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TRANSCENDENT 2000 — Although only a 3 octave keyboard the '2000' features the same design ingenuity, careful engineering and quality components of its larger brethren. The kit is well within the scope of the first time builder — buy it, build it — play it! You will know you have made the right choice.
Complete kit **£165.00** + VAT

BIG NEWS ABOUT OUR LATEST ADVANCES IN **ROBOTICS** SEE INSIDE BACK COVER

SALES COUNTER
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This versatile modular mixer, featured as a constructional article in Practical Electronics can be built up to a maximum of 24 inputs, 4 outputs and an auxiliary channel. Each input channel has Mic and Line inputs, variable gain, bass and treble controls and a parametric middle frequency equalizer. There are send and return jacks, auxiliary, pan and fader controls and output and group switching. The output channels have PPM displays and record and studio outputs. The auxiliary channel also has a PPM display and there is a headphone monitor jack and a built-in talk-back microphone. The mixer modules plug into base units each of which takes up to 6 channels. To eliminate hum, the power supply is in a separate cabinet.

KIT PRICES

Input channel	£19.90	Base unit and wooden front	£27.50
Output channel	£18.50	Pair of mahogany end cheeks	£12.50
Auxiliary channel	£22.50	Power Supply and cabinet	£19.50
Blank Panel	£3.00		

All prices are VAT exclusive

Digital Delay Line — With its ability to give delay times from 1.6 mSecs to up to 1.6 secs. Many powerful effects including phasing, flangine, A.D.T., chorus, echo &

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Complete kit (400 mS delay)
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Parts for extra 400 mS delay
z99.50 + VAT

Free Soldering Practise Kit on request with your first kit — useful tips, well illustrated.

TRANSCENDENT POLYSYNTH — A four octave polyphonic synthesiser with outstanding design characteristics and versatility and performance to match.
Complete kit **£275.00** plus VAT (single voice)
Extra voice (up to three more) **£42.00** plus VAT

DEMONSTRATION TAPE —
Demonstration tape available of Transcendent synthesisers (30 minutes)
£2.00

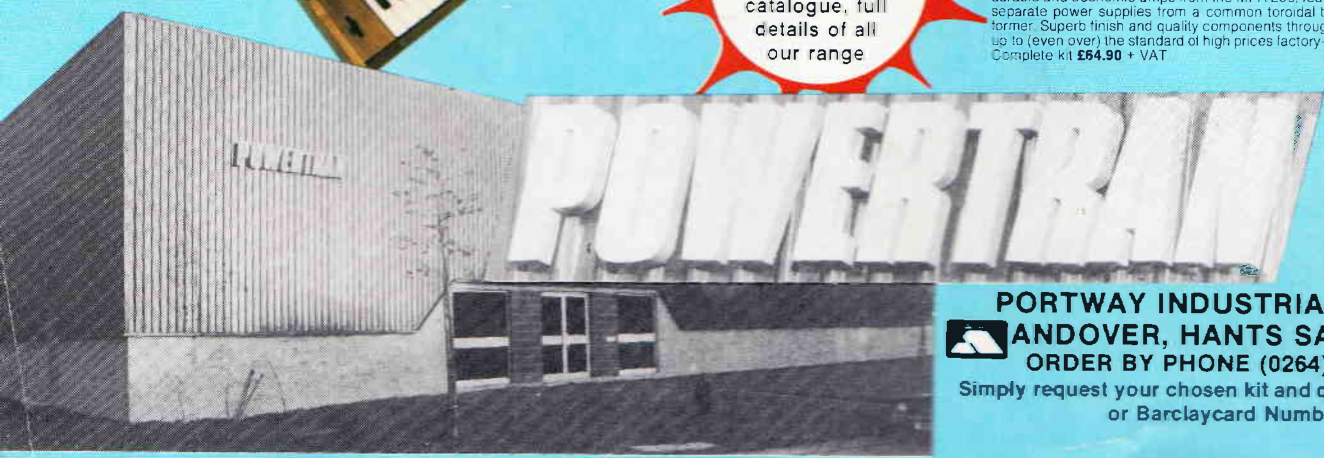
MPA 200 — is a low price, high power 100W amplifier, its smart styling, professional appearance and performance, make it one of our most popular designs. With adaptable inputs the mixer accepts a variety of sources yet straightforward construction makes it ideal for the first time builder. Complete kit **£49.90** + VAT

Chromatheque 5000 — a 5 channel lighting system powerful enough for professional discos yet controllable for home-effects. Sound to light, strobe to music level, random or sequential effects — each channel can handle up to 500W yet minimal wiring is needed with our unique single board design. Complete kit **£49.50** + VAT

ETI VOCODER — 14 channels, each with independent level control, for maximum versatility and intelligibility; Two input amplifiers — for speech/excitation — each with level control and tone control. The Vocoder is a powerful yet flexible machine that is interesting to build and thanks to our easy to follow construction manual, is within the capability of most enthusiasts. Complete kit **£175.00** + VAT

SP2 200 twice the power with two of the reliable, durable and economic amps from the MPA 200; fed by separate power supplies from a common toroidal transformer. Superb finish and quality components throughout — up to (even over) the standard of high prices factory-built units! Complete kit **£64.90** + VAT

Component packs for most kits are available. See our great free catalogue, full details of all our range



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FEATURES

PROJECTS

INFORMATION

NEXT MONTH electronics today INTERNATIONAL

HIGH DEFINITION TV

Back in the November 82 issue, Vivian Capel reported on the state of play with regard to satellite TV. Since then, wheels have been turning, wires have been humming, hands have been wrung and metaphors have been mixed, until finally the momentous decision has been made. Satellite transmissions are to be made using the MAC system (Multiple Analogue Components) rather than the extended PAL system. So next month we've got Vivian Capel to revisit the topic and explain what these systems are, what the proponents (the IBA and the BBC) claim for them, and why MAC was chosen.

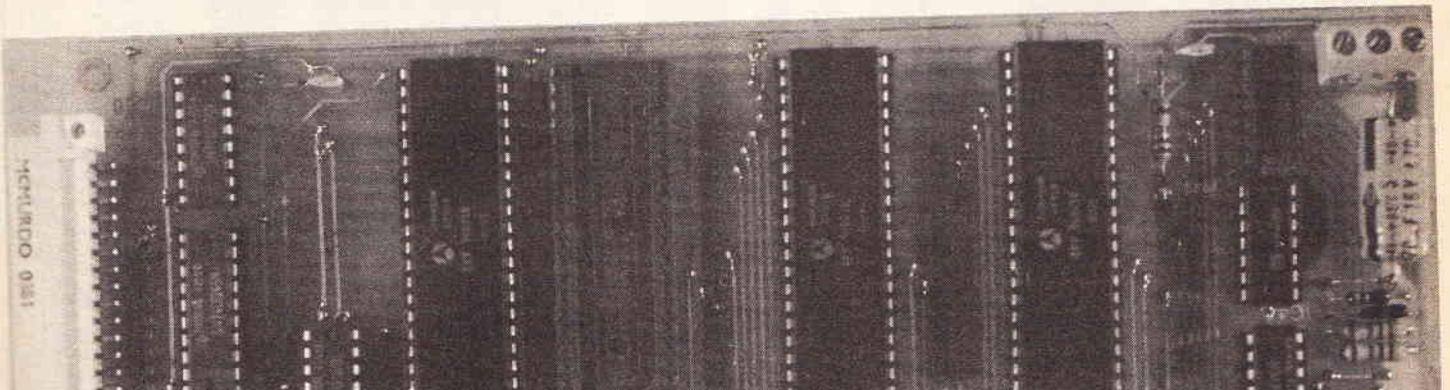
ALARM MODULE

A noisy little beast, this, which consists of a small, compact and completely self-contained project designed to monitor both open and closed loop alarm circuits, together with the main power supply. Short any alarm switches — the siren goes off. Break any alarm cables — the alarm goes off. Rip the thing off the wall — well, you can probably guess. An unimaginative behaviour pattern, perhaps, but very useful in these days of rampant crime. With a built-in piezo speaker and rechargeable battery, this alarm module gives a whole new meaning to the phrase "piercing ears". Don't miss the March edition of ETI.

6502-BASED ANALOGUE BOARD

Here's an excellent project that will appeal to all users of 6502-based microcomputers and Tangerine owners in particular. On one standard-sized printed circuit board (which is designed to accept a TANBUS edge connector, but could easily be modified for other systems), you get up to six channels of eight-bit digital-to-analogue conversion, plus an AY-3-8910 three-channel sound generator. Why not take a break from clever graphics and try your hand at playing tunes, with next month's ETI.

LOOK OUT FOR THE MARCH ISSUE ON SALE 4th FEBRUARY



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

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1N1194A 1.80
1N1196A 2.41
1N1198A 2.65
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1N1204A 1.00
1N1206 1.20
1N3063 38p
1N3065 48p
1N3492 1.85
1N3493 2.20
1N3493R 2.20
1N3602 36p
1N3604 45p
1N3766 3.00
1N3768 4.50
1N3768R 4.50
1N4001 4p
1N4002 4p
1N4003 5p
1N4004 5p
1N4005 6p
1N4006 6p
1N4007 7p
1N4009 20p
1N4148 6p
1N4150 18p
1N4448 22p
1N4517 25p
1N5172 30p
1N5176 94p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 16p
1N5405 17p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1N5625 60p
1N5626 82p
1N5627 68p
1S44 10p
1S131 40p
1S134 56p
1S421 1.00
1S421R 1.00
1S940 10p
1S941 15p
1S961 22p
AA118 28p
AA129 57p
AA143 26p
AA144 45p
AAY30 40p
AAY33 40p
AAZ17 27p
BA100 22p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA144 15p
BA155 15p
BA156 38p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 25p
BA318 30p
BAV10 15p
BAV19 15p
BAV20 15p
BAV45 1.00
BAW62 15p
BAX13 10p
BAX16 11p
BAY38 20p
BAY44 15p
BAY93 20p
BB103B 40p
BB103G 40p
BB104B 80p
BB104G 60p
BB105 52p
BB105A 57p
BB105B 58p
BB109G 60p
BY126 20p
BY127 22p
BY134 25p
BY182 1.26
BY188A 65p
BY206 36p
BY207 36p
BY223 1.56
BY297 48p
BY299 55p
BYW11-800 1.40
BYW11-1000 1.50
BYW12-100 1.30
BYW12-1000 1.40
BYW12-400 2.00
BYX10 36p
BYX50-200R 2.00
BYX55-350 52p
BYX71-350 1.10
BYX71-600 1.52
ITT33 15p
ITT44 10p
ITT921 15p
ITT923 15p
ITT2002 27p
MZ2361 1.80
OA10 70p
OA47 70p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p
[illegible] 75p
SPD9000 75p
SPD9002 95p

BRIDGE RECTIFIERS (PIV shown in brackets)
1 amp type
W01 (100) 20p
W02 (200) 28p
W04 (400) 28p
W06 (600) 40p
2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S06 (600) 55p

6 amp type Square with hole
PW01 (100) 55p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p

25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40

Proprietory Bridges
B40C1500 1.20
B80C3700 1.80
BY164 55p
BY179 92p

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400-500mW E24 Series 2.4-47V 8p
1.3 Watt E24 Series 3.3-82V 15p
2.5 Watt E24 Series 7.5-75V 1.10
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10W Pos. Stud Following voltages only 7V5, 13, 16, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.25
20W Pos. Stud (BZY93 series) E24 values 7V5-75V 2.00

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BPX61 3.48
BPX63 2.93
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BPX86 4.15
CQX13 40p
CQX23 53p
CQX33 48p
LD30A 15p
LD36A 12p
LD37A 12p
LD52A 12p
LD56A 15p
LD57A 15p
LD52C 30p
LD56C 30p
LD57C 30p
LD80A 18p
LD86A 22p
LD87A 22p
LD242 75p
LD271 40p
LD461 25p
LD466 1.45
LD468 1.65
LD471 27p
LD476 1.20
LD478 1.45
LD479 1.65
LD481 27p
LD486 1.25
LD488 1.70
LD489 1.89
LD599 81p
ORP12 1.20
RPY60 2.65
RPY63 2.65
TIL32 71p
TIL63 1.95
TIL64 1.95
TIL65 2.25
TIL66 2.30
TIL67 2.35
TIL78 60p
TIL81 1.60
TIL99 1.35
TIL116 1.10
TIL138 2.40
TIL139 2.40
TIL209 15p
TIL211 19p
TIL212 19p
TIL224 32p
TIL228 42p
TIL312 1.85
TIL313 1.85
TIL401 3.50
TIL403 3.80
TIL406 4.10

GLASS FUSES
100mA-5 Amp
State value in amps and we will supply nearest to above
20mm slow 17p
20mm quick 10p
1.25" slow 17p
1.25" quick 10p
10,000 mF 80V 4.10

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R = red G = green Y = yellow
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G5D 16p 12p
Y5D 16p 12p
Small diffused
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G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 25p 22p
G1D 27p 25p
Y1D 27p 25p
Large clear
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Tri-colour flat
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NEW OPTO DEVICES inc. Superbright see next column

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Angled PCB
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Covers 98p

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CA3021 3.20
CA3022 3.12
CA3026 1.52
CA3028A 1.21
CA3028B 2.53
CA3029 1.44
CA3030A 2.97
CA3033 5.44
CA3034 5.18
CA3036 2.75
CA3039 1.50
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CA3046 69p
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CA3052 2.32
CA3053 1.00
CA3054 1.66
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CA3060 4.09
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LM307N 55p
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LM308H 95p
LM308N 88p
LM309K 2.80
LM310H 1.35
LM310N 1.89
LM311H 1.04
LM311N 70p
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LM317T 1.50
LM318H 2.40
LM318N 1.49
LM319H 2.48
LM319N 2.10
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LM337T 1.99
LM339AN 1.60
LM339N 47p
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LM348N 62p
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LM381N 1.40
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LM386N 2.43
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LM391N80 1.93
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LM396K 13.52
LM709N8 64p
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LM710CN 52p
LM711CH 1.50
LM711CN 75p
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LM723CN 40p
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MC1305 = LM1305N
MC1307 = LM1307N
MC1310 = LM1310N
MC1330 = LM1330N
MC1352 1.76
MC1456 1.80
MC1458 = LM1458
MC1466L 6.77
MC1495L 3.76
MC1496 = LM1496
MC3340 1.45
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NE544N 1.90
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TCA750 4.90
TCA760 4.90
TCA800 3.50
TCA800Q 3.60
TCA830S 1.90
TCA910 2.19
TCA940 1.80
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TDA1003 3.94
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TDA2611A 2.50
TDA2640 3.84
TDA3000 2.76
TL061 40p
TL062 80p
TL064 [illegible]
TL071 38p
TL072 50p
TL074 1.30
TL081 38p
TL082 75p
TL083 85p
TL084 88p
TL170 48p
TL430 3.99
TL494 3.99
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.85
UPC1156 2.75
XR2206 2.82
ZN414 79p
ZN419 2.25
ZN1034 1.99
ZN1040 6.69
ZTK22 89p
ZTK33 38p

TTL
7400 10p
7401 11p
7402 11p
7403 12p
7404 12p
7405 12p
7406 16p
7407 16p
7408 16p
7409 14p
7410 15p
7411 16p
7412 16p
7413 16p
7414 16p
7416 17p
7417 17p
7420 16p
7421 18p
7422 18p
7423 19p
7425 18p
7426 18p
7427 18p
7428 18p
7430 16p
7432 17p
7433 18p
7437 18p
7438 19p
7440 18p
7441 37p
7442 38p
7443 65p
7444 65p
7445 46p
7446 55p
7447 40p
7448 45p
7450 16p
7451 16p
7453 16p
7454 16p
7460 16p
7470 25p
7472 20p
7473 23p
7474 18p
7475 22p
7476 20p
7480 36p
7481 1.19
7482 60p
7483 34p
7484 63p
7485 60p
7486 18p
7489 1.70
7490 20p
7491 30p
7492 25p
7493 20p
7494 30p
7495 30p
7496 31p
7497 1.00
74100 50p
74104 48p
74105 48p
74107 21p
74109 20p
74110 30p
74111 31p
74116 40p
74118 60p
74119 90p
74120 48p
74121 21p
74122 32p
74123 34p
74125 34p
74126 34p
74128 50p
74132 37p
74136 33p
74141 50p
74142 1.32
74143 1.35
74144 1.35
74145 45p
74147 1.00
74148 85p
74150 54p
74151 34p
74153 33p
74154 55p
74155 36p
74156 36p
74157 30p
74159 75p
74160 40p
74161 40p
74162 40p
74163 40p
74164 40p
74165 40p
74166 40p
74170 1.17
74172 2.50
74173 48p
74174 54p
74175 49p
74176 49p
74177 45p
74178 68p
74180 40p
74181 1.15
74182 55p
74184 80p
74185 90p
74186 4.69
74188 2.50
74190 45p
74191 45p
74192 45p
74193 45p
74194 40p
74195 40p
74196 40p
74197 40p
74198 77p
74199 77p
74221 53p

74LS TTL
74LS00 11p
74LS01 11p
74LS02 11p
74LS03 11p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 19p
74LS14 22p
74LS15 12p
74LS20 12p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 12p
74LS32 13p
74LS33 14p
74LS37 15p
74LS38 15p
74LS40 13p
74LS42 28p
74LS47 30p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 18p
74LS76 18p
74LS78 18p
74LS80 1.20
74LS83 33p
74LS85 40p
74LS86 16p
74LS90 20p
74LS92 26p
74LS93 24p
74LS95 24p
74LS96 50p
74LS107 20p
74LS109 20p
74LS112 20p
74LS113 22p
74LS114 22p
74LS122 28p
74LS123 34p
74LS124 80p
74LS125 24p
74LS126 24p
74LS132 30p
74LS136 24p
74LS138 24p
74LS139 27p
74LS145 60p
74LS147 98p
74LS148 80p
74LS151 30p
74LS153 30p
74LS154 60p
74LS155 30p
74LS156 30p
74LS157 27p
74LS158 28p
74LS160 30p
74LS161 30p
74LS162 36p
74LS163 30p
74LS164 30p
74LS165 50p
74LS166 55p
74LS168 55p
74LS169 55p
74LS170 55p
74LS173 48p
74LS174 30p
74LS175 30p
74LS181 88p
74LS183 1.20
74LS190 33p
74LS191 33p
74LS192 40p
74LS193 33p
74LS194 33p
74LS195 33p
74LS196 40p
74LS197 40p
74LS221 48p
74LS240 55p
74LS241 55p
74LS242 55p
74LS243 55p
74LS244 55p
74LS245 1.00
74LS247 60p
74LS248 60p
74LS249 60p
74LS251 45p
74LS253 38p
74LS257 40p
74LS258 40p
74LS259 65p
74LS260 28p
74LS266 25p
74LS273 63p
74LS275 1.25
74LS279 30p
74LS280 95p
74LS283 40p
74LS289 4.70
74LS290 45p
74LS293 40p
74LS295 75p
74LS298 79p
74LS299 1.55
74LS323 1.55
74LS324 1.40
74LS325 2.96
74LS326 2.30
74LS327 2.30
74LS347 95p
74LS348 95p
74LS352 58p
74LS353 58p
74LS362 7.25
74LS365 27p
74LS366 27p
74LS367 27p
74LS368 27p
74LS373 59p
74LS374 59p
74LS375 50p
74LS377 80p
74LS378 60p
74LS386 1.14
74LS390 44p
74LS393 45p
74LS395 87p
74LS396 1.90
74LS398 2.70
74LS399 1.50
74LS445 1.30
74LS490 1.95
74LS540 85p
74LS541 89p
74LS640 99p
74LS641 99p
74LS643 99p
74LS644 99p
74LS668 1.19
74LS669 89p
74LS670 89p
74LS673 5.50
74LS674 9.99

74S TTL
74S00 30p
74S02 32p
74S04 32p
74S08 32p
74S20 60p
74S30 60p
74S32 90p
74S40 1.46
74S64 1.02
74S65 1.02
74S74 75p
74S85 2.90
74S86 1.75
74S112 90p
74S113 90p
74S124 2.25
74S132 1.09
74S133 80p
74S138 1.25
74S139 1.40
74S140 2.50
74S153 1.95
74S157 2.75
74S163 3.00
74S174 2.50
74S175 3.28
74S188 3.00
74S189 3.50
74S194 3.50
74S200 4.50
74S201 4.00
74S225 5.25
74S261 3.00
74S262 8.50
74S287 1.90
74S288 1.90
74S289 1.57
74S301 3.20
74S470 3.25
74S471 6.25
74S473 12.50
74S474 3.90
74S475 8.25
74S571 9.00
74S573 9.00

74H TTL
74H00 1.46
74H01 1.45
74H04 1.55
74H05 1.55
74H10 1.45
74H11 1.45
74H20 1.45
74H21 1.45
74H30 1.45
74H40 1.45
74H51 1.75
74H53 1.65
74H54 1.45
74H55 1.40
74H60 1.70
74H62 1.76

74L TTL
74L02 1.00
74L10 1.70
74L47 3.27
74L74 1.20
74L85 4.20
74L86 1.50
74L93 2.30
74L98 2.90

74C CMOS/TTL
74C00 27p
74C04 29p
74C10 28p
74C14 89p
74C20 28p
74C30 39p
74C32 90p
74C42 96p
74C48 1.40
74C73 54p
74C76 57p
74C83 1.74
74C85 1.35
74C86 1.10
74C89 5.95
74C90 1.05
74C93 1.00
74C95 1.06
74C107 60p
74C151 2.55
74C154 4.85
74C157 1.65
74C160 1.64
74C161 1.18
74C163 1.18
74C164 1.15
74C165 2.00
74C173 98p
74C174 1.10
74C175 1.10
74C192 89p
74C193 89p
74C194 89p
74C195 70p
74C200 10.00
74C221 1.20
74C901 1.91
74C902 71p
74C903 2.30
74C904 1.84
74C905 10.88
74C907 1.91
74C908 1.87
74C911 9.59
74C912 8.00
74C914 2.88
74C915 1.89
74C918 2.50
74C920D 8.50
74C922 4.60
74C923 5.00
74C925 6.00
74C926 6.00
74C928 6.00
74C929 5.20
74C930J 7.60
74C932 3.12

40 CMOS
4000 10p
4001 10p
4002 11p
4006 40p
4007 15p
4008 40p
4009 24p
4010 24p
4011 10p
4012 15p
4013 20p
4014 48p
4015 40p
4016 20p
4017 30p
4018 49p
4019 30p
4020 40p
4021 40p
4022 40p
4023 13p
4024 24p
4025 12p
4026 77p
4027 20p
4028 30p
4029 43p
4030 18p
4031 1.19
4032 89p
4033 1.20
4034 1.29
4035 65p
4036 2.49
4037 1.30
4038 69p
4040 48p
4041 40p
4042 40p
4043 40p
4044 40p
4045 99p
4046 40p
4047 40p
4048 40p
4049 40p
4050 23p
4051 40p
4052 40p
4053 40p
4054 99p
4055 99p
4056 90p
4059 4.35
4060 63p
4063 75p
4066 25p
4067 2.22
4068 14p
4069 13p
4070 13p
4071 13p
4072 13p
4073 13p
4075 13p
4076 44p
4077 18p
4078 18p
4081 13p
4082 13p
4085 49p
4086 49p
4089 1.20
4093 28p
4094 69p
4095 69p
4096 69p
4097 2.88
4098 74p
4099 80p

For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS
4502 50p
4503 28p
4507 33p
4508 1.19
4510 39p
4511 48p
4512 45p
4514 1.10
4515 1.10
4516 39p
4518 39p
4519 29p
4520 49p
4521 1.00
4526 69p
4527 48p
4528 49p
4532 49p
4534 4.25
4536 2.58
4538 89p
4539 99p
4543 65p
4553 2.25
4555 38p
4556 38p
4560 [illegible]
4566 [illegible]
4569 1.50
4584 38p
4585 79p

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CPUs
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6800 2.74
6802 2.89
6809 8.50
8035 3.49
8060 10.90
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8085A 3.49
8900 57.75
9980 21.00
SCMP1 17.85
Z80A 3.15

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2101 4.00
2102AL2 1.35
2111-1 3.00
2114 (200ns) 85p
2532 3.60
2708 2.38
2564 11.95
2708 11.95
2716 (5V) 2.11
2764 9.75
4044 4.50
4060 9.60
4116 (200ns) 75p
4118-3 3.25
4164 4.50
5101(450nS) 1.99
5204 7.50
6116 4.40
6514 3.30
6810 1.15
7489 4.20
74189 4.00
74LS289 1.55
74LS188 2.25
74LS287 3.06
74LS288 1.50

ZERO INSERTION DIL SOCKETS
24 pin 4.99
40 pin 5.99

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ADC0817 10.06
AY5-2376 5.90
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INS1771 20.00
INS1791 30.00
MC1466L 6.50
MC1488 55p
MC1489 55p
MC4024 3.25
MC4044 3.25
MK50250 10.00
MK50398 6.95
MM5307 12.75
MM5357 22.50
MM57105 14.00
MM57109 12.00
MM57160 9.00
MM57161 9.00
MM58174 11.90
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RO2513UC 7.50
SAA5000 3.00
SAA5010 7.10
SAA5012 7.10
SAA5020 6.60
SAA5030 9.00
SAA5040 15.00
SAA5041 15.00
SAA5050 8.50
SAA5052 8.50
TMS6011 3.65
ULN2003A 85p
8T26 1.38
8T28 1.35
8T95 1.35
8T97 1.35
81LS95 90p
81LS96 90p
81LS97 90p
81LS98 1.20
6522 3.19
6532 6.89
6821 1.12
6845 10.00
6847 10.00
6850 1.35
6852 2.40
6875 4.65
8131 3.76
8154 9.42
8155 3.60
8212 1.10
8216 1.00
8223 1.60
8224 2.30
8226 2.50
8228 2.50
8238 5.75
8243 4.68
8250 8.85
8251 3.15
8253 7.90
8254 10.00
8255 2.40
8257 4.00
8259 4.00
8279 4.40
8304 4.60
8544 1.50
8601 1.20
8678CABN 19.50
8832 2.60
8833 2.99
9097 3.00
9601 5.50
9602 2.50
Z80ACTC 2.85
Z80ADART 8.00
Z80ADMA 10.00
Z80APIO 2.80
ZN425EB 3.39
ZN426EB 3.39
ZN427EB 5.99
ZN428EB 4.06

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(See also Linear ICs)
— Positive —
100mA
78L05A 30p
78L12A 30p
78L15A 30p
78L24A 30p
100mA To5
78L05CH 80p
78L12CH 80p
78L15CH 80p
78L24CH 80p
500mA T0202
7805M 47p
7812M 47p
7815M 47p
7824M 47p
1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
1.5 Amp T03
7805K 1.39
7812K 1.39
7815K 1.39
7824K 1.39
— Negative —
100mA T092
79L05 59p
79L12 59p
79L15 59p
500mA T0202
7905M 59p
7912M 59p
7915M 59p
7924M 59p
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p
1.5 Amp T03
7905K 1.99
7912K 1.99
7915K 1.99
7924K 1.99
— Variable —
L200 (2A Pos) 2.50
LM137K 12.00
LM309K 1.35
LM317K 3.42
LM317MP 95p
LM317T 1.75
LM337K 4.60
LM337MP 1.73
LM337T 1.75
LM345K 3.80
LM350K 4.50
LM396K 13.52

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1.00MHz 2.88
1.008MHz 2.74
2.00MHz 2.29
2.097152MHz 3.50
3.2768MHz 1.50
4.00MHz 3.00
4.194304MHz [illegible]
4.433619MHz [illegible]
5.00MHz 1.10
6.00MHz 1.50
6.9375MHz 2.50
8.00MHz 1.75
10.00MHz 1.75
18.00MHz 1.90
20.00MHz 1.90
27.648MHz 2.00
48.00MHz 1.75
100.00MHz 5.50
5.5 MHz Ceramic filter 90p

VALVES
DY86/87/802 1.32
ECC82 1.22
ECC83 1.22
ECC84 1.22
EF86 1.60
EL34 2.89
EL84 2.50
KT66 10.75
KT88 12.50
PC900 1.78
PCC84 3.00
PCC85 3.40
PCC89 1.83
PCF86 2.30
PCF201 3.00
PCF801 2.57
PCF802 2.11
PCL82 1.80
PCL85 2.20
PCL86 2.10
PCL805 2.20
PD510 4.95
PFL200 2.99
PL504 2.11
PL508 2.36
PL519 7.76
PL802 4.17
PY88 1.62
PY500A 2.63
6L6 2.59

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MON	SQN	ELSE	CALL	NUMBER	DIM
	BIT	ON	DATA	RENUM	DEF
FUNCTIONS	CRB	GOTO	READ	BOOT	NEW
ABS	CRF	GOSUB	RESTOR	GRAPH	END
ADR	MEM	POP	RETURN	TEXT	BIT
ASC	MWD	REM	STOP	PLOT	CRB
ATN	LEN	FOR	TIME	UNPLOT	CRF
SIN	MCH	NEXT	WAIT	COLOUR	MEM
COS	POS	ERROR	SAVE	CHAR	MWD
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DIGEST

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You start out as an amoeba trying to advance up the evolutionary chain to become a human. To attain this goal you have to go through a total of six distinctly different evolutionary steps. Do you have the instincts and reflexes to survive and evolve to a higher life form? That's the description of the latest computer game to arrive in the UK. Called 'Evolution', it was written for the Apple Computer System by two Vancouver teenagers.

The game starts with the player controlling an amoeba, which has to fight off bacteria whilst searching for food. If successful, the player evolves into a tadpole, which is chased by a fish, then into a rat trying to escape from snakes, a beaver crossing alligator-infested waters, a gorilla harrassed by monkeys and ultimately into man under laser attack. In 'Evolution', only the strong survive. However, the game has a twist of fate. If the player survives the laser attack, he is destroyed by an atomic explosion and has to return to a more difficult 'Evolution' process. Altogether there are 99 levels (!!), and the photo shows a fully evolved player. Amazing how he's got the animal trained so he can sit in its hand . . .

Sydney Development Company (UK) Ltd is based at 13 Wilton Place, London SW1X 8RL (telephone 01-235 2939).

Hold Everything

The new Boston hand-held instrument case range from West Hyde is moulded from black ABS, although other colours are available for large orders. The styling, which has resulted in an extremely attractive as well as functional case, is ideal for all applications involving hand-held digital readouts such as thermometers and tachometers. The cases feature a separate battery compartment and an optional thumb-button which could be used to operate on-off or range-change switches for example. A choice of display aperture sizes allows for a variety of digital displays to be fitted. The Boston is available ex-stock from West Hyde from whom a data sheet can also be obtained giving further details of this handy sized case. For further information, please contact West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET (telephone 0296 20441).

Sony Stereo

Those awfully nice Sony people have just launched their latest video recorder. The new machine — designated C9 — is Sony's replacement for the C7, and improves on the performance of its predecessor in virtually every way. The C9 is Britain's slimmest video recorder and a front-loader, with virtually all controls accessible from its front surface. It is thus fully-rackable, and at 430 mm is the same width as a standard audio component.

Audio performance is most important, as the C9 is the first Sony home video recorder to offer a stereo or bilingual sound capability. In addition, the machine is equipped with Beta Noise Reduction (BNR), which when utilised will give an audio signal-to-noise ratio of better than 43 dB. Purchasers of C9 will not, of course, be restricted to using stereo cassettes as the new recorder is totally compatible with all existing and future Beta-format machines and tapes, be they mono or stereo.

C9 will be available this week throughout Britain and its likely retail price will be approximately £699 including VAT. But will the software backup be there? Apparently so, since most of the major distributors of pre-recorded video cassettes have already taken the decision to release their titles on stereo wherever possible, and many such titles will be available within days of C9's launch. CBS/Fox for instance, have chosen seven of their classic titles for re-release in stereo — Star Wars, Quest for Fire, Alien, Chariots of Fire, All That Jazz, The Rose and Nine to Five. In addition, all new releases will be issued on stereo and that includes three this month — Taps, Oh Heavenly Dog and South Pacific.

Warner Home Video is another company which has decided to back stereo, and this month will be releasing the following stereo titles — For Your Eyes Only, Moonraker, Outland, West Side Story, Honeysuckle Rose and Rocky II. In addition, the first 10,000 purchasers of C9 will each receive a Beta-exclusive copy of Warner's 'Simon and Garfunkel in Central Park' — a recording of the almost magical open-air reunion concert containing all the duo's classic songs. MGM/UA has also chosen the stereo route, having already released in stereo The Compleat Beatles cassette — a musical anthology spanning the group's history and which includes rare stereo footage of some of their most popular material. In addition, as with other distributors, in future all MGM/UA's titles will be released in stereo where a stereo soundtrack exists.

Of course, with the reappearance of Sony's adverts on the Underground on our way to work, we just couldn't resist poking a bit of fun — see the last page of Digest.

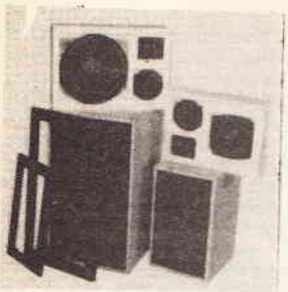
A Voice For VIC

Two new speech synthesiser units for use on VIC computer systems were exhibited for the first time at the Manchester Computer Fair on the 25th November. The Chatterbox and the Mynah Module (good grief!) have been developed by Currah Computer Components of Hartlepool in Cleveland, and offer useful applications at economical prices. The design of Chatterbox allows for it to be used on the VIC 20 expansion port, and a series of software routines have been incorporated into EPROM to allow the user a flexible method of word construction which is easy to learn and use. The Mynah Module has the same specifications as the Chatterbox except for the integral software enhancement. The absence of this software, however, does not impair the operational effectiveness of the unit. In fact, say the designers, it creates an added enjoyment for the more enthusiastic user in that the user has to refer to the master list in order to select the appropriate allophones to be incorporated into the programme. Hmmm . . .

The units operate by using a series of allophones (part of speech), drawn from a master list, to generate English words. They both come complete with a master list of allophones and an informative manual with tables and guide lines as to the use of the allophones. The design of both the units has enabled Currah to reduce component and general costs, therefore allowing for competitive pricing, while giving the confidence to offer a 12 month warranty.

Speech synthesis is particularly useful for educational purposes, and other areas where the units could have interesting applications including games, software and the music industry. The company believes that the Chatterbox and the Mynah Module will both be useful in commercial terms as promotional tools, allowing companies to advertise their products at the press of a function key.

MULLARD SPEAKER KITS

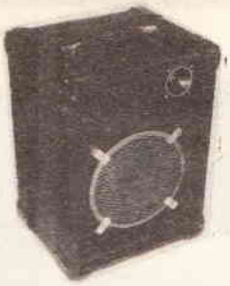


Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on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

8" 40W system — recommended cabinet size 240 × 216 × 445mm
Price £14.90 each + £2.00 P & P.

5" 30W system — recommended cabinet size 160 × 175 × 295mm
Price £13.90 each + £1.50 P & P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.
8" system cabinet kit **£9.00 each + £2.50 P & P.**
5" system cabinet kit **£7.00 each + £2.00 P & P.**



OMP 80 LOUDSPEAKER

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

Price: £49.00 each. £90 per pair
Carriage: £5 each. £7 per pair

BK ELECTRONICS

Prompt Deliveries
VAT inclusive prices
Audio Equipment
Test Equipment
by
Thandar
and
Leader

1K.WATT SLIDE DIMMER

- Controls loads up to 1KW
- Compact size $4\frac{3}{4}'' \times \frac{13}{16}'' \times 2\frac{1}{2}''$
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads

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

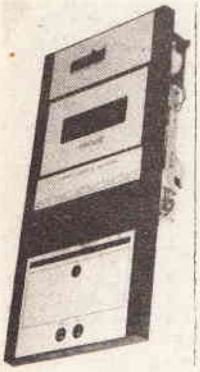
Price: £11.70 each + 50p P&P
(Any quantity)

KEYBOARDS

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

16 way numeric keyboard Standard keyboard providing 0-9 and A-F functions.
Size: 100mm × 100mm × 2mm. Price: **£5.99 + 35p p&p**

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



STEREO CASSETTE TAPE DECK MODULE.
Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5⅛in × 11⅞in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

6 piano type keys

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price £28.50 + £2.50 P&P

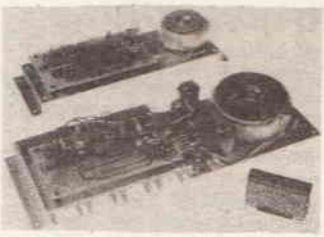
NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Price:—

15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each** £3.00 Packing and Carriage each.

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz. magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each. £3.00 Packing and Carriage each.**

8" 50 watt R.M.S. Impedance 8 ohms, 20 oz. 1½" aluminium voice coil. Resonant Frequency 40Hz. Frequency Response to 6KHz. Sensitivity 92dB. Also available with black cone fitted with black metal protective grill. **Price: White cone £8.90 each. Black cone/grill £9.50 each.** P & P £1.25 each.

OMP POWER AMPLIFIER MODULES

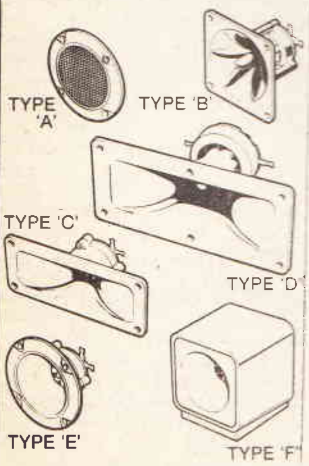


100 WATT R.M.S. AND 300 WATT R.M.S. MODULES
Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

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

PIEZO ELECTRIC TWEETERS — MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £3.45 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.35 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.45 each.**

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £6.90 each.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.35 each.**

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each.**

P&P 20p ea. (or SAE for Piezo leaflets).

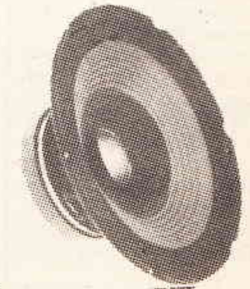
Matching 3-way loudspeakers and crossover

Build a quality 60watt RMS system 8ohms

Build a quality 60 watt R.M.S. system.

★ 10" Woofer 35Hz-4.5KHz
★ 3" Tweeter 2.5KHz-19KHz
★ 5" Mid Range 600Hz-8KHz
★ 3-way crossover 6dB/oct 1.3 and 6KHz
Recommended Cab-size 26" × 13" × 13"

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



12" 80 watt R.M.S. loudspeaker.
A superb general purpose **twin cone** loudspeaker. 50 oz. magnet. 2" aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. **Attractive blue cone with aluminium centre dome.**
Price **£17.99** each + £3.00 P&P.

B.K. ELECTRONICS

37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only. ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by **prior** appointment, please phone 0702-527572.

Daisy, Daisy . . .

From Intelligent Interfaces Ltd comes the new Olympia ESW 3000 daisywheel printer (RRP £1,036). This printer has been developed for applications requiring high quality print and high speed operation. Capable of print speeds up to 50 cps in 10, 12, 15 pitch and proportional spacing, this advanced printer offers bidirectional printing with shortest path seeking to provide maximum output and bold, expanded and double print for presentation. The internal 4K memory allows data to be down loaded to the ESW 3000 from the computer, freeing the operator to select the next task. The Olympia ESW 3000 is capable of handling any type of stationery and options include a sheet feeder and tractor feed. The ESW 3000 joins the Olympia ESW 102 and 103 KSR daisywheel printers already available from Intelligent Interfaces Ltd. They can be contacted at PO Box 30, Stratford on Avon, Warwickshire CV37 7BH (telephone 0789 295385).

It's Under Control

Submin 111 is a new compact sequential controller which has been introduced by Beblec of Weston-Super-Mare to meet industry's needs for a low-cost, versatile and robust controller which can be quickly programmed without the use of ancillary equipment. The new controller has eight input/output channels and a capacity for 2048 sequential steps which can be divided between all channels in any recognised combination. It is capable of processing a wide variety of control instructions at high speeds for a diverse range of applications. Simple toggle switch selection enables either of two programme channels to be selected, A or B, and within each channel there are 1024 sequential programming steps available. The combination of steps ranges from two steps with 512 commands to 16 steps with 64 commands on each of the channels A and B. Programming step speeds can be selected as multiples of the base speed which is 40 mS/step. Submin 111 also incorporates facilities for further time adjustment of 30% either side of the selected speed to give fine programme time control.

In its standard form, Submin 111 is supplied with a RAM (random access memory) which is easily programmed by thumbwheels mounted on the front panel. There is also simple thumbwheel selection of a variety of standard programmable features such as autostart, reset, cycle and interlock facilities. The front panel also houses five pushbutton controls for start, reset, stop, manual select and manual step. A particular feature of Submin 111 is an on-board simulator which enables programmes to be verified before the equipment is connected to any machine or process control. The unit also incorporates LEDs to show the state of each output channel, display of programme address, outputs, control codes and input channel states.

The new controller is housed in a cabinet measuring only 400 x 160 x 82mm. This enables it to be mounted unobstrusively on many machines. Its output channels provide 24 V DC signals for actuating a range of equipment such as microswitches, relays, solenoids, and the like. The Submin 111 can be supplied with a EPROM (erasible programmable read-only memory) while maintaining all the above standard features for economical process and machine control. Beblec also supply many extras including an eight-channel expander, a four-channel inverter for hydraulic drive, an analogue/digital converter, timers and a 16K memory. For further information please contact Beblec Ltd, 28 Lynx Crescent, Winterstroke Road, Weston-Super-Mare, Avon BS24 9DG (telephone 0934 412598).

Shorts

- OK supplies everything, OK? Well, almost — so they're not the OK they once were. OK Machine & Tool (as were) have decided to change their name to OK Industries (UK) Ltd, in order to reflect the growing range of wares. But they're still at Dutton Lane, Eastleigh, Hants SO5 4AA, and they still produce a lot of excellent equipment.
- Speaking of which, the new OK catalogue has been unleashed upon the waiting world, with 108 pages of tools for all occasions. This includes a special product line of low cost tools and other products for use in schools and home, plus lots of useful info. Write to the address above, or phone (0703 610944): and don't forget to mention us, will you?
- What is IT? Well, it's a bit late in the year to be wondering, but for anyone who is, Macmillan Reference Books have just published the 'Dictionary of Information Technology'. The 400 page book has over 6,000 entries and more than 100 illustrations, and costs £20 hardback, £6.95 paperback. From all good bookshops, as the saying goes.
- We often get concerned at the lack of women in the electronics profession — where are you, ladies? — so it was good to hear that the Federation of British Audio has chosen a woman as its Chairman for the second time in its short history. Mrs Sue Sharp of Goldring replaced Roger Fearn of Wharfedale by a unanimous vote, and both expressed long term confidence in the future of British audio products.
- Not only an education but an interest-free credit purchase of a Zenith Z100 computer. That's the opportunity being offered to the lucky students at Clarkson College, New York, where the university will be providing desk-top computers for all incoming students from Autumn 1983. Students pay $200 each semester plus an initial one-time maintenance fee of $200, and when they graduate, the computer's theirs.
- The new 7752 voice synthesiser chip from NEC Electronics uses CMOS technology to combine good speech quality with low bit rate and low power consumption. At 1500 bits per second the 32K on-chip ROM contains about 21 seconds of speech which may be composed of up to 63 messages: for longer messages, extra speech data may be stored in external ROM.
- Wave your flags, everybody; the British Teletext system is fast becoming the world standard. Over 95% of teletext sets sold throughout the world are based on the British system and working services operating to this standard are now running in 13 different countries. Most encouraging of all, the UK system is the only one to be effectively sold in the USA, and the 'Keyfax' teletext magazine was launched there last month nationwide.
- Amateur radio enthusiasts in the Pontefract vicinity will no doubt be interested to hear of the third Pontefract & District Amateur Radio Society's Components Fair. Black boxes are out and home construction in at this event, which takes place on Sunday 13th March (1983 of course!) at the Carleton Grange Community Centre, Carleton, Pontefract. Times are 11.00 am to 4.30 pm and more information can be obtained from P. N. Butterfield G4AAQ, 43 Lynwood Crescent, Pontefract, WF8 3QT.
- Go without a pint of petrol (or a pint of beer), and blow the fiver you'll save on the Mitshubishi 1982 Data Book. Currently available from Altek Microcomponents Ltd, 22 Market Place, Wokingham, Berkshire RG11 1AP, the book contains sections on RAM, ROM, microprocessors, LSI for peripheral circuits, speech synthesis, general purpose MOS LSI, microcomputer systems and software. Full functions and specs are given, plus 111 pages with applications for dynamic and static RAMs, a single board computer, and advice on error detecting and correction.
- Wander into your friendly neighbourhood electrical retailer and you may spot the new Smiths Industries dispenser. The "Superpack" (oh, dear) is an illustrated display carton which can contain up to a dozen time switches, plus leaflets. This should help out the consumer who is often unaware of the huge variety of time switches available.
- The Big One is back. The customary two-year lifespan of the Maplin catalogue has expired, and the new improved version is now available. This monster of the marketing world weighs one-and-a-half pounds and costs one-and-a-half pounds — if you buy it mail order. Otherwise it's £1.25 (£1.90 overseas). Considerably thicker than before, the catalogue contains two new sections on Communications and Computers, but disappointingly there are few new ICs listed. Further details can be found in Maplin's ads. Hi-de-hi.

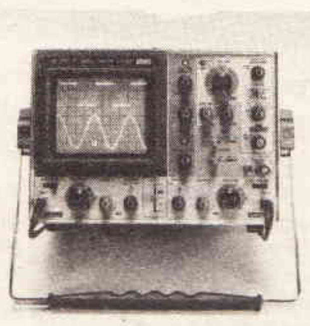
Measuring Gigahertz

The Sabtronics Model 8000 nine-digit frequency meter is a low cost, battery or mains operated, portable instrument capable of measuring frequencies between 1 Hz and 1 GHz. Frequency is covered in three ranges and three gate times are provided. Sensitivity ranges from 20 mV at 10 Hz to 35 mV at 1 GHz. Maximum resolution is 0.1 Hz (10 MHz range), 1 Hz (100 MHz range) and 10 Hz (1 GHz range) all using 10 second gate time. The 8000 costs £155 (plus VAT) and the full specification is available from Black Star Ltd, 9A Crown Street, St. Ives, Cambs, PE17 4EB (telephone 0480 62440).

Hitachi Scopes Stretch Waves

The newly introduced V-303F and V-353F oscilloscopes from Hitachi-Denshi feature a fully variable sweep delay system which enables any section of a waveform to be greatly expanded, thus allowing more detailed examination of complex signals. The sweep delay time is variable between 1 microsecond and 100 milliseconds via a five-way switch and coarse and fine variable controls. A trace intensity mode brightens up the portion of the waveform following the delay providing a rapid method of the finding the desired point on the waveform which requires expansion. Delay time jitter is better than 1 part in 5,000 so very high levels of expansion can be achieved.

The V-203F is a 20 MHz dual trace model featuring 1 mV/div vertical sensitivity, add and subtract modes, active sync separation for video signals, and a rectangular CRT with internal graticule and variable illumination. The V-353F has a 35 MHz bandwidth, a higher tube EHT, a signal delay line, and a higher calibrated maximum sweep speed of 20 nanoseconds/div. Both oscilloscopes carry a full two-year warranty and the prices (excluding VAT) are £340 for the V-203F, and £480 for the V-353F. Reltech Instruments supply the units and can be found at Coach Mews, St. Ives, Huntingdon, Cambs PE17 4BN (telephone 0480 63570).



Nellie Packs Her Trunk

Nellie is probably the oldest first generation computer to have been kept in regular commercial use anywhere in Britain, perhaps even anywhere in the world. Such historic equipment is now so rare that her owners, Bruce Banks Sails Ltd of Sarisbury, Southampton, have been determined that she should not be scrapped so long as any possibility remained that she could be preserved for posterity.

Nellie, a Stantec Zebra computer, was built by Standard Telephones and Cables in the late 1950s. STC has now agreed to take her back for the company archives. The dismantling and removal of her tons of equipment was scheduled to begin on Tuesday, November 30th.

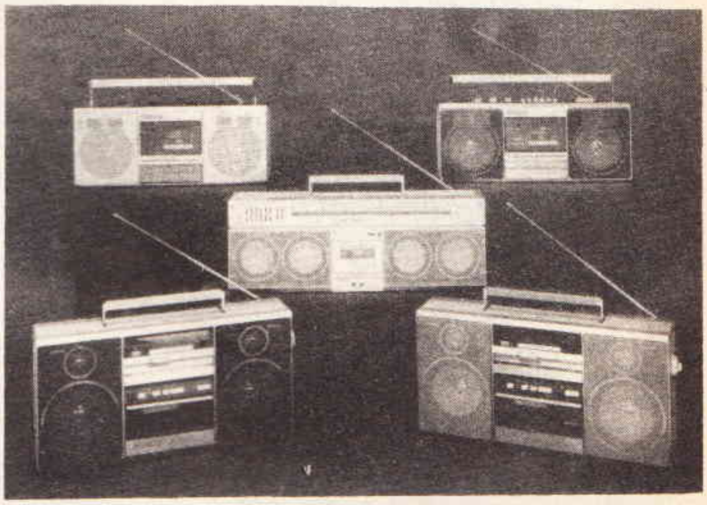
When Nellie is operating, it takes three kilowatts to heat up her 600 valves and 21 fans to make sure they do not overheat. It then takes another four kilowatts to enable her to do her sums when the high tension circuits are switched on. Requiring a 270 square foot computer room of her own, she had a capacity equivalent to a small desk top micro of today.

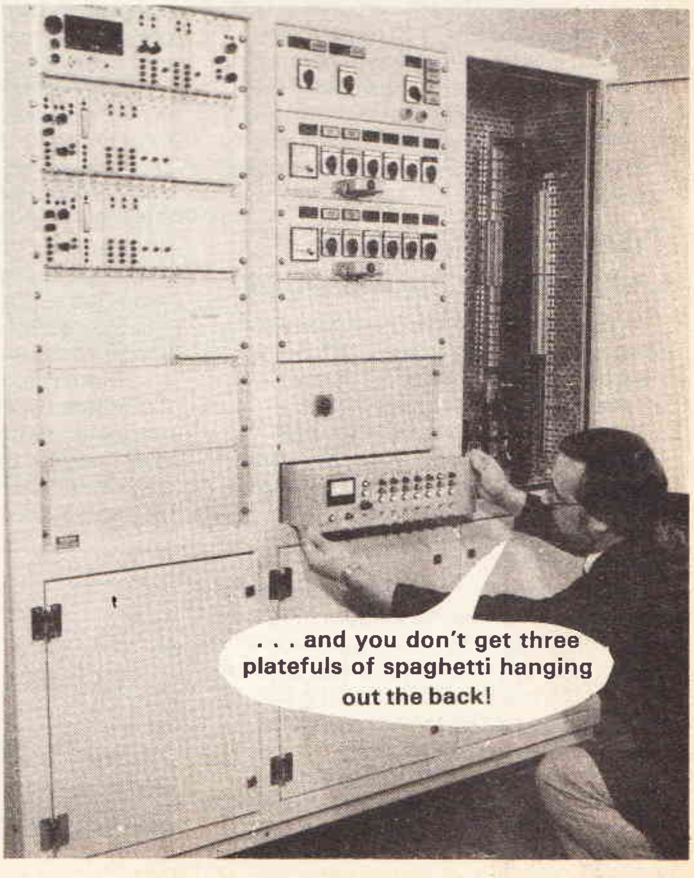
For those interested in computers, the Stantec Zebra can be described as a serial digital computer with a 33-bit word length. Operation is based entirely on a magnetic drum rotating at 100 revolutions per second, 32 words per track giving a word cycle time of about 312 microseconds. Although this sounds absurdly slow compared with modern computers, the long word length enables a high degree of arithmetical precision to be combined with a multiplicity of switching operations that could take place in one word time. For precision mathematics the machine's efficiency is still close to that of the latest equipment available. You can see Nellie, and her PET replacement, in the first episode of the new BBC Computer series.

Transportables Of Delight

A new range of portable stereo radio cassette players that combine "portability with a sound quality equal to many larger home component systems" has been launched by Pioneer. Called 'transportables', the five mobile high fidelity systems start with the SK303L model with a power output of 15 W of music power and retailing at £79 through to the top-of-the-range SK909L model which boasts a power output of 40 W, incorporates a six band graphic equalizer, auto music repeat, skip search and sells for £269. The other models are the SK353L with 15 W of music power and a one-touch record selling at £99.90; the SK707L with 23 W of music power and a music search system selling at £169.90; and the SK757L with 23 W of music power and automatic repeat, selling at £199.90.

Pioneer say the launch follows as a result of their research which reveals that the growing appreciation of quality in home based hi-fi equipment is not matched by public expectations of quality from sound portables which "is virtually non-existent". Pioneer expect the range to become popular with the outdoor leisure market, ethnic groups like the Jamican community — and high income groups who, already owning a larger quality component system, will supplement its use with a Pioneer portable "to take from room to room". How the other half lives!



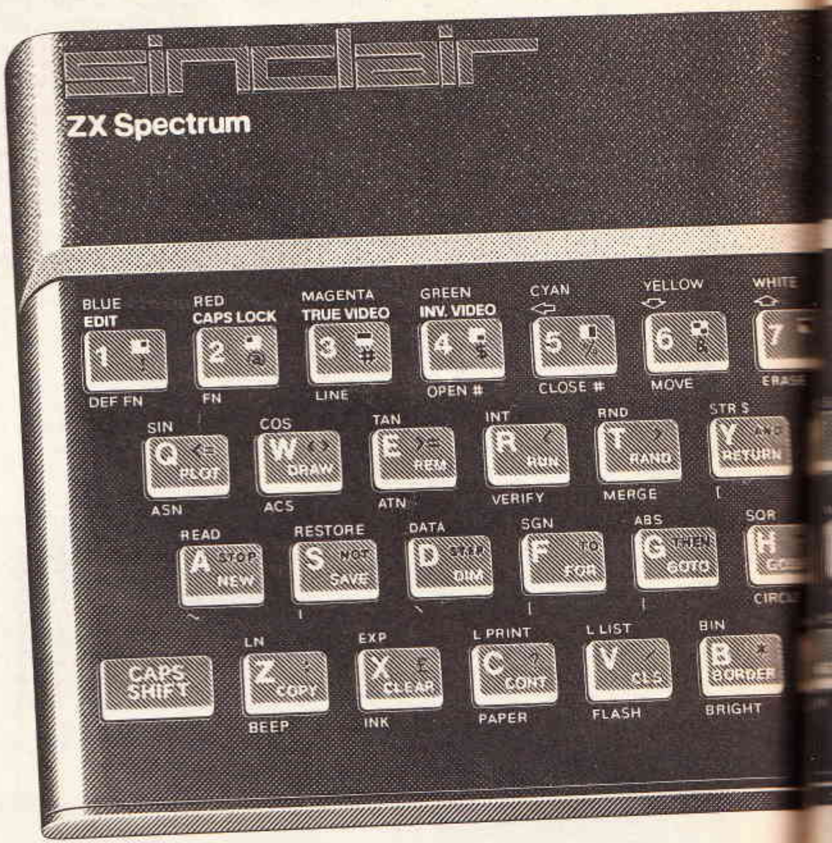


ETI

Sinclair ZX Spectr

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

From only £125!



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

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

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

Professional power–personal computer price!

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

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

You have the facility to support separate data files.

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

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

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

Ready to use today, easy to expand tomorrow

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

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

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

Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound – BEEP command with variable pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
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- Teletext-compatible – user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE – 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um

ZX Spectrum software on cassettes – available now

The Spectrum software library is growing every day. Subjects include games, education, and business/household management. Flight simulation... Chess... Planetoids... history... Inventions... VU-CALC... VU-3D ... Club Record Controller... there is something for everyone. And they all make full use of the Spectrum's colour, sound, and graphics capabilities. You'll receive a detailed catalogue with your Spectrum.

ZX Expansion Module

This module incorporates the three functions of Microdrive controller, local area network, and RS232 interface. Connect it to your Spectrum and you can control up to eight Microdrives, communicate with other computers, and drive a wide range of printers.

The potential is enormous, and the module will be available in the early part of 1983 for around £30.

sinclair

Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS.
Tel: Camberley (0276) 685311.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

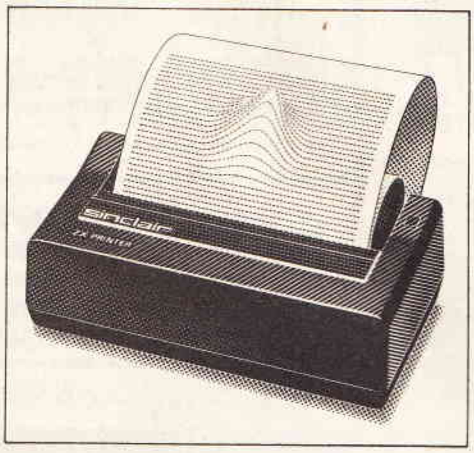
The ZX Microdrive – coming soon

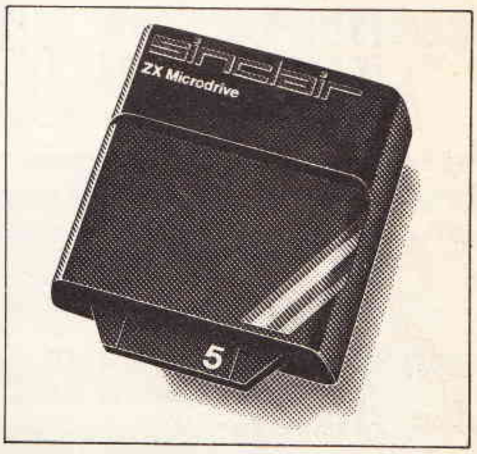
The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing by providing mass on-line storage.

Each Microdrive can hold up to 100K bytes using a single interchangeable storage medium.

The transfer rate is 16K bytes per second, with an average access time of 3.5 seconds. And you'll be able to connect up to 8 Microdrives to your Spectrum via the ZX Expansion Module.

A remarkable breakthrough at a remarkable price. The Microdrives will be available in the early part of 1983 for around £50.





How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

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	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
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*available in kit form £16.95 + VAT

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Fully built & tested

Adjustable range from 5ft. to 25ft.

A really effective fully built module containing both ultrasonic transmitter and receiver and circuitry for providing false alarm suppression. This module, together with a suitable 12V power supply and relay unit as shown, forms an effective though inexpensive intruder alarm. Supplied with comprehensive Data Sheet, it is easily mounted in a wide range of enclosures. A ready-drilled case and necessary hardware is available below.

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- Large bright 0.43" LED displays
- Supplied with full applications data

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Power Supply & Relay Units PS 4012 — £4.25 + VAT

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Contains an inhibit facility for use with shop lifting loops etc. or other break to activate circuits

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THE ETI ORGAN
PART 1

We wanted to publish another top-notch musical project but we also wanted to get away from the synthesiser syndrome. Hence this first-class organ, which is designed to fit large, medium or small pockets/rooms/ambitions. Design by Richard Watts.

The 'Victory' electronic organ was designed as an instrument with capabilities equivalent to those available on manufactured home organs. ETI has previously published designs for synthesisers which, while excellent as a solo instrument, are not able to give a complete ensemble with drums and backing. Part 1 of this article deals with the design of the upper keyboard and a selection of voices such that a working keyboard is possible for a very modest outlay. Subsequent parts will complete the instrument and provide expansion sockets for up-grading the organ at a later date. The entire electronics (with the exception of the amplifier/PSU) is mounted on one double-sided printed circuit board for ease of construction and installation.

A fully-expanded version of the organ containing all of the features mentioned in the text.

Specification

Part 1 consists of a single full-size 44-note industry standard keyboard (F-C) with the following voices: Flute 16', Flute 8', Flute 4', Clarinet 16', and Trombone 16'. The effects available are sustain and vibrato. Part 2 describes the preset voices — piano, harpsichord, Hawaiian guitar, banjo with repeat, and accordion — plus the lower keyboard, an additional 44-note keyboard with melodia and rhythm guitar voices, lower manual accent effect, a 13-note pedalboard with electronic left priority, 8' or 8' plus 16' voices, pedal accent and built-in sustain. There is a choice of bass played from the lower keyboard or the pedal board: a swell pedal with glide control is also included. Finally there is the amplifier, the PSU, a special 12" speaker and a headphone socket.

Part 3 will describe the remaining features of the organ — the rhythm and automatic accompaniment (comprising 16 modern rhythms), speed and volume controls and a down beat indicator; the rhythm section voices (bass drum, tom-tom, claves, snare drum, long and short cymbal, cymbal strike tone and selectable handclap); plus the automatic features, which include single finger chord (12 major, 12 minor, 12 seventh, 12 minor seventh) with latch for chord control, lower manual memory, long and short chord modulation, and choice between two independent bass patterns per rhythm or constant bass.

Keyboard Operation

As can be seen from the keyboard circuit diagram, utilisation of the M208 with its 'matrix scanning' switching results in only 17 connections being required for the 44 notes on the upper keyboard. This is achieved by sending the 12 scanning outputs (F1 to F12), active low, from the M208 pins 21 to 32 through diodes to single key contacts such that all C notes are supplied from the same

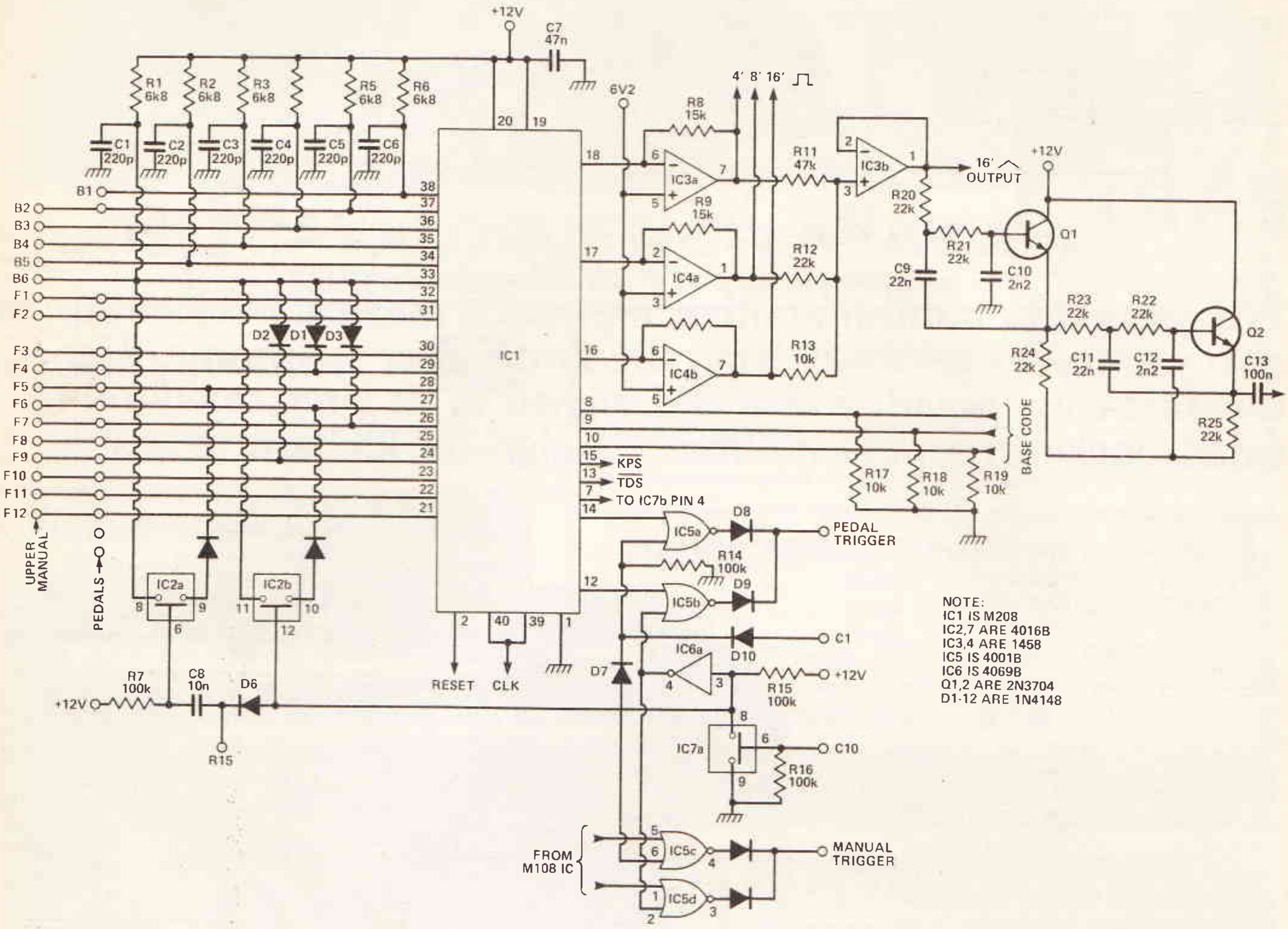


Fig. 1 Circuit diagram of the keyboard scanning and audio generating circuitry, IC2a and b and associated components, IC5, 6a, and 7a and all their associated components are not used in the basic version, nor are pins 7, 13, 14 and 12 of IC1, but have been drawn anyway to save re-drawing the entire circuit next month.

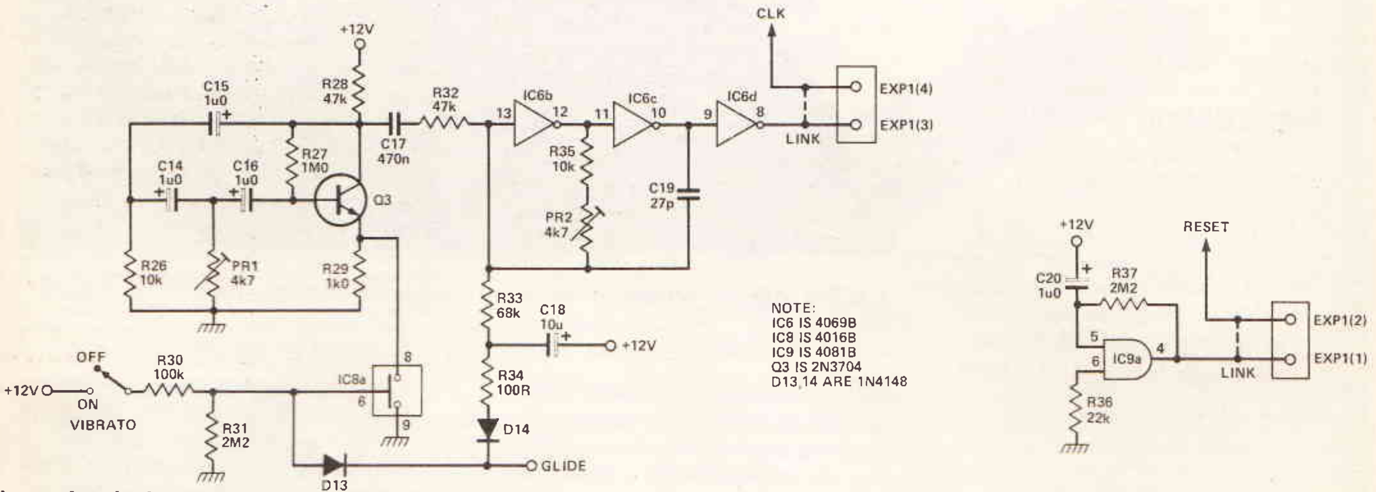


Fig. 2 The clock generator and vibrato circuitry (left) and the master reset circuit (right). D13, D14, R34 and the EXP1 sockets are not included in the basic version.

pin, all D notes from another pin and so on. Keyboard data is collected and returned to the M208 on five separate buss bars, three of which contain a full octave of data (B3, B4, B5), one contains data on the lowest seven notes (B2) and the other (B6) contains only information concerning the state of the highest C key. The B6 line is also used elsewhere for function switching within the M208 as will be shown later.

The M208 control scanning as well as its analogue (audio) outputs are derived from a 1 MHz clock which is input to pins 39 and 40. The clock is obtained from three inverters within IC6 along with C19, R35 and the preset pot PR2. Since PR2 controls the clock frequency it is also used as the master tuning control for the whole organ. Transistor Q3 and its associated components C14, C15, R26, R27, R28 and R29 and the preset pot PR1 form a low frequency oscillator

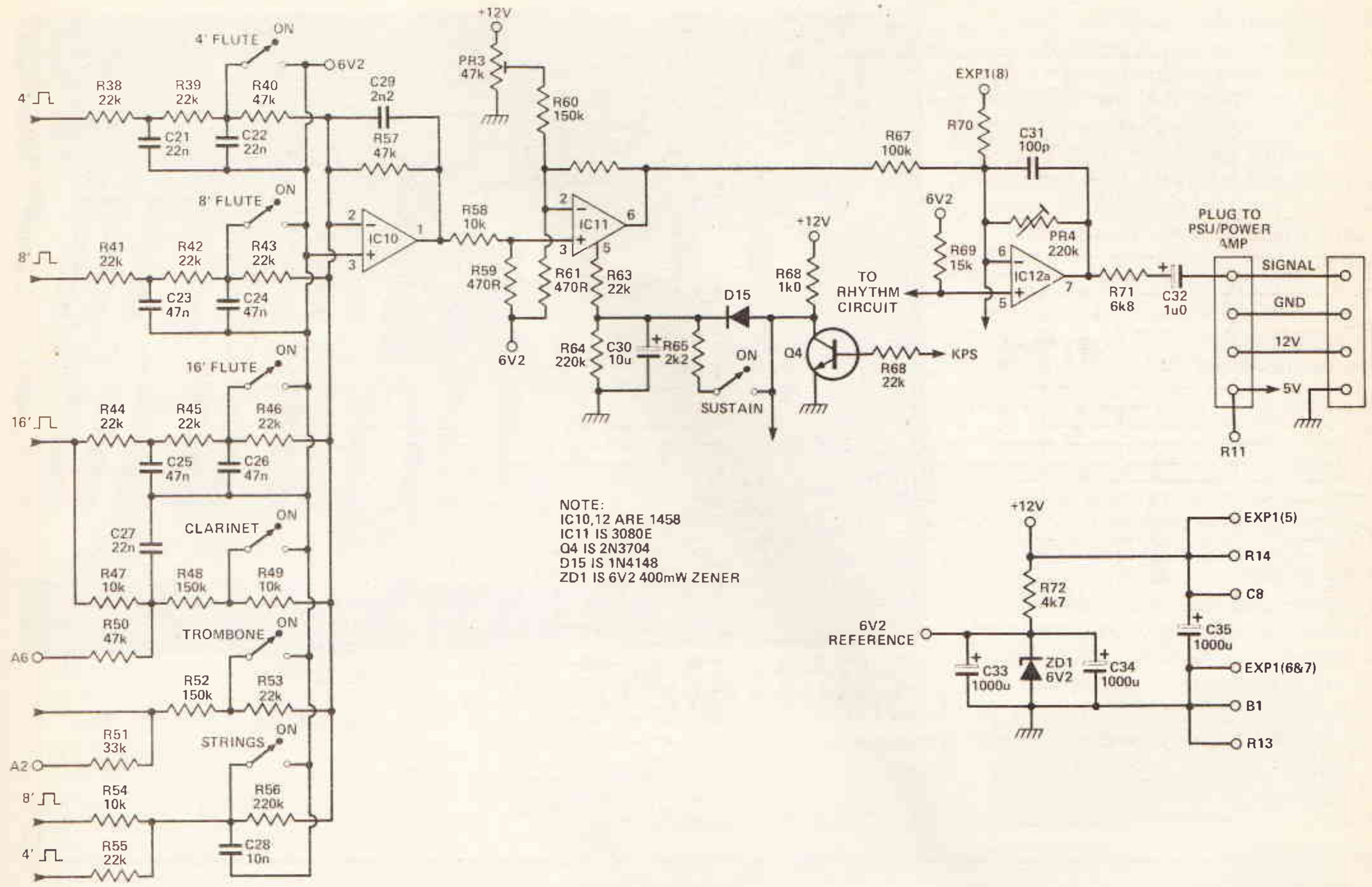


Fig. 3 The filtering and output circuitry for the basic organ.

(approximately 6 Hz) which, when enabled performs as the vibrato oscillator. It is enabled when +12 V is switched from the Vibrato switch through R30 to the analogue switch IC8a. This causes the emitter of Q3 to be connected directly to ground, increasing stage gain and causing the circuit to oscillate. This 6 Hz sine wave is coupled via C17 and R32 to the 1 MHz clock resulting in frequency modulation of the clock frequency, ie vibrato. PR1 sets the vibrato speed.

When a key or keys are depressed, the keyboard data is input to the M208 'B' lines. The chip debounces and decodes this switch information internally and outputs the relevant note frequencies to pins 16, 17 and 18. This analogue information appears as current outputs, such that the note frequencies which appear on pin 18 are exactly twice those appearing on pin 17 which are in turn exactly twice those on pin 16. These outputs constitute the 4', 8' and 16' pitches respectively and are sent directly to op-amps IC3 and IC4 which act as current-to-voltage converters as well as providing a convenient low impedance source for feeding the filter circuits.

The outputs from these op-amps are square wave signals in the form required for filtering or voicing. This square wave with a duty cycle of 50% contains only odd harmonics and is suitable for only the flute type voices. Other voices require both odd and even harmonics and this is obtained by 'staircasing' the three square waves in the ratio of the resistors R11-13 connected to IC3b in the voltage follower mode. Since the largest element of this waveform is at 16' pitch, it is referred to as the 16' staircase.

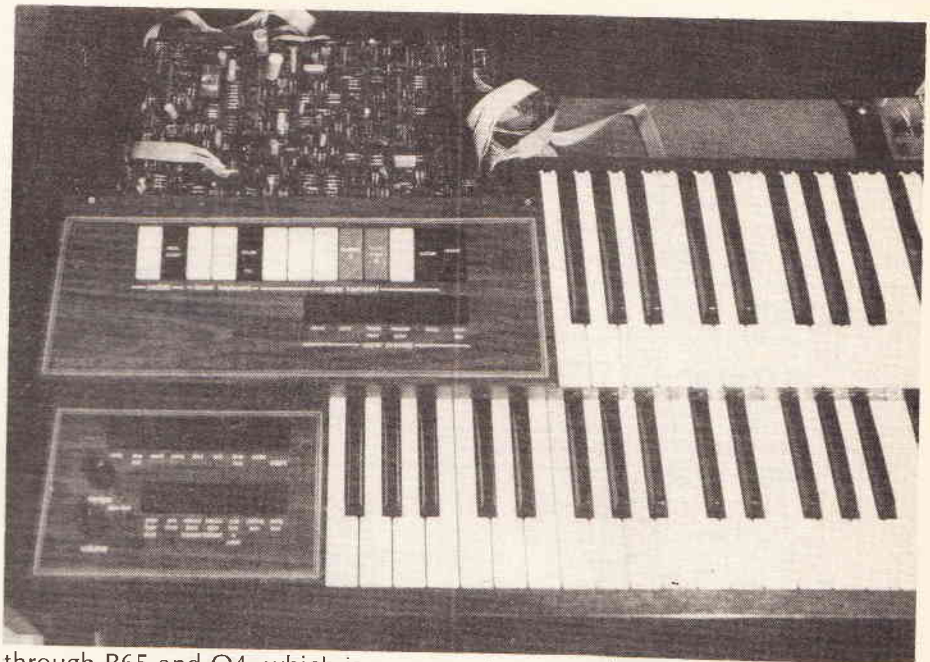
Referring back to the input side of the M208 briefly, the diode D1 connected between F4 and B6 of the M208 causes the last note or notes played to remain latched at the outputs of the M208. This facility is necessary for the sustain feature to be described later. It can be seen that the current-to-voltage converters IC3 and 4 each have their non-inverting inputs tied to $\frac{1}{2}$ V_{DD}; this is an operational requirement of the M208 and is further utilized in the voicing and preamp section, enbling all the op-amps to be run from a single supply rail.

Non-percussive Voicing

These are mainly derived from passive low-pass filters and their selection method is the same. As an example, for the 8' Flute voice the 8' square wave signal from IC4a is applied to the network comprising R41, R42, C23 and C24. The voice switch in the 'off' position switches the filter output directly to $\frac{1}{2}V_{DD}$ which is used as 'signal ground' (as distinct from power supply ground). This shorts out the filter output and so this voice is not heard. In the 'on' position the signal is allowed to pass through R43, which determines its level relative to the other voices, into the mixer amp IC10. It can be seen that for the more complex voice of the String an 8' staircase is made up from R53 and 54 driven from 8' and 4' square waves. The other exception is the Trombone voice which utilises the 16' staircase waveform applied to the active filter circuit comprising Q1, Q2 and associated components.

Output Gating

The output from the mixer amp is fed to IC11 which is an OTA, the 3080E. Its function here is that of a voltage-controlled amplifier. Since the 3080E is actually a current-controlled device (this being supplied via R63), it is the voltage across R64 which will determine the audio output envelope. It can be seen that the base of Q4 is fed via R68 from a signal called $\overline{KPS}$, short for Key Pressed Solo. This is a control signal developed within the M208 which is normally high (+12 V), goes low (0 V) when any key is depressed and remains low until all keys are released. So, with no keys depressed, Q4 is saturated, its collector low and therefore no current is supplied to the OTA. Although the audio from the last notes played is still present at the input of the OTA (due to the latched output facility being enabled on the M208), it is allowed to pass no further and no voice is heard. However, when a key is depressed, Q4 collector goes high and charges C30 via D15: current is supplied through R63 to the OTA resulting in audio appearing at its output. When the key is released, assuming the sustain switch to be in the 'off' position, C30 is discharged quickly



through R65 and Q4, which is saturated again. The result is that the OTA is shut off and no audio passes. If the sustain is switched on the same process take place except that the discharge path is through R64. Now the discharge is much longer and consequently a sustain envelope is applied to the OTA and the audio decays gradually. The output of IC11 is connected to IC12a, the output amplifier/mixer. Overall volume is set by preset PR4.

ETI

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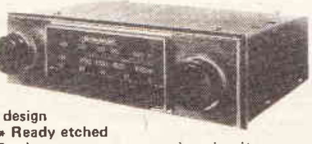

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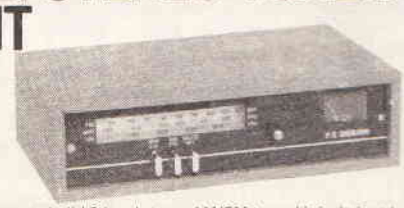

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

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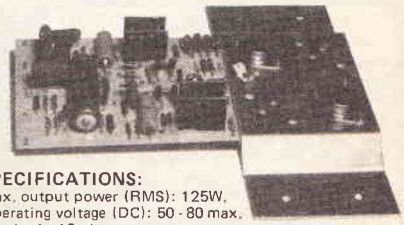

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Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
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Sensitivity for 100 watts: 400mV @ 47K.
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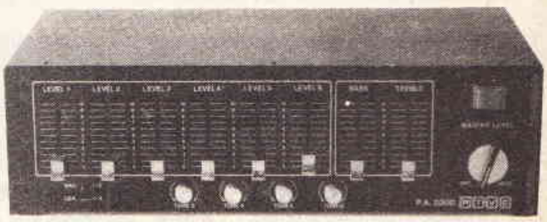

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DESIGNING MICRO SYSTEMS PART 7

To conclude the series, Owen Bishop takes a brief look at the two main ways in which information may be stored and retrieved by the microcomputer.

While the micro is in use, a lot of information may be held in ROM and in RAM. When the power is switched off, all the information in RAM is lost. This might consist of programs, tables of data, and information of various other kinds. If we want to retain this information for use on a future occasion, it must be stored in a form in which it can easily be put back into RAM when required. For certain applications RAM is not large enough to hold all the information we have to deal with. A business might be running a data-base program and require access to names and addresses of thousands of customers. These cannot be held simultaneously in RAM, so they must be loaded in and dealt with batch by batch. A complicated program may be too long to be held in RAM, but can be broken down into sections which are loaded individually for use when required. Some system of transferring information into and out of the micro is therefore almost essential.

The two methods of storage most commonly used involve transferring the information to a magnetic medium. Almost all micros provide a means of transferring information between RAM and a cassette tape. The other method makes use of a plastic disc coated on one or both sides with magnetic material. This is often referred to as a **floppy disc**, to contrast it with the **hard disc** which is often used with minicomputers but (at present) rarely with micros. Discs are made in two standard sizes, 8″ and 5¼″ in diameter. The smaller of these is the kind most often used with micros and is more correctly described as a **diskette**. Diskettes of even smaller diameter are now being produced, most notably for the ZX81 and Spectrum microcomputers (the Sinclair Microdrives).

Tape Measures

Information is stored on tape in the form of a square wave. Successive regions of the tape are magnetised in one direction or the other. The prime requirement is for a tape with low noise and freedom from blemishes. With an audio tape the occasional region with faulty coating makes little difference to the sound, but when the tape is being used for recording binary digits, such a 'drop-out' may convert a 0 to a 1 or the other way about, rendering the recording nonsensical from that point onward. Although it is possible to use ordinary tape for recording computer programs, most people prefer to use specially tested

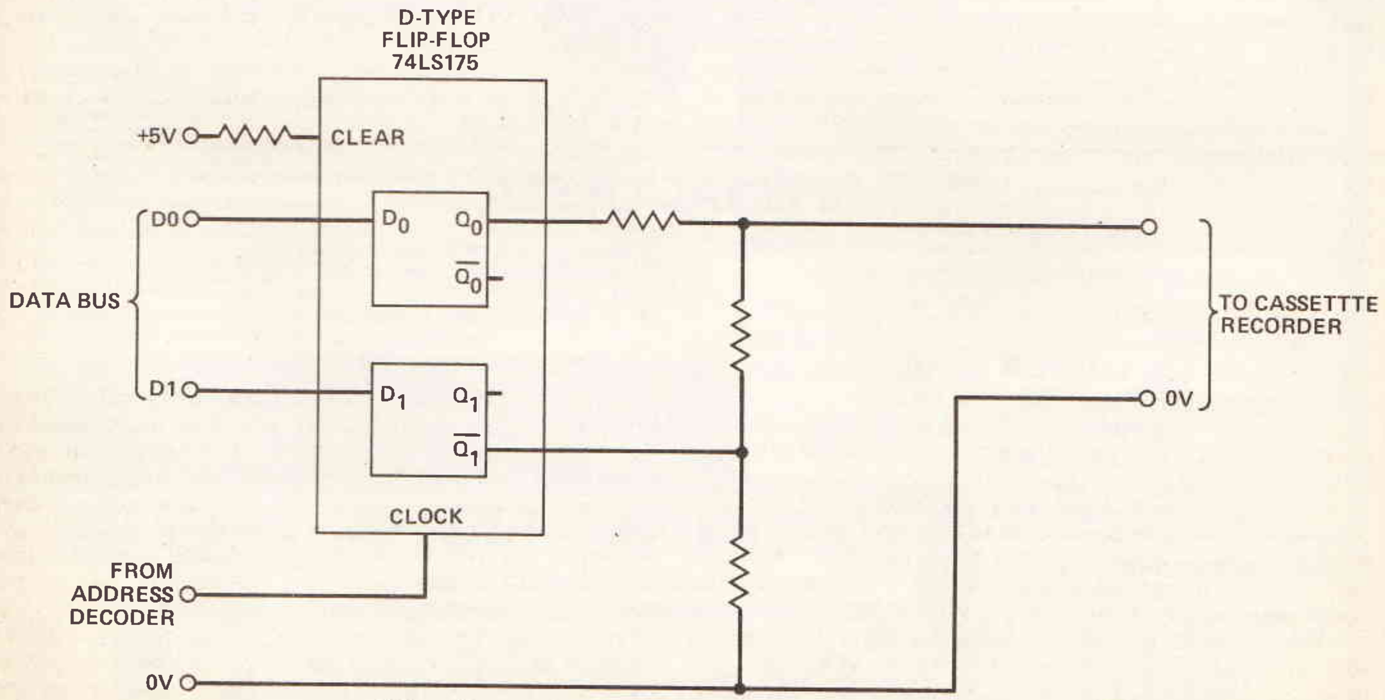


Fig. 1 Typical cassette output circuit (based on the TRS-80). Data is transferred to the outputs Q and $\overline{Q}$ when the clock input is made low. It is then latched until the next write operation. The resistors are chosen to give suitable output levels with different combinations of outputs from the flip-flops.

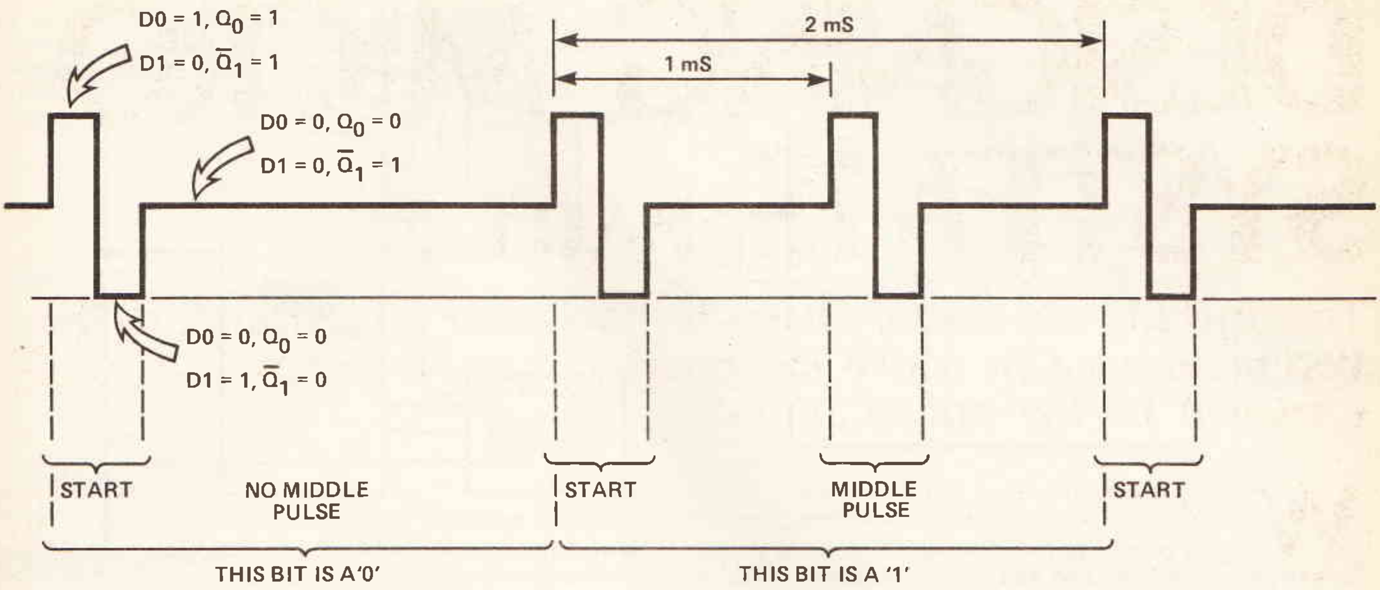


Fig. 2 The coding of the bits in the TRS-80.

'digital' tapes which are guaranteed free from such defects. They are usually supplied in shorter lengths than audio tapes. For example, C10 and C15 are two commonly available lengths. A program of 16K (or slightly longer) fits into a single side of such a tape when recorded at the standard rate of 300 baud. If your program is longer than this, you will probably prefer not to wait as long as 10 minutes or a quarter of an hour to load it and will be thinking of investing in a disc drive.

Figure 1 shows the circuit of a typical cassette output circuit. It occupies a single address in the memory stage of the computer. Data is fed to it as a series of 0s and 1s and a corresponding voltage is fed to the recorder. In the example shown, a positive voltage represents 1, 0V represents 0. In the absence of a signal the output voltage is one half of the '1' level. However, there is little standardisation of microcomputer outputs to cassette recorders, and there are many variations on this theme.

All micros record and load the data serially, that is to say, one bit at a time. Before a byte of information is recorded it is broken down into its eight bits and each bit is sent separately to the cassette output circuit. Methods of coding the information vary widely from one micro to another. This is why it is almost impossible to load one micro with a program saved on a machine of different make.

Bits And Blips

Not only does each micro have its own system of formatting the tape — the way it begins and ends each transmission of data — but the 1s and 0s may be represented in several different ways. The TRS-80, for example sends data at the rate of one bit every 2 mS (500 baud). It indicates the beginning of each bit by a 'start pulse' or 'blip' as in Fig. 2. This is a short swing to high, then to low and finally a return to the 'no-signal' level. If the bit is a 0, no further signal is sent. After 2 mS the next 'blip' indicates the start of the next bit. If the bit is a 1, a blip is sent exactly 1 mS after the start pulse.

When the tape is played back the signal is taken in through a circuit as in Fig. 3, where the 'blips' are detected. Though they do not have exactly the same form as the original signal, the timing is the same and this is all that matters. The micro is programmed to wait until a signal is detected and to sample the input exactly 1 mS later. If a signal is detected at this stage too, the bit is taken to be a 1. If no pulse is detected, the bit is taken as a 0. It then awaits the arrival of the next signal to indicate the beginning of the next bit. At each stage it stores which kind of bit (0 or 1) it has received. When it has received eight bits these are assembled into a byte and stored in RAM. If a flaw in the tape causes a bit to be missed, or an extra bit to be recorded, this upsets the decoding of all bytes for the remainder of the recording. An incorrectly-read bit may alter only the byte it is part of. This too can affect the interpretation of the whole of the remainder of the recording, especially if the recording is a machine-code program.

Another system of recording data depends on **frequency shift keying** (FSK, for short). This method is also used in transferring data from one micro to another by wire. Two standard frequencies are used, one of them having perhaps twice the frequency of the other. When we say 'standard' we mean standard for that model of micro, but for tape recording different makes of micro almost invariably work to different standards. A 0 is represented by a short tone burst of one frequency and a 1 by a burst of the other frequency. On playback (or on receiving the transmission over a line) the computer can easily measure pulse length and so find out which frequency is being sent at each instant. This information is then converted into 0s and 1s and assembled into bytes to be stored in RAM.

Tape Versus Disc

Tape recording computer programs and data files has some considerable advantages which must be matched against considerable disadvantages. The main advantage is cheapness. Within the computer we need relatively simple output and input circuits. The tape recorder itself can be a simple and cheap mass-produced model. Many intending microcomputer owners already possess a tape recorder, so the only expense is the lead to connect it to the micro. A sophisticated hi-fi recorder often gives trouble owing to its noise reduction circuits which turn up the volume during periods of no signal, so feeding the computer with amplified tape noise and confounding its signal detection program. It has often been said the the cheaper recorder, the better it is for use with a micro. However, certain micros give problems

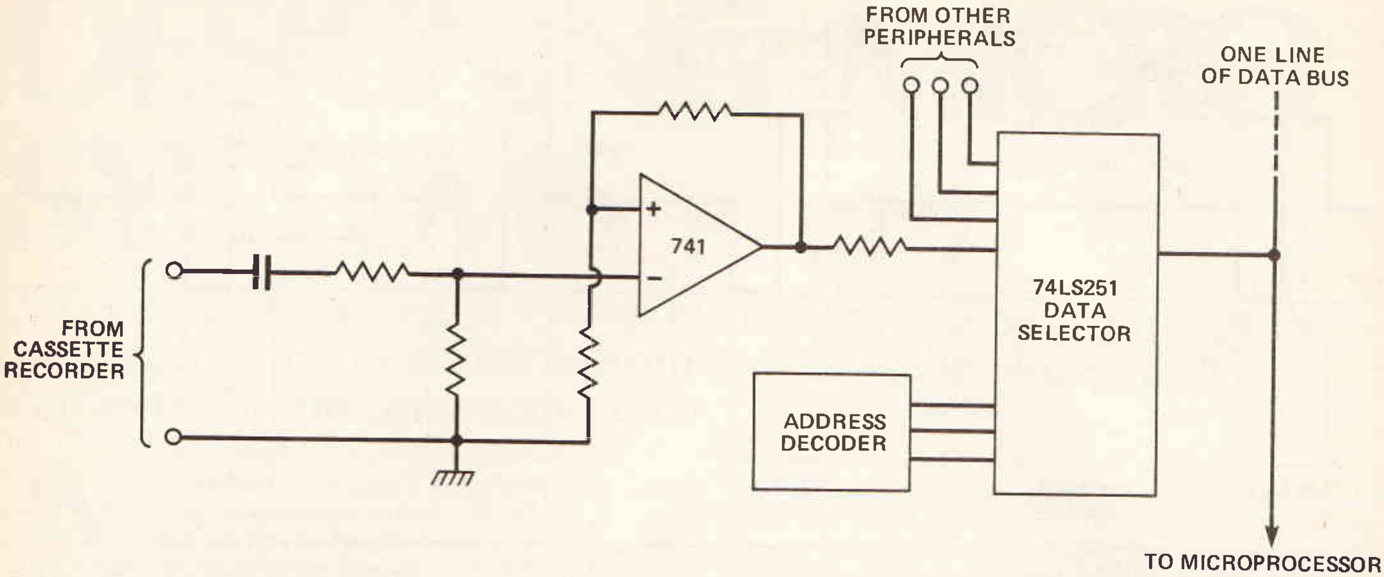


Fig. 3 A typical cassette input circuit has an op-amp wired with positive feedback so that it saturates and its output swings fully in either direction. The data selector is used to send the input from the recorder or from other peripherals such as games controllers.

when loading from tape, and make it necessary to set the playback volume fairly carefully to avoid either too small a signal or a large signal which saturates the input circuits.

Manual Controls

Provided that the user requires only to save and load relatively short programs, the cheapness and availability of cassette recorders outweighs their disadvantages. If a large amount of data is to be handled and if time is costly, the balance of advantage swings firmly toward the disc. One of the disadvantages of the cassette recorder is that its 'record', 'play' and tape winding controls cannot be operated automatically by the computer. They must be operated by the user, with the inevitable consequence of making a mistake. At the least, this wastes time and, at the worst, may cause a valuable program or set of data to be erased.

The only control which micros have over the recorder is to start and stop the motor at the beginning and end of each recording. There is a small relay in the computer which is connected in place of this 'on/off' switch often found on the stem of a microphone. This relay is controlled by the MPU, having its own address or addresses in memory. Usually there is a flip-flop which is toggled by writing to one address or the other. Figure 4 is a typical motor-switching circuit. Such a circuit is very simple and therefore found in all except the very cheapest micros.

A cassette tape passes over the recording/playback head at the standard speed of 1 15/16 inches per second (50 mm/S). At this relatively low speed the rate of recording is limited to a few hundreds of bits per second. Consequently it takes several minutes to record a program which is more than a few kilobytes long. This results in excessively long delays when running data-bases and similar programs.

Other problems with tape are connected with the fact that programs or data files are recorded one after the other along the length of the tape. Recordings can be played back only in the order on which they were recorded. If you want to return to a recording which is earlier on the track, it is necessary to operate the recorder manually, rewinding it to a position in advance of its new starting point. This takes time and is a tedious operation even with the aid of the footage meter. If the item of data you need is part of a long recording, you have to play the recording through from beginning to end to retrieve the single item you need.

Discs have none of these disadvantages and are altogether more reliable than cassette tapes. On the other hand, a disc drive is considerably more expensive than an ordinary cassette recorder. But if we abandon the idea of cheap data storage, we can take advantage of the best available technology and design a device which is ideal for its purpose.

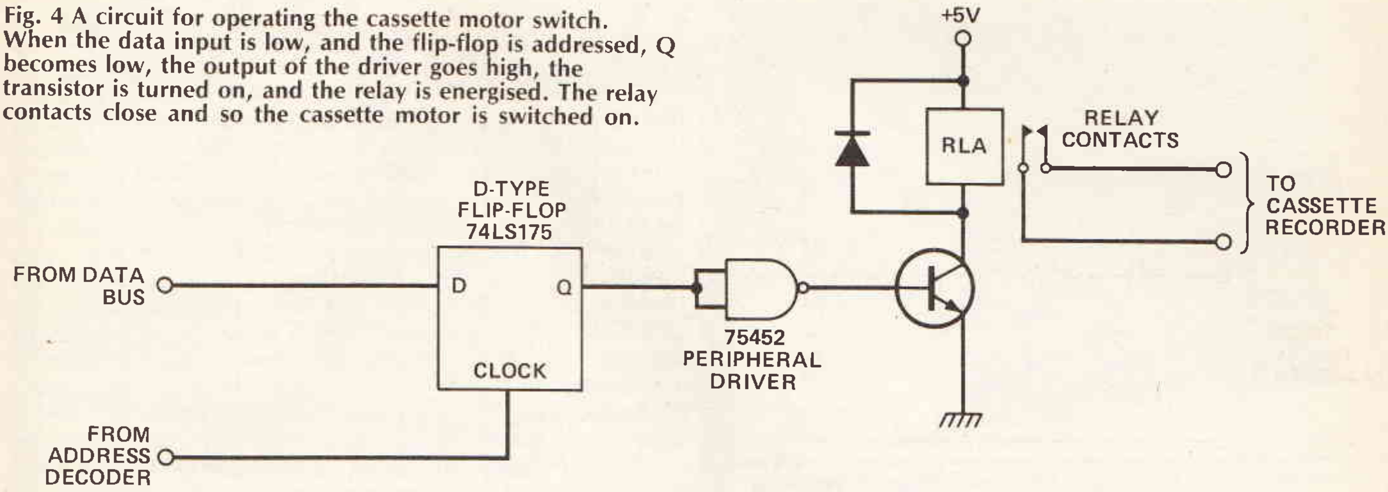
Spin A Disc

The recording medium, disc or diskette, consists of a disc of mylar film coated with magnetic oxide; it may be coated on one side only or on both sides. The magnetic head is very close to the disc when reading and writing data and the disc rotates at high speed, so it is essential to exclude particles of dust. Even the dust from cigarette smoke can cause malfunction (another good reason for giving up — Ed). The disc is therefore sealed in a plastic sleeve, lined with a textured material which lubricates the surface of the disc and removes debris. The case has a slot (Fig. 5) to allow the magnetic head access to the disc. It also has a small hole through which the **sector holes** are visible. These are holes punched in the disc and spaced regularly around it. There is a fixed number, depending on the system on which the disc is being used. Commonly there are 16 such holes, giving a 16-sector disc. The effect of these is that the tracks on the disc, which are concentric, are divided into 16 sectors. The disc drive has a light source located on one side of the disc to shine through the sector holes as the disc spins around. A phototransistor on the other side of the disc detects when a hole passes. This aids the drive in sensing the position of the disc.

Discs which have holes to mark the sectors are known as **hard-sectored** discs. An alternative system has a single hole for detecting each rotation of the disc but relies on software for dividing the track into sectors. Such a disc is known as a **soft-sectored** disc.

Another phototransistor in the drive is used to detect whether the disc is 'write-protected'. There is a notch in

Fig. 4 A circuit for operating the cassette motor switch. When the data input is low, and the flip-flop is addressed, Q becomes low, the output of the driver goes high, the transistor is turned on, and the relay is energised. The relay contacts close and so the cassette motor is switched on.



the edge of the case of the disc: light shines through this notch from below and falls on the phototransistor. The user may fix a sticky tag over this notch to prevent light from passing. In this event, the phototransistor is not activated and the writing action of the drive is inhibited. This serves to prevent the accidental or intentional overwriting or altering of data or programs. This is simply a safety measure: the tag is peeled off should further writing be required.

The Faster Format

In a typical disc drive the disc is rotated at a constant speed of several hundred revolutions per minute. For example, the Siemens FDD100-5 drive rotates at 300 RPM. At the middle track, this gives the magnetic material a speed of about 1400 mm/S relative to the head, compared with 50 mm/S in the cassette recorder. As a result of this and the physically small size of the read/write head, data can be recorded and read at 125 kilobits per second. Reading and writing of data is therefore extremely fast. There is a delay of one second while the disc comes up to full speed: the head takes an average of 300 mS to find the required track and a further 15 mS to settle into position. After that, data is transferred at the rate mentioned above. Should the head need to change from one track to another, as it will if much data has to be transferred, it takes only 25 mS to move from one track to another.

It is evident from the description above that access to data is very much quicker and more direct than is the case with tape. Instead of having to run from one end of a tape

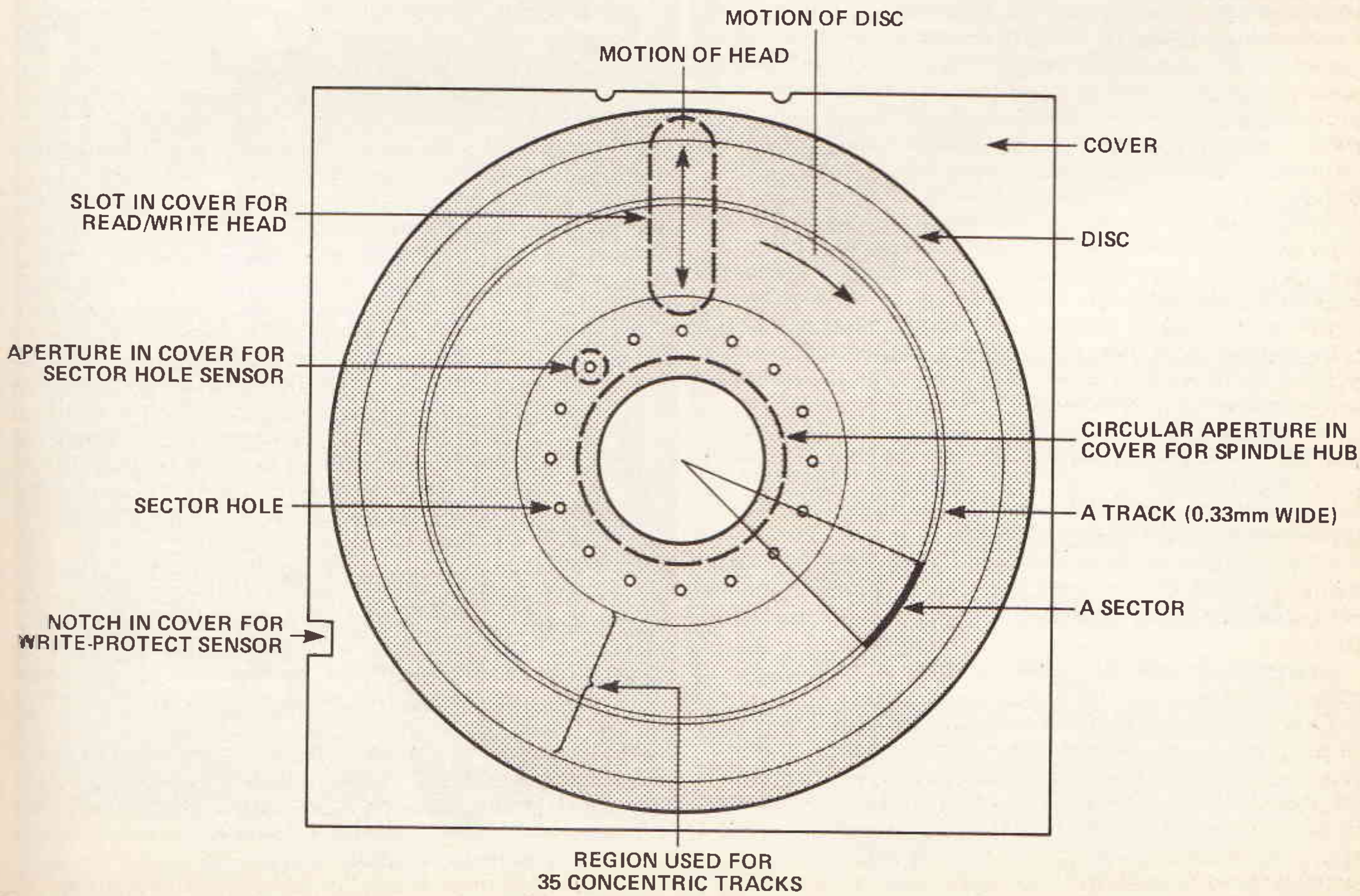
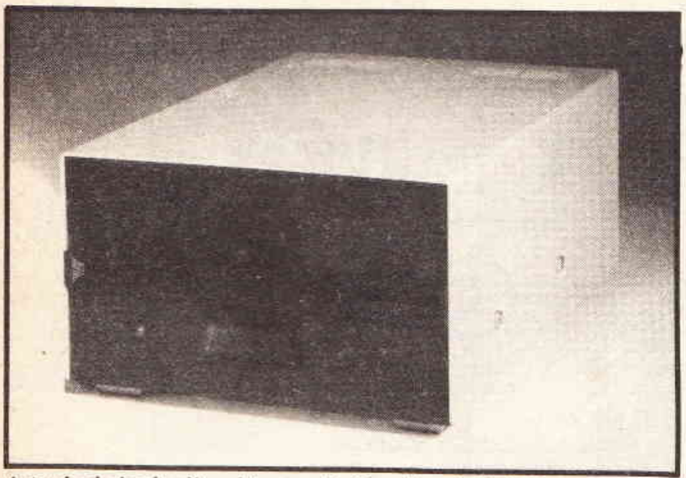


Fig. 5 'See-through' diagram of a hard sectored floppy diskette in its cover. Normally, of course, you cannot see the disc itself.



A typical single disc drive unit. The disc (still in its cover) is inserted in the slot which runs almost the full width of the case. The LED is lit to indicate when the drive is in operation.

to the other, the head can go directly to the track, then to the sector within the track, to find what is required. Changing from one track to another is effected by a stepper motor connected to a worm gear which moves the head radially. The signals from the sector hole sensor tell the drive when the required sector is in position to be read from or written to.

Naturally, the operation of the drive cannot be manual. The drive contains a complicated array of electronics (see photo) to control the disc, the stepper motor, the raising and lowering of the head, as well as those circuits responsible for handling the signals which are to be put on to the disc or have been taken from it. Synchronising these operations requires an impressive amount of logic circuitry: some of the more advanced disc drives even incorporate a microprocessor to take charge of the operation. This has several advantages, especially with a soft-sectored disc. The rate at which the medium passes the head depends on the radial distance from the centre: consequently data is more compressed on the inner tracks and widely spaced on the outer tracks. For reliability, it is the speed on the innermost track which limits the maximum rate of data transfer. Using a microprocessor, it is possible to perform rapid calculations which allow the drive to vary the rate of data transfer according to the radial position of the head. Data is stored at *about* the same density on all tracks but the outer tracks can have more sectors, so the overall storage capacity of the disc is markedly increased.

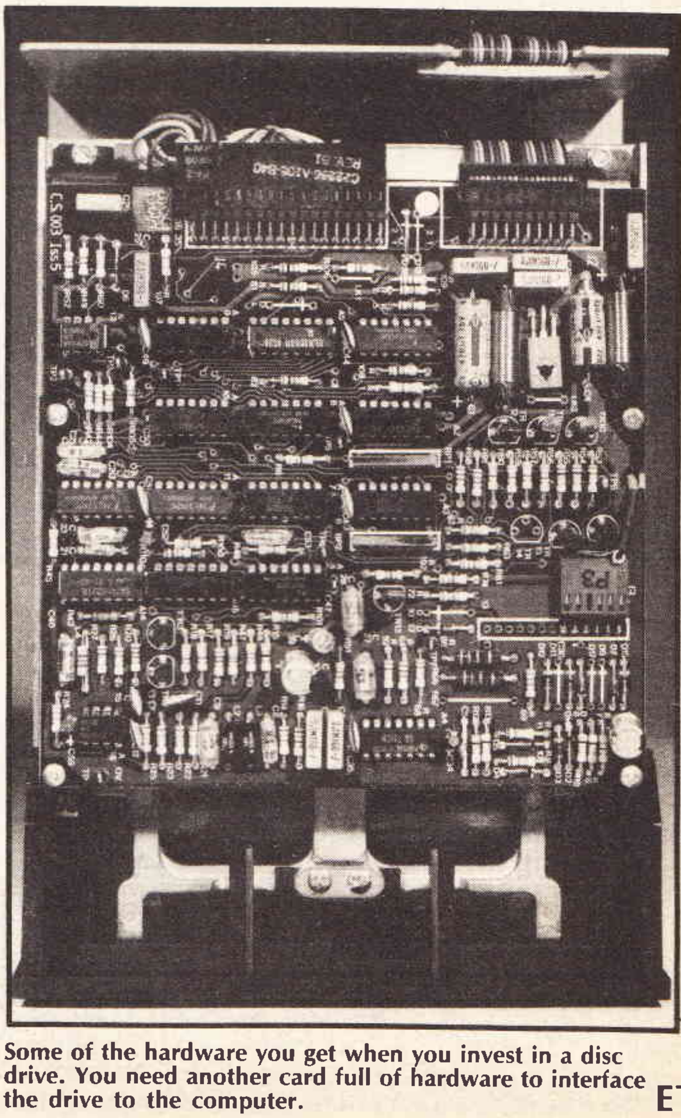
On the whole, the standard method of storage is adequate. A $5\frac{1}{4}$" mini-diskette may have 31 tracks each of 16 sectors, and each sector stores 256 bytes. This gives a total storage of 124 kilobytes on a single-sided disc. Double-sided discs store twice this amount, and the capacity can be further increased by using 'double density' discs in which there are almost twice as many tracks, placed closer together.

Keeping Track Of The Tracks

The disc referred to above which has 31 tracks available for storage of data or programs also has four additional tracks reserved for use by the disc operating system. In order to make efficient use of the disc space, in which items of data may be continually being written, replaced, and deleted, it is essential for a large amount of 'book-keeping' to be done. The system must know on which sector of which track each item has been placed. Items longer than 256 bytes occupy more than one sector, so the system must know how to direct the head from sector to sector to pick up all the data in the correct order.

The reserved tracks contain an index or directory of the contents of the disc so that the whereabouts of every item of data is known. The directory also helps the head to find vacant sectors when a new item of data is to be placed on the disc. The reserved tracks also hold a special program, the disc operating program, which is loaded into RAM when the micro is first powered up. This provides the instructions for accessing the directory tracks and obtaining whatever information is required, and for placing new information on the disc. This program (provided it is well written, which some are not) together with the hardware of the disc drive itself, completely automates the transfer of information between micro and magnetic storage medium. The operator is almost unaware of what is happening except for the comforting clunks and whirrs emanating from the drive. With a well-made drive and by observing a few simple precautions in gentle handling of the discs themselves, the reliability is far higher than with tapes, making this a relatively expensive but infinitely preferable method of data storage.

In concluding this series, we would like to thank Cumana Ltd., 35 Walnut Tree Close, Guildford, Surrey GU1 4UN, for helpful information and for permission to reproduce the photograph of their circuit-board for the Siemens drive, as adapted for use with the Apple II computer.



Some of the hardware you get when you invest in a disc drive. You need another card full of hardware to interface the drive to the computer.

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SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed ¼-½ watt Carbon Resistors	£1
SX12	200	⅛ watt Carbon Resistors	£1
SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm-2m2 Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm-2m2 Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects.
*Quantities approximate, count by weight

"CAPABLE CAPACITOR PAKS"

Pak No.	Qty*	Description	Price
SX16	250	Capacitors Mixed Types	£1
SX17	200	Ceramic Capacitors Miniature Mixed	£1
SX18	100	Mixed Ceramics 1pf-56pf	£1
SX19	100	Mixed Ceramics 68pf-0.5mf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-1000mf	£1
SX24	20	Tantalum Beads, mixed	£1

*Quantities approximate, count by weight

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LCD 10 MEGOHM INPUT IMPEDANCE
*3½ digit *16 ranges plus hFE test facility for PNP and NPN transistors *Auto zero, auto polarity *Single-handed, pushbutton operation *Over range indication *12.5mm (½-inch) large LCD readout *Diode check *Fuse circuit protection *Test leads, battery and instructions included.

Max indication	1999 or – 1999
Polarity indication	Negative only. Positive readings appear without + sign
Input impedance	10 Megohms
Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	– 5°C to 50°C
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155 x 88 x 31mm

RANGES
DC Voltage 0-200mV
0-2-20-200-1000V. Acc: 0.8%
AC Voltage 0-200-1000V
Acc. 1.2% DC Current 0-200uA
0-2-20-200mA 0-10 A. Acc: 1.2%
Resistance 0-2-20-200K ohms
0-2 Megohms. Acc: 1%
BI-PAK VERY LOWEST POSS PRICE **£35.00** each

25 pieces of Audio Plugs, Sockets and Connectors to include DIN 180°-240° Inline 3-6 Pin, Speakers, Phono, Jack, Stereo and Mono etc Valued at well over £3 normal Order No. SX25.
Our Price **1.50** per pak.
Guaranteed to save you money.

SX26	3 Prs of 6 pin 240° DIN Plugs and Chassis Sockets	50p
SX27A	60 Assorted Polystyrene Bead Capacitors Type 9500 Series PPD	£1.00
SX28A	50 Assorted Silver Mica Caps. 5.6pF-150pF	£1.00
SX29A	50 Assorted Silver Mica Caps. 180pF-4700pF	£1.00
SX30A	50 High Voltage Disc Ceramics 750v min up to 8KV Assorted useful values	£1.00
SX31A	50 Wirewound 9 watt (avg) Resistors Assorted values 1ohm-12K	£1.00

BARGAINS

SX91	20 x Large .2" RED LED	£1
SX42	20 small .125 Red LED's	£1
SX43	10 Rectangular Green LED's .2	£1
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New.	£1
SX47	4 Black Instrument Knobs—winged with pointer ¼" Standard screw. Fit size 29 x 20mm.	50p
SX49	20 Assorted Slider Knobs. Black/Chrome, etc.	£1
SX80	12 Neons and Filament Lamps. Low voltage and mains – various types and colours – some panel mounting	£1

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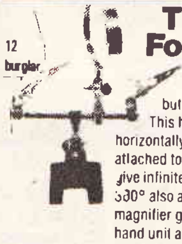
American Police type screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down and other security purposes. BP124 5 watt 12v max – Siren Alarm Module **£3.85**.

The Third and Fourth Hand...



.... you always need but have never got "until now". This helpful unit with Rod mounted horizontally on Heavy Base. Crocodile clips attached to rod ends. Six ball & socket joints give infinite variation and positions through 360° also available attached to Rod a 2½ diam magnifier giving 2.5 x magnification. Helping hand unit available with or without magnifier. Our Price with magnifier as illustrated ORDER NO. T402 **£5.50**
Without magnifier ORDER NO. T400 **£4.75**

SX52
6 Black Heatsink will fit TO-3 and TO-220. Ready drilled. Half price value. £1

SX53 1 Power finned Heatsink. This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled.
TO-3 Size 45mm squarex 20mm high. **40p**
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SX55 1 Heat Efficiency Power Finned Heatsink 90mm x 80mm x 35mm High. Drilled to take up to 4 x TO-3 devices
£1.50 each

SINGLE SIDED FIBREGLASS BOARD

Order No.	Pieces	Size	Sq.Ins.	Price
FB1	4	9 x 2¾"	100	£1.50
FB2	3	11 x 3"	100	£1.50
FB3	4	13 x 3"	156	£2.00

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Order No.	Pieces	Size	Sq.Ins.	Price
FB4	2	14 x 4"	110	£2.00

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NPN like 2N3055 – but not full spec
100 watts 50V min.
10 for £1.50 – Very Good Value
100s of uses – no duds
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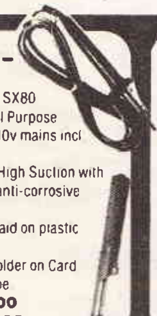

Kit comprises ORDER NO. SX80
1 High Quality 40 watt General Purpose Lightweight Soldering Iron 240v mains incl 3/16" (4.7mm) bit
1 Quality Desoldering pump. High Suction with automatic ejection. Knurled, anti-corrosive casing and teflon nozzle.
1.5 metres of De-soldering braid on plastic dispenser
2 yds (1.83m) Resin Cored Solder on Card
1 Heat Shunt tool tweezer Type
Total Retail Value over **£12.00**
OUR SPECIAL KIT PRICE **£8.95**

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Complete PCB Kit comprises
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1 Sheet PCB Transfers 210mm x 150mm
1 Etch Resist Pen
1 ½ lb pack FERRIC CHLORIDE crystals
3 sheets copper clad board
2 sheets Fibreglass copper clad board
Full instructions for making your own PCB boards
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ORDER NO. SX81

PROGRAMMABLE UNIJUNCTION TRANSISTOR
"PUT" case T0106 plastic MEU22 Similar to 2N6027 /6028 PNPN Silicon

Price: 1-9	10-49	50-99	100+	Normal Retail
Each: 20p	18p	15p	13p	Price £0.35 each

SX33A	6 small (min (SDST/SPDT Toggle Switches 240v 5amp	£1.00
SX35A	6 Rocker Switches 250V 2A	£1.00
SX32A	12 Assorted Jack & Phono plugs, sockets and adaptors, 2.5m, 3.5mm and standard sizes	£1.00
SX71	50 BC108 "Fallouts" Manufacturers out of spec on volts or gain You test.	£1.00
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5 watt (RMS) Audio Amp

High Quality audio amplifier Module. Ideal for use in record players, tape recorders, stereo amps and cassette players, etc. Full data and back-up diagrams with each module.
Specification
• Max Power Supply 30v • Power Output 5 watts RMS • Load Impedance 8-16 ohms • Frequency response 50Hz to 25KHz—3db • Sensitivity 70mv for full output • Input Impedance 50k ohms • Size 85 x 64 x 30mm • Total Harmonic distortion less than ·5%
BI-PAK'S give away price

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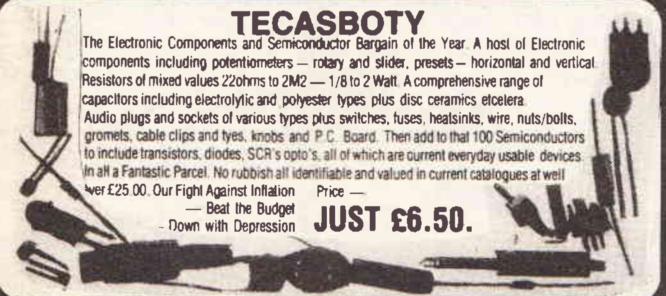
You could not Build one for this price.

TECASBOTY



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2N3055 The best known Power Transistors in the World – 2N3055 NPN 115w.
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BD312 COMPLIMENTARY PNP POWER TRANSISTORS: TO 2N3055.
Equivalent MJ2955 – BD312 – T03
SPECIAL PRICE £0.70 each
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MORE BARGAINS!

SX51	60 metres PVC covered Hook-up wire single and stranded. Mixed colours.	£1
SX58	25 Assorted TTL Gates 7400 Series. 7401-7460.	£1
SX59	10 Assorted flip Flops and MSI TTL	£1
SX60	20 Assorted Slider Potentiometers	£1
SX62	40 Assorted Pre-Sets Hor/Vert etc.	£1
SX79	10 Reed Switches – glass type 3 Micro Switches – with lever	£1

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PROGRAMMABLE STAGE LIGHTING

PART 2

In the second part of this project, we look at the construction for the first of the boards, as well as some alterations to last month's circuits for improved performance. Design by David Colven and Ian Cleverley.

Before moving on to the constructional details for this project, mention must be made of some alterations and improvements to the circuits we published last month. The first of these is on the memory board (Fig. 4 of last month): the output of IC21a (clock signal PC) must be inverted before passing into IC14, and this may be accomplished by using one of the spare gates in IC21 as an inverter.

The second change is more extensive, and consists of an improvement in the digital-to-analogue circuit in the auto-fade unit (Fig. 6 last month). Because of the extent of the modification, we have reproduced the circuit diagram (see Fig. 1) to show the new system. This has involved a bit of renumbering, but the overlays and Parts List match. Also we showed two R70's last month. Let's call the one near IC30 R62. Sorry!

DAC Mark II

As before, the brightness of the lamps is controlled by the three bits latched on the outputs from IC31 (on pins 16, 15 and 10), but in the new circuit these are fed directly into the inputs of IC37, a 4028B BCD-to-decimal decoder. This IC will send one of its outputs high depending on the binary number present on its inputs; in this case we are only using the three least significant bits and the D input (pin 11) is tied to ground.

Thus when light level data is latched into IC31, one of the outputs ('0' to '7') of IC37 will go high, producing a voltage at the inverting input of the voltage comparator IC29 via one of the blocking diode/preset pairs. With this system, the required voltage level for each binary input may be individually set to the correct value

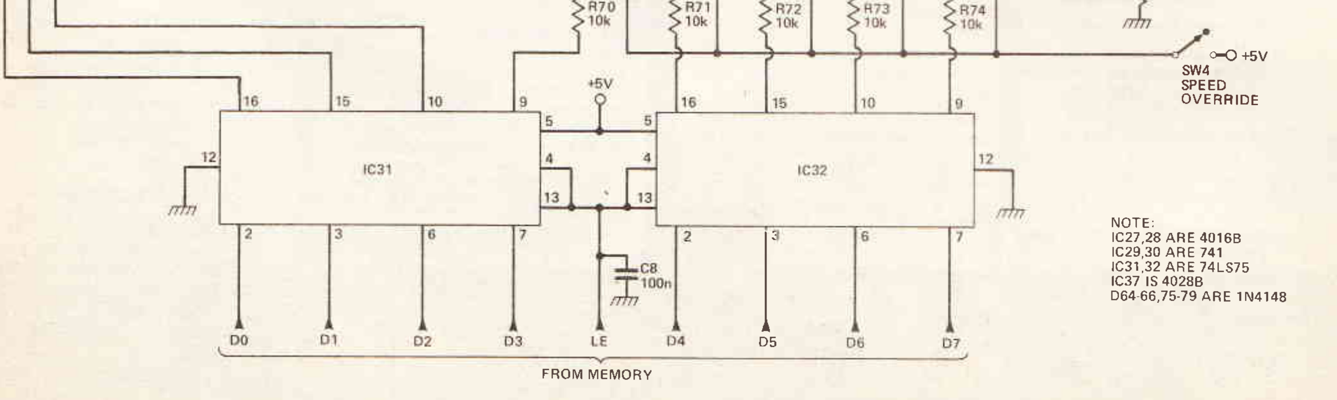


Fig. 1 This modified auto-fade unit offers an improved performance and easier setting up.

(as described last month, phase switching needs a non-linear response). Table 1 summarizes the conversion in order of increasing brightness and shows which preset to adjust for each value: although this requires an extra four presets, the resulting setting-up procedure is much simpler and gives better independent control over the eight levels. The full power setting (level 7) is also better.

TABLE 1

BRIGHTNESS LEVEL	CODE Q_2	Q_1	Q_0	CURRENT SOURCE	VOLTAGE MEASURED AT IC30 PIN 6
0	0	0	0	PR1	1.75
1	0	0	1	PR2	2.5
2	0	1	0	PR3	2.75
3	0	1	1	PR4	2.85
4	1	0	0	PR10	3.00
5	1	0	1	PR11	3.15
6	1	1	0	PR12	4.00
7	1	1	1	PR13	4.25

Construction

The prototype stage lighting unit was built for use in school productions and most of the units were salvaged from ex-government equipment, so the techniques used are not generally applicable. However, we can offer some guidelines and in any case, most constructors will want to alter things to suit their own particular situation.

If a sufficiently large case can be found (or made — it doesn't require much skill at carpentry to produce good results), then the ideal approach is to put the main memory board, manual controls, scene change switches, programming keypad, auto-fade boards and the first two power supplies into one enclosure. To make operation of the unit more convenient, you should try to get one of the sloping-front desk versions. If you are going to use the keypad as a separate hand-held unit, there are plenty of small cases available that will suit the task admirably.

If you can't get a case big enough, or find it more convenient to split things up, then the main memory and manual controls, etc, can be in the desk-top case with the auto-fade units rack-mounted separately. In this case (pun unintended), the auto-fade cards could be connected by edge connectors to a backplane which in turn is connected to the control console by some (very) multi-way cable or ribbon cable.

The power triac and suppressor circuits can also be wall-mounted in a rack system, although edge connectors would not be able to take the high currents involved in this section of the circuit. The live and neutral connections must have a high current bus for the common connections to the light power circuits: for example, the neutral busbar (RS 335-609) is ideal, if you can get hold of it through a local stockists.

Sockets for the lighting circuits can be mounted on the main power case, with a 10 A fuse for each channel as shown in the circuit diagram last month. The main power control unit will, of course, have to have a 120 A isolation switch and suitable fuse. The delta capacitor network and choke combination is there to eliminate most of the mains-borne interference, and the coil consists of 14 turns of 15 A cable on a $\frac{3}{8}$'' ferrite rod: bear in mind, however, that you'll never get rid of all the interference, so be careful where you put your mikes, amps and pickup cables.

Each triac is heatsinked at about 1.5-2° C/W. The prototype used a 150 mm square of 16 gauge aluminium shjeet which seemed more than adequate, but do make sure that the power unit has sufficient ventilation top and bottom and mount the fins vertically. WARNING: the lamps and all the triac wiring is live and it is recommended that the whole unit is isolated if any work is to be done on gantries etc. We also recommend that if you hire extension cables or lamps for your production (or even if you don't!), check them thoroughly, preferably with the correct type of instrument (not a megger or you'll be buying lost of new triacs). The authors had one cable once where someone had connected all three wires, live, neutral and earth, to the earth terminal in the socket! That eliminated four triacs in a rather bright flash.

NOTE

Dr. David Colven B.Sc. Ph.D. is head of Physics and Electronics at St. Birinus' School, Didcot. Ian Cleverley is a fifth form pupil at the school. The design presented here is based on their entry to the Hobby Electronics Wales and West Schools' Electronic Project Competition last year.

PARTS LIST

KEYPAD AND SCENE SELECTOR

Resistors (all $\frac{1}{4}$W, 5%)
R51-60 470R

Semiconductors
D1-63 1N4148

Miscellaneous
PB1-9 push-to-make switches
SW2, 3 1 pole 10 way rotary switches
PCB (see Buylines); case to suit (see text).

Next month we shall be publishing the remaining overlays and parts lists, together with the setting up instructions.

BUYLINES

Most of the components used in this project are completely standard and should be available from any mail order supplier of electronic components. The push-buttons were keyboard switches from Maplin but other types could be wired to the board. The PCBs will be available from our PCB Service from next month.

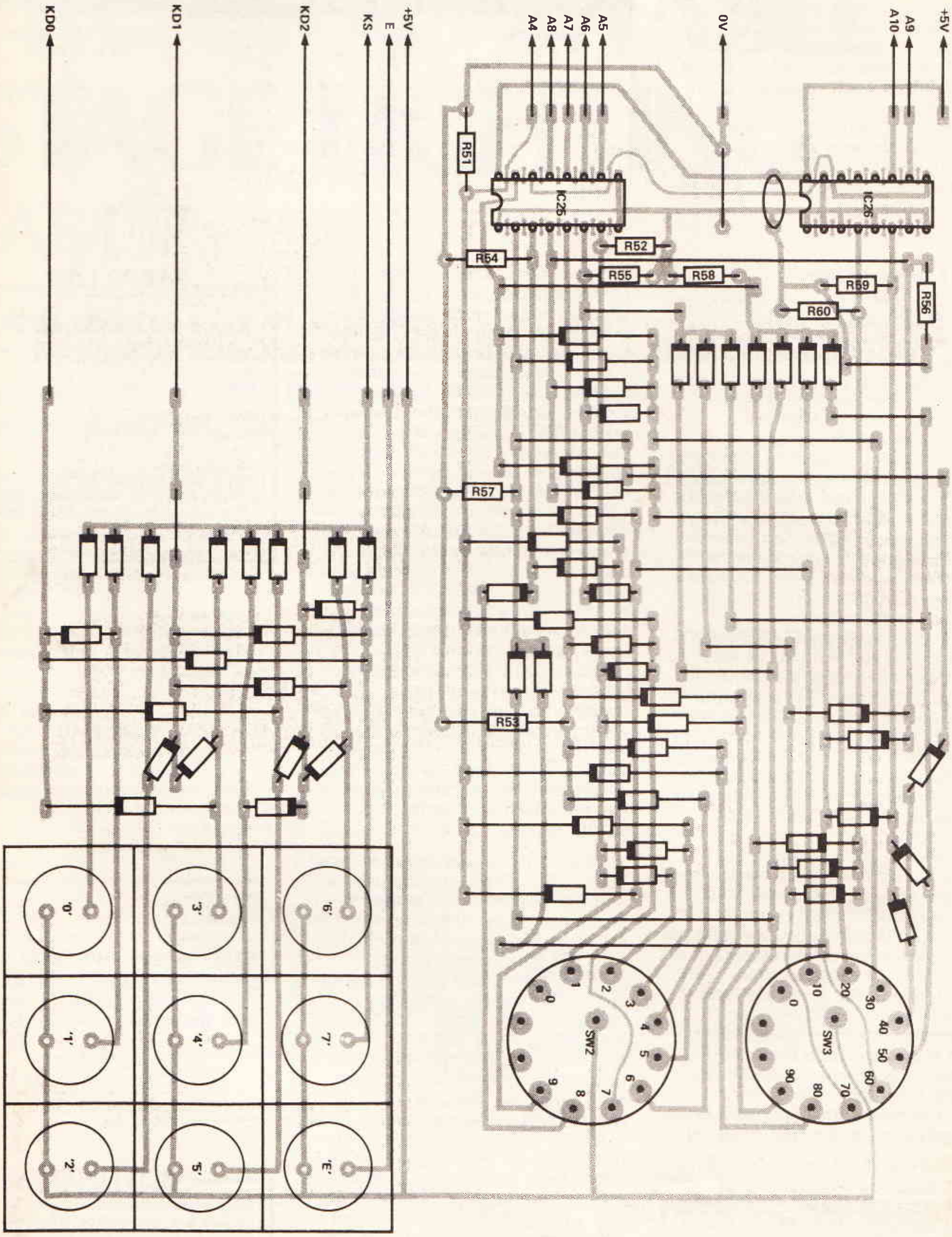
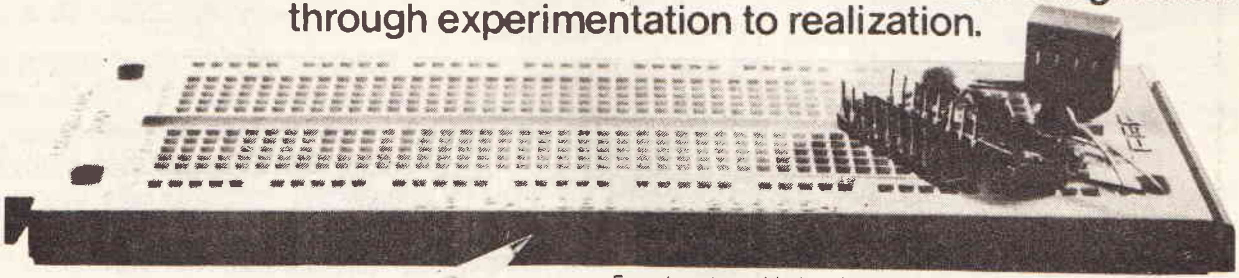
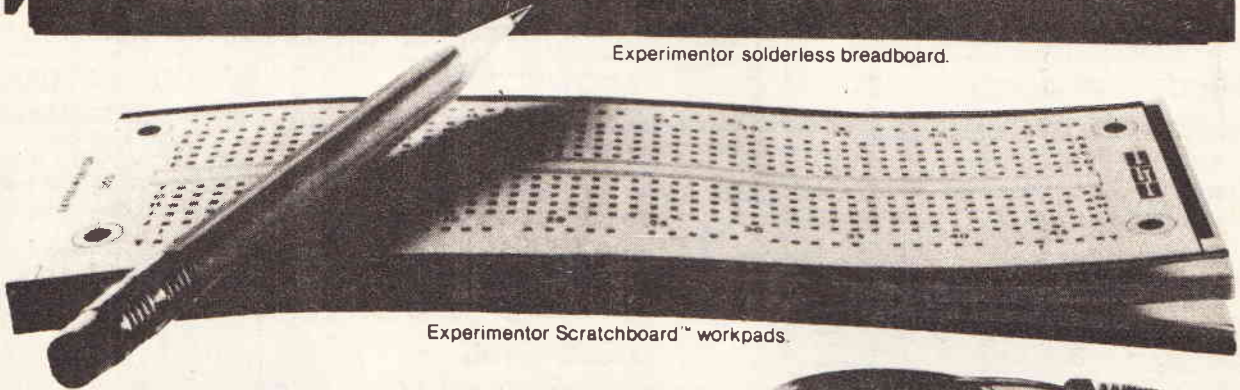


Fig. 2 The overlay for the keypad controller and the scene selector switches. This has been designed as one board, but if your layout requires it, the PCB may be cut up the middle. Two 5 V connections are provided for this possibility. All the diodes are 1N4148s and the unmarked capacitor near IC26 is a 100n polycarbonate or ceramic smoothing capacitor that you may find it necessary to fit.



Experimentor solderless breadboard.



Experimentor Scratchboard™ workpads.

Experimentor Matchboard™ pre-drilled PCBs.

OSCILLOSCOPE UPDATE

From the large number of letters we've received on the topic, we gather that there was a lot of interest in the oscilloscope project we published in May, June and July last year; we gather that there were also a few problems over some of the components which we hope this follow-up will sort out.

Resistors

There were some unusual values, weren't there? All the following substitutions are well within the 1% tolerance specified.

Component	Specified	Substitute
R3	90k9	91k
R4,R19	909k	910k
R7,8,49	2k05	2k0 + 47R*
R18	332k	330k
R21	500k	1M0//1M0
R45	40k2	39k + 1k2*
R46	20k5	20k + 470R*
R48	4k02	3k9 + 120R*

All resistors except those marked with a * should be 1% metal film. Those marked with a * can be 5% tolerance because they are low value resistors in series with much higher value ones. The higher value one of the pair must, of course, be a 1% tolerance type.

Trimmer Capacitors

Any trimmer that covers the *range* of values specified may be used; for instance, CV1a is specified as 5–20p so a 3–30 type would do (it must have a sufficiently high voltage rating). Depending on the size of signal you intend to apply to the 'scope, some of the voltage ratings of the trimmers may be reduced, but this probably is not a good idea unless you know exactly what you want to use the 'scope for (in any case, it probably wouldn't save much money).

Semiconductors

IC1 (uA733) is available from Verospeed, Stanstead Road, Boyatt Wood, Eastleigh, Hants SO5 4ZY, for 89p (including VAT and p&p). Alternatively, the LM 733 is equivalent and is fairly widely available. Q1 was specified as E430, but U430 is equivalent, and is available from Cricklewood Electronics for £5.60 (plus VAT and postage — see their ad. for ordering details).

D9–12 were specified as BA158 (ITT) but we have successfully used BY207s, and these, as well as BAV20s (D13–16) are also available from Cricklewood.

Switches

Both wafer switches can be made up using wafer switch kits, available from Maplin, or through anyone who deals with RS Components Ltd (such as your local friendly TV repair shop). SW1 — use five 1p 12w plus two 4p 3w wafers (see Fig. 1 for wiring details). SW3 — use two 1p 12w wafers.

Pot Core

The original pot core is not now available here; however, Neosid of PO Box 86, Welwyn Garden City, Herts AL7 1AS make a similar type. Order it as ET30 kit. Total price is £1.50 including VAT and p&p. Other pot cores are not likely to work, because a particularly large inductance factor is needed. In any case, depending on the current gain of the actual BD135s used for Q18 and Q19, some trimming of the values of R73 and C28 may be necessary.

Note that the phasing between the transformer primary, T1a and the feedback secondary, T1b is important. If it is wrong, the circuit around the pot core won't oscillate, and Q18 and Q19 will just sit there getting hotter and hotter until they burn out.

Wire sizes are often quoted in SWG sizes value than mm. The nearest equivalents are: 1mm: 42 swg; 3mm: 30 swg; 4mm: 27 swg.

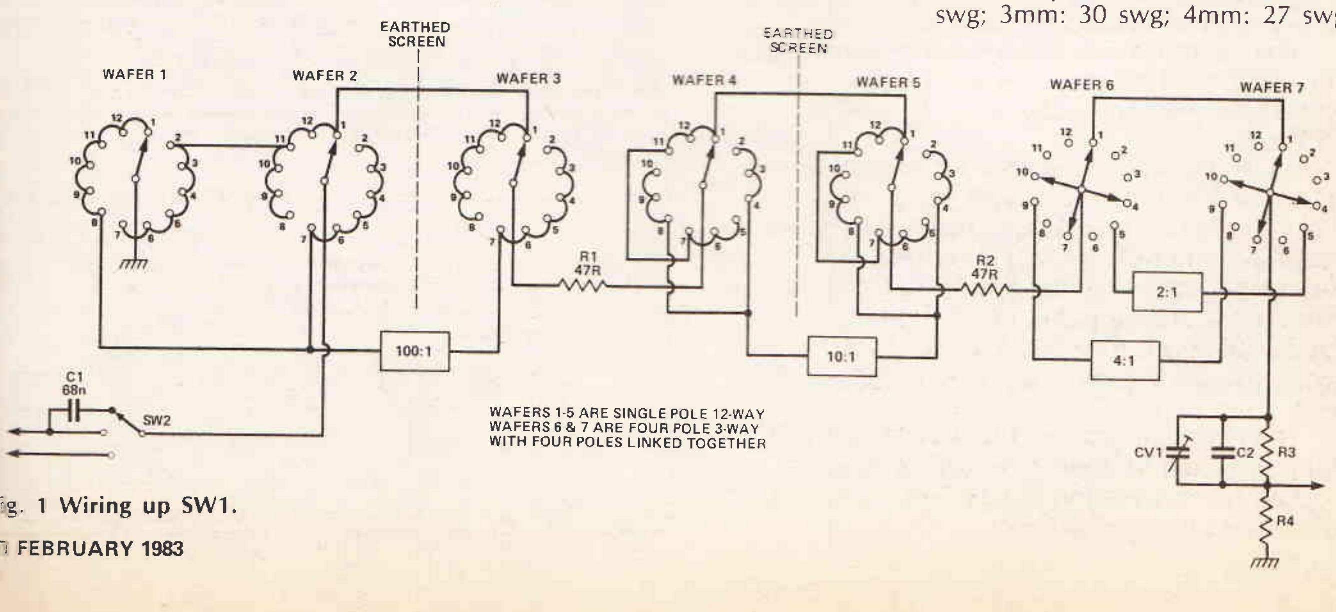


Fig. 1 Wiring up SW1.

MEMOPAK 16K For those just setting out on the road to real computing, this pack transforms the ZX81 from a toy to a powerful computer. Data storage, extended programming and complex displays become feasible.
For even greater capacity, memory packs can be added together (16 + 16 + 16K or 16 + 32K). The MEMOPAK 32K and the MEMOPAK 64K offer large memories at economical prices.

MEMOTECH

The Memotech approach to microcomputing is to take the well-proven and popular ZX81 as the heart of a modular system. This small computer houses the powerful Z80A processing unit and acts as the central processor module through which the MEMOPAKS operate.

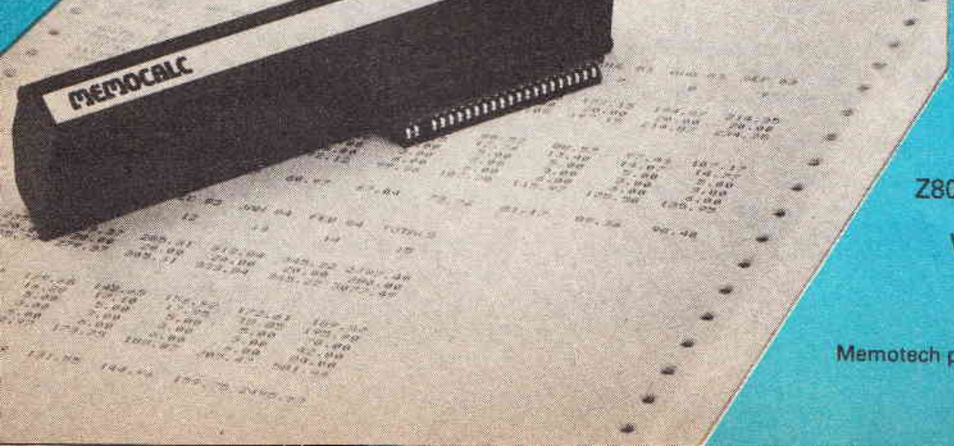
Memotech has a reputation for professional quality, producing units which are designed to fit perfectly, to look well-balanced, and to work efficiently and reliably.

The modular approach gives ZX81 owners the freedom to design the system they really need. Furthermore, the intercompatibility of the modules ensures that later additions will click straight in, to give you a system that grows with your ambitions and abilities.

As one example, a system with 16K of memory and MEMOCALC is all that is required to perform sophisticated numerical calculations giving the same results as a computer at 10 times the price. The problem may be as complicated as a cash flow or production schedule, or as simple as household accounts or pocket money budgeting. If the bank manager wants to see the cash flow, then a single print instruction to the Centronics I/F will give a printout which is more than acceptable to any bank.

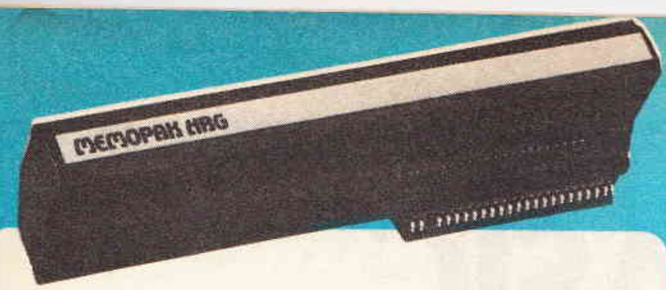
The example system which is shown, on the other hand, would satisfy the needs of someone who wanted to enter data via a light-touch keyboard, construct and label graphs, and then copy the screen to an 80-column printer. Only 16K of memory is used here but with additional memory, more than one video page can be stored. Up to 7 successive pages can be displayed cyclicly to give animated displays.

MEMOCALC The screen display behaves as a 'window' on a large sheet of paper on which a table of numbers is laid out. The maximum size of the table is determined by the memory capacity, and with a MEMOPAK 64K a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Each location in the table can be either a number which is keyed in or a formula which generates a number. Every time the command to 'calculate' is given, all the formulae in the table are re-evaluated. Spreadsheet analysis started as an aid to cash-flow analysis, but this powerful tool has now been generalised and MEMOCALC with its special ability to perform iterative calculations is invaluable in the performance of numerical tasks.



16K	£26.00 +	£3.90	VAT	£29.90
32K	£43.43 +	£6.52	VAT	£49.95
64K	£68.70 +	£10.30	VAT	£79.00
HRG	£34.70 +	£5.20	VAT	£39.90
CI/F	£34.70 +	£5.20	VAT	£39.90
MEMOCALC	£26.00 +	£3.90	VAT	£29.90
Z80 ASSEMBLER	£26.00 +	£3.90	VAT	£29.90
KEYBOARD WITH BUFFER	£43.43 +	£6.52	VAT	£49.95

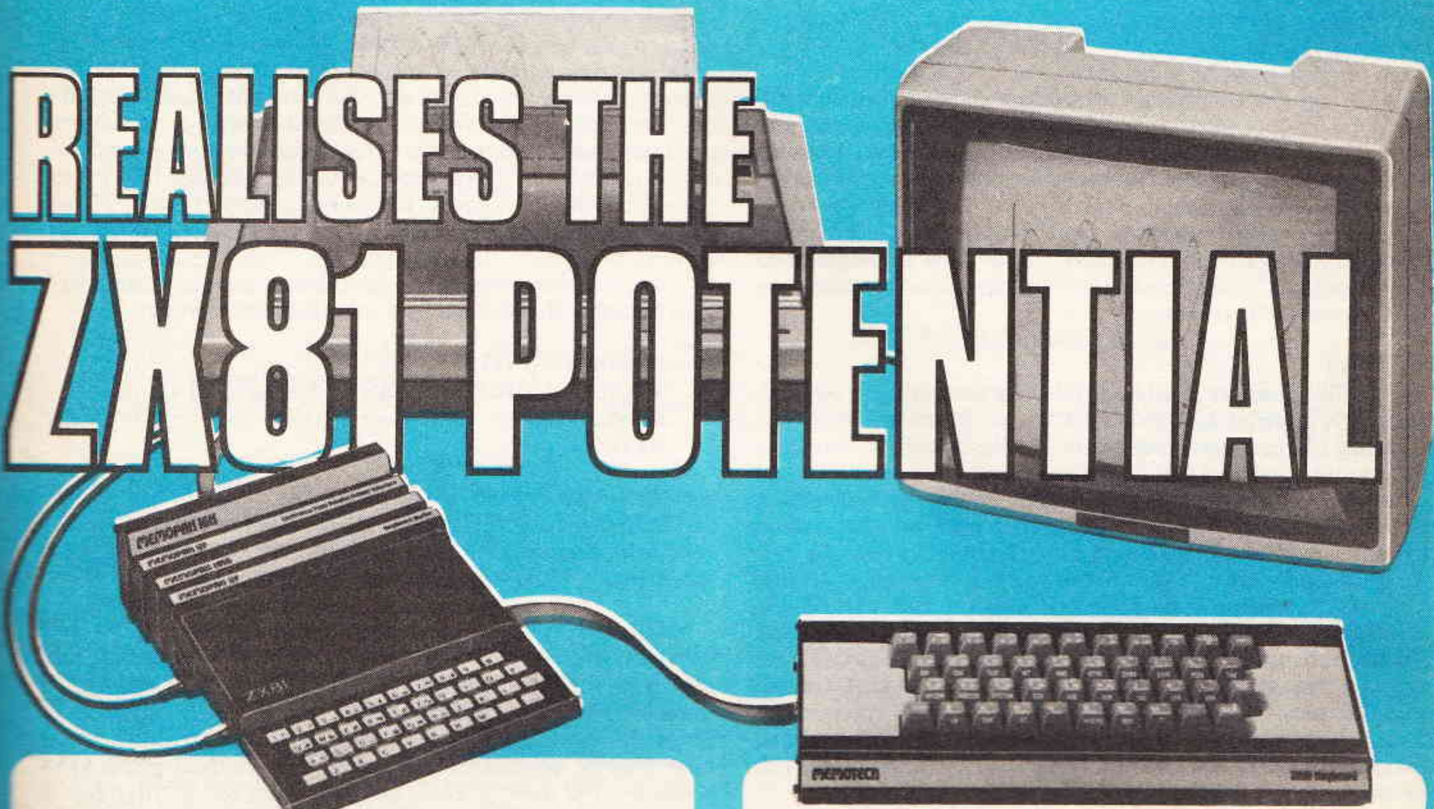
Memotech products are available at larger branches of WHSMITH



MEMOPAK HRG This pack breaks down the constraints imposed by operating at the ZX81 character level and allows high definition displays to be generated. All 248 × 192 individual pixels can be controlled using simple commands, and the built in software enables the user to work interactively at the dot, line, character, block and page levels. Scrolling, flashing and animation are all here.

MEMOPAK Centronics I/F The BASIC commands LPRINT, LLIST and COPY are used to print on any CENTRONICS type printer. All ASCII characters are generated and translation takes place automatically within the pack. Reverse capitals give lower case. Additional facilities allow high resolution printing. The full capabilities of your printer are now under the control of the ZX81.

REALISES THE ZX81 POTENTIAL



MEMOPAK Z80 Assembler This click-in EPROM based pack accepts standard Z80 assembly language mnemonics to allow you to write faster and more compact programs. It has its own ADD, EDIT, LIST, ASSM and QUIT functions, the editor allowing insertion, deletion, automatic line renumbering and error checking. Source code and object code listings can be displayed and printed in decimal or hex format.

MEMOTECH Keyboard The light-touch positive stop keys of this elegant typewriter-pitch keyboard allow you to work faster, more accurately and more confidently. To speed you along we have added an extra SHIFT key to the array at top right. The keyboard is attached by a cable to the Keyboard Buffer which fits in amongst your other Memopaks or straight onto the back of your ZX81.

To ensure that your expectations are realised, care is taken at every stage to design features into the system to anticipate your frustrations and to forestall them. For example:
1) Memories are cumulative e.g. 16K and 32K can be added to the MEMOPAK 16K or even to the Sinclair 16K RAM pack.
2) The HRG firmware allows commonly used constructions (such as scrolling, shading and labelling graphs), which might otherwise be beyond the user's programming capabilities, to be evoked by a few simple commands.
3) The Centronics I/F converts ZX81 character codes into ASCII and expands the print line to the width of the printer, still using the LLIST, LPRINT and COPY commands.

Looking forward, Memotech will continue to back the ZX81 through [illegible] with fast storage devices, pressure sensitive electronic drawing boards and more software packs including a wordprocessor and an RS232 interface.

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CORTEX BASIC

The BASIC used on the Cortex contains many statements which will be unfamiliar to readers who are used to Microsoft. Beginning this month, we'll be taking a brief look at the keywords and their functions. This month: graphics.

BASIC on the Cortex is a derivative of Texas Instruments' Power BASIC, with some additional keywords necessary to make use of some of the features of the Cortex. Some of these involve the graphics commands which we are making the basis of this article.

The video display processor in the Cortex is, in fact, capable of four display modes, but only two of these are implemented by the BASIC. The two types of display are accessed by the TEXT and GRAPH commands.

TEXT

The TEXT mode provides 24 40-character rows in two colours and is intended to maximise the capacity of the TV screen to display alphanumeric characters. A diagram of the screen in this mode is shown in Fig. 1. The character cell number is equal to the horizontal position (0 to 39) plus 40 times the vertical position (0 to 23). The only items that may be displayed in this mode are the alphanumerical character set, which are defined on a six by eight grid of pixels (six pixels across, eight pixels down). There are a possible 256 patterns that can be displayed and on power-up these are defined by the BASIC in the EPROM. Examining the characters shows that the first 32 are symbolic representations of the corresponding ASCII control codes, the next 64 are standard upper case ASCII, the next 32 are 'small capitals' rather than lower case ASCII (these small capitals are used in the error messages), and the remaining 128 characters are not assigned any meaningful pattern.

However, any or all of these character patterns may be changed by using the CHAR command. This has the format

CHAR arg1, arg2, arg3, arg4

where arg1 is the number of the character to be changed (0 to 255), and arg2, arg3 and arg4 define the new bit pattern for the character. These arguments are 16-bit numbers and define the character row by row from top to bottom, with a 1 producing the foreground colour and a 0 producing the background colour. For example, if you type CHAR32,20,20,20: TEXT then your screenful of 'spaces' suddenly develops freckles! (Incidentally, executing TEXT clears the screen and homes the cursor).

Another fun thing to do (although completely pointless!) is to scramble the character set using random numbers. Try

```
10 FOR I = 0 TO 255
20 CHAR I, RND*255,RND*255,RND*255
30 NEXT I
40 TEXT
```

and then type in LIST after running the program. Not so easy to read, eh? To get back the original patterns, just execute a reset with the switch on the rear and the Cortex will re-load the character table from the EPROM.

GRAPH

In GRAPH mode the screen dimensions change to that shown in Fig. 2, a grid of cells 32 by 24. The character cell number is given by the horizontal position (0 to 31) plus 32 times the vertical position (0 to 23). In addition, the screen may also be considered to consist of individual pixels (256 across by 192 down). Thus, each character cell in this mode is eight by eight pixels in size, offering a better pattern resolution than the six by eight pixels of TEXT mode.

As in TEXT mode, executing the GRAPH statement will clear the screen and home the cursor, which in graph mode is an invisible pixel cursor. An alternative method of clearing the screen is to use the program statement

PRINT "<0C>"

which has the advantage of wiping off any text messages or plotted lines but leaving sprites unaffected. The reason why this statement works will be covered in a future article: suffice it to say that the statement executes the ASCII control code for Clear Screen.

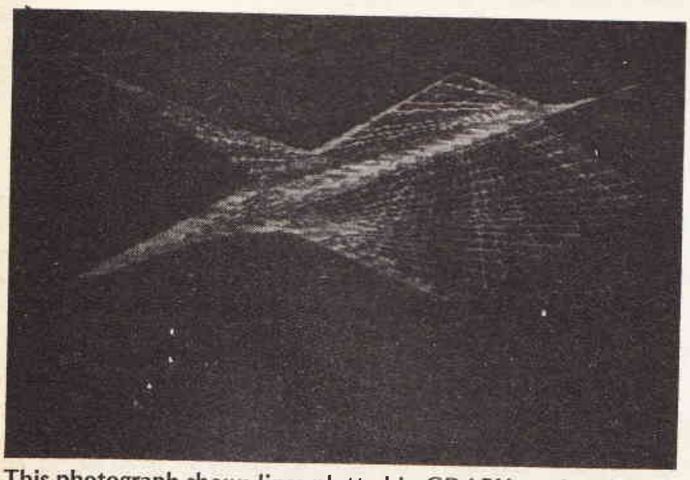
Pixels are numbered from 0 to 255 horizontally and from 0 to 191 vertically. The origin is at the top left-hand corner of the screen as shown in Fig. 2.

PLOT AND UNPLOT

The PLOT statement is used to turn on individual pixels on the text/graphic plane. The basic format is

PLOT arg1,arg2 TO arg3,arg4

By leaving out various parts of the statement, different actions can be performed. If the entire statement is executed, then a line is drawn in the current foreground colour from the pixel co-ordinates given by arg1 and arg2 (arg1 = horizontal, arg2 = vertical) to the pixel co-ordinates given by arg3, arg4. The in-



This photograph shows lines plotted in GRAPH mode. The pixel resolution is 256 by 192 but the limitation on colour means some areas (noticeably to the left of the shape) get 'blocked in' colour.

0	1	2	3	4	5	…	37	38	39
40	41	42	43	44	45	…	77	78	79
80	81	82	83	84	85	…	117	118	119
…	…	…	…	…	…	…	…	…	…
880	881	882	883	884	885	…	917	918	919
920	921	922	923	924	925	…	957	958	959

Fig. 1 Screen position map for the Cortex in TEXT mode. Here the screen is divided into a 40 by 24 grid which can only display the character set — sprites are not possible in this mode.

0,0 — 255,0

0	1	2	3	4	5	…	29	30	31
32	33	34	35	36	37	…	61	62	63
64	65	66	67	68	69	…	93	94	95
…	…	…	…	…	…	…	…	…	…
704	705	706	707	708	709	…	733	734	735
736	737	738	739	740	741	…	765	766	767

0,191 — 255,191

Fig. 2 The screen position map for the Cortex in GRAPH mode. The grid is now 32 by 24 squares and each square may contain members of the character set or the shape table. In addition, up to 32 sprites may be displayed using the shape table patterns, and individual pixels may be set or reset.

visible pixel cursor is left at arg3, arg4 (horizontal, vertical).

If arg1, arg2 are omitted, ie PLOT TO arg3,arg4, then a line is drawn from the current graphic cursor position to the co-ordinates given by arg3, arg4. If the TO arg3,arg4 part of the statement is omitted, ie PLOT arg1,arg2, then the single pixel specified by the co-ordinates arg1, arg2 is set to the current foreground colour. The UNPLOT statement has the same format and variants as the PLOT statement except that the line or pixel is removed instead of being plotted.

COLOUR, COL

Colours may be set up in TEXT or GRAPH mode by means of the COLOUR statement. The format for this is

COLOUR foreground colour, background colour

The two colour arguments can take the values 0 to 15, the corresponding colours being given in Table 1, Cortex Part 1, November 82 issue. If the foreground colour only is given, eg COLOUR 6, then the current background colour is used.

Two colours only are allowed in TEXT mode. Executing a COLOUR statement in a program or in immediate mode will recolour the entire display. By contrast, all 16 colours may be displayed at once in GRAPH mode, with the limitation that each horizontal line of eight pixels (ie one character cell width) can only have one foreground colour and one background colour. Try this program to see what this means:

```
10 COLOUR 4,7: GRAPH
20 COLOUR 1,13: PLOT 0,0 TO 255,191
```

The pixels in the text/graphic plane can be tested for their colour by reading the code into a variable using the COL function. The format is

```
var = COL arg1,arg2
```

where arg1, arg2 are the horizontal and vertical co-ordinates of the pixel to be tested. The variable var will now have a value equal to the colour code of the pixel.

SHAPE, SPRITE, MAG

The SHAPE statement is used to define one of 256 possible eight by eight pixel shape definitions. The format is

SHAPE arg1,arg2,arg3,arg4,arg5

where arg1 is the shape table entry to use (0 to 255), arg2 is the 16-bit integer pattern of the first and second row of the shape, arg3 gives the third and fourth rows, arg4 gives the fifth and sixth rows and arg5 gives the seventh and eighth rows. For arg2 to arg5 the most significant byte defines the first row and the least significant, the second row. For example, to define a solid block use SHAPE 2, −1, −1, −1, −1.

Once shapes have been defined they can be displayed on screen using the SPRITE command. Each sprite plane can hold one sprite, giving a maximum of 32 on screen at once, and if a sprite on a plane is rewritten into a new position the old one is automatically erased. The format for the statement is

SPRITE arg1,arg2,arg3,arg4,arg5

where arg1 is the sprite plane to hold the sprite (0 to 31), arg2 is the horizontal co-ordinate of the sprite's top left pixel, arg3 is the vertical co-ordinate of the sprite's top left pixel, arg4 is the shape number to use for the pattern (0 to 255) and arg5 is the sprite colour (0 to 15).

There are two limitations to the use of sprites. One is that only four sprites at a time may be displayed on a given horizontal line: an attempt to add a fifth will make the overlapping portion invisible. Try this program:

```
10 COLOUR 1,15: GRAPH: MAG 1,0
20 SHAPE 10, −1, −1, −1, −1
30 FOR T=1 TO 14
40 FOR I=1 TO 100
50 SPRITE T, I−T*2, I−T*2, 10,T
60 WAIT 1
70 NEXT I: NEXT T
```

The second limitation is that you can only use a sprite plane if all the ones above it have been used. Hence you must place your first sprite on plane 0, your second on plane 1 and so on. Of course, once a plane has been initialised in this way you can wipe it if necessary by setting its sprite to an all-zeros shape or setting its colour to transparent.

The MAG statement defines both the size and the definition of the sprites. The format is

MAG sprite magnification, sprite definition size

If the sprite magnification is 0 every bit in the shape definition used for the sprite will be displayed as one pixel. If the magnification is non-zero then each bit will be displayed as two pixels horizontally and vertically. If the definition size is zero then one shape table entry will be used to build the sprite. If it is non-zero then four entries will be used. These entries are joined in the following way to build a 16 by 16 point sprite: top left, shape n; bottom left, shape n+1; top right, shape n+2; bottom right, shape n+3, where n is the shape number given to the sprite statement. The shape table entries must start on a four entry boundary, so valid values of n are 0,4,8,12 etc.

Note that the SHAPE, SPRITE and MAG statements will only work if the Cortex is in GRAPH mode.

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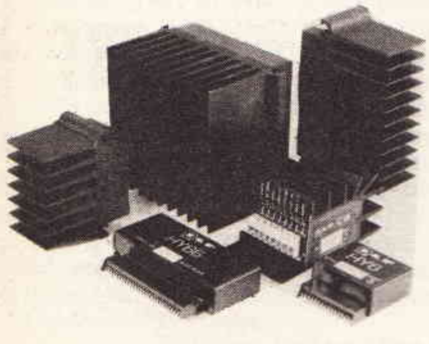

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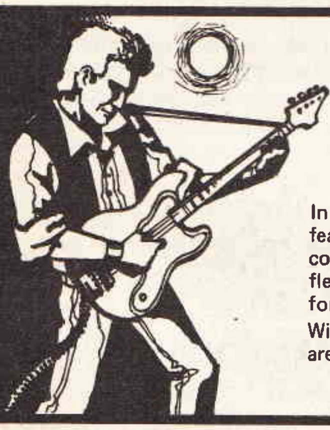

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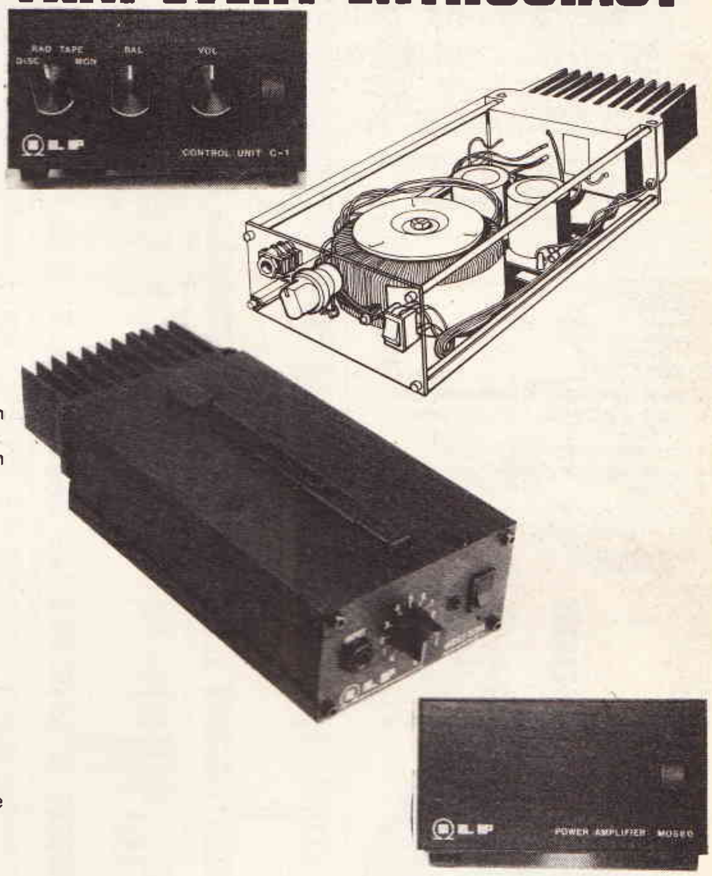

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READER SURVEY

Here's your chance to tell us what you think of the magazine, and this year it's reply paid, so you have no excuse not to respond. As you may have noticed, ETI has a new editor, so changes are afoot. To help us decide what changes would make the magazine better, we need your opinions. And to make it as little trouble as possible we've made all the answers multiple-choice. However, we can't think of everything, so we've left a long section at the end for you to write in your opinions if we have not covered a particular point you would like to make in the questions we've asked or in the choices of answer we've provided.

Incidentally, you'll see that there are lots of little numbers in brackets next to the little boxes we're asking you to tick — please ignore these, they're to help us in our computer-assisted analysis (using the Cortex, of course) of your replies.

Because this survey is reply-paid, a little more origami is required than for previous years: first, pull out the survey form from the magazine and fold along the page fold. Then fold along the line at the centre of this page. Finally, fold and tuck in the two flaps, so that the address and licence number are clearly showing.

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1. What are your main areas of interest within electronics? Please indicate with a tick in the **first** column

- Audio/Hi-Fi ☐ ☐ ☐ (1)
- Computers — design of ☐ ☐ ☐ (2)
- Computers — interfacing and use of ☐ ☐ ☐ (3)
- Digital (other than computers) ☐ ☐ ☐ (4)
- Electronic Music ☐ ☐ ☐ (5)
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- Robotics ☐ ☐ ☐ (7)
- Test Equipment ☐ ☐ ☐ (8)
- Radio Control ☐ ☐ ☐ (9)
- Domestic Electronics (eg, ELCB ☐ ☐ ☐ (10)

2. Please tick in the **second** column next to those subjects you would like to see more of in ETI (please don't tick them all.)

3. Please tick in the **third** column next to those subjects you would like to see **less** of in ETI.
Please list at the end any subject areas not presently covered in ETI that you think we should cover.

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5. Configurations
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- all or most ☐ (1)
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- few or none ☐ (3)

6. Would you like to see similar series in ETI?

- YES ☐ (1)
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If there any other topics you would like to see **series** on please list at the end.

PROJECTS

7. Do you built projects from ETI?

- **Yes,** two or more a year ☐ (1)
- **Yes,** about one a year ☐ (2)
- **Yes,** but less than one a year ☐ (3)
- **No,** not as yet ☐ (4)

8. When you build projects from ETI or other magazines, do you usually:

- Build them more or less as published ☐ (1)
- Make a few adaptations to suit yourself ☐ (2)
- Make a large number of adaptations ☐ (3)

9. Do you:

- Usually buy a complete kit ☐ (1)
- Usually buy the special PCB but obtain other components yourself ☐ (2)
- Make your own PCB ☐ (3)
- Not use a PCB at all ☐ (4)

10. Do you usually use the recommended case?

- YES (1)
- NO (2)

11. Do you find the information in 'Buylines':

- Useful ☐ (1)
- Inadequate ☐ (2)
- Not useful ☐ (3)

(List reasons at end)

BUYING

12. Have you bought electronic components from adverts in ETI during the past year?

- YES ☐ (1)
- NO ☐ (2)

13. Have you bought electronic equipment through adverts in ETI during the past year?

- YES ☐ (1)
- NO ☐ (2)

Note If you have any complaints against advertisers, we would like to hear them.

14. Approximately how much do you spend a year on your **leisure** electronics?

- £0 to £20 ☐ (1)
- £20 to £50 ☐ (2)
- £50 to £100 ☐ (3)
- £100 to £200 ☐ (4)
- more than £200 ☐ (5)

If more than £200, please estimate and write in £ ....

15. Approximately how much do you spend a year **professionally** on **electronic components?** (please include purchases made indirectly, e.g. requisitioning from company stores)

- Nothing ☐ (1)
- Less than £500 ☐ (2)
- £500 to £2000 ☐ (3)
- £2000 to £5000 ☐ (4)
- more than £5000 ☐ (5)

If more than £5,000, please estimate £ ....

16. Approximately how much do you spend a year **professionally** on **electronic equipment** (other than components)?

- Nothing ☐ (1)
- Less than £500 ☐ (2)
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- £2000 to £5000 ☐ (4)
- more than £5000 ☐ (5)

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READING HABITS

17. Do you read ETI regularly?

- No — this is the first copy I have bought ☐ (1)
- No — I buy ETI when there is a project or feature that particularly interests me ☐ (2)
- Yes — but for less than a year ☐ (3)
- Yes — for a year or longer ☐ (4)

18. How do you usually buy ETI?

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- On a regular order from a newsagent ☐ (2)
- From a 'corner shop' type newsagent without a regular order ☐ (3)
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- From a specialist electronics shop ☐ (5)

19. How many people read your copy?

- just you ☐ (1)
- one other ☐ (2)
- several others ☐ (3)

20. How long do you usually keep your copies of ETI?

- less than 1 year ☐ (1)
- 1 year or longer ☐ (2)
- selected copies kept for 1 year or longer but others not kept ☐ (3)

READERSHIP PROFILE

Below we ask you some questions about yourself which we hope you will not mind answering. If there is any section you do not wish to answer, please leave it blank.

21. Age

- 15 or under ☐ (1)
- 16 to 25 ☐ (2)
- 26 to 35 ☐ (3)
- 36 to 45 ☐ (4)
- 46 to 55 ☐ (5)
- 56 to 65 ☐ (6)
- 66 or over ☐ (7)

22. Sex

- Male ☐ (1)
- Female ☐ (2)

23. Marital Status

- Single ☐ (1)
- Married ☐ (2)

24. Employment

- At school ☐ (1)
- At sixth form or Tech. college ☐ (2)
- Student in higher education ☐ (3)
- Employed ☐ (4)
- Self-employed ☐ (5)
- Not employed ☐ (6)
- Retired ☐ (7)

25. If employed or self-employed please indicate your earnings

- under £4,500 p.a. ☐ (1)
- £4,500 to £6,499 ☐ (2)
- £6,500 to £9,499 ☐ (3)
- £9,500 to £14,000 ☐ (4)
- over £14,000 ☐ (5)

26. What is your job title? (please write in below)

....

27. Do you hold a credit card?

YES ☐ (1)
NO ☐ (2)

28. Does your job or course of study involve electronics?

- Mostly ☐ (1)
- Sometimes ☐ (2)
- Not at all ☐ (3)

29. Education: please tick in the **first** column the standard of education you have **already** reached

No formal qualifications	☐ (1)	☐ (1)
CSE	☐ (2)	☐ (2)
O level	☐ (3)	☐ (3)
A level/ Scot. Higher / IB	☐ (4)	☐ (4)
ONC	☐ (5)	☐ (5)
HNC	☐ (6)	☐ (6)
Bachelor's degree	☐ (7)	☐ (7)
Higher degree	☐ (8)	☐ (8)

30. Please tick in the **second** column if you are still studying for a qualification (full or part time)

31. Are you a home-owner?

YES ☐ (1)
NO ☐ (2)

32. Do you own a car?

YES ☐ (1)
NO ☐ (2)

AUDIO

33. Do you own a stereo system?

YES ☐ (1)
NO ☐ (2)

34. Have reviews in Audiophile influenced your choice of system components?

YES ☐ (1)
NO ☐ (2)

VIDEO

35. Do you own or rent a video recorder?

YES ☐ (1)
NO ☐ (2)

36. If YES, which format is it in?

- VHS ☐ (1)
- Beta ☐ (2)
- V2000 ☐ (3)

COMPUTING

38. Do you own a home computer?

YES ☐ (1)
NO ☐ (2)

38. If 'YES', please indicate which make it is:

- Acorn Atom ☐ (1)
- Apple I/II/III ☐ (2)
- Atari 400/800 ☐ (3)
- BBC Model A/B ☐ (4)
- Dragon 32 ☐ (5)
- PET ☐ (7)
- Sharp MZ80 A/B/K ☐ (8)
- Tandy TRS-80 I ☐ (9)
- Tandy Colour Computer ☐ (10)
- Tangerine ☐ (11)
- TI99/44 ☐ (12)
- VIC 20 ☐ (13)
- Video Genie ☐ (14)
- ZX81 ☐ (15)
- ZX Spectrum ☐ (16)
- Home-brew design ☐ (17)
- Other — please list below ☐ (18)

....

Please use this space for any additional comments. Use a separate sheet if necessary.

39. If 'NO', do you think you will be buying a computer in 1983?

YES ☐ (1)

NO ☐ (2)

40. How much do you think you will spend on personal computing in the next year?

£100 or less	☐	(1)
£100 to £300	☐	(2)
£300 to £1000	☐	(3)
more than £1000	☐	(4)

REGULARS

Below is a list of those features fairly regularly in ETI. Please could you rate them, by ticking the appropriate box, on the scale: 1 — essential, wouldn't read the mag without it; 2 — interesting; 3 — sometimes interesting; 4 — not interesting to me; 5 — would prefer to see it discontinued

		(1)	(2)	(3)	(4)	(5)
41	Digest (News)	☐	☐	☐	☐	☐
42	Audiophile	☐	☐	☐	☐	☐
43	Designer's Notebook	☐	☐	☐	☐	☐
44	Tech Tips	☐	☐	☐	☐	☐
45	Read/Write	☐	☐	☐	☐	☐

46 PUBLISHED PROJECTS

Below is a list of the projects we've published in ETI in the last year or so. Please tick in the **first** column next to projects that you found particularly interesting. If you actually constructed (or have started) all or part of any of the projects, please tick in the **second** column.

Active Loudspeaker (Sept)	☐	1	☐
Auto-volume Control (Sept)	☐	2	☐
Cortex Computer (Nov '82-Jan '83)	☐	3	☐
Dual Logic Probe (Sept)	☐	4	☐
Earth Leakage Circuit Breaker (Dec)	☐	5	☐
Electronic Doorbell (Oct)	☐	6	☐
Fuel Gauge (Jan '83)	☐	7	☐
Heat/Light Controller (Oct)	☐	8	☐
IF Strip Tester (Oct)	☐	9	☐
Message Panel (Oct)	☐	10	☐
Message Panel Interface Board (Nov)	☐	11	☐
Microtutor (Aug-Oct)	☐	12	☐
Playmate Guitar Amp (Aug-Sept)	☐	13	☐
Precision Pulse Generator (Nov)	☐	14	☐
Programmable PSU (Jan '83)	☐	15	☐
Robot: Mobile II (Aug)	☐	16	☐
Robot: Chassis Construction (Sept)	☐	17	☐
Robot: Servo Arm Interface (Oct)	☐	18	☐
Rugby Clock (Aug-Sept)	☐	19	☐
Signal Line Tester (Dec)	☐	20	☐
Sound Track (Aug)	☐	21	☐
Sound-to-Light Unit (Oct)	☐	22	☐
Spectracolumn (Dec)	☐	23	☐
Spectrum Analyst (Nov)	☐	24	☐
Stage Lighting Unit (Jan '83)	☐	25	☐
Touch Switch (Oct)	☐	26	☐
Waveform Multiplier (Jan '83)	☐	27	☐
ZX ADC (Jan '83)	☐	28	☐

THE COMPETITION

What other electronics magazines (or magazines that carry constructional projects similar to those in ETI) do you read, and how do you think they compare to ETI?

Roughly how often do you read the competition? / How do you think the magazines rate in comparison to ETI?

	Regularly (1)	Occasionally (2)	Rarely/Never (3)	MAGAZINE	Poor (1)	Fair (2)	About equal (3)	Slightly better (4)	Much better (5)	
50	☐	☐	☐	ELECTRONICS AND COMPUTING	☐	☐	☐	☐	☐	**70**
51	☐	☐	☐	ELECTRONICS AND MUSIC MAKER	☐	☐	☐	☐	☐	**71**
52	☐	☐	☐	ELEKTOR	☐	☐	☐	☐	☐	**72**
53	☐	☐	☐	EVERYDAY ELECTRONICS	☐	☐	☐	☐	☐	**73**
54	☐	☐	☐	HOBBY ELECTRONICS	☐	☐	☐	☐	☐	**74**
55	☐	☐	☐	ELECTRONICS — THE MAPLIN MAGAZINE	☐	☐	☐	☐	☐	**75**
56	☐	☐	☐	PRACTICAL ELECTRONICS	☐	☐	☐	☐	☐	**76**
57	☐	☐	☐	PRACTICAL WIRELESS	☐	☐	☐	☐	☐	**77**
58	☐	☐	☐	RADIO AND ELECTRONICS WORLD	☐	☐	☐	☐	☐	**79**
59	☐	☐	☐	WIRELESS WORLD	☐	☐	☐	☐	☐	**79**
60	☐	☐	☐	TELEVISION	☐	☐	☐	☐	☐	**80**
61	☐	☐	☐	BYTE	☐	☐	☐	☐	☐	**81**
62	☐	☐	☐	COMPUTING TODAY	☐	☐	☐	☐	☐	**82**
63	☐	☐	☐	PERSONAL COMPUTER WORLD	☐	☐	☐	☐	☐	**83**
64	☐	☐	☐	PRACTICAL COMPUTING	☐	☐	☐	☐	☐	**84**

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INDUCTION LOOPS

Do you know what it's like not to be able to hear what's going on at a concert or a meeting? Vivian Capel describes a system that will enable many hearing-aid users to find out what they've been missing.

Persons with normal hearing rarely appreciate the problems associated with the condition of those who are not so blessed. Hearing aids don't restore normal hearing. Owing to the square law which governs sound propagation, microphones are much more sensitive to nearby sounds than distant ones. The human ear seems able to do a certain amount of filtering out of unwanted sounds that hearing aids are not capable of. The result is that a hearing-aid user is very susceptible to unwanted, distracting sounds.

Another effect experienced by hearing-aid users is that sound from a public address system sounds hollow, and it is difficult to distinguish the syllables. This is due to the reflections and reverberations set up in the auditorium. Here two ears come to the rescue of those with normal hearing because the reflected sound is of random phase whereas the direct arrives in-phase. So our ears ignore much of the reverberation and concentrate on the direct sound.

Faced with these problems, hearing-aid users often try turning up the gain to make the sound more intelligible. Of course it doesn't work, in fact it makes matters worse, as the rustles, coughs and other sundry noises now become deafening. In despair, many turn off their aids altogether and try to hear with what limited natural hearing they have.

Plugged-in Audience?

Ideally, anyone hard of hearing should be plugged in directly to the PA system so that they receive only the sound from the stage microphones minus auditorium reverberation and without the audience noises. In the past some attempt has been made to do this in certain halls where a section would be reserved for deaf people, with a number of audio outlets for headphones.

Such arrangements were fraught with problems. One was that the users might have to be segregated from their friends which made them self-conscious. Another was the constant damage done to the headphones and wiring; it was common for users to forget they were wearing headphones and stand up and move away while still connected! Yet another problem was the regular disappearance of loaned headsets.

All these drawbacks can be overcome by the installation of a magnetic loop around the periphery of the whole auditorium which is fed from the PA system. The PA output can then be received by anyone with a suitable hearing-aid within the area. So there is no segregation, the users can sit where they like; there is no wiring or connections to worry about so no maintenance problems; and the users can still hear if they move from their seats.

Hearing-Aids

What then about the receivers? Special headphone sets with built-in amplifiers and induction pick-up coils have been made by firms such as Beyer, Eagle and others for some time. However, for this application these are not necessary. Since 1974, all NHS hearing-aids have a selector switch which has two positions marked M and T. In the M position, the internal microphone is switched on for normal usage. The T position is for telephone use and it disconnects the microphone and switches in an induction coil. This responds to the magnetic field of some telephone earpieces and thus enables the user to hear the telephone without double transduction, that is sound generated by the earpiece being converted back to an electrical signal by the hearing-aid microphone. This greatly improves the quality and intelligibility of the sound heard.

When switched to the T position, the normal hearing-aid becomes an ideal receiver for a magnetic induction-loop sound system. The coil is mounted vertically, which is in the same plane as a loop wired around a hall, and so achieves maximum signal pickup.

From the management's point of view, this means no separate hearing devices to be supplied, with their repair liability and disappearances.

From the user's standpoint there is no fuss over having to obtain and return an aid. The aid can be switched from normal to T at the start of the performance and back again at the end, in an instant. All extraneous noises are cut out, in fact in some cases users can hear better than those with normal hearing! A further big advantage is that the volume can be individually adjusted to suit the particular user, as he or she would do when using the aid normally.

Though many privately-sold hearing-aids incorporate a telephone switch, not all do. Those worn inside the ear lack the facility, as there is simply no extra room for a coil and switch. Some others have an induction coil but no switch so that both microphone and coil output are heard at the same time. This is less satisfactory than being able to switch the microphone out, but providing the signal from the loop is high, it is not too great a drawback.

Looping the Loop

Designing a loop is reasonably straightforward, being a matter of taking the area to be covered, length of the longest side, then calculating the cable resistance, number of turns, and amplifier power to produce the required field strength.

The ideal strength is that which presents a signal to the hearing-aid which is comparable to the output of the internal microphone. Too weak a signal is not desirable as this would mean users having to turn the gain well up which would make the noise of the internal amplifier noticeable. There is a British Standard (BS 6083 Part 4: 1981) which specifies the optimum strength as *100 mA in a single-turn loop of 1 metre diameter.*

This highlights a basic factor, that it is the current and the number of turns that influence the resulting field in any given size of loop. Because the hearing aids will require ➧

negligible power from the magnetic field, the voltage required is only that need to drive the required current through the resistance of the loop. If the resistance can be made very low, the necessary current can be achieved with only a small voltage, hence with minimum power. However, as the field strength is proportional to the product of the current and the number of turns, it can be an advantage to increase the turns even though this also increses the resistance.

The specified current of 100 mA/metre is for the average signal, but peaks will exceed this especially with music. The BS recommends allowing for peaks of 12 dB above average, which increases the current requirement by four times. If dynamic range compression is used in the feed amplifier, this could be reduced. However, if the system is to be used mainly for speech then only much lower peaks need be accommodated. In practice, allowance for 6 dB peaks or twice the average has been found to be adequate. However, to ensure a good safety margin the following calculations assume peaks of 10 dB or three times average.

If the average current in amps is a/10 (where a is the diameter of the loop in metres) the peak is 3a/10. With the exception of the Albert Hall, few halls are circular. A square loop needs slightly more current to provide the same field, about 112 mA for a square of side 1 metre, so the formula becomes I = 3a/9 amps.

However, most halls are rectangular. Doing the calculation properly would be complicated, but for practical purposes we can work out a close figure for halls with a length of no more than 1½ times the width. This can be done by multiplying length and width to give the area, then finding the square root to give the side of a square of equal area. So our formula becomes $I = 3\sqrt{dw}/9$, where d is the length and w the width.

In the case of long narrow areas things are rather different. With a square loop, each side contributes equally to the field. But if we take a square section somewhere near the middle of a long narrow loop, the sides are too far away to have much effect. So only two of the four sides of the square are generating any field. Hence the field is very approximately half what it would be with a square loop of the same width, in the central portions, rising to around three-quarters in the parts adjacent to the sides.

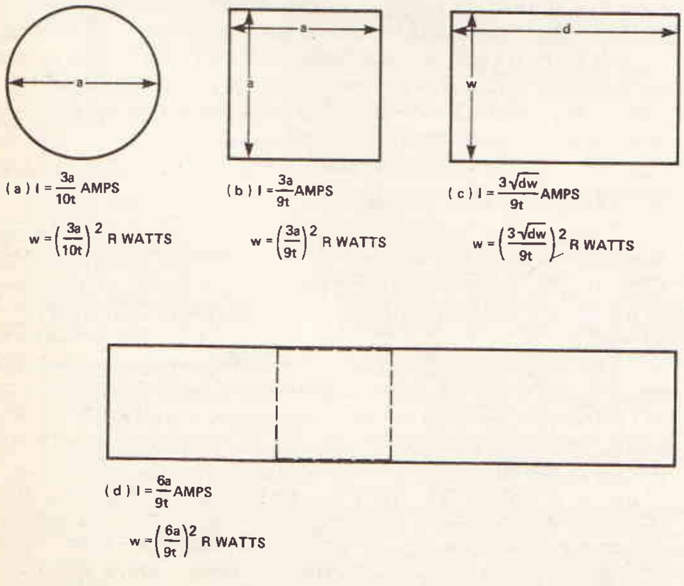

Fig. 1 Formulae for current and power requirement for loops of various shapes.

Choosing The Cable

The above calculations apply for a single-turn loop, but there is no reason why several turns cannot be used to advantage. As you would expect, the current required is divided by the number of turns, so the formula becomes 3a/9t for a square loop (where t is the number of turns).

A convenient method of wiring multi-turn loops is to use mains cable and connect the cores in series using a junction box or terminal strip. Thus a single loop of standard three-core mains cable gives a three-turn circuit without actually running three separate turns around the area.

Now we must match the loop resistance to the output of the amplifier. If a separate amplifier having a four-ohm output is used, the loop should equal this or be a little higher, say five ohms. This is about the lowest resistance that can normally be matched to a standard power amplifier.

Table 1 gives the resistance per 100 metres of a single core of various gauge cables. One of the most commonly used is 16/0.2, three-core which has a resistance of 3R6 per core or 10R8 total. The heavier gauge 24/0.2 can also be used if the run is long and resistance high as a result. This comes out at 2R4 per core or 7R2 for three cores.

The first step then is to measure up the total length of the run. This must include detours around door or window frames, and recesses. For a medium-sized hall a run of around 80 metres is a common average. This gives about 8 ohms for 16/0.2 which matches nicely with an 8R output amplifier. Any value below this needs a 4R output even though it may be closer to 8R, because the load should never go below the rated impedance of the amplifier. Really, it is a matter of juggling the gauge and number of cores to produce the desired resistance for the measured length. Never add a series resistor to make up a value as this not only wastes power but it has an adverse effect on the loop performance.

Table 1

Cores No/Dia (mm)	Total Area (mm^2)	Current Rating (A)	Resistance per 100m (R)
1/0.2*	—	—	57.6
7/0.2*	0.22	1.4	8.2
13/0.2*	0.4	2	4.4
16/0.2	0.5	3	3.6
24/0.2	0.75	6	2.4
32/0.2	1.0	10	1.78
1/0.8*	0.5	—	3.6

*Note that these are not mains cables

Amplifier Power

Although the production of the magnetic field is not a function of power out of current alone, a certain voltage is required to produce the necessary current, hence power is expended. So, what power will be needed from the amplifier?

The formula for calculating power is $W = I^2R$, where the symbols used have the usual meanings.

Combining this with the earlier formula we get:

$$W = \left(\frac{3a}{9t}\right)^2 R$$

If we remember that R depends on the number of turns, and write R = rt, where r is the resistance per turn, then we can re-write the formula for the power as

$$W = \left(\frac{3a}{9}\right)^2 \frac{r}{t}$$

which shows that the more turns we use, the less power is necessary to drive the loop.

Let us look at an example to illustrate. Supposing a hall having 18m as the root of its area and needing 80m of cable to enclose, is wired with 16/0.2. The resistance for a two-core loop would be from the table, 5.8 ohms, and for a three-core loop, 8.6 ohms.

For the two-core loop we have

$$W=\left(\frac{3\times18}{9\times2}\right)^2\times5.8=52.2 \text{ watts}$$

In the case of the three-core loop,

$$W=\left(\frac{3\times18}{9\times3}\right)^2\times8.6=34.4 \text{ watts}$$

With 24/0.2 cable, the resistance for two-core is 3R8 which although below 4R is probably close enough to work from a 4R output. The three-core cable has a resistance of 5.8 ohms. So using the above formula we have

$$W=\left(\frac{3\times18}{9\times2}\right)^2\times3.84=34.4 \text{ watts}$$

for the two-core, and for the three-core

$$W=\left(\frac{3\times18}{9\times3}\right)^2\times5.8=23.2 \text{ watts}$$

Amplifiers

A separate amplifier fed from the 'line out' socket of the existing PA amplifier is the most flexible and satisfactory means of supplying a loop. The power rating can be chosen from the formula already described. However, in some cases it is possible to take a feed from the output of the PA amplifier already installed.

If it is a proper PA amplifier it will have a 100V output tap, and this should be used with a suitable matching transformer. The main requirement is that the amplifier has sufficient power to supply both the loop and the speakers. With many PA systems there is an ample reserve, it is not uncommon to find 80-100 watt amplifiers feeding speakers tapped at 25-40 watts.

100V Outputs

A word of explanation regarding 100V operation and transformer power tappings would not be amiss here. A 100V output is a much more convenient method of connecting mixed loads than working out their impedances when connected in parallel and ensuring that they do not fall below that of the amplifier tap being used. Each load has its own matching transformer which enables each one to be individually adjusted.

The 100V is the output voltage obtained when the amplifier is delivering its full rated power. From the formula

$$Z=\frac{E^2}{W}$$

it can be seen that the actual impedance of this tap depends on the wattage rating of the amplifier, for a 50-watt amplifier it is 200 ohms, for a 100-watt, 100 ohms and so on.

The transformers used for matching PA speakers to the 100V output have a secondary rated in ohms: 4, 8, 16, or often all of these via tappings. These are connected to the speaker, of the appropriate impedance. The primary has tappings rated in watts, so that when a particular tapping is selected, the specified wattages will be taken from the 100V output and fed to the speaker.

So you can have a mixed bag of speakers all set to different powers to suit different locations in the PA system, and the only calculation necessary is to add up all the tappings and make sure that the total does not exceed the power rating of the amplifier. Much easier than calculating parallel impedances!

The 100V Loop

The loop is taken to the appropriate secondary tapping on the 100V transformer and the primary tapped to give the required wattage. Transformers can be obtained from R.S. Components and from Eagle, the latter having fewer tappings and lower ratings but being much cheaper. (R.S. Components do not supply hobbyists direct but TV dealers may be prepared to order for you.)

Some installations in smaller halls may not have a PA amplifier with 100V output, and the speaker system may be operating at low impedance from an ordinary amplifier. In this case there is less room for manoeuvering, but if there is plenty of amplifier power to spare it may be possible if the impedances work out right.

Field Distribution

So much for the electrical features, so now we will consider the magnetic field and its distribution. If the loop is level with the receiving devices and we start at the middle of the loop, the vertical component of the field rises gradually as we move toward the walls supporting the loop. At about halfway between the centre and the walls, it shoots up dramatically to +22dB or thereabouts at a point close to the loop. Then it drops to a null point actually just over the loop at the boundary wall. Beyond this, outside the loop it rises again to about +10dB, then falls linearly. This is shown by the solid line in Fig. 2.

Obviously this is not entirely satisfactory as there are wide differences in field strength across the loop which would call for different gain levels in the user's hearing-aids according to their positions. If instead, the loop is displaced vertically so that it is above or below the level of the hearing-aid coils, the distribution curve can be made more even. Figure 2 also shows vertical components of field distributions for displacements of one tenth, two tenths and four tenths of the loop width.

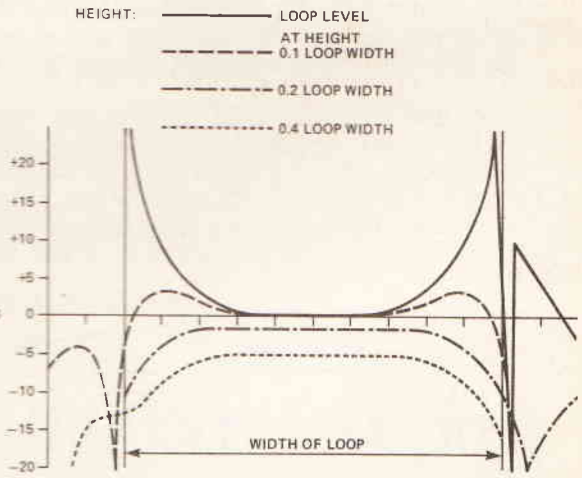

Fig. 2 Vertical field distributions for different heights above (or below) the loop level.

Of all these curves, the one obtained from the one-tenth displacement is the most satisfactory, and usually it is the most convenient. For a hall 10 metres wide which is a fair average for a medium-sized hall, the required displacement will be 1 metre. For seated users, this would put the loop at wainscoting level near the floor, which is a practical place to mount it. It could be at floor level, especially is the hall is wider, as the positioning is by no means critical.

The loop could equally as well be run above the hearing-aid level, and in some cases this may prove to be more practical. Mostly though, this could be rather conspicuous, and may detract from the decor. In both cases, running the loop over door frames or around other relatively small objects will make little difference to the field level in the body of the hall, though it may cause local anomalies.

Vertical displacement of the loop from the level of the receivers causes a lower signal which should be compensated for by an increase in the loop current, hence power supplied by the amplifier. Table 2 gives the ratios of displacement in units of loop-width with the multiplying factors for current and power. For the one-tenth displacement the power is only 1.2 times and can be ignored. For larger displacements though, the power requirements increase drastically. So this is a further reason for keeping the loop to the one-tenth level.

Table 2

Ratio h/a	Multiply current by	Multiply power by
.1	1.1	1.2
.2	1.25	1.6
.3	1.5	2.25
.4	2.0	4.0
.5	2.5	6.25
.6	3.25	10.6
.7	4.25	18.0
.8	5.5	30.2
.9	7.0	49.0
1.0	8.5	72.2

Null And Overspill

It may be wondered why there is a null point as the receiver passes over the loop, or at greater height, just beyond the loop. It is not that the total field disappears, just the vertical component. If the receiver coil is placed horizontally instead of vertically, then there will be maximum pickup over the loop wire, and minimum within the loop, the opposite of normal. One user was heard to complain that the sound faded out to zero when he bent down to pick up something from the floor. This was of course because the hearing-aid coil was tilted through 90° to the horizontal.

Overspill (the magnetic field outside the loop) is unaffected by normal building materials, but falls off linearly with distance. Beyond about a quarter of the loop width it drops to too low a level for practical use. Even this though can be useful. In one case a delighted user related how he could still hear what was going on a visit to the toilet in the foyer!

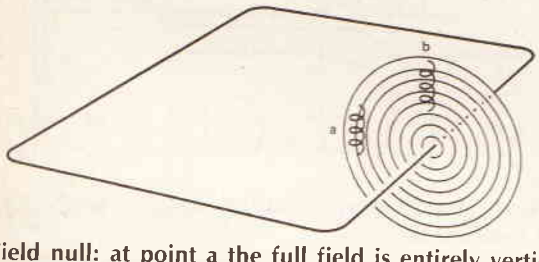

Fig. 3 Field null: at point a the full field is entirely vertical; at point b, the field is entirely horizontal.

In The Home

There is no reason why the same technique should not be used in the home of a person with hearing difficulties to enable them to listen to records, for example. The major problem will be getting a loop with a sufficiently high resistance to be fed by a domestic amplifier; however, this difficulty can be overcome by using several turns of fairly thin wire.

Listening to the television this way poses the added difficulty of coupling the output from the TV to the amplifier. Unless your TV has a special output socket, as a few of the more enlightened manufacturers have take to including, the best solution is to use a TV sound tuner.

IMPROVING YOUR ZX81

In the first of an occasional series on mods to popular computers, Ian Ridout gives details of how you can improve the reliability of SAVEing programs on tape.

Since the ZX81 Sinclair personal computer was introduced, over 400,000 have been sold throughout the world. In technical journals and magazines it has been acclaimed by most critics as ideal for self-tuition in the BASIC language and an excellent introduction to computing. By all accounts it represents unequalled value for money both on its own, with just 1K of RAM memory, and also when the 16K RAM plus printer are added.

However, there are three main complaints about the ZX81:

- the mechanical instability of the add-on units can cause a brief disconnection leading to the loss of either TV picture synchronisation and/or loss of the stored program and data;
- an unexplainable loss of program and data (ie a crash);
- unreliable tape storage of programs.

The first complaint can be overcome by making an extension lead so that movements of the individual units can be tolerated without causing momentary memory pack disconnections. However, only the 16K RAM pack should be plugged into the extension; the printer should still be plugged directly into the back of the ZX81. It is necessary to keep the extension lead short (less than 6") or the effect will be to make system crashes occur more often, probably owing to increased capacitive loading and hence memory access delay. Also it is essential to keep the rear edge connector on the computer board clean, using white spirit and cotton buds.

The second problem could well be an internal software fault which is therefore not alterable by ZX81 users. Alternatively, the power supply regulator could be getting too hot because the unregulated input voltage is too high. I decided that it is better to bolt a much bigger aluminium heat sink to the existing heat sink rather than modify the mains power supply. The reason for this is that reducing the regulator's overhead can spoil its functioning, and therefore you end up with the same problem. The size of the additional heatsink was such that it fitted neatly under the entire keyboard area, hence also eliminating a hot-spot under the left-hand end of the keyboard.

This article describes the steps taken to make the recording of programs onto tape and the loading from tape considerably more reliable.

The Tape Storage System

The IC pin which is used to suply a signal to the TV modulator is also used to supply the signal for tape storage purposes. Consequently, if you connect an audio amplifier and loudspeaker to the 'tape out' (ie MIC) socket, during normal computer usage you will hear a continuous buzzing sound. The video signal from the IC to the modulator consists primarily of high frequencies but most of what you hear is the television frame rate and its harmonics. The output level of this buzzing sound can be used as a very rough indication of whether there is sufficient signal coming out of the MIC socket to allow reliable recordings to be made with your particular tape recorder. However, this method is rather poor because the true signal that is recorded is of much higher frequency than that of the buzzing sound.

When you press SAVE (plus NEWLINE) there is a period of several seconds during which the TV screen goes blank and nothing appears at the MIC socket. After the pause, audio frequency tones are emitted from the IC output pin for recording onto the tape. The picture on the TV screen becomes alternate bands of black and white dashes (data), and black (pauses).

At the end of the recording sequence the IC output signal returns to being a compatible TV video signal, hence a buzz is recorded and the picture on the TV screen returns to normal.

The Present Circuit

The tape recording circuit used in the ZX81 consists of just two resistors and two capacitors (Fig. 1) forming a band-pass filter with a band peak at about 3.4 kHz. The filter response rolls off each side of this centre frequency at 6 dB/octave (20 dB/decade).

The response shape of this filter is perfectly acceptable for this

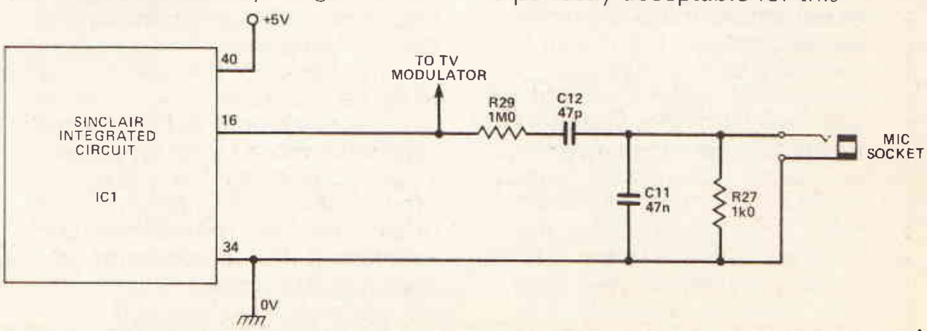

Fig. 1 Original tape-recording circuit.

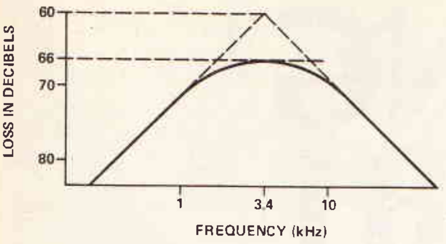

Fig. 2 Response of tape output filter.

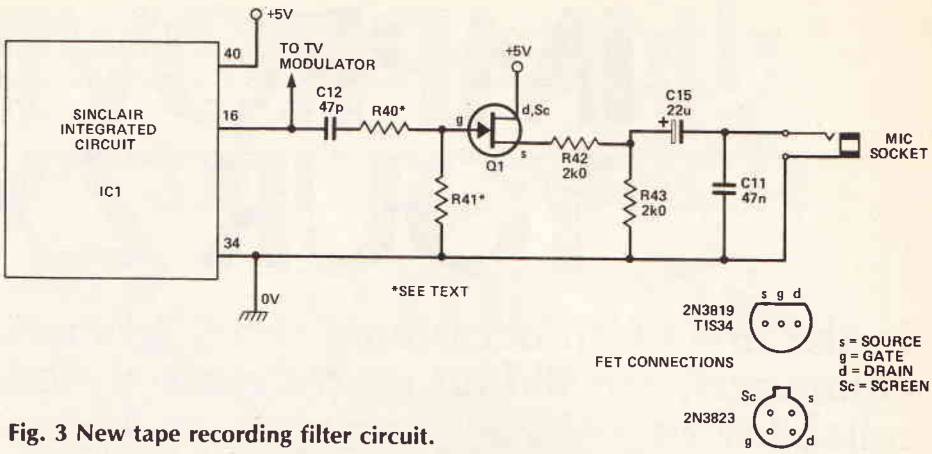

Fig. 3 New tape recording filter circuit.

application but the characteristic that makes recording unreliable is the low output signal level at the MIC socket. With about 4 V peak-to-peak coming out of the IC, a signal of only 2 mV appears at the MIC output socket even with this socket open-circuit. This is because the filter components give a resistive attenuation of 1000 to 1 and because a further halving of the signal takes place owing to the filter shaper. The response of this filter is given in Fig. 2, the axes being plotted with logarithmic scales.

A signal of 2 mV is insufficient to drive most recorders with manual recording-level control and is not high enough to give an adequate signal to tape-noise ratio on recorders with automatic level control.

Circuitry Modification

To ensure reliable tape recording, it is necessary to amplify the signal by at least 10 times and preferably 100–200 times. This could be achieved by connecting a suitable amplifier of the appropriate gain on the output of the Sinclair filter. However, with such a low signal level, it is possible to pick up interference along with the signal, so one would need to be very careful with the layout of the amplifier input wiring and the power supply to the amplifier.

Because of the high signal level and the large bandwidth of the signal at the IC output, it is not practicable to put an amplifier before the filter. It is therefore necessary to redesign the filter connected between the IC output and the MIC socket. The design has to present the original high impedance load to the IC output pin, and preferably should present the original output impedance to the MIC socket although the latter is not essential. Also, the same filter shape has to be preserved but the output signal level has to be considerably higher than the 2 mV presently available. Naturally, it is also an aim to keep the cost of the modification to a minimum.

The result of fulfilling these requirements was a circuit using a cheap junction field-effect transistor (FET) as a source follower, and a few extra resistors, costing in all less than £1. The circuit also has the advantage that the output signal at the MIC socket is not inverted, although this is not essential.

The new tape-recording circuit is shown in Fig. 3. R40 and R41 ensure that the IC is presented with the same resistive load as in the original circuit and C12 gives the same low-frequency roll-off. The DC biasing requirements of the FET dictate that with the gate connected to the negative supply rail, the value of the source resistor should be about 4 k to obtain about 2 V DC on the source. Consequently, to achieve an output resistance in the order of the original 1k0, the output is taken from a tap halfway down the source resistor.

The output needs to be AC coupled, hence the need for the 22u electrolytic capacitor. The 47n capacitor C11 could have been connected directly across the 2k0 resistor R43 but it was more convenient to leave it in its original physical position on the PCB directly across the MIC socket.

It was not found necessary to feed the drain of the FET via an RC decoupling network, so the drain was connected directly to the regulated +5 V supply, the drain current being about half a milliamp.

The values of R40 and R41 need to be set according to whether the cassette machine is of the automatic or manual record level type (see Table 1). Most machines likely to be used for this application would be of the automatic record level type so R40 and R41 should be set to 910k and 91k respectively. If the record level is too high and overloading takes place, reduce R41 to about 15k. For manual record

TABLE 1

	R40	R41
Manual recorders	510k	510k
Auto level recorders	910k	91k*

*See text

level machines these resistors should be set to 510k each. The sum of the values of R40 and R41 should be between 900k and 1M1 in order to preserve the filter characteristic.

Doing The Modification

Advantage has been taken of spaces for components on the PCB which are not used in the UK version, namely R30, 31, 32 and D9. Three of the original components need to be removed and only one of these will be used again. The new layout is shown in Fig. 4 but reference to the photograph will assist.

Make the modification as follows: pull off three of the four rubber feet, leaving the one nearest to the TV output socket. Remove the five screws on the back of the case and note that the two short screws come from under the feet under the keyboard. Remove the back of the case.

Remove the two screws holding the printed circuit board to the front half of the case. Carefully raise the PCB ensuring that the strip-connections from the keyboard are not strained and are disturbed as little as possible. DO NOT remove the keyboard connection strips from the PCB sockets because they are not easy to reinsert.

Locate and remove R27 (1k0) and R29 (1M0). These two resistors will not be used again. The position that R27 occupied will be left empty. Locate and carefully remove C12 (47pF, positioned between C10 and C11). This capacitor will be used in the new circuit.

Before continuing, refer to Fig. 4. Insert the two 2k0 resistors R42 and R43 into the positions marked on the PCB as R31 and R32. Insert one end of R40 (see Table 1 for the value to be used) into the left-hand hole vacated by the removal of R29. Insert one lead of C12 into the right-hand hole vacated by the removal of R29. Solder together the remaining leads of R40 and C12 above the PCB, keeping their leads short.

Insert the positive end of C15 (22u) into the hole shown in Fig. 4. This hole is the one between EAR socket and the modulator which has a PCB track joining it to the two left-hand ends of R42 and R43. Solder the negative end of C15 to the left-hand hole vacated by C12. C15 should be positioned above, but not touching, the EAR socket. Do not be tempted to position C15 in the space between C10 and the modulator because one of the PCB support pillars occupies this space.

Solder the drain of the FET to the hole next to the right-hand end of C11. This is a plated-through hole which is connected to +5 V. Solder the source of the FET to the right-hand end of the position marked on the PCB as the cathode end of D9 (not used in the UK version). Position R41 (see Table 1 for its value), so that is to the right of the FET. Its lower lead is soldered into the left-hand hole of the component designated as R30 (not used) and its upper lead is soldered into the right-hand hole of the position previously occupied by C12. Solder the gate of the FET to the upper lead of R41.

After cutting off all excess leads and thoroughly inspecting all new solder joints for solder blobs and tracking between adjacent holes, put back the two short screws holding the PCB to the front cover. They are the ones near the regulator and half-way along the rear accessory socket. (You might like to use this opportunity to make the heatsink modification described earlier).

Before screwing on the back cover, connect the power, the television and the cassette recorder, write a very short program and ensure that it SAVEs and LOADs properly.

The two short screws go into the holes under the feet behind the keyboard. The new setting for the cassette player volume control will have to be obtained by experimenting.

Fault Finding

If the television picture fails to appear, check that the television is tuned to the correct channel (36) and that the regulator is giving out 5 V. Next, check that the FET is wired correctly and that it has 5 V on its drain and 0 V on its gate. The biasing is such that the source should be at about 2 V. If the source is at 5 V check the connections to R42 and R43 and their values with a multimeter, after disconnecting the computer power. If the source voltage is higher than 3V5 or less than 1 V you have a FET which is on the tolerance limits and the combined value of the source resistors will have to be changed to compensate. Initially, change only R42, but if it has to be varied significantly to achieve 2 V DC on the source then I would suggest replacing the FET.

The type of FET used in this circuit is a junction FET and consequently there are no handling precautions necessary beyond those normally used for bipolar transistors. A 2N3823 was used in the original and the case/screen lead was soldered to the drain before insertion into the PCB. A TIS34 or the very cheap, plastic encapsulated 2N3819 could be used instead.

When a tape has been recorded from the computer, listen to it to see if it is distorted due to overloading. Naturally, it will be necessary to experiment with the playback level when loading the program back into the computer because the record level on the tape will be a little higher even if recorded by an automatic record level machine.

PARTS LIST

Note that this is a list of the *new* components required

Resistors (all ¼W 5%)	
R40	**See Table 1**
R41	**See Table 1**
R42,43	**2k0**
Capacitors	
C15	22u 16 V axial electrolytic
Semiconductor	
Q2	2N3819 or TIS34 or 2N3823

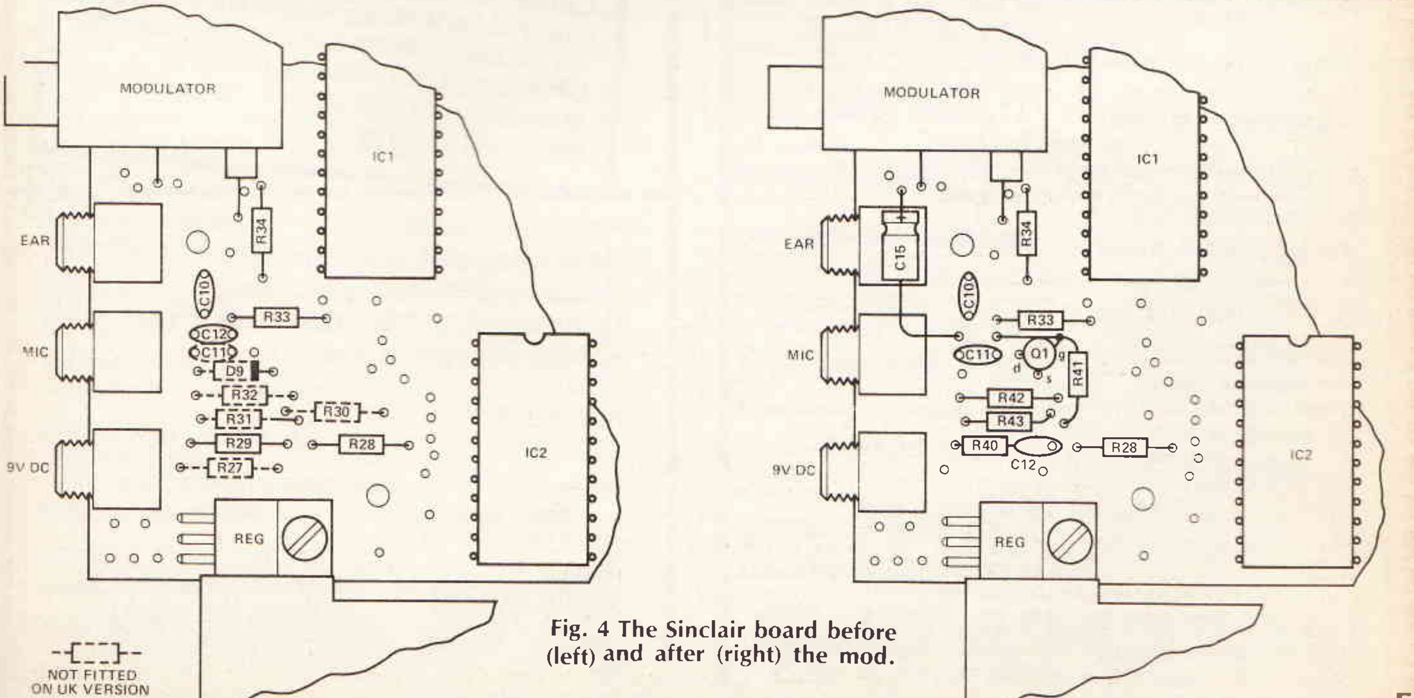

Fig. 4 The Sinclair board before (left) and after (right) the mod.

30 Solderless Breadboard Project — Book 1

Recommended By: BICC VERO

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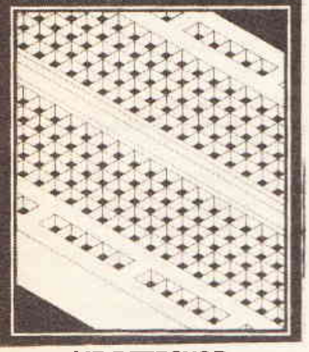

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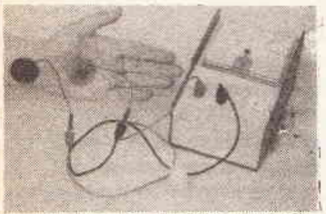

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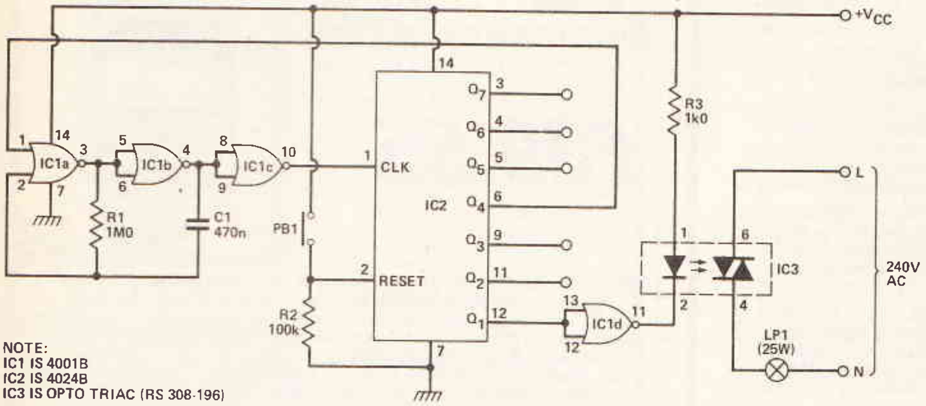
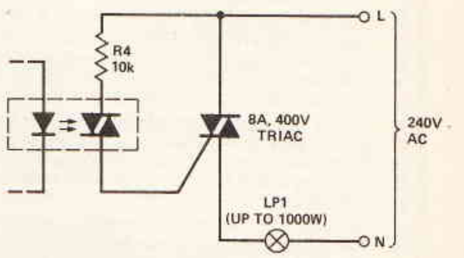
TECH TIPS





Doorbell For The Deaf

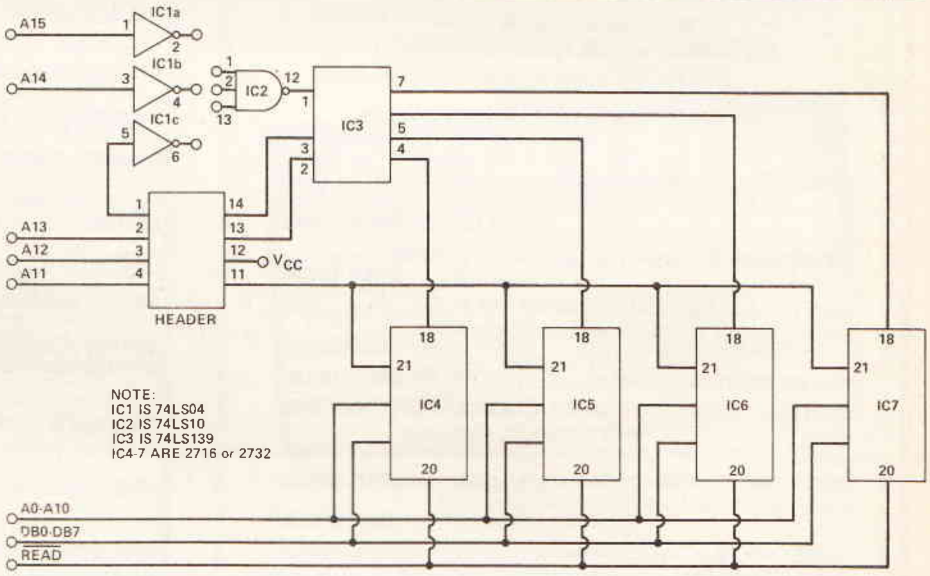
G. C. Dean, Taunton

This 'doorbell' was designed to alert a deaf person by flashing a light on and off several times. IC1a and IC1b form a CMOS oscillator with a disable input at pin 1 of IC1a. IC1c buffers the oscillator to clock IC2 — a seven bit binary ripple counter. Before PB1 is pressed Q_4 will be high (and Q_1 —Q_3 low) and this will disable the clock. When PB1 is pressed, IC2 is reset, Q_4 goes low and the oscillator is enabled. IC2 will be clocked, switching Q_1 high and low until Q_4 goes high again, stopping the oscillator.

Q_1 is fed via IC1d to IC3, an opto-triac, which will control mains loads up to 25 W. As more power than this may be needed, Fig. 2 shows how the opto-triac can be used to trigger a more powerful triac. As drawn the doorbell will flash mains light bulbs on and off four times. If more flashes than this are needed, connect pin 1 of IC1 to Q_5 or Q_6 of IC2 and the doorbell will flash eight or 16 times.

PROM Expansion Card

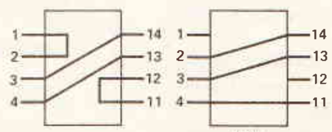
A. Adnitt, Bracknell



This circuit provides a very expandable expansion card for 16 bit address processors and single supply EPROMs. In all expansion cards I have seen they take either four 2K PROMs or two 4K PROMs leaving two empty sockets. Now, by very simple means, an expansion card can be made to give 8K or 16K of memory as shown in the diagram.

If an 8K set-up is first considered with the header wired as shown in Fig. 1a, then pin 21 (Vpp/A11) of IC4-IC7 is held high, A11 and A12 are used for chip select through the 2-to-4 line decoder (half a 74LS139) and IC1 and IC2 are hard-wired to decode address lines A13, 14 and 15 to select a particular 8K block of memory (see table).

Now, when your operator program outgrows this, a new card is not necessary, just a rewire of the header (Fig. 1b) and the larger EPROMs. In doing this, A11 is taken to IC4-IC7, A12 and A13 are used for chip select through IC3 and now with pins 1 and 2 joined together on IC2, hard wiring with IC1 gives a unique 16K block by decoding address lines A14 and A15.



(b)

8K BLOCK	a	b	c
1st	IN	IN	IN
2nd	IN	IN	OUT
3rd	IN	OUT	IN
4th	IN	OUT	OUT
5th	OUT	IN	IN
6th	OUT	IN	OUT
7th	OUT	OUT	IN
8th	OUT	OUT	OUT

IC1

16K BLOCK	a	b
1st	IN	IN
2nd	IN	OUT
3rd	OUT	IN
4th	OUT	OUT

IC1

It must be noted, however, that this can only be used for 2716 and 2732 EPROMs as TEXAS 25XX EPROMs have different pin-outs.

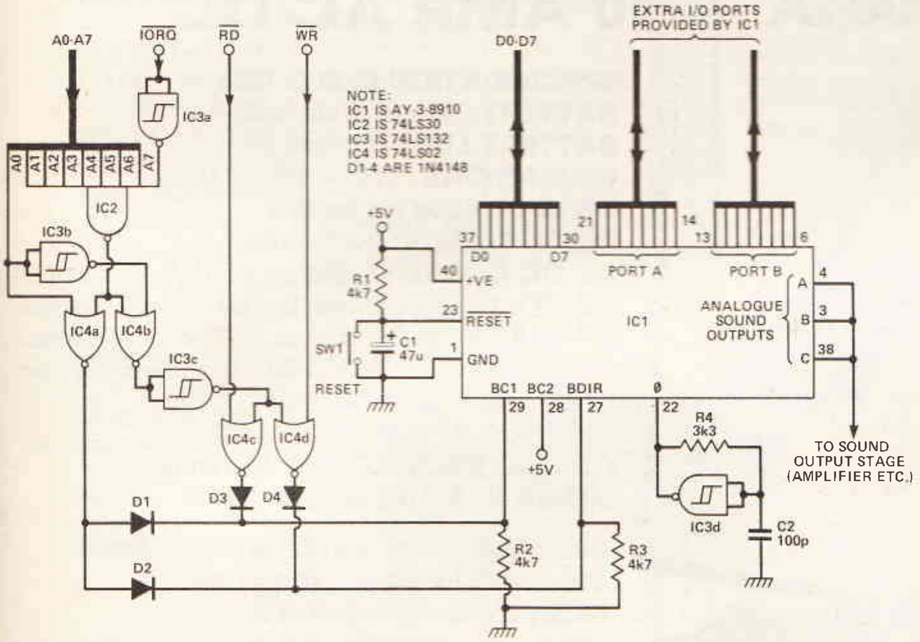
By providing 28-pin sockets and additional wiring, the circuit could be reconfigured to take 2764 PROMs — how's that for versatility, as little as 2K to a mammoth 32K of ROM catered for by one card!

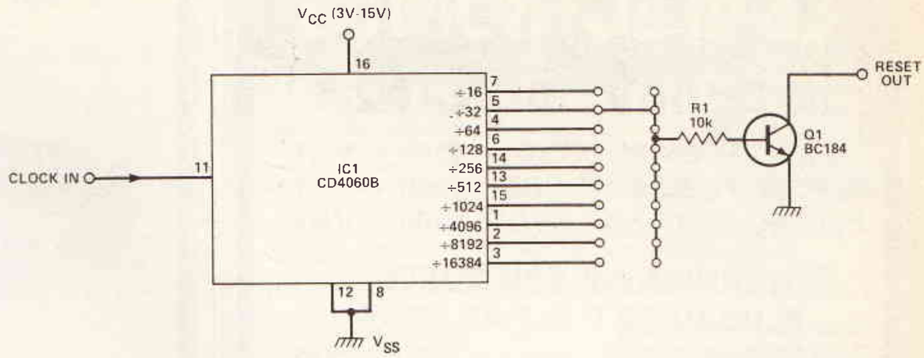
Programmable Sound Generation And the Z80

Bruce Tanner, Malvern

Although the AY-3-8910 Programmable Sound Generator was designed to be operated with General Instruments PIC 1650 series eight-bit microprocessors or the 16-bit CP 1600/1610, it is easily interfaced to the more widely used Z80. The Z80 signals required are A0-A7, $\overline{IORQ}$, $\overline{WR}$, $\overline{RD}$, and D0-D7. In the circuit shown, one of the PSG's registers is selected by writing the required register number to the Z80 port FE (hex) and then the register contents are read/written from/to port FF, although other port numbers may be used by inserting inverters in some or all of A1-A7. In most applications the three PSG audio outputs are connected directly together, although this could be done via manual mixer pots. For a suitable output stage see the computer expansion project in ETI, January 1982.

The PSG offers three independent oscillators with variable amplitudes, a variable noise source and an envelope generator, all in one 40-pin chip. For more information on the chip operation/functions see the General Instrument data sheet, which is often supplied with it.





Microprocessor Debugging Aid

S.K. Garratt B.Sc (Hons), Colchester

If you have ever built a microcomputer system, switched on the power, and found that nothing happened, this simple debugging aid may of interest to you. The problem with troubleshooting microprocessor circuits is the lack of comprehensible signals when probing around the board with an oscilloscope. The answer is simple: the operation of any microcomputer system is predictable, following a pulse applied to the reset line of that system. A 6502, for instance, will spend six clock cycles sorting itself out internally, then make two memory fetches from the reset vector at address FFFC and FFFD. Using the circuit shown it is possible, when connected to a faulty microprocessor system, to examine the address bus, data bus and control signals for several clock cycles after a reset with a simple oscilloscope. (It will be necessary to trigger the oscilloscope timebase from the reset signal generated by the debugging aid.) The user should be looking for such things as broken printed circuit tracks, solder bridges or even high resistance links between tracks, many of which may be easily detected by tracing the system operation during the first few clock cycles after reset.

The debugging aid consists of a CD4060B CMOS divider integrated circuit which is fed from the clock signal of the micro system under test. The output of the CD4060 drives a transistor which in turn may be used to drive the reset line of the microprocessor. This debugging reset signal may be switched to any one of 10 outputs from the CD4060 allowing a choice of the number of clock cycles to be examined.

MINIMUM PAYMENT £20

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ITI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for at a competitive rate.

Drawings should be as clear as possible and the text should be typed. Text and drawings must be on separate sheets. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

ETI

DESIGN COMPETITION RESULTS

The entries started as a trickle and swelled to a torrent, we couldn't get into our office for them (we're allowed a bit of over-emphasis at this time of year). So here is the winner; we also decided to award two runner-up prizes.

Winner: Tim Tanner, of Rainham, Kent, for the 'Humane Alarm'

This circuit is designed to replace the raucous DC buzzer found in some digital alarm clocks. The idea was to design an alarm circuit which would start off at zero volume and increase in loudness over a period of about 30 seconds. By this method the sleeper is brought to consciousness by the minimum sound level required to wake them, instead of receiving a nasty shock in the ear at the crack of dawn. The circuit uses a Pulse Depth Modulation technique to achieve an increase in volume as well as an unorthodox gated astable design to provide the alarm tone.

The increase in volume with time is achieved with just one gate and a few discrete components. IC1d has two distinct states. When pin 9 is low IC1d acts as an ordinary gate and forces the emitter of Q1 to Vcc. When pin 9 is high IC1d ceases to be a gate and becomes an inverting amplifier due to the feedback of C1. R1, R2 and C1 turn IC1d into an integrator. Initially ENABLE is low and so is pin 9: therefore the emitter of Q1 is at Vcc, pin 8 is at 0V and C1 is charged up to Vcc. When ENABLE goes high C1 starts to discharge through R1 and R2. When pin 9 is high the amplifying action of IC1d maintains pin 8 at the switching voltage, approximately half Vcc. Therefore the emitter of Q1 assumes a level that depends on how much voltage is left across C1. Since this gets less with time, the voltage drop

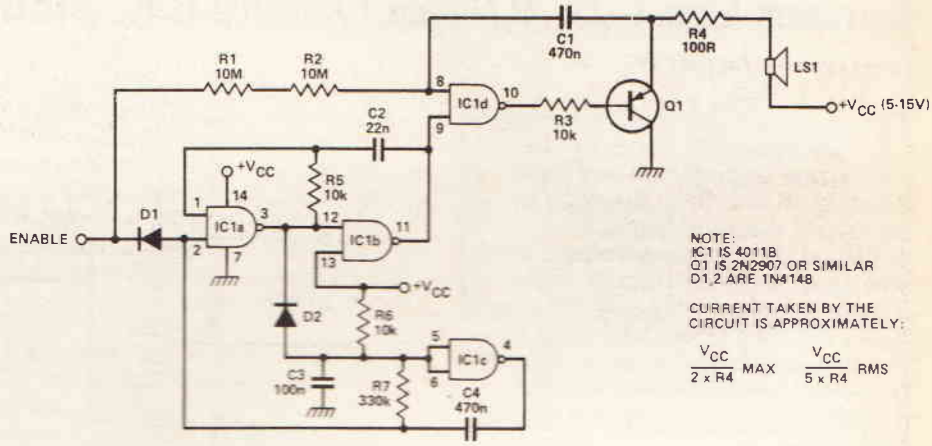
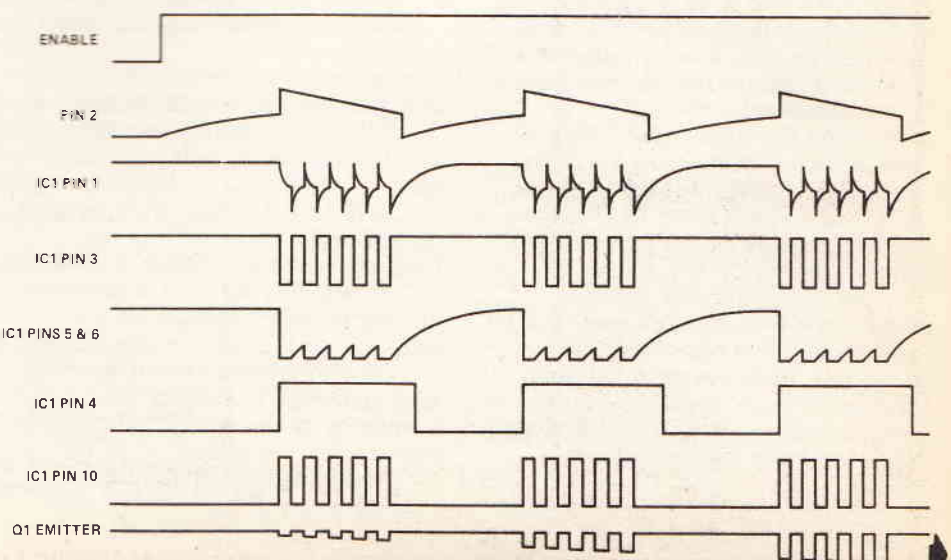


Fig. 1 (above) Circuit diagram of the Humane Alarm.

Fig. 2 (below) Timing diagram.



PARTS LIST

Resistors (all ¼W 5%)	
R1, 2	10M
R3, 5, 6	10k
R4	100R (nominal)
R7	330k
Capacitors	
C1	470n ceramic
C2	22n ceramic
C3	100n ceramic
C4	470n ceramic
Semiconductors	
IC1	CD4011AE
Q1	2N2907 (or similar)
D1, 2	1N4148 (or similar)
Miscellaneous	
LS1	8R miniature loudspeaker
PCB	

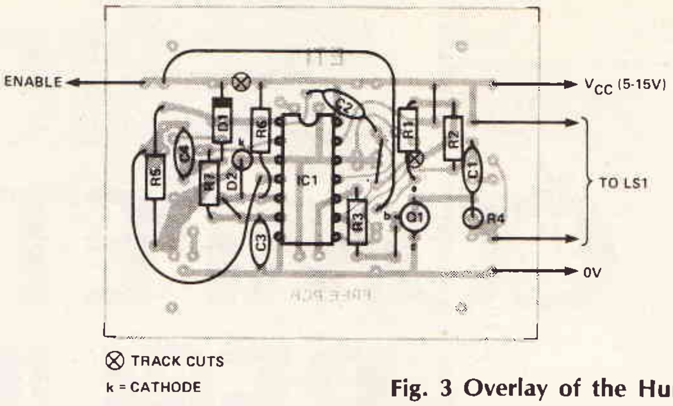


Fig. 3 Overlay of the Humane Alarm.

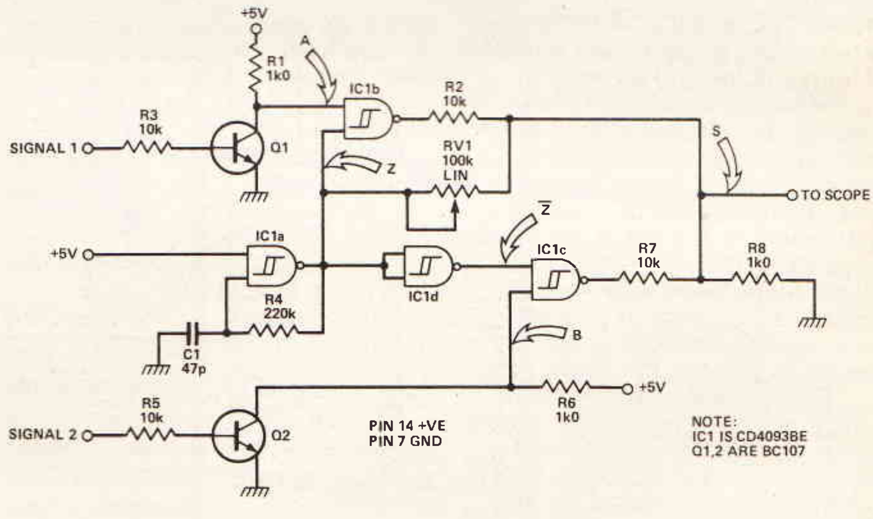
across R3 and LS1 increases with time giving increasing volume.

IC1a-c generate a pulsed-tone waveform. IC1a, IC1b, R5 and C2 form a conventional gated astable which generates the alarm tone. IC1a, IC1c, R7 and C4 form the pulse astable which determines how long the tone astable runs for each cycle. D2, C3 and R6 ensure that the faster running tone astable does not interfere with the operation of the pulse astable. While the tone astable is running, pins 5 and 6 need to be kept low. C3 tries to charge up through R6 but is discharged through D2 every time pin 3 goes low. When the pulse astable switches the tone astable off, C3 is free to charge up through R6 until pin 4 goes low and starts a new cycle. When ENABLE is low both astables are disabled by pulling pin 1 low via D1. Careful study of the 'host' alarm clock PSU will be required to ensure that the ENABLE signal swings between 0V and Vcc.

If the alarm circuit is to be run off the alarm clock PSU take care not to draw any more current than the existing alarm takes. Formulae for the approximate current taken by the circuit are shown on the circuit diagram.

Runner Up: C.G. Bell, of Daigety Bay, Dunfirmline, for this dual trace adaptor.

The circuit employed here generates two traces on the scope upon which any logic input signal is added. Referring to the circuit diagram, Signal 1 is displayed on the upper voltage level and Signal 2 on the bottom. If the display is looked at closely the two traces are seen to be 'stiched' together by a high frequency square wave, but because of the scope's persistence it appears as two normal scan lines.



IC1a provides a relatively high frequency square wave (approx. 100 kHz) which is fed to one input on gates IC1b and IC1c. However before the pulse reaches IC1c it is inverted by gate IC1d to provide a switching action. For the two inputs to be displayed with good resolution the logic input frequency should be no more than a ¼ of the astable frequency. Q1 and Q2 are wired as inverter gates to give the correct polarity of the input signals when they reach the scope.

the potentiometer wired between the switching input of IC1b and point S has two important functions: (i) to ensure a variable degree of trace separation. (ii) to provide a 'summing' function which adds the input signals to their traces.

To get a clearer idea of how the resistor network RV1, R2, R7 and R8 works, refer to the timing diagram and the resulting scope output.

Working from the inverted inputs at A and B, points to note are:

(i) if A or B is high their outputs switch between 1 and 0 at the frequency of the astable;

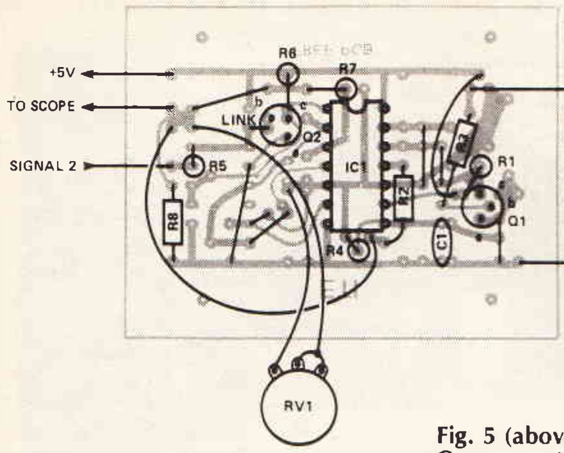
(ii) any low on A or B produces an output which is high for the duration of the logic pulse;

(ii) RV1 is switched, at its input end, between 1 and 0 at the frequency of the astable which is in phase with the output of IC1c.

Assuming no signal input, making A and B high, resistors R2 and R7 are switched between source and ground at 100 kHz. However, the switching of R7 is always the complement of R2. RV1 is in phase with the switching of R7

PARTS LIST

Resistors (all ¼W 5%)	
R1, 6, 8	1k0
R2, 3, 5, 7	10k
R4	220k
Potentiometer	
RV1	100k lin
Capacitor	
C1	47p ceramic
Semiconductors	
IC1	CD4093BE
Q1, 2	BC107
Miscellaneous	
14 pin DIL socket for IC1; input and output sockets to suit	



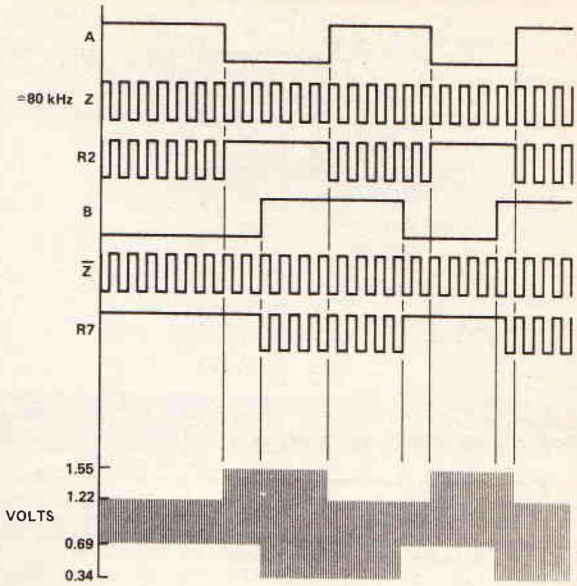


Fig. 5 (above) Component overlay of the dual trace adaptor.

Fig. 6 (right) Waveform diagram of the dual trace adaptor.

and so in this input condition always parallels R7: the result of this is that two resistor configurations are generated alternately for 1/2f seconds each.

The two voltage levels generated form the basic trace lines upon which positive signal excursions can be added. So if Signal 1 goes high and Signal 2 remains low, R2 goes high for the duration of the logic signal but R7 and RV1 are still paralleled and switching between 1 and 0 at the astable frequency. This generates one new resistor configuration which adds 0.344V (RV1 set to 4k0) on to the top trace.

If Signal 2 goes high the bottom trace is raised in similar fashion to a level of approx. 0.69V because RV1 now parallels R8 to ground.

Runner Up: S.D. Solle of REculver, Kent, with the ZX Sound Board.

Sound boards for the ZX81 have been around for some time, however, being in the region of £25 they seem rather extravagant extras. This sound board uses few components, is thus cheap and easy to build, and all manner of sounds can be produced through a simple BASIC program.

The 74LS138 is a one-of-eight decoder, and if the lowest three bits of the ZX address bus (A0, A1 and A2) are used as the three input lines, and A4, IORQ and WR are used as the enable lines, then by POKEing port 11 (not used by the computer) an electrical pulse can be amplified from data output 3 by Q1. The 100n capacitor is used to smooth the current to IC1.

Construction is very simple, the PCB being modified only very slightly. However, it is necessary to mount IC1 upside down in its socket, that is pin 1 is where pin 16 should be and vice-versa. Be very careful when bending the pins (best done with miniature pliers) as they are likely to snap if bent more than once.

The edge connector is available through Watford Electronics. The connections to the edge connector are shown on page 167 of the Sinclair manual.

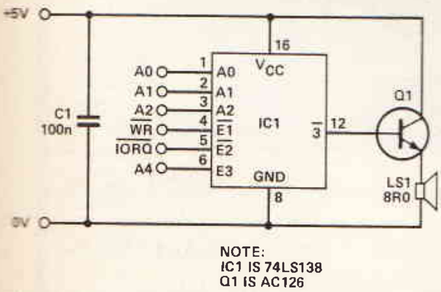
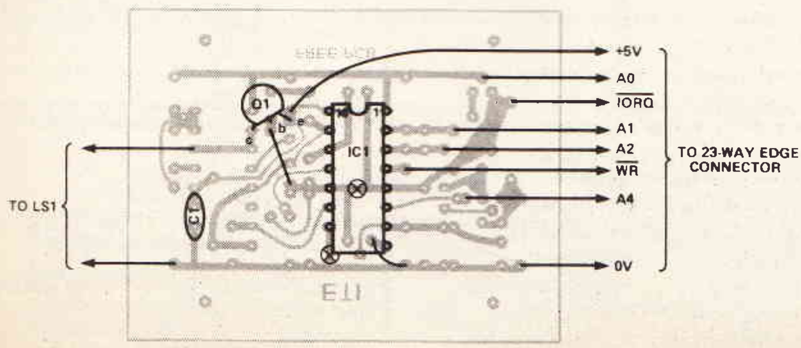


Fig. 7 (above) and Fig. 8 (below) Circuit diagram and overlay of the sound board.



PARTS LIST

C1	100n ceramic
Q1	AC126
IC1	74LS138
Miscellaneous	
8R loudspeaker	
16 pin DIL socket	
23 way edge connector (see buylines)	

BASIC LISTING

```
10 REM: "Y — = ?GOSGOSUB?
   5COPY??ASN?RN DF??RND"
20 PRINT "INPUT COARSE TUNE
   (0-255)"
30 INPUT C
40 PRINT "INPUT FINE TUNE
   (0-255)"
50 INPUT F
60 PRINT "INPUT LENGTH
   (0-255)"
70 INPUT L
80 POKE 16527, C
90 POKE 16526, F
100 POKE 16519, L
110 RAND USR(16514)
120 GOTO 20
```

Type in the above listing, then, before running type in the following direct commands:

```
POKE 16521,186
POKE 16524,73
POKE 16527,2
POKE 16528,188
POKE 16530,136
POKE 16533,195
POKE 16534,143
```

You can now run the program, in FAST mode. (It will not work in SLOW.)

ETI

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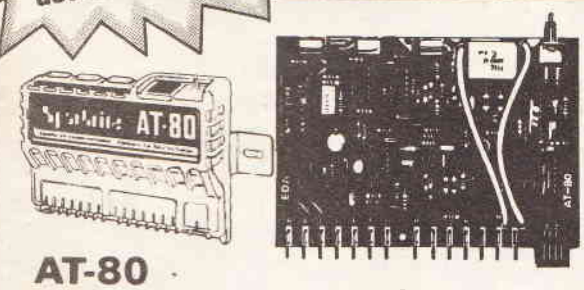

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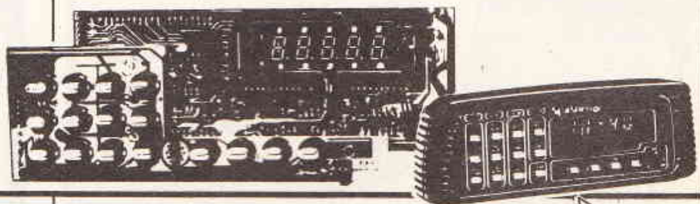

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NEW

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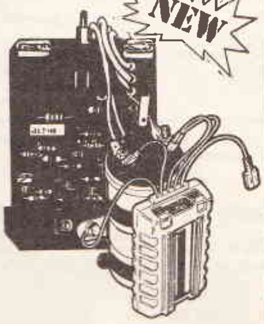

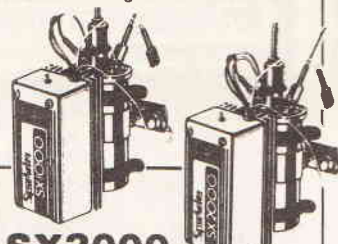

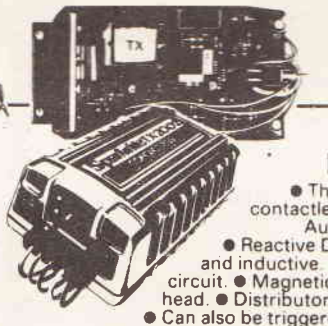

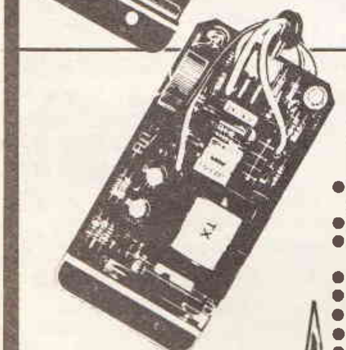

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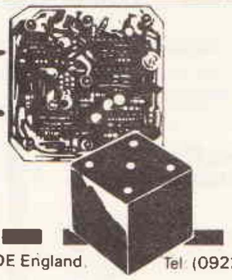

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CONFIGURATIONS

This month Ian Sinclair turns his attention to some of the many circuits that can be used to make waves: could this be a sine of the times?

When you first start to take an interest in circuit configurations, one of the first things that strikes you is the huge variety of sine wave oscillators, many of them known by names that go right back into the mists of time. When you look at these circuits more closely, however, what strikes you is not how different they are but how similar — and that's our starting point for this month.

An oscillator consists of an amplifier with a positive feedback loop and some circuit which has a time constant or is resonant to some frequency. Using this definition, we can include multivibrators among our oscillators, and rightly so, but since we dealt with multivibrators in Configurations Part 4 (November 82 ETI), we'll confine ourselves to sine wave oscillators in this part.

The Shrinking Sine

At times, the amplifier portion seems almost superfluous, because a resonant circuit, which is the most familiar way of forcing an oscillator to operate at some fixed frequency and give a sine wave, is a circuit which will, by itself, oscillate quite happily! The circuit of Fig. 1 will, for example, produce an oscillation when the base of the transistor is briefly pulsed positive. The peak emitter voltage of the transistor during this pulse charges the capacitor, and when the transistor cuts off again, the capacitor discharges through the inductor, setting up an oscillating current which in turn causes a sine wave voltage to appear across the circuit.

This wave decays, however, as Fig. 2 shows, because the coil has resistance and any resistance in a circuit will dissipate energy (as heat) when a current flows through it. That's why an amplifier is needed — just to replace the energy that is lost in the resistance of the coil! Sine wave oscillators that make use of LC resonant circuits do not need a high-gain amplifier, and too much gain will, in fact, distort the waveform, changing it from a pure sine into something more like a square wave. Any oscillator that makes use of the LC resonant circuit must therefore include some means of controlling the gain of the amplifier, because a really well-shaped sine wave will be obtained only when the amplifier gain is just enough to sustain oscillation, and no more. There's another reason: a circuit which includes positive feedback is never very stable, so that the oscillator must include some method of limiting — preventing the amplitude of the oscillation from growing until the tips of the wave start to square off. That's one thing which can be done most easily when the gain of the amplifier is low, because the gain will drop as the transistor approaches the cut-off or the bottomed conditions, and if the gain is low to start with, this drop should be enough to limit the amplitude of oscillation with only a small amount of distortion of the waveform.

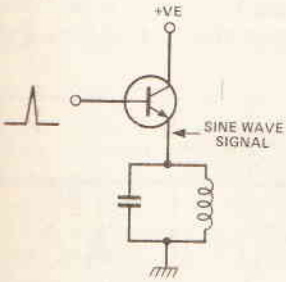
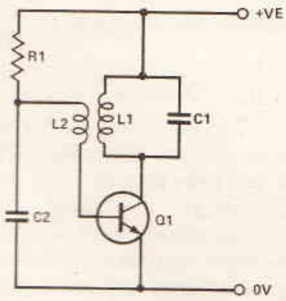


Fig. 1 (Left)A ringing circuit, using a resonant circuit in the emitter of a transistor which is normally cut off, but which can be pulsed briefly into conduction.

Fig. 2 (Right) The form of the 'ringing' wave — this is a sine wave which decays to zero amplitude. If the circuit resistance is very low, the decay may take a 'long' time, meaning that many cycles of wave will be executed before the amplitude becomes zero.



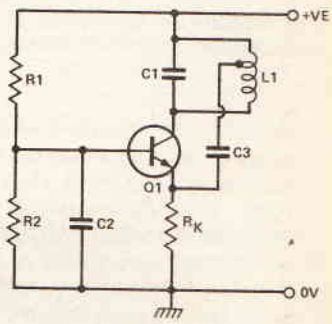
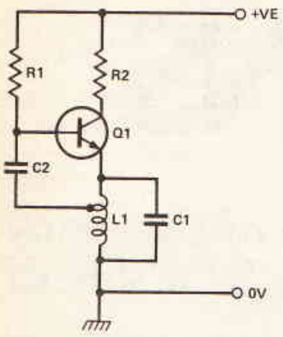


Fig. 3 (Left) A simple two-winding oscillator. This is easy to construct, but not so easy to adjust for a pure sine wave.

Fig. 4 (Right) The Hartley oscillator in one of its many forms. The positive feedback loop is from the collector circuit to the emitter.

Winding You Up

With these words on general principles out of the way, then, we can take a look at some oscillator configurations. Let's start with the simplest one — the two-winding transformer type as shown in Fig. 3. The three building-blocks of amplifier, feedback loop and resonant circuit are obvious, but it's by no means the easiest type to obtain a pure sine wave from. The reason is that the bias of the transistor has to be set by the value of R1, and the gain must be set by the design of L2 — a few turns spaced some distance from L1. There's no quick and easy way of



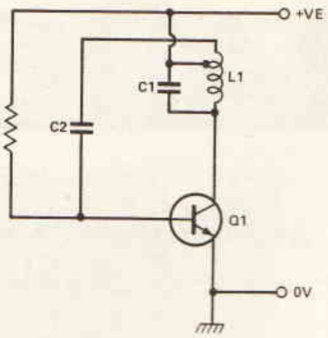
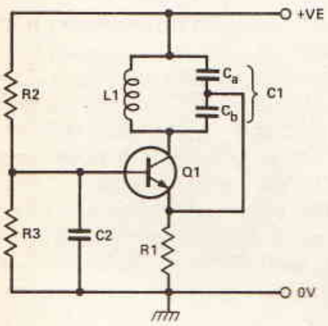


Fig. 5 (Left) Another form of the Hartley oscillator, with feedback from the emitter to the base.

Fig. 6 (Right) A third form of the Hartley circuit, using the coil tapping to invert the signal.

calculating the number of turns and spacing of L2, so that design invariably ends up with cut-and-try methods. The usual technique is to start with too many turns, get the circuit oscillating (which may mean reversing the connections to L2 if you got them the wrong way round), then removing turns for as long as the circuit will continue to oscillate, and finally, restoring a turn or a half-turn. This has to be done to ensure that the circuit will start each time it is switched on.

Much better waveshapes can be obtained with less effort by using the traditional Hartley and Colpitts oscillators that are so beloved of radio hams. One version of the Hartley oscillator is shown in Fig. 4 — this uses feedback from a tapping on the coil to the emitter terminal. This oscillator can give well-shaped sine waves,



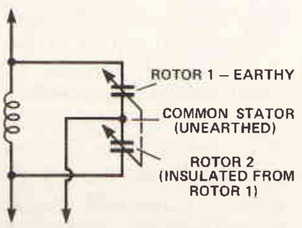


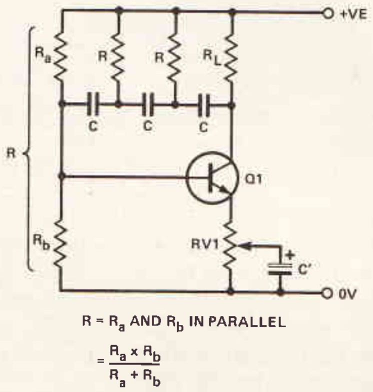
Fig. 7 (Left) The basic Colpitts oscillator.

Fig. 8 (Right) A variable tuning Colpitts can make use of a variable two-gang capacitor of specialised construction.

and seldom needs adjustment. The rule of thumb is to use a coil tapped at about 10% to 20% of its total turns from the 'cold' end (the end connected to the supply), a resistance of around 330R for R_k, and design the bias components R1 and R2 so that the oscillation is a sine wave and is self-starting. The decoupling of the base is essential if the oscillator is to be used as shown; alternatively the base can be driven from a low-impedance source which will cause the output from the resonant circuit to be amplitude modulated.

Figure 5 shows another version of the circuit, in which the tapped coil is in the emitter circuit, feeding back to the base this time, and so leaving the collector free to deliver the waveform. The output wave at the collector is not a pure sine wave, however, so that this output is useful mainly when the output is to be squared to generate harmonics, or if a resonant circuit is to be included in the collector circuit. A wave of better sine shape can be taken from the emitter. Figure 6 shows another variant of the Hartley circuit which uses the tapped coil in the collector circuit — in this example, the tapping is connected to the supply voltage so that the remainder of the coil phase-inverts the signal to feed the base.

The Colpitts oscillator uses a very similar circuit to the Hartley, but with a single coil winding, untapped. The tapping is arranged by using two capacitors connected across the coil, as shown in Fig. 7, which shows the tuned-collector version of the circuit. The combination of the capacitors in series is the tuning capacitance for the inductor, and the ratio of the values should be arranged so that C_a is around $5C_b$ (or more) to give the required signal



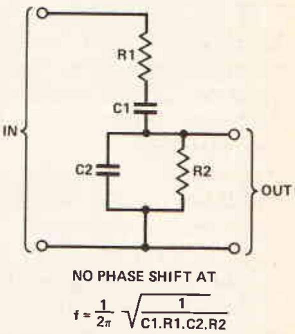


Fig. 9 (Left) The phase-shift oscillator in its simplest form.

Fig. 10 (Right) The Wien bridge circuit, originally devised for measurement purposes.

division ratio. The Colpitts configuration has the advantage that only a two-terminal coil is needed, but the capacitor dividing chain is a nuisance, particularly if frequency has to be varied by using variable capacitors — one solution is the type of twin ganged capacitor shown in Fig. 8.

Since it's possible to make RF oscillators from every conceivable arrangement of amplifier, resonant circuit and positive feedback loop, there are dozens of RF sine wave oscillator circuits, some of them (like the Hartley and the Colpitts designs) stretching back to the 20s and 30s. What keeps the most popular ones alive is that they give

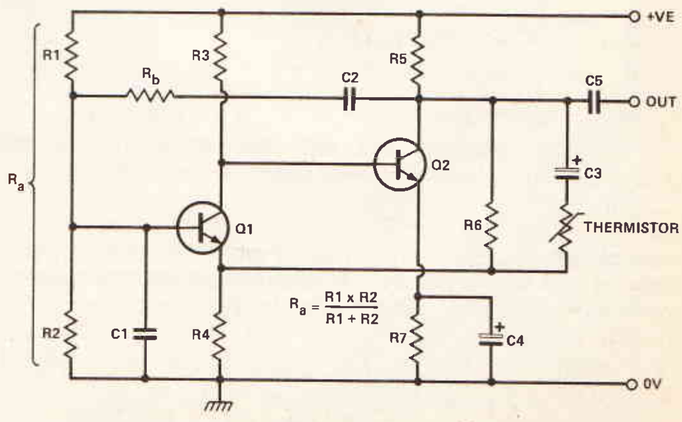


Fig. 11 A Wien bridge circuit circuit, using a thermistor to stabilise amplitude.

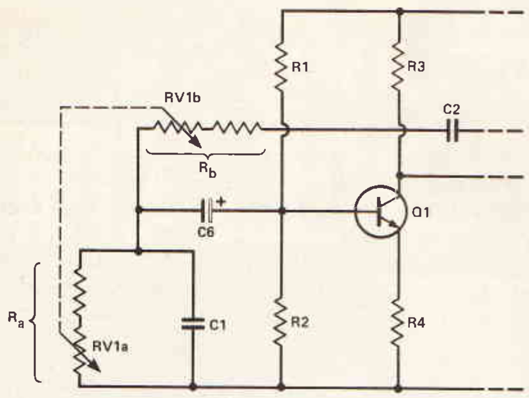


Fig. 12 Frequency variation on a Wien oscillator using ganged potentiometers.

good sine waves, with small frequency drift. There are many other designs which have simply dropped out of use because they could not fulfil the ever-increasingly stringent requirements for frequency stability, so please don't write in with what you think is an original RF oscillator circuit — it's a thousand to one that someone will have patented it in nineteen oatcake and it will have dropped out of use for good reason!

Descending Into Difficulty

At the lower end of the frequency scale, sine wave oscillators which use resonant circuits start to run into component problems. The inductors need iron cores, causing non-linearity, and have very low Q figures (ratio of reactance to resistance), which also permits poorly-shaped

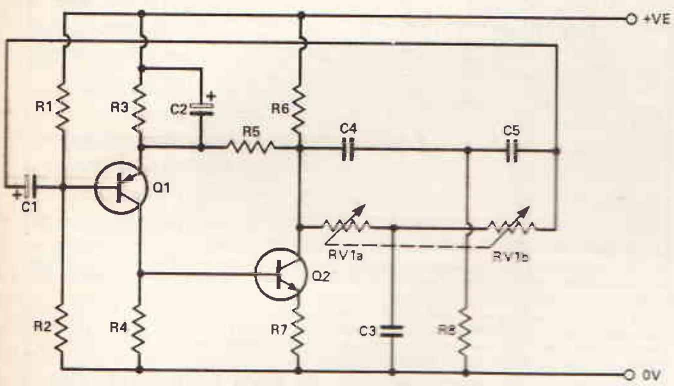


Fig. 13 The twin-T network used in an oscillator circuit.

waveforms. Capacitors tend to be more leaky because of their large capacitance values, and the sheer size of the resonance circuit can be very unwieldy. This leads to the use of RC oscillators for low frequency applications, and to the design of much more complicated oscillator circuits. The problem is that there are no truly resonant RC circuits that are in any way comparable with LC circuits. There are many RC circuits which have minimum or maximum attenuation or phase shift at a 'resonant' frequency, but their selectivity, in terms of the change of frequency is very poor compared to the LC circuit. For this reason, RC oscillators will never give a pure sine wave unless the gain of the amplifier stage is very closely controlled — hence the circuit complications.

The 'classic' RC oscillator circuit is the phase-shift oscillator of Fig. 9. The three RC time constants should be approximately equal, and each should cause a 60° phase shift at the desired oscillating frequency. The set of three then causes a 180° phase shift overall, which is the requirement for oscillation if the gain is sufficient overall. A fair amount of gain will be needed in this circuit because of the attenuation of the three RC circuits, and transistors with low h_{fe} values may not oscillate in this circuit at all. Gain is adjusted by using RV1, which varies the small amount of negative feedback, and this should be set for the best sine wave shape, which will be when the circuit is just oscillating. This may not be the setting for obtaining reliable starting when the circuit is switched on, however.

For purposes where a high-quality sine wave is needed, and particularly if variation of frequency is wanted, more elaborate circuits are used, of which the Wien Bridge and the Twin-T are typical. The Wien bridge circuit itself is shown in Fig. 10 — its peculiar property is that is has zero phase shift at its 'resonant' frequency as shown in the formula. This configuration can be used in a positive feedback loop to ensure that the feedback is in the correct phase only at the correct frequency, but close control of the gain will be needed if the waveform is to remain of good sine shape.

Getting A Bead On It

The conventional way of achieving this on modern RC oscillators is by the use of a subminiature thermistor with negative temperature coefficient. A bead thermistor is used, which will be heated by a signal current of a milliamp or less, and this component is included in a negative feedback loop which controls the gain of the complete amplifier section. When the signal current flowing through the thermistor is high, the thermistor resistance decreases and the increased feedback causes the gain of the amplifier to be reduced. The opposite process occurs if the signal current is too small. The thermistor therefore takes over the task of controlling the gain of the amplifier, allowing us to concentrate our efforts on designing the rest of the circuit.

A typical Wien bridge oscillator circuit is illustrated in Fig. 11. A direct-coupled two-transistor circuit is used, and the gain is controlled by the loop which feeds signal from the collector of Q2 to the emitter of Q1. This loop consists of a fixed resistor R6 and the combination of capacitor and thermistor in parallel with it; the values must be chosen so that the overall gain is fairly low. The Wien bridge network of R_a/C1/R_b/C2 is connected between the collector of Q2 and the base of Q1 (thje positive feedback loop).

Variable frequency operation can be carried out by varying either the resistors of the Wien network or the capacitors, but it is not enough to alter just one component value. Most amateur circuits (see Fig. 12) use small value fixed resistors, plus a ganged potentiometer in series, to make up R_a and R_b: R1 and R2 have high values, so their effect is negligible. Commercial Wien bridge circuits tend to use a FET for Q1, and to carry out frequency variation by using a ganged capacitor for C1 and C2. This gives a larger sweep of frequency, so that fewer ranges are needed, but requires very large resistor values, since the variable capacitors are only 500pF in value. Resistors of many megohms are needed if low frequencies are to be generated, hence the need for the FET at the front end. Commercial Wien bridge circuits can cope with a frequency range of 10 Hz to over 1 MHz in three or four switched ranges.

Finally, Fig. 13 shows a typical circuit using a twin-T network but omitting the complications of the thermistor amplitude control. The twin-T has, for some reason, never been so widely used in this country as in the USA — it seems to be the old Bootstrap v Miller timebase attitude all over again! **ETI**

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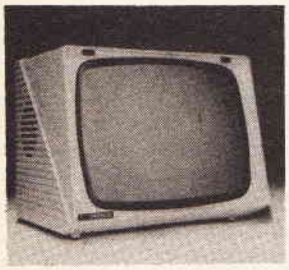

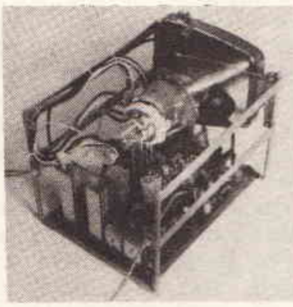

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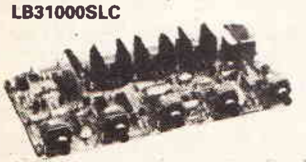

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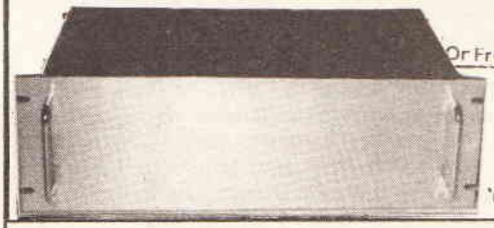

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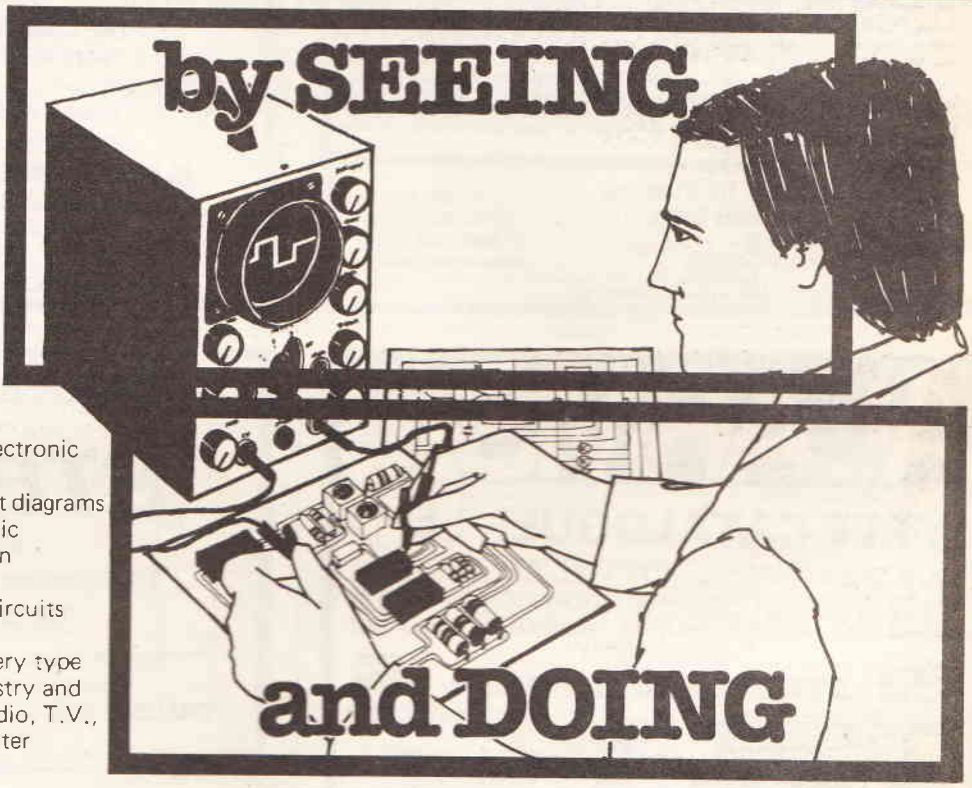

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If, on the other hand, the SYSTEM BUSY is asserted when a reset input is received, the 1Q output will be blocked by the 2Q line until either the busy signal ends (to prevent any data in I/O transit being lost) — or, if the busy line remains 'high' due to a fault, until timeout pulse 2Q ends. Set the timeout components (C2, R5) so that the interval exceeds safely any expected busy interval. Set the RESET interval (C3, R4) to give the required length of pulse *longer* than the timeout period.

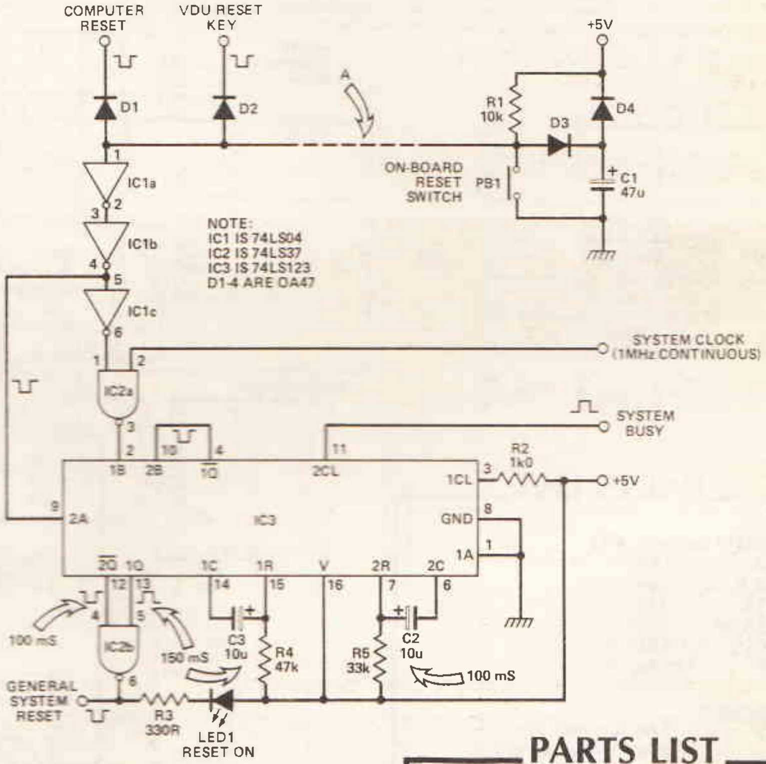

Fig. 1 Circuit diagram for the computer reset generator.

The CLOCK line (any continuous system clock will do) and IC2a provide a permanent RESET if any reset swtich is held down LED1 gives a visual indication of the RESET function.

PARTS LIST

Resistors (all ¼W, 5%)	
R1	10k
R2	1k0
R3	330R
R4	47k
R5	33k
Capacitors	
C1	47u 16 V Electrolytic
C2,3	10u 16 V Electrolytic
Semiconductors	
IC1	74LS04
IC2	74LS37
IC3	74LS123
D1-4	OA47
LED1	any red LED

Time-out Generator And System Failure Alarm

This circuit provides an audible warning of a master clock and/or derived clock failure. It also generates its own time-out reset pulse (which can be applied to the previous circuit at the point A). The two clock lines tested (I suggest the continuous MASTER CLOCK and some derived clock pulse train far down the circuit chain — eg the RAM clock) are biased by R1, R2 and R3, R4 so that pulses via C1 and C2 continously re-trigger the second timer in IC4. If any interruption occurs in either clock line longer than that set by C4, R6 (preset this safely longer than any normally expected period between the clock pulse trains), the $\overline{2Q}$ line will return high causing IC5a to change its outputs and trigger the alarm.

The SYSTEM BUSY line going low will trigger the other half of the timer. If after a preset interval (C3, R5) the busy line is still asserted low the output $\overline{1Q}$ of IC4 will clock IC5a and change the 2Q and $\overline{2Q}$ outputs. In addition to triggering the alarm a TIME-OUT RESET is generated via IC1b. (This could be applied to the RESET GENERATOR circuit making a virtually self-correcting system). IC1b prevents the self-preset system operating in the case of the clock failure as this will usually indicate a more serious hardware fault, ie a short).

The alarm used is a two tone 555-based sound generator requiring 15 V for adequate volume. This has been used to distinguish between the clock and/or timeout failure (high tone) and the high temperature warning described in the fourth circuit (low tone). The output from IC2d enables the 555, while IC2e controls the tone by switching Q1.

PARTS LIST

Resistors (all ¼W, 5%)

R1,2	**1k5**
R3-6,9,10	**1k0**
R7,14	**33k**
R8,15,16	**10k**
R11,13	**15k**
R12	**56k**

Capacitors

C1,2	**1n0 ceramic**
C3	**47u 16 V electrolytic**
C4	**22u 16 V electrolytic**
C5	**33n ceramic**

Semiconductors

IC1	**74LS32**
IC2	**74LS06**
IC3	**74LS08**
IC4	**74LS123**
IC5	**74LS74**
IC6	**555**

Miscellaneous

TX1	**PB-2720**

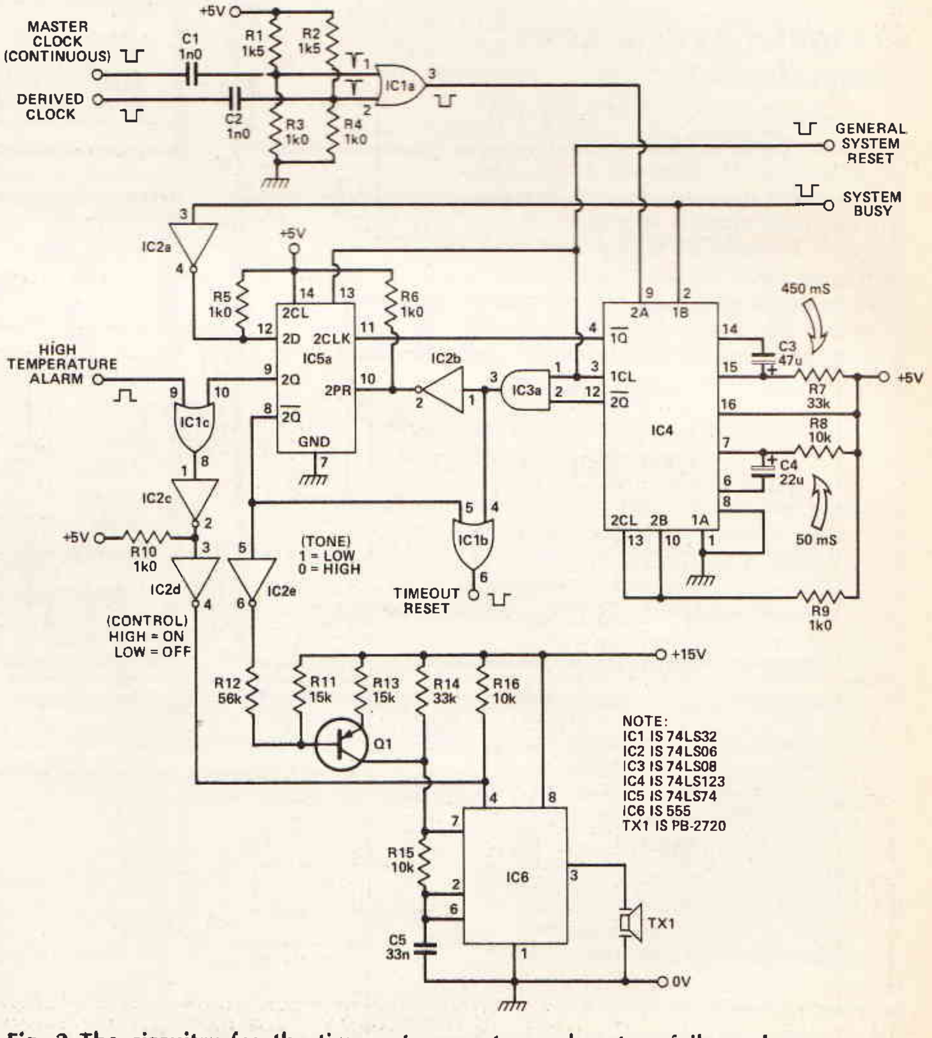

Fig. 2 The circuitry for the time-out generator and system failure alarm.

Supply Voltage Check Scan and DVM Display

This simple scanning circuit is used to check the status of the multitude of DC supply lines in a typical computer/peripherals system. A continous clock input is divided by IC1 (more 7493s can be used if only fast clocks are available) and decoded by IC2.)

The various supply voltages are divided down by the resistor networks R2-R9 and R10-R17 to provide safe levels for the analogue multiplexer IC3, a CMOS 4051B, which passes the selected supply line voltage to the standard DVM circuit. In this case the Intersil ICL 7107 single chip voltmeter is used together with four 7-segment LEDs to provide an accurate visual check on the DC supply lines.

The last input is used to display (in °C) the temperature reading taken by the sensor described in the next section.

PARTS LIST

Resistors (all ¼W, 5%)

R1-9	1k0
R10-17	5k6
R18	270R
R19	1k5
R20	470k
R21	180k
R22	100k

Potentiometers

PR1	220k miniature horizontal preset
PR2	2k2 miniature horizontal preset
PR3	470k miniature horizontal preset

Capacitors

C1,9,11	47u 16 V electrolytic
C2,4,8,10	100n polycarbonate
C3	100p ceramic
C5	10n ceramic
C6	47n ceramic
C7	220n polycarbonate

Semiconductors

IC1,2	74LS90
IC3	4051B
IC4	7107
DISP1-4	common anode seven-segment displays, one half and three full

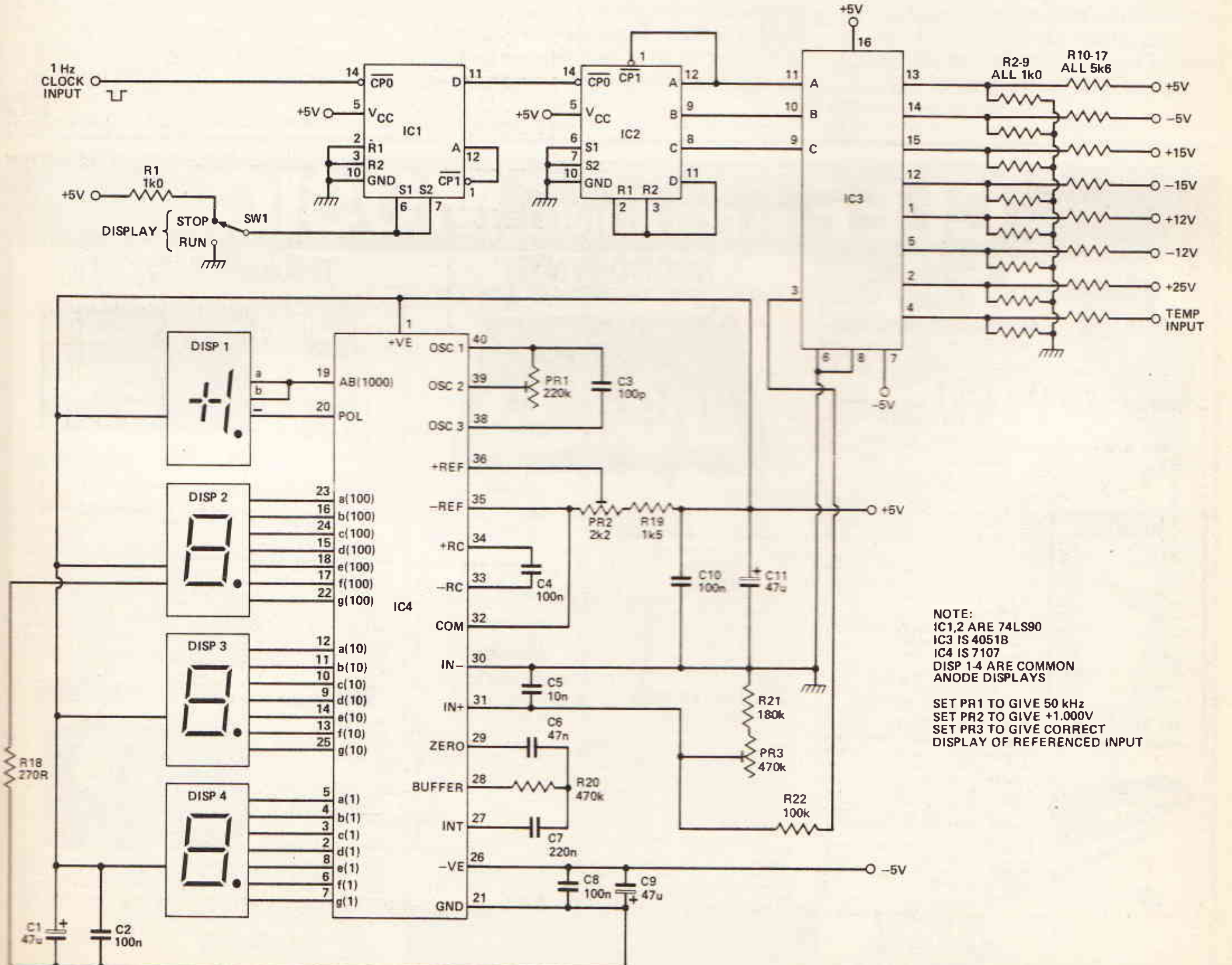

Fig. 3 The supply voltage check scan and DVM display.

PARTS LIST

Resistors (all ¼W, 5%)	
R1	8k2
R2,4	1k0
R3	22k
Potentiometers	
PR1,3	4k7 miniature horizontal preset
PR2	22k miniature horizontal preset
Capacitors	
C1,2	100n ceramic or polycarbonate
Semiconductors	
IC1	AD590
IC2	LM311
ZD1	5V6 400 mW zener
ZD2	6V8 400 mW zener

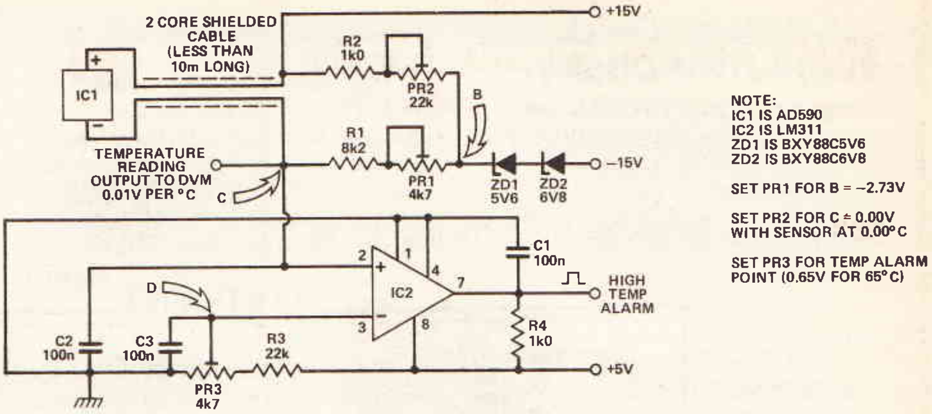

Fig. 4 Circuit diagram for the temperature sensor and alarm.

Computer System Temperature Sensor And Alarm

Analog Devices' AD590 temperature sensor is used to provide an output in degrees Centigrade of the temperature inside the computer console. Zener diodes ZD1, 2 and preset PR1 provide the conversion voltage of —2.732 V needed to change the degrees K to degrees C. PR2 is used to zero the AD590 sensor linear output at some point of its scale (—50° to +150° C). I suggest the 0.00 V output should be set with the sensor in a beaker of a crushed melting ice. The sensor output is best displayed on a digital voltmeter (0.01 V per degree C) or on the specialised DVM chip (see previous circuit).

A voltage comparator (IC1) is used to compare the temperature sensor output with a value preset by PR3 and trigger the high temperature alarm when this value (65°-70° C for most TTL and CMOS) is exceeded. This alarm output can be connected to the alarm buzzer as described in the second circuit.

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Signed ....

Name ....

Address ....

....

....

READ/WRITE

Letters for this page should be addressed to Read/Write at our Charing Cross Road address.

Dear Sirs,

With regards to the Earth Leakage Circuit Breaker article (Electronics Today International Vol. 11 No. 12 December 1982), may we, as manufacturers of ELCB socket outlets, offer the following cautionary advice.

In the article the following recommendation is given for the selection of the relay, ". . . so it's best to use a relay that is capable of switching the full 13 amp maximum that you will ever draw from a socket".

This statement we feel could be dangerously misleading, as under fault conditions very high currents can occur. For example a typical domestic 13 amp fuse will pass approximately 150 amps for a period of 30 mS, and 200 amps for a period of 10 mS.

Our extensive testing of compact relays for this application revealed that short time let through currents of these magnitudes are in excess of relay switching duty capabilities, and that resultant contact welding is a very real possibility.

For this reason our earth leakage sockets incorporate a circuit breaker as the switching element, which possesses switching capabilities well in excess of the demands made by a 13 amp fuse.

Yours faithfully,
for Dorman Smith Britmac Limited, Preston.
E. Johnston,
Project Leader.

In the light of the above comments, we'd like to recommend two courses of action to builders and users of our ELCB design:

1) Use the best quality relay you can, and, if you ever accidentally apply a short circuit to the output terminals, afterwards check, using the test button, that the relay does still release and check visually for damage to the relay contacts;

2) Make sure that all appliances have appropriate fuses (you should have done this anyway). This means that for most hand and garden tools, a 5 A fuse should be used.

Dear Sirs,

It is with much regret that I am writing to you to point out a lethal error in your article on mains potential and safety in your December issue. I am most annoyed that you have made this mistake as many newcomers may read it and be mislead.

ERROR

*IF A FAULT OCCURS IN A PIECE OF MAINS OPERATED EQUIPMENT ANY EXTERNAL METAL PARTS MAY BE PLACED AT **EARTH** POTENTIAL: as you know this should read **MAINS** POTENTIAL.*

Please rectify this fault in your next issue.

W. Moore,
Ashton in Wakefield.

PS I hope you are not dead yet.

Thank you for your wish at the end of the letter — no, we aren't yet dead, but, at the time of writing, we do have the office Christmas party to come!

Seriously, we too are pretty annoyed about the mistake; we hope that everyone who built the project spotted it, as it is rather an obvious blunder.

Dear Sir,

Having just completed the "Touch Dimmer" from Electronics Digest, Volume 2, No. 2, Autumn 1981, I am disappointed to find that a buzz is present which does not allow me to use the unit in the place where I had originally intended it to go. I would be grateful if you would give me some advice in isolating and eliminating this noise.

Yours faithfully,
Christopher Jones,
Solihull.

No you're not reading the wrong magazine; this isn't Electronics Digest, but the Editor's office for ED is not one million miles from the ETI editor's office, and this letter gives us the opportunity to pass on a useful hint.

In general, buzzes in light dimmer circuits come from the suppression components, and in particular from the RF choke (inductor, to those of a more recent electronic vintage). One solution we've used is to set the choke coils in an epoxy adhesive, such as Araldite. Other types of adhesive should not be used, as they might catch fire, and even epoxy adhesive should not be used if the choke shows any tendency to get hot in use.

Sir,

I write in response to the letter from Mr A. Worsley published in the November issue.

It is a sad fact that when an inventor makes an invention, self appointed critics crawl out of the woodwork, eager to discredit the inventor and/or the contribution made by the invention and to offer the world their own highly colourful advice to the inventor. I am certain that your readers will readily recognise the 'what you should have done' brigade.

Mr. Worsley was, in fact, one of a number of subjects upon whom I tried various pieces of test equipment back in 1978/9 and, as with all the subjects, I explained certain structural and operational features of the devices, under the normal bond of confidence as must exist between a researcher and his subject. The devices explained to Mr. Worsley were each capable of performing a single function in my overall technique. Since Mr. Worsley has never seen a dream-machine designed and approved by me, I leave it up to your readers to form their own opinions on the value of his observations.

If I may now reply to Mark Botham's letter in the previous issue. The dream machine has been the subject of continuous development since 1979 and, in its present form, is capable of performing a number of functions to assist an untrained subject. The device is now being tested by selected subjects in the Hearne Research Organization. The Organization has been set up specifically to allow the public access to dream techniques and electronic aids such as the dream machine, and to guide individuals to develop their respective talents in the art of dreaming. Any readers interested in learning more of the Organization should write to me at the address below.

Yours faithfully,
Keith Hearne (B.Sc., M.Sc., Ph.D.),
Hearne Research Organization,
PO Box 84,
Hull HU1 2EL

Dear Sir,

Following up a comment that you made in Read/Write, October 82 issue: "We will do a design for a sound processing preamp if there is sufficient demand from readers". This letter is simply to register my interest in such a project, and a couple of thoughts, which due to my limited knowledge in this field may not be relevant. However, I think I'm correct in saying that the basic operation of the Carver holographic amp is to feed to the right hand speaker not only its usual signal but also a signal that will cancel the left hand signal when it reaches the right ear, and vice-versa; this is necessarily repeated over several stages. It is then delivering to the ears the same sounds as they would hear were they wearing headphones.

My interest is in the reverse situation. Having listened to normal and binaural stereo signals on stereo headphones I wondered whether something could be done about the artificial quality of the former mode of listening (ie normal stereo signals, designed to give their best approximation of realism when fed through speakers, being delivered separately to each ear). Though this is fine when listening to many multi-tracked studio recordings, it totally defeats the object of recordings which attempt to recreate the acoustics of a live performance. Perhaps a realism approaching that of good binaural material could also be achieved when listening to a normal stereo signal on headphones if the headphones tricked the ears into thinking they were listening to speakers — that is, the right earpiece (and therefore ear) received not only its normal signal but also a processed signal representing what the right ear would hear from the left speaker when listening to speakers (and vice-versa). This seems to be the same principle as the Carver holographic amp, but with some inverted signals. Perhaps a sound processing preamp design could also be made to cope with headphones, with a litle extra complexity.

My interest arises from the fact that I'm currently assembling a hi-fi system for headphone listening — one reason being to avoid annoying people around me with excessive volume.

Yours sincerely,
Christopher J. Travis,
Hitchin.

Watch this magazine!

Dear Mr Bradshaw,

Thank you very much for the exposure given to our Viewdata modem (and nuts) in the October issue of ETI. As a regular reader of the magazine, I was naturally pleased to see our product in your 'News' section, complete with the ETI flavour of write-up. I felt that the least we could do was to explain to you what the nuts mean in our advertising.

We design and manufacture from Reading a series of Modems, Multiplexors and Port Selectors. Once assembled, they all look the same (plain, plastic boxes). As they are just as 'plain' as competitive devices, we have chosen to market each range of product with a fruit (or nut). For instance:—

a) 'Modems for Peanuts'
b) Multiplexors — 'Still squeezing data through the old fashioned way? — Concentrate it's cheaper' — so we use oranges.
c) Line Drivers — 'Is the cost of high speed modems driving you bananas?' — hence bananas.
d) Port Selectors — 'Port costs taking a slice out of your budget?' — (see brochure on melons).

Enclosed is a selection of other brochures to show how we have used fruit in advertising. I hope you can now see the connection between our modems and nuts.

Thanking you. I remain,
Yours sincerely,
Douglas S. Staples,
Southern Area Sales Manager,
Micom Borer.

Dear Editor,

Many thanks for forwarding on the latest issue of ETI. My point relates to the article on the new Oric-1 which appeared on page 11.

The Tangerine comment about ULAs is incorrect. The ULAs for both the ZX81 and the Spectrum were completely designed by Sinclair Research and then custom-built for us by Ferranti.

Hope this will set the record straight.

With best wishes,
Yours sincerely,
Bill Nichols,
Sinclair Research Limited
23 Motcomb Street,
London SW1X 8LB.

Dear Sir,

I have just read a letter in Read/Write (ETI October 82) from Gareth Lee regarding the Expander circuit published in your '100 Circuits' feature, and I thought my own experiences with this circuit may be of some interest, particularly to Mr Lee.

I built the circuit for use with my mobile disco and it's used as an expander only. Firstly it is possible to control the expansion ratio crudely by wiring a stereo pot of about 50k between the output and straight-through signal; remember the signal has undergone a 180° phase shift and will have to be inverted again before this control will work. I found it best to do this with an op-amp on the output of the IC with its gain set at five because at audio levels (775 mV in my case) the unit attenuates. It should be possible to alter the gain of the IC by altering the feedback resistor, and using the op-amp to buffer and invert the straight-through signal.

The noise from the IC is not excessive and on my amp is about the same level as that on the phono input.

A possible improvement that may improve the units' appeal to the hi-fi enthusiast would be to split up the audio spectrum into three parts and build separate compander circuits to deal with each part in a similar way to the dbx 38X unit. The circuit is certainly a lot cheaper than a dbx; now how about a circuit for a boom box (Sub harmonic synthesizer) like the dbx 100 unit.

Yours sincerely,
Simon Cooke,
Manchester.

Sinclair Computers: ULA designed by Sinclair

ETI PCB SERVICE

Up until now PCBs were always the hardest component to obtain for a project. Of course you *could* make your own, but why bother anymore?
Now you can buy your boards straight from the designers — us! As of this issue all (non-copyright) PCBs will be available automatically from the ETI PCB Service. Each board is produced from the same master used to build our prototypes, so you can be *sure* it's accurate, and will be finished to the high standard you would expect from ETI.
In addition to the PCBs for this month's projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please note that NO OTHER BOARDS ARE AVAILABLE. If it's not listed, we don't have it!

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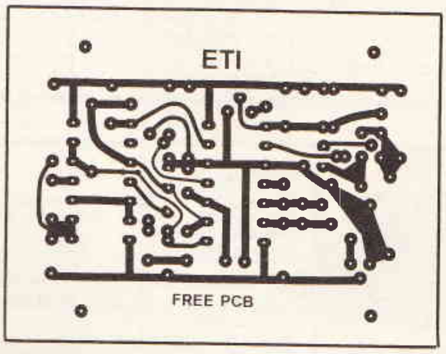

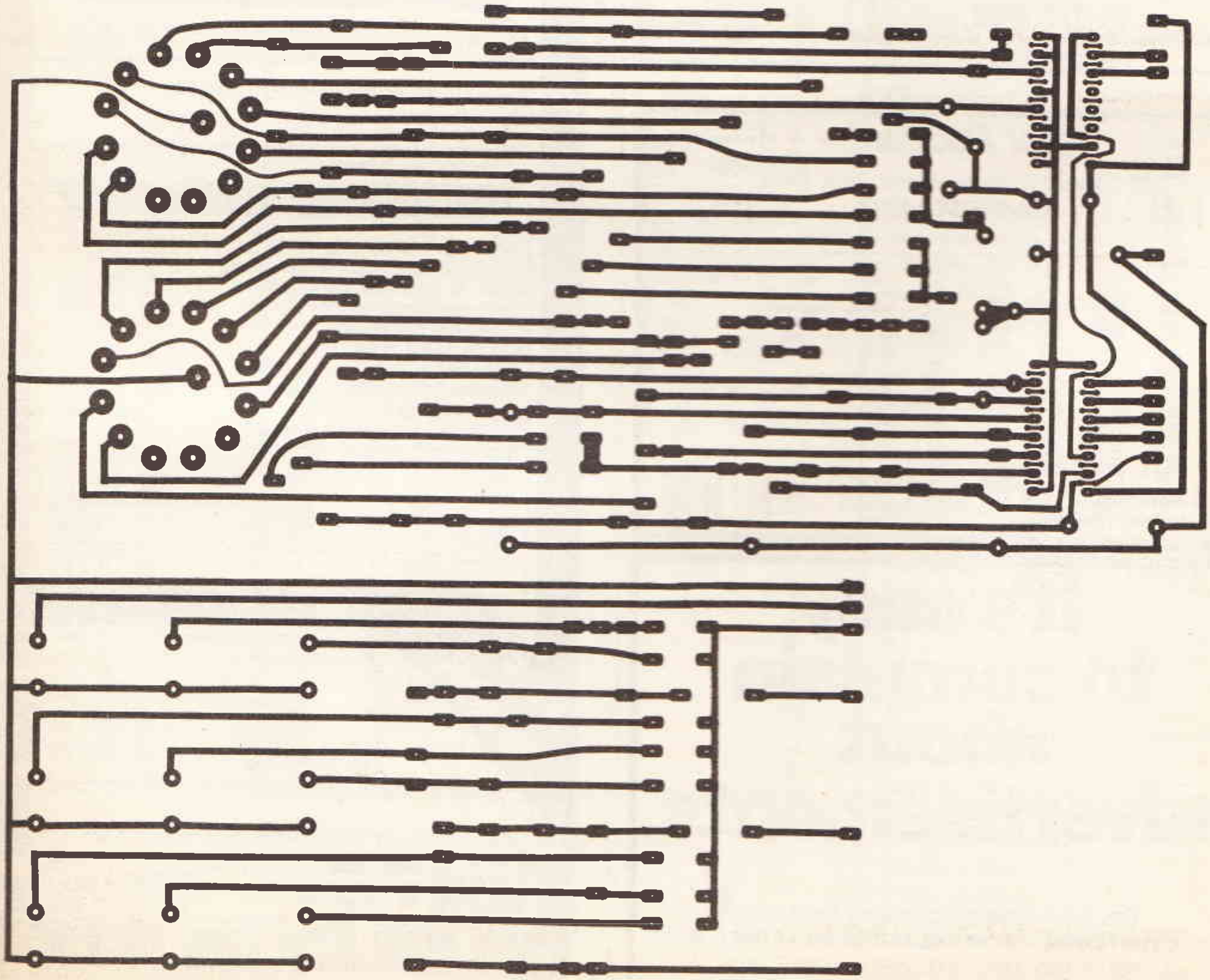

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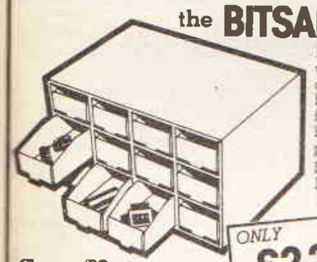

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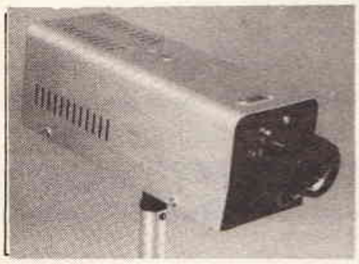

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Baker P.A.	Group 100	15in	100	8/16	£32.00
Baker P.A.	Disco 100	15in	100	8/16	£32.00
Goodmans	HPD Disco	12in	120	8	£29.50
EMI	450	13×8in	10	3/8	£8.00
Goodmans	HP Bass	18in	230	8	£80.00

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3 ohm, 5 × 3in, 7 × 4in. £2.50; 8 × 5in, 6½in. £3; 8in. £4.50; 10in. £5.
8 ohm, 2in. 2½in. £2.00; 3in 5in. 5 × 3in. 6 × 4in. 7 × 4in. £2.50
6½in; 8in x 5in £3; 8in. £3; 10in. £5; 12in. £6.
15 ohm, 3in. 5 × 3¼in. 6 × 4in. 5in. £2.50. 6½, 8 × 5in. £3.
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1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.**
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1000mF 12V **50p**; 25V **35p**; 50V **50p**; 1200mF/76V **80p.**
2200mF 6V **25p**; 25V **42p**; 40V **60p**; 2000mF/100V **£1.20.**
2500mF 50V **70p**; 3000mF 25V **50p**; 50V **65p.**
3300mF 63V **£1.20**; 4700mF 63V **£1.20**; 2700mF/76V **£1.**
4700mF 40V **85p**; 1000mF 100V **£1.**

HIGH VOLTAGE ELECTROLYTICS

8/450V	45p	8 + 8/450V	75p	50 + 50/300V	50p
16/350V	45p	8 + 16/450V	75p	32 + 32 + 32/325V	75p
32/350V	75p	20 + 20/450V	75p	100 + 100/275V	65p
50/350V	80p	32 + 32/350V	85p	150 + 200/275V	70p
50/450V	95p	32 + 32/500V	£1.80	220/450V	95p

TRIMMERS 30pF, 50pF **10p.** 100pF, 150pF **15p.** 500pF **30p.**
CONDENSERS VARIOUS. 1pF to 0.01mF 350V **5p.**
400V-0.001 to 0.05 **5p**; 01 **15p**; 0.25 **25p**; 0.47 **35p.**
1000V 0.1mF **25p**; 0.22mF **30p**; 0.47mF **60p**; 1750V 0.22mF **50p.**
WAFER SWITCHES. 1 pole 12W, 2 pole 6W, 3 pole 4W, 4 pole 3W, 2 pole 2W, 4 pole 2W **60p** ea.
TWIN GANGS 120pF **£1**; 500 + 200pF **£1.**
SINGLE SOLID DIELECTRIC 100pF, 500pF **£1.50.**
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HIGH STABILITY. ½W 2% 10 ohms to 1 meg. **10p**
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WIRE-WOUND 10 ohm to 10K 5 watt **20p.**
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9V 250ma	£1.50	£1	20/40/60V 1A	£4.00	£2
9V 3A	£3.50	£1	25-0-25V 2A	£4.50	£2
9-0-9V 50ma	£1.50	£1	28V 1A Twice	£5.00	£2
10-0-10V 2A	£3.00	£1	30V 1½A	£3.50	£1
10-30-40V	£3.50	£1	30V 5A and 17-0-17V 2A	£4.50	£2
12V 100ma	£2.00	£1	35V 2A	£4.00	£1
12V 3A	£3.50	£1	34-29-0-29-34V 6A	£12.00	£2
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Get moving with these new developments in UK Robotics

— advanced electrohydraulic designs for education, industry and now available to the home constructor.

It is a turtle-type robot which takes programming the two dimensional world of the VDU into the real dimensional world. Given a DC supply of 9-15V it can a bewildering number of moves under computer — forwards, backwards, left and right — with each independently controlled. It has blinking eyes, bleeps a choice of two tones and has a solenoid operated pen to its progress. Touch sensors coupled to its shell return about its environment, to the computer for it to calculate or exploratory action. Hebot II connects directly to port or alternatively with the universal interface board the expansion bus of a ZX81 or other computer.

HEBOTT II

Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus – the ZX81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep programming simple and the robot is operated under BASIC commands with no computer specific software required. The interface board is memory mapped using only 64 bytes at any of 1024 switch selectable locations.

MICROGRASP robot kit with power supply	**£125.00**
Universal computer interface board kit	**£48.50**
23 way edge connector	**£2.50**
ZX81 peripheral/RAM Pack splitter board	**£3.00**

MICROGRASP, INTERFACE BOARD AND ZX81

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If computers interest you then the Cortex will expand your understanding infinitely more than off the shelf machines. Use it in business, education, research or just play with the incredible graphics capability. At Powertran we are using these machines in conventional roles, in product control and R & D. We shall co-ordinate the Cortex user group and distribute software for the TMS 9995 CPU. Complete 16 bit 64K computer kit **£295.00** + VAT. Complete 16 bit 64K computer ready built **£395.00** + VAT.

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...Electronics Today International December issue on CORTEX)

Example prices and specifications

Genesis S101
Base: 19.5" × 11" × 7.5"
Lifting capacity: 1500gm
Arm lift: 6.6"
Weight: 29Kg

4 axis model in kit form	**£390**
5 axis model in kit form	**£445**
5 axis model Ready Built	**£790**

Genesis P101
Base: 19.5" × 11" × 7.5"
Lifting capacity: 2000gm
Arm lengths between axles: 14.0"
Weight: 34Kg

4 axis model in kit form	**£495**
6 axis model in kit form	**£595**
6 axis model Ready Built	**£950**

Complete Systems as shown in Photograph above

Genesis S101

4 axis system in kit form	£635.50
5 axis system in kit form	£695.00
5 axis system Ready Built	£1355

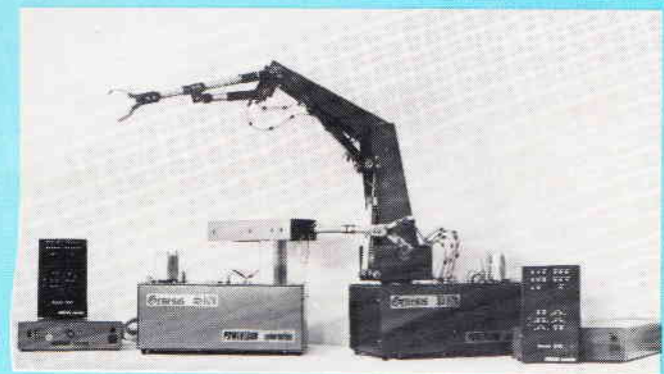
Genesis P101

4 axis system in kit form	£742.00
6 axis system in kit form	£852.00
6 axis system Ready Built	£1525

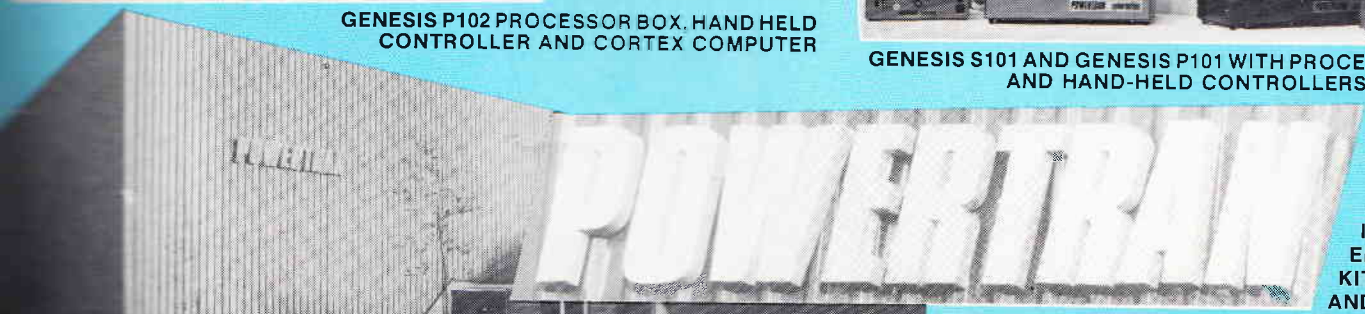
All prices exclusive of VAT

With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operated from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.

GENESIS P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER



GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS



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