SB720 | 45p |
| 2SC2547 | 19p |
| 2SA1085 | 20p |
| 2SB753 | 2.34 |
| 2SB723 | 2.34 |
| 2SK134 | 3.10 |
| 2SJ49 | 3.10 |
| 2SK135 | 4.25 |
| 2SJ50 | 4.25 |
| 2SK227 | 3.55 |
| 2SJ83 | 3.55 |

## CRYSTALS

| | | | |
|---|---|---|---|
| 32.768kHz | 2.70 | 10.245 | 2.00 |
| 100kHz | 3.85 | 10.6985 | 2.50 |
| 455kHz | 5.00 | 10.700 | 2.00 |
| 1.000MHz | 2.95 | 10.7015 | 2.50 |
| 3.2768 | 2.70 | 11.00 | 2.00 |
| 4.000 | 2.00 | 11.115 | 2.00 |
| 4.1934 | 2.00 | 11.520 | 2.00 |
| 4.096 | 2.00 | 8.9985 | 2.00 |
| 4.032 | 2.00 | 9.0015 | 2.00 |
| 4.433619 | 2.00 | 21.000 | 2.00 |
| 4.800 | 2.00 | 24.000 | 2.00 |
| 5.000 | 2.00 | 25.000 | 2.00 |
| 6.5536 | 2.00 | 26.000 | 2.00 |
| 7.000 | 2.00 | 18.000 | 2.50 |
| 7.68 | 2.00 | | |
| 8.000 | 2.00 | | |
| 9.000 | 2.00 | | |
| 10.000 | 2.00 | | |
| 10.240 | 2.00 | | |

XTAL FILTERS
10M4B1: 10.7Mhz, 15Khz BW, 8 pole. 14.50
10M22D: 10.7Mhz, 2.4Khz BW, SSB, 8 pole. 17.20

## RADIO CONTROL

RC XTALS
AM TX/RX
FM RX:
3rd ot/30pF HC25U 1.65
FMTX: Fund 20pF HC25U ½ freq 1.85
PAIRS...AM 3.10
PAIRS...FM 3.25
CHANNELLING:
27MHz 50kHz
35MHz: 20kHz

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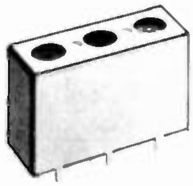
---

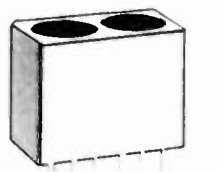
## Chokes, block filters, ceramic filters, resonators, IFTs, oscillator coils, audio filter blocks etc.

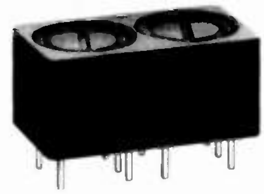
### LOW PASS FILTERS



**Now from 10kHz to 20MHz**
TOKO's recently expanded LPF series covers from the audio spectrum through to 20MHz in a series of LPFs for mpx, video, radio etc.

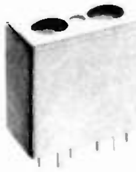
The LPFs are based on 7&10mm formats with up to 4 LC tuned elements per block. Many stock types available.

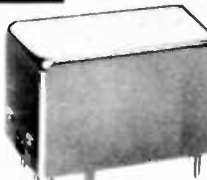




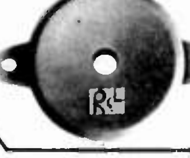
### HELICAL FILTERS for VHF and UHF:

**2 & 3 elements available**
Featuring low insertion losses, -80dB at the +/- 21.4MHz points. Ask for details.

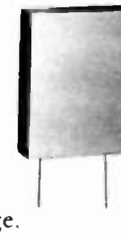




### CERAMIC RESONATORS & PIEZO SOUNDERS

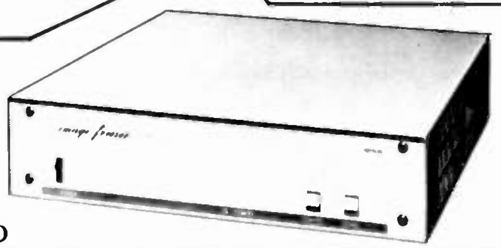


Audio buzzers now down to 1kHz - low cost 400-600kHz crystal replacements for MPUs, RCs etc. Low cost - wide range.



### VIDEO FRAME STORES

- ★ 525/625 operation
- ★ 512 pixell/line
- ★ Local or remote control
- ★ Top/bottom & L/R reverse
- ★ Models available with digitized I/O



Video frame stores are a new addition to TOKO's memory product range. They permit easy analysis of low dose X-Ray pictures, digital processing of picture information (including the VFM10D with 8" disk drive) with much better resolution than available from VTR

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# Hobby Electronics

AUGUST 1981 Vol 3 No 10

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Senior Art Editor: Andrew Sawyer
Advertisement Sales Executive:
Melanie Mackenzie-Aird


## PROJECTS



## FEATURES



## NEWS & INFORMATION




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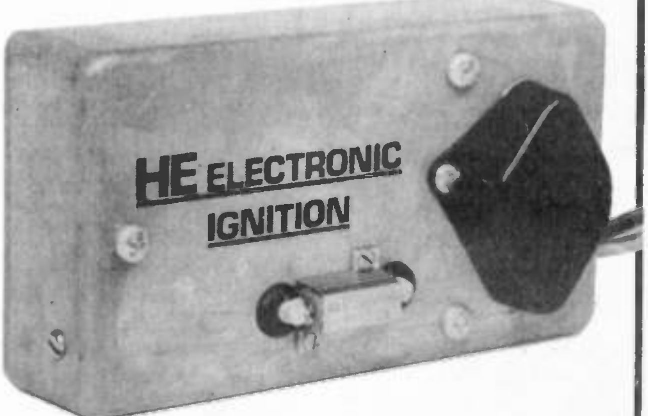
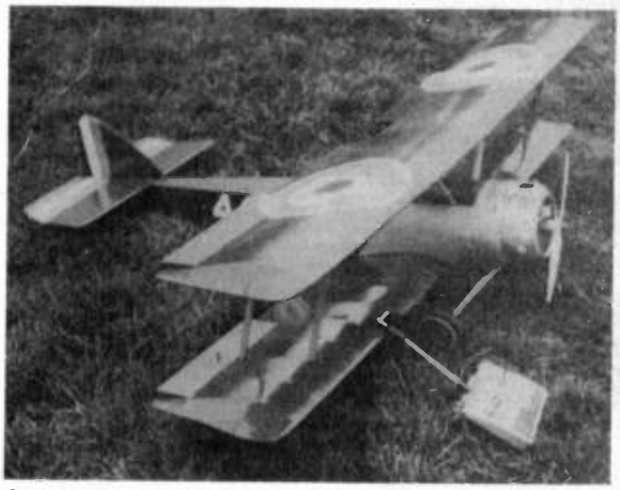



*Ready for use* — the HE Electronic Ignition project (see page 10) which when complete requires only four connections to your car's ignition system. (The project shown on this month's cover was the prototype, with its high-power resistor mounted in the case. The final version has a surface-mounted resistor as shown above, for better heat dissipation



*Ready for flight* — one of the radio-controlled model 'planes at Sandown Race Course on 9th and 10th May. See Radio Control, this month's special feature, on page 15, followed by the report on Sandown on page 20

*Ready for measurements* — special-offer HE Multitester (see page 51), which complements Into Electronic Components, a new series starting this month on page 47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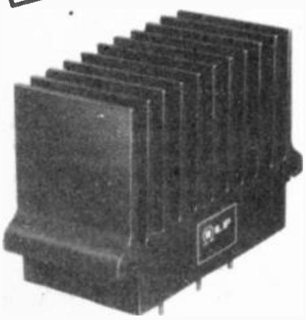
# 20 POWER AMPS
# 19 FUNCTIONAL MODULES
# DAWN

## POWER UP TO 480 WATTS RMS SINGLE CHANNEL

## Which amplifier?

I.L.P. Amplifiers now come in three basic types, each of which is available with or without heatsink. Having decided the system you want – home hi-fi (models HY30, 60 or 120 for example), super quality hi-fi with extra versatility (MOS120, MOS200) or Disco/PA/Guitar (HD120, HD200 or HD400) you will then decide whether amplifiers housed within their own heatsinks or plate amplifiers for bolting to a metal chassis will suit. With choice such as this and a brilliant new range of I.L.P. functional modules to choose from you now have the chance to build the finest audio system ever offered to the constructor.



AMPLIFIER WITH HEAT SINK

### BIPOLAR Standard, with heatsinks / Without heatsinks

| MODEL NUMBER | OUTPUT POWER Watts rms | DISTORTION T.H.D. Typ at 1kHz | DISTORTION I.M.D. 60HZ/7kHz 4:1 | SUPPLY VOLTAGE TYP/MAX | SIZE mm | WT gms | PRICE | VAT | MODEL NUMBER | SIZE in mm | WT gms | PRICE | VAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HY30 | 15w/4-8Ω | 0.015% | <0.006% | ±18±20 | 76x68x40 | 240 | £7.29 | £1.09 | | | | | |
| HY60 | 30w/4-8Ω | 0.015% | <0.006% | ±25±30 | 76x68x40 | 240 | £8.33 | £1.25 | | | | | |
| HY120 | 60w/4-8Ω | 0.01% | <0.006% | ±35±40 | 120x78x40 | 410 | £17.48 | £2.62 | HY120P | 120x26x40 | 215 | £15.50 | £2.33 |
| HY200 | 120w/4-8Ω | 0.01% | <0.006% | ±45±50 | 120x78x50 | 515 | £21.21 | £3.18 | HY200P | 120x26x40 | 215 | £18.46 | £2.77 |
| HY400 | 240w/4Ω | 0.01% | <0.006% | ±45±50 | 120x78x100 | 1025 | £31.83 | £4.77 | HY400P | 120x26x70 | 375 | £28.33 | £4.25 |

*Protection:* Load line, momentary short circuit (typically 10 sec) *Slew rate:* 15V/µs *Rise time:* 5µs
*S/N ratio:* 100db *Frequency response (– 3dB):* 15Hz – 50kHz
*Input sensitivity:* 500mV rms *Input impedance:* 100kΩ *Damping factor:* (8Ω/100Hz)>400

### HEAVY DUTY with heatsinks / Without heatsinks

| MODEL NUMBER | OUTPUT POWER Watts rms | T.H.D. | I.M.D. | SUPPLY VOLTAGE | SIZE mm | WT gms | PRICE | VAT | MODEL NUMBER | SIZE in mm | WT gms | PRICE | VAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HD120 | 60w/4-8Ω | 0.01% | <0.006% | ±35±40 | 120x78x50 | 515 | £22.48 | £3.37 | HD120P | 120x26x50 | 265 | £19.84 | £2.98 |
| HD200 | 120w/4-8Ω | 0.01% | <0.006% | ±45±50 | 120x78x60 | 620 | £27.38 | £4.11 | HD200P | 120x26x50 | 265 | £23.63 | £3.54 |
| HD400 | 240w/4Ω | 0.01% | <0.006% | ±45±50 | 120x78x100 | 1025 | £38.63 | £5.79 | HD400P | 120x26x70 | 375 | £34.28 | £5.14 |

*Protection:* load line, PERMANENT SHORT CIRCUIT (ideal for disco/group use should evidence of short circuit not be immediately apparent).
The Heavy Duty range can claim additional output power devices and complementary protection circuitry with performance specs. as for standard types.

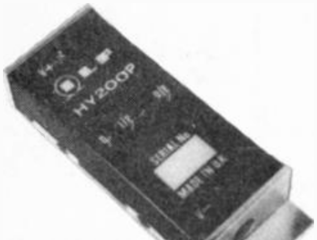


PLATE TYPE

### MOSFET Ultra-Fi, with heatsinks / Without heatsinks

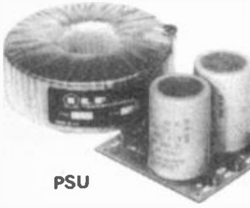
| MODEL NUMBER | OUTPUT POWER Watts rms | T.H.D. | I.M.D. | SUPPLY VOLTAGE | SIZE mm | WT gms | PRICE | VAT | MODEL NUMBER | SIZE in mm | WT gms | PRICE | VAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOS120 | 60w/4-8Ω | <0.005% | <0.006% | ±45±50 | 120x78x40 | 420 | £25.88 | £3.88 | MOS120P | 120x26x40 | 215 | £23.32 | £3.50 |
| MOS200 | 120w/4-8Ω | <0.005% | <0.006% | ±55±60 | 120x78x80 | 850 | £33.46 | £5.02 | MOS200P | 120x26x80 | 420 | £28.53 | £4.28 |
| MOS400 | 240w/4Ω | <0.005% | <0.006% | ±55±60 | 120x78x100 | 1025 | £45.39 | £6.81 | MOS400P | 120x26x100 | 525 | £38.91 | £5.84 |

*Protection:* Able to cope with complex loads, without the need for very special protection circuitry (fuses will suffice).
**Ultra-fi specifications:**
*Slew rate:* 20V/µs *Rise time:* 3µs *S/N ratio:* 100db *Frequency response (– 3dB):* 15Hz – 100kHz
*Input sensitivity:* 500mV rms *Input impedance:* 100kΩ *Damping factor:* (8Ω/100Hz)>400

### POWER SUPPLY UNITS

| MODEL NO. | FOR USE WITH | PRICE | VAT |
|---|---|---|---|
| PSU30 | ± 15V combinations of HY6/66 series to a maximum of 100mA. The following will also drive the HY6/66 series except HY67 which requires the PSU30. | £4.50 | £0.68 |
| PSU36 | 1 or 2 HY30 | £8.10 | £1.22 |
| PSU50 | 1 or 2 HY60 | £10.94 | £1.64 |
| PSU60 | 1 x HY120/HY120P/HD120/HD120P | £13.04 | £1.96 |
| PSU65 | 1 x MOS120/1 x MOS120P | £13.32 | £2.00 |
| PSU70 | 1 or 2 HY120/HY120P/HD120/HD120P | £15.92 | £2.39 |
| PSU75 | 1 or 2 MOS120/MOS120P | £16.20 | £2.43 |
| PSU90 | 1 x HY200/HY200P/HD200/HD200P | £16.20 | £2.43 |
| PSU95 | 1 x MOS200/MOS200P | £16.32 | £2.45 |
| PSU180 | 2 x HY200/HY200P/HD200/HD200P or 1 x HY400/1 x HY400P/HD400/HD400P | £21.34 | £3.20 |
| PSU185 | 1 or 2 MOS200/MOS200P/1 x MOS400/ 1 x MOS400P | £21.46 | £3.22 |

*All models except PSU30 and PSU36 incorporate our own toroidal transformers*



PSU

### FP480
**BRIDGING UNIT FOR DOUBLING POWER**

Designed specially by I.L.P. for use with any two power amplifiers of the same type to double the power output obtained and will function with any I.L.P. power supply. In totally sealed case, size 45 x 50 x 20mm, with edge connector. It thus becomes possible to obtain 480 watts rms (single channel) into 8Ω. Contributory distortion less than 0.005%.
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# OF A NEW ERA

I.L.P.


## Which modules?

In launching eighteen different units all within amazingly compact cases to help make complete audio systems using I.L.P. power amplifiers, we bring the most exciting, the most versatile modular assembly scheme ever for constructors of all ages and experience. Study the list – see how these modules will combine to almost any audio project you fancy – and remember *all I.L.P. modules are compatible with each other*, they connect easily. Modules HY6 to HY13 measure 45 x 20 x 40mm. HY66 to HY77 measure 90 x 20 x 40mm. They are so reliable that all I.L.P. modules carry a 5 year no quibble guarantee.

| MODEL NO. | MODULE | DESCRIPTION/FACILITIES | CURRENT REQUIRED | PRICE | VAT |
|---|---|---|---|---|---|
| HY6 | MONO PRE AMP | Mic/Mag. Cartridge/Tuner/Tape/ Aux + Volume/Bass/Treble | 10 mA | £6.44 | £0.97 |
| HY7 | MONO MIXER | To mix eight signals into one | 10 mA | £5.15 | £0.77 |
| HY8 | STEREO MIXER | Two channels, each mixing five signals into one | 10 mA | £6.25 | £0.94 |
| HY9 | STEREO PRE AMP | Two channels mag. Cartridge/ Mic + Volume | 10 mA | £6.70 | £1.01 |
| HY11 | MONO MIXER | To mix five signals into one + Bass/Treble controls | 10 mA | £7.05 | £1.06 |
| *HY12 | MONO PRE AMP | To mix two signals into one + Bass/Mid-range/Treble | 10 mA | £6.70 | £1.01 |
| *HY13 | MONO VU METER | Programmable gain/LED overload driver | 10 mA | £5.95 | £0.89 |
| HY66 | STEREO PRE AMP | Mic/Mag. Cartridge/Tape/Tuner/Aux + Volume/Bass/Treble/Balance | 20 mA | £12.19 | £1.83 |
| HY67 | STEREO HEADPHONE | Will drive headphones in the range of 4Ω – 2KΩ | 80 mA | £12.35 | £1.85 |
| HY68 | STEREO MIXER | Two channels, each mixing ten signals into one | 20 mA | £7.95 | £1.19 |
| HY69 | MONO PRE AMP | Two input channels of mag. Cartridge/ Mic + Mixing/Volume/Treble/Bass | 20 mA | £10.45 | £1.57 |
| HY71 | DUAL STEREO PRE AMP | Four channels of mag. Cartridge/Mic + Volume | 20 mA | £10.75 | £1.61 |
| *HY72 | VOICE OPERATED STEREO FADER | Depth/Delay | 20 mA | *To be announced* | |
| *HY73 | GUITAR PRE AMP | Two Guitar (Bass/Lead) and Mic + separate Volume/Bass/Treble + Mix | 20 mA | £12.25 | £1.84 |
| †HY74 | STEREO MIXER | Two channels, each mixing five signals into one + Treble/Bass | 20 mA | £11.45 | £1.72 |
| †HY75 | STEREO PRE AMP | Two channels, each mixing two signals into one + Bass/Mid-range/Treble | 20 mA | £10.75 | £1.61 |
| †HY76 | STEREO SWITCH MATRIX | Two channels, each switching one of four signals into one | 20 mA | *To be announced* | |
| †HY77 | STEREO VU METER DRIVER | Programmable gain/LED overload driver | 20 mA | £9.25 | £1.39 |

* Ready August – may be ordered now
† Ready September – may be ordered now

*All the above modules operate from ±15V minimum to ±30V maximum – higher voltages being accommodated by use of dropper resistors. HY67 can only be used with the PSU 30 power supply unit.*

The modules are encapsulated and include latest design high quality clip-on edge connectors.

For easy mounting we recommend
B6 Mounting board for modules HY6 – HY13
78p + 12p. V.A.T.
B66 Mounting board for HY66 – HY77
99p + 13p. V.A.T.

All I.L.P. modules include full connection data.

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# MONITOR

## EDITORIAL

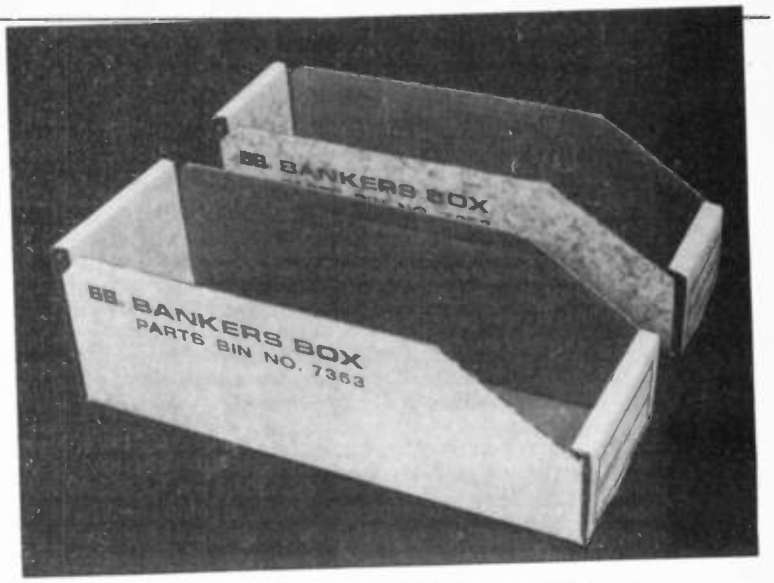
When we announced the postponement of Hobby Electronics '81 — the exhibition that we had planned to hold at the Bristol Exhibition Centre from 29th to 31st May — we had hoped that everybody would receive notice of its cancellation.

We were sorry to hear that, despite our attempts to spread the news, several readers suffered a wasted trip to Bristol.

Why was it cancelled? We simply had insufficient support from the trade to make it worthwhile. This lack of support puzzled and disappointed us, because the media covering South Wales and the West of England had shown great interest in an Exhibition dedicated to electronics hobbyists. We even had enquiries from a local hospital radio station.

Despite the cancellation, the Wales and West Schools' Electronics Project Competition, which was to have been judged at the Exhibition, went ahead as promised. Details of the winning entries are given on page 28.

Hugh Davies
Editor





## Bins That Don't Rattle

STORING COMPONENTS, small tools, nuts and bolts etc, can be a problem for any hobbyist. The choice seems to be: either make your own system of storage bins, or buy an expensive racking system.

Well, HE heard of a completely new (and cheap) method of storage bins for the home handyman, from Bankers Box of Doncaster. The bins are made of fibreboard and come in seven sizes from 51 mm wide by 102 mm high by 305 mm long, up to 203 mm by 102 mm by 457 mm. As a price example the 102 mm by 102 mm by 305 mm bin will cost about £3.75 for a pack of 10, and will be available from major retailers, office stationers and garage forecourts. At these prices, the bins are likely to be very attractive to the hobbyist.

Delivered in flat-pack form, the user folds the storage bins into shape himself — the whole process takes only a few seconds — and no clips or staples are needed.

More information from: Bankers Box, Record Storage Systems, Doncaster (tel no. 0302 884566).

## 35 MHz R/C News

ON 1ST JANUARY 1981, a band of frequencies between 35.010 MHz and 35.200 MHz was made available for model aircraft radio control use. Radio-controlled boats and cars are still restricted to either 27 MHz, or the UHF band around 459 MHz.

In order to make best use of this new band, and to maintain compatibility with the rest of Europe, 10 kHz channel spacing was adopted, as opposed to the nominal 25 kHz spacing in use on the 27 MHz band. The Society of Model Aeronautical Engineers (SMAE) representing the aeromodellers, and the Model Hobby Trade Federation (MHTF) representing the manufacturers and importers of R/C equipment, jointly drafted a code of practice to ensure that transmitters sold to operate on the new band would be capable of safe operation at these close spacings.

Unfortunately, some enterprising importers have taken advantage of a loop-hole in the type-approval procedures. Some of their equipment, although nominally meeting the transmitter specifications, appears unable to perform satisfactorily at 10 kHz spacings and interference to other modellers is being caused. This clearly breaks both the spirit of the code of practice, and its intention.

Angry rumblings have been heard, from other manufacturers and also from the modellers themselves. The equipment in question has, in fact, been banned by some clubs.

Moves are afoot to close the loop-hole by introducing type-approval procedures for receivers as well as transmitters. In the meantime, most reputable manufacturers are offering written guarantees for their receivers' performances at 10 kHz spacings.

## Spectacular TV Light Show

CEL ELECTRONICS HAS introduced two video synthesiser products, one of which will add new light to domestic colour TVs.

Chromoscope C-101 (domestic model) and Chromoscope P-135 (professional model) are claimed by CEL to be all-British inventions. When HE was shown both models by Robin Palmer, director of CEL and designer of the two products, we were impressed by the high standard of design and by the spectacular effects produced.

Chromoscope C-101, priced at £295 including VAT, can be connected to your TV and will generate a sequence of coloured shapes and patterns which merge and blend on the screen. The controls on the C-101 allow an almost infinite adjustment of pattern shape, colour and sequence. And the patterns become even more exciting when you connect the C-101 to your hi-fi system: the modulation effects provide an impressive sound-to-light show. Chromoscope P-135, priced at £675 including VAT, offers studio facilities, such as video and audio inputs, mixing and the insertion of colour into black-and-white images.

We have been given a C-101 to review and will present our findings in next month's Gadgets, Games & Kits supplement. We will also be offering the C-101 at a special price to HE readers, so don't miss next month's issue!

## Repair Service For Electronic Games

CIRCOLEC, UNDER THE joint partnership of John Bell and Richard Ansell, is offering a repair service for all types of video, computer and hand-held electronic games.

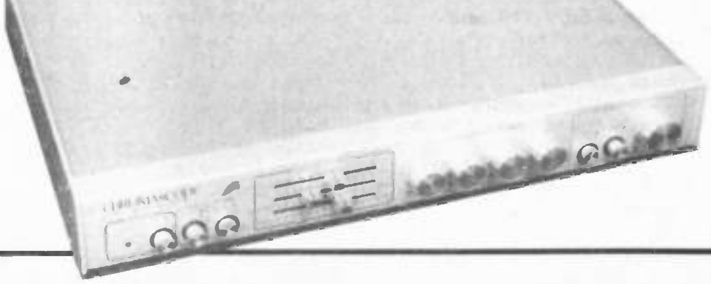
John Bell told HE that his company specialises in the repair of games such as those from Videomaster (Waddington), Computer Games, Atari and Grandstand. Circolec has had two years' experience in servicing 'tens of thousands' of Videomaster games.

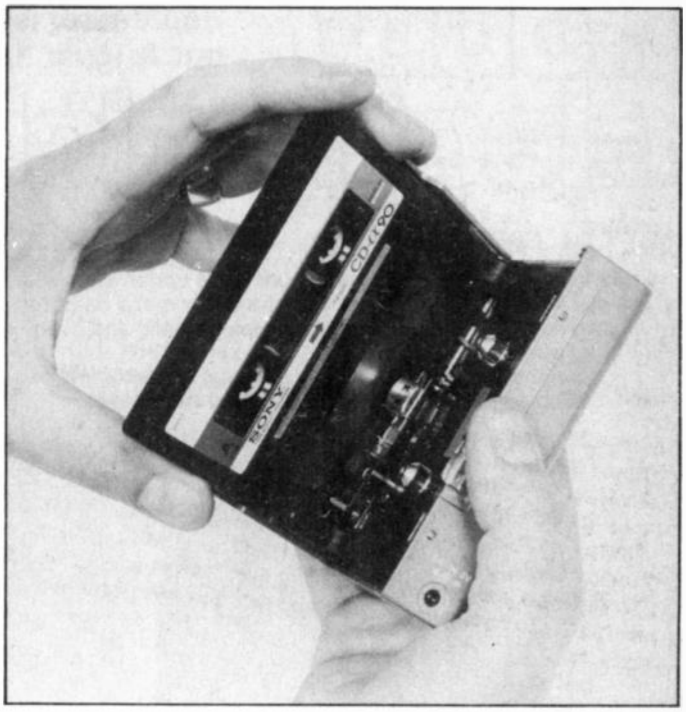
'We have six engineers here doing this sort of work' said John. He has had 30 years' experience in electronics and he is a member of the Institute of Quality Assurance.

### Graphic Equaliser

John Bell also mentioned a 100 W (4 x 25 W) graphic equaliser designed by Circolec. Its features include a three-colour LED display for each channel and the use of touch-sensitive controls. We hope to report on this product in a later issue.

Circolec is based at 1 Franciscan Road, Tooting, London SW17 8BR (tel 01 767 1233).




## Latest Personal Cassette Player From Sony

WELL, WE TRIED, jogging a distance — about 15 metres — while listening to the machine. Then we tried walking doing the same — even further — and after getting our breath back decided that the Sony Walkman-2 is a nice piece of equipment.

Walkman-2 is the latest of the mini personal cassette players, complete with headphones, to hit the market from Sony — the company which originated the idea of personal hi-fi. You may remember that the first personal cassette player to be released in this country was Sony's Stowaway (which later became known as Walkman-1).

The smallest of any such player we've seen yet, the Walkman-2 is about *the same size as a standard cassette case but just under twice the thickness*. We doubt whether any *further* size reductions will be possible (using standard sized cassettes, that is) but it's a fairly safe bet to rely on Sony to do it if it can be done.

### Do Your Own Thing

If you've never listened to a personal cassette machine before then you haven't yet lived! Using one is easy: you simply choose your own music (not that imposed by supermarket muzak speakers, and not that forced on you by the fellow-next-door's tranny tuned in to Radio Gunge) on a cassette, slot the cassette into your player, put on the headphones, switch on and — wham! — you're in another world. You're walking around the streets with Gary Glitter or Grieg; you're jogging with the Beatles or Bach; you could even be playing tennis with the Rolling Stones or Ravel. Whatever you are doing, it's your own sound.

### Walkman Is Fi!

Hi-fi, in fact. Using metal tapes the frequency response of the player is an impressive 40 to 15,000 Hz.

It comes complete with a pair of MDR-4L1S dynamic stereo headphones, a demonstration cassette, batteries, carrying case with shoulder strap, and a battery case for external larger batteries. The headphones give excellent results and quality, and are so light that after listening to your music for a while you almost forget you have them on. If somebody around wants to talk to you but you can't be bothered to take off the 'phones, by pressing a convenient 'mute' button (at the junction where the two separate leads to each 'phone meets) you can cut down the volume so you can hear the real world again.

Two alkaline AA-sized cells fitted into Walkman-2 give approximately nine hours' playing time but if that's not long enough then two D-sized alkaline cells in the handy external battery case give you an unbelievable 60 hours of playing time.

The carrying case looks somewhat odd at first sight, but is very versatile. It can be slung over the shoulder with a detachable strap or (more conveniently) clipped to a belt, waistband or pocket edge.

Walkman-2 itself folds apart to allow cassette insertion and one or two pairs of headphones can be used with it. (A second set of MDR-4L1S headphones will cost you £16.44 including VAT.) Controls on the player are simple and self-explanatory: forward, fast-forward, rewind, stop and volume, and here lies our one and only cause for concern. Unlike Walkman-1 (ie, Stowaway), which had separate volume controls for each channel, Walkman-2 has only one volume control with no means of channel balance adjustment. Fine, if you have evenly matched lug'oles, but not fine otherwise. It *is* worth remembering next time, Sony!

Our overall impression is that Walkman-2 is a lovely machine, well designed, well made, and well priced (considering its quality) at £99.50 including VAT or less.

## Technomatic Tie-up With Texas

COUPLED WITH THE opening of a new, large retail sales shop at 305 Edgware Road, London W2, Technomatic Ltd announces a new deal whereby the company is offering a nationwide distribution service of Texas Instruments' components to the greatly expanding hobbyist market.

One of the early projects which Technomatic will be tackling will be the marketing of Texas Instruments' new solid-state speech synthesiser ICs. These integrated circuits are already available to industry — but Technomatic's aim is to bring the chips to the hobbyist.

The company believes that its success in the field of component distribution stems from a policy of supplying the customer from large stocks of prime grade components, at highly competitive prices, and by return of post. This sort of service ideally suits the hobbyist.

To launch the two new ventures, a set of special prices has been prepared and these will appear in Technomatic's magazine advertisements.

## Digital Multimeter Has Higher Accuracy

When we described the DMM600D digital multimeter, from Danesbury Marketing, under Monitor in last month's issue, we under-rated its accuracy. On the DC voltage ranges the specified accuracy is *0.2%*, not 0.5% as stated.

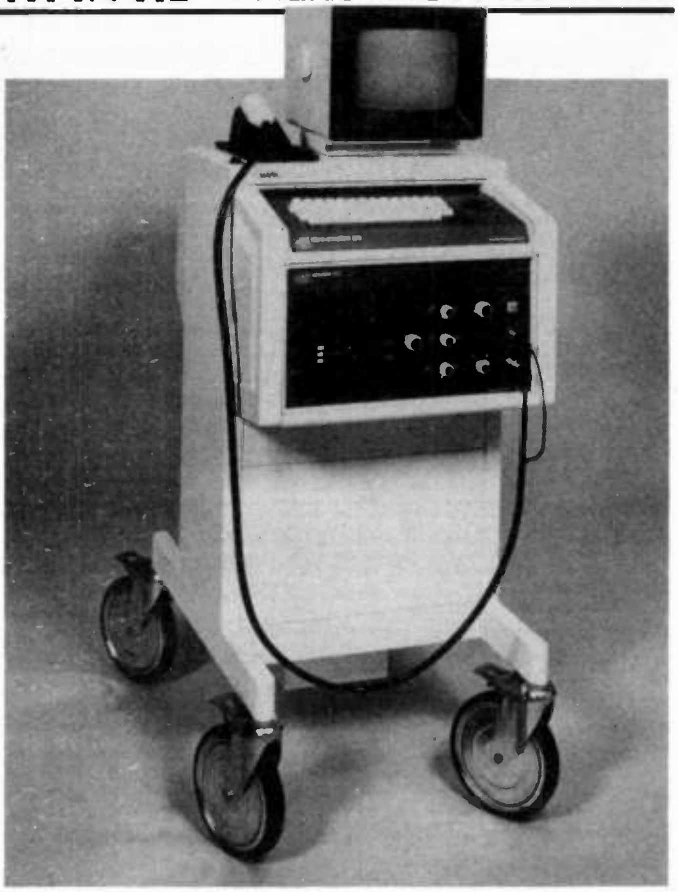
The meter is pocket-sized, covers 21 ranges and is available at a special introductory price of £49.95 for orders of one to four and £47.45 for orders of five to nine. (These prices include VAT and carriage in the UK.)

Carrying case, test leads and handbook are included with the meter.

Danesbury Marketing Ltd, 22 Parkway, Welwyn Garden City, Herts AL8 6HG (tel 07073 29112).

# Hobby Electronics

**Don't miss the September issue out August 14**



No, it's not a robot on wheels but a diagnostic scanner from Advanced Technology Labs Inc. This is just one example of the diagnostic equipment described in Electronics In Diagnostic Medicine

## METAL DETECTOR

So you think you might have a treasure trove underneath your lawn, eh? Well, next month we've got a super metal detector project to help you strike it rich. It's simple to build and even simpler to operate.

A complete kit of parts for the HE Metal Detector will be made available — all you'll need to supply is the spade.

Now where *did* Great-Grandfather bury his gold sovereigns? Carol Ann is seen here using the HE 'Diana' metal detector, described in next month's issue

## MAINS ADAPTOR

How often have you found that the battery in your portable radio/cassette player/calculator or such like is defunct of life, and you have no more cells? Wouldn't it be handy if you could run the device from mains? The HE Power Pack will do the job nicely. Preset voltage control gives a regulated output between 5-15 VDC and current supply is up to about 350 mA. So you see, most battery-powered devices can be run from this handy project.

The HE Power Pack will save you the expense of batteries for many electronic gadgets, such as the transistor radio shown here


## ELECTRONICS IN DIAGNOSTIC MEDICINE

Doctors may still use traditional methods to diagnose your illness or, depending on what is wrong with you, also make use of the electronic diagnostic equipment at their disposal. Guest writer Graham Thirsk, in this special feature for HE, describes some of the more interesting diagnostic equipment developed as a result of advances in diagnostic techniques and advances in electronic technology.

## SHORT WAVE RADIO

Our Short Wave Radio next month may not be the most complex or expensive receiver ever designed, but it is fun to build and use, and it will pull in some of those faraway broadcasts from around the world.

The radio is based on a simple tuned radio frequency (TRF) design covering frequencies of about 1.5 MHz to 33 MHz. Naturally, we hope to have an automatic cutout, inherent in the design, of all frequencies in that nasty, illegal 27 MHz band (although we're not sure if this facility will get past the design stage — nudge, nudge, wink, wink, say no more!)

## CHROMOSCOPE REVIEW

In the Gadgets, Games & Kits supplement supplied free with the September issue we review the Chromoscope C-101, a video synthesiser for home use from CEL Electronics (see under Monitor in this month's issue). The C-101, when coupled to your TV and audio system, will provide a display of coloured shapes and patterns that merge and blend — in harmony with the music.

Items mentioned here are those planned, but unforeseen circumstances may affect the actual contents

# WATFORD ELECTRONICS

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**POLYESTER CAPACITORS:** Axial lead type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1μF 68p; 2μ2 82p; 4μ7 65p.
160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n 38p; 1μF 42p; 1μ5 45p; 2μ2 48p; 4μ7 58p.
1000V: 1nF 17p; 10n 30p; 15n 40p; 22n 38p; 33n 42p; 47n 42p; 100n 42p; 470n 99p.

**POLYESTER RADIAL LEAD CAPACITORS: 250V:**
10nF, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p. 330n, 470n 13p; 680n 19p; 1μF 23p; 1μ5 40p; 2μ2 46p; 4μ7 60p.

**ULTRASONIC TRANSDUCERS** 40kHz 395p/pr

**ELECTROLYTIC CAPACITORS:** (Values are in μF) 500V: 10 52p; 47 78p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3 8p; 4.7 9p; 6.8, 10 10p; 15, 22, 12p; 33 15p; 47 12p; 100, 19p; 1000 70p. 50V: 47 12p; 68 20p; 220 24p; 470 32p; 2200 90p. 40V: 4.7, 15, 22 9p; 3300, 90p; 4700, 120p; 25V: 1.5, 8.8, 10, 22 8p; 33 9p; 47 8p; 100 11p; 150 12p; 220, 15p; 330 22p; 470 25p; 680, 1000, 34p; 2200, 50p; 3300, 76p; 4700 92p; 16V: 40, 47, 100 9p; 125, 12p; 220 13p; 470, 20p; 680 34p; 1000 27p; 1500, 31p; 2200 36p; 3300 74p; 4700 79p.
TAG-END TYPE: 70V: 4700, 245p; 64V: 3300 198p; 2200 139p; 50V: 3300 154p; 2200 110p; 40V: 4700 160p; 25V: 10,000 320p; 15,000 345p.

**TANTALUM BEAD CAPACITORS**
35V: 0.1μF, 0.22, 0.33 15p; 0.47, 0.68, 1.0μF, 1.5 16p; 2.2, 3.3 18p; 4.7, 6.8 22p; 10μF 28p; 16V: 2.2, 3.3 16p; 4.7μF, 6.8, 10 18p; 15, 36p; 22 30p; 33, 47 40p; 100 75p; 220 80p; 10V: 15, 22, 26p; 33, 47 35p; 100 55p; 6V: 100 42p.

**MYLAR FILM CAPACITORS**
100V: 1nF, 2, 4, 4n7, 10 6p; 15nF, 22n, 30n, 40, 47 7p; 56 100n, 200 9p; 470n/50V 12p.

**MINIATURE TYPE TRIMMERS**
2-6pF, 2-10pF; 22p; 2-25pF 5-56pF 30p; 10-88pF 35p.

**COMPRESSION TRIMMERS**
3-40pF; 10-80pF 20p; 20-250pF 28p; 100-580pF 39p; 400-1250pF 48p.

**POLYSTYRENE CAPACITORS:**
10pF to 1nF 6p; 1.5nF to 10nF 10p.

**SILVER MICA** (Values in pF) 2, 3.3, 4.7, 6.8, 8.2, 10, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF 15p each. 200, 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 21p each; 1000, 1200, 1800, 2200 30p each; 3300, 4700pF 60p each.

**CERAMIC CAPACITORS 50V:** 0.5pF to 10nF 4p; 22n to 47n 5p. 100n 7p.

**EURO BREADBOARD £5.20.**

**POTENTIOMETERS:** Rotary, Carbon, Track 0.25W Log & 0.5W Lin 500Ω, 1KΩ & 2KΩ (Linear only) Single Gang 29p
5KΩ-2MΩ Single Gang 29p
5KΩ-2MΩ Single Gang D/P Switch 78p
5KΩ-2MΩ Double Gang 88p

**SLIDER POTENTIOMETERS**
0-25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 110p
Self Stick Graduated Bezels 36p

**PRESET POTENTIOMETERS**
Vertical & Horizontal
0.1W 50Ω—5MΩ Miniature 7p
0-25W 100Ω—3.3MΩ horiz. 10p
0-25W 200Ω—4.7MΩ vert. 10p

**RESISTORS** — Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.

| | RANGE | VAL | 1-99 | 100+ |
|---|---|---|---|---|
| ¼W | 2Ω2—4M7 | E24 | 2p | 1p |
| ½W | 2Ω2—4M7 | E12 | 2p | 1p |
| 1W | 2Ω2—10M | E12 | 5p | 4p |
| 2% Metal Film | 10Ω-1M | | 6p | 4p |
| 1% Metal Film | 51Ω-1M | | 8p | 6p |

100+ price applies to Resistors of each value not mixed.

S-Dec 350p U-Dec B 699p
U-Dec A 465p Euro Breadboard 520p

**OPTO ELECTRONICS**
**LEDs plus clips**

| LEDs plus Clips | |
|---|---|
| TIL209 Red | 13 |
| TIL211 Grn. | 17 |
| TIL212 Yel. | 18 |
| 2" Red | 14 |
| 2" Yllow., Grn. | 18 |
| Square LEDs | 29 |
| ORP12 | 84 |
| 2N5777 | 45 |
| LD271 | 40 |
| SFH205 | 98 |
| TIL32 | 52 |
| TIL78 | 54 |
| 7 Segment Displays | |
| TIL321 C.A.5 | 115 |
| TIL322 C.C.5 | 115 |
| DL704 C Cth .3 | 99 |
| DL707 C.A. .3 | 99 |
| .3" Green CA | 120 |
| DL747 C.A. .6 | 180 |
| FND357 | 120 |
| MAN3640 | 175 |
| 10 Seg Bargraph | 225 |
| LCD 3½ Digit | 599 |

**SWITCHES**

| | |
|---|---|
| MEC, Black body, Red, Grn, Blue, SRL Latching | 95 |
| SRM Momentary | 95 |
| TOGGLE: 2A 250V. | |
| SPST | 33 |
| DPDT | 44 |
| 4 Pole on/off | 54 |
| SUB-MIN TOGGLE | |
| SP changeover | 60 |
| SPST on/off | 54 |
| DPDT 6 tags | 75 |
| DPDT c/off | 80 |
| DPDT Biased | 145 |
| SLIDE 250V: | |
| 1A DPDT | 14 |
| 1A DP c/off | 15 |
| ½A DPDT | 13 |

**We stock parts for most of the projects in this magazine.**

**ACCESS** Just phone your order through. We deal with the rest (but min. £10 please).

**SWITCHES** Miniature Non-Locking
Push to Make 15 Push Break 20
**ROCKER:** SPST on/off 10A/250V 28
**ROCKER:** Illuminated (black) chrome bezel, lights when on. DPST 3A 240V 65
**ROTARY:** (ADJUSTABLE STOP) 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way 45
**ROTARY:** Mains 250V AC. 4 Amp 62

**DIL SOCKETS:** 8-pin 8p; 14-pin 10p; 16-pin 10p; 18-pin 16p; 20-pin 22p; 24-pin 25p; 28-pin 28p; 40-pin 30p.

## VOLTAGE REGULATORS

| | | +ve | | −ve | |
|---|---|---|---|---|---|
| 1A | TO3 | | | | |
| 5V | 7805 | 145p | | 7905 | 220p |
| 12V | 7812 | 145p | | 7912 | 220p |
| 15V | 7815 | 145p | | — | |
| 18V | 7818 | 145p | | — | |
| 1A | TO220 Plastic Casing | | | | |
| 5V | 7805 | 60p | | 7905 | 65p |
| 12V | 7812 | 60p | | 7912 | 65p |
| 15V | 7815 | 60p | | 7915 | 65p |
| 18V | 7818 | 60p | | 7918 | 65p |
| 24V | 7824 | 60p | | 7924 | 65p |
| 100mA | TO92 Plastic Casing | | | | |
| 5V | 78L05 | 30p | | 79L05 | 65p |
| 6V | 78L62 | 30p | | | |
| 8V | 78L82 | 30p | | | |
| 12V | 78L12 | 30p | | 79L12 | 65p |
| 15V | 78L15 | 30p | | 79L15 | 65p |

| | | | | | |
|---|---|---|---|---|---|
| CA3085 | 95p | LM323K | 625p | TAA550 | 50p |
| LM300H | 170p | LM325N | 240p | TBA625B | 75p |
| LM305H | 140p | LM326N | 240p | TDA1412 | 150p |
| LM309K | 135p | LM327 | 270p | 78HO5 | 550p |
| LM317K | 350p | LM723 | 35p | 78HG5 | 650p |

**JACKSONS VARIABLE CAPACITORS**

Dielectric
100/300pF 195p
500pF 250p
6:1 Ball Drive 4511 DAF 160p
Dial Drive 4103 6:1/36:1 775p
Drum 54mm 59p
0-1.365pF 325p
00-2.365pF 395p
0 2 365pF with slow motion Drive 450p
00 208/176 395p
00 208/176 with slow motion drive 450p
C804-5pF 10 15 25 50pF 278p
100 150pF 350p
L 3x310pF 725p
00 3x25pF 550p

**DENCO COILS**
'DP' VALVE TYPE
Range 1 to 5 BL, RD, Yl Wht 122p
6-7 B-Y-R 110p
1.5 Green 150p
'T' type 1 to 5, Bl, Rd, Wht, Yl 150p
B9A Valve Holder 42p
RDT2 145p
RFC 5 chokes 140p
RFC 7 (19mH) 160p
13; 14; 15; 16; 17 120p
18/1.6 135p
18/465 152p
TOC1 124p
MW5FR 122p
MW/LW SFR 154p

**VEROBOARD**

| 0.1 Pitch | clad | plain |
|---|---|---|
| 2½ x 3¾ | 73p | 52p |
| 2½ x 5 | 83p | — |
| 3¾ x 3¾ | 83p | — |
| 3¾ x 5 | 95p | 79p |
| 3¾ x 17 | 326p | 211p |
| 4¾ x 17 | 426p | — |
| Pkt of 100pins | 50p | |
| Spot face cutter | 118p | |
| Pin insertion tool | 162p | |

**COPPER**
Clad Boards
Fibre glass
6x6" 90p
6x12" 150p
S R B P
9 x 8 95p
Ferric Chloride 1lb Anhydr 195p

**DIODES**

| | |
|---|---|
| BY126 | 12 |
| BY127 | 12 |
| CR033 | 250 |
| OA9 | 40 |
| OA47 | 12 |
| OA70 | 12 |
| OA79 | 15 |
| OA85 | 15 |
| OA90 | 8 |
| OA91 | 8 |
| OA95 | 8 |
| OA200 | 8 |
| OA202 | 8 |
| IN914 | 4 |
| IN916 | 5 |
| IN4001/2 | 5 |
| IN4003 | 6 |
| IN4004/5 | 6 |
| IN4006/7 | 7 |
| IN4148 | 4 |
| IN5401/2 | 15 |
| IN5404 | 16 |
| IN5406 | 17 |
| IN5408 | 19 |
| IS44 | 9 |
| IS921 | 9 |
| 6A/100V | 40 |
| 6A/400V | 50 |
| 6A/800V | 65 |

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**ZENERS**
Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V 1.3W 15p each

**NOISE**
Diode 195p

**BRIDGE RECTIFIERS**

| (plastic case) | p |
|---|---|
| 1A/50V | 20 |
| 1A/100V | 22 |
| 1A/400V | 29 |
| 1A/600V | 34 |
| 2A/50V | 35 |
| 2A/200V | 40 |
| 2A/400V | 46 |
| 2A/600V | 66 |
| 6A/100V | 83 |
| 6A/400V | 95 |
| 6A/600V | 125 |
| 10A/200V | 215 |
| 10A/600V | 360 |
| 25A/200V | 240 |
| 25A/600V | 395 |
| BY164 | 56 |
| VM18 | 50 |

**DIAC**
ST2 25

**SCRs Thyristors**

| | |
|---|---|
| 1A200V | 58 |
| 1A400V | 70 |
| 5A/400V | 40 |
| 5A/600V | 45 |
| 8A/300V | 60 |
| 8A/600V | 95 |
| 12A/100V | 78 |
| 12A/400V | 95 |
| 12A/800V | 188 |
| BT106 | 150 |
| BT116 | 180 |
| C106D | 38 |
| TIC44 | 24 |
| TIC45 | 29 |
| TIC47 | 35 |
| 2N5062 | 32 |
| 2N5064 | 38 |
| 2N4444 | 130 |

**TRIACS**

| | |
|---|---|
| 3A100V | 48 |
| 3A200V | 54 |
| 3A400V | 60 |
| 8A100V | 60 |
| 8A400V | 69 |
| 8A800V | 115 |
| 12A100V | 78 |
| 12A400V | 82 |
| 12A800V | 136 |
| 16A100V | 103 |
| 16A500V | 115 |
| 25A800V | 220 |
| 25A1000V | 480 |
| T28000D | 120 |

**7400 TTL**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7400 | 11 | 74126 | 40 | LS48 | 80 | 4015 | 66 |
| 7401 | 11 | 74128 | 42 | LS55 | 30 | 4016 | 32 |
| 7402 | 11 | 74132 | 48 | LS63 | 150 | 4017 | 48 |
| 7403 | 14 | 74136 | 35 | LS73 | 25 | 4018 | 68 |
| 7404 | 14 | 74141 | 70 | LS74 | 25 | 4019 | 42 |
| 7405 | 18 | 74142 | 190 | LS75 | 28 | 4020 | 61 |
| 7406 | 28 | 74143 | 250 | LS76 | 20 | 4021 | 70 |
| 7407 | 28 | 74145 | 70 | LS83 | 50 | 4022 | 66 |
| 7408 | 16 | 74147 | 99 | LS85 | 70 | 4023 | 20 |
| 7409 | 16 | 74148 | 75 | LS86 | 38 | 4024 | 45 |
| 7410 | 14 | 74150 | 80 | LS90 | 35 | 4025 | 19 |
| 7411 | 20 | 74151 | 45 | LS92 | 38 | 4026 | 130 |
| 7412 | 20 | 74153 | 45 | LS93 | 36 | 4027 | 38 |
| 7413 | 24 | 74154 | 75 | LS95 | 45 | 4028 | 58 |
| 7414 | 32 | 74156 | 75 | LS96 | 120 | 4029 | 77 |
| 7416 | 25 | 74157 | 45 | LS107 | 43 | 4030 | 50 |
| 7417 | 25 | 74159 | 99 | LS109 | 30 | 4031 | 170 |
| 7420 | 16 | 74160 | 60 | LS112 | 30 | 4032 | 125 |
| 7421 | 20 | 74161 | 60 | LS113 | 40 | 4033 | 165 |
| 7422 | 20 | 74162 | 62 | LS114 | 35 | 4034 | 195 |
| 7423 | 22 | 74163 | 64 | LS122 | 44 | 4035 | 95 |
| 7425 | 28 | 74164 | 64 | LS123 | 55 | 4036 | 275 |
| 7426 | 30 | 74165 | 62 | LS124 | 105 | 4037 | 115 |
| 7427 | 27 | 74166 | 65 | LS125 | 30 | 4038 | 110 |
| 7428 | 28 | 74167 | 185 | LS126 | 30 | 4039 | 290 |
| 7430 | 16 | 74170 | 168 | LS132 | 45 | 4040 | 59 |
| 7432 | 26 | 74172 | 290 | LS133 | 35 | 4041 | 78 |
| 7433 | 27 | 74173 | 85 | LS136 | 28 | 4042 | 60 |
| 7437 | 27 | 74174 | 72 | LS138 | 35 | 4043 | 70 |
| 7438 | 27 | 74175 | 72 | LS139 | 38 | 4044 | 65 |
| 7440 | 17 | 74176 | 55 | LS145 | 75 | 4045 | 170 |
| 7441 | 68 | 74177 | 75 | LS147 | 199 | 4046 | 75 |
| 7442 | 38 | 74178 | 95 | LS148 | 99 | 4047 | 75 |
| 7443 | 90 | 74180 | 65 | LS151 | 39 | 4048 | 55 |
| 7444 | 90 | 74181 | 140 | LS153 | 39 | 4049 | 30 |
| 7445 | 65 | 74182 | 75 | LS155 | 39 | 4050 | 30 |
| 7446 | 55 | 74184 | 99 | LS157 | 35 | 4051 | 78 |
| 7447 | 50 | 74185 | 99 | LS158 | 36 | 4052 | 78 |
| 7448 | 50 | 74188 | 290 | LS160 | 41 | 4053 | 78 |
| 7450 | 16 | 74190 | 70 | LS161 | 41 | 4054 | 125 |
| 7451 | 16 | 74191 | 70 | LS162 | 41 | 4055 | 125 |
| 7453 | 16 | 74192 | 70 | LS163 | 41 | 4056 | 120 |
| 7454 | 16 | 74193 | 65 | LS164 | 48 | 4057 | 1915 |
| 7460 | 16 | 74194 | 75 | LS165 | 145 | 4059 | 480 |
| 7470 | 35 | 74195 | 65 | LS166 | 85 | 4060 | 90 |
| 7472 | 30 | 74196 | 65 | LS173 | 72 | 4061 | 1225 |
| 7473 | 30 | 74197 | 65 | LS174 | 72 | 4062 | 995 |
| 7474 | 25 | 74198 | 99 | LS175 | 58 | 4063 | 99 |
| 7475 | 40 | 74221 | 80 | LS181 | 130 | 4066 | 36 |
| 7476 | 30 | 74246 | 150 | LS190 | 58 | 4067 | 399 |
| 7480 | 48 | 74247 | 150 | LS191 | 58 | 4068 | 22 |
| 7481 | 120 | 74248 | 150 | LS192 | 58 | 4069 | 20 |
| 7482 | 70 | **74LS** | | LS193 | 65 | 4070 | 26 |
| 7483 | 50 | 74LS00 | 12 | LS195 | 40 | 4071 | 20 |
| 7484 | 80 | LS01 | 13 | LS196 | 58 | 4072 | 20 |
| 7485 | 95 | LS02 | 14 | LS197 | 85 | 4073 | 20 |
| 7486 | 28 | LS03 | 14 | LS221 | 60 | 4075 | 20 |
| 7489 | 205 | LS04 | 15 | LS240 | 96 | 4076 | 60 |
| 7490 | 28 | LS05 | 15 | LS241 | 96 | 4077 | 26 |
| 7491 | 45 | LS06 | 15 | LS242 | 85 | 4078 | 26 |
| 7492 | 30 | LS08 | 15 | LS243 | 85 | 4081 | 26 |
| 7493 | 30 | LS09 | 15 | LS244 | 80 | 4082 | 21 |
| 7494 | 34 | LS10 | 15 | LS245 | 118 | 4085 | 65 |
| 7495 | 50 | LS11 | 15 | LS247 | 40 | 4086 | 70 |
| 7496 | 45 | LS12 | 15 | LS248 | 65 | 4089 | 140 |
| 7497 | 120 | LS13 | 30 | LS249 | 68 | 4093 | 43 |
| 74100 | 85 | LS14 | 48 | LS251 | 40 | 4094 | 168 |
| 74104 | 54 | LS15 | 15 | LS253 | 40 | 4095 | 90 |
| 74105 | 55 | LS20 | 15 | LS257 | 48 | 4096 | 90 |
| 74107 | 32 | LS21 | 15 | **CMOS** | | 4097 | 320 |
| 74109 | 35 | LS22 | 15 | 4000 | 14 | 4098 | 88 |
| 74110 | 40 | LS26 | 18 | 4001 | 14 | 4099 | 95 |
| 74111 | 55 | LS27 | 15 | 4002 | 14 | 4160 | 95 |
| 74112 | 170 | LS28 | 20 | 4006 | 66 | 4161 | 99 |
| 74116 | 88 | LS30 | 18 | 4007 | 18 | 4162 | 99 |
| 74118 | 80 | LS32 | 15 | 4008 | 62 | 4163 | 99 |
| 74119 | 90 | LS33 | 16 | 4009 | 35 | 4174 | 99 |
| 74120 | 75 | LS37 | 16 | 4010 | 40 | 4175 | 105 |
| 74121 | 30 | LS38 | 16 | 4011 | 15 | 4194 | 105 |
| 74122 | 45 | LS40 | 16 | 4012 | 18 | 4408 | 790 |
| 74123 | 50 | LS42 | 35 | 4013 | 34 | 4409 | 790 |
| 74125 | 42 | LS47 | 40 | 4014 | 75 | 4410 | 725 |
| | | | | | | 4411 | 695 |

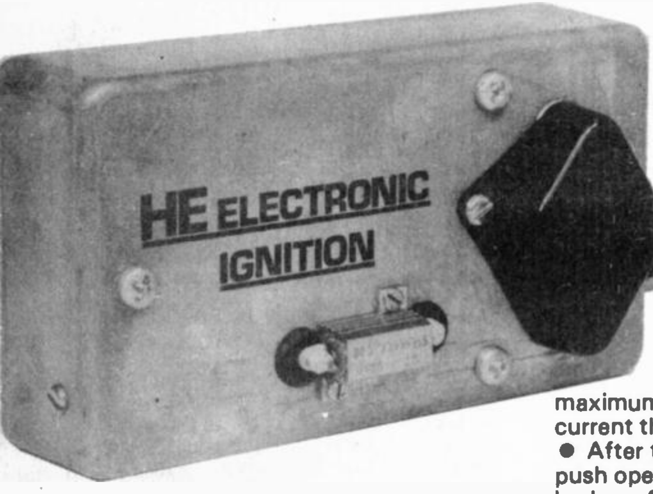
| | | | |
|---|---|---|---|
| 4412 | 800 | LM300HX | 170 |
| 4415 | 480 | LM301A | 26 |
| 4419 | 280 | LM308 | 95 |
| 4422 | 770 | LM318 | 200 |
| 4433 | 770 | LM324 | 50 |
| 4435 | 850 | LM339 | 68 |
| 4440 | 999 | LM348 | 90 |
| 4450 | 350 | LM349 | 115 |
| 4451 | 350 | LM358 | 50 |
| 4490 | 350 | LM379 | 375 |
| 4500 | 675 | LM380 | 80 |
| 4501 | 28 | LM381 | 145 |
| 4502 | 90 | LM382 | 125 |
| 4503 | 50 | LM384 | 99 |
| 4504 | 105 | LM386 | 99 |
| 4506 | 65 | LM387 | 120 |
| 4507 | 40 | LM1458 | 45 |
| 4508 | 265 | LM2917 | 195 |
| 4510 | 68 | LM3900 | 60 |
| 4511 | 68 | LM3909N | 70 |
| 4512 | 75 | LM3911 | 125 |
| **LINEAR ICs** | | LM3914 | 220 |
| 2102-2 | 225 | LM3915 | 220 |
| 2114 | 175 | LM3916 | 240 |
| 2708 | 250 | M252 | 625 |
| 2716 | 275 | M253AA | 1150 |
| 4116 | 140 | MC1304P | 260 |
| 6502 | 525 | MC1310 | 150 |
| 6522 | 570 | MC1455 | 150 |
| 6800 | 375 | MC1458 | 45 |
| 709C 8 pin | 35 | MC1488 | 75 |
| 710 | 48 | MC1489 | 75 |
| 733 | 75 | MC1494 | 694 |
| 741 8 pin | 14 | MC1495 | 350 |
| 747C | 78 | MC1496 | 92 |
| 748C | 36 | MC1648 | 290 |
| 753 | 150 | MC1709G | 90 |
| 810 | 159 | MC1710 | 79 |
| 81LS95 | 135 | MC3340P | 120 |
| 81LS96 | 135 | MC3360P | 120 |
| 81LS97 | 140 | MC3401 | 52 |
| 9400CJ | 350 | MC3403 | 89 |
| AY-1-0212 | 675 | MFC6040 | 97 |
| AY-1-1313A | 660 | MK50398 | 635 |
| AY-1-1320 | 225 | MM5303 | 635 |
| AY-1-5050 | 99 | MM5307 | 1275 |
| AY-1-5051 | 160 | NE543 | 210 |
| AY-3-8500 | 390 | NE544 | 185 |
| AY-3-8910 | 720 | NE555 | 17 |
| AY-5-1224A | 235 | NE556 | 55 |
| AY-5-1230 | 450 | NE560 | 325 |
| CA3018 | 68 | NE561 | 398 |
| CA3020 | 186 | NE562 | 410 |
| CA3023 | 191 | NE564 | 435 |
| CA3028A | 80 | NE565 | 120 |
| CA3035 | 235 | NE566 | 180 |
| CA3045 | 365 | NE567 | 170 |
| CA3046 | 70 | NE570 | 450 |
| CA3048 | 214 | NE571 | 420 |
| CA3059 | 195 | RC4136 | 99 |
| CA3080E | 65 | S566B | 245 |
| CA3081 | 190 | SAB3209 | 425 |
| CA3085 | 95 | SAB3210 | 275 |
| CA3089E | 215 | SAB3271 | 485 |
| CA3090AQ | 375 | SN76003 | 240 |
| CA3123E | 150 | SN76013 | 170 |
| CA3130 | 90 | SN76023 | 170 |
| CA3140 | 48 | SN76033 | 195 |
| CA3189 | 295 | SN76477 | 175 |
| ICL7106E | 795 | SP8629 | 299 |
| ICL7107 | 975 | TAA621 | 250 |
| ICL8038CC | 340 | TA7205A | 225 |
| ICM7205 | 1150 | TAD100 | 159 |
| ICM7216A | 1950 | TBA120 | 70 |
| ICM7217A | 790 | TBA641 | 250 |
| ICM7555 | 80 | TBA800 | 90 |
| LA4032 | 295 | TBA810 | 95 |
| LC7130 | 495 | TBA820 | 70 |
| LD130 | 452 | TCA965 | 120 |
| LF351 | 48 | TDA1004 | 290 |
| LF355 | 75 | TDA1008 | 310 |
| LF356 | 85 | TDA1022 | 575 |
| | | TDA1024 | 105 |
| | | TDA1490 | 290 |
| | | TDA2020 | 320 |
| | | TLO61 | 46 |
| | | TL063 | 95 |
| | | TLO71CP | 45 |
| | | TL074 | 140 |
| | | TLO81 | 42 |
| | | TLO82 | 70 |
| | | TLO83 | 95 |
| | | TLO84 | 120 |
| | | UAA170 | 170 |
| | | UAA180 | 170 |
| | | XR2206 | 350 |
| | | XR2211 | 575 |
| | | Z80 | 780 |
| | | Z80A | 899 |
| | | Z80ACTC | 550 |
| | | Z80CTC | 595 |
| | | Z80P10 | 575 |
| | | Z80APIG | 550 |
| | | ZN1034E | 200 |
| | | ZN1040E | 685 |
| | | ZN414 | 95 |
| | | ZN424E | 130 |
| | | ZN425E | 415 |
| | | ZN426E | 325 |
| | | ZN427 | 625 |
| | | ZN428 | 478 |
| | | ZN429 | 210 |

**TRANSISTORS**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AC125 | 35 | BC214L | 10 | BSX20 | 20 | TIP41A | 55 | 2N3053 | 26 | 2SC2029 | 180 |
| AC126/7 | 35 | BC307B | 14 | BSY65 | 35 | TIP41B | 60 | 2N3054 | 58 | 2SC2078 | 155 |
| AC128 | 25 | BC328 | 16 | BSY95A | 25 | TIP42A | 60 | 2N3055 | 48 | 2SC2091 | 85 |
| AC141/2 | 30 | BC338 | 15 | BU105 | 170 | TIP42B | 75 | 2N3121 | 30 | 2SC2314 | 85 |
| AC142 | 30 | BC441 | 34 | BU205 | 190 | TIP120 | 90 | 2N3133 | 45 | 2SC2166 | 165 |
| AC176/187 | 28 | BC461 | 34 | BU208 | 200 | TIP121 | 99 | 2N3135 | 30 | 2SC1679 | 190 |
| AC188 | 30 | BC477 | 40 | E113 | 45 | TIP122 | 99 | 2N3252 | 46 | 3N128 | 112 |
| ACY17/18 | 70 | BC516/7 | 40 | E176 | 60 | TIP142 | 120 | 2N3442 | 140 | 3N140 | 112 |
| ACY20/21 | 75 | BC547/8 | 14 | E421 | 250 | TIP147 | 120 | 2N3568 | 25 | 40311 | 60 |
| ACY22 | 60 | BC549 | 14 | MJ2955 | 90 | TIP2955 | 60 | 2N3663 | 15 | 40313 | 130 |
| AD140 | 120 | BC556 | 15 | MJE340 | 54 | TIP3055 | 60 | 2N3702/3 | 10 | 40316 | 95 |
| AD149 | 79 | BC557/8 | 15 | MJE370 | 100 | TIS43 | 32 | 2N3704/5 | 10 | 40317 | 60 |
| AD161 | 42 | BC559 | 15 | MJE371 | 100 | TIS44 | 45 | 2N3706/7 | 10 | 40324 | 100 |
| AD162 | 42 | BCY70 | 18 | MJE520/521 | 95 | TIS88A | 50 | 2N3708/9 | 10 | 40326 | 60 |
| AF115 | 60 | BCY71 | 18 | MJE2955 | 99 | TIS90 | 30 | 2N3710/11 | 10 | 40327 | 70 |
| AF139 | 40 | BCY72 | 20 | MJE3055 | 70 | TIS91 | 32 | 2N3713 | 140 | 40348 | 120 |
| AF178 | 75 | BD131/2 | 48 | MPF102 | 66 | ZTX107/8 | 11 | 2N3771 | 179 | 40360 | 40 |
| AF180/86 | 70 | BD133 | 60 | MPF103 | 38 | ZTX109 | 12 | 2N3772 | 195 | 40361/2 | 40 |
| AF239 | 78 | BD135 | 45 | MPF104 | 36 | ZTX300 | 13 | 2N3773 | 270 | 40407 | 60 |
| BC107/8 | 10 | BD136/7 | 40 | MPF105 | 38 | ZTX301/2 | 16 | 2N3819 | 22 | 40408 | 70 |
| BC108B | 12 | BD138/9 | 40 | MPF106 | 40 | ZTX303 | 25 | 2N3820 | 45 | 40411 | 285 |
| BC108C | 12 | BD140 | 40 | MPSA05/06 | 25 | ZTX304 | 17 | 2N3822/3 | 65 | 40412 | 65 |
| BC109 | 10 | BD695A | 85 | MPSA12 | 30 | ZTX314 | 25 | 2N3866 | 90 | 40467 | 130 |
| BC109B | 12 | BD696A | 85 | MPSA55 | 30 | ZTX326 | 30 | 2N3903/4 | 18 | 40468 | 85 |
| BC109C | 12 | BDY17 | 195 | MPSA56 | 30 | ZTX341 | 30 | 2N3905 | 15 | 40594 | 105 |
| BC117 | 24 | BDY60 | 160 | MPSU06 | 65 | ZTX500 | 14 | 2N3906 | 17 | 40595 | 110 |
| BC119 | 38 | BDY61 | 160 | MPSU56 | 60 | ZTX501/2 | 15 | 2N4037 | 48 | 40603 | 110 |
| BC137 | 40 | BF115 | 35 | OC28 | 120 | ZTX503 | 18 | 2N4058 | 10 | 40636 | 175 |
| BC140/3 | 30 | BF167 | 29 | OC35 | 125 | ZTX504 | 25 | 2N4061/2 | 10 | 40673 | 95 |
| BC147 | 9 | BF173 | 27 | OC36 | 120 | ZTX531 | 25 | 2N4069 | 45 | | |
| BC148 | 9 | BF177 | 25 | OC41/42 | 120 | ZTX550 | 25 | 2N4859 | 78 | | |
| BC149 | 9 | BF178 | 30 | OC44 | 40 | 2N526 | 58 | 2N4871 | 55 | | |
| BC153/4 | 27 | BF179 | 35 | OC45 | 40 | 2N696 | 30 | 2N5135/6 | 20 | | |
| BC157/8 | 10 | BF180 | 38 | OC70 | 40 | 2N697 | 23 | 2N5138 | 18 | | |
| BC159 | 11 | BF194/5 | 12 | OC71 | 40 | 2N698 | 40 | 2N5179 | 45 | | |
| BC160 | 45 | BF196/7 | 12 | OC72 | 40 | 2N699 | 48 | 2N5180 | 45 | | |
| BC167A | 10 | BF198 | 16 | OC76 | 50 | 2N706/8 | 19 | 2N5191 | 75 | | |
| BC168C | 10 | BF200 | 30 | OC81 | 50 | 2N918 | 35 | 2N5305 | 24 | | |
| BC169C | 10 | BF224A | 25 | OC82 | 50 | 2N930 | 20 | 2N5457 | 36 | | |
| BC170 | 15 | BF244 | 28 | OC83 | 40 | 2N961 | 65 | 2N5458 | 36 | | |
| BC171/2 | 11 | BF256 | 35 | OC84 | 40 | 2N1131/2 | 24 | 2N5459 | 36 | | |
| BC177/8 | 20 | BF257/8 | 32 | OC170/71 | 85 | 2N1304 | 65 | 2N5485 | 36 | | |
| BC179 | 20 | BF259 | 35 | TIP29 | 34 | 2N1305 | 60 | 2N5777 | 45 | | |
| BC182 | 10 | BF594/5 | 23 | TIP29C | 60 | 2N1671B | 120 | 2N6027 | 32 | | |
| BC182L | 10 | BFR39/40 | 23 | TIP30 | 48 | 2N2160 | 350 | 2SA715 | 60 | | |
| BC183 | 10 | BFR41 | 23 | TIP30C | 58 | 2N2219A | 28 | 2SC495 | 70 | | |
| BC183L | 10 | BFR79 | 23 | TIP31A | 45 | 2N2220A | 23 | 2SC496 | 70 | | |
| BC184 | 10 | BFR80/81 | 25 | TIP31C | 55 | 2N2222 | 25 | 2SC1096 | 85 | | |
| BC184L | 10 | BFX29 | 28 | TIP32A | 46 | 2N2369A | 18 | 2SC1173 | 125 | | |
| BC187 | 26 | BFX81 | 25 | TIP32C | 60 | 2N2476 | 50 | 2SC1306 | 150 | | |
| BC212 | 10 | BFX84 | 28 | TIP33A | 65 | 2N2483 | 27 | 2SC1307 | 220 | | |
| BC212L | 10 | BFX85/86 | 28 | TIP33C | 78 | 2N2497 | 63 | 2SC1449 | 85 | | |
| BC213 | 10 | BFX87/88 | 28 | TIP34A | 74 | 2N2646 | 45 | 2SC1923 | 50 | | |
| BC213L | 10 | BFY50/51 | 23 | TIP34C | 88 | 2N2894 | 30 | 2SC1945 | 225 | | |
| BC214 | 10 | BFY52 | 23 | TIP35A | 160 | 2N2904 | 28 | 2SC1953 | 90 | | |
| | | BRY39 | 40 | TIP35C | 185 | 2N2905A | 26 | 2SC1957 | 90 | | |
| | | | | TIP36A | 170 | 2N2906/7 | 26 | 2SC1969 | 198 | | |
| | | | | TIP36C | 199 | 2N2926G | 10 | 2SC2028 | 85 | | |

# Electronic

**An easily-built Veroboard project which can give advantages of better, more reliable engine starting, particularly in damp weather, and more consistent performance for many thousands of miles. Circuit design by Des Armstrong, who has driven over 100,000 miles in his car with the prototype fitted**




THE CONVENTIONAL CAR ignition system has remained virtually unchanged since the early days of motoring. It was, in fact, invented by Charles Kettering about 60 years ago. The system uses a transformer (known as a coil), a contact breaker (the points) and a capacitor (sometimes called a condensor).

A typical Kettering type of ignition circuit is shown in Fig.2. The coil, points and capacitor are all shown and the whole system operates in the following way:

- As the ignition switch is operated, current is applied simultaneously to the coil and to the starter motor. The starter motor turns the engine, which turns the rotor cam in the distributor, opening and closing the points.
- When the points are closed, current builds up in the coil, reaching a maximum of 4 A after about 4 ms. The current then remains steady.
- After the cam turns far enough to push open the points, the circuit is broken. A voltage V is generated which is given by the basic coil formula:

$$V = It,$$

where I is the inductance of the coil in henries (see Famous Names this monthl) and t is the rate of change of current in seconds. This voltage at the primary of the coil induces a much higher voltage at the secondary (it's a 'step-up' transformer) which is applied to the spark plug in the engine. A fast break of the points thus gives (in theory, at least) an infinite voltage at the primary. However, in practice an arc (spark) occurs at the points and the voltage is limited.

- The capacitor fitted across the points limits the rise of voltage, thus preventing too great an arc at the points gap. The value of this capacitor is chosen to give a compromise between the amount of energy at the spark plug and the amount of energy at the points. (Remember that too much energy at the points causes a lot of arcing which will burn the points out quickly.)

## Why Electronic?

As we've said, the Kettering system has been around for some time and has consequently been refined to a very high standard. But two major weaknesses are still inherent and are difficult to eliminate in such a mechanical system. These are: contact breaker points bounce at high engine speeds, and wear of the points — due to high currents through them and arcing across them.

Some electronic ignition systems use solid-state devices to provide switching thus doing away entirely with the points. But there is little need to do this because we can both prevent wear and eliminate the effects of points bounce electronically, by good design.

To this end, the HE Electronic Ignition system maintains the use of the car's contact breaker points. The points will, with its use, be subject only to mechanical wear and will need changing much less often. A further benefit of retaining the points is their use when timing the engine — they can be, in fact, more accurate than many other methods, such as optical or reluctance sensing.

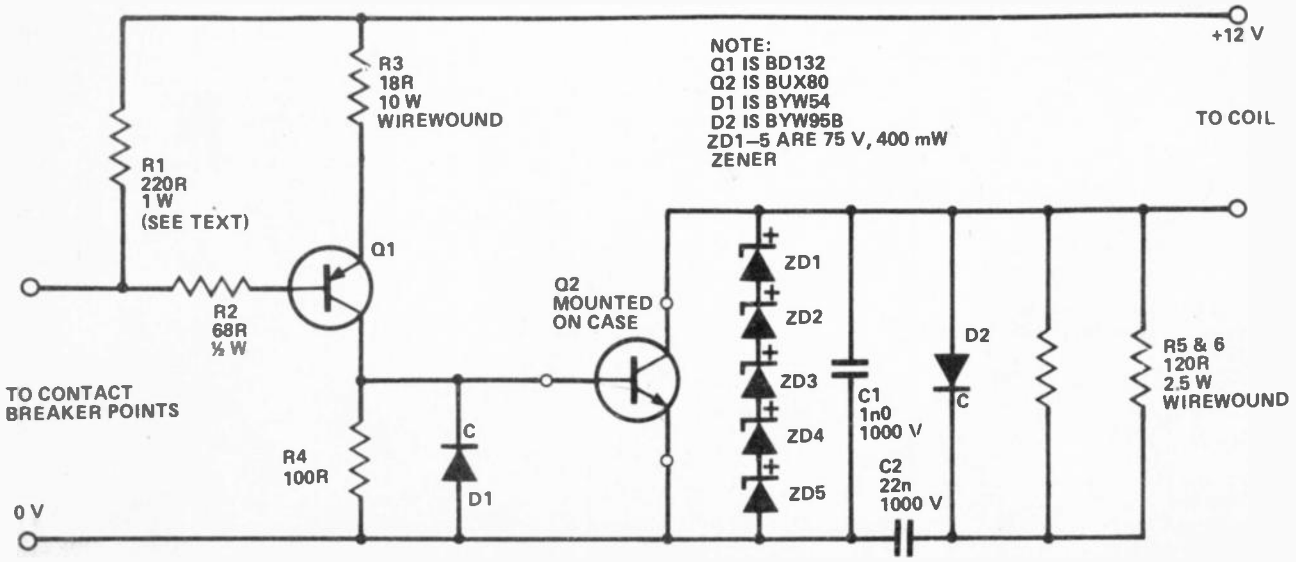



**Figure 1. Circuit of the HE Electronic Ignition project**

# Ignition

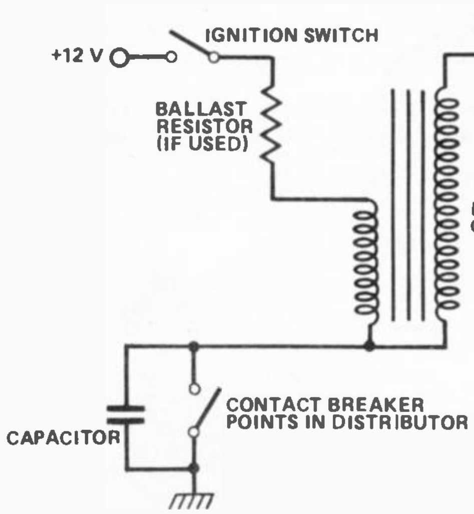



Figure 2. The standard (Kettering) ignition circuit

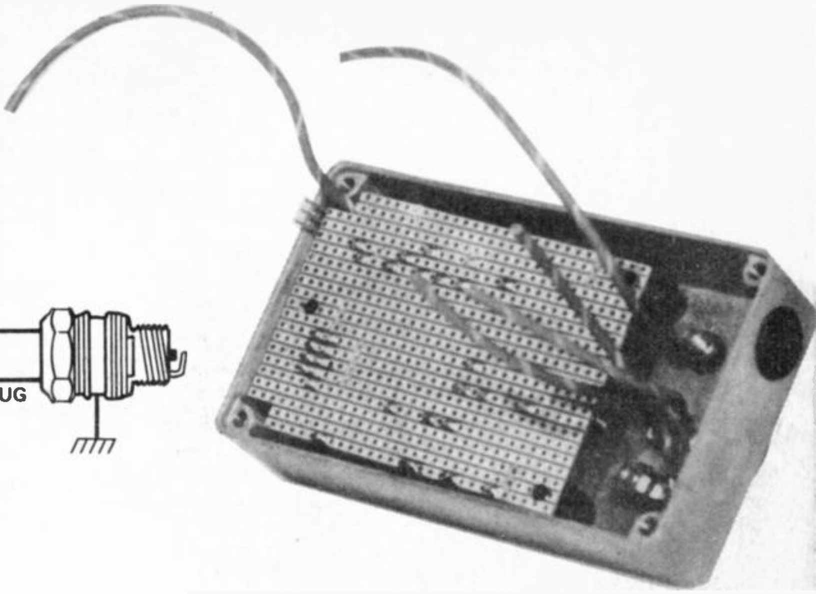


Figure 3. View of the project as the circuit board fits into the case. Note how the three leads of transistor Q1 fit into the board, and how the left-hand lead from resistor R3 comes out from underneath

## Construction

First, cut the Veroboard to exactly 21 strips by 31 holes. Cut and carefully file out the two corners of the board so that it fits into the case, flush to one side. Now drill the board and the case to fit ½" PCB mounting pillars — remember that the Veroboard is to be mounted 'upside down' ie, copper side facing up — then remove the board.

Now, mark and drill the case to fit transistor Q1. The transistor must be bolted on with a mica insulating washer between it and the case, so that when the Veroboard is put in again the three transistor leads fit into the board, as you can see in Fig.3. The metal tab (on one of its faces) must be towards the case side.

Using the mica insulating washer for Q2 as a guide, mark and drill the case to fit the power transistor. Make sure you drill the case and mount the transistor the right way round as shown in Fig.4. Bolt the transistor to the case as shown in Fig.5, preferably smearing both sides of the mica washer with a small amount of heatsink compound to aid heat conduction.

Next mark and drill the case for the ⅜" grommet hole (in the side), and the two ¼" grommet holes and mounting

## Parts List

**RESISTORS**

| | |
|---|---|
| R1 | 220R 1 W |
| R2 | 68R ½ W |
| R3 | 18R 10 W wirewound |
| R4 | 100R ½ W |
| R5,6 | 120R 2.5 W wirewound |

**CAPACITORS**

| | |
|---|---|
| C1 | 1n0, 1000 V mixed dielectric |
| C2 | 22n, 1000 V mixed dielectric |

**SEMICONDUCTORS**

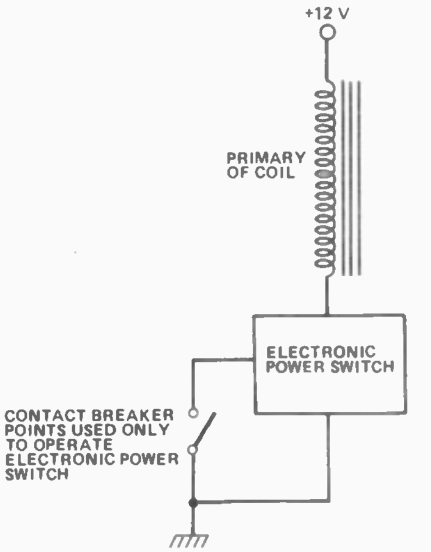
| | |
|---|---|
| Q1 | BD132 PNP transistor |
| Q2 | BUX80 NPN power transistor |
| D1 | BYW54 diode |
| D2 | BYW95B diode |
| ZD1-5 | 75 V, 400 mW zener diode |

**MISCELLANEOUS**

Case, diecast aluminium (114 mm x 64 mm x 30 mm)
Veroboard, 21 strips x 31 holes, 0.1" matrix
3 x ½" PCB mounting pillars
Fixing kits for Q1 and Q2 transistors
Hardware, nuts, bolts, solder tag, washers, self-tapping screws
⅜" rubber grommet
¼" rubber grommet
Cable tie

## How It Works

**The HE Electronic Ignition can be simply thought of as an electronic power switch. The car's contact breaker points are used only to turn the power switch on and off — they no longer switch heavy currents to the primary winding of the coil.**



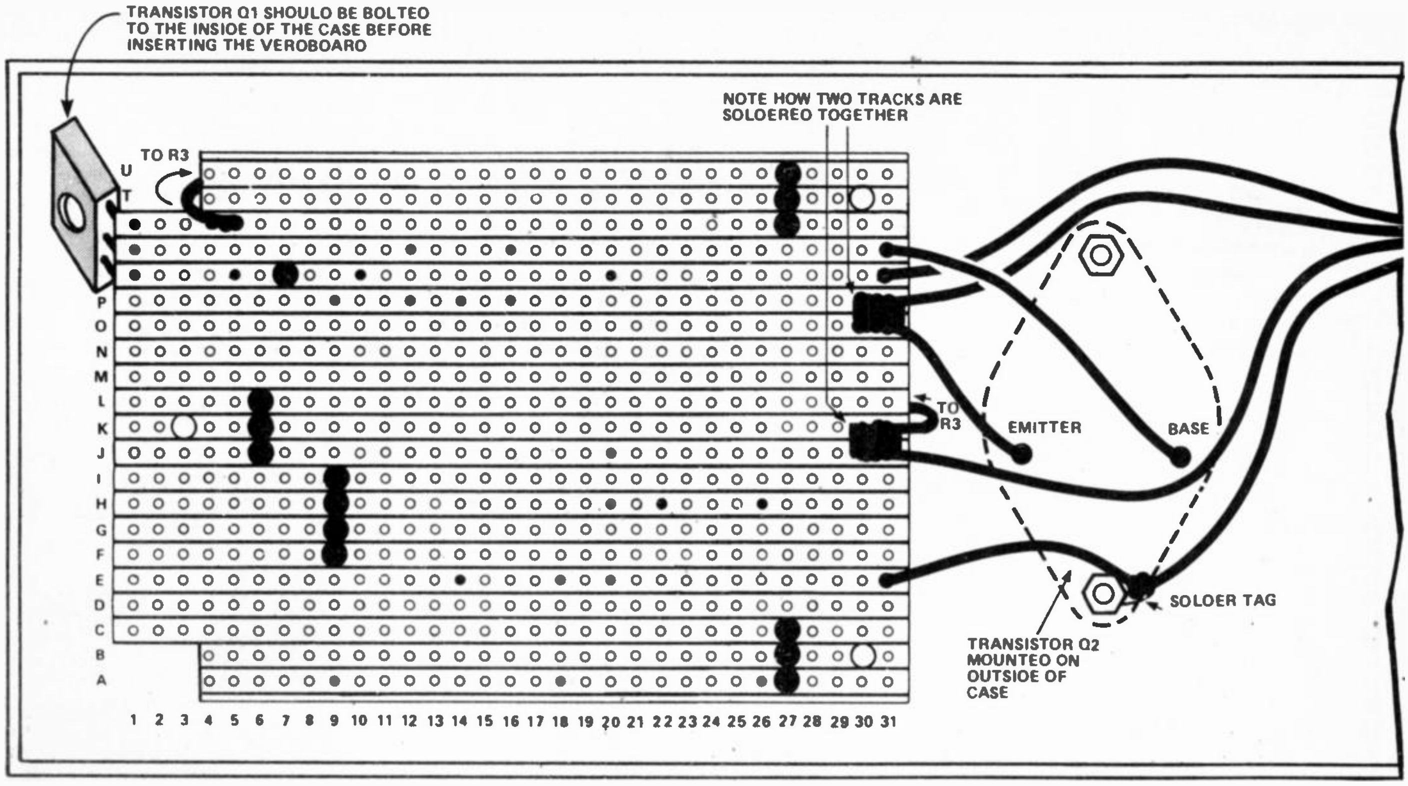

Resistor R1 provides a current of about 60 mA through the points when they are closed. This current is necessary to ensure that any tarnishing or oil droplets on the contacts do not cause a problem.

Transistor Q1 provides an inversion of the pulse from the points, and the output from its collector drives the output transistor Q2. Resistor R2 limits the base current of Q1.

Transistor Q2 is easily capable of handling the 4 A or so of current which passes through it from the coil and it has a voltage rating of 400 V. It is therefore well suited to this application. Nevertheless, to make certain the transistor cannot be damaged by high voltage spikes, zener protection is included. Zener diodes ZD1-5 in series give a total zener protection voltage of 375 V (5 x 75 V).

Under certain conditions 'ringing' occurs (the voltage at the coil oscillates, first positive then negative). Diode D1 is included to short out this voltage when negative.

Diode D2 and resistor R5 cope with situations of points bounce which can cause problems, in the Kettering system, at high engine speeds.




holes for resistor R3 (in the top). Push all grommets into position.

Solder 4" lengths of cable (thick enough to carry at least 4 A of current) to each end of R3 so that when it is finally bolted to the case the two pieces of cable go vertically down through the grommet holes. Cover these connections with 1" lengths of heat-shrink or push-fit sleeving to provide insulation.

Mark and drill the case to fit the transistor cover over Q2. Use self-tapping screws to fasten it down.

Now make up the Veroboard, carefully following the layout diagram in **Fig.6**. Track breaks can be made using a cutting tool or a small (about ⅛") hand-held drill bit. Make sure no swarf lies across adjacent tracks, forming unwanted short circuits.

Resistors R1,2,5, and 6 should be mounted in position about ⅛" above the level of the board, to allow air to circulate. These resistors will get warm when the project is in operation, but this precaution will prevent damage occurring due to heat build-up.

Enlarge the two holes, where diode D2 goes into the board, using a 1.5 mm drill. Now fit D2 making sure it is the correct way round.

Insert and solder all other components and the link, as shown in **Fig.6**.

Position the board upside down (ie, copper side up) so that three leads of Q1 fit into the correct holes of the board and then screw the board down onto the PCB pillars, making sure the left-hand lead of resistor R3 (the resistor on the outside of the case) goes between the corner of the board and the case. You can see this stage in the photograph of **Fig.3**.

Now solder transistor Q1 to the board and cut off any excess leads.

Following the internal connection diagram in **Fig.4** first solder resistor R3's two leads to the board.

Connect the emitter and base of Q2 to the board using (at least) 4 A cable. Put heat-shrink sleeving over the connections at the transistor end to provide insulation.

Now using 4 A cable, connect the solder tag (which is Q2's collector connection) to the board.

Finally, solder four adequate lengths of 4 A cable to the board according to **Fig.4**. These leads should go through the ⅜" grommet and should be colour-coded or marked so you know which is which. Our colour code is shown in **Fig.4** but you needn't use the same as long as you know the difference.

Tightly fasten a cable tie around the four leads to prevent them from being accidentally pulled out.

Screw on the case bottom. Your project is now complete.

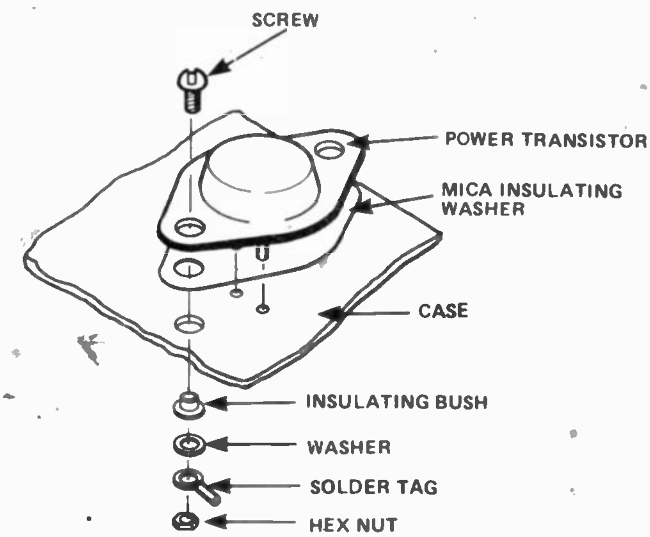



**Figure 5. How to fasten transistor Q2 onto the case. If you have any, smear a small amount of heatsink compound onto both sides of the insulating washer to aid heat conduction**

## Installation

**Figure 7** shows how the original Kettering system of a car is adapted using the HE Electronic Ignition. Comparing this with **Fig.2** you will note the insertion of our system in the low tension lead, between the points (in the distributor) and the negative side of the coil. The capacitor has also been removed from across the points.

Mechanical installation of our circuit is left to the builder as this will depend on the car on which the system is to be fitted.

Electrical installation is as follows:

1. Disconnect the low tension lead

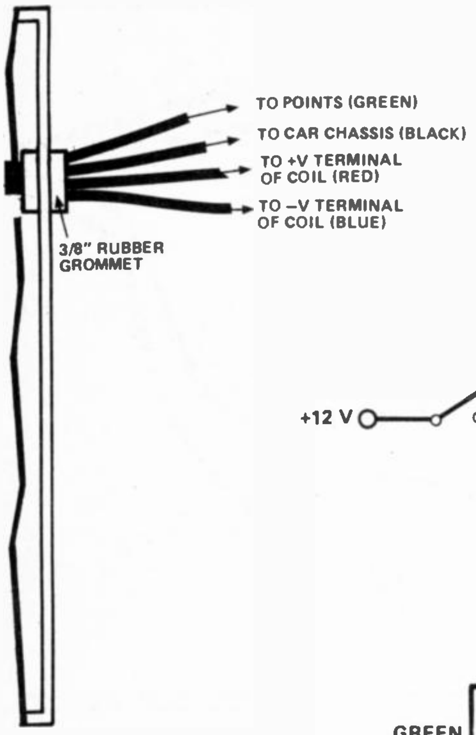
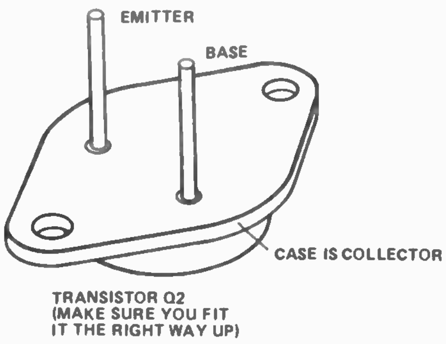



**Figure 4. Connection details of the project also showing the underside component locations and track breaks of the Veroboard. Follow our colour code where indicated so you know which lead is which. Also shown (right) is a leadout diagram of transistor Q2. From this you can see that the transistor's case is its collector connection. It must therefore be isolated from the metal case of the project with a mica insulating washer as shown in Fig.5**



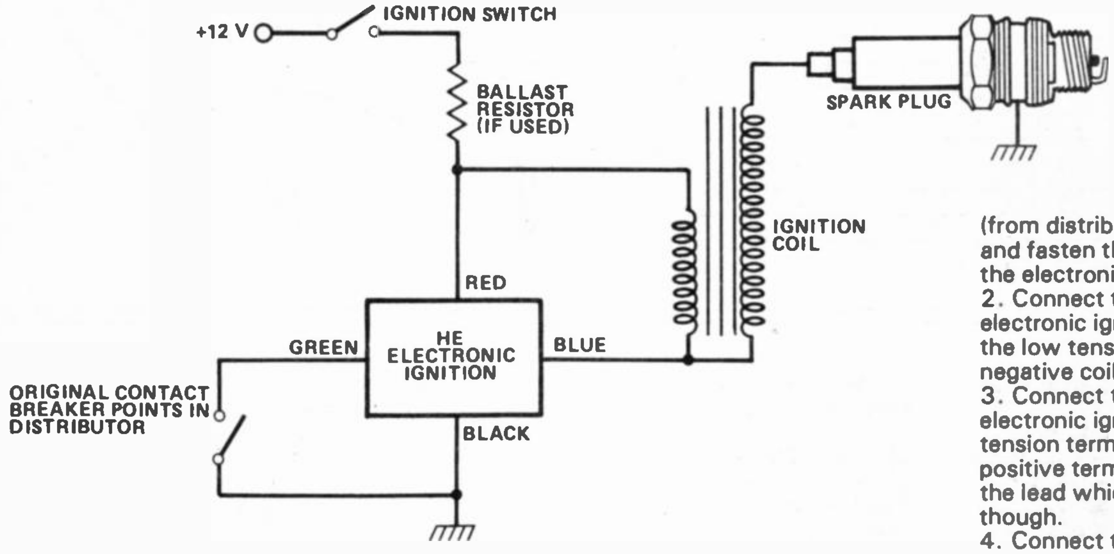




**Figure 7. How the HE Electronic ignition fits into the standard Kettering ignition circuit. The lead colours shown are those adopted in Fig.4. If you use a different colour code when wiring up your project simply change the suggested colours in this diagram to your own**

(from distributor to coil) from the coil and fasten this to the green lead of the electronic ignition.
2. Connect the blue lead from the electronic ignition to the coil (where the low tension lead came from ie, the negative coil terminal).
3. Connect the red lead from the electronic ignition to the other low tension terminal of the coil (the positive terminal). Do not disconnect the lead which is already connected, though.
4. Connect the black lead of the electronic ignition to a *good* earth — preferably somewhere on the engine block or directly to the negative terminal of the battery.

Now you can try starting your car. It should run without any problem. After satisfying yourself that everything is OK, stop the engine and then remove the capacitor from the distributor.

You now have a complete and working electronic ignition system in your car.

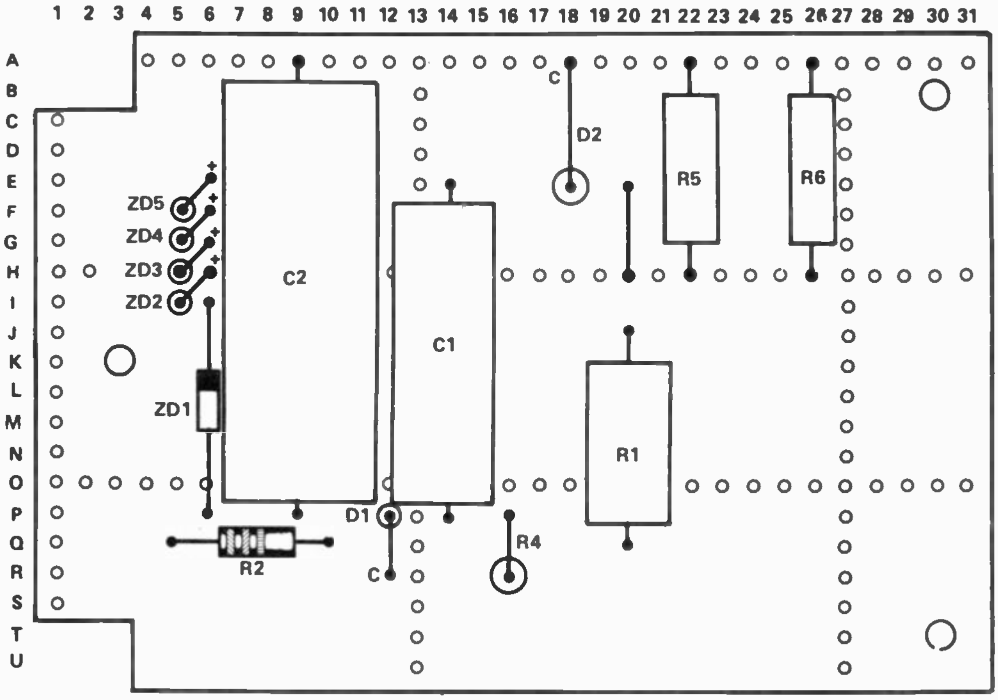


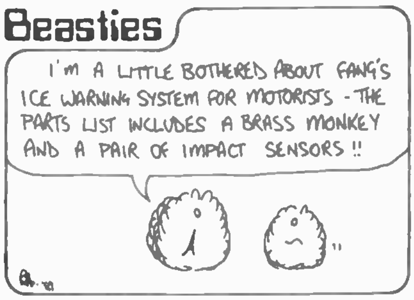

**Figure 6. Veroboard layout of the project.**

## Buylines

**Technomatic Ltd, who advertise in HE, are producing a full kit of parts for this project including case, insulating washers and Veroboard. The price is £18.50 including VAT, for callers.**

**Mail-order customers please add 70p to cover p&p.**

**HE**



## TTLs by TEXAS

| | | | | | |
|---|---|---|---|---|---|
| | | 74367 | 60p | 4025 | 20p |
| 7400 | 11p | 74368 | 60p | 4026 | 130p |
| 7401 | 12p | 74390 | 100p | 4027 | 40p |
| 7402 | 12p | 74393 | 120p | 4028 | 60p |
| 7403 | 14p | 74490 | 150p | 4029 | 75p |
| 7404 | 14p | | | 4030 | 40p |
| 7405 | 18p | 74LS SERIES | | 4031 | 170p |
| 7406 | 30p | 74LS00 | 14p | 4034 | 200p |
| 7407 | 30p | 74LS02 | 14p | 4035 | 110p |
| 7408 | 16p | 74LS03 | 18p | 4036 | 295p |
| 7409 | 16p | 74LS04 | 16p | 4039 | 295p |
| 7410 | 15p | 74LS05 | 20p | 4040 | 60p |
| 7411 | 20p | 74LS08 | 20p | 4041 | 80p |
| 7412 | 20p | 74LS09 | 20p | 4042 | 65p |
| 7413 | 25p | 74LS10 | 20p | 4043 | 75p |
| 7414 | 35p | 74LS11 | 30p | 4044 | 70p |
| 74C14 | 90p | 74LS13 | 30p | 4046 | 80p |
| 7416 | 27p | 74LS14 | 50p | 4047 | 75p |
| 7417 | 27p | 74LS20 | 20p | 4048 | 55p |
| 7420 | 17p | 74LS21 | 30p | 4049 | 30p |
| 7421 | 30p | 74LS27 | 30p | 4050 | 30p |
| 7422 | 22p | 74LS30 | 20p | 4051 | 65p |
| 7423 | 25p | 74LS32 | 27p | 4052 | 80p |
| 7425 | 30p | 74LS37 | 30p | 4053 | 65p |
| 7426 | 30p | 74LS38 | 30p | 4054 | 130p |
| 7427 | 25p | 74LS42 | 60p | 4055 | 125p |
| 7428 | 30p | 74LS47 | 60p | 4056 | 120p |
| 7430 | 17p | 74LS51 | 24p | 4059 | 500p |
| 7432 | 30p | 74LS55 | 30p | 4060 | 90p |
| 7433 | 30p | 74LS73 | 30p | 4063 | 100p |
| 7437 | 30p | 74LS74 | 27p | 4066 | 35p |
| 7438 | 30p | 74LS75 | 36p | 4067 | 400p |
| 7440 | 17p | 74LS76 | 36p | 4068 | 18p |
| 7441 | 70p | 74LS83 | 70p | 4069 | 20p |
| 7442A | 50p | 74LS85 | 80p | 4070 | 30p |
| 7443 | 112p | 74LS86 | 36p | 4071 | 25p |
| 7444 | 112p | 74LS90 | 40p | 4072 | 25p |
| 7445 | 80p | 74LS92 | 70p | 4073 | 25p |
| 7446A | 93p | 74LS93 | 50p | 4075 | 25p |
| 7447A | 60p | 74LS96 | 110p | 4076 | 60p |
| 7448 | 70p | 74LS107 | 45p | 4081 | 22p |
| 7450 | 17p | 74LS109 | 60p | 4082 | 27p |
| 7451 | 17p | 74LS112 | 40p | 4086 | 72p |
| 7453 | 17p | 74LS113 | 45p | 4089 | 150p |
| 7454 | 17p | 74LS114 | 45p | 4093 | 45p |
| 7460 | 17p | 74LS122 | 70p | 4094 | 200p |
| 7470 | 36p | 74LS123 | 60p | 4095 | 95p |
| 7472 | 30p | 74LS124 | 180p | 4096 | 95p |
| 7473 | 32p | 74LS125 | 50p | 4097 | 340p |
| 7474 | 30p | 74LS126 | 50p | 4098 | 90p |
| 7475 | 38p | 74LS132 | 60p | 4099 | 120p |
| 7476 | 32p | 74LS133 | 30p | 40100 | 220p |
| 7480 | 50p | 74LS136 | 45p | 40101 | 132p |
| 7481 | 100p | 74LS138 | 55p | 40102 | 180p |
| 7482 | 84p | 74LS139 | 55p | 40103 | 180p |
| 7483A | 60p | 74LS145 | 120p | 40104 | 99p |
| 7484 | 100p | 74LS147 | 160p | 40105 | 120p |
| 7485 | 110p | 74LS148 | 140p | 40106 | 50p |
| 7486 | 30p | 74LS151 | 70p | 40107 | 60p |
| 7489 | 210p | 74LS153 | 60p | 40108 | 470p |
| 7490A | 30p | 74LS154 | 200p | 40109 | 100p |
| 7491 | 80p | 74LS155 | 50p | 40110 | 300p |
| 7492A | 40p | 74LS156 | 50p | 40114 | 250p |
| 7493A | 30p | 74LS157 | 50p | 4502 | 90p |
| 7494 | 75p | 74LS158 | 60p | 4503 | 50p |
| 7495A | 60p | 74LS160 | 75p | 4507 | 45p |
| 7496 | 50p | 74LS161 | 75p | 4508 | 200p |
| 7497 | 180p | 74LS162 | 90p | 4510 | 70p |
| 74100 | 100p | 74LS163 | 60p | 4511 | 60p |
| 74107 | 34p | 74LS164 | 70p | 4512 | 80p |
| 74109 | 40p | 74LS165 | 100p | 4514 | 200p |
| 74116 | 100p | 74LS166 | 120p | 4515 | 200p |
| 74118 | 100p | 74LS170 | 120p | 4516 | 75p |
| 74119 | 100p | 74LS173 | 110p | 4518 | 70p |
| 74120 | 110p | 74LS174 | 80p | 4520 | 80p |
| 74121 | 34p | 74LS175 | 70p | 4521 | 200p |
| 74122 | 48p | 74LS181 | 200p | 4526 | 90p |
| 74123 | 60p | 74LS190 | 75p | 4527 | 150p |
| 74125 | 60p | 74LS191 | 75p | 4528 | 80p |
| 74126 | 60p | 74LS192 | 75p | 4532 | 110p |
| 74128 | 60p | 74LS193 | 75p | 4534 | 500p |
| 74132 | 60p | 74LS195 | 75p | 4536 | 300p |
| 74136 | 60p | 74LS196 | 75p | 4538 | 120p |
| 74141 | 75p | 74LS197 | 90p | 4543 | 140p |
| 74142 | 200p | 74LS221 | 90p | 4553 | 320p |
| 74145 | 90p | 74LS240 | 120p | 4556 | 60p |
| 74147 | 120p | 74LS241 | 120p | 4560 | 180p |
| 74148 | 100p | 74LS242 | 90p | 4569 | 180p |
| 74150 | 120p | 74LS243 | 90p | 4572 | 30p |
| 74151A | 50p | 74LS244 | 100p | 4583 | 100p |
| 74153 | 50p | 74LS245 | 120p | 4584 | 50p |
| 74154 | 90p | 74LS247 | 140p | 4585 | 100p |
| 74155 | 60p | 74LS251 | 75p | 4724 | 150p |
| 74156 | 60p | 74LS253 | 75p | 40097 | 90p |
| 74157 | 60p | 74LS257 | 75p | 14411 | 700p |
| 74159 | 120p | 74LS258 | 75p | 14412 | 900p |
| 74160 | 70p | 74LS259 | 100p | 14433 | 1100p |
| 74161 | 70p | 74LS266 | 100p | 14500 | 700p |
| 74162 | 70p | 74LS273 | 120p | 14599 | 290p |
| 74163 | 70p | 74LS279 | 55p | | |
| 74164 | 90p | 74LS283 | 75p | | |
| 74165 | 90p | 74LS298 | 160p | | |
| 74166 | 90p | 74LS323 | 250p | | |
| 74167 | 200p | 74LS324 | 150p | | |
| 74170 | 200p | 74LS348 | 200p | | |
| 74172 | 300p | 74LS365 | 48p | | |
| 74173 | 90p | 74LS367 | 50p | INTERFACE ICs | |
| 74174 | 75p | 74LS368 | 50p | AD536A | £13 |
| 74175 | 75p | 74LS373 | 120p | AD561J | 1400p |
| 74176 | 70p | 74LS374 | 120p | AD7524 | 600p |
| 74177 | 90p | 74LS375 | 60p | DM8131 | 375p |
| 74178 | 100p | 74LS377 | 100p | DP8304 | 450p |
| 74180 | 80p | 74LS378 | 80p | DS8835 | 250p |
| 74181 | 160p | 74LS390 | 90p | DS8836 | 150p |
| 74182 | 90p | 74LS393 | 90p | DS8838 | 225p |
| 74184A | 120p | 74LS399 | 200p | MC1488 | 65p |
| 74185 | 120p | 74LS445 | 140p | MC1489 | 65p |
| 74186 | 500p | 74LS670 | 225p | MC3446 | 300p |
| 74188 | 325p | | | MC3480 | 850p |
| 74190 | 90p | 4000 SERIES | | 25S10 | 350p |
| 74191 | 90p | 4000 | 15p | 58174 | £12 |
| 74192 | 90p | 4001 | 18p | 75107 | 160p |
| 74193 | 90p | 4002 | 20p | 75110 | 160p |
| 74194 | 90p | 4006 | 70p | 75114 | 160p |
| 74195 | 95p | 4007 | 20p | 75150 | 175p |
| 74196 | 70p | 4008 | 70p | 75154 | 175p |
| 74197 | 80p | 4009 | 40p | 75182 | 230p |
| 74198 | 120p | 4010 | 40p | 75324 | 375p |
| 74199 | 120p | 4011 | 16p | 75361 | 150p |
| 74221 | 90p | 4012 | 25p | 75363 | 150p |
| 74251 | 100p | 4013 | 35p | 75365 | 150p |
| 74259 | 120p | 4014 | 75p | 75451/2 | 72p |
| 74278 | 200p | 4015 | 70p | 75491/2 | 70p |
| 74279 | 110p | 4016 | 35p | 8T26 | 160p |
| 74283 | 140p | 4017 | 50p | 8T28 | 160p |
| 74284 | 250p | 4018 | 70p | 8T95 | 180p |
| 74285 | 250p | 4019 | 45p | 8T97 | 160p |
| 74290 | 100p | 4020 | 65p | 81LS95 | 120p |
| 74293 | 100p | 4021 | 75p | 81LS96 | 140p |
| 74298 | 100p | 4022 | 700p | 81LS97 | 120p |
| 74365 | 60p | 4023 | 20p | 81LS98 | 140p |
| 74366 | 60p | 4024 | 40p | 9602 | 220p |

| 93 SERIES | | 74S SERIES | | | |
|---|---|---|---|---|---|
| | | | | 74S114 | 120p |
| 9301 | 160p | 74S00 | 60p | 74S124 | 300p |
| 9302 | 175p | 74S04 | 60p | 74S132 | 160p |
| 9308 | 316p | 74S05 | 75p | 74S133 | 75p |
| 9310 | 275p | 74S08 | 75p | 74S138 | 225p |
| 9311 | 275p | 74S10 | 60p | 74S139 | 225p |
| 9312 | 160p | 74S20 | 60p | 74S157 | 250p |
| 9314 | 165p | 74S30 | 60p | 74S163 | 300p |
| 9316 | 225p | 74S32 | 90p | 74S174 | 250p |
| 9321 | 225p | 74S37 | 90p | 74S175 | 320p |
| 9322 | 150p | 74S64 | 60p | 74S194 | 350p |
| 9334 | 360p | 74S74 | 90p | 74S241 | 450p |
| 9368 | 250p | 74S85 | 300p | 74S260 | 70p |
| 9370 | 300p | 74S86 | 180p | 74S373 | 500p |
| 9374 | 200p | 74S112 | 120p | 74S374 | 500p |

## LINEAR ICs

| | | | |
|---|---|---|---|
| AY1-0212 | 600p | MC1310P | 150p |
| AY1-1313 | 668p | MC1458 | 48p |
| AY1-1320 | 320p | MC1495L | 350p |
| AY1-5050 | 140p | MC1496 | 70p |
| AY3-1270 | 840p | MC3340P | 120p |
| AY3-8910 | 750p | MC3403 | 90p |
| AY3-8912 | 650p | MM57160 | 620p |
| AY5-4007D | 520p | NE531 | 150p |
| CA3046 | 70p | NE555 | 20p |
| CA3048 | 225p | NE556 | 70p |
| CA3080E | 72p | NE564 | 420p |
| CA3086 | 48p | NE565 | 130p |
| CA3089E | 225p | NE566 | 155p |
| CA3090AQ | 375p | NE567 | 140p |
| CA3130E | 90p | NE571 | 425p |
| CA3140E | 50p | NE5534A | 250p |
| CA3160E | 100p | PLL02A | 500p |
| CA3161E | 140p | S566B | 270p |
| CA3162E | 450p | SAD1024A | 1250p |
| CA3189E | 300p | SFF96364 | 800p |
| CA3280 | 160p | SL490 | 400p |
| DAC1408-8 | 200p | SN76477 | 175p |
| HA1388 | 260p | SP8515 | 750p |
| ICL7106 | 850p | TA7120 | 200p |
| ICL8038 | 300p | TA7204 | 250p |
| ICM7555 | 80p | TA7205 | 250p |
| LF1331 | 30p | TA7222 | 200p |
| LF351 | 48p | TA7310 | 200p |
| LF356P | 95p | TAA621 | 275p |
| LM10C | 425p | TBA641B11 | 300p |
| LM301A | 27p | TBA651 | 200p |
| LM311 | 70p | TBA800 | 90p |
| LM318 | 200p | TBA810 | 100p |
| LM319 | 225p | TBA820 | 90p |
| LM324 | 45p | TBA950 | 300p |
| LM339 | 75p | TCA220 | 350p |
| LM348 | 95p | TCA940 | 175p |
| LM358P | 50p | TDA1004 | 300p |
| LM377 | 175p | TDA1008 | 320p |
| LM380 | 75p | TDA1010 | 225p |
| LM381AN | 180p | TDA1022 | 570p |
| LM386 | 95p | TDA1024 | 120p |
| LM393 | 100p | TDA1034B | 250p |
| LM709 | 36p | TDA1170 | 300p |
| LM710 | 50p | TDA2002V | 325p |
| LM725 | 350p | TDA2020 | 320p |
| LM733 | 100p | TL071/81 | 45p |
| LM741 | 18p | TL072/82 | 75p |
| LM747 | 70p | TL074 | 130p |
| LM748 | 35p | TL084 | 110p |
| LM2917 | 250p | TL170 | 50p |
| LM3302 | 100p | UAA170 | 175p |
| LM3900 | 70p | ULN2003 | 100p |
| LM3909 | 70p | UPC1156H | 300p |
| LM3911 | 130p | XR2206 | 300p |
| LM3914 | 225p | ZN414 | 90p |
| LM3915 | 225p | ZN419C | 225p |
| LM3916 | 225p | ZN424E | 135p |
| LM13600 | 125p | ZN425E | 350p |
| MB3712 | 200p | ZN427E | 650p |
| | | ZN1034 | 200p |

## VOLTAGE REGULATORS

Fixed Plastic TO-220

| | +ve | | -ve | |
|---|---|---|---|---|
| | | | 7905 | 60p |
| 1A | | | 7912 | 80p |
| 5V | 7805 | 55p | 7915 | 60p |
| 12V | 7812 | 55p | 7918 | 70p |
| 15V | 7815 | 55p | 7924 | 70p |
| 18V | 7818 | 55p | 79L05 | 70p |
| 24V | 7824 | 55p | 79L12 | 70p |
| 100mA | TO-92 | | 79L15 | 70p |
| 5V | 78L05 | 30p | | |
| 12V | 78L12 | 30p | | |
| 15V | 78L15 | 30p | | |

OTHER REGULATORS

| | | | |
|---|---|---|---|
| | | 78HGKC | 600p |
| LM309K | 135p | 78HO5KC | 550p |
| LM317T | 200p | 78MGT2C | 135p |
| LM323K | 500p | 79HGKC | 600p |
| LM723 | 37p | TL497 | 300p |

## OPTO-ELECTRONICS

| | | | |
|---|---|---|---|
| 2N5777 | 45p | ORP60 | 120p |
| OCP71 | 180p | ORP61 | 120p |
| ORP12 | 120p | TIL78 | 55p |

OPTO-ISOLATORS

| | | | |
|---|---|---|---|
| ILD74 | 130p | TIL111 | 90p |
| MCT26 | 100p | TIL112 | 90p |
| MCS2400 | 190p | TIL116 | 90p |

LEDS

| | | | |
|---|---|---|---|
| 0.125" | | 0.2" | |
| | | TIL220 Red | 16p |
| TIL32 | 55p | TIL222 Gr | 18p |
| TIL209 Red | 13p | TIL228 Red | 22p |
| TIL211 Gr | 20p | Rectangular | |
| TIL212 Ye | 25p | LEDs (R, G, Y) | 30p |
| TIL216 Red | 18p | NSB5881 | 570p |
| | | TIL311 | 600p |

DISPLAYS

| | | | |
|---|---|---|---|
| | | TIL312/3 | 110p |
| 3015F | 200p | TIL321/2 | 130p |
| DL704 | 140p | TIL330 | 140p |
| DL707 Red | 140p | 7750/60 | 200p |
| FND357 | 120p | DRIVERS | |
| FND500 | 110p | 9368 | 250p |
| FND507 | 110p | 9370 | 300p |
| MAN3640 | 175p | UDN6118 | 320p |
| MAN4640 | 200p | UDN6184 | 320p |

## TRANSISTORS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AC126 | 25p | BFR40 | 25p | TIP30A | 48p | 2N3055 | 48p |
| AC127/8 | 20p | BFR41 | 25p | TIP30C | 60p | 2N3442 | 140p |
| AC176 | 25p | BFR79 | 25p | TIP31A | 58p | 2N3553 | 240p |
| AC187/8 | 25p | BFR80 | 25p | TIP31C | 62p | 2N3565 | 30p |
| AF116 | 50p | BFR81 | 25p | TIP32A | 68p | 2N3584 | 250p |
| AD149 | 70p | BFX29 | 40p | TIP32C | 82p | 2N3643/4 | 48p |
| AD161/2 | 45p | BFX30 | 34p | TIP33A | 90p | 2N3702/3 | 12p |
| AU107 | 200p | BFX84/5 | 40p | TIP33C | 114p | 2N3704/5 | 12p |
| BC107/8 | 11p | BFX86/7 | 30p | TIP34A | 115p | 2N3706/7 | 12p |
| BC109 | 11p | BFX88 | 30p | TIP34C | 160p | 2N3708/9 | 12p |
| BC117 | 20p | BFW10 | 90p | TIP35A | 225p | 2N3773 | 300p |
| BC147/8 | 9p | BFY50 | 30p | TIP35C | 290p | 2N3819 | 25p |
| BC149 | 10p | BFY51/2 | 30p | TIP36A | 270p | 2N3820 | 50p |
| BC157/8 | 10p | BFY56 | 33p | TIP36C | 340p | 2N3823 | 70p |
| BC159 | 11p | BFY90 | 90p | TIP41A | 65p | 2N3866 | 90p |
| BC169C | 12p | BRY39 | 45p | TIP41C | 78p | 2N3902 | 700p |
| BC172 | 12p | BSX19/20 | 24p | TIP42A | 70p | 2N3903/4 | 18p |
| BC177/8 | 17p | BU104 | 225p | TIP42C | 82p | 2N3905/6 | 20p |
| BC179 | 18p | BU105 | 190p | TIP54 | 160p | 2N4037 | 65p |
| BC182/3 | 10p | BU108 | 250p | TIP120 | 120p | 2N4058/9 | 12p |
| BC184 | 11p | BU109 | 225p | TIP122 | 130p | 2N4061/2 | 18p |
| BC187 | 30p | BU126 | 150p | TIP142 | 130p | 2N4123/4 | 27p |
| BC212/3 | 11p | BU180A | 120p | TIP147 | 130p | 2N4125/6 | 27p |
| BC214 | 12p | BU205 | 200p | TIP2955 | 78p | 2N4401/3 | 27p |
| BC237 | 15p | BU208 | 200p | TIP4055 | 70p | 2N4427 | 90p |
| BC327 | 16p | BU406 | 145p | TIS43 | 48p | 2N4871 | 60p |
| BC337 | 16p | E300 | 50p | TIS93 | 30p | 2N5087 | 27p |
| BC338 | 16p | E308 | 50p | ZTX108 | 12p | 2N5089 | 27p |
| BC461 | 36p | E310 | 50p | ZTX300 | 13p | 2N5172 | 27p |
| BC477/8 | 30p | MJ2501 | 225p | ZTX500 | 15p | 2N5179 | 90p |
| BC516/7 | 40p | MJ2955 | 90p | ZTX502 | 18p | 2N5191 | 90p |
| BC547B | 16p | MJ3001 | 225p | ZTX504 | 30p | 2N5194 | 90p |
| BC548C | 9p | MJE340 | 60p | 2N457A | 250p | 2N5245 | 40p |
| BC549C | 18p | MJE2955 | 100p | 2N696 | 35p | 2N5296 | 55p |
| BC557B | 16p | MJE3055 | 70p | 2N697 | 25p | 2N5401 | 50p |
| BC559C | 18p | MPF102 | 45p | 2N698 | 45p | 2N5457/8 | 40p |
| BCY70 | 18p | MPF103/4 | 40p | 2N706A | 30p | 2N5459 | 40p |
| BCY71/2 | 22p | MPF105/6 | 40p | 2N708 | 30p | 2N5460 | 60p |
| BD131/2 | 50p | MPS6531 | 50p | 2N918 | 45p | 2N5485 | 44p |
| BD135/6 | 54p | MPS6534 | 50p | 2N930 | 18p | 2N5875 | 250p |
| BD139 | 56p | MPSA06 | 30p | 2N1131/2 | 36p | 2N6027 | 48p |
| BD140 | 60p | MPSA12 | 50p | 2N1613 | 25p | 2N6041 | 160p |
| BD189 | 60p | MPSA13 | 50p | 2N1711 | 25p | 2N6044 | 160p |
| BD232 | 95p | MPSA20 | 50p | 2N2102 | 70p | 2N6052 | 300p |
| BD233 | 75p | MPSA42 | 50p | 2N2160 | 350p | 2N6059 | 325p |
| BD235 | 85p | MPSA43 | 50p | 2N2219A | 30p | 2N6107 | 65p |
| BD241 | 70p | MPSA56 | 32p | 2N2222A | 30p | 2N6247 | 190p |
| BD242 | 70p | MPSA70 | 50p | 2N2369A | 25p | 2N6254 | 130p |
| BDY56 | 200p | MPSU06 | 63p | 2N2484 | 30p | 2N6290 | 65p |
| BF200 | 32p | MPSU07 | 60p | 2N2646 | 45p | 2N6292 | 65p |
| BF244B | 35p | MPSU45 | 90p | 2N2904/5 | 30p | 2SC1172 | 150p |
| BF256B | 70p | MPSU65 | 78p | 2N2906A | 30p | 2SC1306 | 150p |
| BF257/8 | 32p | OC28 | 130p | 2N2907A | 30p | 2SC2028 | 120p |
| BF259 | 36p | OC35 | 130p | 2N2926 | 9p | 2SC2029 | 250p |
| BFR39 | 25p | TIP29A | 40p | 2N3053 | 30p | 2SC2078 | 200p |
| | | TIP29C | 55p | 2N3054 | 65p | 3N128 | 120p |

| | |
|---|---|
| 3N140 | 120p |
| 3N141 | 110p |
| 3N201 | 110p |
| 3N204 | 120p |
| 40290 | 250p |
| 40361/2 | 75p |
| 40408 | 90p |
| 40409 | 100p |
| 40410 | 100p |
| 40411 | 300p |
| 40594 | 120p |
| 40595 | 120p |
| 40673 | 75p |
| 40871/2 | 100p |

DIODES

| | |
|---|---|
| BY127 | 12p |
| BYX36-300 | 20p |
| OA47 | 9p |
| OA81 | 15p |
| OA85 | 15p |
| OA90 | 9p |
| OA91 | 9p |
| OA95 | 9p |
| OA200 | 9p |
| OA202 | 10p |
| 1N914 | 4p |
| 1N916 | 7p |
| 1N4148 | 4p |
| 1N4001/2 | 5p |
| 1N4003/4 | 6p |
| 1N4005 | 6p |
| 1N4006/7 | 7p |
| 1N5401/3 | 14p |
| 1N5404/7 | 19p |
| IS920 | 9p |

HEAT SINKS
For TO220 Voltage Regs. and transistors 22p
For TO5 12p

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 | 400p |

ZENERS
2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC

| | |
|---|---|
| 3A 400V | 60p |
| 6A 400V | 70p |
| 6A 500V | 88p |
| 8A 400V | 75p |
| 8A 500V | 95p |
| 12A 400V | 85p |
| 12A 500V | 105p |
| 16A 400V | 110p |
| 16A 500V | 130p |
| T2800D | 130p |

THYRISTORS

| | |
|---|---|
| 1A 50V | 70p |
| 1A 400V | 90p |
| 3A 400V | 100p |
| 8A 600V | 140p |
| 12A 400V | 160p |
| 16A 100V | 160p |
| 16A 400V | 180p |
| BT106 | 110p |
| C106D | 45p |
| MCR101 | 36p |
| TIC44 | 27p |
| 2N3525 | 130p |
| 2N4444 | 140p |
| 2N5060 | 34p |
| 2N5064 | 40p |

LOUDSPEAKERS

| Size | | |
|---|---|---|
| 2½" | 64R | 80p |
| 2½" | 8R | 80p |
| 2" | 8R | 90p |
| 1½" | 8R | 100p |

MODULATORS
6MHz UHF 375p
8MHz UHF 450p

## MEMORIES

| | |
|---|---|
| 2101-4L | 400p |
| 2102-2L | 120p |
| 2107B | 500p |
| 2111-4 | 250p |
| 2112-4 | 300p |
| 2114 | 200p |
| 2114-2L | 300p |
| 4027-3 | 300p |
| 4044 | 700p |
| 4116 | 200p |
| 4118-4 | 550p |
| 5101 | 300p |
| 6116 | £12 |
| 6514-45 | £5 |
| 6810 | 200p |

ROM/PROMs

| | |
|---|---|
| 71301 | 700p |
| 74S188 | 225p |
| 74S287 | 350p |
| 74S471 | 650p |
| 74S571 | 650p |

CPUs

| | |
|---|---|
| 1600 | 1200p |
| 1802CE | 750p |
| 2650A | £16 |
| 6502 | 500p |
| 6800 | 370p |
| 6802 | 550p |
| 6809 | £16 |
| 8080A | 450p |
| 8085A | 550p |
| 1NS8060 | 1000p |
| TMS9980A | £20 |
| Z80 | 450p |
| Z80A | 550p |

EPROMs

| | |
|---|---|
| 1702A | 500p |
| 2708 | 350p |
| 2716 (+5V) | 500p |
| 2532 | 750p |
| 2732 | 750p |

SUPPORT DEVICES

| | |
|---|---|
| 3242 | 800p |
| 3245 | 450p |
| 6522 | 500p |
| 6532 | 825p |
| 6820 | 375p |
| 6821 | 180p |
| 6845 | £10 |
| 6850 | 180p |
| 6852 | 370p |
| 6875 | 600p |
| 8154 | 950p |
| 8155 | 800p |
| 8205 | 320p |
| 8212 | 200p |
| 8216 | 200p |
| 8224 | 250p |
| 8226 | 250p |
| 8228 | 250p |
| 8251 | 400p |
| 8253 | 800p |
| 8255 | 400p |
| 8257 | 800p |
| 8259 | 800p |

| | |
|---|---|
| 8279 | 950p |
| TMS9918 | POA |
| Z80P10 | 400p |
| Z80AP10 | 450p |
| Z80CTC | 400p |
| Z80ACTC | 500p |
| Z80ADART | £12 |
| Z80ADMA | £10 |
| Z80S10-1 | £20 |

UART

| | |
|---|---|
| AY-3-1015P | 400p |
| AY-5-1013P | 350p |
| IM6402 | 450p |

CHARACTER GENERATORS

| | |
|---|---|
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| 5.0MHz | 250p |
| 6.0MHz | 250p |
| 6.144MHz | 250p |
| 7.0MHz | 250p |
| 7.168MHz | 250p |
| 8.00MHz | 250p |
| 8.867MHz | 250p |
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# Radio Control

## The hobby of building land, sea and air models, operated by radio control, is increasing in popularity. Pete Christy* looks at what's entailed, particularly with airborne models

IT HAS BEEN SAID that a radio-controlled model aircraft is the ultimate case of putting your money where your mouth is. Certainly, to the electronics enthusiast a radio control system offers a unique challenge. To aviation enthusiasts it offers a cheaper, safer, and less rule-bound alternative to full-size flying.

Many of you, no doubt, will have witnessed radio-controlled models in action. Flying displays are rapidly becoming major attractions at local fêtes and carnivals. As with so many activities, the experts make it look so easy that many a spectator has been tempted to have a go. Sadly, without some experienced guidance, such solo efforts are almost invariably doomed to failure. Consequently, radio control has acquired a reputation of being a tricky and expensive pastime. Provided the right approach is adopted, neither of these criticisms is particularly true. The purpose of this article is to provide a bit of background information to assist would-be enthusiasts.

### Early Flights

The first radio-controlled model aircraft were developed during the 30s. Until that time the only type of model aircraft around were those designed for free flight. As the name suggests these models were intended to fly untethered as were their full-sized counterparts. The absence of a pilot or any other control system required careful aerodynamic design to ensure that the aircraft was inherently stable. Once launched it was on its own, and its fate was determined by the skill that went into its design and trimming. Despite the apparent shortcomings of such models they represented an interesting challenge, and free flight thrives to this day. It was apparent even in these early days that the ultimate model aircraft was going to be radio-controlled. At the time no frequency allocations had been made for the purpose, and so aeromodellers teamed up with radio amateurs. It was this combination that finally brought success.

Most of these early developments took place in the USA and France, and even before the war the Americans were running radio control events at their national championships. One early American pioneer was Dr Walt Good. While most contemporary radio-controlled aircraft only offered control of one function (usually the rudder), he developed an amazing control system. It consisted of a rotating vane mounted behind the tailplane, and this vane normally rotated freely in the slipstream. On receipt of a coded command, it could be stopped in one of four positions, providing left and right rudder — plus up and down elevator. Using this system, he won several national championships before these activities were abruptly terminated by the Second World War.

After the war, development quickly took up where it left off, much aided by the ready availability of surplus war equipment. Most governments made an allocation in the 27 MHz band for model control at this time.

Perhaps 'radio-controlled' is too strong a term to describe many of these early efforts. Usually only one function, the rudder, could be controlled and on a fairly erratic basis.

This model is a Power House, a 1940s design. In its original form, it was intended for free flight but the model shown here is radio-assisted

### Move Towards Reliability

Reliability was not a word usually associated with these early systems. Most of these aircraft were designed for 'free flight' with occasional nudges from the 'pilot' to aim them in the appropriate direction — 'radio affected' may be a more accurate description. Transistors were unheard of in those days, and it required a fairly large model to haul aloft the valve receivers and associated high-voltage power supplies.

By the late 50s and early 60s, the transistor had arrived. Sizes came down, reliability improved and radio control started to come within the reach of the average modeller. More sophisticated control systems started to appear, and in the early 60s the legendary (or notorious) space control system appeared. For the first time a system offering smooth proportional control was available. In other words, the further the control stick was moved, the further the control surface moved. Previous radio control systems were of the 'bang-bang' variety: operating a switch on the transmitter caused the control surface to move over to its fullest extreme, returning to neutral when the switch was released. This was somewhat like trying to control the speed of a car by jamming the throttle wide open, and switching the ignition on and off. The space control system also allowed the pilot to operate all the controls simultaneously, instead of one, or at the most two, at a time. At last a system was available that offered (at a considerable price) all the control functions available to the pilot of a full-sized aircraft.

However, reliability was still a problem. Although much improved from the early days, the first proportional systems left a lot to be desired. Based on analogue computer principles, drift in response to temperature or battery voltage fluctuations was a major problem. Also the servo motors were controlled by vary-

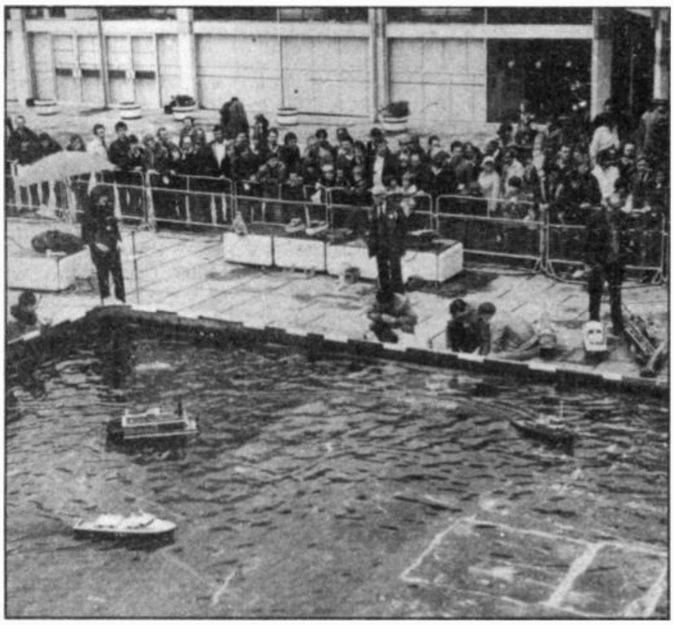
*The author is technical consultant to a radio control equipment manufacturer ing DC voltages. The ensuing soggy control response came in for much criticism. In response to this criticism two Americans, Don Mathes and Doug Spreng, developed a digital system. It was so successful that within two years analogue had been wiped off the market. It was this digital system that was the basis of virtually all currently available radio-controlled systems. Apart from its greater reliability compared with the analogue systems, it was able to make use of cheap integrated circuits that were just starting to become generally available.

Although the versions available now are much more highly developed, the basic principles of operation remain the same. Indeed, so successful and simple are the modern versions that they have replaced the old 'single channel' systems which once represented the bottom of the market.

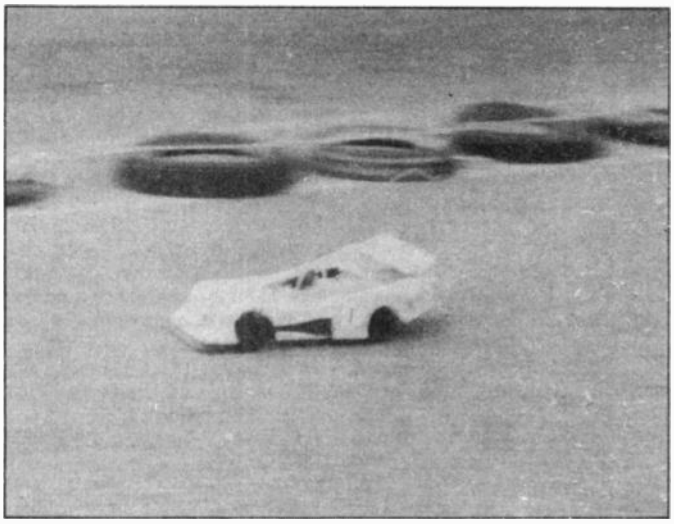
## Choice Of Model

Having acquired a radio control system, the next question is: what to control with it? Well, virtually any model of anything can be radio-controlled. The more usual applications are boats, cars and aircraft. In all three categories there are a wide variety of types for different applications. Perhaps the simplest examples are the 'toy' boats and cars that are now becoming cheaply and readily available. At the other extreme in the car and boat market are some extremely sophisticated machines capable of surprising speed. For example, one racing car kit now available features fully independent suspension, limited slip differential, and a top speed (on a suitable surface) that wouldn't disgrace a small family saloon! A kit like that costs over £100, less the engine and radio, and must be considered a specialist project. For boat and car use a two-channel radio control system is adequate, though some models may occasionally use three.

Incidentally, 'channel' in relation to a radio control system refers to the number of functions it will control, *not* the number of frequencies it operates on. My particular speciality is aircraft, and you will notice that this article is biased towards aircraft models. However, most of the principles apply to all radio-controlled models.



**Special pool laid for the model boats at Sandown Park Racecourse***



**One of the radio-controlled model racing cars moving at high speed around the specially adapted circuit at Sandown Park Racecourse. Some of the crashes looked painfully realistic**

***Courtesy of RADIO MODELLER, Model & Allied Publications**

## Model Aircraft

Aircraft models cover a wide spectrum. The range of models that have been built span from simple gliders and low-powered trainers through to multi-engined scale replicas of famous aircraft. Probably the most sophisticated model aircraft is the helicopter. First demonstrated in the early 70s, model helicopters are now widely regarded as the ultimate challenge to a keen modeller.

**A Garbo helicopter. This was built from a kit imported from Italy***

For control of a car, boat or glider, two-channel control is adequate. For a glider these two channels would normally control rudder and elevator. The minimum number of channels required for full control of a powered aircraft is three: rudder, elevator and throttle. For more sophisticated aircraft and helicopters four channels are required, adding aileron controls. Scale models may have retracting undercarriages, flaps, bomb-drops and indeed anything else that your imagination can conjure up — the sky is literally the limit. Strictly speaking, these extras are luxuries and are not essential to the successful operation of the aircraft.

A typical 'standard' outfit will consist of a four-channel transmitter and receiver, four servos to operate the controls, and rechargeable nickel-cadmium battery packs. (The battery packs are often referred to as Ni-Cads or Deacs, for the same reason that all vacuum cleaners are called 'Hoovers'.) Radio-control systems can be run from dry cells, but this is usually a false economy. The capacity of dry cells is generally much less than good Ni-Cads, and the cost of replacing them every weekend is tremendous. A good set of Ni-Cads and a charger will pay for themselves inside a few months.

## How Radio Control Works

Nearly all modern radio control systems use the standard 'digital' technique. Each control stick on the transmitter determines the width of a pulse generated by the encoder, and each pulse is transmitted in sequence to the receiver. At the receiving end a decoder sorts out the pulses and feeds each one to the appropriate servo.

When the pulse arrives at the servo, a pulse cf the opposite polarity is generated, the width ('on' period) of which is determined by a potentiometer on the servo output shaft. The two pulses are then added. The result is a pulse with a width proportional to the amount of error between the two input pulses. It is the polarity of this pulse which indicates the direction of the error. **Figure 1** illustrates the principle. Because the drive signal fed to the servo motor consists of pulses at full voltage, regardless of width, the servo develops its maximum torque even on very small errors. The result is excellent servo response.

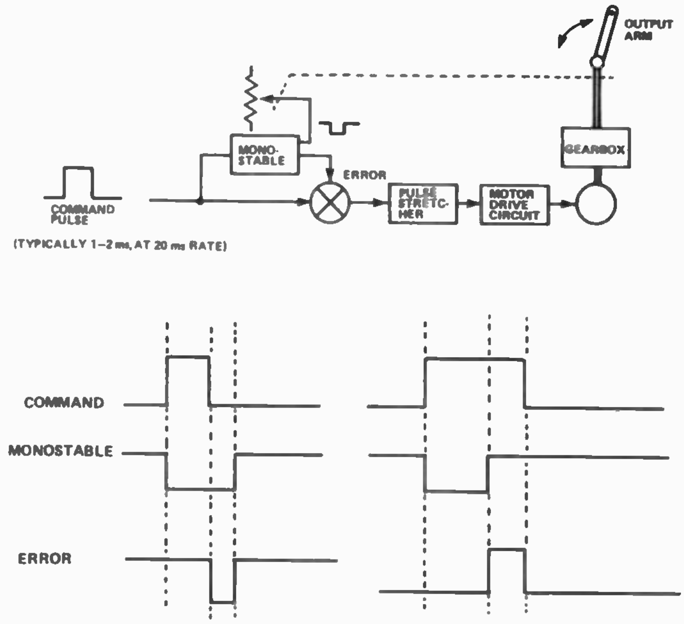



**Figure 1. Remote control, by means of digital pulses, of a servo system**

The control pulses in the transmitter are generated sequentially, with the trailing edge of the pulse for channel 1 coincident with the leading edge of that for channel 2. Consequently it is not necessary to transmit the whole pulse, but simply a marker pulse to indicate the end of channel 1 and the start of channel 2. This simplifies decoding at the receiver considerably. Decoding can be achieved with a simple CMOS counter, or TTL shift register. **Figure 2** shows the sequence of pulses.

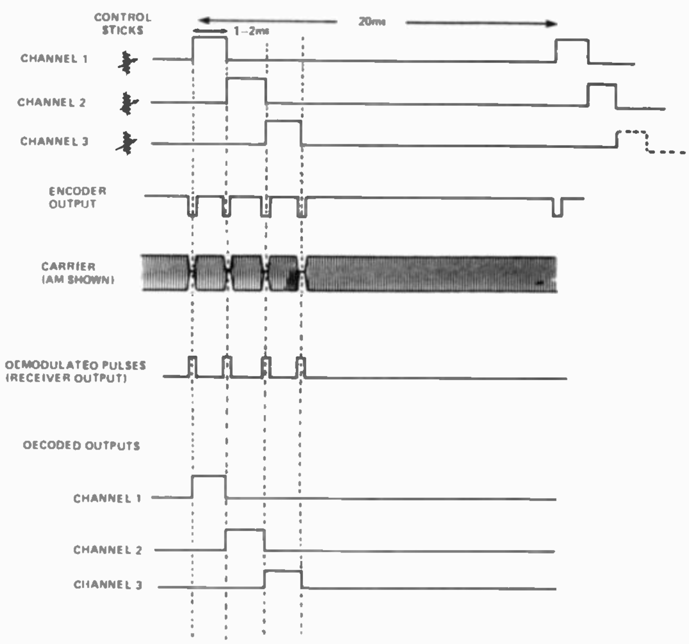



**Figure 2. Waveforms associated with encoding and decoding of control signals for a three-channel system**

Until a couple of years ago the pulses would have been transferred to the transmitted carrier wave by amplitude modulation (AM), but AM is rapidly losing ground in favour of frequency modulation (FM). The advantages of FM over AM are considerable. The range is generally improved, interference rejection is considerably increased and, because this mode of transmission is 'cleaner', it has proved possible to get more spot frequencies in a given band.

## Wavebands For Radio Control

The future of radio-controlled modelling looked somewhat uncertain until recently. Government dithering over the allocation of wavebands for radio control has caused much anguish to modellers. At last three wavebands were specified, details of which are given in **Table 1**.

| Band (MHz) | Maximum Output (W) | Usage |
|---|---|---|
| 26.96 - 27.28 | 1.5 | All models |
| 35.005 - 35.205 | 0.5 | Aircraft only |
| 458.5 - 459.5 | 0.5 | All models |

Note: Equipment for use on the 35 MHz band is subject to type approval procedures

**Table 1. New frequency allocations for radio-controlled models**

Some of you may have noticed that the 27 MHz allocation coincides with the band used for CB radio in many other countries. This has resulted in considerable problems over the past few years. The illegal operation of CB radios in this country has rendered the 27 MHz band virtually unusable near most big towns, and was a major factor in the granting of the new 35 MHz allocation for aircraft use. The 27 MHz band is also used by paging systems, and although pagers and modellers have peacefully coexisted for many years, 27 MHz must now be regarded as obsolete for aircraft use. I certainly couldn't recommend anyone intending to buy new equipment for aircraft to buy 27 MHz gear. Largely because of this situation, the price of 27 MHz equipment has come tumbling down of late. You can now buy a two-channel digital proportional transmitter and superhet receiver for £12. This is a great temptation to newcomers, but if you are thinking in terms of aircraft I would urge you to forget 27 MHz.

Virtually all modern equipment, whichever band it is designed for, will have a plug-in crystal facility. This enables the actual frequency of operation within the band to be changed quite simply. Some more expensive outfits also have a plug-in module facility which enables the equipment to be changed from, say, 27 MHz to 35 MHz.

Because of radio band congestion at many flying sites these days, and to prevent frequency clashes between individual modellers, it is normal practice to fly a pennant from the transmitter aerial. For the 27 MHz band, the colour of the pennant indicates the actual frequency in use. On the 35 MHz band, channel numbers are displayed on a square orange pennant.

The 35 MHz band is significantly smaller than the 27 MHz band. Also, the number of active modellers is increasing all the time. Because of this increased congestion, the channel spacing on the 35 MHz band is only 10 kHz. Previously, back on 27 MHz, the spacing had been 20 kHz. Unlike most other radio systems, a radio control system is almost always required to operate in the presence of very strong signals on the adjacent channels. The pilots are rarely more than a few yards from each other, and when a model is being carried to and from the pit area (space in which the pilots stand), it may be within a few feet of several transmitters putting out over 0.5 W within 100 kHz of each other. This obviously places severe strain on the front end of the receivers. At 10 kHz spacing the problems are even greater, and this was one of the main reasons for the switch to FM. Receivers operating on FM have much better immunity to interference in these high overload situations.

A bonus side effect was the almost total elimination of what is called 'glitching' in high speed models. In a very fast model, it is not unknown for the received signal strength to vary by over 120 dB (one *million* times) per second! Trying to build an AGC (automatic gain control) system to cope with changes as rapid and as large as this defeated many communications experts.

FM systems don't need an AGC, so they don't suffer from the dreaded 'high-speed glitch'.

However, to guarantee that the transmitters can operate safely with these narrow channel spacings, a type approval system is necessary. Consequently 35 MHz equipment tends to be more expensive. In radio control, as in anything else, you get what you pay for.

As can be seen from **Table 1**, an allocation in the ultra-high frequency (UHF) band has been made to modellers. Although long-distance transmission is possible at UHF for airborne models during flight, the ground range can be limited. (This can cause problems during take-off!)

## No Need For A Licence

From 1 January 1981, it was no longer necessary to obtain a licence to operate radio-controlled models. Up to that time it had been possible, through the issuing of licences, to gauge the number of modellers operating in the UK. In January, the total issued was close to 100,000 and had been increasing at a rate of about 1,000 each month.

## Flight Range

I am often asked, in connection with flying models, 'How far will they go?' As with most radio systems, the ground-to-air range will be considerably better than the ground-to-ground range. If everything is working correctly, the air range should be considerably in excess of visual range. In other words you will lose sight of the flying model before you lose radio contact. In terms of ground range this will translate to around one mile, depending on local conditions.

## Flying Hazards

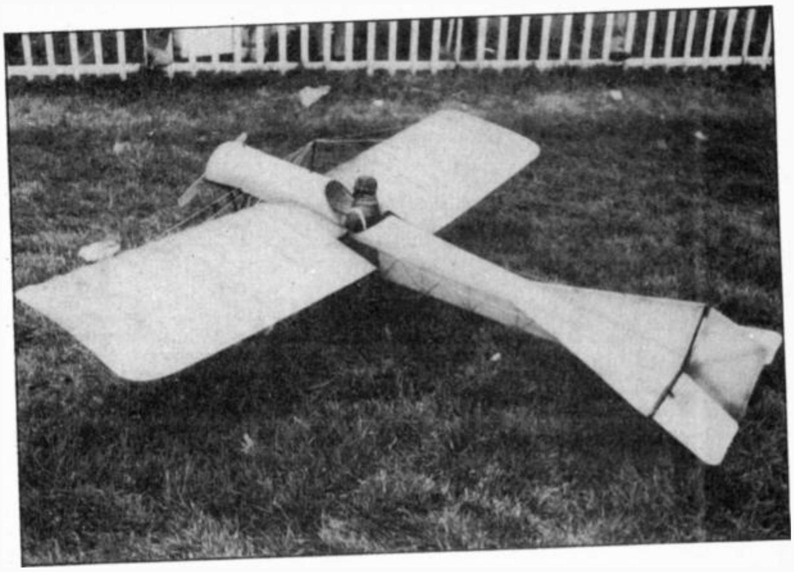
It is worth bearing in mind that an out-of-control model aircraft is a *potentially lethal missile*. Do not attempt to fly one in built-up areas, nor in parks unless you are under expert supervision! It may look easy when you see an expert do it, but the acquisition of these skills is not an overnight process. I strongly recommend taking out a third party insurance policy, no matter where you fly. These policies are very reasonably priced. Schemes are advertised in the modelling press, and most clubs offer club insurance schemes.

## Equipment Cost And Lifespan

It is just about possible to get a radio-controlled model aircraft into the air for under £100, buying everything new. However, a more realistic figure is probably about £220. A good set of 35 MHz radio equipment, which will be a four-channel outfit, will cost around £150. For a little bit less you could get a two- or three-channel set that would be expandable at a later date. Anything substantially cheaper is likely to be either restricted to 27 MHz, or with two or three channels but incapable of being expanded as your skills grow. A first class engine (always a good investment) in the 0.19 to 0.4 cu in bracket is likely to be between £25 and £40. A trainer type aircraft kit will be around £30 to £40.

This may all sound horrendously expensive, but it is nearly all initial outlay. The actual running costs are very low. For example, a good engine, reasonably well maintained, can have an expected working life of 5 to 10 years. A radio control system should last at least 5 years. The model itself is likely to be the cheapest element in the system, and also will have the shortest life. A crash has to be extremely severe before any significant damage will be caused to the engine. Similarly if the radio is properly installed, you have to be very unlucky to damage it severely in an accident. Airframes are, of course, another matter and must be regarded as expendable.

Radio failure is extremely rare these days. Most cases of 'radio failure' can be traced to three causes: pilot error, outside interference, and structural failure. Since most of these causes can be eliminated through taking reasonable precautions, the initial outlay spread over a number of years' use looks more attractive.



**Model based on a monoplane in use before World War I**

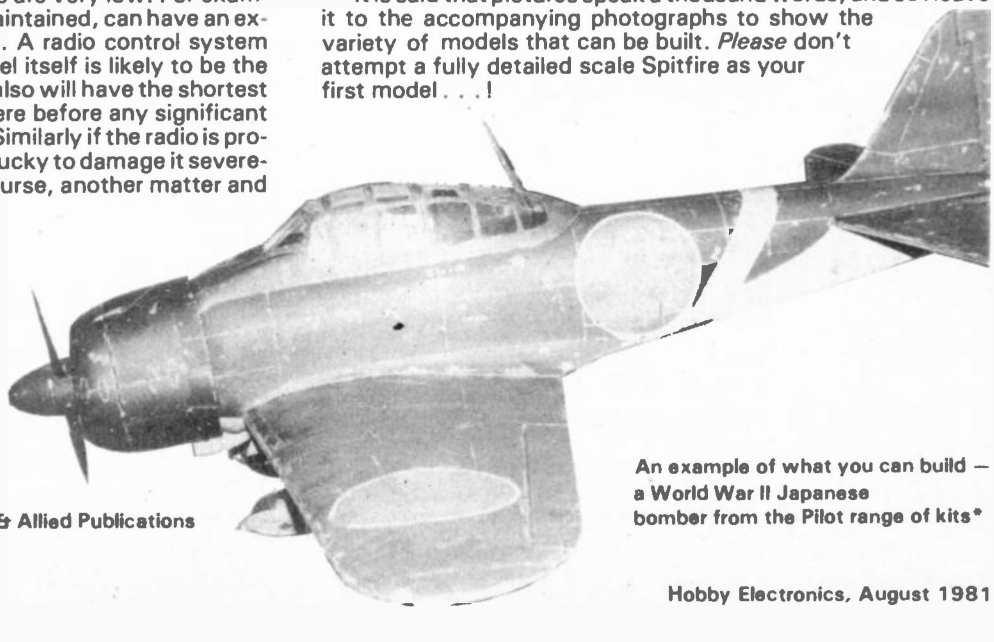
## Making The Right Start

While it is possible to teach yourself to build and fly radio-controlled model aircraft from scratch with no outside assistance, it is not a method I recommend. By far the best method is to seek assistance from the local club. Clubs are always ready to assist and welcome newcomers to the hobby. If you don't know where the local club flies, then contact the local model shop. It will be only too pleased to aim you in the right direction. If you don't know where the local model shop is, then a good guide is the modelling press. There are two magazines published monthly that specialise in radio control: Radio Modeller, and Radio Controlled Models and Electronics, both published by Model and Allied Publications (MAP). A third magazine, Aeromodeller, also from MAP, covers all aspects of model aircraft including radio control.

Another source of information relating to local clubs is the Society of Model Aeronautical Engineers (SMAE), Kimberley House, Vaughan Way, Leicester. The SMAE is the official body that represents modellers, and as such is well worth joining if you become an active modeller. It will be able to supply the addresses of any affiliated clubs that may be in your area.

For those more interested in the electronics behind radio control I thoroughly recommend a book entitled 'Theory and Practice of Model Radio Control' by Paul Newell. It's available from most good model shops and even from some public libraries.

It is said that pictures speak a thousand words, and so I leave it to the accompanying photographs to show the variety of models that can be built. *Please* don't attempt a fully detailed scale Spitfire as your first model . . . !



**An example of what you can build — a World War II Japanese bomber from the Pilot range of kits***

***Courtesy of RADIO MODELLER, Model & Allied Publications**

Example of a plastic ready-to-fly model from Japan. It needs an engine and a radio to be ready for take-off

The pictures shown give some idea of the kinds of models that can be operated by radio control. They were all taken at the Sixth Model Symposium, organised by Elmbridge Model Club at Sandown Park Racecourse on 9 and 10 May 1981. A full story of the event is given on page 20.

David Wilshere, aged 14, is seen here holding an Italian Aviamodelli Mach-1 model. With its tuned-pipe engine, this model is designed for aerobatics

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# Models Galore At Sandown

## As a change to horse racing, Sandown Park Racecourse featured, for just two days, a multiplicity of models

ON SATURDAY AND SUNDAY, 9-10 May 1981, Sandown Park Racecourse in Esher, Surrey was transformed. Instead of the sound of thundering hooves, the air was abuzz with model aeroplanes and helicopters.

This sixth model symposium, organised by Elmbridge Model Club, was reported as being the biggest yet.

HE made a visit at lunchtime on the Saturday when attendance seemed light, presumably because of the Cup Final. (A couple of TVs had been laid on in the grandstand bar area for football addicts.) Biggest attendance was, as in previous years, on the Sunday.

Events were taking place all round the grandstand. Part of the course was roped off for a continuous display of flying models, and this proved to be one of the greatest attractions. For instance, we were intrigued to see one helicopter hovering upside-down above another which was flying the correct way up, with only a few feet between the blades.

Other outside events included radio-controlled model car racing (fast and furious with some sickening grating sounds as cars overturned at the corners of the tarmac track) and radio-controlled model boats on a pool at the back of the grandstand. There was even a radio-controlled model duck!

It was possible to see all these radio-controlled models running side by side this year because the modellers had three frequencies at their disposal: 27, 35 and 459 MHz. (But see the comment under this month's Monitor on page 6 about modellers' fears over specifications for equipment coming into use on 35 MHz.)

Behind the grandstand, 'control line' flying displays were taking place, with the modellers pirouetting on sheets of board in the middle of the paddock, while their 'planes, held and controlled by double cords attached to the end of one wing, looped and dived in the air around them.

Meanwhile, for the indoor enthusiast (or for those who wanted to escape from the occasional burst of rain) there was a railway hall. Here the clubs had laid out displays of all the popular track-gauges. Somewhat incongruously, a slot-car racing layout attracted a big audience in one corner of the hall.

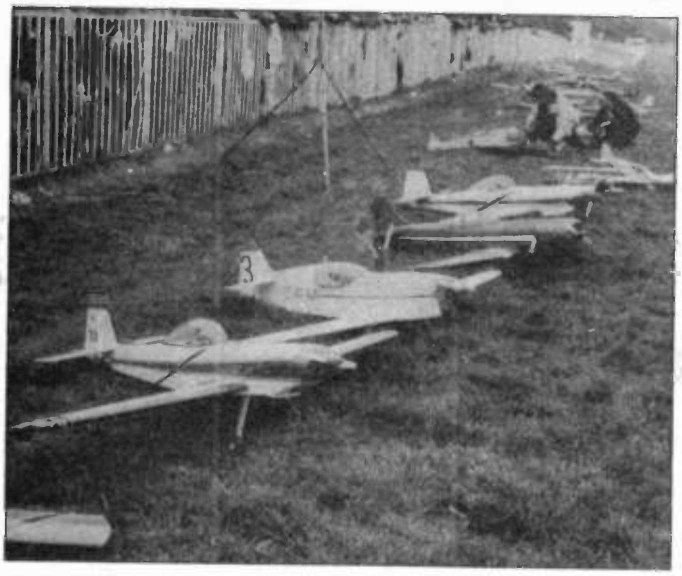
After goggling at finished and working models it was time to visit the trade hall, where you could choose your kit or bag of components . . . and pay the necessary cash.

We thought that the event was a credit to the organisers. Plenty of car parking space was available (even though it was a five-minute walk from the car park, around the outside of the course, to the entrance). Food and refreshments were on sale, and the grandstand enabled you to sit under cover.

You could take the family (we saw an abundance of kids, old and young), see the latest models, and have an enjoyable day out. Here's to number seven!

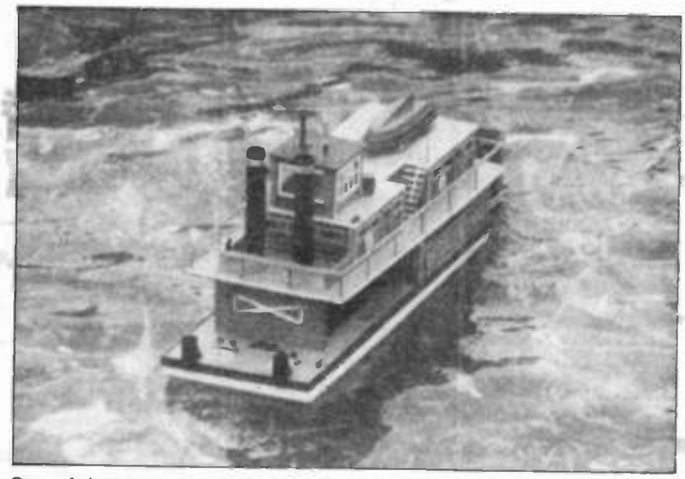
Two enthusiasts preparing a scale model of a Britten-Norman Firecracker for flight. This model uses two engines working on a common gearing system. The aeroplane on which this model is based is a new design and is in use by the RAF as a trainer

The Whitley bomber and its pilot from the Sprengbrook demonstration team. This model has been used over the last few years to drop 'toffee bombs' on the crowd at Sandown



▲ Model aeroplanes from Skyway in Bristol. These are supplied in kit form, with most of the components ready for assembly. The three models in the foreground are a Spinks Akromaster, a Percival Meugull (a plane in use between the First and Second World Wars) and a Russian YAK18

Yes — model helicopters *can* fly upside down! Here Len Mount from the Ripmax demonstration team is flying an inverted helicopter a few feet above one the right way up. Len developed his helicopter to fly in both modes. Both helicopters in this demonstration of 'mirror hovering' are Schluter models from Germany* ▶



One of the more unusual radio-controlled vessels (apart from the radio-controlled duck!). This is a beautifully-finished paddle steamer

A line-up of some of the radio-controlled boats. A high-speed model was racing by at the time (see foreground)

Model trains can be very absorbing . . . This young observer is seen admiring just one of the many layouts in the railway hall

Dave Nieman Models' stand — helicopter specialists based in Wembley. The firm also acts as the main importer of the Hirobo range of models from Japan*

*Courtesy of RADIO MODELLER, Model & Allied Publications

**FREE** OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

**TRANSMITTER SURVEILLANCE** *
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit £2.30.

**RADIO MIKE** *
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp £6.90 comp. kit

**SAFE BLOCK**
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit £1.95.

**6 WAVEBAND SHORTWAVE RADIO KIT**
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. **Price £11.95.**

**SHORT WAVE CRYSTAL RADIO**
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

**RADIO STETHOSCOPE**
Easy to fault find — start at the aerial and work towards the speaker — when signal stops you have found the fault. **Complete kit £4.95.**

**INTERRUPTED BEAM**
This kit enables you to make a switch that will trigger when a steady beam of infrared or ordinary light is broken. Main components — relay, photo transistor, resistors and caps etc. Circuit diagram but no case. **Price £2.30**

**OUR CAR STARTER AND CHARGER KIT** has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £11.50** + £2.50 post.

**GPO HIGH GAIN AMP/SIGNAL TRACER** In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute **bargain at only £1.85.** Suitable 80ohm earpiece 69p.

> **NEW KIT THIS MONTH!**
> CB RADIO — Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller.
> Complete kit with case and instructions only £5.99.

**8 POWERFUL BATTERY MOTORS**
For models, Meccanos, drills, remote control planes, boats etc £2.50.

**WATERPROOF HEATING WIRE**
60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses — around water pipes, under grow boxes in gloves and socks. 23p per metre.

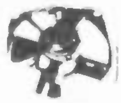
**COMPONENT BOARD Ref. W0998**
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including 4 3amp 400v types (made up in a bridge) 8 transistors type BC107 and 2 type BFY 51 electrolytic condensers. SCR ref 2N 5062, 250uf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

**FRUIT MACHINE HEART** 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the 'jackpot'. **£9.95. + £4 carriage.**

**4-CORE FLEX CABLE**
White pvc for telephone extensions, disco lights, etc. 10 metres £2, 100 metres **£15.** Other multicore cable in stock.

**MUGGER DETERRENT**
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

**EXTRACTOR FANS** – **Mains Voltage**
Ex-computer, made by Woods of Colchester, ideal as blower, central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 rpm but quiet running. Choice of 2 sizes. 5" £5.50 6" £6.50. post £1 per fan.



**POCKET AUDIO COMPONENT TESTER**

With it you can quickly test diodes, rectifiers, transistors, capacitors, check wiring and p.c. boards for open circuits, find the anode and cathode of a diode or rectifier and whether a transistor is PNP or NPN, which are the base collector and emitter connections. Condensers, if bad give a continuous signal but if good, give intermittent signals of varying length depending on their value. The test current is very low (2uA) and the voltage only 1.4v, so it is also possible to check MOS devices, as well as sensitive transistors with out fear of damaging them. The unit is supplied complete with internal battery, which should last many months. **Price £3.45p.**

*(Not licenceable in the U.K.)

**SUPER HI-FI SPEAKER CABINETS**

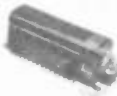
Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.50 the pair.

**LOUDSPEAKERS**
8" woofer and 4" tweeter, 4 ohms 35 watts power rating £6.90 per pair. Ditto but 8 ohms, £11.50 per pair. Post £2.00

**Vu METER SNIP.**

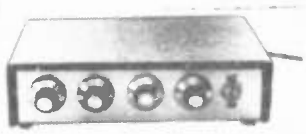
Approximately 1 5/8" square, suitable for use as a recording level meter, power output indicator or many similar applications. Full vision front, cover easily removable if you wish to alter the scale. Special snip price £1.00, or 10 for £9.00.

**MOTORISED DISCO SWITCH**



With 10 amp changeover switches. Multi adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

**3 CHANNEL SOUND TO LIGHT KIT**



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special snip price is **£14.95** in kit form or **£19.95** assembled and tested.

**THIS MONTH'S SNIP**

**REED SWITCHES**
Wire ended, glass encapsulated. Contacts make when magnet brought near. Very many uses, i.e. combination locks, anti-intruder window & door switches, wind direction indicator, computer keyboard, secret switches, etc. etc. **SNIP OFFER 10 SWITCHES FOR £1.00,** inc post and VAT.
Purchasers receive circuits and details of some suggested uses.

**FLUORESCENT TUBE INVERTER**

For camping — car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer an inverter for 12" 8 watt miniature tube for only **£5.25.** (With tube and tube holders as well)

**12v MOTOR BY SMITHS**

Made for use in cars, these are series wound and they become more powerful as load increases — they will in fact burn themselves out if overloaded to stopping point. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price **£3.45.** Ditto, but double ended **£4.25**

**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 + 50p 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.

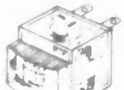
**MULLARD UNILEX**

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 — but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£16.75** including VAT and post.
**FREE GIFT** — buy this month and you will receive a pair of Goodman's eliptical 8"x5" speakers to match this amplifier.

**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 new but without case, but we can supply plastic cases (base and cover) **£1.75** or metal case with window **£2.95.** Also available is adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.**

**DELAY SWITCH**

Mains operated — delay can be accurately set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps — second contact opens a few minutes after 1st contact. **£1.95.**



**LEVEL METER**
Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. **75p.**

**STEREO HEADPHONES**

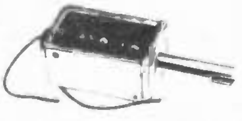
Japanese made so very good quality. 8 ohm impedance padded, terminating with standard ¼" jack-plug. **£2.99** Post 60p.

**BRIDGE RECIFIER**
1 amp 400v 30p each
10 for £2.50. 100 for £20.00

**TIME SWITCH BARGAIN**
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. **£2.50.**

**12V SUBMERSIBLE PUMP**
Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. **Price: £8.50.**

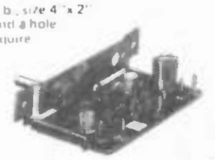
**POPULAR SNIP – STILL AVAILABLE**
And it still carries a free gift of a desoldering pump, which we are currently selling at £6.35p. The snip is perhaps the most useful breakdown parcel we have ever offered. It is a parcel of 50 nearly all different computer panels containing parts which must have cost at least £500. On these boards you will find over 300 IC's. Over 300 diodes, over 200 transistors and several thousand other parts, resistors, condensors, multi-turn pots, recifiers, SCR, etc. etc. If you act promptly, you can have this parcel for only **£8.50,** which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. Surely this is a bargain you should not miss! When ordering please add £2.50 post and £1.27 VAT.



**SOLENOID WITH PLUNGER**
Mains operated **£1.99**
10 — 12 volts DC operated **£1.50.**

**YOUR LAST CHANCE FOR THIS BARGAIN**
100 twist drills, regular tool shop price over £50, yours for only £11.50. With these you will be able to drill metal, wood, plastic, etc. from the tiniest holes in P.C.B. right up to about ¼". Don't miss this snip — send your order today.

**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 1 W 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.



# J. BULL (Electrical) Ltd.

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

J. BULL (Electrical) Ltd – Established 25 years. MAIL ORDER TERMS: Cash with order — please add 60p to all orders under £10, to offset packing, etc. ACCESS & BARCLAYCARD WELCOMED. Our shop is open to callers. BULK ENQUIRIES INVITED. Telephone: Haywards Heath (0444) 54563.

# Thermometer

## Convert your meter to read temperature with this simple add-on unit

USING THIS CIRCUIT you can convert any voltmeter capable of reading 0-1 V to a 0-100°C temperature probe. The device that makes this possible is National Semiconductor's LM335. This is a temperature-sensing integrated circuit housed in a TO-92 transistor type package which acts as a shunt regulator giving an output voltage of 10 mV per degree. The chip gives a 0 V output, not at 0°C as you might expect but at absolute zero, minus 273°C. This means that an output voltage of 2.73 V is obtained at freezing point. To get a 0 V output from the circuit at 0°C, all we need to do is compare the output of the chip with a reference voltage of 2.73 V, which we obtain from a second integrated circuit, the TL430C.

## Construction

Begin by mounting resistors R1,2,3,4,5, integrated circuit IC1 and variable resistor RV1 into the printed circuit board (PCB), as shown in **Fig.2.** As IC1 and IC2 look alike make sure you've picked up the right device, the TL 430C. Check its orientation against the overlay diagram.

Now connect a voltmeter with its negative lead to 0 V and its positive lead to the junction of R4 and R5. With the unit connected to a 9 V battery you should be able to adjust RV1 to obtain disconnect the meter and battery and a reading of 2.73 V. If all is well, solder R6, RV2 and IC2 into the PCB, taking care with IC2's orientation.

Reapply power and connect the meter this time with its negative lead to the junction of R4 and R5, and its positive lead to the junction of R6, IC2 and RV2.

By adjusting RV2 you should obtain a reading corresponding to the ambient temperature. If the temperature is 25°C adjust RV2 for a reading of 0.25 V.

Only one calibration is needed as this sets the chip accurate to within 1°C over a range of −10°C to −100°C.

Now, mark and drill the case to fit the panel meter and on/off switch. Mount the PCB, battery, switch and meter into the case and wire up the project as shown in **Fig.2.**

If you wish to make a temperature probe, you can mount IC2 remotely from the PCB. Choose a mounting to suit your application, taking care that the leads cannot be bridged or short-circuited if measuring water temperature, for example. In fact, it is a good idea to encapsulate the complete IC in epoxy resin or similar, if you intend to use the probe to measure water temperature.

And there you have it. With just two comparatively cheap chips and a handful of components, you have a complete linear temperature measurement system.

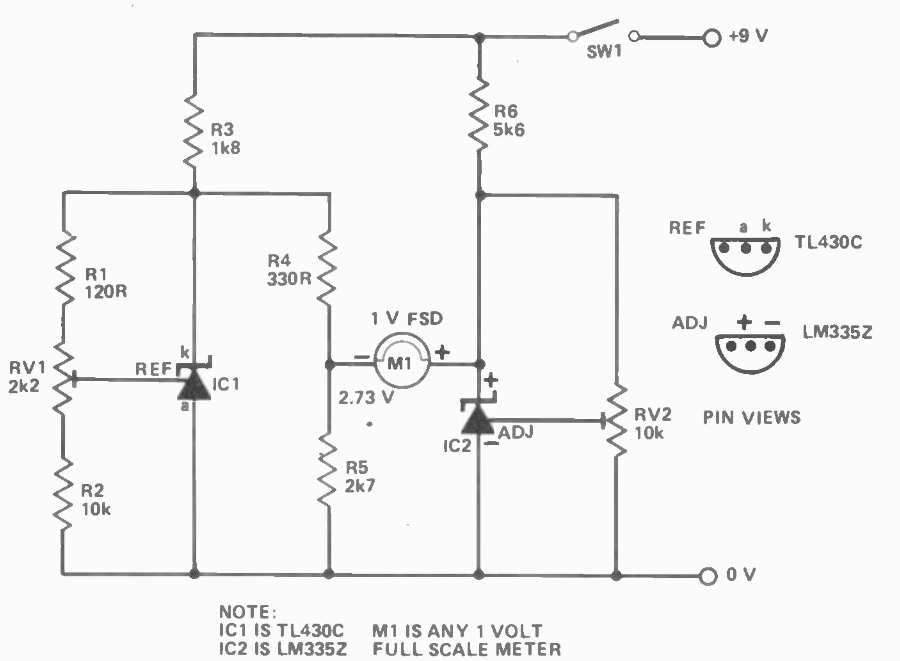



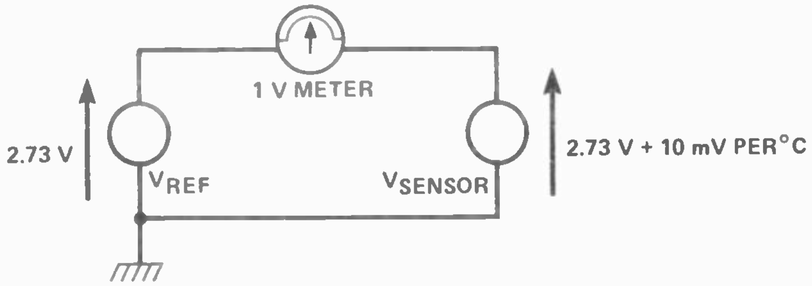

**Figure 1. Circuit of the HE Thermometer**

## Parts List

| | |
|---|---|
| RESISTORS (All ¼ W, 5%) | |
| R1 | 120R |
| R2 | 10k |
| R3 | 1k8 |
| R4 | 330R |
| R5 | 2k7 |
| R6 | 5k6 |
| POTENTIOMETERS | |
| RV1 | 2k2 miniature horizontal preset |
| RV2 | 10k miniature horizontal preset |
| SEMICONDUCTORS | |
| IC1 | TL430C adjustable zener |
| IC2 | LM335Z temperature sensor |
| MISCELLANEOUS | |
| M1 | any meter capable of indicating 0-1 V (for 0-100°C measurement range) — see Building Site on page 39 |
| Case to suit (see Buylines) | |

# How It Works

The heart of the circuit is the LM335Z solid state temperature sensor. When a current of 400 uA to 5 mA is passed through this device, a voltage of 10 mV per degree is developed across it. At 25°C (room temperature) a voltage of 2.98 V will be produced, not the 0.25 V (0.01 x 25) that you might expect. This is because the output is proportional to absolute temperature and 0°C is 273 K so 25°C is (273 + 25 + 100) V, ie, 2.98 V. So that the meter will read zero for 0°C, we generate a reference voltage of 2.73 V corresponding to 0°C, 273 K (the 'K' is for Kelvin — Lord Kelvin, a physicist).




The reference voltage is produced using a special integrated circuit, the TL430C. This chip is connected just like the LM335Z and has a terminal which monitors the output voltage via potential divider R1, RV1, R2. The TL430C will regulate the voltage at its output until a voltage of about 2.7 V appears at its reference input. This occurs for an output voltage of about 3 V. Unlike the LM335Z whose output will change with temperature, the TL430C is designed to be temperature independent and its output will drift by less than 50 parts per million, per degree Centigrade (ie, not more than 150 uV/°C). The required reference voltage of 2.73 V is obtained from the 3 V output via potential divider R4, 5. This network is required because the reference voltage (and so the minimum output voltage) may range between 2.5 V and 3 V for different samples of the device. Preset RV1 accommodates this variation, enabling a 3 V output to be obtained from any sample. To obtain a temperature measurement, a 1 V FSD meter is simply connected between the reference voltage from IC1 and the output of IC2.

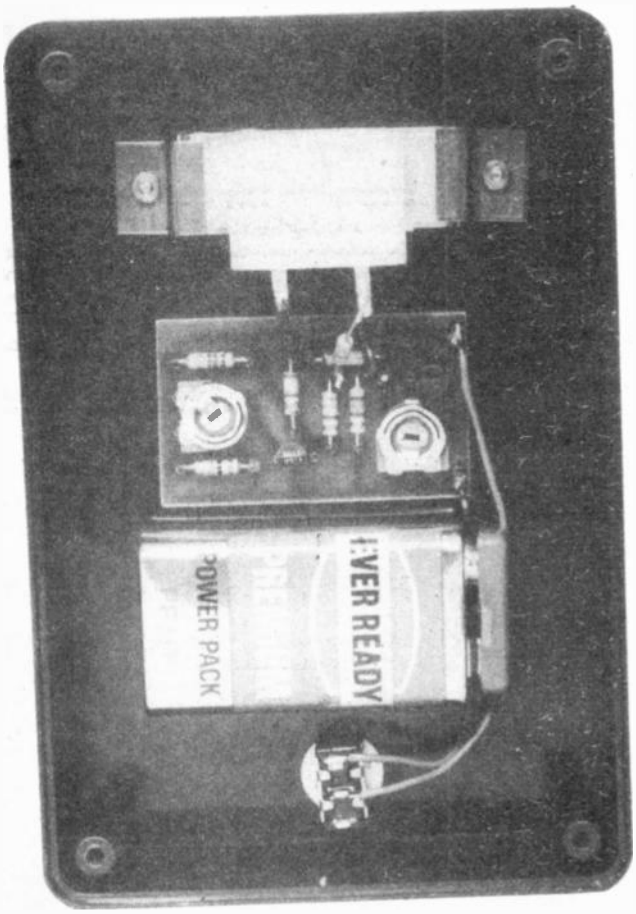
# Buylines

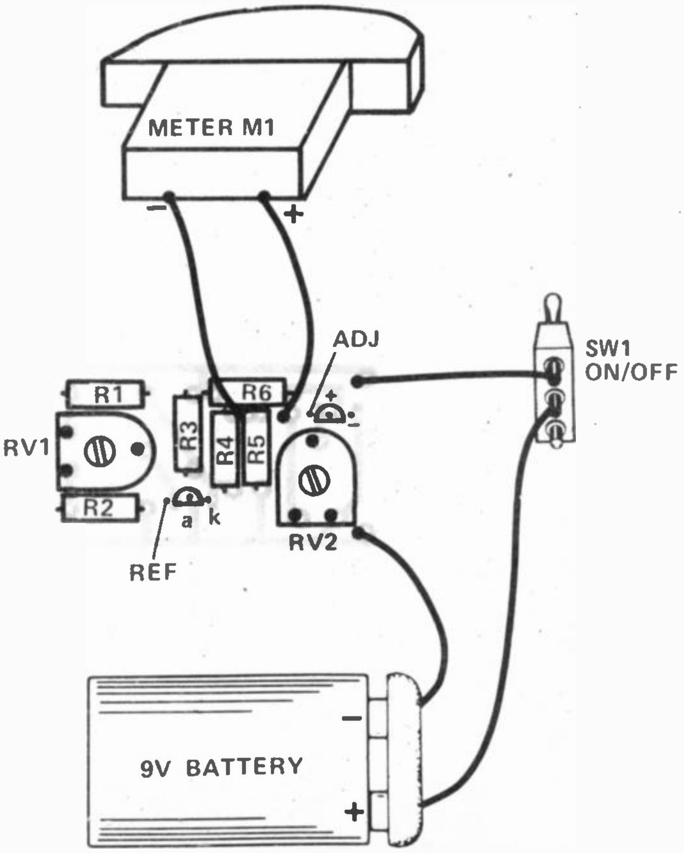
Semiconductors for this project are being stocked by Technomatic. The approximate cost of components (excluding PCB, case and meter) is £8. Shop around for meters because they can vary a great deal in price.

We used a case from Vero Electronics to house our prototype, stock number 202-21390.

Figure 2 (below). Printed circuit board overlay of the HE Thermometer and connection details. Make sure you don't confuse IC1 with IC2 as they are similar both in size and shape. Building Site on page 39 of this month's HE gives practical advice on meters

Below left. Internal view of the HE Thermometer. Keep all leads short and neat




HE

# P.A.T.H Electronic Services

Wholesale & Retail Supply Of Electronic Components

Electronic Equipment Manufacturers | 369 Alum Rock Road, Birmingham, B8 3DR. Tel 021-327-2339

**DISCO.** Sound to Light Unit 3-channel Unit (fully cased). Separate Bass-Middle-Treble. Unrepeatable at £18.90. Set of leads for above £1.50.
Some Units needing attention you to repair £5.95.
Card of MULTICORE Solder 20p.

**ANTEX SOLDERING IRONS!**
CCN 15 watt Iron .... £4.80
CX 17 watt Iron .... £4.80
X25 25 watt Iron .... £4.80
ELEMENTS for above irons, state type .... £1.80
STAND Soldering iron stand type ST3 .... £1.50
Spare TIPS (CCN & CX), 2.3-3-4.7-6mm .... 50p ea.
Spare TIPS X25, 2.3-3-4 7mm .... 50p ea.

**MINIATURE SPEAKERS**
8ohm 1¼", 1¾", 2", 2¼", 2½", 3", 64ohm 2½" .... 80p ea.

**ROTARY SWITCHES**
5W 6P 3 Bank .... 70p
2P 6W 1 Bank .... 30p
2P 30W 2 Bank .... 170p

**LORLIN TYPES**
1P 12W, 2P 6W, 3P 4W, 4P 3W .... 30p

**STEREO** Test cart BIB Type .... 50p

Package containing Ex-equipment boards, FULL of useful components pack with 7 Panels .... £1

DISPLAY. Gas discharge type, 9 digits 70p ea., or 2 for £1

TUNING METRE Centre Zero Fsd 50-0-50µA
Dims 34 x 33 x 21mm .... 50p ea.

MICRO SWITCH
Type V3 SPCO Contacts .... 20p

**TOP-HAT RECTIFIER Diode**
15 AMPS AT 1000 VOLTS .... 25p

**BUMPER PARCEL**
A super value pack containing 1lb gross weight of new components. Rs, Cs, etc Many different sorts .... £1.80

**PANEL METRES, 2" Types**
Available in the following scales. 50µA, 100µA, 500µA, 1mA, 100mA, 500mA, 1A, 25Vac, 50Vac, 300Vac, 30Vdc, 300Vdc .... £4 ea.

**TRANSFORMER 6VA**
Split bobbin construction, 4½ - 0 - 4½ Volt .... 70p

**RELAY**
12-Pole Changeover Contacts, – 12 to 15 Coil .... £1.20

**CABLE**
8m Twin white, ideal for bells, speakers, etc .... 30p per 8m Length
20m pack of assorted cable .... 30p

**CIRCUIT BOARD**

| Size | 1 matrix | 15 matrix |
|---|---|---|
| 2½ x 5" | 30p | 25p |
| 2½ x 3¾" | 25p | 20p |
| 3¾ x 5" | 45p | 40p |

**MAKING PRINTED CIRCUIT BOARDS?**
Materials from STOCK you can rely on!

| | 1mm SS | 1mm DS | 2 4mm SS | 2 4mm DS |
|---|---|---|---|---|
| 6x6in | £0 60 | £0 65 | £1 05 | £1 10 |
| 8x12in | £1 20 | £1 30 | £2 05 | £2 15 |
| 12x12in | £2 35 | £2 55 | £4 02 | £4 29 |

SS = Single sided copper DS = Double sided The above sizes are kept in stock but we can supply any size board cut to order in any of the following thicknesses and weights 1mm 1oz 1/16 1oz and 2oz – 3/32 (2 4mm), 1oz and 2oz – 1/8 (3 2mm) 2oz All available in single or double-sided Special sizes minimum order is 10 boards
We also have some Fibreglass Board 1/16 SS 1oz Second quality 6x6 – 45p, 6x12 85p. 12x12 – £1.70.

**DALO ETCH RESIST PEN**
£0.95 with spare tip

**FERRIC CHLORIDE**
½lb bag £0.80

**FERRIC CHLORIDE**
1lb bag £1.50

**FOTOBOARD**
This board has a positive resist coated surface suitable for manufacturing printed circuit boards to a very high standard Simple to use, just make a master pattern of your circuit on clear acetate sheet, place on Fotoboard and expose to UV or daylight Develop, then etch in the normal way with Ferric Chloride Full instructions supplied One master may be used over and over again for production runs

| | S Sided | D Sided |
|---|---|---|
| 100mm x 160mm (euro card) | £1.50 | £1.75 |
| 100mm x 220mm (4 x 8½in) | £1.80 | £2.00 |
| 203mm x 114mm (8 x 4½in) | £1.85 | £2.10 |
| 203mm x 228mm (8x9in) | £3.80 | All other |
| 408mm x 228mm (16x9in) | £6.80 | sizes to |
| 467mm x 305mm (18x12in) | £9.80 | order |

DEVELOPER CRYSTALS .... 35p
DEVELOPER LIQUID CONCENTRATE .... £1.26
ACETATE SHEET FOR MASTER .... 17p
RESIST STRIPPER CONCENTRATE .... £2.25

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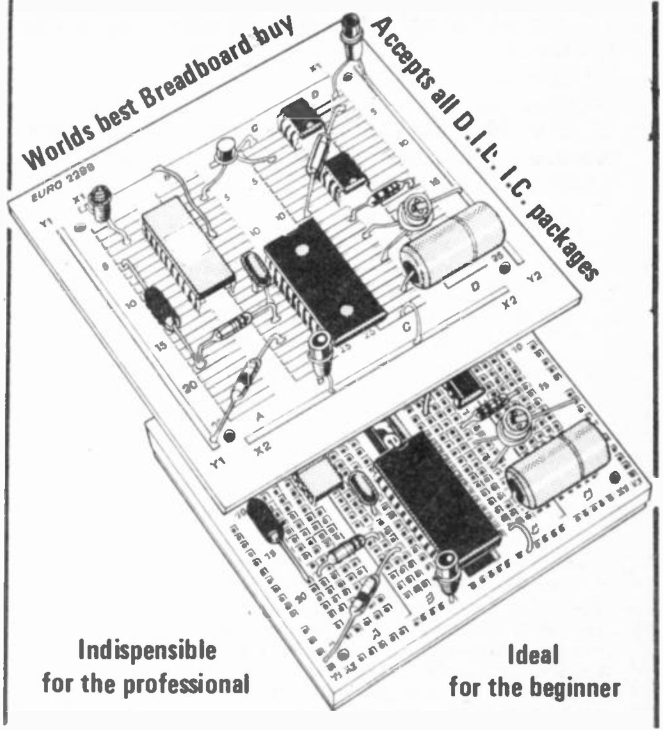


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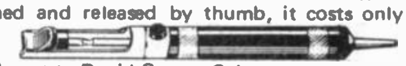

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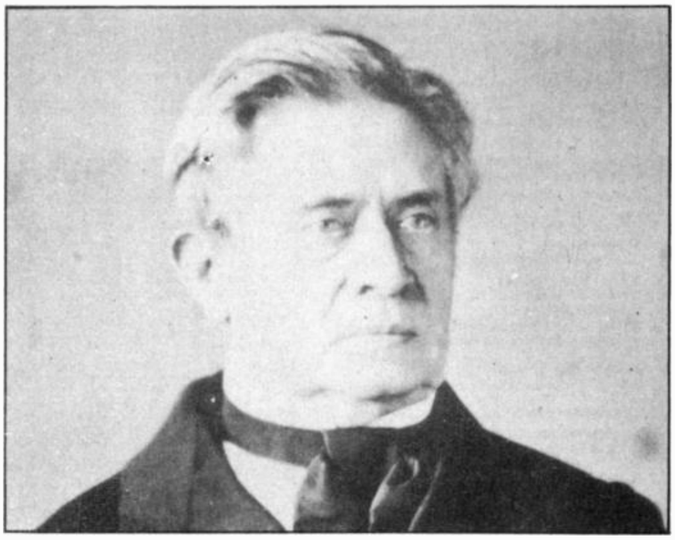
# Famous Names

## Part four of this series looks briefly at the life of Joseph Henry, whose name is associated with the unit of inductance

WE'VE BECOME quite accustomed in this century to remembering the names of famous scientists of the past by using these names for measuring units or instruments. This way, even though you may have only the faintest notion of who Ampere, Ohm or Volta were, you can't escape the familiarity of the names. Nevertheless, some names are not so well known as others, and Joseph Henry must rank among the names which very few of us would recognise except as the name of the unit of inductance.

Perhaps part of that unfamiliarity is because Henry was American, and he worked on many of the projects which, to us in the UK, were the province of Michael Faraday. The two men were, in fact, very often engaged in the same line of research at the same time but, because of the poor communications of the time, were unaware of each other's work. That'll teach us to complain about second-class post!

Let's start at the beginning. Joseph Henry, who was born in 1797, is regarded as the second most outstanding US scientist, taking second place only by a whisker to Benjamin Franklin. Let's see if we can catch some flavour of what he contributed to our knowledge of electricity.



### Choice For Life

Joseph Henry intended to study medicine when he went to Albany Academy in New York in the 1820s, but medicine was a science in its infancy and Henry caught the excitement which surrounded the study of electricity. In 1825 he abandoned medicine and changed to a course of practical science, which we would now call engineering. He was brilliantly successful, and in 1826 was appointed to teach Mathematics and Physics at Albany Academy. This was a wise choice, both for him and for the Governors of the Academy. In Joseph Henry, Albany Academy gained an outstanding teacher and a brilliant scientist. Few discoveries have ever been made which have come as a complete surprise to anyone with a really good grounding in Mathematics and Physics — and there is nothing better than these subjects today to ensure an education which will set you up for life.

His work began to bear fruit in 1829. Until that time, electromagnets had been made by winding bare wire onto insulating formers which were threaded to ensure that one wire could not short against the next — we still wind coils for shortwave receivers this way. Henry demonstrated that by using insulated wire and by winding it closely, layer over layer, he could greatly increase the lift of an electromagnet. He proved the point by constructing a magnet which could lift nearly a ton, and gave it to Yale University.

Electromagnetism naturally led to the idea of generating continuous movement by using electricity, and to a form of electric motor in 1829. This was eight years after Faraday had first demonstrated the possibility of causing continual motion by using magnetic forces, but Henry's motor was a much more practical affair, quite capable of being built in larger form to drive machinery, as indeed it soon was.

### Early Telegraphy

By 1831 Henry was working alongside another famous scientist, Samuel Morse. Their task was the development of the electric telegraph, the invention which, along with the railway, was to open up the West and spread law and civilisation. The telegraph was the start of communications as we know them today. It's difficult for us now to appreciate what this must have meant in an age when the fastest communication between points too far apart to see was by a man and a horse.

The telegraph was initially a very simple device, consisting of an on/off key at one end and a current-detector at the other, with lots of wire in between. The effect of all that wire in between was one of the problems which Henry decided to tackle. In practical terms, the greater the distance between two stations on the telegraph, the slower the operator had to transmit. If he didn't slow down, the receiver did not indicate a clear-cut dot or dash, up to the point where it might even have stopped moving altogether.

In 1831, Faraday had discovered electromagnetic induction. If you move a magnet near a wire, a voltage appears between the ends of the wire while the magnet is moving. Henry took up this idea, and reasoned that physical movement was not necessary, only a change of magnetism. When a current starts flowing through a wire, there must be a change of magnetism from zero (no current) to whatever amount is present when the current reaches its full value. This change of magnetism, Henry reasoned, should also cause a voltage to be induced in the wire — the same wire! He realised further that this induced voltage would oppose the current and try to stop it from increasing. It was this opposing voltage which was causing the odd effects on long telegraph lines, and the effects could be much more conveniently studied by winding the long wires onto electromagnets. Henry looked at some of his old electromagnets, and made measurements of the voltage across the terminals when the current through the coils was changed. He found that for a given shape of magnet, with a set number of turns, the ratio:

$$\frac{\text{voltage across terminals}}{\text{rate of change of current}}$$

was constant.

This constant quantity had no relation to the DC resistance R of the wire. Henry called the quantity 'self-inductance', and another of the essential quantities of electronics was born.

In the same year of 1832, Henry was appointed Professor of Physics at the College of New Jersey — now Princeton University. Some idea of the breadth of his ability may be judged from the subjects he was expected to teach as well as Physics — Maths, Chemistry, Minerology, Geology, Astronomy and Architecture!

### Mutual Inductance

He continued his research, looking now at the transformer effect in the light of his discovery of self-induction. He soon discovered what had been observed by Faraday earlier. If two separate coils of wire are wound around a ring of iron (an arrangement we now call a toroidal transformer, and treat as if it had just been invented!), then a *change* of current through one coil causes a voltage across the other for as long as the current is changing. Once again, Henry made measurements, and showed that the ratio:

$$\frac{\text{voltage across second coil}}{\text{rate of change of current through first coil}}$$

was a constant for a given transformer. He called the quantity mutual inductance, so providing constructors of transformers with a method of measuring the 'goodness' of their construction. It was hardly surprising, then, that the units of both self-inductance and mutual inductance were to be called Henries, in his honour.

## Early Radio?

The days of his great discoveries were almost over, for by this time Henry was a senior scientist devoting his life to bettering science education, but one curious little experiment makes us wonder what might have been. He described coiling a wire round a needle, attaching one end of the coil to earth, and the other to a wire (we would call it an aerial) held up by a kite (see **Fig. 1**). After a lightning-flash some eight miles away, he found that the needle had become magnetised. This was probably the first recorded action of radio waves — he might so easily have gone on to see if the needle would also have become magnetised by a spark generated at a distance by a battery and a coil!

By the time he died in 1878 Henry had achieved all this, and just as important, served as the first secretary of the Smithsonian Institute. The Smithsonian was the agency by which US Government money could be channelled to support scientific research, the start of the process which put a man on the moon and which made the US the predominant force in world technology.

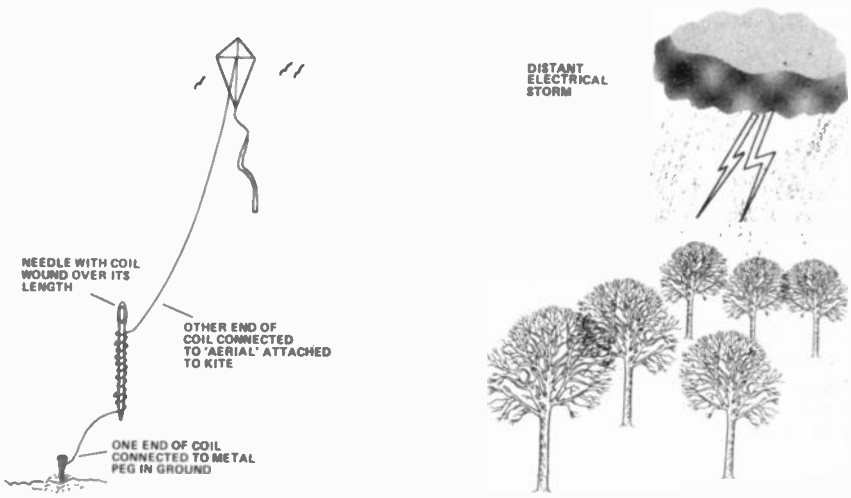



**Figure 1. Henry's experiment where a needle, with a coil of wire wound over its length connected to an 'aerial' and 'earth', became magnetised by the electromagnetic radiation from a distant lightning flash**

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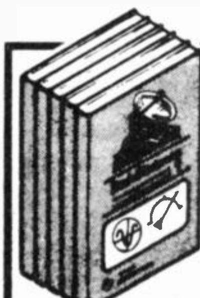

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# Competition Results

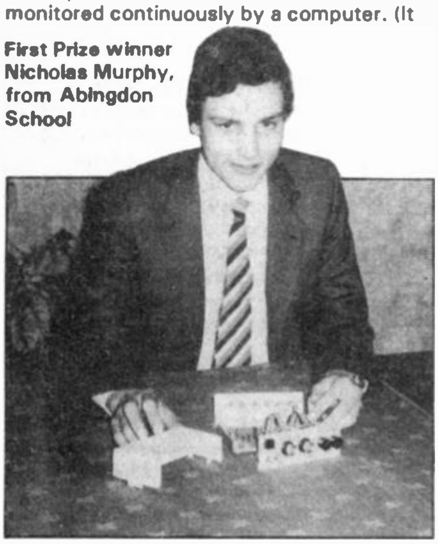
**On Friday 29th May 1981, entries from the finalists in the Hobby Electronics Wales and West Schools' Electronic Project Competition were judged at the Unicorn Hotel in Bristol. We present details of the winning entries**

BECAUSE OF THE high standard — and diversity — of the entries, the final choice was a difficult one. We had to balance, for instance, originality with constructional skill and ingenuity with improvisation. Several of the designs had been built, out of necessity, strictly to a low budget and yet high standards had been maintained.

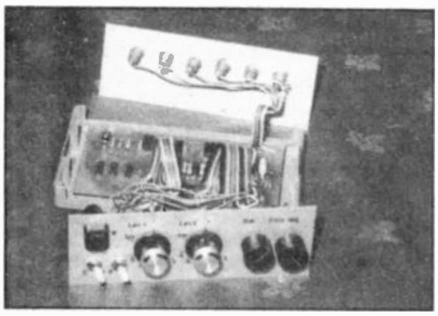
## The Winners

FIRST PRIZE was awarded to **Nicholas Murphy**, aged 17, from Abingdon School, Abingdon, Oxon. His project was a Chemical Conductivity Computer Interface — called Datafeed 1 for short. When connected to two probes immersed in a solution, the instrument compares any detected change in resistance with preset calibrated values. The project was designed from first principles for a practical purpose; that is, to enable chemical reactions to be monitored continuously by a computer. (It has been used with an Apple computer.) Nicholas designed the printed circuit board (PCB) for his project.

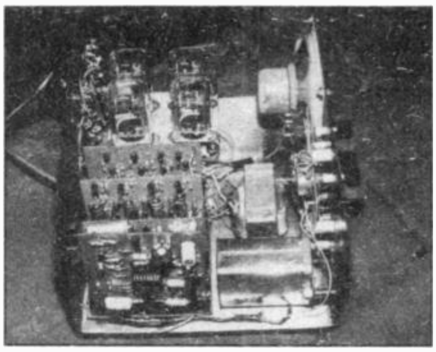
He will receive a component voucher for £100, and Abingdon School will be presented with two Kikusui 538A oscilloscopes, from Telonic Berkeley (UK) Limited. The Hobby Electronics Award Trophy will also be presented to the school.



**First Prize winner Nicholas Murphy, from Abingdon School**



**Front view of Nicholas's project, Datafeed 1, with the cover removed**



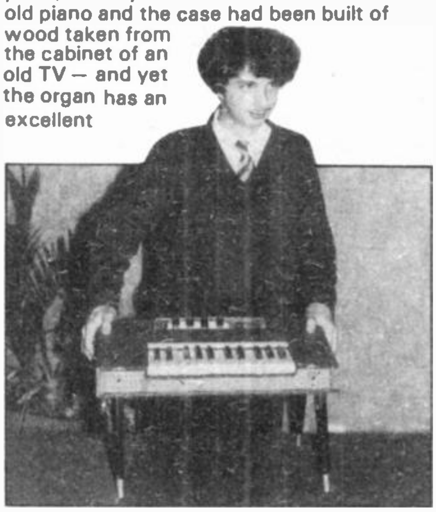
**Project designed and built by Second Prize winner Paul Miller, from Filton High School. The project allows up to 10 power sockets to be switched on and off by ultrasonic remote control**

SECOND PRIZE went to **Paul Miller**, aged 16, of Filton High School, Stoke Gifford, Bristol. His project was a device which could enable physically handicapped people to switch a variety of mains appliances on and off by remote control. The project had been designed by Paul and was among three finalists' entries which had been designed with the International Year of Disabled Persons in mind. Up to 10 power sockets can be controlled by means of a hand-held ultrasonic transmitter. The unit had been built in prototype form for around £12 and included some useful features such as visual (LED) indication of selected channels and manual override. Like the First Prize project this project had been designed from first principles, and made use of PCBs made by Paul.

Paul will receive a component voucher for £50.

THIRD PRIZE and TOP JUNIOR PRIZE both went to **Pierre Varischetti**, aged 13, of Ashmead School, Northumberland Avenue, Reading. His project was an electronic organ, where economy was the keyword (total cost was around £10). To stress this point, the keys had been retrieved from an old piano and the case had been built of wood taken from the cabinet of an old TV — and yet the organ has an excellent appearance, complete with four screw-in legs. It uses six oscillators, with one integrated circuit for each and, despite a simple circuit design and the use of only two HP2-size (1.5 V) cells, it produced a loud and impressive sound. The organ had been designed, as had the other two projects, from first principles, and used PCBs made by Pierre.

Pierre will receive a component voucher for £25 (third prize) *and* a Galactic Invaders television game from Tangerine Computer Systems Limited (under-15 age group prize).



**Pierre Varischetti, from Ashmead School, with his 'economy' electronic organ project. He was the winner of the Third Prize and Top Junior Prize**

A HIGHLY COMMENDED ENTRY was submitted by the Electronics Club of St Birinus School, Didcot, Berkshire. This project, described as a Stage Lighting Computer, was so large and consisted of so many parts (complete with back-up service and test gear) that it took the best part of an hour to set up in the room where the projects were being judged. Although it was still at the experimental stage, the computer was designed to control 16 channels (16 individual sets of stage lights) in 64 steps from a pre-programmed memory. (This step capacity could be expanded according to memory size.) When it is finished, it should be possible to program light sequences (on, fade up, fade down, and off) from a numeric keypad. We were given a demonstration of pre-programmed dimming on one channel.

The Electronics Club, under the supervision of Mr D Colvern PhD, Head of Physics and Electronics, built the computer and its peripheral electronic switch gear as a joint effort, including the design of the PCBs.

Estimated component cost was placed at £150, although much surplus hardware had been used in the prototype.

**Mr D Colvern, Head of Physics and Electronics at St Birinus School, with members of the school's Electronics Club. The lads are seen busy at work setting up their Stage Lighting Computer project**

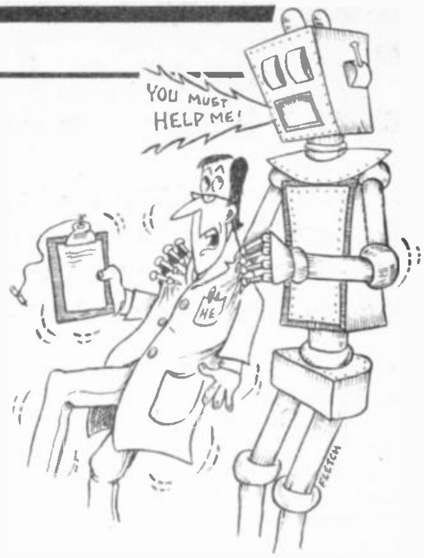
## Free Subscriptions

The first 25 schools which submitted entries will each receive a year's free subscription to HE.

Some of the entries will also be considered for use as HE projects.

We would like to thank all concerned — masters, pupils and parents — who took part in the '81 competition. Despite the cancellation of the Hobby Electronics exhibition at Bristol, we were determined that this competition would go ahead as planned. **HE**

# Clever Dick




## CD's got an answer for nearly everything this month. In fact, the only things he seems to be a bit short of are free binders

SIFTING THROUGH the mountains of mail I received this month, I came across some *really* interesting and stimulating letters (yawn). Anyway, I quickly threw them in the bin and took a look at more of the usual garbage I normally answer — sure enough, here they are:

*Dear CD,*
*I am a flashing lights and weird noises fan. Please could you publish a sort of cross between the HE Super Siren and an interesting LED flasher circuit? I have been buying HE for three years now (grovel, grovel), and there are lots of copies lying around. I am now grovelling at your boots (lick, lick). The FREE binder has got to go somewhere, so why not unstick yourself from it.*
*Stephen J Bernhoeft,*
*Stockport, Cheshire*

*PS Well, it's nicer than D S Nightingale's letter — grovel, grovel, grovel, grovel.*

Well, there's not much I can say after that one except that it's such a grovelling letter I reckon you should send *me* a binder! I'll pass your request for a project onto the project department.

---

The next letter pulls out an old boob.

*Dear Clever Dick,*
*So you think you are clever enough — you haven't found this mistake for two years. Yes, two years, back in July 1979. What I found is in Chit Chat (page 55). Figure 2 shows the diagram of a circuit which is exactly the same as Fig. 1 (page 54). The + and − inputs on the 741 in Fig. 2 should be the other way round.*
*Do I get a binder for finding the record-breaking longest-delay mistake?*
*Your sincerely,*
*Dave,*
*Margate, Kent.*

Mistakes from two years ago worth a binder — you've got to be kidding — I've enough problems coping with the mistakes this month!

---

*Dear Sirs,*
*You mention in Clever Dick of June '81 that you hope to publish a much lower priced amplifier in a "comming issue". Could you please tell me roughly when this might appear and how much will it cost? Are you planning to publish another speaker design with it?*
*If you are designing it yourselves I feel that the Image Width control on the 5080 System is worth retaining, and that it is worth concentrating on an appearance which will distinguish it from commercially available systems.*
*Your faithfully,*
*R Hanbury,*
*Windsor, Bucks.*

Yess, everboddy maykes speeling misstakes now and agen yoo know. Actually our project lads haven't yet finalised designs for the new amplifier system so perhaps some of our other readers have a few suggestions to make, too.

---

At last, the first really sensible letter this month, and it's worth a sensible answer.

*Dear Clever Dick,*
*Thank you for your brilliant mag. As a beginner in electronics I am not sure of the different values of capacitors. What does 10u and 100n mean?*
*Robert Preddy,*
*Bristol*
*PS I'm not scrounging for a binder, but. . .*

Capacitors are measured in farads (abbreviated as F) but farads are very large quantities of capacitance, so we divide the unit down into smaller bits:

- One microfarad (1u) is a millionth of a farad ie, $1 \times 10^{-6}$ F.

A large proportion of all the capacitors you are likely to see will be measured in microfarads, but some applications need smaller values:

- Nanofarads, where $1n = 1 \times 10^{-9}$ F (ie, one thousandth of a microfarad)

And smaller still:

- Picofarads, where $1p = 1 \times 10^{-12}$ F (ie, one thousandth of a nanofarad).

It'll probably all seem a bit complex at first, until you get 'wallpapered' (that's CD slang for 'the hang of it'), but once you do you'll be swapping between 0.01u and 10n as if you have been doing it all your life.
PS It's just as well you're not scrounging for a binder, because I'm not giving any . . .

---

Shut That Door!

*Dear CD,*
*I have recently purchased a digital coded lock from one of your advertisers, and I wish to fit it to my street door. But I cannot seem to get hold of a solenoid type of lock which will operate with the 5-18 V output of the system. Could you help?*
*Thanks for a great mag, keep up the good work.*
*T Winters,*
*London*

I asked around the lazy slobs who 'work' in the HE office and none could give me an answer to this problem. So I'm going to put out a plea to all our readers to see if you can help me with this one. If you know where Mr Winters can obtain a low-voltage operated solenoid lock, let me know and I'll forward the information.

---

The last letter this month is somewhat devious.

*Dear CD,*
*Can you please tell me if RV2 in the HE Phase One Guitar Phase (September '80) is 470k or 47k? Also, where can I get one from, as it is antilog?*
*As a mag which is never BehIND othER mags, how about a kit review on J Bull's CB Monitor kit in G,G&K?*
*Yours cryptically,*
*Chris Hand,*
*Rochdale, Lancs.*

I looked up 'cryptic' in the Oxford Dictionary and it means 'secret, mystical, mysterious, enigmatic, obscure in meaning'. Does this mean that you're secretly trying to persuade me to send you something? Well, it's too obscure in meaning for me — I don't kNOw what you mean!

The potentiometer RV2 should be 470k in value. You should be able to get one from Watford Electronics (who originally stocked the parts for the kit).

A kit review in GG&K on a CB Monitor sounds like a good idea to me. I'll pass on the suggestion to the relevant quarters.

---

I've got to go now, — but keep those letters rolling in. **HE**

CUBE MANIA — FREE OF CHARGE!
WITH STEP-BY-STEP SOLUTION
With purchases totalling over £17.50. Only on request at time of ordering. Offer closes 31 8/81. Subject to availability.
BECOME AN INSTANT MUSICIAN NO EXPERIENCE NECESSARY
The success story of 1981. Hundreds sold already! As featured on "Tomorrow's World"
Create your own music with a VL-TONE. You combine the sound, rhythm and tempo and the VL-1 plays it back . . . beautifully!
CASIO VL-TONE (VL-1) Electronic Musical instrument and calculator.
(RRP £39.95) ONLY £35.95
VL-1 records and plays back up to 100 notes as a melody. One Key Play or Auto Play of Piano, Violin, Flute, Guitar and Fantasy, or create your own unique sounds with A.D.S.R. 10 built-in Auto Rhythms and Tempo control. LCD digital readout of notes and tempo. Also a calculator. Battery powered with memory and program retention. Integral amplifier/speaker. Output jack. With Song Book. Dims.: 1⅛ x 11¾ x 3in.
CASIOTONE POLYPHONIC KEYBOARDS
With built-in amplifier and loudspeaker.
MT-30
(RRP £115) ONLY £95
22 instruments over 3 octaves. 4-position sound memory. Battery or mains. O/P jack. Dims.: 2⅛ x 22¾ x 6½in. 6lb.
★★ NEW ★★ CASIOTONE CT-202
"Son of success . . . The two harpsichords demonstrate the Casiotone's talent for sparkling, crystal clear tones . . . Even more impressive is the clav . . . ." (Melody Maker).
(RRP £325) ONLY £275
49 instruments over 4 octaves. 4 voice memory function with push-button selection. 3 vibrato settings and sustain. Pitch control. O/P jacks. AC only. 3⅝ x 34⅛ x 11 3/16in. 15.8lbs.
CT-301
(RRP £285) ONLY £245
14 instruments over 4 octaves. 8 x 2 rhythm accompaniments. Vibrato and delayed vibrato. Start/stop, synchro start, tempo control, tempo indicator, and rhythm volume. Pitch control. AC only. O/p jacks. 4⅝ x 31⅜ x 12⅞in. 27lbs.
CT-401
(RRP £345) ONLY £295
As 301 plus following; 16 rhythm accompaniments, with fill-in. Casio Auto Chord for one finger or auto accompaniment. Plays major, minor and 7th chords with bass. Balance control, C.A.C. lever, chord lever, memory lever and octave switch. Dims. as 301. Weight 28.2lbs.
CASIO SCIENTIFIC CALCULATORS WITH LIQUID CRYSTAL DISPLAY
for long, long battery life.
FX81 FX100 (FX550)
FX81. 8 digits. 30 scientific functions. 4,000 hours battery life. Auto Power Off. ¾ x 3 x 5⅞in. £12.95.
FX100. 10d, 44f, 7,500 hrs. A.P.O. ¾ x 3 x 5⅞in. £16.95.
FX550. Replaces FX510 shown above. 1 lithium battery lasts 13,000 hrs. A.P.O. 10d, 50f. ⅜ x 2⅞ x 5¼in. £19.95.
SUPER SCIENTIFICS with time dimension.
FX8100. 46f. Clock, calendar, alarm, hourly chimes, countdown alarm, stopwatch. ¼ x 2¾ x 5⅛in. £24.95.
FX7100. Card version, without calendar. £24.95.
FX6100. Hand held version of FX7100. £17.95.
CASIO PROGRAMMABLES
with A.P.O. and memory and programme retention.
FX180P FX3500P (FX602P)
FX180P. 10d, 55f, 2 programmes, 38 functional steps. Integrals and Regressional analysis. ¾ x 3 x 5⅞in. £19.95.
FX3500P. As FX180P but 61f, 9/32 x 2⅞ x 5¼in. £22.95.
FX602P. As FX502P shown above but with alpha numeric display 10+2d, F1f. 32 to 512 program steps, 22 to 88 registers. 10 pairs unconditional jumps, 9 subroutines, 9 levels, 33 parenthesese, 11 levels £74.95
CASIO MELODY ALARM CLOCK CALCULATORS
MQ1200
ML90
MQ1200 12 melodies, 2 alarms, hourly chimes, date memories, anniversary memories, calendar. 1 9/16 x 6 x 2¾in. £19.95.
ML-90. Wallet version of above, with stopwatch. £14.95.
ML-75. Card version of ML-90. 3/16 x 3⅝ x 2⅜in. £15.95.
ML2000 Office version of MQ-1200. 1¾ x 4 x 6¼in. £22.95.
UC365 UC3000
UC365. 3 melodies, universal calendar, date memories, two date alarms, daily alarm, hourly chimes, countdown alarm/stopwatch, time memory. ¼ x 4½ x 2½in. £19.95.
UC360. Card version of above. 7/32 x 3⅝ x 2⅜in. £19.95.
UC3000. Office version. 1¾ x 4 x 6¼in. £27.95.
Send 20p for our illustrated catalogue.
THESE SPACE INVADERS WILL ALARM YOU — THE PRICE WON'T
Casio's most amazing watches ever!
CA-90 (left) £24.95
CA-901 (right) £29.95
Time and auto calender, calculator, alarm, hourly chimes, stopwatch, dual-time. DIGITAL SPACE INVADER GAME.
100 METRE WATER RESISTANT WATCHES
with alarm and stopwatch
W-150 (left) £32.50
W-150C (right) £25.95
Time and auto calendar, alarm, hourly chimes, countdown alarm timer with repeat memory function. Time is always on display, regardless of mode. S/S.
W100 (left) £19.95
UC50W (right) 50m W/R £19.95
W100 is the resin case/strap version of W150.
UC50W 50 metre water resistant with universal full month calendar display with forward and backward stepping.
LCD ANALOGUE/DIGITAL
AA81 (left) Chrome £29.95
AA82 (right) Stainless Steel £39.95
Dual time, analogue and digital. Alarm, hourly chimes, countdown alarm timer, stopwatch, auto calendar.
12 MELODY ALARM AND STOPWATCH
M12 Resin £17.95. M1200 S/S £29.95.
SYMPHONIC ALARM CLOCK
MA-1 £9.95
Mozart No. 40 or Buzzer. Hourly chimes. Snooze facility 1¾ x 4½ x 3in.
MA-1
PRICE includes VAT and P&P. Send cheques, P.O. or phone your ACCESS or BARCLAYCARD number to:
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Dept. HE, FREEPOST, 164-167 East Road, Cambridge CB1 1DB
Tel. 0223 312866

# GADGETS GAMES & KITS

**Two items from Casio are reviewed in GG&K this month: the VL-Tone combined electronic musical instrument and calculator and the fx-3500P programmable calculator. Also under review this month is Adventures With Microelectronics, from Unilab, an educational kit containing a variety of experimental electronic projects**

## Casio VL-Tone — Electronic Musical Instrument And Calculator

Of all the gadgets that we've reviewed so far in GG&K, the VL-Tone from Casio has been the most fascinating because of the variety of its functions.

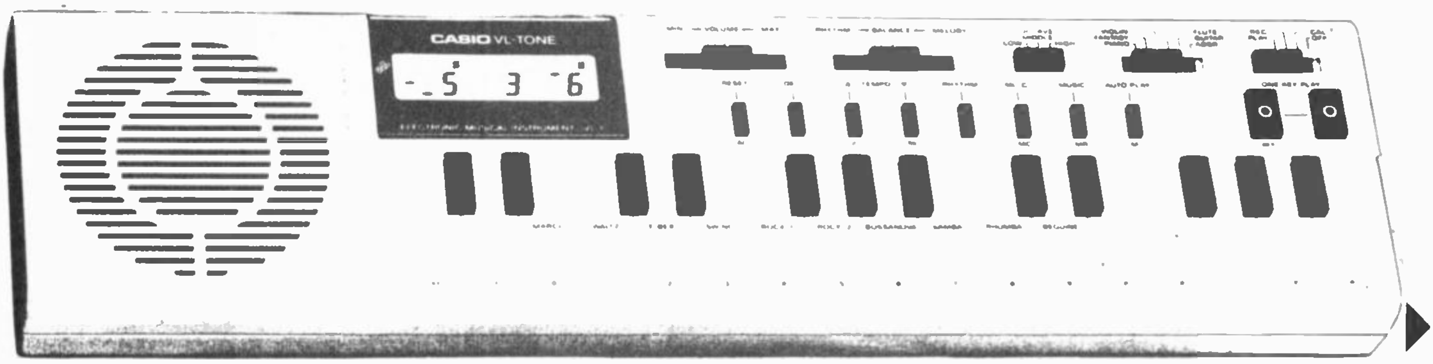
The VL-Tone comprises a 29-note keyboard (including sharps and flats), a panel with 5 slide controls and 10 push-button controls, an 8-digit liquid crystal display (LCD) and a built-in loudspeaker. The whole instrument is housed in a rugged cream-coloured case 300 mm long by 75 mm wide by 30 mm deep.

What the instrument does is almost unbelievable, considering its small size. Its functions are outlined below.

- Manual play function — the 29-note keyboard comprises nearly two and a half octaves. It is a monophonic keyboard — only one note at a time can be played (in other words, you can't play chords).
- Melody storage — up to 100 notes can be stored in the VL-Tone's memory, and each note number is indicated on the LCD as it is played and as it is replayed from memory.

Two methods of replay are possible: 'one key play' and 'auto play'. For the first, the melody is tapped out, one note at a time, on two buttons designated for the purpose. Thus regardless of how badly the melody was keyed in, you can tap out the notes in perfect rhythm. In the second method, the melody is played back from memory automatically — exactly as you entered it — although there is provision for tidying up its rhythm and for correcting any miskeyed notes. There is also a repeat function that will replay the melody four times.

- Auto rhythm function — the following rhythms can be selected to accompany your musical efforts: march, waltz, four-beat, swing, two rock rhythms, bossa nova, samba, rhumba and beguine. You can easily switch from one to another as you are playing, and vary the rate in up to 18 steps.
- ADSR — the letters ADSR stand for attack, decay, sustain and release, and with the VL-Tone you can use these functions together with other elements to configure sounds of your own choice by inserting eight code digits into the calculator memory. Believe it or not, up to *80 million* combinations are possible!
- Preset sounds — apart from the ADSR function, you can select piano, fantasy, violin, flute and guitar. The tonal quality of these sounds is surprisingly realistic, and to change the pitch of each, the



## PUSHBUTTON CONSO TELEPHONE

This is a superbly styled, one-pice, very compact push button telephone with last-number re-dial facility (on pressing one button it will redial the last number you dialled). A special MUTE Button enables you to talk at your end without the other party hearing you. The electronic buzzer can be switched on or off.

**£25.95** + £1.95 P&P

## DUAL TIME MUSICAL ALARM CHRONOGRAPH

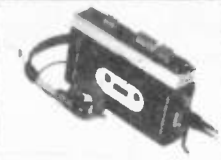
Continuously displays hours, mins., secs., day of the week. AM/PM indicator and alarm-on indicator – 1/10th sec. chronograph with lap time facility. Alarm plays "YELLOW ROSE OF TEXAS." Comes with a fully adjustable stainless steel matching bracelet. (Chrome colour).

**£12.95** LM101 +50p P&P

## SLIM PENDANT WATCH

This watch is beautifully designed as a slim pendant and comes complete with a 26in. long neck chain. The functions include: hours, minutes, seconds, day, month and 4-year auto calendar. Comes in gold colour and is ideal for day and night wear.

**£6.95** + 50p P&P



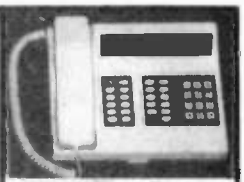
## SOUND-A-ROUND STEREO PLAYER

You can enjoy a very high-quality perfect stereo wherever you go or whatever you are doing. This very high quality stereo player comes complete with a carrying case, a set of super sensitive extremely lightweight headphones and a demonstration cassette. A very special feature is the 'HOT LINE,' this enables you to hear what is going on around you through a built-in microphone. It has a socket for additional headphones.

**£44.95** + £1.95 P&P

Extra headphones

**£7.95** + 75p P&P



## COMPUPHONE LAMBDA 738

This is the most advanced computerised telephone on the market. It has a built-in calculator, clock with seven alarms, a stop watch/timer, 28 memories to store most frequently used telephone numbers, automatic dialling of pre-programmed number, automatic re-dial with repeat dialling at short intervals until the other party answers, a one-way speaker enables you to monitor the line. Push-button dialling, built-in telephone index and lots of other features. It is being sold in Exchange and Mart at £150.00, but we are offering it at a very special price.

**£99.95** + £2.90 P&P

## FLIP CALLER PUSHBUTTON TELEPHONE

This is a very compact beautifully designed, high technology digital telephone. It has last number re-dial facility at the touch of a button. The folding part directs the sound into a built-in microphone during use, and protects they keys when not in use.

**£23.95** + £1.95 P&P

## DUAL MELODY WORLD TIMER

At a touch of a button it displays time anywhere in the world, with geographical position indicated by flashing that zone on the world map.

It has two alarms, a home time alarm and a world time alarm, each play different melody for approx. 30 secs. it also has song demonstration facility.

**£24.95** + 75p P&P

## LADY'S SUGAR COATED WATCH

Lady's 9-function LCD watch. Hours, minutes, seconds, month, date, backlight, auto date/time display mode. 4-year auto calender. This watch has an optional auto date/time display mode. In this mode, time and date is alternatively displayed every 2 seconds (Chrome or gold).

**£5.95** + 50p P&P

## HANDHELD SPACE INVADERS

A superb game, provides endless fun for children and adults alike. (WARNING – THIS GAME CAN SERIOUSLY EFFECT YOUR PAST-TIME). It gives you 90 seconds to hit enemy craft. The elapsing time and 4 digit score is constantly displayed. Score is decremented if you hit a friendly ship or if enemy missile penetrates your defence.

**£10.95** + 75p P&P

## DUAL TIME COUNTDOWN ALARM CHRONOGRAPH

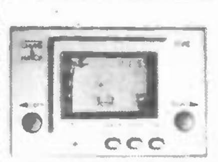
This superb watch has all the features one would ever need. It has selectable 12/24-hr. display count-down timer/alarm dual-time zone, chronograph with lap time facility, 24-hr. alarm with 5 min. snooze facility, back light fully adjustable stainless steel bracelet and we are offering it at our incredibly low price.

**£8.95** + 50p P&P

## 8-DIGIT LADY'S SNOOZE ALARM

This is a very good value for money, it has large easy to read 6-digit display and shows hours, minutes and seconds, pressing a button it shows date, month, and day of the week. the 24-hour alarm has 5 min. snooze facility. It has a fully-adjustable bracelet and a backlight. (Gold colour).

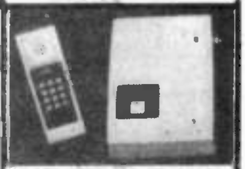
**£7.95** + 50p P&P



## GAME & WATCH

Watch/game combination. 4 games available, each with two options. Fireman (pictured above) rescuers catch the LCD figures in a net as they jump from a burning building and bounce them into the ambulance. Also available – Exterminator, Juggler and Flagman.

**£13.95** + 75p P&P

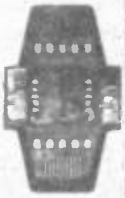


## ALCOM CORDLESS TELEPHONE

This telephone system gives you freedom from the desk, the base station connects to your telephone line, the remote hand set can be carried in own case with shoulder strap or clips to your belt. You can receive calls or make calls from within a radius of ¼-mile from base station. The hand set has push-button dialling with last number re-dial facility and has rechargeable batteries. The batteries are charged when plugged into base station. It is being sold elsewhere for £169.00, we are offering it at a very low price.

**£139.95** + £2.90 P&P

## GALAXY GAME II



This hand-held computerised game unit has three different games, and allows one or two players to play at two skill levels (slow and fast). A two-digit display shows the score.

The three games are:

1. CROSS FIRE
2. PASS THROUGH
3. FOLLOW ME

**£10.95** + 75p P&P

## ELECTRONIC LIGHTERS

Beautifully styled lighters for gentlemen and ladies. No need to change flint or put in new batteries. Battery-operated models also available if required (please specify). These lighters come in attractive presentation cases and are ideal gifts.

**£4.50** +50p P&P

## SUPER SLIM PEN WATCH

Beautifully-styled super slim stainless steel ballpoint pen (replaceable refill) combined with precision quartz timepiece, normal display is hours and minutes with flashing colon, date and month and second, can be displayed by pressing a button, 4-year auto calendar. It comes in a very neat presentation case. Our price

**£8.95** + 50p P&P

## CAR STEREO PLAYER WITH AM/FM MPX RADIO

This compact, quality product is designed to provide you with exceptional listening pleasure. The features include: AM/FM dial-in-door, local/distance attenuator switch for better stereo reception, AM/FM indicator, FM stereo indicator. Fast forward and eject button for cassette, balance, volume and tone controls. 7-watts per channel output.

**£29.95** + £1.90 P&P

Suitable speakers £5 per pair + 95p P&P

## SMOKE DETECTOR FIRE ALARM

Statistics show that it is not the fire that kills, it is the toxic fumes before the flames which are the killers. This early warning smoke detector can detect the fire at its early stages, and give those extra vital minutes to save life. At our offer price you could put one in each room. If you buy four, we will give you one free. Each unit comes complete with a battery. (Please note that all units are tested before despatch in case of malfunction, our liability is limited to the replacement of alarm unit).

**£8.95** + 75p P&P

(P&P for more than one unit £1.50)

## STAR CODE 10 WALKIE TALKIES

Made by GENERAL ELECTRIC COMPANY use 49MHz AM (Crystal controlled – single channel). The other features include: STAR CODE signal key for sending morse code messages (range approx. ¼-mile).

Combination speaker/mic. (range approx. ⅛-mile).

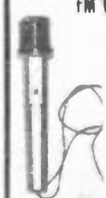
S.A.E. for details.

**£23.95** + £1.95 P&P

## FLUORESCENT PORTABLE LIGHT

A very useful battery-operated high-power fluorescent light for use in the car or for camping. Uses 8 'D' size cells and it has a socket for 12V DC input for use in the car. Power consumption is 6 watts. New circuit makes batteries last longer.

**£4.95** + 95p P&P



## FM WIRELESS MICROPHONE

This high quality Electret microphone can be tuned to transmit in the range 85-95MHz FM. It can be received on any FM receiver, the range depends on the sensitivity of the receiver. Uses one penlight battery which fits inside the microphone. Ideal for parties, discos and clubs.

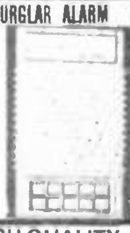
**£8.95** + 50p P&P

## NENTONE WALKIE TALKIES

These impressively designed Walkie Talkies are very good value for money. These have built-in morse-code button, volume control, telescopic antenna, belt clip, transmit receive indicator, 49 MHZ AM crystal controlled transreceiver. The effective range for morse code is approx. ¼-mile and for speech approx. ⅛-mile. Use standard PP3 type battery.

**£18.95** + £1.95 P&P

## 32 TUNES DOORCHIME/BURGLAR ALARM



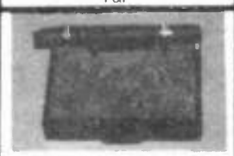
This doorchime is powered from 9V d.c. source, and has battery back-up facility. It has an automatic tune advance facility and single or dual play options at 3 selectable speeds. A built-in burglar alarm circuit allows construction of a NORMALLY CLOSED alarm system. two bell pushes can be connected, each playing different tunes.

**£9.95** + 95p P&P

## THREE-IN-ONE FLUORESCENT

This very compact unit is a torch, a portable fluorescent light and a hazard flashing amber light, all built into one neat case. It comes complete with a shoulder strap to allow both hands to be free. Ideal for campers, hikers and motorists. Runs on six 'C' size batteries.

**£6.95** + 95p P&P



## COMBINATION LOCK BRIEFCASE

This is a very good quality simulated leather executive brief case with combination lock (1 million combinations) having three independent digit combinations on each side. You set your own combination and you can change the combination whenever you desire. We are offering this superb product at a very special price.

**£16.95** + £2.90 P&P

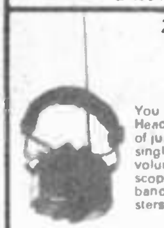
## RAPIDE REACTOLITE SUNGLASSES

These photochromatic sunglasses get darker as the sun gets brighter, and are crystal clear in the shade. These are available in strong metal frames in silver, gold or black colour. These come complete with a simulated leather carrying case. The suggested retail price is £12.95, but we are offering them at a very special price of

**£4.95** + 75p P&P

'Sunsitive' Photochromatic sunglasses

**£2.95** + 75p P&P

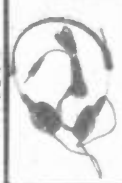


## 2-BAND HIGH QUALITY HEADPHONE RADIO

You can buy this AM/FM Headphone radio for the price of just headphones. Runs off a single PP3 battery, has a volume control and a telescopic aerial for FM waveband. The ideal gift for youngsters.

**£9.95** + 95p P&P

## LIGHTWEIGHT HIGH QUALITY STEREO HEADPHONES



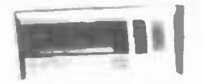
This is a very high quality stereo headphone, to minimise the size and weight it uses Sanarium cobalt magnet and a sensitive polyester film vibrator unit enables very stable Hi-Fi stereo sound, with minimum distortion. The frequency range is 20-20,000Hz, impedance 32 ohms, sensitivity 98 db/mw, maximum input power 100mw, weight 40 gms (excluding cord).

**£7.95** + 25p P&P

## CAR ELECTRIC AERIAL

Add a little luxury to your car by installing this motorised car aerial. Can be installed in any car or truck with 12V supply. It is an excellent value for money and is an ideal gift.

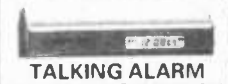
**£8.95** + £1.25 P&P



## QUARTZ TRAVEL ALARM CLOCK

This is a very versatile alarm clock, you can use it in the car, in the kitchen or as a desk top clock. Large (1cm character size) display makes it easy to read from a distance. It has 4-year auto calendar, backlight, AM/PM indicator and alarm on indicator.

**£7.95** + 75p P&P



## TALKING ALARM CLOCK/STOPWATCH

This 'Sharp' Talking Clock is a 'state-of-the-art' product. On pressing the button it announces the time. At the preset alarm time a musical alarm is played and again the time is announced. It has 5 mins. snooze facility. Also has a useful timer and speaks time elapsed every 1 min., 5 mins. or 30 mins., whichever is selected in the stop watch mode it announces the elapsed time at preset intervals or on pressing of a button at any time it is an ideal gift, especially useful for blind people. Overall size is 11.4 x 6 x 2.2cms.

**£39.95** + £1.95 P&P

| | |
|---|---|
| Lady's Sugar-Coated Dress Watch | £5.95 + 50p P&P |
| Lady's 9-Function Dress Watch | £4.95 + 50p P&P |
| Lady's 4-Function Dress Watch | £3.95 + 50p P&P |
| Gent's 5-Function Watch | £3.95 + 50p P&P |
| Vibration Sensitive Car Alarm | £1.50 + 50p P&P |
| Door Chain Burglar Alarm | £1.99 + 50p P&P |
| Gent's Ultra Slim 12/24-hr. Melody Alarm Chrono | £10.95 + 50p P&P |
| 100W Instant Soldering Gun (Pistol type) | £6.50 + 95p P&P |

**AKHTER INSTRUMENTS LTD.**
**11-15 BUSH HOUSE**
**HARLOW, ESSEX CM18 6NS**
**Tel. 0279 414464**

PHONE YOUR BARCLAYCARD OR ACCESS NUMBER FOR IMMEDIATE DESPATCH
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whole keyboard can be shifted to one of three different octaves during play or replay.

- Demo melody — one press of the orange button on the VL-Tone produces a 'German folk song', complete with a variety of rhythm backings.
- Calculator — in this mode, the flat notes on the keyboard become calculator keys, working in conjunction with the LCD 8-digit display. Add, subtract, multiply, divide, square root, percentage, four constants and memory functions are available.

## Power Supply

The VL-Tone uses four AA-size cells, and these are claimed to give 12 hours of continuous use in music mode and 4,000 hours of continuous use in calculator mode. Alternatively, the instrument can be operated from a Casio mains adaptor. If the VL-Tone is left switched on without being used, its auto-power-off (APO) function automatically turns off the supply after about six minutes. The contents of the memory are protected when this happens.

## On Test

This was one gadget that we couldn't put down once we started playing with it. It was uncanny to be able to hear our recorded melodies played back, complete with a backing rhythm. The ADSR function made it possible to invent some of the wierdest sound imaginable!

After a while, we found that our one-note-at-a-time dexterity on the keyboard improved, and we felt more confident with the pieces in the Casio VL-Tone song book.

The sound from the VL-Tone (particularly the bass notes) was considerably enhanced when the instrument was played through a hi-fi system.

One useful facility was the pitch control. With this you could bring the VL-Tone into concert pitch with other musical instruments.

## Comment

The VL-Tone performed admirably when put through its paces. One very small niggle was the 'plopping' sound it made when it was switched off (or turned itself off automatically). This was particularly noticeable when the instrument was played through a separate amplifier.

It is being offered at a discount price of £35.95 (normal RRP £39.95 by Tempus, Department HE, FREEPOST, 164-167 East Road, Cambridge CB1 1DB (tel 0223 312866). The songbook and a soft cover are included in this price.

# CASIO fx-3500P

Casio's new year calculator release was a set of three programmables. Although these do not quite come up to the FX501/502P standard, their low prices are bound to find them a wide market. Here, we review the best of the three models — the fx-3500P.

## Presentation

The 3500 has a stiff ABS plastic case measuring 132 x 72 x 7 mm which fits into an attractive leatherette wallet. The unit has 38 keys, most with two or three functions. The keys do not actually click, but have a positive feel and we always knew when a function had been activated.

The instruction booklet is not particularly helpful, but the use of a large number of examples should guide the user to a reasonable understanding of the calculator's operation. A card is provided (as with all Casio scientifics) giving physical constants and useful conversion factors, but there is no short form operation guide as provided with the FX501/502P. No program library is included and perhaps, if Casio is keen to keep its prices as low as possible, it could publish a program library separately.

## Display

This unit is an LCD device which displays 10 digits plus a 2-digit exponent in slightly smaller figures (internal calculations are performed to 11 significant figures for accuracy). The display can be set to read out to any number of decimal places (FIX mode) or significant figures (SCI mode). The calculator maintains full internal accuracy, even when rounding the display, but the internal result can be rounded to match the display using INV RND. An engineering key is provided to move the decimal point in either direction, three places at a time, so that the exponent is always a multiple of three.

A range of indicators is provided for power on, inverse key, constant, mode, program, and data entry. Our only complaint was that there is no indication that the display is set to FIX or SCI modes. The display is easily read at any angle in any incident light.

## Functions

The literature for the fx-3500P claims 61 functions. The calculator makes light work of all the usual jobs such as trig, logs, hyperbolics and their inverses, powers, roots, reciprocals, factorials, decimal sexagesimal and polar/rectangular conversions, random numbers, pi and percentages. There are 18 parentheses nestable in six levels, which basically means that the calculator can hold six separate answers, each evaluated inside up to three brackets. A capability unique to Casio is the fraction function which allows answers to simple arithmetic calculations to appear as fractions. This function also changes fractions to their lowest terms or to decimals, if required.

The 3500 has seven memories designated as six K-registers which


allow full register arithmetic plus display/register exchange, and one M-register, which gives one-touch recall, but allows only M+ and M− arithmetic. All seven memories are non-volatile as is program storage and calculator mode.

## Statistical Functions

The 3500 offers two statistical modes; standard deviation as provided on most decent scientifics, and linear regression for computation using related pairs of data. In addition to the usual standard deviation functions for both sets of data, linear ▶

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| | |
|---|---|
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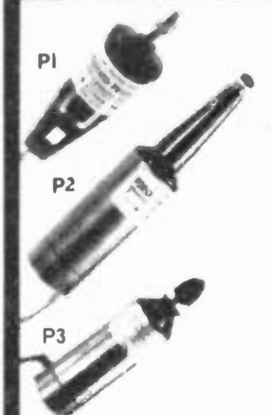


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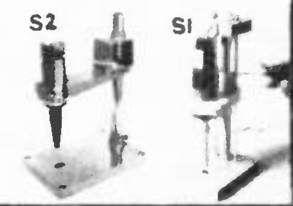


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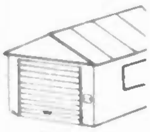
## EVERY DOOR SHOULD HAVE ONE

Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors. The unit, which comes complete with a 10-way keypad, requires an easily remembered four digit code to be entered before the door can be opened, while the intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre wired plug and a momentary or latched output version can be made.

The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code. The complete kit measures 7 × 6 × 3 cms. deep and consumes a mere 40uA when not in use, and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for **ONLY £10.50** and think about all the keys you can lose or forget without ever locking yourself out. As featured in PE, May '81.

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At this price you can use this kit in place of moving coil meters in virtually any application from bathroom scales to bicycle speedometers — the possibilities are endless.

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|---|---|
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Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

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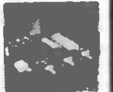

**DLZ1000K**
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum **£8.00**

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# TK Electronics

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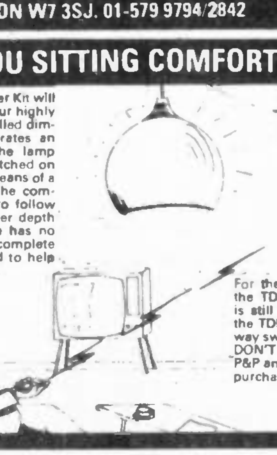

In years to come everyone will be selling remote control dimmers, but you can have your TDR300K kit now for ONLY £14.30 for the dimmer unit and £4.20 for the transmitter.

For the more athletic of you, the TD300K Touchdimmer kit is still available at £6.50 and the TDE/K Extension kit, for 2-way switching etc., is £2.
DON'T FORGET to add 50p P&P and 15% VAT to your total purchase.

### TRIACS

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|---|---|
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| 741 Op Amp | 19p |
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| AY-5-1230/2 Clock/Timer | £4.50 |
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| CA3140 CMOS Op. Amp | 45p |
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| TL082 Dual J-FET Op Amp | 60p |
| TL084 Quad JFet Op. Amp | £1.00 |
| TMS 1121 Clock/7 day timer | £8.50 |
| ZN1034E Timer | £1.80 |
| ZN414 AM Radio | 95p |
| All ICs supplied with Data Sheets | |
| Data Sheets only — per device | 10p |

regression mode provides sum of products of data pairs, slope (gradient), intercept, correlation coefficient, x-estimate and y-estimate. Casio literature claims the availability of logarithmic, exponential and power regression, but this can only be accomplished by correction of data — for example, with exponential regression it is necessary to input x and ln y. Unfortunately, it is impossible to write a program to handle the correction process because programs will not run in linear regression or standard deviation modes.

## Integration

Computation of definite integrals is achieved by the familiar Simpson's rule. The user must write a program to evaluate f(x). He or she then chooses the number of sample points required from 2 to 512, enters the upper and lower limits of integration and within a reasonable time, the integral is displayed. If the number of iterations is not set, the calculator decides for itself, weighing up execution time against accuracy of result.

We tried evaluating the integral for a first order Bessel function between 0 and 180° and found that in 16 seconds, the 3500P produced an answer accurate to six significant figures, and, if we waited 32 seconds, we received an answer accurate to nine significant figures. Similarly good results were achieved with other functions such as the sine integral.

## Programming

The fx-3500P has 38 merged steps (ie, each step performs one function, no matter how many keystrokes). These are shared between two buttons, P1 and P2. Programming is limited in all respects — there is no GOTO, GOSUB, INT, or FRAC capability although rounding to the nearest integer is possible in FIX mode. Limited jumping is also provided: RTN performs a jump to the first step of the program: $x>0$ and $x \leq M$ jump to the first step, if met and continue otherwise. This limited jumping renders the branches almost useless although simple loop control is possible. As a programmable, the 3500 resembles recent models from Sharp which simply store and evaluate formulas. One good feature is the ease of programming: one simply has to select program mode and then perform a calculation in the usual way (the calculation is actually carried out as it is entered). Two forms of halt command are provided, one to display intermediate results and one which displays a prompt for data input.

No keycodes are provided for program checking and there are no editing facilities other than selective clearing of programs, which is rather annoying as it means that if you make one mistake you have to re-enter the entire program.

## Comment

The fx-3500P is a powerful calculating machine with limited programming features at a very reasonable price. It will appeal to the engineer, 0 level statistician, A level mathematician/physicist, and low-level researcher. The fx-3500P costs £22.95, from Tempus.

In the same range as the 3500P we have the fx-180P, a beefier version running on two penlight cells which has the same features as the 3500P apart from hyperbolics, and costs £19.95. Also at this price is the fx-2700P which uses the same case as the 3500P, although it has no linear regression or integrate modes, can only store one program, and has an eight-digit display.

The fx-3500P, fx-2700P and fx-180P are all available from Tempus, HE Freepost, 164-167 East Road, Cambridge CB1 1DB (tel 0223 312866).

## Timings

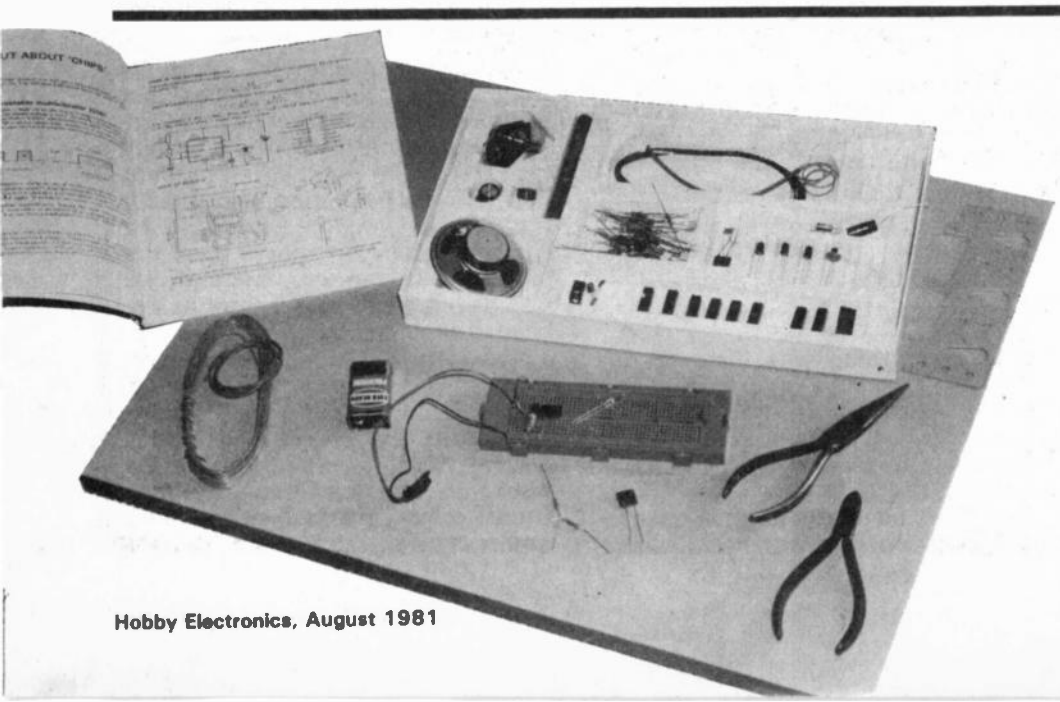
A loop was written to run functions 100 times and the test results are tabulated below.

basic loop time: 12.5s

| Function | Loop Time (s) | Average Execution Time of Function (s) |
|---|---|---|
| multiply by 7 | 24.5 | 0.12 |
| store in M | 14.5 | 0.02 |
| store in K3 | 15 | 0.025 |
| square root | 19 | 0.065 |
| natural logarithm (ln) | 38 | 0.255 |
| sine | 50.5 | 0.38 |
| reciprocal ($^1/_x$) | 17 | 0.045 |
| extract 7th root | 75 | 0.625 |

These results show the fx-3500P to be a very fast machine. In use, it is possible to work through a calculation at a reasonable pace without having to check the display to see that a scientific function has been calculated.

| Good Points | Bad Points |
|---|---|
| Slim, stiff, attractive case and wallet | Instruction manual |
| Continuous memory | No program library or operation guide |
| Display | Poor program functions, jumps and editing |
| Speed and accuracy | |
| Fraction capability | |
| Linear regression | |
| Integration | |



# Adventures With Microelectronics

If you want to get used to handling electronic components, including integrated circuits, then Adventures With Microelectronics could be for you.

At a cost of £36.36, this self-teach introduction to electronic components and circuits comes complete in a single box 320 mm by 198 mm by 35 mm. When you lift the lid you are greeted with a handwritten warning sheet stating in bold black letters: 'STOP!!! TRANSISTORS ARE DELICATE! HANDLE THEM *VERY GENTLY*, AND

READ *ALL* THE INSTRUCTIONS!'

Well, at least that should discourage the absolute beginner from rushing in without reading the glossy hard-bound instruction book supplied with the kit and making a mess of things.

## What's In The Box

Apart from the book, the box contains an inset tray holding a piece of Bimboard (solderless circuit board, similar to the Eurobreadboard described in Introduction To Electronic Components on page 47), resistors, capacitors, integrated circuits and a variety of other components, all sitting neatly in different compartments.

## Choice Of Projects

You can use these components to make any or all of the following projects:

- An astable, monostable or a bistable
- NAND, OR and NOR gates
- Two-tone door bell
- Warbling-wailing siren
- Two-octave electronic organ
- Pulsed flashing lamp
- Light-operated alarm
- Electronic dice
- Traffic lights
- Pulsed bleeper
- Four-bit binary counter
- Reaction timer
- MW/LW radio receiver

Components for each project are simply plugged into the appropriate holes in the Bimboard, together with links and wires as necessary. In this way, the same components can be used over and over again.

## The Book

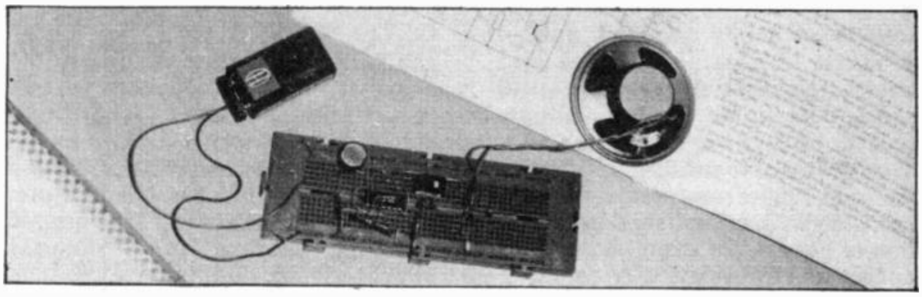
We found the instruction book, by Tom Duncan, to be well written, well printed and easy to follow. Drawings were made clearer by the use of two-colour printing (for example, on the Bimboard layouts the hole positions are shown in black, with the components overprinted in blue).

The book starts out by making you familiar with what the 'bits and pieces' — electronic components, that is — look like, what they do and how they are identified in a circuit.

Full details are also given on how to prepare components for insertion in the board.

Each project section is divided into:

- What you need — components to be retrieved from the box
- Here is the circuit — circuit of project, with pin functions of any ICs used
- How to build it — where to place the components, with any special precautions



- How it works — circuit description
- Things to try — a few experiments to try with the completed project, such as the effects of changing the value of induvidual components or of changing their positions in the board

One recurrent instruction throughout the book was CHECK THE CIRCUIT CAREFULLY. That bit of advice is equally applicable to HE projects!

## Trying A Project

Back to the same kitchen table where the ZX81 kit was built (see last month's GG&K), and in close range of a supply of coffee, we had a bash at the Light-operated Alarm project.

All the components required for the project were selected from the box. We found that three types of resistor had been supplied but despite the different bodies for each, the colour codes were clearly visible.

The two types of 'disc ceramic' capacitor were *rectangular* (plate type), and the markings on each type might cause some confusion. Under the 'Bits and Pieces' section it says: 'On a capacitor, 0.1 uF may be marked as .1mfd and 0.01uF as 10n'. Under 'What You Need', you are asked to look for 0.01uF and 0.1uF. The capacitors in question were labelled 100nZ and 10K.

No problem was found in inserting the resistors, IC and miscellaneous components, although care was needed in manipulating the leads of the two transistors to ensure that they lined up with the holes in the board without shorting to each other.

We found that a pair of fine-nosed tweezer pliers were of great assistance in inserting such awkward leads.

## On Test

After everything was inserted, including the links and connecting leads, the circuit was carefully checked. Everything looked correct, and so the switch link was connected. The LED gave a brief flash and then the circuit died. When the battery connector was twiddled the circuit perked up — and died again.

When the battery voltage was checked it was found to be well above 9 V (a PP3 battery was supplied with the kit.) But when it was tried again the circuit refused to work.

We tried another PP3-sized battery and the circuit came alive. As soon as the light-sensitive resistor was covered, the LED began to flash. By operating the slide switch, audible clicks could be heard from a loudspeaker connected to the board.

We tried the various experiments suggested and some interesting results were obtained. For instance, you could arrange for the circuit to operate as a light-sensitive 'alarm clock'. (When the dawn breaks the loudspeaker gives out a loud squeal.)

## Opinion

We thought that Adventures With Microelectronics was a good educational kit, and it should give many hours of entertainment — without the need of a soldering iron. As mentioned above, some of the components need careful handling (hence the big notice that greets you when you open the box). Some hand tools (cutters and pliers) are all that are required in addition to what is supplied.

The kit also introduces you to solderless prototype circuit board, and this board is invaluable for circuit experiments.

## Battery Post Mortem

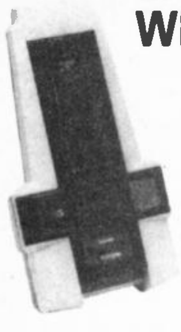
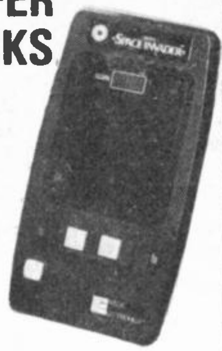
We tracked down the cause of failure when the circuit was first switched on. When pressure was applied to the terminals of the battery supplied with the kit (Premium PP3-P Power Pack from Ever Ready) the voltage dropped to zero on an HE test meter. So we cut open the battery case and, sure enough, we discovered a dry solder joint at the base of the cell stack.

Adventures With Microelectronics is available from Unilab Limited, Clarendon Road, Blackburn BB1 9TA (tel 0254 57643). Cost is £36.36 with the book, or £34.16 without the book (these prices are inclusive of VAT and postage).

HE

Galaxy 1000

# SPECIAL OFFER WHILE STOCKS LAST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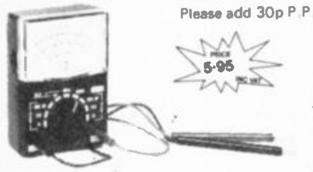



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| CD4002 | 0.20 | CD4511 | 1.97 |
| CD4007 | 0.20 | CD4514 | 2.20 |
| CD4008B | 0.75 | CD4520B | 0.90 |
| CD4009 | 0.40 | CD4522 | 1.10 |
| CD4010 | 0.46 | SN7400 | 0.19 |
| CD4011B | 0.20 | SN7401 | 0.19 |
| CD4012 | 0.20 | SN7403 | 0.19 |
| CD4013B | 0.40 | SN7404 | 0.10 |
| CD4014 | 0.78 | SN7410 | 0.19 |
| CD4015 | 0.80 | SN7412 | 0.24 |
| CD4016 | 0.38 | SN7414 | 0.55 |
| CD4017B | 0.72 | SN7420 | 0.16 |
| CD4018B | 0.75 | SN7423 | 0.26 |
| CD4019B | 0.42 | SN7426 | 0.35 |
| CD4020B | 0.90 | SN7432 | 0.24 |
| CD4022B | 0.78 | SN7440 | 0.16 |
| CD4024B | 0.64 | SN7441 | 0.65 |
| CD4028B | 0.75 | SN7442 | 0.49 |
| CD4029B | 1.08 | SN7445 | 0.91 |
| CD4034B | 2.60 | SN7446 | 0.48 |
| CD4035B | 1.09 | SN7447 | 0.48 |
| CD4040 | 0.85 | SN7448 | 0.45 |
| CD4041B | 0.88 | SN7450 | 0.19 |
| CD4042B | 0.67 | SN7453 | 0.16 |
| CD4047B | 1.02 | SN7454 | 0.16 |
| CD4049 | 0.34 | SN7460 | 0.15 |
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# Building Site

## This month, Keith Brindley looks at meters and describes how to adapt them to measure different voltages and currents

THE ELECTRONIC THERMOMETER on page 23 of this issue uses a meter to indicate the measured temperature. We have given the necessary specifications of this meter as being any meter which measures 1 V FSD. Now, 1 V FSD (FSD means full-scale deflection) meters aren't easy to come by. True, if you have a multimeter, chances are it *could* have a 1 V range. But what if you want to use a panel meter such as we have in our prototype, and you can't find one which specifically measures 1 V FSD?

Perhaps we should take a look at how meters work, and then we may be in a position to answer the questions. Most commonly used meters are of the moving-coil type and so we'll restrict ourselves to them. **Figure 1** shows the external appearance and internal construction of a typical moving-coil meter.

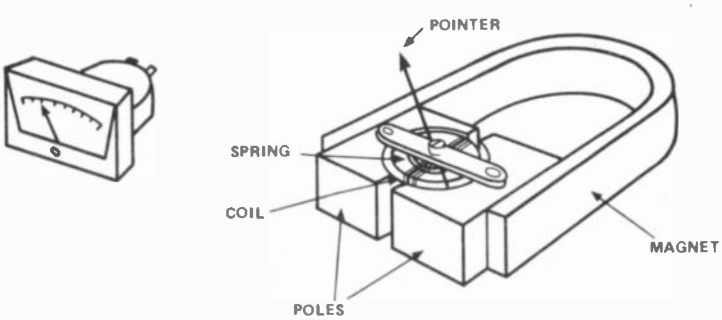


**Figure 1. Typical external appearance and internal construction of a moving-coil meter**

When an electric current flows through a wire, a magnetic field is produced around this wire. The field is strengthened when the wire is wound into a coil.

It doesn't take an Einstein to realise that if the coil (plus magnetic field) is suspended in the magnetic field from a permanent magnet, the two fields will interact and the force will turn the coil. In fact, the coil will turn an amount proportional to the current through it. Thus, the pointer attached to the coil will point to a position which depends on the size of the current.

The characteristics of a meter are defined as:

- the current to produce end-of-scale (ie, full-scale) deflection. For example, if a meter is specified as 100 uA FSD then a current of 100 uA ($1 \times 10^{-4}$ A) will deflect the pointer to a full reading.
- the coil's resistance. From Ohm's law:

$$V = I R,$$

where V is the voltage in volts, I is the current in amps and R is the resistance in ohms. Using this fomula we can calculate the voltage which also produces FSD. Say, the coil's resistance R = 1k0 and the current for FSD (as before) is 100 uA then

$$V = 1000 \times 1 \times 10^{-4} = 0.1 \text{ V}.$$

So this meter could be used to directly measure up to 0.1 V, ie, 100 mV.

## So What?

What's the good of a meter which can only measure 100 mV or 100 uA? What happens if we want to measure 1 V or 1 mA? Do we have to go out and buy a new meter?

No! We can adapt the first meter to measure higher voltages or currents simply by adding a resistor to it — not any old resistor, mind you, but one specially calculated for the application.

## Higher Voltages

To measure a higher voltage than 100 mV we add a series resistor, R, as in **Fig.2**. The coil resistance M of the meter is 1k0 and the FSD current I is 100 uA.

The voltage across the meter must reach a maximum of 100 mV, so we can work out from all this information that the voltage across the resistor R will be the voltage to be measured, 1 V, minus the meter voltage, 100 mV;

$$\text{ie, } V_R = V_{measured} - V_M,$$
$$= 1 - 0.1,$$
$$= 0.9 \text{ V}.$$

The current around the circuit I = 100 uA (the current to give FSD),

$$\text{therefore,} \quad R = \frac{V}{I} = \frac{0.9}{100 \times 10^{-6}} = 9\text{k}0.$$

So, with a series resistor of 9k0 the meter will indicate a measured voltage of 0-1 V.

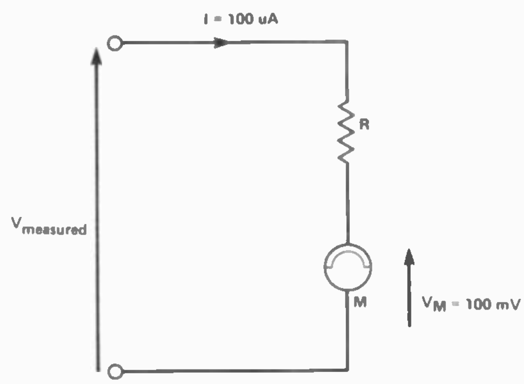


**Figure 2. A series resistor added to your meter allows it to indicate higher voltages**

## Higher Current

Similarly, we can adapt a meter to read higher values of *curlent.* How? By adding a *parallel* resistor, of course. **Figure 3** shows the idea.

A voltage across our meter, of 100 mV, causes FSD. Now, because the resistor and the meter are in parallel, the resistor voltage $V_R$ must also be 100 mV.

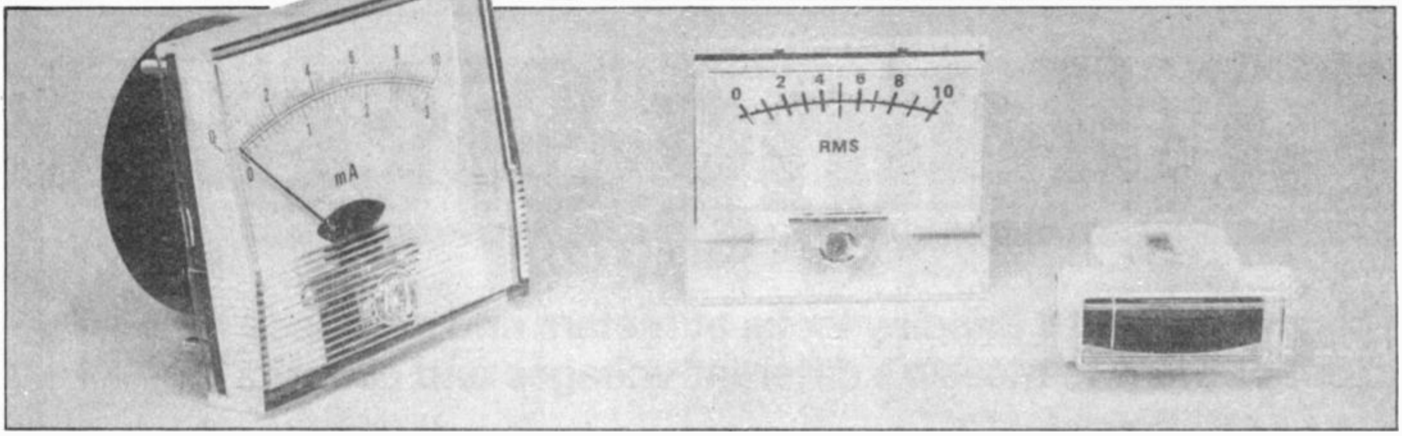


Figure 4. A selection of commonly available moving-coil meters

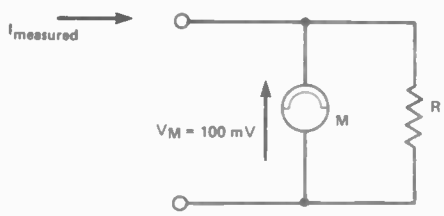


Figure 3. By adding a resistor in parallel with the meter, higher currents can be indicated

The current through the meter is 100 mA, so — you guessed it — the current through the resistor equals the measured current, minus the meter current:

$$I_R = I_{measured} - I_M,$$

$$= 1\text{ mA} - 1\text{ uA},$$

$$= 9.99 \times 10^{-4}\text{ A}.$$

So, the resistance,

$$R = \frac{V}{I},$$

$$= \frac{100\text{ mV}}{9.99 \times 10^{-4}\text{ A}},$$

$$= 100.1\text{R},$$

And for most purposes, a resistance of 100R will do, for our meter to indicate a current of 0-1 mA.

Finally, Fig.4 shows a collection of some available types of moving-coil meter. As you can see, they come in a variety of shapes and sizes but as long as you know their specifications you can adapt them to different ranges. **HE**

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| 1508 | 8DL307 7 segment LED display .3" | £0.80 |
| 1509 | 8DL527 dual 7 segment LED display .5" | £1.80 |
| 1510 | BDL707 7 segment LED display .3" | £0.98 |
| 1511 | BLD747 7 segment LED display .6" | £1.75 |
| 1512 | 8DL727 dual 7 segment LED display .5" | £1.90 |

### MISCELLANEOUS

| | | |
|---|---|---|
| 1514 | ORP12 Light Dependent Resistor | £0.60 |
| 1518 | Photo transistor P20 NPN | £0.60 |
| 1519 | Photo Darlington MEL11 NPN | £0.26 |
| 1520 | Photo transistor OCP71 PNP | £0.40 |
| 1526 | FPE100 Infra Red Emitter | £0.38 |
| 1527 | CQY89 Infra Red LED | £0.38 |
| 2219 | Right Angle Bracket 1½" × ½" | £0.07 |
| 2220 | Right Angle Bracket ½" × ½" | £0.06 |

### Beginners Pak: No. 1
### 100 Transistors

A pack of well known transistors, As used in many popular projects. A must for beginners (and very useful to experienced constructors too).

| | | | | |
|---|---|---|---|---|
| 10 | BC107/8 | T018 | Metal | NPN |
| 10 | 8C237 | T092 | Plastic | NPN |
| 5 | 8C177/8 | T018 | Metal | PNP |
| 5 | BC251 | T092 | Plastic | PNP |
| 10 | BFY51-8C141 | T039 | Metal | NPN |
| 5 | 8C160 | T039 | Metal | PNP |
| 5 | 2N3055 | T03 | Metal | NPN |
| 2 | 8D312/MJ2955 | T03 | Metal | PNP |
| 5 | TIP29-31 | T0220 | Plastic | NPN |
| 2 | TIP30-32 | T0220 | Plastic | PNP |
| 10 | OC71-76 | Germanium | | PNP |
| 5 | AC128-188 | Germanium Metal | | PNP |
| 5 | AC127 187 AC176 | Germanium Metal | | NPN |
| 5 | OC44-45 | Germanium | | PNP |
| 5 | TIS43-UT46 | Unijunction Plastic | | |
| 5 | 2N3819 | F.E.T | | |
| 2 | MEL11 | Photo Transistor Plastic | | |
| 2 | 8D131 | T0126 | Plastic | NPN |
| 2 | 8D132 | T0126 | Plastic | PNP |

100 TOTAL

All devices – brand new and full spec as per device coding. Data and lead out details included in pak.
Normal Retail Value £23.00
Our Special Offer Price £15.00

### Beginners Pak: No. 2
### 100 Rectifiers, SCR's, Triacs, Diodes.

| | |
|---|---|
| 20 | IN4001-IN4007 1Amp Silicon Rectifier |
| 20 | IN5401-IN5407 3Amp Silicon Rectifier |
| 20 | IN4148 Fast switch diodes Silicon |
| 10 | OA200 BAX13-6 General Purpose Diode Silicon |
| 5 | C106D Thyristor 400v T0202 Case |
| 2 | 10Amp Triacs 400v T0220 Case Isolated Tab |
| 2 | 4Amp Triacs 400v T0220 Case Non-isolated Tab |
| 10 | Assorted 3Amp Thyristors 50-600volts T064-T066 Case |
| 5 | Assorted 1Amp Thyristors 50-600volts T039 Case |
| 6 | OA81-91 General Purpose Germanium Diodes |

100 TOTAL

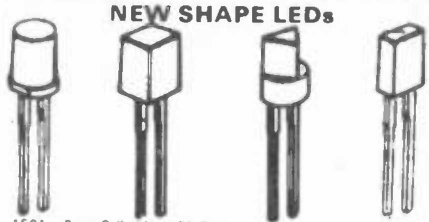
All devices brand new and ful spec Data and lead out details included.
Normal Retail Value £17.00
Our Special Offer Price £11.00

### UNTESTED SEMICONDUCTOR PAKS

| | | |
|---|---|---|
| U1 | 150 germ Gold Bonded Diodes OA47 | £1.00 |
| U2 | 150 germ point contact diodes OA81 | £1.00 |
| U3 | 150 Silicon G.P. 200mA Diodes OA200 | £1.00 |
| U4 | 150 Silicon Fast Switch Diodes IN4148 | £1.00 |
| U5 | 25 Stud type Silicon Rectifiers up to 10A | £1.00 |
| U6 | 10 SCR s 5Am- T066 | £1.00 |
| U7 | 40 Sil Trans NPN T018 Case 8C107/8/9 | £1.00 |
| U8 | 40 Sil Trans PNP T018 Case 8C177/8/9 | £1.00 |
| U9 | 40 Sil Trans NPN T018 Case 2N706 | £1.00 |
| U10 | 30 Sil Trans NPN TO5/39 2N697/2N1711 | £1.00 |
| U11 | 30 Sil Trans PNP TO5/39 2N2905/1132 | £1.00 |
| U12 | 30 Sil Trans NPN T039 8FY51-8C141 | £1.00 |
| U13 | 30 Sil Trans PNP T039 8C160-161 etc | £1.00 |
| U14 | 10 Sil Trans NPN T03 2N3055 | £1.00 |
| U15 | 10 Sil Trans NPN T0220 TIP29-31-33 | £1.00 |
| U16 | 10 Sil Trans PNP T0220 TIP30-32-34 | £1.00 |
| U17 | 30 Sil Trans NPN T039 High Vlts. 8F258 115 | £1.00 |
| U18 | 40 Sil Trans T092 8C237 8 | £1.00 |
| U19 | 40 Sil Trans T092 8C251 | £1.00 |
| U20 | 40 Sil Trans NPN T092 8C183-4 | £1.00 |
| U21 | 40 Sil Trans PNP T092 8C257 8C212L | £1.00 |

Code No s mentioned above are given as a guide to the type of device in the pak, The devices themselves are normally unmarked

### NEW SHAPE LEDs



| | | |
|---|---|---|
| 1561 | 3mm Cylindrical LED Red | £0.26 |
| 1562 | 3mm Square LED Red | £0.26 |
| 1563 | 3mm Triangular LED Red | £0.26 |
| 1564 | 5mm Rectangular LED Red | £0.26 |
| 1565 | 5mm Cylindrical LED Red | £0.26 |
| 1566 | 5mm Square LED Red | £0.26 |
| 1567 | 5mm Triangular LED Red | £0.26 |
| 1568 | 3mm Cylindrical LED Green | £0.28 |
| 1569 | 3mm Square LED Green | £0.28 |
| 1570 | 3mm Triangular LED Green | £0.28 |
| 1571 | 5mm Rectangular LED Green | £0.28 |
| 1572 | 5mm Cylindrical LED Green | £0.28 |
| 1573 | 5mm Square LED Green | £0.28 |
| 1574 | 5mm Triangular LED Green | £0.28 |
| 1575 | 3mm Cylindrical LED Yellow | £0.28 |
| 1576 | 3mm Square LED Yellow | £0.28 |
| 1577 | 3mm Triangular LED Yellow | £0.28 |
| 1578 | 5mm Rectangular LED Yellow | £0.28 |
| 1579 | 5mm Cylindrical LED Yellow | £0.28 |
| 1580 | 5mm Square LED Yellow | £0.28 |
| 1581 | 5mm Triangular LED Yellow | £0.28 |

### CERAMIC PAKS

Containing a range of first quality miniature ceramic capacitors.

MC1 40 miniature ceramic capacitors:
5 of each value:
22pf, 27pf, 33pf, 39pf, 47pf, 56pf, 68pf, 82pf. **£1.00**

MC2 40 miniature ceramic capacitors:
5 of each value:
100pf, 120pf, 150pf, 180pf, 220pf, 270pf, 330pf, 390pf. **£1.00**

MC3 40 miniature ceramic capacitors:
5 of each value:
470pf, 560pf, 680pf, 820pf, 1000pf, 1500pf, 2200pf, 3300pf. **£1.00**

MC4 35 miniature ceramic capacitors:
5 of each value:
4700pf, 6800pf, .01uf, .015uf, .022uf, .033uf, .047uf. **£1.00**

### SPEAKERS AND CROSSOVERS

| | | |
|---|---|---|
| 1901 | Dome Tweeter 3½" 8 ohms 50w | £3.20 |
| 1902 | Dome Tweeter 3" 8 ohms 20w | £2.60 |
| 1903 | Flared Horn Tweeter 8 ohms 30w | £3.80 |
| 1904 | 2 way crossover 15w 8 onms | £1.24 |
| 1905 | 2 way crossover 40w 8 ohms | £2.70 |
| 1906 | 3 way crossover 60w 8 ohms | £3.50 |
| 1907 | Piezo Tweeter | £5.20 |
| 1914 | 70mm 80 ohm speaker | £1.20 |
| 1915 | 70mm 8 ohm speaker | £0.95 |
| 1916 | 56mm 8 ohm speaker | £0.65 |
| 1917 | 2¼" 8 ohm speaker | £0.75 |
| 1918 | 2¼" 64 ohm speaker | £0.82 |
| 1919 | 5¼" whoofer 4 ohms 10w | £3.90 |
| 1920 | 5¼" whoofer 8 ohms 10w | £3.90 |
| 1921 | 5¼" Dual cone wide range 8 ohms | £5.80 |
| 1922 | 8" Dual cone long throw 8 ohms 15w | £4.84 |
| 1923 | 8" whoofer dual 4 - 8 ohms rubber edge 20w | £7.80 |

### DIL SOCKETS

1601 8 Pin £0.09

| | | | | | |
|---|---|---|---|---|---|
| 1602 | 14 Pin | £0.11 | 1606 | 22 Pin | £0.24 |
| 1603 | 16 Pin | £0.12 | 1607 | 24 Pin | £0.28 |
| 1604 | 18 Pin | £0.18 | 1608 | 28 Pin | £0.32 |
| 1605 | 20 Pin | £0.20 | 1609 | 40 Pin | £0.36 |

### LATE ADDITIONS – High Current Transistors

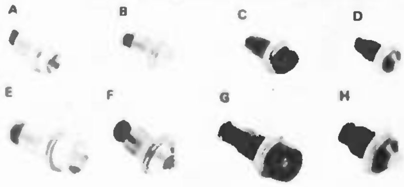
| | VCEO | VC8O | I.C. Max | |
|---|---|---|---|---|
| 8FT32 | 60 | 80 | 3A | £0.60 |
| 8FT33 | 80 | 100 | 3A | £0.62 |
| 8FT34 | 100 | 120 | 3A | £0.65 |
| 8FT37 | 100 | 120 | 3A | £0.95 |

RPYY76A Infra Red Detector £0.65

### EARPIECES & BUZZERS

| | | |
|---|---|---|
| 500 | Solid State Buzzer 4-25v | £0.75 |
| 501 | Crystal Earpiece | £0.42 |
| 502 | 8 ohm Earpiece 2.5mm Plug | £0.18 |
| 503 | 8 ohm Earpiece 3.5mm Plug | £0.18 |
| 505 | 200 ohm Earpiece 3.5mm Plug | £0.44 |

### LED CLIPS AND HOUSINGS




| | | | |
|---|---|---|---|
| 1548 | LED Plastic clips .125" | | £0.15 |
| 1549 | LED Plastic clips .2" | | £0.18 |
| 1550 | LED Housing (nickel plated) .125" | A | £0.26A |
| 1551 | LED Housing (nickel plated) .125" | B | £0.228 |
| 1552 | LED Housing (matt black) .125" | C | £0.37C |
| 1553 | LED Housing (matt black) .125" | D | £0.31D |
| 1554 | LED Housing (nickel plated) .2" | E | £0.34E |
| 1555 | LED Housing (nickel plated) .2" | F | £0.28F |
| 1556 | LED Housing (matt black) .2" | G | £0.44G |
| 1557 | LED Housing (matt black) .2" | H | £0.36H |

### BULBS AND NEONS

| | | |
|---|---|---|
| 1534 | LES 8ulb 6v 0.36w | £0.24 |
| 1535 | LES 8ulb 6.5v 1w | £0.24 |
| 1536 | LES 8ulb 14v 0.75w | £0.24 |
| 1538 | MES 8ulb Round 6v .04A | £0.24 |
| 1539 | MES 8ulb Round 6.5v .15A | £0.20 |
| 1540 | MES 8ulb Round 6.5v .3A | £0.20 |
| 1541 | MES 8ulb Round 12.0v .1A | £0.20 |
| 1542 | MES 8ulb Round 12.0v 2.2w | £0.20 |
| 1543 | Neon Red Round 240v | £0.34 |
| 1544 | Neon Red Rectangular 240v | £0.34 |
| 1545 | Neon Orange Rectangular 240v | £0.34 |
| 1546 | Neon Green Rectangular 240v | £0.34 |
| 1547 | MES 8atten Holder | £0.18 |

### CARBON FILM RESISTOR PAKS

These paks contain a range of Carbon Film Resistors, assorted into the following groups

| | | | |
|---|---|---|---|
| R1 | 80 Mixed | ¼w 100 ohms-820 ohms | £1.00 |
| R2 | 80 Mixed | ¼w 1K ohms-8.2K ohms | £1.00 |
| R3 | 80 Mixed | ¼w 10K ohms-82K ohms | £1.00 |
| R4 | 80 Mixed | ¼w 100K ohms-1M | £1.00 |
| R5 | 60 Mixed | ½w 100 ohms-820 ohms | £1.00 |
| R6 | 60 Mixed | ½w 1K ohms-8.2K ohms | £1.00 |
| R7 | 60 Mixed | ½w 10K ohms-82K ohms | £1.00 |
| R8 | 60 Mixed | ½w 100K ohms-1M | £1.00 |

### TANTALUM BEAD CAPACITORS

| | | | | | |
|---|---|---|---|---|---|
| 401 | 0.1uf 16v | £0.11 | 414 | 47.0uF 16v | £0.55 |
| 402 | 0.22uf 16v | £0.11 | 415 | 100uF 10v | £0.62 |
| 403 | 0.33uf 16v | £0.11 | 416 | .1uF 35v | £0.12 |
| 404 | 0.47uF 16v | £0.11 | 417 | .22uF 35v | £0.12 |
| 405 | 0.68uF 16v | £0.11 | 418 | .33uF 35v | £0.12 |
| 406 | 1.0uF 16v | £0.11 | 419 | .47uF 35v | £0.12 |
| 407 | 2.2uF 16v | £0.12 | 420 | .68uF 35v | £0.12 |
| 408 | 3.3uF 16v | £0.13 | 421 | 1.0uF 35v | £0.12 |
| 409 | 4.7uF 16v | £0.14 | 422 | 2.2uF 35v | £0.13 |
| 410 | 6.8uF 16v | £0.15 | 423 | 3.3uF 35v | £0.15 |
| 411 | 10.0uF 16v | £0.16 | 424 | 4.7uF 35v | £0.18 |
| 412 | 22.0uF 16v | £0.28 | 425 | 6.8uF 35v | £0.30 |
| 413 | 33.0uF 16v | £0.50 | 426 | 10.0uF 35v | £0.38 |

### ELECTROLYTIC PAKS

A range of paks each containing 25 first quality, mixed value miniature electrolytics.

| | | |
|---|---|---|
| EC1 | Values from .46mFD-10mFD | £1.00 |
| EC2 | Values from 10mFD-100mFD | £1.00 |
| EC3 | Values from 100mFD-1000mFD | £1.00 |

### POWER SUPPLIES

| | | |
|---|---|---|
| 137 | AC-DC Adaptor 6, 7½, 9 & 12 volts | £3.75 |
| 138 | DC-DC Adaptor 6, 7½, 9 volts | £2.70 |

### CABINETS

| | | |
|---|---|---|
| 139 | Teak 30 Case | £7.00 |
| 140 | Teak 60 Case | £9.50 |

### VEROBOARD

| | | |
|---|---|---|
| 2201 | 2.5" × 5" .1 copper | £0.76 |
| 2202 | 3.5" × 3.75" .1 copper | £0.66 |
| 2203 | 2.5" × 17" .1 copper | £2.28 |
| 2204 | 3.75" × 5" .1 copper | £0.86 |
| 2205 | 3.75" × 3.75" .1 copper | £0.76 |
| 2206 | 3.75" × 17" .1 copper | £2.96 |
| 2207 | 4.75" × 17.9" .1 copper | £3.90 |
| 2208 | 2.5" × 1" 5 in pack | £0.92 |
| 2209 | 3.75" × 17" .1 Plain | £1.92 |
| 2210 | 3.75" × 2.5" .1 Plain | £0.48 |
| 2211 | 5.0" × 3.75" .1 Plain | £0.72 |
| 2212 | vero pins Double sided .040mm .1" (in 100's) | £0.52 |
| 2213 | vero pins Single sided .040mm .1" (in 100's) | £0.52 |
| 2214 | DIP Breadboard | £3.26 |
| 2215 | Vero Cutter | £1.06 |
| 2216 | Insertion Tool .1 | £1.46 |
| 2217 | PC8 Transfers | |
| 2218 | 12 volt mini drill | £7.00 |

### BREADBOARD

| | | |
|---|---|---|
| 2195 | EXP325 | £1.84 |
| 2196 | EXP350 | £3.62 |
| 2197 | EXP650 | £4.14 |
| 2198 | EXP300 | £6.61 |
| 2199 | EXP48 | £2.65 |
| 2200 | EXP600 | £7.26 |

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# Electronic Organ – 4

## The last part of our organ project gives details of final wiring up, tuning and adjustments to complete your own working model

IF YOU HAVE religiously followed our instructions to date, your organ will now be ready for final wiring up. This basically means: the interconnection of Board 2 (the top-octave generator) to Boards 3 and 4 (the dividing and keying boards); and the interconnection of Boards 3 and 4 to the keyboard contacts.

All these connections and their positions are critical so follow the diagram, given in **Fig.1**, starting with the 12 connections from the top-octave generator. Use a fairly stiff variety of multi-stranded wire and carefully form each piece: to come vertically up from Board 2; then, to bend back at 90° towards the back of the organ; to bend left at 90° along the back of the board; then, to bend forward at 90° towards the front; and finally, to bend down at 90° to the correct connection point on either Board 3 or Board 4. The view of the complete project (**Fig.2**) shows the idea.

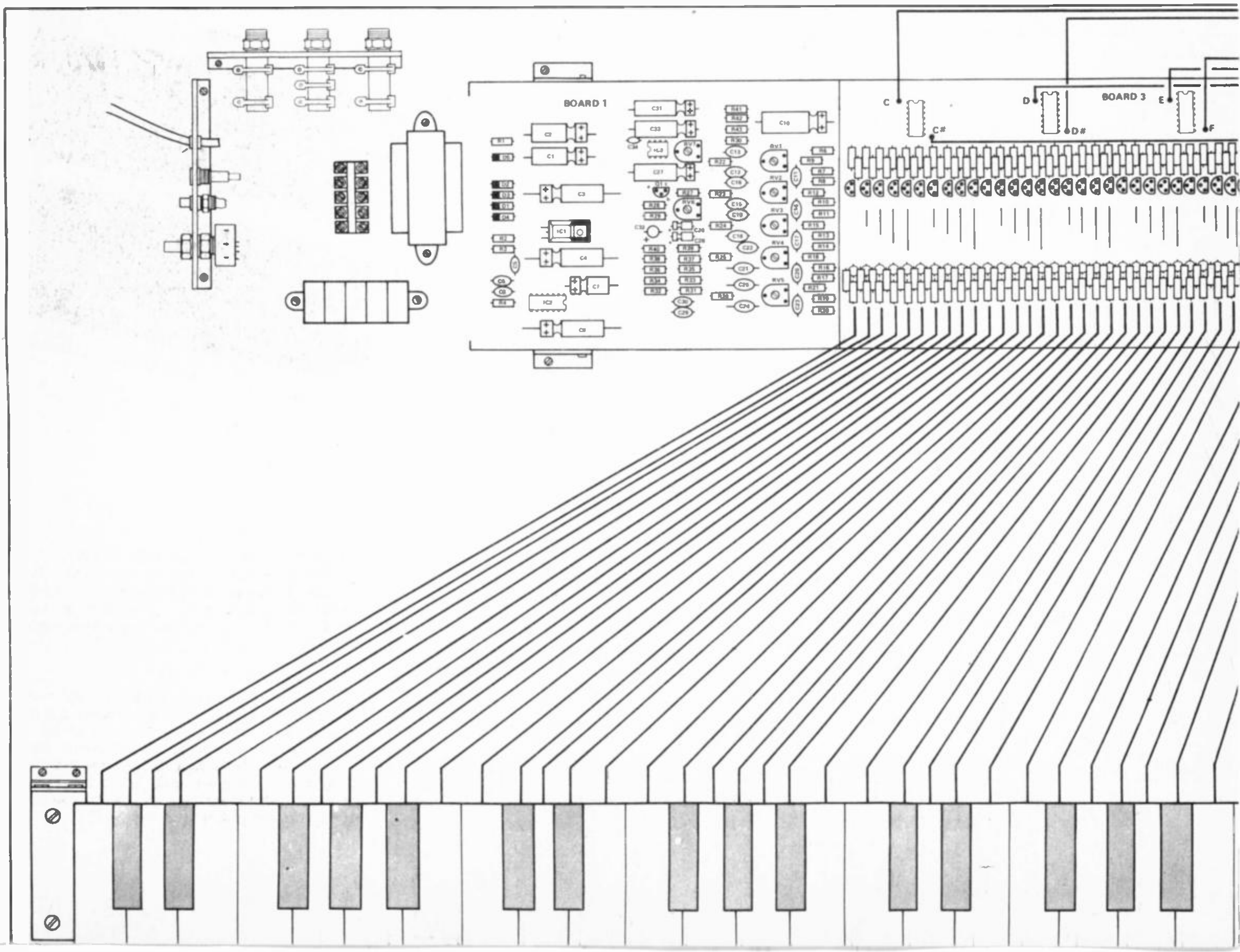
Now, cable-tie (with lacing-cord, plastic ties or string) the group of 12 interconnections together with all previously connected power supply leads, in a number of places. This should form a fairly thick and solid cableform running along the back of the organ.

Again following **Fig.1**, start to wire-up the keyboard contacts to Boards 3 and 4. The 60 pins on the bottom of the two circuit boards each need a single multi-stranded wire connection to the corresponding keyboard contact underneath the keyboard. This job is quite straightforward but will be long and monotonous because of the number of connections.

A good tip here is to use coloured wire. If you only have a few different colours (after all, not many people will have 60 different coloured reels of wire) then group the leads into small numbers and stick to the same pattern of colours in each group eg, red, white, blue, green, black; red, white, blue, green, black, etc.

Now cable-tie each group of leads after connecting each lead of the group at both ends. The view in **Fig.3** shows the idea.

Finally, the common connection of all keyboard contacts should be taken via a single length of multi-strand wire to +12 V. Make the connection from the far right-hand side of the keyboard contacts strip to the top right-hand edge of Board 4, where you will find a +12 V



## London Demonstration Of HE Electronic Organ

Wearing the smile during HE's special demonstration is Trevor Hawkins, designer of the HE Electronic Organ. Great interest was shown in the prototype instruments on display at St David's Church Hall, London N7. The event was organised by the Organ Constructors Society

connection. Your organ should now be complete — it only remains to tune it and make final adjustments.

Connect a speaker or pair of headphones to the output and turn the organ on. If all is well, you should hear nothing!

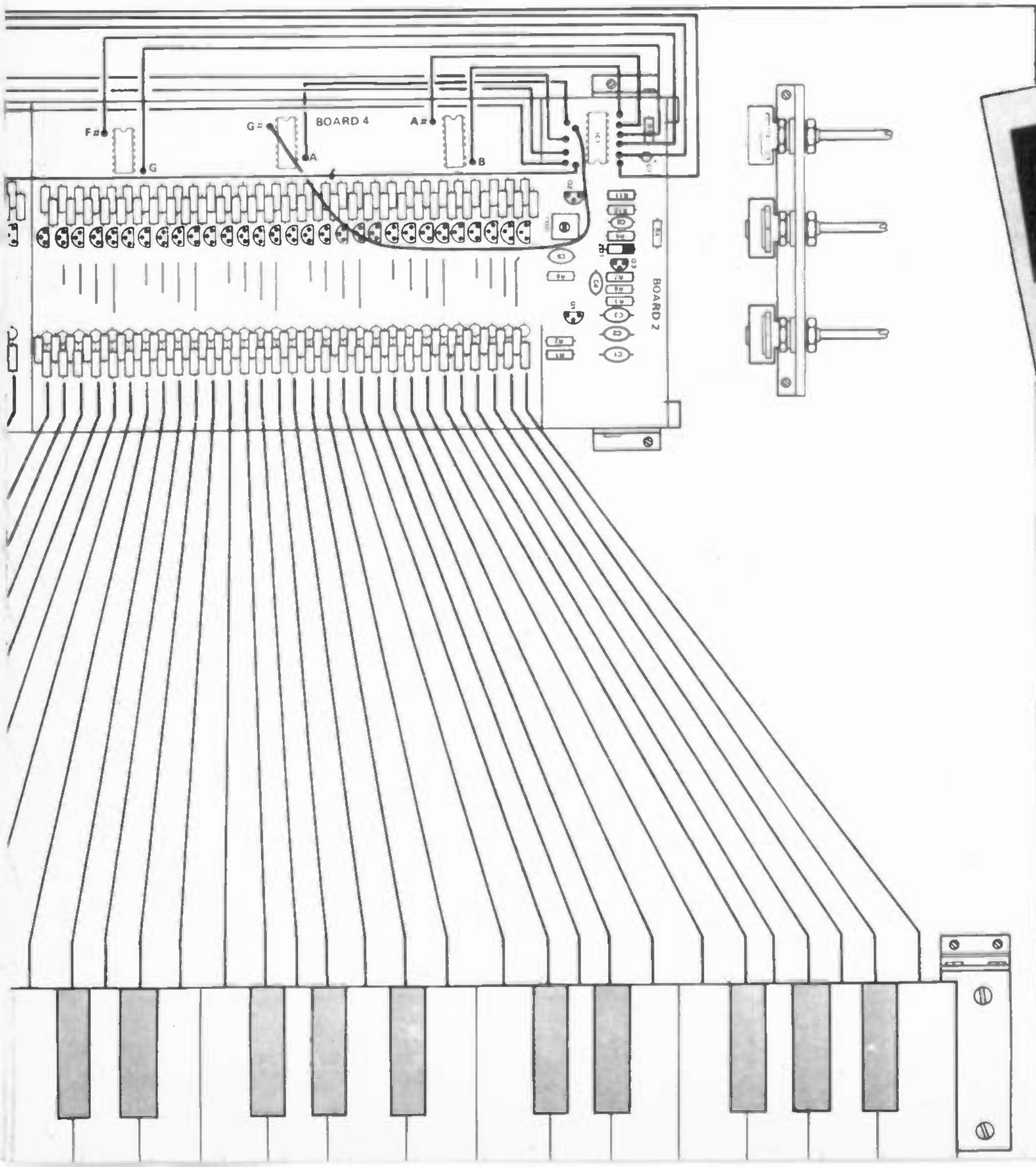
Now make sure all five stop switches are pressed down and set all preset resistors on Board 1 to mid-position.

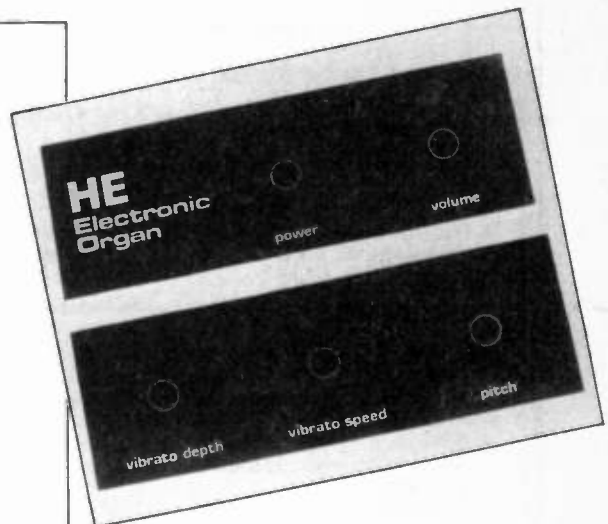
Press any note of the keyboard. You should hear it at the output. Potentiometer RV8 should control the volume.

Turn potentiometers RV1 and RV2 of Board 2 fully anti-clockwise and RV3 to mid-position.

With any available tuned reference (for example, pitch pipes, tuning-fork, another tuned instrument), adjust the slug of the coil on Board 2 till the organ is correctly tuned. You only need to adjust the coil until *one* note is correctly tuned, the rest are automatically then in tune.

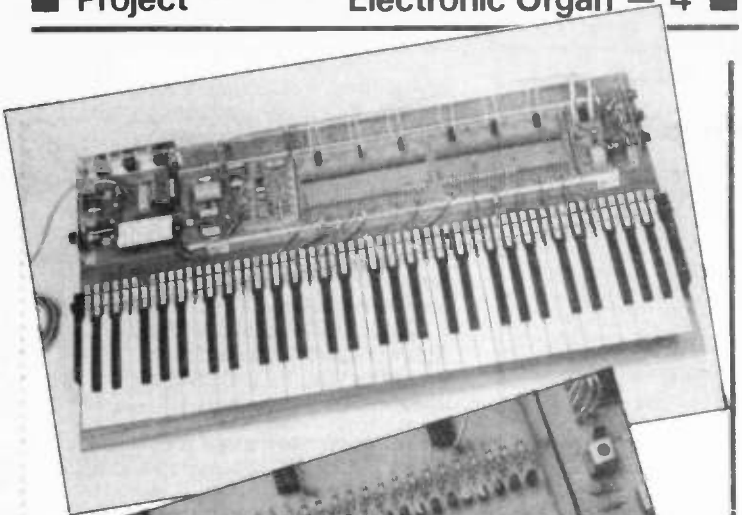
The final job is to adjust presets RV1-6 on Board 1 so that the volume levels of each octave of notes are the same and there is no amplitude step between any B-note and the C-note immediately above it. Preset RV7 adjusts the overall volume and should be set so that when a quantity of notes are played together the amplifier is not overloaded, thus preventing distortion.




Above you can see the ready-labelled panels available for the HE Electronic Organ. These panels can be glued onto the two main control panels of your organ to give a labelled finish. See Buylines for price details

Figure 1 (left). Final connection details of the project. Leads between Boards 2,3 and 4 should be taken along the back of the organ, and tied together into a cableform. Connections from Boards 3 and 4 to the keyboard contacts should be made in small groups of different coloured leads, each group tied together (see Figure 4)



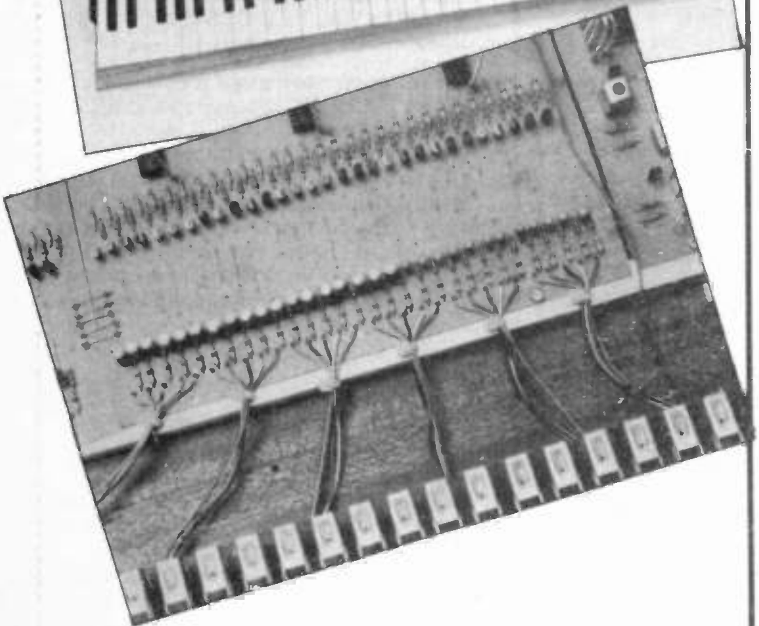


Figure 2 (top). The complete HE Electronic Organ

Figure 3. Connections between Board 3 and 4, and the keyboard contacts should be cable-tied into small groups

## Errata

A few minor errors in the first part of this project, back in the May issue of HE, have come to our notice. These are as follows:

- In Fig.2, capacitor C9 should have a value of 220u, not 220n as we show. The Parts List is correct, however. Also capacitor C12 can be 22n and capacitor C13 can be 10n, although neither are critical.
- Again in Fig.2, capacitor C3 should be turned around (ie, its positive plate should be at the bottom).
- In Fig.3, the positive plate of capacitor C3 should be at the right-hand side, and capacitors C28 and C32 should both be turned around.

We have no record of errors in following issues but we will obviously keep our readers up to date if we hear of any.

## Buylines

A limited number of kits for the HE Organ can be obtained from:

Mr A T Hawkins
23 Blenheim Road
St Albans
Herts AL1 4NS

for £99 inclusive. The kits contain all metalwork, hardware and PCBs, as well as the keyboard and components. You only need to supply your own baseboard and case.

For those readers who prefer to buy the components themselves, Mr Hawkins is willing to supply the keyboards separately. None of the other items should be difficult to find.

Mr Hawkins also has some attractive ready-labelled panels for the organ. These can be glued onto the two main control panels to give a neat finish. The ready-labelled panels cost £2 per pair.


# HE PROJECT KITS

Make us your No. 1 SUPPLIER OF KITS and COMPONENTS for H.E. Projects. We supply carefully selected sets of parts to enable you to construct H.E. Projects. Kits include ALL THE ELECTRONICS AND HARDWARE NEEDED. Printed circuit boards (fully etched, drilled and roller tinned) or varoboard are, of course, included as specified in the original article, we even include nuts, screws and I.C. sockets. PRICES INCLUDE CASES unless otherwise stated. BATTERIES ARE NOT INCLUDED. COMPONENT SHEET INCLUDED. If you do not have the issue of H.E. which includes the project – you will need to order the instruction reprint at an extra 45p each.

Reprints available separately 45p each + p&p 40p
LATEST KITS: S.A.E. OR PHONE FOR PRICES

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|---|---|
| ULTRASOUND BURGLAR ALARM, July 81 | £16.98 |
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| PUBLIC ADDRESS AMPLIFIER, Mar '81 | £16.56 |
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| PA mic | £4.40 |
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| WINDSCREEN WIPER CONTROLLER, Mar '81 | £6.98 |
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| PHOTOGRAPHIC TIMER, Mar '81 | £2.99 |
| HEARTBEAT MONITOR, Feb '81 | £21.28 |
| HIGH IMPEDANCE VOLTMETER, Feb '81 | £8.98 |
| AUDIO SIGNAL GENERATOR, Feb '81 | £17.21 |
| BACKGRUND NOISE SIMULATOR, Feb '81 | £6.43 |
| TWO-TONE TRAIN HORN, Feb '81 | £4.77 less case |
| MEDIUM WAVE RADIO, Feb '81 | £6.98 |
| BENCH AMP, Jan '81 | £9.19 |
| NICARD CHARGER, Jan '81 | £6.98 |
| CHUFFER, Jan '81, less case | £6.44 |
| CAR REV COUNTER, Jan 81, less case | £21.20 |
| Case extra | £5.98 |
| DIGITAL SPEEDO, Dec. '80 | £35.89 |
| MODEL TRAIN CONTROLLER, Dec. '80 | £16.86 |
| BATTERY CHARGE MONITOR, Dec.'80 | £4.91 |
| JACK LEAD TESTER, Dec. '80 | £1.99 |
| STEREO POWER METER, Dec. '80 | £18.98 |
| PARTY GRENADE, Nov '80 | £7.98 |
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RADIAL leads:– 0.47uF/25V 8½p; 10uF/16V, 22uF/16V, 47uF/16V, 100uF/16V, 100uF/25V 12½p; 220uF/63V 39½p; 1000uF/16V 35½p; 220uF/16V 64½p.

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# Into Electronic Components

**In this new series Ian Sinclair describes electronic components and how they are used in electronic circuits.**

**To understand how electronic components are working, it is important to be able to measure the quantities of voltage, current and resistance associated with them. This series has been tailored to measurements made with the easy-to-use HE Multitester (see special offer on page 51). Most of the measurements described can also be made with a standard multimeter**

HAVE YOU EVER really thought about electronic components? You see a list of components for an HE project, you send away for them from a component supplier, you get them, solder them in and that's it. Trouble is, it's not always like that, is it? Component X is unavailable: will component Y do? Does it matter if it's rated at 16 V or at 25 V? Why is one resistor rated at ¼ W while the other is rated at ⅛ W? What do they do, anyway? These are the kinds of questions that we'd like to sort out in this series, and so that this can be useful to all our readers we've made it a practically-based series as well. In addition, because we have a lot of readers who regard circuit calculations as a form of black magic, we've explained these as well. It might mean fewer letters to Clever Dick, but he won't mind that!

## Bits 'n' Pieces

Electronic components, as if you didn't know, are the things you have to connect together to make an electronic circuit. They range from transistors and ICs, resistors and capacitors to switches and potentiometers and the printed circuit board (PCB) itself. Each of them carries out some definite action in the circuit, and each of them can go wrong. Knowing about them helps you to understand what each one is doing, and also to find out if one of them has gone astray.

One method we use to divide electronic components into different classes is the idea of active and passive. It's a simple enough idea, but it's not quite so simple to explain, especially to a complete beginner. Resistors, capacitors and inductors are all *passive* components. If you put an electrical signal into a circuit made up entirely from these components, the most you can ever expect is that you might just get as much signal power out of the circuit as you put into it. It's more likely that you'll get less out, and as sure as a politician forgets promises you'll never get a greater signal power at the output.

*Active* components are things like transistors and ICs. Given a direct current (DC) supply, you can put a signal into these devices and get greater signal power out. You're not getting something for nothing mind you because the extra power has come from the DC supply, but this is an action which simply cannot be done by passive components alone. It's a more complicated action too and, as you must have gathered, it needs a DC supply.

## Save The Solder

Now this series isn't just going to rabbit on about components. This is HE you're reading, and we like our learning to be practical. At the same time, we don't want to put you to the expense of buying components which might be of limited use if they all end up soldered to scraps of PCB. To get around the problem, the series is designed around a solderless breadboard. For old customers, yes, this is our good friend the Eurobreadboard, and if you have one from a previous HE 'Into' series, it will still serve you well. For newcomers, the Eurobreadboard is a method of building circuits using modern components but without soldering, so that your components remain as fresh-and-usable after our series as they were before. The Eurobreadboard will cost you a bit at the start, but it'll pay for itself in components over its long and useful life. As an example, mine earns its keep all the time because I use it to try out circuits before I even reach for the soldering iron and as often as not, I find I need or want some change in the circuit which would have been awkward if I had soldered all the components into a PCB.

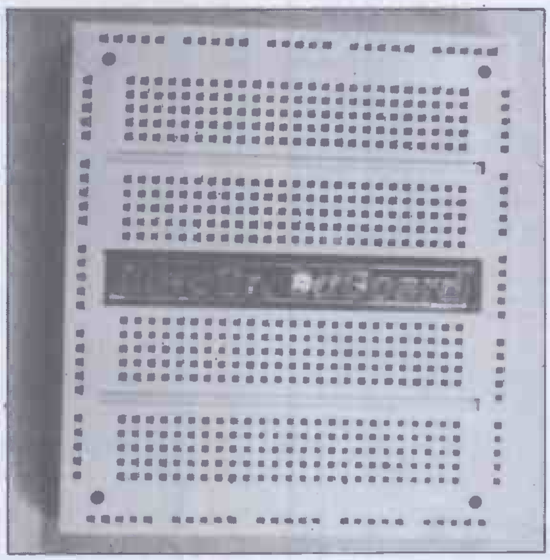


Figure 1. Example of Eurobreadboard. Components are connected into a circuit simply by plugging them into the holes provided on the board

What is this Eurobreadboard, then, which is the first component in this series? Figure 1 shows it in all its naked page-3-of-the-Sun-beauty. On top of the board, which is a plastic slab, is a set of holes, lots of them, arranged in groups of five. We can insert bits of wire into these holes, and the bits of wire can be the leads of components like resistors, capacitors and transistors. There's only room for one wire in each hole, and that's why the holes are in groups of five. One wire pushed into one hole in a group of five is held by a metal clip, and the same clip will also hold and make contact with another wire pushed into another hole in the group, as surely as if you had soldered both wires to the same track on a PCB.

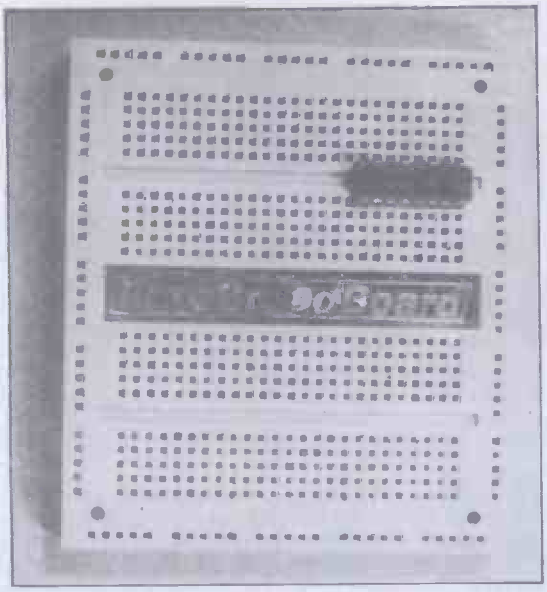


Figure 2. Using Eurobreadboard along with an integrated circuit. The holes of the Eurobreadboard are arranged so that an IC can be plugged in as easily as any other component

The next cunning part is that the groups of holes are arranged in four columns. The spacing between the columns allows us to plug ICs into the holes (see Fig.2), so that each pin of the IC is connected to a different group of holes. Just to make life easier still, the columns are lettered A,B,C and D, and the rows of holes are numbered 1-25. The good thing about all this is that we can use this numbering system to show you exactly where on the board a lead should be plugged in. For example, we can show on a diagram a wire plugged into 5A. This has to be one of the five holes on column A, line 5, as shown in **Fig.3**. Which hole? Doesn't matter, because they're all connected. If we showed in a diagram two components plugging into 5A, that means one lead in one of the holes of 5A, the other lead in any other hole of line 5A, leaving three holes unused for any other connections we might want to make to this line.

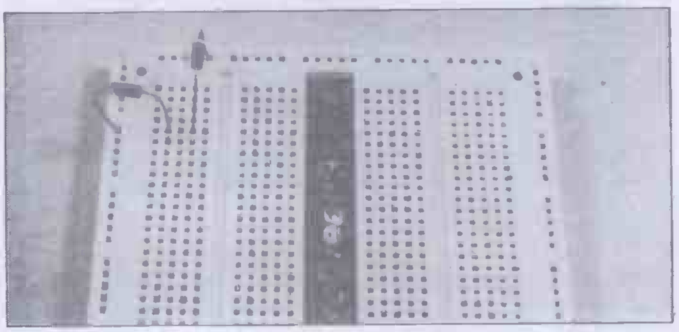


Figure 3. Resistors plugged into Eurobreadboard

Five holes per line is sufficient for practically all circuits, but we usually need more connections for positive (+V) and negative (−V) supply lines. To make this easier, there are four longer lines of holes around the edge of the Eurobreadboard, which are marked X1, X2, Y1 and Y2. All the holes in one line are joined underneath the board, but these four lines are not joined, allowing you to use four separate supply connections on the one board, if you want.

## Quintessential Quantities

You don't get very far in any hobby or craft without measurements, and you can't measure without units. Electronics is no exception, and the three quantities that we need to concentrate on at this stage are volts, amps and ohms. The usual forms these can take are given in **Table 1**.

Voltage is the pushing quantity, the one which drives an electric current around a circuit, and it is measured in units called volts, named after an Italian pioneer of more than two hundred years ago, Alessandro Volta.

Current is the rate at which electricity flows in a circuit, and it is measured in units which are named after a French pioneer, Ampere. We usually shorten this to amp (causing various examiners and professors to have hysterics) but for electronics use nowadays, the amp is rather a lot of current. We get around this by using thousandths of amps, called milliamps (shortened to mA) and millionths of amps, called microamps (uA) as units for small currents. Don't mix these two up, it's milli for thousandths, and micro for millionths; the milli is a thousand times larger than the micro.

When electric current flows through a resistor, a push (voltage) is needed to keep up the flow (current). Another old-timer, Georg Simeon Ohm, discovered that the ratio of voltage to current for a sample of a metal stayed constant, even when quite different values of voltage and current were used. We know this discovery now under the name of Ohm's law, and we use it also in the name of the unit of electrical resistance, the ohm.

We'll go into lots more detail about Ohm's law and the ohm in the next part of this series but that's all we need in that line of enquiry for this month.

## Batteries — No Hens

Batteries are an essential part of electronics nowadays, as they were in the beginning, because so much of modern electronic circuitry is portable. Batteries, made up of a collection of individual cells, are important in other ways also because they introduce us to voltage, the quantity that pushes current around, in a practical way. What happens inside one of these cells, then? **Figure 4** shows a cross-section of the most common type of cell — the carbon-zinc type. You can see that the cell has a metal casing which is made of zinc and which is used to enclose the rest of the bits and pieces. At the centre of the case, there's

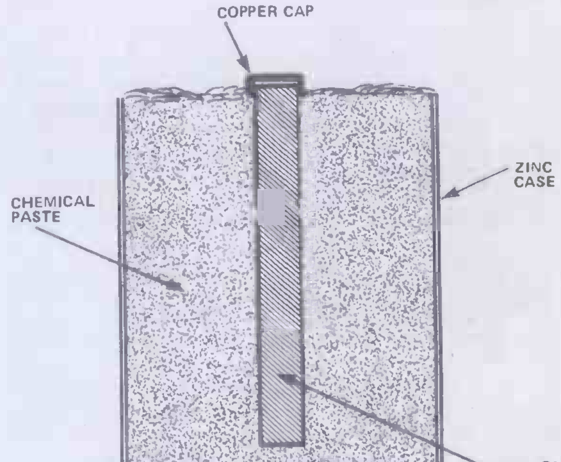



Figure 4. Conventional zinc-carbon cell, which is the unit used for most batteries

| VOLTS | AMPS | OHMS |
|---|---|---|
| 1 millivolt (mV) = $\frac{1}{1000}$ volt<br>1 microvolt (uV) = $\frac{1}{1000000}$ volt<br><br>so that: 1000 uV = 1 mV<br>1000 mV = 1 V<br>also: 1000 V = 1 kilovolt (kV) | 1 milliamp (mA) = $\frac{1}{1000}$ amp<br>1 microamp (uA) = $\frac{1}{1000000}$ amp<br><br>so that: 1000 uA = 1 mA<br>1000 mA = 1 A | 1 milliohm (mR) = $\frac{1}{1000}$ ohm<br>1000R = 1 kilohm (k)<br>1000000R = 1 megohm (M)<br>so that: 1000k = 1MO |

Table 1. Quantities of voltage (volts), current (amps) and resistance (ohms)

a rod made of carbon — dense, hard carbon that conducts electric current almost as well as a piece of metal. Between the carbon and the zinc, there's a paste of chemicals, slightly moist, and at the top end of the zinc case there's a sealing cap made from pitch or plastic.

What happens is this — the paste contains a very weak acid which can't quite dissolve the zinc by itself. Dissolving zinc means that tiny particles of zinc, called ions, have to move from the metal to the paste, and this can't happen unless other particles, called electrons, also move in the other direction. Now as it happens, the movement of these electrons (and ions) is what we call electric current, and we have the peculiar situation that zinc can't dissolve unless electric current can flow. It's not so peculiar, really, because it's like saying that you can't go into a full car park until someone drives out.

We can make a path for the electric current by connecting a circuit between the carbon rod and the zinc. The electrons are then free to flow through the circuit, the zinc, the moist chemical in the paste, and the carbon — all the way round. What is pushing them is the energy from the chemical action, zinc dissolving in a weak acid, giving us the voltage that we need to keep the action going.

Now the carbon-zinc battery (we get 1.5 V from each cell, and six of them give us a 9 V battery) will be as much as we need for many of our purposes, but it's by no means the only kind of battery around. There are the nickel-cadmium types, for example, whose chemical action can be reversed, allowing them to be recharged (a better word would be 'reformed' — it's not electric charge that is stored). There are the manganese-alkaline batteries, useful when you want a comparatively high current now and again — perfect for photographic flash-units. There are also silver-oxide batteries which keep a steady voltage for years when the current drain is small and steady — we use them in watches and calculators. Plenty of other types of batteries are also available, but they are all specialised types.

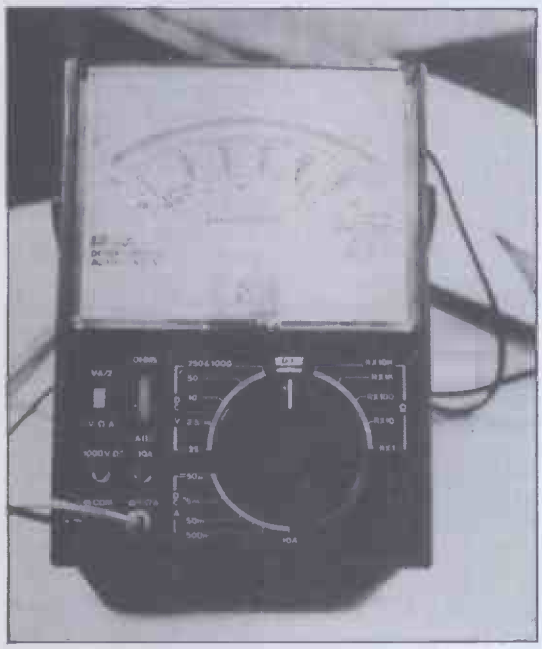


**Figure 5. The HE Multitester. If you already have a multimeter (20k/V or better) then you will be able to use it for the measurements described in this series. If you have *no* meter then take advantage of this excellent instrument at an attractive price**

## Multiple Measurements

One item essential to any serious constructor or troubleshooter is a multimeter. If the only meter you've met is a gas meter, and you think that a multimeter measures 'multis', then you'd better spend some time on this section. We're going to be using a multimeter throughout this series, and in the next part we'll be exploring inside one to see how it works. For the moment, though, it is enough to say that a multimeter is a meter which can make measurements of volts, amps and ohms, and which has several ranges for measuring each of these quantities.

Why should we need several ranges of each? Think of voltage measurements first of all. You might at some stage want to work on TV receiver servicing or the servicing of high-power stereo amplifiers. That means that you'll want to be able to measure voltages of up to 300 V or so. You'll also need to be able to measure quantities like the voltage drop between the base and the emitter of a transistor, which is around 0.6 V. Now there's no way that you can measure both of these amounts on the same scale. If you have a meter with a scale that's labelled 0 to 100, then if the 100 represents 100 V, 0.6 V is so close to 0 that you could never read it correctly. Because very small readings on a scale are so difficult to see and unreliable (especially if the needle is slightly sticky), we make use of several different scales, and choose whichever one gives a reading around the middle or the high end of the scale rather than close to zero. That's why the HE Meter (see **Fig.5** and the special offer on page 51) has voltage scales whose maximum values are 0.125 V, 0.250 V, 1.25 V, 2.5 V, 10 V, 25 V, 50 V, 125 V, 250 V, 500 V and 1000 V.

Having explained why we have several scales for each quantity we want to measure, why then do we need to measure so many quantities? The ability to measure DC voltage is always useful, because readings of these voltages can tell us, for example, the state of a battery (if we take the readings in the correct way) or whether a circuit is operating correctly. We need to be able to measure AC voltages because, for example, it can be useful to know: if the mains supply is switched on, or how much AC voltage is obtained from the mains transformer. We need DC current ranges less often than DC voltage ranges although current readings are sometimes essential. We also need resistance ranges to check if that blackened resistor is really a 2k2, or to find the value of that resistor with its colour bands rubbed off, or to check whether a capacitor has become 'leaky'.

## Readings

Taking readings with a multimeter is something that most people have to pick up for themselves — and usually do so wrongly. Let's start with DC voltage readings. To make a reading of DC voltage will entail the use of one of the DC voltage scales. Which one? If you have absolutely no idea, then it makes good sense to start with the meter switched to the highest range, which on the HE Meter is the 250 V range. It's marked 250/1000 V, incidentally, but it reads to 1000 V only if the positive probe is plugged into the 1000 V socket. If, on the other hand, you have a pretty good idea what the voltage will be

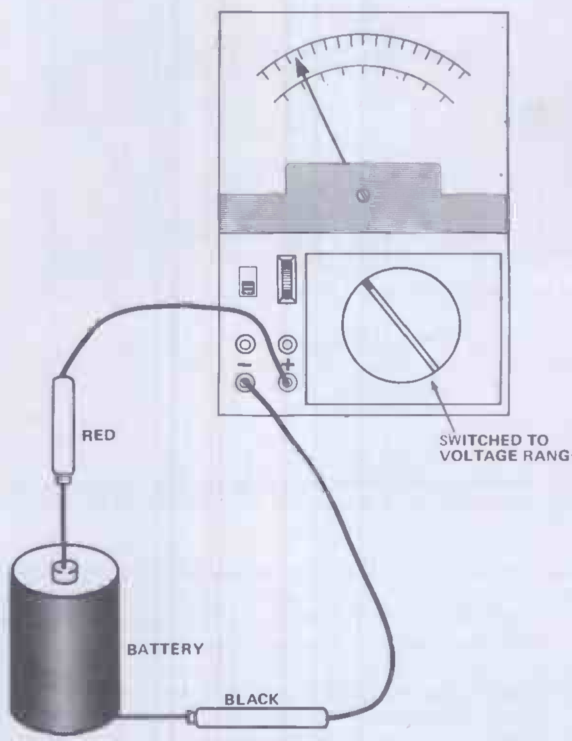



**Figure 6. Making a voltage reading with a meter. The probes are connected to the points across which the voltage is to be read**

(because, say, you're using a 9 V battery), then use a range that will take in the battery voltage: on the HE Meter this would be the 10 V range. With the range adjusted, plug the negative probe lead (black) into the socket on the meter which is marked – COM, and the positive probe lead (red) into the socket on the meter marked + VOA. Now touch the end of the black probe on the negative terminal of the battery, and the red probe end on the positive battery terminal as shown in Fig.6. (If the needle tries to go backward you must have the connections the wrong way round.)

Now read the voltage from the needle position on the scale. Which scale? You should know — you've just selected it! If you are switched to the 10 V scale of the HE Meter, then you look for the scale which is marked from 0 to 10 — on the HE Meter it's the fourth of the black lettered scales, reading from the top. Look for the position of the needle along that scale — it should be halfway between 8 and 10. The mirror on the scale, incidentally, is to show you when you are looking in the right direction to read the scale. When you can't see the reflection of the needle because of the needle itself, you are in the right position, directly over the scale.

Sometimes the reading part isn't quite so straightforward as that, because the values read on the meter have to be multiplied or divided by 10. For example, a meter having a 0-10 scale, can be used for a 0-100 V range. That just means that 10 on the scale represents 100 V, 3 on the scale represents 30 V and so on. You take your reading, multiply by 10 (in this example) and you're there.

Another oddity that sometimes occurs is negative voltage. You know when a voltage is negative to earth when the needle of the meter tries to move backwards when you place the probes on the circuit. There's no real problem, though. Just reverse the connections to the circuit so that the red lead is on the earth line and the black probe on the point at which you want to measure the voltage. Go ahead and make the measurement, remembering to write down the negative sign to remind yourself, and then return to using the probes in the usual way for other readings of positive voltages.

Alternating (AC) voltages are read in the same way as DC voltages, but with the meter switched to the AC voltage ranges. The HE Meter has AC voltage ranges of 5 V, 10 V, 25 V, 50 V, 125 V, 250 V, 500 V and 1000 V.

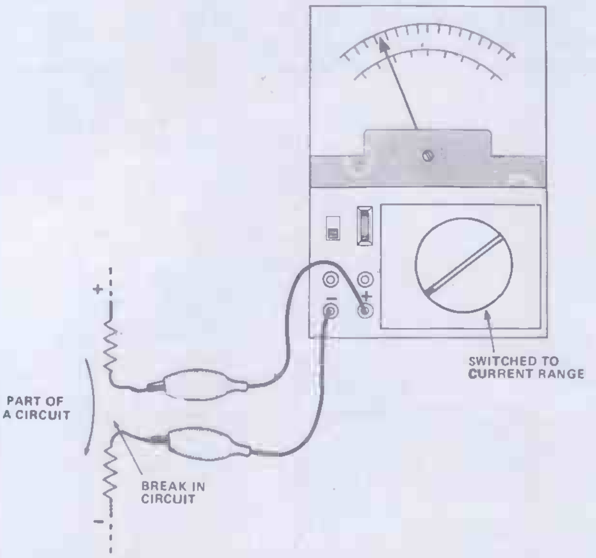



**Figure 7. Making a current reading. The circuit is broken and the meter is connected into the break so that the current flows through the meter**

Measurement of DC currents comes next. It's an entirely different business from measuring voltage, because to measure a current we have to make the current flow through the meter. This means breaking the circuit where the current is to be measured, and inserting the meter, correct way round, in the gap (see Fig.7). Correct way round? Yes, because if the current flows through the meter the wrong way round, it'll try to move the needle backwards. The correct way is with the more positive side of the break connected to the positive (+V) meter lead, and the more negative side to the negative (–V) meter lead. For current ranges it's preferable to clip the meter leads in place, to prevent them falling off. The HE Meter, in common with many multimeters, does not have probes ending in clips, but since the connection sockets for the meter are of the standard 4 mm type, it's not difficult to get hold of leads that will fit, such as those shown in Fig.8. If all else fails, squeeze the socket end of a crocodile clip until the HE Meter probe is a tight push fit into it. Also as before, if you haven't a clue as to how much current is likely to flow, it's safer to start with the meter switched to a high range, like the 500 mA range on the HE Meter.

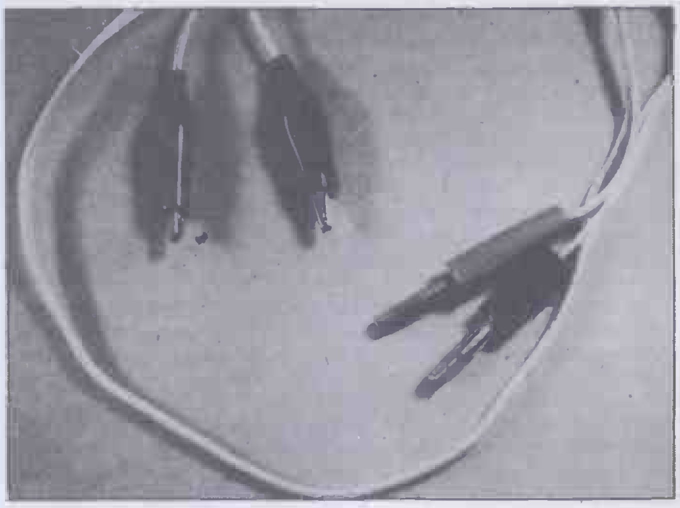


**Figure 8. Leads like these fitted with a pair of crocodile (croc) clips are very useful for all sorts of measurements. Of course, if you do happen to have three hands . . .**

You can't damage the meter if you try to measure currents with the meter switched to a voltage range — all you'll get is a wrong reading. What you must *never* do is to try to measure a voltage when the meter is switched to a current range, because this can make the needle of the meter swing over violently. Meters nowadays (and the HE Meter is no exception — I've just opened it to check!) are protected against such booboos, but it makes sense not to rely too much on the protection. If you teach yourself *always* to break into the circuit and connect up before you switch to a current range, and *always* to switch back to the 250 V range (or off) after making any set of readings, you are much less likely to send the needle supersonic in this way.

The measurement of resistance is something quite different again. You start by shorting the leads together, and this is much easier if both have clip ends (see Fig.9a). Switch to the lowest ohms scale, marked Rx1 on the HE Meter (make sure that all switches are correctly set — the slide-switch on the HE Meter should be at the VOA position as it is for most readings), and use the ohms adjustor, a wheel or knob, to set the needle reading to zero ohms. Unlike other readings, the zero ohms mark is at the right-hand end of the scale. Once that's done, you connect the meter probes to the resistor you want to measure, one to each lead, as shown in Fig.9b. You can then read the resistance on the resistance scale. If the value of the resistor is too high, the reading will be so close to the left-hand side of the ohms scale (marked ∞, meaning infinitely large resistance) that it will be useless trying to take a reading, and you'll have to switch to a higher ohms scale. If you only want an approximate idea of the resistance value you won't need to go through all the procedure of shorting the leads together again and adjusting the needle over the zero ohms for the new scale, but if you want a precise reading you'll have to make the effort.

Don't try to make resistance readings on a resistor which is connected into a circuit, because you'll be measuring the resistance of the components that are connected to it as well. If you have to take a resistance reading on a component in a circuit, unsolder one end and pull it clear of the PCB first. Circuits built on Eurobreadboard have a distinct advantage here!

Two more points about resistance readings are worth noting. One is to switch back to voltage ranges, or OFF, whenever you've finished with resistance readings, because if you connect to a voltage with the meter switched to the ohms range, you stand a good chance of damaging the meter. The other point is that the ohms readings depend on the use of a battery (two cells are used in the HE Meter) inside the meter, and this battery will have to be replaced whenever you find that you can't get the needle to the zero mark by using the ohms adjustor. Another consequence of using this internal battery arrangement is an odd one. When the meter is switched on to any ohms scale, the polarities are reversed — that is, there's a negative voltage at the +VOA socket, and a positive voltage at the — COM socket. This is unimportant until you want to use the meter for checking diodes — but we'll deal with this problem in a later part of this series.

Next month — much more on meters and measurements. We'll hold off practical work until you've had time to buy the HE Meter, if you haven't a meter at the moment. The really heavy use of meter measurements comes in Part 6 and later, when we look at diodes, transistors, and their kin, but we'll have something to measure in each part. See you next time.

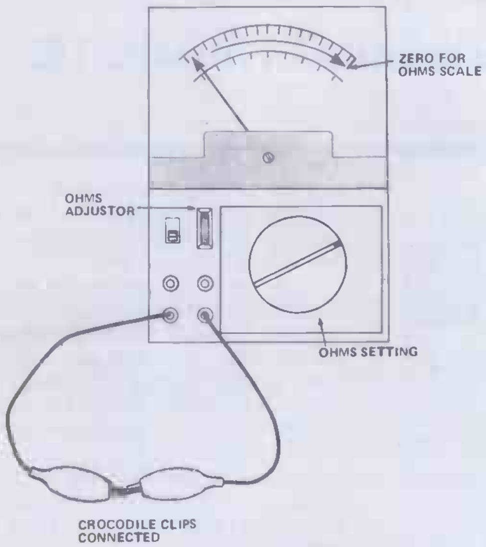
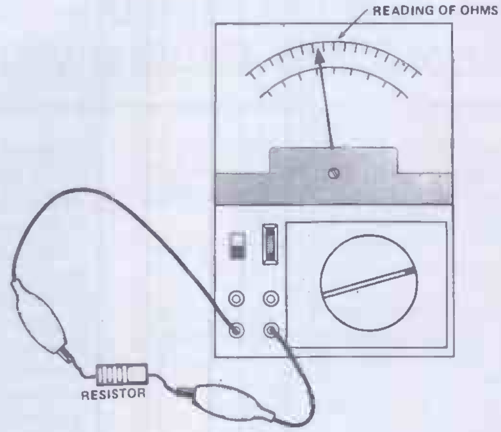



**Figure 9. Making a resistance reading using one of the ohms scales of the HE Multitester: a) join the crop clips together and adjust the ohms adjustor until the needle points to zero (0) on the ohms scale, b) connect the clips to each lead of the resistor under test, as shown. A similar procedure is used with other meters, with the exception of a few from Russia**





HE

# Multitester Offer

# Special Offer To HE Readers Only

## Invaluable Aid To The Hobbyist

THIS Multitester offers much more than a standard multimeter, as the specification shows. Apart from DC and AC voltage, DC current, resistance and decibel ranges, the HE Multitester has a range doubler for voltage and current measurements. Thus sensitivity on DC voltage ranges extends to 50k/V.

The meter dial is large (111 mm by 89 mm) and easy to read. It has a mirror strip to improve accuracy of readings.

The new series Into Electronic Components, which starts in this month's issue, has been written around this Multitester. Although other instruments can be used in conjunction with the series, the HE Multitester is undoubtedly the best choice.

So take advantage of this special offer: the Multitester is supplied complete with test leads with probes attached, batteries and instructions for only £19 plus 95p post and packing.

## Multitester-Only £19

### Specification

- Overload protected by two silicon diodes
- Uses double jewelled ± 2% meter with mirror and ± 1% temperature stabilised resistor

| Measurement | Ranges | Accuracy | Remarks |
|---|---|---|---|
| DC Voltage | 0-125-250 mV 0-1.25-2.5-5-10 -25-50-125-250 -500-1000 V | ±4% 125 mV to 2.5 V 500 to 1000 V ±3% except as noted | Sensitivity 50k/V range doubled 25k/V normal |
| AC Voltage | 0-5-10-25-50- -125-250-500 -1000 V | ±4% of full scale | Sensitivity 10k/V range doubled 5k/V normal |
| DC Current | 0-25-50 uA 0-2.5-5-25-50 -250-500 mA 0-5-10 A | Same as forDC voltage | |
| Resistance | 0-2k -20k -200 k 0-2M-20M (centre scale 10) | ±3% of scale length | Batteries: one penlight 1.5 V one rectangular 9 V |
| Decibels | − 20 to + 62 dB | | 8-ranges |
| Size | H170 x W124 x D50 mm | | |
| Weight | 590g (battery and test leads included) | | |

To: HE Multitester Offer, Modmags Limited, 145 Charing Cross Road, LONDON WC2H 0EE

Please send me . . . . . . Multitester(s) at £19.95 including post and packing.
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*Please note that the offer applies to UK mainland only: allow 28 days for delivery*

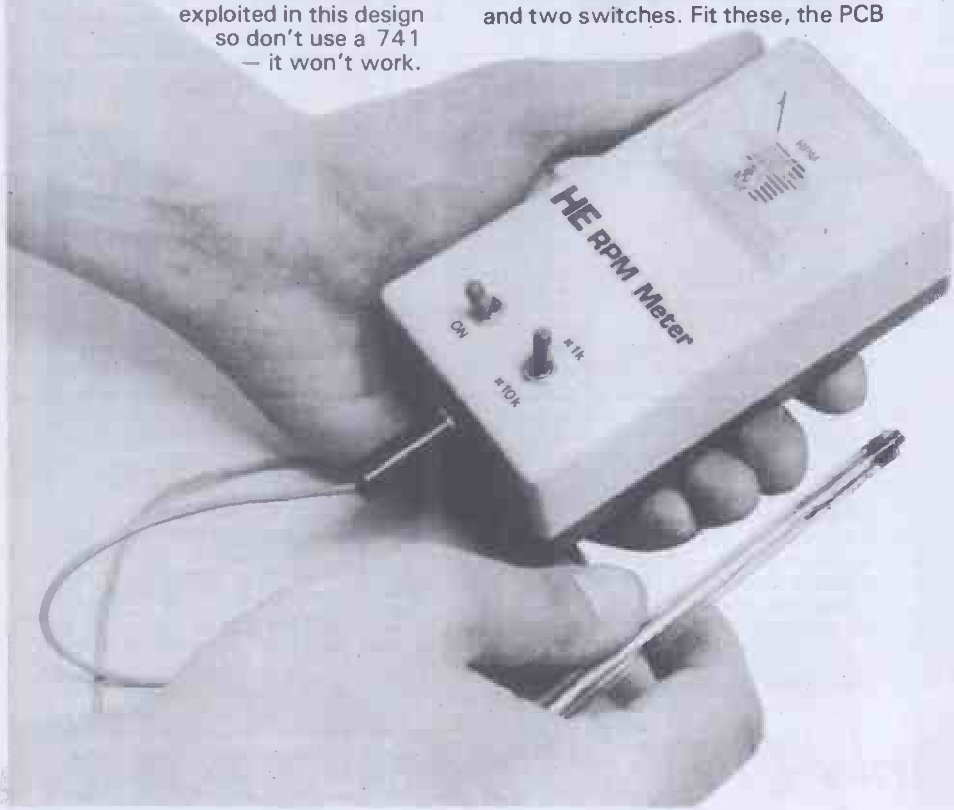
# RPM Meter

## Can you count from 0 — 30,000 in one minute? With the HE Electronic Rev Counter you can!

THIS LINEAR SCALE revs-per-minute counter lets you measure the speed of rotating objects from about 300 RPM to 30,000 RPM. Use of a light-sensitive probe means no mechanical linkage is required and faster or slower speeds could be measured with only simple modifications. The input stage features a self-adjusting Schmitt trigger circuit that enables the probe to work in a range of ambient lighting conditions. A single 9 V battery provides the power, and low current drain means a useful life will be obtained from a PP3-sized source.

### 01 34555

Can you rearrange those numbers to make a well-known phrase or saying? Of course, it's an anagram of the 3140 MOSFET (Metal Oxide Semiconductor Field Effect Transistor) operational amplifier and the familiar 555 timer. The advantages of the 3140 over the less-expensive 741-type of op amp are: its common mode input range which includes the negative supply rail, faster output slew rate and very high input impedance — millions of megohms. All these characteristics are exploited in this design so don't use a 741 — it won't work.




### Construction

Build up the printed circuit board (PCB) first. Insert and solder resistors followed by capacitors. Capacitor C5 is polarised, so make sure you get it the right way round. **Figure 2** gives details of component locations.

Next, insert and solder PCB pins at the nine points where off-board connections are made. This may seem unnecessary but it means that you can make (and remake if needed) all connections after the board has been fitted into the box so that all wiring is neat, and not in a 'bird's-nest' state.

Now solder in zener diode ZD1, making sure that it is the right way round.

Use integrated circuit sockets to hold the two ICs. As well as making it easier to substitute and test ICs, the sockets enable you to whip out the chips if they are required for another project without having to attack the finished unit with a hot soldering iron. (Note that despite the use of MOS transistors in the 3140, the device is not susceptible to damage from static electricity and no special handling precautions are required.)

Mark and drill the case for the meter and two switches. Fit these, the PCB and the battery into their final positions. Two or three self-adhesive foam pads are ideal to hold the circuit board and battery.

Now, wire up the project as the connection details in **Fig.2** show.

Finally, mount the photo-transistor in an old felt-tip or ball-point pen, after covering the body of the sensor transistor (see **Fig.3**) with a short length of opaque sleeving to cut down ambient light. Readily-obtainable heat-shrink, or rubber, sleeving is ideal, but if you can't obtain this a few turns of insulating tape, neatly wrapped round, will do the job.

### Calibration And Use

Calibration is very simple. All you need to do is switch to the 0 — 3,000 RPM range and point the sensor at an electric light bulb. The light from the lamp will be modulated at the 50 Hz mains frequency corresponding to a 3,000 RPM signal (50 x 60). Wait a moment for the auto-Schmitt input stage to adjust itself, you may have to point the sensor away from the lamp slightly, until the meter gives an indication. Then adjust RV1 for a reading of 3,000 RPM, full-scale on the meter. In fact, because the lamp brightens for each half-cycle of the mains, its output frequency is 100 Hz. However, on the 3,000 RPM range, the unit is unable to respond to a 100 Hz input and indicates 3,000 RPM. By switching to the 30,000 RPM range, you should obtain a true reading of 6,000 RPM. For this reason you should always commence your measurements with the unit switched to the 30,000 RPM range.

In use, the object to be measured is arranged so that the sensor sees an increase in reflected light once per revolution. For example, you can measure the speed of an electric motor by slipping a short length of black sleeving over its shaft. Paint one side of the sleeving with white paint so that the sensor sees white and black sections alternately as the shaft revolves. Although the input stage will compensate automatically for various lighting conditions it may sometimes be helpful to illuminate the shaft with the light from a small pocket torch. One of those with a lens-end pre-focus bulb is ideal.

To obtain a 0-300,000 RPM range, use a 10k resistor for R5. To measure slower revolutions, simply arrange for more black/white transitions per revolution using striped paper wrapped

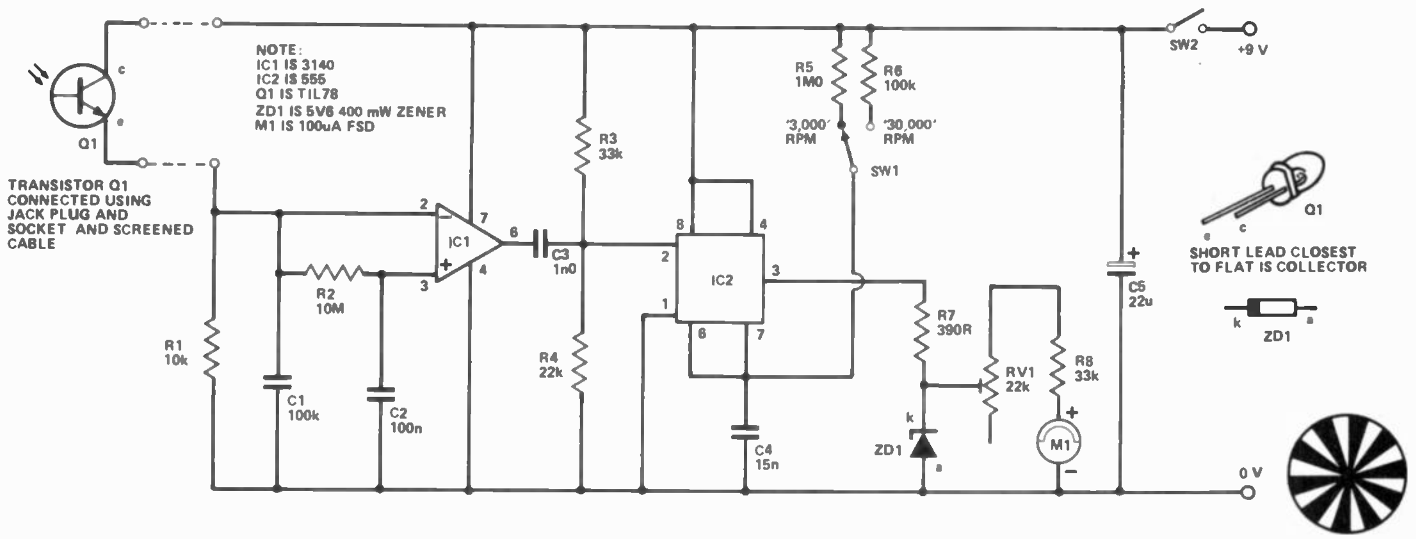



Figure 1. Circuit of the HE RPM Meter

MAKE A DISC LIKE THIS TO EXTEND THE SLOW SPEED RANGE TO 0–300RPM

around the shaft or a radially patterned disc mounted on a rotating wheel. Ten black/white stripes per revolution give a 0-300 RPM range and so on. There are many techniques for measuring the speed of rotating objects. This unit is cheap and simple to build and calibrate providing an excellent introduction to electronic measurement systems. Build one for your lab or workshop or just for fun — amaze your friends with a 'revolution' in electronics!

## Parts List

**RESISTORS**

| | |
|---|---|
| R1 | 10k |
| R2 | 10M |
| R3,8 | 33k |
| R4 | 22k |
| R5 | 1M0 |
| R6 | 100k |
| R7 | 390R |

**POTENTIOMETER**

| | |
|---|---|
| RV1 | 22k miniature horizontal preset |

**CAPACITORS**

| | |
|---|---|
| C1,2 | 100n ceramic |
| C3 | 1n0 ceramic |
| C4 | 15n polyester |
| C5 | 22u, 16 V tantalum |

**SEMICONDUCTORS**

| | |
|---|---|
| IC1 | 3140E MOSFET operational amplifier |
| IC2 | 555 timer |
| Q1 | TIL 78 photo-transistor |
| ZD1 | 5V6, 400mW zener diode |

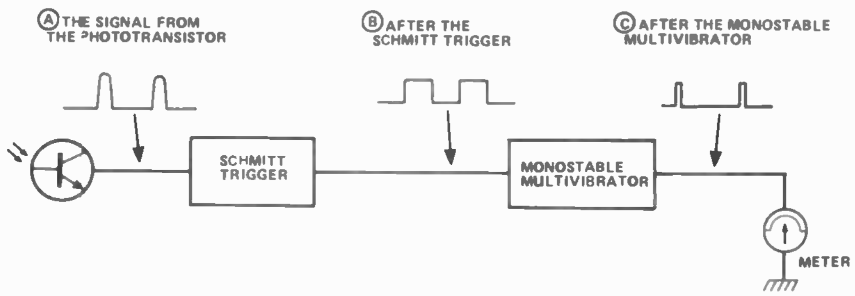
**MISCELLANEOUS**

| | |
|---|---|
| SW1 | single-pole, double-throw toggle switch |
| SW2 | single-pole, single-throw toggle switch |
| M1 | 100 uA FSD moving-coil meter |

3.5 mm jack plug & socket (or similar)
Case to suit (see Buylines)

## How It Works

**The input signal is 'squared up' by the Schmitt trigger whose output drives a monostable multivibrator; ie, each time the monostable is triggered by the Schmitt trigger it produces an output pulse whose period is determined by the associated resistor. A simple changeover switch selects the appropriate timing resistor for the selected measurement range. The output from the monostable is used to drive a meter — the closer the pulses (ie, a greater RPM), the more the meter needle moves.**




Light falling on transistor Q1 causes a current to flow through it (because it is a photo-transistor) and a voltage is developed across resistor R1. If the light is modulated ie, goes brighter and dimmer, the voltage across R1 will rise and fall in sympathy. Capacitor C1 removes any noise spikes which may have been picked up by the connecting leads and the resultant signal goes to the inverting input of IC1. This is an op amp used as a comparator; comparing the voltage at the inverting input. We obtain the reference voltage by low-pass filtering the input voltage with R2 and C2. An input signal producing a voltage across R1 which ranges from 1 V to 4 V will result in a reference voltage of about 2.5 V, the average of the peak and trough values. The exact reference voltage will also be a function of the input's mark-to-space ratio which should ideally be 50% (ie, equal light and dark areas on the rotating surface).

The output of IC1 consists of a squarewave at the same frequency as the input signal. This output signal triggers the 555 timer on each falling edge. A differentiating circuit C3,R3 and R4 is used to produce a short trigger pulse. The 555's monostable output pulse is a function of range setting resistors R5 and 6.

To make the unit less sensitive to falling battery voltage the output of IC2 is clipped by ZD1, a 5V6 zener diode, and the meter is driven from this voltage through a current-limiting series resistance comprising RV1 and R8.

Current pulses from IC2 are averaged in the meter, the deflection of which indicates the input frequency scaled in RPM. To allow for variations in component tolerances, full-scale deflection is obtained from an 80% duty cycle. The supply is smoothed by C5 which should be mounted close to IC2.

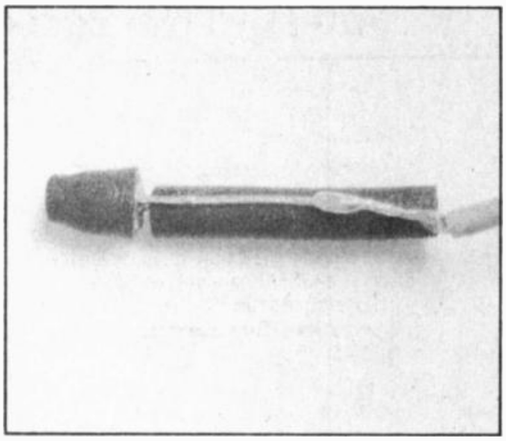


Figure 3. Close-up details of the phototransistor, insulated with rubber sleeving, prior to insertion into a pen body.

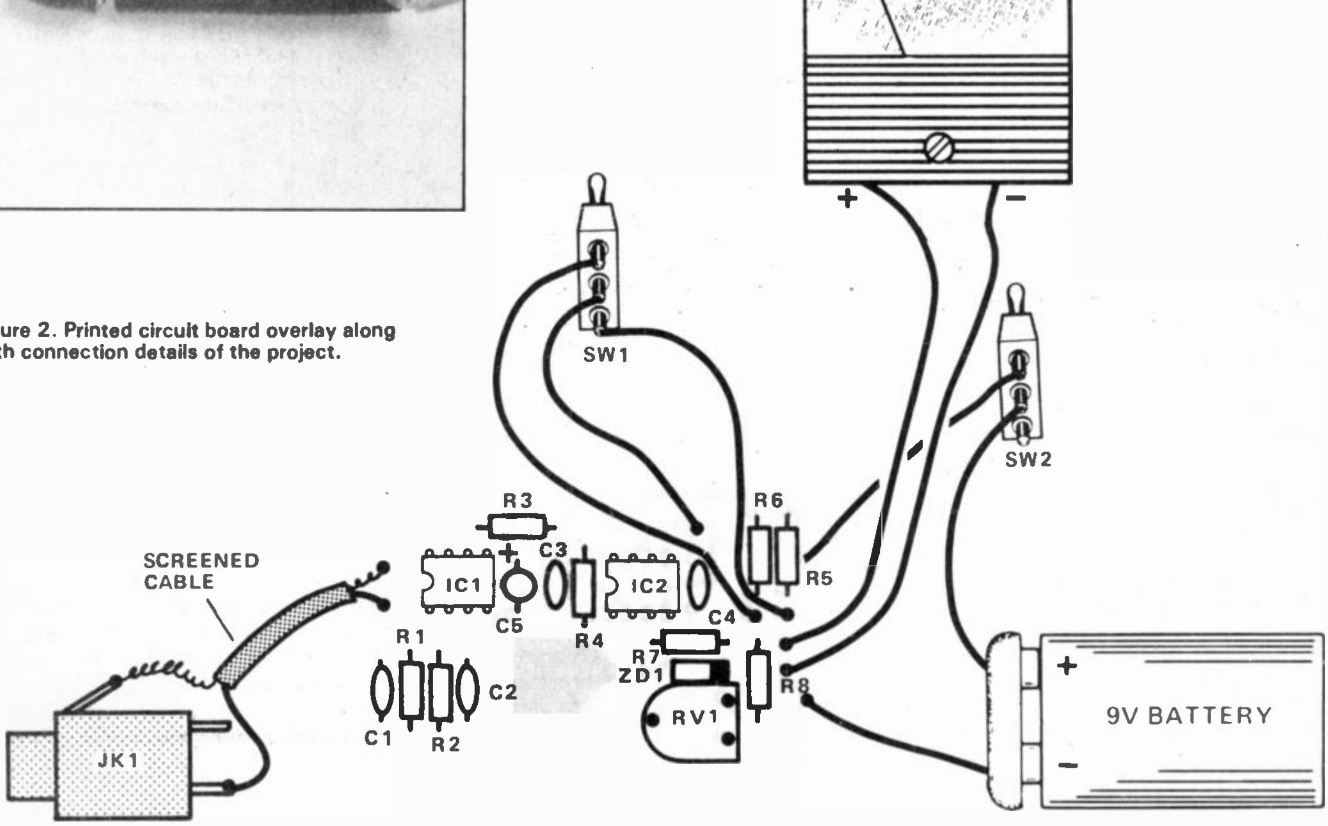
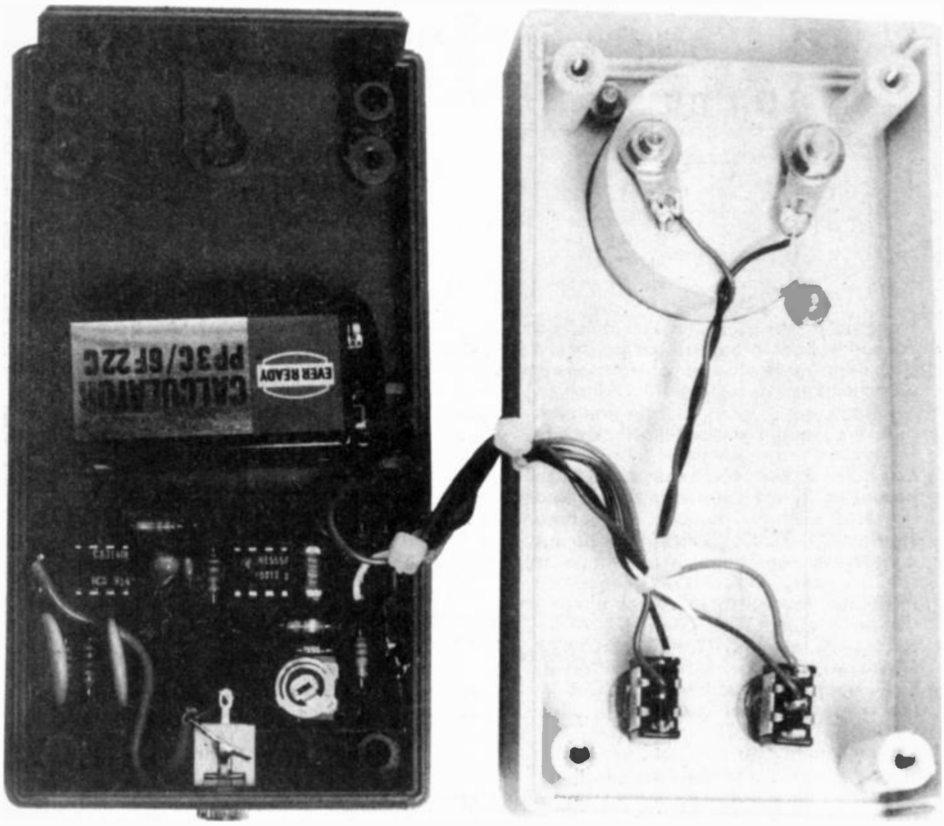



Figure 2. Printed circuit board overlay along with connection details of the project.



Left. Internal view of the HE RPM Meter.

HE

## Buylines

None of the components should cause any difficulty and you should find several sources of suitable devices. Shop around for the meter: price depends on physical size and quality. As you would expect, smaller ones are cheaper.

In case of difficulty, the 3140, 555 and TIL 78 are still available from Technomatic Ltd.

Approximate price of components (excluding case, PCB and meter) will be £5.

The case we used to house our prototype was type 202-21029, available from Vero Electronics.

# Your Letters

## A selection of your letters to the Editor

ALTHOUGH IT IS DIFFICULT to eliminate *all* the errors from a technical publication such as HE, sometimes it is our readers who have misunderstood what has been printed, as this first letter shows.

*Dear Editor,*
*I have recently completed a project which you printed in HE in the April 81 issue. The project was the Windscreen Washer Alarm. In the section 'How It Works', you state that 'When the probe resistance is less than the internal resistance (as it will be if the level of fluid is above the bottom of the probes) — surely this is an error and it should be 'below the bottom of the probes'?*
*I would be pleased if you could inform me if it is an error as I have completed this project for an examination and on the 'write up' I have to explain its function.*
*G Whalley*
*Halesowen,*
*West Midlands.*

No mistake was made in the 'How It Works' section for this project. If the fluid is above the bottom of the probes (that is, when both probes are immersed in the fluid) then the resistance between them will be lower than the circuit resistance and no alarm will be given.

*Dear Sir,*
*I am thinking of building a car radio. Could you please advise me if there are any kits available for a radio or cassette player and from whom I would be able to buy one?*
*A D Wilson*
*Knutsford,*
*Cheshire.*

The only car radio kit that we are aware of is that being offered by RTVC, 323 Edgware Road, London W2 (tel 01 723 8432). This is a simple MW/LW receiver, with five push-buttons for tuning and with an audio output of 6 W. It uses an LP1181 IF module from Mullard Ltd. According to RTVC, the printed circuit supplied with the kit is undrilled, and the company cannot supply an after-sales service, apart from replacement of faulty components.
The kit (constructors' pack 7A) costs £10.50 plus £2 post and packing. Constructors' pack 7A contains a stainless steel retractable locking aerial and a loudspeaker, at an additional cost of £1.95 plus £1.15 postage and packing.

*Dear Mr Davies,*
*I have just purchased a soldering iron but have no instructions with it. I am a beginner in Electronics and would be very grateful for a pamphlet or some notes on the operation and workings of a soldering iron.*
*Leo McHugh*
*Co. Dublin, Eire.*

*PS I think your mag is the best on the market, keep up the good work.*

We last covered soldering technique under Building Site in the December '80 issue of HE, on pages 62 and 63. I'll make sure that you receive a copy of this article. See Building Site next month, too.

*Dear Sir,*
*In your May and June editions of HE you had a two part project of an Infra-red Remote Controller. Under the Buylines section, it said that kits from TK Electronics were available, a receiver for £4.83 inc VAT and a transmitter for £10.35 inc VAT. Surely the transmitter and receiver prices are the wrong way round?*
*P Robinson*
*Middlesbrough,*
*Cleveland.*

Yes, it was a mistake — the prices were transposed under Buylines on page 50 of the May '81 issue and under Buylines on page 61 of the June '81 issue. The cost of the receiver should have been shown as £10.35 including VAT and the cost of the transmitter as £4.83 including VAT.

And we'll have to end it there for this month.

**HE**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# UOSAT – Britain's hobbyist satellite

**In the run-up to the UOSAT launch, Bill Mitchell* outlines the functions of the satellite and the measurements it is to make. As he points out, the keen amateur will be able to monitor the radio and video transmissions from UOSAT using inexpensive equipment**

THE FIRST SATELLITE built specifically to promote a greater practical interest in space science among educational establishments, and with facilities for use by radio amateurs and hobbyists, is now undergoing final test prior to its launch in September of this year. Designed and constructed by the University of Surrey with material and financial support from British industry, UOSAT (University Of Surrey SATellite) will transmit coded and voice-synthesised speech data that can be picked up by most amateur VHF FM communications receivers. It will also incorporate a charge-coupled device (CCD) camera for the transmission of pictures that can be received by an ordinary domestic TV set by the use of a simple adaptor circuit.

Unlike previous radio amateur satellites launched either under the auspices of AMSAT (Radio Amateur Satellite Corporation) OSCAR series, or by the USSR (RS1 and 2), which have been intended primarily for increasing the VHF and UHF range of transmissions by radio amateurs, UOSAT's function is to stimulate a greater practical interest in space science among schools, colleges and universities; to provide radio amateurs and hobbyists with a tool for studying the ionosphere through which the transmissions travel; and to establish an active body in the UK with the resources to contribute further to the amateur satellite programme.

As such, with the wide range of measurements it is capable of performing and the large volume of data that it will be transmitting back to earth, UOSAT represents a unique British achievement in space science for the masses, and can possibly be best described as a universal multimeter in the sky.

## Vision And Voice

Much of the analogue and digital data being transmitted back to earth will require something more than a standard FM communications receiver, although their reception will not be beyond the capabilities of the keen amateur. What makes UOSAT so unique is the provision of earth pictures from its solid-state camera, and its synthesised speech transmission.

Covering an area of 500 x 500 km (300 square miles) of the earth's surface, the image from the earth-pointing camera will be formed on a charge-coupled device (CCD) and stored in the satellite's on-board computer until transmission to ground, a process that takes three to four minutes. Unlike images from conventional weather satellites, the picture will be transmitted in such a way that it may be readily received and stored by a simple receiver and displayed on any domestic TV set. The pictures will have a resolution of about 2 km and will show 16 grey levels, with land features and land/sea boundaries being enhanced. Experimental data in graphical form will also be available by the same link.

Once the satellite is in orbit and functioning correctly, the University of Surrey plans to make available full details and circuitry for the necessary ground receiving and display equipment that will enable a domestic TV set to receive these pictures. At present, the intention is that the circuit will be supplied by an appointed contractor, and will take the form of an easy-to-assemble kit of parts costing around £150.

The speech transmissions will be made by means of an electronic voice synthesiser controlled by the on-board computer, and will include details of telemetry, experimental data and satellite operations using a vocabulary of about 150 words. Transmissions will be on 145.825 MHz, and any standard unmodified narrow-band FM amateur receiver should be able to receive them by means of a small, fixed pair of crossed dipole aerials.

## Experiments For The Scientists

The satellite will also carry a number of experiments intended for scientific research. These include a series of beacons transmitting at different frequencies, two particle counters to provide information on solar activity and auroral events, and a magnetometer — identical to that used on the Voyager missions to Jupiter and Saturn — for measuring the earth's magnetic field. These experiments will make possible a detailed study of how phenomena such as solar activity affect the transmission of radio signals through the ionosphere.

## On-board Micro Control

UOSAT will be controlled by a powerful on-board microcomputer, based around the RCA CDP 1802 microprocessor, which will have access to the satellite experiments, telemetry and command systems. It will enable telemetry surveillance, command and status management, experiment data storage and processing, dissemination of orbital data together with operating schedules and general news, and closed-loop attitude control using magnetorquers. It has direct high-speed data links with the magnetometer and radiation experiments to allow rapid data acquisition yielding fine time-resolution data, and also has access to the earth imaging experiment memory area for the purpose of image processing.

The computer software is resident in dynamic RAM loaded from the ground via the telecommand link, and can be modified or replaced during flight by a ground command station at the

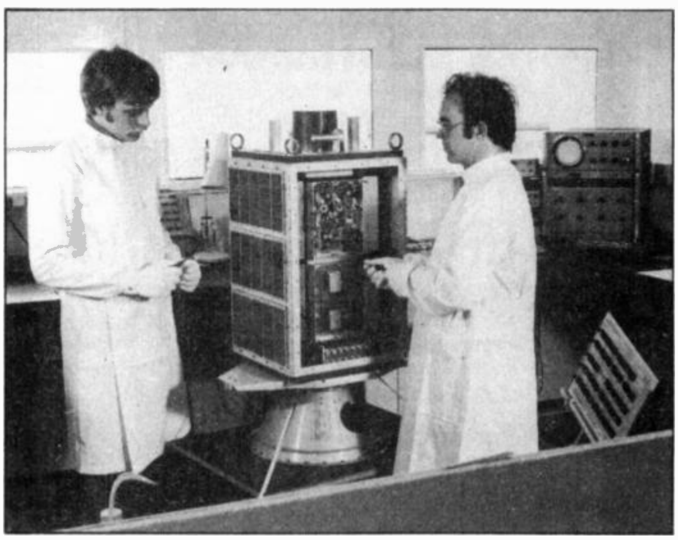


**Figure 1. The clean room at the University of Surrey in which UOSAT is being assembled. On the left is Steve Greenland and on the right is Dr Martin Sweeting, Project Manager**

# first educational &

University of Surrey. This will enable the accommodation of changes in the mission profile and allow for the rectification of possible software or hardware failures.

## Launch Date

UOSAT will be launched as a secondary payload by a NASA Delta 2310 rocket from the Western Test Range at Vandenberg, California, the main payload being the NASA Solar Mesosphere Explorer spacecraft. The launch is currently scheduled for September this year, but this may be advanced to July depending on the readiness of the NASA rocket and prevailing weather conditions. An announcement on this will be made as soon as possible. However, whatever the launch date, UOSAT will be placed into a polar orbit with a period of 95 minutes, at a height of 530 km (about 330 miles), and the expected life before re-entry is estimated at four to five years.

## Data And Transmission Frequencies

For those who may be interested in establishing their own receiving station for UOSAT, the following lists the types of data being transmitted and the frequencies of transmission.

### Telemetry

To cater for a wide range of user ground-station facilities, 60 analogue telemetry channels and 45 digital status points will be available via the VHF (145.825 MHz) and UHF (435.025 MHz) data beacons in the following formats: 1200, 600, 300, 110 and 75 baud ASCII; 45.5 baud RTTY (Baudot); 10 or 20 words per minutes Morse code; and synthesised voice.

Any pair of these formats will be available simultaneously via the VHF and UHF data beacons. The 1200 baud telemetry option also has a CHANNEL DWELL facility.

### Data Beacons

Two VHF/UHF beacons will provide the primary engineering and experiment data links to the outside world, and these have been designed to provide a healthy satellite-to-ground transmission link to enable reliable and straightforward reception by the simplest of amateur ground stations using a fixed pair of crossed dipole aerials.

The data sources available to these beacons are: telemetry, ASCII, Baudot, Morse code, satellite computer, primary output port, secondary output port, speech synthesiser, earth imaging experiment (CCD camera), and image data.

Details of the two beacons are as follows:

| | | |
|---|---|---|
| General data beacon — | Frequency: | 145.825 MHz |
| | Modulation: | CW |
| | Data format: | audio frequency shift keying |
| | Power output: | 450 mW |
| Engineering data beacon — | Frequency: | 435.025 MHz |
| | Modulation: | CW |
| | Data format: | audio frequency shift keying |
| | Power output: | 400 mW |

## Propagation Studies

Phase-referenced beacons on 7.001, 14.001, 21.001 and 28.001 MHz will support a wide range of ionospheric experiments and observations, while two microwave beacons on 2.401 and 10.470 GHz will encourage the study of super high frequency (SHF) propagation.

Two particle radiation counters (one detecting electrons of energies greater than 40 keV, and the other detecting protons greater than 2 MeV) will provide real-time information on solar activity and auroral events. A three-axis, wide-ranging, fluxgate magnetometer will examine the fine structure of the earth's magnetic field, any disturbances to it and their relationship to radio wave propagation.

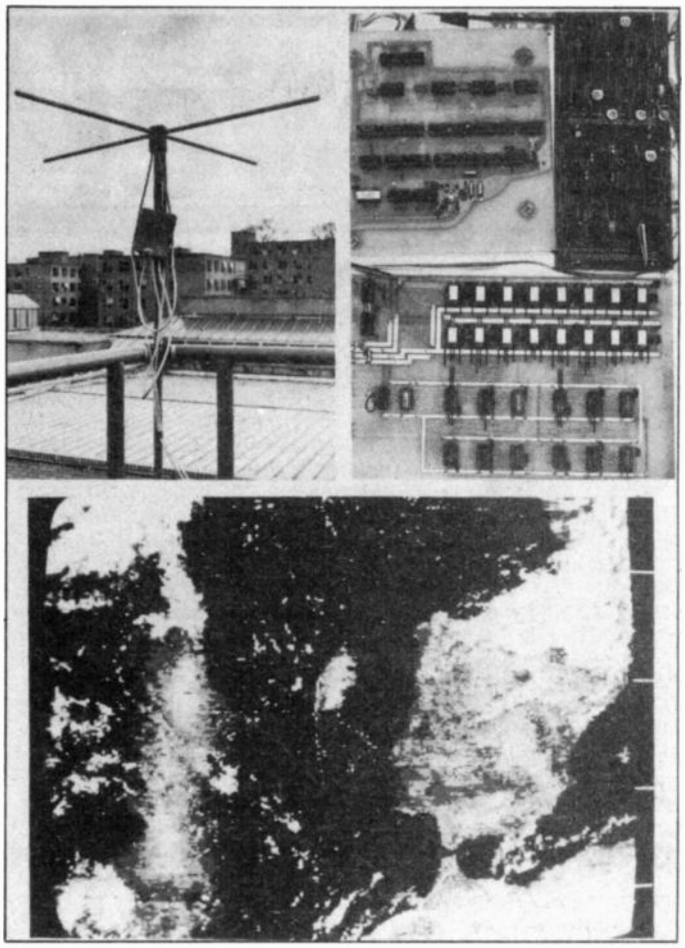


**Figure 2. The montage shows (top left) the simple crossed dipole aerial for receiving transmissions; (top right) the prototype of the equipment which stores and displays picture data; (bottom) the test picture used to develop the system**

## Education Experiments

The earth-pointing, CCD two-dimensional array will provide land and sea image data for digital transmission via the general data beacon, using minimum-shift audio frequency shift keying at 1200 bits $s^{-1}$ line synchronous. The image format is 256 x 256 pixels with 16 grey levels. The camera optics are organised to cover a 500 x 500 km area of the earth's surface yielding a resolution of around 2 km.

The digitally synthesised speech experiment module under the control of the satellite computer will 'speak' telemetry, experiment data and satellite 'news' with a limited vocabulary of around 150 words transmitted on either of the data beacons.

## A Chance To Make Your Mark

If successful, these experiments should help to overcome the difficulties faced by most amateurs trying to enlarge their knowledge of space sciences. Any radio amateur will be able to use his or her equipment to gain interesting and useful knowledge about that area of space surrounding the earth which most affects the quality of radio transmissions.

The potential that exists for radio amateurs to make a contribution to space science will, through the use of UOSAT, be comparable with that of amateurs in fields such as astronomy and ornithology. **HE**

*The author is Editor of Electrotechnology and of the IEETE Bulletin, Institute of Electrical and Electronics Technician Engineers

# Variable Bench Power Supply


## A cheap and easy-to-build project for use wherever you need a good-quality, low-voltage supply

WE KNOW THAT a bench power supply isn't the most original of projects, but we are sure that it *is* one of the most useful.

A good quality, well regulated power supply has a place on virtually every electronics hobbyist's bench. You see dry-cell batteries, while useful in self-contained projects, have their drawbacks: a limited range of voltages; an output which varies with battery age; low current; and last but not least — their cost. However, a power supply, because it is mains-operated, doesn't suffer from these drawbacks.

The HE Variable Bench Power Supply is a simple-to-build project using a minimum of components to provide an output which is an ideal voltage source for experiments, most projects, or car radios etc — in fact, it can be used for any circuit requiring a voltage between 1.4 V and 13.5 V and a maximum current of 1 A.

With series resistors the power supply can also charge Ni-Cd cells (by setting the output voltage to 12 V and selecting resistor values as shown by Table 1).

Resistor values for other currents and combinations of cells can be calculated from the formula:

$$R = \frac{12 - V_c}{I_c}$$

where $V_c$ is the total voltage of the cells and $I_c$ is the charging current. The resistor power rating is given by:

$$P = I_c^2 \times R.$$

After setting up the power supply with the resistor and the cells in series, simply adjust the power supply output voltage to trim the charging current to the exact value required.

Output voltage is fully variable within the upper and lower limits via a calibrated control, which also serves as an on/off switch. The output current is indicated on a panel meter. Ripple (the variation in output voltage — greatest when the supply is fully loaded) is negligible ie, less than 5 mV peak-to-peak, at full output.

| Battery or cell type | Current 12-hour charge | Resistor value | Resistor rating |
|---|---|---|---|
| PP3§ | 9 mA* | 470R | ¼W |
| PP9§ | 100 mA | 39R | ½W |
| AAA | 20 mA | 530R | ¼W |
| AA | 66 mA | 150R | 1W |
| C | 250 mA | 39R | 3W |
| D | 500 mA | 18R | 6W |

* — 17-hour rate
§ — 8.4 V batteries
all others — single cells 1.25 V

**Table 1. Values and powers of resistors to use in series with the power supply when charging Ni-Cd cells**

The heart of the bench power supply is a voltage regulator integrated circuit LM317K — a simple three-terminal device (input — adjust — output) — well tried and tested in industry for some years but still relatively new to the hobby market-place. This IC monitors its own output current and limits it to 2 A in the event of a short circuit, thus avoiding any possible damage.

Two fuses are used — one within the mains circuitry, to cover transformer failure, and one in the low-voltage circuitry to give protection in the event of a prolonged short circuit.

## Construction

The first constructional step is the marking and drilling of the case. A mild steel case similar to that of our prototype is recommended to avoid electrical interference with equipment positioned near the power supply.

Cut out a round hole in the front panel for the panel meter — probably the most suitable tool for this is an Abraframe hacksaw — alternatively you can drill a circle of small holes and then file-out the large hole for the meter.

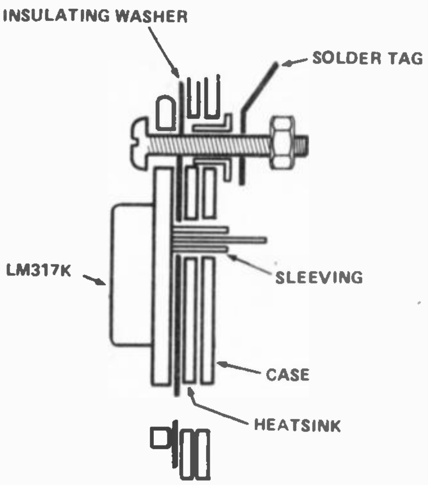



**Figure 1. How to mount IC1 and its heatsink to the case**

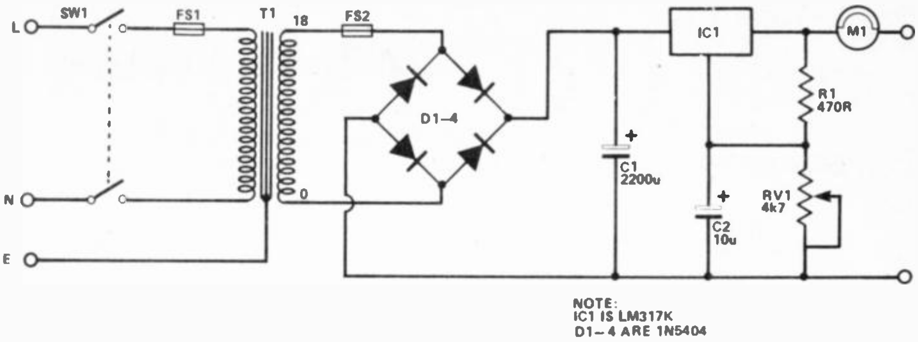



**Figure 2. Circuit of the HE Variable Bench Power Supply — it's very simple, because the complicated things happen inside IC1**

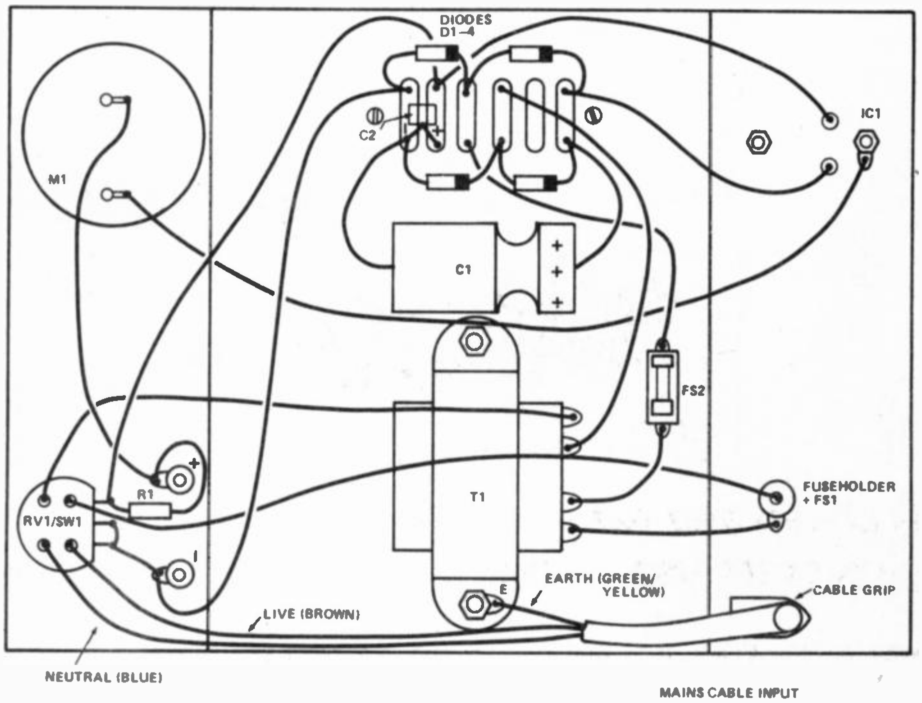



**Figure 3. Wiring and connection details of the project**

Drill and fit the two output terminals and the switched potentiometer onto the front panel.

Next, mount the transformer firmly to the base of the case not forgetting the solder tag for an earth connection.

Using the heatsink as a drilling guide mount the LM317K IC and heatsink using an insulating kit as shown in **Fig.1**. Remember to put a solder tag under one of the IC mounting screws.

Drill and fit the panel-mounting fuseholder and cable clamp to the rear panel.

Now, fix the tag strip, the chassis-mounting fuseholder and capacitor C1 into position. We found that the most convenient way to mount the capacitor was with a couple of double-sided adhesive pads.

Following **Fig.3** wire up the project, including diodes D1 to D4, capacitor C2 and resistor R1. *Remember that the unit is mains-powered so be careful with all connections (the earth wires are particularly important), and sleeve or tape all mains connections.*

Finally your power supply is ready to test. If you have a multimeter, checking the output voltage is straightforward. If you haven't got a multimeter, then set the output to minimum and connect a 12 V bulb (max 12 W) across the output of the supply and check that the bulb brightness increases as you turn the control clockwise. The scale shown in **Fig.4** can be marked onto your front panel, and should give fairly accurate results.

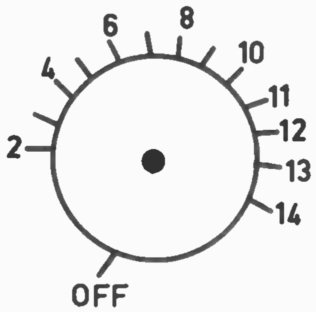
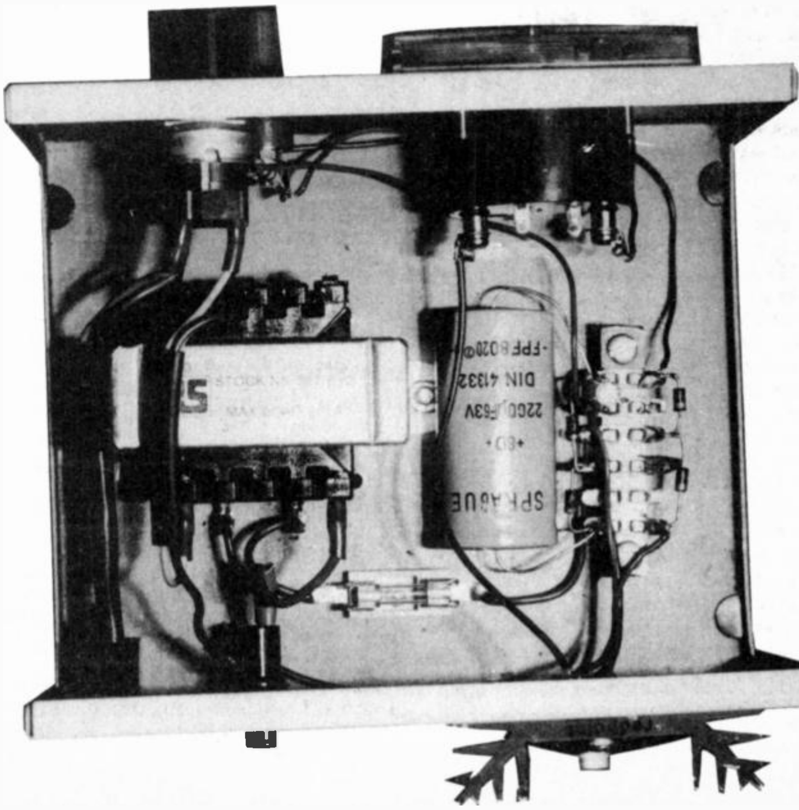


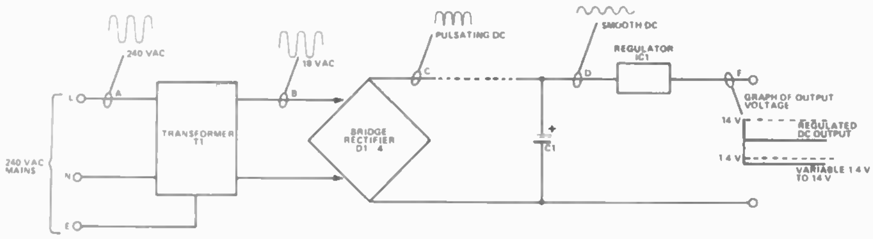

**Figure 4. Mark the front panel control with this scale to give an accurate indication of output voltage**



## How It Works

There are four basic changes taking place within the HE Variable Bench Power Supply:

- the incoming 240 VAC mains (point A) is reduced to 18 VAC (point B)
- the voltage at point B is changed to a pulsating DC voltage (point C)
- this pulsating DC voltage is smoothed to that at point D
- the smoothed voltage is regulated and adjusted to a variable DC output.




Transformer T1 reduces the mains input voltage to 18 VAC. Full-wave rectification of this AC voltage is provided by bridge rectifier D1 to D4, and this full-wave rectified DC voltage is smoothed by capacitor C1.

Integrated circuit IC1 compares a proportion of the output voltage with an internal 1.2 V reference, and then allows more or less current to pass in order to keep the voltage output constant. Adjusting RV1 determines how much of the output is compared with the reference and therefore determines the output voltage. Capacitor C2 helps the regulator to give an extra smooth output by providing extra feedback of ripple voltage.

## Parts List

RESISTOR (¼ W, 5%)

| | |
|---|---|
| R1 | 470R |

CAPACITORS

| | |
|---|---|
| C1 | 2200u, 63 V electrolytic |
| C2 | 10 u, 35 V electrolytic |

SEMICONDUCTORS

| | |
|---|---|
| IC1 | LM317K voltage regulator |
| D1-4 | 1N5404, 3A diodes |

MISCELLANEOUS

| | |
|---|---|
| T1 | 240/18 V, 1 A transformer |
| FS1 | panel mounting fuseholder + 500 mA fuse |
| FS2 | chassis fuseholder + 2 A fuse |
| M1 | 1 A panel meter |

2 x output terminals
Knob to suit
Heatsink + mounting kit for IC1
Case to suit
Mains cable clamp
Tagstrip

## Buylines

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HE

VOL 2 NO 2 OUT AUGUST 21st

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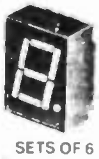

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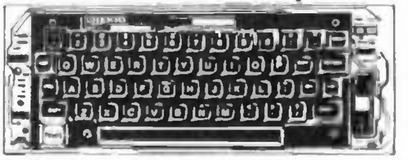

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# CB Breaker One Four

**The publishers of HOBBY ELECTRONICS would like to point out that it is at present a contravention of the Wireless Telegraphy Act of 1949 and 1968 to use, manufacture, install or import CB transmitting equipment. It is not the intention of Modmags Ltd to incite, encourage or condone the use of such equipment.**

## Rigs coming down in price and interest growing in the UHF band: Rick Maybury gives the latest news on CB

I WAS HOPING to tell you all about a meeting between the Home Office and the CB lobbyists this month, but what with one thing and another and our very tight production schedule this just cannot be. However, all is not lost, there's no shortage of news this month. On the rig scene the prices just keep tumbling. To date the cheapest rig we have heard of will cost under £40 retail — if things keep up they'll be giving them away in cornflakes packets soon!

At last we have a manufacturer who will be building rigs in this country, and what's more, the retail price is expected to be under £50. We've seen some early prototypes and I can report that if the finished version looks and performs anything like the ones we've seen then the Japs had better look out!

I've also come across a couple of UK companies which are looking seriously at the 934 MHz CB band. At least one manufacturer is (at the time of writing) into the early prototype stage and first reports seem very favourable. However, this particular frequency is not really good for mobile work. On the other hand, it would be ideal for line of sight communication and I can see a promising future for business users wishing to communicate between buildings. As this frequency allows for higher power than 27 MHz and there is no apparent restriction on antennas, I can foresee parabolic dish antennas springing up all over the place. And here's another thought: the high frequency and fairly wide bandwidth would permit a reasonable picture to be transmitted over fairly large distances using slow scan techniques. Do I hear any offers for video CB?

### Recent Accessories

Back to good old 27 MHz now. We have been literally inundated with new CB accessories lately. Some are good, many are dreadful but out of the morass a couple have really shone.

The first is an antenna, and it comes from none other than Philips — that's right, Philips the TV people. It doesn't half work well, and we'll be featuring a full review of it in a future issue of Citizens' Band magazine, so look out for it.

The second accessory worthy of note is a new antenna system that comes from Wintjoy. The system comprises a rather strange looking spider connector that will take a variety of different elements. Strangest of the lot is a combination made up of an aluminium rod for the main radiating element and three rubber ducky antennas acting as groundplane. We've never seen anything like it. Anyway, a number of different combinations are possible, enough in fact to suit virtually any kind of set-up, from mobile to base including, by the way, a marine option — very ingenious.

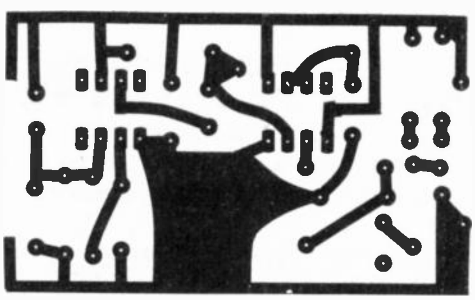
### CB On A Plate

Well, that's about the lot for this month. Just time for a quick mention of London's first CB restaurant which'll be opening about the time you read this. It's called the Eyeball Bistro Club and can be found in Princes Street, near Oxford Circus. Lots of CB-flavoured food, cheap prices, and rigs on show (and, later in the year, in use).

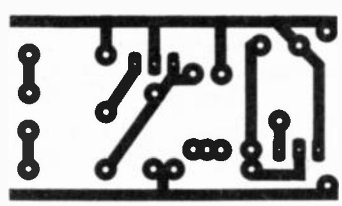
I'm off now for Home Office Special, followed by Eyeball Chops, French Fire Stiks and Half Wave Platter. Catch you all next month! Now, where's my knife and fork?

**HE**

# PCB Foil Patterns



PCB foil pattern of the HE RPM Meter



HE Thermometer PCB foil pattern

**HE**

# 1st NATIONAL CB Citizens' Band SHOW!

Have you heard about CB? Citizens' Band radio is to be legalised this Autumn; yes, that's right, our very own personal two-way radio system that can be used in the car, the home — anywhere. As you can imagine, CB will be a real boon to the motorist, the housebound, those who go for outdoor activities — and don't forget that CB can save lives!

With all this in mind **Citizens' Band** magazine, the country's leading CB publication, will be holding a **major** CB exhibition in September, timed as closely as possible to coincide with legalisation. If you want to know more about CB, or you are a CBer, come along to the Royal Horticultural Hall on 11th, 12th, 13th September and see Britain's biggest ever CB show.

There will be stands and exhibits from many of the country's leading CB accessory dealers plus, for the first time ever, working examples of the new legal rigs that will be on sale this Autumn. That's right, a number of manufacturers and importers will be on hand to show the new CB equipment that almost anyone can buy and use.

There's something for everyone, CBers old and new. The latest accessories and antennas, gadgets — in fact everything connected with CB including the new equipment.

Come along in September and see what CB can do for you. Even if you've never heard of CB, you soon will, so don't miss out — whether you're a motorist or a small businessman with an eye to the future, CB is for you! CB is the future of two-way communications . . . .

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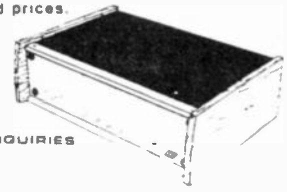

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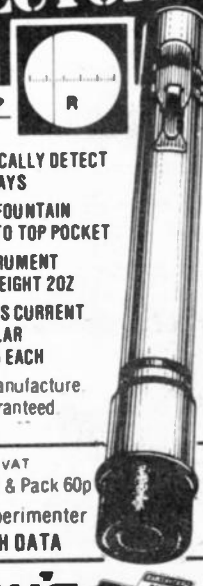

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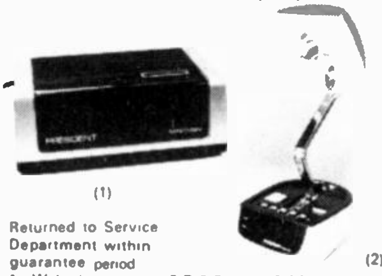

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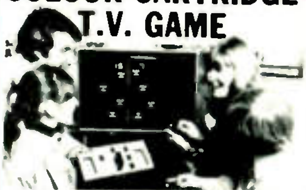

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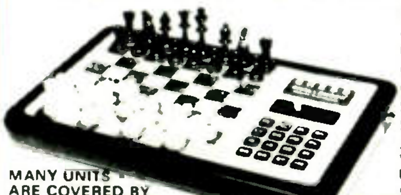

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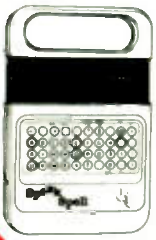

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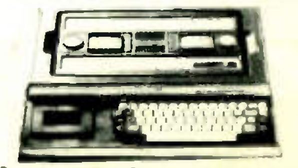

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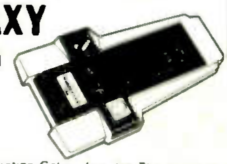

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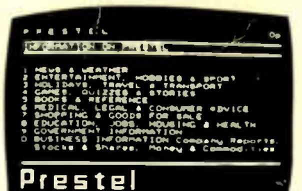

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