electronics today

INTERNATIONAL

ISSN. 0142-7229

MAY 1981 65p

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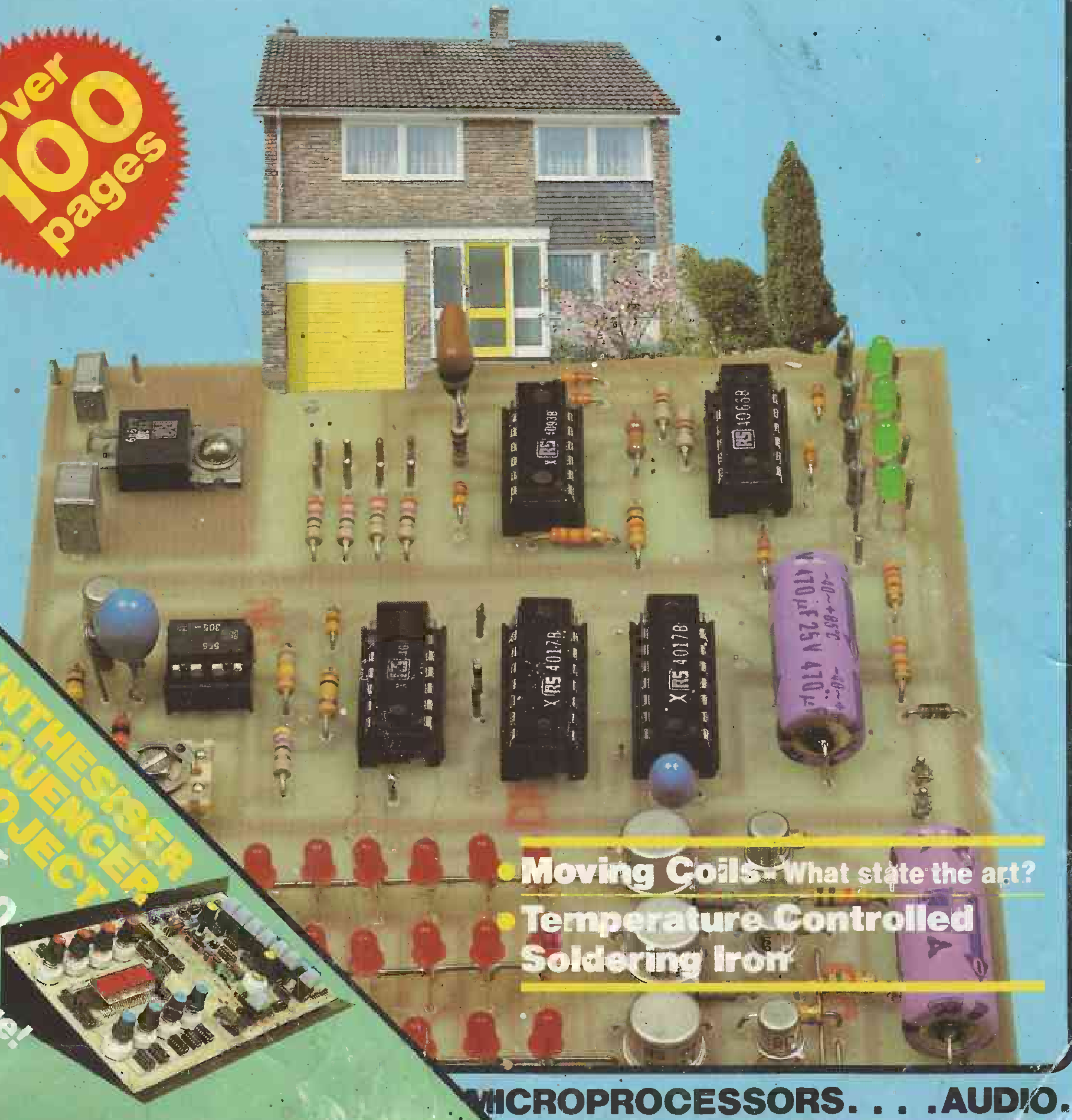

SYNTHESISER SEQUENCER PROJECT

Over 1000 note storage!

- Moving Coils - What state the art?
- Temperature Controlled Soldering Iron

MICROPROCESSORS. . . .AUDIO. .

TRANSCENDENT POLYSYNTH

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready built equipment costing thousands of pounds. Designed by synthesizer expert Tim Orr and being featured in this issue of Electronics Today International, this latest addition to the famous Transcendent family is a 4 octave (transposable over 7½ octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes. Whereas conventional synthesizers handle only one at a time.

The basic instrument is supplied with 1 voice and up to 3 more may be plugged in. A further 4 voices may be added by connecting to an expander unit, the metalwork and woodwork of which is designed for side by side matching with the main instrument. Each voice is a complete synthesizer in itself with 2 VCOs, 2 ADSRs, a VCA and a VCF (requiring only control voltages and a power supply, the voice boards are also suitable for modular systems). One of these voices is automatically allocated to a key as it is operated. There are separate tuning controls for each VCO of each voice. All other controls are common to all the voices for ease of control and to ensure consistency between the voices.

Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards fit with PCB mounted plugs and sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or metal film of 0.5% and 0.1%), nuts, bolts, etc.

EXPANDABLE POLYPHONIC SYNTHESIZER

COMPLETE KIT

ONLY

£320 + VAT

(Single voice)

Plug in extra Voices — Kit price £52 + VAT (£48 + VAT if ordered with kit)

Cabinet size 31.1" x 19.6" x 7.6" rear 3.4" front

Kit also available as separate packs

ADSR IC CEM 3310	£4.00
VCO IC CEM 3340	£6.00
0.1% 25 ppm M.F. Res	£0.50
0.5% 25 ppm M.F. Res	£0.25
30 ppm multilayer ceramic cap	£0.50

ICs and details of all packs in our

FREE CATALOGUE

Pack		Price
POLY 1	Pair of PCB's for multiplex cct. K.B. contacts	£9.50
POLY 2	IC's, IC sockets, Rs, Cs, for multiplex cct.	£8.20
POLY 3	Superior quality keyboard	£32.25
POLY 4	Contacts & bus bars	£12.00
POLY 5	Double sided plated through PCB for digital control & pitch/gate generator cct.	£17.25
POLY 6	Rs, Cs, heat sink for fitting to Pack 5	£10.50
POLY 7	IC's, IC sockets, diodes for fitting to Pack 5	£31.30
POLY 8	Double sided mother board (for plug in voices)	£18.90
POLY 9	Rs, Cs, connectors for mother board	£14.10
POLY 10	IC's IC sockets, Trs, heat sinks for mother board	£13.10
POLY 11	PCB for master controls (left of section marked VOICES)	£18.80
POLY 12	ICs, IC sockets, diodes, Trs, Rs, Cs for master control PCB	£9.30
POLY 13	Pots, Switches for master control board	£11.80

Pack		Price
POLY 14	PCB for VOICE controls	£6.80
POLY 15	Pots, switches, diodes, Cs for VOICE PCB	£4.80
POLY 16	PCB for plug in voice	£8.20
POLY 17	Rs, Cs, presets, connectors for one voice	£16.30
POLY 18	ICs, IC skts, diodes for one voice	£27.50
POLY 19	Transformer 0-120-240, 17-0-17, 0-7.7	£6.30
POLY 20	Pitch bend control	£3.90
POLY 21	Misc parts eg. jack sockets, knobs, mains switch etc.	£13.00
POLY 22	Ribbon cable, ribbon cable connectors, mains cable	£8.45
POLY 23	Fully finished metalwork and fixing parts	£25.60
POLY 24	Solid teak cabinet	£25.80
Total cost for individually purchased packs for single voice instrument		£355.15
Complete kit for 4 voice expander including connectors		**£295.00**

All prices VAT exclusive.

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

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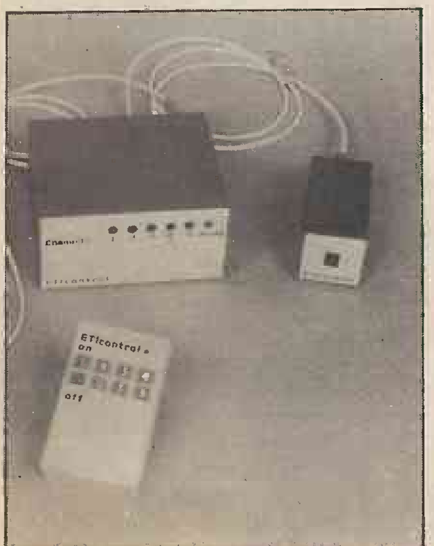
EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and postal documentation.
U.K. ORDERS: Subject to 15% surcharge for VAT * No charge is made for carriage * or at current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.
SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9a.m.-12 noon, 1-4.30p.m. Monday-Thursday.

MANY MORE KITS ON PAGE 8

Compose yourselves p.36

Sounds amazing p.45



Remotely interesting p.51

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MAY 1981 VOL 10 NO 5

FEATURES

PROJECTS

INFORMATION

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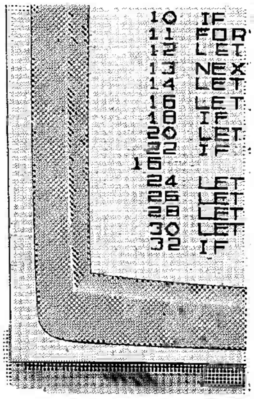
New! Sinclair ZX81 Personal Computer.

Kit: £49.95 complete



Reach advanced computer comprehension in a few absorbing hours

Built: £69.95 complete

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

Lower price: higher capability
With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

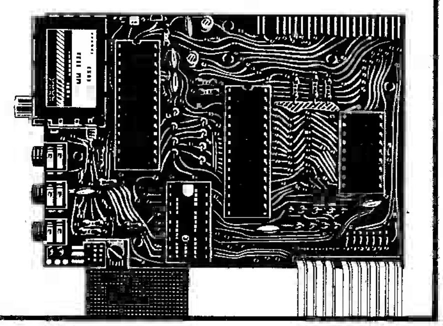
Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

Kit or built – it's up to you!

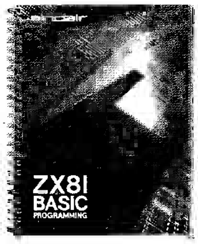
The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New Sinclair teach-yourself BASIC manual



Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.

WATFORD ELECTRONICS

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ELECTROLYTIC CAPACITORS: (Values are in µF) **500V:** 10 **52p**; 47 **78p**; **250V:** 100 **65p**; **63V:** 0.47, 1.0, 1.5, 2.2, 3.3 **8p**; 4.7 **9p**; 6.8, 10 **10p**; 15, 22, **12p**; 33 **15p**; 47 **12p**; 100, **19p**; 1000 **70p**. **50V:** 47 **12p**; 68 **20p**; 220 **24p**; 470 **32p**; 2200 **90p**. **40V:** 4.7, 15, 22 **9p**; 3300, **80p**; 4700, **120p**; **25V:** 1.5, 6.8, 10, 22 **8p**; 33 **9p**; 47 **8p**; 100 **11p**; 150 **12p**; 220, **15p**; 330 **22p**; 470 **26p**; 680, 1000, **34p**; 2200, **50p**; 3300, **76p**; 4700 **92p**; **16V:** 40, 47, 100 **9p**; 125, **12p**; 220 **13p**; 470, **20p**; 680 **34p**; 1000 **27p**; 1500, **31p**; 2200 **36p**; 3300 **74p**; 4700 **79p**.
TAG-END TYPE: 450V: 100µF **85p**; **70V:** 4700, **245p**; **64V:** 3300 **198p**; 2200 **139p**; **50V:** 3300 **154p**; 2200 **110p**; **40V:** 4700 **140p**; **25V:** 10,000 **320p**; 15,000 **345p**.

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n 47n, 68n **16p**; 100n, 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n **60p**; 1µF **68p**; 2µ2 **82p**; 4µ7 **85p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n, **38p**; 1µF **42p**; 1µ5 **45p**; 2µ2 **48p**; 4µ7 **68p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **38p**; 33n **42p**; 47n, 100n **42p**; 470n **99p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n 470n **13p**; 680n **19p**; 1µ **23p**; 1µ5 **40p**; 2µ2 **48p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33 **15p**; 0.47, 0.68, 1.0, 1.5 **16p**; 2.2, 3.3 **16p**; 4.7, 6.8 **22p**; 10 **28p**; **16V:** 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **38p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V:** 15, 22, **28p**; 33, 47 **35p**; 100 **55p**; **6V:** 100 **42p**.

POTENTIOMETERS: Rotary, sCarbon, Track, 0.25W Log & Lin.
470Ω, 680Ω, 1KΩ & 2KΩ (Linear only) Single Gang **29p**
5KΩ-2MΩ Single Gang Log & Lin **29p**
5KN-2MΩ Single Gang D/P Switch **78p**
5KΩ-2MΩ Double Gang Log & Lin **69p**
Wire Wound Single Turn 1 Watt 20Ω 20KΩ **115p**

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10 **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**; **50V:** 470nF **13p**.

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

CERAMIC CAPACITORS 50V
Range: 0-5pF to 10,000pF **4p**
0-015µF, 0-022µF, 0-033µF **5p**
0.047µF **6p**; 0.1µF, 0.2µF **7p**

PRESET POTENTIOMETERS
0.1W 50Ω—5MΩ Miniature Vertical & Horizontal **7p**
0-25W 100Ω—3-3MΩ horiz. larger **10p**
0-25W 200Ω—4-7MΩ Vert. **10p**
Cermet, Precision, multiturn, 0.75W ¾in 100Ω-100KΩ **89p**

SILVER MICA (Values in pF) 2, 3-3, 4-7, 6-8, 8-2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF **15p each**
200, 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **21p each**
1000, 1200, 1800, 2200 **30p each**
3300, 4700pF **60p each**

RESISTORS — Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL	1-99	100+
¼W	2.2Ω-4.7M	E24	2p	1p
½W	2.2Ω-4.7M	E12	2p	1p
1W	2.2Ω-10M	E12	5p	4p
2% Metal Film 10Ω-1MΩ			8p	4p
1%0.5W 51Ω-1M		E24	8p	6p

100+ price applies to Resistors of each type not mixed values.

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 12nF **10p**

MINIATURE TYPE TRIMMERS
2-6pF, 2-10pF **22p**; 2-25pF, 5-56pF **30p**; 10-88pF **38p**

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

JACKSONS VARIABLE CAPACITORS
DILICON
100/300pF **195p**
500pF **250p**
6:1 Ball Drive
4511/DAF **160p**
Dial Drive 4103
6:1/36:1 **775p**
Drum 54mm **55p**
0-1-365pF **325p**
00 2 365pF **395p**
0 2 365pF with slow motion Drive **450p**
0 0 208/176 **395p**
.. with slow motion drive **450p**
C804-5pF: 10. 15: 25: 50pF **280p**
100, 150pF **350p**
'L' 3x310pF **725p**
00-3x25pF **550p**

RF CHOKES
1µH, 4.7, 10, 22, 33, 47, 100, 200, 470, 750, 1mH, 2.5, 5, 10 **35p each**
22mH, 33 **45p**; 43, 100, 120 **75p each**

VEROBOARD 0.1in

	Clad	Plain
2½ x 3¾"	73p	52p
2½ x 5"	83p	—
3¾ x 3¾"	63p	—
3¾ x 5"	95p	79p
3¾ x 17"	325p	211p
4¾ x 17"	426p	—

'VQ' Board **150p**
DIP Board **330p**
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Combs **6**

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DIL PLUGS
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Ribbon Cable
10 way & 20 way available

Soldercon pins: 100 **60p**; 500 **275p**.

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18pin	16p	52p
20pin	22p	65p
22pin	25p	70p
24pin	30p	76p
28pin	35p	85p
36pin	—	105p
40pin	40p	109p

EDGE CONNECTORS: (Double type)

	.1	.156
2x10 way	—	82p
2x15 way	—	98p
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2x22 way	150p	125p
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2x30 way	188p	—
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2x43 way	250p	—

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OA95 8
OA200 8
OA202 8
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1N916 5
1N4001/2 5
1N4003 6
1N4004/5 6
1N4006/7 7
1N4148 4
1N5401 15
1N5404 16
1N5406 17
IN5408 19
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1S921 9
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MVAM115 158

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8A800V 115
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12A400V 82
12A800V 135
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16A400V 105
16A800V 220
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25A800V 295
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2A/200V 40
2A/400V 46
2A/600V 65
6A/100V 63
6A/400V 95
6A/600V 125
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10A/600V 350
25A/200V 240
25A/600V 396
BY164 56
VM18 DIL 50

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6805 670
6808 1050
6810 280
6821 315
6840 790
6850 315
6852 380
8080A 450
8085A 1100
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81LS96 125
81LS97 125
8212 210
8214 425
8251 475
8253 900
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8T28A 195
8T95N 160
8T97N 150
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AY-5-1013 365
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MC1489 90
MC14411 950
MC14412 1250
RO-3-2513U 600
SFF96364E 950
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709C 8 pin 35
710 67
733 75
741 8 pin 15
747C 14 pin 78
748C 8 pin 34
753 B pin. 185
810 150
9400CJ 350
AY-1-0212 595
AY-1-1313A 660
AY-1-1320 225
AY-1-5050 99
AY-1-5051 160
AY-3-1015 550
AY-3-1270 840
AY-3-8500 390
AY-3-8910 850
AY-3-8912 950
AY-5-1224A 235
AY-5-1230 450
AY-5-1317A 630
AS-5-3500 350
AY-5-4007D 450
AY-5-8100 775
CA3011 110
CA3012 175
CA3014 157
CA3018 68
CA3019 70
CA3020 186
CA3023 191
CA3028A 80
CA3035 230
CA3036 115
CA3043 275
CA3045 365
CA3046 70
CA3048 214
CA3059 195
CA3075 213
CA3080E 85
CA3081 190
CA3085 95
CA3089E 215
CA3090AQ 375
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CA3130 90
CA3140 48
CA3160 95
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ICL7107 975
ICL8038CC 340
ICL8211A 150
ICM7204 550
ICM7205A 1150
ICM7207 475
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ICM7216AJ 1950
ICM7216B 1950
ICM7217A 790
ICM7224 785
ICM7555 89
LD130 452
LF351 49
LF356 90
LM10 396
LM301AP 26
LM308T 95
LM311 70
LM318N 200
LM324A 50
LM339 68
LM348 90
LM349 115
LM379 415
LM380 80
LM381N 145
LM382 125
LM384 140
LM386 99
LM387 120
LM389 99
LM733 99
LM1458 45
LM2917 195
LM3900 60
LM3909N 70
LM3911 125
LM3914 240
LM3915 240
LM3916 255
LM13600 135
M252AA 625
M253AA 1150
MC663 60
MC1204 250
MC1301 79
MC1303 88
MC1304P 280
MC1310P 150
MC1458 45
MC1488 90
MC1489 90
MC1494 694
MC1495 350
MC1496L 92
MC1596 225
MC1710 79
MC3302 150
MC3340P 120
MC3360P 120
MC3401 52
MC3403 135
MC3405 150
MFC6040 97
MK50398 635
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NE565A 120
NE566 160
NE567V 170
NE570 450
NE571 420
RC4136D 99
S566B 265
SAB3209 425
SAB3210 275
SAS560 150
SAS570 150
SG3402 295
SL414A 275
SN76003N 240
SN76013 170
SN76013NO 130
SN76018 148
SN76023 170
SN76023ND 170
SN76033N 195
SN76115N 215
SN76131 125
SN76227N 95
SN76477 175
SN76660 120
SP8629 299
TAA621AX1 260
TAA661A 155
TAA700 250
TAD100 159
TBA120S 70
TBA540Q 220
TBA550Q 330
TBA641-A12
BX or BX11 250
TBA651 190
TBA800 90
TBA810 95
TBA820 70
TBA920Q 260
TBA990Q 270
TCA270Q 250
TCA965 120
TDA1004 290
TDA1008 310
TDA1022 575
TDA1024 105
TDA1490 290
TDA2020 320
TDA2030 320
TL061CP 46
TL062CP 90
TL064CN 159
TL071CP 45
TL072CP 90
TL074CN 140
TL081CP 42
TL082CP 70
TL083CP 95
TL084CN 120
UAA170 170
UAA180 170
XR2206 350
XR2211 575
XR2266 750
ZN414 95
ZN423 195
ZN424E 130
ZN425E 415
ZN426 TBA
ZN1034E 200
ZN1040E 685

TTL 74 (TEXAS)
7400 11
7401 11
7402 11
7403 14
7404 14
7405 18
7406 36
7407 34
7408 17
7409 20
7410 17
7411 25
7412 20
7413 32
7414 38
7416 30
7417 30
7420 19
7421 38
7422 25
7423 28
7425 28
7426 43
7427 32
7428 35
7430 19
7432 27
7433 36
7437 38
7438 32
7440 20
7441 88
7442 58
7443 120
7444 116
7445 105
7446 132
7447 72
7448 75
7450 20
7451 20
7453 20
7454 20
7460 20
7470 40
7472 30
7473 35
7474 34
7475 56
7476 40
7480 52
7481 120
7482 75
7483 90
7484 99
7485 105
7486 33
7489 205
7490 42
7491 84
7492 50
7493 57
7494 85
7495 70
7496 80
7497 176
74100 130
74104 62
74105 62
74107 34
74109 60
74110 54
74111 68
74112 170
74116 198
74118 85
74119 120
74120 75
74121 35
74122 50
74123 66
74125 50
74126 45
74128 65
74132 56
74136 65
74141 75
74142 185
74143 260
74144 250
74145 80
74147 180
74148 125
74150 130
74151 70
74153 70
74154 120
74155 75
74156 75
74157 70
74159 165
74160 99
74161 90
74162 99
74163 99
74164 120
74165 120
74166 130
74167 205
74170 205
74172 375
74173 110
74174 100
74175 82
74176 80
74177 86
74178 110
74179 165
74180 90
74181 280
74182 88
74184 130
74185 130
74188 310
74190 130
74191 120
74192 120
74193 120
74194 102
74195 75
74196 90
74197 88
74198 160
74199 160
74221 150
74246 150
74247 151
74248 189
74249 189
74251 110
74265 66
74273 287
74278 249
74279 99
74283 149
74284 350
74285 350
74290 107
74293 136
74297 236
74298 185
74365 96
74366 96
74367 96
74368 96
74390 185
74393 185
74490 186

74L
74L00 .88
74L30 80
74L47 380
74L75 145
74L85 349
74L121 165
74L123 325

74S
74S00 90
S04 73
S132 138
S138 240
S158 240
S188 210
S189 158
S194 300
S195 795
S241 540
S262 880
S287 325
S288 210
S470 325
S472 1150
S475 825

74LS
LS00 13
LS01 13
LS02 15
LS03 15
LS04 16
LS05 23
LS08 22
LS09 23
LS10 20
LS11 32
LS12 32
LS13 40
LS14 60
LS15 40
LS20 21
LS21 32
LS22 35
LS26 44
LS27 35
LS28 35
LS30 20
LS32 25
LS33 35
LS37 30
LS38 35
LS40 28
LS42 66
LS47 85
LS48 105
LS49 105
LS51 25
LS54 30
LS55 30
LS63 160
LS73 45
LS74 36
LS75 45
LS76 45
LS78 60
LS83 105
LS85 90
LS86 36
LS90 50
LS91 125
LS92 75
LS93 60
LS95 115
LS96 120
LS107 45
LS109 75
LS112 40
LS113 75
LS114 40
LS122 70
LS123 75
LS124 180
LS125 45
LS126 45
LS132 80
LS133 35
LS136 55
LS138 70
LS139 70
LS145 120
LS147 210
LS148 170
LS151 80
LS153 85
LS155 96
LS156 85
LS157 70
LS158 70
LS160 90
LS161 98
LS162 110
LS163 95
LS164 115
LS165 155
LS166 175
LS168 210
LS169 210
LS170 288
LS173 105
LS174 147
LS175 110
LS181 296
LS183 298
LS189 128
LS190 95
LS191 95
LS192 95
LS193 95
LS194 125
LS195 130
LS196 120
LS197 85
LS200 345
LS202 345
LS221 120
LS240 165
LS241 165
LS242 165
LS243 165
LS244 195

TRANSISTORS p
AC125 35
AC126 35
AC127 25
AC128 25
AC141 30
AC142 30
AC176 28
AC187 28
AC188 30
ACY17 70
ACY18 70
ACY19 75
ACY20 75
ACY21 75
ACY22 90
ACY28 75
ACY39 65
ACY41 85
AD142 120
AD149 79
AD161 42
AD162 42
AF118 95
AF124 70
AF126 65
AF139 40
AF178 75
AF186 70
AF239 78
ASZ21 125
BC107 10
BC107B 12
BC108 10
BC108B 12
BC108C 12
BC109 10
BC109B 12
BC109C 12
BC114 22
BC115 22
BC117 24
BC118 23
BC119 38
BC137 40
BC139 40
BC140 30
BC142 30
BC143 30
BC147 9
BC147B 10
bc148 9
BC148B 10
BC149 9
BC149C 10
BC153 27
BC154 27
BC157 10
BC158 10
BC159 11
BC160 45
BC167A 10
BC168C 10
BC169C 10
BC170 15
BC171 11
BC172 11
BC177 20
BC178 20
BC179 20
BC182 10
BC183 10
BC184 10
BC182L 10
BC183L 10
BC184L 10
BC181 20
BC186 30
BC187 25
BC212 10
BC212L 10
BC213 10
BC213L 10
BC214 10
BC214L 10
BC237 14
BC238 14
BC307B 14
BC308 16
BC327 15
BC328 15
BC337 15
BC338 15
BC441 34
BC461 34
BC477 40
BC516 40
BC517 40
BC547 14
BC548 14
BC549C 14
BC556 15
BC557 15
BC558 15
BC559 15
BCY30 68
BCY34 85
BCY35 50
BCY39 85
BCY40 85
BCY42 14
BCY43 35
BCY45 50
BCY58 35
BCY59 35
BCY70 18
BCY71 18
BCY72 20
BCY78 24
BD112 125
BD124 115
BD131 48
BD132 48
BD133 60
BD135 45
BD136 40
BD137 40
BD138 40
BD139 40
BD140 40
BD144 198
BD145 175
BD158 55
BD205 110
BD206 110
BD222 85
BD245 45
BD378 70
BD434 55
BD517 75
BD695A 85
BD696A 85
BDY56 180
BDY60 180
BDY61 180
BF115 35
BF154 25
BF158 25
BF167 25
BF173 27
BF177 28
BF178 30
BF179 35
BF180 38
BF182 38
BF184 38
BF185 38
BF194 12
BF195 12
BF196 12
BF197 12
BF198 16
BF199 18
BF200 30
BF224A 25
BF244B 29
BF245 30
BF256A 35
BF256B 45
BF257 32
BF258 32
BF259 35
BF274 42
BF336 40
BF337 40
BF451 35
BF594 30
BF595 30
BFR39 23
BFR40 23
BFR41 23
BFR79 23
BFR80 25
BFR81 25
BFR98 105
BFX29 28
BFX81 45
BFX84 26
BFX85 28
BFX86 28
BFX87 28
BFX88 28
BFY18 50
BFY50 23
BFY51 23
BFY52 23
BFY53 32
BFY55 32
BFY56 32
BFY64 35
BFY71 20
BFY81 120
BRY39 40
BSX20 20
BSX26 34
BSX29 34
BSX78 45
BSY26 30
BSY95A 25
BU105 170
BU205 190
BU206 200
BU208 200
E421 250
MD8001 250
MJ490 90
MJ491 175
MJ2955 90
MJE170 150
MJE180 150
MJE340 64
MJE370 100
MJE371 100
MJ480 90
MJE520 65
MJE521 95
MJE2955 99
MJE3055 70
MPF102 86
MPF103 36
MPF104 36
MPF105 36
MPF106 40
MPSA05 22
MPSA06 25
MPSA12 32
MPSA55 30
MPSA56 30
MPSU02 58
MPSU05 55
MPSU06 56
MPSU52 65
MPSU55 80
MQSU56 80
MPU131 52
OC26 170
OC28 130
OC35 125
OC36 120
OC41 120
OC42 120
OC44 120
OC45 40
OC70 40
OC71 40
OC72 40
OC74 50
OC75 50
OC76 50
OC77 50
OC81 50
OC82 50
OC83 40
OC84 40
OC140 110
OC170 85
OC171 85
OC200 85
TIP29 34
TIP29A 36
TIP29B 56
TIP29C 60
TIP30 47
TIP30A 45
TIP30B 50
TIP30C 58
TIP31A 45
TIP31B 48
TIP31C 55
TIP32A 48
TIP32C 60
TIP33A 65
TIP33C 75
TIP34A 74
TIP34C 88
TIP35A 100
TIP35C 185
TIP36A 170
TIP36C 199
TIP41A 55
TIP41b 60
TIP42A 60
TIP42B 75
TIP120 90
TIP121 99
TIP122 99
TIP141 120
TIP142 120
TIP147 120
TIP2955 60
TIP3055 90
TIS43 32
TIS44 45
TIS45 45
TIS46 45
TIS59 50
TIS74 50
TIS90 30
TIS91 32
UC734 65
ZTX107 11
ZTX108 11
ZTX109 12
ZTX212 28
ZTX300 13
ZTX301 16
ZTX302 16
ZTX303 25
ZTX304 17
ZTX314 25
ZTX326 30
ZTX341 30
ZTX500 14
ZTX501 15
ZTX502 15
ZTX503 18
ZTX504 25
ZTX1 25
ZTX550 25
2N697 23
2N698 40
2N699 45
2N706A 19
2N708 19
2N918 35
2N1131 24
2N1132 24
2N1302 45
2N1303 60
2N1304 65
2N1305 60
2N1306 65
2N1307 65
2N1308 88
2N1613 30
2N1670 150
2N1671B 100
2N2160 295
2N2217 45
2N2218A 45
2N2219A 28
2N2220A 26
2N2221A 26
2N2222A 25
2N2297 45
2N2303 45
2N2368 25
2N2369A 16
2N2476 90
2N2483 27
2N2484 27
2N2492 50
2N2497 63
2N2646 45
2N2784 55
2N2904 28
2N2905A 30
2N2906 25
2N2907 25
2N2907A 25
2N2926G 10
2N3011 28
2N3020 45
2N3053 26
2N3054 68
2N3055 48
2N3108 45
2N3252 46
2N3302 30
2N3441 140
2N3442 140
2N3663 15
2N3702 10
2N3703 10
2N3704 10
2N3705 10
2N3706 10
2N3707 10
2N3708 10
2N3709 10
2N3710 10
2N3711 10
2N3713 140
2N3771 179
2N3772 195
2N3773 270
2N3819 22
2N3820 46
2N3822 65
2N3823 65
2N3824 65
2N3866 90
2N3879 150
2N3903 18
2N3904 18
2N3905 15
2N3906 17
2N4037 45
2N4041 40
2N4058 10
2N4061 10
2N4062 10
2N4064 115
2N4220 78
2N4234 48
2N4236 46
2N4264 24
2N4286 15
2N4289 18
2N4314 88
2N4400 18
2N4427 90
2N4859 78
2N4871 55
2N4898 135
2N4901 175
2N4921 55
2N4922 60
2N5102 145
2N5135 20
2N5136 20
2N5138 18
2N5172 18
2N5179 45
2N5180 45
2N5191 75
2N5305 24
2N5308 24
2N5457 36
2N5458 36
2N5459 35
2N5485 35
2N5777 45
2N5879 180
2N6027 32
2N6388 180
2SD234 75
3N128 112
3N140 112
40311 90
40313 130
40315 90
40316 95
40317 90
40320 90
40323 80
40324 100
40326 90
40327 70
40347 80
40348 120
40360 40
40361 50
40362 50
40408 70
40411 225
40467A 130
40468 85
40594 105
40595 110
40603 110
40636 175
40673 95

SPECIAL OFFER
741 **15p**
NE555 **18p**
2114L-300n **175p**
2114L-200n **225p**
2532-32K **900p**
2732-450n **900p**
2708 **350p**
2716-5V **450p**
4116-16K **100p**
IM6402 UART **390p**
MM1702AQ **200p**

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COMPUTER CORNER

SUPERBOARD II Series II. Ready built and tested. 50Hz, No Flicker. Incl. Manuals and Programme Cassette **£149**

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610 EXPANSION BOARD 8K RAM (Expandable to 24K). Ideal for Superboard, UK101, etc. **£150**

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Single ended DIP Jumpers 24in 14 pin **145p**; 16 pin **165p**; 24 pin **240p**; 40 pin **385p**.

Double ended DIP Jumpers

Length	14 pin	16 pin	24 pin	40 pin
6in	185p	205p	300p	465p
12in	195p	215p	315p	490p
36in	230p	250p	375p	585p

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p
4 pole on/off	54p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT c/off	85
SPDT biased both ways	105
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
4 pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p
4 pole 2-way	24p

PUSH BUTTON 6A with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p
Mini Non Lock Push to Make	15p
Red, Blue, Grn. Push to Break	25p

DIL SWITCHES

SPST: 4 way **85p**; 6 way **95p**; 8 way **115p**; 10 way **145p**.

ROTARY (Adjustable Stop) SWITCHES: 1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way, 4 pole/2 to 3 way **45p**

ROTARY: Mains DP 250V 4A on/off **56p**

ROTARY: Make your own multiway switch. Shafting Assembly: Has adjustable stop. Accommodates up to 6 wafers (mechanism only) **90p**

WAFERS: (Break before Make) 1 pole/12 way; **2p**/6 way; **3p**/4 way; **4p**/3 way; **6p**/2 way **56p**

Mains DP Switch 250V/2A to fit **45p**

Spacers **4p**

Screen **6p**

'D' CONNECTORS (Cannon type)

Pins	Plugs	Sockets	Covers
9way	95p	125p	—
15way	135p	198p	150p
25way	198p	284p	170p
37way	290p	398p	185p

CRYSTALS

100KHz	323
200KHz	370
455KHz	383
1MHz	323
1.008M	395
1.28MHz	392
1.6MHz	323
1.8MHz	323
1.8432MHz	362
2MHz	305
2.4576MHz	362
3.2768M	323
3.57954M	105
4.000MHz	290
4.032MHz	323
4.19430M	270
4.433619M	135
5.0MHz	355
5.185M	323
5.24288M	425
6.0MHz	323
6.144MHz	295
6.5536MHz	290
7MHz	290
7.168MHz	290
7.680M	323
8.0MHz	392
8.08333M	362
8.867237M	362
9.375M	323
10.0MHz	323
10.7MHz	323
12MHz	392
14.31818M	362
16.0MHz	290
18MHz	323
18.432M	323
20.0MHz	323
26.0MHz	383
26.69MHz	290
27.648M	323
38.6667M	350
48.0MHz	323
100.00MHz	323
116.0MHz	300

Parts available for ETI Projects

TRANSFORMERS (Mains Prim. 220-240V)

6-0-6V; 9-0-9V; 12-0-12V 100mA **98p**

3VA: 0-6V 0-6V (PCB mounting) **175p**

6VA: 6V-.5A 6V-.5A, 9V-.4A 9V-.4A; 12V-.3A 12V-.3A; 15V-.25A 15V-.25A **220p**

12V: 4.5V-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A; 12V-.5A 12V-.5A; 15V-.4A ⅛⅝V-.4A; 20V-.3A 20V-.3A **250p** (30p p&p)

24VA: 6V-1.5A 6C-1.5A; 9V-1.3A 9V-1.3A; 12V-1A 12V-1A; 15V-.8A 15V-.8A; 20V-.6A 20V-.6A **320p** (55p p&p).

50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A, 25V-1A 25V-1A; 30V-.8A 30V-.8A **365p** (60p p&p).

100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A **820p** (74p p&p). (NB: p&p charge to be added above our normal postal charge.)

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WITH LID	p
3x2x1"	65
4x2½x2"	85
4x2¾x1½"	85
4x2¾x2½"	103
4x4x1½"	85
4x4x2½"	120
5x4x2"	95
5¼x2¾x2½"	130
5¼x4x1½"	99
5¼x4x2½"	120
6x4x2"	120
6x4x3"	148
7x5x2½"	165
7x5x3"	180
8x6x3"	210
10x4¼x3"	230
10x7x3"	275
12x5x3"	260

PANEL METERS

FSD 60x46x 35mm

0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
445p each

4¼x3¼x1½"
0-50μA
0-100μA
0-500μA
595p each

VOLTAGE REGULATORS

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

LM300H	170p	LM723	38p
LM305H	140p	TAA550	50p
LM309K	135p	TBA625B	95p
LM317K	350p	ZDA1412	150p
LM317H	240p	78H05 + 5V/5A	
LM323K	550p		595p
LM325N	240p	78HG +5V to +25V	
LM326N	240p	5A	650p
LM327	270p	79HG	850p

OPTO

LEDs with Clips

TIL209 Red	13
TIL211 Grn.	17
TIL212 Yel.	18
TIL220 .2" Red	14
.2" Green, Yellow or Amber	18
.2" High Bright Red	49
.2" Flashing Red	48
.2" Red/Green	46
Square LEDs, Red, Green, Yellow	30
LD271 Infra Red	40
SFH205 Detector	90
TIL32 Infra Red	65
TIL78 Detector	75
BARGRAPH. Red 10 segments	225
LS400	255
OCP71	120
ORP12	63
ORP61	85
2N5777	45

ISOLATORS

IL74	55
TIL111/2/4	90

7 Segment Displays

TIL307	675
TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
DL747 .6" CA	180
8" Orange CA	250
FND357 Red	120
FND500	115
3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
3" ± 1 Green CA	150
DVM176	1885
LCD 3½ Digits	675
LCD 4 Digits	750
LCD 6 Digits	850

LS245	350
LS247	135
LS248	135
LS249	135
LS251	130
LS253	95
LS257	95
LS258	120
LS259	180
LS261	450
LS266	75
LS273	180
LS275	320
LS279	88
LS280	250
LS283	90
LS290	130
LS293	130
LS295	215
LS298	215
LS299	420
LS300	175
LS302	175
LS320	270
LS323	450
LS324	200
LS325	320
LS326	330
LS327	315
LS346	185
LS347	150
LS348	190
LS352	185
LS353	185
LS365	65
LS366	65
LS367	65
LS368	90
LS373	150

LS374	150
LS375	150
LS377	199
LS378	140
LS379	215
LS384	250
LS385	420
LS386	85
LS390	140
LS393	140
LS395	210
LS396	199
LS398	275
LS399	230
LS445	140
LS447	195
LS490	245
LS668	105
LS669	105
LS670	270
LS673	750
LS674	850

CMOS

4000	14
4001	14
4002	15
4006	86
4007	19
4008	76
4009	46
4010	50
4011	18
4012	24
4013	43
4014	80
4015	82
4016	35
4017	70
4018	76
4019	42
4020	85
4021	90
4022	85
4023	24
4024	60
4025	24
4026	170
4027	45
4028	92
4029	98
4030	55
4031	185
4032	125
4033	175
4034	213
4035	95
4036	275
4037	115
4038	110
4039	299
4040	85
4041	80
4042	70
4043	80
4044	80
4045	175
4046	96
4047	98
4048	65
4049	35
4050	38
4051	86
4052	86
4053	86

4054	130
4055	130
4056	135
4057	2850
4059	575
4060	110
4061	1225
4062	995
4063	120
4066	46
4067	430
4068	26
4069	22
4070	25
4071	25
4072	25
4073	25
4075	23
4076	85
4077	30
4078	28
4081	26
4082	25
4085	90
4086	90
4089	150
4093	55
4094	210
4095	95
4096	95
4097	340
4098	115
4099	150
4160	115
4161	115
4162	115
4163	115
4174	110

4175	120
4194	115
4408	790
4409	790
4410	750
4411	960
4412F	1250
4412V	1520
4415F	480
4415V	850
4419	280
4422	570
4432	1050
4435	850
4440	999
4450	350
4451	350
4490F	350
4490V	750
4501	28
4502	105
4503	65
4506	75
4507	48
4508	280
4510	85
4511	98
4512	84
4513	225
4514	220
4515	250
4516	90
4517	415
4518	90
4519	80
4520	90
4521	210
4522	150

4526	98
4527	125
4528	100
4529	150
4530	90
4531	130
4532	120
4534	510
4536	310
4538	145
4539	120
4541	150
4543	150
4549	395
4553	399
4554	192
4555	85
4556	60
4557	425
4558	174
4559	450
4560	199
4561	104
4562	525
4566	195
4568	299
4569	195
4572	36
4580	495
4581	320
4582	135
4583	105
4584	55
4585	99
4597	330
4598	390
40106	99
40174	160

WEMON

The Definitive Monitor

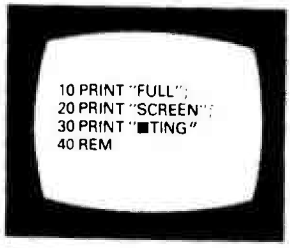
A 4k monitor specially designed to produce the best from your **Superboard, Superboard Series 2, UK101 or Enhanced System.**

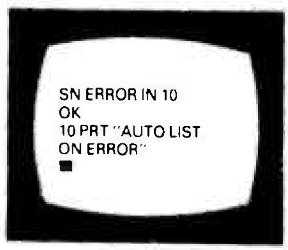
Look at these superb facilities:

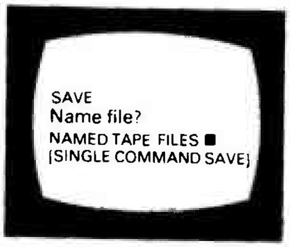
- Full screen editing.
- Home cursor/screen clear facility.
- True insert/delete.
- Fully programmable cursor control with meaningful symbols on screen.
- Single key Basic
- True ASCII keyboard routine.
- Auto remote control of tape recorder (requires only a relay).
- Open line facility.
- Named tape files.
- Two key video swap (Series 2 only).
- Bell (Series 2 only).
- Cursor indication of quotes mode.
- User definable flashing cursor character.
- User controllable command vectoring for your own machine code routines.
- Full or partial scroll-up or scroll-down (callable by program).
- Auto list on error (displays faulty line upon carriage return).
- Single command save (automatically returns "list").
- Centronics compatible printer driver.

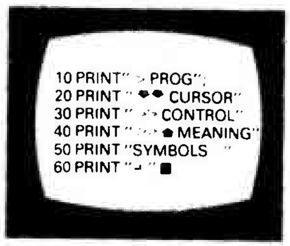
Monitor functions include:

- Scrolling list in data mode.
- Warm restart vector.
- Fill memory.
- Search memory.
- Two save and three load routines.
- Floppy disc vector.
- Break handling routine.
- Tabular display of memory.









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DIGEST

Visionary Idea

That world-famous character Uncle Clive Sinclair has struck again. This time Sinclair Research Ltd has developed a new flat-screen pocket-size television which should be available by the middle of next year. Its announcement follows a five year development project costing £1 million and partly backed by the National Research and Development Council. The investment for manufacturing what will initially be a pocket black-and-white TV with FM radio will be around the £5 million mark, supported by industry grants from the Scottish Economic Planning Department who will provide £1.5 million plus a regional development grant of £1.1 million, making 22% of the total capital employed. (Perhaps Sinclair's catch-phrase should be 'your wish will be granted'?) Sinclair's contribution will be funded from profits derived from its equally well-known personal computer business. Sinclair have managed to achieve a number of interesting breakthroughs with their flat screen TV, not least perfecting a new method of vacuum-forming glassware, a volume reduction of 2½ times over a conventional CRT, and a power requirement reduction five times better than previously achieved. Impressive huh? Manufacture of the tube has been sub-contracted to Timex who will produce it in Dundee and expect to employ an extra 1,000 people by 1985.

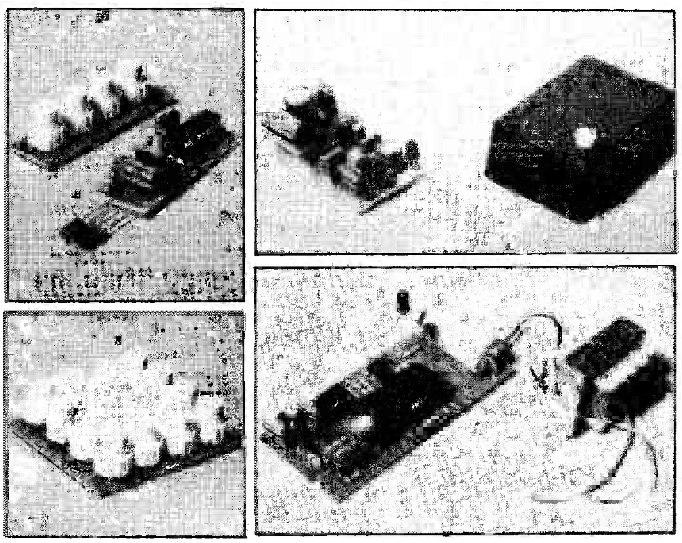
The cathode ray tube measures approximately 4 x 2 x ¾ inches and is assembled from two sheets of glass, a flat front plate and a vacuum-formed backing plate. The phosphor screen is coated on the interior of the backing plate and is viewed through the front face from the same side that the electrons strike. As a result, the brightness is more than double that of a conventional CRT with the same beam energy. The electron gun is set to one side of the screen with its axis parallel to the screen. Two sets of electrostatic deflection plates in the gun assembly provide horizontal and vertical scanning and a third set between the phosphor screen and front face bends the electron beam towards the screen. The tube assembly lends itself to low-cost mass production and has significantly fewer components than a conventional CRT. There will be many applications for this new tube; doubtless to say Sinclair will consider linking it to his personal computer, and the basic tube can be modified for projection TV systems. A full colour three-tube system is being carefully considered with the electronics and optics able to fit into a shoe-box-sized unit projecting onto a wall-mounted screen. The initial TV/radio unit should retail for about £50. We ask ourselves 'is there anything this man can't do?'

Mini-Movies

Matsushita Electric of Japan have come up with a new mini colour video camera which contains the tape recorder as well. They think that it's such a good design that it should be made a world standard for miniature video. It uses metal evaporated magnetic tapes which are actually slightly smaller than standard audio cassettes. The camera/ recorder is almost as small as a conventional hand-held video camera; 229 mm (D) x 118 mm (H) x 67 mm (W) and weighs only 2.1 kg including batteries. The tape speed is 14.3 mm/S which is the slowest among systems of this kind. Matsushita achieved the compactness of this device thanks to the development of the 'Cosvicon' ½ inch colour image pick-up tube coupled with extensive use of LSI in the circuitry. For further details on this camera contact: National Panasonic UK Ltd, 300-318 Bath Road, Slough, Berkshire, SL1 6JB.

Kitting Out

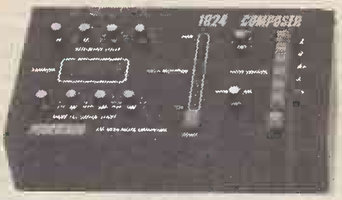
TK Electronics, who specialise in electronic mini-kits for hobbyists, have extended their range to include some remote control kits. These include the MK6 Simple Infra-Red Transmitter (as featured in Kit Review last month), the MK7 Infra-Red Receiver, the MK8 Coded Infra-Red Transmitter and the MK12 16-channel Receiver. The MK6 and MK7 consist of a small hand-held, battery operated transmitter and a small mains powered receiver with a triac output capable of switching mains loads of up to 500 W. The MK8 can transmit up to 32 different commands depending on the keyboard used. The MK12 is a mains-powered unit with 16 CMOS outputs (0 to 15 V) which may be interfaced with logic, or used to drive relays or triacs for power switching. By changing the value of one resistor in the MK8 kit and adjusting the present on the MK12, simultaneous operation to two or more receivers in the same area can be achieved. Prices are: MK6 — £4.20, MK7 — £9.00, MK8 — £5.90, MK12 — £11.95 plus 40p postage and 15% VAT. TK Electronics, 11 Boston Road, London W7 3SJ.



TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

COMPLETE KIT ONLY £168.50 + VAT!



Designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd) and featured as a constructional article in ETI, this live performance synthesizer is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal trim!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price! Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

Cabinet size 24.6″ x 15.7″ x 4.8″ (rear), 3.4″ (Front).

1024 COMPOSER

THIS MONTH'S FRONT COVER FEATURE!

COMPLETE KIT ONLY £89.50 + VAT!

ETI VOCODER

COMPLETE KIT ONLY £195 + VAT!

KIT INCLUDES FREE FOOT CONTROL AND TEST OSCILLATOR

Panel size 19.0″ x 5.25″. Depth 12.2″.

Featured as a construction article in **Electronics Today International** this design enables a vocoder of great versatility and high intelligibility to be built for an amazingly low price. 14 channels are used to achieve its high intelligibility, each channel having its own level control. There are two input amplifiers, one for speech either from microphone or a high level source e.g. mixer or cassette deck and one for external excitation (the substitution signal) from either high or low level sources. Each amplifier has its own lever control and a rather special type of tone control giving varying degrees of bass boost with treble cut or treble boost with bass cut. The level of the speech and excitation signals are monitored by LED PPM meters with 10 lights — 7 green and 3 red which indicate the level at 3dB steps. There are three internal sources of excitation — a noise generator and two pulse generators of variable frequency and pulse width. Any of the internal sources and the external source can be mixed together. There is a voiced/unvoiced detector which substitutes noise for the excitation signal at the points in speech where the vocal chord derived sounds of the speaker are substituted for by the unvoiced sounds of sibilants, etc.There is a slew rate control which smooths out the changes in spectral balance and amplitude enabling a change of the speech into singing or chanting and other special effects. A foot switch is provided to permit a complete freeze in spectral balance and amplitude whenever required. An LED on this indicates when the freeze is in operation.

An output mixer allows mixing of the speech, external excitation and vocoder output. The majority of the components fit into the large analysis/synthesis board with the rest on 8 much smaller boards with the controls and sockets mounted on them for ease of construction. Connectors are used for the small amount of wiring between the boards.

The kit includes fully finished metalwork, professional quality components (all resistors 2% metal oxide) nuts, bolts, etc. — even a 13A plug!

TRANSCENDENT DPX

MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr published in Electronics Today International

COMPLETE KIT ONLY £299 + VAT!

Cabinet size 36.3″ × 15.0″ × 5.0″ (rear) 3.3″ (front)

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound—fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano as a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass as the lower end (the keyboard is electronically split after the first two octaves) or vice-versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.).

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

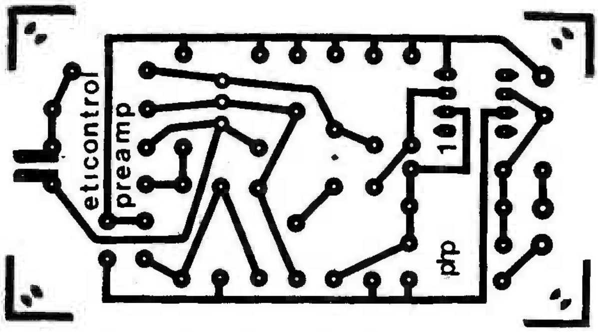
The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

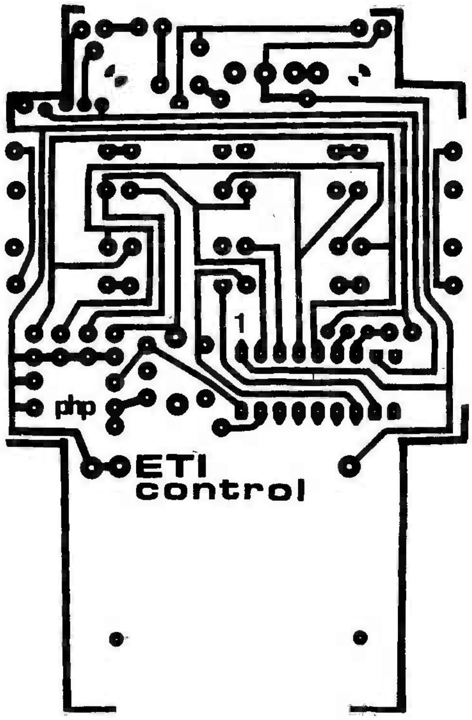
POWERTRAN

MANY MORE KITS ON PAGE 107. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER

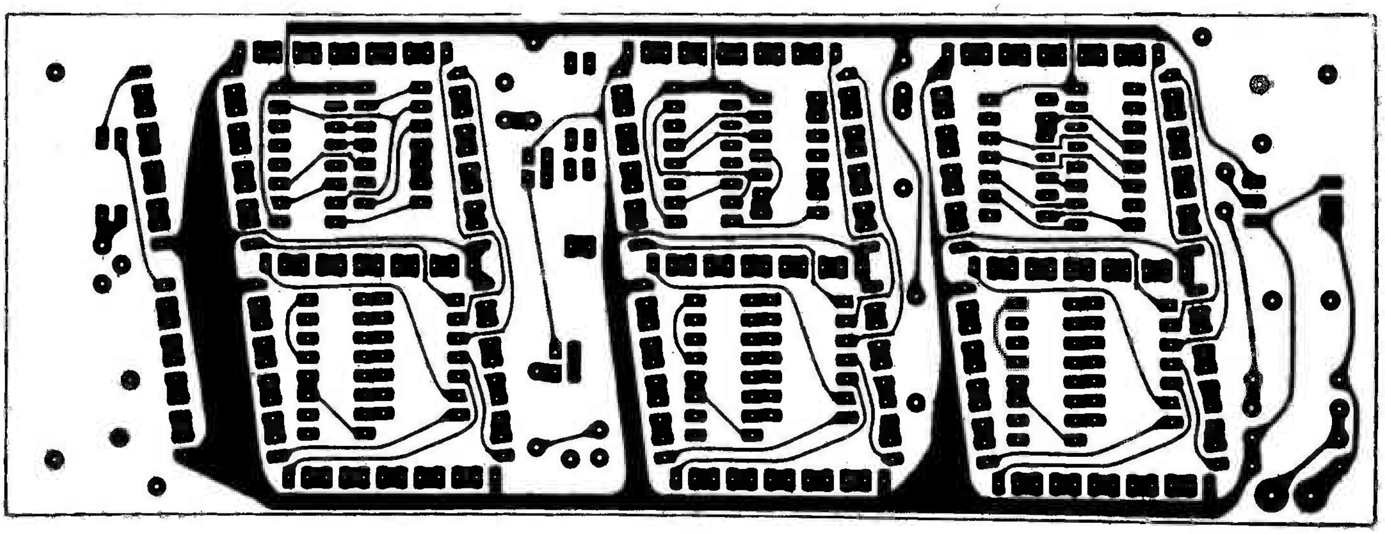
All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices.

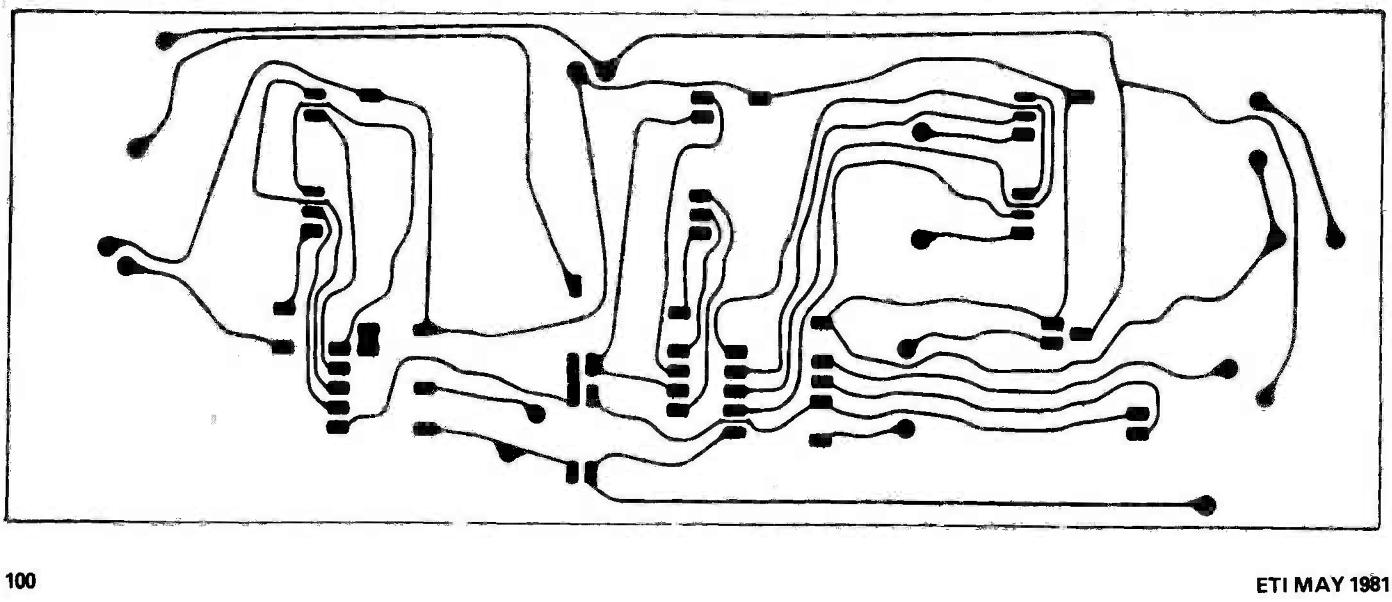
PCB FOIL PATTERNS

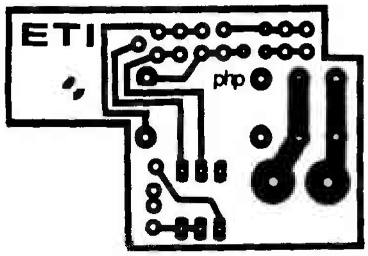




Above: The Remote Control preamp board.
Right: Remote Control transmitter board.
Below: The two sides of the Digital Clock PCB.



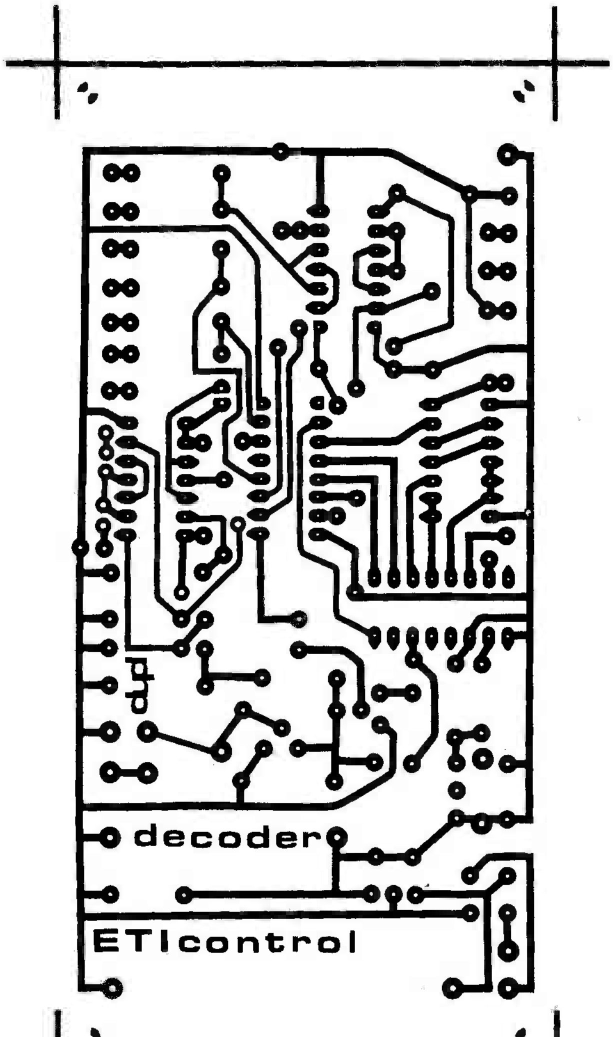


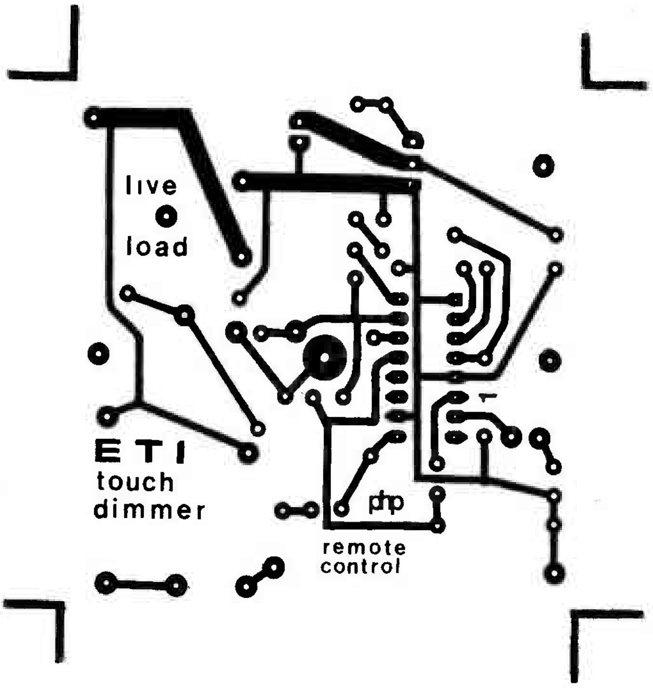


Above: Power switch foil pattern.

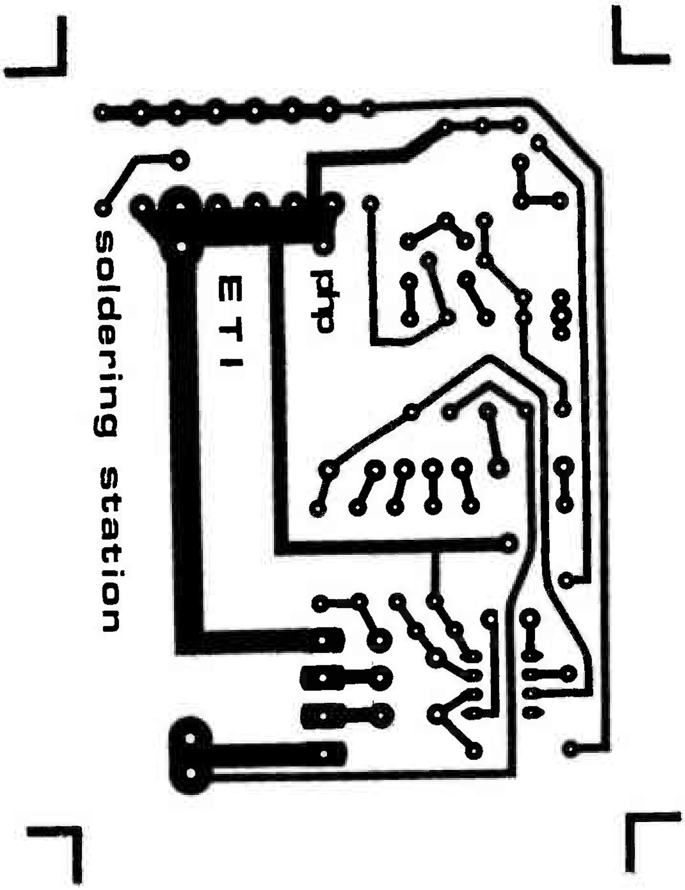
The foil patterns for the 1024 Composer are too large to fit into the magazine. You can obtain them by sending us a large SAE. Commercial firms should note that Powertran hold the copyright on the board.

Below: The Remote Control decoder board.

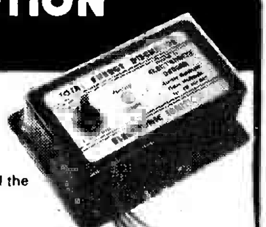




Above: Touch dimmer PCB.
Below: Foil pattern for the Microstation.



ELECTRONIC IGNITION SAVES PETROL



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TOTAL ENERGY DISCHARGE gives all the advantages of the best capacitive discharge ignitions;

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SOPHISTICATED TRIGGER CIRCUIT. This circuit removes all unwanted signals caused by contact volt drop, contact shuffle, contact bounce, and external transients which, in many designs, can cause timing errors or damaging un-timed sparks. Only at the correct and precise contact opening is a spark produced. Contact wear is almost eliminated by reducing the contact breaker current to a low level — just sufficient to keep the contacts clean.

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ALL KITS C/W circuit, comprehensive instructions & full parts guarantee

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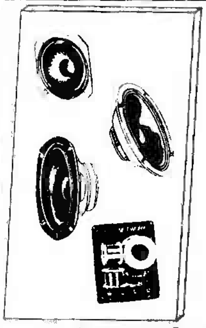

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Comprises:
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- ★ 3" tweeter
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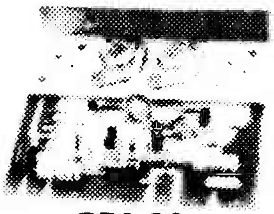
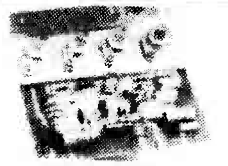
THE POWERFET AMPLIFIER

See next month's issue for our component bargains or send SAE for lists

IT GROWS!

 +  = 

PFA 80
(100W plus into 8Ω)

Elegant Simplicity
Advances in high technology should make life simpler. A cluttered power amplifier board may well perform superbly, but its busy elaboration is an indication that its design is pushing the limit of its component technology.
There are now many first-class bipolar power amps on the market. All of them are complex and consequently expensive. Any additional improvements in the areas where they are weak (e.g. H.F. distortion) can only be obtained with yet further complexity and cost.
Only a new technology can provide the sort of "quantum jump" in component performance necessary to reduce the clutter on the board, reduce the cost and make the highest fi once more affordable.

Powerfets
So far 29 semiconductor manufacturers have invested in this new technology. Clearly powerfets are something special.
Their enormous power gains eliminate conventional drive circuitry in power amps, permitting delightfully simple designs. Their freedom from secondary breakdown and their tendency to shutdown when thermally overstressed, result in inherently stable and destruction proof output stages, not needing protection circuitry. And perhaps best of all, their lack of charge storage make them fast and responsive, producing amplifiers of wide bandwidth and low distortion even at high frequencies.

PFA80/120
The PFA is perhaps the perfect realisation of the classic powerfet amp design. The superb P.C.B. allows the use of either one or two pairs of output devices, providing easy expandability for those starting with the smaller system. (The extra output pair of the PFA120 results in lower distortion and improved efficiency, particularly into low impedance loads.)
The components used in the PFA have been chosen with extreme care. The lowest noise input devices and lowest distortion gain stage devices were selected regardless of cost. 140V powerfets were chosen against the more usual 120V to give improved safety margins.

Specification	PFA80	PFA120
Bandwidth	10Hz—	100KHz± 1dB
Output power RMS into 8Ω	80W (Vs=± 50V)	120W (Vs=± 55V)
T.H.D. from 1w to rated output at all audio frequencies	≤0.008%	≤0.005%
SNR	120dB	120dB
Slew Rate	20V/μs	20V/μs
Gain	X22	X22
Rin	30K	30K
Vs max.	± 70V	± 70V
Cost (built)	**£15.95**	**£22.85**
(kit)	**£13.95**	**£20.85**

PFA 120
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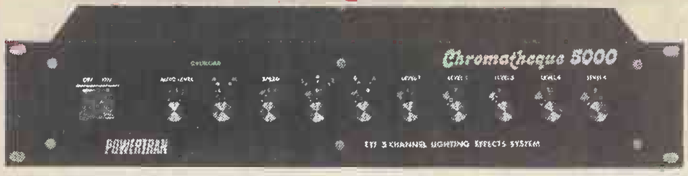

Panel size 19.0"×3.5". Depth 7.3"

COMPLETE KIT ONLY **£49.50 + VAT!**

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

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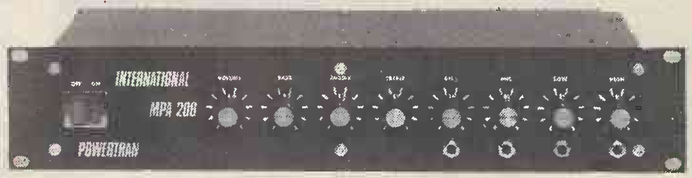

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.

SP2-200 2-CHANNEL 100W AMPLIFIER

Panel size 19.0"×3.5". Depth 7.3"

NEW!

COMPLETE KIT ONLY **£64.90 + VAT!**

The power amplifier section of the MPA 200 has proved not only very economical but very rugged and reliable too. This new design uses two of these amplifier section powered by separate power supplies fed from a common toroidal transformer. Input sensitivity is 775mV.
Even simultaneously driven, each channel delivers over 100W rms into 8 ohms. The kit includes fully finished metalwork, fibreglass PCBs, controls, wire,etc — complete down to the last nut and bolt!

POWERTRAN

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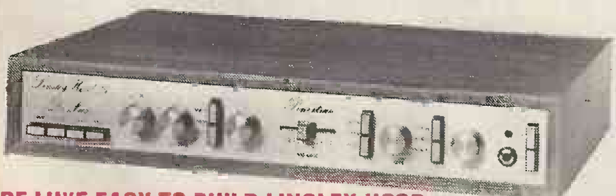
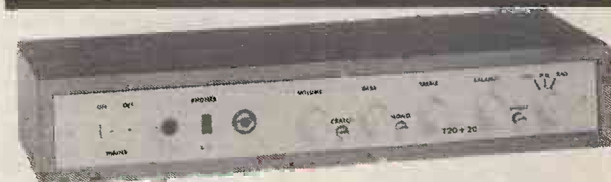


DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £85.00 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring while distortion is less than 0.01%.



T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30 + 30) is also available for **£38.40**+VAT.
MATCHING TUNERS — See our FREE CATALOGUE!

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc. and full instructions — in fact everything!

BLACK HOLE CHORALIZER

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

COMPLETE KIT ONLY **£49.80** +VAT (single delay line system)

De Luxe version (dual delay line system) also available for **£59.80**+VAT

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

Lights-on Reminder

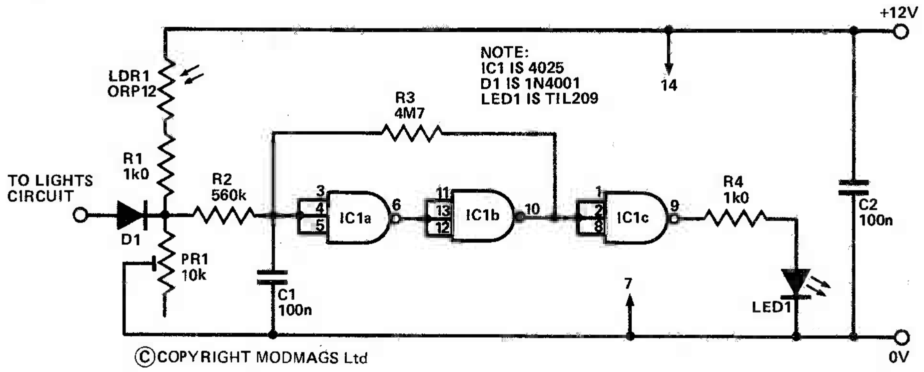
If you are apt to forget to switch on the car lights at the onset of darkness, this indicator lamp should prove useful. It switches on when the ambient light level drops below a preset threshold value, unless the sidelights have been switched on already. If the lamp does come on, it is automatically cancelled when the sidelights are turned on.

The circuit utilizes a CMOS 4025 IC, which is a triple three-input NOR gate. In this circuit the three inputs of each gate are connected together so that each gate actually operates as a simple inverter. IC1a and IC1b are wired in series and R2 and R3 provide positive feedback, giving a sort of Schmitt trigger action. IC1c is connected as an inverter/buffer stage at the output of the trigger circuit, and this drives indicator lamp LED1 by way of current limiting resistor R4. If the input voltage to the trigger circuit is more than about half the supply voltage LED1 will be switched off, but it will be turned on if the input voltage falls below about half the supply potential.

The input of the trigger is fed from a potential divider circuit which consists of LDR1, R1 and PR1. When the light level becomes inadequate, the resistance of LDR1 increases and gives an input voltage to the trigger circuit sufficiently low to cause LED1 to switch on. The point at which this occurs can be adjusted by PR1.

D1's anode connects to the junction of the side lights and the switch that controls them. Assuming the vehicle is of the usual negative earth variety, D1 will be reverse biased when the lights are switched off and will not affect the circuit. When the lights are switched on it is forward biased and the input of the trigger circuit is taken to almost the full positive supply voltage. This ensures that LED1 is switched off and the photocell is rendered ineffective.

The circuit can only be used with positive earth systems if D1 and the connection to the sidelights are omitted, and LED1 will not then be muted by switching on the sidelights.



Power Controller

This is a conventional diac-triac mains power controller which can handle loads of up to about 300 W or so (higher loads of up to about 1000 W can be controlled if the triac is fitted with a suitably substantial heatsink).

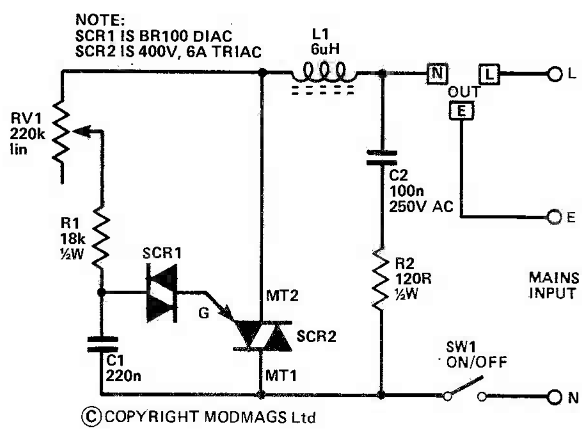
Circuits of this type operate by switching full power to the load for only part of each half cycle. For example, half power is obtained by switching power through the load for only the second half of each half cycle. Since the switching device (which is triac SCR2 in this circuit) is either switched fully on or off it dissipates little power, and good efficiency is obtained.

Full power is obtained with RV1 at minimum resistance, as the voltage on C1 is then virtually equal to the mains voltage. Thus the voltage on C1 reaches the trigger potential of diac SCR1 early in each mains half cycle, causing SCR1 to fire and switch on the triac for the major part of each half cycle. The triac switches itself off at the end of each half cycle when the current flowing through it falls to zero, so that it is ready to start afresh at the beginning of each new half cycle.

As RV1 is adjusted for increased resistance, the voltage on C1 lags further behind the mains voltage so the triac is not triggered until later in each half cycle, giving reduced output power. The triac will fail to trigger at all with RV1 set towards maximum resistance, giving zero output power.

Due to its fast switching time the circuit inevitably generates strong radio frequency signals, and L1, C2 and R2 are included to largely suppress these signals and prevent the unit from radiating RFI. Make sure that L1 has a sufficiently high current rating for the load in use.

In the interest of safety the unit should either be housed in an earthed metal case, or a plastic case should be used (with any exposed metalwork being earthed). RV1 should be a type having a plastic spindle and it should be fitted with a plastic control knob. Do not touch any of the wiring while the unit is plugged into the mains supply.



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BUYLINES

Sheets for Sep 79, Dec 79, Jan 80 and April - July 80 are temporarily out of stock. Earlier ETIPRINT sheets are available.

Send a cheque for PO (payable to ETI) for £1.20 per sheet with details of the project for which you require an ETIPRINT, and the month and year of publication to:

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HOW IT WORKS

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

ETIPRINTS

Sticky Solution

From Devcon come two types of epoxy adhesives in handy 9 oz bottle twin packs. A really useful aid for DIY and modelling, there is a choice of '5 Minute' or 'Slow Cure' adhesives. The five minutes type, as its name suggests, cures in 4 to 7 minutes and provides superfast bonding even with thin films and at low temperatures. It is clear, non-shrinking and has good chemical resistance, though is not suitable for long term immersion in water. The 'Slow Cure' epoxy is a tough adhesive setting in about 30 minutes, has a long working life and can be drilled, sanded or machined. For more information, Devcon is a division of ITW Ltd at Station Road, Theale, Reading, Berks, RG7 4AB.

Home, Home on the. . .

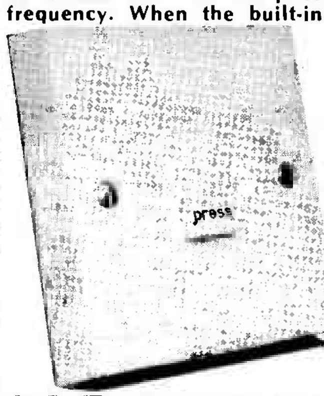
The Design Council is currently exhibiting a range of products representing in all its glory the microelectronics revolution which now affects all our lives. The exhibition shows some 40 British-made microelectronics products which are available now or will be in the near future. These products are meant to make life easier — improving efficiency or simply for amusement. The exhibition is divided into different areas of the home, for example the kitchen includes the 'Sensamatic' tumble dryer and the Satchwell Sunvic 'HC1201' central heating controller. The playroom section is filled with electronics games and kits, like Rowtron's Home Entertainment Centre which is a microcomputer-based television games system. In the living-room there is a highly sophisticated Chess Computer. In the sports and hobbies categories there is Paterson's digital thermometer and time signal for developing photographs, a car computer from Smith's Industries and at the 'front door' is a Yale Diplomat burglar alarm system. There are plenty more things to see at the Microelectronics Come Home exhibition which will be at the Scottish Design Centre from 30th March to 30th May.

DIY Sound

A new company called DIY Hi-Fi has just launched 'Cecilia', a pair of low cost DIY loudspeakers. They are of the bookshelf variety utilising the Pioneer TS 107 drive unit which was originally developed for in-car hi-fi systems. The speakers will cost around £35 to build and one of the contributing factors to this low cost is that there are no electrical components, such as crossovers etc, except for the drive units themselves which incorporate a strontium magnet and a compact dual cone giving a full extended frequency of 50-20,000 Hz! The finished speakers are extremely efficient, producing 91.5 db at 1 W/metre, power handling is 20 W maximum with a nominal impedance of 4 R which can be converted to 8 or 16 R. The finished size is 17" x 9" x 8½" deep. DIY Hi-Fi reckon you can easily build them in a weekend and they provide complete step-by-step, easy-to-follow instruction guides and full size blueprint plans for just £2.50 including postage and packing. DIY Hi-Fi, York House, Swan Street, West Malling, Kent.

Lights Out

MK Electric have recently brought out a new logic time delay switch. It is an ideal way to provide lighting economically in buildings where stairways, landings and corridors only need intermittent lighting. At the heart of the device is an oscillator with a variable pulse frequency. When the built-in counter has recorded a set number of pulses, the switch is turned off. For a short delay period, the oscillator frequency is increased, resulting in a shorter counting period. The delay adjustment screw is on the back of the switch which is set during installation for a time delay of between two and 15 minutes. It cannot be altered once set. The triac is protected by a fuse located at the front of the switch, but this can be locked to prevent unauthorised removal. The Logic Time Delay Switch can be installed for one-way, two-way or multi-way operation, with the delay switch as the master unit and standard logic press switches or architrave switches as extension units. There is also an override facility provided, useful when maintenance work or routine cleaning is carried out. A built-in neon indicator glows through the face-plate for easy location. The switch has a 400 W rating, for tungsten lighting only. For further details contact MK Electric Ltd, Shrubbery Road, Edmonton, London N9 0PB.



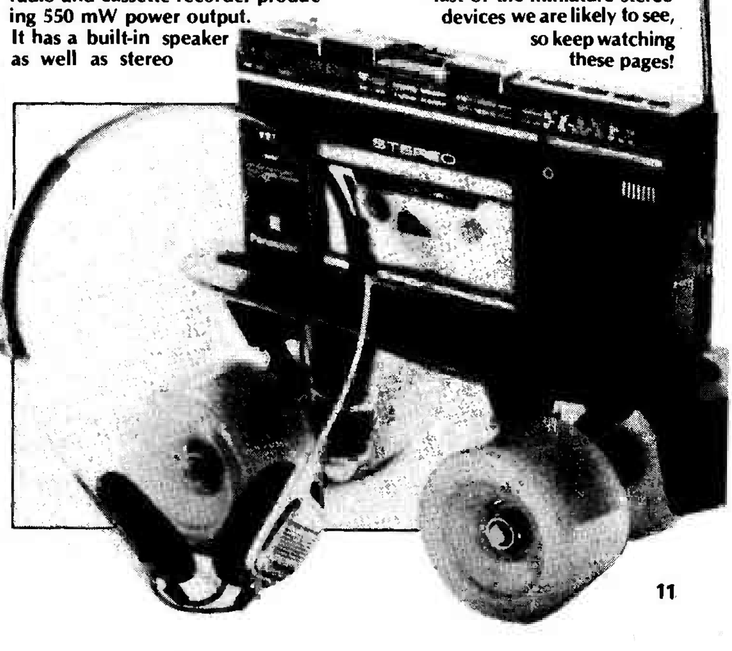
Testing, testing...

If you're still using neon screwdrivers and moving coil voltmeters, get with it and take a look at the two new additions to the Steinel range of voltage testers. The Mono Check is a single pole phase tester with great improvements over the conventional electrician's screwdriver. The internal resistance of the instrument is 10M and the current through the human body is reduced to a fraction of that required by neon testers. Under extreme conditions of insulation (for example, you're standing on a wooden ladder on an insulated floor) the tester will maintain as bright an indication as if it were directly earthed. The test range is 80-250 V AC relative to earth and the Mono Check remains safe at overloads six times this range. There is a function test switch located in the handle to confirm correct operation. The recommended retail price of the Mono Check is £3.80 plus VAT.

The Steinel range of two-pole voltage testers have a unique design; each instrument consists of two probe tips connected by a lead, with a solid state readout (LEDs or neons in the existing testers) built into one of the probes. This makes the testers inexpensive, reliable and practically unbreakable. The instruments are safe and simple to use; you can hang them on the wall (or round your neck) until you need them, then just place the probes on the test points and the readout operates automatically. On the simplest device this is just an indication of whether an AC or DC voltage greater than 4V5 is present, and DC polarity. Other instruments will display AC or DC voltages in bar form (eg 6, 12, 24, 110, 240 and 415 V), or allow continuity checks. We've been using these testers ourselves since November and think they're excellent, so it's good to see a new addition. The Digi-Check hand-held multimeter follows the same design philosophy but features a 3½ digit LCD display as the readout. The scale can be easily changed whilst using the instrument and if you find yourself in a position where you can't see the display (unlikely), then pressing a button on the probe latches the reading into memory. The ranges are 0.1 mV to 500 V DC, 10 mV to 500 V AC, and resistances from 0R1 to 20M. The Digi-Check is powered by four built-in NiCad batteries and there is an integral mains battery charger (no accessories required) which is overcharge-proof. The complete meter only weighs 250 g and has an RRP of £68.75 plus VAT. You can find Steinel at 288 Chester Road North, Sutton Coldfield, West Midlands B73 6RR.

Is It A Bird? Is It A Plane?

Not entirely unexpected after the Sony Stowaway's runaway success (along with the offerings of its many competitors), comes the first of a new breed of 'music on the move' ideas. It is a miniature stereo cassette/radio from Panasonic — the RX 2700. It is a pocket-sized unit which includes a compact FM/AM radio and cassette recorder producing 550 mW power output. It has a built-in speaker as well as stereo headphones and is able to record from its own radio in either stereo or mono, or can record in mono from its built-in microphone — useful for dictation. Among its other features are LED indicators, two-step tone control, one-touch recording, autostop, pause control and variable sound monitor. For the mere sum of £133.50 you too can have this versatile little device along with a carrying case and hip/shoulder strap. It is available now from Panasonic dealers. This is not likely to be the last of the miniature stereo devices we are likely to see, so keep watching these pages!



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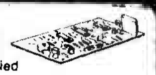

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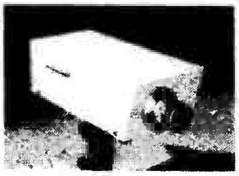

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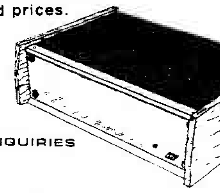

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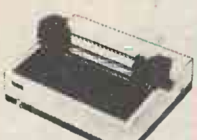

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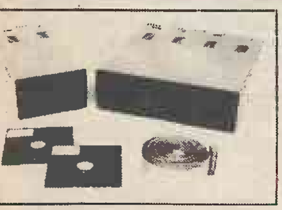

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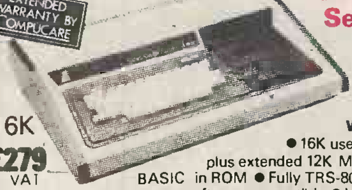

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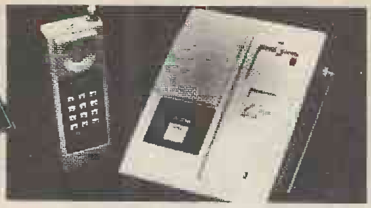

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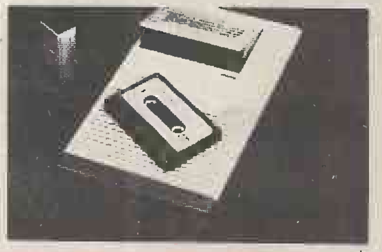

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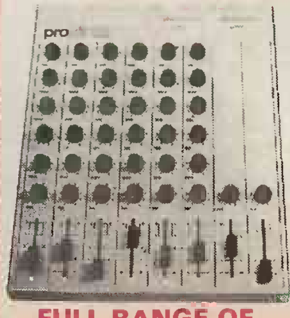

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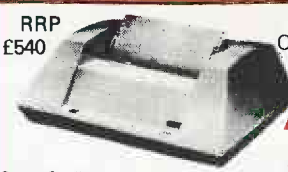

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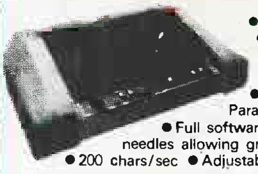

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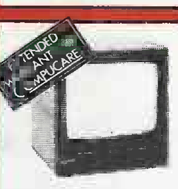

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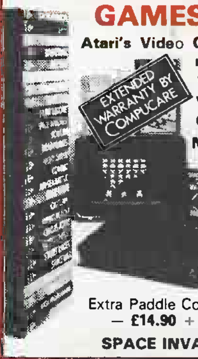

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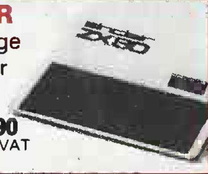

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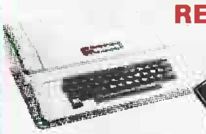

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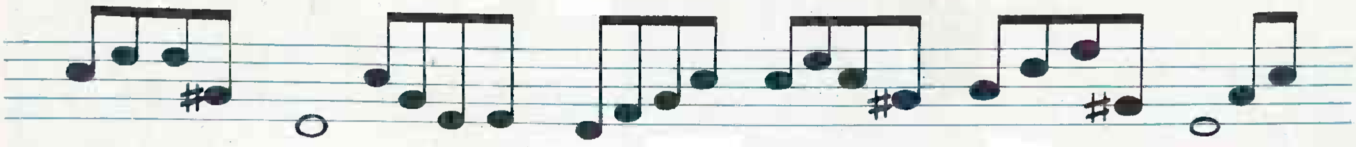

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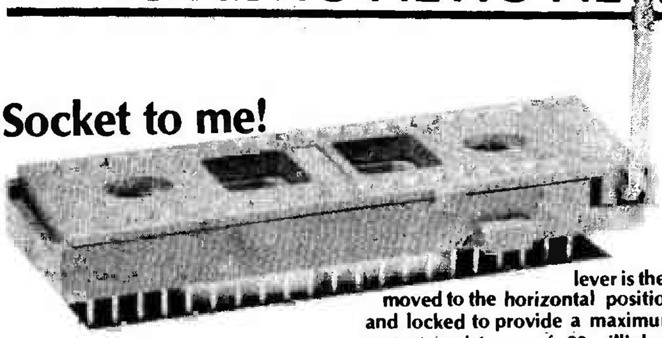


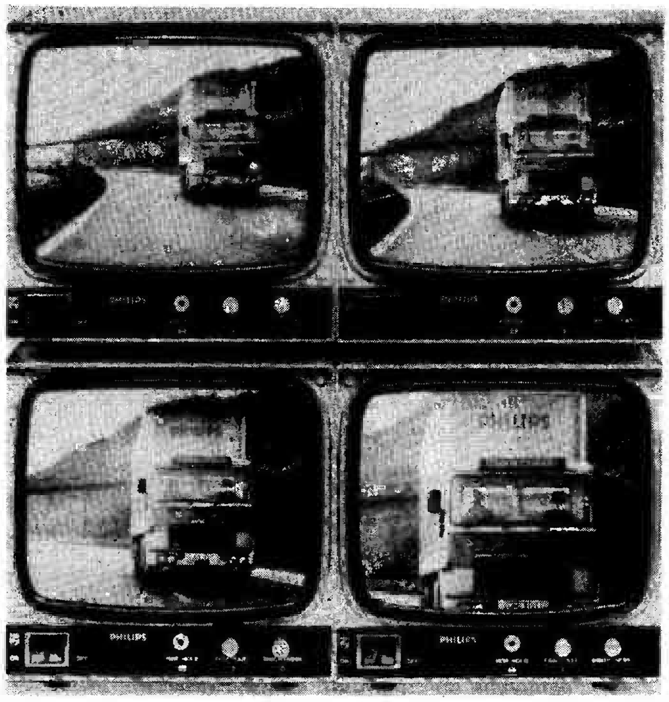
A range of Lever Actuated Zero Insertion Force sockets has been recently launched by Winslow International. The design is space saving — giving a height above the PCB of only 0.283 inches. When the lever is lifted to the upright position the socket will accept the IC without any force being applied to it. The lever is then moved to the horizontal position and locked to provide a maximum contact resistance of 20 milliohms at 10 mA. The socket is manufactured from Glass Reinforced PBT Resin and contact plating is 75 microinches of gold over hard nickel. It is available in 24, 28, 40 and 64 contact versions. More details are available form Winslow Component Systems Ltd, 71 Tunnel Road, Tunbridge Wells, Kent TN1 2BX.

A Case In Point

Lascar Electronics are offering a FREE custom moulded handheld instrument case worth over £1 to any enthusiast building their LCD meter kit, which they claim to be the first of a new generation of DPMs. The meter gives a battery life of at least 10 times that of existing types. LCD watch manufacturing techniques have been used to reduce the depth to a minimum. The 0.6 inch digits can be read to a distance of 10 m. The unit also incorporates a digital hold facility, auto-zero, auto-polarity, programmable decimal points and a 200 mV full scale deflection. Display backlighting is a customer option. The meter is supplied with brackets for front or rear panel mounting. The custom moulded case accepts the DPM, a PP3 battery and allows space for the customer's own PCB (the data sheet on the meter includes 10 small easy-to-build handheld instruments). The total cost of the meter is £19.95 plus 50p postage and packing and £3.06 VAT. The offer of the free case is valid until the end of December this year. For further information contact Lascar Electronics at Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex SS13 1LH.

Phone Around

Now that British Telecom has taken over the communications network for the Post Office, some exciting new innovations are taking place, not the least of which is the yellow telephone box idea. Enough of the controversy though, let's get on with the real story. British Telecom has placed an order worth £10 million for the Herald electronic business telephone system. With this new system Britain can no longer be accused of being inefficient and old-fashioned in its approach to telecommunication by comparison with other countries. Herald is the most advanced small business system in the world. Based on a microprocessor and purpose designed large-scale integrated circuits, the Herald offers a unique range of programmable facilities. It can be arranged to function as a multi-line exchange, as a key system, as an automatic call distribution system or as a satellite to a large PABX. It is easy to install and maintain and is low-cost. The terminal is available in either standard or de-luxe models with a compact Central Control designed to blend into the office environment. Unfortunately the company hasn't mentioned whether the standard colour is British Telecom yellow! Buzby, you've got a lot to answer for!



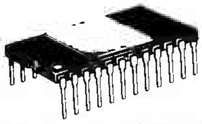
Dial-a-Picture

Still pictures can now be sent over any distance for the cost of a single phone call with the Philips Slowscan system. The system is ideal for cheap remote observations of buildings, industrial processes and motorways where it is not feasible to install high quality video circuits for real-time pictures. The application for this system is already in evidence on the M4 motorway. A CCTV camera is located at the Chepstow interchange, viewing the approach road. Still pictures, updated every 8.5 S, are displayed on monitors situated 17 miles away in the Police Control Centre at Cwmbran, providing the Police with information on motorway conditions. The system has the facility for selecting up to four pre-set camera positions, and should the operator require closer examination of an incident, he can switch the Slowscan transmission system from a low definition/high speed scan of 8.5 S to a high definition/low speed scan of 17 to 35 S. The system comes from Pye Business Communications, Cromwell Road, Cambridge, CB1 3HE. This division of Philips will be re-named the Communication and Control Division of Philips Business Systems after 1st April this year.

Swimming Around?

The Casio W-100 series of watches are able to function up to a depth of 100 m and feature a 12-digit display. The integrated LCD shows full information simultaneously — hours, minutes, seconds, AM/PM (or 24 hour clock), day, month and date. Even when operating the secondary functions such as countdown alarm and stopwatch the W-100 still displays the current hour and minutes in an offset position. It is also capable of a daily alarm and half-hourly time signal. The Casio W series is a range that offers a choice of bracelet or case styles. The W-100 itself has a resin case and strap and costs £22.95. The W-150C features a stainless steel case with black resin strap at £27.95. Top of the range is the W-150 with full stainless steel case and strap at £32.50. (All these are recommended retail prices and this type of product is usually sold at lower prices.) Further information from: Casio Electronics Co. Ltd, 28 Scrutton Street, London EC2A 4TY.

MICROS



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LS55	70	4012	24
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LS73	40	4014	85
LS74	40	4015	85
LS75	48	4016	42
LS76	45	4017	82
LS78	45	4018	28
LS83	105	4019	48
LS85	105	4020	99
LS86	45	4021	105
LS90	50	4022	95
LS91	125	4023	25
LS93	75	4024	75
LS95	115	4025	25
LS96	180	4026	180
LS107	45	4027	48
LS109	75	4028	82
LS112	80	4029	105
LS113	65	4030	60
LS114	49	4033	175
LS122	70	4034	210
LS123	95	4035	125
LS124	180	4040	105
LS125	60	4041	80
LS126	60	4042	60
LS132	95	4043	95
LS133	30	4044	95
LS136	55	4046	130
LS138	70	4047	98
LS139	90	4049	45
LS145	120	4050	48
LS148	175	4051	80
LS151	96	4052	80
LS153	85	4053	80
LS155	96	4054	130
LS156	96	4055	135
LS157	76	4068	28
LS158	85	4069	28
LS160	120	4070	30
LS161	98	4071	25
LS162	110	4072	25
LS163	100	4073	25
LS164	115	4075	25
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LS195	125	4519	70
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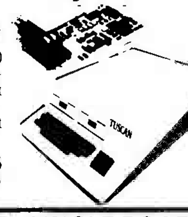

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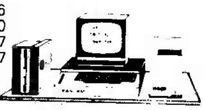

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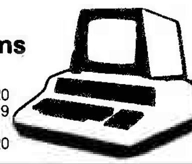

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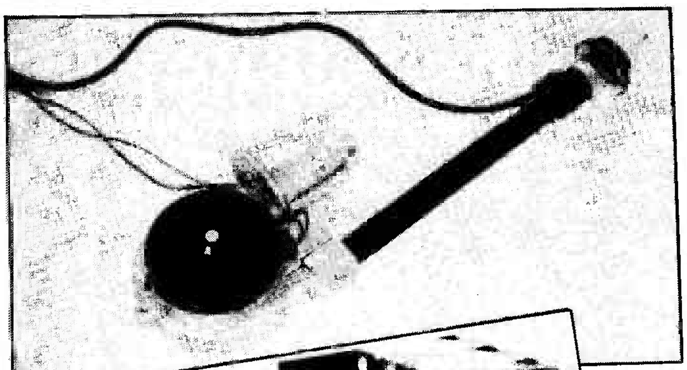

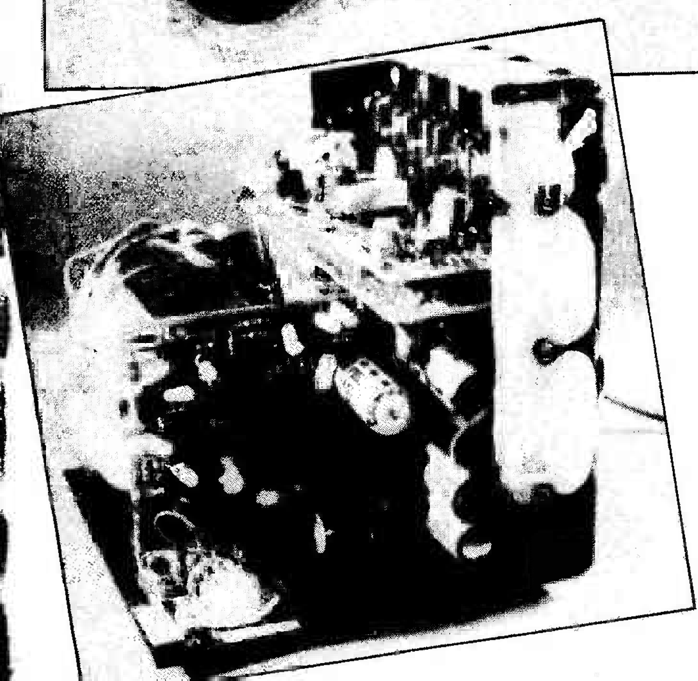

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Continuing our current theme of remote-controlling everything (almost), we look at a range of Mullard ICs, intended for use in hi-fi systems, that allow DC control of just about all the functions you can think of. In this article Keith Brindley examines two members of the family; applications circuits and suitable PCBs are included so you can try them out for yourself.

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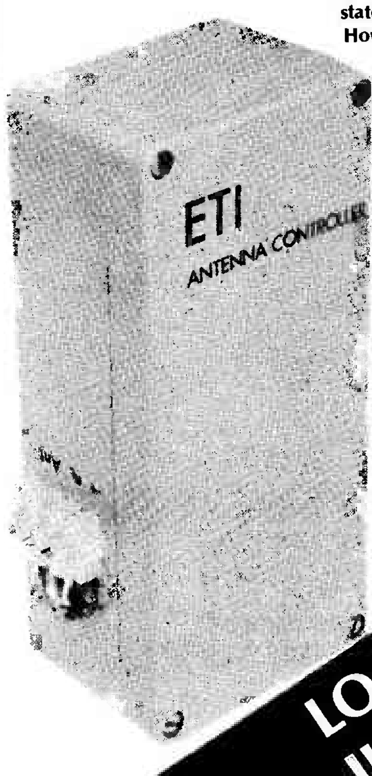

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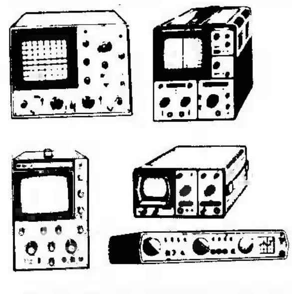

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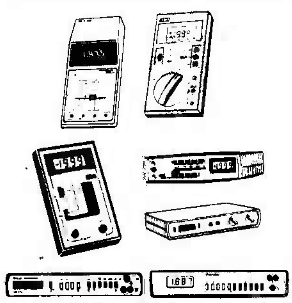

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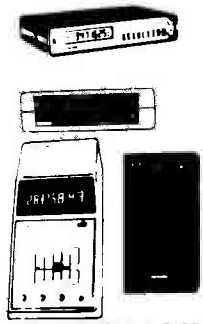

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DESIGNER'S NOTEBOOK

The CMOS family contains many useful ICs, and in this month's extended Notebook, Ray Marston takes an in-depth look at the 4066B quad bilateral switch.

The 4066B CMOS IC is described in the manufacturer's literature as a 'quad bilateral switch', a pretty fair description since the device contains four independent electronic switches, each capable of passing signals in either direction and being controlled (turned on or off) by a single high-impedance terminal. The switches have a very high off impedance, an on impedance of about 90 R, and can be used to switch both analogue and digital signals. The ICs typically cost a mere 50 pence each, not bad for four independent SPST switches.

Basic 4066B Circuits

Figure 1 shows the outline and pin notations of the 4066B quad bilateral switch, which can be used with any supply voltage in the range 3 to 18 V. Note that, since the switches are of the bilateral type, either switch terminal can be used as the input or output.

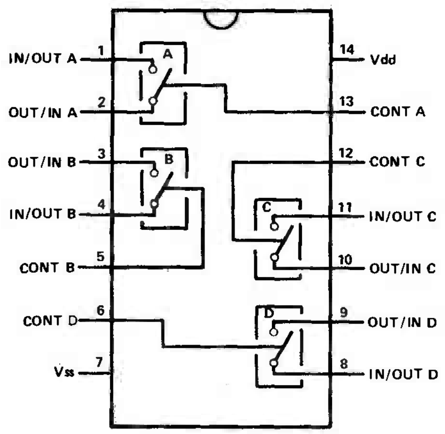


Fig. 1 Outline and pin notations of the 4066B quad bilateral switch.

Figure 2a shows the basic way of using the bilateral switch; the switch can be turned off (open circuit) by taking the control terminal to V_{SS} or turned on by taking the control terminal to V_{DD}. In digital switching applications (Fig. 2b) the IC can be used with a single-ended supply, with V_{SS} at 0 V and V_{DD} at the desired positive supply. In analogue switching applications (Fig. 2c), a split power supply (either true or effective) must be used, with the positive rail to V_{DD} and the negative to V_{SS}; in this case, of course, the maximum supply limits are restricted to ±9 V. Typically, the bilateral switch introduces less than 0.5% of signal distortion when used in the analogue mode.

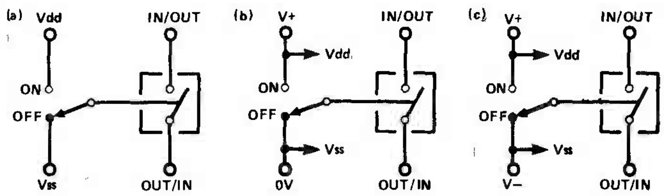


Fig. 2 (a) The basic bilateral switch is turned off by taking the control terminal to V_{SS} and turned on by taking the control to V_{DD}. (b) In digital switching applications, V_{DD} is V+ and V_{SS} is 0 V. (c) In analogue switching applications where a split power supply is used, V_{DD} must go to V+ and V_{DD} to V−.

Certain simple precautions must be observed when using the 4066B. First, the switch signals must in no circumstances be allowed to rise above the V_{DD} voltage or fall below the V_{SS} voltage. Each unused switch in the 4066B package must be disabled (see Fig. 3) either by taking its control terminal to V_{DD} or V_{SS} (as most convenient), or by taking all three terminals to V_{SS}.

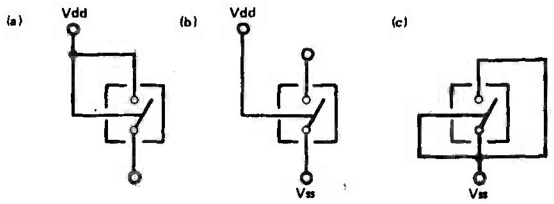


Fig. 3 Unused bilateral switches must be disabled, either by taking the control terminal to V_{DD} and one of the switch terminals to V_{DD} (a) or V_{SS} (b), or by taking all three terminals to V_{SS}.

Figure 4 shows how the 4066B can be used to implement the four basic switching functions of SPST, SPDT, DPST and DPDT. Figure 4a shows the SPST connections, which we have already discussed. The SPDT function is implemented by wiring an inverter stage (a 4001 or 4011, etc) between the IC1a and IC1b control terminals as shown. The DPST switch (Fig. 4c) is simply two SPST switches sharing a common control terminal, and the DPDT switch (Fig. 4d) is two SPDT switches sharing a common inverter stage in the control line.

Note that the basic switching functions of Fig. 4 can be expanded or combined in any desired way by simply adding extra switches/4066B-packages, as appropriate. Thus, a 10-pole double-throw switch can, for example, be made by using five of the Fig. 4d circuits and joining their control inputs together. ➜

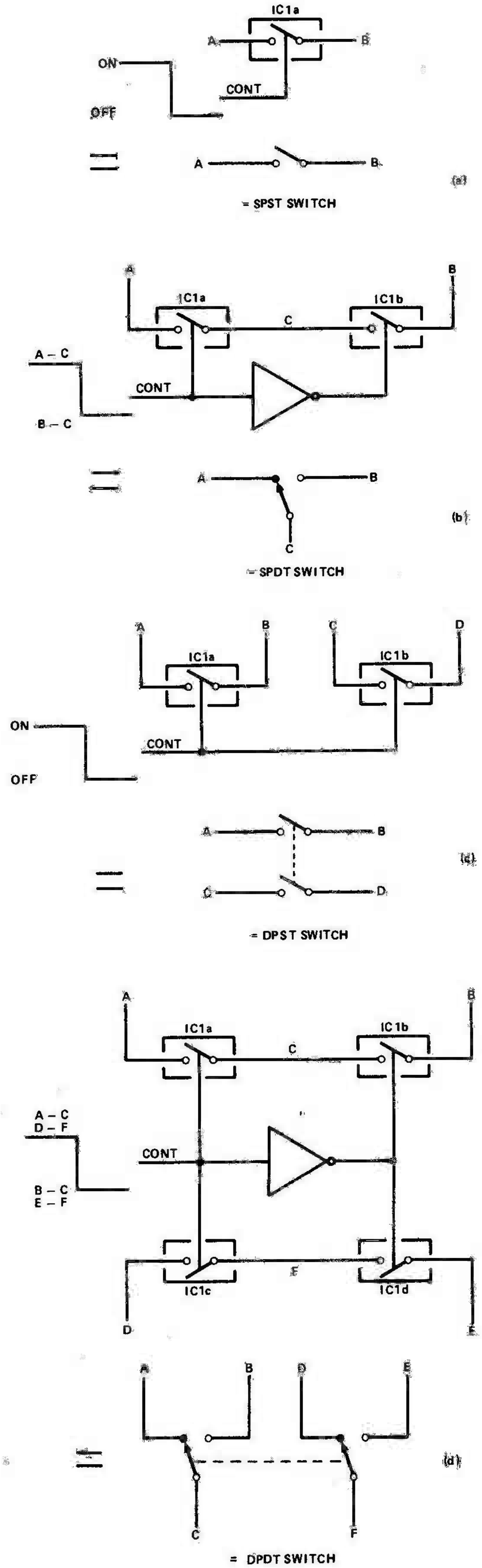


Fig. 4 Using the 4066B to implement the four basic switching functions.

Six Latching Circuits

Figure 5 shows how a 4066B switch can be used as a simple but very useful press-button activated latch; the LED is merely used to indicate the state of the latch and can be replaced with a short circuit if preferred. Circuit operation is easily understood.

Suppose initially that the latch is off (switch open). In this case the output, and hence the control bias applied via R2, will be zero, so the switch will maintain its off state. If PB1 is now momentarily closed the control voltage will go high and turn the switch on, thus driving the output high and maintaining the control drive high (switch on) once PB1 is released. This new state will be maintained until PB2 is closed, at which point the switch will latch into the off state again. R1 is used in the circuit to ensure that a supply short will not occur if both buttons are pressed at the same time; with R1 in the position shown, the switch will turn off if both buttons are pressed at once; if R1 is moved to the low side of PB2, the switch will turn on if both buttons are pressed at once.

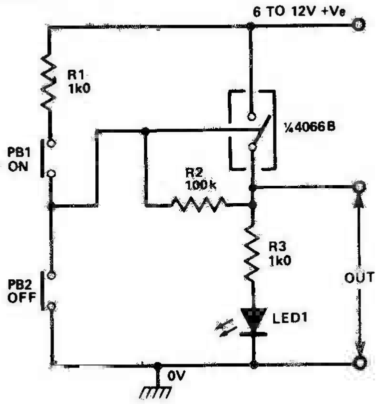


Fig. 5 Push-button latch using the 4066B.

The Fig. 5 circuit has a couple of interesting characteristics. First, the control bias resistor can be given any desired value up to practical limits. Figure 6, for example, shows how the value can be increased to 10M to make a latching touch switch that can be activated by placing a finger across the upper or lower set of touch contacts. R1 and C1 are used to suppress hum signals and ensure positive switching.

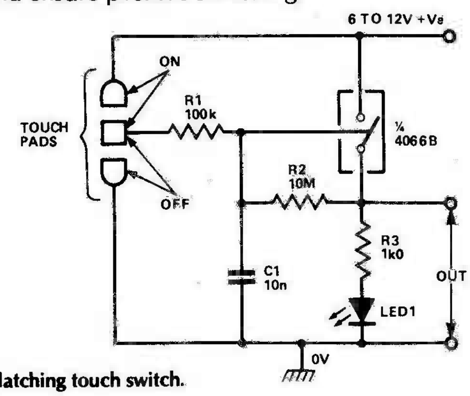


Fig. 6 A latching touch switch.

Another useful feature is that, since the on resistance of the switch is only 90 R or so, the voltage loss across the switch can be quite low (90 mV at 1 mA): in practice, the on current should be limited to 10 mA maximum. Figure 7 shows how this low-loss effect can be exploited to make a push-button power switch that can be used to connect or disconnect the power supply to a piece of electronic equipment (amplifier, test gear, etc).

When the switch is off, Q1 is cut off and the circuit consumes a typical standby current of less than 1/ uA. When the switch is on, Q1 acts as a voltage follower with its base tied to the positive line via IC1a, so the output voltage is high. The actual voltage drop between the output and the supply is equal to the IC1a drop plus the base-emitter drop of Q1 and typically ranges from 600 to 800 mV. The available output current depends on the gain and current rating of Q1, but currents of a few hundred milliamps are readily available from a single transistor.

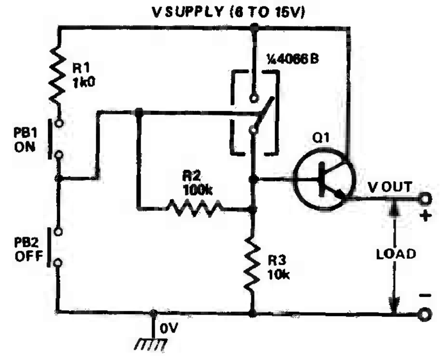


Fig. 7 This push-button-activated power switch can be used to replace a conventional slide or toggle switch.

A slightly more efficient version of the push-button power switch is shown in Fig. 8. In this case the load is wired between the collector of Q1 and the positive supply rail. The voltage drop in this circuit is determined only by the saturation characteristics of Q1 and may typically be in the range 200 to 600 mV.

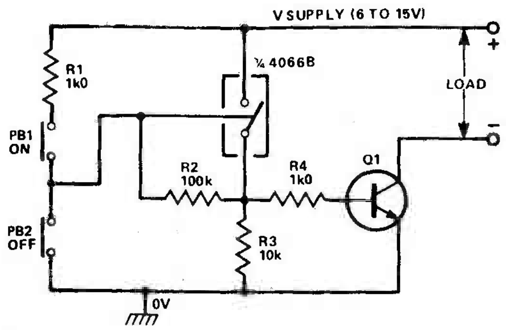


Fig. 8 An alternative version of the push-button power switch.

Figure 9 shows how the above circuit can be modified for use as a 'close-to-activate' burglar, panic or fire alarm, in which Q1 output feeds directly to a heavy duty 'alarm' relay which, in turn, actuates an external bell or siren. Any number of normally-open sensors/switches can be wired in parallel in the 'PB' positions. The circuit consumes only a microamp or so when in the 'ready' or off mode.

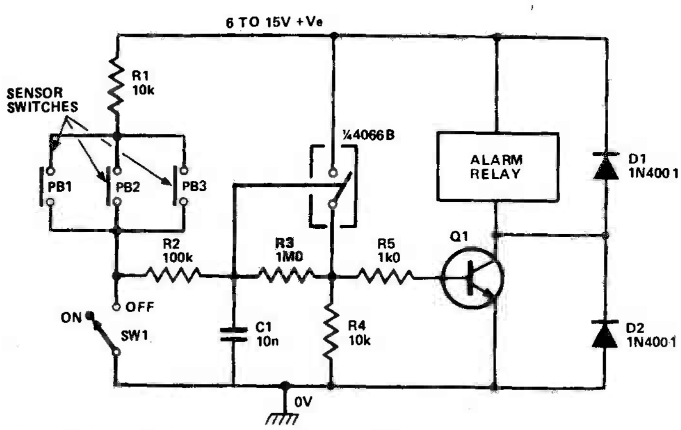


Fig. 9 A close-to-activate burglar/panic/fire alarm.

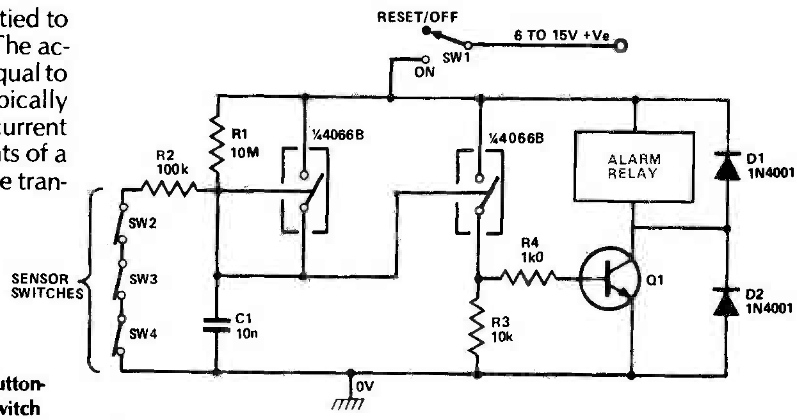


Fig. 10 A break-to-activate burglar alarm.

Finally, Fig. 10 shows how a pair of 4066B switches can be used to make a break-to-activate burglar alarm in which any number of normally-closed sensor switches can be wired in series and which typically consumes a standby current of only 1 uA or so. Here, if any of the switches open, the control terminals of IC1a and IC1b are pulled high by R1 and cause both switches to close; IC1a then shorts out R1, ensuring that the switches will not turn off again when the sensor switches close. Simultaneously IC1b activates the alarm relay via Q1. Note that, once this alarm circuit has been activated, it can only be turned off again by resetting the sensor switches and momentarily breaking the supply connections via SW1.

Digital Control

The 4066B can be used to digitally control or vary resistance, capacitance, impedance, amplifier gain or oscillator frequency in any desired number of discrete steps. Figure 11 shows how the four switches of a single 4066B can be used to vary the effective value of a resistance in 16 digitally-controlled steps of 10k each. In practice, of course, the step magnitudes can be given any desired value (determined by the value of the smallest resistor) so long as the four resistors are kept in the ratio 1-2-4-8.

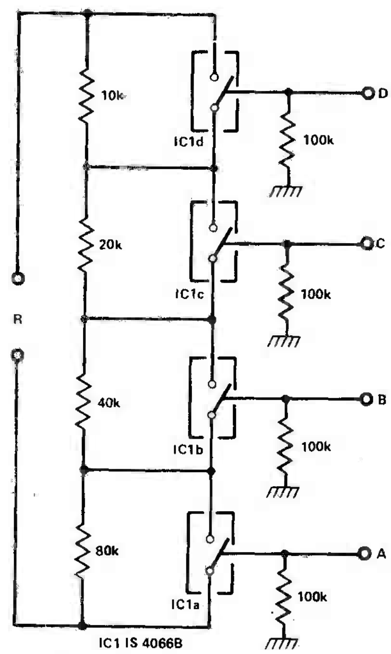
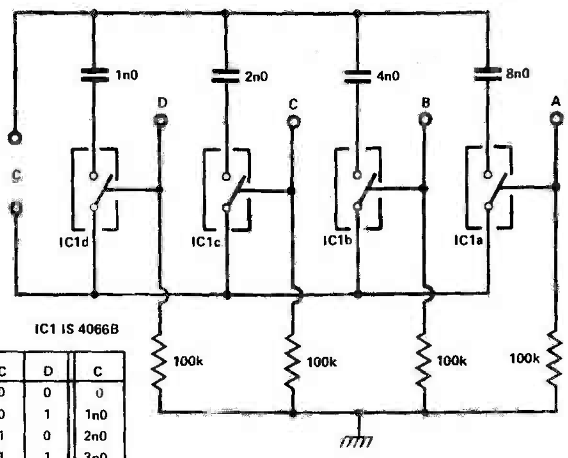


Fig. 11 This circuit gives 16-step digital control of resistance. R can be varied from zero to 150k in steps of 10k.

A	B	C	D	R
0	0	0	0	150k
0	0	0	1	140k
0	0	1	0	130k
0	0	1	1	120k
0	1	0	0	110k
0	1	0	1	100k
0	1	1	0	90k
0	1	1	1	80k
1	0	0	0	70k
1	0	0	1	60k
1	0	1	0	50k
1	0	1	1	40k
1	1	0	0	30k
1	1	0	1	20k
1	1	1	0	10k
1	1	1	1	0



A	B	C	D	C
0	0	0	0	0
0	0	0	1	1n0
0	0	1	0	2n0
0	0	1	1	3n0
0	1	0	0	4n0
0	1	0	1	5n0
0	1	1	0	6n0
0	1	1	1	7n0
1	0	0	0	8n0
1	0	0	1	9n0
1	0	1	0	10n
1	0	1	1	11n
1	1	0	0	12n
1	1	0	1	13n
1	1	1	0	14n
1	1	1	1	15n

Fig. 12 A similar circuit to that of Fig. 11 gives 16-step digital control of capacitance. C can be varied from zero to 15n in steps of 1n0.

Figure 12 shows how four switches can be used to make a digitally-controlled capacitor that can be varied in sixteen steps of 1n0 each.

Note that in the Fig. 11 and 12 circuits the resistor/capacitor values can be controlled by operating the 4066B switches manually, or automatically using simple logic networks, microprocessors, up/down counters, and so on.

The circuits of Figs. 11 and 12 can be combined in a variety of ways to make digitally-controlled impedance and filter networks. Figure 13, for example, shows three different ways of using the circuits to make a digitally-controlled first-order low pass filter.

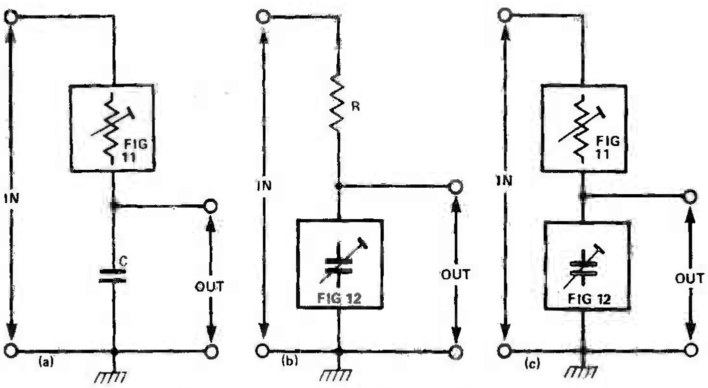


Fig. 13 Three ways of using the circuits of Fig. 11 and Fig. 12 to make a digitally-controlled first-order low pass filter.

Digital control of amplifier gain can be obtained by hooking the 'resistance' circuit of Fig. 11 into the feedback or input path of a standard op-amp inverting circuit, as shown in Figs. 14 and 15. The gain of such a circuit is equal to R_F/R_{IN}, where R_F is the feedback resistance and R_{IN} is the input resistance. Thus, in the Fig. 14 circuit, where the controlled resistance is in the feedback loop, the gain can be varied from zero to unity in 16 discrete steps of 'one fifteenth' each, ie giving a sequence of 0, 1/15, 2/15, 3/15, ... , 14/15, 15/15.

Fig. 14 Digital control of gain using the Fig. 11 circuit. The gain can be varied between zero and unity in 16 steps.

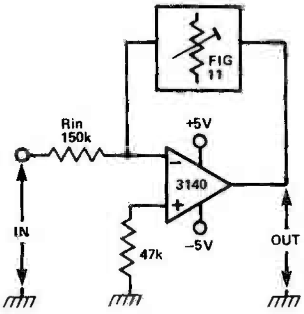
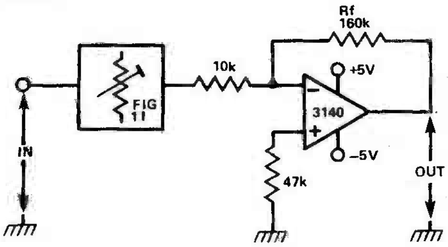


Fig. 15 This application of the Fig. 11 circuit gives digital control of gain between unity and x 16 in 16 steps.



In the Fig. 15 circuit, where the controlled resistance is in the input path, the gain can be varied from unity to x 16 in 16 steps, giving a gain sequence of 1, 2, 3, 4, 5, 6, . . . Note that in both of these circuits, the op-amp uses a split power supply so the 4066B control voltage must switch between the negative and positive supply rails.

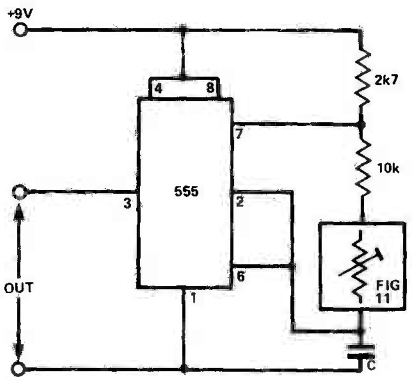


Fig. 16 Digital control of the frequency of a 555 astable. The frequency can be varied in 16 steps.

Figure 16 shows how the Fig. 11 circuit can be used to digitally control the frequency of an oscillator in 16 discrete steps. In this example the circuit is that of a 555 astable, but the general control principle can be applied equally well to many other types of oscillator circuit.

Figure 17 shows how a trio of 4066B switches can be used to implement digital control of the decade range selection of 555 astable. Here, only one of the switches must be turned on at any time. Naturally, the circuits of Figs. 16 and 17 can be combined to form a wide-range oscillator that can be digitally controlled by a computer, for example.

Synthesized Multi-Gang Pots

The synthesizing principle is quite simple and is illustrated in Fig. 18, which shows the circuit of a synthesized four-gang 10k - 100k rheostat for use at signal frequencies up to about 15 kHz.

Here, the 555 is used to generate a 50 kHz (nominal) rectangular waveform whose mark/space ratio can be varied from 11:1 to 1:11 by RV1, and this waveform is used to control the switching of the 4066B stages. All of the 4066B switches are fed with the same control waveform, and each switch is wired in series with a range resistor (RA, RB, etc), to form one gang of the 'rheostat' between the pairs of terminals, as shown.

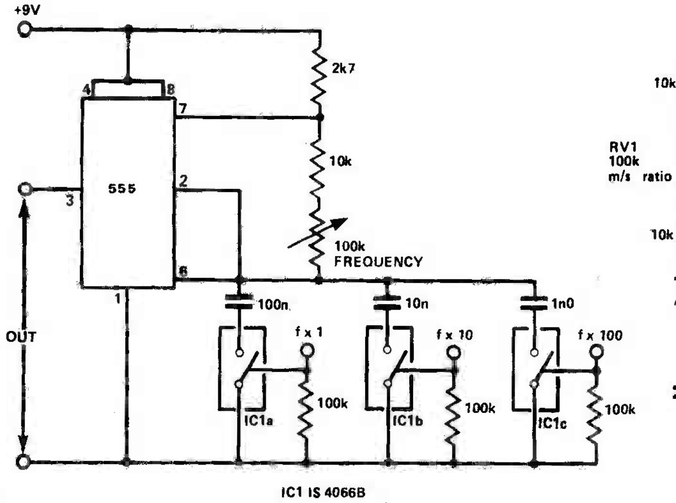


Fig. 17 Digital control of decade range switching of a 555 astable.

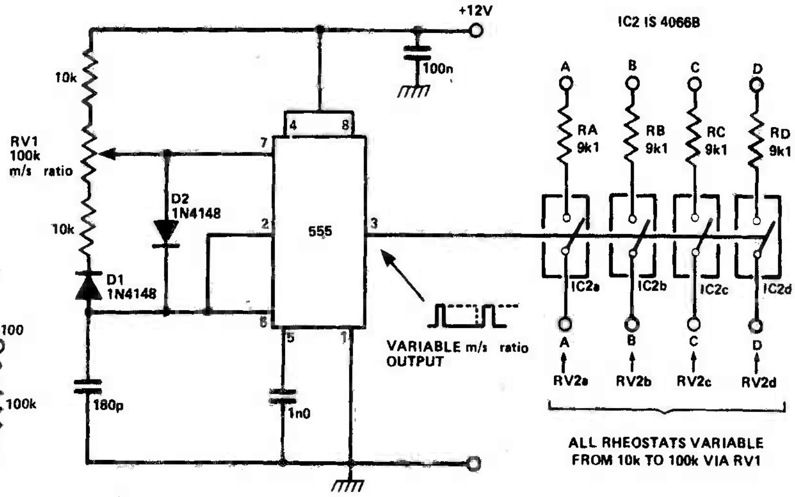


Fig. 18 Synthesized precision four-gang rheostat.

Remembering that the switching rate of this circuit is very fast (50 kHz) relative to the rheostat's maximum signal frequency (15 kHz), it can be seen that the mean or effective value of the 'rheostat' resistance can be varied with mark/space ratio control RV1. Thus, if IC2a is closed for 90% and open for 10% of each duty cycle (mark/space ratio of 9:1), the apparent (mean) value of the resistance will be 10% greater than RA, ie 10k. If the duty cycle is reduced to 50%, the apparent RA value will double, to 18k2. If the duty cycle is further decreased, so that IC2a is closed for only 10% of each duty cycle (mark/space ratio 1:9), the apparent value of RA will increase by a decade, to 91k. Thus, the apparent resistance of each 'gang' of the 'rheostat' can be varied by RV1.

There are some important points to note about the Fig. 18 circuit. First, the circuit can be given any desired number of 'gangs' by simply adding an appropriate number of switch stages and range resistors. Since all switches are controlled by the same mark/space ratio waveform, perfect tracking is automatically assured. Individual gangs can be given different ranges, without affecting the tracking, by giving them different range resistor values. The sweep range and the law of the rheostat can be changed by changing the characteristics of the mark/space ratio generator.

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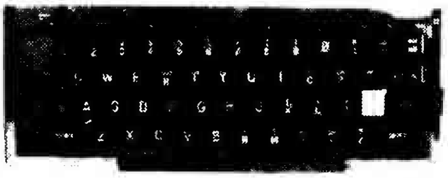

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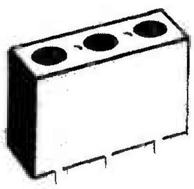

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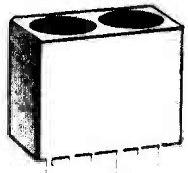

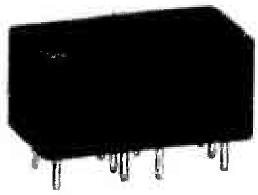

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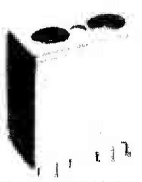

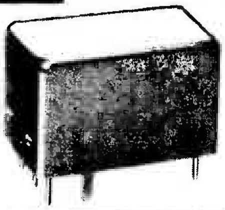

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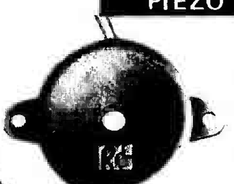

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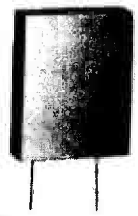

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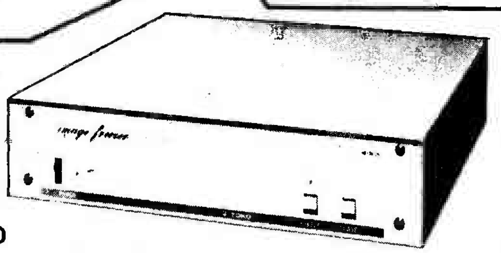

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It is something of an anachronism that in this day of high technology, we should still use solder to join the pieces of our electronic puzzles. And it isn't due to lack of choice: conductive polymers, force-fit, ultrasonics, wire-wrapping, clamp mass or unit terminators and even microweld have all been tried and are very useful in some specialised areas. But the fact remains that soldering is one of the most reliable and versatile ways of making an electrical and mechanical joint with a minimum of cost and time.

The ETI Microstation has been designed to make the process even more reliable and versatile. Its main purpose is melting the solder and locally heating the parts to be joined. It must do so:

- Whatever the thermal mass of these parts;
- In a very short time (before the heat has diffused into and damaged the electronic component or lifted the PCB track — a good rule of thumb is less than 3 S)
- Without overheating the solder (the flux burns and an oxide layer is formed, making it extremely difficult to wet the component).

The key words here are 'thermal mass' and electronic components vary wildly in this respect. Because of this, one usually ends up with three or even four irons in the tool box.

Thermomechanically-controlled irons (magnetic Curie point or thermocouple-switched) can be an improvement, but they are not adjustable and the switching of the heating element creates current spikes that can be very nasty to MOS and other sensitive devices. In addition, they are usually bulky and slow-reacting.

Electronically-controlled soldering stations with adjustable temperature are an improvement; the trouble with many of them is the relatively low maximum output power. The trouble with *all* of them is the price! Practically all electronic stations use a special heating element incorporating a temperature sensor. Unfortunately, this increases the maintenance costs as well.

As a last criticism, on practically all models the tip is invariably too far from the handle and does not allow a precise work control.

The Microstation is based on a very low voltage heating element-bit initially introduced on portable, battery-powered irons. It has a very low thermal mass and no thermal resistance between element and bit, allowing a very fast-reacting temperature regulation. In addition, the low voltage operation makes it completely harmless to sensitive integrated circuits.

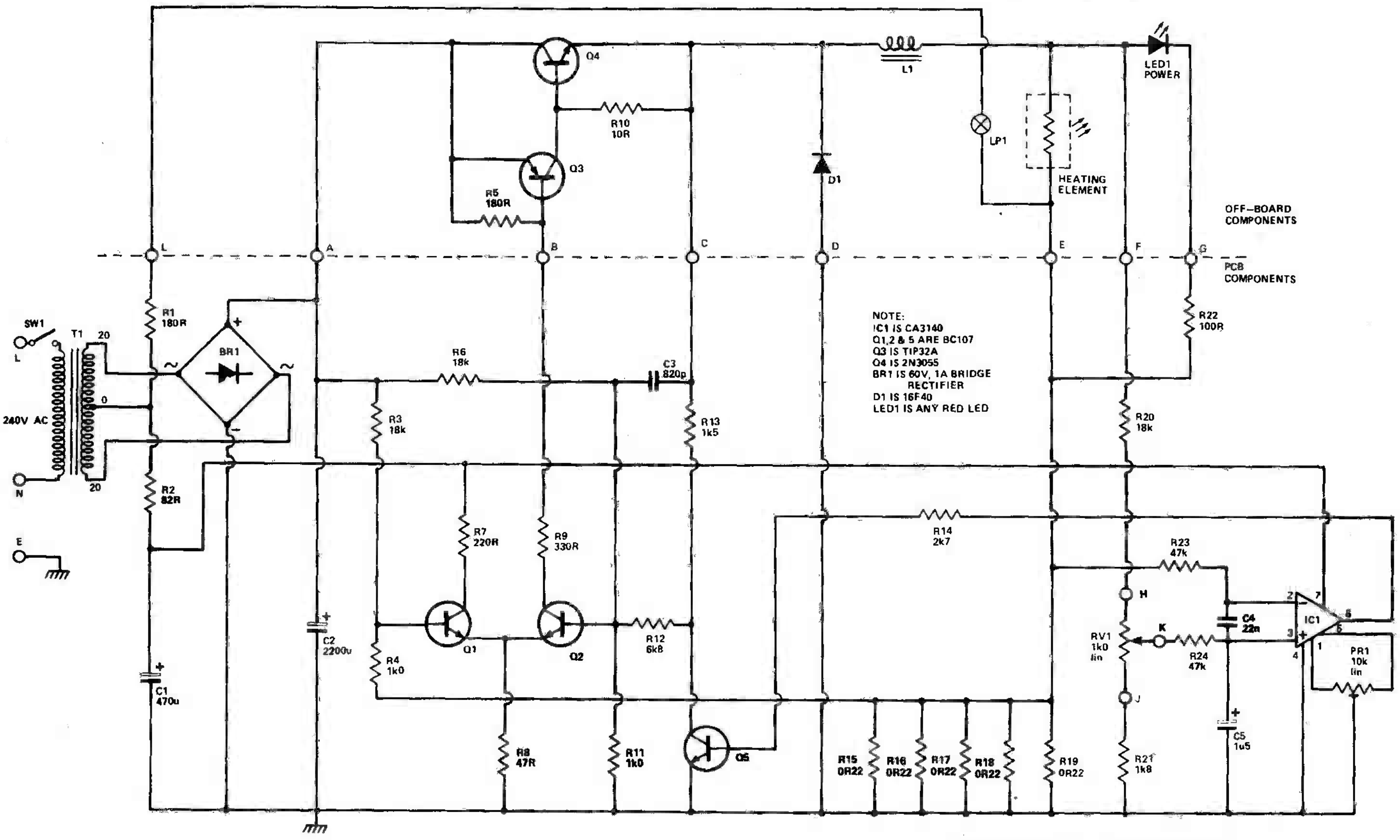
The temperature sensing is performed by measuring the resistance of the heating element itself (by including it in a Wheatstone bridge configuration) and therefore does not require any complicated thermal sensors.

The low working voltage of the element (2V5) implies a high current consumption at maximum power (12 to 15 A). The only type of power supply that can effectively handle and control such currents is the switched mode step-down converter. This circuit accepts a high, unregulated voltage and generates a high current-low voltage output that can be easily controlled. The principle is to store packets of energy in an inductor and then discharge them into the load at a different voltage. The current tends to be constant, so the ratio of the times taken to store and release the energy are the same as the ratio between input and ouput voltage.

As the power-controlling transistors are either switched on or off, the theoretical efficiency of the circuit is 100%. In practice, the finite switching times mean that some power is dissipated, and the heatsink can become quite hot.

One of the most crucial parts of a switched mode supply is the storage inductance and many tomes have been written

Fig.1 Circuit diagram. Components above the dotted line are mounted either on the heatsink, case or in the actual soldering iron.



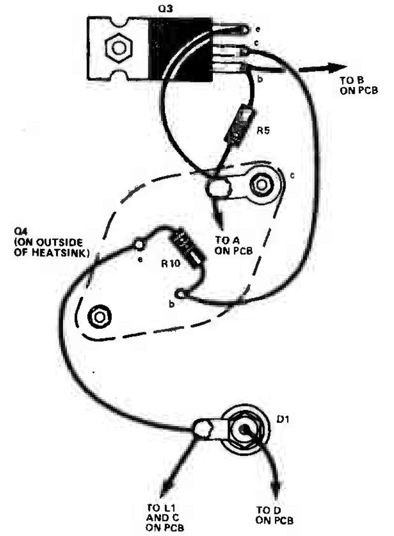


Fig.2 This drawing shows the off-board components as they should be mounted on the heatsink (seen from the inside of the case). The photograph on the last page may also help with construction.

about the pros and cons of different materials, magnetic polarisation and loss distribution. The basic problem is that core loss and size are proportional to the energy packet, but minimising them means increasing the switching frequency, and therefore the power semiconductor loss. This loss occurs during the transition period between the on and off states and is directly proportional to switching frequency. In practice, the core choice was mainly dictated by availability to the hobby market and many a beautiful formula had to stay in its book.

As mentioned earlier, no thermal sensor as such is used. The temperature is sensed by measuring the resistance of the heating element itself which is slightly temperature-sensitive. (It

HOW IT WORKS

The circuit can be split into three main sections; power supply, main converter and temperature-sensing circuitry.

The supply rail for the main converter is standard, with the transformer output being full-wave rectified by BR1 and smoothed by C2. The op amp supply relies on the fact that the centre tap of the transformer is always at mid-voltage, $V_{cc}/2$, whatever the polarity of the incoming AC; it only needs to be filtered by R2/C1.

The circuitry of the main converter can be considered to be equivalent to an op amp, with the differential pair Q1, Q2 functioning as the inverting and non-inverting inputs respectively, and Q3, Q4 being the output stage. The circuit will oscillate at a high frequency, as follows. Assume Q4 is turning on, so that Q4 emitter is now at the supply voltage — this increase in voltage is coupled to the base of Q2 by C3 and R12-R13. C3 is included to improve the high frequency response. Q2 now conducts more heavily, tending to turn on Q3 (and hence Q4) still further and this regenerative action means that Q4 turns hard on. D1 will not conduct as it is reverse biased.

Current does not flow in the load immediately because of inductor L1; instead the current increases exponentially towards V_{cc}/R_{LOAD}. As the current flows through R15-19 it generates a voltage which is coupled to Q1 base via R4. As the load current increases, it reaches a point where the voltage on Q1 base exceeds that on Q2 base, and Q4 now begins to turn off. L1 again opposes this voltage change and lowers the voltage at Q4 emitter, a regenerative action that turns Q4 hard off. L1 forces Q4's emitter so low that D1 conducts and allows current to continue to flow through the load. The energy stored in the coil is discharged into the load and so the current through the heating element and R15-19 is decreasing. Thus the voltage on Q1 base eventually falls below that on Q2 base, turning Q4 on and starting the whole cycle again.

During each cycle, when Q4 conducts, the power output is $V_{cc} \times I_{LOAD}$ but the power in the load is only $V_{LOAD} \times I_{LOAD}$. The difference is stored in L1 and delivered to the load when Q4 is blocked. The mean current output of Q4 is therefore much lower than the effective continuous load current.

Temperature control is achieved by using the Wheatstone bridge built around IC1. The heating element and R15-19 form one arm of the bridge, R20, RV1 and R21 form the other. The reference voltage from RV1 is compared with that across the inputs of IC1. The output of the op amp controls the oscillator feedback voltage by means of Q5.

varies between 0.155 and 0.22 R at 100°C and 400°C respectively.)

In practice, we don't even need to measure the temperature itself. By including the heating element into a Wheatstone bridge configuration, its resistance is continuously compared to the fixed resistors. Any change from the preset balance condition appears as an error signal that can be directly used to control the power input and therefore correct the temperature. The resulting temperature regulation is effective between 50°C and 500°C (as we discovered by melting a couple of heating elements during our trials), but for practical purposes, the temperature range was limited to 200°C-450°C, with a very good linearity.

Construction

The main point to remember throughout the construction of this project is the fact that the output currents can be very high indeed — more than 15 A peak. All current-bearing conductors (and that includes the output leads, the internal connections and the coil) must accept such currents without overheating. A 0.75 mm square cross-section wire seemed adequate. A well-ventilated enclosure is also recommended, a few holes in the bottom and the back can do wonders.

All power semiconductors (Q3, Q4 and D1) should be mounted on a 2.1°C/W heatsink (100 mm or 125 mm wide extrusion — see pictures). Make sure that each one is insulated with mica washers and thermal compound. The power semiconductors should be protected from electrical contact with the outside world by some form of cover on the heatsink and the whole thing mounted in a case that would not curl up at the sight of molten solder.

Coil L1 is made by winding 50 turns of 1 mm square enamelled copper wire onto a toroidal core. A bit of masking tape keeps things tidy, as you can see from the photograph.

The soldering iron itself is made from a small piece of double-sided PCB, press-fitted into a piece of aluminium tubing (100 mm by 14 mm). Screw connections from an ordinary terminal block are soldered at the right spacing onto the PCB. Although it *can* be replaced by some insulating material, note that the aluminium uniformly dissipates the heat coming from the element and allows a very comfortable grip at a small distance from the tip. A small magnet mounted on the side of the tubing is one of the quickest and most practical stands. The size of tubing even allows for mounting a small lamp inside the handle : very useful for precision work.

The PCB before interwiring.

The element and light bulb are mounted on a piece of double-sided PCB.

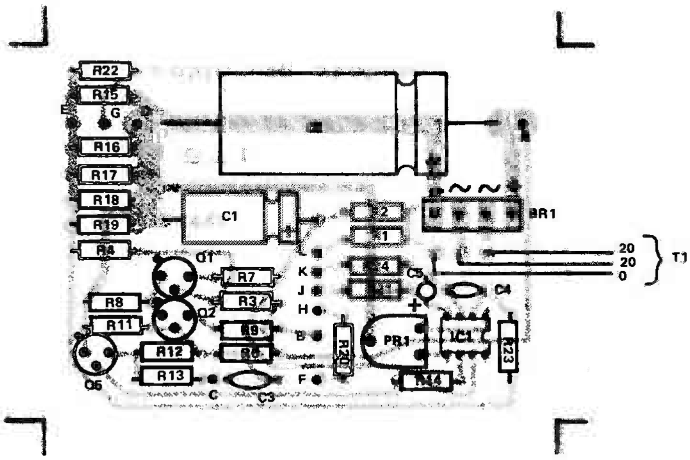


Fig.3 Component overlay for the PCB.

PARTS LIST

Resistors (all ¼ W, 5% except where stated)

R1	180R, 1 W
R2	82R
R3,6,20	18k
R4,11	1k0
R5	180R
R7	220R
R8	47R
R9	330R
R10	10R
R12	6k8
R13	1k5
R14	2k7
R15-19	0R22, 2W5 wirewound
R21	1k8
R22	100R
R23,24	47k

Potentiometers

RV1	1k0 linear
PR1	10k miniature horizontal preset

Capacitors

C1	470u 25 V axial electrolytic
C2	2200u 63 V axial electrolytic
C3	820p polystyrene
C4	22n ceramic
C5	1u5 35 V tantalum

Semiconductors

IC1	CA3140
Q1,2,5	BC107
Q3	TIP32A
Q4	2N3055
BR1	60 V, 1 A bridge rectifier (in-line type)
D1	16F40
LED1	any red LED

Miscellaneous

LP1	6 V, 60 mA bulb
SW1	mains switch

Transformer (20-0-20), toroidal core (see Buylines), heatsink (see text), case ref. BA1016, aluminium tube, magnet, sponge.

Setting Up

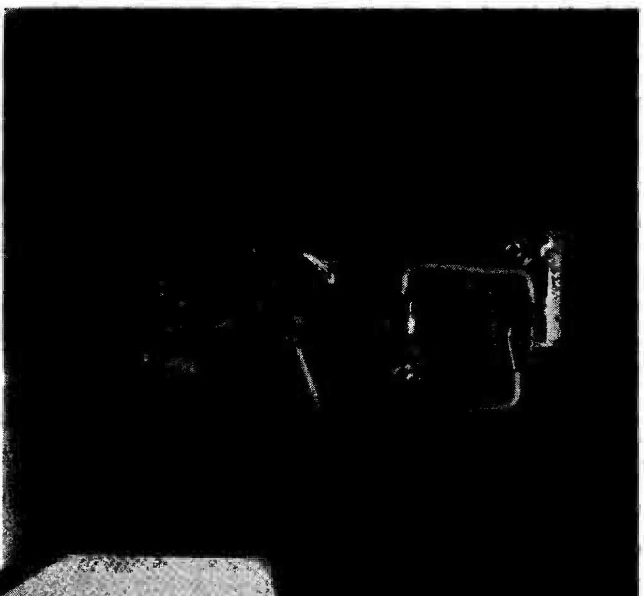
Once all connections are made, the converter section should function immediately — the setting-up procedure only applies to the thermal stabilisation circuitry. The op amp IC1 must be a true zero detector and for that, we must remove any offset voltage. To do so, short-circuit the two inputs (pins 2 and 3) and adjust PR1 until the output starts flickering on and off. Remove the short circuit and the Microstation is now ready for use.

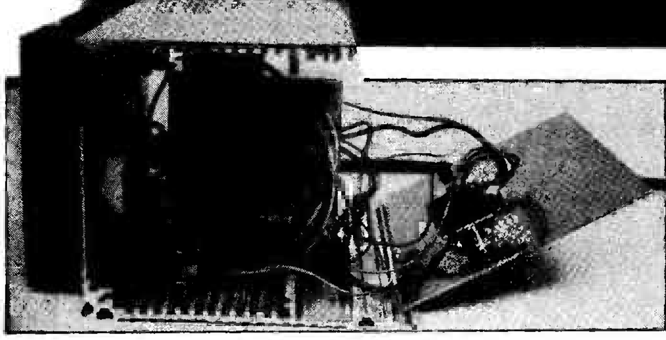
BUYLINES

One of the objectives that we set ourselves at the start of this project was to keep things simple. Although a whole new breed of components specially designed for switched mode supplies is slowly appearing, these are still very difficult to obtain from hobby suppliers. Most of the semiconductors we used are widely available types; D1 can be obtained from Electrovalue.

The toroidal core used for L1 can be obtained from Electro-Tech Components Ltd, 317 Edgware Road, London W2 — the order code is TMC3.

The case used for the prototype is a new model from West Hyde and the heating elements can be supplied by most distributors who sell cordless rechargeable irons, eg Marshall's, Electrovalue.





Top: This photograph shows the mounting details of the heatsink components. All these components must be completely insulated from the heatsink by mica washers.
Bottom: Internal view of the case after the interwiring has been completed. The PCB slides into the channels provided.

ETI

KIT REVIEW

Home-built amplifiers are very popular and this month Kit Review takes a look at one of the cheapest.

The subject of Kit Review this month is the RTVC IC10+10 amplifier, which at £14.95 must be the cheapest stereo amplifier you can buy. The finished amp features 10 W RMS output per channel, three inputs (MIC, PU and AUX) and bass and treble tone controls. The volume of each channel is varied by independent slider pots on the front panel; the tape output level has similar controls. Push-buttons are provided for mute, mono and a 'disco' function, which converts the power amps to mono operation and the preamplifier to a two-channel mixer (so that two mono record decks, for example, may be faded in and out independently). A pre-punched chassis is included in the kit, with a black vinyl finish cover.

Starting Out

As with any kit, the first thing to do is check that all the parts are present (they were) and read the instructions thoroughly. This caused my confidence in RTVC to flag slightly, as, despite their assurances, there are several errors. The colour code for a 1R0 resistor is brown-black-gold, not brown-black; 6k8 is blue-grey-red, not blue-grey-blue; and D2 is shown the wrong way round on the circuit diagram.

It is also disconcerting to discover that three holes in the chassis have to be redrilled because they're in the wrong place, and the power amp PCB has to be drilled. I would have thought that, on the whole, a kit like this is more likely to be bought by the beginner or less experienced constructor who is unlikely to own a PCB drill. I don't recommend using a domestic drill; I tried it with the first PCB I made myself and ended up with two halves. Slapped wrists, RTVC.

As well as a PCB drill, you might find a solder sucker handy as well. Two components on the preamp (a Mullard module) have to be removed and replaced with different values. Take care when you do this as the PCB tracks are thin and can lift off.

Power Amp

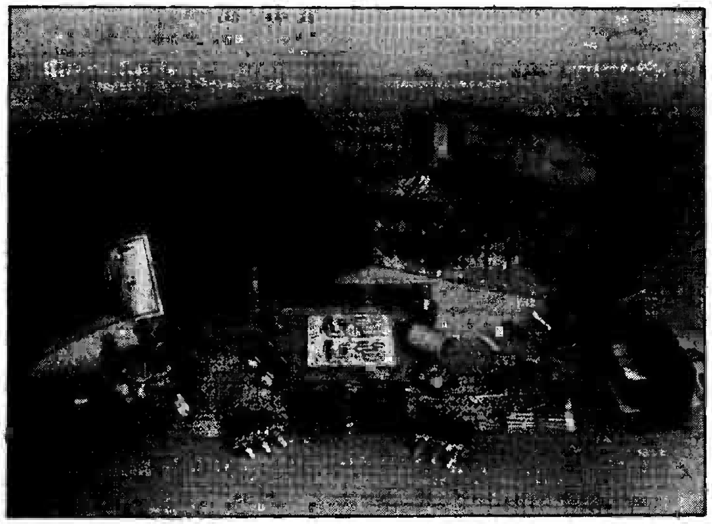
Once the board had been drilled, the construction of the power amp presented no problems, except that the diodes are marked on the overlay with a '+'; I would have preferred to see 'anode' or 'cathode' which is less ambiguous. The overlay is a photographic one and fairly clear. Lengths of wire should now be soldered for all connections (except the inputs) as these solder directly to the foil side of the board, which is inaccessible once the board has been mounted. A good point about this kit is that power ICs are used which make construction a great deal easier than if power transistors were used.

Preamp And Controls

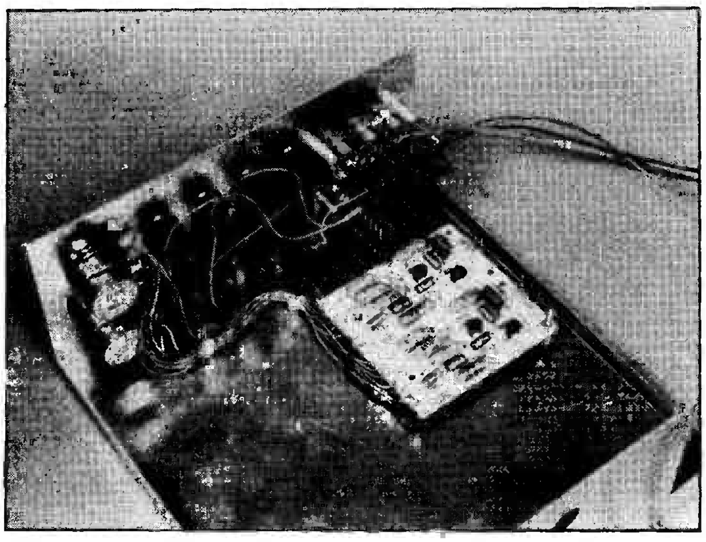
I found this part of the kit very tedious and fiddly. Being basically lazy I hate interwiring, and there's a lot of it in this kit. The best method is to fit the lower switch bank and the slider pots to the front panel first — interconnect them and solder generous lengths of wire where appropriate for connections elsewhere in the chassis. Note that some of the links between pins on the switches can be made on the underside as the pins go right through; otherwise things get a bit cramped. Then mount the top switch bank and the DIN input sockets on the rear panel and complete that part of the wiring. Finally, solder lengths of wire to all the rotary pot pins (including the two cross-connections) before mounting them on the front panel. Once they're in place you can complete all the connections to the preamp and fit cable ties to keep things neat. Wirestrippers are essential to prevent damage to your fingers and/or sanity.

Rearguard Action

Before bolting the power amp to the chassis, the signal earth lead from the front panel switches should be cut to length and soldered to the copper side of the board. The board is held in place by the ICs which should *not* be insulated from the chassis — this acts both as a heatsink and the negative supply connection. The input connections from the switch bank can now be soldered directly to the leads of the input resistors. Fit-



This is what you get in the kit. What you *don't* get includes connecting wire, mains lead and a mains switch. The preamplifier is supplied as a ready-built module.



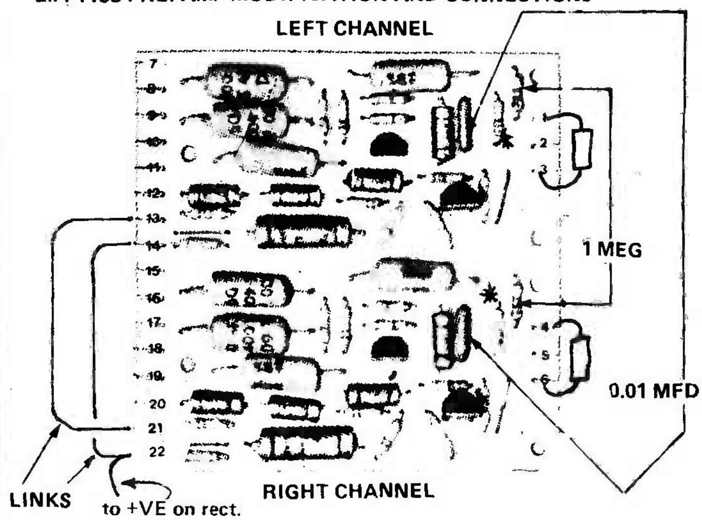
Halfway home and the worst is over. As you can see, the amount of interwiring required is extensive. The section shown corresponds to the instructions below.

ting the remaining rear panel sockets proved a trial of strength, as the retaining rings are very stiff! The photograph showing the output connections is a bit indistinct and reference to the main circuit diagram for clarification revealed another mistake — the pins on the headphone socket are incorrectly numbered. I finally solved the problem by assuming the wiring was symmetrical.

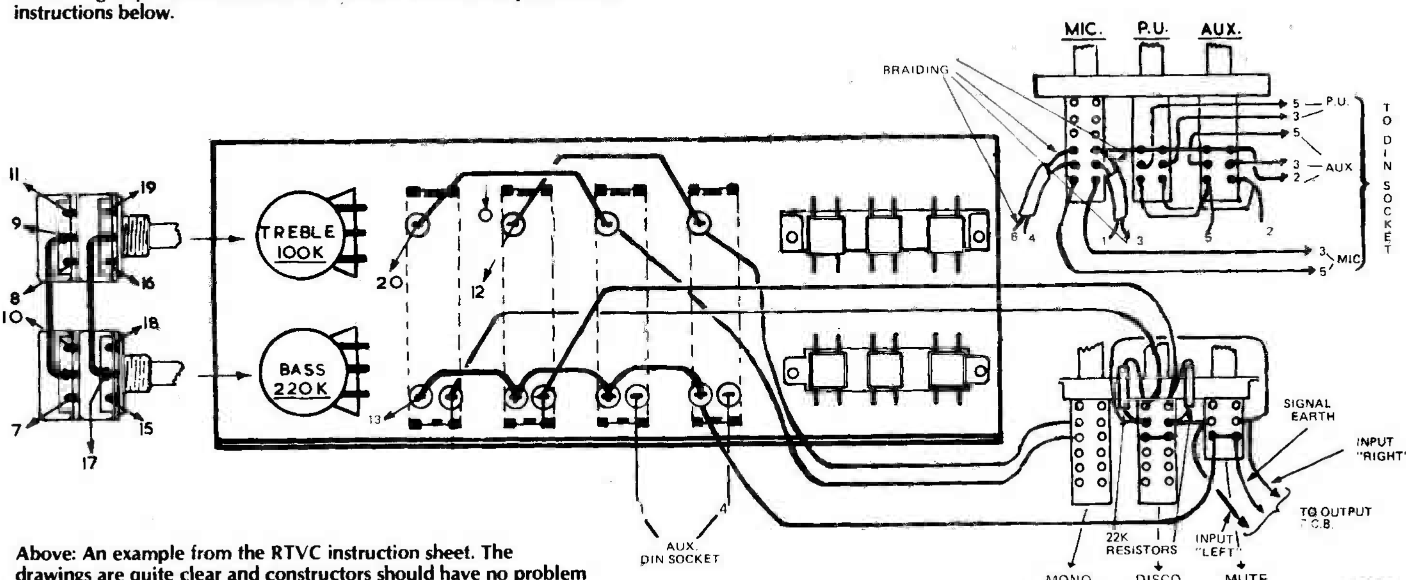
Finishing Off

The final bits to fit are the fuseholder, rectifier, transformer and mains switch — you have to provide the latter yourself as RTVC describe it as optional. I would have thought it was essential. After making the power supply connections and completing the case construction the amp is ready to go. The instructions do not say anywhere that the mains earth lead should be bolted to the chassis — this is a serious omission considering the large amount of bare metal on the chassis.

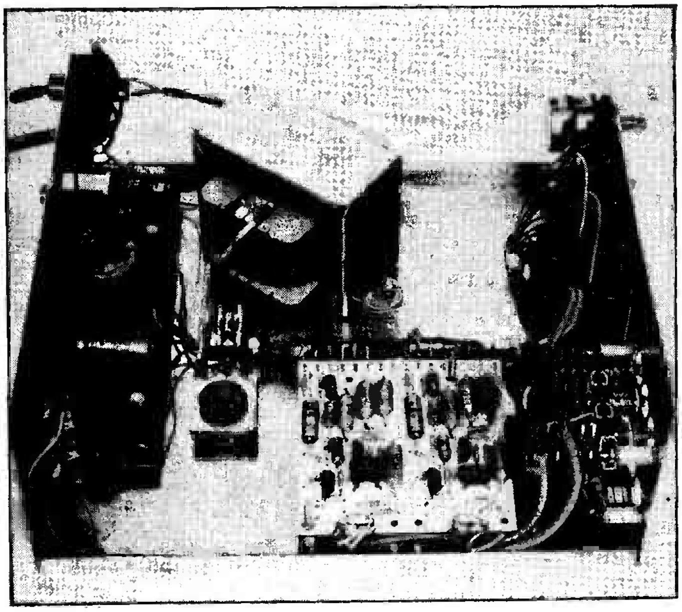
L.P. 1183 PRE. AMP MODIFICATION AND CONNECTIONS



Above: Several component changes are required on the preamp module.



Above: An example from the RTVC instruction sheet. The drawings are quite clear and constructors should have no problem in following them.



Everything in place and ready for testing. All the sockets mount on the rear panel — three inputs, DIN loudspeaker sockets and a headphone socket. Inserting the headphones automatically mutes the speakers (provided you got the wiring right!). The power ICs bolt directly to the rear panel too, so that the chassis provides both heatsink and earth return; but make sure you connect the mains earth too.

In Use

The amplifier worked perfectly first time; and even the office audiophile admitted that the kit represented good value for money. Some hum is evident when no signal is present but this is not noticeable when you're actually playing music. Having already built the '12+12' kit which this amplifier replaces, I feel that the new version offers a definite improvement in layout, appearance, ease of construction and sound quality. Although the kit took me eight hours to complete, this was partly due to double-checking the errors in the instructions and partly to deciding the best approach to adopt — I'm sure I could build a second one in half the time.

I have contacted RTVC regarding the errors and await their reply, which will be published in Digest next month.

Conclusions

For the price involved this kit represents a good buy (I once built a homebrew power amp with tone controls from discrete components that cost me £20). However, the kit would probably appeal more to the beginner in electronics and so the errors in the instructions and the need to drill the PCB are definite minus points. As RTVC suggest in the instructions, having a friend who is familiar with electronics is a good idea if you should need any help.

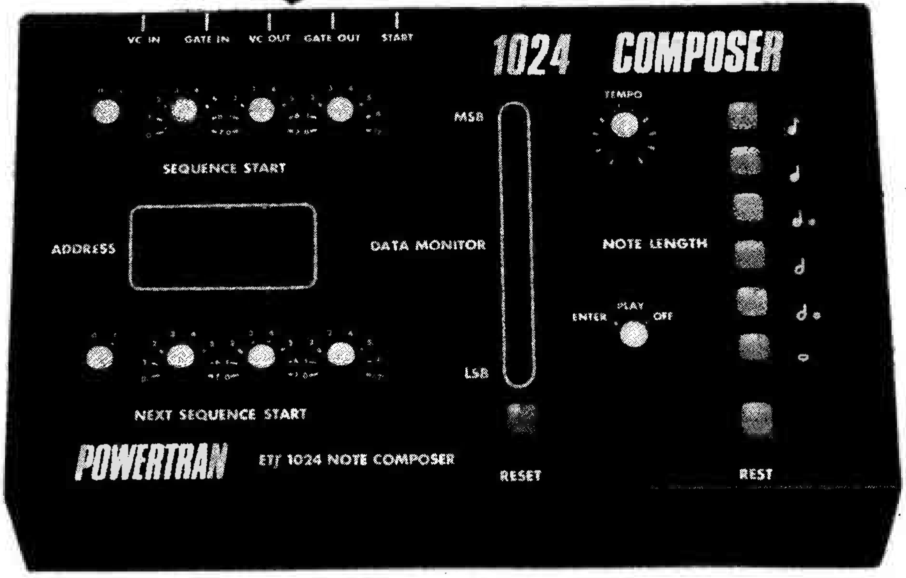
PETER GREEN

BUYLINES

10 + 10 Watt Stereo Amplifier Kit £14.95 plus £2.90 postage and packing. RTVC, 323 Edgware Road, London W2. Telephone: 01-723 8432.

ETI

SYNTHESISER SEQUENCER



Treat your synth to this sequencer/composer and let it play sequences of up to 1024 notes. Design by Richard Becker of Powertran Electronics.

The 1024 composer is a machine which will repeatedly cause a synthesiser to play a pre-determined series of notes either as short sequences or a large composition of 1024 notes, ie several minutes long. The sequence can be of any number of notes from two to 1024. If the length is less than 1024 then the unused sections of the memory of the composer can be used for alternative sequences as there is full control over the starting and finishing points of the sequence. For example, 64 different 16-note sequences or 128 different eight-note sequences could be stored. The address of the note being played or entered is shown clearly on four seven-segment LED displays whilst the address at the beginning and end of the sequence selected are indicated by the position of the rotary switches which set them up.

The memory stores not only the pitch of the notes but also their length. There is a choice of six lengths ranging from half a beat to four beats. In addition, a rest or series of rests of one beat can be entered.

Socket To Me

The composer is programmed from the synthesiser by plugging into the VOLTAGE CONTROL OUT and GATE OUT sockets, Transcendent 2000 owners needn't feel left out! You can easily add a couple of jack sockets to the rear panel of the 2000 and fit three bits of wire; VC OUT to IC6 pin 6, GATE OUT to IC4 pin 6 and common line to common line on the HI OUT socket. As for any other synths without these sockets, if the handbook mentions 1 V/octave (the standard) you will be able to find the control voltage at the input of the VCO and the gate voltage at the input of the ADSR. The synth control voltage is converted to a digital code by an integrated A-to-D (analogue to digital) converter. An integrated D-to-A converter does the opposite on playback.

The outputs of the composer plug into the EXT VC IN and EX GATE IN sockets of the synth. Provision is made for the gate voltage to be of either polarity depending on the synth's requirement (the Transcendent 2000 requires a negative gate voltage). A synth usually sounds at its best when the filter is tracking with the VCO. If there is a control input for the VCF put the control voltage into here too. If there is no such socket it will be possible to find a suitable point on the VCF to inject the control voltage. On the Transcendent 2000 take VC IN to Q10 pin 12 via a 43k resistor.

Musical Memories

Now that we are plugged in, one of the note length switches is pressed. Pressing a key now programs in that note's pitch and length. To enter a rest, ie an interval with no note being played, press the rest switch followed by any key as many times as there are beats in the rest period.

It doesn't matter how long you take between entering notes. Go down to the pub in the middle of your composition if you like; it will still play back with perfect timing. What's more it doesn't matter if there's a power cut or anyone pulls out the plug while you're away. Hands up all those of you who have lost a painstakingly entered computer program that way! The composer, though mains powered, has a trickle charged Nickel-Cadmium battery to supply the memory (which uses a pair of CMOS 4K synchronous RAMs) when there's no mains connected. After switch-off the memory will retain the data for months and will change only when reprogrammed. Should you find that you have entered a bum note — no hassle. Just advance the START-OF-SEQUENCE switches to the offending entry, press RESET, enter the correct note/note length combination. Take the address to where you left off, press RESET and carry on.

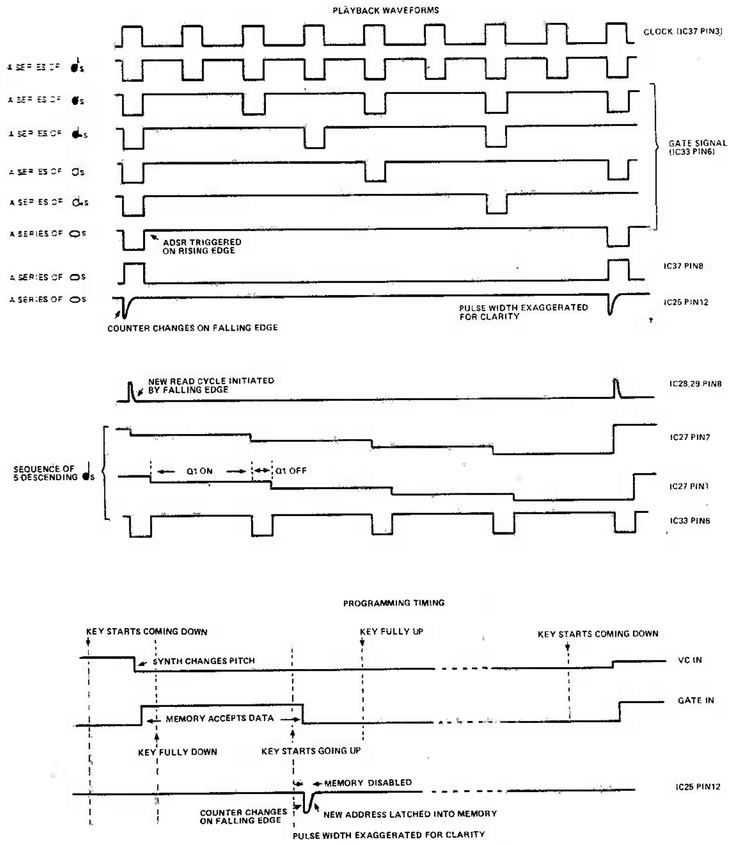


Fig.1 Waveforms at various points in the circuit during playback and programming.

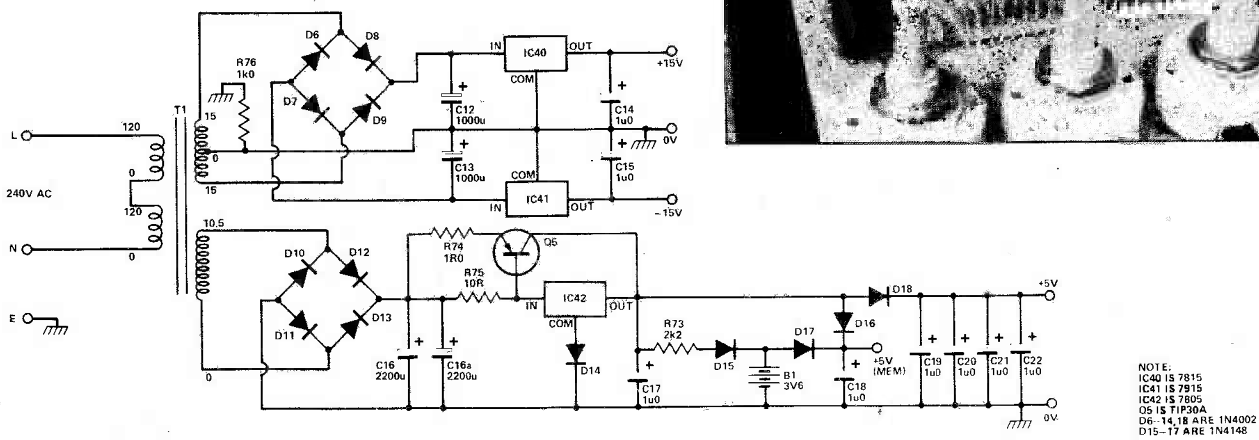
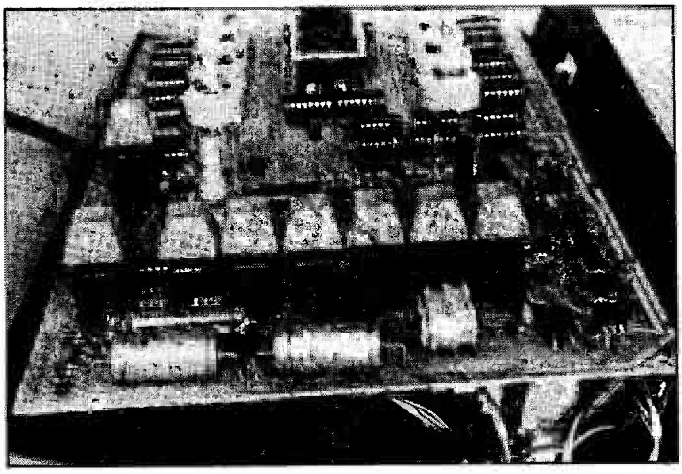


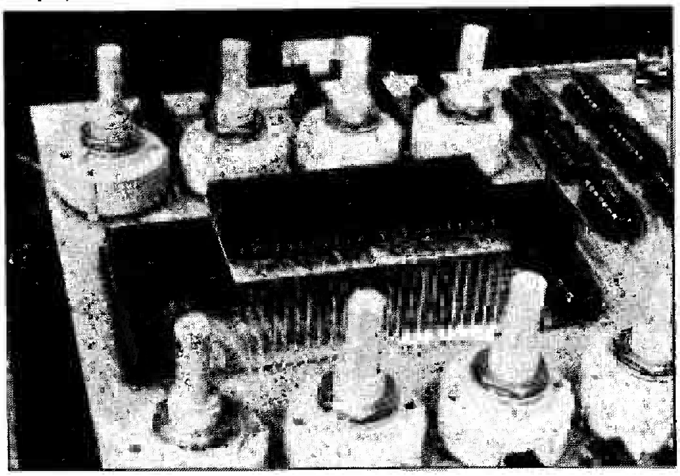
Fig.2 Circuit diagram for the power supply. Note that R76 (not given in the Parts List) solders directly to the mains transformer. See Fig.4.

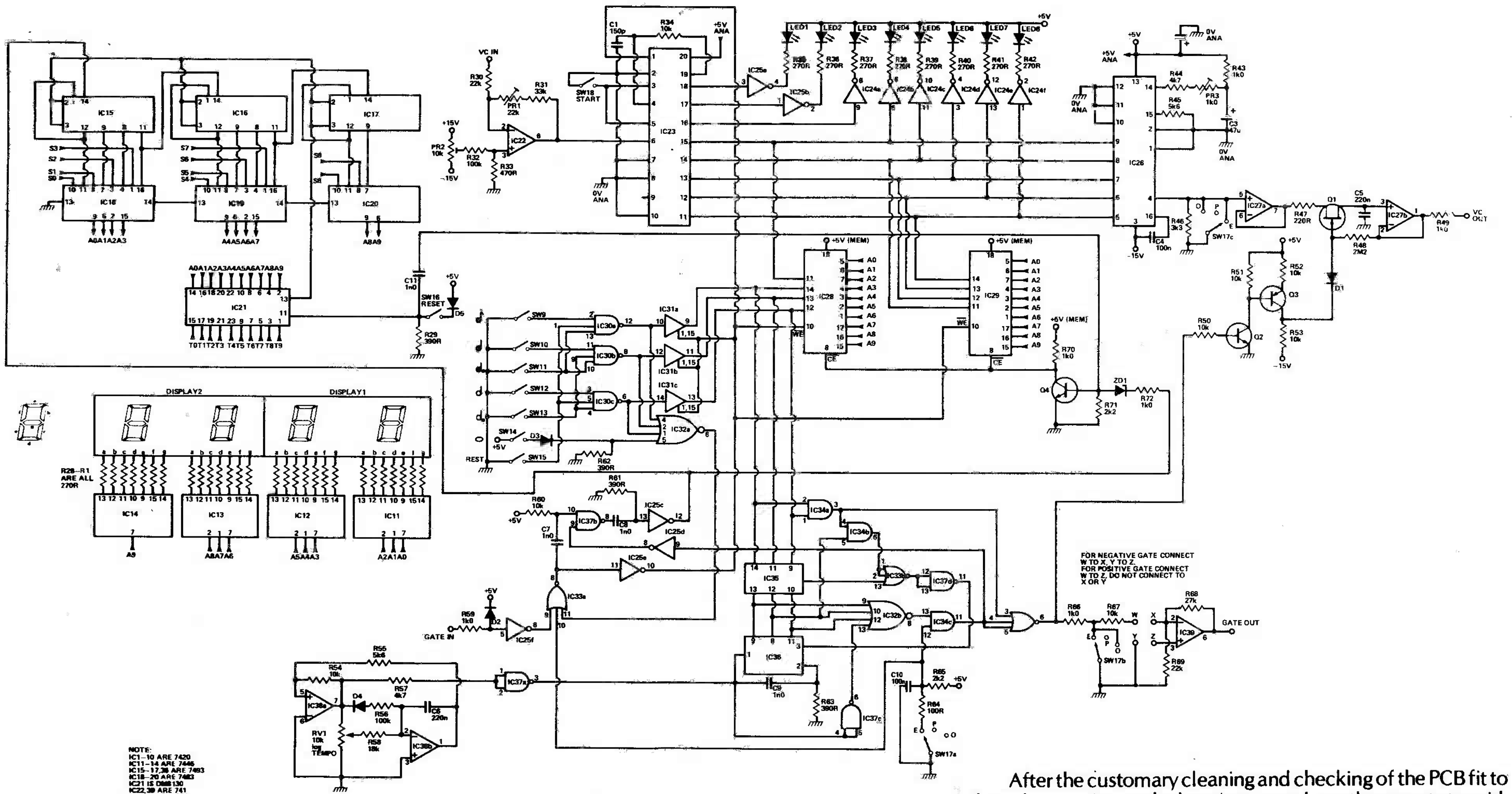
Construction And Setting Up

The PCB is double-sided so start by linking the two sides with link pins, soldered to both sides, at the points indicated by black dots on the overlay. Now fit everything else except the displays. The tempo potentiometer is soldered to the side of the board which its pins enter. Mica washers are required under the 7915 and the 7815 to prevent shorting to the tracks. To fit the displays at the correct height above the board, stretch some 22 swg wire to stiffen it, cut 46 2" lengths and bend through 90° the last 3 mm of each one. Lay a 10 mm thick spacer bar across IC11-14 and lay the displays onto the spacer. Pass a wire through each hole in the displays and down into the PCB, solder the bent ends to the display, turn over the PCB, trim off the excess wire and solder in place. The photographs should make this clear.



Above and below: All the switches except the start switch mount directly on the PCB. The photograph below also shows the mounting details of the display.





NOTE:
IC1–10 ARE 7420
IC11–14 ARE 7446
IC15–17,36 ARE 7493
IC18–20 ARE 7483
IC21 IS DM8130
IC22,39 ARE 741
IC23 IS ADC0804
IC24 IS 7404
IC25 IS 7414
IC26 IS DAC0808
IC27 IS TL082 OR LF353
IC28,29 ARE 6514
IC30 IS 7410
IC31 IS 74LS367
IC32 IS 7425
IC33 IS 7427
IC34 IS 7408
IC35 IS 7485
IC37 IS 74132
IC38 IS 1458
Q1 IS BF244C
Q2,4 ARE BC182L
Q3 IS BC212L
D1–5 ARE 1N4148
ZD1 IS 2V7 400mW ZENER
LED1–3 ARE TIL222
LED4–8 ARE TIL220
DISPLAY1,2 ARE NSN784
TTL MAY BE EITHER 74 SERIES OR 74LS SERIES

Fig.3 Circuit diagram of the composer. The binary encoding circuitry for the switches is shown below.

BUYLINES

After the customary cleaning and checking of the PCB fit to the cabinet, wire up the base/rear panel, set the presets to mid-way and plug in. Switch to ENTER, press a NOTE LENGTH switch and the START switch together with any key. This starts the ADC converting and is done at each switch-on. Press the top note of the keyboard together with any NOTE LENGTH switch and adjust the input offset null preset (PR2) until the red LEDs are all off, whilst the green LEDs (indicating the three least significant bits which are not stored) show either binary 3 (011), ie bottom two LEDs on, or binary 4 (100), ie the third one up on. The LEDs may flicker between these states. Next press the key two octaves down and adjust the gain control PR1 so that only the top two of the red LEDs are on whilst the green ones again show binary 3 or 4. This ensures that the ADC is halfway between changing the code given by the five most significant bits.

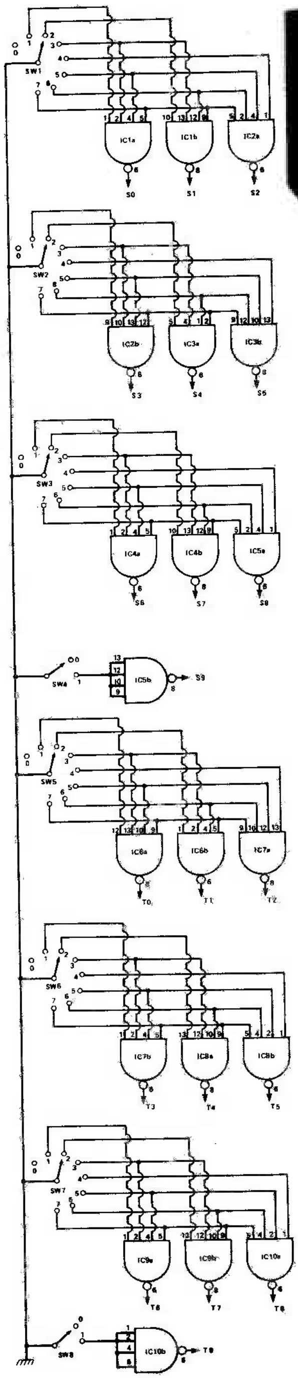
HOW IT WORKS

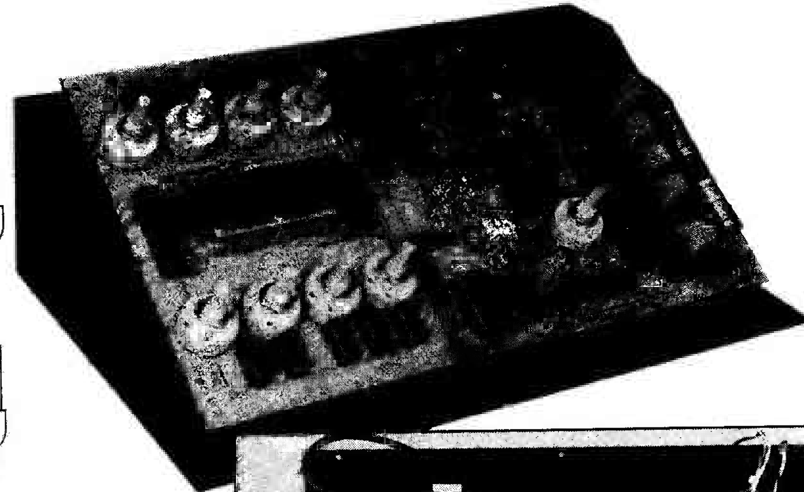
The voltage control input (pitch data) is applied via IC22 to the A-to-D converter IC23 which produces an eight-bit binary code equivalent to the pitch voltage. C1 and R34, in conjunction with an internal Schmitt trigger, form the internal clock operating at a few hundred kilohertz. All eight bits are monitored by LEDs, driven by IC24 and IC25a and b, although only the five most significant bits are used. These go on a data bus connecting to the memory and the D-to-A converter IC26, the reference current for which enters pin 14. The quantized current from pin 4 generates a voltage across R46. Q1, C5, IC27b form a sample and hold circuit, controlled by the output gate signal. This permits a change in pitch only at the same time as the gate pulse starts. The output of IC26 changes a clock phase earlier.

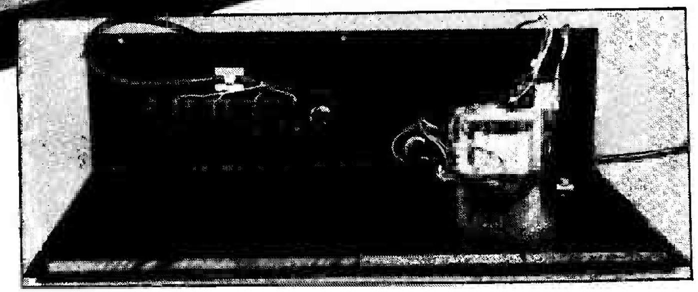
IC1-10 encode the addresses set up on SW1-8 to the equivalent 10-bit binary codes. IC15-17 form a binary counter which is reset to all zeros at suitable times by the output of IC21. IC18-20 are binary adders which add the output of the counter to the output of IC1-5 to produce the address code for the memory. Thus when the counter is reset, the memory address is that set up by the START OF SEQUENCE switches SW1-4. The outputs of IC6-10 are compared with the memory address by the 10-bit comparator IC21 — a reset signal is generated when they are the same, so the sequence is finished and goes back to the start. The seven-segment displays are driven by the decoders IC11-14 which are connected to the memory address bus.

When entering data the counter is clocked by the gate pulse applied via IC25f, IC33a, IC37b, IC25c. Assuming the synth to be correctly adjusted with the pitch voltage changing *before* the gate signal is produced, the pitch voltage changes when a key goes down and the ADC generates the appropriate code. The gate signal then puts the memory into the write mode and enables the tri-state buffer IC31 and the ADC, entering the ADC data and the note length/rest data from IC30, IC31 into the memory. As the key is released the gate signal ceases, the memory is returned to the read mode and the buffer and ADC are disabled. The end of the gate signal results in a negative pulse from IC25c pin 12. On its negative going edge the counter adds one to the address. The pulse is also applied via Q4 to pin 8, the enable input of the memory, briefly disabling it. As pin 8 returns to 0 V the new address is latched in. The base of Q4 is also connected to the reset circuit so that the latched-in address is updated when the counter is reset.

IC38 is an asymmetric relaxation oscillator producing a 1:2 mark/space ratio pulse at IC37 pin 3, the negative edge of which clocks the divide-by-eight counter IC36. During playback the output of IC36 is compared with the note length/rest data by four bit comparator IC35. When there is equality IC35 pin 6 goes high and is applied to one of the two reset pins of IC36 via IC33b, IC37d. When the clock returns to high the other reset pin (pin 2) also goes high, resetting the counter. The counter therefore counts as far as the binary code from the memory, stays there for one phase of the clock and resets to zero. The all-zeros state of the counter is detected by IC32b, the output of which clocks the address counter. The clock (inverted) is applied to IC32 pin 13 to restrict its output to a single clock phase when the counter receives no reset ie when the note length is four beats and the memory reads out all zeros. The output of IC32b becomes the gate signal after passing through IC33c, which inhibits the gate when data '1X1' is detected by IC34a ie when there is a rest (101 programmed in). The counter is reset after two clock pulses by the output of IC34b. When there is a mains supply the logic receives 5 V via D18, the memory receives 5 V via D16 and the battery is charged via D15. D14 raises the output of IC42 from 5 V to about 5V6 to compensate for the drops across D16, D18. When there is no mains supply the logic is shut down but the memory still gets 3 V from the battery via D17. As the logic is all down Q4 turns off, disabling the memory so that only microamps are consumed.







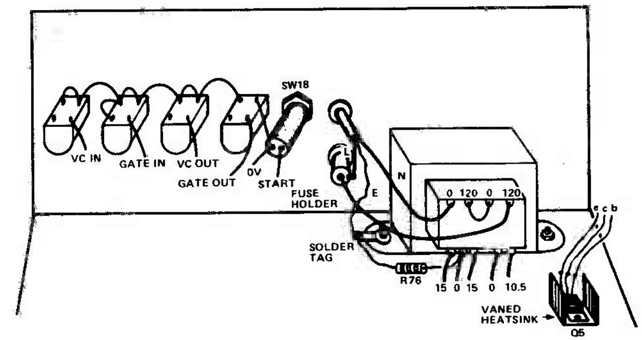


Fig.4 How to wire the off-board components.

Fig.5 (left) The switch encoder circuitry.

To confirm the correct encoding of each note, enter each one down the keyboard, switch to PLAY, press RESET and observe the red LEDs progressively showing a larger binary number.

Set the START OF NEXT SEQUENCE switches to 0003 and the START OF SEQUENCE switches to 0000, press RESET, enter the note two octaves down from the highest three times (any note length). Switch to PLAY with TEMPO halfway advanced and adjust PR3 for 2 V on VC OUT ie set the control voltage to 1 V/octave. Now you can bolt together the cabinet and start composing!

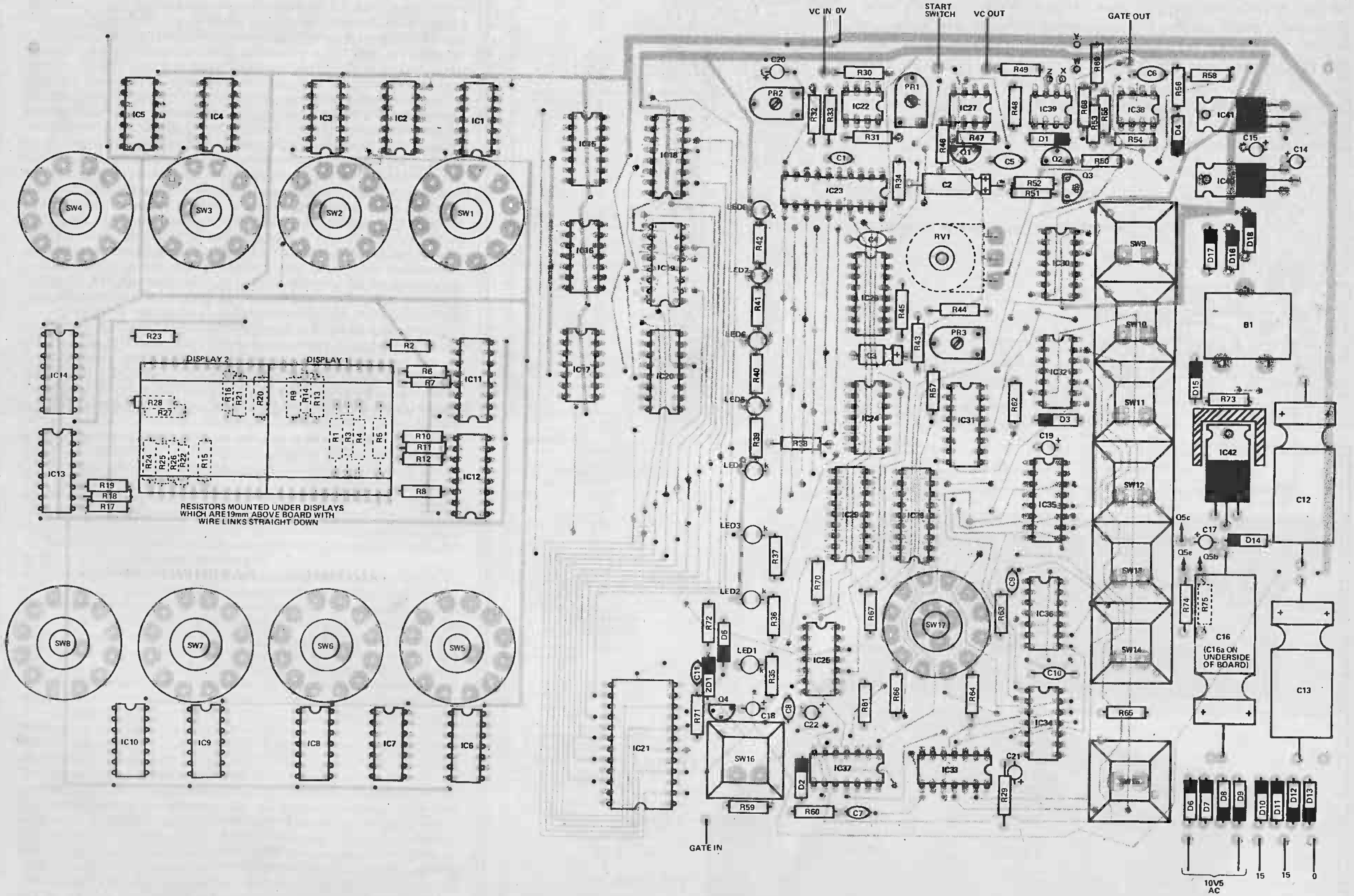


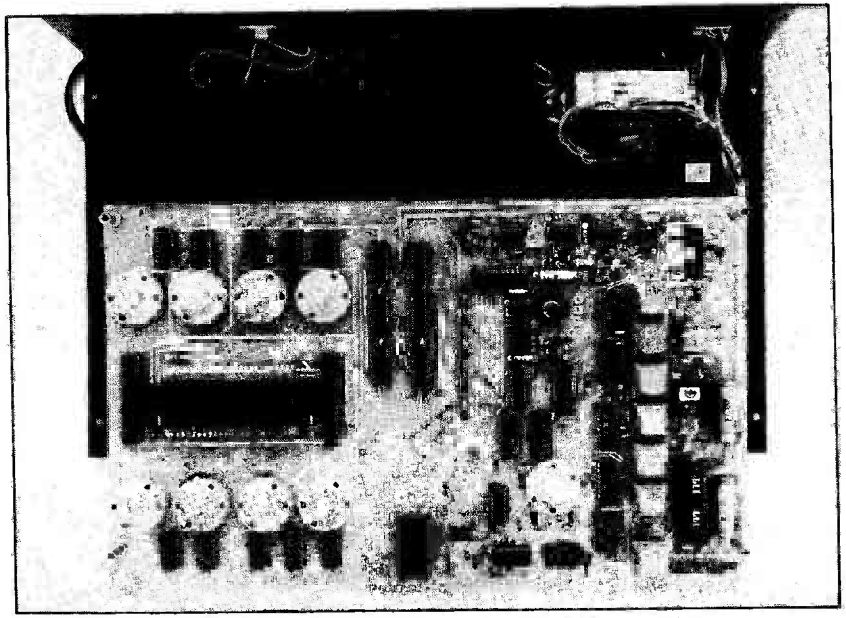
Fig.6 Overlay for the composer. The PCB is double-sided; note that this view is of the component side of the board and shows the copper tracks for that side. C16a is soldered underneath the board using the spare pads adjacent to C16.

PARTS LIST

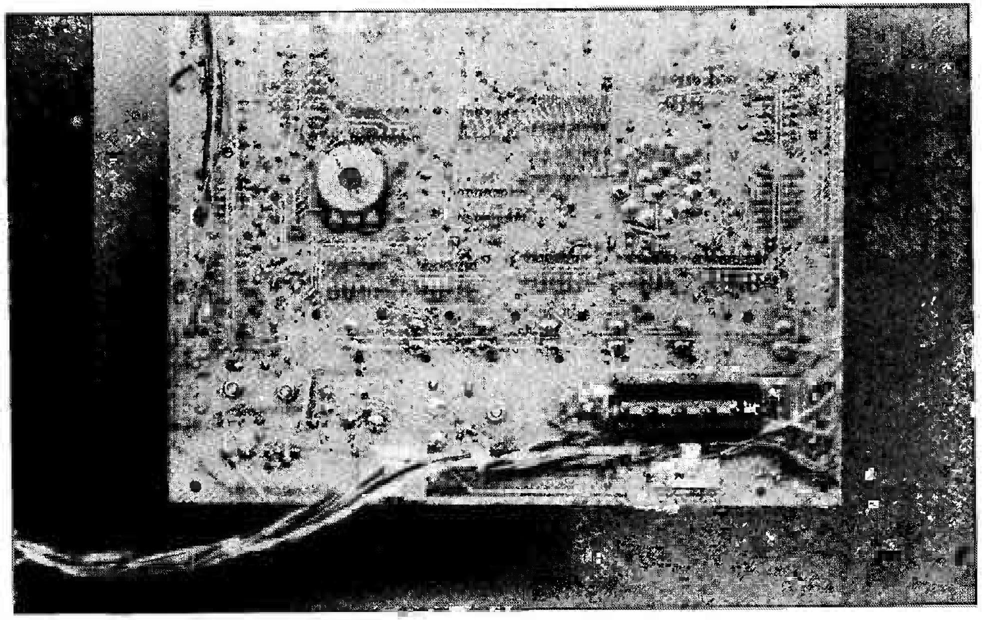
Resistors (¼ W 5% carbon film except where stated)	
R1-28, 35-42	270R
R29, 61, 62, 63	390R
R30	22k metal oxide
R31	33k metal oxide
R32	100k metal oxide
R33	470R metal oxide
R34, 50, 51, 52, 54, 60, 67	10k
R43	1k0 metal oxide
R44	4k7 metal oxide
R45	5k6 metal oxide
R46	3k3 metal oxide
R47	220R
R48	2M2
R49, 59, 66, 70, 72,	1k0
R53	47k
R55	5k6
R56	100k
R57	4k7
R58	18k
R64	100R
R65, 71, 73	2k2
R68	27k
R69	22k
R74	1R0
R75	10R
Potentiometers	
RV1	10k logarithmic
PR1	22k cermet preset
PR2	10k miniature horizontal preset
PR3	1k0 miniature horizontal preset
Capacitors	
C1	150p ceramic
C2	220u 10 V axial electrolytic
C3	47u 10 V axial electrolytic
C4, 10	100n polyester
C5, 6	220n polycarbonate
C7, 8, 9, 11	1n0 ceramic
C12, 13	1000u 25 V axial electrolytic
C14, 15, 17-22	1u0 tantalum
C16, 16a	2200u 25 V axial electrolytic
Semiconductors	
IC1-10	7420
IC11-14	7446
IC15-17, 36	7493
IC18-20	7483
IC21	DM8130
IC22, 39	741
IC23	ADC0804
IC24	7404
IC25	7414
IC26	DAC0808
IC27	TL082 or LF353
IC28, 29	6514
IC30	7410
IC31	74LS367
IC32	7425
IC33	7427
IC34	7408
IC35	7485
IC37	74132
IC38	1458
IC40	7815
IC41	7915
IC42	7805
Q1	BF244C
Q2, 4	BC182L
Q3	BC212L
Q5	TIP30A
D1-5, 15-17	1N4148
D6-14, 18	1N4002
ZD1	2V7 400 mW
LED1-3	TIL222
LED4-8	TIL220
DISPLAY 1, 2	NSN784
TTL may be either 74 series or 74LS series	
Switches	
SW1-8	1-pole 12-way rotary with adjustable stop
SW9-16	keyboard 1-pole momentary make with 19 mm caps
SW17	4-pole 3-way rotary
SW18	panel-mounting momentary make

Miscellaneous

IC sockets, 3V6 Ni-Cd PCB-mounting battery, TV5 heatsink (2 off), transformer (secondaries 15-0-15 @ 100 mA, 10V5 @ 1 A), fuse holder, double-sided PCB, jack sockets (4 off), cabinet, spacers etc.



The complete PCB, with wiring finished and ready for fixing to the front panel.



Underside of the PCB showing RV1 and C16a in place.

ILP

SIMPLY AHEAD and staying there

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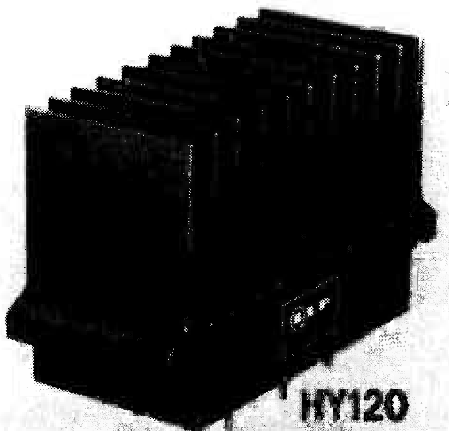
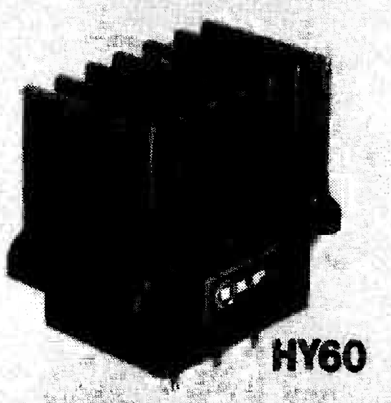
New Profile Amplifiers - Two New Series





MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

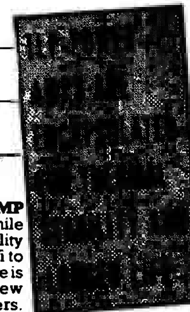
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

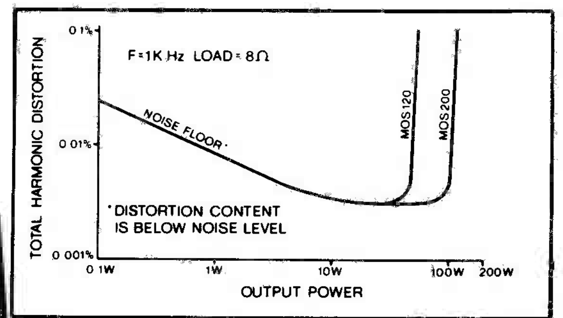
BIPOLAR

(Standard O-P Transistors)

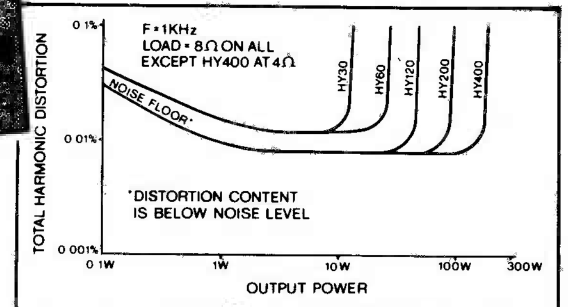
CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77

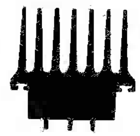




Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV. Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV. Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



THE NEW PROFILE EXTRUSIONS

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SONIC HOLOGRAPHY

Hologram: a three-dimensional image. Sonic: pertaining to sound. Sonic Hologram, therefore, a three-dimensional sound image? Well almost! Ron Harris explains.

Sonic holograpy refers to a new principle of music reproduction being pioneered by Carver in their C4000 preamplifier. The aim is to more closely approach in the average room, the sound field found in a concert hall, using only the normal stereo pair of loudspeakers.

In operation the circuit's effect is to spread the sound image well beyond the speakers and add a marked 'depth' to the music. Such manipulation of the signal goes against the present trend in British hi-fi to exclude all controls except volume and input select. When examined closely this approach has just the faintest whiff of cowardice about it — rather than try and design a good compensation circuit it is easier to leave it out altogether.

It is also true that some of the best amplifiers around today follow this rationale — the Meridian and the Exposure for example — and are none the worse for doing so. However, all living rooms need equalisation to overcome their imperfections and some help is better than none. The ideal answer is probably a parametric equaliser which can be tuned to cancel the major system/room resonances and hence flatten the overall response closer to that ideal straight line.

Control Lines

The 4000 is the exact opposite of the Meridian. It has controls for EVERYTHING. Tone controls are provided for each channel with variable turn-over frequencies, a most sensible and useful addition. An auto-correlator and an expander are also included with variable threshold for each. Between them they offer the experimenter a phenomenal increase in perceived signal-to-noise ratio — albeit at a small degradation in absolute sound quality.

The main feature is undoubtedly the Hologram Generator with its associated time-delay amps. Holographic reproduction can be obtained from the normal two speakers perfectly well, but for those wishing to enhance the effect still further, the time-delay feature is useful. We will return to this later, firstly let us consider how the basic hologram circuit operates.

Binaural Beginnings

Most readers will have heard, or at least heard of, the binaural recording techniques, where music is captured on tape using a dummy head with microphones positioned in the 'ears'. When replayed on headphones, a remarkably accurate model of the original sound field is set up around the listener, ie it sounds very close to the hall in which the recording was made.

Reproduce a binaural record through loudspeakers, however, and the field is destroyed. Headphones work because they isolate each ear from the other channel completely. The right ear hears only the sound which reached that microphone in the dummy head.

The aim of Carver's Hologram circuitry is to attempt to simulate this isolation in a room using the loudspeakers. It does it by 'cross-feeding' each channel with an anti-phased version of the other. The left speaker thus receives a normal LH signal plus an added-in RH channel 'cancellation' signal.

In order to sound 'correct' to the ear, some compensation is required for the fact that the ears are different distances from the speakers and that the head throws a sound 'shadow', effectively altering the perceived frequency response as the sound passes around the head.

To properly isolate the ears, the signal from the LH speaker and the cancelling signal from the RH speaker must arrive at the

Right: The Carver C-4000 Sonic Holography Pre-amplifier. As you can see from the front panel there is no shortage of facilities. The set of six push-button set apart, beneath the logo, control the main circuits — including the Sonic Hologram. It is a nice ergonomic touch to have the Volume Control well separated from the rest as it makes it easier to 'find' in use.

Inputs are provided for two tape decks — with full dubbing — two pickups, a tuner and an 'auxiliary'. Output level may be switch-matched to the particular power-amp in use.

ear simultaneously and correctly equalised. Time delay is thus required and the listening zone will be relatively limited. Excessive movement will mean that the signals do not arrive in sync and little cancellation will occur.

MIT Basics

A Ph.D candidate at MIT in America did some work on determining the amount of time delay needed in compensation and also the exact modifications required to the frequency response. Using a technique similar to binaural recording he took frequency response plots, etc from two tiny microphones placed in his ears.

From this emerged a figure of around 675 mS for the delay, and the complex frequency plot shown in Fig. 3. The closer a filter can be built to approximate this curve, the better will be the isolating effect and hence the sharper the holographic effect.

These plots were taken under anechoic conditions and things become considerably more complex under reflective conditions — the real world. Carver uses a 12 pole filter to shape response below 1 kHz and a second, five pole, filter for higher frequencies. The phasing problems must be horrendous. Time delay is achieved using wide-band FET amplifiers because they produce a better sound quality than IC CCD delay lines.

Amplitude-To-Phase

One additional circuit was required in the final design, to allow for varying methods of 'multi-miking' records. This type of recording does not preserve the original sound field nearly as well as the simple 'crossed pair' techniques and to extract an effective hologram it is necessary to reorganise the amplitude variations in the signal into a particular, very complex, phase relationship. This is fed to the appropriate loudspeakers.

The C-4000 makes use of the fact that stereo positioning is entirely amplitude related, ie if a drum is louder on the left channel than on the right it will appear to emanate from a position closer to that speaker. This enables the preamp to place the sound laterally and the phase information already on the recording is then used to provide a 'depth' relationship.

A two position switch is provided on the preamp which is labelled 'normal and 'theoretical'. Set to the former it optimises the playback for normal stereo multi-miked recordings and switching to the latter will allow better reproduction of 'natural' recordings ie 'cross-pair' etc.

Practise

That's the theory then, but how does it do in practise? Very well actually. We tested the preamp as a 'normal' piece of hi-fi first of all and it exceeded its specifications comfortably on all counts.

Setting up the holographic generator is a little tricky, but use of the special test record from Carver greatly facilitated things. Once aligned, seating position is critical to around three feet laterally and about seven feet front to back. Outside this area the effect is greatly lessened but still present.

Playing a record and switching in the hologram proved to be an unnerving experience. The sound stage expands enormously and appears totally divorced from the speakers. On a classical piece the effect is simply of being nearer the orchestra with instruments appearing to be playing well outside the speakers!

On rock records, with all their attendant re-mixing, some quite startling things began to happen. The Pink Floyd's 'The Wall' and 'Dark Side' have to be heard to be believed. Live LPs reproduce brilliantly, giving a greatly enhanced 'presence' to the music, much closer to being there!

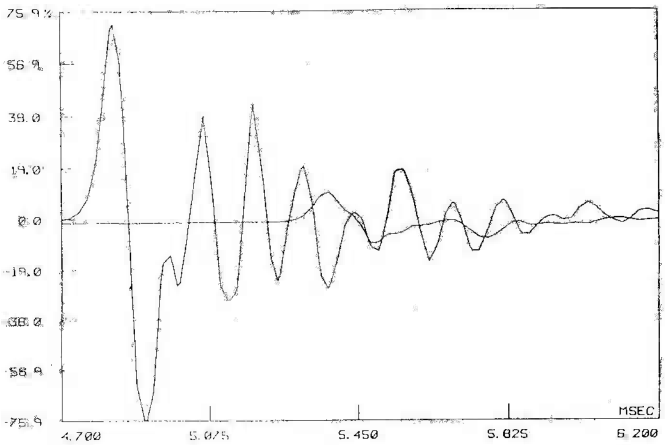


Fig. 1. The time difference between the two ears with a signal source placed at 60° to the left of the listener. The first large rise shows the left ear receiving the pulse, and 675 mS later the right ear hears the same signal, greatly attenuated by the head.

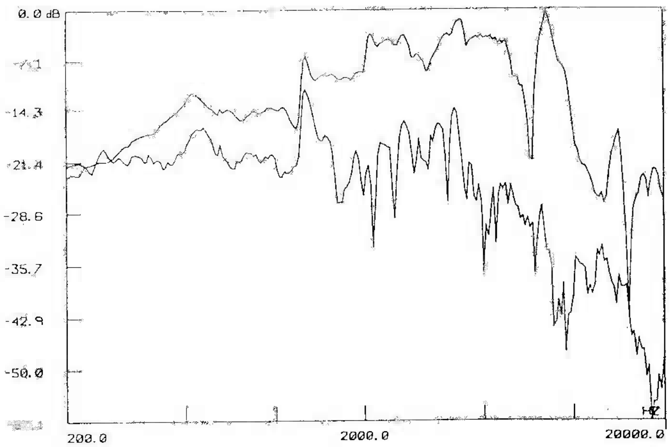


Fig. 2. Frequency response differences between the two ears hearing the same pulse from the same place as in Fig. 1. Below 200 Hz there is little difference as the head is too small to 'shadow' sound below this frequency.

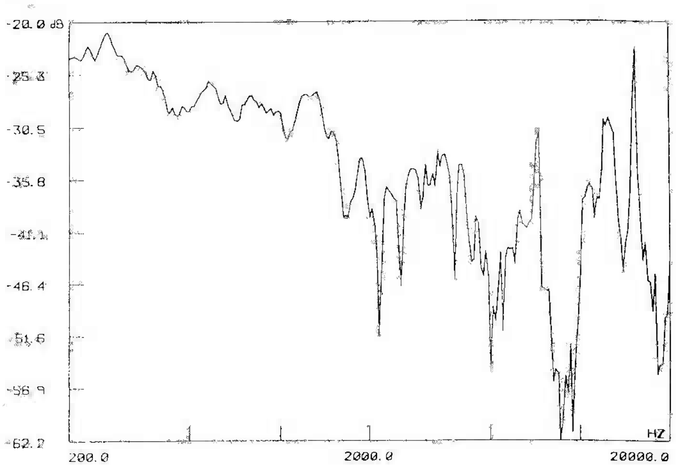
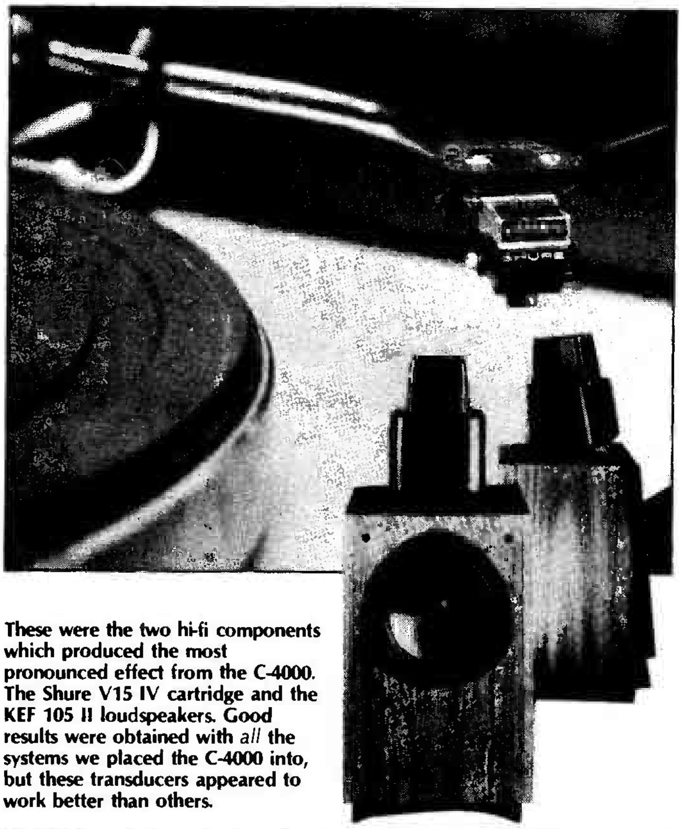


Fig. 3. The difference between the two plots in Fig. 2 drawn against frequency. The various troughs and peaks are introduced by ear lobes, the shape of the head etc.



These were the two hi-fi components which produced the most pronounced effect from the C-4000. The Shure V15 IV cartridge and the KEF 105 II loudspeakers. Good results were obtained with *all* the systems we placed the C-4000 into, but these transducers appeared to work better than others.

Overall the sound is warmer and more accessable and the image is no longer simply hung in between the speakers in a flat two-dimensional manner. Switching back to stereo from holographic reproduction is quite a disappointment in many ways as the depth appears to vanish and the image contracts so much.

Adding Up

The time delay amps included in the preamp (of around 20 W RMS) are to drive additional speakers to the rear of the listener to enhance the effect. Frankly, I didn't feel this was needed at all. Putting in the extra units *did* change things, but two speakers were quite enough!

Experiments also showed that some ancillary equipment works better than others. KEF 105s gave the best results of the speakers tried and the Shure V15 IV cartridge gave consistently better results than any other pickup. It probably maintains better phase relationships between signal components than the rest.

So there it is. A new approach to music reproduction in the home — and one that works. The C-4000 is not cheap at around £600 but in view of the fact that it offers greatly enhanced reproduction of most material it deserves very close consideration.

My thanks to Carver for permission to reproduce the graphs, used herein, from their brochures.

ETI

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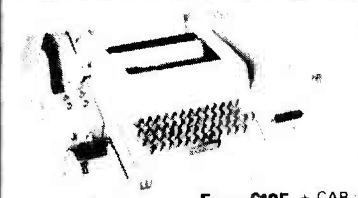

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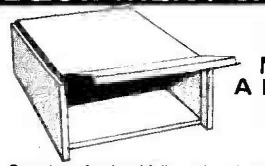

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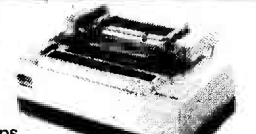

This must be one of our greatest bulk deals, this fabulous printer is listed at over £1800 and judging by the construction we are not surprised. Made under license from the LOGABAX Co. the DMZ180 is an exceptionally sturdy high speed 180 cps matrix printer, capable of printing up to 132 characters per line on standard "Fan Fold" sprocket fed paper. A precision 7 × 7 matrix head using ruby bearings, gives a clear concise type font. Many other features include internal buffer for high throughput, standard ink ribbon, software controllable form and tab functions, standard "CENTRONICS" ASCII parallel interface etc. etc.

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K107	18	BC213L transistors
K108	8	2N5060 thyristors, 30V 0.8A T092 case
K109	15	BC114 transistors
K110	4	BD131 transistors
K111	4	BD132 transistors
K112	12	3A 100V rects, wire ended
K113	30	DA002 rects 150V 0.5A
K114	15	XK6116 (BF241) transistors
K115	18	SP1218 (2N3702) transistors
K116	10	MPSL01 NPN 140V T092
K117	10	BF450 PNP TV IF amp transistor
K118	16	ME4101 NPN 60V AF low noise
K119	10	2N5401 NPN 160V T092
K121	20	7V5 400mW zeners
K122	10	VR525 5.25V 2.2W zener
K123	10	56V 1W zener
K124	50	.02μF disc ceramic
K125	200	1k 5% ¼W carbon film resistors
K126	100	300pF 63V polystyrene preformed caps
K127	25	47μF 25V axial lead caps
K128	25	15μF 40V do
K129	8	AA113 diodes
K130	25	470R V 0.1W presets
K131	10	VA1086 thermistor
K133	20	3 way 5A term blocks
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K135	30	4.7μF 10V radial elecs
K136	4	AC187k transistors
K137	5	18μF 100V non-polarized caps
K138	30	¼" coil former with slug
K139	40	.025μF 50V mylar caps
K140	30	.05 do
K141	40	0.01μF 400V axial caps (C296)
K142	25	wire ended neons std size, 90V
K143	200	squares mica insulation 25mm sq.
K144	30	IR5 3W wirewound resistors
K145	10	1500μF 16V caps — radial PC mntg.
K146	25	330μF 4V axial caps
K147	3	150μF 350V caps—radial PC mntg.
K148	30	transformer former type X228
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K150	10	switches type W430
K151	12	0.125" red LED's
K152	10	0.2" red LEDs
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K154	15	5 pin 180° Din socket, clip fix
K155	100	metres thin flex (10×2m lengths)
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K158	6	SPCO centre off white rocker switches
K159	20	0.3W presets 500k V with knurled knob
K161	20	0.3W presets 2k5 V
K162	20	0.3W presets 2M5 V with knurled knob
K163	400	15R ¼W 5% preformed vert mntg resistors
K164	50	22pF 2% silver mica caps
K165	20	Sub-min reed switch, body 20mm long
K166	100	3300pF 630V polyester PC mntg caps
K168	50	AA144 diode preformed as above
K169	30	8V2 400mW zener as K167
K171	25	11V do
K173	12	1.5μF 25V tant bead caps
K174	12	0.47μF 25V tant bead caps
K176	24	150R 0.1W vert presets
K177	24	470R 0.1W horiz presets
K178	24	470R 0.1W vert presets
K179	24	2k 0.1W horiz presets
K180	24	2k 0.1W vert presets
K181	24	2k2 0.1W horiz presets
K185	200	1R ½W CF preformed Rs for horiz mntg, 15mm centres
K187	18	PE5030 NPN Si TO92 transistors. Vce 35V, Hfe 75
K188	18	F544 PNP Si TO92 transistors. Vce 20V, Hfe 300
K189	30	1N649 600V 0.4A diodes, preformed for H mntg
K190	16	BZY85 8V2 250mW zener diodes
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K192	25	RGP10B 100V 1A switching diode

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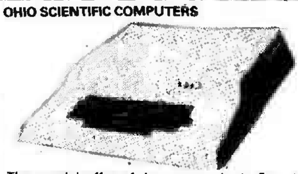
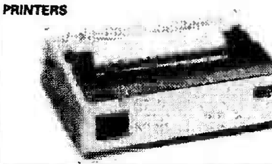


The special offer of the century (only Swanley could do it!):- For just **£159** we will supply Superboard 3 with a free power supply and modulator kit and our free guard band kit (a brilliant breakthrough in itself for this kit extends the display to 32x32, gives 1200 and 300 Baud tape speeds, increases the computing speed by 50% and converts the display to 50Hz for flicker free viewing). Guard band kit is also supplied separately for **£10.** 4K extra ram **£16.95.** Case **£27.** Cassette recorder **£17.** Cegmon improved monitor rom **£29.50.** Assembler/Editor tape **£25.** Word processor program **£10.** Display expansion kit, 30 lines x 54 characters for Superboard 2 (not 3) **£20.** Cheapo memory expansion offer:- Buy a 610 expansion board with 8K ram on board and space for another 16K for **£159** and get a free 5V 4A power kit and any extra ram you want for **£3/K.** Buy a minifloppy disc drive + case + power supply + DOS for **£275** and we will do the extra ram for **£2/K** (max 16K). Wemon Improved monitor rom **£19.95.** New Series 2 Challenger C1P:- cheapo 4K version **£202.** Ohio 8K version (illustrated) **£259.**

PRINTERS



Buy any of the below and get a free interface kit and word processor program for UK101 or Superboard 2:- OKI Microline 80 (illustrated) **£329.** Base 2 800MST **£299.** Selkosha GP80 **£225.** Epson MX80 tractor **£359.** Epsom MX80 tractor + friction **£399.** Epson MX70 **£279.** Epson TX80 **£296.**

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COMPONENTS ★
1N4148 **1.5p.** 1N4002 **3.7p.** NE555 8 dil **26p.** 741 8 dil **20p.** BC182, BC184, BC212, BC214, BC547, BC549 **6.1p.** Resistors 5% ¼W E12 10R to 10M **1.5p, 0.8p** for 50+ of one value. Polyester capacitors 160v .015, .068mf **2.9p,** .047, .1mf **4.4p,** .01mf **3.3p,** .022, .033mf **3.7p,** .15, .22, .33mf **5.4p,** .47mf **6.6p.** Polystyrene capacitors E12 63v 10 to 1000pf **4p,** 1n2 to 10n **5p.** Ceramic capacitors 50v E6 22pf to 47n **2.5p.** Electrolytic capacitors 50v .5, 1, 2mf **6p,** 25v 5, 10mf **6p,** 16v 22, 33mf **6p,** 47mf **5p,** 100mf **7p,** 330, 470mf **9p,** 1000mf **11p.** Zeners 400mw E24 2v7 to 33v **7p.** Preset pots subminiature 0.1W horiz or vert 100 to 2M2 **8p.** IC sockets 8 dil **8.7p,** 14 dil **10.1p,** 16 dil **12p.**

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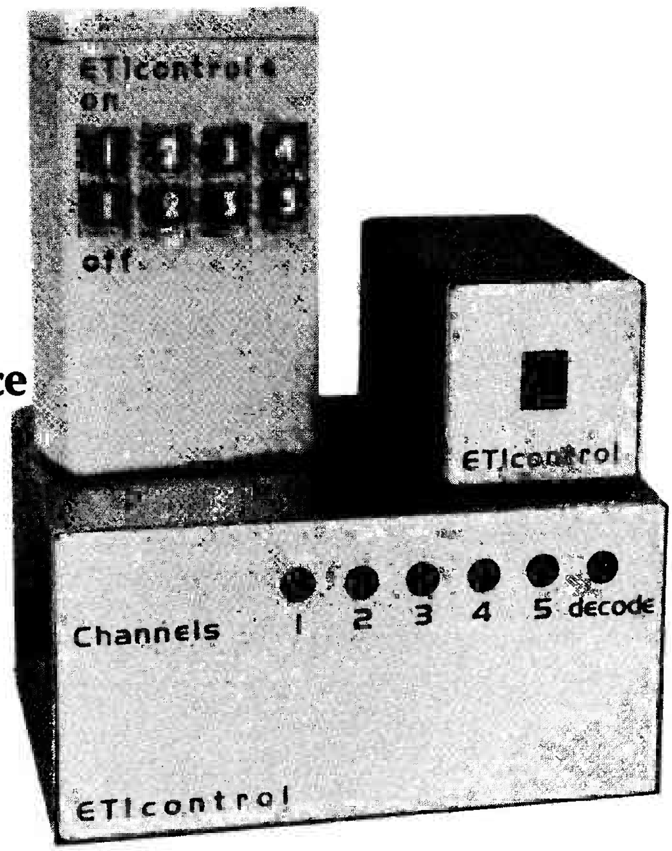
INFRA RED REMOTE-CONTROL



Specifically designed to remote-control three mains switches and two lamp dimmers in a single room, this infra-red system can be used to activate virtually any electrical appliance from the comfort of the armchair or bed. Pure luxury at a modest price. Design by Ray Marston. Development by Plamen Pazov.

This sophisticated five-channel infra-red remote control system comprises a small hand-held transmitter and a combined receiver/decoder unit that provides five independent channels of decoded outputs (logic 0 or logic 1). Three of the control channels are of the latching type and are each controlled by a pair of push-buttons (one ON, one OFF) on the transmitter: an ON instruction produces a logic 1 output from the appropriate channel of the decoder, while an OFF instruction produces a logic 0 output.

The remaining two control channels are of the non-latching type and are each controlled by a single push-button in the transmitter: the decoder produces a logic 1 output when a non-latching transmitter button is pressed or a logic 0 output when the button is released. The transmitter thus uses a total of eight push-buttons to control the total of five remote-control channels. The system has a typical remote-control range (from transmitter to receiver) of about 10 m.

The system is specifically designed to control up to three mains power switches and two lamp dimmers in a single room. With this in mind, the remote-controlled power switch and the remote-controlled touch dimmer projects described elsewhere in this issue of ETI, and the noiseless power switch project of the March '81 issue, have been specifically designed to interface with the outputs of the decoder unit of this five-channel remote-control system. The power switches are designed to be controlled by the latching channels, and the dimmers by the non-latching channels.

Thus, you can use the system to turn on lamps, TVs, hi-fi systems, or any other appliances that draw mains currents below 5 A, by using it in conjunction with this month's remote-controlled power switch project; or to control electric heaters or other appliances that draw mains currents up to 15 A by using it in conjunction with the noiseless power switch from the March issue; plus two touch controlled lamp dimmers, all from the comfort of an armchair or bed.

In practice, of course, you can use the single hand-held transmitter to control up to five appliances in every room of the house if you so wish. All you need to do is fit a duplicate receiver/decoder unit, etc., in all required rooms. Thus, you can use the transmitter to control dimmers, hi-fi and TV when you are in the lounge, and use the same transmitter to control a lamp, radio and electric heater when you are lying in bed. Nice.

Construction: The Transmitter

The transmitter unit is specifically designed to fit in a small Verobox (see Buylines). All components, including the eight push-button switches, are mounted on a single PCB, with the switches mounted directly on the copper side of the PCB and all other components mounted on the 'plain' side. A good deal of care is required in the construction.

Start the construction by etching the PCB and cutting it to size, noting its unusual shape. Now assemble all components other than the push-button switches, LED1 and IC1 on the plain side of the PCB and solder them in place, noting the following points;

(i) All but three of the resistors are mounted vertically on the PCB; (ii) An 18-pin DIL socket is soldered to the PCB to accommodate IC1; (iii) The two IR diodes are mounted vertically on the PCB but are then bent at right angles to pass through holes cut in the case front panel. Slide switch SW1 is soldered directly to Veropins on the PCB and is angled so that its control knob passes through a slot in the front panel. Capacitor C1 has a 10 V rating and needs to be as small as possible.

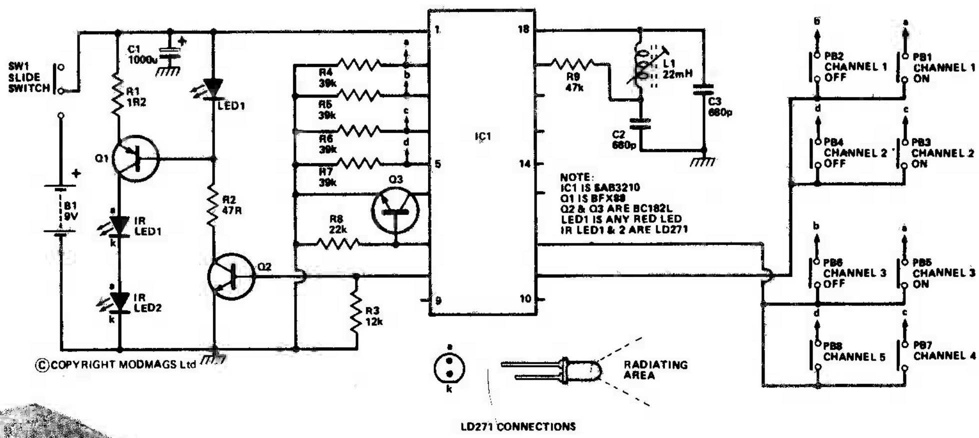


Fig.1 (Right) Circuit diagram for the infra-red transmitter.
Below: The completed transmitter. The two infra-red LEDs and the on/off switch are mounted through the front panel; the 'transmit' LED is positioned on the top of the case with the push-buttons so that it can be seen during operation. Note that channels 1 to 3 have two buttons each (on and off). Channels 4 and 5 are non-latching and only require one button.

HOW IT WORKS

TRANSMITTER
The heart of the transmitter is IC1, an LSI PMOS chip. This chip receives instructions via an eight-row (pins 9-16) by four-column (pins 2-5) matrix that can be activated by up to 32 push-button switches. Only eight switches are used in our application. The circuit is clocked at about 60 kHz by the R9-L1-C2-C3 oscillator when the IC is active.

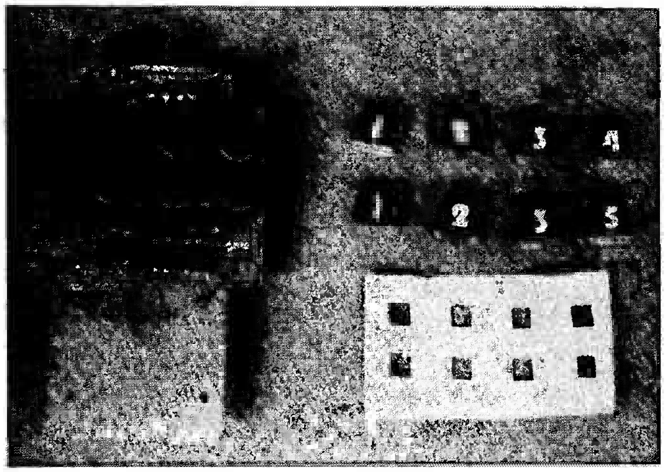
When the transmitter is in the quiescent state the IC is disconnected from the battery by turn-on transistor Q3 and the complete circuit (including the clock oscillator) is de-energised. Under this condition the entire circuit draws a total leakage current of only a few microamps from the supply battery. When any of the key switches are pressed, negative potential is applied to one of the 'row' pins via one of the resistors R4-7; pin 7 goes high and turns Q3 on, thus energising the IC and its clock oscillator.

Whenever the IC is energised by a press-button operation a keyboard scanner commes into operation, detects the code of the actuated switch and converts this information into a clock-related serial output code that appears on pin 8 and is unique to that particular switch. This serial code signal is fed to the infra-red transmitter LEDs via Q2 and Q1.

The transmitter serial code consists of a start bit, followed by six information bits, which are read out in biphase code at half the clock frequency. This seven-bit serial code signal has a total frame time of about 11 mS and is repeated at a time-base rate of about 130 mS throughout the duration of a key press. When the press-button is released a seven-bit 'end of signal' code frame is transmitted and the transmitter then automatically deactivates again when Q3 turns off.

The serial output code from pin 8 is amplified by Q2 and is used to pulse constant-current generator Q1 on and off via R2 and LED1. Q1 feeds current pulses of several hundred milliamps to the two series-connected infra-red transmitter LEDs, this high current being supplied by storage capacitor C1. Although the peak IR LED currents are very high (thus ensuring a good operating range), the mean currents (averaged over one time-base period) amount to only 5 mA or so.

Thus, considering that the transmitter will typically only be required to operate for about half-a-second per instruction, it can be seen that roughly 100,000 instructions can be transmitted from a single PP3 battery during its life. Put another way, a single PP3 is capable of transmitting 250 instructions every day for about one year.



This photograph shows the copper side of the assembled PCB, with the ingredients of the 'mylar sandwich'. The plastic fits over the switches and the caps hold it in place.

BUYLINES

The SAB3210 and SAB3271 are available from Electrovalue and Watford Electronics — Watford can also supply the LD271 and SFH205. The push-button switches and switch caps are available from Ambit International, as is the variable inductor L1. The cases used for the preamp and decoder unit are obtainable from West Hyde Developments (order as Samos 006 and 001 respectively).

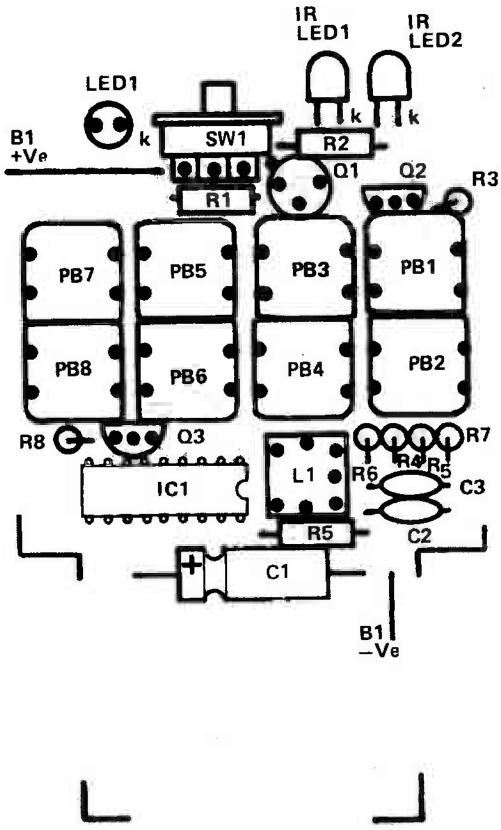


Fig.2 Component overlay for the infra-red transmitter; the board is a peculiar shape so that it will fit the case specified. Most of the resistors are mounted vertically to save space. The overlay is drawn with the component side uppermost — PCB1-8 and LED1 are actually soldered on the copper side, as shown in the photographs.

PARTS LIST

TRANSMITTER

Resistors (All ¼ W, 5%)	
R1	1R2
R2	47R
R3	12k
R4,5,6,7	39k
R8	22k
R9	47k
Capacitors	
C1	1000u 10 V axial electrolytic
C2,3	680p polystyrene
Semiconductors	
IC1	SAB3210
Q1	BFX88
Q2,3	BC182L
LED1	any red LED
IR LED1,2	LD271
Miscellaneous	
SW1	miniature slide switch
PB1-8	KHC10901 (push-to-make non-locking)
L1	87BN132HM (22 mH variable inductor)
Verocase (code 202-21303J), caps for switches (KT5 — 8 off)	

Now turn the PCB over and solder the eight push-button switches (and LED1) to the copper side. A great deal of care is required here and a miniature soldering iron is needed. Proceed as follows. First, remove the snap-on caps of the switches and straighten the four switch mounting legs, using a pair of pliers. Note that small pips are moulded into the underside of the switches, to fix their height slightly above the surface of the PCB: do not remove these pips. Now press one switch into position from the PCB copper side and solder its four legs to the PCB. Repeat the process, soldering one switch at a time, until all eight switches are in place. You'll find this a distinctly fiddly process.

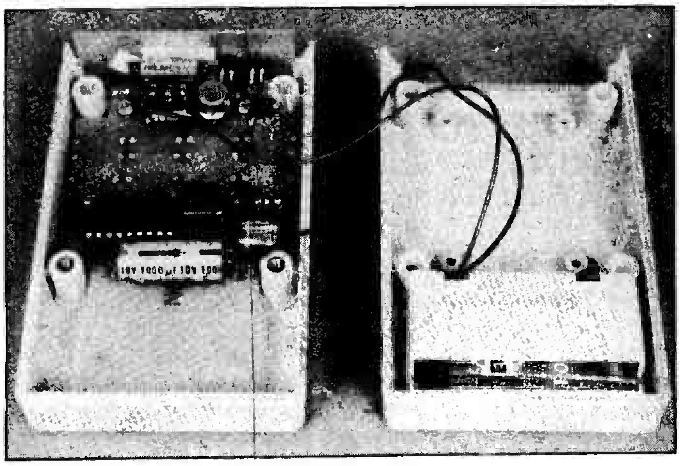
When all eight switches are in place, take a strip of white mylar film (available from your local art shop), place it over the bank of switches, cut holes in the strip so that the eight push-button operating shafts pass freely through the mylar, and then fit the switch caps back in place and check that the switches operate freely. The mylar film simply enhances the appearance of the finished transmitter unit.

This completes the construction of the electronics side of the transmitter and it can now be given a simple functional test. First, set the adjustable core of L1 to mid position, fit IC1 into place, connect a 9 V (PP3) battery, and turn SW1 on. Now press the push-button switches one at a time and check in each case that LED1 flashes intermittently for the press duration. If all is well, you can fit the unit into its case, as follows.

First, offer the PCB assembly up to the top half of the case (the battery holder is in the lower half), align it with the two small front mounting holes and carefully mark out the positions of the eight push-button switches on the case, so that four broad accommodating slots can be cut in the case to accept the switches as shown in the photographs. Cut the slots and re-check the fit.

Now similarly line up the PCB assembly so that holes/slots can be cut in the metal front panel to accept LED1, the two IR diodes, and the control knob of SW1. Once the holes are cut, complete the connections to the PP3 battery in the holder in the lower half of the case and screw the whole assembly together. The transmitter construction is then complete.

Note that the transmitter cannot be given a final test until the receiver/decoder construction is complete. When using the unit, however, note that the only function of SW1 is that of ensuring that the transmitter will not be activated accidentally when carried in the pocket, etc: in normal use SW1 can be left permanently on, since the unit consumes virtually zero quiescent current.



The transmitter PCB mounted in its case. You can see how the infra-red LEDs are bent at right-angles, and the slide switch soldered to Vero pins, so that they face forward through the front panel.

→

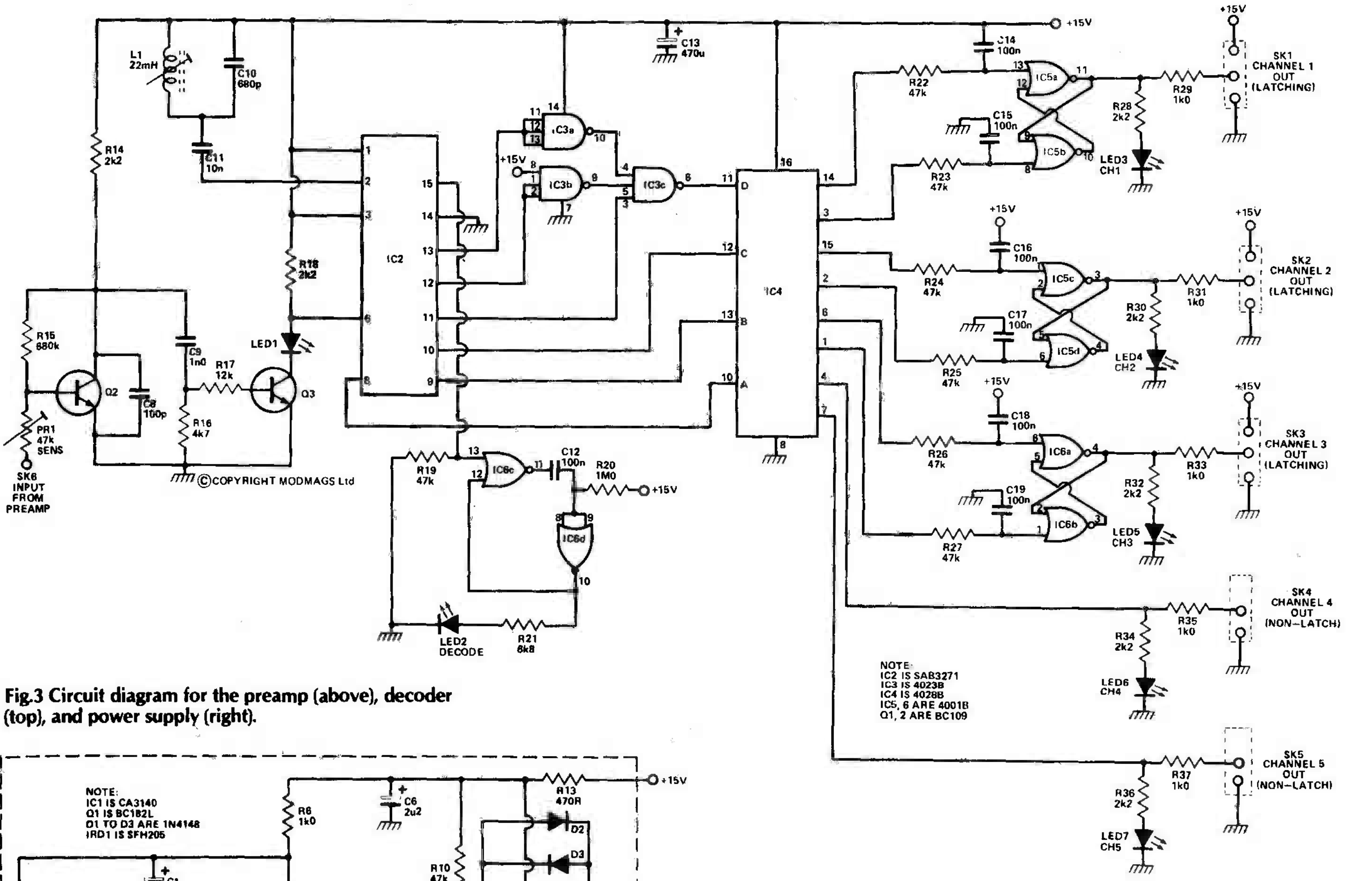
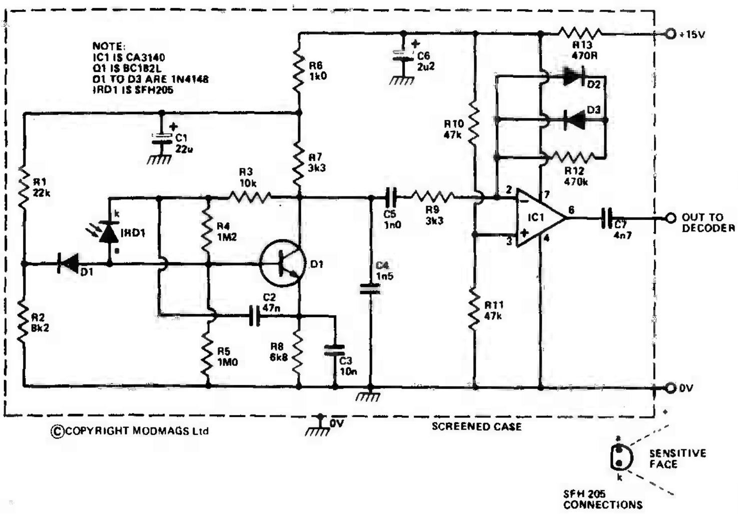
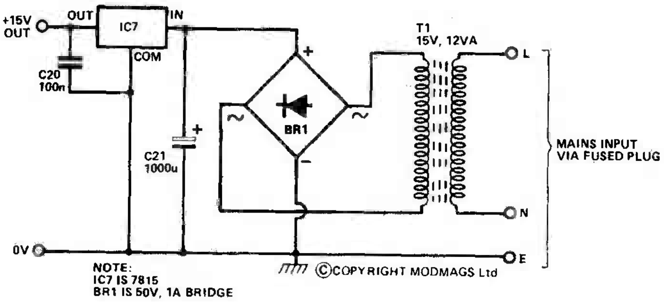
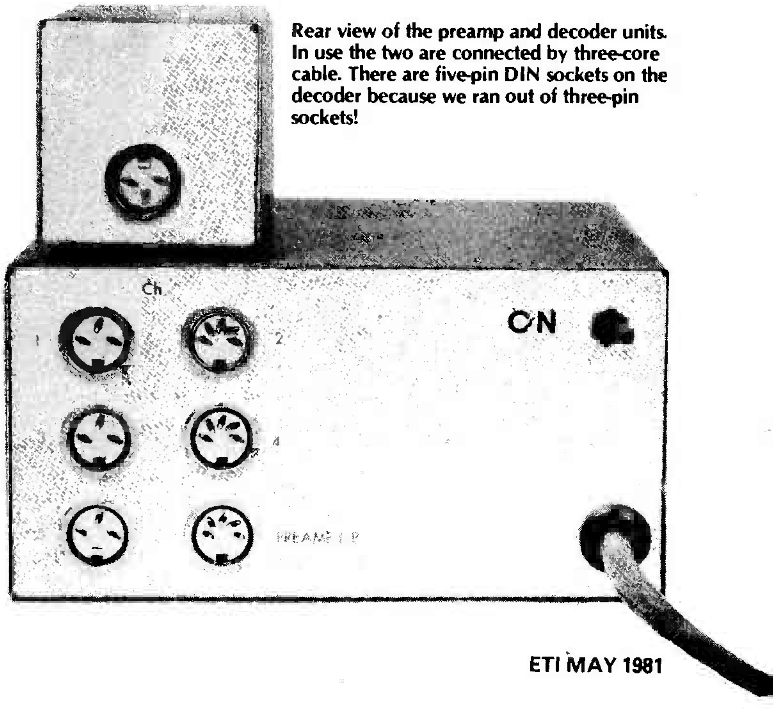


Fig.3 Circuit diagram for the preamp (above), decoder (top), and power supply (right).







Rear view of the preamp and decoder units. In use the two are connected by three-core cable. There are five-pin DIN sockets on the decoder because we ran out of three-pin sockets!

Construction: The Receiver/ Decoder

The receiver/decoder is built as two units, with the IR preamp housed in one small screened case and the main decoder circuit and power supply housed in a separate, larger, box: the two units are interconnected by a length of three-core cable. In use, the preamp is placed in a clearly visible position in the room and the main unit is hidden out of sight.

Start the construction by building the IR preamplifier, assembing the components as shown by the overlay. Take care to ensure that infra-red detector IRD1 is connected with the correct polarity. When construction is complete, mount the PCB in a steel or tin case, after first cutting a hole in the case front for IRD1, and ground the case to the 0 V supply line. Finally, fit a DIN socket in the rear of the case, to facilitate connections to the main decoder/power supply unit, and complete the interwiring.

HOW IT WORKS

THE RECEIVER/DECODER

The receiver/decoder unit detects the infra-red signals from the remote-control transmitter, amplifies them to a useful level, decodes the information that the signals carry, and then uses this information to implement a switching action on one or other of the latching or non-latching outputs of the decoder. These outputs can then be used to activate external power switches and lamp dimmers, etc. The receiver/decoder unit comprises three main sections, an infra-red receiver/preamplifier, the main receiver/decoder unit, and the power supply.

The transmitter IR signals have a basic frequency of about 30 kHz (half the transmitter clock frequency): they are detected by IRD1 in the receiver preamp and are amplified first by Q1 and then by IC1. A problem in designing IR preamplifiers is that the circuit not only has to provide high gain for long range operation but must also not saturate when the transmitter is placed only a few inches from the receiver.

With the latter point in mind, R1-R2-D1 and C2 are used to prevent the bias point of Q1 shifting under heavy drive conditions. D2 and D3 clip the level of the final IC1 output signal, to prevent overdriving of following stages. The values of C2-C3-C4-C5 and C7 are chosen to make the preamplifier reasonably frequency selective, thereby ensuring a good low-noise figure. The preamplifier unit must be mounted in an electrically screened case.

The output of the preamp is further amplified by the Q2-Q3 stages of the decoder circuit and are then passed on to pin 6 of IC2. Preset PR1 enables the effective sensitivity of the circuit to be varied over a wide range and LED1 is used as a sensitivity indicator when initially setting up the circuit.

IC2, which uses L1 and C10-C11 as clock elements, inspects the incoming pin 6 signal, checks it for compatability with its own clock frequency and with certain logic parameters, and if all is well converts the seven-bit biphase serial input signal into an equivalent six-bit parallel code, which appears on pins 8 to 13. Simultaneously, each time that a correct code conversion is made, a brief positive pulse appears on pin 15, and this pulse is used to trigger monostable IC6c-IC6d and thereby drive LED2 on to give a visual indication of the decoding action of the circuit; this LED indication is of value when initially adjusting L1 to set up the system.

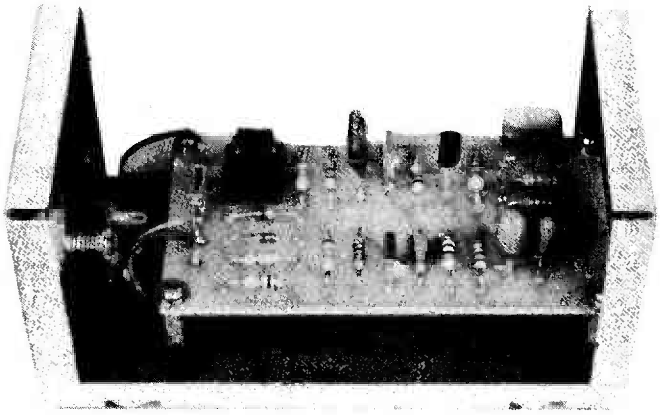
The six-bit parallel output code signals of IC2 are fed to IC3 and IC4, which decode eight of the possible six-bit combinations (corresponding to the eight possible codes generated by the eight push-buttons in the infra-red transmitter) and these decoded signals are made available on pins 14, 3, 15, 2, 6, 1, 4 and 7 of IC4. Each of these outputs is normally low, but can be driven high by closing the appropriate button on the IR transmitter.

The pin 4 and pin 7 outputs of IC4 are made available, via 1k0 limiting resistors, at output sockets SK4 and SK5 respectively of the decoder unit, and act as non-latching remote control output channels. The 14/3, 15/2 and 6/1 outputs, on the other hand, are each used to control a simple set-reset bistable which has its output taken to one of the SK1-3 sockets, each of which acts as a latching remote control channel output. Note that the inputs to the bistables are damped by simple R-C networks, to eliminate transient activation. Also note that all output channels are provided with LED indicators, to give a visual indication of the channel state.

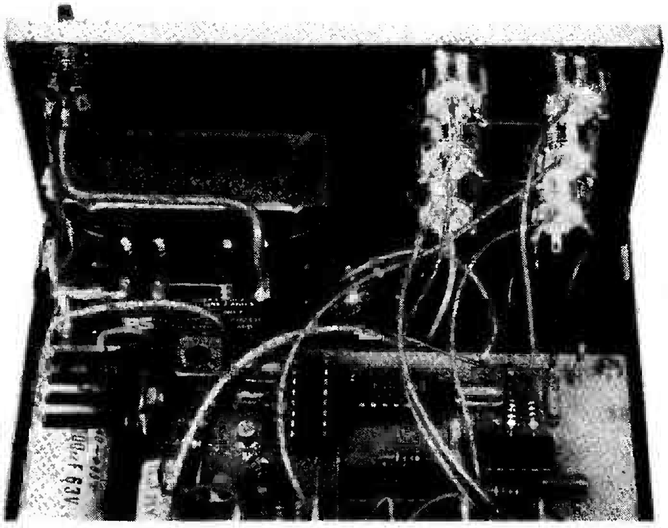
The complete receiver/decoder unit is powered from 15 V DC supply, derived from the mains via T1-BR1 and IC7. This supply is also made available at channel output sockets SK1 to SK3 and can be used to power auxiliary circuitry, such as the remote-controlled power switch described elsewhere in this issue of ETI.

Proceed now with the construction of the main decoder/power supply unit, noting that some care is needed in the construction of the PCB. Start the PCB assembly by fitting the four wire links and the Veropins and then systematically fit the remaining components in place, working through the assembly from the left (PSU components) to the right. Fit the regulator (IC7) with a small heatsink, sufficient to dissipate roughly 3 W.

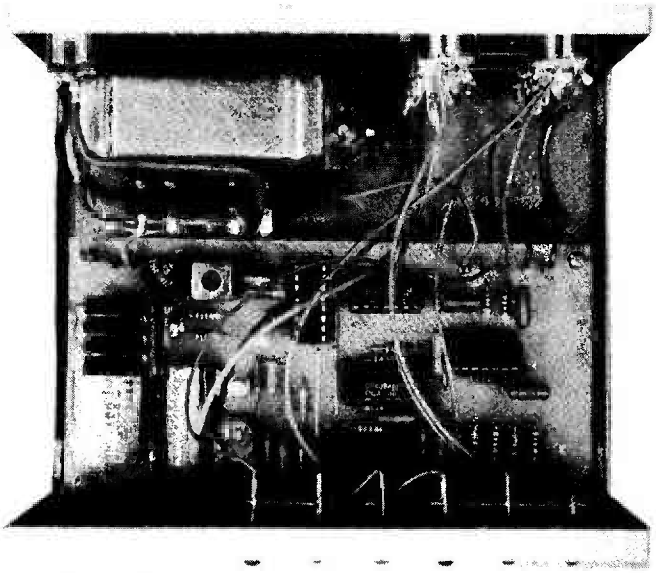
When the assembly is complete, fit the PCB assembly into a suitable case, together with mains transformer T1, six DIN sockets (one input, five output) and the six indicating LEDs, and complete the interwiring. Finally, complete the mains connections and check that the 15 V regulator circuit is working correctly, with outputs available at sockets SK1 to SK3. If all is well the system is ready for setting up.



Inside the preamplifier case; power and signals pass via the DIN socket on the left. The infra-red detector diode is fitted at the far right of the PCB and requires a cut-out in the side of the case.



Close-up of the wiring for the sockets on the decoder unit. One of these is for the input from the preamp — the other five distribute the decoded signals to the equipment under control.



General view of the decoder/power supply unit showing the internal layout. The common ground connection for the LEDs is made by soldering a length of tinned copper wire to the cathodes.

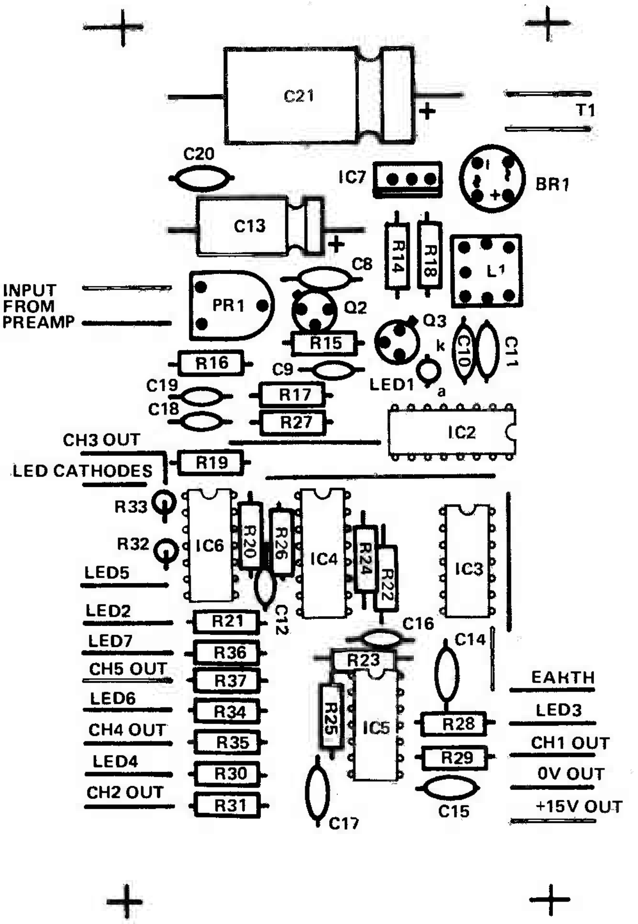


Fig.4 Component overlay for the decoder PCB. Note that LED1 is for setting up only and is soldered to the PCB.

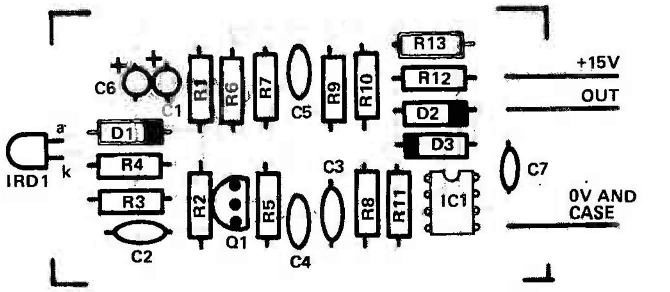


Fig.5 Overlay for the preamplifier. The leads of IRD1 have to be bent so that the sensitive face points forward.

Setting Up The System

To initially set up the five-channel remote control system, proceed as follows. First, interconnect the preamp and the main decoder/power supply unit. Switch the units on and adjust preset PR1 so that LED1 (mounted on the PCB) just glows faintly and then turn PR1 back so that the LED just turns off. Now operate the transmitter by pressing one of its buttons and see if LED2 illuminates, indicating that a decoding action is taking place. Adjust the core of L1 (in the decoder) to find the extreme positions at which decoding ceases and then finally set the core halfway between these points. If you can't get the circuit to work, use a 'scope to check that a code signal is being received from the output of the preamp; if not, you've probably fitted the transmitter LEDs or the preamp detector diode the wrong way round.

When all is well, check (by means of the indicating LEDs) that you can turn all five control channels on and off by using the appropriate press buttons on the transmitter. Finally, check that the system has a control range up to about 10 m, slightly adjusting the PR1 setting if necessary. The setting up procedure is then complete and the system is ready for use.

Using The System

To use the system with the touch dimmer, simply take the outputs of the SK4 and/or SK5 non-latching channels to the + and − inputs of the dimmer unit. To use the system with this month's power switch project, use the latching outputs of sockets SK1, SK2 or SK3 to feed instructions and power to the switch units.

PARTS LIST

IR PREAMP/DECODER/POWER SUPPLY

Resistors (All ¼W, 5%)	
R1	22k
R2	8k2
R3	10k
R4	1M2
R5,20	1M0
R6,29,31,33,35,37	1k0
R7,9	3k3
R8,21	6k8
R10,11,19,22,23, 24,25,26,27	47k
R12	470k
R13	470R
R14,18,28,30,32, 34,36	2k2
R15	680k
R16	4k7
R17	12k
Potentiometers	
PR1	47k miniature horizontal preset
Capacitors	
C1	22u 25 V tantalum
C2	47n polyester (C280)
C3,11	10n polyester (C280)
C4	1n5 polycarbonate
C5,9	1n0 polycarbonate
C6	2u2 35 V tantalum
C7	4n7 polycarbonate
C8	100p polystyrene
C10	680p polystyrene
C12,14,15,16,17, 18,19,20	100n polyester (C280)
C13	470u 25 V axial electrolytic
C21	1000u 63 V axial electrolytic
Semiconductors	
IC1	CA3140
IC2	SAB3271
IC3	4023B
IC4	4028B
IC5,6	4001B
IC7	7815
Q1	BC182L
Q2,3	BC109
BR1	50 V, 1 A bridge rectifier
D1-3	1N4148
IRD1	SFH205
LED1-7	0.2" red LED
Miscellaneous	
L1	87BN132HM (22 mH variable inductor)
SK1-6	three-pin DIN sockets

Transformer (15 V, 12 VA), ⅜" grommet, cases (see Buylines).

Finally, to use the system to control the noiseless power switch project of the March '81 issue, use one of the latching outputs of the decoder to feed control information only (NOT power) to the noiseless switch.

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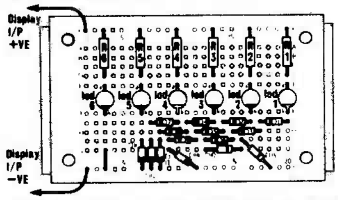

You will need; One EXP 300 or EXP 350 breadboard 15 silicon diodes 6 resistors 6 Light Emitting Diodes

Just look at the diagram, Select R1, plug it into the lettered and numbered holes on the EXPERIMENTOR BREADBOARD, do the same with all the other components, connect to the battery, and your project's finished. All you have to do is follow the large, clear layouts on the 'Electronics by Numbers' leaflets, and ANYBODY can build a perfect working project.

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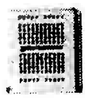

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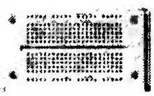

EXP 300 £5.75 The most widely bought bread-board in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 × 14 pin DIPS. Use this breadboard with Adventures in Microelectronics

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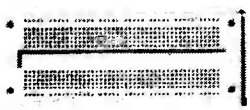

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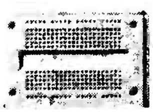

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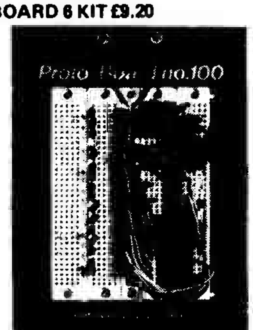

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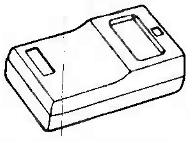

This is one of our range of PROJECT KITS. It includes all the parts required to complete the project, including the case. Calibration is very simple and an accuracy of up to 1% can be obtained. The instrument covers the range −50°C to +150°C. Read-out is on an LCD display. Power requirement is a 9V Battery. An ideal instrument for home or laboratory. Full instructions included.

PROJECT KIT 800104 £26.50

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This 'electronic musical box' can be used in a variety of applications. These include toys, video games and doorbells. It can be programmed to play no less than 27 tunes. The circuit is based on the AY-3-1350 which offers a considerable improvement over similar devices. The output can be switched from 'piano' to 'organ' like quality. The project includes all the components, case, loudspeaker and full instructions. An easy project for the beginner. An additional amplifier is available if required.

PROJECT KIT 80502K	£25-95	(Musical Box)
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[redacted]

The High COM system of noise reduction, developed by TELEFUNKEN, offers considerable advantages over existing systems. The Compressor/Expander circuits are designed around a specially designed IC, the U401B. The unit is designed for use with cassette and reel-to-reel tape systems to give professional quality, low noise recordings.

TECHNICAL SPECIFICATIONS:

Frequency Range	20-18Hz (+0, −3dB)	Distortion	less than 0.2%
Signal/Noise ratio	80dB (DIN input)	Noise reduction	at 100Hz : 15dB
	85dB (Socket input)		at 3kHz : 20dB
Input Sensitivity	DIN 0.6mV/6k ohm		at 15kHz : 25dB
Output Sensitivity	DIN 130mV/79k ohm	FULL SPECIFICATION AVAILABLE	

The project packs include all the electronic components, self adhesive front panel, prebuilt and tested HIGH COM modules and PCBs. The meter circuit uses an LED bar display and is essential for the operation of the unit.

HIGH COM (81117-1)	£49-55	HIGH COM Power Supply (8117-2)	£14.50
Meter/Display (9860 + 9817)	£15.40	Case for project	POA

DISCO PROJECTS

MINIMIXER

This mixer is easy to assemble, most parts are mounted on the single PCB. It incorporates two stereo disc inputs, two microphone inputs and a stereo tape input. Slider controls for level controls, rotary pots for tone controls. Distortion is approx 0.1%, frequency response 20Hz to 25kHz (3dB)

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This ceiling lights project controls a matrix of 25 × 100W lamps. A preprogrammed IC switches them in 22 different sequences of patterns. Patterns can be repeated if required. Triac controlled outputs. Lamps not supplied. Mains operation.

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A specially printed poster comes to life when the red and green lamps powered by this circuit are switched on. A random sequence makes the disco girl appear to dance. Poster included. Lamps not provided (100W)

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ASTROLOGUE

When it finally gets off the ground, the Space Shuttle may have a solar power system. Ian Graham reports on the latest developments

Despite last minute hitches in the Space Shuttle's first- flight preparations, plans for future flights are well advanced. To help provide power for Space Shuttle flights, Lockheed Missiles & Space Company is building a huge solar array wing for NASA The wing, which folds up like an accordion, will be used on an early mission to prove that Solar Electric Propulsion (SEP) arrays can generate the enormous power required.

The amount of fuel that can be carried on-board the Shuttle limits its time in orbit to seven days. The SEP array offers a means of extending the vehicle's orbital period.

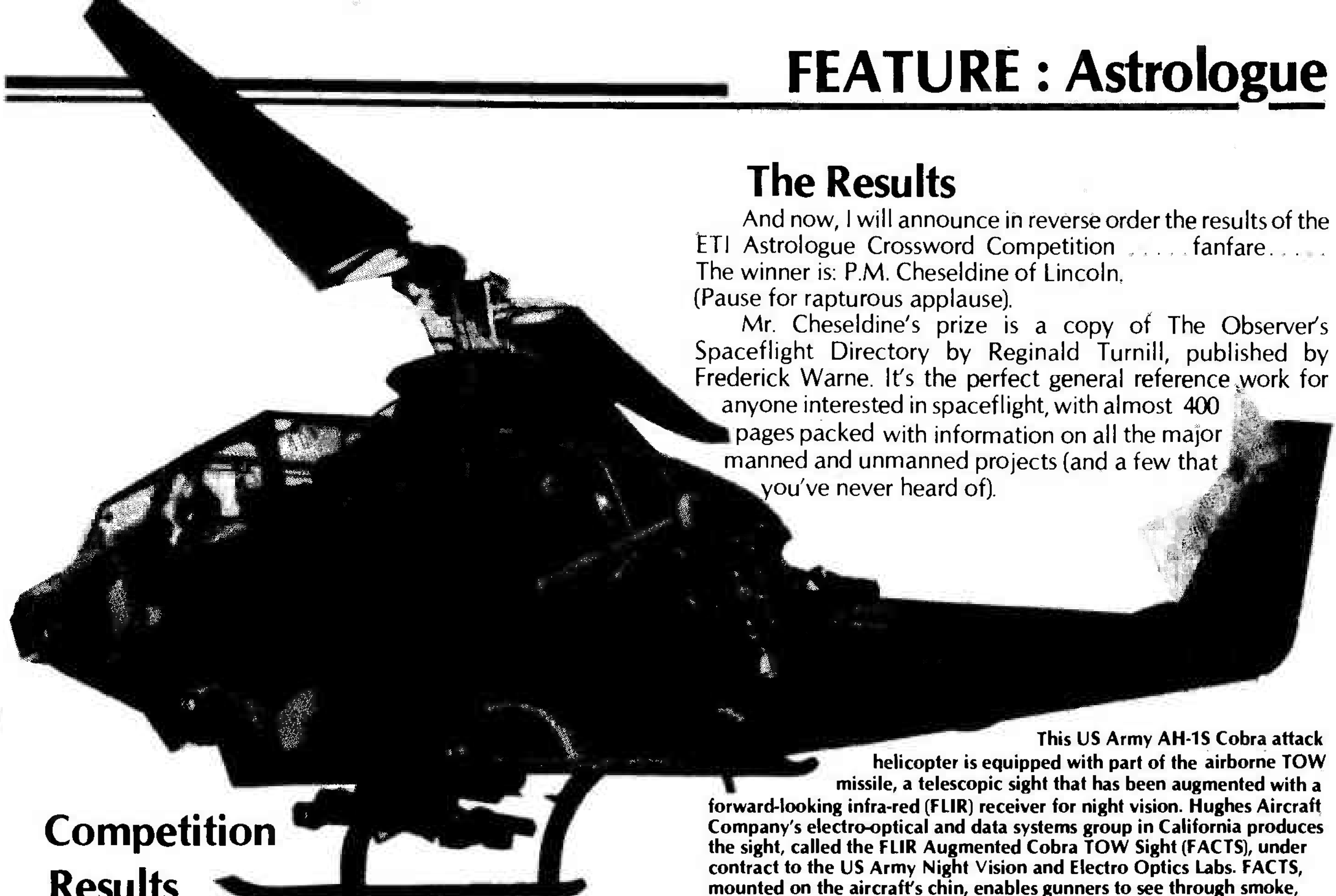
The experimental wing is 105 ft long and 13½ ft wide. In space it is unfolded from the cargo bay, and on its first flight it will be unfolded and retracted several times to study its behaviour in space.

Materially Speaking

The wing is not a rigid structure, but is made from a lightweight, flexible plastic (called kapton) and contains wrap-around-contact cells welded directly to the array blanket. This printed circuit approach has been adopted to eliminate heavy adhesives and allow greater flexibility during handling.

The structure represents an advance in solar power generation. It can produce 66 W per kilogram compared with 20 W per kilogram in present systems. Up to 75 W per kilogram is feasible using the same structural concepts.

Lockheed originally produced this design for use with a space propulsion system incorporating ion engines to power Earth-orbital and planetary missions. The potential fuel economy of ion propulsion is 10 times that of any conventional propulsion system.



The Results

And now, I will announce in reverse order the results of the ETI Astrologue Crossword Competition . . . . . fanfare . . . . . The winner is: P.M. Cheseldine of Lincoln. (Pause for rapturous applause).

Mr. Cheseldine's prize is a copy of The Observer's Spaceflight Directory by Reginald Turnill, published by Frederick Warne. It's the perfect general reference work for anyone interested in spaceflight, with almost 400 pages packed with information on all the major manned and unmanned projects (and a few that you've never heard of).

This US Army AH-1S Cobra attack helicopter is equipped with part of the airborne TOW missile, a telescopic sight that has been augmented with a forward-looking infra-red (FLIR) receiver for night vision. Hughes Aircraft Company's electro-optical and data systems group in California produces the sight, called the FLIR Augmented Cobra TOW Sight (FACTS), under contract to the US Army Night Vision and Electro Optics Labs. FACTS, mounted on the aircraft's chin, enables gunners to see through smoke, haze or darkness to accurately fire TOW missiles, rockets and cannon. It makes the helicopter gunship a round-the-clock combat machine.

Competition Results

January 31st marked the end of the Astrologue Crossword Competition, set in the January issue. Check your answers against the correct solutions shown here. Most of the millions of entries received (a slight exaggeration) were correct. Some found their way to Astrologue from as far away as South Africa and India. However, the business of totting up the numerical value of the solutions sorted out the men from the boys.

If you gave each square of the grid a value and did the arithmetic, you should have arrived at 1522. If you wrote down all the solutions and added up the value of each, you should have had 2169 on the bottom line (as some letters appeared in both across and down positions and were counted twice). Some enterprising readers came up with their own computer programs to take the pain out of the arithmetic. My thanks to Henry Budgett of Computing Today for his assistance in bringing the magic of the silicon chip to bear on the Astrologue Crossword.

M	E	R	C	U	R	Y		S	P	E	C	T	R	A
A		O				A		U				H		L
R	O	C	K		S	W	I	N	G		U	R	S	A
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E		N				A		F				E		A
G	R	A	V	I	T	Y		O	R	B	I	T	E	R

SHORTS

Representatives of 17 European governments met in Paris in January to discuss plans for an Operational Meteosat System. It was felt that such a system would be of substantial benefit to Europe and would also be a valuable contribution to the global observation programme of the World Meteorological Organisation. Meteosat 1, launched in November 1977, still collects weather information from land, marine and airborne observation platforms.

British Aerospace Dynamics Group's Bristol Division has just taken delivery of a fourth Ferranti Argus 700 computer system, valued at £93,000. This latest addition to British Aerospace's 700 family will be used in the development of real-time software for military applications.

Galileo, NASA's Jupiter probe (featured in ETI March '81 Astrologue), will be fitted with a European engine. Messerschmitt-Bolkow-Blohn are to build the engine, which will consist of one main thrust chamber and 10 small attitude control thrusters.

The Space Shuttle launch has been put back to some time in April, because of a fault found in the thermal insulation of the External Tank. When the tank was fuelled, some of the insulation separated from the contracting tank. Martin-Marietta engineers will have to make repairs in situ.

One of Jimmy Carter's last acts before packing up his knick-knacks was to propose a 1982 NASA budget of $6.72 billion, more than a 20% increase over this year's budget. The Space Shuttle gains by the increase — its funding goes up from £1.94 billion to £2.23 billion.

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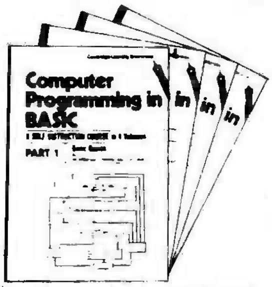

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A.N.S. COBOL (ANS) £5.90

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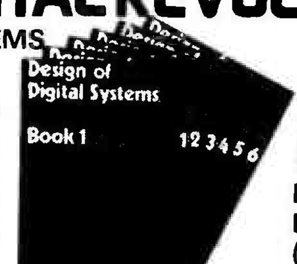

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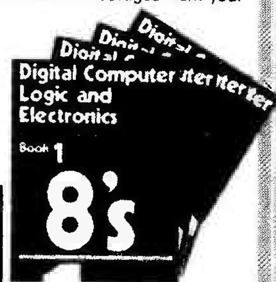

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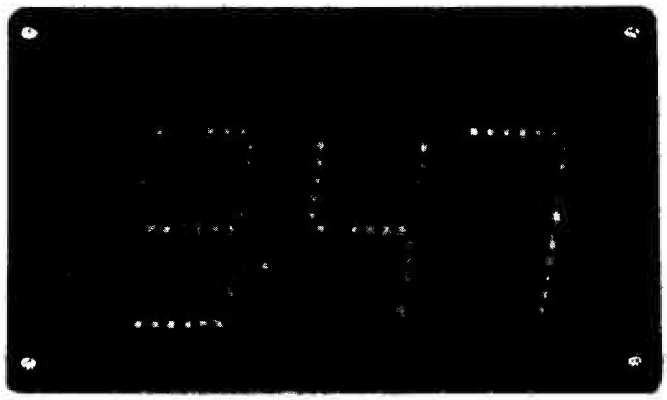
DIGITAL CLOCK



Here's the ideal thing for the kitchen, workshop, garage or shed — in fact, anywhere you need a digital clock that just can't be missed! Design by Barry Wilkinson.

Isn't it what you've always wanted — a digital clock with a decent sized display? Seeing the time at a glance is convenient in many situations and that's precisely what this clock has been designed for. The display features three seven-segment digits for the 'minutes units', 'minutes tens' and 'hours units' plus a single column '1' for the hours tens' displays. Each segment in the individual display is made up of a string of LEDs connected in series. Each vertical segment contains five individual LEDs, while each horizontal segment contains six. Overall height of the display is around 60 mm.

We used rectangular LEDs as they provided by far the best looking display compared to the more familiar round LEDS. A 'flashing colon' between the hours and minutes digits is provided to reassure you that the clock is going! However, as a binary divider clocking from the mains is used to drive the clock, a 1 S output is unfortunately not available and so the next best output was chosen. This proved to be a division of 32 and thus, from 50 Hz, a pulse is obtained every 1.56 S — this is used to flash the colon.

Design

There are a number of interesting aspects to the design of this digital clock. For a start, conventional CMOS binary dividers have been used in preference to one of the special clock divider chips. The latter are very handy, no doubt about that, but they are incapable of driving a large sized display like the one used here. The voltage drop across each segment of the multi-LED display varies depending on the type and colour of LED used. Whilst we have used red LEDs, which have a voltage drop of around 1V6 each, green or yellow LEDs may be used and these have around a 2V1 drop each; some of the new 'high efficiency' LEDs also exhibit a 2V1 drop. This means that for a horizontal segment in our display, the maximum voltage drop may be as high as 12V6 (six LEDs times 2V1). The clock chips available cannot readily cope with this but CMOS decoders can be arranged to do what we want.

You will notice from the circuit that the LED segments are driven by 4511 CMOS decoders which provide up to 25 mA per segment, with the actual current being determined by current limiting resistors. The current per segment in our circuit is limited to around 20 mA. However, the maximum voltage across CMOS is limited to 15 V and a supply of around 18 V was necessary to allow for the drop across the display segment plus the drop across the limiting resistor and the 1V5 lost in the 4511 output circuit. To overcome this difficulty, we stabilised the negative supply rail for the CMOS to 12 V and the negative side of all the display segments is taken to the *unregulated* negative supply. The zener action of the LEDs (ie, there is no current flow below about 1V4 per LED) ensures that the outputs of the 4511 are never 'pulled' below their negative supply rail.

Construction

We found it necessary to use a double-sided printed circuit board for this project to avoid a large, cumbersome board which we feel sure you'd agree would be rather unattractive.

The board used in our prototype did not use plated-through holes as it is not really necessary. However, there are many fine tracks on the board and we recommend you use a soldering iron with a small tip. When soldering tracks on the top side of the board where a component lead connects to a corresponding track on the underside of the board, always ensure that you heat the joint sufficiently to get a good flow of solder and avoid a dry joint.

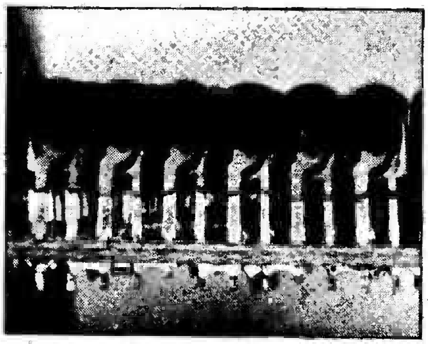
To commence assembly, first check that the three mounting holes around the board perimeter and the two holes for the time setting push button switches are the correct diameter. It's awfully hard to drill the board after the other components are mounted.

Commence assembly by soldering in all the resistors, capacitors and diodes and the two transistors. You could leave C1, which mounts on the rear side of the board, until all the other components are assembled if you wish. Take care with the orientation of the diodes, paying particular attention to the component overlay. Note that different value current-limiting resistors are required, according to the type (and thus the voltage drop) of LEDs chosen. Refer to Table 1 for the appropriate values.

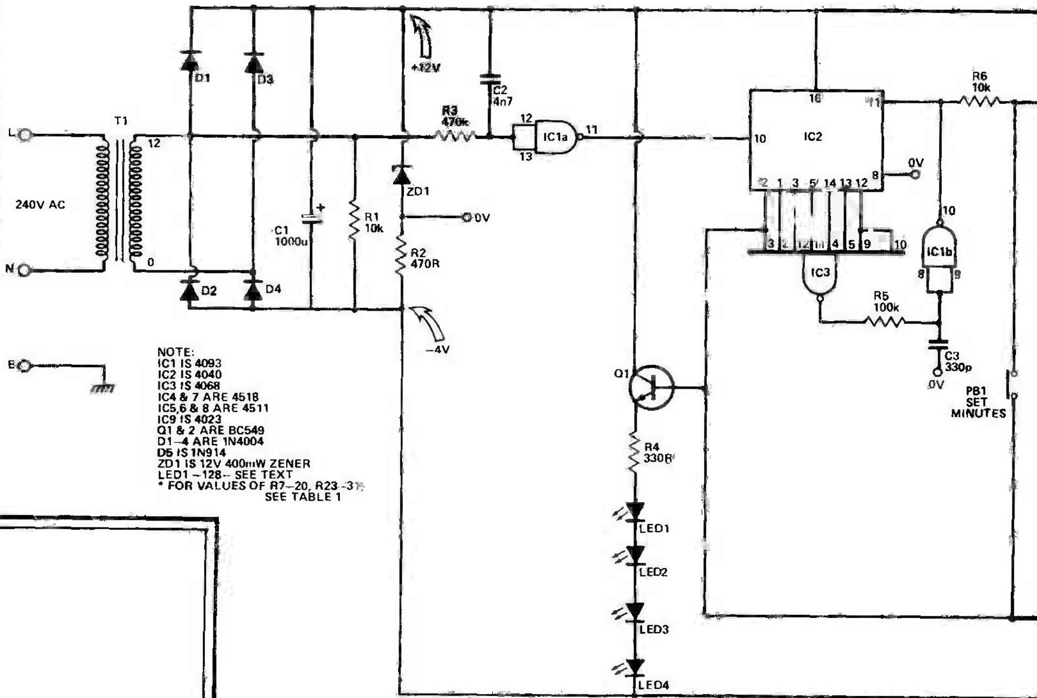
Resistor	1V6 LEDs	2V1 LEDs
R7, 10, 13, 14, 17	180R	150R
R20, 23, 26, 29	180R	150R
R8, 9, 11, 12, 15, 16	270R	180R
R18, 19, 24, 25, 27, 28	270R	180R
R30, 31	270R	180R

Table 1. Value of current limiting resistors for the LEDs.

As CMOS ICs are used, take care when inserting them that you handle the devices with due care. Carefully remove them from their packaging, taking care not to handle the pins — pick them up with your thumb and forefinger grasping the ends of the package, not the pins. Make sure you have them correctly



Above: The LEDs are mounted by butting the 'shoulders' on the leads against the PCB.
Fig.1 (Right) Circuit diagram of the Digital Clock.



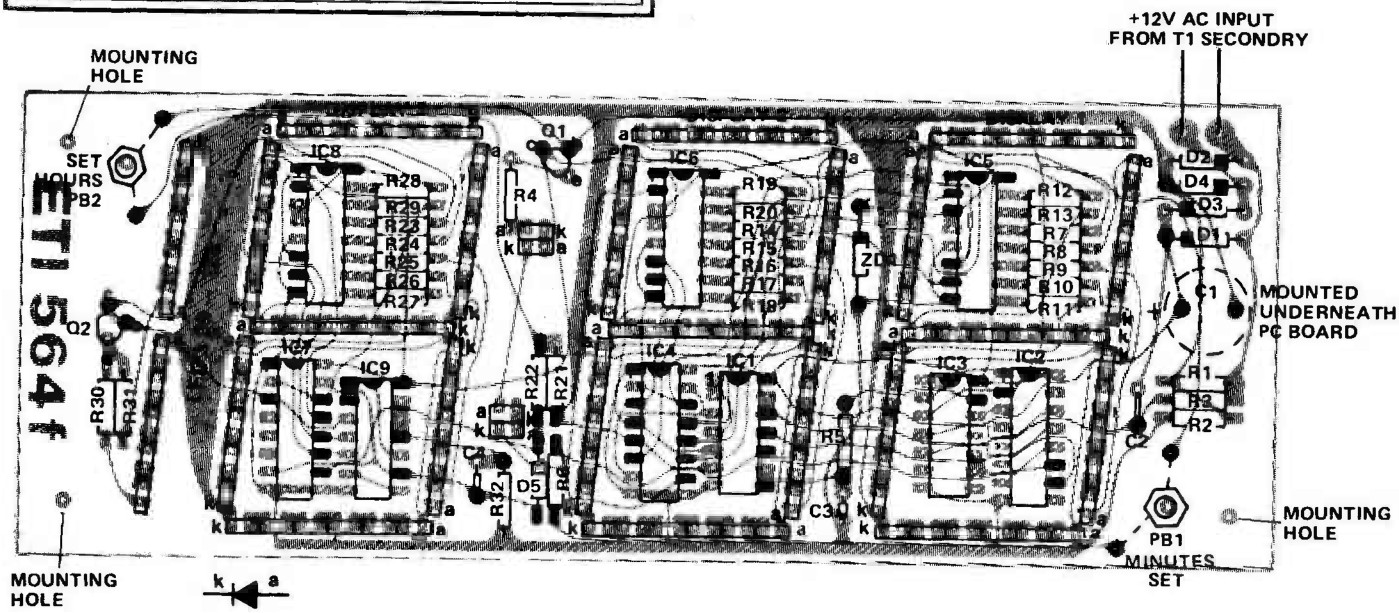
PARTS LIST

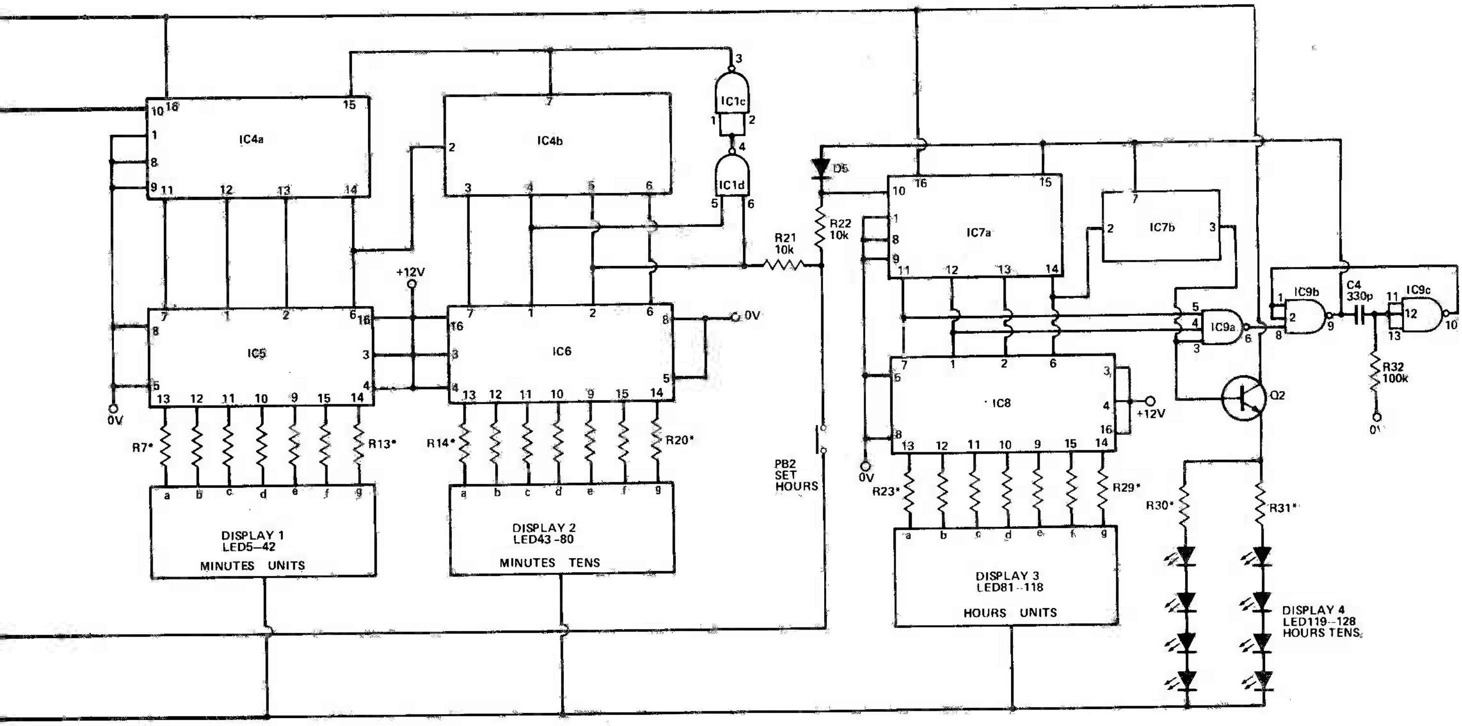
Resistors (all ¼ W, 5%)	
R1,6,21,22	10k
R2	470R
R3	470k
R4	330R
R5,32	100k
R7-20	see Table 1
R23-31	see Table 1
Capacitors	
C1	1000u 25 V electrolytic, PCB-mounting
C2	4n7 polyester
C3,4	330p ceramic
Semiconductors	
IC1	4093B
IC2	4040B
IC3	4068B
IC4,7	4518B
IC5,6,8	4511B
IC9	4023B
Q1,2	BC549
D1-4	1N4004
D5	1N914
ZD1	12 V, 400 mW
LED1-128	rectangular LEDs (see text)
Miscellaneous	
PB1,2	push-button switches, non-latching
Transformer (12 V @ 1 A), sheet of plastic, case etc.	

The power supply is simply a transformer with a 12 V secondary, whose output is full wave rectified by D1-4 and filtered by C1. The IC supply is stabilised by ZD1 to 12 V DC. The AC voltage is also coupled to the input of IC1a by R3 to provide a 50 Hz clock frequency. R3 protects IC1a against input damage as the AC voltage exceeds the supply rail of the ICs. C2 acts as a filter to prevent false counting, and IC1 has Schmitt trigger inputs which also help to prevent false triggering. The output of IC1a is a clean 50 Hz square wave.

To derive the 'minutes' output the mains frequency must be divided by 3000: this is done by IC2, a 12-stage binary counter. The total division ratio of this IC is 1:4096, so the outputs of the 4th, 5th, 6th, 8th, 9th, 10th and 12th stages are decoded (when all are high), taking the output of IC3 low on the count of 3000 (binary 101110111000). After a short delay (about 30 uS) due to R5/C3, the output of IC1b goes high, resetting IC2. This immediately causes the output of IC3 to return high

Fig.2 The overlay as seen from the component side. Note that this is a double-sided board.





HOW IT WORKS

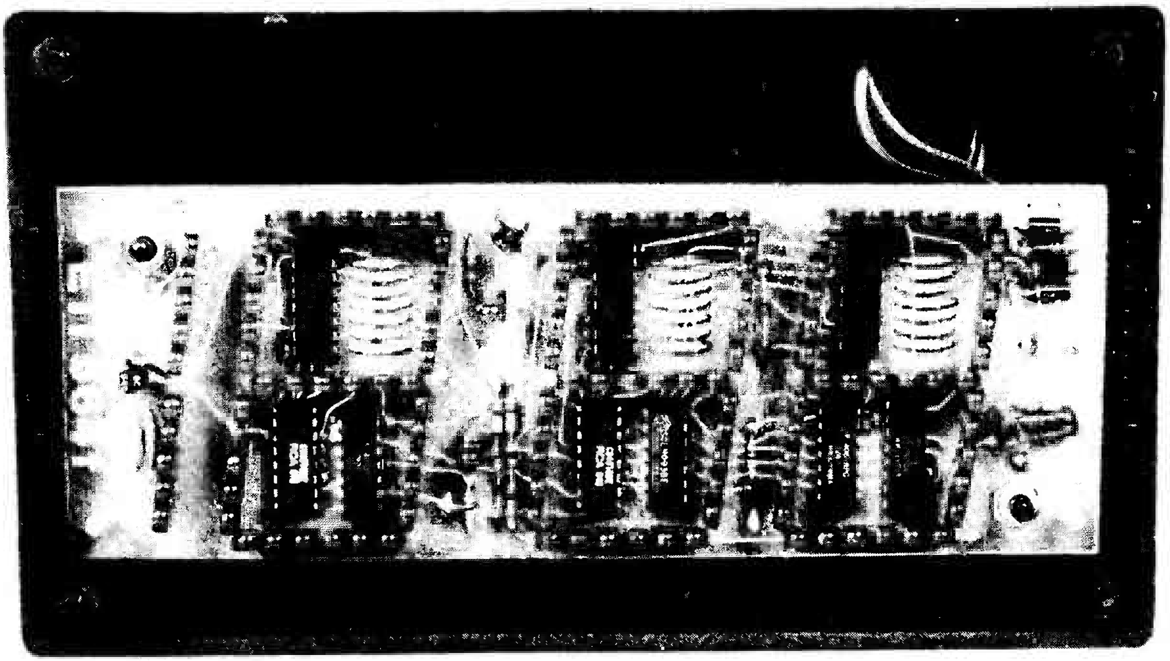
but, again due to R5/C3, the output of IC1b will remain high for about 20 uS, ensuring correct resetting and the clocking of the minutes counter.

One of the outputs of IC2 (pin 2) is used to drive the colon and to provide the clock pulses for the 'fast set' modes. Using a binary divider means that a 1 Hz pulse is not available, so we chose the 1.56 S output (50/32).

The output of IC1b (a 20 uS pulse once per minute) is used to clock IC4a, one half of a dual decade counter. The outputs of IC4a are decoded by IC5, which drives the 'minutes units' display. The 'divided-by-10' output of IC4a clocks IC4b, whose outputs are decoded by IC6 to display the 'tens of minutes'. As time has yet to be decimalised (!), IC4b is set to divide by six. This is done by IC1d which detects when the 2nd and 3rd outputs are high (binary 0110) and provides the reset pulse via IC1c.

The third output of IC4 is used to clock the hours counter, IC7. This, like IC4, is a dual decade counter with the first half being decoded by IC8 and the second being clocked by the output of the first. As only a simple '1' is needed for the tens of hours (12 hour clock) no decoder is necessary, only a buffering transistor. IC9a detects when IC7 reaches decimal 13 (0001 0011 binary) and triggers a monostable formed by IC9b and IC9c. This is used to reset IC7 to zero hours but as there is no zero hour in the 12 hour system we need to reset to a '1'. This is done by D5, which pulls pin 10 of IC7 high for the duration of the reset pulse and allows it to fall back again a few microseconds after the end of reset pulse, (the delay being due to stray capacitance). This causes IC7 to clock on to '1'.

Fast setting is done simply by injecting the 1.5 S pulse directly into the minutes or hours counters, using the push buttons.



oriented before inserting them in the board. Also ensure that you put each IC in its correct place and on the correct side of the board too! Sockets cannot be used for the ICs as many of the pins are soldered on both sides of the board.

LED Astray

The rectangular LEDs specified measure 2.5 mm wide by 5 mm long. If you elect to use conventional round LEDs, the miniature 3-4 mm diameter types should be used. Many of the larger sized round LEDs will not fit this PCB as they have a shoulder around the base of the unit that measures 6 mm in diameter, preventing the close packing possible with the other types.

The LEDs we used have a shoulder or 'step' in their leads a few millimetres from the base. We pushed the LEDs down onto the PCB until this shoulder stopped them going any further. The outside lead of each segment array was soldered and then each group checked for alignment before soldering the other leads. Once you have the LEDs mounted and soldered in place, the two push button switches may be mounted.

At this stage, if you are satisfied everything has been mounted correctly, the board may be tested — *but give it another thorough check first!* In particular, look for solder 'bridges' between IC pins or across closely-spaced tracks as well as possible dry joints.

Simply apply 12 V AC to the two pins marked on the board overlay and see that the clock operates as it should. Try the 'hours set' and 'minutes set' buttons to see that they have the required effect. If all is not well, switch off and re-check the component placement and orientation, check for dry joints, etc.

Now the clock may be finally assembled. An earth lug should be mounted under one of the transformer mounting bolts and the mains cable earth soldered to it. The PCB should be mounted behind a sheet of red plastic (if you're using red LEDs) to improve the contrast of the display and hide the other components. It will be necessary to drill two small holes in the plastic opposite the time-set buttons — a match can then be inserted to depress the buttons. If you prefer, you can mount the switches off-board and fit them in a convenient position on the case. Make sure the case has adequate ventilation, as the clock dissipates some 10 W. Once the clock is complete, all that remains is to plug in and set the time.

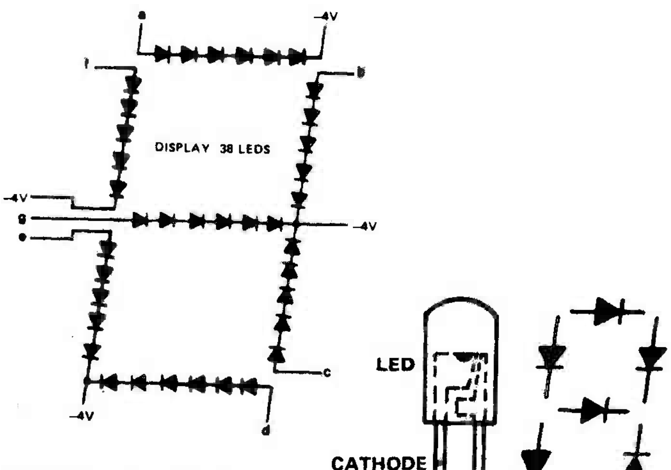


Fig.3 Orientation of the LEDs for each of the 'seven-segment' displays. Lead identification can be made as shown on the right.

Setting the time

1. Switch on.
2. Press the minutes button until the minutes display is correct. To prevent multiple pulsing due to contact bounce, the button should be pressed and released when the colon is **off.**
3. Set the hours in a similar manner to the minutes. If the minutes display is less than 40, again operate the button when the colon is **off**. If the minutes display is 40 or more, operate the button when the colon is **on.**
4. An easy way to set the clock to the *exact* time is to first set it some 20 - 30 S fast by the push buttons, then compare it to a known time standard (you might use a radio time signal for this). Turn off the power for the exact time *difference* and the clock will cease counting. The large filter capacitor will hold its charge long enough to store the last time, for up to a few minutes, until power is returned. When the time signal equals the clock display, turn the power back on.

BUYLINES

There should be no problem obtaining any of the components for this project as nothing is out of the ordinary. Although you can expect to pay nearly £30 for the LEDs alone, it should be borne in mind that the nearest commercial equivalent to this clock costs over £100.

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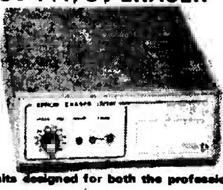

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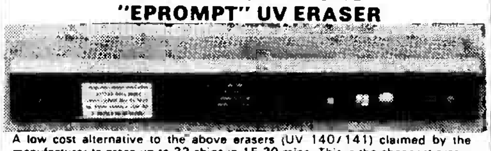

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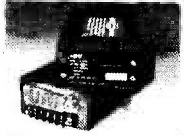

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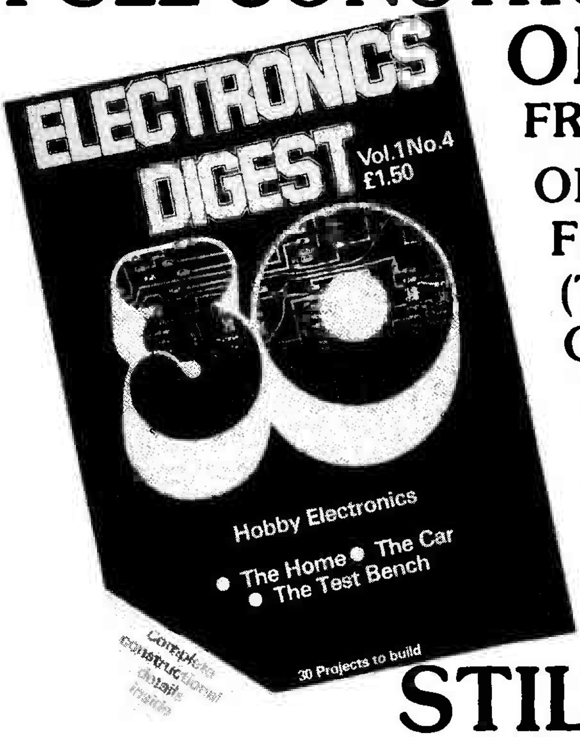

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MICROBASICS

This month Microbasics returns to the hardware. Henry Budgett takes a look at the 6500 family in general, and the 6502 in particular.

The hardware side of Microbasics is returning briefly this month for a close look at just one chip, the 6502 CPU. Although this device has hogged the limelight owing to its starring roles in such machines as the PET, Apple, Microtan and ATOM it is far more than just a one-off. Part of a complete family of devices, the 6500 series, it represents the public face of the design architecture. Why look at it in detail? Well, in the near future you are going to see one of its brethren in a major new role, but more of that in a month or two.

Family Characteristics

Figure 1 and Table 1 give the details of the whole range; there is a new device promised but I don't have details yet. Although I'm going to concentrate on the 6502, most of the information is directly relevant to the others in the family.

Physically it is supplied as a standard 40 pin DIP which needs a single 5 V supply and a clock generator. Internally the device operates on a two phase clock but this is generated from a single input which should be crystal controlled. The CPU actually sends the second clock phase back out again for synchronisation purposes and this appears on pin 39.

The size of the internal data bus and its associated registers is eight bits — hence the term 'eight bit micro'. These registers and the rest of the internal workings are shown in Fig. 2. It should

Features	R6503, R6513	R6504, R6514	R6505, R6515	R6506	R6507
Addressing Capability	4096 Bytes (AB00-AB11)	8192 Bytes (AB00-AB12)	4096 Bytes (AB00-AB11)	8192 Bytes (AB00-AB11)	8192 Bytes (AB00-AB12)
Interrupt Request Capability	IRQ, NMI	IRQ	IRQ	IRQ	—
"Ready" Signal	—	—	RDY	—	RDY
*Timing Signals Required	Single Phase TTL Level Ø0 (IN), or Crystal or RC	Single Phase TTL Level Ø0 (IN), or Crystal or RC	Single Phase TTL Level Ø0 (IN), or Crystal or RC	Single Phase TTL Level Ø0 (IN), or Crystal or RC	Single Phase TTL Level Ø0 (IN), or Crystal or RC
Other Control Signals	RES, R/W	RES, R/W	RES, RW	Ø1 (OUT), RES, R/W	RES, R/W

*6513, 6514 and 6515 are slave microprocessors requiring external Ø1 and Ø2 clock inputs

Table 1. Details of each of the CPUs.

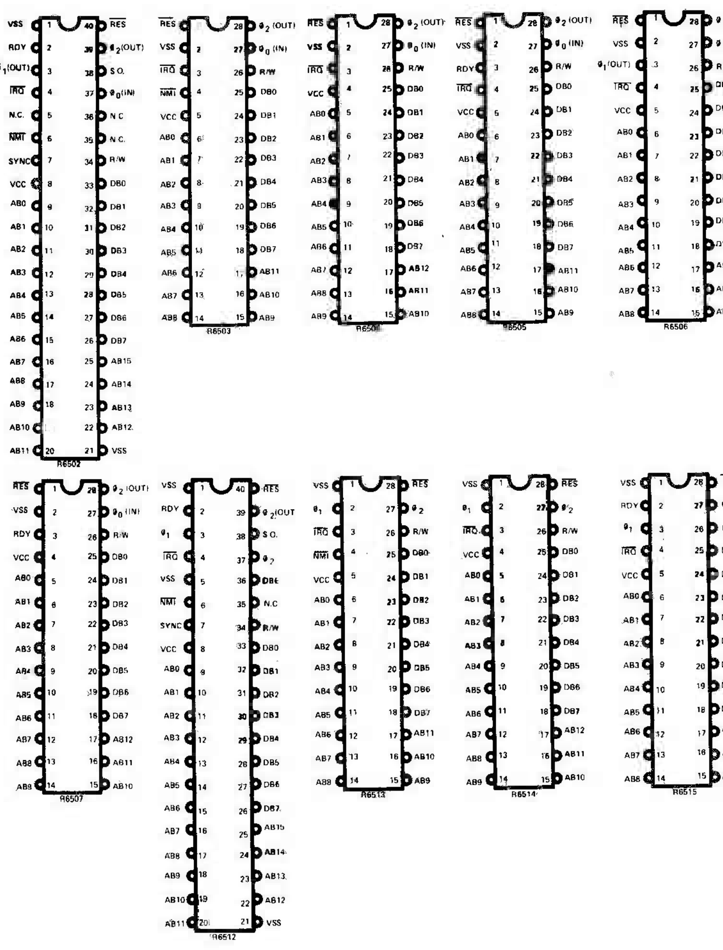

Fig.1 Pin designations for all the CPUs in the 6500 family.

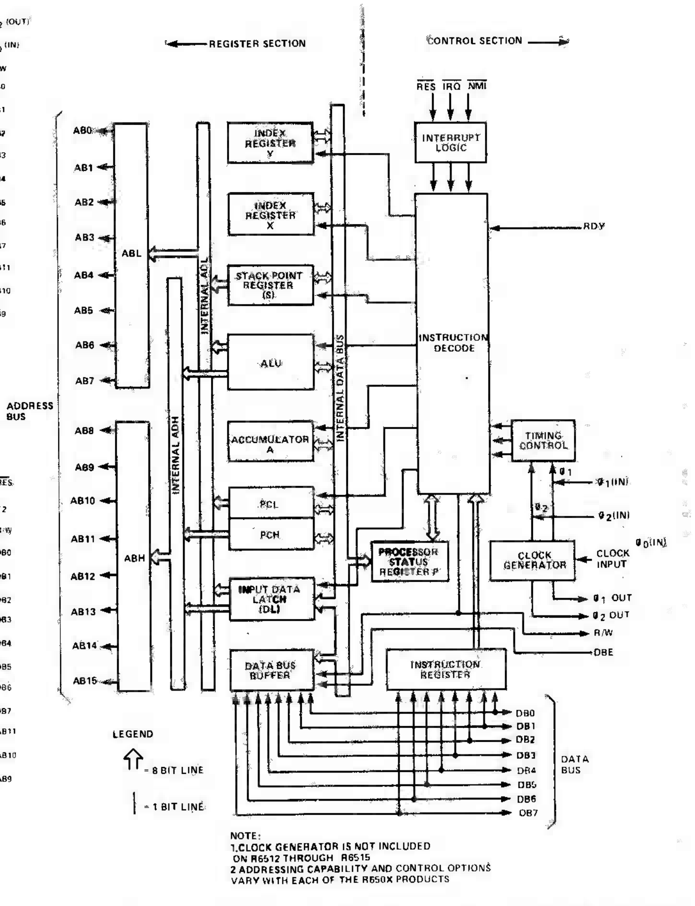

Fig.2 Block diagram of a 6500-series CPU. The registers are all eight bits wide except the program counter; this consists of a high and low byte (PCH and PCL).

be noted that this block diagram is for the generalised 6500 device and not the 6502 specifically but the differences are slight. Although the data bus is only eight bits wide the address bus is a full 16 bits across which gives access to 65,536 possible memory locations. Some of the other members of the family, notably those with only 28 pins, have a more limited addressing capability. Table 1 has the details.

Pin By Pin

In order to take a close look at the functioning of the device I'll go through it pin by pin. Where to start? Being logical (?) let's begin with the data bus. This occupies eight pins, 26 to 33 (DB_7 to DB_0) and is a true tri-state, bi-directional highway. What's actually on it at any given instant is controlled by the pins R/W (34) and RDY (2). The functions of these will be explained later.

The address bus is found on pins 9 to 25 (AB_0 to AB_{15}). This is a unidirectional bus, you can't 'read' an address. The addressing capabilities of these 16 lines are shown in Fig. 3, obviously those 6500 series devices with fewer address lines can only access a part of this range. An address is set onto the lines during the Ø1 clock pulse and is stated as being 'valid', jargon for being stable and OK, some 300 nS after Ø1 goes high (given a 1 MHz clock). The address remains stable on the bus until the next Ø1 clock pulse.

BINARY ADDRESS High-Order		BINARY ADDRESS Low-Order		DECIMAL NUMBER	HEXADECIMAL Address Code	
15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0		Page Number	Byte Number
0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0	00	00
0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 1	1	00	01
0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	255	00	FF
0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 0	256	01	00
1 1 1 1	1 1 1 0	1 1 1 1	1 1 1 1	65279	FE	FF
1 1 1 1	1 1 1 1	0 0 0 0	0 0 0 0	65280	FF	00
1 1 1 1	1 1 1 1	0 0 0 0	0 0 0 1	65281	FF	01
1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	65535	FF	FF

ADDRESSABLE MEMORY FIELD (65536 Bytes)

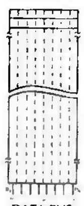

Fig.3 The addressing range of the 6500-series. Only part of this range can be covered by some of the CPUs.

Of Reading And Writing

The R/W pin (34) controls the direction in which information travels on the data bus. The line is normally high (READ mode), unless the processor wishes to send something to memory or the outside world (WRITE mode) in which case it is forced low. All transitions (changes of state) occur during the Ø1 period which allows data to be transferred during the Ø2 clock period. The second major control line for the buses is the Ready (RDY) line found on pin 2. This is normally high but when pulled low, during Ø1, it effectively shuts the CPU down — provided the current operation is *not* a WRITE. This allows slow memory devices such as EPROMs to be catered for and, more importantly, operations such as DMA, Direct Memory Access, to occur.

Interruptions

The 6502 supports two types of interrupt, Non Maskable and 'normal'. The Non Maskable Interrupt ($\overline{NMI}$) is a control input found on pin 6 and this should normally be held high. The processor *must* break off from whatever process it is currently performing (it performs essential 'housekeeping' first) when this line goes low. Being an edge triggered control the line can stay low indefinitely without causing further interrupts, to issue another it must first be taken high and then low again. When an NMI occurs the current status of the program counter and the status word are saved on the stack and the program counter is then loaded with the interrupt vector, in the case of the 6502 this is FFFA and FFFB. The contents of this memory pair contain a further address which is the start of the interrupt service routine.

The case of the other interrupt is rather more complicated in that it can be turned off if you want by manipulating a bit in the status register. The physical manifestation (classy eh?) of this control is a pin labelled $\overline{IRQ}$ (4) which is normally held high. When pulled low by a peripheral device it signals an interrupt to the processor. If the interrupts are enabled then a similar action to that of the NMI is performed. It should be noted that the $\overline{IRQ}$ line is not edge triggered so as long as the line is low the CPU will try to service interrupts.

The ultimate interrupt to any CPU is the RESET ($\overline{RES}$) signal which is found on pin 40. During power-up this line should be held low until conditions have stabilised and then taken high. In practice a simple RC combination will suffice. When the line goes high it causes the processor to fetch a new 'vector' from a specific address, this loads the program counter to a known starting point in the user program. In this way the machine powers up with all the functions set correctly; the line should also be fed out to all the support chips to ensure that they too turn on correctly.

Alone in the 6500 series the 6502 possesses a control line called SYNC which is found on pin 7. This is used to identify the specific cycle taking place within the CPU, (it approximates to the M1 signal in the 8080. The line goes high during Ø1 of an OP-CODE FETCH and is used to tell the outside world to mind its own business for a while. If the RDY control is taken low during the same Ø1 cycle as the SYNC goes high it stops the processor in its current state. This allows single instructions to be executed if handled correctly.

There is one further control line called SO which appears on pin 38. It is not used — except with a specialised I/O port — so you can ignore it.

Registered Design

So much for the outside, what goes on inside that hunk of black plastic? The block diagram of Fig. 2 shows the registers; the only ones of interest from our point of view are the stack pointer, the program counter and the status word. Although the address range of the 6502 requires a full 16 bit bus the stack pointer only contains eight bits. These eight bits act as the lower half of an address, the top half being set at 01 Hex. The 6502 stack is an area of memory that resides in Page 1 (hence the 01 Hex top half), which is used by the CPU and the user programs as a temporary storage area.

A Program Counter consists of a 16 bit register which contains the address of the next instruction to be executed, or rather it contains the address of the next memory location which will be accessed.

The status word is important to both the hardware and software engineer. Eight bits wide, it contains seven flags which indicate the current status of sections of the hardware within the CPU. Bit 0 indicates the carry status; it gets set if the result of a calculation in the Accumulator exceeds 255, and is effectively a ninth bit in the Accumulator. Bits 1,3,6 and 7 are concerned with the programming aspects of the device and Bit 5 is not used. This leaves Bit 2 which is the Interrupt Disable flag that I mentioned earlier, and Bit 4 which indicates that a BREAK instruction has been found.

Programming The Beast

As this is mainly a hardware orientated article I'm not going to say anything about the actual programming of the 6502; only that ETI has a major new project planned which involves the 6500 series and will answer all your questions. I can't go into any greater detail at present, but in a month or two all will be revealed.

ETI

computing today

MAY 1981

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LIVING IN BABEL?

With the ever increasing family of computer languages to contend with we decided to start taking a look at some of the most important ones for the micro user. Just what they do and why one does it better than another are the sort of questions we'll be trying to answer over the next few issues. We start with COMAL, the newest recruit onto the micro scene.

BINDING IT TOGETHER

Many computers seem to lack sufficient documentation and, unfortunately, the ZX80 is no exception. A veritable library seems to have sprung up around it and we take a look at some of the best, and worst, on offer.

CONQUERING EVEREST FOR FUN

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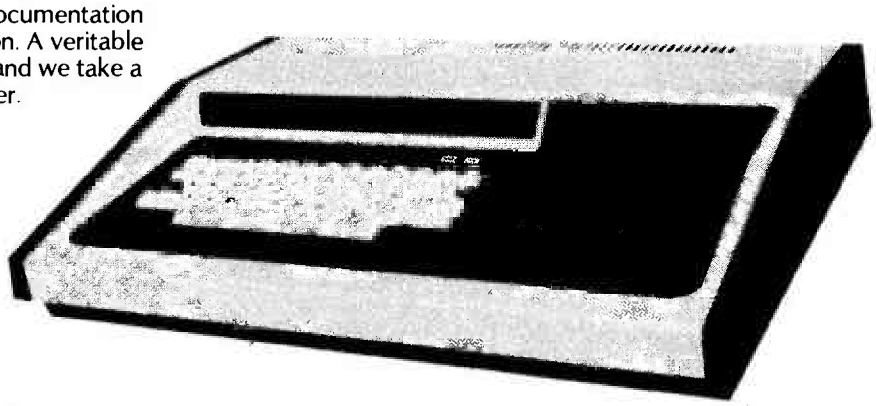

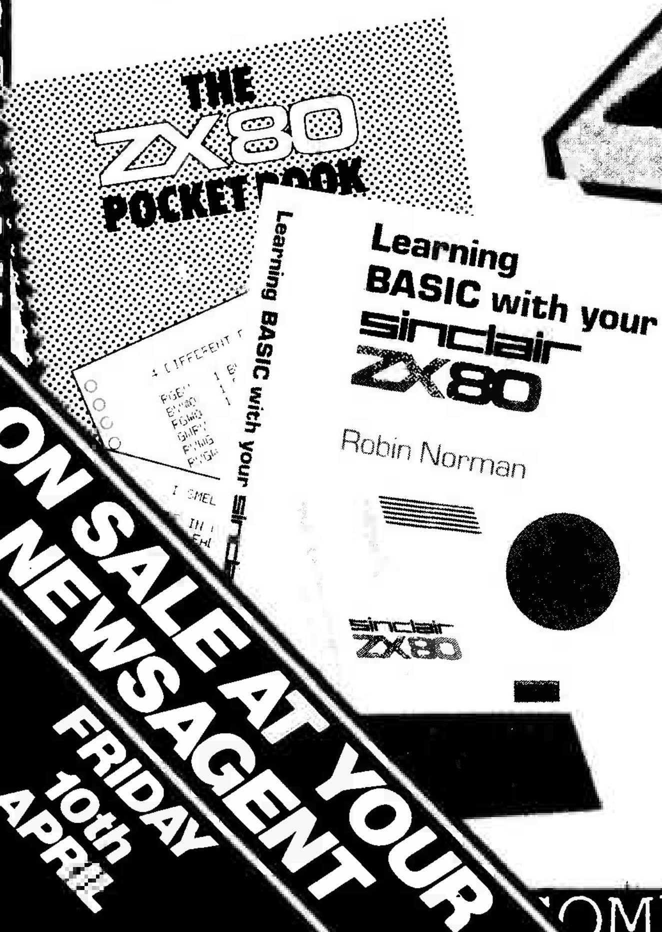

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Following in the footsteps of the successful TRS-80 came the Video Genie system. Now, however, it may well have taken a step or two ahead of its American cousin by going all multicoloured. We sent in our expert to have a look and his report on this low-cost colour graphics machine makes very interesting reading for anyone thinking of taking the Eastern path to computerisation.

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LS54	25p
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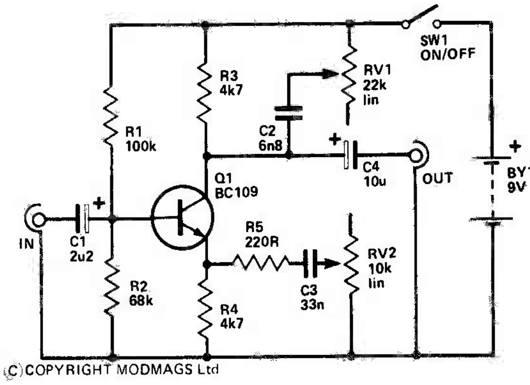
Guitar Treble Booster

This simple treble booster circuit can be used to give a more brilliant sound to an electric guitar and could possibly be of use with other instruments. Q1 is connected as a straightforward common emitter amplifier with R3 as the collector load, R4 as the emitter bias resistor and R1 plus R2 to provide base biasing. Although the voltage gain provided by a common emitter stage is normally quite high, this is not the case here, since the emitter bias resistor is not bypassed by a capacitor. As R3 and R4 have the same value, the voltage gain of the circuit is approximately unity.

In fact there is an emitter bypass capacitor (C3), but this has a low value and is in series with R5 and RV2. With RV2 at maximum resistance the effect of C3 on the response of the unit is minimal and for practical purposes the degree of treble boost applied is of no significance. If RV2 is adjusted for lower resistance, C3 has more effect and begins to produce a significant amount of treble boost. The boost is only produced at higher frequencies incidentally, due to the low value of C3 and its consequent high impedance ineffectiveness at low frequencies. With RV2 at minimum resistance the response starts to rise at about 800 Hz and reaches a maximum degree of boost of about 26 dB at frequencies of around 10 kHz or more. R5 limits the degree of high frequency boost and this is necessary in the interest of low noise and good stability.

The full degree of boost at the highest audio frequencies may give a sound that is too harsh for some tastes and so RV1 and C2 have been included in the circuit. With RV1 at maximum resistance these do not have any significant effect on the unit, but at lower resistance settings the high frequency response becomes flattened off and towards minimum resistance the response turns over at frequencies above about 8 kHz. RV1 and RV2, therefore, give considerable control over the treble boost and enable the response to be tailored to suit individual tastes.



Simple MW Radio

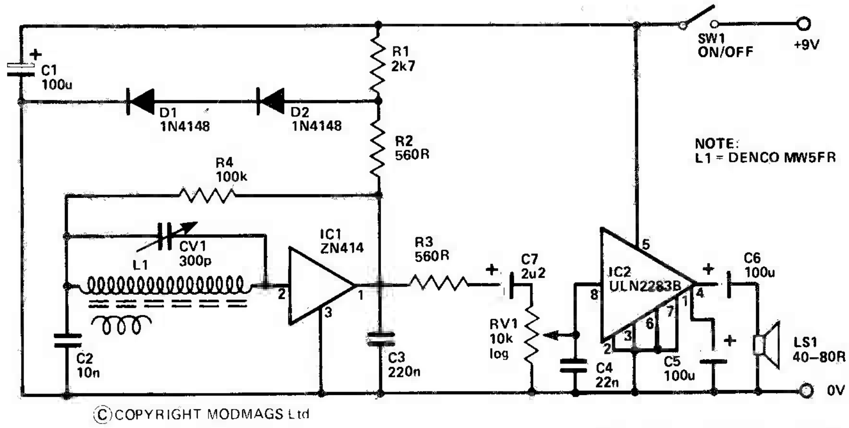
This simple medium wave broadcast receiver has an output power of up to about 150 mW RMS for an internal high impedance loudspeaker and is based on two ICs. The familiar ZN414 is used to provide the RF amplifier, detector and AGC functions, while a ULN2283B device is used as the audio power amplifier.

The circuitry around IC1 is quite straightforward with D1, D2 and R1 being used as a shunt stabiliser, which gives the required operating voltage of 1V2 to 1V3 for IC1. CV1 is the tuning control and L1 is the tuned winding of the ferrite aerial. The ZN414 has a high input impedance which renders the low impedance coupling winding on the ferrite aerial unnecessary. This can either be ignored or it can be carefully removed from the aerial, if preferred.

RF filtering at the output of IC1 is provided by C3, R3 and C4. Effective RF filtering is essential as a small amount of RF leakage into the input of audio amplifier IC2 would almost certainly be sufficient to cause severe instability in the circuit as a whole. RV1 is the volume control and is also used to bias the input of IC2. C5 decouples the supply to the input stages of IC2 and helps to prevent low frequency instability due to feedback through the supply lines. C6 couples the output of IC2 to the loudspeaker.

IC1 provides an audio output signal of 25-30 mV RMS on reasonably strong signals. The voltage gain of IC2 is set at a nominal figure of 43 dB (about 140 times) by an internal negative feedback circuit and this is, therefore, well matched to the signal level provided by IC1.

The quiescent current consumption of the circuit is typically about 15 mA, but as IC2 has a class AB output stage, the current consumption rises somewhat (to a maximum average level of about 25 mA) at higher volume settings. The ULN2283B device used in the IC2 position is available from Ambit International.



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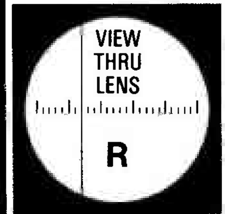

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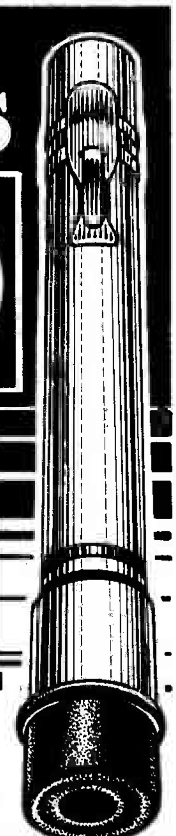

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7473	34p	–	–
7474	28p	32p	36p
7475	28p	–	–
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74157	60p	65p	–
74161	90p	–	–
74163	80p	–	–
74164	120p	110p	–
74166	120p	–	–
74170	235p	–	–
74172	445p	–	–
74173	110p	–	–
74174	85p	–	–
74175	80p	100p	–
74180	92p	–	–
74181	150p	–	–
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74190	85p	–	–
74191	85p	–	–
74193	85p	95p	–
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74197	75p	–	–
74198	140p	–	–
74241	150p	–	–
74266	–	95p	–
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18	18p	14	30p
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2N2646	45p	BC148	7p	BC338	14p
2N2904	23p	BC149	7p	BC348	15p
2N2906	23p	BC157	8p	BC547	12p
2N2926	7p	BC159	10p	BC548	8p
2N3053	25p	BC167	10p	BC549	9p
2N3055H	60p	BC170	10p	BCY33A	120p
2N3440	60p	BC170A	11p	BD242C	80p
2N3442	120p	BC170C	12p	BF258	35p
2N3702	8p	BC171	10p	BFT60	28p
2N3703	8p	BC171A	11p	BFW22	20p
2N3704	8p	BC172A	10p	BFY50	28p
2N3771	150p	BC172B	10p	MJ1000	95p
2N3906	15p	BC172C	10p	MJ4030	225p
2N4304	20p	BC172	10p	MPU131	25p
2N4351	50p	BC173C	10p	TIP29	40p
2N4352	50p	BC174B	10p	TIP29A	30p
2N5447	10p	BC182L	10p	TIP30A	42p
2N5449	12p	BC207B	15p	TIP31	26p
2N5943	55p	BC212L	8p	ZTX108	8p
2N6385	125p	BC213A	8p	ZTX314	20p
ACY19	75p	BC250A	12p		
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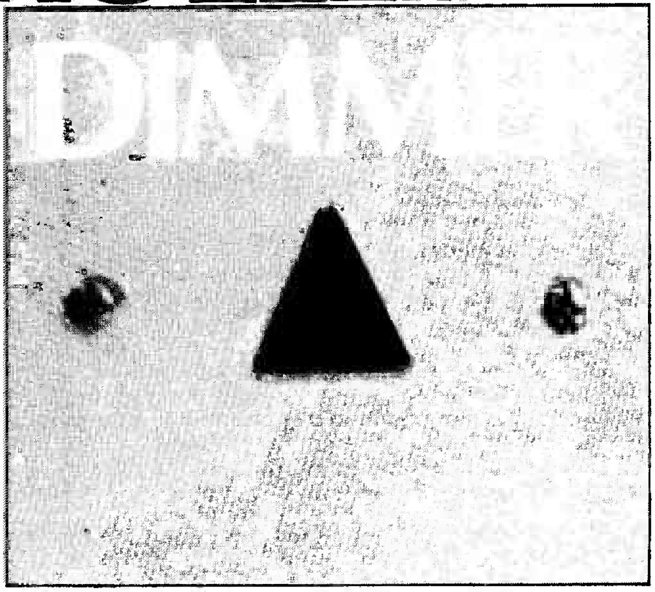


This smart lamp dimmer can be controlled directly by the built-in touch pad or remotely with the five-channel transmitter unit described elsewhere in this issue. Design by Ray Marston. Development by Plamen Pazov.

This sophisticated little touch dimmer is an updated version of the programmable touch dimmer described in the April '80 issue of ETI, in that this new unit can be controlled either directly by a touch pad fitted to the unit or remotely with a press button on the transmitter of the five channel remote control system described elsewhere in this issue; the new dimmer can thus be remote-controlled from the comfort of an armchair, etc. The 'five channel' system can, in fact, independently control two of these dimmer units. Each dimmer can power any lamp load up to 300 W.

The dimmer is 'smart' in that it has built-in logic and sensing networks that enable the unit to be turned on or off or dimmed up or down by using a single touch pad or remote-control button. If the pad (or switch) is simply touched for a brief period (60 to 400 mS) the lamp merely changes state, ie, from off to on, or vice versa, depending on the previous state.

A longer touch (greater than 400 mS) causes the lamp brilliance to cycle slowly from dim to bright or vice versa for the duration of the touch, taking about 7 S to span the full brilliance range: when the touch is removed the prevailing brilliance level is latched into memory and maintained indefinitely. At switch-off (a brief touch) the prevailing brightness level remains in store and is automatically resumed again at switch-on (another brief touch). In the case of dimming, control starts from the stored value.

Remote Control

The dimmer can be controlled locally by the touch pad or remotely using the infra-red remote controller. In either case, the dimmer works in the OR mode, so that alternate operation is directly available. The remote control system has a maximum range (from transmitter to receiver) of about 10 m; the remote control facility can be implemented by a pair or wires taken to the dimmer from one of the decoder outputs of the remote control system. These wires pass only a few milliamps from a 12 V source and can easily be concealed in a slot made in the wall plaster. The wires connect to an opto-isolator built into the dimmer unit and this isolator ensure that the wires have several kilovolts of mains isolation, thereby ensuring a very high safety factor.

Construction

Our prototype is designed to fit into a standard plaster-depth lighting switch box. Before starting construction, check the project's suitability to your existing wiring by making an accurate cardboard cut-out of the PCB and checking that it will fit comfortably into your existing lighting switch box. If not, you'll need to fit a new (modern) box. If all is well you can proceed with the construction.

Construction calls for a certain amount of care. Note that the S556B IC is a special-purpose touch dimmer device manufactured by Siemens and must not be confused with the similarly numbered NE566N VCO IC. On our prototype we've mounted the S566B and the 6 pin opto-isolator IC in a single 16 pin DIL socket. Triac SCR1 is fitted with a small heatsink, made from a piece of scrap aluminium; ensure that this heatsink will not foul the lighting switch box when the dimmer unit is fitted into place. Note that two Veropins are fitted to the PCB to provide the remote-control connections. Connections to the mains live terminal and the lamp load are made via a two-way screw terminal strip mounted on the PCB.

Blank Checks

When construction is complete, connect the unit to the mains via a lamp load in accordance with the circuit diagram and the overlay and give the unit a functional check, using the touch pad point at the centre of the PCB. Check that the unit dims and turns on and off as already described. Also check that it does not cause excessive interference on your radio set; if ex- ➔

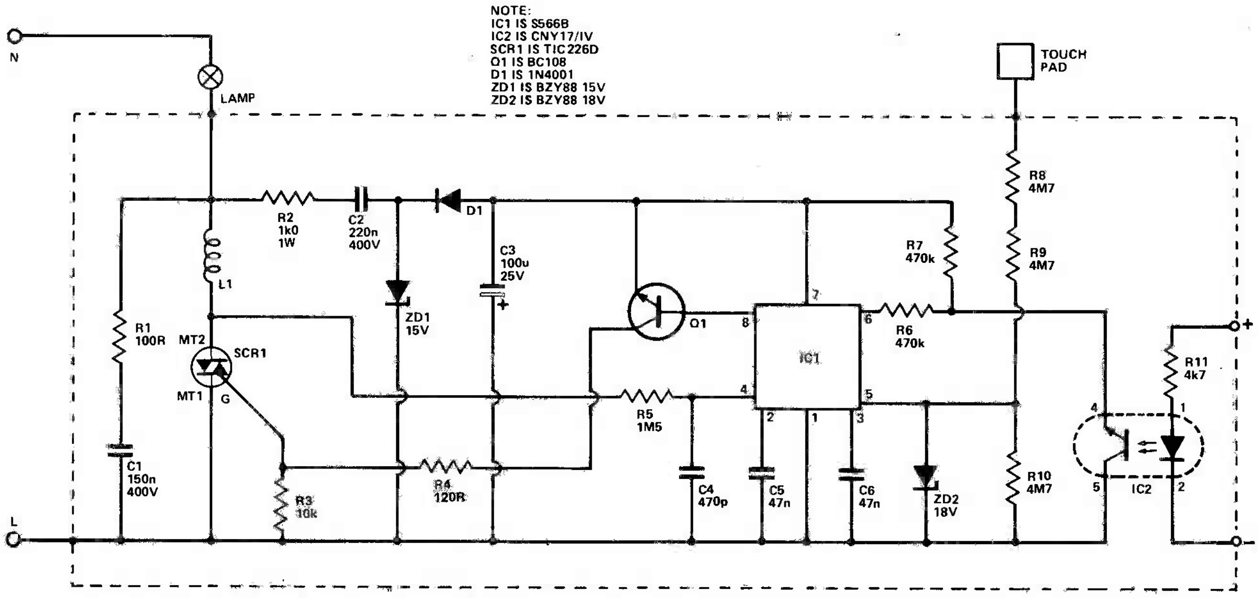


Fig.1 Circuit diagram.

HOW IT WORKS

The 'intelligent' action of the circuit is carried out in special-purpose PMOS integrated circuit IC1. This chip receives instructions from a touch-pad or a touch 'switch'. It processes the input touch-duration information and then sends (or does not send) appropriate gate drive pulses to triac SCR1 via pin 8 and current-boosting transistor Q1.

If IC1 decides that the lamp should be switched on it sends one 30 uS, 100 mA gate pulse to the triac in each mains half cycle (every 10 mS), at some phase-delayed time after the start (zero-crossing point) of each half cycle. The magnitude of the phase delay determines the brilliance of the lamp. If the triac is triggered shortly after the start of each half cycle (short delay) the lamp burns brightly: if it is triggered near the end of each half cycle (long delay) the lamp burns dimly. The maximum and minimum phase delays are limited to 150° and 30° respectively, enabling the lamp power to be varied from roughly 3% to 97% of maximum by the triac.

Although IC1 and Q1 generate relatively high peak drive power (1 W2), their mean power dissipation is very low (about 12 mW). This power is derived from the mains via R2-C2-ZD1-D1 and C3 and is delivered to IC1 and Q1 as a smooth 14 V DC from reservoir capacitor C3. This method of operation is only made possible by the fact that the triac is not gated on until at least 30° after the start of each half cycle, thereby enabling C3 to attain and maintain a virtually full 14 V charge throughout each half cycle. The IC logic operation is synchronised to the zero-crossing points of the mains signal by the R5-C4 network.

Touch information can be fed to either pin 5 or pin 6 of IC1. The pin 5 input is intended for genuine touch contact use and works on the high-impedance hum-pickup principle. The touch pad is effectively connected to the mains live terminal via high-value resistors R8-R9-R10, which limit the touch pad current to safe and minimal levels. ZD2 limits the pin 5 hum signal amplitudes to safe values.

The pin 6 input is intended for use with push-button switches connected between the mains live terminal and the junction of R6-R7. In our circuit the built-in transistor of opto-isolator IC2 is used in place of a conventional push-button and can be activated by one of the non-latching decoder outputs of our five-channel remote control-system.

The dimmer can be used with lamp loads up to 300 W, this limitation being imposed by the heat dissipation of triac SCR1. L1, R1 and C1 are RFI-suppression components.

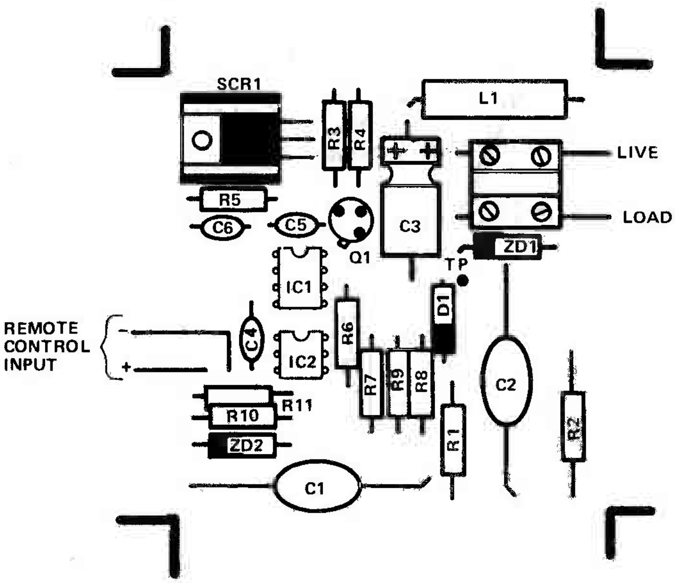


Fig.2 Component overlay for the touch dimmer.

PARTS LIST

Resistors (all ¼ W 5% unless otherwise stated)

R1	100R
R2	1k0 1 W
R3	10k
R4	120R
R5	1M5
R6,7	470k
R8,9,10	4M7

Capacitors

C1	150n 400 V polyester
C2	220n 400 V polyester
C3	100u 25 V axial electrolytic
C4	470p ceramic
C5,6	470n polyester

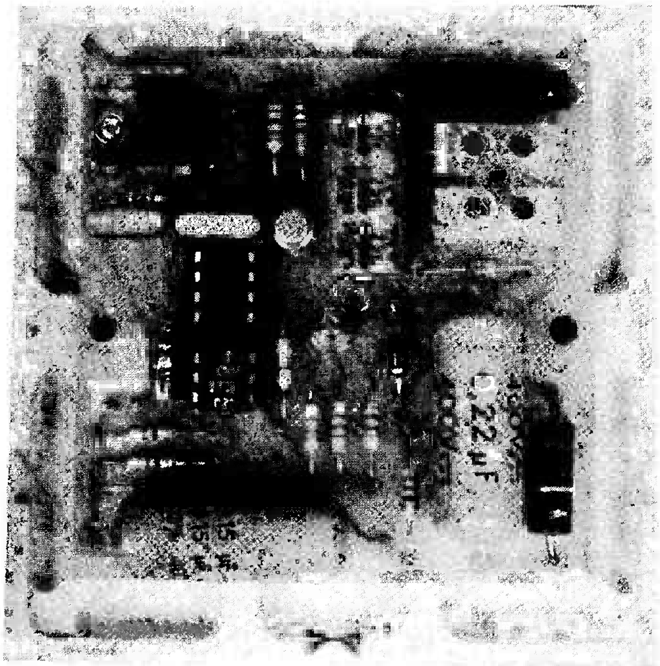
Semiconductors

IC1	S566B
IC2	CNY17/IV
SCR1	TIC226D
Q1	BC108
D1	1N4001
ZD1	BZY88 15V zener
ZD2	BZY88 18 V zener

Miscellaneous

L1	3 A suppressor choke (ref. TV3C)

MK blanking plate, touch plate, 2-way terminal block.



Component-side view of the PCB. Note the small heatsink on the triac and the small size of the high-voltage capacitors. The PCB is secured by the central fixing bolt.

cessive interference is experienced, try reducing the value of R1 to 47R. To check the remote control facility, use a push button switch to connect a 9-12 V DC supply to the terminals, observing the polarity shown.

When you are satisfied that the unit is operating correctly you can fit the PCB and the touch pad (see Buylines) to a standard blanking plate (available from your local electrical shop) as shown in the photos. The plate is provided with a central 'knock-out' hole. Open the hole, push the touch pad through the plate hole and the central hole in the PCB and bolt the two units firmly together, using a pair of nuts and washers (one on either side of the PCB) fitted to the screwed thread of the touch pad; a certain amount of fiddling may be necessary to ensure a firm fitting. Check that the holes on either side of the PCB line up with the securing holes in the blanking plate.

When you finally fit the completed unit into its switch box take care to ensure that no shorts occur. To play really safe, you can cover the inside of the box and the SCR1 heatsink with insulation tape at vulnerable points. You can bury the remote-control wires in a groove made in the plaster, taking the connections to the dimmer through one of several knock-out holes provided in the switch box. The other end of the wires goes to one of the non-latching outputs of the remote-control decoder.

BUYLINES

This project uses a few hard-to-get parts. Electrovalue can supply IC1, IC2 and the choke. Watford can supply IC1, SCR1 and the anodised touch plate. All other components should be readily available, but ensure that the capacitors are reasonably small types.

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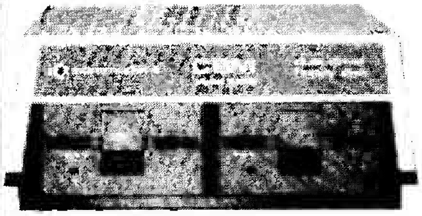

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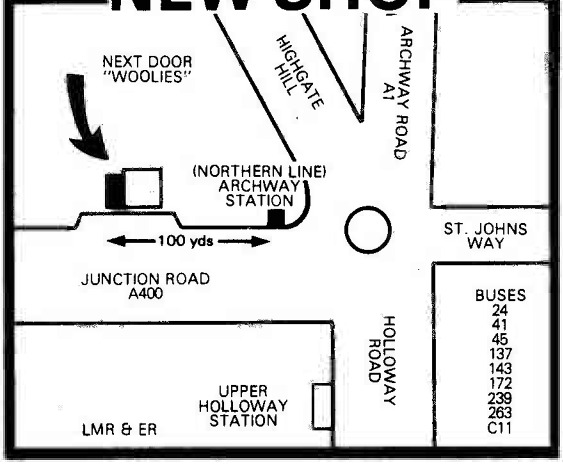

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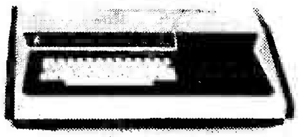

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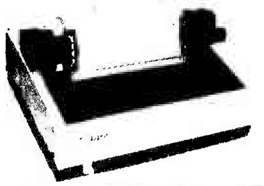

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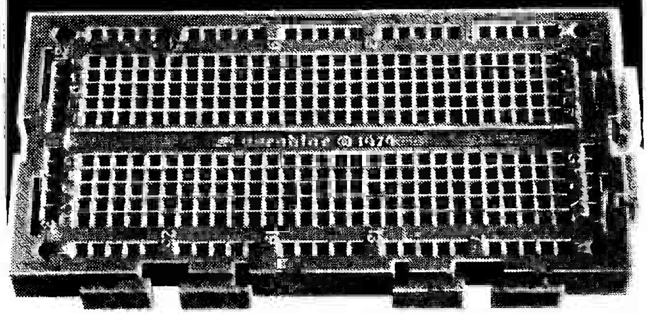

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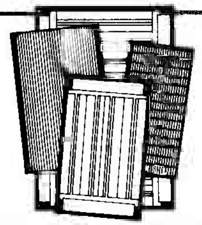

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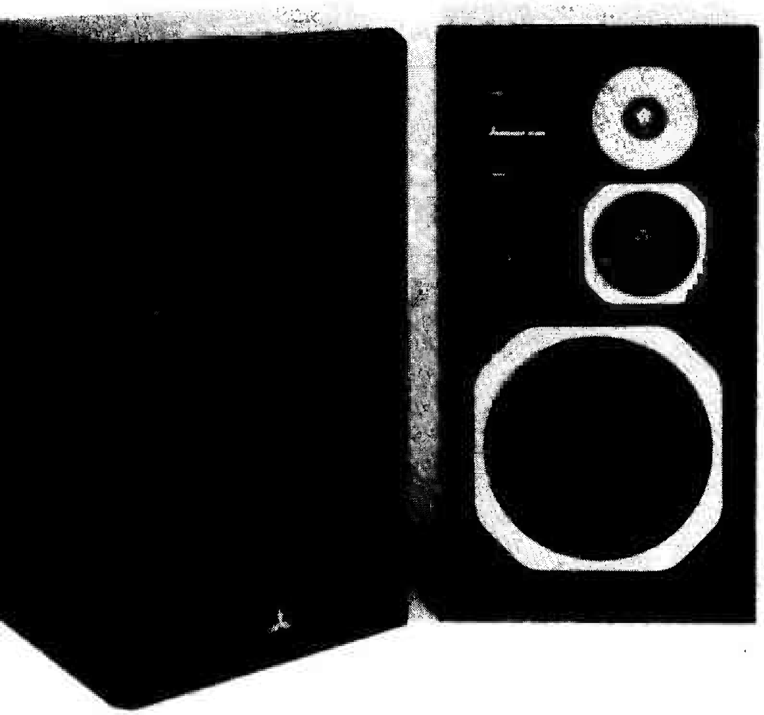


We begin this month with a review of the Mitsubishi DS-32B, a £250 speaker from the land of the rising yen. Loudspeakers remain the one significant area of hi-fi which the Oriental production machine has — so far — failed to dominate.

Only the Yamaha NS1000 and the Sony G1 have achieved any sort of acclaim in England's green and pleasant land, despite recent spending to engineer a "European Sound". The DS-32B is the Mitsubishi attempt to redress that balance.

It is a three-unit bass reflex design, claimed to handle 120 W of amplifier power and constructed to a very high standard indeed. The enclosures are supplied in stereo pairs (offset drive unit) with level controls fitted to the cone mid-range unit and the titanium tweeters.

Magnetic Personality

Mitsubishi make great play of the magnets used on their units, claiming to have developed a new ferro-nickel alloy for the woofer. Basically, what it actually comes down to is that strong magnets with high field strength and a 'long' gap have been employed to ensure linearity on high cone excursions.

The level controls are positioned on the front panel behind the grille and offer three positions of adjustment to the user. First reactions of the suspicious British will undoubtedly be to turn down the treble control.

The second will be to put it back again.

These units show none of their earlier Eastern brethren's tendency to cut through anything in their path with a sword-edged treble. If anything, Mitsubishi have over-compensated a little.

At approx 24 x 12 x 13 inches these speakers are not going to dominate the average living room, but they should be used on stands for best results — about 10-12 inches clear of the carpet will put the tweeter nicely at ear level and free the bass reponse remarkably. Connection is simple, as the speaker uses those 'push-clamp' terminals, which bite into the lead once released. Not as useful as screw terminals, but a universe ahead of the dreaded DIN.

Tested Responses

The DS-32B should not prove a difficult load to drive, as the impedance did not fall below 4R at any point in the frequency spectrum. Second order filters are used in the crossover networks, giving a 12 dB/oct roll-off, centred on frequencies of 800 Hz and 5 kHz. The unit changeover was smooth, with no attendant irregularities in the frequency response of the speaker as a whole.

The titanium tweeter gave a particularly fine account of itself, exhibiting a smooth and extended performance with excellent dispersion — the offset arrangement means that 'lobes' are created in the dispersion pattern of a stereo pair, thus creating a better field around a central listening position.

For listening tests the DS-32Bs were set up — on stands — next to my reference speakers, the KEF 105 II. Obviously no attempt at direct comparison can be made, but it is important when auditioning, loudspeakers in particular, to have a standard available for comparision.

Ear Lies The Rub

Overall the DS-32B gave a very creditable performance. The balance tends to be a little 'warm' and the mid-range is slightly recessed in the 1 kHz-3 kHz region. Whilst this does take any hint of an 'edge' off the sound it lends a slightly unreal smoothness to the sound. I found I was turning *up* the mid-range unit to restore the balance. For the size of cabinet the bass response is very good, with nice definition of the instruments. The cut-off is sharp at the bottom end and this would tend to enhance the clarity of an enclosure of this size, so this is no bad thing overall.

At the top of the spectrum, that metal tweeter is well integrated into the system and has a generally good performance. It can sometimes add a little uncertainty to high energy, high frequency material, but only sometimes and only to a degree which is very acceptable at its price.

Concluding Tones

Judged against the asking price, I feel the DS-32B is an excellent speaker. Its value for money rating *has* to be high, when you consider the quality of the finish and high degree of engineering present in the units.

The sound quality is competitive indeed and deserves a chance to compare itself against better known enclosures from this side of the channel. I can recommend the DS-32B and would suggest that anyone in the £200-£300 speaker market makes the effort to hear them before committing his money.

●

Moving Onto Coils

Moving coil cartridges have only recently descended into the mainstream of hi-fi. With that emergence has come an increase in the number of units which do not require a step-up device, thus reducing the cost.

The best known of these was probably the Ultimo 10X — 'was' because the model has now been replaced (by Dynavector) by the Mark 2. And this, by the sheerest of contrived coincidences is one of two high-output cartridges under test this month. The other is the Mayware MC3L, a fine-line stylus design from the 'Formula 4' people.

The output of these units is similar at around 2-3 mV, sufficient to drive most preamps and higher than many moving magnet designs. You can pick up the rest of the technical details from Table One. As the two cartridges are priced at approximately £65 and £55 respectively they are well within the financial reaches of 'mid-fi' buyers and offer an interesting alternative to other moving magnet cartridges in this price range.

The Ultimo End?

The 10X2 is an increased output version of its predecessor, but unusually in these days and ways, no price increase accompanies the model change. Indeed under the Dynavector exchange system, if you trade in your old unit it will generate a hefty discount on the price of a new 10X2. Therefore you could say the price has actually *fallen* for a change.

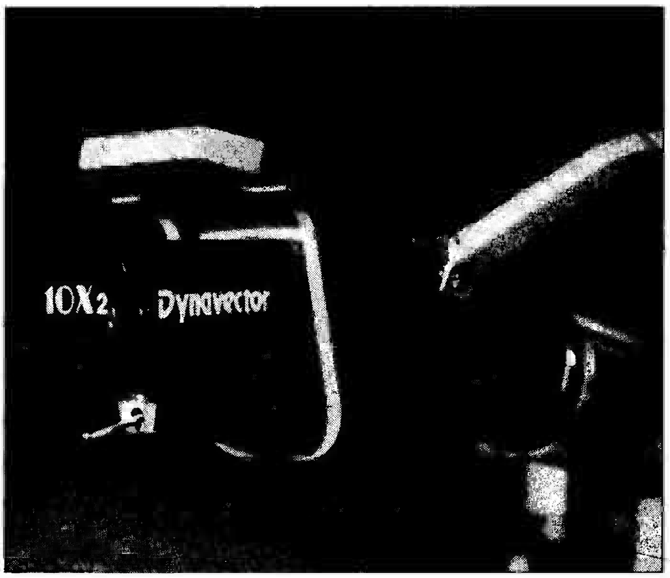
The cartridge is a low compliance design, at around 15 cu, and will this transmit more energy back into the arm than units such as the 900IGC and 600LAC which are possessed of more units in their compliances.

This means that the arm used will have to have a fairly high mass, to bring the combined resonant frequency to an acceptable frequency — above warps but below audibility — say between 10 Hz and 15 Hz. To test the 10X2 I used an AT1010 and an integrated turntable with mid-mass arm. In addition an SME Series III was used with its mass suitably raised to match the Dynavector.

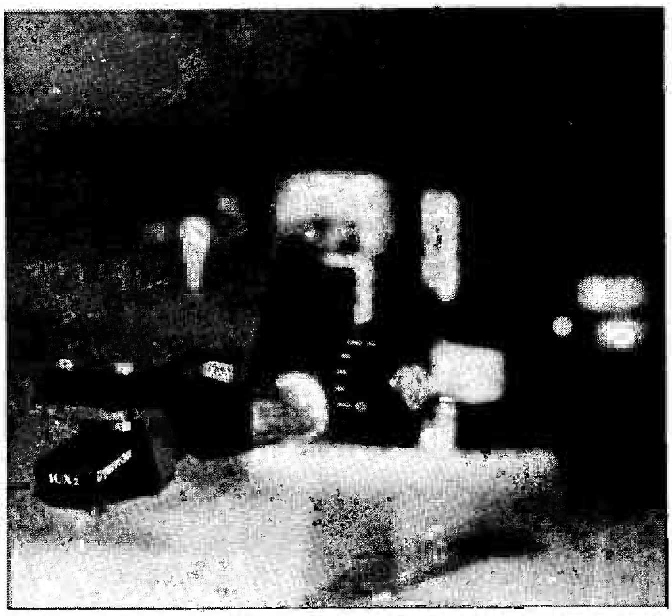
Because the SME is such a low mass design, it is possible to *add* mass to its effective value, in order to use low compliance pick-ups. Any readers out there who wish to know more details of this can write to SME for information sheet No. 24. Tell them ETI sent you!

Good Public Image

The 10X2 is startling to see in the end of *any* arm, having retained that transparent red plastic case, with a long cantilever and rigid mounting bracket. The disc clearance is substantial to say the least, and arm height should be carefully adjusted.



The 10X2 in close up. Note the massive fixing bracket and the "see-through" casing. Bright red too.



Fitted to an arm, on this the Dynavector, the 10X2 looks a little less imposing. It never looks anything less than striking, though!

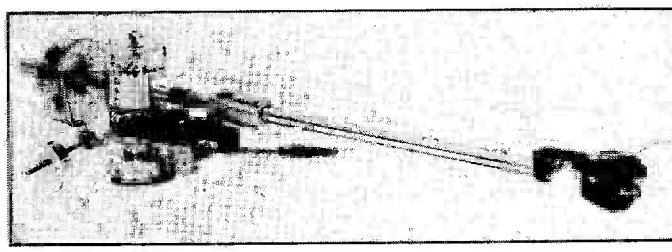
The sound is a distinct improvement on the already high standard of its earlier version. The balance is well struck between bass extension and detail in the low registers, and the imaging is nothing short of excellent. Treble quality is sweet and extended with very good detail rendition.

At the price the Dynavector offers very good value for money indeed, having most of the virtues of the more expensive moving coils and lacking their vice of price (!?) If I have any criticism at all of the 10X2 it is in that the low mid-range *can* sound a little constricted with some material, such as massed voices. It is a minor aberration.

A sound design then, well recommended, and with the advantages of (i) not needing a step-up device and (ii) a good trade-in deal on your old Ultimo if you're upgrading. ➔

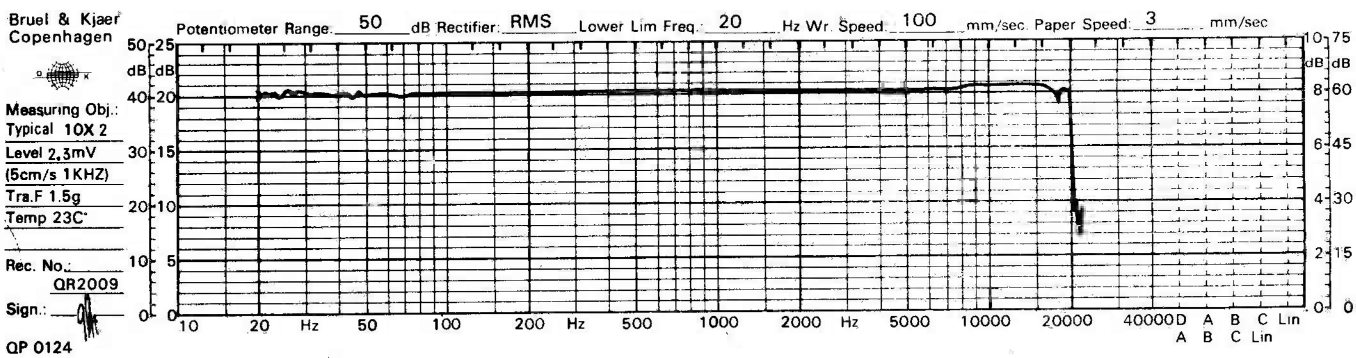
TABLE ONE

	MAYWARE MC3L	DYNAVECTOR DV10X2
Compliance (vertical-horizontal) (cm/dyne)	8×10^{-6}	15×10^{-6}
Output level (1 kHz/ 5 cm sec)	2.6 mV	2.4 mV
Stylus type	line contact	elliptical
Separation (5 kHz)	22 dB	24 dB
Freq response (20 Hz-20 kHz)	± 2 dB (see graph)	± 2 dB (see graph)
Optimum tracking weight	2 g	1.6 g
Weight	7 g	9.6 g
Typical price	£53	£68 (less with exchange)

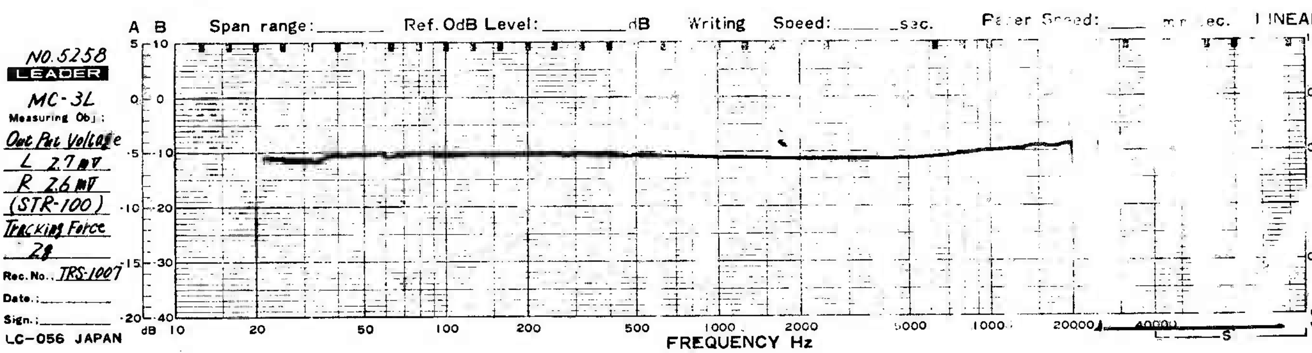


Above: the faithful Formula 4 pickup arm in which the cartridges were tried during listening tests. It is well suited to low compliance designs such as these, and gave good results.

Left: the lab test results for the MC3L and the 10X2 set out for comparison.



Above: the frequency response of the new Dynavector 10X2 pickup. Not a lot to comment on is there?



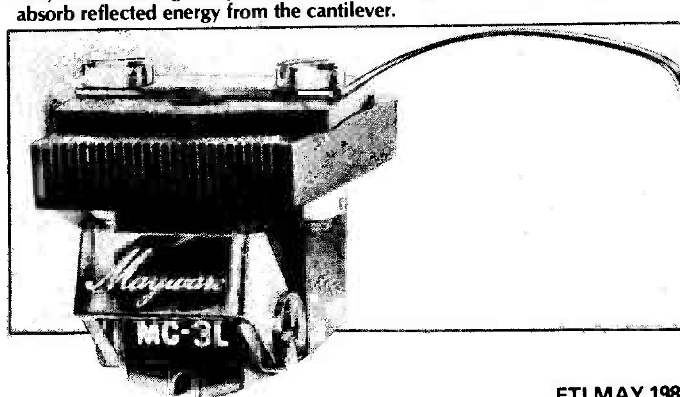
Above: measured frequency response of the Mayware MC3L moving coil cartridge.

Mayware Mayhap

The MC3L is the latest from Mayware, best known for their excellent Formula 4 pickup arm — now in its Mark 3 incarnation. Their previous pickup, the MC-2C, is a low device of high quality and so the DC3L is their next step in cartridge design.

Visually it is the opposite of the flamboyant Dynavector, being simple and black in appearance. The cartridge body is very sensibly shaped with a good large surface area to the top, which aids fixing to the arm. This means that the pickup as a whole will be better integrated, as it will inevitably be more rigid than it would with a smaller contact area between headshell and cartridge.

Mayware's new high-output moving coil cartridge. The body is designed to absorb reflected energy from the cantilever.



The compliance of this unit is very low indeed at 8 cu, a figure which I feel will limit the arm it can be employed with. For the purposes of review I managed to beg, steal and borrow a Formula 4 (an earlier model) and fitted the unit into it. Listening tests were mainly conducted with this assembly, although for interest and devilment I did fit the MC3L into my SME III, with maximum damping and highly modified effective mass to tune the resonance.

Testing Benches

On test the MC3L acquitted itself well, the frequency response in particular impressing with its high linearity and well maintained separation. Output measured at 2.6 mV per channel.

There was nothing at all to cause the slightest worry here, so I was able to move on happily to playing some music, expecting something pleasant in the light of the test results.

. . . And Ears

I was not disappointed. Initial impressions, later reinforced by continued use, were of a wealth of detail with fair bass extension and 'smooth-as-silk' treble. Mid-range is firm and weighty with good control of vocals — not always a strength of moving coil units. Overall the balance is full and rich with good imaging and better than average tracking ability. My only real quibble is with that lower-than-low compliance. It does limit the versatility of the MC3L considerably, which is a shame as it has the virtue to delight a wide audience.

Common Ground

These two cartridges have a lot in common, in that neither requires a step-up device, both are low compliance, both are sensibly priced and have that rendition of detail which makes moving coils such an attractive proposition. Few moving magnets (G900 IGC?) can equal them in this respect.

Each has its good and not-so-good points. The 10X2 handled bass energy a little better than the MC3L, but the Mayware leaves it for dead on vocal material where there is a deal of energy in the mid-range; opera in particular. Both sound very good indeed on most rock music and which is 'best' is really up to the purchaser. I shall refrain from choosing between the two — I liked them both!

●

Reference Point

The cartridge I used as a reference in the comparision was the Ortofon MC30 with the T30 transformer. It is priced right at the top-end of the market and makes an interesting counterpoint to this month's models. I was intending to run the review in this month's Audiophile, but I just haven't the space to do it justice — so I'm holding onto the verbiage until next month. With all the tales of wonders unveiled by such exotic groove followers as the Linn Asak and the Koetsu filling the printed page these days, the Ortofon appears to have been overlooked. This is unjust indeed . . . .

ETI

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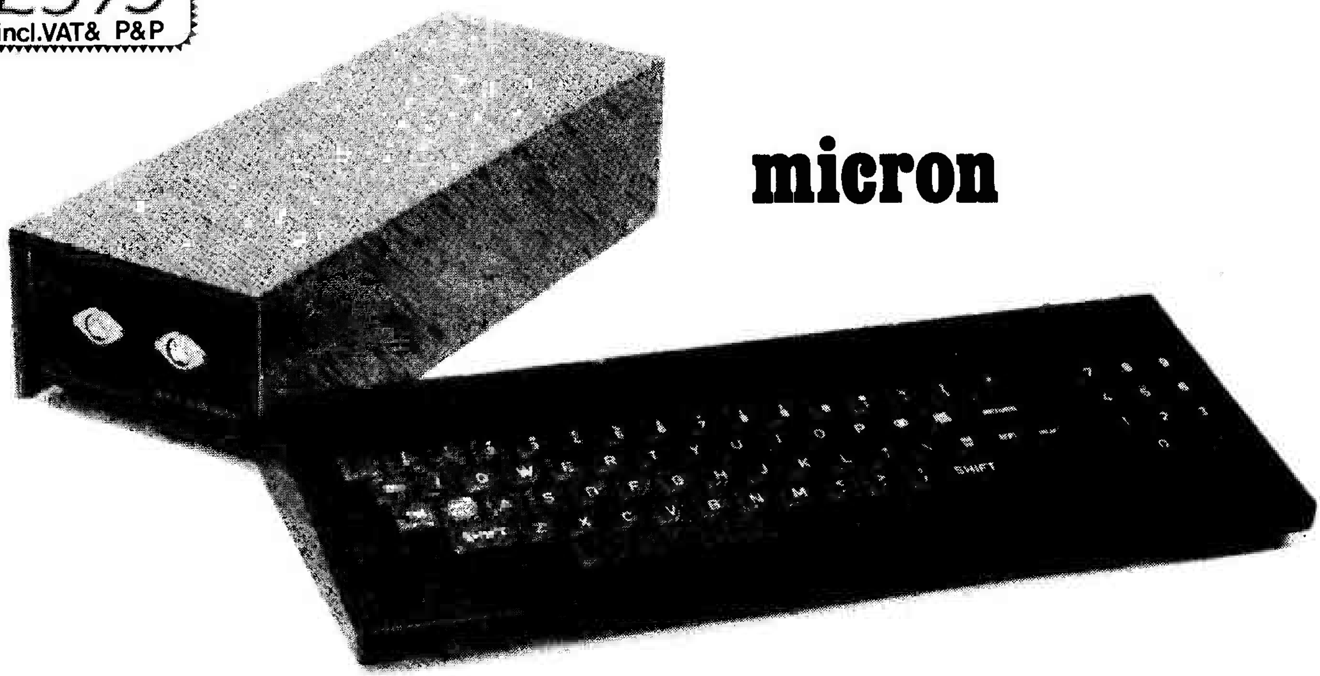

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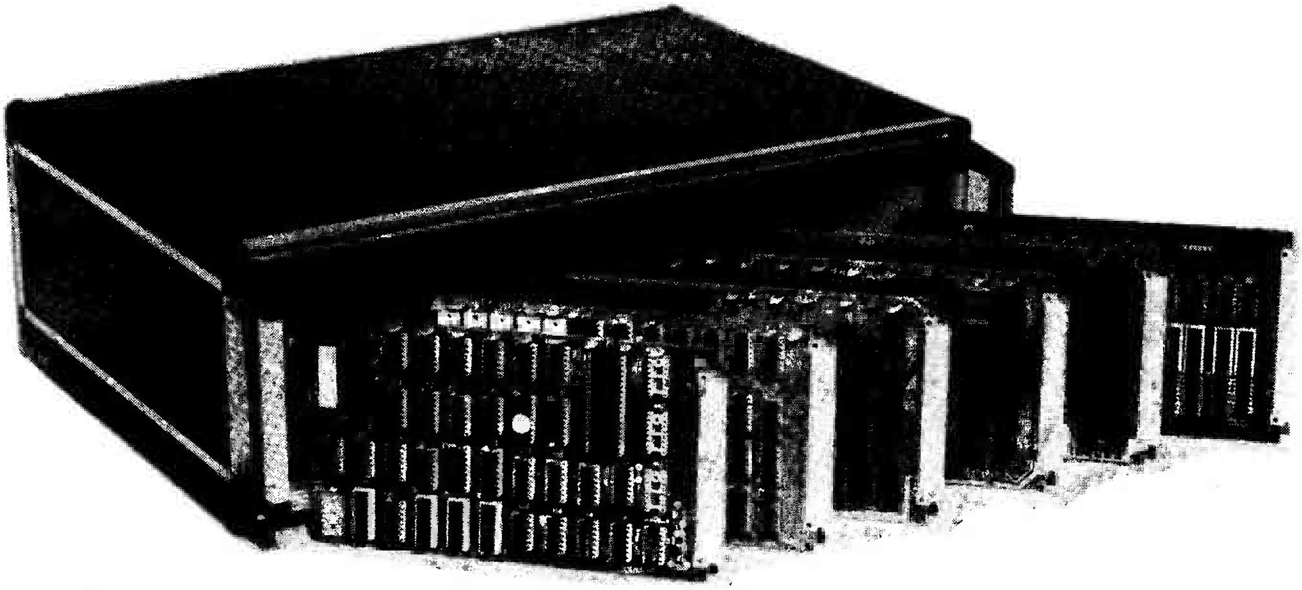

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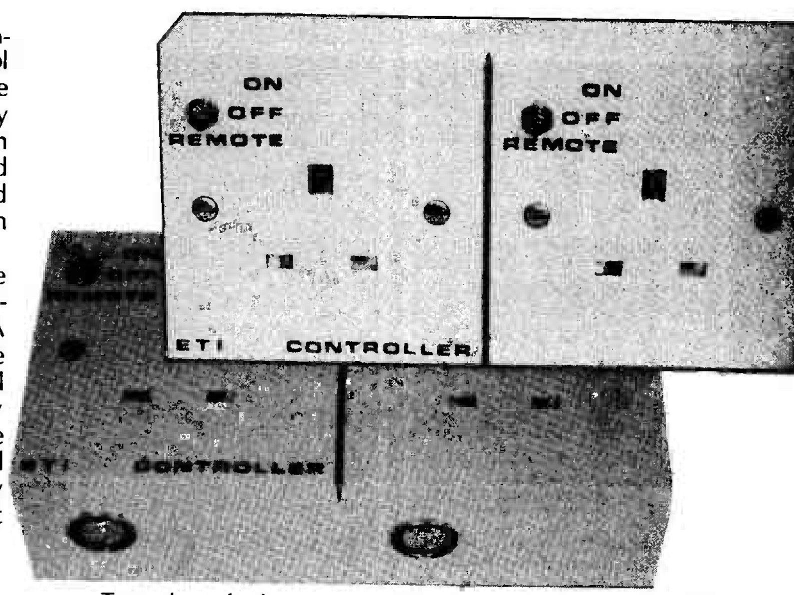
REMOTE-CONTROLLED POWER SWITCH

Designed to interface with the five-channel remote control system, this 5 A mains switch can be activated directly or with the remote control transmitter. Design by Ray Marston. Development by Plamen Pazov.

This project is a 5 A mains switch that is specifically designed to interface with the five-channel remote control system described elsewhere in this issue of ETI. When the interface is complete, the switch can be activated either directly by a built-in toggle switch or with a pair of control buttons on the infra-red transmitter. The switch can be remote-controlled at ranges up to 10 m and can be used to activate lamps, TVs and hi-fi systems, etc, from the comfort of an armchair. Three such switches can be controlled by the remote control system.

The power switch is designed to fit into standard surface mounting mains sockets: a single switch can be fitted in a standard stocket or two switches can be fitted in a double socket. A feature of the design is that the actual control input to the switch is made via an opto-coupler, which provides several kilovolts of mains isolation; an input current of only a few milliamps from a 9 V or greater supply is required to activate the switch in the remote mode. The switch is thus quite versatile and can, with a little ingenuity, be activated automatically by suitable sensor networks, such as those published in last month's ETI.



Construction

When building this project it must be noted that the PCB is designed to be used with a specific miniature type of relay (see Buylines) and that the board is fairly cramped, with all resistors and diodes mounted vertically on the PCB. The relay has two sets of contacts, which are wired in parallel; external connections to the relay are made using a vertically-mounted two-way terminal strip. All other connections are made using Veropins.

When constructing the unit, build up the PCB as shown, fitting the relay last of all, and fit the unit in one corner of the surface mounting box after first completing the interwiring to SW1, SK1 and SK2 (the mains output socket) in accordance with the circuit diagram.

Now fit the top plate/socket into place, complete the mains connections, connect SK1 to one of the latching outputs of the five-channel decoder and give the unit a functional test. Check that the switch can be turned on and off directly with SW1, and that it can be controlled remotely (using the five-channel transmitter) when SW1 is set to the remote position.

Note that SW1 should be fitted to the actual socket plate of the power switch and that socket SK1 (a DIN socket) should be fitted to the lower face of the surface mounting box.

To make a dual power switch unit, simply fit two identical units into a double surface mounting box, but use two single sockets.

HOW IT WORKS

Circuit operation is so simple that it is virtually self-evident. Q1 is used as a relay driver and the relay contacts are used to make or break the live mains connections to output socket SK2. Q1 can be activated either directly by SW1 or remotely via opto-coupler IC1 and one of the latching outputs of the decoder of the five-channel remote control system. The decoder also provides the relay-driving circuit with a 15 V DC supply.

When SW1 is set to the on position, Q1 and the relay are driven on via R2, and parallel-connected contacts RLA/1 and RLA/2 feed mains power to the load through SK2. When SW1 is set to the off position, no drive is fed to Q1 base, so Q1 and the relay are off and no power is fed to the load.

When SW1 is set to the remote position, opto-coupler IC1 is used to control the base drive to Q1. Q1 and the relay turn on when the control input (B) is fed with a logic 1 or high signal, or off when fed with a logic 0 or low signal: these signals are available from the output of the five-channel decoder and can be set with the remote control transmitter.

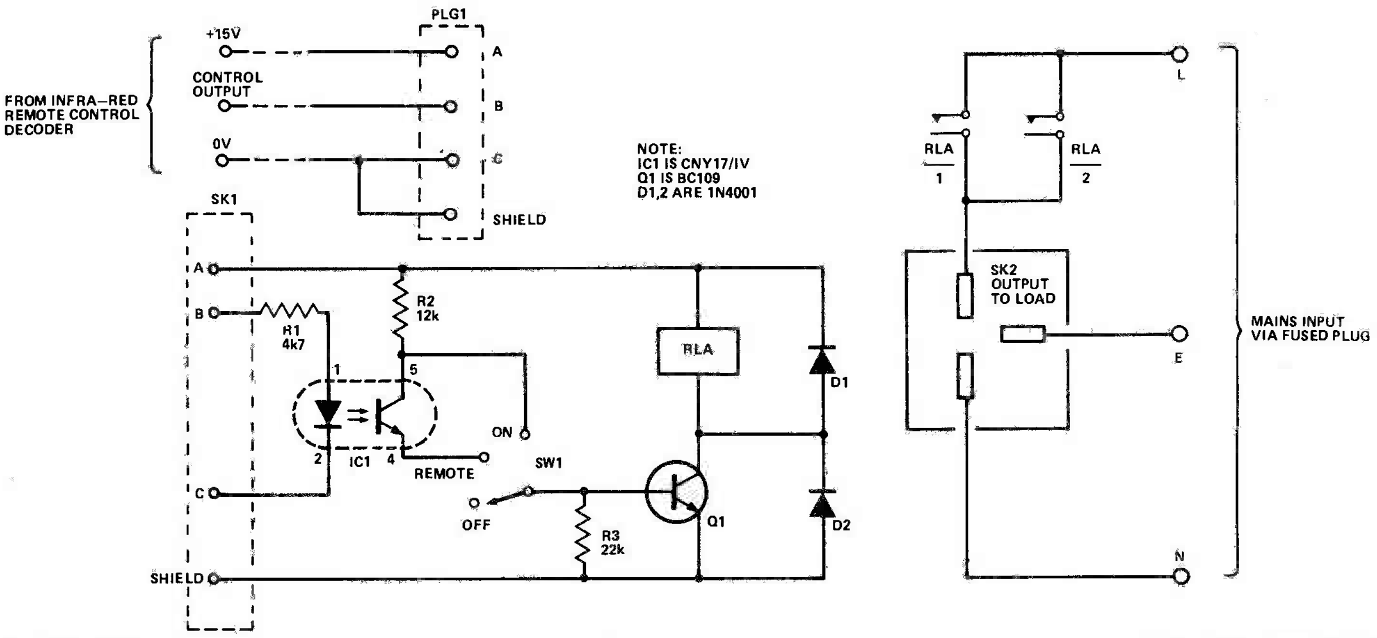


Fig.1 Circuit diagram.

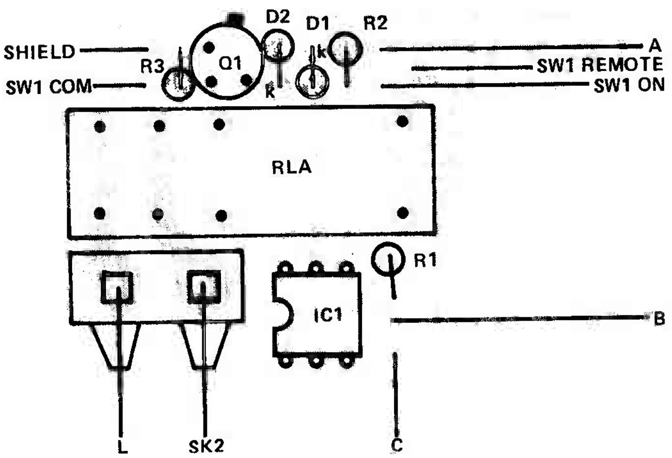


Fig.2 Component overlay. The terminal block is secured by tightening the lower pair of screws onto wires soldered to the PCB.

PARTS LIST

Resistors (all ¼ W, 5%)	
R1	4k7
R2	12k
R3	22k
Semiconductors	
IC1	CNY17/IV
Q1	BC109
D1,2	1N4001
Miscellaneous	
SW1	three-way toggle switch
SK1	three-pin DIN socket
SK2	surface-mounting mains socket
PLG1	three-pin DIN plug
RLA	12 V, coil > 120R, PCB-mounting, 5 A mains-rated contacts

BUYLINES

The relay is a miniature type for PCB-mounting and is available from Watford Electronics, ref. RL6. The CNY17/IV opto-coupler is available from Electrovalue.

Two internal views of the power switch, showing the interwiring. The mounting box is MK reference number 2025.

ETI

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All the advantages of the SLC without chase. Controls: bass/mid/treble/master sensitivity.

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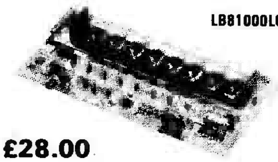

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An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswitch trigger and module cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

4 CHANNEL SEQUENCER

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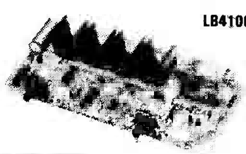

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1 AND 3 CHANNEL DIMMERS

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M – Magnetic
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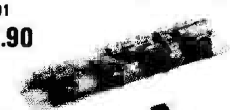
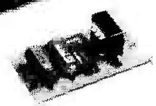


LBPSU1 **£7.20**



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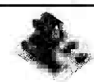
960B S/N	110DB S/N	110DB S/N	110DB S/N
LB25	LB100	LB150	LB250
£11.20	**£19.70**	**£29.20**	**£43.50**

Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering.



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3-0-3	200	238	**2.60**	.70
0.6, 0.6	1A 1A	212	**3.00**	.75
9-0-9	100	13	**2.30**	.70
0.9, 0.9	330 330	235	**2.15**	.70
0-8-9, 0-8-9	500 500	207	**2.75**	.75
0-8-9, 0-8-9	1A 1A	208	**3.85**	.75
0-15, 0-15	200 200	236	**2.15**	.70
0-20, 0-20	300 300	214	**2.75**	.90
20-12-0-12-20	700(DC)	221	**3.50**	.90
0-15-20, 0-15-20	1A 1A	206	**4.60**	1.05
0-15-27, 0-15-27	500 500	203	**4.05**	.85
0-15-27, 0-15-27	1A 1A	204	**6.10**	1.05

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Pri 220-240 Volts

Amps 12v	24V	Ref.	Price £	P&P
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1 0	0.5	213	**2.75**	.90
2	1	71	**3.25**	.90
4	2	18	**4.05**	.85
6	3	70	**5.60**	95
8	4	108	**7.40**	1 20
10	5	72	**8.25**	1.20
12	6	116	**8.85**	1.20
16	8	17	**10.85**	1.30
20	10	115	**13.85**	1.50
30	15	187	**16.85**	1.50
60	30	226	**33.35**	1 80

30 VOLT (Pri 220-240V)
Sec 0-12-15-20-24-30V

Amps	Ref. No.	Price £	P&P
0 5	112	**2.85**	.90
1 0	79	**3.60**	.90
2 0	3	**5.60**	1 05
3.0	20	**6.30**	1 20
4 0	21	**6.60**	1 20
5 0	51	**9.60**	1.20
6 0	117	**11.10**	1 20
8.0	88	**14.35**	1.50
10 0	89	**16.60**	1 50

50 VOLT (Pri: 220-240V)
Sec 0-19-25-33-40-50V

Amps	Ref. No.	Price £	P&P
0 5	102	**3.60**	90
1.0	103	**4.60**	1.05
2.0	104	**7.30**	1 20
3 0	105	**8.60**	1.20
4 0	106	**10.85**	1.30
6 0	107	**15.10**	1.50
8 0	118	**20.20**	1.70
10 0	119	**24.10**	2.20

60 VOLT (Pri 220-240)
Sec 0-24-30-40-48-60

Amps	Ref. No.	Price £	P&P
0 5	124	**3.85**	.90
1 0	126	**5.60**	1.05
2 0	127	**7.55**	1.20
3 0	125	**11.10**	1.30
4 0	123	**12.35**	1.50
5 0	40	**14.15**	1.60
6 0	120	**17.60**	1.60

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Input/Output Tapped 0-115-210-240V

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75	64	**4.10**	.90
150	4	**5.60**	1.05

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1000	84	**18.60**	1 60

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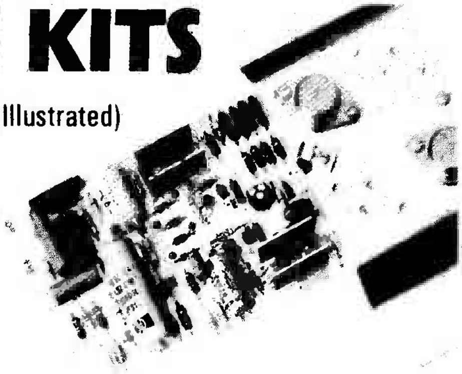

SPECIFICATIONS

Max. Output power	125 watt RMS
Operating voltage (DC)	50-80 Max.
Loads	4-16 ohms
Frequency response measured at 100 watts	25Hz-20KHz
Sensitivity for 100 watts	400mV @ 47K
Typical T.H.D. @ 50 watts 4 ohms load	0.1%
Dimensions	205 x 90 and 190 x 36 mm

The P.E. power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES

Suitable LS coupling electrolytic for 125W model **£1.00** plus 25p p&p

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Suitable Mains Power Supply Unit for 125W model **£7.50** plus £3 15 p&p.

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MULLARD LP1183 STEREO PREAMP

FREE!

Original listed price over £5.00. Suitable for ceramic and auxiliary inputs, when you purchase 2 power module kits.

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2 WAVE BAND MW LW
- Easy to build
- 5 push button tuning
- Modern styling design
- All new unused components
- 6 watt output
- Ready etched & punched P.C.B.
- Incorporates suppression circuits
- Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features. Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.

The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.

Complete with instructions. **£10.50** plus £2.00 p&p

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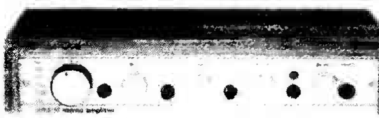

30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14¾" x 10" approx

READY TO PLAY **£32.90** plus £3.80 p&p

HI FI STEREO AMPLIFIER MODULES

- Mullard LP1183 built preamplifier suitable for ceramic and auxiliary inputs. £1.95 plus 70p p&p
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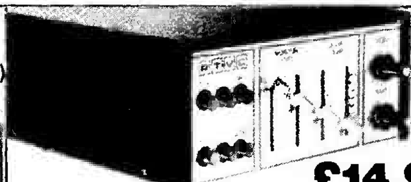
- Matching I.C. 10 + 10 Stereo Power amplifier kit. £3.95 plus £1.15 p&p
- Matching power supply kit with transformer. £3.00 plus £1.96 p&p
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes. £1.70 plus 80p p&p.
- Complete with application notes.



10+10 WATT STEREO AMPLIFIER KIT

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- Featuring latest SGS/ATES TDA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection.
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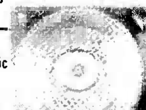
- Attractive black vinyl finish cabinet. Size 9" x 8⅜" x 3⅝" approx
- Converts to a 20 watt Disco amplifier.

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amplifier assembly kit and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs and contrasting ready made black vinyl finish cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit

SPECIFICATIONS

Suitable for 4 to 8 ohms speakers

Frequency response	40Hz — 20KHz
Input Sensitivity	P.U. 150mV Aux. 200mV Mic. 1.5mV
Tone controls	Bass ± 12db @ 60Hz
	Treble ± 12db @ 10KHz
Distortion	-1% typically @ 4 watts
Mains supply	220-250 volts 50Hz



BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge. **£8.50** plus £3.15 p&p when purchased with amplifier.
Available separately **£10.50** plus £3 16 p&p.

8" SPEAKER KIT 2 8" approx. twin cone domestic use speakers. **£4.75** per stereo pair plus £1.70 p&p when purchased with amplifier. Available separately **£6.75** plus £1.70 p&p.

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STEREO DISCO PREAMPLIFIER

matching above modules, suitable for twin deck mixing with P.F.L. output and Mic/Tape input.
Ready built, ready to play with circuit diagram and application notes to suit our power module kits. **£21.95** plus £1.72 p&p

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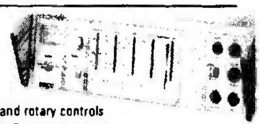

Brushed aluminium fascia and rotary controls. Size approx 14" x 4" x 10¼. Five vertical slide controls, master volume, tape leverl, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak. **£76.00** plus £4.60 p&p

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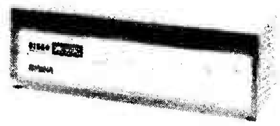
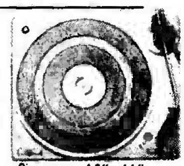
Size appox 13⅜" x 5¼" x 6¾". 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume



£30.60 plus £3.68 p&p

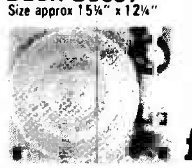


BSR Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco use.

£12.25 OUR PRICE plus £3.16 p&p Size approx 13" x 11"

PHILLIPS RECORD PLAYER DECK GC037

Size approx 15¼" x 12¼"



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TECH TIPS

555 VCO

J. Harrold, Bristol.

This circuit uses the 555 timer and a few external components to produce a simple low cost VCO, (not just pulse position modulation), and unlike other "cheap" VCOs does not require a MOSFET op-amp costing £1 or more to buffer the output up to a useful level.

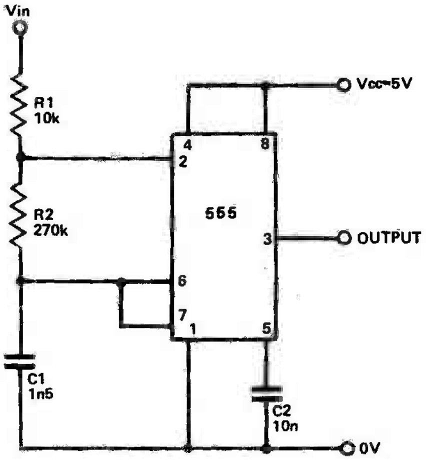
The 555 is basically connected in its astable mode, but instead of wiring the top of the timing chain R1, R2, C1 to V_{cc} it is connected to the input voltage V_{IN}. The mark/space ratio is set by R1, R2 in the usual way for the 555 and if R2 $\gg$ R1, it is unity. It should be remembered that pin 7 is grounded during part of the oscillation so R1 affects the current drawn from the input. The output (pin 3) of 555 can source or sink currents of up to 200 mA and so can drive TTL, CMOS or a high impedance loudspeaker directly. The frequency of oscillation f, in Hertz, is

$$\frac{1}{C1\,(R1 + 2R2)\ln\left[\dfrac{V_{IN} - V_{cc}/3}{V_{IN} - 2\,V_{cc}/3}\right]}$$

From this it can be seen that oscillation begins as V_{IN} rises above two-thirds V_{cc}, so for maximum frequency sweep V_{cc} should be as low as possible, ie 5 V. If R2 $\gg$ R1 so that R1 + 2.R2 $\sim$ 2.R2 then the frequency range depends on the time constant C1.R2 and with the component values shown the output varies fairly linearly from 2 kHz to 15 kHz as V_{IN} varies from 4 V to 12 V.

If the conditions R2 $\gg$ R1, V_{cc} = 5 V and V_{IN} > 4 V are satisfied, then

$$f \sim \frac{1}{C1R2}(V_{IN} \times 0.6 - 1.6)$$



If linearity is unimportant, the lower frequency limit can be substantially reduced (f = 0 when $V_{IN} < \frac{2}{3} V_{cc}$).

Capacitor C1 must be a low leakage type. The VCO output can also be modulated by applying a suitable signal to the control voltage (pin 5) of the 55.

Computer-controlled Synthesizer Keyboard

P. McChesney, Wirral.

The technique described here produces an accurate analogue voltage from a synthesizer keyboard by processing digital data and converting it to an analogue voltage, replacing the well-known method that uses resistor ladders. It is primarily aimed at people who already possess a microcomputer and who are building a synthesizer, either of their own design, or using published circuits such as those which have appeared in ETI. Although the technique described might at first sight appear both more elaborate and expensive than the resistor ladder method, it possesses three major advantages — firstly, the number of discrete components is small and although they need not be of high precision, only minimal setting-up is required to give high stability performance: secondly, software can be written to obtain a sequencer and also to produce special effects: thirdly, no substantial changes are required to make it polyphonic.

Figure 1 shows a diagram of the monophonic design. The keyboard uses a diode matrix such that when one key is pressed, a binary code is produced on the six-bit data bus. This code is linear (for example, if the fourteenth key is pressed, then binary 14 is produced) and of negative logic. It is therefore inverted either by using inverters as shown, or by writing software to perform the same task. The code then goes to the microcomputer (which, in the case of the author, is 6800-based but could have been any microcomputer) which continually checks the data received. If the code is zero, then the computer goes back and checks the code again and continues to do this until a code other than zero is received. Once this happens, the computer searches a look-up table and outputs a corresponding eight-bit code which is passed to a D-to-A converter. The data in the look-up table follows a log-law and so the analogue output of the DAC likewise follows the log-law. This means that the VCO is linear, thereby making it both simpler and more accurate.

The strobe is optional and serves to prevent stray codes being generated if two keys are pressed simultaneously. Figure 2 shows the arrangement of resistors (tolerance not important) in the strobe. Each switch shown is the spare pole on the keyboard contact. Point X is at V_{cc} when no key is pressed, at 0.5 V_{cc} when one key is pressed and at 0.33 V_{cc} when two keys are pressed, etc. A window discriminator is used to distinguish the case when only one key is pressed (monophonic operation). The output of the discriminator is adjusted to match the TTL levels required by the microcomputer input and the program is

**Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.
ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. 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.**

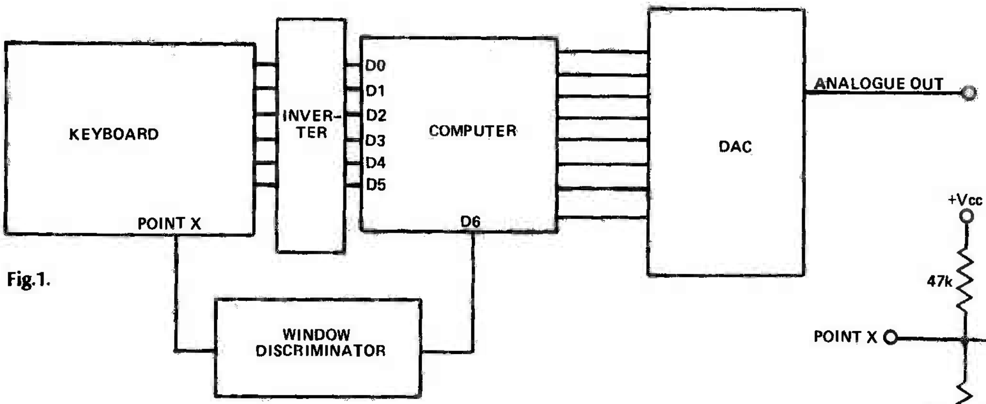


Fig.1.

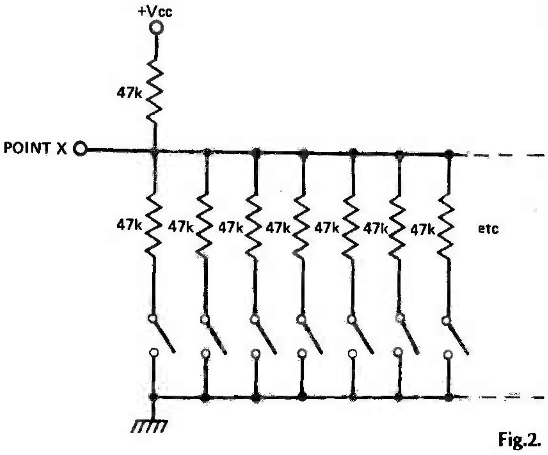
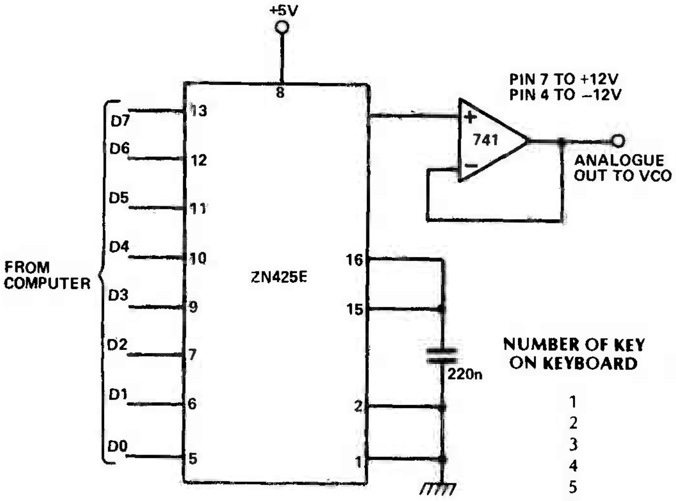


Fig.2.



written such that the code from the keyboard is ignored when the discriminator shows that more than one key has been pressed.

The look-up table of the microcomputer already referred to is given in Table 1. The first column gives the number of the key on the four-octave keyboard, the second column shows the binary number (positive logic) produced by the keys, whilst the third column shows the corresponding output number. Depending on the aural sensitivity of the listener, it is possible that at the bottom of the scale, one or two notes might sound slightly off-key due to inaccuracies of about 1.7%. To be undetectable, the note error should ideally be ±0.5% but this is only obtainable using the 12-bit code given in Table 2. Unfortunately, outputting a 12-bit code would require the use of latches on the microcomputer output (which is normally eight bits wide), and also a 12-bit D-to-A converter which could be obtained by using two eight-bit DACs, scaling the output of one by 256 to give the correct weighting and then adding the two outputs together. However, for most applications the eight-bit code given in Table 1 is quite sufficient and has the advantage of requiring only one DAC.

TABLE 1

NUMBER OF KEY ON KEYBOARD	SIX-BIT KEY CODE	EIGHT-BIT OUTPUT CODE
1	000001	00010001
2	000010	00010010
3	000011	00010011
4	000100	00010100
5	000101	00010101
6	000110	00010111
7	000111	00011000
8	001000	00011001
9	001001	00011011
10	001010	00011101
11	001011	00011110
12	001100	00100000
13	001101	00100010
14	001110	00100100
15	001111	00100110
16	010000	00101000
17	010001	00101011
18	010010	00101101
19	010011	00110000
20	010100	00110011
21	010101	00110110
22	010110	00111001
23	010111	00111100
24	011000	01000000
25	011001	01000100
26	011010	01001000
27	011011	01001100
28	011100	01010001
29	011101	01010101
30	011110	01011011
31	011111	01100000
32	100000	01100110
33	100001	01101100
34	100010	01110010
35	100011	01111001
36	100100	10000000
37	100101	10001000
38	100110	10010000
39	100111	10011000
40	101000	10100001
41	101001	10101011
42	101010	10110101
43	101011	11000000
44	101100	11001011
45	101101	11010111
46	101110	11100100
47	101111	11110010

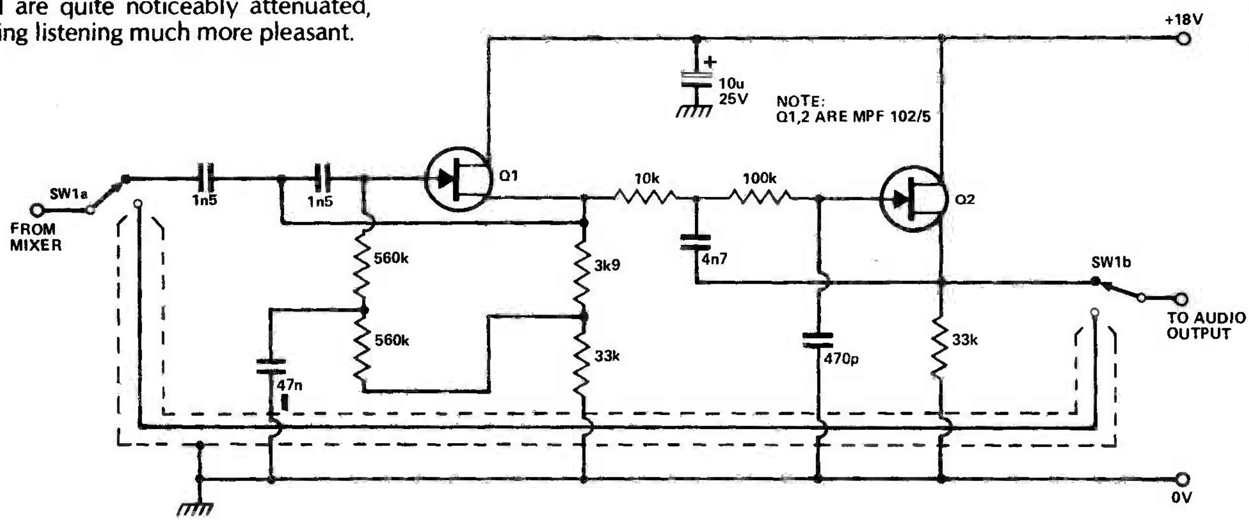
TABLE 2

NUMBER OF KEY ON KEYBOARD	SIX-BIT KEY CODE	12-BIT OUTPUT CODE
1	000001	000100001111
2	000010	000100011111
3	000011	000100110000
4	000100	000101000011
5	000101	000101010110
6	000110	000101101010
7	000111	000110000000
8	001000	000110010110
9	001001	000110101111
10	001010	000111001000
11	001011	000111100011
12	001100	001000000000
13	001101	001000011110
14	001110	001000111111
15	001111	001001100001
16	010000	001010000101
17	010001	001010101011
18	010010	001011010100
19	010011	001011111111
20	010100	001100101101
21	010101	001101011101
22	010110	001110010000
23	010111	001111000111
24	011000	010000000000
25	011001	010000111101
26	011010	010001111101
27	011011	010011000010
28	011100	010100001010
29	011101	010101010111
30	011110	010110101000
31	011111	010111111110
32	100000	011001011001
33	100001	011010111010
34	100010	011100100001
35	100011	011110001101
36	100100	100000000000
37	100101	100001111010
38	100110	100011111011
39	100111	100110000011
40	101000	101000010100
41	101001	101010101110
42	101010	101101010000
43	101011	101111111101
44	101100	110010110011
45	101101	110101110100
46	101110	111001000001
47	101111	111100011010

Active Audio Filter

E. Vaughan, High Wycombe

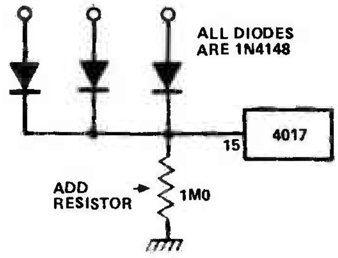
The main drawback of passive IF filters is their insertion loss when using inductors, necessitating the use of a two or three stage high-gain preamp to compensate for this loss. With an active audio filter the insertion loss can be low, nonexistent or even provide gain. In this FET filter there is virtually no insertion loss. When this filter is incorporated in a receiver and switched in, there is an apparent improvement in the signal-to-noise ratio and readability of signals. High and low frequency heterodynes and audio chatter outside the filter passband are quite noticeably attenuated, making listening much more pleasant.



Waterproofing Problems

J.E. Fox, Birmingham.

Here is a problem I encountered recently which may be of some interest to your readers. I was using 1N4148 diodes as a three-input OR gate to reset a 4017 decade counter. On trying to waterproof the circuit, it failed to count. This was eventually tracked down to a build-up of charge on the reset pin (pin 15). Insertion of a 1M0 resistor to ground completely solved the problem. Obviously the waterproofing eliminated any leakage from the reset pin which would occur on a normal PCB.



Power Supply Metering

R.A. Fairs, Twickenham.

When constructing power supplies it is often desirable to include a voltmeter and ammeter in the actual unit. For cost purposes one meter may be made to read the two functions independently using a suitable switch. The first circuit depicts a simple way of achieving this using a single pole switch.

The paralleling resistor (R_p) (which gives the original meter a greater current capability) is left in the circuit unswitched; since it has a very low value, there will be very little voltage dropped across it. For example, a 6 R meter having 10 mA FSD will have R_p = 0.06 R when converted to read 1 A.

$$R_p = R_m I / I'$$

where I = original current reading of meter for FSD

I' = required current reading of meter for FSD

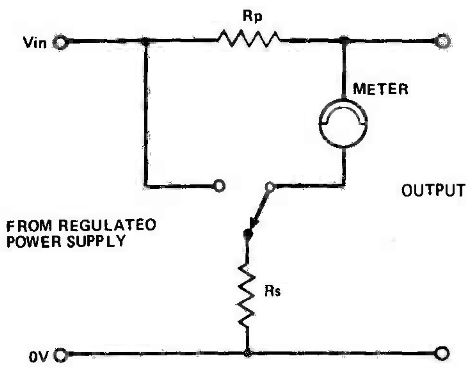
R_m = Resistance of meter

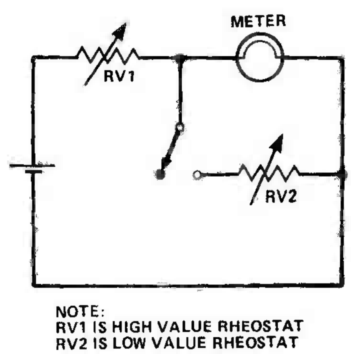
The series resistor to convert the meter to a voltmeter is switched, its value is given by:

$$R_s = \frac{V_{IN} - I R_m}{I}$$

To find the resistance of the meter (R_m) set up the second circuit, and proceed as follows:

1) Adjust RV1 for meter FSD.
2) Parallel RV2 with the meter via a switch, adjust RV2 so that the meter now reads 1/2 FSD.
3) Measure RV2: this is the resistance of the meter.





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**The space invaders are back.
This time right on your wrist!**

CA-90 specification
Time: Hours, minutes, seconds, am/pm, day and date. One-touch changeover between 12/24-hour formats.
Calender: Automatic; day, date, month and year, preprogrammed until the year 2002.
Calculator: 8 digits (7 digits for negatives). Four basic calculations, with constants for +, −, ×, ÷.
Alarm: 24-hour reminder alarm, with "alarm on" symbol.
Hourly time signal: Every hour, on the hour. The signal, with display symbol, can be switched on or off.
Stopwatch: Professional 1/100 second stopwatch measuring net, lap and first and second place times.
Dual time: An alternative time (second time zone) can be memorised. Hours and minutes; 12 or 24 hour format.
Tone control: Pitch can be varied in 10 steps.
Game: Additive digital invader speed game.
Dimensions: 46.0 x 36.0 x 10.55mm (thickness). Resin case/strap. Mineral glass.
The Game
The keyboard is effectively divided in half. Any or all of the left-hand buttons (1, 2, 4, 5, 7, 8) become AIM and any or all of the right-hand buttons become FIRE.
The random digital invaders attack from the bottom right and move across the display. Every time you tap AIM your missile number, displayed top right, progresses by 1. When your missile number coincides with an invader, tap FIRE and that spaceship will disappear, adding to your score. Since this is a speed game, the earlier you destroy an invader, the higher it will score. The game is over if 3 of the 16 spaceships in an encounter penetrate your defences.
There are 2 stages, each stage having 9 encounters. In stage 1 the game speeds up with each encounter and in stage 2 the invaders attack from a closer position. After stage 2 the game reverts back to the beginning of stage 1, but the score, which is added and displayed after each encounter, is carried forward.
Depending very much on your skill, one game can last for as much as an hour or more. The highest score so far will be retained in a non-volatile memory (this will be erased if the stopwatch function is utilised).

CASIO'S MOST AMAZING WATCH EVER

CA-90

All this for
ONLY £24.95
(RRP £27.95)

- Watch
- Calculator
- Alarm
- Hourly chimes
- Stopwatch
- Dual time
- Digital space invader game

Game display

A CLASSIC IN ITS TIME

You don't have to be a highbrow to appreciate the beauty of this clock. Battery powered, it is ideal for office, lounge, kitchen, bedroom, caravan or boat. Compact and lightweight, it can be used as a travel alarm clock or car clock.

MA-1 Alarm Clock

ONLY
£9.95
(RRP £11.95)
Large blue LCD display of full digital time. Symphonic alarm or buzzer, with snooze facility. hourly time signal. Integral loudspeaker and amplifier with 3 position volume control. A large top button gives night-time illumination and switches the alarm off. Alarm function: "Symphonie Nr. 40 G Moll" (W. A. Mozart K.550) for about 30 seconds or buzzer for 60 seconds. Three AA size batteries last approx. 15 months. Quartz accuracy. Dimensions: 43mm x 115mm x 76mm (1¾ x 4½ x 3inches).

CASIO'S BEST SELLING WATCHES

AA81 M1200 W150B

LCD ANALOGUE/DIGITAL ALARM CHRONOGRAPH with countdown alarm. **AA-81** chrome, s/s bracelet **£29.95. AA-81G.** Gold plated **£49.95. AA-82.** All s/s **£39.95. 12 MELODY ALARM CHRONOGRAPHS** with countdown alarm. **M-12** resin case/strap **£24.95. M1200** all stainless steel **£29.95.**
100 METRE WATER RESISTANT Alarm chronographs with countdown alarm. **W100.** Resin case/strap **£19.95. W150C** Stainless steel case/resin strap **£25.95. W150B** Stainless steel case/bracelet **£32.50.**

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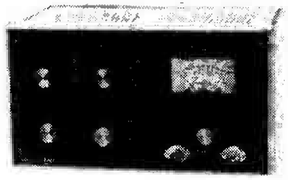

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THE ZX80 MAGIC BOOK £4.75

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MAKING THE MOST OF YOUR ZX80 £5.95

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1K ZX80 MOVING DISPLAY GAMES PROGRAMS!!!

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37 Way: **90p** (plastic), p&p 35p.
9 Way (metal) **60p**, 15 Way (metal) **95p**, 25 Way (plastic) **85p**, 37 Way reduced from 90p to **80p.** 50 Way (plastic) **90p.**

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HP 5082/7414 4 digit DIL display full spec **£1.50 each**, p&p 35p. Large quantities POA.
LED 3 Digit DIL **55p**, p&p 35p.
HP5082/7650 .4"cc, left and right decimal point, high brightness (unmarked), only **50p**, 12 for **£5**, p&p 35p.

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Ribbon Cable Headers 16 DIL Jermyn, gold-plated, with cover **45p**, p&p 25p.
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Tantalum Capacitors 25 volt. 4.7 uF, 14 for **£1**, p&p 35p.

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Battery eliminator 6VDC 200MA 240V AC input ideal for calculators, radio, etc., give away price 95p each. Large quantities P.O.A. p&p 35p.

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EAO KEY SWITCH oblong fascia, 25mm x 18mm (approx. 18mm hole), fixing supplied, brand new with 2 keys. **£2.95** p&p 35p.

SUPERSAVER 7
SN74116 Dual 4 Bit letch **75p**, p&p 35p.
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SUPERSAVER 8
ITT 4cx 250b brand new full spec £7.50 each p&p 35p.

SUPERSAVER 9
5 digit 7 segment DIL LED .11" displays 5 for **£1.50** p/p 35p.

SUPERSAVER 10
9-way male/female connector, ELCO 8129, 0.1 inch pitch, gold-plated PCB mounting, ideal for bussing two PCBs together. Superb value, **35p**, p&p 35p.

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SUPERSAVER 12
TMS 3128NC Static shift register, **£1.50**, p&p 35p.

SUPERSAVER 14
Recording Designs Ltd digital cassette deck. 50-100 Baud RS232 240V input. A professional superb deck. **£48**, p&p £2.

SUPERSAVER 15
5K ¾" multiturn trimpots, PCB mounting, per box of 14 **£2.50**, p&p 35p.

SUPERSAVER 16
OPTRON OPTO SLOTTED SWITCH (Type OPB-814) **£1**, p&p 35p.

Just arrived. ICL Termiprinter terminal with keyboard. Switchable rates. 4 only. **£125 + VAT.**

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TIL209, red **10p.** 0.2in, red **12p.** 0.2in. green **28p.** 0.2in, yellow **28p.** RL54 red Axial lead. **15p.** P&P on all above 35p.
VERNITRON Ceramic filters type FM4 10 yMHz **45p**, p&p 35p.
TRANSISTORS, BD236 **40p**, BC183L **10p**, BF195 **10p.**
TBA 810S, with data, **85p**, 4-way Dil switches, **75p.** MC1303 Dual Stereo preamp with data, **£1.25.** 7in. Nylon cable ties 100 for **£1.50.** All p&p 35p.
TMS 4030, 4096 x 1 dynamic RAM 200 ns removed from PCBs. **£1 each.** 16 for **£15**, p&p 35p.
GPO LINE MATCHING TRANSFORMER. With 12V reed relay etc. removed from equipment. **£1 + 40p p&p.**
CAPACITOR SCOOP. 1.600uF at 10v, 160uF at 25v. Axial lead. 2 dozen for **£1** + 35p p&p.
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GIVEAWAY
18 pin low profile dil socket 13p EACH or 8 for £1 p&p 35p
Just arrived. ITT 2082 Data Modem. Brand new and boxed, with manual. 600/1200 Baud. Data Modem to CC ITT. V24/RS232C. Channel centre frequencies 1300 and 1700Hz (600 Baud) or 1300 and 2100Hz (1200 Baud). Synchronous or asynchronous operation over 2 or 4 wire, switch or dedicated lines, built in self and lines test functions. Some of the best equipment we have ever obtained. £115 each, p&p £3 (fraction of original cost).

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16 Dil	17p	18 Dil	20p
22 Dil	28p	24 Dil	35p
28 Dil	45p	All p&p 35p	

WE STOCK a vast range of TTL, CMOS, some 74LS. MINIATURE TOGGLES, etc.
PSUs. We have a large stock of power supplies at very realistic prices (callers).

RELAYS
Banor resettable double pole changeover 12V **£1.** Both p&p 35p.

JUST ARRIVED – PCB 008 OSCILLATOR Containing 1 NPN transistor, 1 resistor, 1 transformer and PP3 battery connector. 30mm x 20mm (approx). **15p** each. **9 for £1.** p/p 35p. **PCB 009** 1 x CD4069, 1 x CD4011, 5 transistors, 7 capacitors, 12 resistors, 1 diode, 45mm x 55 mm (approx). **25p** each. p/p 35p.
CENTRONICS 101A Dot Matrix printer. Fully overhauled. 165 char/sec. £250 inc. VAT. Carriage at cost. A GIVEAWAY BUY – ONLY 2 LEFT.
PL259 PLUGS. (State large or small cable entry) **68p.**
PL259 SOCKET CHASSIS MOUNT. 50p p&p 30p.

The instruction set for the 10660 CPU can be found in **MICROPROCESSOR/MICRO-COMPUTERS by BRANKO SOUCEK – Publishers WILEY INTERNATIONAL SCIENCE.**
ICL POWER SUPPLY (exchange units) 240V AC input. Output +24V at 2 amps DC, –24V at 2 amps DC (adjustable to 12V) +5V at 4 amps DC –100V DC and 6.3V AC. £10.50.
Terms cash with order (official orders welcomed from colleges, etc). All enquiries s.a.e. please. All prices inclusive of VAT, unless otherwise stated. Postage as shown per item.
FOR THE PROFESSIONAL USER. CP Clare Keyboard switches with buttons (blank) **65p** each p&p 35p.
BURROUGHS keyboard, 96 key station. On-board crystal and TTL. Brand new and boxed. 500mm x 190mm. At the time of advert no data. No keytops at all. Clare pender. Reed switches. Bargain £12 each, p&p £1.50.
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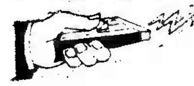
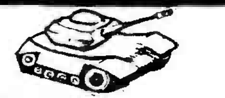
REMOTE CONTROL COMPONENTS AND KITS





LD271 IR Emitting diode	.36
SFH205 Photodiode Detector	.90
SL480 IC Pulse Amp.	1.70
SL490 32 Command Encoder/ transmitter	2.40
ML922 10-channel receiver + 3 analogue outputs	4.20
ML926 16-channel receiver 4 momentary binary outputs	1.40
ML928 16-channel receiver, 4 latched binary outputs	1.40
ML929 16-channel receiver, 4 latched binary outputs	1.40
Clip-on Plastic Reflector for IR LEDs, increases range	.20

NEW ML925 A decoder designed for model/toy control, providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights, etc. **2.10**

To make things EVEN EASIER, we have designed several new kits: —

MK6 — Simple Infra Red TRANSMITTER. A Pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery **4.20**

MK7 — Infra Red RECEIVER. Single channel, range approximately 20 ft. Mains powered with a triac output to switch loads up to 500W at 240Vac, but can be modified for use with 5 to 15V dc supplies and transistor or relay outputs. **9.00**

'Special Price' MK6 and MK7 together. Order as RC500K. **12.50**

MK8 — Coded Infra Red TRANSMITTER. Based on the SL490, the kit includes 2 IR LEDs, measures only 8x2x1.3 cms. and requires a 9V (PP3) battery **5.90**

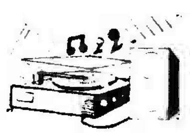
MK9 — 4 Way KEYBOARD. For use with the MK8 kit, to make a 4-channel remote control transmitter **1.90**

NEW

MK10 — 16-Way KEYBOARD. For use with the MK8 kit, to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) Kit **5.40**

MK11 — 10 On-Off Channel IR RECEIVER with 3 analogue outputs (0-10V) for controlling such functions as lamp brightness, volume, tone, etc. Other functions include an on/standby output and a toggle output, which may be used for sound muting. Based on ML922 decoder IC. Includes its own mains supply **12.00**

MK12 — 16 Channel IR RECEIVER. For use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary, depending on whether the ML926 or ML928 is specified. Includes its own mains supply. **11.95**

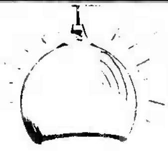


NEW

MK13 — 11-Way KEYBOARD. For use with MK8 and MK11 kits. Transmits programme step + and —, analogue + and — (3), mute, normalise analogue outputs, and on/standby **4.35**

ARE YOU SITTING COMFORTABLY?

Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter. The complete kit, which includes easy to follow instructions, will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.



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

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

24HR. CLOCK/APP. TIMER KIT

Switches any appliance up to 1KW on and off at preset times once per day. Kit contains AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit	£14.90
CT1000KB with white box (56/131×71mm)	£17.40
Ready Built	£22.50

DIGITAL VOLTMETER/ THERMOMETER KIT

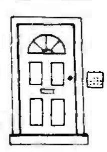
Based on the ICL 7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery). **£19.50**

INTEGRATED CIRCUITS

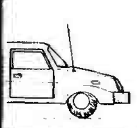
555 Timer	21p
741 Op Amp	18p
AY-5-1224 Clock	£2.60
AY-5-1230/2 Clock/Timer	£4.50
AY-3-1270 Thermometer	£8.20
CA3080 Transconductance Op Amp	72p
CA3130 CMOS Op Amp	75p
ICL7106 DVM (LCD drive)	£7.00
LM377 Dual 2 W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual/low noise Preamp	£1.00
LM386 250mW low voltage Amp	75p
LM1830 Fluid Level Detector	£1.50
LM2917 f-v Converter (14 pin)	£1.60
LM3909 LED Flasher/Oscillator	60p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver (linear)	£2.10
LM3915 Dot/Bar Driver (log)	£2.20
MM74C911 4 digit display controller	£6.50
MM74C926 4 digit counter with 7 seg o/p	£4.50
S566B Touchdimmer	£2.50
SL440 AC power control	£1.75
SN76477 Complex Sound Generator	£2.52
TBA800 5W Audio Amp.	58p
TBA810AS 7W Audio Amp	£1.00
ICM7555 CMOS 555 Timer	79p
TDA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp	£2.85
TL081 J-FET Op Amp	37p
TL082 Dual J-FET Op Amp	60p
ZN1034E Timer	£1.80
TMS 1121 Clock/7 day timer	£8.50

All ICs supplied with Data Sheets
Data Sheets only — per device **10p**

EVERY DOOR SHOULD HAVE ONE



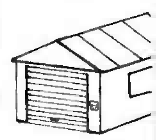
Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors.
The unit, which comes complete with a 10-way keypad, requires an easily remembered four digit code to be entered before the door can be opened, while the intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre-wired plug and a momentary or latched output version can be made. The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code.



The complete kit measures 7 x 6 x 3 cms. deep and consumes a mere 40uA when not in use, and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for

ONLY £10.50

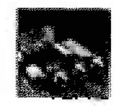
and think about all the keys you can lose or forget without ever locking yourself out.
As featured in PE, May '81.



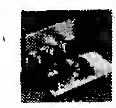
DISCO LIGHTING KITS

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

DL 1000K
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.60**



DLZ1000K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**
Optional Opto Input DLA1 **60p**



CMOS

4000	17p	4019	42p	4069	19p
4001	18p	4023	22p	4070	19p
4002	18p	4025	21p	4071	18p
4007	17p	4026	£1.30	4077	26p
4011	19p	4027	40p	4081	20p
4012	17p	4028	50p	4093	54p
4013	38p	4040	80p	4501	24p
4015	75p	4049	38p	4511	90p
4016	35p	4050	40p	4514	£1.80
4017	70p	4060	£1.08	4516	£1.80

CAPACITORS

Polyester 250V

0 01	6p	0.22	12p
0.002	6p	0.33	12p
0.033	7p	0 47	15p
0 047	7p	0 68	18p
0 068	7p	1.0	24p
0.1	7p	1.5	27p
0.15	12p	2.2	31p

Electrolytics A Axial R Radial

63V	1 0	R	5p	16V	10	R	5p
	2.2	R	5p		22	R	5p
	4 7	R	6p		33	R	5p
	10	R	7p		47	R	6p
	47	R	12p		100	R	8p
25V	22	A	8p		220	R	11p
	47	A	10p		470	R	14p
	100	A	14p		1000	R	20p
	110	A	15p	10V	47	A	8p
	470	A	24p		100	A	8p
	1000	A	34p		220	A	12p

Tantalum (bead)

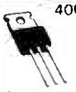
35V	0.1	9p	10V	22	20p
	0 22	9p	6.3V	33	20p
	0.47	9p		47	27p
	1.0	9p	3V	100	27p
25V	2.2	10p			
	4.7	14p			
	10	20p			

Ceramic 50V

100pF	4p	1,000pF	4p
220pF	4p	2,200pF	4p
470pF	4p	4,700pF	5p
		10,000pF	5p

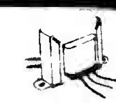
TRIACS

400V Plastic Case (Texas)



3A TIC206D	49p
8A TIC226D	58p
12A TIC236D	85p
16A TIC246D	95p
25A TIC263D	190p
6A with trigger Q4006LT	80p
8A isolated tab TXAL226B	65p
Diac	18p

MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

Opto isolated **TRIAC**
M O C 3 0 2 0
0.6A/400V **£1.10**

LEDs

0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red	16p
Rectangular Green	17p
Rectangular Yellow	17p

Flat Face Rectangular, Triangular, Arrowhead Square

Red	17p
Green	20p
Rec. Yellow	20p

MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

MK1 TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater 1KW **£4.**

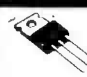
MK2 SOLID STATE RELAY
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero voltage switch, this kit may be wired to form a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0.5°C 3KW **£5.55**

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW. **£4.50**

VOLTAGE REGULATORS



Available in 5V, 12V & 15V versions.

78L series 100mA pos.	28p
79L series 100mA neg.	60p
78 series 1A pos.	52p
LM317T adjustable 1.2V-37V 1.5A	£1.80
79 Series 1A neg-5 vol	75p

RECTIFIERS

1N4001 1A/50V	4p
1N4004 1A/400V	6p
1N5401 3A/50V	8p
1N5404 3A/400V	10p
1A 50V Bridge	19p
1A 400V Bridge	22p
3A 50V Bridge	48p
3A 400V Bridge	58p

(Bridge rectifiers are miniature PCB mounting types)

DISPLAYS

DL504 Red 0.5" c.c. pin compatible with FND 504	75p
DL307 Red 0.3" c.a. pin compatible with DL707	75p
DL727 Dual 0.5" c.a. Red	£1.50
MP463 0.5" c.c. Red, four digit multiplexed clock display	£2.20

BOXES

Moulded in high impact ABS. Supplied with lids and screws. Black.

B1	75×6×35mm	65p
B2	95×71×35mm	85p
B3	115×95×37mm	95p

VMOS POWER FETS

VN10KM 0.5A/60V (TO92)	52p
VN66AF 2A/60V (TO220)	88p

D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p
Soldercon Pins			50p/100

ZENER DIODES

400mW3 3V-30V	8p
1.3W 7.5-27V	15p

RESISTORS

¼W 10 ohm-10M E12 series

Pack of 10 (one value)	10p
10 Packs (10 values)	80p

TRANSISTORS

BC108	8p	BFY50	20p
BC182	8p	TIP31A	40p
BC182L	8p	TIP32A	40p
BC212	9p	2N3055	45p
BC212L	9p	2N3442	90p
BC337	18p	2N3819	20p

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD 50p P&P AND 15% VAT TO TOTAL. OVERSEAS CUSTOMERS ADD £1.50 (Europe), £4 (elsewhere) for P&P. Send sae for price list and with all enquiries. Callers welcome 9.30-5.00 (Mon-Fri) 10.00-4.00 (Sat).

TK Electronics
(ETI), 11 BOSTON ROAD
LONDON W7 3SJ. 01-579 9794/2842