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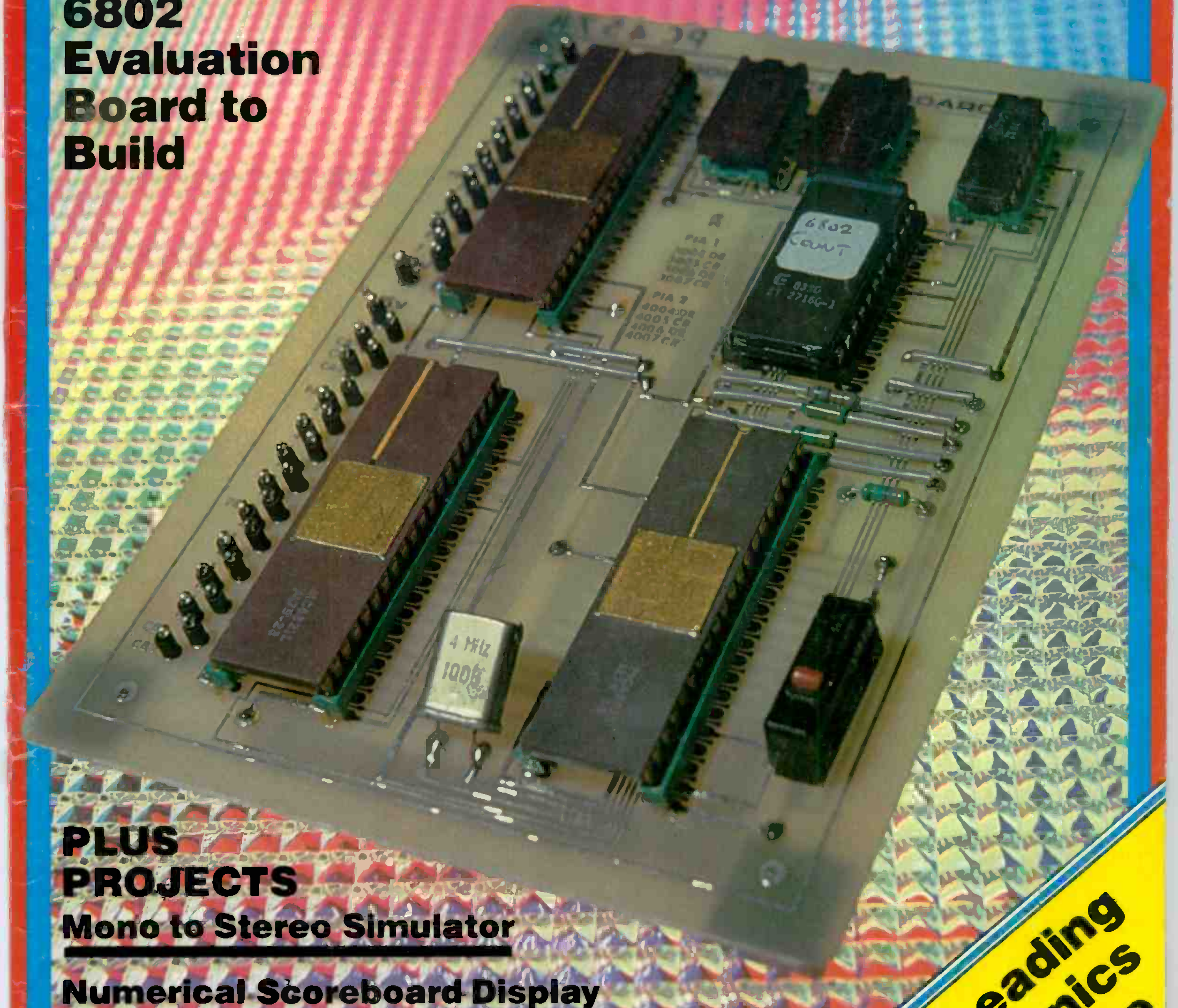
MAY 1985 £1.10

Break into code!

6802 Evaluation Board to Build



PLUS PROJECTS

Mono to Stereo Simulator

Numerical Scoreboard Display

Universal EPROM Programmer MkII

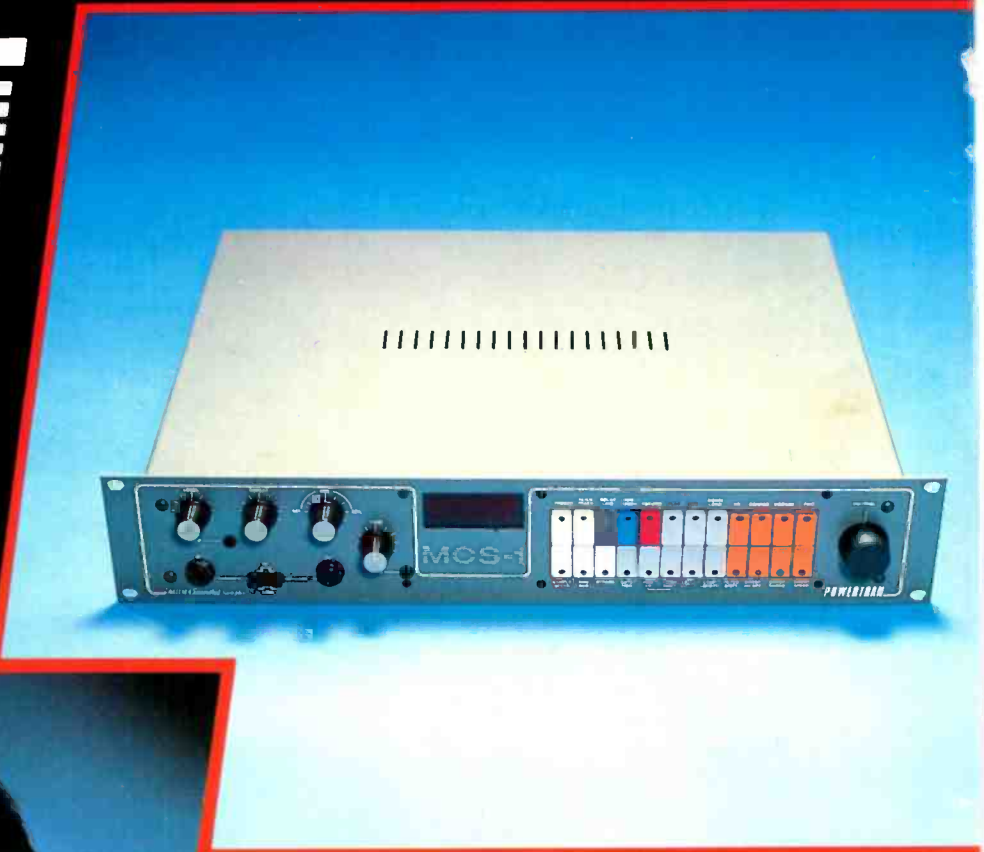
UK's Leading Electronics Magazine

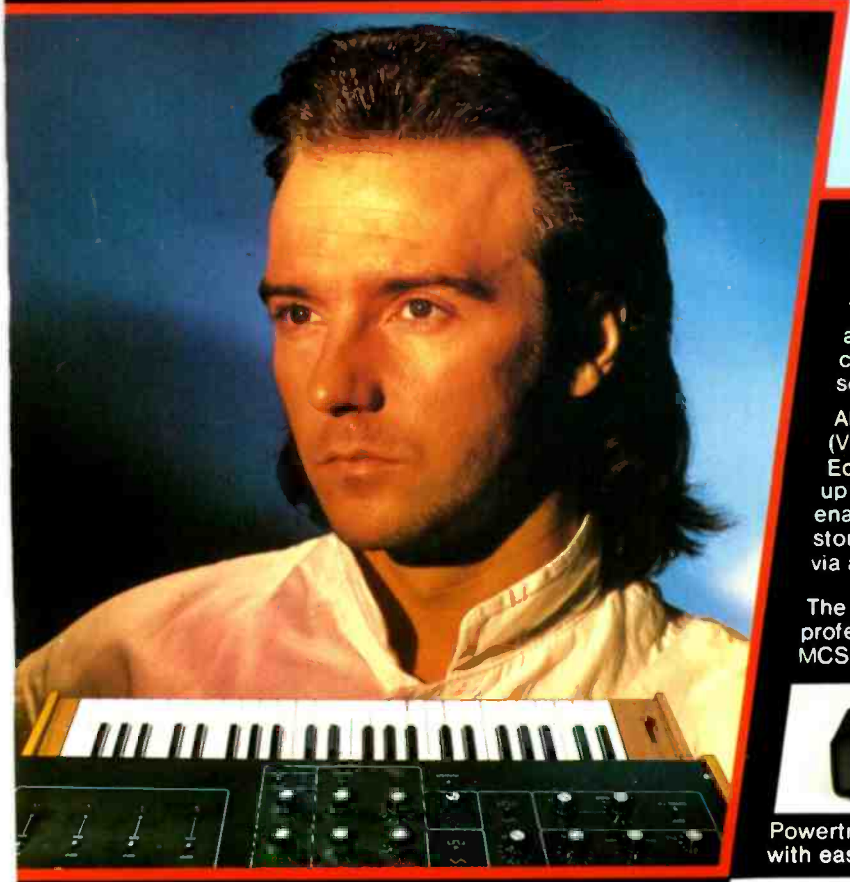
.AUDIO....COMPUTING....MUSIC.. ...ICS..

MCS1

DIGITAL SAMPLER & DELAY LINE

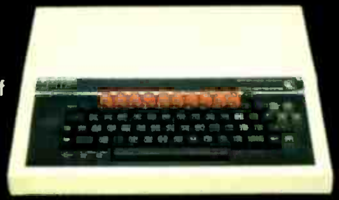
Just one of our customers for the MCS/1 - Midge Ure of Ultravox.
Get the professional sound of a Powertran MCS/1 into your act.





Once again, Powertran and E&MM combine to bring you versatility and top quality from a product out of the realms of fantasy and within the reach of the active musician.

The MCS-1 will take any sound, store it and play it back from a keyboard (either MIDI or v/octave). Pitch bend or vibrato can be added and infinite sustain is possible thanks to a sophisticated looping system.



All the usual delay line features (Vibrato, Phasing, Flanging, ADT, Echo) are available with delays of up to 32 secs. A special interface enables sampled sounds to be stored digitally on a floppy disc via a BBC microcomputer.

The MCS-1 gives you many of the effects created by top professional units such as the Fairlight or Emulator. But the MCS-1 doesn't come with a 5-figure price tag. And, if you're prepared to invest your time, it's almost cheap!

MCS-1 complete only **£849** + VAT
Save even more with the MCS-1 kit: only **£599** + VAT
Demonstration Tape **£2.50** + VAT

Powertran kits are complete down to the last nut and bolt, with easy-to-follow assembly instructions.

Specification
Memory Size: Variable from 8 bytes to 64K bytes.
Storage time at 32 KHz sampling rate: 2 seconds.
Storage time at 8 KHz sampling rate: 8 seconds.
Longest replay time (for special effects): 32 seconds.
Converters. ADC & DAC: 8-bit companding.
Dynamic range: 72 dB.
Audio Bandwidth: Variable from 12 KHz to 300 Hz.
Internal 4 pole tracking filters for anti-aliasing and recovery.
Programmable wide range sinewave sweep generator.
MIDI control range: 5 octaves.
+1 V/octave control range: 2 octave with optional transpose of a further 5 octaves.

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INTERNATIONAL MAY 1985 VOL 14 NO 5

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Liven up your old record collection or just enhance your stereo with this add-on circuit developed around one specialised chip.

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This month we open the gate on 'Digital Lab' — a software package for the Commodore 64 designed, logically, to help with logic design.

INFORMATION

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ELECTROLYTIC CAPACITORS: (Values in uF) **500v**, 10uf **52**; 47 **78p**; **63V**: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7 **8p** 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **20p**; 100 **19p**; 220 **26p**, 1000 **70p**, 2200 **99p**; **50V**: 68 **20p**, 100 **17p**; 220 **24p**; **40V**: 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**. **25V** 1.5, 4.7, 10, 22, 47 **8p**; 100 **11p**; 150 **12p**; 220 **15p**; 330 **22p**; 470 **25p**; 680, 1000 **34p**; 1500 **42p**, 2200 **50p**; 3300 **76p**; 4700 **92p**; **16V**: 47, 68, 100 **9p**, 125 **12p**; 330 **16p**, 470 **20p**, 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **26p**; 4700 **72p**.

TAG-END CAPACITORS: **64V**: 2200 **120p**; 3300 **145p**; 4700 **245p**; **50V**: 2200 **95p**; 3300 **155p**; **40V**: 4700 **160p**; **25V**: 2200 **70p**; 3300 **85p**; 4000, 4700 **75p**; 10,000 **250p**; 15,000 **270p**; **16V**: 22,000 **200p**.

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42**; 470n **52p**; 680n 1uF **68p**; 2u2 82p.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **8p**; 150n, 220n **10p**; 330n, 470n **15p**; 680n **19p**; 1u5 **40p**; 2u2 **48p**.

FEED-THROUGH CAPACITORS
1000pF/450V 10p

SIEMENS pcb Type Miniature poly Capacitors

250V	
1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n	7p
18n, 22n, 27n, 33n, 39n, 47n	8p
39n, 56n	12p
82n, 100n	11p
100V	
100n, 120n	10p
150n, 180n	12p
220n, 270n	16p
330n, 390n	20p
470n, 560n	26p
680n	30p
1uF 34p 2u2	50p

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0.22, 0.33 **15p** 0.47, 0.68, 1.0, 1.5 **16p**; 2.2, 3.3 **18p**; 4.7, 6.8 **22p** 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **36p**; 22 **45p**; 33, 47 **50p**; 100 **95p**; **10V**: 15, 22, **26p**; 33, 47 **50p**; 100 **80p**; **6V**: 100 **55p**.

POTENTIOMETERS: Carbon Track, Rotary 0.25W Log & LIN Values. 470R; 1K & 2K (Linear only)

Single Gang		35p
5K — 2M	Single Gang Log & Lin	35p
5K — 2M	Single Gang DP Switch	95p
5K — 2M	Double Gang	99p

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

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm

5K — 500K	single gang	80p
Graduated Bezels for above		45p

CERAMIC CAPACITORS 50V:
Range: 0.5pF to 10nF **4p**. 15nF, 22nF 33nF; 47nF **5p**. 100nF/300V **7p**. 200nF/6V **8p**.

PRESET POTENTIOMETERS

0.1W Miniature Vertical or Horizontal 100R to 4M7	8p
0.25W Larger 100R to 3M3 Horz	12p
0.25W Larger 200R to 4M7 Vertical	12p

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

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, 800, 800, 820	21p each
100, 1200, 1800, 2200	30p each
3300, 4700pF	80p

MINIATURE TRIMMERS Capacitors
2-6pF 2-10pF **22p**; 2-25pF; 5-65pF **30p**; 10-88pF **36p**.

Hitachi 256K DRAM £35

2764 250ns £4.25

27128 250ns £9.75

RESISTORS Carbon Film, miniature, Hi-Stab, 5%.

	RANGE	Val	1-99	100 +
0.25W	2Ω2 — 10M	E24	3p	1p
0.5W	2Ω2 — 4M7	E12	3p	1p
1W	2Ω2 — 10M	E12	6p	4p
2% Metal Film	51Ω — 1M	E24	8p	4p
1% Metal Film	51Ω — 1M	E24	5p	4p

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

RESISTORS NETWORK S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K, 100K **28p**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K & 100K **28p**.

TRANSISTORS

AC126/7	35
AC141/2	35
AC176	35
AC187	35
AC188	35
ACY19/21	75
ACY22/41	78
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	80
AF168	80
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
BC107	12
BC107B	14
BC108	12
BC108B	14
BC108C	14
BC109	12
BC109B	14
BC109C	14
BC114/5	30
BC117/8	25
BC137/9	40
BC140	38
BC142/3	38
BC147	12
BC147B	18
BC148	12
BC148B	18
BC149	12
BC149C	15
BC182L	10
BC183L	10
BC184	10
BC184L	10
BC186/7	28
BC188 6/7	28
BC12	10
BC212L	12
BC213	10
BC213L	12
BC214	10
BC214L	12
BC237/8	15
BC256B	38
307B	15
BC308	18
BC318	60
BC327	18
BC337/8	18
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	15
BC556/7	16
BC558/9	15
BCY39/40	85
BCY41/42	30
BCY45	50
BCY58/59	38
BCY70/71	18
1BCY72	25
BCY78	30
BD114	190
BD121	95
BD124	115
BD131/32	65
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	88
BD205/6	110
BD245	65
BD378	70
BD434	70
BD517	75
BD645	80
BD695A	150
BD696A	150
BF115	45
BF154/8	30
BF167	35
BF173	35
BF177	38
BF178	35
BF179	40
BF184/5	38
BF194/5	12
BF198/9	18
BF200	60
BF224A	40
BF224B	40
BF245	50
BF256A	45
BF256B	50
BF257/8	32
BF259	40
BF275	55
BF336/7	35
BF394	40
BF451	40
BF494/5	40
BF594/5	30
BFR39/40	30
BFR41/79	25
BFR80/81	25
BFR98	105
BFX29	35
BFX81	45
BFX84	35
BFX85/6	35
BFY50/51	30
BFY52	30
BFY53	35
BFY55/56	56
BFY64	40
BFY81	120
BFY90	80
BRY39	50
BSX20	30
BSX26/29	45
BSY26	35
BSY95	35
BU105	180
BU205	180
BU206	200
BU208	200
BUY69C	225
MD8001	250
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	85
MJE521	96
MJE2955	98
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	30
MPSA08	30
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	40
MPSU02	58
MPSU05	60
MPSU06	60
MPSU52	65
MPSU55	60
MPSU56	60
OC26	170
OC28	220
OC35	50
OC36/41	75
OC42/75	75
OC71/72	50
OC75/76	55
OC81/82	50
OC83/84	70
OC170/71	75
OC70	40
OC200	75
TIP29A	32
TIP29C	35
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	78
TIP34A	85
TIP34C	105
TIP35A	120
TIP35C	130
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	120
TIP147	120
TIP2955	70
TIP3055	70
TIS43	50
TIS44/5	45
TIS88A	50
TIS90/91	30
UC	65
VK1010	99
VN10KM	70
VN46AF	95
VN66AF	110
VN88AF	120
VN89AF	120
ZTX107/8	12
ZTX109	12
ZTX212	28
ZTX300	13
ZTX302	16
ZTX303	25
ZTX304	17
ZTX326	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	125
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	25
2N708	25
2N918	40
2N1131/2	40
2N1302	45
2N1307	70
2N1671B	160
2N2160	325
2N2219A	28
2N2220A	28
2N2221A	25
2N2222A	25
2N2368	25
2N2369A	18
2N2483/4	27
2N2646	48
2N2904/5	28
2N2906/7	28
2N2907A	28
2N2926G	10
2N3053	25
2N3054	55
2N3055	50
2N3252	46
2N3441/2	140
2N3614/5	180
2N3663	20
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	35
2N3820	60
2N3822/3	60
2N3866	90
2N3903/4	18
2N3905/6	15
2N3906	17
2N4037	60
2N4058	15
2N4061/2	15
2N4264	30
2N4286	25
2N4289	25
2N4314	78
2N4400	25
2N4427	80
2N4871	55
2N5135/8	30
2N5138	25
2N5172	25
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	180
2N6027	32
2SA671	250
2SA715	75
2SC495	85
2SC496	85
2SC1061	250
2SC1096	85
2SC1162	45
2SC1173	125
2SC1306	100
2SC1307	180
2SC1449	95
2SC1678	140
2SC1679	180
2SC1923	85
2SC1945	225
2SC1963	80
2SC1957	80
2SC1969	160
2SC2028	85
2SC2029	200
2SC2078	170
2SC2091	85
2SC2314	86
2SC2166	105
2SC2335	200
2SC2547	40
2SC2612	200
2SD234	74
2SK45	80
2SK288	225
2SJ83	225
2SJ85	225
3N128	115
3N140	115
40315	90
40316	95
40324	100
40326/7	70
40347	90
40348	120
40360	80
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40673	75
40871/2	90

RF CHOKES Miniature PCB type

1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u	30p
1mH, 1m5, 2m2, 4m7, 10mH	35p
22m, 33m, 43m	60p
100m	75p

DIODES

AA119	8
AA129	10
AAY30	8
BA100	10
BY100	15
BY126	12
BY127	10
CR033	198
OA9	10
OA47	10
OA70	9
OA79	10
OA81	10
OA85	10
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	12
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	60

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	30
2A/50V	26
2A/200V	40
2A/400V	42
2A/600V	50
6A/100V	83
6A/400V	96
10A/200V	215
10A/600V	296
25A/200V	240
25A/600V	396
BY164	56

ZENERS

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

TRIACS

3A200V	54
3A400V	56
8A100V	60
8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	136
16A100V	103
16A400V	106
16A800V	220
25V500V	220
25A800V	296
T2800	125

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75158	150
75159	195
75160	420
75162	650
75182/4	99
75188/9	100
75322	140
75324	360
75325	00
7536'/3	150
75365	00
75450	86
75451/2	52
75454	70
75491/2	65

SCR THYRISTORS

5A/40V	32
5A400V	40
5A600V	48
8A300V	60
8A600V	90
12A100V	78
12A400V	96
12A800V	188
BT106	150
BT116	180
C106D	36
TIC44	24
TIC45	29
TIC47	36
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

COMPUTER ICs

2102L	160
2114	275
2147	300
2516	350
2532	400
25L32	450
2564	600
26501	75
2716-5V	350
2732-4	450
2764-250	428
27C64	1000
27128-250	995
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3242	675
4027	95
4116-200n	125
4164-150n	425
4416-2	425
4532-3	250
4532-4	250
4816-100ns	200
4864-15	425
5514	250
6116-150	325
6116L-120	350
6117-100n	575
6167-6	795
6264L-15	£16
63A03	£14
6402	350
6464L-15	£11
6502CPU	325
6502A	545
6503	350
6503	650
6504	600
6504 250	550
6505	650
6505	600
6520PIA	175
6522VIA	340
6530	£11
6532RRIOT	650
6545RTC	899
6551ACIA	650
6592	00
6592PC	£20
6800	220
6802	275
6803	850
6805	670
6808	520
6809E	680
6810	150
6821	150
68B21	220
6840	375
6843	800
6845	650
6845SP	750
6847	650
6850	120
6852	250
6854	625
68B54	750
6859	£4
6875	500
68000	£30
8035	350
8080A	425
8085	£6
8085A	950
8088	£18
8123	160
8131	475
8150	800
8154	750
8155	400
8156	400
81LS95	176
81LS96	175
81LS97	178
81LS98	176
8202	£25
8205	228
8212	220
8214	495
8216	150
8224	300
8226	300
8228	310
8236	00
8243	290
8250	£11
8251A	350
8253	1370
8255	400
8256AC	£15
8257-5	400
8259	400
8271	£50
8272	£15
8279	750
8282	450
8283	450
8284	550
8288	£11
8748	£55
8T26A	99
8T27	150
8T31	350
8T95	90
8T97N	90
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33	150
AM7910	£30
AY-3-1015	300
AY-5-1013	300
CD4724	150
COM8017	275
COM8116	700
D8748	£55
DM8131	275
DP8303	450
DP8304	350
DS3647	00
DS3691N	£5
DS88LS120	495
DS8820	110
DS8830	140
DS8831	125
DS8832	200
E9364	800
E9365	£28
FD1691	£15
FD1771	£15
FD1791	£22
FD1795	£26
HD26501	75
HD63AO3RP	£14
HM6845SP	755
IM6402	380
INS8060N	1250
MC1488	60
MC1489	60
MC14411	675
MC14412	725
MC3242	590
MC3446	250
MC3447P	315
MC3486	225
MC3487	225
IM6402	350
MC6845	625
MC6846	625
MK3886-2M	£7
MM5280D	696
MM5303	636
MM5307	1275
MM5387A	865
MM58174	875
MM74C922	420
RO-3-2513L	700
RO-3-2513U	650
SAA5050	675
SFF9364	800
SP0256	850
SPO256AL2	475
TCJ3101J	£13
TMS2716-3V	728
TMS4047	100
TMS4164	398
TMS4416-2	598
TMS4500	£12
TMS4532-3	350
TMS5100	600
TMS6011	500
TMS9914	895
TMS9927	£14
TMS9928	£16
TMS9929	£16
TMS9980	£12
TMS9995	£12
ULN2003	75
UPD7002	725
WD1691	£14
WD1770	£20
WD2143	850
Z80CPU 2.5	295
Z80ACPU 4M	380
Z80 CTC	285
Z8002CPU	00
Z80A CTC	310
Z80BCPU	£11
Z80 DART	850
Z80A DART	800
Z80B	£8
Z80 DMA	795
Z80ADMA	925
Z80 PIO	250
Z80A PIO	315
Z80 SIO-1	850
Z80A SIO	£9
Z80ASIO-2	£9

LINEAR ICs

555Cmos	95
702	75
709C 8 pin	35
710	48
741 8 pin	16
747C 14 pin	70
748C 8 pin	30
735 8 pin	185
810	158
9400CJ	375
ADC0808	1000
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	150
Booklet for AY-3-8910	390
AY-3-8912	500
AY-5-1317A	630
AY-5-1350	386
CA3011	130
CA3012	175
CA3014	278
CA3018	85
CA3019	90
CA3020	210
CA3023	210
CA3028A	110
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3048	220
CA3059	325
CA3075	213
CA3080E	70
CA3081	160
CA3085	160
CA3086	60
CA3089E	200
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	45
CA3160	90
CA3161	180
CA3162	525
CA3189	275
HA1336W	175
HA1388	235
ICL7106	675
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038CC	345
ICL8211A	750
ICM7205A	1150
ICM7215	1050
ICM7216AJ	£22
ICM7216C	£22
ICM7217A	750
ICM7224	£11
ICM7240	300
ICM7555	105
ICM7556	150
LA3550	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	320
LC7120	300
LC7137	350
LF347	150
LF351	60
LF353	90
LF355	90
LF356	90
LF357	100
LF398	495
LM10	325
LM301A	30
LM307	45
LM308T	78
LM311	60
LM318N	150
LM319	180
LM324A	45
LM334Z	150
LM335Z	135
LM337	275
LM339	40
LM348	60
LM349	125
LM358	50
LM377	210
LM379	495
LM380	115
LM381N	175
LM382	200
LM384	225
LM386	110
LM387	200
LM389	160
LM393	65
LM394CH	380
LM558	170
LM725CN	300
LM733	65
LM1458	35
LM1871	300
LM1889	400
LM2907	395
LM2917	325
LM3900	70
LM3909N	85
LM3911	185
LM3914	300
LM3915	345
LM3916	300
LM13600	150
LS7220	280
M706B1	150
MS1513L	230
MS1515L	320
MS1516L	475
MB3712	200
MB3756	440
MC1204	250
MC1301	90
MC1303	96
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1455	50
MC1458	35
MC1469	300
MC1494	894
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	75
MC3401	50
MC3403	95
MC3404	65
MC3405	150
MC3422	00
MC3423	80
MC3442	00
MC3487	00
MC4016	00
MF10	300
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	140
NE543K	225
NE544	200
NE555	25
NE556	65
NE558	170
NE560	350
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	175
NE5534A	160
OM335	750
RC4136D	60
RC4558	55
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	585
SG3402	295
SL490	350
SL6270CD	150
SN76227N	95
SN76477	470
SN76488	525
SP8629	350
SP0256AL	475
TA7120	140
TA7204	150
TA7205	90
TA7222	150
TA7310	125
TAA661A	190
TAA700	275
TAA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA920Q	200
TBA990Q	350
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	180
TDA1004	350
TDA1008	310
TDA1010	235
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	250
TDA2004	270
TDA2006	320
TDA2020	320
TDA2030	190
TDB0791	420
TL170	50
TL430C	90
TL507	110
TL509	110
TL061CP	40
TL062CP	65
TL064CN	95
TLO71CP	40
TLO72CP	75
TL074CN	130
TL081CP	35
TL082CP	56
TL083CP	75
TL084CN	110
TL091CP	60
UA2240	120
UA78540	230
ULN2003	90
ULN2004	90
ULN2283	150
ULN2803	190
UPC575	275
UPC1025H	375
UPC1156H	298
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	180
ZN423E	130
ZN424E	130
ZN425E	595
ZN426E	200
ZN427E	600
ZN428E	450
ZN429E	240
ZN459	615
ZN1034E	200
ZN1040E	665
ZNA234E	925

TTL74

7400	25
7401	28
7402	28
7403	25
7404	30
7405	30
7406	40
7407	40
7408	25
7409	25
7410	25
7411	25
7412	28
7413	25
7414	60
7416	35
7417	35
7420	25
7421	50
7422	40
7423	35
7425	35
7426	40
7427	35
7428	35
7430	25
7432	30
7433	30
7437	30
7438	40
7440	30
7441	90
7442	85
7443	100
7444	100
7445	110
7446	110
7447	95
7448	110
7450	30
7451	30
7453	30
7454	30
7460	30
7470	50
7472	50
7473	50
7474	45
7475	55
7476	48
7480	60
7481	175
7482	100
7483	100
7484	105
7485	100
7486	40
7489	200
7490	55
7491	70
7492	110
7493	50
7494	100
7495	60
7496	75
7497	200
74100	175
74104	70
74105	70
74107	45
74109	70
74110	55
74111	55
74112	170
74116	160
74118	110
74119	160
74120	90
74121	48
74122	65
74123	75
74125	60
74126	60
74128	55
74132	70
74136	50
74141	65
74142	235
74143	250
74144	250
74145	100
74147	160
74148	130
74150	170
74151	60
74153	70
74154	130
74155	75
74156	90
74157	75
74159	170
74160	100
74161	100
74162	100
74163	100
74164	110
74165	100
74166	130
74167	250
74170	190
74172	400
74173	130
74174	100
74175	100
74176	100
74177	110
74178	130
74179	130
74180	100
74181	300
74182	120
74184	170
74185	170
74190	120
74191	120
74192	120
74193	120
74194	100
74195	75
74196	120
74197	100
74198	200
74199	200
74221	200
74246	130
74247	120
74248	145
74249	175
74251	90
74259	150
74263	75
74265	60
74273	180
74276	130
74278	160
74279	80
74283	100
74284	440
74285	300
74286	80
74290	120
74293	80
74297	175
74298	180
74351	180
74365	70
74366	70
74367	70
74368	70
74376	120
74390	100
74393	100
74426	60
74490	100

74C

74C244	150
74C245	150
74C373	180
74C374	425
74C922	625
74C923	645
74C925	650

74S

S00	40
S02	40
S03	40
S04	40
S05	40
S08	40
S09	40
S10	40
S11	40
S15	60
S20	40
S22	40
S30	60
S32	50
S37	50
S38	70
S40	40
S51	40
S64	40
S65	40
S74	70
S85	295
S86	100
S112	150
S113	120
S114	120
S124	300
S132	90
S133	50
S134	60
S135	110
S138	170
S139	170
S140	60
S151	140
S153	140
S157	200
S158	190
S162	300
S163	300
S174	250
S175	300
S188	200
S189	225
S194	280
S197	300
S201	250
S225	500
S226	350
S240	375
S241	375
S244	474
S251	225
S257	225
S258	225
S260	70
S262	£10
S287	200
S288	180
S289	200
S301	350
S365	250
S373	375
S374	375
S412	380
S470	325
S471	600
S472	400
S474	400
S475	425
S571	300
S573	450

74LS

LS00	25
LS01	25
LS02	28
LS03	28
LS04	25
LS05	25
LS08	28
LS09	28
LS10	28
LS11	25
LS12	28
LS13	35
LS14	50
LS15	28
LS19	45
LS20	25
LS21	28
LS22	25
LS24	50
LS26	25
LS27	25
LS28	28
LS30	25
LS32	50
LS33	25
LS37	25
LS38	30
LS40	25
LS42	50
LS47	60
LS48	90
LS49	100
LS51	25
LS52	25
LS54	25
LS55	25
LS63	55
LS73	30
LS74	35
LS75	45
LS76	40
LS78	40
LS83	70
LS85	70
LS86	35
LS90	50
LS91	90
LS92	55
LS93	55
LS95	70
LS96	90
LS107	40
LS109	45
LS112	45
LS113	40
LS114	40
LS122	70
LS123	100
LS124	125
LS125	100
LS126	50
LS132	60
LS133	50
LS135	28
LS136	45
LS138	60
LS139	60
LS145	95
LS147	165
LS148	130
LS151	70
LS153	70
LS154	155
LS155	70
LS156	70
LS157	60
LS158	60
LS160	70
LS161	70
LS162	70
LS163	70
LS164	75
LS165	110
LS166	150
LS168	140
LS169	100
LS170	140
LS173	100
LS174	75
LS175	70
LS181	190
LS183	190
LS190	85
LS191	85
LS192	100
LS193	100
LS194	75
LS195	75
LS196	65
LS197	65
LS221	65
LS240	80
LS241	80
LS242	95
LS243	95
LS244	80
LS245	120
LS247	105
LS248	105
LS249	105
LS251	75
LS253	75
LS256	120
LS257	75
LS258	75
LS259	125
LS260	70
LS261	100
LS266	60
LS273	120
LS275	350
LS279	70
LS280	160
LS283	80
LS290	80
LS292	660
LS293	80
LS294	999
LS295	140
LS297	650
LS298	100
LS299	225
LS320	210
LS322	360
LS323	400
LS324	150
LS325	150
LS326	290
LS327	290
LS347	120
LS348	140
LS352	110
LS353	110
LS355	220
LS356	200
LS363	150
LS264	150
LS365	50
LS366	50
LS367	50
LS368	50
LS373	100
LS374	100
LS375	70
LS377	130
LS378	95
LS379	130
LS380	310
LS382	310
LS384	460
LS385	330
LS386	50
LS390	60
LS393	100
LS395	110
LS396	300
LS398	195
LS399	135
LS445	125
LS447	60
LS465	140
LS490	150
LS540	140
LS541	140
LS624	155
LS629	130
LS640	200
LS641	150
LS645	195
LS668	90
LS669	90
LS670	170
LS673	890
LS674	800
LS678	275
LS682	250
LS684	350
LS687	350

SWITCHES

TOGGLE: 2A, 250V
SPST 35p DPDP 48p

SUB-MIN TOGGLE

SPST on/off	58p
SPDT c/over	64p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	80p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
4-pole 2 way	220p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A

with 10mm Button

SPDT latching	150p
DPDT latching	200p
SPDT moment	150p
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch
Assorted Colours
75p each

GAS/SMOKE DETECTORS

TGS812 or
TGS813

£6 each

DIP SWITCHES

(SPST) 4 way 65p; 6 way 80p; 8 way 85p; 10 way 125p (SPDT) 4 way 150p

ROTARY SWITCHES

(Adjustable Stop type)

1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way 48p

ROTARY: Mains DP 250V 4 Amp on/off 65p

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only 90p

WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 Way 55p
Mains DP 4A Switch to fit 45p
Spacers 4p. Screen 6p.

ROCKER SWITCHES

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL Mini front mounting switches

Decade Switch Module	275p
B.C.D. Switch Module	295p
Mounting Cheeks (per pair)	75p

JUMPER LEADS (Ribbon Cable Assembly)

Length 14pin 16 pin 24pin 40 pin
Single ended DIP (Header Plug) Jumper
24 inches 145p
165p 240p 380p
Double ended DIP (Header Plug) Jumper
6 inches 185p 205p 300 485
12 inches 198p 215p 315p 24 inches 480p
210p 3235p345p 540p 36inches
290p 370p 480p 525p

JUMPER LEADS (Ribbon Cable Assembly)

IDC Female Header Socket Jumper Leads 36

	20pin	26 pin	34 pin	40 pin
Single ended	150p	200p	260	300p
Double ended	290p	370p	480	525p

VEROBOARD 0.1in

2½ x 3¾	95p
2½ x 5	110p
3¾ x 3¾	110p
3¾ x 5	125p
3¾ x 17	420p
4¾ x 17	590p
Pkt of 100 pins	55p
Spot face cutter	150p
Pin insertion tool	165p

VQ Board	195p
DIP Board	395p
Vero Strip	95p

PROTO DECs

Veroblock	480p
S-Dec	395p
Eurobreadboard	590p
Bimboard 1	675p
Superstrip SS2	1350p

VERO WIRING PEN

+ spool	380p
Spare spool	75p
Combs	5p

DALO ETCH RESIST PEN

Plus spare tip 100p

FERRIC CHLORIDE

1 lb bag Anhydrous
195p + 50p p&p

ULTRASONIC TRANSDUCER

40KHz 475 pr

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double sided
6" x 6"	100p	125p
6" x 12"	175p	225p

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	25p	80p
40 pin	30p	90p

EDGE CONNECTORS

2x6 way	—	111p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	210p	175p
2x22 way	215p	250p
2x23 way	175p	—
2x25 way	265p	275p
2x28 way	160p	—
2x30 way	310p	—
2x36 way	360p	—
2x40 way	360p	—

SIL SOCKET 0.1" Pitch 20 way 85p

ANTEX SOLDERING IRONS

C15W	525p;	CS17W	545p
C18W	550p;	XS25W	570p
Spare Bits	65p;	Elements	230p
Iron Stand	175p;	Heat Shunt	30p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	165p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	235p	160p	320p
40 way	220p	250p	180p	340p
50 way	235p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	170p	—	—	175p
DIN41612 2 x 32 A + B	275p	-	220p	285p
DIN41612 2 x 32 A + C	295p	-	240p	300p
DIN41612 3 x 32 A + B + C	380p	385p	280p	395p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	90p
16 pin	48p	105p
24 pin	65p	175p
28 pin	290p	295p
40 pin	290p	255p

RIBBON CABLE

price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
26 way	55p	80p
34 way	60p	85p
40 way	70p	90p
50 way	100p	135p
64 way	120p	150p

ZIF TEXTOOL DIL SOCKETS

24 pin	575p
28 pin	995p
40 pin	945p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male	85p	80p	120p	150p
	110p	175p	225p	300p
	100p	100p	150p	250p
Female	80p	125p	190p	275p
	150p	200p	260p	390p
	100p	125p	195p	355p
Covers	75p	70p	70p	65p

IDC 25 way 'D' Plug 385p; Socket 450p

25 way 'D' CONNECTOR (RS232)

Jumper Lead Cable Assembly

18" long, Single end, Male	475p
18" long, Single end, Female	510p
36" long, Double Ended, M/M	995p
36" long, Double Ended, F/F	£10
36" long, Double Ended, M/F	995p

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	465p	480p
36 way Centronix	450p	475p
36 way Female	480p	480p

PANEL METERS

FSD
60 x 46 x 35mm
0–50μA
0–100μA
0–500μA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0.aA
0.2A
0.25V
0.50V AC
0.300V AC
"S"
"VU" 450p each

CRYSTALS

32.768KHz	100
100KHz	545
200KHz	370
455KH	370
1MHz	265
1.008M	275
1.28MHz	450
1.6MHz	200
1.8MHz	545
1.8432M	230
2.0MHz	225
2.4576M	200
3.12MHz	240
3.276M	160
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.806MHZ	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	200
7.7328MHz	250
7.68MHz	200
8.0MHz	160
8.089333M	395
8.86723M	220
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	160
12.528M	300
14.31814M	170
15.0MHz	200
16.0MHz	220
18.0MHz	160
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	160
38.6667M	240
48.0MHz	240
100.0MHz	295
116.0MHz	300

RELAYS

Miniature, enclosed, PCB mount

SINGLE POLE Changeover
RL-91 205R Coil; 12V DC, (10V5 to 19.5V), 10A at 30V DC or 250V AC 195p

DOUBLE POLE Changeover, 6A 30V DC or 250V AC
RL-100 53R Coil, 6V DC (5V4 to 9V9) 190p
RLS-111 205R Coil, 12V DC (10V7 to 19V5) 195p
RLS-114 740R Coil, 24V DC (22V to 37V) 200p

ASTEC UHF MODULATORS

Standard 6MHz	375p
Wideband 8MHz	580p

BUZZERS

miniature, solid-state 6V, 9V & 12V 70p

PIEZO TRANSDUCERS PB2720 70p

LOUDSPEAKERS

Miniature, 0.3W- 8

2in, 3½in, 2½in, 3in	80p
2½in 40Ω 64Ωor 80Ω	80p
8" x 4" 8Ω	200p
7" x 5" 8Ω	225p
8" x 5" 8Ω	250p

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular £65
- MICROVITEC 1431. 14" Colour RGB input. Connecting cable incl. £165
- MICROVITEC 1451. 14" £237 Medium resolution £250
- KAGA 12". Med-res RGB £250 Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc . £259 (car £7)
- KAGA 12". As above but Hi-Resolution £309 (car £7)
- Connecting Lead for KAGA £5

Carriage £7 Securicor

"SPECIAL OFFER"

	1+	10+
2764-250nS	425	415
27128-250nS	975	965
6116LP-120nS	325	310
6264lp-150nS	995	965

TRANSFORMERS

3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA 130p
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A 235p
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A 260p
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A 250p
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A 345p (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A 385p (50p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A 520p(60p p&p)
Specially wound for Multirail computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A 620p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A 965p (75p)

P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	50p	7905	50p
12V	7812	50p	7906	50p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	50p	7918	50p
			7924	50p

100mA TO92 Plastic package

5V	78LO5	30p	79LO5	50p
6V	78LO6	30p	—	—
8V	78LO8	30p	—	—
12V	78L12	30p	79L12	50p
15V	78L15	50p	79L15	50p

ICL7660	248p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	78H05 + 5V/5V	550p
LM309K	135p	78H12+12V/6A	640p
LM317K	250p	78HG + 5V to + 25V 5A	585p
LM317KP	450p		
LM323K	450p	79HG − 2.25V to −24V; 5A	685p
LM337	175p		
LM723 Var	30p		
78S40	225p		

SOLDERCON PINS

Ideal for making SIL or DIL Sockets

100 pins	45p
500 pins	195p

ALUM BOXES

3 x 2 x 1"	85p
4 x 2½ x 2"	100p
4 x 2½ x 2½"	103p
4 x 4 x 2"	105p
4 x 4 x 2½"	120p
5 x 4 x 1½"	95p
5 x 4 x 2½"	120p
5 x 2¾ x 1½"	90p
5 x 2¾ x 2½"	120p
6 x 4 x 2"	120p
8 x 4 x 3"	150p
7 x 5 x 3"	160p
8 x 6 x 3"	210p
10 x 4 x 3"	240p
10 x 7 x 3"	275p
12 x 5 x 3"	280p
12 x 8 x 3"	295p

CMOS

4000	20
4001	25
4002	25
4006	70
4007	25
4008	60
4009	45
4010	45
4011	25
4012	25
4013	35
4014	60
4015	60
4016	40
4017	60
4018	60
4019	58
4020	60
4042	43
4021	58
4022	67
4023	30
4024	50
4025	22
4026	90
4027	40
4028	50
4029	75
4030	35
4031	130
4032	70
4033	130
4034	146
4035	70
4036	275
4037	115
4038	75
4039	280
4040	60
4041	57
4042	50
4043	42
4044	50
4045	110
4046	60
4047	60
4048	55
4049	35
4050	35
4051	70
4052	60
4053	60
4054	85
4055	85
4056	85
4057	1000
4059	435
4060	68
4061	500
4062	986
4063	85
4066	45
4067	245
4068	25
4069	25
4070	25
4071	25
4072	25
4073	26
4075	25
4076	68
4077	25
4078	28
4081	25
4082	25
4085	60
4086	60
4089	125
4093	37
4094	70
4095	95
4096	100
4097	275
4098	60
4099	110
4160	95
4161	95
4162	95
4163	95
4174	95
4175	105
4194	105
4408	850
4409	850
4410	725
4411	750
4412	805
4415	590
4419	280
4422	770
4435	850
4440	900
4450	360
4451	350
4490	450
4500	395
4501	38
4502	60
4503	40
4504	99
4505	385
4506	100
4507	45
4508	130
4510	55
4511	55
4512	55
4513	150
4514	115
4515	115
4516	55
4517	275
4518	45
4519	32
4520	53
4521	115
4522	125
4526	60
4527	65
4528	68
4529	150
4530	90
4531	130
4532	65
4534	400
4536	275
4538	60
4539	60
4541	96
4543	70
4548	40
4549	400
4553	245
4554	160
4555	35
4556	55
4557	250
4558	120
4559	395
4560	180
4561	104
4562	350
4566	195
4568	250
4569	175
4572	45
4580	255
4581	125
4582	99
4583	100
4584	60
4585	70
4597	330
4599	155
40085	60
40097	45
40098	42
40100	215
40101	130
40102	140
40103	412
40104	120
40105	220
40106	60
40107	55
40108	325
40109	100
40110	235
40114	240
40161	194
40163	75
40174	75
40175	75
40181	220
40182	90
40192	75
40193	95
40194	70
40195	75
40244	196
40245	196
40257	196
40373	220
40374	220
45106	586

OPTO

OCP71	120
ORP12	85
ORP61	86
BPX25	250
BPW21	320
TIL139	225

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2" Red	12
2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	100p
Green/Yellow	115p
0.2" Tri colour Red/Green/Yellow	65
Hi-Brightness Red	58
High-Bri Green or Yel	68
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yellow	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH. Red 10 segments	275

ISOLATORS

IL74	145
ILD74	145
ILQ74	275
TIL111/2/4	70
ILCT6 Darlington	135
TIL117	125
4N33 Photo Darlington	136

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	225
SLOTTED Optical Switch similar to RS Comp.'s	295

COMPUTER CORNER

- QL RGB MONITOR, Medium resolution £239
- EPSON RX80 Printer £209
- EPSON RX80 F/T Printer £219
- EPSON FX80 Printer £316
- EPSON FX100 Printer £429
- KAGA/TAXAN KP810 Printer £249
- KAGA/TAXAN KP910 Printer £339
- SEIKOSHA GP100A Printer £122
- BROTHER HR15 Daisywheel £329

Cable for above printers to interface with BBC Micro £7

- TEX EPROM ERASER — Erases up to 25 Eproms. Has a built.in safety switch £30
- SPARE 'UV' Lamp Bulb £8
- C12 Computer CASSETTES in Library cases 35p
- 8½" & 9½" Fan Fold paper (1000 sheets) .... £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)

CALL IN AT OUR SHOP FOR A DEMONSTRATION ON ANY OF THE ABOVE ITEMS. BE SATISFIED BEFORE YOU BUY OR WRITE IN FOR OUR DESCRIPTIVE MICRO PERIPHERALS LEAFLET.

DISC DRIVES

(CUMANA)
DRIVES CASED with PSU & CABLES

- CS100 — Single Cased with PSU, 40 track, 5¼" S/S 100K £119
- CD200 — Twin Cased with PSU, 40 Track, 5¼" S/S 200K £236
- CS200 — Epson Single Cased with own PSU D/S, 40 Track, 5¼" 200K £149
- CD400 — Epson Twin Cased with own PSU D/S, 40 track, 5¼" 400K £280
- MITSUBISHI 5¼" SLIM LINE DISC DRIVES
  Double Sided, Double Density, Track Density 96 TPI, Track to track access time 3msec.
- CS400 MITSUBISHI Single Slimline, 5¼" Cased with PSU. DSDD. 1 Megabyte (400 K with BBC) £185
- CD800 MITSUBISHI Twin Slimline, 5¼" Cased with PSU. DSODD. 2 Megabyte. (800 K with BBC) £339

5¼" DISKETTES (Lifetime Warranty)

- 10 3M Diskettes Single side Double density £14
- 10 3M Diskettes Double side Double density £23

N.B Carriage on Drives £7 securicor

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied.

£22

BBC MICRO WORDPROCESSING PACKAGE

A complete wordprocessing package (which can be heavily modified to your requirements, maintaining large discount). We supply everything you need to get a BBC Micro running as a word-processor. Please call in for a demonstration.

Example Package:
BBC Micro, with DFS Interface, Wordwise, Twin 400K TEC Disc Drives, 12" High-res green monitor, Brother HR15 Daisywheel printer, Beebcalc & Database software on Disc, 10 3M Discs, 500 sheets of paper, 4way mains trailing socket, manuals and all cables.

Only: £1,069

BBC & MICROCOMPUTER & ACCESSORIES

BBC Model B Only £315

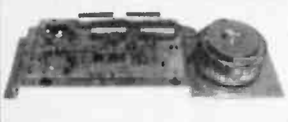
We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Light-pen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM. The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEB-CALC, Software (Educational Application & Games), BOOKs, etc, etc. Please send SAE for our description leaflet.

OMP POWER AMPLIFIER MODULES

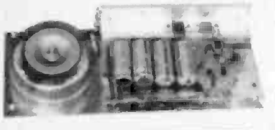
★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE S.A.E. 28p STAMP FOR CURRENT LIST

OMP POWER AMPLIFIER MODULES

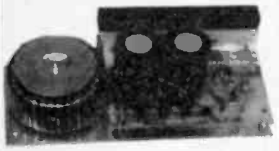
Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market. i.e., Industry, Leisure, Instrumental and Hi-Fi. etc. When comparing prices, NOTE all models include Toroidal power supply. Integral heat sink, Glass fibre P.C.8 . and Drive circuits to power compatible Vu meter. Open and short circuit proof. **Supplied ready built and tested.**



OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV at 10K, Size 360 × 115 × 72mm. PRICE £32.99 + £2.50 P&P.



OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE £39.99 + £2.50 P&P.



OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. —130dB, Size 300 × 150 × 100mm. PRICE £62.99 + £3.50 P&P.

OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE £79.99 + £4.50 P&P.

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm. PRICE £8.50 + 50p P&P.

NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV). If required, P.A. version (50KHz bandwidth & Input Sensitivity 775mV). Order — Standard or P.A.

19" RACK CASED MOS-FET STEREO AMPLIFIERS with twin power supplies and L.E.D. Vu meters plus X.L.R. connectors.

Three models (Ratings RMS into 4 ohms)

MF200 (100 + 100w) **£169.00**
MF400 (200 + 200w) **£228.85**
MF600 (300 + 300w) **£274.85**

Securicor Delivery £10.00

LOUDSPEAKERS

5 to 15 INCH Up to 300 WATTS R.M.S. All speakers 8 ohm Impedence.

Cabinet fixing in stock. S.A.E. for details.

POWER RANGE

8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.

12" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 – £3.00 P&P ea.

15" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 20Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. PRICE £37.49 – £3.00 P&P ea.

McKENZIE

12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco.
2" ally voice coil. Ally centre dome. Res. Freq. 45Hz. Freq. Resp. to 6.5KHz. Sens. 98dB. PRICE £24.99 – £3.00 P&P ea.

12" 85 WATT R.M.S. C1285TC P.A./Disco 2" ally voice coil. Twin cone.
Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £24.99 – £3.00 P&P ea.

15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £49.99 – £4.00 P&P ea.

WEM

5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £20.00 – £1.50 P&P ea.

8" 150 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £27.00 – £1.50 P&P ea.

10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £30.00 – £2.00 P&P ea.

12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £38.00 · £3.00 P&P ea.

SOUNDLAB (Full Range Twin Cone)

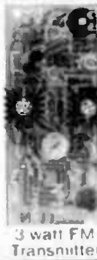
5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £9.99 · £1.00 P&P ea.

6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 · £1.50 P&P ea.

8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 · £1.50 P&P ea.

PANTEC

HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with Instructions.



3 watt FM Transmitter

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt) Price: £8.62 + 75p P&P.

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) Price: £13.74 + 75p P&P.

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £17.82.** Transmitter 80 × 50 × 15mm (9/12 volt). **Price: £11.27** P&P + 75p each. S.A.E. for complete list.

VISA

POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME, SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED.

BURGLAR ALARM

Better to be '**Alarmed**' then terrified.

Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.

Indoor alarm — Electronic swept freq. siren. 104dB output.

Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions

IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.

SAVE £148.00 Usual Price £228.85

BKE's PRICE £79.99 + £4.00 P&P

? Why buy a collection of self-assembly boards!

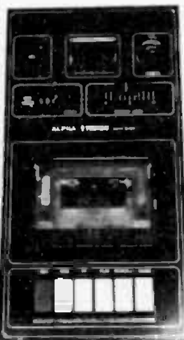
OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full Range 45Hz - 20KHz.

OMP 12/100 watts 20" × 15" × 12" **£125.00** per pair
OMP 10/200 watts 18" × 15" × 11" **£145.00** per pair
OMP 12/300 watts 20" × 15" × 11" **£169.00** per pair

Delivery: Securicor £8.00 per pair

STEREO CASSETTE DECK



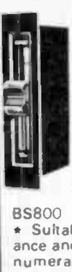
STEREO CASSETTE DECK Ideal for installing into Disco and Hi-Fi cabinet/Consoles. Surface mounting (Horizontal). Supplied as one unit with all electronics including mains power supply.

- ★ Metal top panel Black finish
- ★ Piano type keys including pause
- ★ Normal/Chrome tape switch
- ★ Twin Vu Meters
- ★ 3 Digit counter
- ★ Slider Record Level control

Size 171 × 317 mm Depth 110 mm

PRICE £35.99 + £3.00 P&P

1 K-WATT SLIDE DIMMER



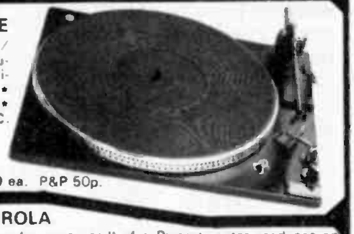
- ★ Control loads up to 1Kw
- ★ Compact Size 4⅔" × 1" × 2½"
- ★ Easy snap in fixing through panel/cabinet cut out
- ★ Insulated plastic case
- ★ Full wave control using 8 amp triac
- ★ Conforms to BS800
- ★ Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £12.99 + 75p P&P (Any quantity)

BSR P295 ELECTRONIC TURNTABLE

• Electronic speed control 45 & 33⅓ r.p.m. • Plus/Minus variable pitch control • Belt driven • Aluminium platter with strobed rim • Cue lever • Anti-skate (bias device) • Adjustable counter balance • Manual arm • Standard ½" cartrige fixings • Supplied complete with cut out template • D.C. Operation 9-14v D.C. 65mA

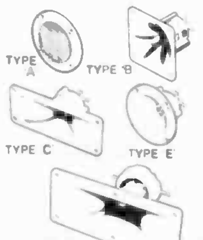
Price £36.99 — £3.00 P&P



ADC Q4 mag. cartridge for above. Price £4.99 ea. P&P 50p.

PIEZO ELECTRIC TWEETERS MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price **£5.39 each** + 40p P&P.

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each** + 40p P&P.

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each** + 40p P&P.

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each** + 40p P&P.

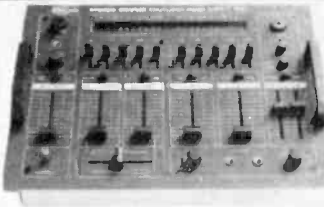
TYPE 'E' (KSN1038A) 3⅜" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each** + 40p P&P.

LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. **Price £3.99** + 40p P&P.

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L. & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:— 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot. L. & R. Master Output controls. Output 775mV. Size 360 × 280 × 90mm.

Price £134.99 — £3.00 P&P



B. K. ELECTRONICS

UNIT 5, COMET WAY, SOUTHEND-ON-SEA,
ESSEX, SS2 6TR TEL: 0702-527572

DIGEST

Call For Science Minister

Science needs a minister, say the Alliance for Science, a campaign set up by three trade unions who represent 100,000 scientists and technologists. They are also calling for a National Economic Development Council (NEDC) to cover research and development, pinpointing crucial research areas to permit the most effective use of funds.

In a pamphlet entitled *The case for a research and development strategy*, the group call on the government to co-ordinate such a strategy as suggested by the House of Lords Select Committee on science and technology. They argue that a science minister should head a cabinet committee to look at science funding and plot long term research and development objectives.

They call for more government funds to be pumped into research and development, particularly in areas such as information technology where we are said to be falling behind our competitors, and they believe that an NEDC is the best way of ensuring that the money goes to where it is needed most.

The pamphlet is the second publication from the Alliance, which was launched in December of last year. The three unions involved are the Association of Scientific, Technical and Managerial Staffs (ASTMS), the Association of University Teachers (AUT) and the Institution of Professional Civil Servants.

For further information about the Alliance for Science contact Bill Brett of IPCS on 01-928 9951, Paul Cotterell of AUT on 01-221 4370, or Stan Davison of ASTMS on 01-267 4422.

Handheld Logic Analyser

An ultra-compact logic analyser, which provides a full range of measurement facilities in a handheld, battery-operated format, has been introduced to the UK by House of Instruments.

The SOAR 1300 Series, available in 10MHz or 20MHz versions, use a high-contrast liquid-crystal dot-matrix display to provide comprehensive logic-timing, state and signature analysis on up to 16 channels, with features such as trigger position, trigger pass count and trigger delay included as standard. The 1"x3" display is mounted on the top and shows eight channels at a time.

The instrument measures 253 x 140 x 38mm and weighs only 1kg, making it ideal for field-service use. Power is provided by four AA batteries or an optional AC mains adaptor, while key set-up parameters and acquisition data are retained for up to one year by an internal battery-backup memory function.

The 1300 Series may be used in single, repeat or compare acquisition modes, and data display, compare and search facilities are provided. Other display features include a x4 magnification, a window facility for examining part of a larger display, and a histogram display to compare the numbers of high- and low-level bits.

The instrument has built-in self-checking facilities, including battery-low indication, and an automatic power-off function to conserve battery life between readings.

The price of the 10MHz model (1310) was not available when we went to press, but the 20MHz version (1320) costs £1987.00 plus VAT. The instrument is also available in a form better suited to bench use, with the display on the front panel and a tilt stand. These models are designated 1410 (10MHz) and 1420 (20 MHz), and the 1420 costs £2146.00 plus VAT.

House of Instruments, Raynham Road, Bishops Stortford, Hertfordshire CM23 5PF, tel 0279-55155.

Watford Moves

Watford Electronics, a company which started with one man working from his home, has just moved into new, purpose-built premises in Watford's High Street.

The company was founded twelve years ago by Nazir Jessa, an optician who spent his evenings and weekends selling components from a stock kept in the corner of his bedroom. Although he advertised 'mail order only', Nazir spent his weekends serving the people who insisted on calling in person, and the queues often filled his lounge and hall and extended to the front gate and beyond.

Assisted by his younger Brother Raza, he build the company up until, after three years, he was able to buy the shop next door. Within a year the extra stock needed to serve the fast-expanding business filled even this space, and the problem has only been remedied with the move to the new building.

Called Jessa House, the premises house over 7000 different components and micro peripherals and cost £700,000 to build. Nowadays they actually welcome personal callers, and although they now have a staff of thirty Nazir and Raza still take their turn behind the counter.

Watford Electronics, 250 High Street, Watford, Hertfordshire WD1 2AN, tel 0923-37774.

● Electrovalue's spring '85 catalogue is now available and its 44 A5 pages list a wide range of components, tools, computer equipment, test gear and technical books. The catalogue can be obtained free of charge from Electrovalue Ltd, 28 St Judes Road, Englefield Green, Egham, Surrey TW20 0HB, tel 0784-33603.

● Cirkit, the re-incarnation of component suppliers Ambit International, will be launching their spring catalogue on April 11th. It will be available from leading newsagents throughout the country for £1.15 and lists over 4000 components along with kits, tools and microcomputer peripherals. Circkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire EN10 7NQ.

● We ran out of space this month, but we'll make sure we give the results of the Reader Survey Free Subscription offer next month.

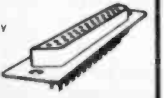
Rapid Electronics

MAIL ORDERS:
Unit 1, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

ACCESS AND
BARCLAYCARD
WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	55p	66p	90p	150p
Right angle	90p	135p	200p	350p
Sockets solder lugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
Covers	100p	90p	100p	110p



CONNECTORS

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

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.

Plug chassis mounting	38p
Socket free hanging	60p
Socket with 2m lead	120p

27128-250 £7.50

Brand new Hitachi product. Ideal for use with the BBC Micro. Please note this price is not a misprint!!

TRANSFORMERS

3VA PCB Mounting
2x6V@0.25A;2x9V@0.15A
2x12V@0.12A;2x15V@0.1A 180p

6VA PCB Mounting
2x6V@0.5A;2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 270p

Standard. Chassis Mounting
6VA: 2x6V@0.5A; 2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 240p

12VA: 2x6V@1A; 2x9V@0.6A
2x15V@0.4A;2x20V@0.3A 350p

SOLDERING IRONS

Antex CS 17W Soldering iron	430
2.3 and 4.7mm bits to suit	85
Antex XS 25W soldering iron	530
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22 swg solder	100
0.5kg 22 swg solder	750

VERO

Verobloc	395
Veroboard Size 0.1 in matrix	
2.5 x 1	26
2.5 x 3.75	95
3.75 x 5	120
3.75 x 17	350
4.75 x 17	465
VQ board	190
Veropins per 100:	
Single sided	55
Double sided	65
Spot face cutter	145
Pin insertion tool	185
Wiring pen	375
Spare spool 75p Combs	6

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 15p.
Push to break 22p.
Rotary type adjustable stop
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

MICRO

		17128-250	750	6800	200	6522	330
		6116P3	390	6802	280	6532	520
		6264P15	2250	6809	600	6551	540
2716	310	4116P4	70	6810	140	8085A	320
2532	380	4164-15	480	6821	140	8156	380
2732 one time programmable	280	41256-15	2850	6840	360	8251	350
		Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
2732	430	Z80A CTC	320	6875	500	8259	400
2764-250	430	Z80A S10	880	6880	100	MC1488	70
2764 BBC	430	Z80A DMA	880	6502	370	MC1489	70

SOCKETS

	Low profile	Wire wrap
8 pin	7p	28p
14 pin	8p	45p
16 pin	10p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	15p	75p
24 pin	17p	82p
28 pin	15p	95p
40 pin	25p	135p

Professional ZIF sockets
24 pin 430p 28 pin 480p
40 pin 595p

COMPONENT KITS

0.25W Resistor Kit. Contains 1000 0.25W 5% resistors from 4.7 ohms thru to 10M. Quantities depend upon popularity i.e. 10x10R, 30x470R, 30x10K, 25x470K. Just £7.90

Ceramic capacitor Kit. Total of 250 miniature ceramic capacitors from 22p to 0.1u. Just £6.90

Polyester capacitor Kit. Total of 110 miniature polyester capacitors from 0,01u to 0.47u. Just £6.90

Preset Kit. Total of 110 miniature preset resistors from 100R to 1M. Horizontal mounting type. Just £6.90

Radial Electrolytic Capacitor Kit. A pack containing a total of 93 miniature caps from 1u to 2200u Just £7.50

Nut and Bolt Kit. Contains 800 assorted items. 100 each 6BA ¼in, ½in, nuts and wshrs, 4BA ¼in, ½in, nuts and wshrs. Just £3.20

CABLES

20 metre pack single core connecting cable ten different colours. 75p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way gery ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	46
LM317K	270	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
DA47	10	1N4006	7
DA90	8	1N4007	7
DA91	7	1N5401	12
DA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mW zen	6
▶1N4148	3	1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11
Clips to suit - 3p each.			
Rectangular:		TIL32	40
red	12	TIL111	60
green	17	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	35
Seven segment displays:			
Com cathode.		Com anode.	
DL704 0.3"	95	DL707 0.3"	95
FND500 0.5"	100	FND507 0.5"	100
10 bar DIL LED display, red			180

5mm superbright LED 250mcd red 30

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	65
▶12V Electronic buzzer	70
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	21
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

EURO CONNECTORS

Gold flashed contacts:	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

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

* * * * * * * * * * * *

NEW 1985 CATALOGUE

Our new fully illustrated 50 page detailed information on over 3000 product lines at the most competitive prices in the market. The catalogue costs just 70p including postage or free with orders over £20 in value. Send for your copy today!

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CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.

Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.

Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p

Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p;

Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.

Cer. disc. 22p-0.01u 50V, 3p each.

Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.

Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.

Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

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

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81	150
SPECTRUM 2 x 28 way edge connector wire wrap.	200
AMPHENOL PLUGS	
24 way IEEE IDC.	450
36 way Centronix IDC	490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	70	70	70	–
16 way	75	80	80	–
20 way	90	90	95	130
26 way	105	110	115	155
34 way	115	130	130	180
40 way	140	140	145	210
50 way	165	165	170	240
60 way	195	195	200	–

LINEAR

		IC7611	98	LM358	50	LM3915	265	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM13600	110	NE570	370	TL061	40
555CMDS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	150	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	130	MC3302	75	NE5534	105	TL071	38
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	65	TL072	60
748	35	ICM7555	80	LM386	90	MF10CN	330	RC4558	40	TL074	110
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195	TL081	30
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220	TL082	50
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	105
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250	UA2240	140
CA3089	200	LM10C	325	LM733	70	ML928	210	SP0256AL2	425	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	Speech data	50	ULN2004	80
CA3130E	85	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	365
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90	ZN414	80
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65	ZN423	135
CA3136	100	LM3342	85	LM2917N8	195	NE555	20	TBA950	220	ZN424P	130
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165	ZN425E	350
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	265	NE566	140	TDA1022	490	ZN427E	600
										ZN428E	450
										ZN459	285
										ZN1034E	200

TRANSISTORS

				BC548	5	BFR40	23	2N1613	30	2N3906	10		
				BC549	10	BFR80	23	2N2218A	45	2N4037	45		
				BC557	10	BFR81	23	2N2219A	28	2N4058	10		
AC125	35	BC158	11	BC558	10	BFX29	30	2N2221A	25	2N4060	10	TIP35C	125
AC126	30	BC158	10	BCY70	16	BFX84	30	2N2222A	20	2N4061	10	TIP36A	115
AC127	30	BC159	10	BCY71	16	BFX85	30	2N2368	25	2N4062	10	TIP36C	130
AC128	30	BC160	40	BCY72	16	BFX86	30	2N2369	18	40360	40	TIP41A	45
AC176	25	BC168C	10	BD115	56	BFX87	30	2N2484	27	40361	50	TIP42A	45
AC187	25	BC169C	10	BD131	40	BFX88	30	2n2646	60	40362	50	TIP120	60
AC188	25	BC170	8	BD132	40	BFY50	27	2N2904	28	40408	50	TIP121	60
AD142	120	BC171	10	BD133	50	BFY51	27	2N2904A	28	2N5457	30	TIP122	60
AD161	42	BC172	8	BD135	35	BFY52	27	2N2905	28	2N5458	30	TIP141	110
AD162	42	BC177	16	BD136	35	BFY53	30	2N2905A	28	2N5459	30	TIP142	120
AF124	60	BC178	16	BD137	35	BFY55	30	2N2906	28	2n5485	35	TIP147	120
AF126	50	BC179	18	BD138	35	BFY56	30	2N2906A	28	2N5777	45	TIP2955	70
AF139	40	BC182	10	BD139	35	BRY39	50	2N2907	24	2N697	20	TIP3055	60
AF186	70	BC182L	10	BD140	35	BSX20	22	2N2907A	24	2N698	40	TIS43	40
AF239	55	BC183	10	BD204	110	BSX29	35	2N2926	10	2N706A	20	TIS43	40
BC107	10	BC183L	10	BD206	110	BSY95A	30	2N3053	28	2N708	25	TIS44	45
BC107B	12	BC184	10	BD222	85	BU205	160	2N3054	55	2N918	35	TIS45	45
BC108	10	BC184L	10	BF180	35	BU206	200	2N3055	50	TIP29	35	TI590	30
BC108B	12	BC212	10	BF182	35	BU208	170	2N3442	120	TIP29A	35	TI591	30
BC108C	12	BC212L	10	BF184	35	MJ2955	99	2N3702	9	TIP29B	35	VN10KM	65
BC109	10	BC213	10	BF185	25	MJE340	50	2N3703	10	TIP29C	35	VN46AF	94
BC109C	12	BC213L	10	BF194	12	MJE520	50	2N3704	9	TIP30	35	VN66AF	110
BC114	22	BC214	10	BF195	12	MJE521	90	2N3705	10	TIP30A	35	VN88AF	120
BC115	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10	TIP30B	35	ZTX107	11
BC117	22	BC237	7	BF197	12	MPF102	40	2N3707	10	TIP30C	40	ZTX108	11
BC119	35	BC238	7	BF198	15	MPF104	40	2N3708	10	TIP31A	35	ZTX109	11
BC137	40	BC308	10	BF199	18	MPSA05	23	2N3709	10	TIP31B	35	ZTX300	14
BC139	38	BC327	8	BF200	35	MPSA06	25	2N3772	170	TIP31C	40	ZTX301	16
BC140	29	BC328	8	BF244B	35	MPSA12	29	2N3773	195	TIP32A	35	ZTX302	16
BC141	30	BC337	8	BF245	35	MPSA55	30	2N3819	32	TIP32B	38	ZTX304	20
BC142	28	BC338	12	BF256B	45	MPSA56	30	2N3820	50	TIP32C	40	ZTX341	20
BC143	30	BC477	22	BF257	32	MPSU05	55	2N3823	65	TIP33A	65	ZTX500	13
BC147	10	BC478	22	BF258	30	MPSU06	55	2N3866	90	TIP33C	75	ZTX501	18
BC148	10	BC479	22	BF259	30	MPSU55	55	2N3903	10	TIP34A	70	ZTX502	18
BC149	10	BC517	30	BF337	35	MPSU56	55	2N3904	10	TIP34C	80	ZTX503	18
BC157	11	BC547	5	BFR40	35	2N118L	22	2N3905	10	TIP35A	105	ZTX504	25

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed.

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	5.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	16.0MHz	200

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2½ x 2"	95
71x46x22mm	50	6 x 4 x 2"	120
95x71x35mm	86	7 x 5 x 2½"	165
140x90x55mm	140	8 x 6 x 3"	205

TTL

		7412	25	7440	25	7476	40	74107	40	74157	80	74180	85
		7413	36	7442	74	7480	50	74109	60	74160	90	74181	230
		7414	60	7444	105	7483	65	74121	50	74161	90	74182	85
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120
7402	25	7420	25	7448	98	7489	170	74125	50	74164	115	74192	120
7403	25	7421	30	7450	25	7490	55	74126	50	74165	90	74193	110
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80		
7411	25	7438	45	7475	55	74100	125	74154	135	74179	90		

CMOS

		4016	26	4034	145	4054	70	4081	18	4502	50	4529	80
		4017	43	4036	270	4055	70	4082	20	4503	45	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	18	4019	35	4040	46	4060	70	4086	60	4508	115	4538	70
4001	18	4020	48	4041	55	4063	80	4089	120	4510	48	4543	65
4002	18	4021	55	4042	45	4066	24	4093	26	4511	50	4549	390
4006	65	4022	60	4043	45	4067	230	4094	70	4512	50	4553	215
4007	18	4023	18	4044	50	4068	18	4095	70	4514	115	4555	50
4008	50	4024	35	4046	60	4069	18	4097	260	4515	115	4556	50
4009	40	4025	18	4047	52	4070	22	4098	70	4516	48	4559	390
4010	40	4026	120	4048	50	4071	18	40106	38	4518	48	4560	110
4011	18	4027	28	4049	26	4072	18	40109	100	4520	48	4584	38
4012	18	4028	40	4050	26	4073	18	40163	75	4521	110	4585	65
4013	26	4029	45	4051	48	4075	24	40173	100	4526	70	4724	140
4014	50	4030	18	4052	48	4076	60	40175	75	4527	60		
4015	42	4031	125	4053	60	4077	24	40193	90	4528	45		

LS TTL

		LS20	22	LS75	38	LS123	70	LS161	60	LS221	78	LS365	42
		LS21	22	LS76	28	LS125	37	LS162	60	LS240	105	LS366	42
		LS22	22	LS78	28	LS126	37	LS163	60	LS241	80	LS367	42
LS00	22	LS26	22	LS83	68	LS132	53	LS164	70	LS242	80	LS368	42
LS01	22	LS27	22	LS85	82	LS136	35	LS165	95	LS243	80	LS373	80
LS02	22	LS30	22	LS86	35	LS138	48	LS166	88	LS244	80	LS374	80
LS03	22	LS32	22	LS90	40	LS139	48	LS170	120	LS245	88	LS375	55
LS04	22	LS37	22	LS92	50	LS145	92	LS173	80	LS247	77	LS377	100
LS05	22	LS38	22	LS93	45	LS147	130	LS174	60	LS251	55	LS378	88
LS08	22	LS40	22	LS95	58	LS148	115	LS175	60	LS257	55	LS390	82
LS09	22	LS42	60	LS96	120	LS151	55	LS190	75	LS258	55	LS393	82
LS10	22	LS47	78	LS107	42	LS153	80	LS191	55	LS259	90	LS399	115
LS11	22	LS48	78	LS109	42	LS154	220	LS192	75	LS266	28	LS541	115
LS12	22	LS51	22	LS112	42	LS155	55	LS193	75	LS273	80	LS670	170
LS13	35	LS55	22	LS113	32	LS157	48	LS195	60	LS279	56		
LS14	45	LS73	28	LS114	32	LS158	48	LS196	75	LS283	70		
LS15	22	LS74	28	LS122	56	LS160	60	LS197	75	LS353	85		

The Rapid Guarantee

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

ORDERING INFO. All components brand new and to full spec. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £20 in value. Minimum order £5. Send cheque/P.O. or Access/Visa number with order. Our new 50 page catalogue is given free with all orders over £20. Available at 70p each. Telephone orders welcome with Access or Visa. Official orders accepted from colleges, schools etc. Export orders no VAT but please add for carriage. We are open Monday to Friday.

Events Diary

Amateur Radio & Computer Fair - April 8th
Bretton Hall College, Wakefield, from 11.00am. Organised by North Wakefield Radio Club. Free Admission, various stalls, film shows, amateur radio talkin on 145.550MHz, beer and refreshments available. Contact S. Thompson, G4RCH, 2 Alden Close, Morley, Leeds LS27 OSG, tel 0532 - 536633.

The Limits of Digital Audio - April 9th
The IEE, Savoy Place, London WC2 at 7.00pm with tea from 6.45pm. Lecture by Dr. Lagadec of Willi Studer AG organised by the Audio Engineering Society. Non AES members welcome to join-up on the evening.

Motorola Power Design Seminar - April 15th
Sheraton Hotel, Heathrow. Programme includes SIDAC technology, switchmode 1,11 & 111, switchmode rectifiers and power MOSFETs and cost is £28.75. Contact Betty Fogg, IEL Travel Ltd, 9 Argyll Street, London W1V 2HA, tel 01- 734 8200.

Innovation '85 - April 16-19th
Cranfield Institute of Technology, Cranfield, Bedford, from 10.00am to 5.30pm daily. IT exhibition sponsored by Rank Xerox and intended to provide a clear overview of the technology for those considering installations and for students and others planning careers. Innovation '85, Bridge House, Oxford Road, Uxbridge, Middlesex UB8 1HS, tel 0895 - 51133.

Northern Computer Show - April 16-18th
Belle Vue, Manchester. Business and professional computer exhibition aimed at both established and first time users. Contact the Exhibition Manager, The Northern Computer Show, Reed Exhibitions, Surrey House, 1 Throwley way, Sutton, Surrey SM1 4QQ, tel 01-643 8040.

Computer Aided Design & Engineering in the Aircraft Manufacturing Industry -April 17th
Institution of Mechanical Engineers at 6.00pm. Lecture by H. Hitch of British Aerospace Aircraft Group. Contact Peter J. Pugh. Engineering Manufacturing Forum, I. Mech. E., 1 Birdcage Walk, London SW1H 9JJ, tel 01- 222 7899.

Hospital Broadcasting Conference - April 19-21st
Newport, Gwent. Residential weekend including training sessions, equipment exhibitions, seminars and debates organised by the National Association of Hospital Broadcasting Organisations. Non-members are welcome and the cost is £51.00 including full board. Contact Alf Partridge, Conference Chairman, NAHBO, c/o 56 Fleet Road, Benfleet, Essex SS7 5JN.

Scottish Design Engineering Show - April 23-25th
Anderston Exhibition Centre, Albany Hotel & Holiday Inn, Glasgow. Exhibition of new design engineering ideas aimed at engineers and managers. Contact Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01-891 5051.

Portable Computing Conference - April 25/26th
Fulcrum Centre, Slough. Conference and exhibition aimed at enabling management staff to assess the value and implications of portable computing techniques and including products from fifty or more leading suppliers. Costs from £109.25 for a half-day to £281.75 for two days. Contact the National Computing Centre, Oxford Road, Manchester M1 7ED, tel 061- 228 668962

The British Electronics Week - April 30th to May 2nd
Olympia, London, 10.00am to 6.00pm daily. The exhibition brings together the All Electronics/ECIF Show, Fibre Optics and Electronic Product Design, and the organisers claim that virtually every electronics company will be represented. Free entry by ticket obtained in advance from Evan Steadman Services Ltd, The Hub, Emson Close, Saffron Walden, Essex, CB10 1HL, tel 0799 26699.

Electronic Production Efficiency Exposition - April 30th to May 2nd
NEC, Birmingham. See February issue for details or phone 0280 - 815226.

Framestores Make The World Go Round

Those of you who manage to stay awake in front of the television may have noticed a change recently in the style of the BBC 1 rotating globe symbol. The old mechanical model with its electric motor and fixed camera has gone, to be replaced by an all-electronic system using framestores.

The BBC's graphic designers came up with a new image of the world, with improved accuracy and detail. The symbol achieves a full three-dimensional effect using solid continents and islands mapped onto a transparent sphere, which is enhanced by colour shading and highlighting. The hardware for displaying the symbol was developed by Engineering Designs and the animation was produced by the staff of the BBC Computer Graphics Workshop. The original map database of 20,000 points was provided by Glasgow University.

The full rotation of the world takes 12 seconds which is equivalent to 600 television fields. To store this digitally would normally take some 250 Mbytes of memory, but a data-saving technique has been invented (patent applied for) which stores a single field of the world in only 8 Kbytes. Each map is imprinted upon the foreground (the highlighted gold) and the background (the shaded blue). For each TV field a map is read from memory in sequence so that the world appears to rotate.

The hardware uses two 800 Kbyte full-resolution framestores to reproduce the blue and gold areas of the symbol and the captions. This data is stored as eight-bit samples in accordance with the internationally agreed coding standard (CCIR Rec. 601). The compressed map data is stored in a separate memory of more than 4.5 Mbytes. Erasable 28 Kbyte memories are used for all data storage, and high-speed digital techniques are employed throughout.

Fourteen such equipments have been installed in the BBC's main and Regional centres, each with their own caption identification. The London equipment optionally displays a caption indicating the page number for programmes subtitled on Ceefax.

Engineering Information Department, BBC, Broadcasting House, London W1A 1AA, tel: 01-927 5432.

ETI Takes Allsorts

One of the advantages of working on a magazine is that you get some very interesting things through the post. Advertising agencies keen to catch your eye send out all manner of promotional novelties, and there is scarcely a desk in the company which does not groan under the weight of pens, ashtrays, diaries and 'executive' toys, each emblazoned with the name of some electronics company or other.

Occasionally some go a little further, and not a few desks still bear the lens-less spectacles, sparklers and mounted lump of coal which mark some of the more notable recent advertising campaigns.

But no-one ever bothered to send us anything to eat. Presumably, writers on food magazines spend their entire working lives chomping through the edible offerings from each morning's post bag, but not so electronics writers.

Until now, that is. Possibly labouring under the impression that ETI stood for Eating Today International, Only Natural Products Ltd, part of the Bassett foods company, recently sent us a packet of their new Traditional Recipe Liquorice.

The accompanying press release waxed lyrical about mixtures of liquorice and aniseed and the marriage of traditional techniques with modern production methods which went into producing this fine product, and indeed, the liquorice does taste pretty good as the Assistant Editor can well testify. But none of this explains why they sent a sample to us.

Still, who's complaining. The Assistant Editor is now considering the idea of starting a regular food column in the hope of attracting more such samples, and wishes it to be known that, if Bassetts are planning any further promotional activity, he'd prefer it if they sent him some Liquorice Allsorts next. Please?
(P.S. Or some Fudge? Ed.) **ETI**

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

ACORN COMPUTER SYSTEMS

BBC Model B Special offer	£300 (a)
BBC Model B+Econet	£335 (a)
BBC Model B+DFS	£346 (a)
BBC Model B+DFS +Econet	£399 (a)

UPGRADE KITS

A to B Upgrade Kit	£65 (d)
DFS Kit	£95 (d)
Econet Kit	£55 (d)
Speech Kit	£47 (d)

ACORN ADD-ON PRODUCTS

Z80 2nd Processor	£348 (a)
6502 2nd Processor	£175 (a)
Teltext Adaptor	£190 (b)
IEEE Interface £282	£282 (b)
Prestel Adaptor	£99 (b)
RH Light pen	£39.50 (c)

BBC FIRMWARE

1.2 Operating System	£7.50 (d)
Basic II ROM	£22.50 (d)
View Word Processor ROM	£48.00 (c)
Wordwise Word Processor ROM	£34.00 (d)
BCPL ROM/Disc	£86.00 (b)
Disc Doctor/Gremlin Debug ROM	£28 (d)
EXMON/TOOL KIT ROM	£28 ea (d)
Printmaster (FX80)/Graphics ROM	£28 ea (d)
ULTRACALC spreadsheet ROM	£69 ea (c)

COMMUNICATION ROM

Termi Emulator	£28 (d)
Communicator	£59 (d)
Commstar	£229 (d)

TORCH UNICON products including the IBM Computible GRADUATE in stock
For detailed specification on any of the BBC Firmware/Peripherals listed here or information on our complete range please write to us.

PRINTERS

EPSON

RX80FT **£225**(a) RX80T **£215**(a) FX80 **£315**(a) FX100 **£435**(a)

KAGA TAXAN

KP 810 (80col) **£265** (a) KP910 (156col) **£359** (a)
JUKI 6100 **£325** (a) **BROTHER** HR15 **£325** (a)

ACCESSORIES

32K Internal Buffer Parallel **£99** (b)

EPSON

Serial Interface: 8143 **£28** (c); 8148 with 2K **£59** (c)
Paper Roll Holder **£17** (d); FX80 Tractor Attachment **£37** (c)
Ribbons: FX/RX/MX80 **£5** (d) FX/RX/MX100 **£10** (d)
RX/FX80 Dust Cover **£4.50** (d)

KAGA TAXAN

RS232 with 2K Buffer **£85** (c) KP810/910 Ribbon **£6.00** (d)

JUKI 6100

RS232 with 2K Buffer **£65** (c) Ribbon **£2.50** (d)
Tractor Attachment **£129** (a) Sheet Feeder **£199** (a)
BBC Parallel Lead **£7** (d) Serial Lead **£7** (d)
2000 Sheets Fanfold Paper with extra fine perforation
9.5" x 11" **£13.50** (b) 14.5" x 11" **£17.50** (b)
Labels per 1000's; single row 3½" x 17/16" **£5.25**(d)
Triple Row 27/16" x 17/16" **£5** (d)

MODEMS

— All modems listed below are BT approved

MIRACLE WS2000:
The ultimate world standard modem coverall all common BELL and CCITT standards up to 1200 Baud. Allows communication with virtually any computer system in the world. The optional AUTO DIAL and AUTO ANSWER boards enhance the considerable facialities already provided on the modem. Mains powered **£129(b)**. Auto Dial Board/Auto Answer Board **£30(c)** each. (awaiting BT approval) Software lead £4.50.

TELEMOD 2:
Complies with CCITT V233 1200/75 Duplex and 1200/1200 Half Duplex standards that allow communications with VIEWDATA services like PRESTEL, MICRONET etc. as well as user to user communications. Mains powered **£64(b)**.

BUZZ BOX:
This pocket sized modem complies with V21 300/300 Baud and provides an ideal solution for communications between users, with main frame computers and bulletin boards at a very economic cost. Battery or mains operated, **£52(c)**. Mains adaptor **£8(d)**.

BBC to Modem data lead **£7.**

DISC DRIVES

These are fully cases and wired drives with slim line mechanisms of high quality, Shuggart A400 standard interface. Drives supplied with cables manuals and formatting disc suitable for the BBC computer. TEAC 80 track drives are supplied with 40/80 track switching as standard. All drives can operate in single or dual density format.

1 x 100K 40T SS:TS55A	£89(b)
1 x 400K 40/80TDS:TS55F	£125(a)
2 x 100K 40T SS:TD55A with psu	£250(a)
2 x 400K 40/80T DS: TD55MP with psu	£365(a)
2 x 400K 40/80TDS:TD55M Mitsubishi with psu	£350(a)
CS55A with psu	£125(b)
CS55F with psu	£169(b)

3M 5¼" FLOPPY DISCS

High quality discs that offer a reliable error free performance for life. Each disc is individually tested and guaranteed for life. Ten discs are supplied in a sturdy cardboard box.

40T SS DD **£15 (c)** 40T DS DD **£18 (c)**
80T SS DD **£22 (c)** 80T DS DD **£24 (c)**

DRIVE ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives	£14.50 (c)
Single Disc Cable	£6 (d)
10 Disc Library Case	£1.80(c)
30/40 Disc Lockable Box	£14 (c)
Dual Disc Cable	£8.50 (d)
30 Disc Case	£6 (c)
70/80 Disc Lockable Box	£19 (c)

MONITORS

MICROVITEC 14" RGB:

1431 Standard Resolution	£165 (a)
1451 Medium Resolution	£240 (a)
1441 Hi Resolution	£399 (a)
1431 AP Std Res PAL/AUDIO	£210 (a)
1451 AP Med Res PAL/AUDIO	£280 (a)
1451 DQ3 Med Res for QL	£239 (a)

Above monitors are now available in plastic or metal cases, please specify your requirement.

KAGA Super Hi Res Vision III RGB	£340 (a)
Hi Res Vision II	£235 (a)

MONOCHROME MONITORS 12":

Kaga Green KX1201 G Hi Res	£99 (a)
Kaga Amber KX1201 A Hi Res	£105 (a)
Sanyo Green DM8112CX Hi Res	£90 (a)
Swivel Stand for Kaga Monochrome	£21 (c)

All monitors are supplied with leads suitable for the BBC Computer. Spare leads available.

ATTENTION

All prices in this double page advertisment are subject to change without notice
ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

SPECIAL OFFER

2764-25	£4.40
27128-25	£9.50
6264LP-15	£12

GANG OF EIGHT INTELLIGENT FAST EPROM COPIER

Copies up to eight eproms at a time and accepts all single rail eproms up to 27256. Can reduce programming time by 80% by using manufacturer's suggested algorithms. Fixed Vpp of 21 & 25 volts and variable Vpp factory set at 12.5 volts. LCD display with alpha moving message. **£395(b).**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.

Softy II	£195(b)
Adaptor for 2764/2564	£25.00(c)

UV ERASERS

All erasers with built in safety switch and mains indicator.

UV1B erases up to 6 eproms at a time	£47(c)
UV1T as above but with a timer	£59(c)
UV140 erases up to 14 eproms at a time	£88 (b)
UV141 as above but with a timer	£71 (b)

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS

No of Ways

	9	15	25	37
MALE:				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw Lock	130	150	175	-

TEXTOOL ZIF

SOCKETS	
28-pin £8.00	24-pin £5.75
	40-pin £9.75

EDGE CONNECTORS

	0.1"	0.156"
2 x 6-way (commodore)	—	300p
2 x 10-way	150p	—
2 x 12-way (vic 20)	—	350p
2 x 18-way	—	140p
2 x 23-way (ZX81)	175p	220p
2 x 25-way	225p	220p
2 x 28-way (Spectrum)	200p	—
2 x 36-way	250p	—
1 x 43-way	260p	—
2 x 22-way	190p	—
2 x 43-way	395p	—
1 x 77-way	400p	500p
2 x 50-way(S100conn)	600p	—

EURO CONNECTORS

DIN 41612		
2 x 32 way St Pin	230p	275p
2 x 32 way Ang Pin	275p	320p
3 x 32 way St Pin	260p	300p
3 x 32 way Ang Pin	375p	400p
IDC Skt A + B	275p	
IDC Skt A + C	350p	

For 2 x 32 way please specify spacing (A + B, A + C).

AMPHENOL CONNECTORS

36 way plug Centronics (solder) 500p (IDC) 475p
36 way skt Centronics (solder) 550p (IDC) 500p
24 way plug IEEE (solder) 475p (IDC) 475p
24 way skt IEEE (solder) 500p (IDC) 500p
PCB Mtg Skt Ang Pin
24 way 700p 36 way 750p

GENDER CHANGERS 25 way D type

Male to Male	£10
Male to Female	£10
Female to Female	£10

RS 232 JUMPERS

(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female Female	£10.00
24" Male Male	£9.50
24" Male Female	£9.50

DIL SWITCHES

4-way	90p	6-way	105p
8-way	120p	10-way	150p

TELEPHONE CONNECTORS

4 way plug	110p
6 way plug	180p
6 way rt ang skt	160p
Flexible cable	
4 way	50p/m
6 way	72p/m

RIBBON CABLE

(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	-
20 pin	75p	-
24 pin	100p	150p
28 pin	200p	-
40 pin	200p	225p

MISC CONNS

21 pin Scart Connector	200p
8 pin Video Connector	200p

74 SERIES

7400	30p
4701	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
7436A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p
7443A	100p

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74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/628	140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	85p
74LS152	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	100p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS244	80p
74LS245	100p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS290	180p
74LS283	80p
74LS290	80p
74LS292	90p
74LS293	80p
74LS295	140p
74LS297	90p
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	500p
74LS324/624	350p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS373	90p
74LS374	90p
74LS375	75p
74LS377	140p
74LS378	95p
74LS379	140p
74LS381	450p
74LS390	60p
74LS393	110p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	140p
74LS640	300p
74LS640-1	300p
74LS641	200p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
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74LS645-1	400p
74LS668	80p
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74S10	50p
74S11	75p
74S20	50p
74S22	100p
74S30	50p
74S32	60p
74S37	60p
74S38	75p
74S40	50p
74S51	45p
74S64	45p
74S74	75p
74S85	450p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	550p
74S132	100p
74S133	60p
74S138	180p
74S140	100p
74S151	150p
74S153	150p
74S157	210p
74S158	200p
74S163	400p
74S169	700p
74S174	300p
74S175	320p
74S188	180p
74S189	225p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	820p
74S240	400
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S283	270p
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74S288	200p
74S289	225p
74S299	550p
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4009	45p
4010	60p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	250p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	35p
4051	65p
4052	60p
4053	60p
4504	80p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	90p
4095	90p
4096	90p
4098	75p
4099	90p
4501	38p
4502	55p
4503	36p
4504	95p
4505	360p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	60p
4528	65p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	75p
4541	90p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	60p
4724	150p
14411	150p
14412	750p
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CA3028A	110p
CA3046	70p
CA3059	25p
CA3080	50p
CA3080E	70p
CA3086	80p
CA3089E	210p
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CA3130E	90p
CA3130T	130p
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CA3140T	100p
CA3160E	90p
CA3161E	200p
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CA3189E	270p
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D7002	£8
DAC1408-8	300p
DAC0800	300p
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ICL7660	250p
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LF353	80p
LF355	90p
LF356N	110p
LF357	100p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	225p
LM311	90p
LM318	150p
LM319	180p
LM324	44p
LM334Z	115p
LM335Z	130p
LM336	180p
LM339	40p
LM348	60p
LM358P	50p
LM377	300p
LM380N-8	150p
LM380	150p
LM381AN	170p
LM382	200p
LM383	325
LM384	220
LM386N-1	100p
LM387	230p
LM389	180p
LM391	180p
LM392N	110p
LM393	385p
LM394CH	400p

LM709	35p
LM710	45p
LM711	100p
LM723	90p
LM725CN	300p
LM733	85p
LM741	22p
LM747	70p
LM748	30p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	600p
LM1889	450p
LM2917	300p
LM3302	90p
LM3900	60p
LM3909	100p
LM3911	180p
LM3914	350p
LM3915	340p
LM3916	340p
LM13600	150p
M51513L	230p
M51516L	450p
MB3712	200p
MC1310P	150p
MC1413	75p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	200p
MC3401	70p
MC3403	65p
MF10CN	3400p
MK50240	900p
MK50398	790p
ML920	500p
ML922	400p
MM6221A	300p
NE531	120p
NE544	190p
NE555	22p
NE556	60p
NE564	400p
NE565	120p
NE566	150p
NE567	125p
NE570	400p
NE571	300p
NE592	90p
NE5532P	150p
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TA7130	140p
TA7204	150p
TA7205	80p
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TBA231	120p
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TBA820M	78p
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TC9109	500p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TDA1010	225p
TDA1022	450p
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TDA1170S	300p
TDA2002	325p
TDA2003	190p
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TDA2020	320p
TDA2030	250p
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TEA1002	700p
TL081CP	40p
TL082	60p
TL084	90p
TL071	40p
TL072	70p
TL074	110p
TL081	35p
TL082	55p
TL083	75p
TL084	100p
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ZN414	80p
ZN419P	175p
ZN423E	130p
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ZN425E8	350p
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6V		7806	50p	7906	50p
18V		7808	50p	7908	50p
12V		7812	45p	7912	50p
15V		7815	50p	7915	50p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
6V	100mA	78L06	30p		
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	80p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
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LM323L	3A 5V	350p
78H05KC	5A 5V	540p
78H12	5A 12V	640p
78P05	10A 5V	900p
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LM350T	10A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	575
78GUIC	1A+VAR	225p
179HGGKC	5A+VAR	675p
79GUIC	1A+VAR	250p
Switching Regulators		
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TL497		300p
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		6N139	175p

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		Red Array (10)	225p
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(bi-colour)	100p	Array(10)	225p
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		R,G,Y	30p

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74C928	650p	DRIVER	
72168	£22		
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6809E	£12
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6829	£12.50
6840	375p
68B40	600p
6850	160p
68B50	250p
6852	250p
6854	650p
68B54	800p
6875	500p
8154	850p
8155	380p
8156	380p
8205	225p
8212	220p
8216	160p
8224	300p
8226	425p
8228	450p
8243	290p
8250	950p
8251A	325p
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8259C-5	400p
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4027-3	300p
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4118-3	500p
4164-15	500p
41256-20	£15
4164-20	320p
4416-20	450p
4532-20	250p
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5516	550p
6116P-3	450p
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18SA030	200p
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74S287	225p
74S288	180p
74S387	225p
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82S123	150p
82S129	175p

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2532-30	550p
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2708	400p
2716+15v	350p
2716-35	550p
2732	450p
2732A-2	700p
2732A-35	550p
2764-25	450p
27C64-25	£10
27128-25	950p
27128-30	950p
TMS2716	500p

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CRT6545	£9
EF9364	£8
EF9365	£25
EF9366	£25
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MC6845SP	650p
MC6847	650p
SFF96364	£8
TMS9918	£15
TMS9927	750p
TMS9928	£10
TMS9929	£10

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AD561J	£20
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AM25LS2521	350p
AM25LS2538	350p
AM26LS31	120p
AM26LS32	120p
D7002	£8
DAC80-CB1-V	£28
DM8131	600p
DP8304	360p
DS3691	500p
DS8830	140p
DS8831	150p
DS8832	150p
DS8833	225p
DS8835	280p
DS8836	150p
DS8838	225p
MC1488	60p
MC1489	60p
MC3446	250p
MC3459	450p
MC3470	475p
MC3480	850p
MC3486	250p
MC3487	250p
MC4024	550p
MC4044	550p
MC14411	900p
MC14412	750p
ULN2003	75p
ULN2004A	90p
ULN2068	290p
ULN2802	190p
ULN2803	180p
ULN2804	190p
75107	90p
75108	90p
75109	120p
75110	90p
75112	160p
75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	120p
75159	220p
75160	500p
75161	350p
75162	400p
75172	300p
75182	90p
75188	60p
75189	60p
75451	70p
75452	70p
75453	70p
75454	70p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	120p
8T95	120p
8T96	120p
8T97	120p
8T98	120p
81LS95	140p
81LS96	220p
81LS97	140p
81LS98	220p
88LS120	500p
9602	300p
9636A	160p
9637AP	160p
9638	200p
ZN425E8	350p
ZN426E8	350p
ZN427E	600p
ZN428E8	450p
ZN429E	210p
ZN447E	900p
ZN459CP	300p

DISC CONTROLLER ICs

6843	£8
8272	£26
FD1771	£20
FD1791	£22
FD1793	£20
FD1795	£28
FD1797	£22
WD2793	£36
WD2797	£32
WD1691	£15
WD2143	£8

CHARACTER GENERATORS

RO3-32513	
U.C.	750p
L.C.	700p

KEYBOARD ENCODERs

AY 5 2376	1150p
AY 5 3600	750p
74C922	550p
74C923	650p

BAUD RATE GENERATORS

MC14411	750p
COM8116	850p
4702B	750p

UART

AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	450p

UHF MODULATORS

6MHz UHF	375p
MHz UHF	450p
Sound & Vision 12MHz	£12

CRYSTALS

32.768 KHz	100p
100 KHz	400p
1.00MHz	270p
Freq in MHz:	
1.8432	225p
2.00	255p
2.45760(L)	200p
2.45760(S)	250p
2.5	250p
2.662	250p
3.276	150p
3.5795	200p
4.00	150p
4.194	200p
4.43	100p
4.608	250p
4.9152	250p
5.000	150p
6.00	140p
6.144	140p
7.00	150p
7.168	175p
8.00	150p
8.867	175p
10.00	175p
10.50	250p
10.70	150p
11.00	300p
12.00	150p
14.00	175p
14.318	160p
14.756	250p
15.00	200p
16.00	200p

LOW PROFILE SOCKETS BY TEXAS

8 pin	39p	22 pin	22p
14 pin	10p	24 pin	24p
16 pin	11p	28 pin	26p
18 pin	16p	40 pin	30p
20 pin	18p		

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	22 pin	75p
14 pin	30p	24 pin	75p
16 pin	42p	28 pin	100p
18 pin	50p	40 pin	130p
20 pin	66p		

Turned Pin Low Profile Sockets

8 pin	25p	16 pin	35p	20 pin	45p	24 pin	55p	40 pin	90p
14 pin	30p	18 pin	40p	22 pin	50p	28 pin	65p		

TRANSISTORS

AD161/2	45p
BC107/8	18p
BC109C	20p
BC169C	18p
BC172	18p
BC177/8	30p
BC179	30p
BC182/3	15p
BC184	16p
BC187	30p
BC212/3	16p
BC214	18p
BC237	16p
BC327	18p
BC337	16p
BC338	16p
BC461	40p
BC477/8	36p
BC516/7	50p
BC547B	20p
BC548C	16p
BC549C	18p
BC557B	18p
BC559C	24p
BCY70	30p
BCY71	36p
BD131	75p
BD132	80p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	80p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	40p
BF256B	50p
BF257/8	40p
BF337	38p
BFR39	32p
BFR40/1	32p
BFR79	32p
BFR80/1	32p
BFR96	180p
BFX29	45p
BFX30	45p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	30p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU205	200p
BU208	200p
BU406	145p
BUX80	800p
BUY69C	350p
E310	50p
MJ413	250p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	150p
MJE3055	120p
MPF102	40p
MPF103/4	40p
MPF105	40p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	30p
MPSA70	50p
MPSA93	340p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP55	180p
TIP120	75p
TIP121	75p
TIP122	80p
TIP125	75p
TIP126	80p
TIP142	120p
TIP147	120p
TIP2955	90p
TIP3055	70p
TIS93	30p
VN10KM	50p
VN66AF	90p
VN88AF	£1
ZTX108	16p
ZTX300	18p
ZTX452	45p
ZTX500	20p
ZTX502	20p
ZTX504	22p
ZTX552	55p
ZTX652	60p
ZTX752	70p
2N697	35p
2N698	45p
2N706A	36p
2N708	36p
2N918	45p
2N930	30p
2N1131/2	50p
2N1613	36p
2N1711	36p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	30p
2N2484	30p
2N2646	50p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	12p
2N3053	38p
2N3054	60p
2N3055	55
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	25p
2N3704/5	25p
2N3706/7	25p
2N3708	25p
2N3773	200p
2N3819	40p
2N3823	30p
2N3866	90p
2N3904	22p
2N3906	22p
2N4036	65p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	60p
2N5485	45p
2N5875	250p
2N5883	375p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	200p
3N140	200p
3N141	200p
3N201	200p
3N204	200p
40290	250p
40361/2	75p
40595	120p
40673	90p
40871/2	100p

DIODES

BY127	12p
BYX36300	20p
OA47	10p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4006	6p
1N4006/7	7p
1N5401/2	12p
1N5403/4	14p
1N5404/5	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

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

TRIACS PLASTIC

3A400V	60p
6A400V	70p
6A500V	88p
8A400V	75p
8A500V	95p
12A400V	85p
12A500V	105p
16A400V	220p
16A500V	130p
T2800D	130p
TIC206D	60p
TIC226D	75p
TIC246D	110p

THYRISTORS

3A400V	18p
8A600V	180p
12A400V	160p
16A100V	180p
16A400V	180p
C106D	45p
MCR101	36p
2N3525	130p
2N4444	180p
2N5060	330p
2N5061	32p
2N5064	35p

ZENERS

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

WW-5

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HOT LINE DATA BASE

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THE ORIGINAL FREE OF CHARGE dial up data base 1000's of stock items and one off bargains.
ON LINE NOW - 300 baud, full duplex CCITT tones, 8 bit word, no parity.

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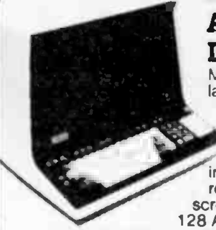
Cure those unnerving hang ups and data glitches caused by mains interference

SD5A As recommended by **ZX81** news letter matchbox size up to 1000 watt load *£5.95*

L2127 compact completely cased unit with 3 pin fitted socket Up to 750 watts *£9.99*



Anderson Jacobson AJ510 VIDEO DISPLAY TERMINAL

Made by one of the USA's largest peripheral manufacturers the AJ510 Professional VDU terminal has too many features to include in space available – just a few are: internal Z80 cpu control, very readable 15" non glare green screen, 24 lines by 80 characters, 128 ASCII character set with lower case and graphics, standard RS232 interface, Cursor addressing, numeric key pad etc. Supplied in good **TESTED** second hand condition with full manual £225.00 + carr £10.00. Data sheet on request.

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Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.

ETRI 99XUOI Dim 92 x 92 x 25 mm Miniature 240 v equipment fan complete with finger guard **£9.95.**

GOULD JB-3AR Dim 3" x 3" x 2.5" compact very quiet running 240 v operation **NEW £6.95**

BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00 **OUR PRICE ONLY £12.95 complete with data.**

MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock Call for Details. Post & Packing on all fans £1.60

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12" KGM 320-321, high bandwidth input, will display up to 132 columns x 25 lines Housed in attractive fully enclosed brushed alloy case. B/W only ***£32.95***

24" KGM large screen black & white monitor fully enclosed in light alloy case Ideal schools, shops, clubs etc ***ONLY £55.00*** Carriage £10.00

A Major company's over production problems, and a special **BULK PURCHASE** enable **TWO** outstanding offers.

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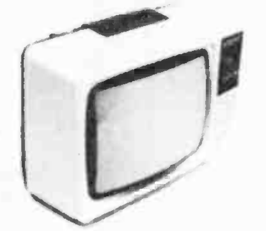
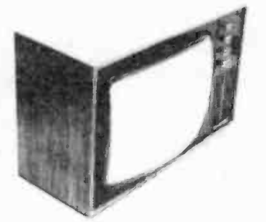


'SYSTEM ALPHA' 14" Multi Input Monitor.

Made in the **UK** by the famous **REDIFFUSION Co.** for their own professional computer system this monitor has all the features to suit your immediate and future monitor requirements. Two types of video input, **RGB** and **PAL** Composite Video, allow direct connection to most makes of micro computers and **VCR's**. An internal speaker and audio amplifier may be connected to your system's output or direct to a VCR machine, giving superior colour and sound quality. Many other features include PIL tube, Matching **BBC** case colour, Major controls on front panel, Separate Contrast and Brightness – even in **RGB** mode, Two types of audio input Separate Colour and audio controls for Composite Video input, BNC plug for composite input, 15 way 'D' plug for RGB input, modular construction etc. etc.

This must be **ONE OF THE YEAR'S BEST BUYS!!!**

Supplied **BRAND NEW** and **BOXED**, complete with **DATA** and 90 day guarantee. **SUPPLIED BELOW ACTUAL COST – ONLY £149.00 + Carr.**



DECCA RGB 80-100 Monitor.

Little or hardly used manufacturer's surplus enables us to offer this special converted **DECCA RGB** Colour Video TV Monitor at a super low price of only **£99.00**, a price for a colour monitor as yet unheard of!! Our own interface, safety modification and special 16" high definition PIL tube, combine with the tried and tested DECCA 80/100 series chassis to give 80 column definition and picture quality found only on monitors costing **3 TIMES OUR PRICE**. In fact, **WE GUARANTEE** you will be delighted with this product, the quality for the price has to be seen to be believed. Supplied complete and ready to plug directo to a **BBC MICRO** computer or any other system with a **TTL RGB** output. Other features include internal audio amp and speaker, Modular construction, auto degaussing 34 H x 24 D, 90 day guarantee. Supplied in **EXCELLENT** condition, **ONLY £99.00** + Carr. Also available **UN-MODIFIED** but complete with MOD DATA. Only £75.00.

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DATA MODEMS

Join the communications revolution with our super range of **DATA MODEMS** with prices and types to suit all applications and budgets!!

Most modems are **EX BRITISH TELECOM** and are made to the highest standard for continuous use and reliability. RS232 interfaces are standard to all our modems, so will connect to ANY micro etc with an RS232 serial interface.

DATEL 2B see **SPECIAL OFFER** centre of this ad

MODEM 13A. 300 baud. Compact unit only 2" high and same size as telephone base. Standard CCITT tones. CALL mode only. Tested with data ***ONLY £45.00 + PP £4.50.***

MODEM 20-1, 75-1200 baud. Compact unit for use as subscriber end to PRESTEL, MICRONET or TELECOM GOLD. Tested with data. ***£39.95 + PP £6.50.***

MODEM 20-2, same as 20-1 but 1200-75 baud ***£99.00.***

TRANSDATA 307A 300 baud acoustic coupler. Brand new with RS232 interface **ONLY £49.95**

DACOM DSL2123 Multi Standard Modem. switchable CCITT or USA BELL 103 standard V21 300-300, V23 75-1200, V23 1200-75 or 1200-1200 half duplex.
Auto answer via MODEM or CPU. CALL or ANSWER modes plus LED status indication. Dim 2.5 x 8.5 x 9 **BRAND NEW** fully guaranteed ***ONLY £268.00 + PP £4.50.***

DATEL 2412 Made by SE LABS for BT this two part unit is for synchronious data links at 1200 or 2400 baud using 2780/3780 protocol. Many features include Auto answer, 2 or 4 wire working etc. etc. **COST OVER £800.** ***OUR PRICE £185.00.***

DATEL 4800, RACAL MPS4800 high speed good condition ***£285.00 CARR £10.00***

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- CALL, ANSWER and AUTO modes
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BRAND NEW CENTRONICS 739-2

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The "Do Everything Printer" at a price that will **NEVER** be repealed. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of ***ONLY £199.00*** + VAT Complete with full manual etc. Limited quantity –Hurry while stocks last.
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HUNDREDS OF PRINTERS EX STOCK FROM £49.00. Call Sales Office for Details.

1 only large **CALCOMP 1036** AO 3 pen drum plotter and offline 915 magtape controller. Good working order. ***£2500.00.***

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PDP 1140 System comprising of CPU. 124K memory + MMU 16 line RS232 interface. RP02 40 MB hard disk drive. TU10 9 track 800 BPI Mag tape drive, dual rack system, VT52 VDU etc. etc. Tested and running	***£3750.00***
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READ/WRITE

To Boldly Go...

Dear Sir,

The article about Electronics for Peace in the April Issue of ETI shows clearly how Electronics Technicians can get themselves a bad name for political naivete. The organisers of this movement should know that including the word "Peace" in the title of any organisation means that it will be regarded as a front for Communist activity. If one then goes on to publish secret information on weapons systems, suspicions are heightened whatever the organisers may say. You may rest assured that anyone foolish enough to join such a movement will be certain to have their phone tapped! In due course they may also be invited to a Worker's Congress in Prague, the bourne whence no worthwhile technician ever returns.

This is not to say that a truly independent political organisation for technicians is not needed, indeed it is vitally necessary. But it should be organised under the banner of FREEDOM, something which is anaethema(sic) alike to Communist and Capitalist systems. (Electronics for Freedom -EfF)?

In every society of the world the Technician suffers exploitation by immature and often incompetent megalomaniacs. Technicians as a class are rather meek, but if we are to inherit the earth we have to find a better way to make the concensus (sic) of our views publicly known. We have to assist in creating a just society, make communication between peoples easier and use our skills to expand the capabilities of the mind. Electronics is vital in all this, so the objectives of the organisation would be as follows:

1. *Making possible secret mass referenda on all important political issues by electronic means using TV, radio or telephone.*
2. *Development of Computor Systems, Languages and Programmes to formulate just and unambiguous legislation, regulations and codes of practice.*
3. *Development of personalised communication systems with miniaturised privacy devices (scramblers), and computerised translation facilities.*
4. *Development of bioelectronic devices and biofeedback methods for mind control and expansion. Also to enable the assessment and evaluation of personality types.*

The last objective is the final frontier of electronics - understanding the nature of the mind and discovering who are fit persons to be trusted with power. These activities are far more worthwhile than merely ferreting out details of obsolescent wepons systems for the benefit of the RIS.

Anyone who feels they would like to form an organisation on these lines can get in touch with me at the University of Surrey where I work.

Yours faithfully,
Keith Wakeham
Church Crookham
Hampshire

Nice try, Mr. Wakeham, but you can't fool us. 'The final frontier', all that stuff about 'Computor Systems', 'personalised communication systems' and expanding 'the capabilities of the mind'. Beam us up Scottie, if you're not Mr. Spock. By the way, we gather Captain Kirk's been looking for you.

Bass From The Wood

Dear Sir,

I have scanned 'The Final Link' by Vivian Capel (ETI April 1985) with interest. It was surprising for me that no mention was made of studio and concert hall acoustics. There were two programmes recently on Radio 3, concerning concert hall 'design' and the reactions of performers and listeners. Even in these programmes, I felt that the experts have somehow got several matters wrong.

It is well known that the Festival Hall and the Barbican are unsatisfactory - due, it is said, to the air-conditioning ducts under the seats absorbing most of the deep bass.

No mention was made of Bayreuth or Covent Garden, and it was implied that hard walls (brick or stone) were good. My experience is that the bass from Bayreuth is very good, the walls being, I believe, of wood.

A visit to Covent Garden immediately exposes the good bass, but on my equipment the bass from there is rather weak. I wonder if this is because suspended microphones tend to 'blow away' from the deep bass?

A recent broadcast from a cathedral in Wales sounded very bad indeed (stone wall etc). It was a Mozart string orchestra, and even a moderate volume setting was too high. The only solution was to turn the volume very low.

If the bass of the hall is good, volume can be turned surprisingly high, with every pleasure, to my ears. Some Wagner records come through very well.

A particularly irritating habit of the BBC is to broadcast a concert at reasonable volume level; then on return to the studio the voice is often too loud, even painful, so the volume has to be turned down. This could be due to a combination of poor studio acoustics, poor monitor speakers and insensitive control engineers.

I also find that only tape at 7 1/2 ips gives really good HiFi. Discs are not bad with the Goldring Epic cartridge (only £15) but here again volume has to be kept fairly low, to avoid listener fatigue and discomfort. Here again I suggest it is the deep bass which goes wonky. Of course, commercial discs do not give much in the way of really deep bass. I find that some popular discs have quite good bass almost regardless of the size and make of the speakers. I'd guess these attractive results are given by microphones on rigid heavy stands set close to the bass instruments.

I use a Quad 303 amplifier and my speakers are approximately 10 cubic feet each made of brick and stone. Upper register is via Treleax and Olidax horns (sic), attenuated

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BZX 88 C3V3	5p
BZX 88 C3V9	6p
BZX 88 C4V7	5p
BZX 88 C6V2	5p
BZX 88 C9V1	6p
BZY 88 C11	5p
BZY 88 C12	3p
BZX 61 C15	9p
BZX 61 C16	9p
BZX 79 C5V6	10p
BZX 79 C6V8	10p
BZX 79 C13	10p
BZX 79 C20	10p
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HM6116P-3 16k cmos ram 150nS 2716.
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HM6116I-2 16k cmos ram 120nS ceramic.
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TC5501P 1k cmos ram 5v 450nS.
2114LC 1k x 4 static ram 450nS.
2114LC-1 1k x 4 static ram 300nS.
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HM6147P 4k x 1 static ram 70nS.
2147EC 4k x 1 static ram 70nS.
uPD2167-3 16k x 1 static ram 55nS.
HM6167P 16k x 1 static ram 70nS.
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TC5565PL-15 8k x 8 cmos static ram.
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uPD27232C 32k eprom 450nS 1 prog only.
2732-30 32k 5v eprom 300nS.
2732-25 32k 5v eprom 250nS.
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HD6303 Micrprocessor cmos 6801/3.
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80C35 Microprocessor cmos 8035.
80C39 Microprocessor cmos 8039.
MSM80C85ARS Micrprocessor cmos 8085.
TMP8035 Microprocessor 8-bit.
M5L8039P-6/8 Microprocessor 8-bit.
8085A Microprocessor 8-bit.
uPD8086D Micrprocessor 8-bit.
uPD8088 Microprocessor 16-bit.
uPD8741A Micrprocessor + eprom.
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MSM81C55RS Ram + I/o cmos.
uPD8156 Ram + I/o.
uPD8212 I/O port.
uPB8214 Priority Interupt Controller.
uPB8216 Bus Driver.
uPB8228 System Control/Bus Driver.
uPD8237A-5 DMA Controller.
uPD8243C I/O expander.
uPD82C43C I/O expander cmos.
8251A USART.
MSM82C512ARS USART cmos.
8253-5 Programmable Interval Timer.
MSM82C53-5RS Programmable cmos Interface.
uPD8257-C Programmable DMA Controler.
uPD8259AC Programmable Interupt Cont.
uPD8259C-5 Programmable Interupt Cont.
8279-5 Keyboard/Display Interface.
uPD8282 Octal Latch.
uPD8283 Octal Latch.
uPD8284A Clock Generator/Driver.
uPD8286 8-bit bus transceiver.
uPD8287 8-bit bus transceiver.
uPD8288 Bus Controller.
uPD8289 Bus Aribiter.
*8755A 2k x 8 eprom + I/o.
HD46503 Floppy Disk Controller.
HD46505SP 6845 equivalent.
HD46810 MC6810 equivalent.
F6821P Farichild MC6821 equivalent.
HD68A40 Programmer Timer Module.
HD4650 MC6850 equivalent.
HD46850 ACIA.
HD46852 SSDA.
HD146818P Hitachi clock peripheral,
Prices on application

MISCELLANEOUS IC's

uPD765AC Floppy Disk Controller.
MB8876 Fujitsu FDC FD1791-1/2.
MB8877 Fujitsu FDC FD1793.
MSM5832RS OKI Real Time Clock micro.
uPD7001 8-bit cmos a-d convertor.
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uPD7201 Peripheral Controller.
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uPD3301D-2 Programmable CRT Controller.
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uPD7220D Graphics Controller.
Prices on application

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Prices on application

MISCELLANEOUS

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RELAY 20601-L28-231	13p
FILTER 30K6	23.40p

to suit 12" woofers set in the enclosures.

There are some listening room effects - it is a longish room with plastic/concrete floor.

I hope these remarks could lead to further work along the lines of Mr. Capel's aticle.

Yours sincerely,
John Elliott MSc
Farnborough
Hants.

Personally, we listen to most of our music in the bath and we sometimes wonder if the lack of fidelity isn't due to the water in our ears.

Film Facts

Dear Sir,

I read with interest Mr. Armstrong's feature on 'telecine' and whilst agreeing with almost all within there are several points of accuracy that I would contest.

1. The aspect ratio between the cinema and television is not necessarily different. The 1.33 to 1 (4 to 3) aspect ratio used by most TV stations throughout the world is in fact Motion Picture Academy Ratio. Almost all films pre-1950, many films of the 50's and 60's and all film series made for television are to this ratio. In the early years of television round display tubes were used and 5:4 would have been displayed with better efficiency; despite this 4:3 for television was chosen so as to be compatible with the cinema.

2. The frame of Cinemascope film is not the same size as an ordinary 35mm film. A standard Academy frame is .625" high, there are quite broad 'rack lines' between frames. The frame height of Cinemascope is .715" and the rack lines are very narrow (35 thou.)

3. A true Cinemascope, that is 20th Century Fox, film will have 4 track magnetic sound; to accommodate this and not encroach on the picture area the sprocket holes on the film are smaller, the pitch is the same, however.

4. In the sequence of operations for a projection system at step two it is said that a claw engaging with the holes in the film moves the frame into position. Although 35mm cameras may use claws, 35mm projectors do not. The usual practise is to use an intermittent sprocket driven by a Maltese Cross mechanism.

5. Although it is common practice to refer to all anamorphic formats as Cinemascope this is rather akin to calling all vacuum cleaners Hoovers. Cinemascope was in fact a trade name of an anamorphic system used by 20th Century Fox. This system has now not been used for some years; most anamorphic films now are shot to the Panavision standard on their equipment.

Yours faithfully,
Nick Lyons
Normanton
West Yorkshire

Help-line

Dear Sir,

I have been a contented and successful project builder, reader of your magazine for quite a while now. With such outstanding comprehensive coverage and useful up to date information, not to mention those marvellous projects, that unanimously puts your magazine aside from the rest.

You must now be wondering why I am writing to you. It is because I am in need of some information. Being an electronic enthusiast for quite some years now, I was happily employed and able to carry out projects, now due to unexpected redundancy, I am now turning those projects into my profession.

I am now in the proces of setting up a design and production workshop, specialising in the designing and manufacturing of:- Disco, Group, P A, HiFi and Studio Equipment. As these units will have a robust rugged but classic look! Further to this the units will have high specifications, useful tailor-made units to suit.

With such a marvellous ornate new venture, I can not possibly let down the appearence of my units. By using the readily available commercial standard size and shapes slider potentiometers, plus the unavailability of stepped rotary controls (pots), not to mention the control knobs. If you could be so kind as to enlighten me as to who or where I could obtain the following:

1. Slider potentiometers, with travel less than 40mm both single and stereo.
2. Stepped rotary potentiometers.
3. Stepped slider potentiometers.
4. A manufcturer who would make any of the above to my specifications and finally control knobs not available to retail outlets.

Your help will be greatly appreciated from a happy and grateful reader.

Yours faithfully,
R. Leslie
Wolverhampton

From one 'electronic enthusiast' to another - whirr, click, pyangg! No, but seriously, we've printed Mr. Leslie's letter because we can't really help him, although his predicament must be shared by many. ETI would like to see itself helping those in need of technical information of the sort Mr. Leslie seeks - hobbyists and, especially, people seeking to make the best of enforced redundancy with the help of their hobby. Since we are already overstretched producing the magazine and answering specific queries about the projects we have published, there is room for a 'reader-to-reader' enquiry service, through which ETI readers could help each other.

If anyone can offer Mr. Leslie some assistance we would be pleased to forward any details. If anyone seeks help from other readers, not necessarily on matters dealing with ETI projects or features, we would be happy to publish their request in what we hope will become a special 'help line' section of the magazine.

The one thing we'd ask is that you keep your letters short, preferably sticking to the meat of the query. We will, in any case, edit them if necessary.

Please send letters for this page to: Read/Write, c/o the Editor, ETI, ASP ltd, 1 Golden Square, London W1R 3AB. Send Help Line queries to Help Line, c/o the Editor, ETI at the same address. Please note that any letter we receive is liable to be published unless clearly marked 'Not for publication'. We reserve the right to edit letters for space reasons. **ETI**

DIGIVISION INSIDE OUT

A digital Dallas? Computerized Coronation Street? Vivian Capel takes a look at the future of television and finds it's much the same.

During the early days of post-war television when I worked with a television service company, engineers would often append the comment 'digital interference' to their job sheets. No, they weren't blaming interference from a nearby computer, they were few and far between in those days, and most, in any case, were analogue. Otherwise expressed, they were reporting 'finger trouble', faults brought on by the television viewer fiddling with the array of presets that adorned the rear panels and sides of the TV receivers of the day.

Digital techniques were then known only to a small coterie — in the computer industry, mainly. Such things could never be applied to audio or television. Why, how could they accomodate the vast number of valves that would be needed, to say nothing of powering them?

The coming of semiconductors changed all that, but there seemed little to be gained from abandoning the simplicity of analogue signal processing. So, domestic sound and vision reproducers have remained firmly analogue - until recently. With its narrower bandwidth, audio was the obvious candidate for digitization. The compact disc has certainly shown what advantages can be obtained by digital signal storing and processing, with its low distortion and absence of noise.

But what about television? Professional studio equipment has employed digital techniques for many years. Independent television has had a digital standards converter in use since 1972, and the numerous weird effects increasingly seen on our TV screens demonstrate the growing use of digital video effects generators in broadcast studios.

Since 1977, ITT Semiconductors has been developing methods of applying digital techniques to domestic TV receivers. Seven years later, and at a cost of some £20 million, what is claimed to be the world's first digital domestic TV receiver went on sale — the Digivision D1000.

Reception

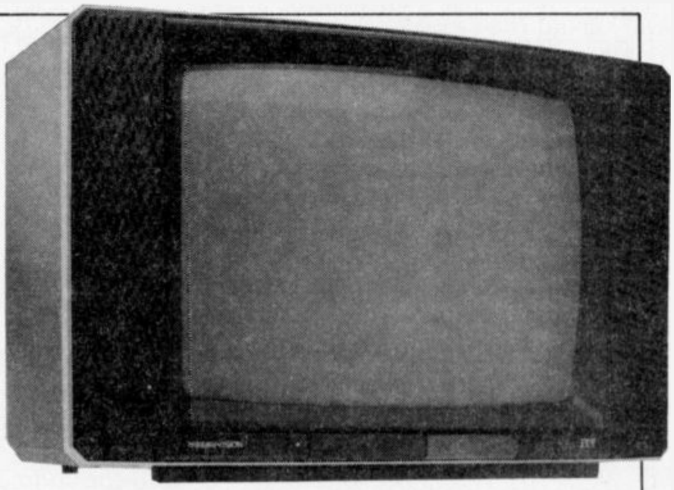
How does it work and what does it do? The principal source of signal degradation in any system is the transmission process - whether that be broadcasting or some form of analogue recording. The compact audio disc overcomes most signal degradation by recording and replaying digital signals but this advantage is not obtainable with digital TV at present, because the television signal itself is not digital. The set can only do its best with whatever is presented to it in the way of a normal analogue transmission via the aerial.

Because of this, the tuner and the IF stages of the Digivision receiver are conventional, as is the vision demodulator. From that point on the digital circuits take over.

The vision signal is converted to a 7-bit digital data stream. By employing a system of averaging on alternate lines, 8-bit resolution is achieved giving 255 sampling levels. As with a conventional TV, the colour or chroma signal is processed separately from this luminance or black-and-white portion.

The eye is less sensitive to colour definition than light and shade detail, which is why the chroma signal has a much smaller bandwidth than the luminance. Furthermore, the eye is less aware of small hue differences than shade gradations. Hence, the chroma signal is represented here by 63 sampling levels, obtained by a 6-bit data stream.

Ironically, it is the sound signal that gets the best treatment digitally; a 14-bit sampling system gives 16,383 levels. This is of course as it should be, because the ear is very sensitive to the distortion produced by an inadequate number of sampling levels, whereas the eye is less critical of gradation differences.



ITT's Digivision - the look of the future?

Processing

After conversion to digital signals the luminance information is filtered, the contrast is set, and black-level clamping and white balancing are carried out. A single chip is used for the video processing, and this includes the colour decoding. For PAL decoding a delay line is used in the normal analogue receiver. The function of this is to delay the signal for 64 *u*s, or one complete line, in order to obtain the averaging on alternate lines to cancel phase aberrations. However, in place of the conventional glass delay line and ultrasonic transducers at each end, the delay is obtained by blocks of RAM with capability for storing the required one line. This occupies far less space than a glass delay line - only three square millimetres of chip area. The store is accomodated in the video processor chip along with the filters and other decoding functions.

The chip permits the decoding of NTSC colour signals as transmitted in America, and in this mode the delay circuit can be used as a comb filter for separation of the chrominance and luminance signals.

After processing and decoding, the digital signal is converted back to analogue. This task is performed on the same chip that carried out the A/D conversion. From there the three colour outputs are taken to conventional output stages to drive the display tube.

Deflection signals are generated digitally in a further chip in which division and count-down circuits provide both line and field scanning pulses which drive their respective output stages. These are synchronised from the digital video input.

A master clock generator provides the pulses for all the conversion and processing functions, and a microcomputer chip controls the whole operation. It scans the control keyboard which can have up to 32 keys covering brilliance, colour, and volume, among other things. Included is a phase-locked loop which provides tuning for VHF and UHF, plus a memory to store data for receiving up to 30 channels. The chip also incorporates a memory to store factory-programmed data for tube drive and timebase control. The clock generator runs at 17.73 MHz, four times the colour subcarrier frequency.

In the sound circuit, one chip converts to digital and back again to analogue to feed the sound output stages and speakers, just as with the video signal. It seems as though the designers missed a trick here. If they had employed PWM (pulse width modulation) to drive the speakers there would have been no need of an analogue output stage which generates considerable distortion. In between the A/D and D/A conversions, another chip takes care of the sound signal processing. It includes the ability to deal with two-carrier TV stereo signals.

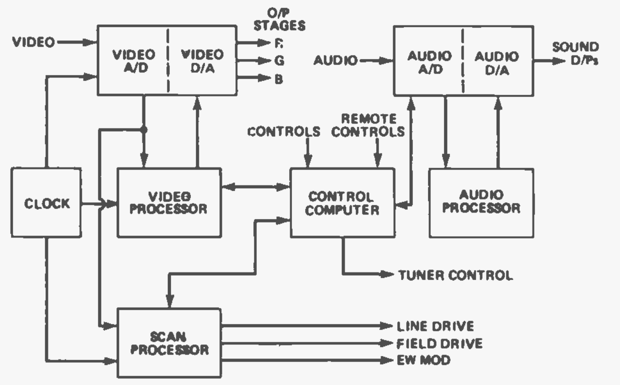


Fig. 1 Block diagram of the Digivision Circuit.

Sound reproduction is usually the lowest priority with most TV sets and the results are pretty 'lo-fi'. Here though, some attention has been given to this side of matters. The twin output stages deliver 15 watts each to two, three-driver speakers having bass-reflex loading.

Servicing

One thing that Digivision service engineers will not be able to report is 'digital interference' — in spite of it being a digital device. There are no viewer-accessible presets, only the normal controls. One internal preset sets the HT voltage, which is common practice with conventional TV's. All other adjustments such as picture height and width, tube-drive and timebases are made by re-programming the control computer. This can only be done by using a service computer that plugs into a socket provided for the purpose. ITT has dubbed this device an 'electronic screwdriver'. Maybe, but a conventional screwdriver costs a lot less! Dealers purchasing five Digivisions get one service computer

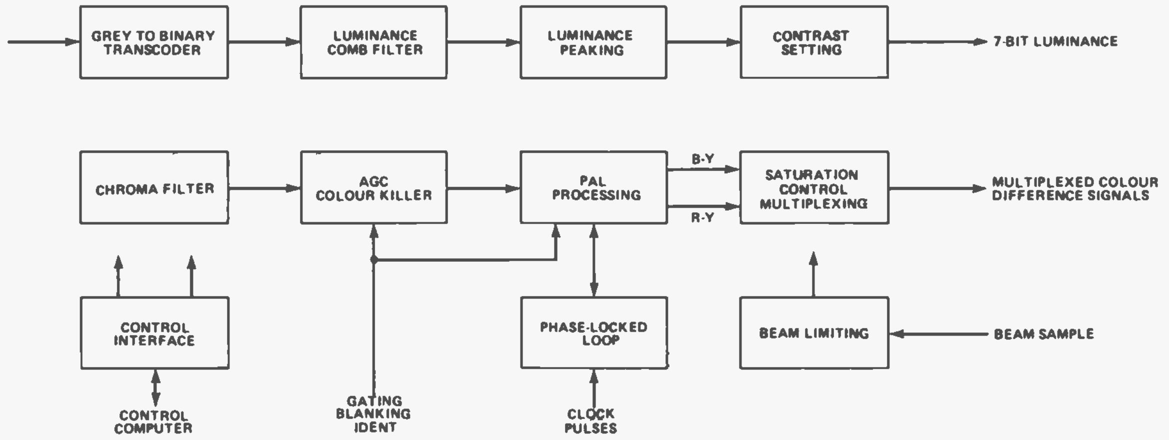


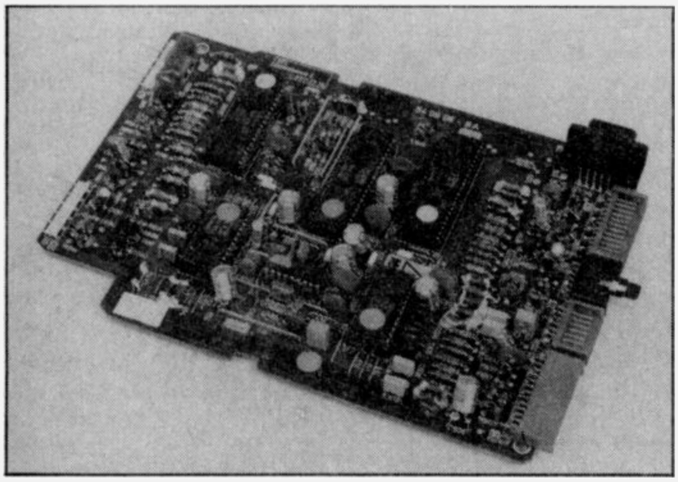
Fig. 2 Simplified function chart of the video processor IC.

free from the makers. The snag is that owners who are qualified and prefer to do their own servicing, especially after the guarantee has expired, will be without the means to do so.

Apart from the clock generator and tuner interface IC's there are six VLSI chips. If you didn't know, that stands for Very Large Scale Integration, and just how large can be gathered from the fact that one chip can contain up to 200,000 transistors.

Possible Enhancement

That brings us to the obvious question, is it all worth it? Are there dramatic improvements comparable to those obtained with digital audio recording? Given a good signal from the aerial and good programme material, a conventional analogue TV which is properly adjusted is capable of excellent results. What limitations there are arise from the transmission system. These are: horizontal definition, line structure — which is easily noticeable on very large screens - and mutual interference between colour and luminance signals due to the way the colour sub-carrier is interleaved into the video spectrum to save bandwidth.



The main processor board of the Digivision.

These, and degradation due to transmission and reception conditions, will be suffered by the digital set just as much as the analogue. Real improvement could only be expected when the transmissions themselves become digital — which is likely to be a long way ahead. What then about reliability?

The makers claim that peak performance is held longer than with conventional sets because the onboard computer monitors performance continually and makes the necessary adjustments to maintain it. However, to put things in perspective, modern TV sets need far less adjustment than did their predecessors. Most faults occur in the display tube and deflection circuits which are conventional with the Digivision. Most sets these days contain a number of chips, and all can and do break down. Statistically, the more semi-conductor elements a chip has, the greater the chance of failure. On this basis the VLSI IC's offer less prospect of longevity than the far simpler units employed in analogue receivers. All the same, there are many complex chips in daily use that have a good record of reliability and only time will tell with the Digivision.

In the absence of any major benefits to the viewer, it seems that digital television at present is an exploratory step.

The number of scanning lines could be increased. Plans are already afoot to double the line number by using 2.2 kbyte of RAM for line storage to enable each line to be traced twice. This would not increase the actual vertical definition, but the doubling of the lines would make them virtually indistinguishable, even on very large screens.

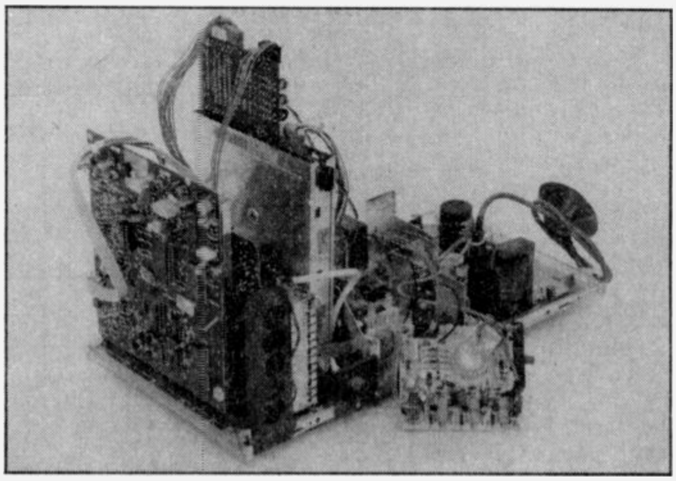
Another possibility is to use a field store that will hold a complete field of picture. By use of this the TV could be given a still-frame capability just like a video recorder. The only snag is that you could not continue viewing from where you left off, or inch to the next frame, since material transmitted while you were viewing the still frame would have passed. But some studio trick effects would be possible.

Two pictures could be displayed at the same time. With TV programmes as boring as they are, this could be a boon, as viewers could then transfer their attention to whichever seemed the most interesting! Zoom facilities could also be incorporated enabling a portion of the picture to be enlarged at will. Another possibility is the enhancement of the received signal by identifying and eliminating ghosts caused by multipath reception. With the problems caused in some areas by high rise buildings, this would give a positive advantage over analogue sets.

Other Makers

ITT have proved to be the first in the field but others are following. The Finnish firm Salora have produced a digital receiver which is now on sale and uses the same chips as Digivision. They are the first with the smaller 20 and 22-inch screen sizes, the ITT being 26-inch. Salora call their offering the Digicomputer, which could be a little misleading. Optional extras include a satellite tuner and PAL/SECAM/NTSC converter.

We may be seeing many other makers producing digital TV's, because the ITT subsidiary Intermetall — which makes the chips at Freidberg — are supplying packages of the complete line-up of chips to such firms as Matsushita, Toshiba, Sharp and Zenith. Some 21 companies have signed up to buy the package from Intermetall. Knowing the cut-throat competition exist-



The sound and picture goes in here and it comes out...

ing among these giants, it is almost certain that their research teams are busily finding ways to produce their own, with sufficient differences and perhaps improvements to circumvent the patent laws.

A further chip is being added to the package from Freidberg and that is one that will process any of the existing European teletext systems (except the French Antiope). To assemble all that on one chip is quite an achievement, especially as it includes automatic switching between the systems.

There are also plans to produce a digital VHS video recorder. This could be a major step forward, as the reproduction from domestic video recorders leaves much room for improvement. It all depends on whether they can digitize the main noise and distortion producing areas. Principally, these are in the recording process itself and with present technology digital video recording using the VHS format seems very unlikely.

As for those future gimmicks, the frame store and such, these are well in the future and present sets will not be adaptable. It requires about 4 megabits for a high quality frame store, and at present 1 megabit seems the maximum for a single chip.

It appears that digital TV — along with about practically everything else — is the set prospect for the future. (I wonder if we will ever get crisp, clear, digital hi-fi telephone conversations with no clicks, crackles and noise?). Present purchasers of digital sets will have the satisfaction of being in at the start of a new technology, but at present there are few other compensations for the extra cost.

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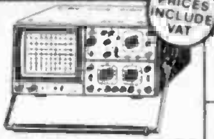

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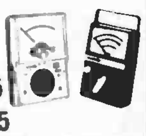

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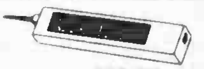

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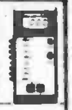

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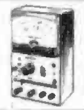

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THE REAL COMPONENTS

We may be biased, but we think the majority of you will get quite carried away by John Linsley Hood's article on transistors.

I looked last month at the way in which transistors were developed and how they had evolved into their present form. I now propose to look at some of the various contemporary types.

As a working electronics engineer I tend to look unsympathetically at the propaganda of the 'back to valves' brigade. The enormous scope for circuit design now available to the electronics fraternity is due entirely to the wealth of devices at our disposal. Of course, one has to know what devices are available and how to use them properly so that they give of their best, and it is also necessary to know their individual strengths and weaknesses so that one always uses the most appropriate device for the job in hand. There are a lot of them to choose from, so let us take a look.

Small Signal Junction Transistors

These exist as small metal cans or blobs of moulded plastic with three (or sometimes four) wires, as shown in Fig. 1. There isn't much difference nowadays between the longevity and reliability of plastic and metal can encapsulations, especially since the can is often just a receptacle into which epoxy resin has been poured to hold the silicon chip in place. Metal can types, especially those which are hermetically sealed, tend to be a good bit dearer than plastic moulded types.

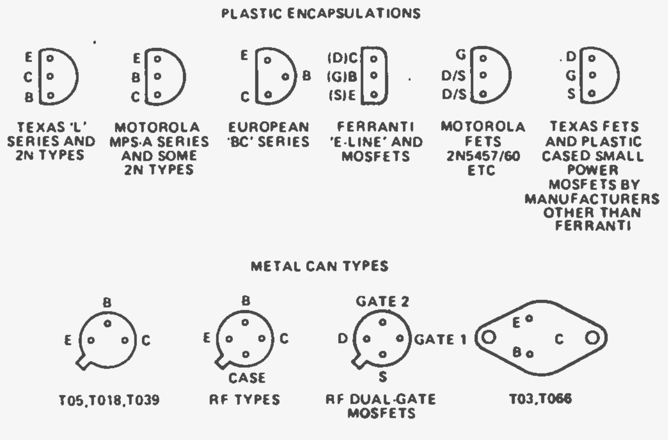
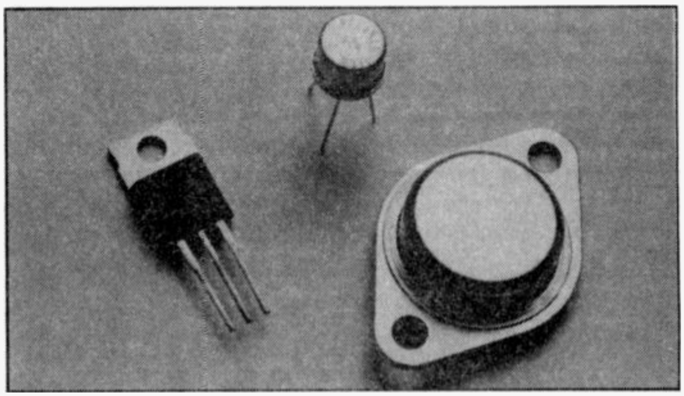


Fig. 1 Common transistor connection arrangements.



The chip inside the encapsulation will normally be of either the planar or the epitaxial planar type, both of which are shown in Fig. 2. Epitaxial (or epitaxial base) types have an additional thin layer of a different type of silicon grown on the chip by vapour phase techniques before the other diffusions have been made. They are cheaper and generally work better than other types and are therefore the most commonly used.

Typical power dissipations for small signal plastic transistors range from about 250 to 650 milliwatts. Metal can ones will typically handle from 300-1000 milliwatts dissipation. It is good practice to keep dissipations down to about half of the rated maximum.

Small signal NPN and PNP transistors can generally be regarded as 'maids of all work' in the small circuit field. They are easy to use, inexpensive, reasonably difficult to damage, and will work well when used within their limits. Certain types are particularly suited for use in very low-noise, low impedance applications. Because they can be used in complementary symmetry arrangements, some very crafty circuit layouts are possible. The circuit symbols for these devices are shown in Fig. 3a.

Darlington Transistors

These consist of a pair of small signal transistors coupled together in one case. They are available in NPN and PNP types and the circuit symbol for the NPN type is shown in Fig. 3b, with my own preferred symbol shown in Fig. 3c. They are similar to other junction transistors except that they have current gains of between 20 000 and 50 000 and relatively high input impedance. Typical input impedances would be from 100k to 250k for output currents of between 2 and 10mA, which is the range

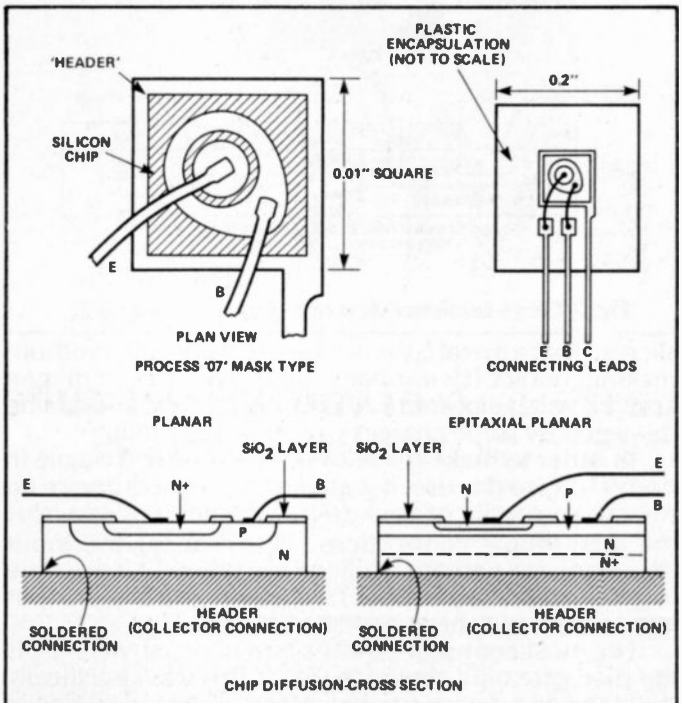


Fig. 2 The construction of a typical small-signal, plastic-encapsulated transistor.

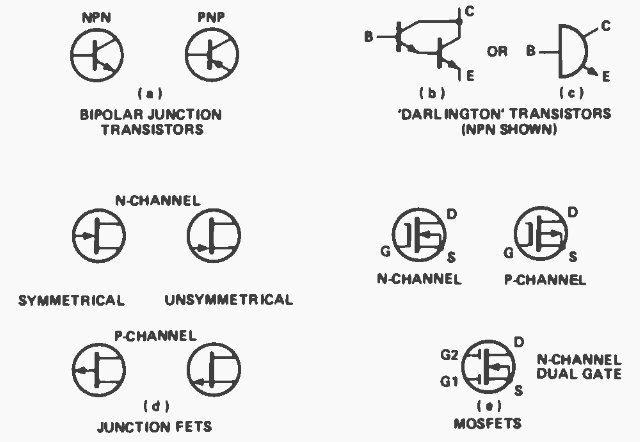


Fig. 3 Transistor circuit symbols.

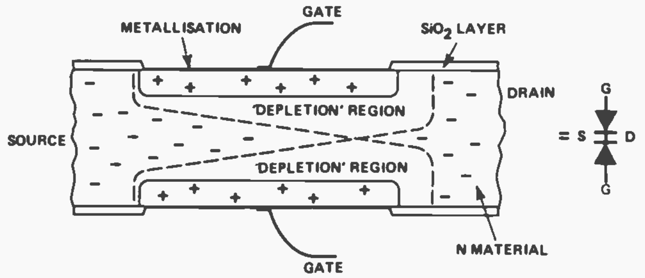
over which they work best. The Motorola MPSA-12/14 (NPN) and the MPSA-62/64 (PNP) are good examples. Inevitably they are a bit dearer than standard single transistors.

Junction Field Effect Devices

These were the original high impedance transistor types and are represented in circuit diagrams by the symbols shown in Fig. 3d. Their physical construction is shown in Fig. 4.

They differ from junction bipolar transistors in that their input terminal, the gate, is normally non-conducting. In fact, it is a reverse biased junction diode, and the only current which will flow is the normal reverse leakage current of such a diode. Typical input impedances for good quality devices of this type range from ten thousand to a million megohms.

Contrary to popular legend, these devices will not normally be damaged by static charges any more than any other small signal diode would be, so they don't need especial care in use. They come into their own where very high input impedances are needed, and where the extra cost of using a junction FET is justified — they are about five times the cost of an equivalent bipolar device. The better examples are also less noisy in high impedance circuitry than bipolar devices but one needs to choose carefully because some of the cheap and cheerful junction FETs are not very good in this respect.



(NOTE UNSYMMETRICAL SHAPE OF DEPLETION REGION DUE TO GREATER DRAIN-GATE POTENTIAL)

Fig. 4 Cross-sectional view of an N-channel FET, showing the depletion regions which result when the device is just biased to cut-off.

Junction FETs also make good RF amplifier devices at frequencies up to about 300MHz, and can offer very low noise in this application. In circuitry, they will tend to have a lower stage gain than bipolar devices, unless a very high impedance output load is employed which usually means an active load of some kind. They have a very flat drain current/drain voltage characteristic which makes them good at rejecting HT line ripple effects, and also allows them to be used as nearly ideal constant current sources.

The chip construction of a junction FET is shown in Fig. 5. The chip acts as a thin conducting layer of P-type or N-type silicon (germanium is almost never used, though it is still used sometimes in bipolar devices), into which a depletion layer will expand, narrowing and finally cutting off the undepleted layer through which current may flow as the reverse bias potential applied to the gate is increased. Junction FETs are usually, though not always, symmetrical, so source and drain may be interchanged.

Small Signal MOSFETs

These devices, sometimes also known as insulated gate field effect transistors or IGFETs (MOSFET stands for Metal Oxide Silicon FET), have the general construc-

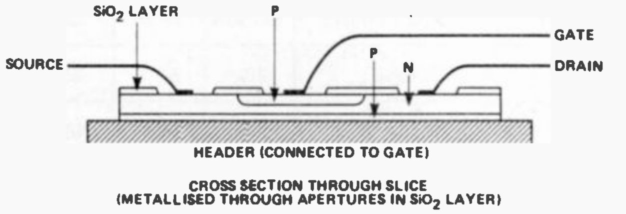
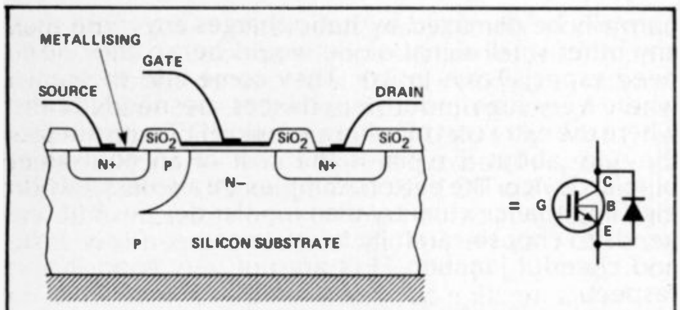
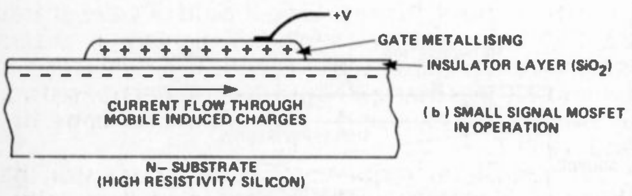


Fig. 5 Cross-sectional view of an N-channel small signal junction FET.



(a) TYPICAL SLICE CROSS SECTION FOR SMALL SIGNAL 'LATERAL' MOSFET NOTE VERY THIN SiO_2 LAYER OVER GATE



(b) SMALL SIGNAL MOSFET IN OPERATION

Fig. 6 Cross-sectional views showing the construction and operation of a MOSFET.

tion shown, for the wafer, in Fig. 6a. They work on the principle that if a charge (i.e., a voltage) is applied to an insulating layer, a charge of the opposite type will be attracted to the other face, as shown in Fig. 6b.

If that other face happens to lie in the body of a slice of high impedance (low impurity, or intrinsic) silicon, then current will flow in that charge layer. If the insulating layer is very thin, only a few volts need be applied to the gate in order to make current flow through the charge layer. The layer, which can be less than a micron thick, is usually made by oxidising the outer face of the silicon slice, so that a metal layer can be deposited on it without making contact. It is normally capable of withstanding an applied voltage of some 20 or 30 volts only, and can be damaged by static charges or careless handling.

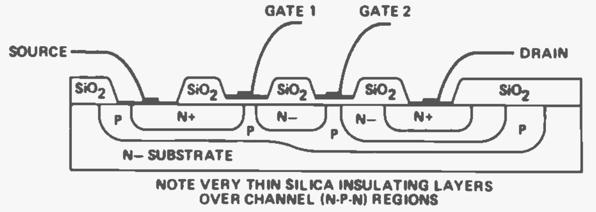


Fig. 7 Cross-sectional view of a dual-gate MOSFET.

In order to make these devices a little less fragile in normal day to day use, it is customary to incorporate on the chip a couple of back-to-back zener diodes across the gate-source connections. This reduces the input impedance to perhaps a million megohms. It is possible to get unprotected MOSFETs which have a higher input impedance, but these need careful handling.

The most common variety of small signal MOSFET is the dual gate type shown in Fig. 7. This was specifically designed as a device for RF amplification and mixing in radio and TV tuners, and is usable up to a few hundred megahertz. The second gate can be used to screen the input signal gate from the output signal on the drain, permitting stable RF amplification. In this application, it acts in a similar way to the screened-grid or RF pentode type of valve. I have shown the circuit symbol for these transistors in Fig. 3c.

All of these MOSFETs require a forward voltage applied to the gate electrode to cause them to conduct.

	TYPICAL INPUT IMPEDANCE	TYPICAL STAGE GAIN	OUTPUT IMPEDANCE (COMMON EMITTER)	TYPICAL MAXIMUM WORKING FREQUENCY	NOISE FIGURE (dB) (MINIMUM)	TYPICAL (MAX) WORKING VOLTAGE	TYPICAL (MAX) WORKING CURRENT	COMMENTS
SMALL SIGNAL JUNCTION TRANSISTORS	0.5-20k	40-200	200k +	300MHz	1dB	150V	500mA	NOT VERY LINEAR WITHOUT NFB
SMALL SIGNAL DARLINGTON TRANSISTORS	250k	100-500	200k	100MHz	6dB	40V	1A	TEMPERATURE SENSITIVE
JUNCTION FETS	10^{11}R	10-30	10M	400MHz	2.5dB	30V	15mA	LINEAR
DUAL-GATE MOSFETS	10^{12}R	50-100	500k	500MHz	2dB	20V	20mA	CAN BE DAMAGED BY STATIC CHARGES
SMALL POWER MOSFETS	10^{12}R	50-200	250k	500MHz	6dB	100V	1A	CAN BE DAMAGED BY STATIC CHARGES- VERY LINEAR
POWER TRANSISTORS (NPN)	10-200R	10-30	5k	40MHz	N/A	400V	25A	CAN SUFFER FROM 'HOLE' STORAGE EFFECTS
POWER TRANSISTORS (PNP)	10-200R	10-30	5k	10MHz	N/A	100V	15A	SOMEWHAT SLUGGISH & SUFFER FROM 'HOLE' STORAGE
POWER DARLINGTONS	20k	50 +	5k	4MHz	N/A	120V	15A	SLUGGISH AND SUFFER FROM 'HOLE' STORAGE
POWER MOSFETS	100M +	50 +	10k	500MHz	POOR	750V	10A	HIGH INPUT CAPACITANCE-PRONE TO OSCILLATE IF NOT PREVENTED
POWER FETS	10M +	10 +	5k	100MHz	N/A	?	?	HIGH OPERATING CURRENT REQUIRED

Table 1 A comparison of the characteristics of different transistor types.

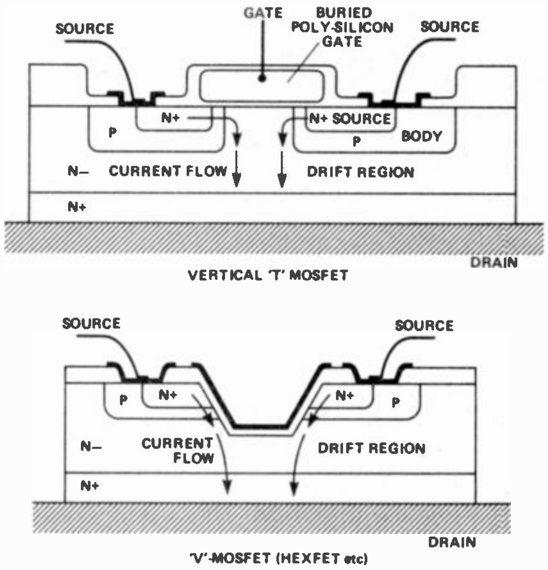


Fig. 8 Cross-sectional views of MOSFETs.

This will be positive in the case of an N-channel MOSFET (operating on a positive DC supply line) and negative in the case of the less common P-channel types. Small signal devices of this type will typically have a mutual conductance or Gm of a few milliamps per volt. This allows a simple calculation of stage gain from

$$\text{Gain} = \text{Gm} \times \text{RL}$$

where RL is the effective load impedance.

Recently, and to my great delight, small signal versions of the T-MOS type of power MOSFET have been introduced. These have a slightly different type of chip construction to the normal small-signal MOSFET, and I have shown this in Fig. 8. Their big advantage is that they can withstand drain voltages of up to about 100V, whereas the average dual-gate device or small signal junction FET can only cope with some 20-30V.

By comparison with bipolar transistors, MOSFETs are much more linear in their characteristics and do not suffer from operational problems such as thermal runaway and hole storage. The absence of this latter defect makes small signal TMOS devices considerably better than bipolar junction devices when used in the class A stages of audio amplifiers, as in the case of the Audio Design power amplifier shown in ETI last summer.

The circuit symbol used for the TMOS device is the same as that used for other MOSFETs except that they are only available in single gate versions.

I have shown the normal operating characteristics of the various small signal transistors in Table 1, and a group of curves showing their input voltage/output current characteristics in Fig. 9.

Bipolar Junction Power Transistors

These are heavier duty versions of the small signal transistors we have already come across, and range in current handling capacity from an ampere or so for some of the small plastic encapsulated types with a metal cooling tag to 400 amperes in the case of some of the big industrial devices.

Permitted dissipations, with adequate heat-sinking, range from one to many hundreds of watts, and maximum collector voltages can be up to 500-1000 volts in specialised types, with 60-150V being more common in easily found devices such as the 2N3055 or 2N3442.

There isn't a big difference in price between the plastic encapsulated types and the hermetically sealed metal TO66 or TO3 versions, so, for DIY projects where one isn't buying a lot of power transistors, the metal can versions may be preferable. They are certainly easier to cool.

Power junction transistors are available in NPN and PNP types, just like small signal devices, but the PNP ones tend to be a bit slower in action and a bit less burst-proof than the NPN ones. One should beware of assuming that because they are complementary in characteristics they can be treated as identical. A nice comment I once heard was that 'NPN and PNP power transistors are as similar as a man and a woman of the same height and weight'.

The transition frequency of a power transistor, that is, the frequency at which the current gain falls to unity, will usually lie within the range 4-20MHz, which is considerably lower than the transition frequency of a typical small signal device which would probably be between 100 and 400MHz. In addition to being more sluggish than small signal types, power transistors also have lower current gains. Whereas a small signal junction transistor has a typical current gain of 100-500, a power device might have a current gain of only 15-80, with the lower

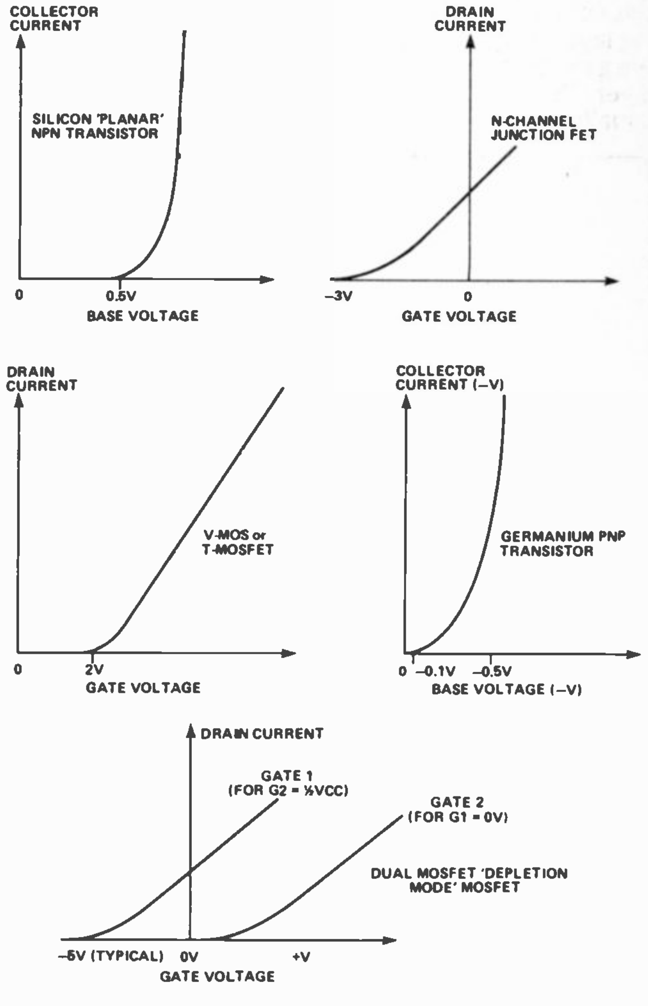


Fig. 9 Graphs showing the input voltage/output current characteristics of different types of transistor.

values usually being found at higher collector currents.

Since this can occasionally be a nuisance where high output currents are required (remember that the required drive current is the output current divided by the current gain), compound Darlington power transistors are available which have current gains in the range 1000-10,000. These are very useful, especially since they are not a lot dearer than single power transistors. However, they do have snags, of which the chief are that their output current for a given forward voltage is very temperature dependent and that they they are, if anything, even more sluggish than ordinary power output devices.

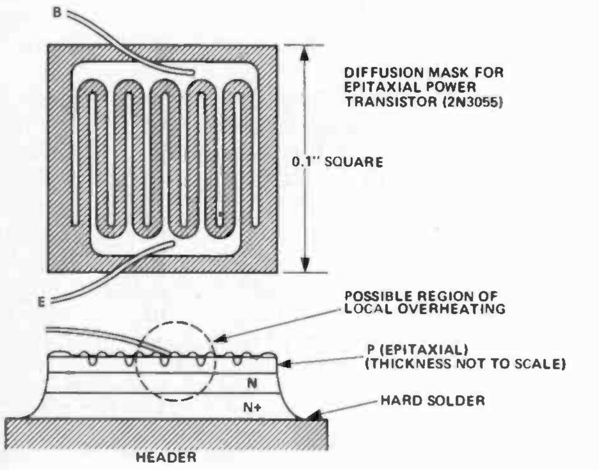


Fig. 10 Sectional views of a 2N3055 power transistor chip.

The major problem with bipolar junction power transistors is that of secondary breakdown. This arises because the forward voltage of a conducting semiconductor junction — such as the base emitter junction in a transistor — drops as the temperature of the junction rises. So, in a power transistor, which has a typical chip cross-section as shown in Fig. 10, if the current flow through the transistor makes the chip get hot, it is likely that some parts of its area will get hotter than others. The base-emitter junction forward voltage in these regions will then drop, and more current will flow through this region. This will cause the collector current opposite these areas to increase, which will make the areas concerned still hotter . . . and so on, until the device goes phut.

The only way to avoid this is to make sure that such transistors are always operated well within the 'safe operating area' specified by the manufacturers. Ensuring that this condition is always met can be tricky in equipments designed to drive dynamic loads such as loudspeakers or motors. Nevertheless, it is practicable.

Power MOSFETs

Small signal dual-gate devices have a lateral current flow, that is, in a direction parallel to the surface of the wafer, and consequently have a fairly high channel resistance. In order to use the MOSFET principle in power devices, a means had to be found of lowering the conducting resistance. The chip construction employed is shown in Fig. 8.

In this arrangement, the current flows in a vertical direction (ie., at right angles to the surface of the wafer). This means that the channel length is defined not so much by the accuracy of the wafer masking during successive diffusions as by the actual thickness of the diffused layer, which can be very narrow indeed and quite accurately controlled.

Power MOSFETs are very fast devices by comparison with the relatively sluggish bipolar power devices. They are also very much more linear, although they don't have such a high gain. Apart from the fact that they require a forward bias of 2-3V to force them into conduction, they are similar in characteristics to output 'Beam-tetrode' valves, but, of course, much more compact and free from the need for a cathode heater supply.

Their main drawback is that they are inclined to see wires connected to their pins as small inductances, whereupon they will happily oscillate at a few hundred megahertz until they burn out either themselves or some other, weaker link. This can be avoided simply by the use of a suitable 'gate stopper' resistor, in the range 250R-2k2. They also have an absolute limit on the voltage which can be applied to their gates in either a forward or a reverse direction. This usually requires both attention to the circuit design, and some form of zener diode protection.

Cost considerations apart, I think that they have overtaken bipolar junction transistors as power amplifier output devices provided that they are correctly employed. Moreover, they are quite immune to 'secondary breakdown', and whilst they do have other problems, there is nothing that cannot fairly easily be avoided.

Power MOSFETs are currently available in working voltages up to 500V, and current ratings up to 50 amperes — although not both in the same package. Maximum power ratings are now up to the 150 watt mark,and rising.

Combination devices are beginning to appear, consisting of small power MOSFETs driving large power bipolar transistors, all on the same chip and in the same package. They combine the easy drive characteristics of power MOSFETs with the very high current capabilities of power transistors, mainly for uses like motor driving. Also appearing are power MOSFETs with built-in logic elements, to give muscle to low-power logic circuitry.

Power Junction FETs

These were introduced by Sony, in Japan, just before the general acceptance and widespread manufacture of power MOSFETs. They are, in effect, just bigger versions of the small signal devices described above, with higher voltage, current, and dissipation ratings. The few audio amplifiers built by Sony using these had a good reputation.

I am not sure whether the success of the 'vertical' power MOSFET will mean that power junction FETs (which behave in a manner very similar to that of valve triodes) have now become obsolete, or whether in the fullness of time they will be made by other manufacturers and become widely available.

I propose to look next month at the topic of transistor parameters, y, z and h, and the techniques of performance calculations using these. I will also look a bit more closely at the way in which transistors are employed, with particular reference to some of the hidden snags, since the quality of the designs which we make for ourselves will depend a lot on our ability to avoid unforseen problems and to choose the most appropriate device and the best way of using it. After all, it often costs no more to make up a good design than a less satisfactory one, and the same components may serve for both.

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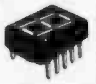

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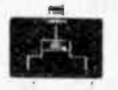

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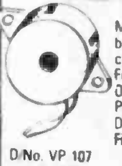

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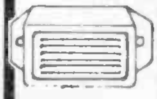

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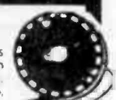

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6802 EVALUATION BOARD

The 6802 is not a microprocessor we have paid a lot of attention to in the past. C.P. Atkins has come up with this straightforward design for those who would like to get to know it a little better.

This project was designed for people who wish to break into the world of microprocessors. Many such systems have been designed in the past but most are still too complicated for the hobbyist to understand. Other people buy expensive computer systems and find they still know very little about the micro and how it works, quite often because of a monitor program which controls every move.

The project described is very simple and of basic design yet forms a powerful base upon which to design complex systems. It was primarily designed to allow people to teach themselves microprocessor hardware design and machine-code, allowing the user not only to program the circuit but also to program the vectors. Hex displays are added so that the programmer can actually see the result. In time the user should find it unnecessary to keep designing new circuits and just reprogram the board for each requirement instead.

The draw back with this project is that every time you wish to change or modify the program you will have to reprogram an EPROM, unless you are lucky enough to have access to an EPROM emulator. Because most of the people likely to construct this project will own or have access to a computer, I have also designed an EPROM emulator which will run the board, and this will be described in a future article. Simply by loading an area of RAM with micro-code and then isolating the RAM from the computer, the 6802 board can be made to think it is addressing EPROM. In this way machine code can be changed with care and can also be stored on tape or disk when a program is completed or modified. By building up in this way a powerful system can be put together quite cheaply.

The 6802 Microprocessor

The 6802 microprocessor was used because it has the familiar 6800 instruction set, but it also includes some additional features. The 6802 is an eight bit microprocessors which contains all the registers and accumulators of the present 6800 plus an internal clock oscillator and drives. It also has 128 bytes of RAM at hex address 0000 to 007F. The first 32 bytes at hex address 0000 to 001F may be retained in a low power mode by using Vcc standby, thus retaining memory on powerdown, but this feature is not incorporated on the evaluation board.

The processor has three sixteen bit registers and three eight bit registers. These are the Program Counter, Stack Pointer, Index Register, A and B accumulators and a condition code register or status register. The program counter is a two byte (16 bit) register that points to the current program address. The stack pointer is also a two byte register and contains the address of the next available location in an external push down, pop up stack. This stack is normally the part of the RAM which can be put anywhere in your memory map.

The index register is a very useful register because it is also two bytes wide and can be used as a general purpose register or, more importantly, for the indexed mode of memory addressing. Two eight bit accumulators are used to store results from the arithmetic logic unit (ALU). The last register mentioned is the status register or condition code register which holds the condition flags of the ALU. Only the first six bits are used, the last two being held at one. The flags are Negative (N), zero (2), overflow (V), carry from bit 7 (C), and half carry from bit 3 (H). These bits of the condition code register are used to test conditions for the conditional branch instructions. Bit 4 is the interrupt mask bit (I).

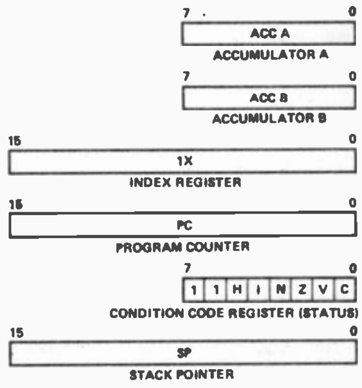


Fig. 1 The registers provided on the 6802.

The control and timing signals for the 6802 are identical to those of the 6800 except that TSC, DBE, 01, 02 and two unused pins have been eliminated and some signal and timing lines have been added. These are RAM enable (RE), crystal connections Extal and Xtal, memory ready (MR), Vcc standby, and enable 02 output (E).

The internal oscillator is crystal controlled, but other clocks may be used if desired. The connections are for a series resonant crystal. A divide-by-four circuit is included, so a 4MHz crystal is used and the board effectively runs at 1MHz.

The 6802 has a set of 72 different instructions which are exactly the same as those of the 6800. The instruction set is very elegant (unlike, for example, the instruction sets of the Intel 8080 and 3085 micros) and for this reason is ideal for learning with. The full instruction set is given in a book called "6800 microprocessor applications manual," which any constructor who is serious about learning micro-programming should purchase.

The 6802 uses the $\overline{\text{RESET}}$ signal for its start and restart procedures. A low on the RESET input causes it to go to address FFFE H and fetch the most significant byte of the restart address stored there. The 6802 then increments its program counter to FFFF H and fetches the least significant byte of the restart address stored there. While this signal is low all the registers are cleared and the interrupt mask bit is set. This is bit 4 in the condition code register.

The restart address is loaded into the program counter and fetches its next instruction from that address. Since the 6802 always goes to FFFE H and FFFF H to get the RESET vector address, the user must ensure that the starting address of the EPROM is stored there. This is 8000H on the 6802 evaluation board (H means hex).

Interrupts

There are three different types of interrupts: non-maskable interrupt (NMI), interrupt request (IRQ) and a software interrupt. The non-maskable interrupt is, as the name suggests, not maskable. A low on this pin causes the processor to finish its current instruction and push the return address, index register, accumulators, and condition code register on the stack. The 6802 then goes to address FFFC H to get the most significant byte. After that it goes to FFFD H to get the least significant byte. These two bytes are then loaded into the program counter and the interrupt subroutine is started somewhere in memory.

The interrupt request works a little differently because it is maskable. A low on the IRQ pin will have no effect unless the interrupt mask has been cleared. If it has been cleared an $\overline{\text{IRQ}}$ input will cause the 6802 processor to push the return address, index register, accumulators, and condition code register on the stack after it has finished its current instruction.

It then goes to address FFF8H to get the most significant byte and to FFF9H to get the least significant byte. The processor then sets the interrupt mask so that no other IRQ interrupt routine can start, after which the program counter is loaded with the contents of FFFH and FFFG H and the interrupt routine starts.

Note that NMI has a higher priority than hat of IRQ. On the evaluation board NMI and IRQ are linked together and connected to the interrupt pins on the 6821 PIA's, so that all the interrupts are controlled via the PIA (peripheral interface adapters) handshake lines. These are CA1, CA2, CB1 and CB2, and these will be explained later.

The software interrupt request

VECTOR MS	LS	DESCRIPTION
FFFE	FFFF	RESET
FFFC	FFFD	NON-MASKABLE INTERRUPT
FFFA	FFFB	SOFTWARE INTERRUPT
FFF8	FFF9	INTERRUPT REQUEST

Fig. 2 The interrupt vector byte locations.

The board contains just seven chips. These are one 6802 microprocessor, one 2716 EPROM, one 7400, two 6821 PIA's (peripheral interface adaptors) and two TIL 311 hex displays. The microprocessor is connected up in a minimum configuration, which is to say that there are no fancy extras.

The data bus is 8 bits wide and is connected to both PIA's and the EPROM. The address bus is 16 bits wide. A0 to A10 are fed into the EPROM giving a memory area of 2K. A15 is taken off the bus, inverted through a two input NAND gate, and used to enable the EPROM via pins 18 and 20. The 2K memory starts at hex address 8000H. This figure is arrived at in the manner shown in Fig. 3.

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	BINARY
8				0				0				0				HEX

Fig. 3 Derivation of the memory start address.

The end of the EPROM is 8000 + 2K which is 87FF. When the reset switch is pushed for a restart the micro thinks it is looking at address FFFE but in this case it is 87FE. So our reset or restart vectors are stored in 87FE and 87FF. Since the EPROM starts at address 8000H, 80H will be stored in address 87FE and 00H will be stored in 87FF. Obviously if the EPROM was being programmed in an external programmer the 8000H would be the same as 0000H.

Decoding of the PIA's is made simple by the number of chip enables the 6821 has to its credit. RS0, RS1, and CS1 are connected to A0, A1, and A2 respectively, and this is the same on both PIA1 and PIA2 (IC3, IC4). On PIA1 (IC3) the four register addresses were decoded for 5004H to 5007H, so A14 was connected to $\overline{\text{CS2}}$ and A12 is NANDed with the valid memory address line and connected to CS0. PIA2 is decoded for 4004H to 4007, so A14 is connected to CS0 and A15 is connected to $\overline{\text{CS2}}$. The R/W, Reset, and E(02 clock) signals are straightforward connections to similar pins on the micro.

That leaves the $\overline{\text{IRQA}}$ and $\overline{\text{IRQB}}$ signals. These have all been linked together and connected to the $\overline{\text{IRQ}}$ and $\overline{\text{NMI}}$ signal on the micro, just to keep things simple. The remaining 20 pins on each chip, namely PA0-PA7, PB0-PB7, and the four control lines CA1, CA2, CB1 and CB2, are all connections to the outside world. It is from here that you will see the results of the program you have written.

To help you to see this, two TIL311 hex displays have been linked to the PA0-PA7 lines of PIA 1. These displays take one four bit word and decode and drive the seven segment display. So, using your PIA data register as a memory location, you can display your answer or the result of a program. These displays are also latched so a result will stay until changed. Including these eight lines, there are thirty two input/output lines and eight control lines, which is more than you would get in a home computer.

The 6802 has an oscillator and a driver circuit, so the clock is produced simply by putting a 4MHz crystal between the XTAL and EXTAL pins of the micro (pins 38 and 39). Because the circuit is so small, pull up resistors are fitted to some of the signals. In a bigger system with more chips these signals would automatically be dragged up.

For our use some signals are held high. These are RAM enable (RE), memory ready (MR) and Halt. Other signals that are in operation but are pulled-up are the interrupt lines, (pins 4 and 6), the VMA (valid memory address) signal which should be gated to the peripheral chips in some way, and the Reset signal which is also connected to a micro switch for use with restart procedures. This leaves the BA (Bus Available) signal which we are not really interested in. This is left disconnected.

HOW IT WORKS

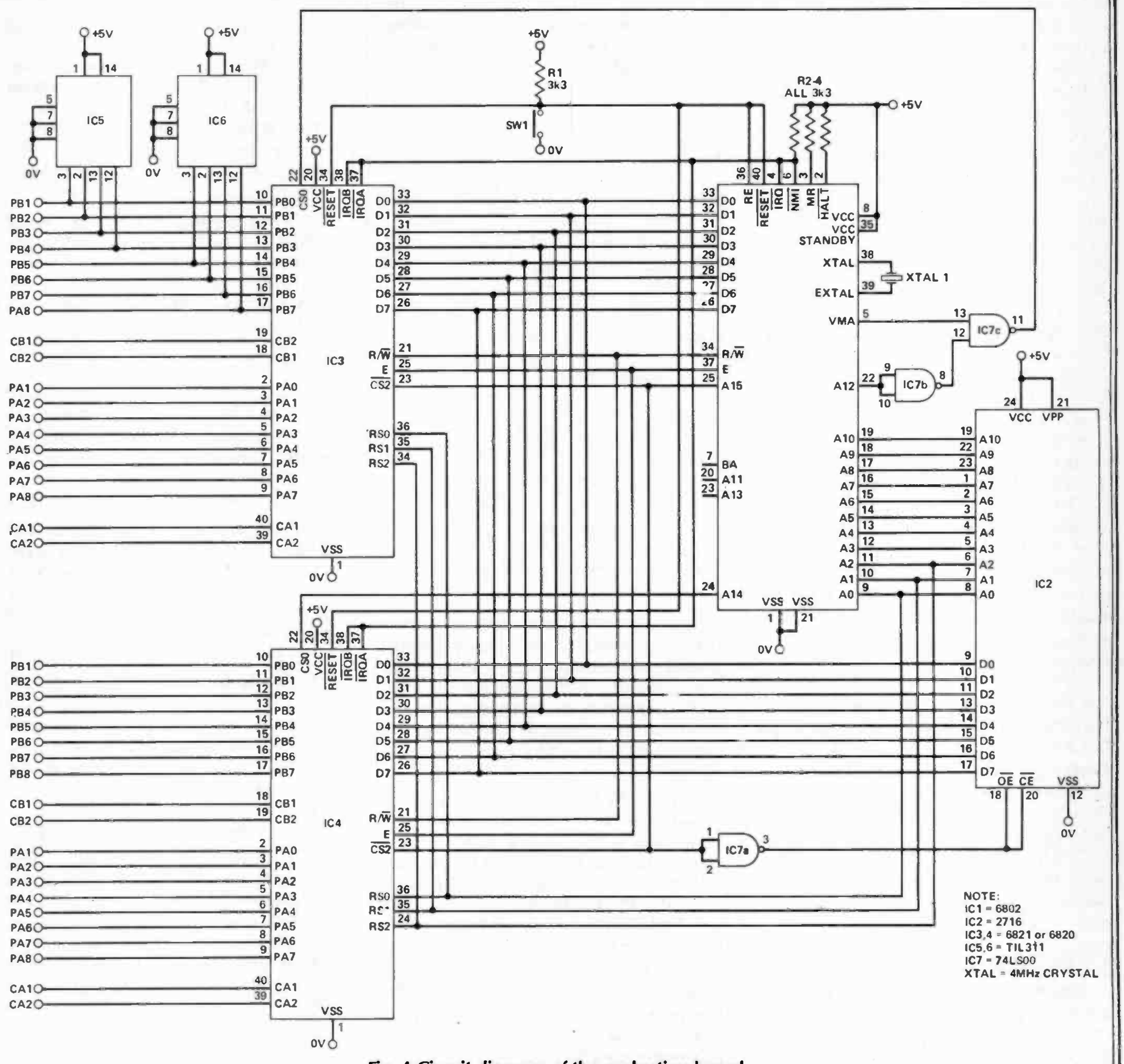


Fig. 4 Circuit diagram of the evaluation board.

NOTE:
IC1 = 6802
IC2 = 2716
IC3,4 = 6821 or 6820
IC5,6 = TIL311
IC7 = 74LS00
XTAL = 4MHz CRYSTAL

is controlled by micro-code, and registers are stored on the stack. The program counter is loaded with the contents of FFFAH and FFFBH and then jumps to the interrupt routine in memory. It can also be used as a break function.

Address Modes

There are seven address modes that can be used by the programmer. They are:- Accumulator addressing, immediate, direct, extended, indexed, implied, and relative addressing.

In direct addressing, the 8 bit address of the operand must be stored in the lowest 256 memory locations, from 0000 to 00FF, Direct addressing is sometimes called base page addressing because the operand must be in the first 256-byte page of memory. The 6802 uses address locations FFF8 to FFFF to store reset and interrupt addresses so as to keep the lowest 256 addresses free for direct addressing.

An example of this mode is the ADD $09 instruction, which adds the contents of memory location 09H to the contents of the A accumulator and leaves the result in accumulator A. The advantage of this mode of addressing is that it is quicker than extended addressing because it uses two instructions instead of three.

Extended addressing uses the second and third bytes of the instruction to store the address of the operand, a rather different approach to that used in the Intel and Zilog processors. The second byte contains the high order address byte and the third byte contains the low order address byte. For example ADDA $073A would be written in three memory bytes as BB 073A. This instruction adds the contents of memory location 073A to Accumulator A. Extended addressing is used for all memory beyond $FF, but can be used for memory below that point. Note that $ also denotes Hexadecimal in 6802 assembler. As an

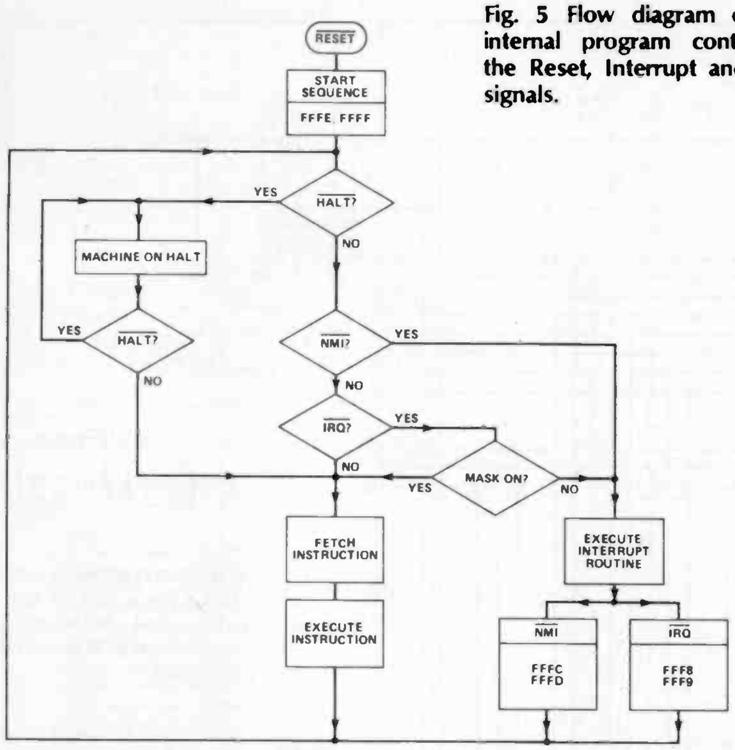


Fig. 5 Flow diagram of the internal program controlling the Reset, Interrupt and Halt signals.

example, compare these two instructions:

Direct	LDAA FF	➡	96FF
Extended	LDAA 00FF	➡	B6 00FF

They both have the same effect.

With indexed addressing, the operand is obtained from an effective address. The address is calculated by adding the offset number in the second byte of the instruction to the contents of the 16 bit index register. For example, suppose the index register contains a base address of 4321H. The instruction Add A $30 in index addressing first calculates the effective address from which it will get its operand by adding the displacement of 30 H to the base address of 4321H. This gives an effective address of 4351. The 6802 then fetches the byte from memory at the effective address of 4351H, adds the contents to Accumulator A, and then leaves the result in Accumulator A.

In the implied addressing mode the operand address is contained in the instruction op-code. For example the command 'DEX' is simply written as 09. Only one byte is used in implied addressing.

In relative addressing a displacement contained in the second byte of the instruction is added to the program counter. The next instruction is fetched from the address. The displacement is stored in the second byte, and the most significant bit of this second byte is the sign bit which allows the displacement to be positive or negative. A number from −128 to +127 can be derived.

Because the program counter automatically increments after each fetch, the displacement is added to the address after that in which the displacement byte was stored. Therefore, when measured from the instruction address, the relative addressing range is −126 to +129 addresses. When jumping to a location you actually state the address you wish to jump to. The easy way to remember relative addressing is to bear in mind that you always branch or jump relative to a memory location. For example:

	0050	
Branch	0051	20 FE ↑
	0053	
Jump	0050	
	0051	6E 0050 ↑
	0054	

The above two examples have the same effect, which is to go back one address space.

Accumulator addressing is a special case of implied addressing. The operand is one of the accumulators and this is indicated in the op code for the instruction. An example of this would be CLR A which is a one-byte code.

Little has been said so far about the Peripheral Interface Adaptors, of which there are two on the evaluation board. In effect, it will be these chips which the operator will program, so an insight into their operation will be useful.

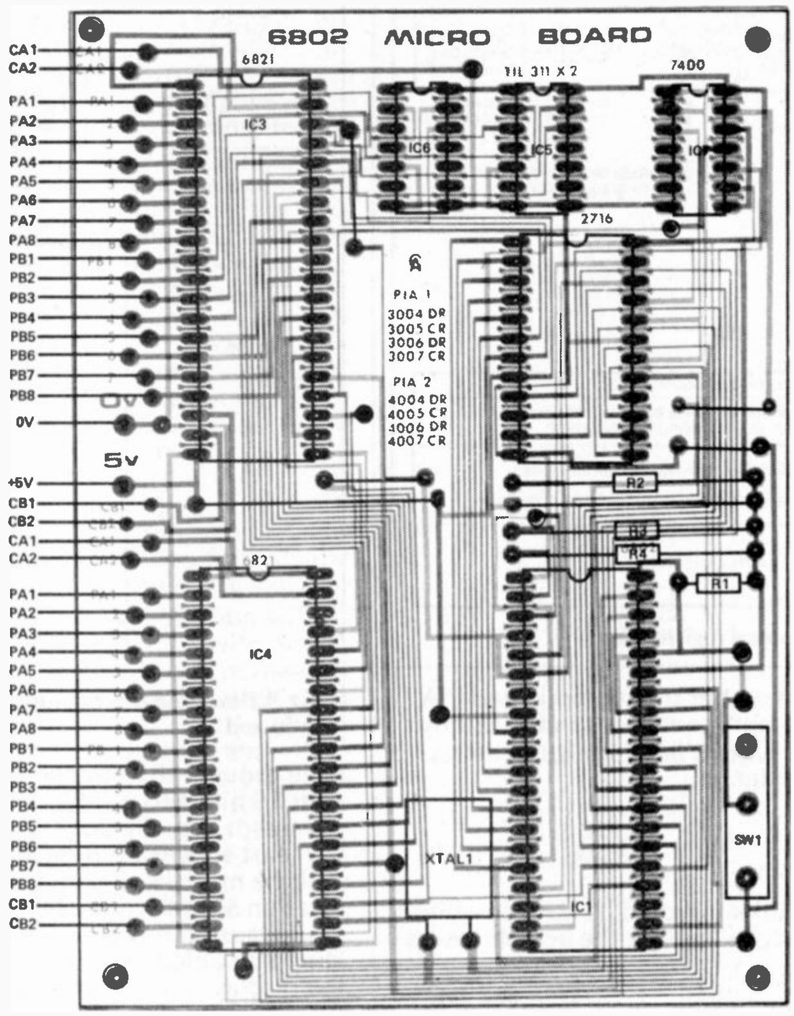
An input/output port must provide a versatile programmable interface between the microprocessor and the external system devices (peripherals). These devices or peripherals can be simple lamps, switches or keyboards or more complex devices such as tape recorders, visual displays or other circuits. There are no special instructions for the PIA because, as far as the 6802 is concerned, it appears as a block of four memory addresses which can be read from or written into like any other RAM.

The addresses chosen must be consecutive and in the case of the evaluation board these addresses are 5004H, 5005, 5006 and 5007 for PIA1 (IC3). For PIA 2 (IC4) the addresses 4004, 4005, 4006 and 4007 are used. The eight data lines of the PIA are simply connected to the MPU data bus as normal and it will be noticed that several control lines are also connected between the two as discussed earlier.

Small differences aside, the PIA can be considered as two identical halves, side A and side B each having eight data (I/O) input/output lines and two special lines used for control or handshake purposes. To avoid repetition the A side only will be described.

PA0 to PA7 are data I/O lines which can be used as either inputs or outputs dependent upon how the programmer writes the initialisation routine. You could, for example, programme three lines as inputs and five as outputs. CA1 and CA2 are peripheral control lines; CA1 is always an input but CA2 can be initialised as an input or output.

There are three registers for each half of the PIA but one register serves two purposes. The Control register may cause some problems as it contains all the control flags. At this stage we are only concerned with bit 2, because it is this bit which decides which register has this memory address. When bit 2 is 0, the address 5004 (4004 for PIA 2) belongs to the direction register. When bit 2 is 1 the address 5004 belongs to the data register. The remaining bits are all connected with the behaviour of the control



◉ = THROUGH BOARD LINK

Fig. 6 Component overlay of the evaluation board.

PARTS LIST

RESISTORS	
R1-R5	3k3
SEMICONDUCTORS	
IC1	6802
IC2	2716
IC3,4	6821 OR 6820
IC5,6	TIL 311
IC7	74LS00
MISCELLANEOUS	
SW1	SPDT micro switch
XTAL1	4MHz crystal

PCB; IC sockets — 3 off 40 pin, 1 off 24 pin and 3 off 14 pin; 42 off PC terminal pins.

BUYLINES

Everything here is widely available with the possible exception of the TIL 311 display ICs, and these are sold by Technomatic. The PCB is available from our PCB Service.

lines CA1 and CA2 (CB1 and CB2 for the other side of PIA 1).

The addresses are well thought out in that, when the reset switch is operated, all the registers in the PIA are reset to zeros. This includes bit 2 in the control register. So the first time address 5004H is used, it will address the direction register. After this the programmer will ensure that bit 2 is set to 1, so that any further references to 5004H will address the data register. It is most unlikely that you will have to change the direction register contents in the same program but if so, it would be necessary to clear bit 2 first and reset it again afterwards.

As discussed earlier, I/O lines can be programmed as input or output in any configuration. For example if the direction register was initialised with 0000 1111, PA0-PA3 would be inputs and PA4-PA7 would be outputs. The register is available to the programmer as address 5004H.

Once initialised, the data register is the one most used by the programmer and therefore has priority over the direction register which also shares memory address 5004H.

Unfortunately more has to be said about the control register flags. The main differences between sides A and B of the PIA are here and this is best shown in Fig. 8. Bit 2 has already been discussed, but every other bit in this register also has some effect upon the behaviour of the peripheral control lines CA1, CA2, CB1 and CB2. A detailed explanation can be found on a Motorola 6821 applications sheet.

CA1 and CA2 only are shown in Fig. 8, but side B is the same (CB1 and CB2). The illustration may be a bit confusing, and for this reason some examples will be given later. For simple programming little knowledge is needed of the control register, but as you progress an understanding will become essential.

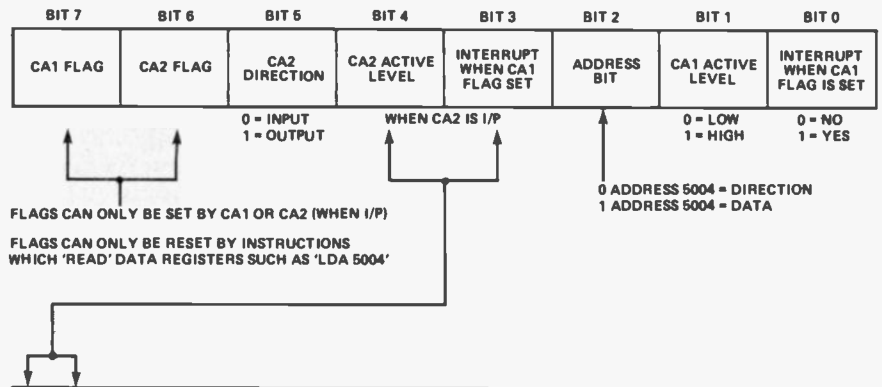
PIA 1 (IC3)		PIA 2 (IC4)	
SIDE A		SIDE A	
CONTROL	5005	CONTROL	4005
DIRECTION	5004	DIRECTION	4004
DATA	5004	DATA	4004
SIDE B		SIDE B	
CONTROL	5007	CONTROL	4007
DIRECTION	5006	DIRECTION	4006
DATA	5006	DATA	4006

Fig. 7 Register addresses on the evaluation board.

Construction and Testing

The complete project is contained on one, small, double-sided PCB. The tracks are necessarily very close together so great care must be taken during soldering to ensure that adjacent tracks are not accidentally bridged. Terminal pins are used for the external connections and these should be pushed through the board before any other components are installed. IC sockets are recommended and these should be soldered into place next, followed by the switch, the resistors and the crystal. Finally solder the display onto the board and then insert the ICs into their sockets, taking care that they are the right way around.

When the board has been assembled, check it carefully and then connect up the 0 and 5V rails. The TIL 311 displays should illuminate and show the letters FF. If all is well, the next stage is to try a test program.



	WHEN CA2 IS OUTPUT	WHEN CB2 IS OUTPUT
00	SETS ON ACTIVE TRANSITION OF CA1 RESETS WHEN DATA REGISTER IS READ	MUCH THE SAME BUT FOR THE DIFFERENCES OF CLOCK TIMING (TIMING EDGE)
01	SETS AUTOMATICALLY WHEN E FALLS RESETS WHEN DATA REGISTER IS READ	SETS AUTOMATICALLY WHEN E RISES RESETS WHEN DATA REGISTER IS WRITTEN
1X 1X	BECOMES THE SAME AS 'X'. WHILE 'X' REMAINS 0, CA2 REMAINS 0 AND VICE VERSA	EXACTLY THE SAME

Fig. 8 Operation of the PIA control register flags.

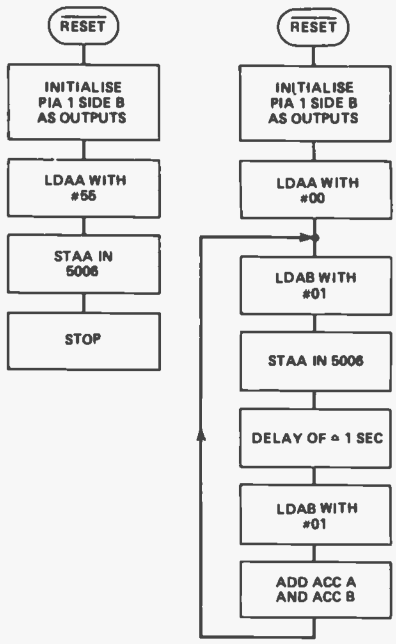


Fig. 9 Flow diagrams of programs 1 (left) and 2.

To do this you will need either a programmed EPROM or an EPROM emulator. For those who do not already have one, an EPROM emulator design will be described in a follow-on article, but other emulators such as the one described in our July and August issues last year should be suitable. Constructors who do not have an emulator but do have access to an EPROM programmer and a UV eraser can simply load the test program onto a 2716 EPROM.

ADDRESS	PROGRAM
0000	8E 000F
0003	CD FF04
0006	FF 5006
0009	86 55
000B	B7 5006
000E	3F
07FE	80 RESET VECTOR
07FF	00 RESET VECTOR

Program 1

Program 1 is very simple and should cause the displays to show 55 when the reset switch is pushed. If this fails to work check the program. If it still does not work, check the signals described earlier with an oscilloscope. You need not worry about the complicated waveforms, just check that a switching signal is present or, in some cases, that the signal is held high.

Once this works you are ready to start writing your own programs.

Remember that complicated PIA, and note that it was initialised by two simple lines using the index register.

```
CE FF04
FF 5006
```

In full this would be written quite differently using the accumulators

```
86FF       LDA #FF
B75006     STA 5006
8604       LDA #04
B75007     STA 5007
```

You can see how the 16 bit index register can simplify things. Overall program speed can be increased using this method, although it would be no advantage in the initialisation routine. It comes into its own in the subroutines.

In the example, the contents of the index register are said to be stored in location 5006H. You may have thought this strange, trying to stuff 16 bits into 8. What the processor actually does is to store the least significant byte in 5007H and the most significant byte in location 5006H.

Because the programmer may like to be able to see a change on the displays, delays are a widely used subroutine. Again the 16 bit index register comes into use. An example of this is shown, giving a delay of around a second.

```
CE0000      LDX    0000
09        ▲ DEX
26FD        BRE
```

This can be used in a program such as Program 2, which is a count sequence. This will cause the display to count up to FF before resetting to 00.

```
ADDRESS                PROGRAM
0000      8E           000F          LDS      000F
0003      CE           FF04          LDX      FF04
0006      FF           5006          STX      5006
0009      86           00            LDA#     00
000B      C6           01          ▲ LDAB#    01
000D      B7           5006          STA      5006
0010      CE           0000        ↑ LDX      0000
0013      09                         DEX
0014      26           FD            BRE
0016      C6           01            LDAB#    01
0018      1B                         ABA
0019      20           FO            BRA

07FE      80           00
```

Program 2

ETI

WOULD YOU HAVE THE COURAGE TO JOIN DATELINE?

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☐ Creative
☐ Practical
☐ Intellectual

2 Indicate which activities and interests you enjoy by placing a '1' (one) in the appropriate box. If you dislike a particular activity, write a '0' (nought) in the box. If you have no preference, leave the column blank.

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☐ Fashion
☐ Pubs
☐ Sport
☐ Pets
☐ Folk music
☐ Jazz
☐ Travelling
☐ Cinema
☐ Good food
☐ Politics
☐ Classical music
☐ Art/Literature
☐ 'Live' theatre
☐ Science or technology
☐ Creative writing/painting
☐ Poetry
☐ Philosophy/Psychology/Sociology
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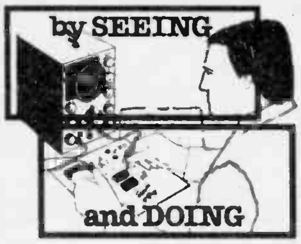

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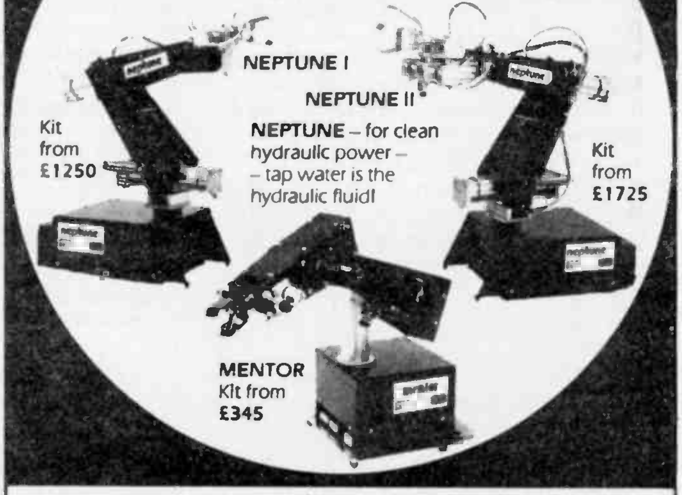

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UNIVERSAL EPROM PROGRAMMER MARK II

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As far as the world of microelectronics is concerned, a lot of water can pass under the bridge in 18 months. In August 1983, a design for a universal EPROM programmer was published in ETI and, as its name suggests, this piece of equipment allowed virtually all the common single supply EPROMs to be programmed. At this time the largest device available was the 27128, only preliminary data being available for the 27256. In the intervening period the 27256, 27512 and 27513 have become available and since they use a different programming voltage to the previous devices may not be programmed by the original programmer. The 2764A and 27128A have also made an appearance, these being lower programming voltage versions of the 2764 and 27128 respectively. This being the case, it seemed appropriate to introduce a MkII version of the EPROM programmer to support these new devices and at the same time make some other improvements. We have produced an upgrade board to allow existing users of the MkI board to enhance it and also a single MkII board for those without the earlier board.

The MkII Universal EPROM Programmer is capable of programming a comprehensive range of single supply EPROMs varying in size from the 2758 to the 27512 and 27513 and including the 27-series, 25-series and the Motorola 68-series as well as a number of EEPROMs. In addition it allows the 2764 and larger devices to be programmed by the intelligent programming method hence reducing programming times drastically. All supply voltages have been made switchable under program controls so there is no need for a switch on the programming console. Two LEDs have been provided to indicate the current status of the programmer — in particular whether or not it is safe to remove the device. A modification to speed up EPROM reading has been made and, as a final enhancement, it is easier to set up since the adjustment of the programming voltages has been made much finer and the potentiometers are now more accessible when the board is rack-mounted.

In both versions, the programmer is fully programmable and everything is controlled by software. It is designed around the Tanbus specification which means that it should be an easy task to interface it to any 6502 or 6809 based system and users of a Tangerine computer will be able to plug the programmer directly into the system rack.

New Devices

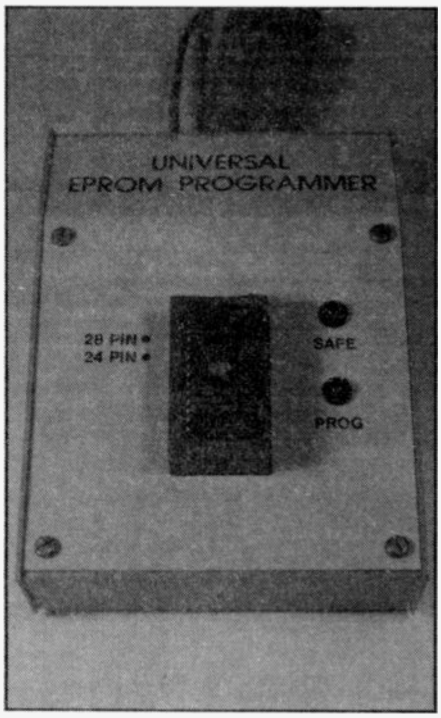
Before describing the new programmer it is helpful to outline the advances in the realm of EPROMs which have made this upgrade necessary. Table 1 shows the pinouts of all the devices which are supported. A similar illustration was included with the original article showing how standard pinouts made designing a *universal* programmer relatively easy. The new devices conform to the same standard and also have JEDEC pinouts.

This family of devices must now include the largest single page EPROMs which will be used with 8-bit processors, as the capacity of a 27512 is 64K bytes — in other words, it occupies the entire memory map of an 8-bit system. The 27513 has the same capacity as the 27512 but the memory is organised differently having 4 pages of 16K bytes each and therefore representing the first of a new class of devices — paged EPROMs. To specify the page to be accessed a write operation is performed. The least significant 2 bits of the following data word then specify the page number.

The major fact about the 27256 and 27512/2513 which makes them incompatible with the original EPROM programmer is that the programming voltage is 12.5V. This follows the trend of decreasing programming voltages as the capacity increases and the silicon die size decreases, the devices up to and including the 2732 using 25V and the 2764 and 27128 using 21V. In addition, versions of the 2764 and 27128 which also use the new 12.5V Vpp have been released. These are known as the M2764A and 27128A.

Intelligent programming is possible on all devices from the 2764 upwards. In this case, 1ms programming pulses are applied to the EPROM until it verifies, at which point a further pulse is applied. This contrasts with the standard programming method in which a 50ms programming pulse is always used. As the larger EPROMs are introduced, intelligent programming becomes increasingly desirable. It can reduce programming times from almost one hour to about eight minutes for the 27512.

Intelligent programming requires the supply voltage to be raised from the normal 5V to 6V during the programming cycle, a facility not available on the MkI board. A different programming time reduction method has been introduced on the latest version of the Texas 25 series devices and on some manufacturers' recent 2732s and 2764s. These devices use a fixed length programming pulse of 10mS rather than the standard 50mS pulse.



The console of the programmer.

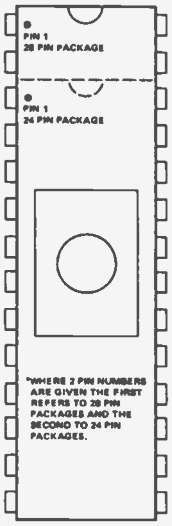
Another facility introduced on some of the newer devices is referred to as 'intelligent identifier' or 'auto select mode'. After applying +12V to A9, where this facility is available, one of two bytes may be read out depending on the logic level of A0. These two bytes contain codes identifying both the device type and the manufacturer. It was decided not to implement this mode for two reasons. Firstly, the facility was designed for industrial production programming where the process is often carried out by those with a minimal knowledge of electronics. By contrast, the home user will probably be clear about what device type is being used. Secondly, not all devices include the facility, and it is reasonable to assume that applying +12V to A9 of EPROMs without intelligent identifier will be detrimental. In an environment in which all devices from the 2758 upwards are to be programmed, the provision of the feature will increase the likelihood of destroying EPROMs.

The price of EPROMs has been influenced by the fact that quartz windows could only be fitted in ceramic packages. Recent advances now allow a seal to be made between quartz and plastic and, as a result, some manufacturers are releasing EPROMs in plastic packages at a significant cost reduction. Over the past few years, the price of EPROMs has already reduced to the point where they are comparable to the price of ROMs. Since a large proportion of the remaining cost is due to the quartz window, manufacturers have also started producing EPROMs without the quartz window at an even lower price.

The lack of quartz window means that these devices cannot be exposed to ultra voilet and erased. They are referred to as production EPROMs or OTP EPROMs (One Time Programmable). Since these EPROMs are electrically identical to standard EPROMs, they are programmed in exactly the same way.

Some EPROMs are now available not only in the standard 24 or 28 pin DIL (dual-in-line) packages but also in the newer, smaller, LCC (leadless-chip-carrier) packages which have pins spaced at

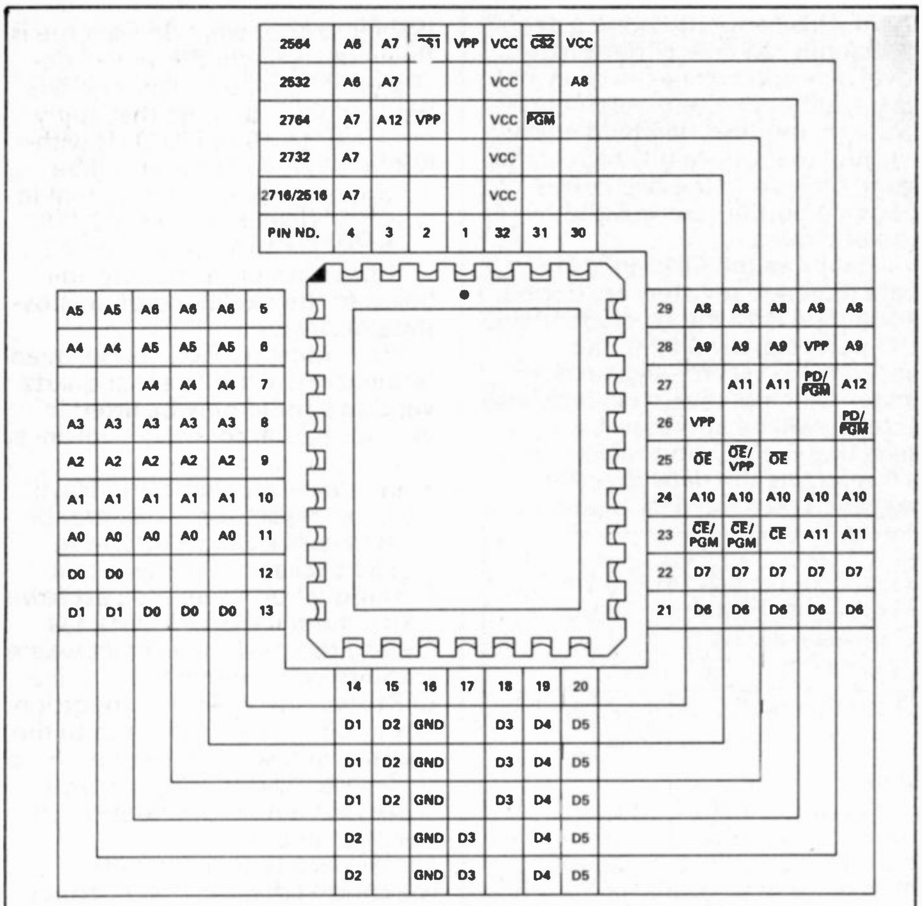
27513	27512	27256	27128 27128A	2564	2764 2764A	68764	2532	2732 2732A	68732	2716 2516	2758	*PIN NO.
N/C	A15	VPP	VPP	VPP	VPP							1
A12	A12	A12	A12	$\overline{\text{CS1}}$	A12							2
A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	3/1
A6	A6	A6	A6	A6	A6	A6	A6	A6	A6	A6	A6	4/2
A5	A5	A5	A5	A5	A5	A5	A5	A5	A5	A5	A5	5/3
A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	6/4
A3	A3	A3	A3	A3	A3	A3	A3	A3	A3	A3	A3	7/5
A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	A2	8/6
A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	9/7
A0	A0	A0	A0	A0	A0	A0	A0	A0	A0	A0	A0	10/8
D0	D0	D0	D0	D0	D0	D0	D0	D0	D0	D0	D0	11/9
D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	12/10
D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	D2	13/11
GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	14/12



*WHERE 2 PIN NUMBERS ARE GIVEN THE FIRST REFERS TO 28 PIN PACKAGES AND THE SECOND TO 24 PIN PACKAGES.

*PIN NO.	2758	2716 2516	68732	2732 2732A	2532	68764	2764 2764A	2564	27128 27128A	27256	27512	27513
28							VCC	VCC	VCC	VCC	VCC	VCC
27							$\overline{\text{PGM}}$	$\overline{\text{CS2}}$	$\overline{\text{PGM}}$	A14	A14	$\overline{\text{WE}}$
26/24	VCC	VCC	VCC	VCC	VCC	VCC	N/C	N/C	A13	A13	A13	A13
25/23	A8	A8	A8	A8	A8	A8	A8	A8	A8	A8	A8	A8
24/22	A9	A9	A9	A9	A9	A9	A9	A9	A9	A9	A9	A9
23/21	VPP	VPP	AR	A11	VPP	A12	A11	A12	A11	A11	A11	A11
22/20	$\overline{\text{OE}}$	$\overline{\text{OE}}$	$\overline{\text{E}}$/ VPP	$\overline{\text{OE}}$/ VPP	PD/ $\overline{\text{PGM}}$	$\overline{\text{E}}$/ VPP	$\overline{\text{OE}}$	PD/ $\overline{\text{PGM}}$	$\overline{\text{OE}}$	$\overline{\text{OE}}$	$\overline{\text{OE}}$/ VPP	$\overline{\text{OE}}$/ VPP
21/19	AR	A10	A10	A10	A10	A10	A10	A10	A10	A10	A10	A10
20/18	$\overline{\text{CE}}$/ PGM	$\overline{\text{CE}}$/ PGM	A11	$\overline{\text{CE}}$/ PGM	A11	A11	$\overline{\text{CE}}$	A11	$\overline{\text{CE}}$	$\overline{\text{CE}}$	$\overline{\text{CE}}$/ PGM	$\overline{\text{CE}}$
19/17	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7	D7
18/16	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6	D6
17/15	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5	D5
16/14	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4	D4
15/13	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3	D3

Table 1 Pin-outs of all devices supported by the programmer.



2564	A6	A7	$\overline{\text{CS1}}$	VPP	VCC	$\overline{\text{CS2}}$	VCC
2532	A6	A7			VCC		A8
2764	A7	A12	VPP		VCC	$\overline{\text{PGM}}$	
2732	A7				VCC		
2716/2516	A7				VCC		
PIN NO.	4	3	2	1	32	31	30

A5	A5	A6	A6	A6	5
A4	A4	A5	A5	A5	6
		A4	A4	A4	7
A3	A3	A3	A3	A3	8
A2	A2	A2	A2	A2	9
A1	A1	A1	A1	A1	10
A0	A0	A0	A0	A0	11
D0	D0				12
D1	D1	D0	D0	D0	13

29	A8	A8	A8	A9	A8
28	A9	A9	A9	VPP	A9
27		A11	A11	PD/ $\overline{\text{PGM}}$	A12
26	VPP				PD/ $\overline{\text{PGM}}$
25	$\overline{\text{OE}}$	$\overline{\text{OE}}$/ VPP	$\overline{\text{OE}}$		
24	A10	A10	A10	A10	A10
23	$\overline{\text{CE}}$/ PGM	$\overline{\text{CE}}$/ PGM	$\overline{\text{CE}}$	A11	A11
22	D7	D7	D7	D7	D7
21	D6	D6	D6	D6	D6

14	15	16	17	18	19	20
D1	D2	GND		D3	D4	D5
D1	D2	GND		D3	D4	D5
D1	D2	GND		D3	D4	D5
D2		GND	D3		D4	D5
D2		GND	D3		D4	D5

Table 2 Pin-outs of all LCC devices which could be supported by the programmer.

0.05" on 4 sides of a rectangle and so allow a much greater PCB packing density. Internally these devices are identical to conventionally packaged EPROMs and as a result the programming requirements are the same. To handle them, the EPROM programmer only needs to be provided with a different socket on the console. Table 2 shows the pin-out of those devices currently available in this package. It should be noted that the 25 series devices differ from each other and the 27 series devices in this configuration more than in the standard DIL package. Accordingly, it would be advisable to consider programming only the 27 series EPROMs in LCC configuration or to provide a number of different sockets.

Similar Devices

The term EPROM is usually taken to mean UV erasable PROM, but there is a closely related family of devices — electrically erasable programmable read-only memories, known as EEPROMs or E^{2}PROMs. At the time of designing the original programmer, the extra complexity involved in supporting EEPROMs was not considered justifiable in view of their high cost. The price of EEPROMs has not dropped drastically and they are, therefore, still quite rare among home computer users. But numerous enhancements to these devices have been made which simplify the programming and accordingly they may be supported by the MkII programmer.

The fact which complicated the programming of the original Intel 2816 (2K x 8 EEPROM) was the fact that it used a 21V programming voltage which had to be shaped by an RC circuit to give an exponential rise. the next development still used 21V for programming but the waveform shaping requirement was relaxed, the only restriction then being on the fall time of the Vpp pulse. The latest EEPROMs don't even require a high programming voltage, internal circuitry generating this from the +5V supply. In addition, there are now some devices which support these very latest programming techniques but are compatible with earlier devices, accepting either 21V or TTL programming levels.

EEPROMs have also developed in the method of programming. On the first devices, a byte could only be programmed if it were first erased, either by writing an FF(HEX) to that byte or by using the complete chip erase facility. On the more recent devices, bytes may be directly re-programmed without the need for erasing first. Programming times and the number of programming cycles have also seen improvements. The first 2816 required 10mS programming pulses whereas some of the newer versions will programme in 2mS per byte. The technology used in EEPROMs, HMOS-E FLOTEX cell design, has an inherent limitation on the number of programming cycles. The original EEPROMs had a lifetime of 10,000 cycles but 1 million cycles is now not uncommonly quoted.

Unfortunately, there isn't the same degree of standardisation among EEPROMs as with UV EPROMs. Although a 2816 is always a 2K x 8 EEPROM, different manufacturers' devices with this number may represent a number of different points within the progression outlined above. In addition 2816A, 2817, 2817A and 5213 are variations on the same theme by various manufacturers. Because of these complications, we won't give a list of EEPROM type numbers which are supported by the MkII Universal EPROM programmer. It will, in fact, handle all those 2K x 8 devices which feature TTL level programming. Some 8K x 8 EEPROMs are also becomming available — for example, the 2864 and 52B33. Where these are programmed by TTL levels, they may also be supported by the MkII programmer.

Mark II Board — Hardware

This section refers to either the MkII EPROM programmer or the MkI with the addition of the upgrade board, the hardware of these two configurations being identical with one exception. The MkI board has 4 x 6821 PIAs, of which 2 are used by the programmer for control functions leaving 2 free for general use. The MkII board utilises 3 PIAs for controlling the programmer, the 4th having been omitted in order to fit the extra circuitry onto the PCB. The upgrade board makes use of the 3rd PIA on the MkI board but does not, however, affect the 4th one which means that this configuration gives a spare PIA, the true MkII board not having this facility. (See 'How It Works' for part numbering.)

Table 3 is a memory map of the MkII Universal EPROM Programmer in which the function of each bit is outlined. Some bits control certain functions such as Vcc and Vpp voltage levels, the majority, however, control the signal levels on various pins of SK3, the EPROM socket. For all bits connected to SK3, except those marked Vcc or Vpp, writing a 1 will set the pin to a logic high, whereas writing a 0 will set it to a logic low. For the Vcc and Vpp bits, a 1 sets the pin to the currently selected Vcc or Vpp voltage and a 0 sets the pin to 0V. It will be noticed that some pins have more than one bit controlling them. This happens where a particular pin can take either a logic level or a Vpp voltage. In such cases, although this wouldn't normally be required, it would not be harmful to set both bits high at the same time since the two corresponding outputs are isolated by use of diodes.

Finally, in the 6821 PIA, the data direction registers are double addressed with the corresponding I/O port register. Bit 2 in the appropriate control register determines which of these two registers actually will be addressed, a 1 selecting the I/O port register and a 0 selecting the data direction register. Once the data direction register is selected, setting a 1 to a bit in this register selects the corresponding bit in the I/O port to be an output whereas a 0 selects the I/O port bit to be an input.

EPROM PIN NO. / FUNCTION

IC NUMBER	REGISTER	ADDRESS OFFSET	DATA DIRECTION	BIT DESIGNATIONS 7	6	5	4	3	2	1	0
IC9	PORT A/ DATA DIRECTION REGISTER A	0	OUTPUT	1 / A15	UNUSED	UNUSED	2 / A12 or $\overline{CSI}$	23 / A11 or A12	21 / A10	24 / A9	25 / A8
IC9	CONTROL REGISTER A	1	—			CA2 UNUSED			SELECT REGISTER AT ADDRESS 0 0-DATA DIRN A 1—PORT A	CA1 UNUSED	
IC9	PORT B/ DATA DIRECTION REGISTER B	2	OUTPUT	3 / A7	4 / A6	5 / A5	6 / A4	7 / A3	8 / A2	9 / A1	10 / A0
IC9	CONTROL REGISTER B	3	OUTPUT (CB2)			SET TO 1 TO MAKE CB2 OUTPUT	SET TO 1 TO MAKE CB2 OUTPUT	26 / A13 or VCC	SELECT REGISTER AT ADDRESS 2 0-DATA DIRN B 1-PORT B	CB1 UNUSED	
IC8	PORT A/ DATA DIRECTION REGISTER A	4	OUTPUT/ INPUT	19 / D7	18 / D6	17 / D5	16 / D4	15 / D3	13 / D2	12 / D1	11 / D0
IC8	CONTROL REGISTER A	5	—			CA2 UNUSED			SELECT REGISTER AT ADDRESS 4 0-DATA DIRN A 1-PORT A	CA1 UNUSED	
IC8	PORT B/ DATA DIRECTION REGISTER B	6	OUTPUT	VCC +5V SELECT NOT (VCC+5V) =VCC +6V SELECT	VPP +12V5 SELECT NOT (VPP+6V AND NOT (VPP+12V5) AND NOT (VPP+21V) = VPP+25V SELECT	VPP +21V SELECT	VPP +6V SELECT	23 / VPP	22 / VPP	27 / $\overline{PGM}$, $\overline{CE2}$, A14	20 / A11 or $\overline{CE}$
IC8	CONTROL REGISTER B	7	—			CB2 UNUSED			SELECT REGISTER AT ADDRESS 6 0-DATA DIRN B 1-PORT B	CB1 UNUSED	
IC7	PORT A/ DATA DIRECTION REGISTER A	8	—	UNUSED BY EPROM PROGRAMMER AVAILABLE FOR GENERAL USE VIA SK2 (ON MK1 BOARD)							
IC7	CONTROL REGISTER A	9	—	UNUSED BY EPROM PROGRAMMER AVAILABLE FOR GENERAL USE VIA SK2 (ON MK1 BOARD)							
IC7	PORT B/ DATA DIRECTION REGISTER B	A	OUTPUT	UNUSED	UNUSED	UNUSED	22 / $\overline{OE}$	RED LED ON	GREEN LED ON	28 / VCC	1 / VPP
IC7	CONTROL REGISTER B	B	—			CB2 UNUSED			SELECT REGISTER AT ADDRESS A 0-DATA DIRN B 1-PORT B	CB1 UNUSED	

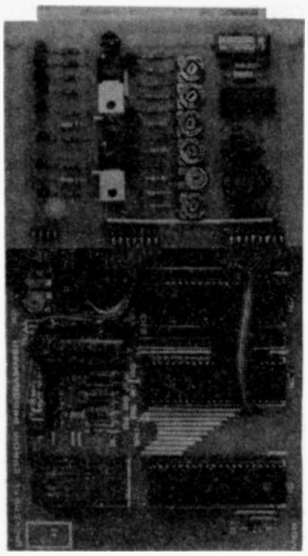
NOTE:
IN CASES WHERE MORE THAN 1 FUNCTION IS GIVEN FOR A PARTICULAR BIT THE ACTUAL FUNCTION DEPENDS ON WHICH DEVICE TYPE IS BEING USED. DETAILS MAY BE FOUND IN FIGURE 1.

Table 3 Memory map of the programmer.

The Upgrade Board — Construction

Construction of the upgrade board for the MkI programmer is straightforward and no special comments need to be made. Interfacing to the main board and setting up do require explanation. The procedure is as follows:

A. Remove the regulator IC10 from the main board. This may be re-used as IC12 or IC13 on the upgrade board.
B. Remove R4, R5 and C1 from the main board. RV1, RV2, RV3, Q3, Q4 and R6 may also be removed if required.
C. Remove SW1 if fitted to the main PCB or if not fitted remove the two wire links in its place.
D. Remove D1 on the main board.
E. Add D3 to the main board, connecting the cathode to SK3 pin 1 and the anode to IC9 pin 9.
F. Replace C5 (10n) by 100n on the main board.
G. Physically fix the upgrade board to the main board by use of three plastic bolts. If the fixing holes marked on the upgrade board are used they will allign with 'track-free' areas of the main board. The photographs with this article illustrate the means of interconnection.
H. make the connections between the two boards as shown in Table 4.



An early prototype of the upgrade

J. If using a programming console remove the switch, connecting the two wires which this interrruped directly to the appropriate ZIF socket pins and add 1 green and 1 red LED which are wired to connector A on the upgrade board via a 4-way cable as follows:

A/1	Green LED anode
A/2	Green LED cathode
A/3	Red LED anode
A/4	Red LED cathode

K. Installation is now complete and Vcc and Vpp voltages need to be set up as follows after first temporarily removing the wires to connector C:

1. Apply +5V to C7 only and adjust RV4 to give +5V on B4.
2. Apply +5V to C6 only and adjust RV5 to give +12.5V on B4.
3. Apply +5V to C5 only and adjust RV6 to give +21V on B4.
4. Remove +5V from C5 and adjust RV7 to give +25V on B4.
3. Apply +5V to C4 only and adjust RV8 to give +5V on B2.
4. Remove +5V from C4 and adjust RV9 to give +26V on B2.

UPGRADE BOARD CONNECTOR	MAIN BOARD DESTINATION
C/ 1	IC7 PIN 14
C/ 2	IC7 PIN 13
C/ 3	IC7 PIN 12
C/ 4	IC8 PIN 17
C/ 5	IC8 PIN 15
C/ 6	IC8 PIN 16
C/ 7	IC8 PIN 14
C/ 8	IC7 PIN 11
C/ 9	IC7 PIN 10
C/10	IC8 PIN 12
B/ 1	IC11 PIN 1
B/ 2	NO CONNECTION
B/ 3	SK3 PIN 28
B/ 4	O/P (CENTRE) OF IC10
B/ 5	SK3 PIN 1
B/ 6	OV (IC11 PIN 11)
B/ 7	SK3 PIN 22
B/ 8	+5V (IC11 PIN 13)

Table 4 Connections between the upgrade board and the original programmer.

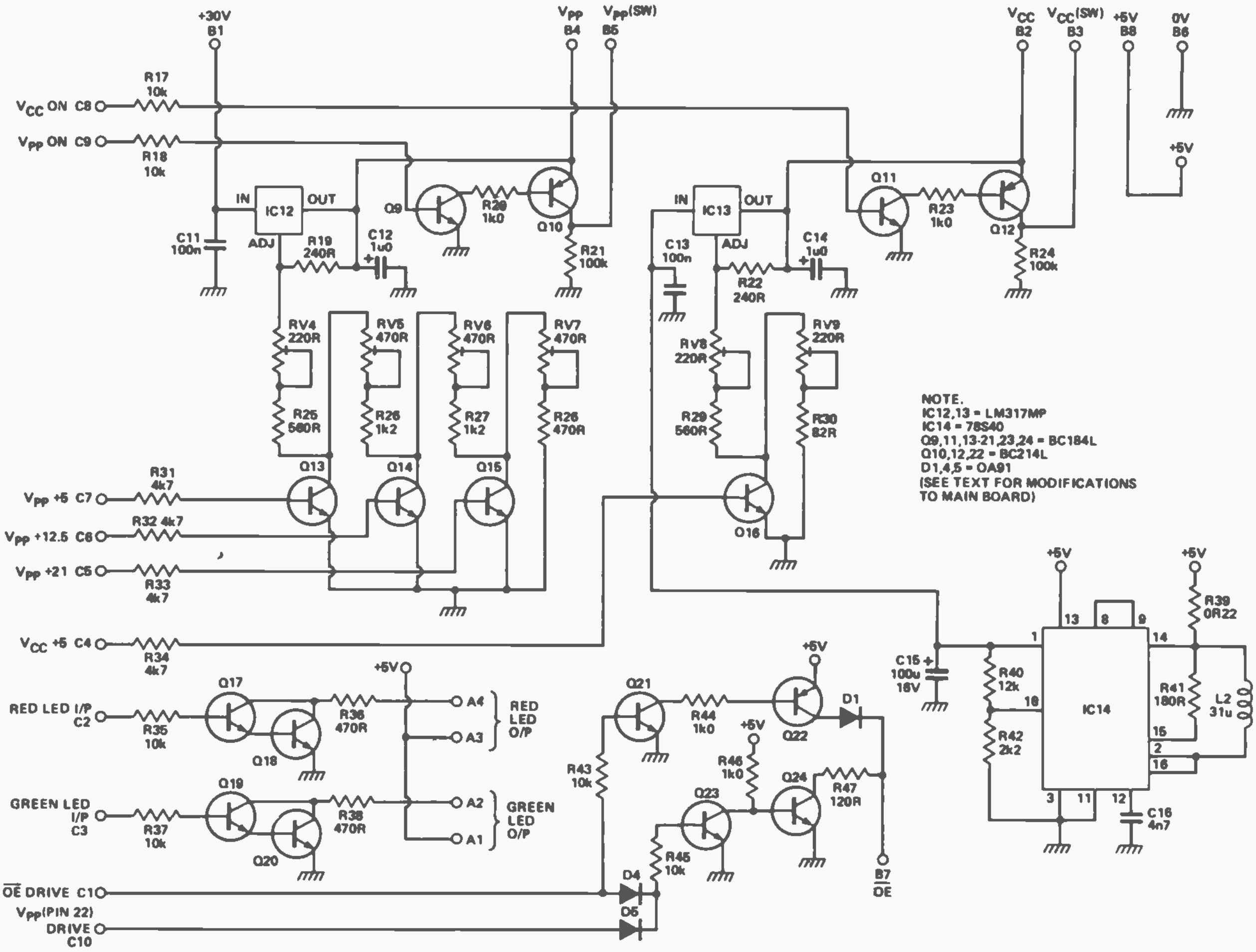


Fig. 1 Circuit diagram of the upgrade board (note component numbering).

PROJECT: EPROM Programmer MkII

HOW IT WORKS

Readers should note that the component numbers on Fig. 1 — the upgrade board circuit diagram — do not start at 1. Instead they follow on from the component numbers on the main MkI board. The following description assumes a knowledge of the workings of the MkI board to which the upgrade board is connected and a description of which may be found in ETI August 1983.

The upgrade board supplies Vpp (selectable to +5V, +12.5V, +21V or +25V), Vcc (selectable to +5V or +6V), a replacement driver for $\overline{OE}$ (the active low output enable line) and drivers for two LEDs. The old part of the Vpp circuitry which generates an unregulated +30V by use of a 78S40 has been retained. However, the regulator consisting of a LM317MP and a resistor chain, in which portions of the chain could be switched out by transistors, has been replaced. The new regulator is similar to the one on the MkI board but differs in two respects. Firstly each variable resistor in the chain has a fixed resistor in series with it, hence giving a more accurate means of setting up the voltages. Secondly an extra resistor portion and transistor have been added to allow the +12.5V programming voltage to be selected. This regulation circuit comprises IC12, Q13, Q14, Q15 and the associated passive components. An unswitched Vpp is passed to various Vpp switches on the main board. Transistors Q9 and Q10 provide a switched Vpp which replaces the supply to EPROM pin 1, previously switched manually. IC14 and its associated components form a second step-up circuit providing a +8V supply which is regulated to either +5V or +6V for Vcc. This regulator circuit is built around IC13 and is a similar configuration to the Vpp regulator. Transistors Q11 and Q12 provide a switched Vcc supply which replaces the original, manually switched supply to EPROM pin 28.

It should be noted that the Vcc supply to pin 24 on the EPROM need not come from this circuitry as no 24pin devices feature intelligent programming, so +5V will always be used.

On the original board a 10nF capacitor, C5, was connected between $\overline{OE}$/Vpp on pin 22 of the EPROM socket and 0V. This was a compromise between the 100nF suppression capacitor actually specified in the 2732 data sheet and a value which wouldn't slow down logic edges too much. On the new circuit the recommended 100nF capactitor is used but logic signals are not significantly slowed down as a result of the Q21/Q22 combination which provides a high current $\overline{OE}$ signal capable of charging the capacitor rapidly and Q24 which provides a logic low signal bypassing the suppression capacitor. Capacitor C5 should be changed on the original board.

Transistor Q23 provides a NOR function, turning Q24 on when neither of the signals driving EPROM pin 22 are present.

Transistors Q17, Q18, Q19 and Q20 simply form two darlington drivers with built-in current limiting resistors to drive two LEDs indicating programmer status. In addition to the extra circuitry on the upgrade board an extra diode, D3, is added to the main board. This is to provide the extra address line A15 to pin 1 of the EPROM socket, the diode being required to isolate it from the Vpp supply which can also be present on this pin. This diode — an OA91 — should be fitted between SK3 pin 1 (cathode) and IC9 pin 9 (anode).

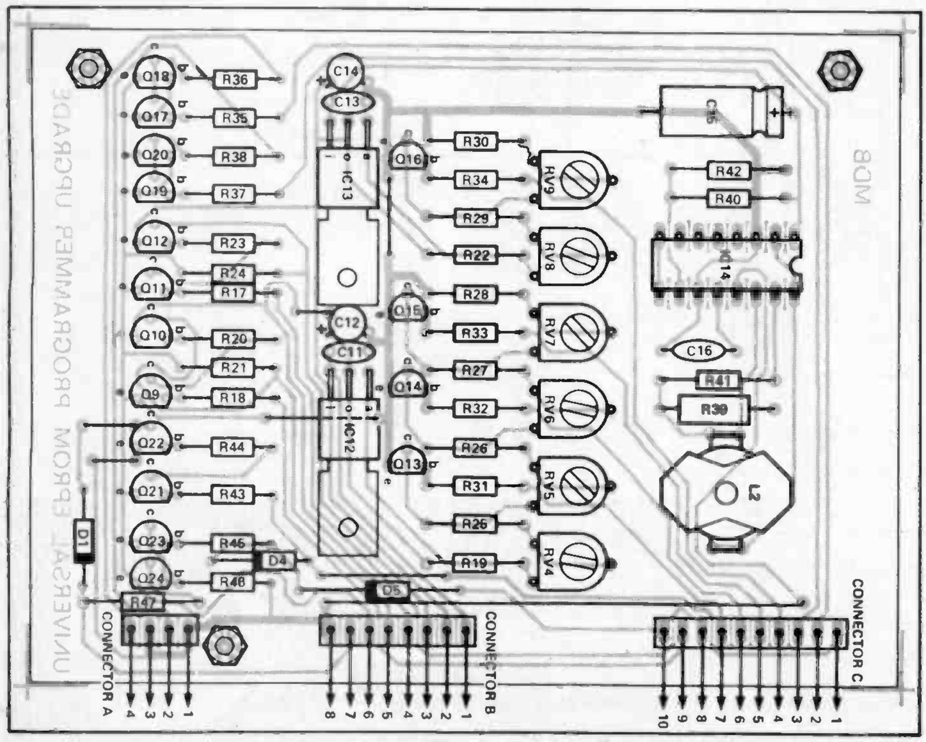


Fig. 2 Overlay diagram of the upgrade board.

PARTS LIST

RESISTORS (all ¼W, 5% unless stated)

R17, 18,35,37,43, 45	10k
R19,22	240R
R20,23,44,46	1k0
R21,24	100k
R25,29	560R
R26,27	1k2
R28,36,38	470R
R30	82R
R31,32,33,34	4k7
R39	OR22 W/W
R40	12k
R42	2k2
R47	120R 1/2W
RV4,8,9	220R vertical min preset
RV5,6,7	470R vertical min preset
CAPACITORS	
C5 (replace on main board)	100n ceramic
C11,13	100n ceramic
C12,14	1u tantalum
C15	100u 16V axial electrolytic
C16	4n7 polyester
SEMICONDUCTORS	
IC12,13	LM317 MP
IC14	78S40
Q9,11,13,14,15,16, Q17,18,19,20,21, 23,24	BC184L
Q10,12,22	BC214L
D1,D4,D5	OA91
D3 (fit on main board)	OA91
MISCELLANEOUS	
L2	31uH, 13 turns 22 SWG on RM6 pot core (AL=250)
Connectors A,B,C	0.1" pitch right angled molex connectors. 4,9 and 8 ways respectively.

PCB, three plastic bolts and nuts for attaching to main PCB.

BUY LINES

All components are standard. The biggest problem may be in finding a 28-pin ZIF socket. These are supplied by Watford Electronics and Technomatic. Electrovalue and Maplin will supply a OR22 wirewound resistor and Electrovalue will also supply the RM6 pot cores. The Molex connectors are standard inter-PCB connectors and the Euro connector for the MkII board likewise. The version of the LM317 you should look for is one in a TO 202 or TO 220 case - a 317 M or 317 T will do if you can't find a 317 MP. All semiconductors should be available from any supplier with a good stock - Technomatic, Rapid and TK advertise the LM317 T, Watford advertises all the other ICs.

Over the next two months, we'll be dealing with an entirely self-contained version of the MkII and with the software to drive the upgrade.

NEXT MONTH

Next month's ETI leads off with a major feature on TIME DOMAIN ANALYSIS, an invaluable technique for circuit design and analysis brought within the reach of everyone with a home micro. Our comprehensive feature, complete with program listings in standard BASIC, explains the technique and how to use it.

A major constructional project is the SECOND PROCESSOR FOR THE ACORN ELECTRON. Second processors are among the most exciting add-ons for computers and this feature explains the whys and wherefores in general terms before leaping into the particular circuit. Of course, the board can be adapted to suit any 6502/6510 computer.

Meanwhile, on the analogue front, John Linsley Hood continues his series on THE REAL COMPONENTS, explaining the y, z and h characteristics of transistors and how to handle them in designing circuits. Linsley Hood also unveils a LOW-COST AUDIO MIXER which will bring near-professional facilities to the humblest of PA, broadcast, domestic and studio systems.

In addition, we include the second part of the EPROM PROGRAMMER UPGRADE - the completely self-contained board-; an EPROM EMULATOR designed for use with the 6802 board featured in this issue, but adaptable to any system; a HEAT PEN add-on for digital voltmeters, which will convert almost any DVM into a multi-purpose thermometer; TECH TIPS; READ/WRITE and the new ETC section, featuring COLUMNS, REVIEWS and SCRATCHPAD, the ETI diary.

Plus all the usual ETI features in a jam-packed issue. It's on sale on MAY 3RD - SO AVOID DISAPPOINTMENT AND PLACE YOUR ORDER NOW.

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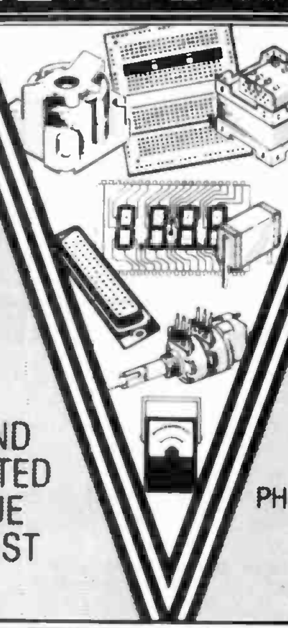

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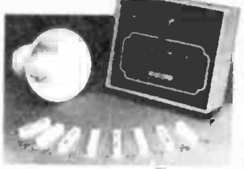

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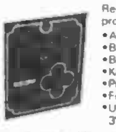

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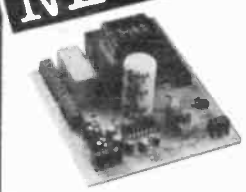

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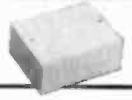

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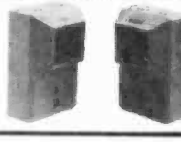

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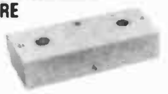

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This scoreboard has been designed for use in a gymnasium or other large space and uses mains light bulbs to provide a display which is large enough to be seen from a distance and bright enough to be read easily in daylight. The scores or other numerical information are normally entered via thumbwheel switches but the system could also be adapted to accept data from a microcomputer. The basic model has a four digit display which could be used, for example, to show a two-digit score for each of two teams, but the number of digits can easily be increased to suit other applications.

The Circuit

The heart of the project is a digit driver module. This uses a 7447A (BCD to seven segment decoder) to drive a digit composed of mains lamps via seven triacs. The BCD information is fed serially through a shift register, and picked off the drive the display.

One module is used per digit in the display, and they are chained together so that they form a long shift register of four bits per digit. The control logic is isolated from the mains by an opto-isolator module at the start of the chain, and only one of these is needed for the display.

The third module is a power supply. This provides two separate 5V supplies, one for the circuitry in the display drivers and the other for circuitry isolated from the mains by the opto-isolator module. The supplies shown only offer up to 100mA, so for displays with a lot of digits a different regulator may be needed.

Finally, there is a controller module. This takes data from up to

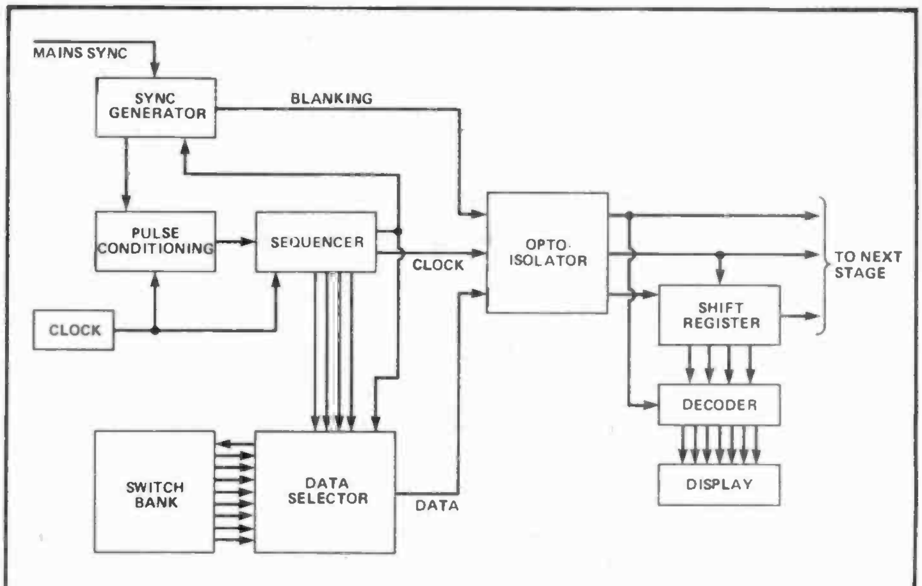
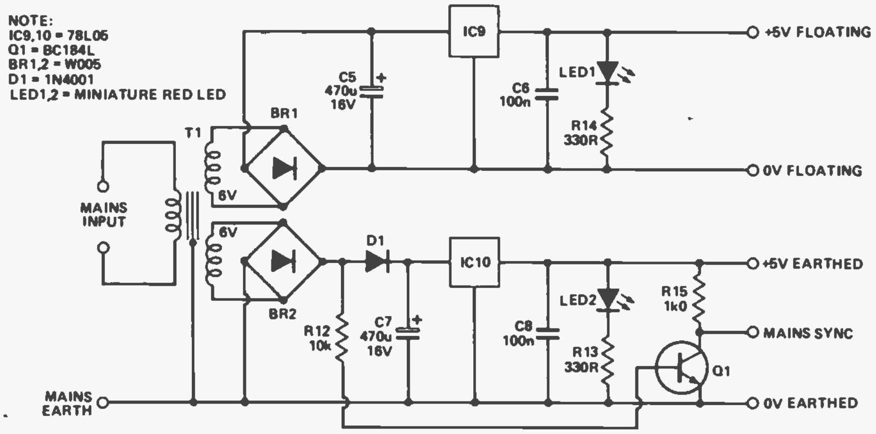


Fig.1 Block diagram of the complete system.

HOW IT WORKS



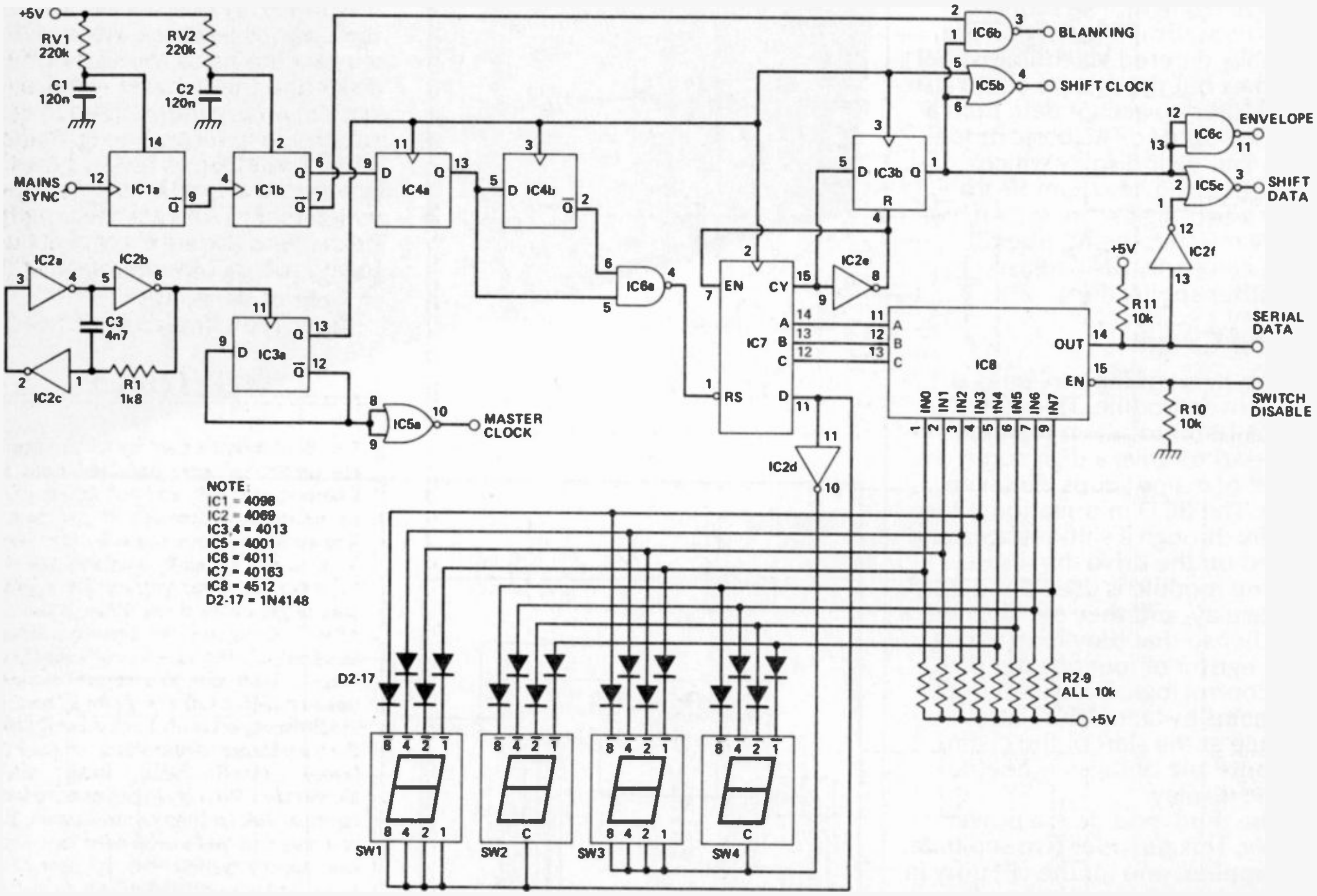
The power supply is in two sections, each of which has a bridge rectifier and a smoothing capacitor followed by a voltage regulator (ICs 9 & 10). C6 and C8 cut out any high frequency spikes and protect the regulators from oscillation. Each section is also fitted with a LED and current limiting resistor as a visual check of operation.

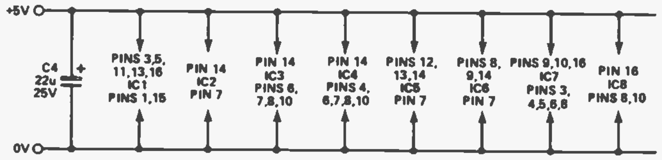
The section that supplies power to the control electronics has its 0V connected to earth as a safety precaution, and also provides mains sync pulses to the controller module. The bridge rectifier BR2 is isolated from the smoothing capacitor with a diode D1, so a full wave rectified AC waveform appears at the junction between D1 and R12. This is fed to TR1, which is driven hard on for all but the brief interval when the waveform is at less than 0.7V, 100 times a second.

The mains sync pulses are not necessarily at the zero crossing point of the mains because of the phase shifts that can occur through the transformer. To overcome this, they are fed into a monostable IC1a which is trimmed so that its output is truly at the mains zero crossing point. This is fed into a second monostable whose output is gated with the controller blanking output to hold the triacs off for a period into the mains half cycle. This achieves the dimming function.

IC2a, 2b, 2c, and 3a produce a square wave clock at about 50kHz. It is also used to control the operation of the remainder of the module.

IC4a, 4b, and 6a produce a pulse lasting for exactly one clock period at each mains crossing. This is used to reset IC7, a four bit counter. The counter controls IC8, an eight input multiplexer, to sequence through the bit inputs from the thumbwheel switches. Output D from the counter selects one switch bank or the other via IC2d.





Figures 2, 3, 4 and 5. Circuit diagrams of the power supply (top left), the controller (above), the opto-isolators (above right) and the digit driver board. Note the use of separate earthed and floating +5V supplies, the controller being operated from the earthed supply, and bear in mind that one digit driver board is required for each digit of the display.

When the counter reaches 15 the carry output goes high and the counter is inhibited via IC2e. This means that, after each mains zero crossing, the data bits from the thumbwheel switches appear in turn at the serial data output and via IC2f and 5c at the shift data output to the digit drivers.

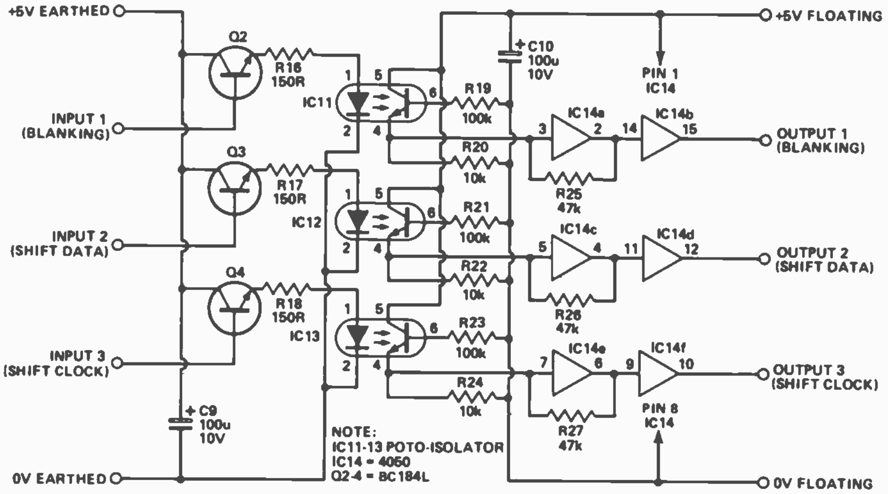
The beginning and end of this sequence is detected by IC3b which produces an envelope signal while data is coming out of the controller. The signal is made available to an external controller via IC6, and also gates the shift data and shift clock outputs to the digit drivers. It is also fed into the blanking signal so that, even with a very short period set for the monostable IC1b, the triacs cannot come on while data is being transmitted.

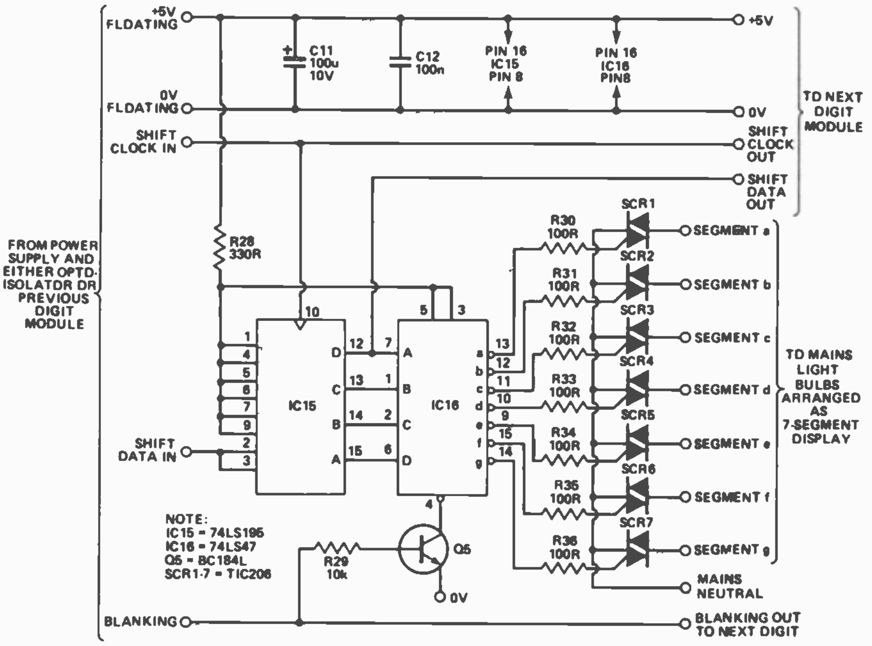
The three control signals connected to the digit drivers are fed through an opto-isolator circuit to prevent any mains potentials reaching the control circuits, hence making the unit completely safe for connection to, for example, a home computer.

Each of the three channels is identical, so reference will be made to one channel only. An emitter follower transistor Q2 drives the LED in the opto-isolator IC11. The opto-isolator transistor, biased by R19 to improve its high frequency response, is buffered by a Schmitt trigger (IC14a & R25), and a final output buffer IC14b drives the output.

IC15 is a four bit shift register, which converts the serial data to parallel at its outputs. The fourth output passes serial data on to the next driver module in the chain, thus with four digit drivers each gets its new data after sixteen clocks. The parallel BCD data is decoded by IC16 to form the segment drive to each of seven triacs.

The blanking signal drives Q5 which switches off the outputs of IC16, preventing the possibility of a digit being displayed while the shifting process goes on and allowing the display to be dimmed.





four BCD thumbwheel switches and turns it into a serial stream to send to the display drivers. It also takes mains zero crossing pulses from the power supply and uses them to time the serial transmission. This allows the display data to be updated while the displays are off at the zero crossing point of the AC mains cycle.

The controller also provides connections so that the display can be driven by a special purpose external controller, or by a simple I/O port on a home computer. In the case of a display with more than four digits, this is probably the easiest way to enter data and the circuitry for the thumbwheel switches can be omitted.

Construction

The box should be built first, and this is probably the most difficult part of the construction for those who are not naturally good at carpentry. It is not possible to give exact details and dimensions because these will vary according to the size of the digits and the number required, but the arrangement used in the prototype is shown in Fig. 6 and may be useful as a guide. Note the downward tilt of the display area which makes for easy viewing from below, and the steel brackets used to support a coloured plastic filter in front of the lamps.

The circuit boards are all single

BUYLINES

The BCD thumbwheel switches used in the prototype were obtained from RS Components, who will not supply parts to non-trade customers. If you cannot find another source you will either have to persuade a friendly local radio dealer to order them for you or, for a small surcharge, order them through Crewe-Allan & Company, 51 Scrutton Street, London EC2. The transformer came from Maplin, who can also supply suitable opto-couplers. Other suppliers may also stock these parts but check carefully that the transformer dimensions suit the PCB layout. Maplin also stock sheet aluminium which could be cut up to form the heatsink and the control panel, but you may find that a local hardware shop can supply panels cut to size. The semiconductors are all readily available, with the exception of the 4098 and possibly the 40163. Cricklewood and Maplin stock the 4098 and Watford stock all of the semiconductors. The PCBs are available from our PCB service, and don't forget that you will need one digit driver board for each digit of your display.

PARTS LIST CASE AND CONTROL PANEL

D2-17	1N4148
FS1	panel-mounting fuse holder and 3A fuselink
LP1	panel-mounting mains neon
SK1	7-pin DIN socket or other multipole connector to choice
SW1-4	BCD ten position thumbwheel switch with true and inverse outputs
SW5	DPST toggle or other mains on-off switch

mains lights bulbs and batten lampholders as required; wood, brackets, etc, for enclosure; coloured filter for front of display; small aluminium panel for the controls and nuts and bolts to mount; cable ties or spiral wrap or similar; stand-off pillars, nuts and bolts for mounting PCBs; ribbon cable, writing, etc.

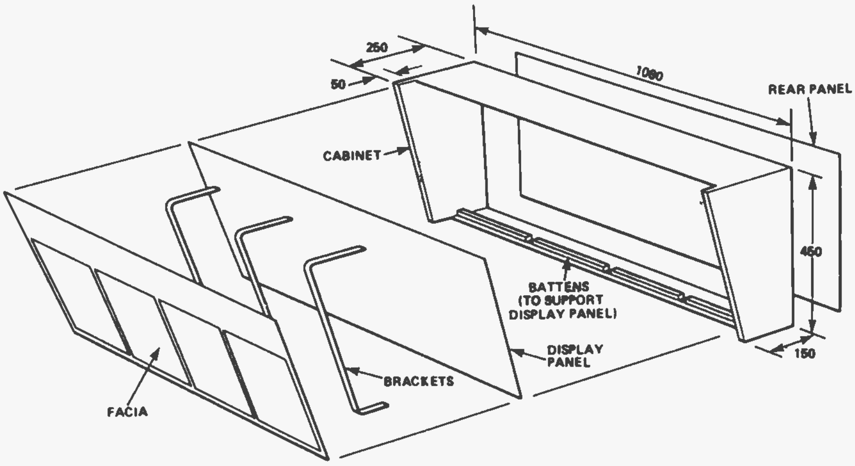


Fig. 6 Details of the cabinet used for the prototype.

sided except for the controller which is double sided. The legs of the components on the controller board are used to bridge between tracks on each side of the board, so in places the components must be soldered on the top side of the board as well as underneath. This rules out the use of sockets for the ICs.

Printed circuit board pins are used for the flying lead connections to the power supply (except the mains into the transformer), the isolator module, and the display drivers (except for the triac-to-lamp connections). The pins should be installed first, followed by the wire links, the resistors, the capacitors, and the semiconductors. Be careful with the ICs as some of them are CMOS. Leave the power supply transformer until last and do not fit the triacs for the time being.

The triacs on the digit driver modules are mounted with a small heatsink sandwiched between them and the board. This is a length of aluminium strip, details of which are shown in Fig. 9. The heatsink also provides the extra two mounting points for the board. Each triac is bolted to the board through the heatsink with a mica washer and bush to insulate the tab. Silicone grease should be used between the tab and the aluminium to improve heatflow.

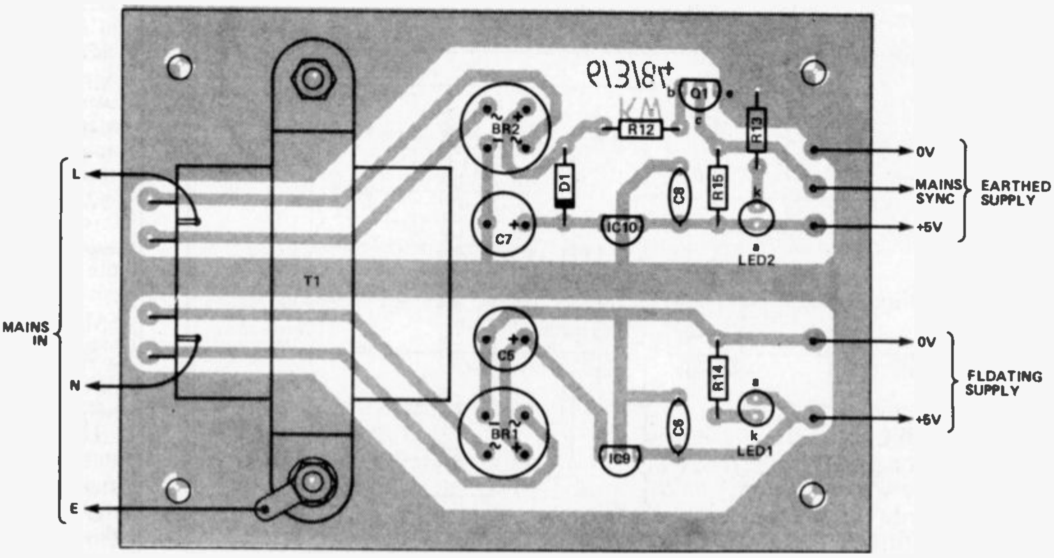
Two of the pins on each triac are

PARTS LIST POWER SUPPLY

RESISTORS (all ¼W 5%)	
R12	10k
R13,14	330R
R15	1k
CAPACITORS	
C5,7	470u 16V radial electrolytic
C6,8	100n 5% polycarbonate
SEMICONDUCTORS	
IC9,10	78L05
Q1	BC184L
D1	1N4001
BR1,2	W005
LED1,2	miniature red LED
MISCELLANEOUS	
T1	6-0-6V, 500mA mains transformer, chassis mounting

PCB; 1mm terminal pins; earth tag; nuts and bolts for mounting transformer.

Fig. 7 Component overlay of the power supply board. Note the earth connection to the frame of the transformer and the mains connections taken directly to the transformer, not to the PCB.



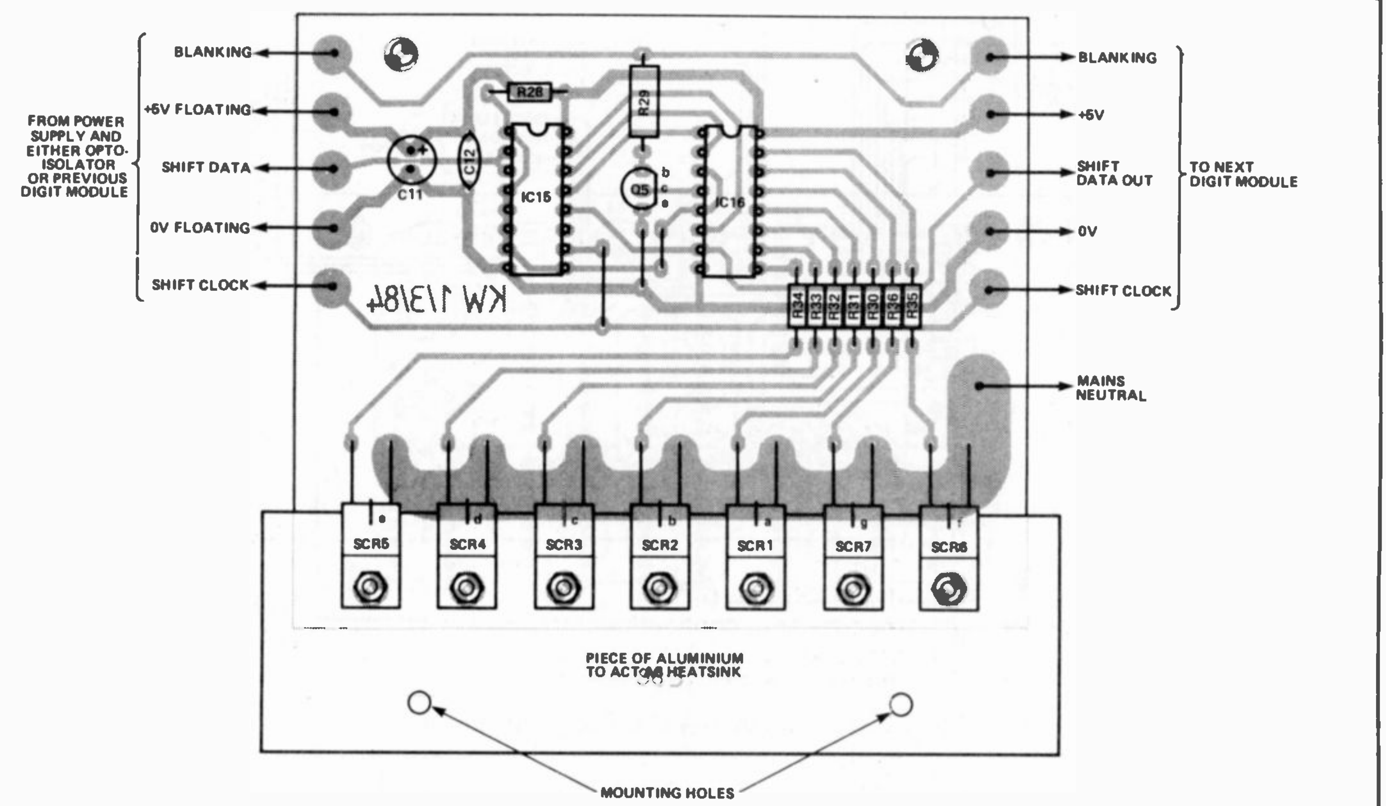


Fig.8 Component overlay of a digit driver board. The lamp connections are made directly to the centre pins of the triacs.

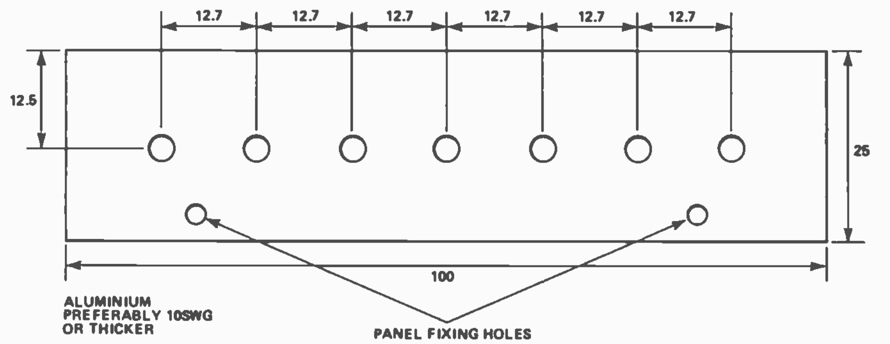


Fig.9 Drilling details of the heatsink for the digit driver board.

PARTS LIST DIGIT DRIVER MODULE

RESISTORS (all ¼W 5%)	
R28	330R
R29	10k
R30-36	100R
CAPACITORS	
C11	100u 10V radial electrolytic
C12	100n polycarbonate
SEMICONDUCTORS	
Q5	BC184L
IC15	74LS195
IC16	74LS47
SCR1-7	TIC206

MISCELLANEOUS

PCB; 1mm terminal pins; nuts and bolts, mica washers and insulating bushes for triacs; heatsink (see text and Buylines); IC sockets if desired — 2 off 16 pin DIL.

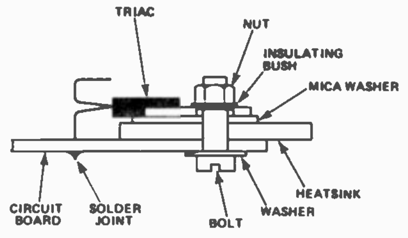


Fig.10 Mounting arrangements for the triacs.

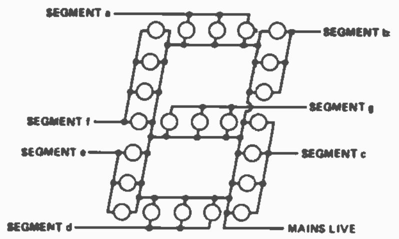


Fig.11 How the lamps are connected to form a 7-segment display.

bent down to pass through the board, while the centre pin is bent up for a flying lead connection to the lamps. Only after the triac-heatsink assembly has been completed should the triacs be soldered to the board.

The displays themselves are pygmy bulbs in bulb holders, mounted on a wooden panel. 15W bulbs should give sufficient light for most applications. Three bulbs are used for each segment as shown in figure 11, but for larger displays it might be better to use the small incandescent strip lamps commonly found in bedside lights for each segment.

The reverse of the lamp panel is used as a chassis, and the various circuit boards are screwed onto it through standoff pillars. Interwiring is kept neat by using spiral wrap around the cable

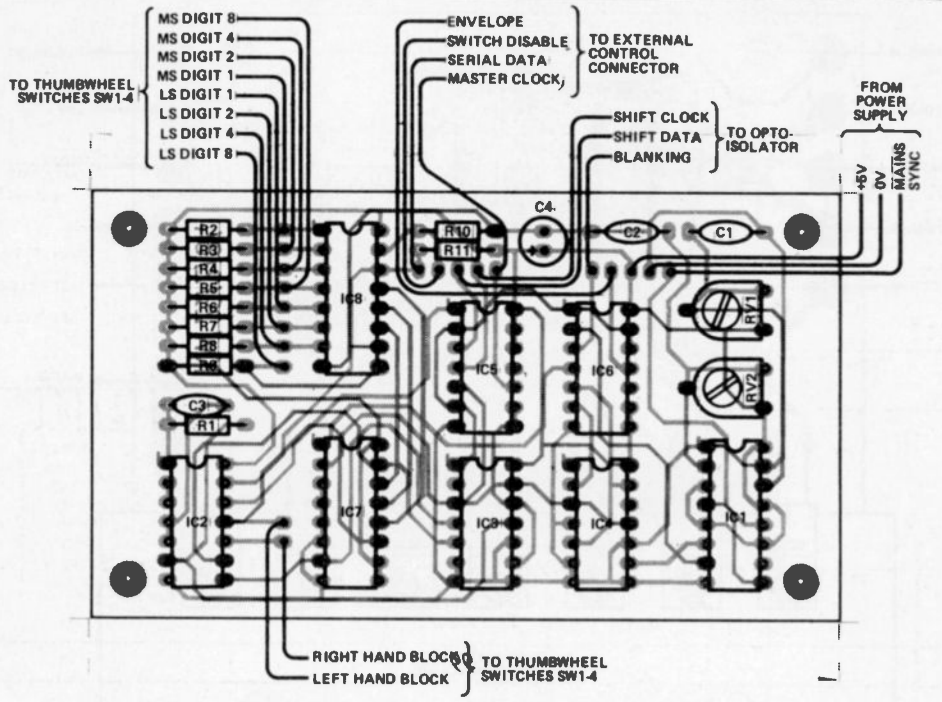


Fig.12 Component overlay of the controller board.

PARTS LIST — CONTROLLER MODULE

RESISTORS (all ¼W 5%)		C3	4n7 5% polycarbonate	IC5	4001
R1	1k8			IC6	4011
R2-11	10k	C4	22u 25V radial electrolytic	IC7	40163
RV1,2	220k miniature horizontal preset			IC8	4512
		SEMICONDUCTORS			
ACITORS		IC1	4098	MISCELLANEOUS	
C1,2	120n 5% polycarbonate	IC2	4069		
		IC3,4	4013	PCB	

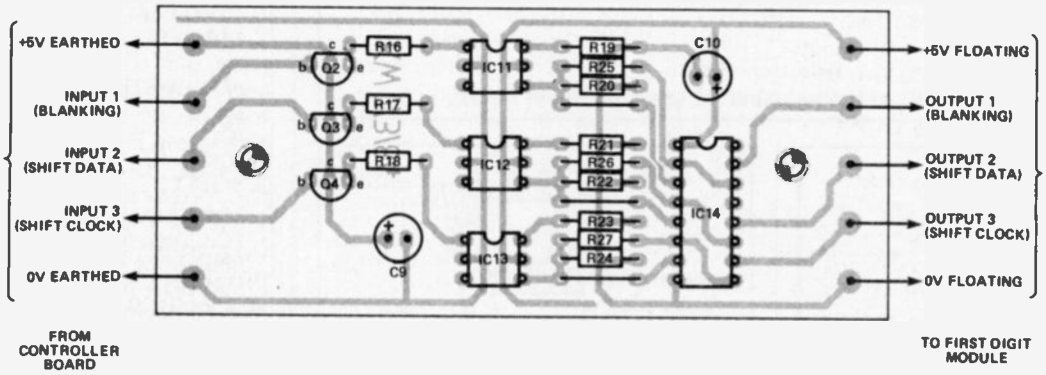


Fig.13 Component overlay of the opto-isolator board.

PARTS LIST — ISOLATOR MODULE

		CAPACITORS			
RESISTORS (all¼W 5%)		C9,10	100u 10V radial electrolytic	IC14	4050
R16-18	150R				
R19,21,23	100k	SEMICONDUCTORS		MISCELLANEOUS	
R20,22,24	10k	Q2-4	BC184L	PCB; 1mm terminal pins; IC socket if desired — 1 off 16 pin DIL.	
R25-27	47k	IC11-13	Opto-isolator (see Buylines)		

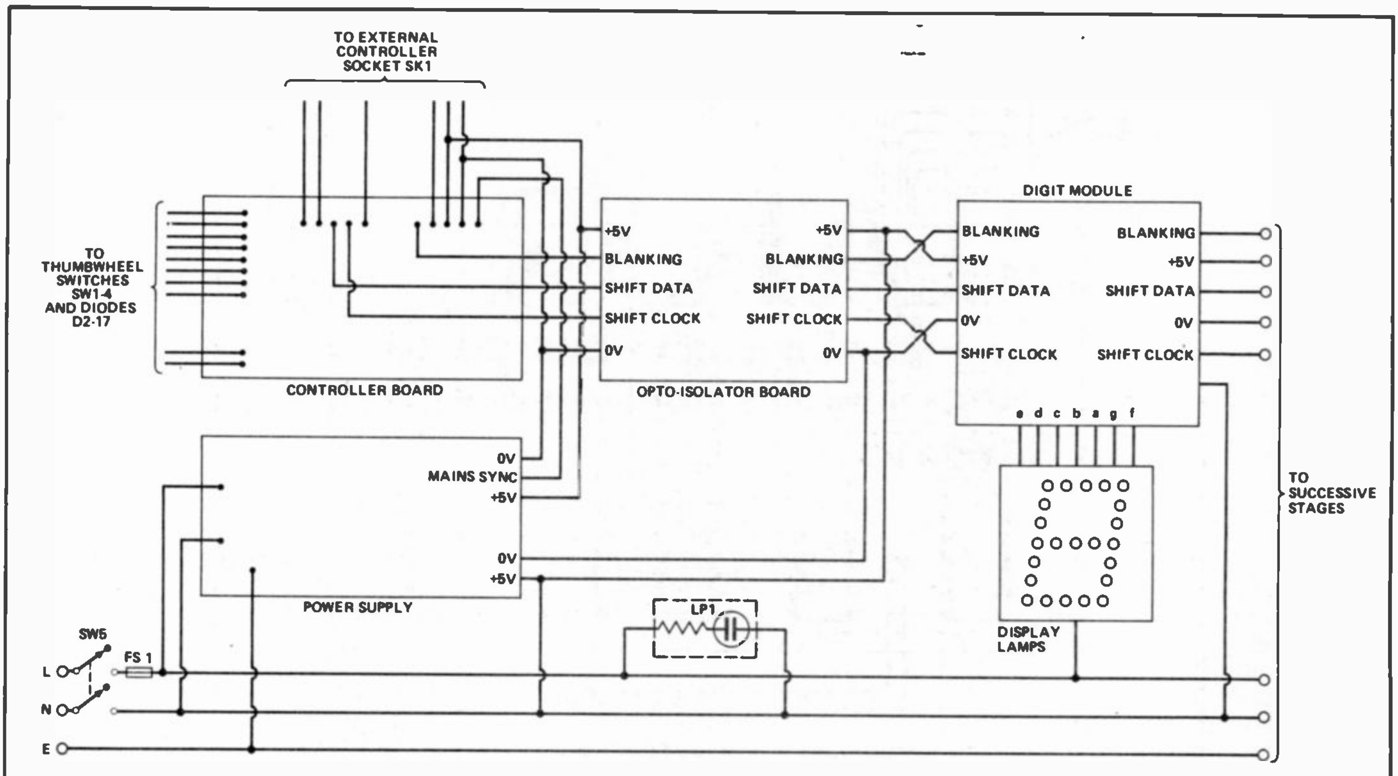


Fig.14 Interconnection of the boards.

looms, or ribbon cable as appropriate. Make sure that suitable cable is used for the mains supply to the lamps, between the lamps and the triacs, and the returns from the digit driver boards.

The supply, return, and earth wires have been taken individually to a central supply point, rather than chaining them from one point to the next. This includes the power supply module as well as each display. Remember that much of the wiring carries mains voltages and currents, and must be of a high standard to avoid the risk of accidents.

The diodes associated with the thumbwheel switches are mounted on the switches themselves, and the arrangement shown uses the inverse data outputs. If the switches used do not have inverse outputs, turn all the diodes round, swap the common connections for the two pairs of digits and alter the pull-up resistors on the controller module so that they pull down to 0V. If a display of less than four digits is required, simply omit switches and diodes starting with SW1, then SW2, etc.

Any convenient connector can be used for the outlet to the external controller. A seven pin DIN socket has been used in the prototype. The external controller can interrogate the thumbwheel switches by intercepting the serial data and control signals. It can inject data in place of the switch data by driving the switch disable input to a logic "1" (anything over 3.7V), at which point the output of IC8 goes high impedance and can be driven externally.

If the switch inputs are never going to be used, the controller module may be dedicated to external control by omitting IC4, 7, and 8, and R2-R9. The copper track on the component side of the board leading to IC3 pin 1 should be cut (close to the IC as it also goes to other places) and a wire link soldered between the pad of IC8 pin 15 and IC5 pin 2. This allows the external controller to generate the envelope signal. IC6 pins 5 and 6, and IC3 pins 4 and 5 must be wired to 0V to protect their CMOS inputs.

Setting Up and Use

It is a good confidence booster if the power supply works when you switch it on. Try it with its outputs disconnected, and the LEDs should light to show that something is getting through. If you have a meter, check that both outputs are producing 5V.

Unfortunately, very little intermediate checking can be performed on the rest of the circuit. Be careful when poking around the digit driver areas as these are live when the mains is connected.

Make the set up adjustments with a single bulb plugged in somewhere, and arrange for the display to show all "8"s. Set RV1 on the controller module fully anticlockwise and RV2 fully clockwise. Switch on, and the lamp should be at full brightness. Using an insulated screwdriver so that mains hum pickup does not affect adjustments, slowly turn RV1 clockwise until the lamp suddenly goes dim, and stop there. Now turn RV2 anticlockwise, and the lamp should increase in brightness. The lamp may be set to the desired operating brightness, remembering that the cooler a lamp is run, the longer it will last.

If the display is to be run at full brightness, either because you need that much light or because you wish to keep RF interferences to a minimum, continue to turn RV2 anticlockwise until the lamp suddenly goes out then turn it back to the point where the lamp comes on again.

The display is now ready for use, so switch off and install all the lamps. It would be as well to have a few spare triacs in stock, because when bulbs blow they tend to take their triacs with them. Running the display at reduced brightness should help a little.

ETI

STEREO SIMULATOR

Liven up your mono recordings, give breadth to your stereo with this unit developed by the indefatigable Dave Bradshaw from an idea by B. Webb.

There are many occasions when you're stuck with a mono signal, but it seems a waste. Mono is particularly irritating when you're using stereo headphones - it feels as if everything is coming just from the exact centre of your head. Here's a little unit that can remove that irritation.

Let's get one point perfectly straight, though. When you're presented with a mono signal, there's no way that you can get a true stereo signal back again. There are complex processes available to synthesise an apparent stereo signal, but these are very costly and time consuming and are primarily of use in the recording studio.

So, what the circuit does here is a bit of sleight of hand. By introducing phase and amplitude differences between the two channels, a semblance of ambience can be generated, and this can remove the more objectionable effects of listening to mono through a stereo medium. However, the unit described here does not restore the stereo information.

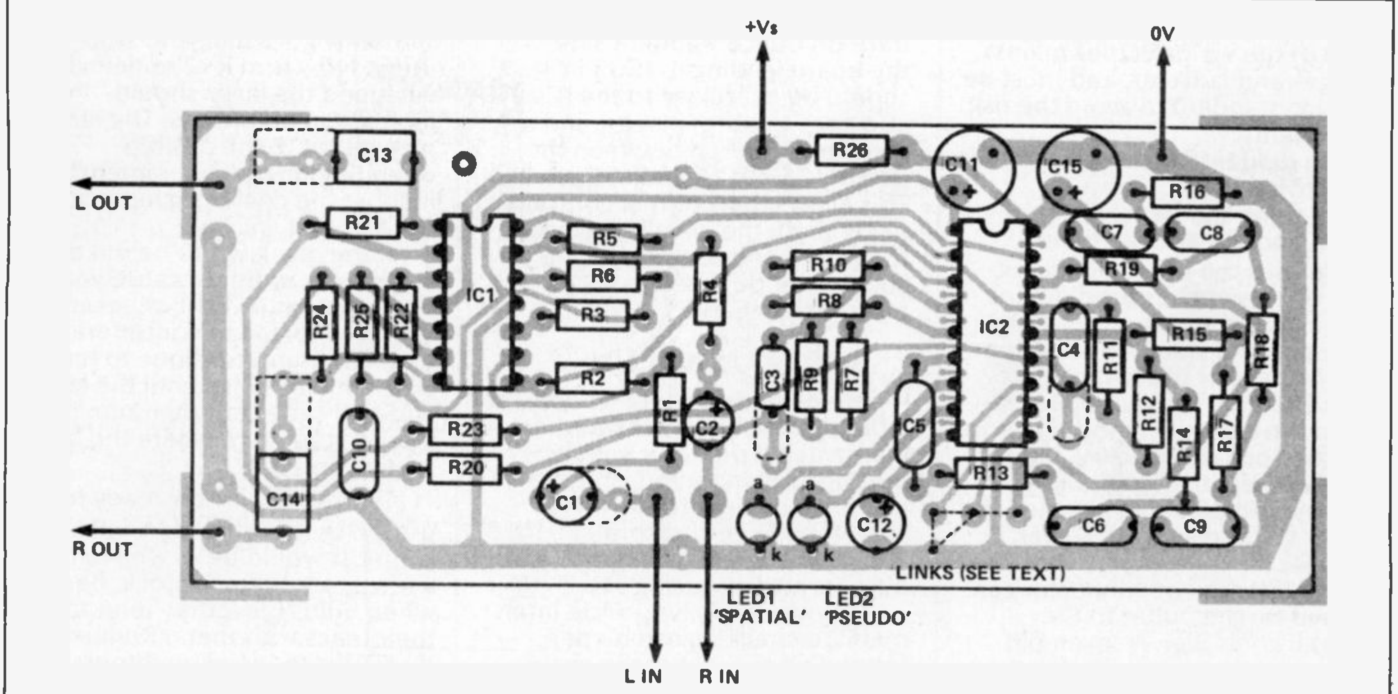
As a bonus, the unit can also be used to generate spatial stereo. In this, each channel is intermixed with the other channel out of phase. In theory, this expands the stereo image. In practice, the degree of success depends very strongly on the material being listened to. The effect can make the results from headphones rather more comfortable, so you might like to try out the spatial stereo as well as the pseudo variety.

The Circuit

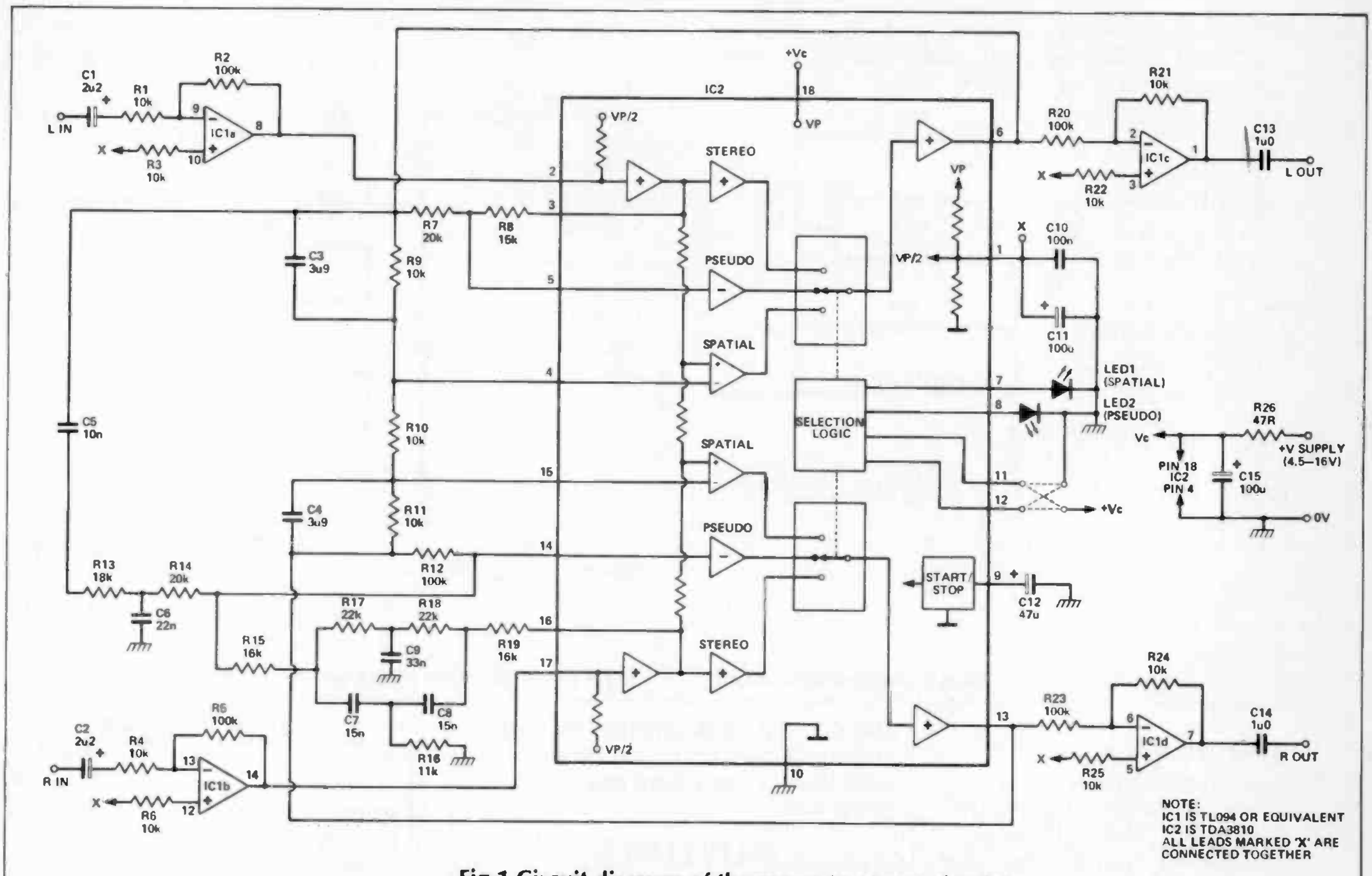
The circuit used here is a more-or-less direct 'lift' of the circuit in Mullard's application notes. The TDA3810 is a purpose-made device for pseudo and super stereo, so why reinvent the wheel?

To the special IC has been added a quad op-amp, to boost the signal to the level required for optimum noise performance, and to reduce and buffer the signal after the TDA3810. In the parts list, we specify a TL094, but any quad op-amp can be used provided there is sufficient supply voltage for it - it so happens that the TL094 can operate down to 4.5 V, which is the minimum supply voltage for the TDA3810. Maximum supply voltage for the 3810 is 16.5V, which is below the maximum for the TL094.

Supply current will be in the region of 10 mA (without the LEDs), a little more to the top end of the supply range, a little less for



Component overlay for the complete circuit.



NOTE:
IC1 IS TL094 OR EQUIVALENT
IC2 IS TDA3810
ALL LEADS MARKED 'X' ARE CONNECTED TOGETHER

Fig.1 Circuit diagram of the mono-to-stereo simulator.

a low supply voltage (around 7 mA for 5V). Obviously, supply current with the LEDs depends on what LEDs you use.

If a relatively 'clean' supply is available, R26 and C17 may be omitted. This may be particularly of value when lower supply voltages are used, as the voltage drop across R26 may be significant.

The actual mode that the circuit is in is selected by the voltages applied to pins 11 and 12 of IC2 according to Table 1. Pins 11 and 12 could either be permanently connected to the appropriate voltages, or could be attached via a two pole, three way mode selection switch -one vital point, the switch must be break before make, otherwise it will momentarily short the positive supply to ground when it is moved.

Sensible values of capacitors C13 and C14 depend on the input impedance of the circuit being fed by the unit. The outputs of IC1c and d will be at around half the supply voltage, so if you have to use electrolytic capacitors check the voltage at the input point to see which way round the capacitors should go. Also, check the input DC voltage, as it may be necessary to reverse the input capacitors.

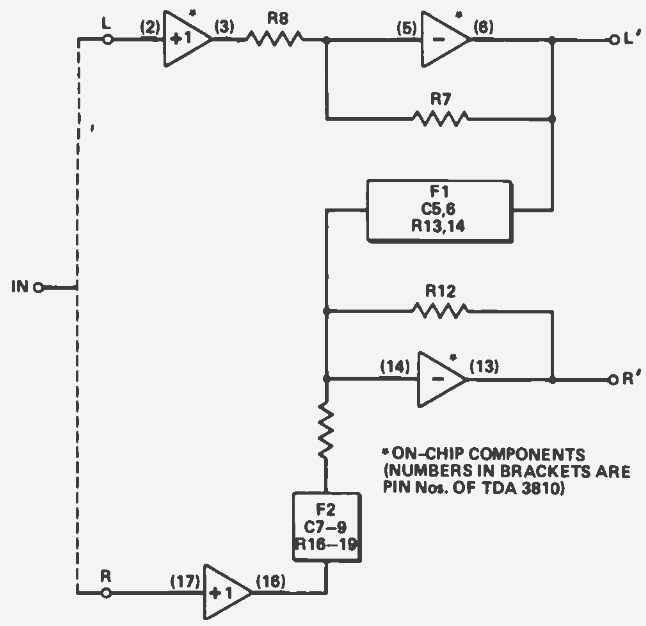
HOW IT WORKS

In the stereo mode, operation is quite straightforward, as all the TDA3810 does is act as a buffer. The op amps IC1a and b are configured as x 10 amplifiers, for reasons that will be discussed later, and IC1c and d are ÷ 10 amplifiers. So the net result is no change.

In the pseudo-stereo mode, IC1a - d act as before. However, IC2 is configured somewhat differently by its internal switches. The two filters, F1 and F2 are brought into circuit. Basically, the signal applied to the L input goes through to the L output with a small amplification and inversion. However, some of the inverted L input is passed to the input of the inverting amplifier in the R chain, via low-pass filter F1. This is combined with some of the non-inverted input fed in via the R terminal, which is passed through notch filter F2. Analysing what's going on in either F1 or F2 is difficult (particularly, in F2), and after several pages of algebra, we were little the wiser, so we cheated and used the values given in the manufacturer's data sheet! Let it suffice to say that the R channel has a different phase to the L channel as well as a different frequency response, and that response varies with frequency.

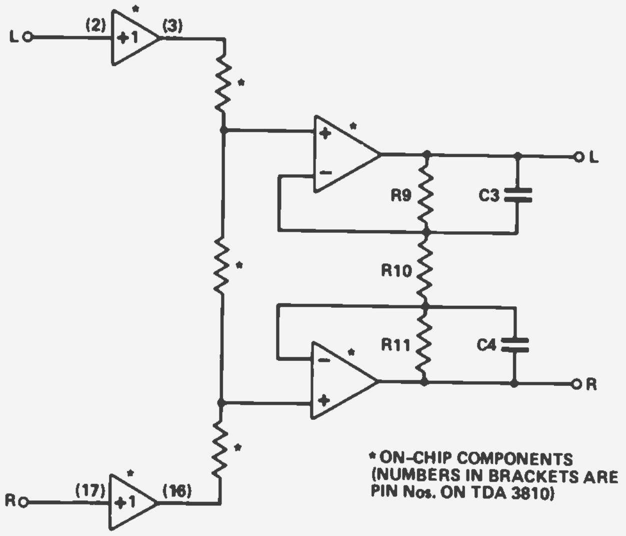
Finally, in spatial stereo mode, the configuration is as shown in Fig. 3. The input signals are buffered then slightly intermixed by the resistors connected between the +1 buffers' outputs. The signals are passed to the op-amps which invert them. These op-amps are configured so as to produce anti-phase cross-talk, ie the right output contains 50% of the left input, but inverted. At higher frequencies, capacitors C3 and C4 reduce the cross-talk.

Op-amps IC1a and b increase the input signal level to 2V RMS, which assumes a 200mV RMS input signal to the whole unit - probably more common than 2V! 2V is the recommended minimum input voltage to the TDA3810 with a 12V supply; obviously, if the supply voltage is significantly lower than this, then the input signal level to IC2 should be decreased to allow sufficient operating headroom for it and for IC1a and b. This will be detrimental to the noise performance. Obviously, the gains of IC1a and b will have to be adjusted accordingly, as will the gains of IC1c and d.



*ON-CHIP COMPONENTS (NUMBERS IN BRACKETS ARE PIN Nos. OF TDA 3810)

Fig.2 Block diagram of the circuit in pseudo-stereo mode.



*ON-CHIP COMPONENTS (NUMBERS IN BRACKETS ARE PIN Nos. ON TDA 3810)

Fig.3 Block diagram of the circuit in spatial stereo mode.

Construction

The first move should be to insert the IC sockets, making sure that you get them the right way round. This makes it easier to locate the positions of all the other components. Next insert and solder the resistors, followed by the capacitors, and then the LEDs. Finally, before inserting the ICs, check your work carefully and, in particular, look for solder bridges.

Now pick your insertion point in the main system that you're adding the unit to. The best point would be before the volume control, if the signal here is of a suitable level. In this way, the unit receives a more-or-less constant input signal level which makes for optimum signal-to-noise ratio.

The supply requirements of the circuit have already been mentioned. With a standard split supply circuit, it will probably be sufficient to feed the circuit from just the +ve supply and the 0V-the current consumption requirements of the circuit are modest and should not cause any problems.

BUYLINES

No special problems should occur here. The TDA3810 (as well as the more common TL094) can be purchased from Technomatic. Of the other components, the only trouble you may have is with the 3n9 capacitors for C3 and 4. Not many capacitor types are made with E12 series values nowadays, the E6 series being much more prevalent. However, polystyrene still seem to be available in E12 values, and this can be used here. The main problem with polystyrene capacitors is their size, but this has been allowed for on the PCB (in the main, polycarbonates have been specified for their relatively small size, not for any other reason; so long as the tolerance is 10% or better, any type should do, as this circuit does not have super-fi pretensions!).

MODE	CONTROL INPUT STATE		LED SPATIAL PIN 7	LED PSEUDO PIN 8
	PIN 11	PIN 12		
MONO PSEUDO–STEREO	HIGH	LOW	off	on
SPATIAL STEREO	HIGH	HIGH	on	off
STEREO	LOW	X	off	off

LOW = 0 to 0.8V (the less positive voltage)
HIGH = 2V to Vp (the more positive voltage)
X = don't care

Table 1 Mode-switching logic.

PARTS LIST

RESISTORS (all ¼W 5%)

R1,3,4,6,9-11,21, 22,24,25	10k (11 off)
R2,5,12,20,23	100k (5 off)
R7,14	20k
R8	15k
R13	18k
R15,19	16k (15k+ 1k)
R16	11k (22k//22k)
R17,18	22k

CAPACITORS (polycarbonate unless stated)

C1,2	2μ2 16V electrolytic
C3,4	3n9
C5	10n
C6	22n
C7,8	15n
C9	33n
C10	100n ceramic
C11	100μ10V electrolytic
C12	47μ 16V electrolytic
C13,14	1μ
C15	100μ 16V electrolytic

SEMICONDUCTORS

IC1	TL094
IC2	TDA3810
LED1,2	LEDs to choice

MISCELLANEOUS

PCB, wire, pins for off-board connections, switch if required (2-pole, 3-way, break before make).

ETI PCB SERVICE

In order to ensure that you get the correct board, you must quote the reference code when ordering. The code can also be used to identify the year and month in which a particular project appeared: the first two numbers are the year, the third and fourth are the month and the number after the hyphen indicates the particular project.

Note that these are all the boards that are available — if it isn't listed, we don't have it.

Our terms are strictly cash with order — we do not accept official orders. However, we can provide a pro-forma invoice for you to raise a cheque against, but we must stress that the goods will not be dispatched until after we receive payment.

1981
☐ E/8106-8 Waa-Phase.............. 1.76
☐ E/8106-9 Alien Attack.............. 4.00
☐ E/8107-1 System A-Input (MM or MO.................... 3.05
☐ E/8107-2 System A — Preamp 5.95
☐ E/8107-3 Smart Battery Charger ... 2.27
☐ E/8108-5 Watchdog Home Security (2 boards) 6.11
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TECH TIPS

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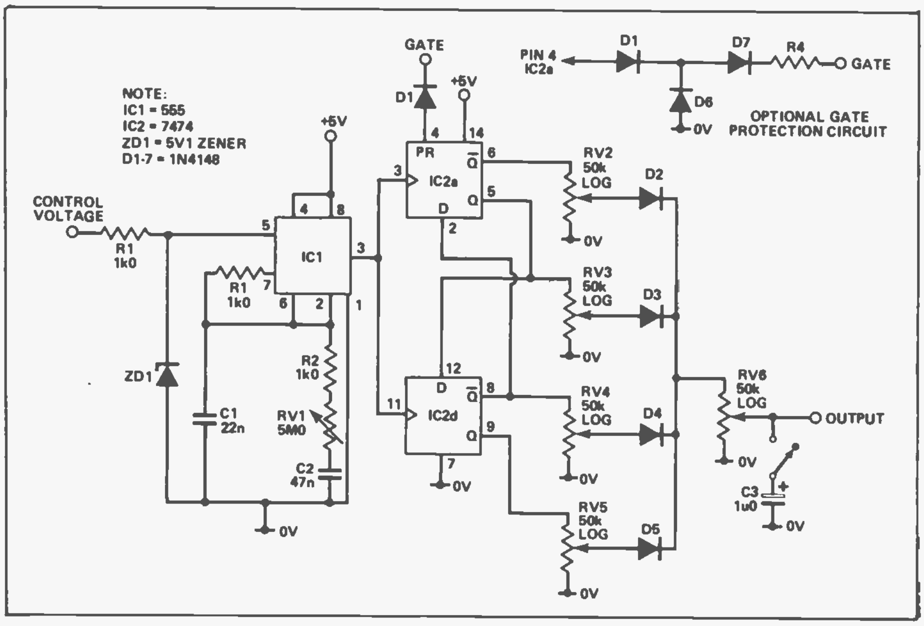


This simple circuit is quite useful for generating a number of functions. It can be used for trilling, vibrato or higher frequency modulation. It will also provide voltages for note sequences, gating, controlling filters, VCA's or any voltage controlled module.

A 555 timer is used as a simple voltage controlled clock with the five megohm potentiometer determining sequence speed along with the voltage at the control voltage input. This input will vary the speed with a positive voltage applied. This function is non-linear, has a 3:1 range and increases speed as the voltage decreases. With the component values shown (5M and 22n) the range is 2Hz to 7KHz. Larger values of CR will result in slower rates, and small values, faster ones.

A 7474 flip-flop is wired as a walking ring counter. The outputs overlap, so the final output is apparent as four steps. Moving one

FET Grid-dip Oscillator

G. G. Mellor
Macclesfield

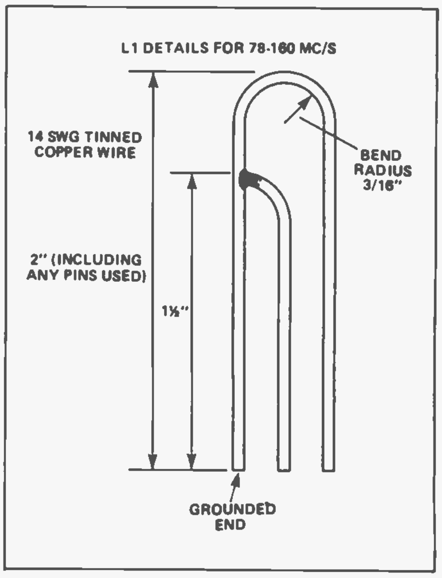
A relatively up to date version of the well known triode valve grid-dip oscillator can be constructed very simply and cheaply by replacing the RF triode by a FET such as the 2N3819, the BF245A or preferably, MPF106 in the trusty Hartley circuit. Although the physics of a triode and a FET are obviously different, they seem to operate in a similar fashion.

A non-mathematical explanation of the oscillation assumes an alternating RF potential on the source of Q1 which, due to the auto-transformer action of L1, gets amplified without any phase change (to make good any circuit losses). This voltage is fed to the gate of Q1. Since we are using Q1 in source follower mode, FET action maintains the amplitude of the alternating RF we first assumed. The tank circuit, L1 and C1, will provide the initial RF we require for this explanation on power-up.

The GDO must be calibrated and this can be done in one of (at least) two ways:

i) Listen for the GDO frequency on a good communications receiver and, using spot frequencies, calibrate the C1 scale.
ii) Measure the GDO frequency with meter using a high impedance probe on the source of Q1.

Using the GDO is simple, the appropriate coil for L1 is plugged in and the GDO switched on. L1 (which is mounted on a 3 pin DIN plug external to the circuit) is brought in the vicinity of the tuned circuit under test (TCUT). C1 is adjusted for a local minimum in the



Coil	Frequency Range (MHz)	Number Of Turns	Tap	Wire Gauge (SWG)	Number of Turns Per Inch	Coil Diameter
A	1.6-3.5	139	32	36ENA	Close Wound	¾"
B	3.45-7.8	40	12	36ENA	Close Wound	¾"
C	7.6-17.5	40	14	24Tinned	32	½"
D	17.2-40	15	5	20Tinned	16	½"
E	37-85	4	1½	20Tinned	16	½"
F	78-160	See Diagram				

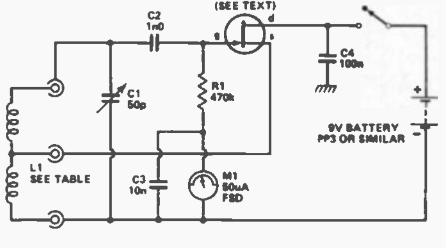
of the four level controls moves the whole sequence. These should be adjusted for preferred operation. The primary disadvantage here is that individual notes are difficult to tune accurately so the sequence should be run fairly fast in order to minimise note inaccuracies when controlling a VCO.

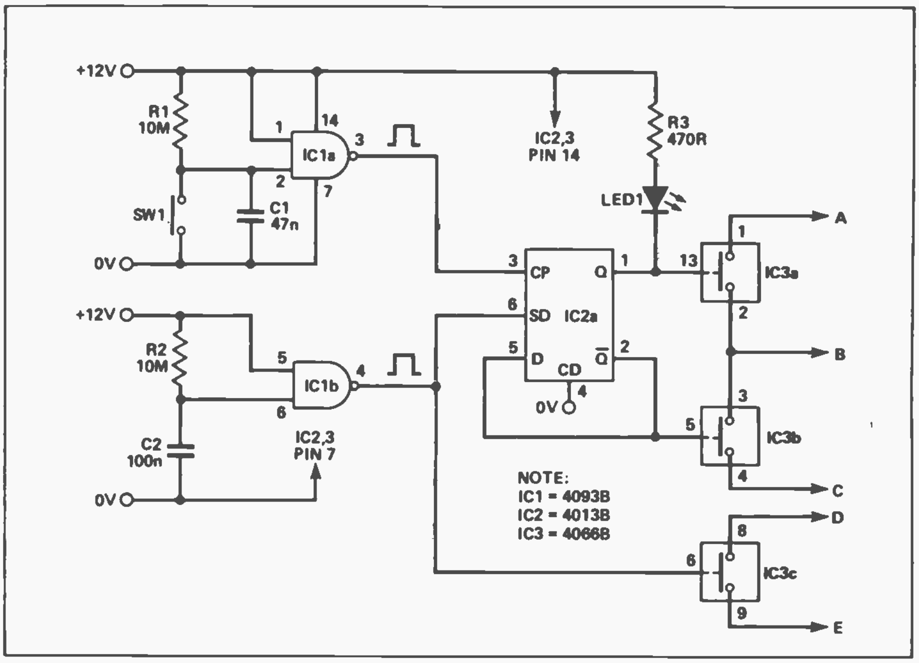
The sequencer can be turned off at the gate input with a ground. No connection, or a positive voltage will allow the circuit to operate. This input is protected from normal synthesiser positive voltages, but negative voltages should not be applied unless you use the optional gate protection circuit. The 50K pot on the output controls the level from 0 to 3.5 volts. The 1μ0 capacitor and switch are used to provide a slide function.

Note the power supply is 5 volts and must be regulated. Higher voltages may destroy the 7474 IC. If 5 volts is not available, use any 5 volt voltage regulator to step down a higher voltage.

---

meter reading and the frequency read off the scale. This "dip" in the reading occurs because some of the RF feedback in the GDO is absorbed by the TCUT consequently making the natural potential on the gate of Q1 less negative. It should be noted that loose coupling to the TCUT is essential to avoid the GDO frequency being "pulled" away from the value indicated on the scale. A dip can also occur when the GDO frequency is an integral sub-multiple of the TCUT frequency. However, practice in using the GDO will soon remedy this, and in any case there in no excuse for being a factor of 2, 3 or 4 out of the waveband you are supposed to be working in!





Push-button Operated Change-over

D. Wells
Newport Pagnell

The circuit shown was developed during the design of a DC controlled pre-amplifier. Using momentary contact switches allowed standardisation of all front panel switches. As well as giving a single or double pole change over switch the circuit ensures that the power up state of the switches is always the same. In the author's application only DC control voltages were being switched so the limitations of the 4066 switches at audio frequencies were unimportant; other applications may need to take account of these.

IC1a goes high when SW1 is pressed, R1 and C1 provide a debounce function. The outputs of IC2a change state on the positive edge of IC1a output. As the two outputs of IC2a are complementary and are connected to the control inputs of two switches in IC3, a change over switch is achieved by commoning the outputs of the two switches. R3 and LED1 are optional and form a visual indication of switch status.

IC1b provides a short high pulse at its output immediately after power up. The values of R2 and C2 ensure that this pulse is longer than the pulse from IC1a. The high from IC1b is connected to the set input of IC2a and causes the power up state to always be:

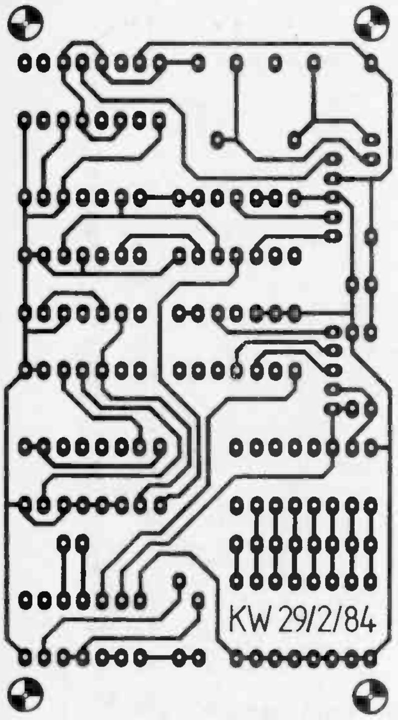
point A connected to point B and point B to C open circuit.

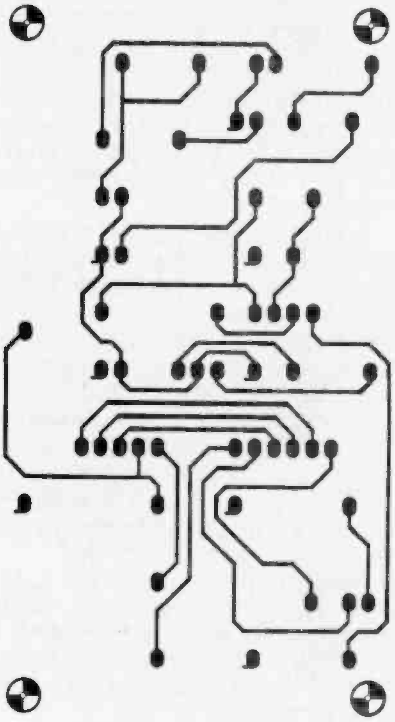
As it stands the circuit only uses half the gates in all three IC's. One possible use for these spare gates is shown in the diagram. The positive pulse from IC1b is fed to one of the spare switches in IC3. This switch was connected in parallel with one of the source select inputs thus ensuring that the same source was always selected at power up (the source switches were latched by the audio switching IC used). Other functions that could be implemented include: two single pole single throw switches; another single pole change over switch; a double pole single throw switch.

Could G M. Heath get in touch with us over his contribution to Tech Tips and would all future contributors help us by marking their name and address on each sheet of their submission. Thanks.

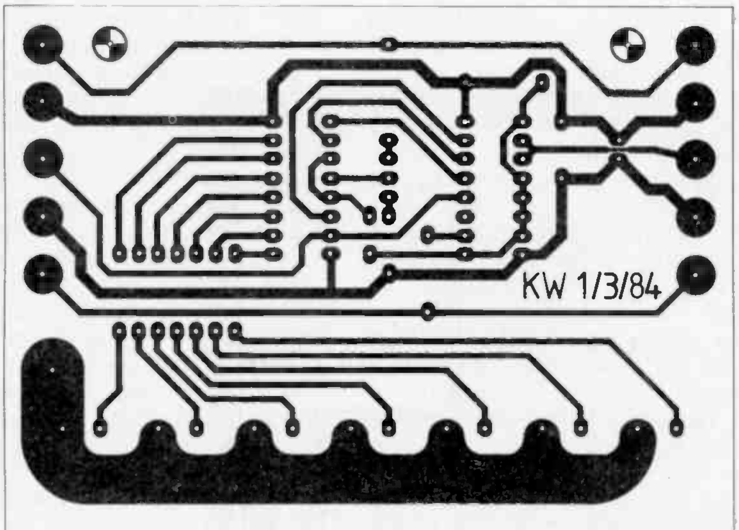
ETI

PCB FOIL PATTERNS

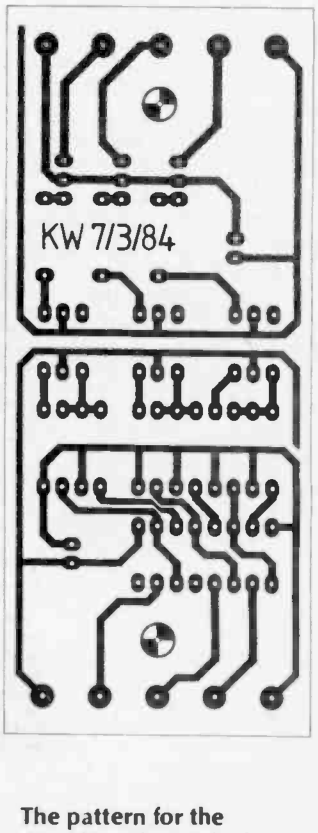




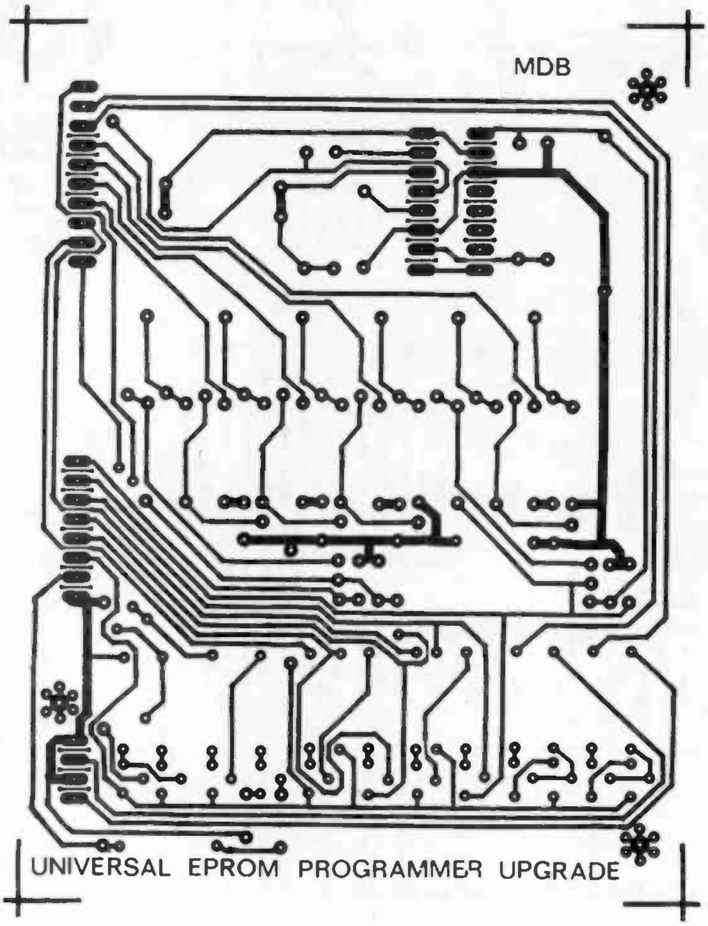
The top and bottom patterns for the scoreboard controller module.



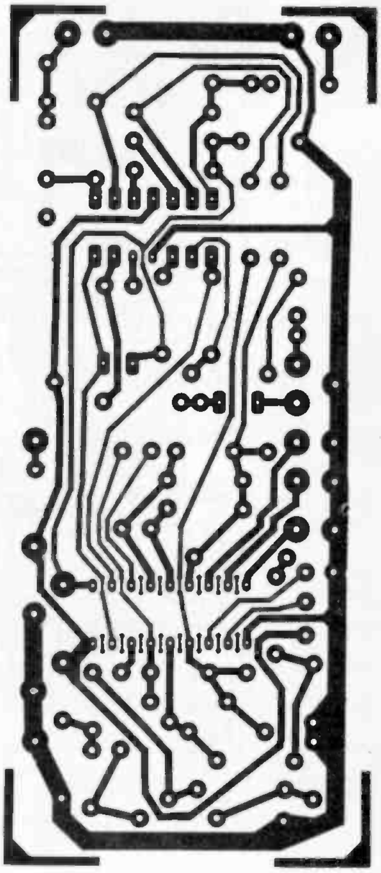
The digit driver board pattern for the scoreboard.



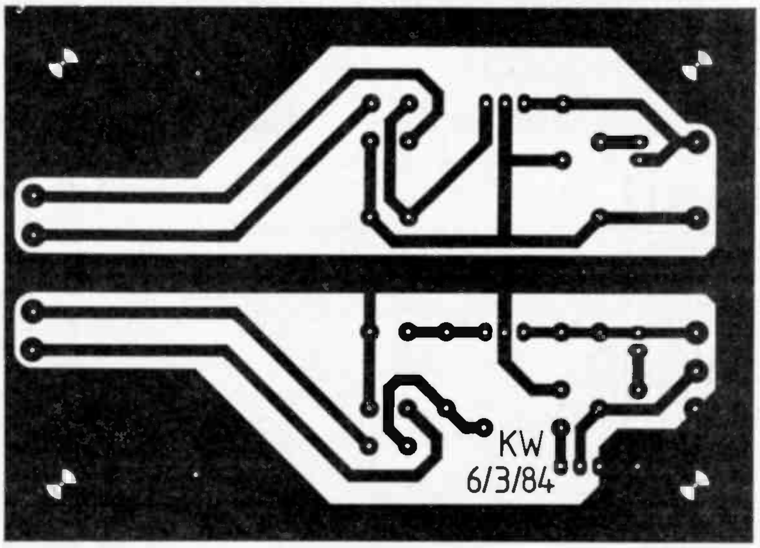
The pattern for the scoreboard opto-isolator module.



The EPROM Programmer upgrade board foil pattern.

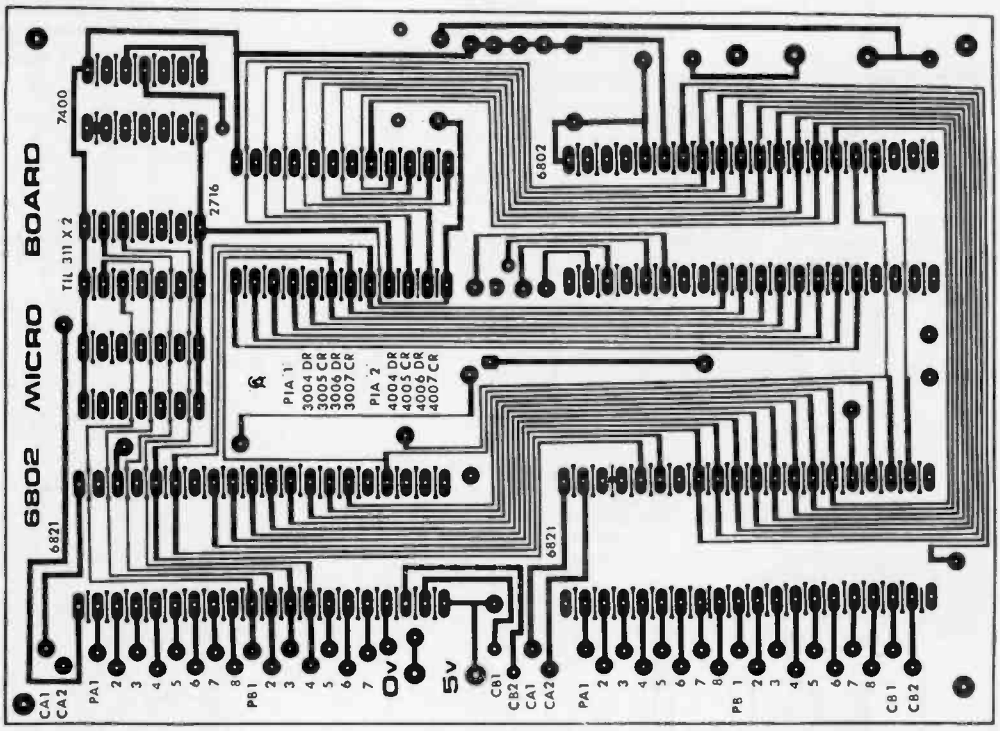


The mono-to-stereo simulator foil pattern.

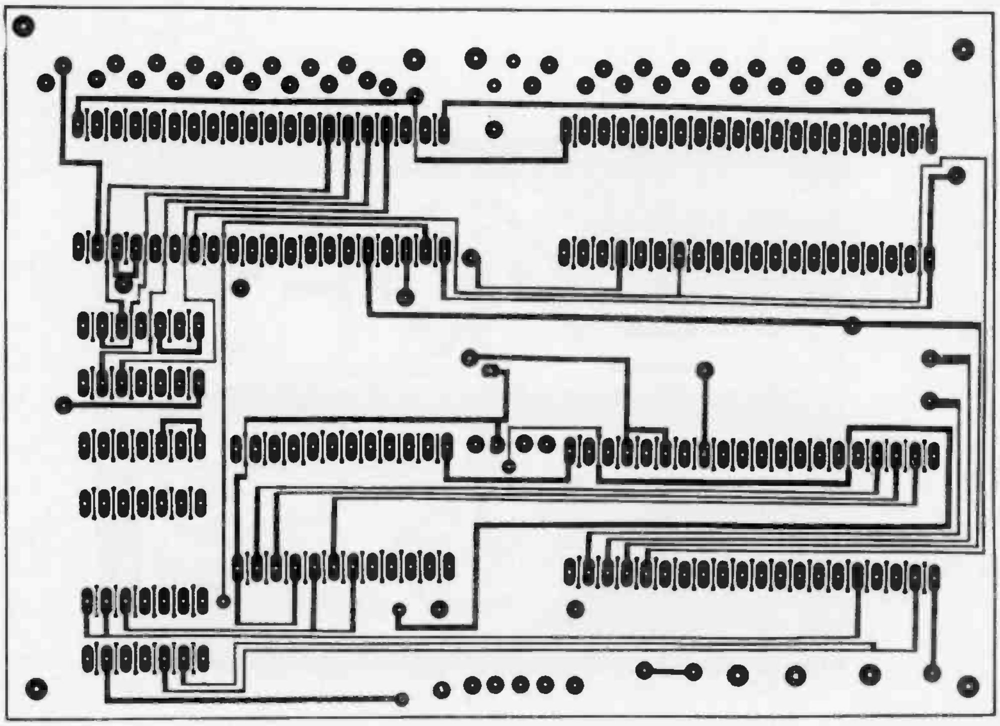


The power supply board pattern for the scoreboard.

FOIL PATTERNS



The top and bottom patterns for the 6802 Evaluation Board.



ETI

OPEN CHANNEL

Keep it human

When electronic communications systems were in their infancy, it seemed that the existing news communicators - newspapers - were in for a hard time. Pundits (then, and some even now) predicted the rise of the *electronic* newspaper and demise of the real McCoy. Well, the technology of the electronic newspaper is now with us, but it's being given a run for its money - after all, who on earth wants to sit in front of a computer display: CRT, LCD or other, to read the news when you could have a real, live newspaper folded on your lap.

The Financial Times will be the first UK publication to make use of SatStream North America and it obviously hopes to eliminate freighting costs, as well as being able to produce the paper in North America, hours earlier than previously possible.

A single satellite link is to be used between the FT's head office at Bracken House in the City of London and the printer in New Jersey State, USA. Facsimile pages will be digitally transmitted from Bracken House to the printer at data rates upto 128 Kbits per second, via BTI's earth terminal, sited at Ealing. Confirmation of page reception will be provided by a low-data rate return path using BTI's KiloStream service.

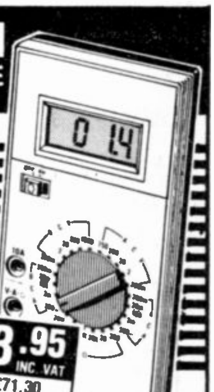
The point I'm making is that, yes, electronic services can be super fast, super efficient, and just plain super, but they can also de-humanise a customer service, so much so that the customer will choose not to use it. The example I've used here shows that electronic services can be used to great advantage in the planning, preparation and production of a newspaper, but in the end *the human consumer must be catered for.* Paper newspapers do this, electronic newspapers don't. The principle is not restricted to newspapers, and planners of electronic services shouldn't forget it.

It's for yoo-hoo

This month sees the planned start of British Rail's new service for commuting business - people : telephone links on-board trains. The first stage will cover the London/Manchester and London/Liverpool lines, and goes into service with a single telephone in each first class executive Pullman carriage. BR plans to expand this rapidly (hopefully to second class, too - some of us fee-paying, ordinary-mortal commuters know what a 'phone is, you know!) and foresees a high usage of electronic mail via portable terminals. In effect, commuters can use the train as a mobile office. Presumably, BR feels that its commuters should get some more work done and stop wasting time reading humanised newspapers.

Keith Brindley

Open Channel welcomes letters and information on products and events to do with telecommunications. Please address correspondence to 'Open Channel', ETI, ASP Ltd., 1 Golden Square, London W1R 3AB.



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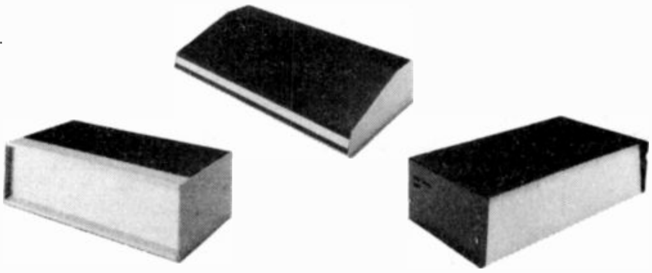

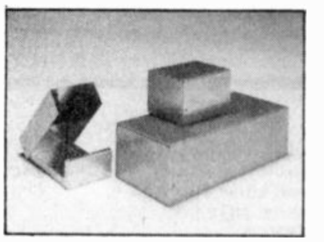

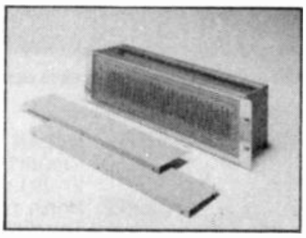

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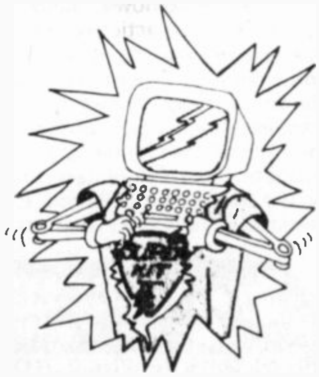

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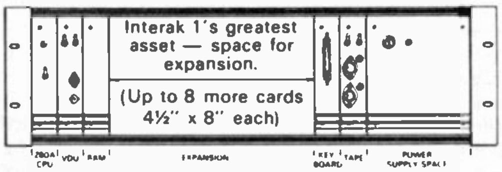

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SCRATCH PAD

by Flea-Byte

Steve Wozniak is one of the legends of the electronics world. While still hardly more than a teenager, he and his friend Steven Jobs built a smallish, microprocessor-based device in a garage in California. This was in the mid-seventies and, when they started to sell similar devices through their local electronic parts supplier, they caused quite a stir. They began manufacturing the device on uncased PCBs and gave it a name - the Apple computer. By the early eighties, Jobs and Wozniak were reckoned to have personal fortunes well in excess of $10m each. But, while Jobs went on to lead the Apple Computer Co. to greater and greater things, Wozniak quit in 1983, taking his money with him. He went into rock promotion, lost a couple of million, and signed up for a degree course in computer engineering - as a student. A couple of years later, the mercurial Wozniak applied for a job... as an engineer working at Apple Computer. Despite his millions, he was accepted on the 'shop floor' and helped develop products for the Apple IIe and IIc. Then, early this year, he quit again saying he was fed-up with working on computers. Instead, says Wozniak, he is starting a company called MBF Corporation - which stands for 'My Best Friend'. MBF's first product will be a controller for home video systems. 'It is not,' says Wozniak defiantly, 'a computer or a peripheral'.

•••

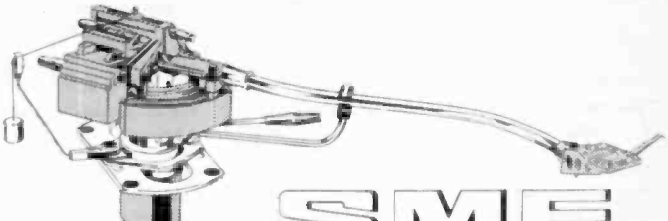
Interesting to note the results of the latest poll in 'New Scientist'. Asked - among other things - to name three famous scientists, members of the Great British Public plumped overwhelmingly for 'Don't Know'. Don't Know is, of course, dead - like most of the other scientists who appeared in the poll results. He or she is, however, thought to be responsible for inventing the wheel, viruses, sexual reproduction and the Third Law of Thermodynamics. Readers will be pleased to learn that, according to the poll results, the world's greatest living scientist (in fact, the world's only living scientist) is Sir Clive Sinclair, inventor of the tricycle.

•••

The latest news from Silicon Valley suggests that maybe it should be renamed. Cocaine Valley, perhaps? Or Amphetamine Alley? Evidently, the use of 'uppers' like cocaine and amphetamines has become so widespread among the electronics community that many companies have had to consider screening prospective employees for signs of drug use. IBM has actually introduced a screening policy. (Perhaps the company should now be known as Big Blues!) Practically every other big name in the Valley has fought shy of such a move. They are doubtless aware of the fact that hardly anybody could stand the pace of developing breakthrough technologies every other day without recourse to stimulants. Also Intel, Nat Semi, Apple and the rest must know that there are more jobs around in their part of the world than qualified people to fill them. Indeed, with an average salary of $28,000 which is already 75% higher than the US average, perhaps it's time for the high technology companies of Silicon Valley to start offering inducements in non-financial forms to woo new talent. Could the sunrise industries become the snowfall industries?

•••

While the robot population of Britain rose by 33% last year to a total of 2,623 (not including the occupants of the House of Commons or the cast of 'Crossroads'), the country is still only sixth in the league behind France, Italy, West Germany (with 6,600 robots), the US (13,000) and Japan (64,600). Of course, it's common knowledge that the Japanese have a different system for counting robots. For example, they claim to have developed a device controlled by 67 16 and 8-bit micros which can read music, listen to instructions, talk and play keyboards. In Britain, this would be known as Richard Clayderman.



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We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you all the boring details. (Don't forget to give us your telephone number).

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OOPS!

Corrections to projects are listed below and normally appear for several months. Large corrections are published just once, after which a note will be inserted to say that a correction exists and that copies can be obtained by sending in an SAE.

EPROM Card (June 1984)
On the circuit diagram, Q2 base is shown connected to +25V, but should be connected to +5V. Q3 should not be connected to 0V, but only to point a. The capacitor connected between +25V and 0V is C5 and should be 2μ2 35V tantalum bead. Switch connected across C4 is SW1 on overlay. Increase R8 to 2k7 if using suggested PSU. (R8 OK for 24V).

Spectrum Joystick Interface (June 1984)
The PCB and the circuit diagram do not agree; the circuit diagram is correct, and all PCBs sent out by the PCB service should have been amended. IC3 is 74LS241, as correctly stated in the parts list but incorrectly given in the footnote to the circuit diagram.

CMOS Tester (August 1984)
C3 and C2 are reversed on the overlay: C3 is the electrolytic and C2 the polyester. R33 is 100K, not 1M as given in the parts list, and RV1 is a 1M horizontal skeleton preset. R1-16 are two, eight-resistor SIL packages, the component labelled C14 on the overlay is SK1, and the connections to D2 shown in Fig. 3 are reversed. On the circuit diagram, the eight lines connecting SW9-16 to the inverters are shown in reverse sequence. Some of the inverters have been given the wrong designations; the correct sequence, reading down from the top, is:- IC1f, IC2a, IC2b, IC1e, IC1d, IC1c, IC1b, IC1a, IC2c, IC2d, IC2e, IC3d, IC3a, IC3b, IC3c, IC2f. Finally, the pin numbers are missing from ICs 3e and f; the input of IC3e is pin 11 and its output pin 12, and the input of IC3f is pin 14 and its output is pin 15. The PCB is correct in all respects.

Sharp Joystick Interface (August 1984)
Some of the inverter pins are incorrectly labelled on the circuit diagram. Pins 11 and 10 are shown reversed on IC1b, pins 9 and 8 are shown reversed on IC1c, and the output of IC4d is pin 10, not pin 20. Note that a number of the inverters have been incorrectly shown as non-inverting buffers.

AM/FM Radio (November 1984)
In Fig. 2, the oscillator and IF sections should be shown connected to ground; the PCB is correct. In Fig. 4, C31 should be 10n to give the 75us deemphasis shown in Fig. 3, but 4n7 has been found to give a brighter midrange. R38 in Fig. 5 should, of course, be 820k rather than 280k and it and the bottom end of C38, C44 etc should be shown connected to ground. In the construction section on page 25, four pieces of 8mm plywood are mentioned but in fact only three are needed — the fourth side is the front panel. See also the note in December News Digest regarding availability of the inductors.

Digital Control Port (November 1984)
The second sentence in the "Testing" section on page 30 should include the words 'without any ICs in place'. In the second paragraph of that section, the check for +5V should be made on pin 3 of IC101, not IC1. At the bottom of the first column on page 31, the last sentence should finish with B3 = 0.

Video Vandal (November 1984)
In Fig. 8 on page 54, R16 and R17 should be shown connected to the base of Q4, and C12 and SW2 should be in the D output line rather than the 0V line. It may also be beneficial to add a diode across R3 with its anode connected to the slider of RV1. In Fig. 10, R52 and LED2 are shown connected across the +12V supply but it is better to place them across the −12V supply so as to even-up the dissipation in the ICs.

VCDO (March 1985)
RV2 should be 10k (right in parts list, wrong on circuit diagram).

REVIEW

Digital Lab

Computer software

Associate Services Ltd.
23 Chesham Street
London SW1X 8NQ

price: £29.95

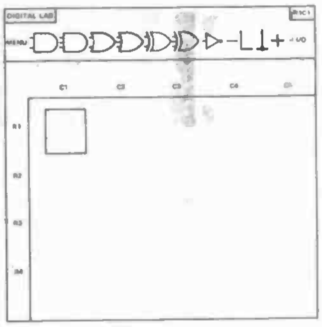
For some years now, sophisticated circuit design and analysis software has been available for expensive minicomputers and mainframes. One of the most interesting developments in the micro field in recent months - interesting, that is, for those involved in electronics - is the introduction of cheap packages for circuit design and analysis on home computers.

Digital circuit design and testing would seem to be the obvious direction for software developers in this area to take. So it's surprising to find that the best packages (and there are only a handful of them) are actually devoted to modelling and analysing linear circuits.

Apart from Sinclair Research's 'Make-A-Chip' package for the Spectrum, which pretends to be no more than educational, there has been nothing to my knowledge tackling the problems of either combinatorial or sequential logic design. Until now, that is.

'Digital Lab' is a package produced by Associated Services (London) Ltd., of 23 Chesham Street, London SW1X 8NQ, for the Commodore 64. The disk-based software comes with a 60-page manual and costs around £30. In all fairness, Associated Services aim the program at 'pupils and students who would like to extend their practical approach to designing and constructing logic circuits' - although they do claim that the program can be used to help actual circuit construction.

I must confess that I assumed 'Digital Lab' would turn out to be a real designer's tool before actually trying it out. In that respect, I was disappointed. The package allows you to link together as many gates as you can fit into a 99 row by 99 column matrix (windowed on the screen as a five by five matrix), but there are no NAND, NOR or EXNOR gates available - these having to be built-up from ANDs, ORs and NOTs - and the maximum number of inputs to any one gate is only three. Neither does the package support sequential logic - except by allowing you to observe the action of single RS, D-type and JK bistables.



The initial screen of Digital Lab

With these restrictions, 'Digital Lab' can only substantiate a claim to being an educational tool. And, despite one or two quirks, as an educational tool it works well. The quirks are largely to do with the style in which the software has been programmed. The author could have made one or two simple modifications to improve the package - for example, the ability to hold the 'input-output screen' (in which the circuit you have designed is assigned input and output names) and alter the design would have been useful. As it stands, if you want to alter your circuit in any way, input-output lines have to be re assigned from the start. This is quite a tedious procedure.

I would expect to see more packages like this being produced in the future. No doubt, their authors will learn from this one and make what improvements they can. At the moment, 'Digital Lab' has the edge because the competition is practically non-existent. Its own merits are also clear. It is a powerful, value-for-money aid in learning about combinatorial logic. It is not really a designer's tool and, even as a learning aid, it should be used together with a good book on logic circuits. Its one virtue for the professional or advanced amateur is that the program takes the tedium out of calculating truth-tables for complex gate arrangements. For this reason alone, Commodore-64 owners involved in logic design may well have reason to be very grateful to Associated Services.

Gary Herman

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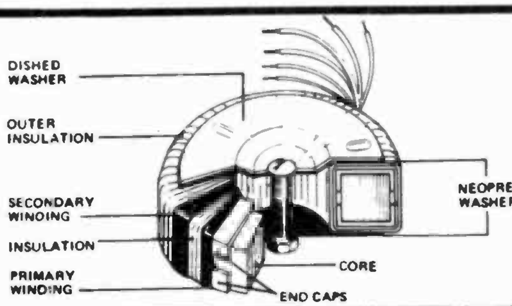

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0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

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Regulation 18%

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1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0 50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10.00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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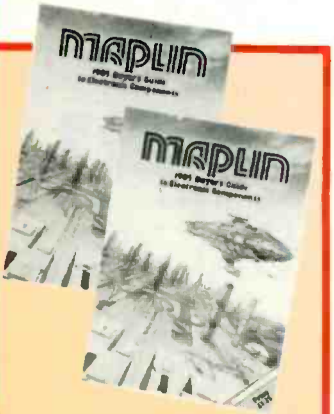

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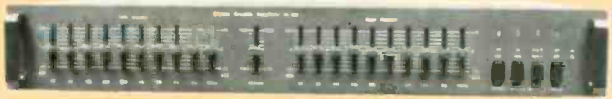

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