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DECEMBER 1985 £1.20

6809 SINGLE-BOARD COMPUTER

SPECDRUM DRUM SEQUENCER

PULSE GENERATOR

COMBINED DIRECT INJECT, COMPRESSION UNIT AND NOISE GATE

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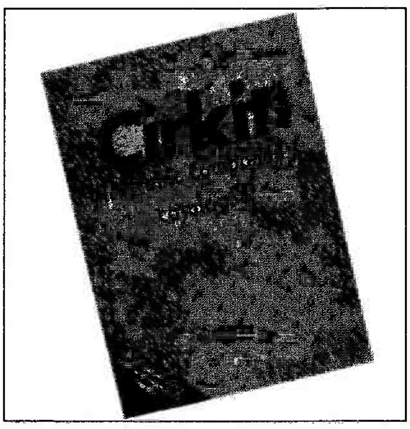

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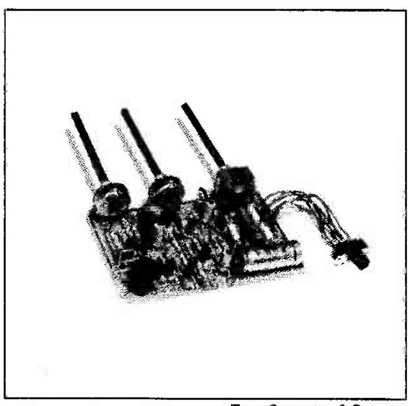

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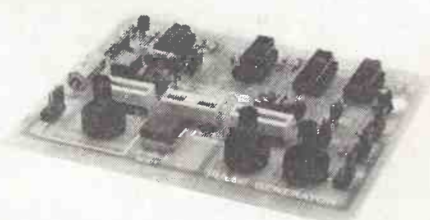
FEATURES

PROJECTS



We apologise for having to hold over the scheduled part of the Digital Sound Sampler. This has been due to circumstances beyond our control. We hope to bring you full constructional details next month.

ETCETERA

INFORMATION

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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 15p
330n, 390n 20p
470n, 560n 28p
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/20V 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, 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

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	6p	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 18p
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K 2K2, 4K7, 6K8, 10K, 22K, 47K & 100K 20p.

TRANSISTORS

AC126/7	30
AC141/2	35
AC176	25
AC187	25
AC188	25
ACY19/21	75
ACY22/41	75
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	80
AF188	80
AF124/26	60
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	25
BC117/8	25
BC119	35
BC137/9	40
BC140	29
BC142/3	28
BC147	12
BC147B	15
BC148	12
BC148B	15
BC149	12
BC149C	15
BC182L	10
BC183L	10
BC184	10
BC184L	10
BC186/7	28
BC188 6/7	25
BC212	10
BC212L	12
BC213	10
BC213L	12
BC214	10
BC214L	12
BC237/8	10
BC238	10
BC256B	35
BC307B	15
BC308	12
BC318	80
BC327/8	12
BC337/8	12

BC441/61	34
BC477	22
BC516/7	30
BC547/8	12
BC549C	12
BC556/7	15
BC558/9	15
BCY39/40	85
BCY41/42	30
BCY45	50
BCY58/59	36
BCY70/71	18
BCY72	18
BCY78	30
BD114	190
BD121	95
BD124	115
BD131/32	55
BD133	50
BD135	45
BD136/37	35
BD138/39	35
BD140	40
BD144/45	198
BD158	68
BD184	35
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	35
BF178	35
BF179	40
BF184/5	35
BF194/5	12
BF198/9	18
BF200	35
BF224A	40
BF224B	40
BF245	38
BF256A	45
BF256B	50
BF257/8	32
BF259	30
BF275	55
BF336/7	35
BF394	40
BF451	40
BF494/5	40
BF594/5	30

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BFR41/79	25
BFR80/81	25
BFR98	105
BFX29	28
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	28
BSX26/29	32
BSY26	35
BSY95	35
BU105	180
BU205	160
BU206	200
BU208	170
BUY69C	225
MD8001	250
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	50
MJE521	90
MJE2955	98
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	23
MPSA08	30
MPSA12	29
MPSA55	30
MPSA56	30
MPSA70	40
MPSU02	58
MPSU05	50
MPSU06	55
MPSU52	65
MPSU55	60
MPSU56	55

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	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	75
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
UC734	99
VK1010	99
VN10KM	65
VN46AF	90
VN66AF	110
VN88AF	220
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	46
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
2N5135/6	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	150
2SC1449	95
2SC1678	140
2SC1679	180
2SC1923	65
2SC1945	225
2SC1963	80
2SC1957	80
2SC1969	160
2SC2028	85
2SC2029	200
2SC2078	170
2SC2091	85
2SC2314	88
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	60
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40673	75
40871/2	90

74HC

HC00	55
HC02	55
HC08	55
HC10	55
HC20	55
HC32	55
HC42	135
HC51	55
HC74	70
HC86	60
HC107	70
HC109	75
HC139	120
HC153	35
HC160	135
HC161	135
HC164	135
HC165	270
HC173	120
HC174	120
HC175	120
HC240	195
HC249	195
HC241	195
HC242	135
HC244	195
HC245	195
HC259	270
HC373	225
HC374	225
HC393	225
HC640	240
HC645	240

RF Chokes Miniature PCB type
1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u ... 35p
1mH, 1m5, 2m2, 4m7, 10mH ... 40p
22mH, 33mH, 43mH, 47mH ... 60p
100mH, 220mH ... 75p

COMPUTER ICs

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2114	275
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4532-3	250
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4864-15	200
5514	250
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63A03	£14
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6503	650
6504	600
6504 250	550
6505	650
6505	600
6520PIA	175
6522A	545
6522VIA	340
6530	£11
6532RRIOT	650
6545RTC	899
6551ACIA	650
6592	00
6592PC	£20
6800	220
68000	200
6802	275
68A02	345
6803	850
6805	670
6808	520
6809E	680
6810	150
6820	150
6821	150
68B21	220
6840	375
6843	600
6845	650
6845SP	750
6847	850
6850	120
6852	250
6854	625
68B54	750
6859	£4
68009	£30
8017	275
8035	350
8080A	425
8086	58
8085A	950
8088	995

8123	160
8131	475
8150	800
8154	750
8155	400
8156	400
81LS95	175
81LS96	175
81LS97	175
81LS98	175
8202	£25
8205	225
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	£49
8272	£45
8279	750
8282	450
8283	450
8284	550
8288	£11
8748	£55
8T26A	99
8T27	150
8T31	350
8T95	90
8T97N	90
88LS120	395
9502	220
9637A	250
AM26LS31C	125
AM26LS32A	125
AM26LS33	150
AM7910	£30
AY-3-1015	300
AY-5-1013	300
CD4724	150
COM8017	275
D8748	£33
DM8131	275
DP8303	450
DP8304	350
DS3647	600
DS3691N	350
DS88LS120	300
DS8820	110
DS8830	140
DS8831	125
DS8832	200
E9364	800
E9365	£28
FD1691	£15
FD1771	£15
FD1791	£22
FD1795	£28
HD26501	75
HD4315	250
HD6301	225
HD63A03RP	700
HM6845SP	755
IM6402	380
INS8060N	1250
MC1488	100
MC1489	100
MC14411	675
MC14412	725
MC3242	590
MC3446	250
MC3447P	315
MC3486	225
MC3487	225
IM6402	350
MC6845	625
MC6846	625

MK3886-2M	£7
MM5280D	698
MM5303	636
MM5307	1275
MM5387A	865
MM58174	875
MM74C922	420
RO-3-2513L	700
RO-3-2513U	650
SAA5050	875
SFF9364	800
SP0256	475
SPO256AL2	475
TCJ3101J	£13
TMS2716-3V	725
TMS4047	100
TMS4164	200
TMS4416-2	355
TMS4500	£12
TMS4532-3	350
TMS6011	500
TMS9914	895
TMS9927	£14
TMS9928	£16
TMS9929	£16
ULN2003	75
UPD7002	440
WD1691	£14
WD1770	£15
WD2143	850
Z80CPU 2.5	295
Z80ACPU 4M	380
Z80 CTC	285
Z80A CTC	310
Z80BCPU	£11
Z80 DART	650
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	80
702	75
709C 8 pin	35
710	50
741 8 pin	15
747C 14 pin	70
748C 8 pin	30
735 8 pin	185
810	160
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	390
Booklet for AY-3-8910	150
AY-3-8912	430
AY-5-1317A	630
AY-6-1350	366
CA3011	130
CA3012	175
CA3014	275
CA3018	85
CA3019	90
CA3020	210
CA3023	210
CA3028A	110
CA3035	255
CA3036	270
CA3043	375
CA3045	385
CA3046	70
CA3059	25
CA3075	215
CA3080E	70

CA3081	180
CA3085	160
CA3086	60
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	90
CA3161	180
CA3162	540
CA3189	260
CA3240E	100
HA1336W	175
HA1388	235
ICL7106	675
ICL7107	975
ICL7611	95
ICL7660	250
ICL8038CC	300
ICL8211	225
ICM7216C	£22
ICM7217A	750
ICM7224	£11
ICM7240	300
ICM7555	80
ICM7556	140
LA3550	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	320
LC7120	300
LC7137	350
LF347	120
LF351	60
LF353	90
LF355	90
LF356	90
LF357	100
LF398	495
LM10	325
LM301A	30
LM307	45
LM308T	75
LM311	60
LM318N	150
LM319	180
LM324A	45
LM334Z	125
LM335Z	130
LM337	250
LM339	40
LM348	60
LM349	125
LM358	50
LM377	210
LM379	495
LM380	80
LM381N	175
LM382	190
LM384	225
LM386	90
LM387	200
LM389	160
LM393	85
LM394CH	380
LM3900	45
LM3909	85
LM3914	265
LM3915	265
LM558	170
LM725CN	300
LM733	65
LM1458	35
LM1871	300
LM1869	400
LM2907	395
LM2917	300
LM3900	70
LM3909N	65
LM3911	185
LM3914	300
LM3915	345
LM3916	300
LM13600	110
LS7220	280
M706B1	150
M51513L	230
M51515L	320
M51516L	475
MB3712	200
MB3756	440
MC1204	250
MC1301	90

MC1310	135
MC145106	695
MC1455	50
MC1458	35
MC1469	300
MC1488	70
MC1489	70
MC1494	695
MC1495	300
MC1496L	70
MC1596	225
MC1709G	90
MC3302	75
MC3401	50
MC3403	65
MC3404	85
MC3405	150
MC3423	80
MC3457	00
MC4016	00
MF10	300
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	120
NE543K	225
NE544	190
NE555	20
NE556	60
NE558	170
NE560	350
NE564	420
NE565A	120
NE566	150
NE567V	140
NE570	400
NE571	300
NE5532	150
NE5534A	120
OM335	650
RC4136D	55
RC4558	55
SAB3209	425
SAB3271	485
SAB4209	295
SG3402	295
SL490	300
SL6270CD	150
SN76227N	95
SN76477	380
SN76488	525
SN76489	400
SP8629	350
SP0256AL	425
TA1002	485
TA7120	120
TA7204	150
TA7205	90
TA7222	150
TA7310	120
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	220
TDA1022	400
TDA1024	110
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	190
TDA2004	230
TDA2006	320
TDA2020	320
TDA2030	190
TDB0791	420
TL170	50
TL497A	185
TL507	110

TL509	110
TL061CP	40
TL062CP	60
TL064CN	95
TL071CP	40
TL072CP	70
TL074CN	110
TL081CP	30
TL082CP	55
TL083CP	75
TL084CN	100
TL091CP	60
UA2240	120
UA78S40	225
ULN2003	75
ULN2004	75
ULN2283	150
ULN2803	190
UPC575	275
UPC1025H	375
UPC1156H	295
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	360
ZN409	160
ZN414	80
ZN423E	130
ZN424E	130
ZN425E	595
ZN426E	200
ZN427E	600
ZN428E	450
ZN429E	240
ZN459	615
ZN1034E	200
ZN1040E	665
ZNA234E	925

TTL74

7400	22
7401	22
7402	22
7403	25
7404	25
7405	25
7406	38
7407	38
7408	25
7409	25
7410	25
7411	25
7412	25
7413	35
7414	50
7416	35
7417	35
7420	25
7421	30
7422	30
7423	32
7425	32
7426	36
7427	30
7428	30
7430	22
7432	29
7433	35
7437	29
7438	39
7440	25
7441	85
7442	65
7443	95
7444	100
7445	100
7446	100
7447	95
7448	98
7450	25
7451	30
7453	25
7454	25
7460	25
7470	48
7472	35
7473	40
7474	36
7475	48
7476	40
7480	50
7481	175
7482	90
7483	85
7484	100
7485	100
7486	35

7489	170
7490	55
7491	65
7492	55
7493	50
7494	90
7495	65
7496	72
7497	170
74100	195
74104	[illegible]
74105	[illegible]
74107	40
74109	60
74110	55
74111	55
74112	160
74116	160
74118	100
74119	150
74120	90
74121	45
74122	50
74123	73
74125	50
74126	50
74128	55
74132	60
74136	63
74141	80
74142	230
74143	250
74144	225
74145	85
74147	130
74148	105
74150	130
74151	60
74153	70
74154	135
74155	75
74156	90
74157	75
74159	175
74160	90
74161	90
74162	90
74163	90
74164	110
74165	90
74166	130
74167	200
74170	160
74172	390
74173	100
74174	100
74175	80
74176	80
74177	80
74178	120
74179	90
74180	85
74181	230
74182	85
74184	160
74185	160
74190	117
74191	140
74192	191
74193	110
74194	80
74195	90
74196	63
74197	85
74198	190
74199	190
74221	95
74246	125
74247	120
74248	145
74249	172
74251	90
74259	140
74263	75
74265	60
74273	150
74276	150
74278	150
74279	75
74283	110
74284	300
74285	310
74286	90
74290	85
74293	85
74297	165
74298	156
74351	175
74365	68
74366	68
74367	68
74368	65
74376	117
74390	100
74393	103
74426	65
74490	89

74C

74C244	150
74C245	150
74C373	180
74C374	425
74C922	550
74C923	600
74C925	650

74S

S00	45
S02	40
S03	40
S04	40
S05	40
S08	40
S09	40
S10	40
S11	50
S15	60
S20	40
S22	60
S30	50
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	75
S151	140
S153	140
S157	200
S158	190
S162	300
S163	300
S174	250
S175	300
S188	180
S189	225
S194	280
S197	300
S201	250
S225	500
S226	350
S240	375
S241	375
S244	475
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	22
LS01	22
LS02	22
LS03	22
LS04	22
LS05	22
LS08	25
LS09	22
LS10	22
LS11	22
LS12	22
LS13	30
LS14	50
LS15	22
LS19	45
LS20	22
LS21	22
LS22	22
LS24	50
LS26	22
LS27	22
LS28	24
LS30	22
LS32	22
LS33	23
LS37	22
LS38	25
LS40	22
LS42	[illegible]
LS47	75
LS48	75
LS49	95
LS51	22
LS52	25
LS54	[illegible]
LS55	25
LS63	52
LS73	28
LS74	28
LS75	38
LS76	28
LS78	34
LS83	65
LS85	70
LS86	35
LS90	40
LS91	86
LS92	50
LS93	45
LS95	58
LS96	90
LS107	40
LS109	45
LS112	40
LS113	38
LS114	36
LS122	55
LS123	60
LS124	120
LS125	37
LS126	37
LS132	52
LS133	44
LS135	28
LS136	35
LS138	48
LS139	48
LS145	90
LS147	130
LS148	115
LS151	55
LS153	65
LS154	120
LS155	55
LS156	55
LS157	47
LS158	48
LS160	60
LS161	60
LS162	60
LS163	60
LS164	70
LS165	95
LS166	88
LS168	138
LS169	90
LS170	120
LS173	80
LS174	60
LS175	60
LS181	190
LS183	186
LS190	75
LS191	55
LS192	75
LS193	75
LS194	70
LS195	60
LS196	75
LS197	75
LS221	65
LS240	80
LS241	80
LS242	80
LS243	80
LS244	70
LS245	88
LS247	75
LS248	100
LS249	100
LS251	55

LS253	70
LS256	90
LS257	55
LS258	55
LS259	90
LS260	70
LS261	100
LS266	25
LS273	80
LS275	350
LS279	55
LS280	180
LS283	70
LS290	80
LS292	850
LS293	75
LS294	999
LS295	130
LS297	850
LS298	100
LS299	220
LS320	210
LS322	360
LS323	300
LS324	140
LS325	150
LS326	290
LS327	290
LS347	120
LS348	140
LS352	115
LS353	85
LS355	220
LS356	200
LS363	140
LS264	150
LS365	42
LS366	42
LS367	42
LS368	42
LS373	80
LS374	80
LS375	55
LS377	100
LS378	85
LS379	127
LS380	310
LS382	310
LS384	457
LS385	310
LS386	50
LS390	60
LS393	48
LS395	100
LS396	195
LS398	185
LS399	115
LS445	125
LS447	75
LS465	130
LS490	148
LS540	100
LS541	98
LS624	155
LS629	120
LS640	150
LS641	140
LS645	195
LS668	87
LS669	85
LS670	150
LS673	850
LS674	850
LS678	275
LS684	300
LS687	300

DIODES

AA119	8
AA129	10
AAY30	8
BA100	10
BY100	15
BY126	12
BY127	10
CRO33	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	1
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	60

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

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
75361/3	150
75365	00
75450	85
75451/2	50
75454	70
75491/2	65

ZENERS

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

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

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
T28C0	125

DIAC

ST2 25

VARICAPS

BB105B	40
BB106	40

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SWITCHES

TOGGLE: 2A, 250V
SPST 35p DPDT 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
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch
Assorted Colours
75p each

DIP SWITCHES

(SPST) 4 way 65p; 6 way 80p; 8 way 85p; 10 way 125p (SPDT) 4 way 190p

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 68p

ROTARY: (Make-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 65p
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	298p
Mounting Cheeks (per pair)	75p

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
36 inches	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36

	20pin	26 pin	34 pin	40 pin
Single ended	160p	200p	260p	300p
Double ended	290p	370p	480p	525p

GAS/SMOKE DETECTORS

TGS812 or TGS813
£6 each
Holders for above 40p

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

VERO PINS per 100

Single ended	55p
Double ended	60p
Wire wrape S/E	155p
Wire wrape D/E	255p

FERRIC CHLORIDE
1 lb bag Anhydrous 125p + 50p p&p

VERO WIRING

Pen + spool	380p
Spare spool	75p

Combs	8p
Pen + Spools + Combs	599p

PROTO DECs

Veroblock	480p
S-Dec	395p
Eurobreadboard	590p
Bimboard 1	575p
Superstrip SS2	1350p

VERO TOOLS

Spot face cutters	150p
Pin Insertion Tool	185p

DALO ETCH RESIST PEN
Plus spare tip 100p

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	28p	80p
40 pin	30p	90p

EDGE CONNECTORS

	.1"	.156"
2x6 way	—	75p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	175p	160p
2x22 way	200p	170p
2x23 way	150p	—
2x25 way	250p	245p
2x28 way	180p	—
2x30 way	280p	—
2x36 way	300p	—
2x40 way	320p	—
2x43 way	400p	—
2x75 way	600p	—

SIL SOCKET 0.1" Pitch 20 way 65p

ANTEX SOLDERING IRONS

C15W	525p	CS17W	545p
C18W	550p	XS25W	570p
Spare Bits	85p	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	65p	65p	65p	100p
16 way	75p	75p	80p	—
20 way	90p	90p	95p	185p
26 way	105p	110p	115p	230p
34 way	115p	130p	135p	320p
40 way	140p	145p	150p	335p
50 way	165p	170p	175p	350p
60 way	195p	210p	225p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	125p	—	—	175p
DIN41612 2 x 32 A + B	200p	—	175p	185p
DIN41612 2 x 32 A + C	225p	—	185p	210p
DIN41612 3 x 32 A + B + C	280p	290p	295p	300p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	95p
16 pin	45p	100p
24 pin	85p	135p
28 pin	150p	200p
40 pin	200p	255p

RIBBON CABLE

price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
28 way	55p	80p
34 way	60p	85p
40 way	70p	90p
50 way	100p	135p
64 way	120p	160p

ZIF TEXTOOL DIL SOCKETS

24 pin	550p
28 pin	650p
40 pin	800p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	160p	250p
Female				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	260p	390p
PCB pins	100p	125p	195p	355p
Covers	75p	70p	70p	85p

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 CONNECTORS

	IDC	SOLDER
24 way IEEE plug	465p	460p
24 way IEEE socket	485p	480p
36 way Centronics plug	375p	390p
36 way Centronics socket	480p	450p

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
0–1A
0–2A
0–25V
0–50V
0–300V AC 465p

CRYSTALS

32.768KHz	100
100KHz	400
200KHz	370
455KH	370
1MHz	265
1.008M	275
1.28MHz	450
1.6MHz	200
1.8MHz	545
1.8432M	200
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	95
3.6864M	300
4.0MHz	140
4.032MHz	290
4.19430M	150
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	150
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	175
7.7328MHz	250
7.68MHz	200
8.0MHz	140
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	170
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	155
16.0MHz	200
18.0MHz	150
18.432M	150
19.968MHz	150
20.0MHz	150
24.0MHz	150
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295

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-113 53R Coil, 6V DC (5V4 to 9V9) 190p
RL6-111 205R Coil, 12V DC (10V7 to 19V5) 195p
RL6-114 740R Coil, 24V DC (22V to 37V) 200p

ASTEC UHF MODULATORS

Standard 6MHz	375p
Wideband 8MHz	550p

BUZZERS

miniature, solid-state 6V, 9V & 12V	70p
PIEZO TRANSDUCERS PB2720	70p

LOUDSPEAKERS

Miniature, 0.3W- 8

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

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular **£66**
- MICROVITEC 1431, Standard Res, Colour RGB input 14" incl cable **£185**
- MICROVITEC 1451, 14" Medium resolution **£229**
- KAGA 12", Med-res, RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£225** (car £7)
- KAGA 12". As above but Hi-Resolution **£310** (car £7)
- Connecting Lead for KAGA **£3**

Carriage £7 Securicor

BT TELEPHONE CONNECTOR

LJU 1/4A	Mini Line Master	435p
LJU 1/6A	Mini Line Slave	295p
LJU 2/4A	Line Master	370p
LJU 2/6A	Line Slave	250p
LJU 3/4A	Flush Master	370p
LJU 3/6A	Flush Slave	240p
LJU 10/3A	Dual Splitter	550p
	4 WAY BT Plug	65p

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/0.2A 235p
6VA: 2x6V/0.5A; 2x9V/0.4A; 2x12V/0.25A; 2x15V/0.2A 280p
Standard Split Bobbin type:
6VA: 2x6V/0.5A; 2x9V/0.4A; 2x12V/0.3A; 2x15V/0.25A 250p
12VA: 2x4.5V/1A3; 2x5V-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 (60p 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)
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 955p (75p)
P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	45p	7905	50p
12V	7812	45p	7908	50p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	45p	7918	50p
			7924	50p

100mA TO92 Plastic package

5V	78L05	30p	79L05	45p
6V	78L06	30p	—	—
8V	78L08	30p	—	—
12V	78L12	30p	79L12	45p
15V	78L15	30p	79L15	45p

ICL7660	245p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	78H05 + 5V/5V	550p
LM309K	135p	78H12+12V/5A	695p
LM317K	250p	78HG + 5V to + 25V 5A	585p
LM317KP	450p		
LM323K	450p	78HG–5V to –24V/5A	785p
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	99p
5 x 4 x 2½	120p
5 x 2¾ x 1½	90p
5 x 2¾ x 2½	130p
6 x 4 x 2	120p
6 x 4 x 3	150p
7 x 5 x 3	180p
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	4075	25	4543	70
4001	25	4076	70	4548	40
4002	25	4077	25	4549	400
4006	70	4078	25	4553	245
4007	25	4081	25	4554	180
4008	80	4082	25	4555	35
4009	45	4085	60	4556	55
4010	40	4086	60	4557	250
4011	25	4089	125	4558	120
4012	25	4093	40	4559	395
4013	35	4094	70	4560	150
4014	60	4095	95	4561	104
4015	60	4096	100	4562	350
4016	40	4097	275	4566	160
4017	55	4098	80	4568	250
4018	60	4099	110	4569	175
4019	60	4160	95	4572	45
4020	80	4161	96	4580	255
4021	60	4162	96	4581	125
4022	70	4163	96	4582	99
4023	30	4174	96	4583	100
4024	50	4175	105	4584	55
4025	25	4194	105	4585	55
4026	90	4408	850	4597	330
4027	45	4409	850	4599	155
4028	45	4410	725	40085	90
4029	75	4411	750	40097	45
4030	35	4412	805	40098	42
4031	130	4415	590	40100	215
4032	65	4419	280	40101	130
4033	130	4422	770	40102	140
4034	146	4435	850	40103	412
4035	70	4440	900	40104	120
4036	250	4450	380	40105	220
4037	115	4451	350	40106	60
4038	75	4490	450	40107	55
4039	280	4500	395	40108	325
4040	60	4501	40	40109	100
4041	60	4502	60	40110	235
4042	50	4503	40	40114	240
4043	45	4504	100	40161	194
4044	50	4505	350	40163	75
4045	110	4506	100	40174	75
4046	60	4507	45	40175	75
4047	60	4508	130	40181	220
4048	55	4510	55	40182	80
4049	40	4511	55	40192	75
4050	35	4512	55	40193	95
4051	70	4513	150	40194	70
4052	60	4514	115	40195	75
4053	60	4515	115	40244	196
4054	85	4516	55	40245	196
4055	85	4517	275	40257	196
4056	85	4518	50	40373	220
4057	1000	4519	35	40374	220
4059	420	4520	55	45106	586
4060	70	4521	115		
4061	500	4522	125	**OPTO**	
4062	986	4526	60	OCP71	120
4063	90	4527	65	ORP12	85
4066	45	4528	70	ORP61	86
4067	245	4529	145	BPX25	250
4068	25	4530	90	BPW21	320
4069	25	4531	120	TIL139	225
4070	25	4532	65		
4071	25	4534	385		
4072	25	4536	250		
4073	25	4538	80		
		4539	80		
		4541	95		

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	85
Hi-Brightness Red	58
High-Br. 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	60
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	150
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	225
SLOTTED Optical Switch similar to RS Comp's	295

TURNED PIN Low Profile

Professional DIL SOCKETS

8 pin	22p
14 pin	25p
16 pin	32p
18 pin	38p
20 pin	42p
22 pin	48p
24 pin	52p
28 pin	60p
40 pin	80p

SPECIAL OFFER

	1+	10+
2764-250nS	220p	205p
27128-250nS	350p	345p
6116LP-120nS	200p	195p
6264LP-150nS	480p	475p

COMPUTER CORNER

- EPSON FX80 Printer £315
- EPSON FX100 Printer £429
- EPSON LX80 Printer £225
- EPSON RX80 F/T Printer £215
- KAGA/TAXAN KP810 Printer £235
- KAGA/TAXAN KP910 Printer £339
- BROTHER HR15 Daisywheel £318

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 32p
- 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.

5¼" DRIVES for the BBC Micro

(All Drives are supplied cased with Power Supply and Utilities Disc

- **CS200** — Epson Single 200K, 40 track Double sided £107
- **CS400S** — Mitsubishi Single 400K, 80T, Double sided 40 track switchable £130
- **CD400** — Epdon Yein 400K, 40 track, Double sided £175
- **CD800S** — Mitsubishi Twin 800K, 80T, 40/80 track switchable £230
- **TWIN Disc drive case** with Power supply and Cables to house your own drives £35
- All Single Drives with Power supply are supplied in a twin case for later inclusion of a second drive.
  (Securicor Carriage on Drives £7)
- **DISC INTERFACE KIT** complete £75
- **DFS Manual** (comprehensive) (NO VAT) £7

SPECTRUM 32K UPGRADE

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

£18

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 EPSON 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.

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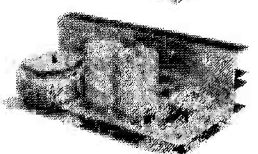
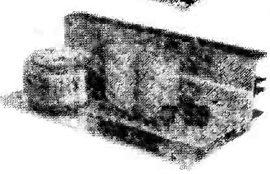
Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market. i.e., Industry, Leisure, Instrumental and Hi-Fi. etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B., 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 355 × 115 × 65mm.
PRICE £33.99 + £3.00 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
PRICE £39.99 + £3.00 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
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
PRICE £79.99 + £4.50 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.

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.
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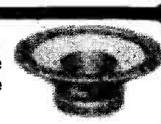
LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.



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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.

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 £28.76 + £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 £29.80 + £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 £54.99 + £4.00 P&P ea.
10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.
2" voice coil. Res. Freq. 75Hz. Freq. Resp. to 7.5KHz. Sens. 99dB. PRICE £19.15 + £2.00 P&P.
10" 200 WATT R.M.S. C10200GP Guitar, Keyboard, Disco.
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB. PRICE £51.00 + £3.00 P&P.
15" 200 WATT R.M.S. C16200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens 101dB. PRICE £59.45 + £4.00 P&P.
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £85.00 + £4.00 P&P.

WEM
5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £19.99 + £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 £29.49 + £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 £33.49 + £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 £41.49 + £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.
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1¼" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

PANTEC

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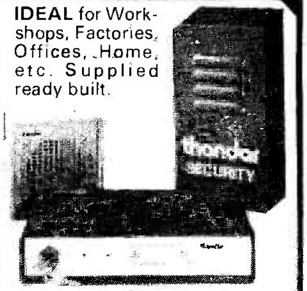
3 watt FM Transmitter

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: £14.49 + 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:** £11.29 P&P + 75p each. S.A.E. for complete list.

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.**

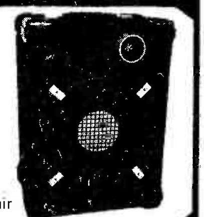
IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.



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

SAVE £138.00 Usual Price £228.85
BKE's PRICE £89.99 + £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. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W. 1mtr. dB.

OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair. Delivery: Securicor £8.00 per pair

OMP 19" STEREO RACK AMPS

Professional 19" cased **Mos-Fet** stereo amps. Used the **World** over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4ohms). Input Sensitivity 775mV

MF200 (100 + 100)W. £169.00 **Securicor**
MF400 (200 + 200)W. £228.85 **Delivery**
MF600 (300 + 300)W. £274.85 **£10.00**

1 K-WATT SLIDE DIMMER

★ Control loads up to 1Kw
★ Compact Size 4⅓" × 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 £13.99 + 75p P&P

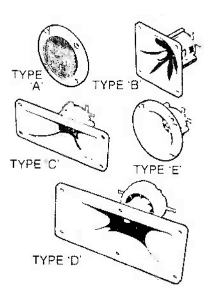
BSR P295 ELECTRONIC TURNTABLE

★ 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

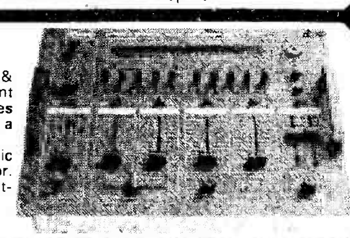
PIEZO ELECTRIC TWEETERS MOTOROLA

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 £4.90 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) 3¾" 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

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DIGEST

'Electronic weapons being used against us', Greenham women claim

Women peace campers at Greenham Common claim they are being attacked with electronic weapons from within the base.

They believe that some form of electromagnetic wave or other signal is being directed at them and is responsible for a series of illnesses they have suffered over the past year.

Symptoms range from mild headaches and drowsiness to bouts of temporary paralysis and, in one case, an apparent circulatory failure which required emergency treatment. Women have also complained of sharp pains and problems with speech coordination. A team of doctors from the Medical Campaign Against Nuclear Weapons are compiling a report on the condition of the women affected.

The women first noticed a pattern of illnesses emerging late last year. They discounted food or water poisoning as a cause and started to suspect interference from inside the base. They found that women at different points around the camp appeared to have experienced similar symptoms at the same time, even when they were not in contact with one another.

They believe there is a deliberate intent to make life difficult for them and so drive them away. Some of the worst affected women now find it impossible to stay around Greenham for more than a short period of time.

Electronic weapons are known to have been used by security forces on a number of occasions. The Americans are reported to have used ultrasound to disorient and demoralise their enemies during the Vietnam war and a number of American police forces are believed to have carried out trials with infra-sound generators mounted on the back of trucks. The high intensity, low frequency pressure waves these produce are said to cause vomiting, nausea and a range of other disturbances and to induce fits in those who are subject to them. American medical groups have protested against the proposed use of these weapons for urban riot control.

Microwave radiation is also believed to have been used as a weapon at various times. The most celebrated instance was the irradiation of the US Embassy in Moscow during the 1950s, '60s and '70s. It has never been made clear whether the Russians used the signal as a weapon or for surveillance, but a television documentary screened last year reported a high incidence of cancer amongst ex-Embassy staff and suggested that disorders of the blood and nervous system could also have been caused by the signal.

The women at Greenham Common suspect that more than one type or frequency of radiation is being used against them. They say that the symptoms vary from time to time and seem to reflect what takes place on the base. Large numbers of women have complained of sudden feelings of extreme tiredness shortly before major events such as the departure of a cruise missile convoy and on other occasions when their activities might have proved particularly awkward for the forces using the base.

ETI has carried out a number of tests around the base in cooperation with journalists from other organisations. Readings taken with a wide range signal strength meter showed marked increases in the background signal level near one of the womens' camps at a time when they claimed to be experiencing ill effects.

On another occasion previously low signal levels near the camp rose sharply when the women created a disturbance just outside the perimeter fence of the base. Whether this indicated an attempt to subdue the women by electronic means or merely the use of a radar surveillance system it is impossible to say.

The signal levels measured were well above normal background levels but still within official safety limits. However, there is evidence from a number of sources that low levels of electromagnetic radiation can have harmful effects, especially where exposure takes place over a long period of time.

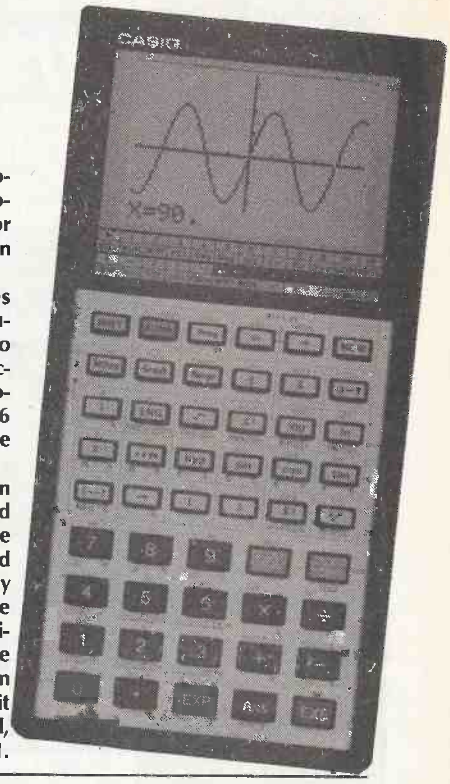
Ministry of Defence officials have denied that any form of electronic signal is being used against the women. Tests at the base are continuing.

A Graphic Display

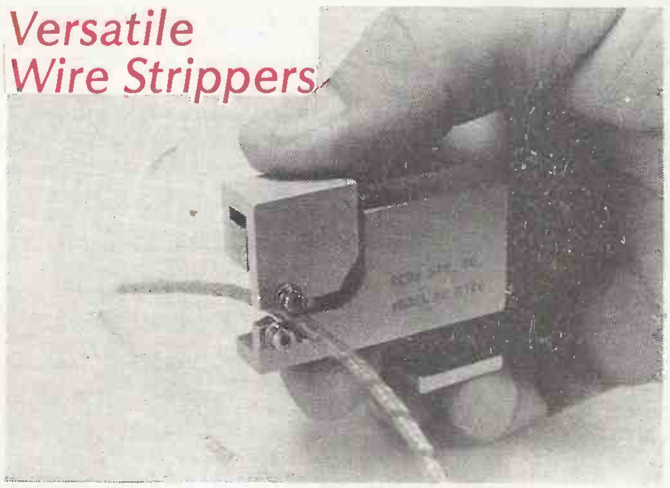
Casio Electronics have introduced a full-function programmable scientific calculator which draws graphs and charts on an integral LCD screen.

The hand-held FX7000G features a 35x52mm screen with a resolution of 63x95 pixels. It can also display up to 8 lines of 16 characters. It is capable of up to 422 programming steps, utilising 26 memories and up to 10 separate program areas.

Twenty algorithms are built-in to draw graphs of standard mathematical functions and the FX7000G can draw bar charts and plot points. The calculator, say Casio, will be 'unbeatable' for the correlation of experimental variables. The RRP is £99.95 and the FX7000G is obtainable from Casio Electronics Co Ltd, Unit Six, 1000 North Circular Road, London NW2 7JD, tel 01-450 9131.



Versatile Wire Strippers



From the US company Reon Manufacturing comes a new range of wire stripping tools designed for a variety of different types and thicknesses of equipment cable.

All the units are housed in the same casing and different wire diameters and sleeving materials are catered for by changing the cutters. Cutters will handle wire in diameters down to 0.025" and can also cope with extruded, high-temperature sleeving up to 9/32" in diameter.

The tools are designed for ease of use, a rotating blade being used to cut sleeving to a controlled depth and a gripper anvil removing the cut sleeve. Priced at around £42, further details should be obtained from Kern Electrical Components Ltd., 2 Albury Close, Battle Farm Industrial Estate, Reading, Berks RF3 1BD (0734-596368).

ETI Printed Circuit Board Service

Readers tiring of the apparently never-ending saga of the PCB service may console themselves with the thought that the magazine staff are exhausted by it too.

The lack of a PCB Service page this month will not go unnoticed. Our humblest apologies. The situation, is quite simply, that legal complications have delayed the start-up of the service. As anyone who has ever bought or sold a house will know, the law takes not only its course but its time. We are assured that the service will be on-stream within a matter of days. Please write to us for further information or wait until our next issue.

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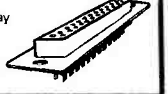
Rapid Electronics

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	35p	40p	55p	100p
Right angle PCB	85p	130p	200p	260p
Sockets solderlugs	45p	50p	65p	120p
Right angle PCB	115p	170p	290p	350p
Covers	70p	80p	80p	95p



CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	8p	8p	2.5mm	10p	9p
3 pin	13p	13p	3.5mm	10p	9p
5 pin	14p	13p	Standard	17p	20p
Phono	10p	14p	Stereo	25p	25p
1mm	12p	9p	4mm	12p	12p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 40p
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 55p
Socket free hanging . . 90p
Socket with 2m lead 125p

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 60p. SPDT centre off 65p.
DPDT 70p. DPDT centre off 75p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 15p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W, 4P3W 53p
DIL switches:
4SPST 70p 6SPST 80p 8SPST 90p.
BCD rotary Hexadecimal 180p
Decimal 170p

SOCKETS

	Low profile	Wire wrap
8 pin	4p	28p
14 pin	7p	48p
16 pin	8p	55p
18 pin	9p	65p
20 pin	10p	75p
22 pin	12p	80p
24 pin	12p	85p
28 pin	13p	100p
40 pin	18p	140p

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

SOLOERING IRONS

Antex CS 17W Soldering iron	480
2,3 and 4.7mm bits to suit .	85
Antex XS 25W soldering iron	500
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
Iron stand for CS/XS irons	170

VERO

Protobloc 1 breadboard	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	390
4.75 x 17	495
VQ board	190
Veropins per 100:	
Single sided	55
Double sided	65
Spot face cutter	150
Pin insertion tool	190
Wiring pen	375
Spare spool 75p Combs .	6

MICRO

Brand new Micro products at lowest ever prices.
Take advantage of our volume discounts now!

Type	speed	manfr.	1+	10+	25+
2716	450nS	AMD	3.10	2.80	2.50
2764	250nS	Hitachi	2.20	2.10	1.95
27128	250nS	Hitachi	2.90	2.70	2.50
6116P3	150nS	Hitachi	1.50	1.20	1.05
6264LP15	150nS	Hitachi	3.20	3.00	2.80
4164	150nS	Hitachi	1.60	1.40	1.20
41256	150nS	NEC	3.20	3.00	2.80
Z80ACPU	4MHz	SGS	2.70	2.50	2.20

MICRO

				6800	200	6522	330
		27128-250	290	6802	280	6532	520
		6116P3	150	6809	600	6551	540
2716	310	6264P15	320	6810	140	8085A	320
2532	380	4164-15	160	6821	140	8156	380
2732 one time programmable	280	41256-15	320	6840	360	8251	350
		Z80A CPU	270	6850	165	8253	370
		Z80A P10	270	6852	240	8255	320
2732	280	Z80A CTC	270	6875	500	8259	400
2764-250	220	Z80A S10	700	6880	100	MC1488	60
2764-BBC	220	Z80A DMA	700	6502	370	MC1489	60

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.lu. 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	50
78L12	30	79L12	50
78L15	30	79L15	50
7805	40	7905	45
7812	45	7912	45
7815	45	7915	45
LM317K	230	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mWzen	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	10	TIL111	55
green	12	TIL78	40
yellow	12	ORP12	86
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	30

Seven segment displays:
Com cathode. Com anode.
DL704 0.3" 95 DL707 0.3" 95
FND5000.5" 100 FND5070.5" 100
10 bar DIL LED display 140

5mm highbright 10 Superbright 30

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	396
▶6V Electronic buzzer	70
▶12V Electronic buzzer	70
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	75
20mm panel fuseholder	25
Red or black probe clip	30
4mm terminals	36
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

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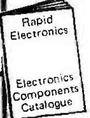
NEW 1986 CATALOGUE



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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

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

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

				LM358	40	LM3915	190	NE567	100	TDA1024	90
		IC7611	100	LM377	210	LM13600	100	NE570	230	TL061	40
		ICL7621	200	LM380	80	MC1310	150	NE571	195	TL062	65
555CMOS	55	ICL7622	190	LM381	130	MC1496	70	NE5532	160	TL064	105
556CMOS	150	ICL8038	395	LM382	130	MC3302	75	NE5534	105	TL071	32
709	35	ICL8211A	200	LM384	160	MC3340	130	RC4136	65	TL072	55
741	16	ICM7555	55	LM386	85	MF10CN	330	RC4558	45	TL074	105
748	35	ICM7556	150	LM387	90	ML922	415	SL486	240	TL081	28
AY38910	390	LF347	90	LM393	45	ML924	290	SL490	280	TL082	45
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	90
CA3046	60	LF353	70	LM711	48	ML926	275	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	270	ML927	275	SP8629	250	UA2240	130
CA3089	200	LM10C	325	LM733	70	ML928	275	SP0256AL2	425	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	275	Speech data	50	ULN2004	80
CA3130E	75	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	395
CA3140E	38	LM318	110	LM748	35	NE531	135	TBA810	65	ZN414	75
CA3160	95	LM324	40	LM1458	35	NE544	170	TBA820M	60	ZN423	100
CA3136	100	LM334Z	85	LM2917N8	170	NE555	20	TBA950	220	ZN424P	70
CA3189	260	LM335Z	130	LM3900	50	NE556	45	TCA940	165	ZN425E	340
CA3240E	100	LM339	40	LM3909	85	NE565	95	TDA1008	250	ZN426E	200
ICL7106	680	LM348	60	LM3914	190	NE566	95	TDA1022	270	ZN427E	580
										ZN428E	435
										ZN459	190
										ZN1034E	190

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

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid & screws		4 x 2¾ x 1½"	95
		4 x 2¼ 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	28	7440	28	7476	40	74107	40	74157	70	74180	90
		7413	38	7442	70	7480	50	74109	50	74160	80	74181	240
		7414	48	7444	105	7483	48	74121	40	74161	80	74182	80
7400	25	7416	38	7446	130	7485	88	74122	50	74162	80	74190	70
7401	28	7417	38	7447	88	7486	38	74123	50	74163	80	74191	75
7402	25	7420	28	7448	88	7489	140	74125	45	74164	110	74192	75
7403	28	7421	50	7450	28	7490	40	74126	45	74165	80	74193	70
7404	25	7422	28	7451	28	7491	70	74132	50	74167	200	74194	75
7405	28	7427	30	7453	28	7492	55	74141	80	74170	170	74195	75
7406	40	7428	30	7454	28	7493	45	74145	75	74173	90	74196	75
7407	40	7430	28	7460	28	7494	80	74147	130	74174	90	74197	75
7408	28	7432	30	7472	35	7495	60	74148	105	74175	80	74198	160
7409	28	7433	38	7473	35	7496	80	74150	135	74176	80	74199	160
7410	28	7437	30	7474	35	7497	150	74153	70	74177	80		
7411	28	7438	35	7475	45	74100	120	74154	135	74179	90		

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	55	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	[illegible]	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	MPSJ06	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

CMOS

		4016	20	4034	145	4054	70	4081	15	4502	50	4529	55
		4017	35	4036	270	4055	70	4082	15	4503	45	4532	50
		4018	40	4039	270	4059	400	4085	35	4507	45	4534	390
4000	15	4019	30	4040	40	4060	45	4086	50	4508	95	4538	40
4001	15	4020	40	4041	50	4063	75	4089	120	4510	45	4543	40
4002	15	4021	40	4042	30	4066	25	4093	22	4511	50	4549	390
4006	40	4022	40	4043	45	4067	230	4094	55	4512	50	4553	215
4007	15	4023	15	4044	45	4068	18	4095	80	4514	85	4555	35
4008	45	4024	30	4046	48	4069	15	4097	260	4515	85	4556	35
4009	25	4025	18	4047	50	4070	20	4098	50	4516	45	4559	290
4010	25	4026	90	4048	35	4071	18	40106	35	4518	45	4560	110
4011	15	4027	22	4049	23	4072	18	40109	100	4520	45	4584	35
4012	15	4028	35	4050	23	4073	18	40163	75	4521	110	4585	50
4013	24	4029	40	4051	45	4075	18	40173	100	4526	45	4724	140
4014	40	4030	20	4052	45	4076	50	40175	75	4527	35		
4015	40	4031	125	4053	45	4077	30	40193	90	4528	40		

LS TTL

		LS20	20	LS75	30	LS123	45	LS161	55	LS221	70	LS365	40
		LS21	20	LS76	30	LS125	38	LS162	55	LS240	65	LS366	40
		LS22	20	LS78	28	LS126	38	LS163	55	LS241	60	LS367	40
LS00	18	LS26	20	LS83	45	LS132	45	LS164	55	LS242	60	LS368	40
LS01	20	LS27	20	LS85	50	LS136	35	LS165	65	LS243	60	LS373	60
LS02	20	LS30	20	LS86	22	LS138	38	LS166	85	LS244	55	LS374	60
LS03	20	LS32	20	LS90	25	LS139	38	LS170	100	LS245	55	LS375	40
LS04	18	LS37	20	LS92	35	LS145	75	LS173	45	LS247	60	LS377	80
LS05	20	LS38	20	LS93	30	LS147	100	LS174	45	LS251	45	LS378	65
LS08	20	LS40	20	LS95	50	LS148	100	LS175	45	LS257	45	LS390	55
LS09	20	LS42	35	LS96	75	LS151	35	LS190	60	LS258	45	LS393	55
LS10	20	LS47	60	LS107	25	LS153	35	LS191	55	LS259	70	LS399	95
LS11	20	LS48	65	LS109	25	LS154	120	LS192	55	LS266	32	LS541	95
LS12	20	LS51	20	LS112	30	LS155	45	LS193	55	LS273	55	LS670	110
LS13	25	LS55	20	LS113	30	LS157	35	LS195	55	LS279	50		
LS14	35	LS73	33	LS114	30	LS158	35	LS196	55	LS283	60		
LS15	20	LS74	25	LS122	45	LS160	50	LS197	55	LS353	75		

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Dial M For Money

The figure in the stripes and spots is not, contrary to appearance, Spiderman with a dose of the measles. Nor is it Superman after emerging from an ultra-modern phone booth. It is (short pause for the intake of breath) — Digital Man, dubbed 'the dots-and-dashes figure' and currently parading as 'the star of British Telecom's nationwide Faraday Lecture tour, "Beyond the Telephone — Or Intelligent Network".' Or so it says in BT's publicity material.

Shown being cossetted by a bevy of lovely schoolgirls, Digital Man — although singularly lacking in eyes, ears, mouth or nostrils — is accompanying BT's Chief Executive of Technology, Mr. Bill Jones, as he makes his way about the country giving the 1985-86 series of Faraday Lectures.

The Faraday Lectures were inaugurated in 1924 by the Institute of Electrical Engineers to promote interest in their field. The IEE invites a major organisation each year to lecture on one aspect of the work of electrical engineers to an audience largely composed of school and college students. And jolly good fun they are, too (although not quite as fascinating as the annual Royal Society lectures).

For BT, only recently privatised and now threatened by the entry of Cable & Wireless offshoot, Mercury Communications, into the Telecoms' game, the Faraday Lectures are a heaven-sent opportunity for public relations and recruitment. 'Young people, who may be about to choose a career, will be a particularly important part of the audience,' says Bill Jones, noting that BT's aim is to 'stimulate a lasting interest in electronics and telecommunications'. Hence Digital Man, the NAND-gate incarnate. And hence BT's budget of £750,000 for the exercise.

This may look like a small fortune, but it's a trifling amount compared to BT's recently announced first quarter profit of £443 million before tax. With that number of coins, you might think BT would start giving local calls away, like they do in a number of other countries.

But BT want more. In early October, they increased phone charges. In mid-October, they talked of putting them up again for domestic and small business users while reducing charges to the corporate users.

In between times it was revealed that they had introduced hidden price rises. In the shape, for example, of a charge to all those receiving consolidated bills who want to see a call-by-call analysis. Digital Man could provide such an analysis with one hand tied behind his back. But I guess he's too busy telling the world how wonderful BT are.

BT's future may be with Intelligent Networks, but the company itself seems like a most unintelligent network. It may need to look 'beyond the telephone' when Mercury flies on to the scene, happily connecting up its 'independent' network to BT's.

Could it be that the Oftel report (which has given Mercury the go-ahead to link-up with the existing telephone network) is the writing on the VDU for BT? Will Digital Man save them in the face of the looming Mercury monster? Or will they settle for the protection afforded by vast profits in the short time before the Mercury monster arrives? What does lie beyond the telephone?

Faraday lecture dates: November 6th: St. David's Hall, Cardiff; 13th: City Hall, Sheffield; 17th: Free Trade Hall, Manchester; December 4th: The Dome, Brighton; 11th: The Conference Centre, Harrogate; January 22nd: The Guildhall, Portsmouth; 30th: The Philharmonic Hall, Liverpool; February 4th-6th: Logan Hall, London; 12th: The Town Hall, Birmingham; 26th: Sir William Whitlaw Hall, Belfast; March 5th: The University Great Hall, Exeter; 12th: Colston Hall, Bristol; 19th: The Assembly Rooms, Derby.

● Philips have announced their intention to develop an add-on adaptor for TV sets enabling them to pick up MAC standard signals from satellites via a parabolic aerial. It should be on the market by early 1987 and is designed to handle any changes in TV picture aspect ratio which may be introduced. The MAC standard has been formulated to improve picture definition by separating chrominance and luminance signals. Better sound fidelity and multi-channel sound will also be achieved. Philips see the move as a commitment to 'future high-definition TV'.

● Castle Associates have set-up a hire division specialising in acoustic test instruments. Among the instruments available on short-term rental are sound level meters, environmental noise analysers, dosemeters and vibration meters. Customers may take up the option of purchasing a new instrument at 'a generous allowance'. Details from Castle Associates Ltd., Slater Road, Scarborough YO11 3UZ, tel 0723-584250.

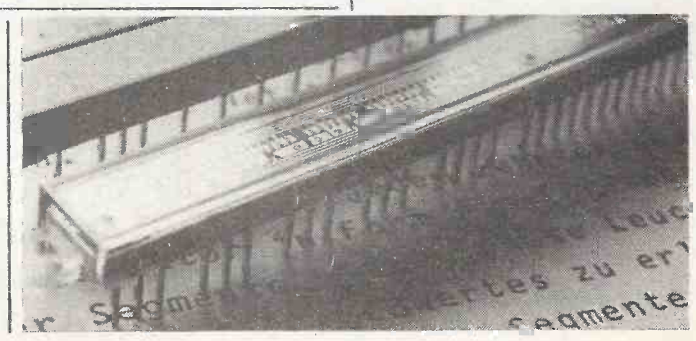
Called To The Bar

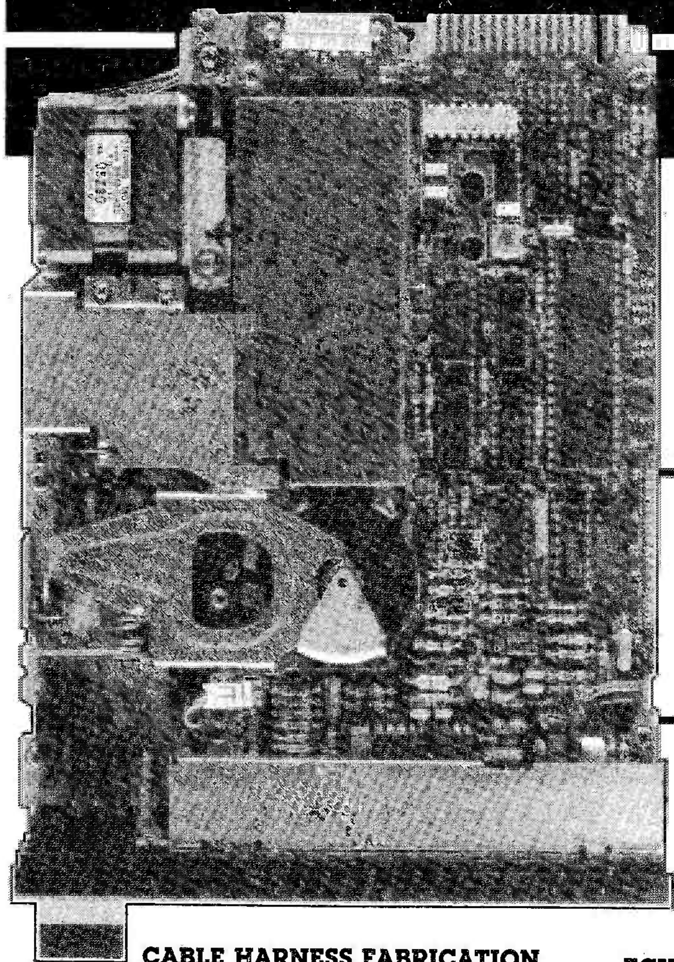
New 101 segment LED bargraph displays from Siemens and Hewlett Packard provide precision alternatives to mechanical meters.

The Siemens range (illustrated) features LEDs combined in groups of ten with common cathodes. One version of the display includes a yellow luminous dot after every tenth segment for ease of reading. The HP range has been extended to include high efficiency red and high performance green devices, in addition to the standard red display. For details contact Siemens Ltd., Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS (09327-85691) and Hewlett-Packard Ltd., Miller House, The Ring, Bracknell, Berks RG12 1XN, 0344-424898.

● Texas Instruments have published a European edition of volume 3 of the TTL Data Book series covering bipolar programmable logic and memory devices, including PAL (programmable array logic) FPLAs (field programmable logic arrays) and Schottky TTL memories. The volume is available from Texas Instruments Ltd., PO Box 50, Market Harborough, Leicestershire, at £6.50 plus £1.50 p&p.

● **ERA Technology have produced a report titled 'Zinc Carbon and Alkaline Primary Batteries' which investigates the product range of the four leading UK suppliers: Duracell, Ever Ready, Varta and Vidor. Value-for-money comparisons are based on actual discharge rates. The report costs £65 (£55 to members) from Publication Sales, ERA Technology Ltd, Cleeve Road, Leatherhead, Surrey KT22 7SA.**





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COMPONENTS

74 SERIES

7406	0.40
7407	0.40
74ALS37	0.30
74LS00	0.12
74LS02	0.13
74LS04	0.12
74LS08	0.12
74LS10	0.13
74LS14	0.50
74LS20	0.13
74LS27	0.12
74LS30	0.13
74LS32	0.13
74LS74A	0.15
74LS86	0.35
74LS93	0.35
74LS22	0.45
74LS123	0.45
74LS125	0.45
74LS138	0.25
74LS157	0.25
74LS161A	0.50
74LS163A	0.50
74LS166	0.75
74LS175	0.50
74LS191	0.50
74LS193	0.40
74LS241	0.50
74LS242	0.50
74LS243	0.50
74LS244	0.50
74LS245	0.75
74LS257	0.75
74LS273	0.30
74LS365	0.50
74LS367	0.50
74LS373	0.45
74LS374	0.45
74LS393	0.50
74LS465	0.75
74S04	0.25
74S734	2.00

C MOS

4013	0.25
4016	0.25
4049	0.25
4066	0.30
4070	0.20

MEMORIES

2716	2.50
2732–45	3.00
2764–25	3.00
27128–25	3.50
3764–20	2.50
4116–3N	0.40
4864–2	2.00
6116–4	2.00
8264–2	3.00
81256–15	5.00

VARIOUS I.C.s

14L4–2CN	1.00
1691	8.00
1793	9.00
2143	8.00
9216	8.00
6301–1N	1.00
63S141	1.50
82S23	1.00
82S123	1.50
6845	5.00
LM1889	1.25
SN76489	2.00
SY6551A	2.50
TMS9928	5.00
TMS9929	3.00
HA14625–5	2.00
HEF4011	0.15
Z80ACPU	1.50
Z80ACTC	1.40

INDUCTORS – AXIAL

4.7MH	0.05
22MH	0.05
33MH	0.05
100MH	0.05

CRYSTALS

1.8432MHz	2.00
3.579545MHz	0.50
4.00MHz	0.50
4.433619MHz	0.50
10.6875MHz	0.50
10.738635MHz	0.50
15.00MHz	0.50
10.00MHzOSC	4.50

I.C. SOCKETS – STD

20 PIN	0.15
24 PIN	0.15
28 PIN	0.15
40 PIN	0.25

I.C. SOCKETS – LOW PROFILE T.I.

16 PIN	0.10
18 PIN	0.10
28 PIN	0.20
40 PIN	0.25

MODULATORS – ASTEC

UM1286(8MHz)	1.50
UM1285–8(USA)	2.50

REGULATORS

UA7805CKC	0.25
UA7812CKC	0.25

TRANSISTORS

2N3904	0.12
2N3906	0.12
BC107	0.15
TIP2955	0.50
TLO81CP	0.35

DIODES

IN4004	0.05
IN4148	0.02
IN5402	0.10
BZX79C4V7	0.05
BZX79C5V1	0.05
BZX79C5V6	0.05
BZX79C12	0.05
BZX79C7V5	0.05

POTENTIOMETERS

1K HOR. PRESET	0.10
1K CERMET	0.25
22K HOR. PRESET	0.12

SWITCHES

ML3KEYTOP	0.10
2 WAY ON--OFF DIP	0.15
NEON MAINS	0.75
4 POL DIL	0.25
8 POL DIL	0.55
T.V. TO COMPUTOR	0.75
MINI-SLIDE	0.15
C+K 8631 PUSH	0.25

RESISTORS O.25W c/f

Measured in OHMs.
All 0.01 each.

1.0	180	33K
1.1	200	36K
1.2	220	39K
1.3	240	43K
1.5	270	47K
1.6	300	51K
1.8	330	56K
2.0	360	62K
2.2	390	68K
2.4	430	75K
2.5	430 M/F	82K
2.7	470	91K
3.0	510	100K
3.3	560	110K
3.6	620	120K
3.9	680	130K
4.3	750	150K
4.7	820	160K
5.1	910	180K
5.6	1K	200K
6.2	1KM/F	220K
6.8	1.1K	240K
7.5	1.2K	270K
8.2	1.3K	300K
9.1	1.5K	330K
10	1.6K	360K
11	1.8K	390K
12	2K	430K
13	2.2K	470K
15	2.4K	470K ½W
16	2.7K	510K
18	3K	560K
20	3.3K	620K
22	3.6K	680K
24	3.9K	750K
27	4.3K	820K
30	4.7K	910K
33	5.1K	1M
36	5.6K	1.2M
39	6.2K	1.3M
43	6.8K	1.8M
47	7.5K	2M
51	8.2K	2.2M
56	9.1K	2.4M
62	10K	3M
68	11K	3.6M
75	12K	4.3M
82	13K	4.7M
91	15K	5.1M
100	16K	5.6M
110	18K	6.2M
120	20K	6.8M
130	22K	7.5M
150	24K	8.2M
160	27K	9.1M
	30K	10M

CAPACITORS

CERAMIC PLATE

All 0.03 each

10NF	47 PF
22NF	68 PF
22NF DISC	100 PF
47NF DISC	150 PF
8.2 PF	220 PF
15 PF	560 PF
27 PF	1000 PF
33 PF	1500 PF
39 PF	4700 PF

ELECTROLYTICS – AXIAL

470 MF/25V	0.07
4700 MF/16V	0.35

ELECTROLYTICS – RADIAL

10MF/16V	0.05
10MF/63V	0.05
22MF/35V	0.08
47MF/16V	0.08
100MF/25V	0.10
470MF/10V	0.12
470MF/16V	0.12
2200MF/25V	0.20
4700MF/16V	0.25

POLYESTERS

22NF	0.06
100NF	0.06
047MF	0.06

SIBITATS

47NF	0.06
100NF	0.06

TANTLUMS

1MF35V	0.10
10MF35V	0.15
22MF16V	0.18

TRIMMERS

5.5–40PF	0.15

MISCELLANEOUS

3.5MM PCB MTG JACK SOCKET	0.12
PHONO SOCKET – NUT FIXING	0.14
BNC SOCKET – CHASSIS MTG	0.40
20 × 5MM PCB MTG FUSEHOLDER	0.10
20 × 5MM PCB MTG FUSEHOLDER COVER	0.10
20 × 5MM 3.15A QUICK BLOW FUSE	0.10
6 PIN DIN R/A PCB MTG SOCKET	0.35
7 PIN DIN R/A PCB MTG SOCKET	0.35
9 WAY 'D' TYPE R/A PLUG	0.25
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Page 11

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Page 12

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NEWS:NEWS:NEWS

DIARY

Cellular Communications International — November 5-7th
Wembley Conference Centre, London. For details see September '85 ETI or contact Online at the address below.

Electronics for Peace: London Group Meeting — November 7th
London New Technology Network, Camden, London, 7.30 p.m. Discussion entitled 'Are nucelar weapons a deterrent?'. For details contact Louis Barman on 01-541 1825.

Comex '85 — November 12/13th
Chesford Grange Hotel, Kenilworth, Warwickshire. Conference and exhbition devoted to mobile communication products. Conference topics include the development of radiopaging, the various issues surrounding the future of cellular radio and the re-allocation of the bands used until recently for 405 line television. For details contact Sarah Welch-Hawksby, Federation of Communication Services, PO Box 442, London SE19 3LT, tel 01-653 2657.

Programming In Ada: A Hands-On Workshop — November 12-15th
London. For details see November '85 ET or contact ICS at the address below.

Compec '85 — November 12-25th
Olympia, London. For details contact Reed Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ, tel 01-643 8040.

Electronic Component Quality — November 22nd
Institution of Electrical Engineers, London, 10.00 a.m. Discussion meeting at which six papers will be presented. For details contact the Secretary at the address below.

Acorn User Christmas Show — November 22/23rd
Central Hall, Westminster, London. Tickets cost £3.00 (adults) and £2.00 (under 16s) at the door or £2.00 and £1.00 in advance. Contact Edition Scheme Ltd at the address below.

6809 Show — November 23/24th
Royal Horticultural Halls, London. Tickets £3.00 (adults) and £2.00 (under 16s) at the door or £2.00 and £1.00 in advance. Contact Edition Scheme Ltd at the address below.

International Test And Measurement Exhibition — November 27-29th
Olympia 2, London. For details see February '85 ETI or contact Network Events Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX, tel 0280-815226.

Satellite Communications — December 3/4th
Tara Hotel, London. For details see November '85 ETI or contact Online at the address below.

The History of Sound Broadcasting — December 5th
IEE, London. Lecture by Dr. G.J. Phillips, formerly of the BBC. For details contact the Secretary at the address below.

The Which Computer? Show — January 14-17th
NEC, Birmingham. For details contact Cahners at address below.

Electronics In Oil And Gas — February 4-6th
Barbican, London. For details see November '85 ETI or contact Cahners at the address below.

Electronic Production Efficiency Exposition — March 11-13th
Olympia, London. For details see November '85 ETI or contact Cahners at the address below.

Addresses:
Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01-891 5051.
Edition Scheme Ltd, HR House, 447 High Road, Finchley, London N12 0AF, tel 01-345-6566.
ICS Publishing Co (UK) Ltd, 3 Swan Court, Leatherhead, Surrey KT22 8AD, tel 0372-379211.
Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, tel 01-240 1871.
Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01-868 4466.

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TORCH UNICORN products including the IBM Compatible 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.

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Serial Interface: 8143 **£28** (c);
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KAGA TAXAN
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JUKI 6100
RS232 with 2K Buffer **£65** (c)
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BBC Parallel Lead **£7** (d)
Serial Lead **£7** (d)

BROTHER HR15
Sheet Feeder **£199** (a)
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MODEMS

— All modems listed below are BT approved

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The ultimate world standard modem coverall all common CCITT standards (BELL standards outside the UK) 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.**
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WS3000 V2123 (V21E V23) **£295 (a)**
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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, **£62(c).** Mains adaptor **£8(d).**
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2764-25 .... £2.40
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6264LP-15 .... £5.00

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Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end — making it possible to produce almost any cable configuration on site
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Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
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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)
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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. **£71 (b)**
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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
24-pin **£7.50**
28-pin **£9.00**
40-pin **£12**

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	Plug	Socket
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		400p
IDC Skt A + C		400p

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

MISC CONNS

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

AMPHENOL CONNECTORS

	Solder	ZDC
36 way plug	500p	475p
36 way skt	550p	500p
24 way plug IEEE	475p	475p
24 way skt IEEE	500p	500p

PCB Mtg Skt Ang Pin
24 way 700p 36way 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
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4-way 90p 6-way 105p
8-way 120p 10-way 150p

RIBBON

(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	160p	200p
40 pin	200p	225p

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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
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74351	200p
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74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
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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
74LS49	100p
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/	629/140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
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	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS244	80p
74LS245	110p
74LS247	110p
74LS248	110p
74LS249	110p
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74LS253	75p
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74LS266	60p
74LS273	125p
74LS279	70p
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74LS283	80p
74LS290	80p
74LS292	900p
74LS293	80p
74LS295	140p
74LS297	£9
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
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	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	60p
74LS393	100p
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	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
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74LS670	170p
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74S02	50p
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74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	60p
74S37	60p
74S38	60p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S85	300p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	300p
74S132	100p
74S133	60p
74S138	180p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	200p
74S158	200p
74S163	300p
74S169	550p
74S174	300p
74S175	320p
74S188	180p
74S189	180p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S283	270p
74S287	225p
74S286	200p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p

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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	125p
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
4097	270p
4098	75p
4099	90p
4501	36p
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	80p
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	750p
14412	750p
14416	300p
14419	260p
14490	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	20p
40110	225p
40114	225p
40147	280p
40163	100p
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40175	100p
40192	100p
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40245	150p
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CA3086	60p
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CA3280G	270p
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DAC0800	300p
DAC0808	300p
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LC7120	300p
LC7130	300p
LC7137	350p
LF347	120p
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LF355	90p
LF356N	110p
LF357	100p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	73p
LM310	225p
LM311	
LM318	150p
LM319	160p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	160p
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	270p
LM389	180p
LM391	[illegible]
LM392N	110p
LM393	385p
LM394CH	380p
LM709	35p
LM710	48p
LM711	100p
LM723	60p
LM725CN	300p
LM733	65p
LM741	22p
LM747	70p
LM748	30p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	550p
LM1889	450p
LM2917	300p
LM3302	90p
LM3900	80p
LM3909	107p
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	300p
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
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NE5533P	160p
NE55334P	120p
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TA7130	140p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	90p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA940	175p
TDA1010	225p
TDA1022	400p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	190p
TDA2004	240p
TDA2006	320p
TDA2020	320p
TDA2030	250p
TDA2593	500p
TDA3810	750p
TDA7000	350p
TEA1002	700p
TL061CP	40p
TL062	60p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	35p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
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UA759	320p
UA2240	120p
UAA170	170p
UCN4801A	550p
ULN2003A	75p
ULN2004A	75p
ULN2068	290p
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ULN2803	180p
ULN2804	190p
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UPC1156H	300p
UPC1185H	500p
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XR2206	400p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
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ZN424E	130p
ZN425E8	350p
ZN426E	300p
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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
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

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LM323K	3A 5V	350p
78H05KC	5A 5V	575p
78H12	5A 12V	640p
78P05	10A 5V	900p
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LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T	3A+VAR	225p
LM350T	5A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	650
79HGKC	5A+VAR	675p
78GUIC	1A+VAR	225p
79GUIC	1A+VAR	250p
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TL494		300p
TL497		300p
78S40		250p

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6809E	£8
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8039	420p
80C39	700p
8080A	420p
8085A	300p
80C85A	750p
8086	£22
8088	1750p
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(CMOS Z80)	

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6850	160p
68B50	250p
6852	250p
6854	650p
68B54	800p
6875	500p
8154	850p
8155	380p
8156	380p
8205	225p
8212	200p
8216	160p
8224	300p
8226	425p
8228	550p
8243	260p
8250	950p
8251A	325p
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2708	400p
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2716-35	550p
2732	450p
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2732A-35	550p
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AD561J	£20
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AM26LS32	120p
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DM8131	600p
DP8304	350p
DS3691	350p
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
MC3418L	990p
MC3486	250p
MC3487	250p
MC4024	550p
MC4044	550p
MC14411	950p
MC14412	750p
ULN2003	75p
ULN2004A	75p
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
75365	150p
75450	50p
75451	50p
75452	50p
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	140p
81LS97	140p
81LS98	140p
88LS120	300p
9602	300p
9636A	160p
9637AP	160p
9638	190p
ZN425E8	350p
ZN426E8	350p
ZN427E	600p
ZN428E8	450p
ZN429E	210p
ZN447E	900p
ZN449E	300p
ZN459CP	300p
8271	POA
8275	£29
8279	£11
8284	480p
8287	380p
8288D	950p
8755A	£16
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TMS9901	500p
TMS9902	500p
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Z80ADMA	750p
Z80ASIO-0/1/2/9	700p
Z80BP10	500p
Z80BCTC	500p
Z80DART	900p

MEMORIES

2016-150	400p
2101	400p
2102	250p
2107B	500p
2111A-35	400p
2114-3L	250p
2147	400p
4116-15	200p
4116-20	150p
4164-15	200p
41256-20	500p
4164-20	300p
4416-15	400p
4532-20	250p
4816AP-3	200p
5101	370p
5514	450p
5516	550p
6116P-3	350p
6116LP-3	400p
6264-15	700p
6264LP-15	800p
6810	160p
74S189	225p
74S201	350p
74S289	225p
93415	800p
93L422	950p
93425	800p

ROMS/PROMs

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24S10	250p
18S030	200p
18SA030	200p
74S188	180p
74S287	225p
74S288	180p
74S387	225p
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82S123	150p

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8272	£12
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FD1793	£20
FD1797	£22
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WD2797	£27
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32.768 KHz	100p
100 KHz	400p
1.00MHz	270p
Freq in MHz	
1.8432	225p
2.00	255p
2.45760	200p
2.5	250p
2.662	250p
3.12MHz	175p
10.00MHz	175p
3.276	150p
3.5795	100p
4.00	140p
4.194	150p
4.43	100p
4.608	250p
4.9152	200p
5.000	150p
6.00	140p
17.734	200p
7.00	150p
7.168	175p
8.00	150p
8.867	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
18.00	170p
18.432	150p
19.969	150p
20.00	175p
24.00	150p
48.000	175p
116	250p
PXO1000	£12

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MSM5832RS	350p

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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		

OPTO-ELECTRONICS

		MAN4640	200p
		MAN6610	200p
FND357	100p	NSB5881	570p
FND500	100p	TIL311	650p
FND507	100p		
MAN74/DL704	100p		
MAN71/DL707	100p	MAN8910	120p
MAN3640	175p		
TIL32	55p	TIL78	55p
TIL31A	120p	TIL81	120p
TIL100	75p	SFH305	100p

DRIVER

9368	350p

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74C925	650p
74C926	650p
74C928	650p
72168B	£22
ZN1040	670p

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ILQ74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
ILQ74	220p	16N137	360p
		6N139	175p

Turned Pin Low Profile Sockets

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

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READ/WRITE

Oldrad?

Dear Sir,

I am grateful for the opportunity to make known the devastating frustration I experienced in my dealings with Newrad in the matter of the Linsley Hood amplifier.

I sent the firm my cheque for £49.49 from London on 10 September, 1984, for MA2 and MA3 kits plus air postage to South Africa. Delivery was to be six weeks from 21 September. I sent reminders in November and again in January 1985. I received an air parcel in mid-February.

The kits were incomplete in many respects. Some items were ridiculously unsuitable and others of very poor quality. As a result of further correspondence, I received a supplementary parcel, the contents of which were still incomplete and inappropriate. A third parcel attempted and failed to restore the order to specification.

At my instigation the firm sent me a cheque 'to cover interest on the money held for eight weeks.' The actual total delivery period in the end proved to be 22 weeks.

The contents of the parcels gave me the impression of an organization unsuited to its undertaking and woefully lacking in quality control. My attempts at assembly have been unsuccessful as a result. I have over 55 years experience in this field backed by full instrumentation and I am extremely angry and frustrated as a result.

I am determined to bring the project to completion. It seems I was supplied with primitive prototype PCBs and unsuitable components. As I am not prepared to repeat this distressing experience, please tell me where I can find a competent supplier of kits or assembled power amp PCBs.

Yours faithfully,
Dr. A.H. Barzilay
South Africa.

Dear Sir,

In the June to September 1984 editions of your magazine, you printed a series of articles on the construction of an amplifier by John Linsley Hood, which was called 'Audio Design'.

In this article it was stated that a kit was available from a company called Newrad Instrument Cases Ltd. I tried to contact them by post without success and when I phoned them I was given all sorts of strange stories and excuses but precious little information.

In the end, I decided to build the design from scratch — but I cannot get two types of component which are specified.

These are a small MOSFET (VN1210M) and the low ESR electrolytic capacitors of which there are quite a few.

I would be most grateful if you could send me the names of companies which supply these.

Yours faithfully,
R.D. Wren
Bristol.

Oh dear! I'm afraid the staff at ETI Towers are as distressed and frustrated as our correspondents over the matter of Newrad (tired and emotional, some would say). And we haven't even been constructing the kit! I am glad to say that things are looking up. First, for those of you interested in building the JLH system who have heard that Newrad have made changes to the PCBs, we are about to reprint the series with all necessary revisions in our sister magazine, Electronics Digest. This is a quarterly and the relevant issue will be appearing towards the end of the year.

As far as the companies are concerned: the VN1210M transistor (in fact, all the transistor types) are stocked by Hart Electronic Kits Ltd., Penylan Mill, Oswestry, Shropshire, SY10 9AF. Hart may also be able to supply the low ESR electrolytics, but — to avoid disappointment — they suggest that any potential customers write to them first to check the stock situation.

I trust that this will be the end of correspondence on this unhappy affair. — Ed.

Artificial Intelligence

Dear Sir,

I am about to start an association for those interested in building robots. I would like you to help me through your magazine to get in touch with other associations in other countries.

I know of one association in Sweden:

Stockholm Robot Sallskab
Leif E.K. Wikstrom
Bjorkhyttevagen 93a
711 00 Lindesberg
SWEDEN

Yours faithfully,
Dansk Robot Forening
Hans Ostergaard
Saekedammen 5
DK-3460 Birkerod
DENMARK.

Come on now, all you robots. Drop Hans a line. — Ed.

We are please to note that a number of readers responded to the letter from Rodney Dulce of the Philippines which appeared in October, 1985, issue of ETI. We will be able to provide a subscription to Rodney as soon as the paperwork is sorted out. And we will be replying to those of you who wrote to us individually. Just give us a bit of time.

We have also received a letter from an S. Davies of Leeds recommending what appears to be an audio repair company called KIA. We would like to be able to pass on their address to our readers — unfortunately S. Davies failed to supply it. Any chance of another letter?

ETI welcomes all queries, letters and contributions large or small. Any letter we receive is liable to be published unless marked 'Not For Publication'. We reserve the right to edit letters for reasons of space.

In general, please *type* your contributions using double-spacing and wide margins. Any diagrams should be neatly drawn in ink on plain paper and PCB foil patterns (if enclosed) should be at 2:1 scale. Please print any program listings at 4½ inch column width or (if more suitable to the listing) we may accept listings at 9 inches column width. The specifications for listings are meant to facilitate layout and avoid errors that may creep in if listings have to be re-typed. As a guideline, 4½ inches is most suitable for BASIC or other high-level language listings while 9 inches would suit hex-dumps or annotated assembly language listings. Please send any letters and contributions to ETI, ASP Ltd., 1 Golden Square, London W1R 3AB.

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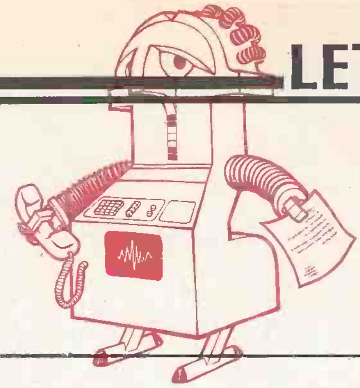

AUNTIE STATIC'S PROBLEM CORNER

Dear Auntie,
Can you please tell me why there are so many different types of capacitors? What is the difference between ceramics, polyester, polystyrene, mica and all the rest?
S. Reed,
Exeter.

In an ideal world, capacitors would be capacitors and there would be nothing to choose between them. In the real world there is no such thing as a capacitor, in the sense of a device which obeys all the text book rules, and we can only hope that our assemblies of insulating and conducting sheets will behave more or less like one.

What we end up with is something like that shown in Fig. 1, where L, R_s and R_p are extra circuit elements that arise because of the way the capacitor is constructed.

You couldn't cut the capacitor open and find them inside, but they are very real because the circuit you've soldered your capacitor into sees all the extra components and behaves accordingly. The effects can be minimised by making L and R_s as small as possible and R_p as large as possible, partly by paying attention to the construction of the capacitor and partly by the choice of dielectric material. The value of L depends on whether the capacitor is wound internally or constructed in flat layers, and R_s results from dielectric losses as well as any physical resistances inside the capacitor. The different compromises that can be reached give rise to a variety of different types of capacitor, some of which are more suited to certain types of circuits than others.

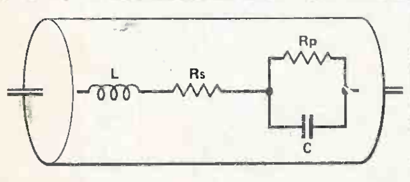

Fig. 1 Equivalent of capacitor

The fact that capacitors are not entirely capacitors is just the beginning of the problem. Another little hiccup is that the value of any capacitor you use will keep changing. Take ceramics for instance. How long do you think it would take for the value of a high K ceramic capacitor to drop by 5%, just through the normal ageing process? Months? Years? I'm afriad not. A high K ceramic can change in value by 5% between 6 minutes and an hour after being manufactured, and will continue to decline logarithmically thereafter, so that in 10 hours it will be another 5% down, after 100 hours (not much over four days) another 5% is lost, and so on. No wonder they are not recommended for use in tuned circuits and oscillators!

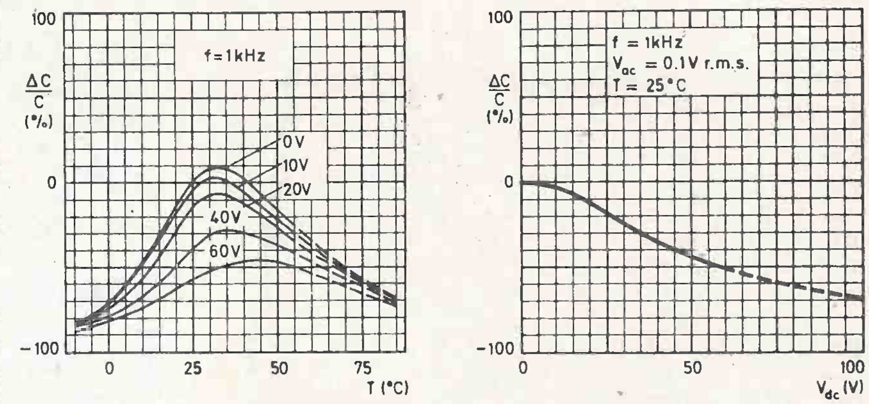

Fig. 2 Variations in capacitance.

An even greater change in value occurs if the temperature changes. Take a look at the graphs in Fig. 2, taken from a manufacturers data sheet. A ceramic of this type (Mullard 629 series) will drop in value by 70% from its marked value at 25°C if the temperature drops to freezing point. Your 1n0 capacitor now has a value of 300p! Perhaps you don't freeze your circuits, but marked variations occur for quite normal household temperature variations, as you can see. If you have the audacity to wire the capacitor into a circuit, the value can change yet again. With a DC voltage of 60V applied, you've got less than half the capacitance you thought!

We all know that ceramics are notoriously bad in many respects, but other types exhibit similar characteristics to a lesser extent. Capacitance will change with time, temperature and frequency. Losses and insulation resistance will vary and so on. The type you choose will depend on the kind of demand your circuit makes on it.

Ceramics, as we have seen, would be reserved for circuits where the value is not critical. (Having said that, there are fairly stable brands of ceramics made for circuits which make use of some of their more desirable characteristics.) For applications requiring high stability — oscillators, tuned circuits, filters, etc — mica or polystyrene are particularly good. Polycarbonates are useful when a high insulation resistance is needed.

In some applications a low ESR or low equivalent series resistance capacitor (that is one having a low value of R_s) can be important. The resistance itself can directly dissipate heat (this is the reason for the maximum ripple current rating on electrolytics for use in power supplies) and will cause a shift in the ideal 90° phase relationship between voltage and current. The losses increase with frequency, so careful choice is needed for high frequency applications.

In pulse circuits the series inductions can be a prime consideration. This depends mostly on the way the capacitor is constructed. In sample and hold circuits, dielectric absorption will cause certain types of capacitor to fall in voltage as soon as the input is removed (this is quite distinct from any leakage that may occur), so low hysteresis dielectrics such as polystyrene or polypropylene would be used. And so it continues.

The study of materials used for capacitor dielectrics, or Dielectric Materialism as Marx called it, is a very involved subject. As with my earlier advice about transistors, it's a case of using general purpose types in non-critical applications, using general rules and your own experience in choosing components for more exacting needs, and resorting to manufacturers data sheets on the odd occasion when the right choice will make all the difference to your circuit.
— Auntie.

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NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

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Etienne Scrooge, known to his friends as Eti for short (he stood less than five feet in his woollen socks) looked out of his window. People scurried about the streets in the swirling snow, collars up to defend themselves against the biting wind. Everywhere the sound of Carols could be heard — Carole King, Carol Bayer-Sager, J. Carroll Nash, Carroll Leavis, Caryl Chessman, Carole Lombard., O. Carol (after whom Neil Sedaka had once written a song). It was a glorious sound. Eti had just invented the world's first dyslexic transistor (it was an NNP type), Christmas was coming, the goose was getting fat — and, happily, had not yet been told about Christmas — and he felt good! He gave vent to his emotions:

'Humbug!' he cried. 'Humbug! Bah! Humbug!'

He felt even better for that, and went off to read the Christmas edition of ETI — a magazine he felt a strange kinship to — over a generous breakfast of cornflakes and kidneys. Eti turned to the ETI ACTIVATOR, but soon realised that it wasn't one of his inventions. Then he turned to the ETI AUTOWIPER, but once again they had used his name for no good reason and without his permission or any sort of explanation. He decided to sue the publishers, but first dashed off a note explaining the principles of operation behind the NNP transistor. Suddenly, he was confronted by the ghost of Lee de Forrest.

'It'll never work,' said de Forrest. 'Why don't you read the new Barry Porter article, or find out about Gallium Arsenide. Or you could settle down to a short story by John Linsley Hood.'

'A short story by John Linsley Hood!' snorted Etienne. 'Humbug!'

'No,' said de Forrest, 'but it's not Brighton Rock, either.'

And it wasn't...

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The second in our series of sound processing units, this exciting device adds brilliance to your sounds. High fidelity buffs may murmur disapprovingly, but similar units to this one are all the rage in recording studios and those who've heard the Activator say that it reaches parts of the audio spectrum that even ultra-fi can't!

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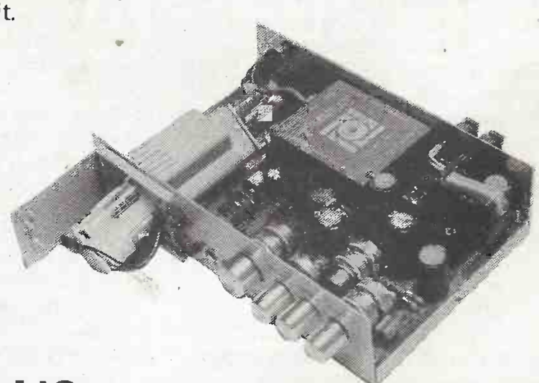

PLUS

Gallium Arsenide — The Fast One, Barry Porter on PCBs, Xmas Book Round-Up, a Christmas story by JLH and all our regular features.

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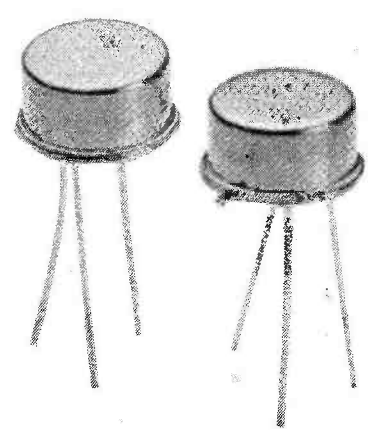
DESIGNING TRANSISTOR STAGES



Les Sage looks at some variations on a common theme.

Having introduced the practical techniques involved in designing a common emitter transistor stage (ETI, November 1985), this month we'll concentrate on more general consideration of different configurations. Each circuit has been fully tested and its basic characteristics are given in the appropriate diagram. Component values have been calculated using similar techniques to those dealt with last month, involving emitter, collector and base voltages and currents and transistor gain. Two gain figures are used, one for signals (AC) and the other for notional DC levels (notional because most of the circuits are AC coupled). The DC gain figure, however, is an indication of circuit stability.

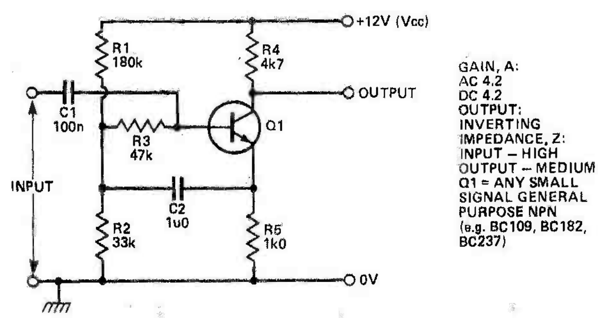


Fig. 2 Bootstrapped common-emitter.

Bootstraps And Feedback

The main problem with the standard stabilized common emitter stage of last month (ETI, November 1985) is the rather low input impedance resulting largely from the base bias resistors shunting the input signal. A way round this problem is to use three bias resistors and include an extra 'bootstrapping' capacitor (Fig. 2). The principle of operation is that any input signal present at the transistor's base will, by emitter follower action, appear at much the same magnitude at the emitter. Since C2 (the bootstrap capacitor) is relatively large, it will act as a short circuit to the AC signal at the emitter and couple it without any attenuation to the junction of R1 and R2. Resistor R3 will have more-or-less the same AC signal at both ends, so there cannot be any AC current flowing through it and all the signal input goes into the transistor.

The input impedance is then that of the transistor stage and is not shunted by the bias chain. The DC bias conditions have not been altered significantly by the presence of R3 although, in practice, emitter follower action is not 100% and the junction of R1 and R2 is at a slighly lower potential than the input signal, meaning that a very small current still flows into the bias chain.

A second benefit of this configuration — and one not often realised — is that any noise on the supply lines will now be decoupled to the emitter through C2 instead of being fed down the bias chain into the transistor's base. Since the emitter circuit has a very low impedance, it will remove the noise.

The un-bypassed emitter resistor, R5, adds to the input impedance of this circuit by introducing current feedback. The input impedance is approximately equal to the h_{fe} x R5 (typically greater than 100k). The output impedance is also quite high. This can be reduced — at the expense of also reducing input impedance — by a voltage feedback arrangement as in Fig. 3. In this circuit, a current proportional to output voltage is fed back to the input through R2, so that any tendency for the collector current to change is counteracted by an opposite tendency in the feedback current. This is a very economic arrangement, giving good stability at low cost and complexity. The circuit is probably most familiar for its DC stabilization characteristics, but among single transistor stages it is the closest thing to a virtual earth amplifier.

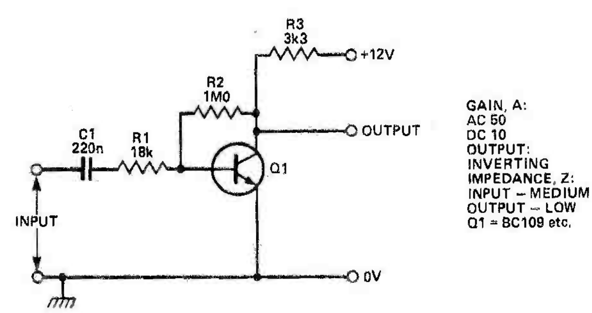


Fig. 3 Virtual earth common emitter.

Ideally, the transistor should have a very high current gain, h_{fe}, which is not too difficult with contemporary silicon devices. If R1 is large compared to the source

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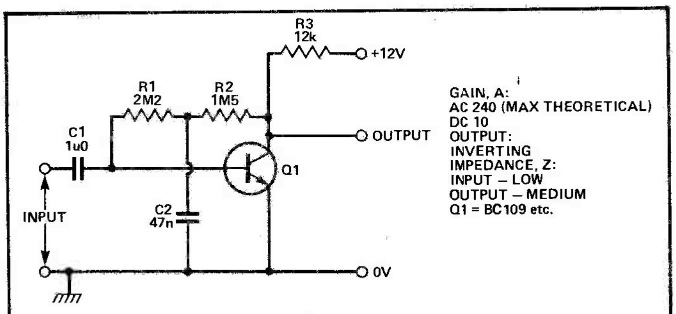

Fig. 4 Feedback decoupled common emitter.

resistance and the transistor input resistance (it's in the order of ten times Ql's input resistance as it stands), then the circuit input impedance will be roughly equal to R1 and the gain roughly equal to the ratio of R2 to R1. The output impedance is reduced by the ratio of closed-loop gain to open-loop gain. In an actual circuit, this worked out to be about three quarters, giving an output impedance of about 2k5 (0.75xR3).

For high gains (and it is only with high gains that the approximate values are really reliable, R1 must be quite low. Reducing R1, however, is also liable to upset the calculations and, in practice, a compromise is required. The circuit makes a good current-to-voltage converter, with output voltage equal to input current multiplied by feedback resistance.

Figure 4 shows how to obtain a higher input impedance at high gains. Two feedback resistors — R1 and R2 — are used, their junction being decoupled to earth through C2. This gives a moderate input impedance (which can be increased by the addition of an input resistor as in Fig. 3) and high gain but at the cost of increasing output impedance against the Fig. 3 circuit. The effect is due to the action of C2 in shunting signal frequencies to earth and avoiding AC feedback. The circuit may be considered the voltage feedback equivalent of the current

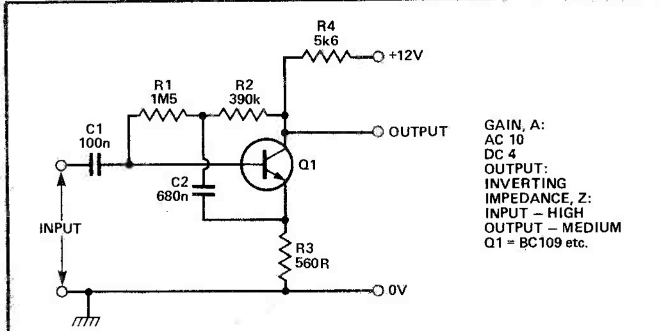

Fig. 5 Bootstrapped high impedance amplifier.

feedback common emitter with a bypass capacitor across the emitter resistor (Fig. 1, ETI November 1985, with R5 shorted out).

A refinement to Fig. 4 can be seen in the circuit shown in Fig. 5. Capacitor C2 now shunts signal frequencies to the transistor emitter. By bootstrap action, R1 is now effectively an open circuit to AC signals, giving high input impedance and an associated reduction in gain. This configuration combines good DC stability with reasonable gain and high input impedance. The output impedance remains fairly high, due to the absence of direct parallel-derived AC voltage feedback. The circuit, however, finds an ideal use as a ceramic cartridge input stage where a high input impedance is required with not much gain.

Because of its high input impedance and very low output impedance, the emitter follower (or, common collector) circuit (Fig. 6) makes an ideal buffer between stages. The low output impedance (in the order of 10R) means that it will drive almost anything current-wise. The circuit also has an input impedance which is higher than that of all the previous circuits we've seen, even though the emitter circuit impedance of around 500k is shunted by the bias resistors. It therefore presents a very small load to any preceding stage. Add to this the fact that voltage gain is practically unity and it is clear why many engineers — unable or unwilling to design circuits for a particular purpose — just stick an emitter follower at the input and the output of some conventional amplification stages.

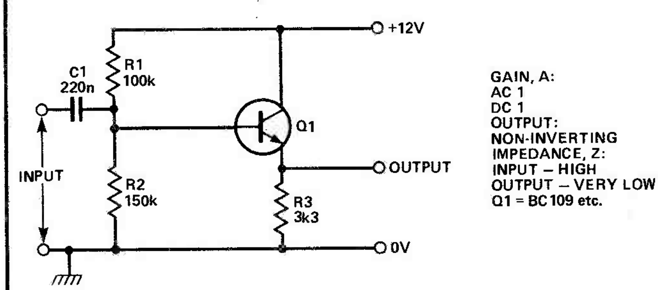

Fig. 6 Emitter follower.

In practice, many emitter followers can be omitted altogether — especially if circuits are custom-designed. Nevertheless, it remains a useful addition to the designer's armoury.

Ground To Base

So far, all the circuits described have been for low frequency applications. At the higher frequencies characteristic of radio and video, they will all show a distinct lack of gain. The responsibility largely belongs to the Miller capacitance effect. All transistors display a certain amount of capacitance between junctions. The capacitance between the base and collector is small and would not seem to be a cause for concern. However, the Miller effect says otherwise. A capacitance between the input and output of an inverting amplifier (for example, between the base and collector in a common emitter stage) appears to the input signal as having a value equal to the actual capacitance multiplied by the voltage gain. This is a form of negative feedback. What's more, the capacitance appears to shunt the signal to earth, so that base-collector capacitance multiplied by voltage gain is added to base-emitter capacitance. This produces a considerable reduction of input impedance at high frequencies and, in conjunction with input source resistance and the transistor's base layer resistance, a loss of signal amplitude and therefore of effective gain. For somewhat different reasons, emitter follower performance (which is dependent on current gain) also falls off at high frequencies.

One way of overcoming such effects is to operate the transistor in grounded (or, common) base mode. The transistor conducts DC as normal and component values are calculated as with a common emitter, but the signal is injected into the emitter and the base is held at ground potential to AC by a large-value capacitor. Any feedback signal due to internal transistor junction capacitance between collector and base is now shorted to ground by

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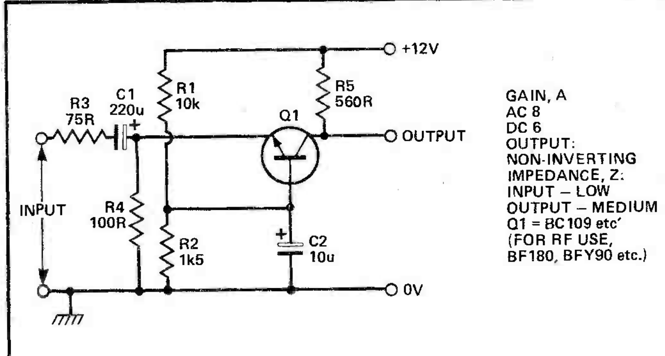

Fig. 7 Grounded base amplifier.

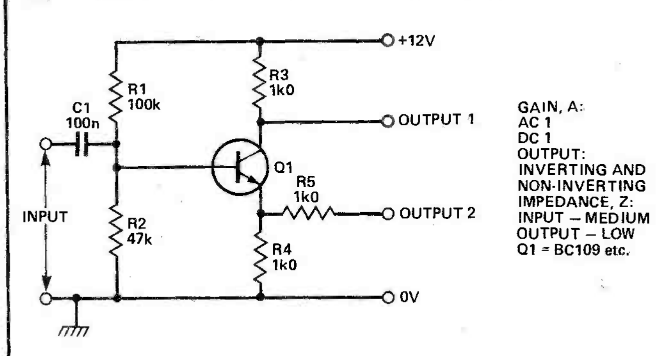

Fig. 8 Phase splitter.

the external capacitor (C2 in Fig. 7). In fact, the base-collector capacitance is no longer directly connected between input and output since the base itself acts as a screen. There is no Miller-amplified feedback capacitance, and the input signal feeds into the already low emitter impedance. Thus, voltage gain remains useful even at very high frequencies (up to the transition frequency f_T).

One characteristic worth noting is that the grounded base configuration is non-inverting since the signal is injected into the emitter and the output is taken from the collector. This is useful for video applications, as is the low input impedance of the circuit (suitable for terminating aerial feeder cables).

Non-inversion can also be achieved with a common emitter stage by taking an output from the emitter itself.

Figure 8 shows a circuit commonly known as a phase-splitter, since output 1 and 2 are in antiphase — the first being equal in amplitude to the input but inverted in phase, the second being equal in amplitude *and* phase to the input. The amplifier has unity voltage gain. Strictly speaking, it only works as a phase splitter for a sine wave, since other waveforms may be degenerated. The main uses of this circuit are for driving balanced lines or as a means of obtaining variable phase for musical effects. R4 is included to ensure that both outputs are of equal impedance.

In the final part of this series we'll be dealing with some useful two-transistor stages. These will show how many of the compromises necessary in designing single transistor stages can be avoided.

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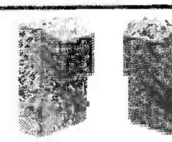

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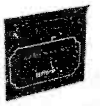

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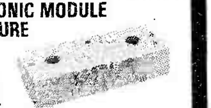

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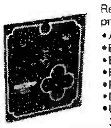

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REDUCED INSTRUCTION SET COMPUTERS

Carefully avoiding some of the obvious puns, Mike Bedford takes a look at RISC chips.

The most visible trend in the development of microprocessor technology since the release of 4-bit processors in the early 1970's is a continual increase in the width of the data bus, a factor which is commonly used as a broad classification of processors. Today 8-bit is the accepted type for home computers, 16-bit tends to be used for small business machines and 32-bit is found in scientific machines.

Hand in hand with this development has been an increase in the complexity of the instruction set. The earlier 4 and 6-bit devices could only carry out simple logic and arithmetic functions such as AND, OR, ADD and SUBTRACT, various branches and subroutine calls and limited memory access consisting of LOAD and STORE instructions. As 8-bit development continued, the number of addressing modes increased as did the complexity of the arithmetic functions. Multiply is included on the 6809, for example, this being an 8-bit processor which also offers some limited 16-bit instructions. With 16 and 32-bit processors multiply and divide are the accepted norm and many other advanced instructions such as loop constructions and block moves are to be found. It goes without saying that increasing execution speeds accompanied the foregoing trends.

A few figures will help to illustrate these trends. The number of basic instruction types on the 8080, the first popular 8-bit processor launched in the mid 1970's, is 30. The later 6502, also an 8-bit device and extensively used in home computers, has a similar number, whereas the 6809, one of the latest and most advanced 8-bit micros released about 1979, has 43. The 68000, a typical 16-bit processor, has 61. Comparing numbers of instructions between processors is not easy as one processor may have as different instructions what are merely different addressing modes of the same instruction on another device. The numbers above are not necessarily the numbers of instructions claimed by the manufacturers but would, for example, class all conditional branches as a single instruction.

It has been suggested that by the end of the decade, virtually all computers for engineering applications will employ some degree of RISC architecture.

What probably gives a more accurate picture of the complexity of the chip is a count of all the op-codes, a figure which gives a measure of the number of combinations of instructions and addressing modes. When these numbers are considered we see about 200 for the 8080, 266 for the 6809 and over 1,000 for the 68000. Comparing performance numerically is once again difficult but it is quite clear that the 6809 is considerably faster than the 8080 or the 6502 and that the 68000 probably gives a 3 fold speed increase over the 6809.

Even a quick glance at the above figures would lead to the conclusion that complicated instruction sets are

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necessary to achieve high processing speeds, and indeed this has traditionally been the point of view throughout the development of computer architecture. The argument for this link is that if a particular function is not available as a processor instruction it will have to be replaced by a series of simpler instructions. For example, if multiply is not available it has to be replaced by a routine carrying out multiple additions and/or shifts, a process which

The Pyramid 90x is claimed by its manufacturers to give 8-10 times the performance of a similar machine with conventional architecture.

will usually be much more time consuming than a hardware implementation of the function.

Recent developments suggest that this trend of increasing complexity in microprocessors may be reversed. The RISC or Reduced Instruction Set Computer offers the possiblity of very high speeds coupled with an extremely simple yet innovative architecture.

Development Of RISC

It has been suggested [1,2] that by the end of the decade virtually all computers for engineering applications, from PCs to multi-user mini-computers, will employ some degree of RISC architecture. Some advocates of RISC would indeed go as far as to suggest that all computers of the late 1980's will include RISC processors. Before going on to describe such a processor and how a simple approach can achieve impressive speeds, it will be useful to outline the development of this type of architecture.

The project which is generally considered to represent the first work carried out on a RISC type architecture is the IBM-801, the design of a simplified instruction set being a result of statistical indications that the most commonly encountered instructions are simple ones such as LOAD, STORE, branches and simple arithmetic. Although this project has not, as yet, yielded a commercial product, preliminary results suggest that it has a performance comparable to the IBM 370/168 mainframe at almost 2 MIPS (million instruction per second) while other reports have claimed speeds as high as 10 MIPS. In view of the fact that the 801 is essentially a mini computer rather than a mainframe, this is a very impressive figure.

Another large company engaged in RISC research is DEC who are reported to have two such projects, code-named Nautilus and Titan. Once again, no commercial product has yet evolved and few details have been published. From those snippets of information that are available, we can say that Nautilus is intended as a general purpose machine which fits somewhere beteween the VAX and the System 10/20 machines and has a speed of about 10 MIPS, whereas Titan is an engineering workstation with some degree of VAX compatibility which should yield speeds in the region of 2 MIPS.

Other large ocmputer companies are known to be carrying out research in this field but so far only two RISC machines are on the market, both manufactured

We have the promise of microprocessors with a much increased speed-to-cost ratio in the not too distant future.

by smaller companies. The Pyramid 90x is a general purpose machine intended for both commercial and engineering applications. It is clearly intended to compete with the DEC VAX 11/780 and is claimed by its manufacturers to give 8-10 times the performance of a similar machine with conventional architecture. The Ridge 32, on the other hand, brings the power of a VAX to an engineering workstation for applications such as CAD and solid modelling. The claims for this machine are that it executes I/O faster than the VAX 780 and can execute linear equations faster than a VAX 750 with a floating point accelerator.

Although it is interesting to see the impact made by RISC in the realm of mini computers, the area which will be of most interest to readers of this article will be the development of RISC microprocessors. The first such device, RISC I, was completed in 1982 by a team of staff and graduate students at the University of California in Berkley.[3] The team, led by Professor David A. Patterson, designed the chip from initial discussion to first silicon in a near record time of only 19 months. The fact that such timescales could be achieved and speeds in excess of those of commercial devices such as the 68000 could be demonstrated by a team with little previous knowledge of VLSI design can be attributed primarily to the simplicity of the architecture. Since impressive performance is possible with minimal design effort, we have the promise of microprocessors with a much increased speed to cost ratio in the not too distant future. In the following

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INSTRUCTION	OPERANDS	DEFINITION	DESCRIPTION
ADD			
ADDC	Rs,S2,Rd	**Rd←Rs+S2**	Integer add
SUB	Rs,S2,Rd	**Rd←Rs+S2+carry**	Add with carry
SUBC	Rs,S2,Rd	**Rd←Rs-S2**	Integer subtract
SUBR	Rs,S2,Rd	**Rd←Rs-S2-carry**	Subtract with carry
SUBCR	Rs,S2,Rd	**Rd←S2-Rs**	Integer subtract
AND	Rs,S2,Rd	**Rd←S2-Rs-carry**	Subtract with carry
OR	Rs,S2,Rd	**Rd←Rs &S2**	Logical AND
XOR	Rs,S2,Rd	**Rd←Rs/S2**	Logical OR
SLL	Rs,S2,Rd	**Rd←Rs xor S2**	Logical exclusive OR
SRL	Rs,S2,Rd	**Rd←Rs shifted S2**	Shift left
SRA	Rs,S2,Rd	**Rd←Rs shifted S2**	Shift right logical
	Rs,S2,Rd	**Rd←Rs shifted S2**	Shift right arithmetic
LDL	(Rx)S2, Rd	**Rd←M[Rx+S2]**	Load long
LDSU	(Rx)S2, Rd	**Rd←M[Rx+S2]**	Load short unsigned
LDSS	(Rx)S2, Rd	**Rd←M[Rx+S2]**	Load short signed
LDBU	(Rx)S2, Rd	**Rd←M[Rx+S2]**	Load byte unsigned
LDBS	(Rx)S2, Rd	**Rd←M[Rx+S2]**	Load byte signed
STL	(Rx)S2, Rd	**M[Rx+S2]←Rm**	Store long
STS	(Rx)S2, Rd	**M[Rx+S2]←Rm**	Store short
STB	(Rx)S2, Rd	**M[Rx+S2]←Rm**	Store byte
JMP	COND,S2(Rx)	**PC←Rx+S2**	Conditional jump
JMPR	COND,Y	**PC←PC+Y**	Conditional relative
CALL	Rd,S2(Rx)	**Pd←PC next**	Subroutine call
		PC←RX+S2	and change window
		CWP←CWP -1	
CALLR	Rd,Y	**Rd←PC next**	Call relative
		PC←PC+Y	and change window
		CWP←CWP - 1	
RET	Rm,S2	**PC←Rm+S2**	Return
		CWP←CWP + 1	and change window
CALLINT	Rd	**Pd← last PC**	Disable interrupts
		next CWP←CWP-1	
RETINT	Rm,S2	**PC←Rm+S2**	Enable interrupts
		next CWP←CWP+1	
LDHI	Rd,Y	**Rd(31:13)←Y**	Load immediate high
		Rd(12:0)←0	
GTLPC	Rd	**Rd←last PC**	Restart delayed jump
GETPSW	Rd	**Rd←PSW**	Load status word
PUTPSW	Rm	**PSW←Rm**	Set status word

Rs = Source register 1
Rd = Destination register
Rm = Register for store
PSW = Status register
Y = Offset

S2 = Source register 2
Rx = Index register
CWP = Register window pointer
PC = Program counter
M = Memory

Table 1. The instruction set for the RISC 1 Microprocessor.

description of RISC architecture the discussion will be based on the Berkley RISC I and later RISC II chips, although most of what is said could be applied to any machine using RISC philosophy.

Minimal RISC

The most obvious question to tackle first is how a simplified instruciton set can lead to high processing speeds. To put this another way, where is the fallacy in the usual argument that incorporating increasingly complex functions into the hardware decreases execution time by removing software overheads?

One problem with this conventional argument is that very often a single advanced processor function of a modern microprocessor may not be all it seems. Instead of a complex instruction being implemented fully in hardware, the situation is that such features are actually translated to a series of micro-instructions, these being a low level of instruction within the device.

An implication of this is that single instructions on modern microprocessors can often take many cycles to execute. For example, on the 68000, the signed multiply instruction can take up to 42 cycles, 122 cycles are required for signed divide and even a commonly encountered instruction such as return from exception (interrupt return) can take 110 cycles. A closely related point is that, even for simple instructions, if a processor has a number of different variants and/or addressing modes the internal circuitry must be configured to suit each different requirement. This switching of gates is once again carried out by micro-coded instructions with the inevitable speed reduction.

The RISC I and RISC II processors are not micro-programmed and, with a couple of exceptions, are

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able to execute all instructions in a single cycle. Table 1 shows the RISC I instruction set. It will be noticed that there are only 31 instructions and, in contrast to most modern 16 and 32-bit micro-processors, the device is totally devoid of the more esoteric instructions. Coupled with the fact that there are only two addressing modes, it is not difficult to see how all functions can be hardwired, hence obviating the need for micro-coding.

The RISC philosophy is that memory should only be accessed by LOAD and STORE instructions (these being the exceptions which take two machine cycles to execute) all processing being carried out from register to register internally. This limited memory access means, for example, that in order to add two memory locations together into a third, the processor would need to load the contents of the first two memory locations into registers, add the two registers together and finally carry out a store from the register containing the result into the third location.

An implication of this approach is that a large number of internal registers is essential. In fact, the register organisation is quite inovative and will be described shortly. Conveniently, it is because of the simplicity of the processor ALU and control logic (about 6% of RISC I compared to about 50% on many commercial processors) that it is feasible to devote a large area of the chip to the registers required by RISC architecture.

One possible argument against the approach outlined above is that, although it appears able to provide impressive speeds at a reasonable cost, the limited instruction set means that a much greater programming effort will be required. Since the programming time generally represents the greatest part of the cost of a system containing both hardware and software, this could be a considerable disadvantage. It would undoubtedly limit the attractiveness of RISC processors if programming had to be carried out in assembler language, but RISC I is designed to be programmed in a high level language. Under these circumstances the limited instruction set is quite transparent to the applications programmer, being of concern only to the writers of the compilers.

The use of high level languages does not merely mask a possible disadvantage: indeed, the RISC I processor was designed with high level languages very much in mind, PASCAL and C being the languages considered. As part of the initial design, statistical data on the frequency of occurrence of various constructions together with the corresponding numbers of machine instructions were analysed. The results led the Berkley team to the conclusion that the most time consuming parts of high level language programmes are concerned with subroutine calls and handling of local variables. As we shall see, the RISC register architecture addressed both these points, reducing their execution times considerably.

Single instructions on modern microprocessors can often take many cycles to execute. On the 68000, 122 cycles are required for signed divide....

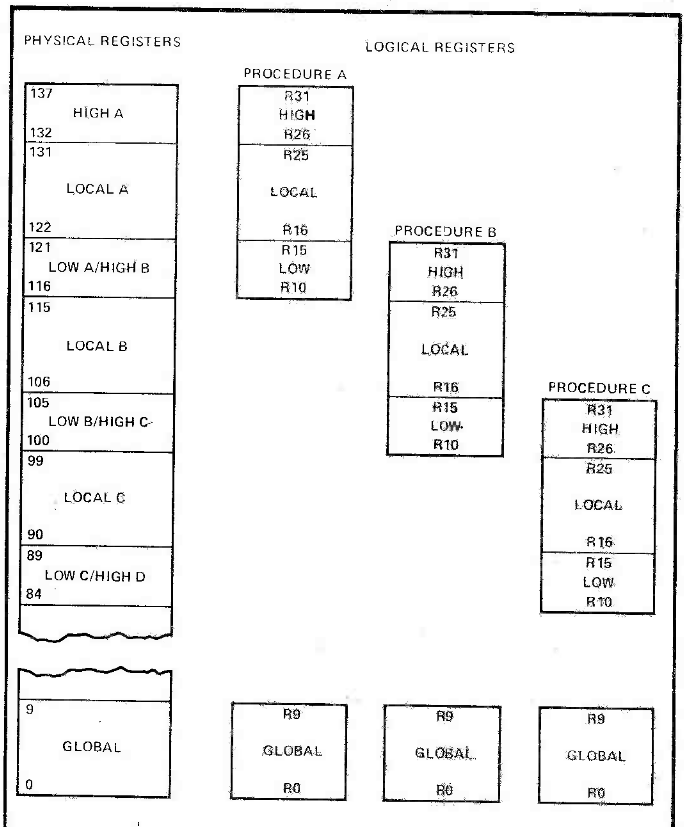

Fig.1 The register architecture of the RISC microprocessors.

Registers

It has already been stated that the RISC I processor offers a large number of general purpose registers. The organisation of these registers and the way in which they greatly contribute to the fast execution of subroutine calls will now be described.

A conventional microprocessor has a relatively small number of internal registers. For example, the 6809 has only two general purpose data registers and two index registers; even the more advanced 68000 has only eight data registers and seven address registers. This means that, on entering a subroutine, all registers which are going to be used by that routine for its internal working must be saved on entry and restored on return to the calling code. This saving and restoring is carried out by means of a stack in memory, this also being the method used for passing parameters to and from the subroutine. It is the need for these PUSH and PULL instructions which so much slows down subroutine calls on conventional processors.

RISC I obviates the need for this time consuming process by using 137 registers which are arranged as a number of overlapping register windows. This scheme is illustrated in Figure 1. The left hand bank shows the internal numbering of the registers in the processor whereas the three banks on the right represent three separate register windows which map physically onto the total pool of 137 registers. Any subroutine has access to one window of 32 registers which are always referred to as R0-R31 irrespective of which physical registers they are mapped onto.

It will be noticed that each register window is split into four segments referred to as global, low, local and high. The global registers are used for values which are

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likely to be accessed by a number of different procedures since these are common to all windows. The local registers are used for local working within a particular routine. Whenever a subroutine call or a return is executed, a new window is automatically selected and the local registers used by the calling routine became accessible, thereby obviating the need to save their contents on a stack.

As far as the passing of parameters is concerened, this is where the low and high registers are used. Since the low registers of one window overlap the high registers of a neighbouring window, the means of passing parameters to a procedure is to place them in low registers prior to issuing the call. Conversely, the called procedure will pick up the parameters passed to it in its high register area - once again removing the need for a stack.

Clearly this philosophy places a limit on the depth of subroutine calls which may be nested since there are only a finite number of registers from which to create new windows. To cope with this problem, the RISC I processor recognises overflow and underflow conditions. Under these circumstances a trap takes place to a software routine which stacks the registers in memory in the conventional manner. If this condition were to happen frequently, the performance would clearly suffer. Research has shown that in average programms, such conditions occur relatively infrequently - if 8 windows are available it is suggested that overflows only happen on about 1% of subroutine calls.

Running The RISC

To conclude this introduction to RISC and to wet the appetite for what could be just round the corner, a comparison of the RISC I and RISC II processors against common 16-bit microprocessors of today will be made. Throughout this section it should be borne in mind that we are talking about a VLSI chip with 44,000 transistors. This compares to 68,000 for the Motorola 68000, and only 5% of the RISC chip is devoted to control functions (that is, the actual processing) compared to 30%-50% on most 16 bit processors.

The RISC I processor achieved a clock frequency of only 1.5 MHz compared to its design frequency of 7.5 MHz, a factor attributable mainly to the development team's lack of experience in VLSI design. In spite of this poor circuit speed, RISC I showed up very favourably when compared with a number of commercial 16 and 32-bit processors. Comparisons were made with the Intel 8086, Intel 432 and Motorola 68000, running benchmark tests in high level languages. Of the 4 programs, RISC I proved to be the fastest of the four processors for 3 of the tests and faster than the average for the fourth. The tests are not conclusive because different high level languages were used on the different micros, but the initial results were clearly encouraging.

The RISC II processor ran at 12MHz, giving a cycle time of 330nS which also implies an execution time of 330nS for all but LOAD and STORE instructions. At the time of writing, the RISC II processor has not been built into a microcomputer system and the performance figures are therefore based on simulations. However, it is claimed that for C programs, an 8 MHz RISC II can outperform the 8 MHz iAPX 286, 10 MHz NS 16032, 12 MHz 68000 and 18 MHz HP 9000. Simulated comparisons have also been made against the DEC VAX 11/780 mini computer. Although this is not comparing like with like because the VAX is a multi user virtual memory machine, it is nevertheless impressive to report that a RISC II running at 12 MHz is able to compile C programs 2 to 2.5 times faster than such a machine.

RISC 1 proved to be the fastest of the four processors for three of the tests and faster than the average on the fourth.

Conclusions

It is difficult to know how to conclude an article on an aspect of micro electronics which is still in its infancy. Clearly the 'keep it simple' approach to microprocessor design has much to commend it, offering high speed processing at a potentially low cost. RISC advocates predict a rosy future for this type of processor and there is no reason to question the basis for their optimism. Nothing is certain in the electronics industry, however, as a look at the predictions made in the late 1970's regarding bubble memories makes clear. So, is the reduced instruction set computer another dream that will never come to fruition or will it be a major factor shaping the future? Only time will tell!

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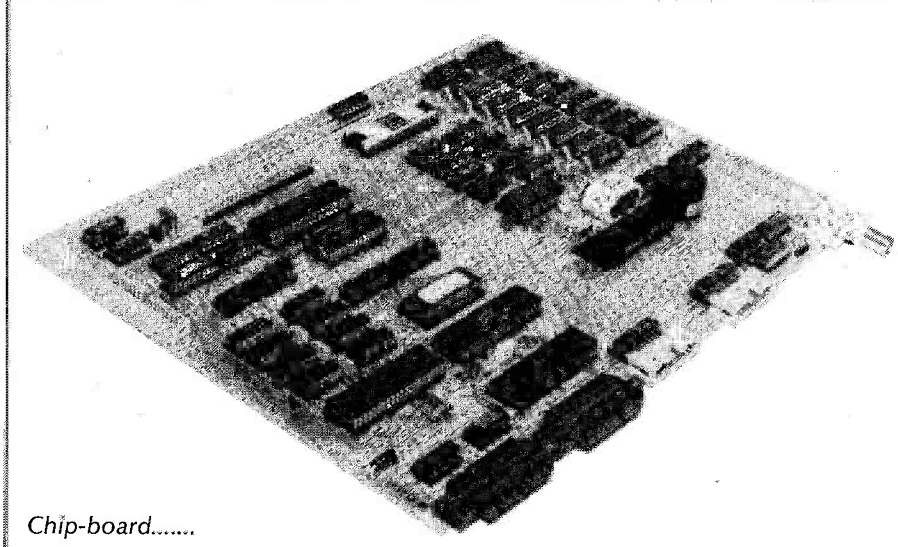
6809-BASED MICROCOMPUTER

In this, the first of a series of articles, G. Mills of Micro Concepts describes a new single-board microcomputer designed by Dave Rumball.

This article describes a single board, 6809-based microcomputer which incorporates a state-of-the-art graphics processor and other advanced features. It can be built at very low cost and is also available from Micro Concepts as a kit.

One of its features is the ability to appear as a Flex standard machine to the wide range of Flex software. This would be of interest to those who are involved in writing software for microprocessor controlled equipment, allowing the board to be used as an inexpensive but sophisticated software development system. In case you aren't aware, the Flex operating system has a wide range of cross assemblers and an elegant command set, and is widely used for this type of work. British companies currently using Flex based development systems for microprocessor software development include Dacom, Racal, and Westwood. Because of its advanced features, this board offers a more cogenial environment for software development than many more expensive systems. Companies currently using the Micro Concepts kit (known as the Microbox II) for software development include Thorn EMI and British Telecom.

The design should also be of interest to those who want a really useful computer for very little money. It runs serious wordprocessing and data base software, has beautiful graphics, superb resolution, a completely soft character set and the prototype cost around £450 to build including discs, video monitor, keyboard, power supply and operating system (and the price is coming down).



Chip-board.......

By way of introduction, the following is a partial description of the hardware:

Central processor — Motorola 68B09E.

64K of dynamic RAM for the central processor.
When running the board in the monitor mode, 8K of this is mapped out by the monitor EPROM. When running the Flex operating system, only 4K of the monitor EPROM is retained. This 4K contains driver routines for the discs, serial ports and parallel ports, as well as interface routines for the graphics chip and terminal emulator.

A floppy disc controller that will support up to two 3½ or 5¼ inch floppy disc drives, single or double density, single or double sided, 40 or 80 track.

One parallel keyboard port.

Two independent bi-directional RS232 ports with software programmable baud rates (50 to 19.2k baud), parity, stopbits, etc.

One Centronics standard parallel printer port.

A buffered, fifty pin expansion bus.

All of the above will be familiar to anyone who has experience with run-of-the-mill Flex machines available from a number of manufacturers. The following features are unique to this design:

An additional 128K of dynamic RAM partitioned into alphanumeric video RAM, graphic video RAM, and RAMdisk.

An alphanumeric display format of 108 columns by 24 lines when using the terminal emulator resident in the monitor EPROM. The terminal

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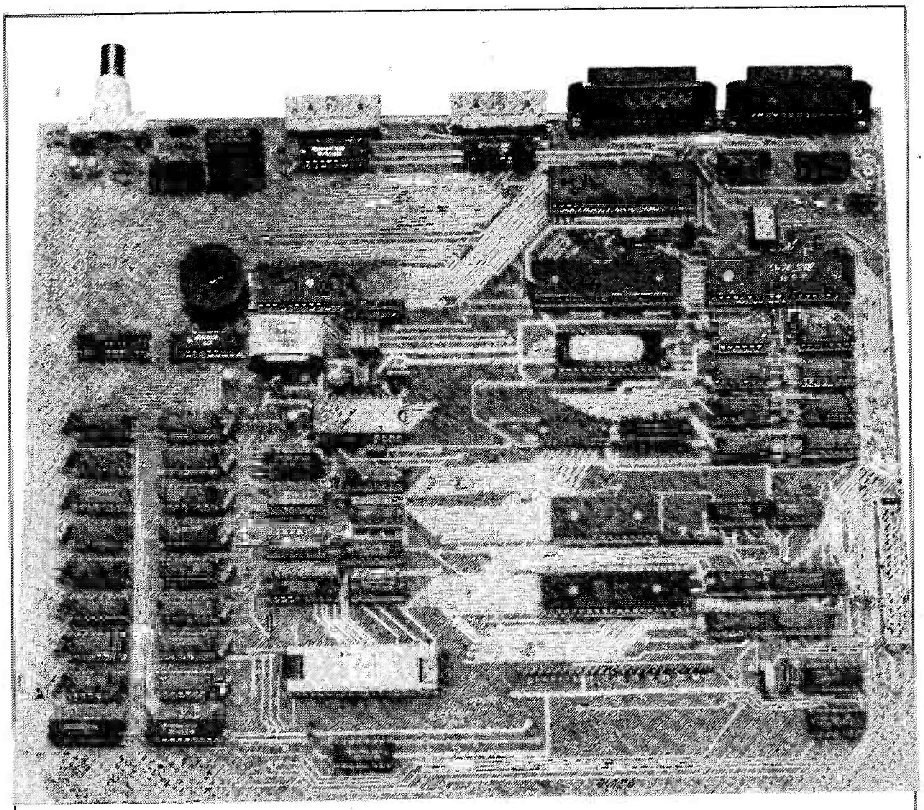
emulator and the associated character set are in software and therefore can be redefined if desired. Alternate memory resident emulators come with the kit. One gives a format of 84 by 24 and another 128 columns by 56 lines.

Exceptional monochrome graphics facilities generated by an NEC 7220A graphic display controller. The resolution of the display is 768 pixels by 576 pixels. By way of comparison, this is a resolution 2.7 times greater than the BBC Model B in its highest resolution mode. Graphics primitives (for example the Bresenham algorithm for arc and line drawing) are built into the 7220A, resulting in very fast drawing speeds.

A RAMdisc facility, using a variable amount of the 128K RAM. This RAMdisc looks exactly like a floppy disc to the operating system. The capacity of the disc can vary between 170 sectors (42.5K) when



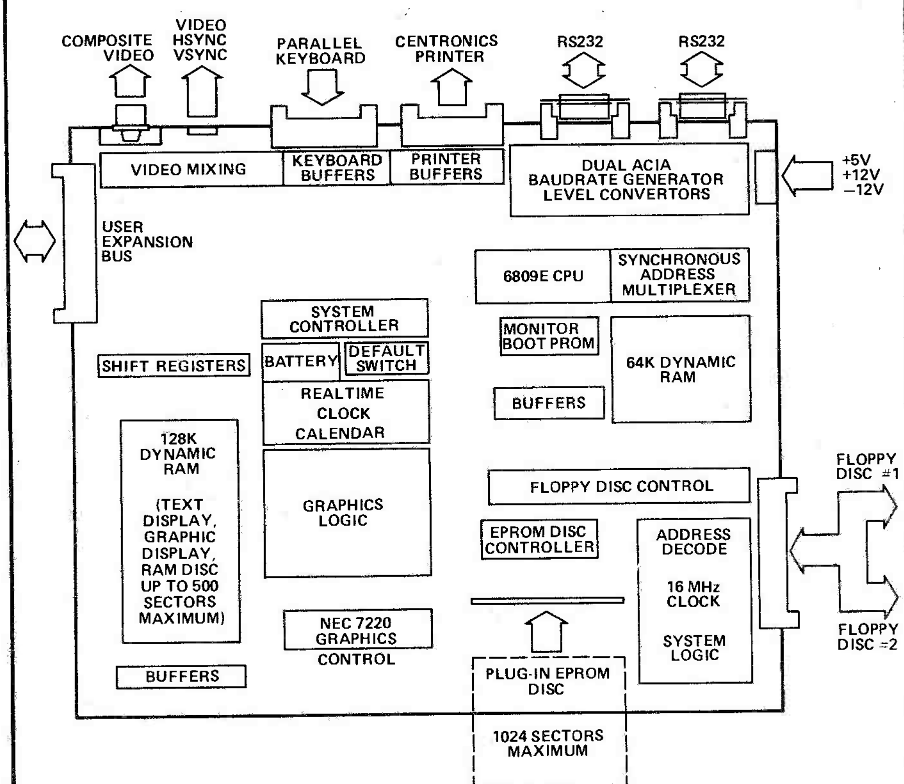


Fig. 1 Location of the principal components on the board.

using the full graphics capabilities of the machine, and 500 sectors (125K) when the machine is being used with a serial terminal and no graphics output. Its mid capacity, when using the terminal capacities of the 7220A, is exactly the size of a single density, single sided 40 track Flex disc. This enables the user to perform fast disc to disc copying with only one disc drive.

An EPROM based silicon disc which again looks to the DOS exactly like a floppy disc, but this time write protected. The EPROM disc is fabricated on its own small PCB which plugs into the main board. This allows the user to keep a number of these discs programmed for different applications. The capacity of this board is 4 EPROMS which can be 27128's, 27256's, or 27512's. These will give 64K, 128K, or 256K bytes of disc space respectively.

An on-board EPROM programmer requiring only a programming power source (for 21V EPROMS three 9 volt batteries stablized by a zener diode can be used).

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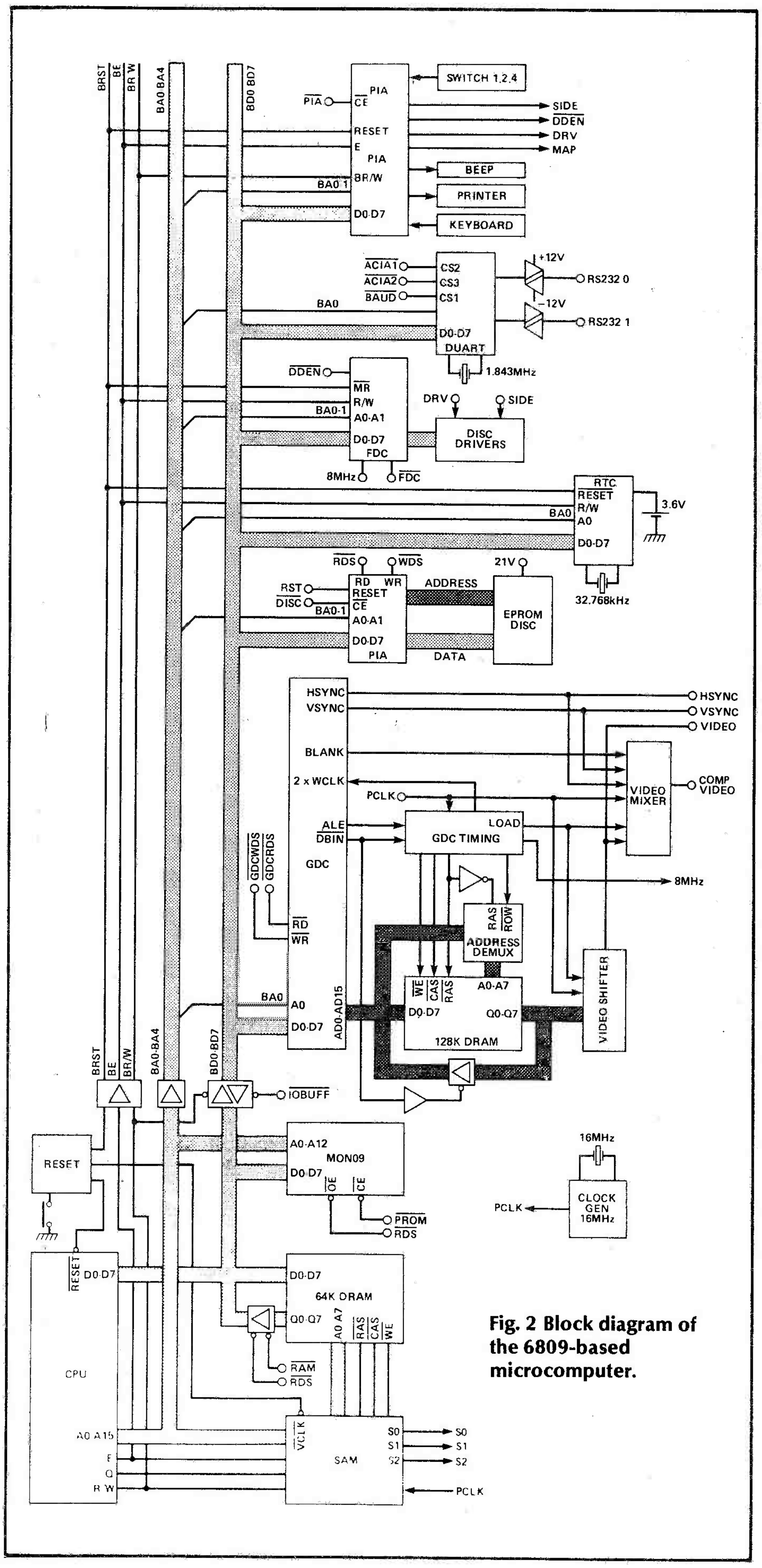

Fig. 2 Block diagram of the 6809-based microcomputer.

A battery backed-up real time clock and calendar. This is used by Flex to date stamp files. The clock chip also contains 50 bytes of non-volatile RAM, some of which is used to maintain system parameters such as baud rates, floppy disc step rates, physical to logical mapping of disc drives and start-up parameters for the graphics device.

It should be apparent by now that the board has been designed with some thought. The combination of EPROM disc and RAM disk makes it very fast indeed and in most cases disc access time is not even noticeable.

The effect of the silicon discs and the fast graphics hardware is to make the machine compare favourably with the graphics on much larger machines (in one incarnation it was used by Imperial College as a graphics terminal for a VAX). Further, the terminal emulation software and the handling of the ROM and RAM discs so that they look like floppy discs enables the system to run Flex software with no more modification than would be necessary with any other Flex computer. In fact, it will boot any Flex operating system. It is in effect a superset of existing Flex computers, not an entirely new departure that leaves the software developers years behind.

Another interesting feature of the design is the low chip count. Fully populated, and including the EPROM disk, the board has only 68 chips of which 24 are memory and five are EPROM.

We hope this brief introduction has whetted your appetite! Next month Dave Rumball will describe the design of the board and the reasoning behind his choice of chips and facilities. Succeeding articles will cover construction and use and will include a list of available software. For those who can't wait that long, the kit is available from Micro Concepts at the address below and includes full construction details. Contact them for information on prices, etc.

Micro Concepts, 2 St. Stephens Road, Cheltenham, Gloucestershire GL51 5AA, tel 0242 - 510 525.

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AUTOMATIC TEST EQUIPMENT

The writing's on the wall for signature analysis, says W.P. Bond.

The increasing predominance of VLSI, microprocessors and large memories has made the use of advanced techniques of automatic testing essential. Signature Analysis (SA) is such a technique and, although first developed over a decade ago, it plays an important part in modern ATE.

SA is a data-compression technique, introduced by Hewlett-Packard in 1970 as a field-service aid for fault-finding in microprocessor-based equipment, but with unexpected applications in functional testing. The theory is fairly complex — at least, if the maths is not taken on trust. If we accept the mathematical foundations as sturdy, the process is reasonably easy to understand.

Figure 18 shows a typical SA set-up. It is, in effect, a pseudo-random sequence generator with an external input connected to the circuit node at which system data is being monitored. The heart of the device is a 16-bit shift register whose contents can be read out on a hex display. On successive clock pulses, the register will shift, producing a binary sequence at the output, X, and an associated sequence of hex numbers on the display. Assuming for the moment that the data input, W, is held low (that is, no data is entering the shift register), the device acts just like a pseudo-random sequence generator. The feedback loop through the exclusive-OR gate, XOR2, ensures that the shift register will cycle through all its possible states (with the exception of all bits zero) whatever the initial state (as long as it was not all bits zero). The proof of this derives from the theory of binary sequences and is connected with the fact the feedback loop is effectively generating a polynomial function whose value is determined by the state of the shift register at any given time. The state of the shift register at a particular time can, in turn, be specified by reference to preceding stages. In the simplified diagram of Fig. 19 (which shows the Fig. 18 set-up with the data input and associated OR gate removed), the input at time r, X_r, is given by the expression:

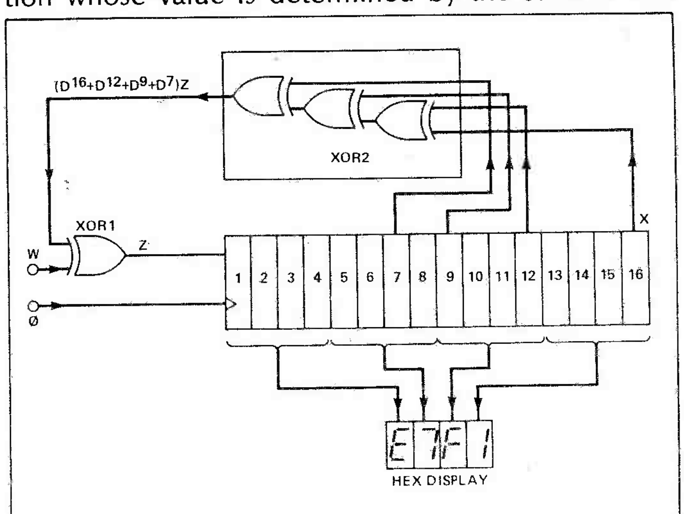

Fig. 18 Signature analysis set-up.

$$X_{r-16} \text{ xor } X_{r-12} \text{ xor } X_{r-9} \text{ xor } X_{r-7}.$$

This expression can also be written using what's called D-notation. This uses a particular operator, D (something like the differential operator of analytical calculus), to represent the effect of a delay of one clock cycle. The above expression becomes:

$$D^{16}(X) \text{ xor } D^{12}(X) \quad \text{xor } D^{9}(X) \text{ xor } D^{7}(X),$$

where $D^n(X)$ represents n successive operations on X.

If we wanted to generate the sequence of inputs into the Fig. 19 circuit, we could simply take any initial state of the shift register (except for all bits zero, which will never change) and work out successive values of the polynomial. We would get a sequence of ones and zeroes which would, eventually, start repeating. Starting from any single digit in the sequence and taking the next 15 digits (cycling round the sequence, if necessary) will produce states of the shift register.

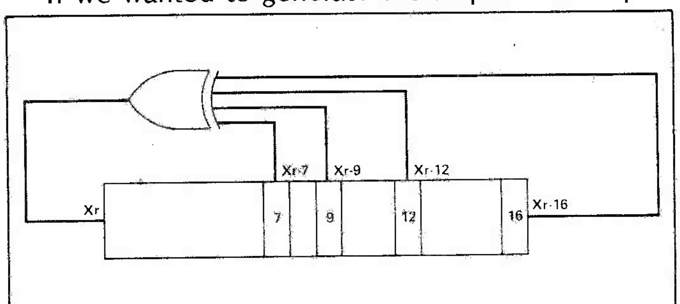

Fig. 19 A pseudo-random sequence generator.

It can be shown that the above polynomial will generate a sequence of 65535 digits before it starts repeating. Any device with n-stages which generates a sequence of 2^n-1 ones and zeroes before repetition is called, for obvious reasons, a maximum length sequence generator. In the case of the circuit shown in Fig. 19, we talk of a maximum length sequence (or m-sequence) of period $2^{16}-1$. Using the technique of starting from one digit within the sequence and taking a string of 16 consecutive digits, we arrive at $2^{16}-1$ smaller sequences of 16 bits each. Since there can only be 2^{16} possible sequences of 16 bits (this time including the all bits zero option), and since the m-sequence doesn't start repeating until the 65536th bit,

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the m-sequence clearly gives rise to every possible state of the 16-stage shift register (with the familiar exception).

The useful thing about the m-sequence is that there is no *evident* structure to it. It appears to be random, although it is in fact rigidly determined by the initial state of the shift-register and the feedback (or transition) polynomial. By converting each of the states of the shift register into a decimal or hex number we can give another useful expression to this pseudo-random sequence. Table 1 shows the different ways of expressing the sequence for a 3-stage generator (Fig. 20):

CLOCK	I/P	A	B	C	HEX/DEC	O/P
1	1	0	0	1	1	1
2	1	1	0	0	4	0
3	1	1	1	0	6	0
4	0	1	1	1	7	1
5	1	0	1	1	3	1
6	0	1	0	1	5	1
7	0	0	1	0	2	0

Table 1.
Three stage shift register pseudo-random sequences.

Check for yourself that the sequence now repeats.

In the above example, the decimal/hex sequence 1,4,6,7,3,5,2 can be simply read out of the shift-register as with the Fig. 18 circuit. Whatever the number that comes up, we know exactly which number will follow it.

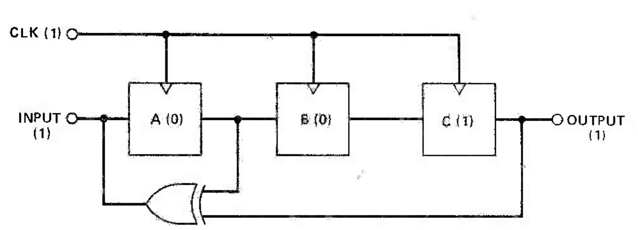

Fig. 20 Simplified three stage sequence generator.

If we now go back to Fig. 18 and start feeding data in on W input, what will happen? Left to its own devices, the shift register will cycle through its sequence of 65535 numbers, one for every clock pulse. But as soon as the W input goes high (in other words, as soon as a data bit 1 arrives on the input), XOR1 will invert the bit on the feedback line. The shift register jumps out of its pre-ordained sequence. Since this sequence includes every possible number between 1 and 65535 already, all that will happen will be that the shift register lands somewhere else in its sequence and will carry on from there. Every data high will cause the shift register to jump to a different part of the sequence, so that a given sequence of data bits will generate a new sequence of numbers in the shift register. After a precise number of clock signals — enough to cover all states of the unit under test — the shift register is stopped and a final number can be read out. This is the signature of the input sequence (also known as the cyclic redundancy code, or CRC). Assuming all the circuits concerned are properly initialised and the time window does not deviate, the signature will be the same each time the SA device sees the same data input. Clearly, any single bit error is certain to be detected, since such an error will cause one and only different jump in the sequence. Multiple bit errors will cause the sequence to jump several times, and it may end up where it would have been if no error had occurred. The chances of this happening are very small — with a 16-bit shift register, they amount to one in $2^{16}-2$. There is an approximate 99.998% chance that a multiple bit error will result in a wong signature and so be detected. This near certainty is possible because the original sequence is, in effect, random.

The main advantage of the signature analysis technique is that it is capable of detecting time related errors and can be used to test microprocessor-based systems, for example, or large memory configurations at full system speed. SA procedures require access to a test point for data input, access to a clock signal and the provision of start and stop signals to determine the time window (Fig. 21). The UUT's own clock is often used although it may be more convenient to use other bus signals (RD and WR), for example. Start and stop signals are often provided by a stimulus program built-in to UUT hardware.

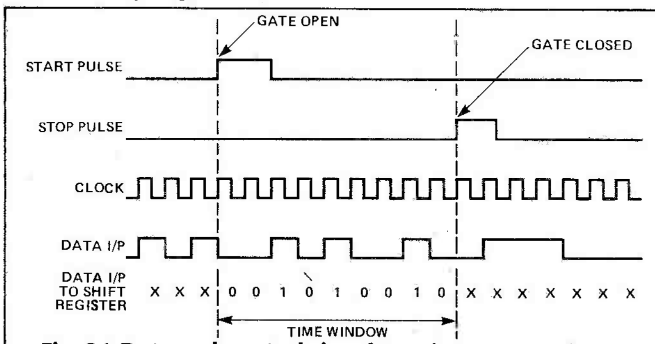

Fig. 21 Data and control signals to signature analyser.

Figure 22 shows how SA can be applied to test an n-bit ROM. A counter is used to cycle through the ROM's address range and the outputs are monitored using the system clock as the SA clock. Start and stop signals are both taken from the MSB of the counter and therefore need to trigger on opposite edges. Using this method, there is no real limit to the size of memory that can be tested, which is particularly important with regard to newer devices and technologies like bubble memory with sizes upwards of one megabit.

The same principle can be used to test RAM, although a method of loading the memory with known data is required. In this case, the stimulus program which initializes the system, provides start and stop pulses and exercises all the test nodes may utilise RD and WR signals as clock inputs. Signatures arrived at when writing data to RAM using WR as a clock signal could simply be compared with signatures arrived at when reading data back using RD as a clock input. This is a less complicated procedure than one using the system clock of the UUT.

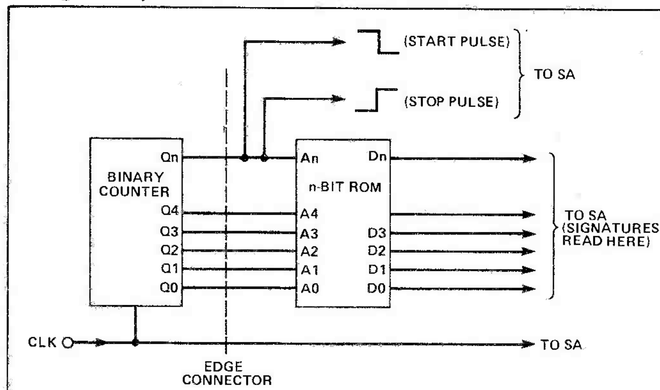

Fig. 22 ROM testing by signature analysis.

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One difficulty in testing microprocessor-based bus systems is the presence of feedback loops. A bad signature may be propagated around the loop, for example on a data bus. In such a case, the presence of a fault could be detected but not isolated to component level. In the mpu system of Fig. 23, interrupts must first be disabled or masked if any meaningful and repeatable signatures are to be derived. The data bus must be broken by means of jumpers, switches or buffers and the processor should be allowed to free-run, cycling through its address range. This last can be achieved by putting an instruction on the mpu's now disconnected data inputs causing the program counter to increment and repeat as long as the instruction is present. Normally a no-operation (NOP) instruction will do the trick.

Signatures can be taken from the address bus. If these are wrong, either the micro is not free-running, or there is an address fault. Then the ROMs, RAM and I/O can be enabled in turn and their outputs verified on the data bus. Once again, the RAM must be loaded with known data. If the data bus cannot be isolated, one can often utilise tri-state buffers to isolate the mpu and then force an instruction on to it, vectoring it to a particular address in ROM containing an analysis routine. But such complications are enough to ensure that ATE only uses signature analysis to test large memories, circuits without feedback and easily controllable mpus.

Bus Emulation

There are other options for testing mpu and bus-structured boards, of course. Bus Timing Emulation is a technique developed by Columbia Automation (now Zehntel) for use on their Columbia 2000ATE model. This is currently being used by Smiths Industries for testing complex modules.

Emulation is, in effect, a form of real-time simulation, originally designed as a microprocessor development tool. Unlike simulation testing, emulation is perfectly suited to the uncovering of dynamic faults — even with the UUT being run at full system speed.

To use emulation to test mpu-based bus-structured we must know the timing specifications and protocol of the bus — which are, of course, determined by the controlling mpu and are largely independent of any particular devices attached to the mpu bus. The timing emulator in the ATE is used to replace the mpu. It can be synchronized with the UUT clock and itself produces synchronous timing signals to different isolated areas of the bus.

Bus structure allows the functional grouping of sub-circuits into blocks like RAM, ROM and PIO so that the ATE can apply and measure data within each block simultaneously. For stimulation and monitoring to work, the ATE software needs to be able to manipulate data, check it instaneously *and* during a time window and tri-state circuit blocks and components — all in real-time.

Bus timing emulation may be combined with static (step-time) testing of read, write, buffer and control functions and with signature analysis of the UUT with the mpu installed. In this way, static faults, component dynamic faults and microprocessor faults can all be detected — the main drawback being the need to remove or tri-state mpus.

Memory emulation eliminates the need for processor removal. The technique was developed by Genrad Inc. and approaches the problem of dynamic real-time testing from the other end. The UUT processor is clipped with a header, allowing it to remain resident while being controlled by the ATE.

The ATE can selectively overdrive test signals and force a processor to redirect its activity from memory resident on the UUT to ATE-supplied memory, thus creating a memory overlay. On reset, the micro will go through its reset routine. Where an OPCODE FETCH is generated (as with the Z80 and 8085), the program counter is reset to 0000h — where the first instruction following reset will be stored. Other micros (such as the 6800 and 6502) load the contents of FFFEh and FFFFh into the program counter as the vector address of the reset routine.

If the mpu control signals (ALE on the 8085, VMA on the 6800 or MREQ on the Z80, for example) have been overdriven by the ATE, the micro will — after reset — address ATE memory as though it was its own. This stage is known as 'capture mode' and the UUT memory is masked from the mpu.

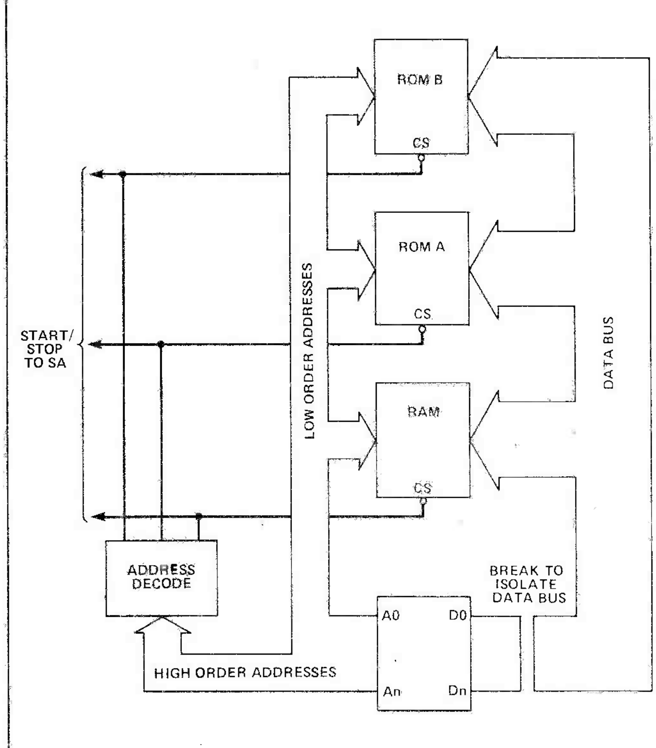

Fig. 23 Bus structured circuit.

In the next stage of the process, the UUT can be tested by using 'target routines' stored in ATE memory. These are of two main types: the diagnostic test routine (DTR) and the idle routine. Tester memory is partitioned into segments which can be placed anywhere in the UUT processor address map, so that the mpu may still have access to parts of its memory or to talkable devices on the bus. DTRs are used to test functional blocks of the UUT, while an idle routine keeps the micro in a known condition under tester control during changeover from one to another test procedure.

In this way, the micro retains access to the system as a whole, while allowing selective real-time testing at full system speed. Stimulus and test measurements can be synchronized and the whole process closely duplicates the actual performance of the UUT, allowing the detection of interactive and component dynamic faults which might otherwise be hidden from a test procedure. **ETI**

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1985 PROJECT/ FEATURE INDEX

Listed below are all the major articles we have published in the last 12 months, including those appearing in this issue. We have not listed regular features such as News Digest, Read/Write and the various columns in the Etcetera section but we have included Tech Tips and Reviews and put each of them under separate headings. These sections are quite short so we have not bothered to cross-reference any of the entries, but articles under the main Projects and Features headings are listed twice or even three times in some cases to make them as easy to find as possible. We have also listed corrections to projects where necessary.

FEATURES

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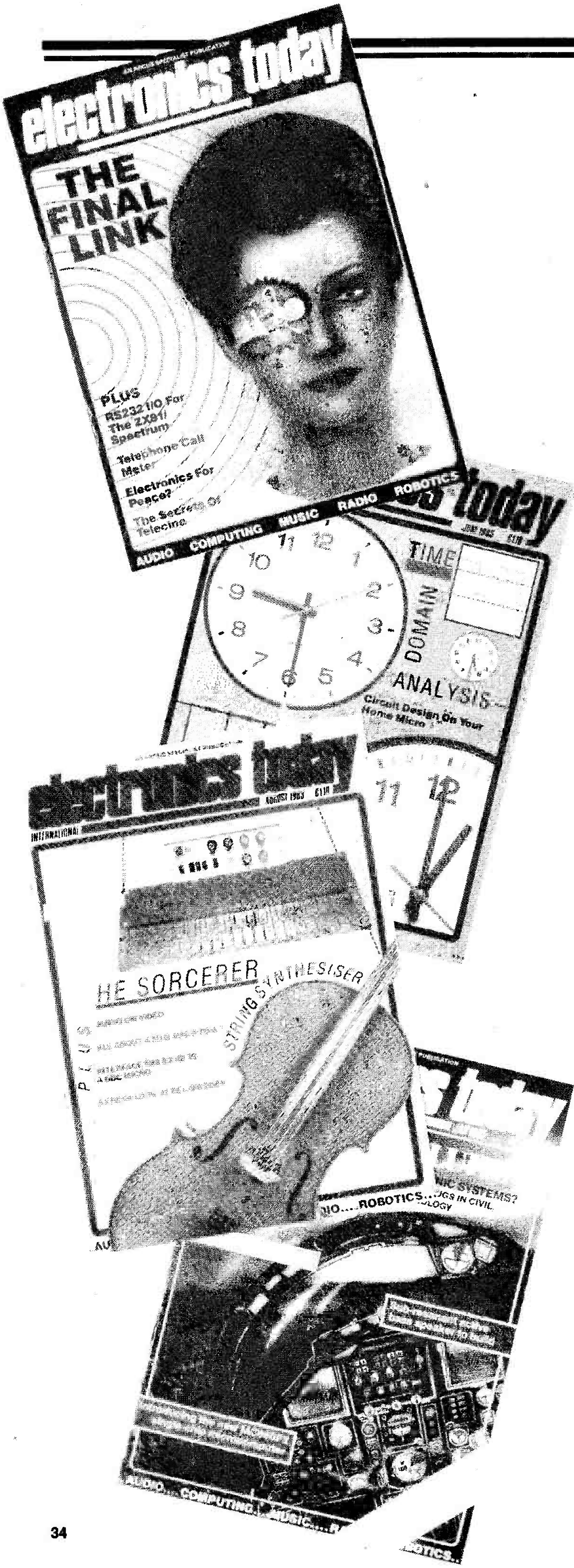

Article	Part	Month	Page
Crescendo Alarm		Feb	28
FET Grid Dip Oscillator		May	54
Frequency Fine Tuning For ETI Distortion Meter		Jul	52
Low Cost Z80 DRAM Drive And Refresh		Mar	54
Mr Discrete's Car Alarm		Aug	55
Multi-Input ExOR Gates		Feb	28
Novel Input Stage And Gain control		Oct	53
	Errata	Dec	55
PA Tone Control		Dec	54
Pick-up Preamplifier		Mar	54
Pulse Group Generator		Jul	52
Push-button Operated changeover		May	55
Regulator for DC Generators		Mar	55
Sensitive continuity Tester		Sep	61
Simple CMOS Frequency-Window Discriminator		Jul	53
Slot Car Brake Lights		Jun	53
TV Sync Generator		Mar	55
Two Utilities For ETI Spectrum Centronics Interface		Aug	54
Walking Ring Sequencer		May	54

[redacted]

PROJECTS

Active Bass Loudspeaker		Jan	15
Alarm, household (The Second Line Of Defence)	part 1	Sep	36
	part 2	Nov	60
Audio mixer, low cost		Jun	38
	Errata	Aug	62
BBC 'B' typewriter interface		Aug	41
Buzby Meter		Apr	34
Capacitance meter, large value (Millifaradometer)		Nov	44
CCD delay line effects board (ETI Sonneti)		Apr	57
Chorus Unit		Nov	48
	Errata	Dec	55
Combo unit (ETI Sonneti)		Mar	22
	Errata	Jun	51
Component measuring bridge		Aug	30
Compression Gate		Dec	46
Cortex PIO		Sep	53
Cymbal Synthesiser		Nov	58
Data Logger		Feb	45
Digital Delay Line	part 2	Jan	62
	Errata	Jun	51
Digital Delay Line Expansion		Feb	24
Digital Sound Sampler	part 1	Oct	27
	part 2	Nov	63
Digital Framestore	part 2	Jan	44
	part 3	Feb	55
	part 4	Mar	59
	part 5	Apr	48
Direct Injection Box		Sep	43
Distortion Meter	part 1	Jan	55
	part 2	Feb	37
	part 3	Mar	43
DRAM Card Update		Jan	28
Drum Sequencer for the Spectrum (SpecDrum)		Dec	41
Effects board, CCD delay line (Sonneti)		Apr	57
Electron Second Processor	part 1	Jun	32
	part 2	Jul	43

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[redacted]

REVIEWS

[redacted]

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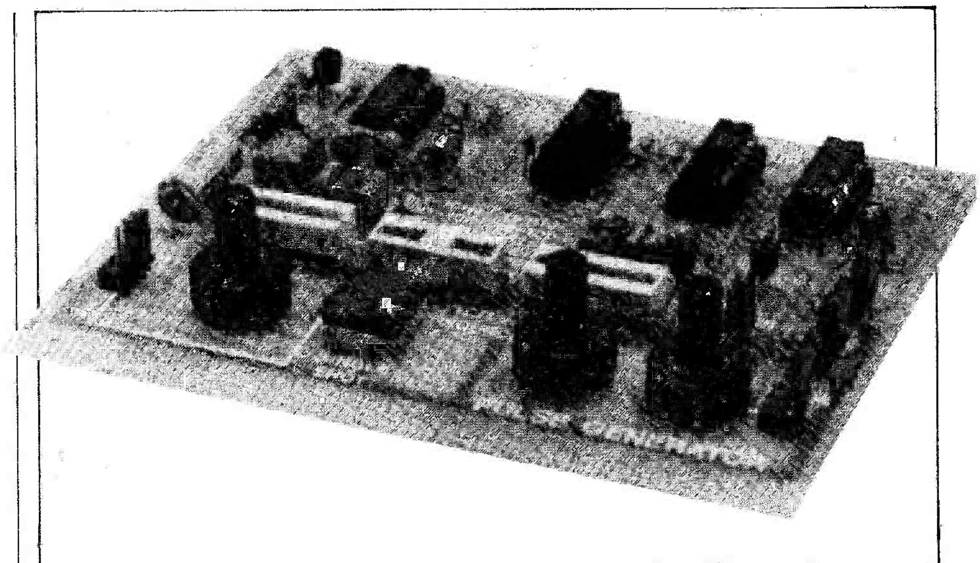
PULSE GENERATOR

Mike Meakin describes another of his low-cost test equipment modules, a versatile pulse generator board.



This instrument has been designed as one of a series of test gear modules and complements the power supply which was presented in our October issue and the waveform generator which appeared in the November issue. Each module is assembled entirely on one PCB, complete with all switches, potentiometers, sockets, and so on. This removes the need for cases and other hardware and so reduces the cost.

Further expense is avoided by using the power supply module to provide the operating voltages for the other modules, thus eliminating the duplication involved in providing separate power supplies. Ideally, therefore, the power supply module should be built and used to drive the pulse generator, but in practice there is no reason why another supply should not be used if you don't need all the facilities of the main PSU module.

The pulse generator provides output pulses with widths variable from 1us to 1s at repetition rates from 1Hz to 1MHz. CMOS, TTL and open collector outputs are provided together with a sync output. The internal clock can be switched out when not required and the generator can then be driven from an external clock or operated in single shot mode. The design is inevitably a compromise between complexity and cost but it is felt that most of the facilities the average hobbyist is likely to require are provided.

The heart of any pulse generator is the monostable timing circuit, and a large number of IC devices are available to provide this function. However, obtaining a very wide timing range with sensible values of R and C limits the field.

The 555 timer would seem well suited to this application but the practical minimum pulse width obtainable from this device is about 10us. The 74121 series of TTL monostables require large values of timing capacitors and behave erratically at high duty cycles. The 74C221 chosen for this circuit is a CMOS device with a performance which is superior to that of both the 4528 and 4538 monostables from the 400 series. A six decade timing range can be achieved with changes of capacitance only and it behaves well at high duty cycles.

Three outputs are available on the board. The TTL output is provided by five inverters in parallel and is capable of driving ten standard TTL loads. The input is driven from a 15V CMOS output but protection is given by an internal diode. A Schottky device must be used in this position. The 0 to 15V variable output is obtained from five paralleled CMOS buffers and a potential divider, giving a maximum source impedance of about 300R. Some protection is provided by the 47R series resistor. Finally a VMOS transistor provides an 'open collector' or more correctly an open drain output. This sturdy device can sink up to 500mA and withstand 60V. It is ideal for use as a relay or LED driver.

Construction

Because the switches and potentiometers are all mounted directly onto the PCB, any labelling of functions and switch positions will also have to be done on the board itself. Various methods of doing this were described in the Waveform Generator article in last month's issue and will not be repeated here. However, if you want a particularly neat end result you will have to either screen print the board or use rub-down lettering, and both of these processes must be undertaken before any other constructional work on the board is started.

Installation of the components should begin with the wire links and progress in the normal fashion through hardware devices (switches, sockets, etc), passive

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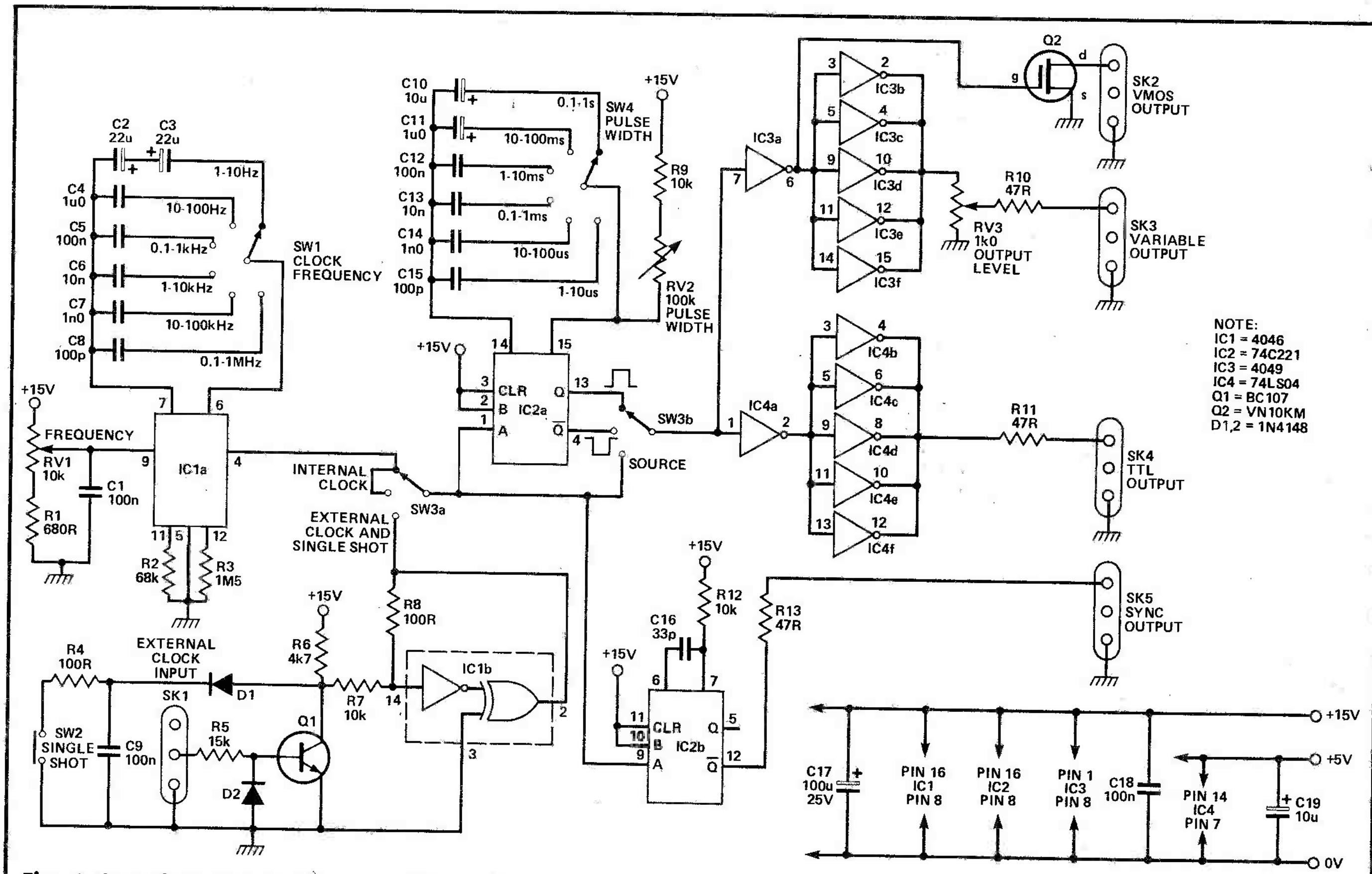

Fig. 1 Complete circuit diagram of the pulse generator. The board is intended for use with our earlier power supply module so no PSU circuitry is shown here.

HOW IT WORKS

The VCO section of a 4046 phase lock loop IC is used as a clock. This circuit gives a 50% duty cycle square wave output at pin 4 of IC1. The six decade timing capacitors are selected by SW1. For the lowest frequency range two 22u tantalum capacitors are connected back to back to give a non-polarized capacitor whose value should ideally be 10u. The timing resistors R2 and R3 in conjunction with the voltage obtained from RV1 set a 1:10 frequency range.

SW3A selects either the VCO output or the external and single shot inputs. The section of the 4046 normally used as a phase comparator is connected as a Schmitt trigger to clean up the input pulses. These are obtained from an external clock via a transistor buffer whose input is protected by a series current limit resistor R5 and reverse polarity protection diode D2. The external clock input will operate either from a pulse source or an AC signal as long as it crosses the 0.6V turn-on potential of the transistor. The single shot or manual pulse is obtained by shorting the Schmitt trigger input to 0V with SW2. It is de-bounced by the R6, C9 time constant.

Half of the 74C221 is connected as a negative-edge non-retriggerable monostable. SW4 selects the timing capacitor and RV2, R9 alter the time period over a 1:10 range. The input pulse also triggers the other half of IC2 to give a negative going sync pulse of about 500ns at SK5. This is coincident with the leading edge of the output pulse and can be used to trigger an oscilloscope. SW3B directs either a positive going pulse, a negative going pulse or the source signal to the output stage. The VCO square wave signal, the external clock or manual pulses can thus be sent directly to the output.

BUYLINES

The fixed resistors, the capacitors and the semiconductors are all widely available with the possible exception of the 74C221 which can be obtained from Cricklewood. The only supplier we know of for the carbon track presets is RS Components who will only accept orders from trade and professional customers. However, Crewe Allen & Co of 51 Scrutton Street, London EC2 will obtain parts from them on pyament of a small handling charge. The stock numbers are 184-350 for the 10k preset, 184-388 for the 100k preset and 184-322 for the 1k0 preset.

The DIL switches used on the prototype were an ERG DS16D 1-6 for SW1 and SW4 and an ERG DS16D 1-3+1-3 for SW3. ERG will not handle small orders but electronics clubs, schools and others prepared to order reasonable quantities could try contacting them at Luton Road, Dunstable, Bedfordshire LU5 4LJ, tel 0582 - 62241. Unfortunately, we do not know of anybody who stocks similar switches or will supply the ERG switches in small quantities. The board has been laid out to accept eight position switches as well as six position ones and this would permit an RS stock number 337-532 DIL switch to be used in the SW1 and SW4 positions. The extra switch positions would simply be ignored in use. RS do stock a two-pole DIL switch but the sections are ganged, making it unsuitable for use as SW3. A standard eight way DIL switch could be used but the operator would always have to make sure that only one switch in each group of four was selected at any one time. The only other alternative we can think of is to use standard rotary or slide switches and glue or bolt them to the board.

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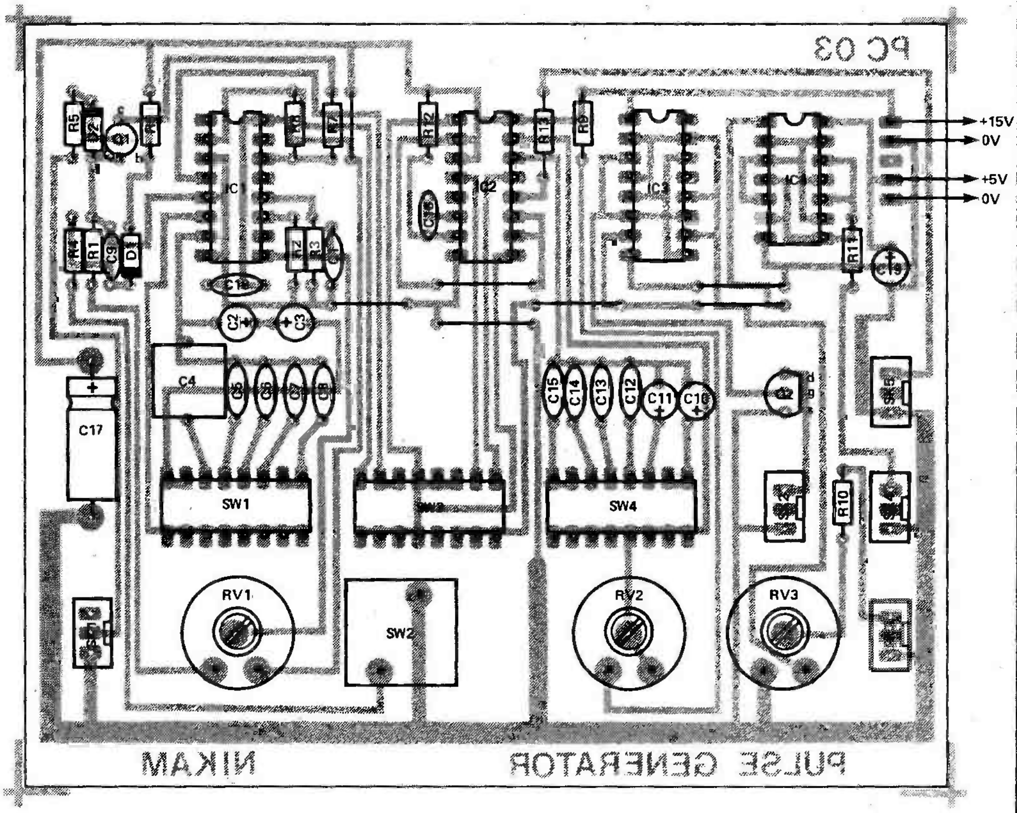
Fig. 2 The component overlay for the pulse generator PCB.



PARTS LIST

RESISTORS	
R1	680R
R2	68k
R3	1M5
R4	100R
R5	15k
R6	4k7
R7, 9, 12	10k
R8	100k
R10, 11, 13	47R
RV1	10k carbon track preset with integral knob
RV2	100k carbon track preset with integral knob
RV3	1k0 carbon track preset with integral knob

CAPACITORS	
C1, 5, 9, 12, 18	100n polyester
C2, 3	22u 16V tantalum
C4	1u0 polyester
C6, 13	10n polyester
C7, 14	1n0 polyester
C8, 15	100p polystryene
C10, 19	10u 16V tantalum
C11	1u0 35V tantalum
C16	33p ceramic plate
C17	100u 25V axial electrolytic

SEMICONDUCTORS	
IC1	4046
IC2	74C221
IC3	4049
IC4	74LS04
Q1	BC107
Q2	VN10KM
D1, 2	1N4148

MISCELLANEOUS	
SK1-5	3-way Molex PCB plug with polarising post
SW1, 4	1-pole 6-way DIL slide switch
SW2	PCB mounting keyboard switch
SW3	2-pole 3-way DIL slide switch

PCB; IC sockets if desired, 3 off 16 pin and 1 off 14 pin DIL.

components (resistors and capacitors) and finally the active components (the ICs, transistors and diodes). Take care that tantalum and electrolytic capacitors and the various active components are all inserted into the board the right way around. It is best to use sockets for the ICs but there is no reason why they should not be soldered directly into the board if you prefer and are careful. Since the DIL switches may suffer slight movement when operated, it is best to avoid sockets and solder them directly into place.

When the board is complete, connect up the +5V and +15V rails from the power supply module or from another regulated power supply. The current drawn from the main supply rail, the +15V one, will be about 25mA. Set SW3a to internal clock, the frequency control potentiometer to mid position and the frequency range to 0.1–1kHz. Select source and then apply power to the board.

Both the variable and the TTL outputs can be monitored either with an audio amplifier or a piezo sounder. The positive and negative going pulses should be checked with the width switch set to 0.1–1ms to confirm that the monostable is operating. Finally, a LED in series with a 1k0 resistor should be connected between the VMOS output and the plus 15V supply, observing the correct polarity of the LED. Select negative going output pulse, external clock and pulse width range 0.1–1s. If the single shot switch is pressed the LED should momentarily illuminate. Those who have access to a scope can of course test the board more comprehensively.

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6116 150ns	1.99	1.80	1.65
6264 150ns Low Power	5.00	4.45	4.00
2716 450ns 5 volt	3.85	3.45	3.30
2732 450ns Intel type	4.75	4.25	4.10
2764 300ns Suit BBC	2.95	2.65	2.50
27128 300ns Suit BBC	3.95	3.55	3.35
27256 250ns	7.55	6.95	6.50

Low profile IC sockets: Pins	8	14	16	18	20	24	28	40
Pence	12	13	14	16	18	24	27	38

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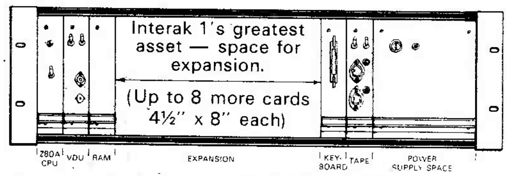

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SPECDRUM DRUM SEQUENCER

Use a Spectrum to control your kit of drum synths — it's the only way to beat time, courtesy of Digisound.

The Specdrum drum sequencing package is a cost-effective and highly flexible method of generating rhythmic structures using a Spectrum or Spectrum + computer, a simple interface and cassette software running to about 15K of machine code. An external clock input is provided to allow synchronisation with tape machines or other devices and the hardware can also be used as a conventional joystick interface when not running the Specdrum software. It uses the Spectrum PSU and is compatible with Interface 1, microdrives and Sinclair-type printers.

The software incorporates a pattern editor (16 patterns of up to 32 events each), a chain editor (eight chains of up to eight patterns each), a sequence editor (eight sequences of up to 12 chains each with or without repeats) and a track editor (two tracks of 24 combined sequences, chains, patterns and repeats). There is real-time pattern modification and the facility for interfacing microdrives and tape. The external sync operates on a 10V p-p max. level. The interface allows around 60 events per second to be programmed and can store more than 70,000 events per track.

The events are trigger pulses intended to be sent to drum synthesizers under the control of the sequencer. There are four accented triggers and two unaccented triggers. Accenting affects the quality of the output of most drum synths. Data lines D0-D3 produce trigger pulses whose level (from 0V to 5V) can be controlled by four individual pots. All these pulses may be simultaneously accented by means of data line D6 — an accent effectively overriding the potentiometer setting and producing a 5V pulse at the output whenever it occurs (Fig. 1). Data lines D4 and D5 generate unaccented triggers called O and X, respectively. The O trigger consists of an uninterrupted output at either +5V or −5V (hardware selectable) between two or more consecutive events. This allows the unit to provide open/closed hi-hat control — an inverted, −5V, pulse being necessary to the hi-hat facility offered by the Digisound 'El-Cymb' unit (one of a series of Digisound Digi-Drum units which

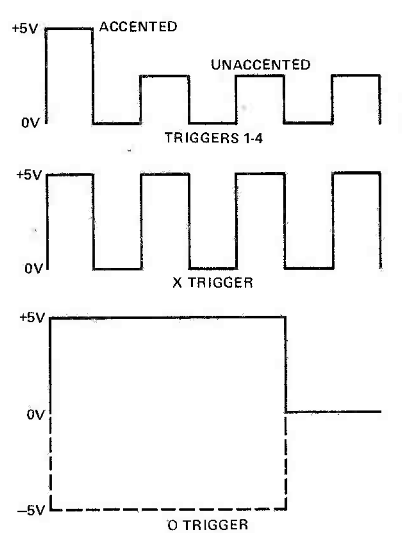
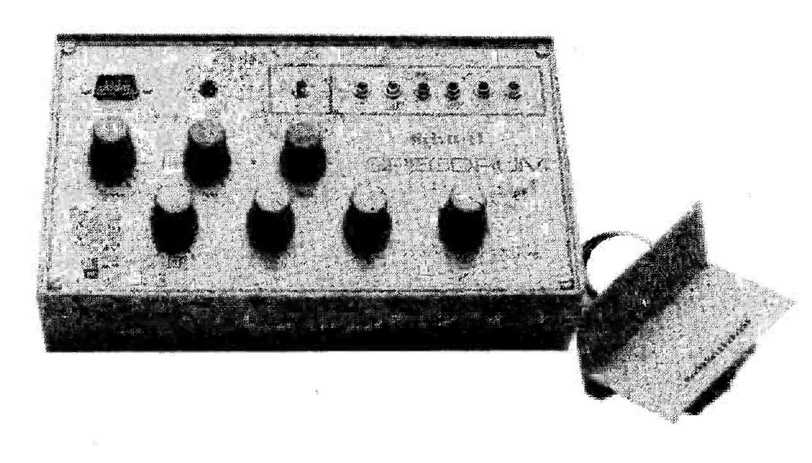


Fig. 1 Specdrum trigger pulses.



The completed unit

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HOW IT WORKS

The complete circuit diagram for the interface is shown in Fig. 2. It may be divided up into a number of circuit blocks: address decoding; trigger generation and accenting; joystick interface; and a master clock.

Memory address decoding is performed by IC4 and IC5a, d, e and f, which generate two hardware control signals, WRSEL and RDSEl. The decoding checks for A5, so that the hardware appears at addresses 1F, 5F, 9F and DF (hex). This simplified I/O decoding is quite adequate in this application and does not conflict with other Sinclair hardware. In fact, the software is designed to make full use of microdrives if they are available.

The decoded $\overline{\text{RDSEL}}$ signal directly controls the two enable pins of an octal buffer (IC2), which is responsible for reading in the appropriate switch status from a standard Kempston joystick. With a logic 0 on the enable pins, the joystick position is passed to D_0-D_5 of the data bus. Data bit D_7 is used to transfer the hardware clock which is responsible for timing duties, synchronization of the display and memory latching. This clock is built around IC6, a 555 configured for astable operation. Potentiometers RV5 RV6 provide, respectively, fine and coarse speed/tempo control. The output of the 555 is taken to the break connection of jack socket J1. This allows an external clock to be used for synchronization. Any incoming clock signal is cut down by the resistor/zener diode network connected to the J1 'make' connection. The +5V signal is buffered and inverted by IC5b and reinverted to generate CLK and $\overline{\text{CLK}}$ signals, switchable at S1. This feature is included so that clock signals with extreme duty cycles may still be used. With such signals, inversion may be necessary to allow the software enough time to carry out the display routines. When there is insufficient time for the software, the display is drawn in stages. The third position of S1 grounds the clock, so that the hardware may be used as a conventional joystick interface. If this was not done, games software might mistake the ungrounded incoming clock signal for the fire button! The normal address location of joysticks in games software is 1Fh, making them compatible with this unit.

The remaining hardware is concerned with generating the six trigger pulses. With a logic 1 on WRSEL, IC1 (an octal D-type latch) is enabled and data lines D_0-D_6 pass valid trigger information to the rest of the cirlcuitry. D_0-D_3 are the four channel triggers to which an accent control may be added. This information is generated by D_6, and accents all triggers simultaneoously by ANDing the accent pulse with the outputs on D_0-D_3. It is possible to individually regulate the level from 0 to 5V on each trigger by means of pententionmeters RV1–4, which control the amount of feedback from the output to the indidivual channel inputs. The presence of an accent pulse takes all levels to 5V. The trigger outputs are taken off the potentiometer wipers and each is buffered by one of IC8's four op-amps.

The O and X triggers are treated in a different manner in software and are not provided with an accenting facility. The X trigger on D5 is treated like a fully accented trigger, providing a positive-going 5V pulse which returns to 0V between two adjacent events. The O trigger on D4 is used to generate an uninterrupted output bet-

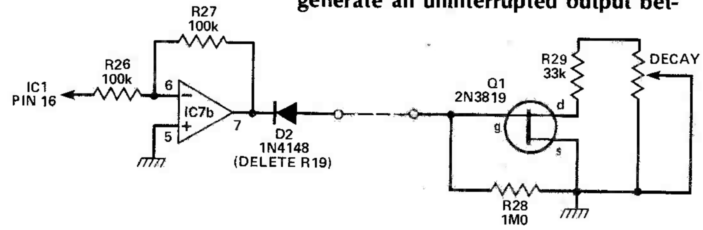

Fig. 2a Modification for use with El-cymb or other negative trigger device

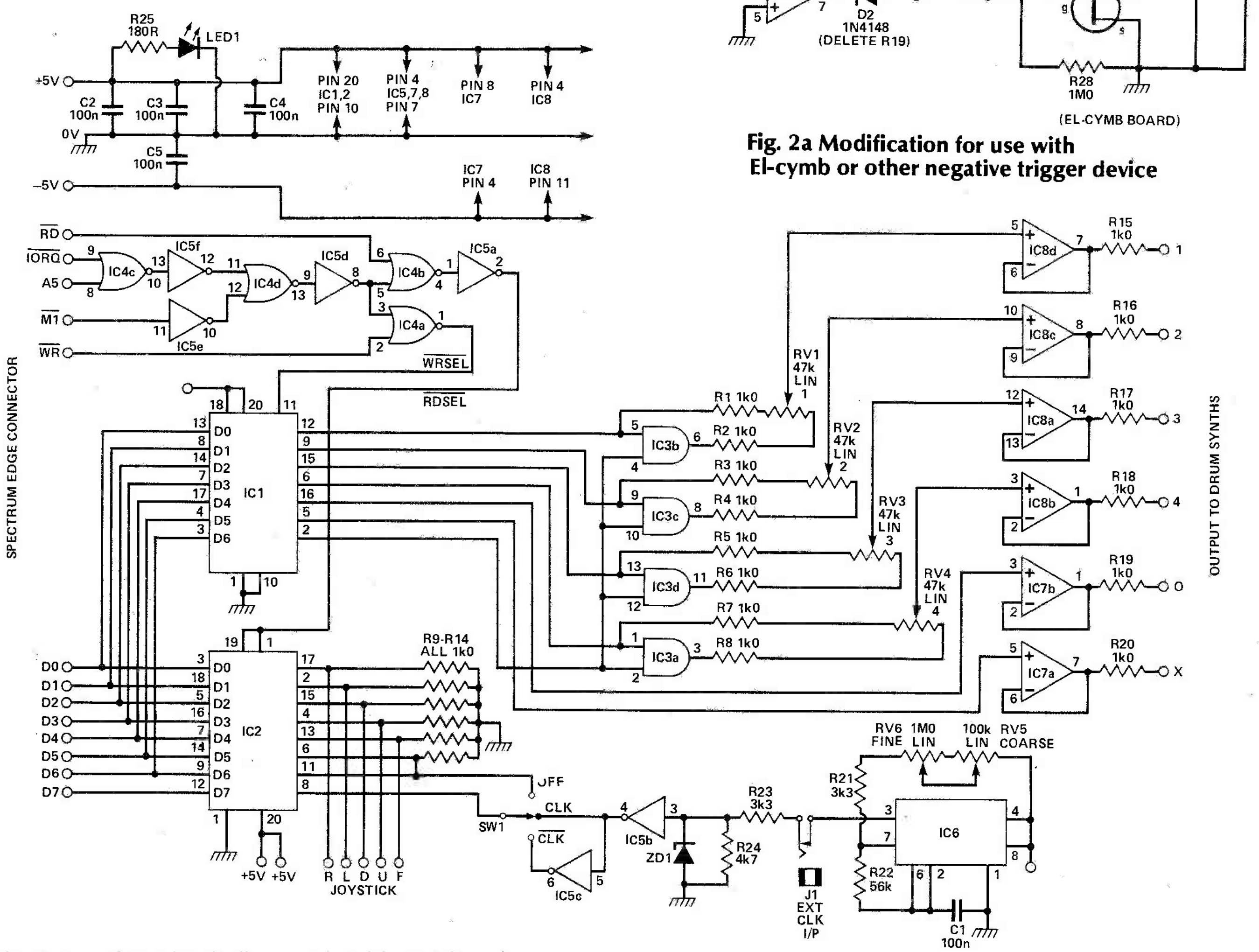

Fig. 2 Complete circuit diagram (positive 0 trigger)

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ween two or more consecutive events. The O and X signals pass directly to output buffers configured around the two halves of IC 7. The O trigger buffer may be arranged to invert the incoming 0 to +5V pulse, generating a 0 to −5V signal. A negative voltage can be used to open and close the signal path between the drain and source pins of a 2N 3819 FET in order to control certain units, like the El-Cymb. R29, the resistor between the drain pin and the decay pot, is responsible for setting the difference in decay characteristics and may be altered. The modification for the El-Cymb is shown in Fig. 2a. The diode that replaces R19 is included to block any positive voltages which if they occurred would probably result in the destruction of the FET.

The unit is powered by +/5V from the Spectrum PSU and draws around 80mA on the positive rail. The Spectrum can withstand this for long periods of time even with Interface 2 and microdrives attached. Capacitors C2–C5 are for decoupling purposes and LED1 provides a power-on indication.

PARTS LIST

RESISTORS (5%, ¼W carbon film)

R1-20	1k0
R21, 23	3k3
R22	56k
R24	4k7
R25	180R
R26, 27	100k
RV1-4	47k lin.
RV5	100k lin
RV6	1M0

CAPACITORS

C1-5	100n polyester

SEMICONDUCTORS

IC1	74LS373
IC2	74LS244
IC3	74LS08
IC4	74LS02
IC5	74LS04
IC6	NE 555
IC7	MC 1458
IC8	LM 348
D1	5mm Red LED
D2	1N 4148
ZD1	5V6 400mW zener

MISCELLANEOUS

J1-7 3.5mm mono jack sockets, 9-way D-Plug, Spectrum edge connector, 8-way Molex sets (2 off), 16-way ribbon cable (1m), case with printed and punched panel, K9 control knobs and caps (7 off), SW1 1 pole, 3-way rotary switch, PCBs.

BUYLINES

The complete kit of parts, including software but excludng ordinary wire and solder, is available from Digisound Ltd., 14-16 Queen St., Blackpool, Lancs. FY1 1PQ. The cost is £43.47 inclusive of p&p and VAT. Digisound are also making available a set of PCBs and the software on cassette for £18.40 inclusive.

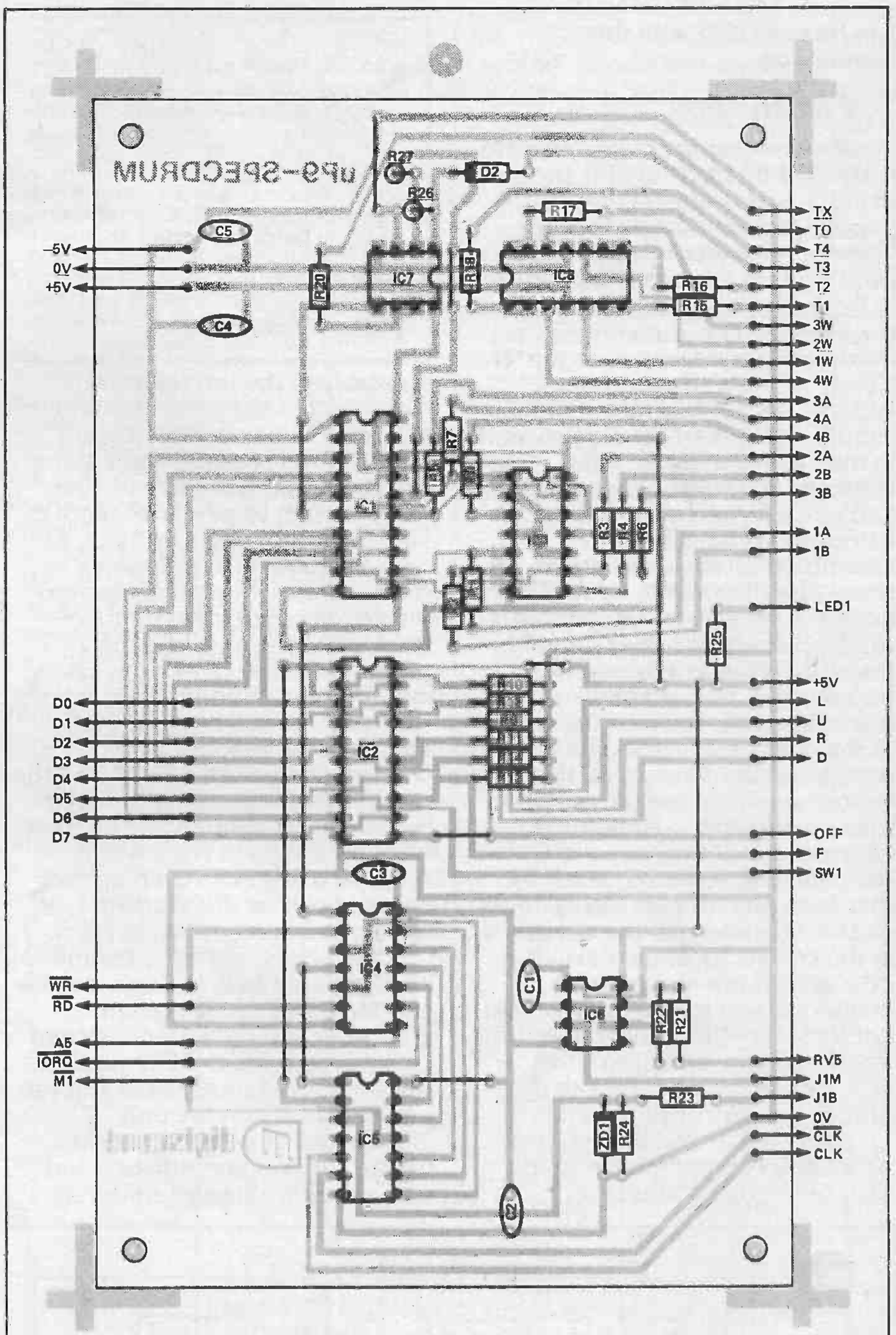

Fig. 3 Component overlay for main board.

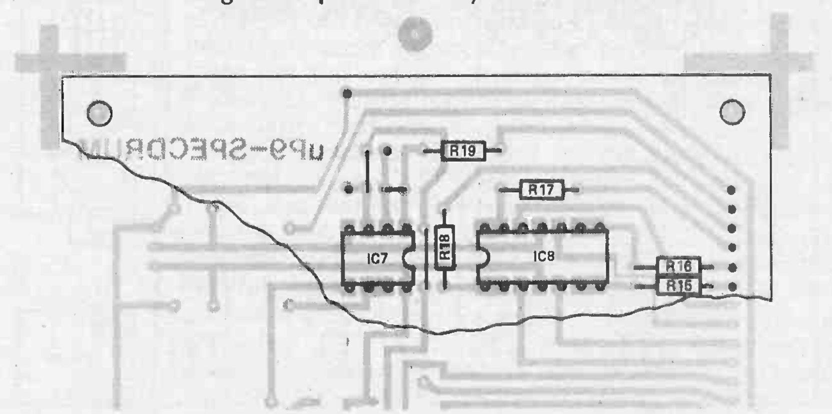

Fig. 4 Changes to overlay for positive 0 trigger generation.

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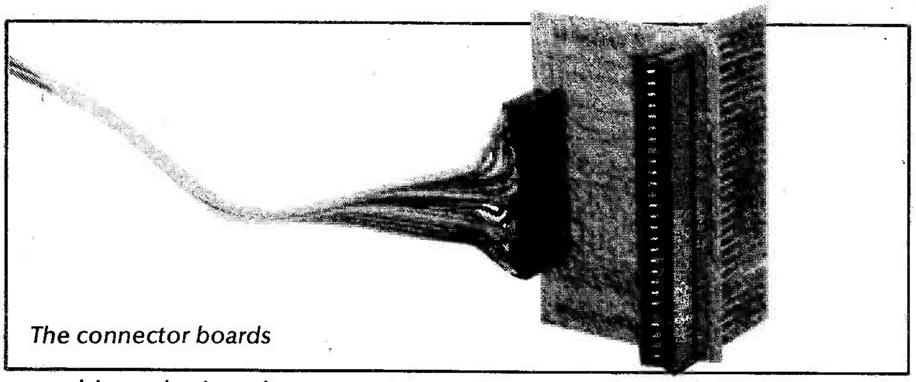
can be operated with this sequencer).

Construction

The component overlay for the main PCB (marked uP9) is shown in Fig. 3 — this arrangement generates an inverted O trigger. The changes needed to generate a positive O trigger are shown in Fig. 4, Figure 2a shows the circuit of the inverted O outut and the modifications necessary to the 'El-Cymb' module to produce a variable decay. Assembly is a fairly simple matter and should proceed in the normal manner: links, resistors, IC sockets, capacitors and so on. When all of the components have been assembled on the main board, it should be thoroughly treated with a solvent cleaner and inspected for dry joints and solder bridges. Insert the 28-way edge connector into the PCB marked uP8 and with the PCB evenly towards the body of the connector solder the two parts together. Then bend the exposed ends of the pins so that they meet evently. Slide the edge connector PCB (marked uP2) between the two rows, ensuring that each pin lines up with a finger on this PCB and that the cut-out is in the correct location. Push the PCB against the rear of the connector and solder in place. Do not let solder flow closer than 1cm from the exposed edge of this PCB, or it may interfere with the proper location of peripherals.

Using the available case and panel, the connections from the Spectrum edge connector



The connector boards

assembly to the interface are hardwired to the main PCB and made via Molex connectors on uP8. This necessitates the cutting of a small slot in the plastic case wide enough to pass the length of 16-way ribbon cable through. Be sure not to reverse the Molex connections when plugging onto the edge connector assembly — the easiest way to avoid this is probably to find (and if necessary mark) the earth connection on uP8 (two pads joined near the slot). Then, ensure that this is connected to earth on uP9 and the rest of the connections will follow in the correct sequence. The panel wiring is shown in Fig. 5 and is simply a matter of matching the connections on this diagram with the connections shown in Fig. 3.

Once construction is complete and fully checked, the unit may be connected to the Spectrum computer and the latter switched on. At switch-on, the TV/monitor display should be as usual and the power-on LED on the unit illuminated. If anything seems wrong, turn off immediately and recheck all wiring and soldering until the error is located.

In Use

The users' manual which accompanies this package provides comprehensive information on how to use it. The unit will function with most analogue or digital percussion sound generators currently available. The sound generators may be connected to the triggers in any desired manner, bearing in mind the open/closed hi-hat function. As an example of the system's flexibility, it is possible to trigger two drum modules from a single output, adjusting the dynamic sensitivity of the modules so that one is triggered by an unaccented (low level) trigger and both by an accented (high level) trigger.

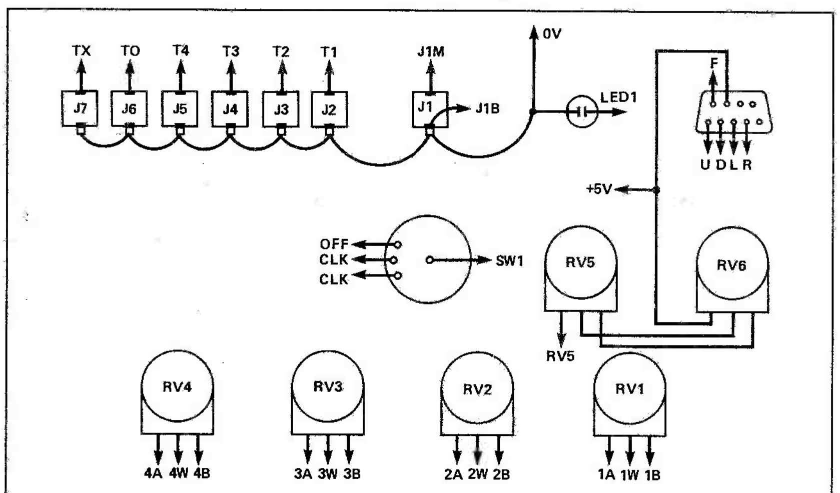


Fig. 5 Panel wiring diagram.

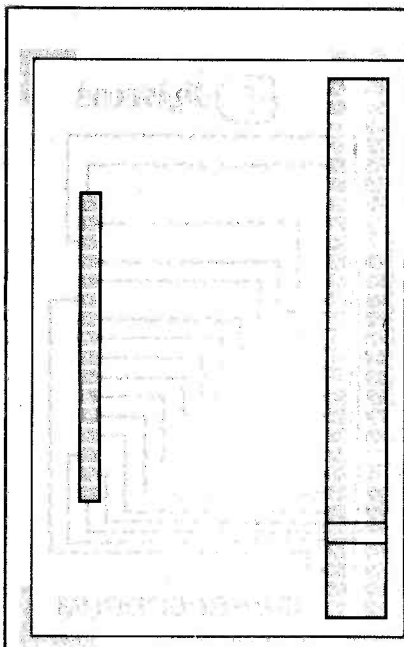


Fig. 6 Overlay of connector board.

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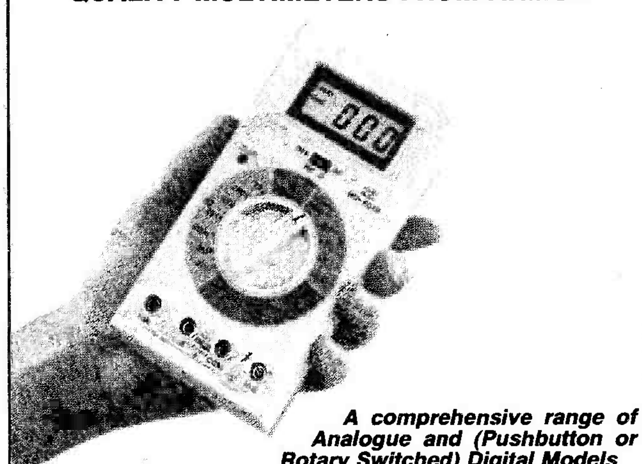

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DI COMPRESSION GATE

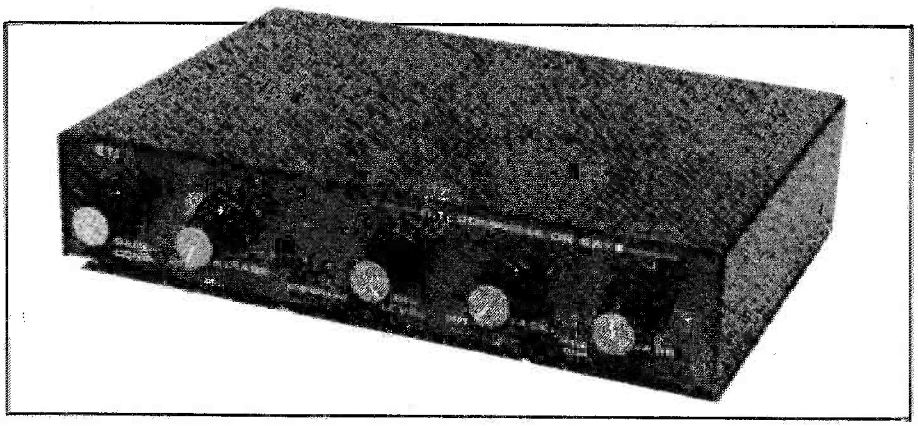
The first ETI Sound Processor is a unit combining compressor, noise gate and direct inject box, designed by Allan Bradford of Time Machine Sound Engineering.

The combination of compressor and noise gate is a useful one. The 'pumping' noise associated with high levels of compression can be eliminated by the gate, while the 'topping and tailing' facility afforded by the compressor makes the gate an excellent feedback-killer for PA systems. Comprehensive envelope shaping of sounds for special effects is also possible.

The compressor has a wide range exponential control characteristic which produces a smooth response in the management of 'peaky' signals, with full control over release or recovery time. Attack time is preset for general use, but a front panel screwdriver adjustment enables it to be slowed to allow 'punch-through' effects. Subsequent stages in the audio chain are still protected from overload by an independent fast limiter riding 12 dB above the compression threshold. Gain reduction and limiting are displayed on four LEDs.

The Noise Gate has an attack fast enough for drum kits (but can be slowed right down for 'violating' sounds) and release time is fully variable to suit the program material. An internal time constant eliminates modulation of the signal due to individual waveforms when short release times are employed. The depth of noise-gating is preset at −60 dB but again a front panel screwdriver adjustment permits this to be softened.

Side-chain inputs are provided both for control of compression (for voice-over effects and 'de-essing' and for triggering the noise gate. Two compression gates can be cross-linked for stereo operation.



Inputs are low impedance microphone level and outputs are line level. Inputs and outputs can be balanced or unbalanced via jack or XLR sockets. The unit uses an external power supply for reasons both of economy and hum prevention. Inputs are also provided for direct injection of instruments and of amplifier loudspeaker outputs. The latter will be of particular interest to guitarists wishing to exploit the sound of valve amplifiers while maintaining complete isolation from other instruments. At 1M0 impedance the DI inputs place negligible load on any instruments plugged into them — particularly important if a guitar is to be plugged into the line input, in order to preserve the natural sustain of the instrument. A parallel line jack is provided in order simultaneously to connect the instrument to a monitor amplifier.

A switch is provided to reduce the overall sensitivity of the unit by 10 dB. With the compressor RELEASE knob pushed in the compression gate is matched to −10 dBm line and mic level signals. With it pulled out the unit is matched to 0 dBm line and mic levels.

Two parallel output jack sockets are provided, allowing simultaneous connection to more than one piece of equipment without the need for splitters. These outputs are line level and are unbalanced. A balanced XLR line level output is also provided.

Cold Compressor

The compressor controls the maximum signal level by reducing gain progressively above a certain fixed level known as the threshold. Most sounds fluctuate in amplitude and the effect of compression is to reduce the size of signal peaks and to boost average signal level relative to the peaks (Fig. 1). The dynamic range of the signal is therefore reduced, and this can have several important applications.

LIMITING: This means protection from overload by suppression of unacceptable transients. The ATTACK preset is usually set not quite fully anticlockwise (around 1ms) — but for maximum overload protection in critical applications it may be turned fully anticlockwise,

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running the risk of LF distortion. The GAIN/COMP control is advanced so that one or two green LEDs flicker on with the peaks of the music. The RELEASE control should be set about one quarter turn clockwise (about 0.25s). Avoid simultaneous short attack and release times. Release time should be sufficiently long to avoid individual peaks modulating the signal as a whole, with a resultant rasping distortion.

LIFTING VOCALS: Human voices can have a very wide dynamic range and the average level may be substantially below the peak level. By compressing vocals the average level may be boosted so that they become audible in a mix. Compression should be applied to vocals subtly (around 10dB). Too much can make them flat and lifeless.

RECORDING: The human ear can happily accommodate sounds with a dynamic range of 120dB, while the dynamic range of tape recordings is often only 60dB or so. To make maximum use of tape, without quiet sounds being lost in noise and loud sounds saturating the tape and distorting, some compression of signals with a large dynamic range is desirable.

'Thin' or 'peaky' sounding recordings can be salvaged, percussion, for example, often sounding more solid. 'Mix thickening' can be used to increase the average sound level and obtain the sort of impact demanded in modern commercial sound recording. It's used particularly in recording advertising jingles and dico music.

SUSTAIN: The compressor may be used to add artificial sustain to instruments (Fig. 2). The gain is wound right up but the compressor clamps the output signal at compression thresholds. Only when the amplified signal falls below this level of the compression threshold will the signal resume its natural decay. RELEASE should be kept short and the GAIN/COMP control advanced to give the required degree of sustain.

It is also possible to combine sustain with a 'punch-through' attack by allowing the amplified signal to pass unattenuated for a short time before compression takes over. Set the ATTACK preset and RELEASE control to around mid-position. The fast limiter will prevent excessive excursions of the signal but 12dB of punch-through is still available to preserve naturally percussive sounds or add percussion to softer sounds.

Other Features

The four LEDS form a rever... driven bargraph. The right hand LED indicates up to 10 dB of gain reduction. With this LED on and the next LED flickering, gain reduction is in the region of 10 to 20dB. Two green LEDs on and the yellow LED flickering indicate up to 30dB of gain reduction. The leftmost red LED shows that the fast limiter is working, handling transisents too fast to be controlled by the compressor (Fig. 3).

A two-pole jack socket is wired with the tip as a control input and the ring as a signal output for external connections to the compressor. A standard mono jack may be used. The socket may be used either as a control input or as an insert point. A line level signal fed to the EXT COMP socket will cause a reduction in the level of a music signal passing through the

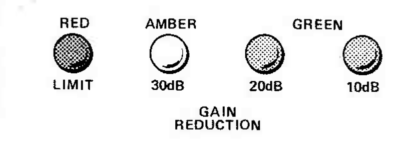

Fig. 3 The compressor LED display.

compression gate ordinarily. This allows voice-overs or 'ducking' effects to be achieved easily — one signal controlling the level of one or more others.

As an insert point, the EXT COMP socket can be used to introduce equalisation into the control path for 'de-essing' and 'de-popping', which are dealt with below.

Noises off

A common hazard of recording and public address work is the inclusion of unwanted sounds in the mix, such as guitar amplifier noise, hum from keyboards, tape hiss, low level RF pick up or 'spillage' of sound from one microphone into other microphones. The problem is aggravated by the high gains associated with large amounts of compression.

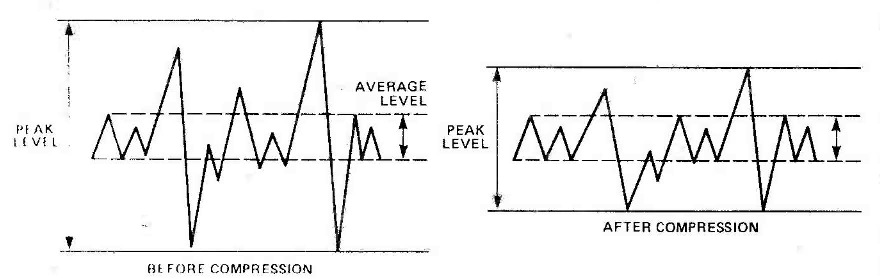

Fig. 1 Average and peak signal levels before and after compression.

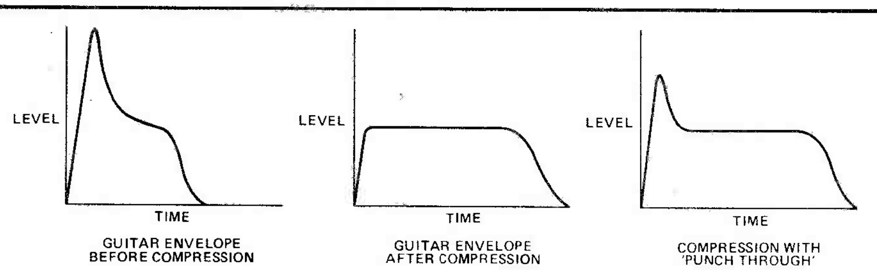

Fig. 2 Using the compressor to add artificial sustain.

BUYLINES

A complete kit of parts including the fully finished steel case and associated hardware is available from TIME MACHINE Sound Engineering for £68.00 including VAT, postage and packing. The double sided, legended PCB is available separately at £9.00 and the case at £14.00. The ready built power supply in a plug costs £24.00. A stereo pair with dual power supply and a cross-linking lead costs £154.00 in kit form. All prices include VAT, postage and packing. Contact:
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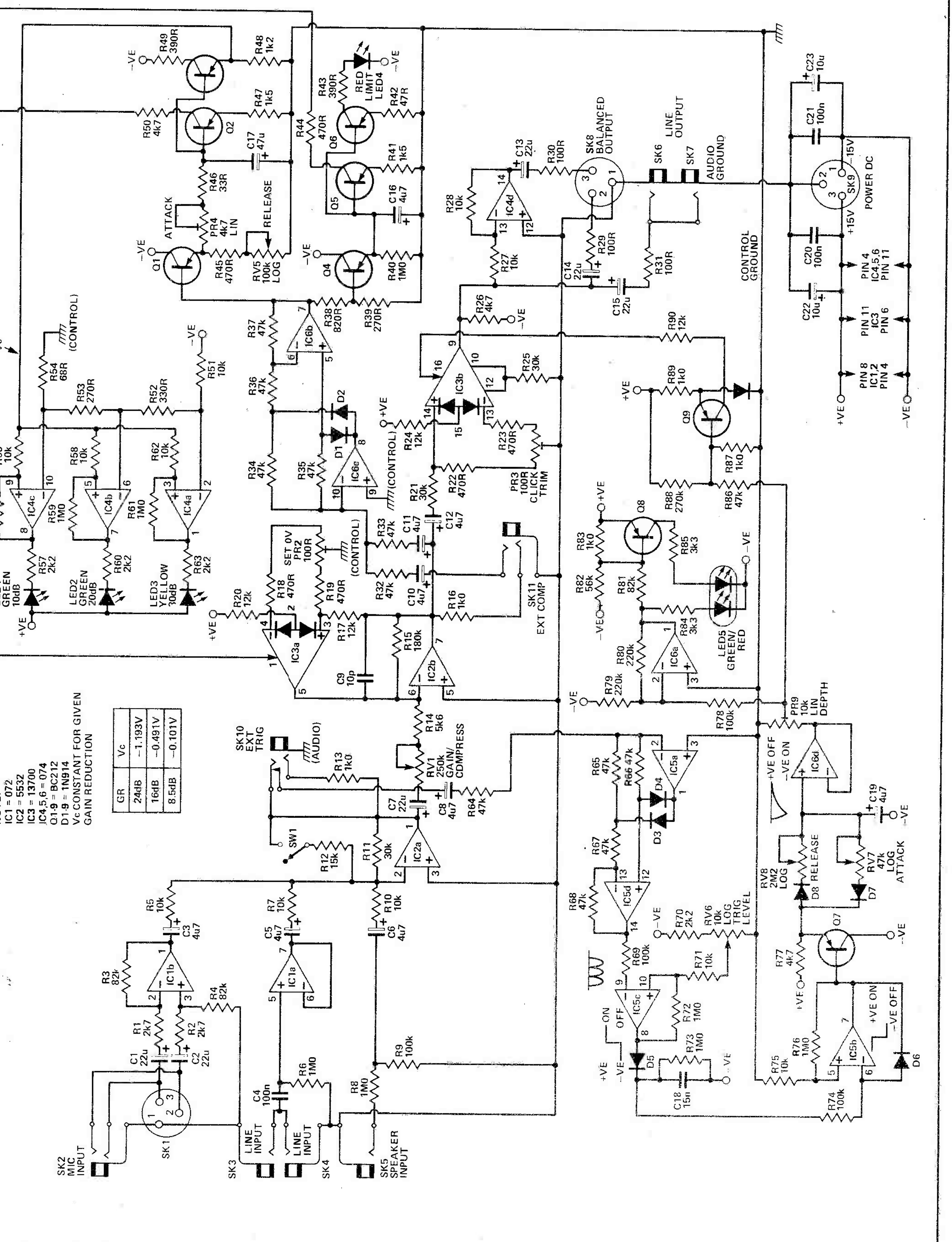

Fig. 4 Complete circuit diagram of the DI compression gate.

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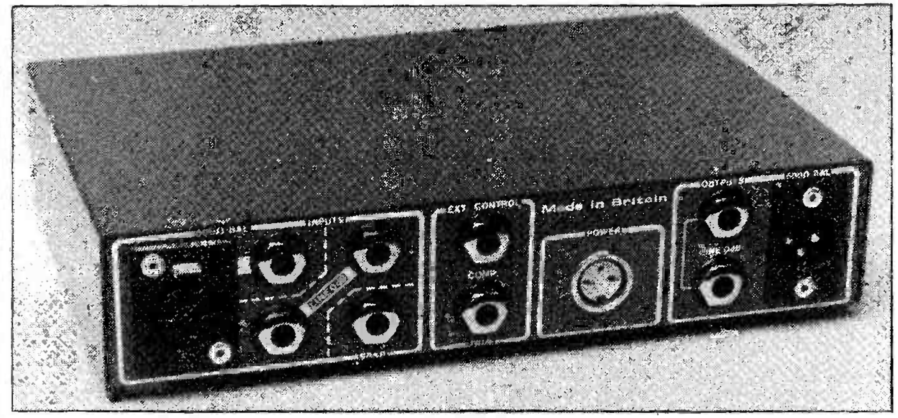

A noise gate discriminates between 'signal' and 'background', shutting down the audio channel in the absence of a useful signal. The level at which the gate opens is set by the Trig Level control. With a useful signal present, turn the control anti-clockwise from fully on until the gate opens. The sound will become audible and the LED indicator will turn from red to green.

The speed with which the gate opens when a signal exceeds the threshold is set by the ATTACK pot. When this is fully anti-clockwise the gate will open within one half-cycle at 10 kHz — fast enough for the sharp transients of drum kits. For vocals, the ATTACK control should be advanced to about one quarter turn clockwise, slowing the attack slightly and avoiding a faint click as the gate opens. The speed with which the gate closes is set by the RELEASE control. This may be set fully anti-clockwise for a sharp cut-off, or advanced clockwise to provide a fade-out which compliments the natural decay of the signal.

Depth is preset to give 60dB attenuation when the gate is closed, but may be adjusted with a screwdriver down to zero.

Softening the attenuation makes the effect of gating more subtle and also allows the noise gate to be used as a 'two-level device' for controlling monitoring levels during recording.

Other Features

A tri-colour LED shows red for closed, green for open and varying shades of amber in between these states. It also responds to the DEPTH preset, turning slowly from amber to green as this preset is turned anti-clockwise.

A two-pole jack socket is wired with the tip as a trigger input and the ring as a signal output for external connections to the noise gate. A standard mono jack plug may be used. This socket can be used as a straightforward trigger input in which an external signal turns on the gate or as an 'insert point' — for example, to introduce equalisation into the control path so that the gate only opens to signals of the desired frequencies. This latter technique will improve the ability of the noise gate to discriminate between wanted and unwanted signals.

A signal passing through the compression gate may have its envelope substantially modified as

HOW IT WORKS

Microphone inputs are debalanced by differential amplifier IC1B which has a gain of 30 dB, while line level signals are buffered by high impedance follower IC1a and loudspeaker level signals are attenuated by 20dB by R8 and R9. The resulting matched signal levels are summed by IC2a, the gain of which is switched between 0 dB and + 10 dB by SW1.

The compressor is centered on IC2b and OTA IC3a which together form a voltage controlled amplifier, the quiescent gain of which is set by RV1. Current flowing into IC3 pin 1 increases the negative feedback around IC2b and so reduces the overall gain of the system. From here the signal passes through the noise gate VCA constructed around the other half of IC3 (unless this is by-passed by SW2) and thence to the outputs, where IC4d provides an antiphase signal for the other half of the balanced output. PR2 and PR3 are used to minimise control breakthrough in the two VCAs.

The signal at the output of the compressor VCA (IC2 pin 7) is full wave rectified by IC6b and c. If this rectified signal is larger than the voltage drops associated with Q1 and Q2 then current flows into the control pin of IC3a to reduce the gain, and it is this voltage drop which constitutes a threshold above which the signal is compressed. The bigger the signal tries to get, the harder Q2 is turned on, the more current flows and the more the gain is reduced. The closed loop system thus formed makes for very stable control of level which is unaffected by temperature. The exponential control characteristic of Q2 means that the compression ratio (change-in-input-dB/change-in-output-dB), nominally 5:1, actually increases with compression giving a very 'musical' operation over a wide 30dB range of compression. The response and recovery times are set by PR4 and RV5. Q3, R48 and R49 generate a control voltage Vc proportional to the control current and therefore to the amount of gain reduction, and this feeds the bargraph driver built around IC4a, b and c.

A second side chain with fixed time constants is built around Q4 and Q5. With its input subject to a 12dB attenuation (R38 and R39) it provides the limiter function and responds very quickly to transients, dumping large currents into IC3a pin 1. Q6 drives LED 4 to indicate operation. SK11 allows external signals to control the compressor, or equalisation to be introduced into the side chain.

The signal from IC2a (prior to the compressor) is full wave rectified by IC5a and d and then compared with a reference voltage set by the TRIG LEVEL pot RV6. If the signal exceeds this level the output of Schmitt trigger IC5c goes high and the output of IC5b goes low. The time constant introduced by D5, C18 and R72 prevents IC5b being toggled by individual cycles of the signal waveform. Q7 is included to increase the current output of IC5b in order to achieve attack times as short as 40µsec. The low leakage capacitor C19 is discharged by the ATTACK pot RV7; once the signal falls below the level set by RV6 and IC5b goes high again, C19 charges back up towards 0V via RELEASE pot RV8 and R77. The resulting envelope, buffered by follower IC6d and at a level set by the DEPTH preset PR9, controls the noise gate VCA IC3b, via current source Q9. IC6a and Q8 drive the green and red halves of the tricolour LED in opposite senses to provide indication of gate status. SK10 allows an external signal to be substituted into the noise gate side chain, or for the internal signal to be looped through an external processor.

By careful attention to maximum signal levels at the input to IC3b as determined by the compression threshold, an optimum trade off between distortion and signal to noise ratio is achieved, as shown in the specification.

Signal grounds and ground lines in which control currents flow are kept separate on the PCB, joining only where the power supply arrives on the board and is decoupled.

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outlined above. The noise gate controls can be used to further modify envelopes. Slowing the gate ATTACK gives a gradual start to sounds while a fast RELEASE gives an abrupt finish to sounds. This latter technique is often used to cut off the 'flap' or reverbera-

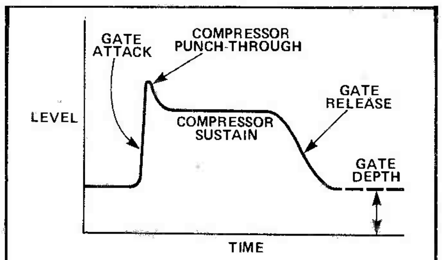

Fig. 5 The parameters defining the shape of the sound envelope.

tion of drums, giving greater impact to the sound.

The parameters available are shown in Fig. 5 and resemble those of ADSR envelope shapers found on sound synthesizers.

Feedback Suppresion

If the overall gain of a PA system exceeds a critical level, the criteria for oscillation are met and

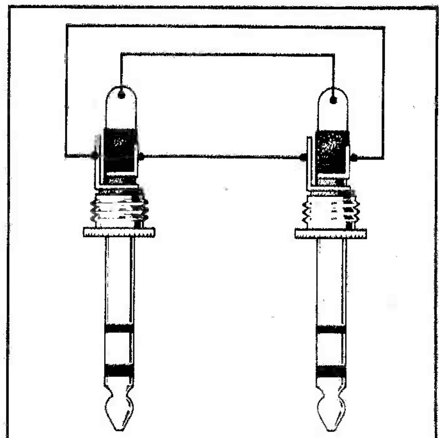

Fig. 6 Wiring of the lead required for stereo operation using two compression gates.

a loud tone is generated. PAs are often used in frequency-selective environments and the feedback generally occurs at a discrete pitch — the resonant frequency at which system gain is highest.

Compression can help by getting rid of large pulses of sound pressure which would shock the system into oscillation. In the absence of a useful signal, however, the gain of a compressor rises and feedback can 'creep up', resulting in howl-round even during periods of apparent silence. The noise gate overcomes this

PARTS LIST

RESISTORS (1% metal oxide)

R1, 2	2k7
R3, 4, 81	82k
R5, 7, 10, 27, 28, 51, 55, 58, 62, 71, 75	10k
R6, 8, 40, 56, 59, 61, 72, 73, 76	1M0
R9, 69, 74, 78	100k
R11, 21, 25	30k
R12	15k
R13, 16, 83, 87, 89	1k0
R14	5k6
R15	180k
R17, 20, 24, 90	12k
R18, 19, 22, 23, 44, 45	470R
R26, 50, 77	4k7
R29, 30, 31	100R
R32, 33, 34, 35, 36, 37, 64, 65, 66, 67, 68, 86	47k
R38	820R
R39	270R
R41, 47	1k5
R42	47R
R43, 49	390R
R46	33R
R48	1k2
R52	330R
R53	270R
R54	68R
R57, 60, 63, 70	2k2
R79, 80	220k
R84, 85	3k3
R88	270k
RV1	250k lin pot
PR2, 3	100R min horiz preset
PR4	4k7 vert cermet preset
RV5	100k log pot with push/pull SPST switch
RV6	10k log pot with DPDT switch
RV7	47k log pot
RV8	2M2 log pot
RV9	10k vert cermet preset

CAPACITORS

C1, 2, 7, 13, 14, 15	22u 16V minelect
C3, 5, 6, 8, 10, 11, 12	4u7 40V minelect
C4, 20, 21	100n polyester
C9	10p ceramic
C16, 19	47u 16V tantalum
C17	47u 16V minelect
C18	15n polyester
C22, 23	10u 40v minelect

SEMICONDUCTORS

IC1	TL072
IC2	NE5532
IC3	LM13700N
IC4, 5, 6	TL074
Q1-9	BC212L
D1-9	1N914
LED1, 2	Green standard LED
LED3	yellow standard LED
LED4	red standard LED
LED5	Tricolour round LED

MISCELLANEOUS

SK1	Female panel mounting XLR
SK2, 10, 11	Stereo break ¼" jack socket
SK3, 4, 5, 6, 7	Mono ¼" jack socket
SK8	Male panel mounting XLR
SK9	Prof 3-pin DIN panel socket
SW1	see RV5
SW2	see RV6

Knobs (collet or grub screw, 5off); PCB; case; stick-on cabinet feet (4 off); PCB pillars (tapped and studded plus nuts, bolts and locking washers, 4 off); PCB linking pins (63 off); Veropins (35 off), self tap screw (no 4 x 6 mm, 4 off); 6BA nuts, bolts and locking washers (4 off); power supply ±15V at 120 mA per rail regulated.

problem and microphones may be operated with between 6 and 10dB more gain than otherwise.

Special Patches

STEREO OPERATION: A pair of compression gates may be cross-linked for stereo operation using a stereo jack to jack lead wired as

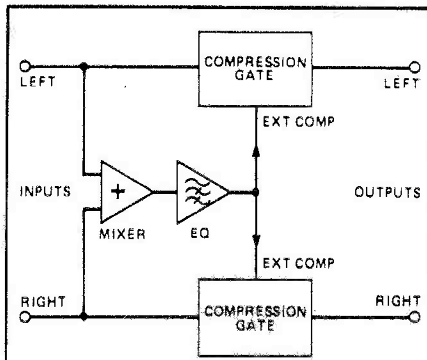

Fig. 7 stereo 'de-essing' arrangement for removing excessive sibilance.

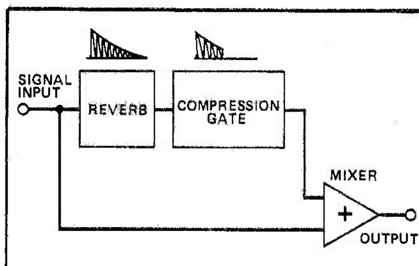

Fig. 8 Using the gate to provide sharply cut-off reverberation.

shown in Fig. 6, with one end being plugged into each EXT COMP socket.

STEREO DE-ESSING: Incoming left and right signals should be mixed and then passed through an equaliser. This equalised signal is fed into the EXT COMP input of each compression gate. A treble boost will cause low frequency components to be compressed most for suppressing 'rumble' or microphone 'popping'. In each case adjust the GAIN/COMP con-

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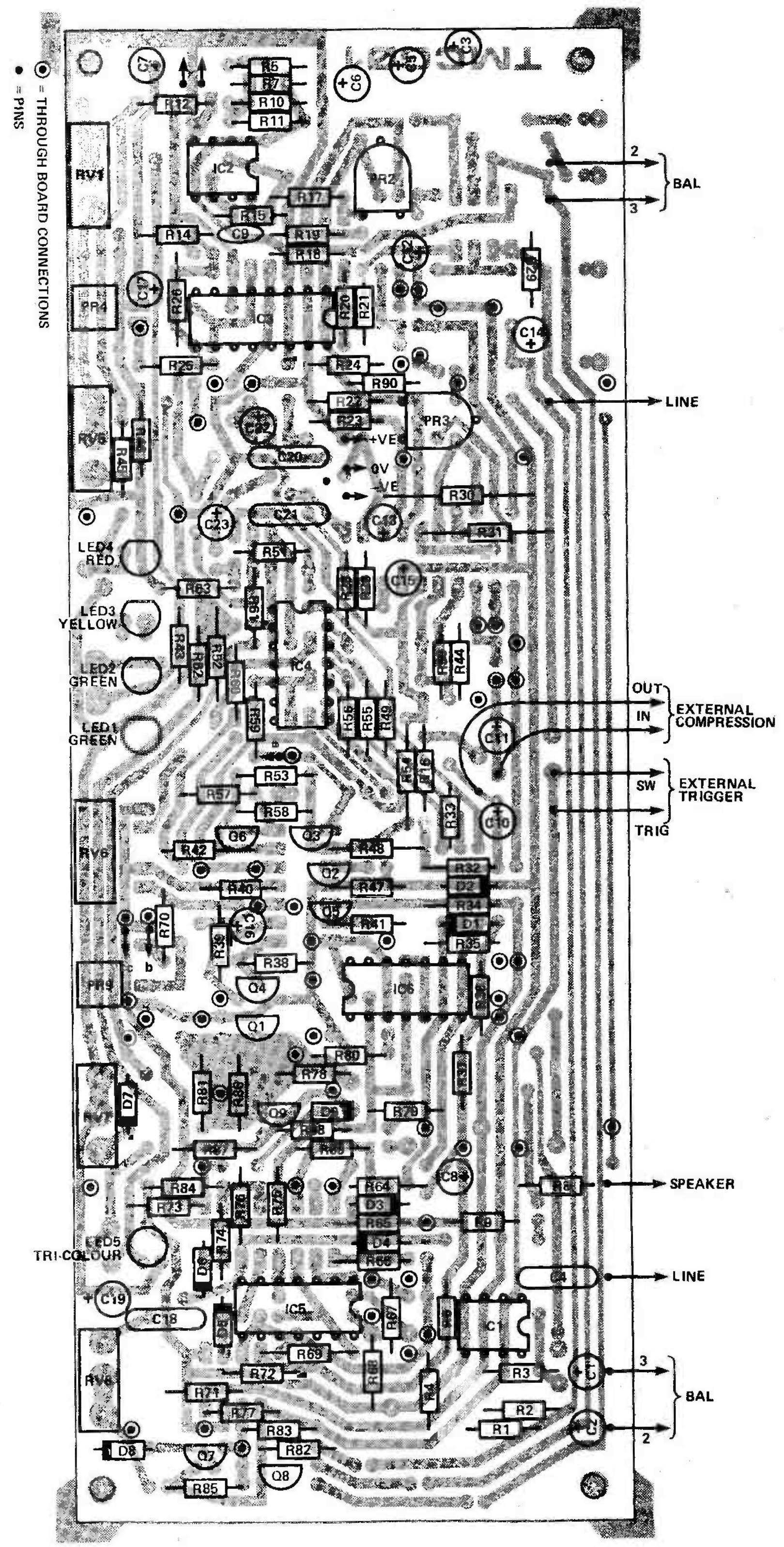

Fig. 9 Component overlay of the compression gate PCB.

trol for the best results, keeping the compressor RELEASE time short so as not to compress the section following the offending sibilant.

GATED REVERB: With the gate RELEASE fully anti-clockwise, adjust the gate Trig Level so that the reverberation cuts off prematurely and abruptly. This is particularly effective on drums (Fig. 8).

EXTERNAL GATE: Sending a signal into the EXT TRIG socket enables that signal to trigger

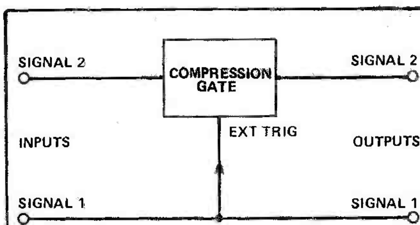

Fig. 10 External gating of the unit to provide voice-over effects.

whatever sound is passing through the compression gate. Softening the gate DEPTH by turning the preset anti-clockwise makes the nosie gate a 'two-level device'. This is the complement of the compressor voice-over patch, in which the presence of a signal at the EXT TRIG input switches the signal passing through the compression gate from attenuated to full (Fig. 9).

Construction

The PCB is double sided and linking pins are used to make the through-board connections, their positions being marked by stars printed on the component side of the board. Great care should be taken to ensure that every pin is soldered on both sides of the board — work systematically and check thoroughly as nine out of ten faults will be found to be due to a pin not being soldered somewhere, usually on the underside of the PCB.

Solder components in order of height: resistors, diodes, IC sockets, presets, transistors, capacitors, LEDs and pots. Take care to observe polarity of diodes and capacitors as marked. It helps if the LEDs are the correct way round, too. The LED leads should be bent at 90°, 5mm behind the plastic package and soldered so that the bends are 5 mm above the PCB.

Note that the Alps pots supplied with the kits solder to

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pins in order to be the correct height above the board. Solder Veropins in the pot positions and attach the PCB mounting pillars to the board corners using the studded ends and nuts, then fix the PCB inside the case by passing four bolts through the mounting holes in the bottom of the case. Next cut the pot spindles to length (10 mm) and mount them on the front panel. The pot tags can now be soldered to their respective pins and perfect alignment is ensured. The whole assembly may

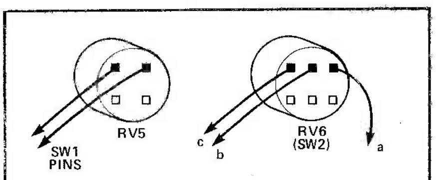


Fig. 11 Wiring of the switches on RV5 and RV6.

now be removed from the case for testing.

Pins should also be used for the off-board connections as well as the connections to the switches on RV5 and RV6 (Fig. 10). Connec-

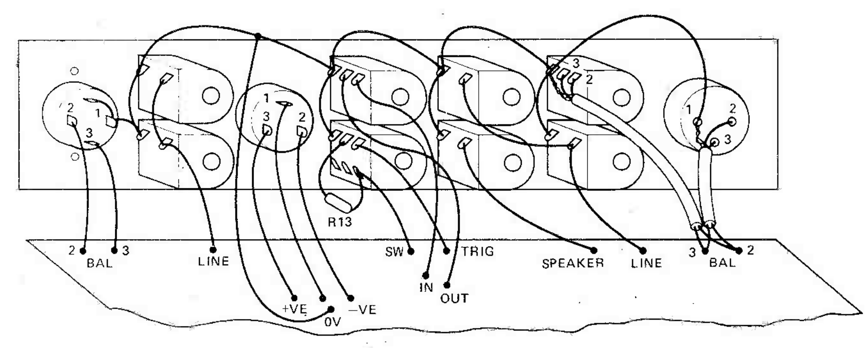
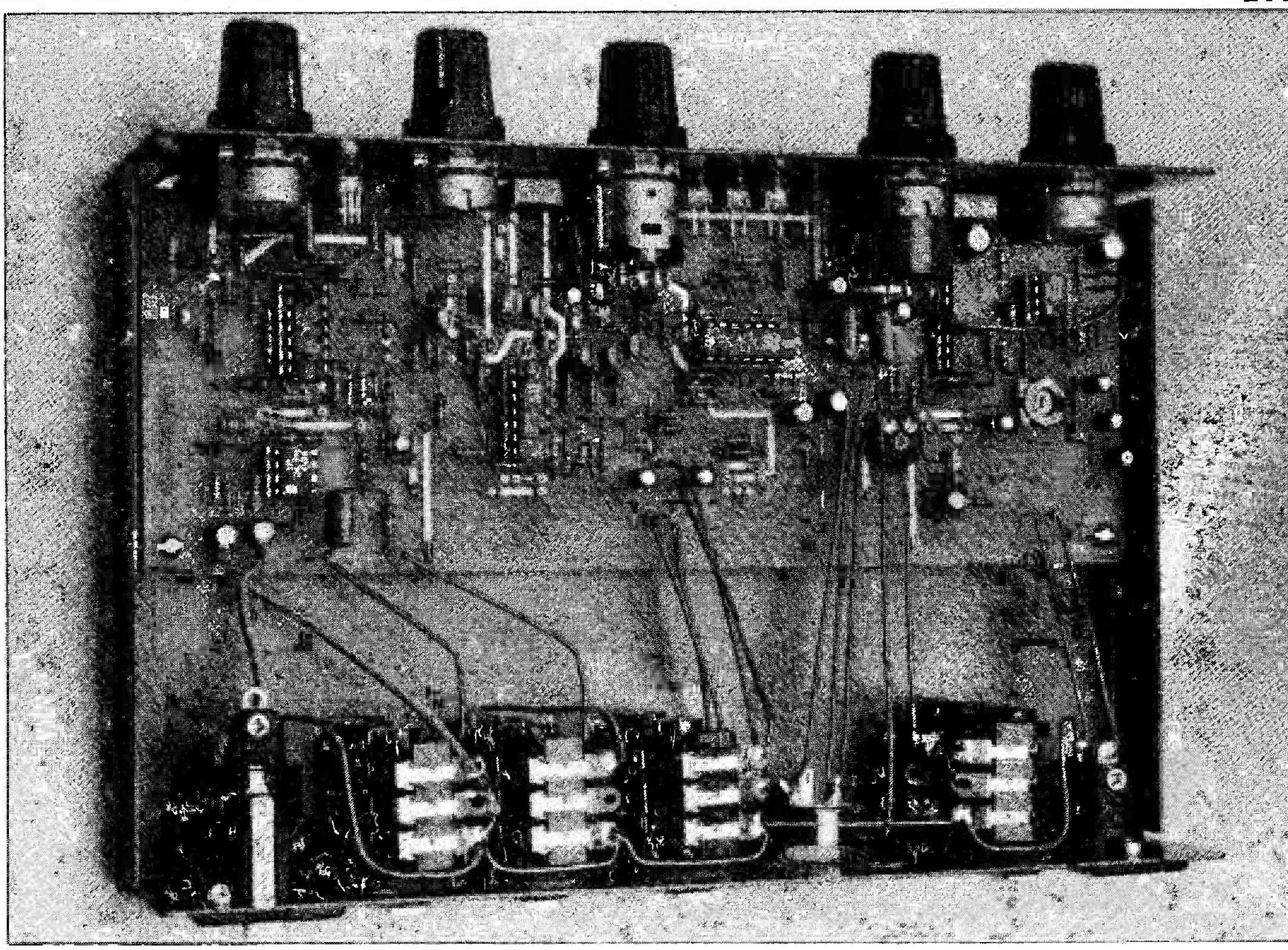


Fig. 12 Wiring of the connectors on the rear panel.

tions to the sockets are shown in Fig. 11 but it is probably wise to complete the setting up and to bench test the completed board prior to wiring it into the case.

The DI compression gate is designed to run from any regulated power supply providing ± 15V at up to 120mA per rail. A custom power supply built into a mains plug case and with a 2metre lead terminated in a 3-pin DIN plug is available from the kit manufacturers.

The only setting up required is of the two presets RV2 and RV3. Using a voltmeter on its most sensitive range, adjust RV2 to set IC2 pin 7 to precisely 0V. Next set gate ATTACK and RELEASE at minimum and the DEPTH preset fully clockwise, then either feed a sine wave into a line input or use a microphone in order to trigger the Noise Gate — adjust the THRESHOLD control so that the gate opens and closes as the incoming signal goes up and down in volume. A click will be heard as the gate opens and closes and RV3 should be adjusted until this is minimized. **ETI**



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FOR FRIENDSHIP, LOVE OR MARRIAGE Dateline

is the way to meet

'She just kissed me and that was it!'

Ron Watt toyed for ages with the idea of joining Dateline.

'One or two of my friends suggested it would be a good idea,' said Ron, a House Sales Officer from Kidcalder, West Lothian. At 29, most of his friends were married. 'It's very hard to meet people because you don't really want to go to a disco or for a drink on your own — always assuming that you will meet the sort of people that you want to go out with. Dateline gets you through the first hurdle of asking people out because you can write to them.'

Coincidentally, Ron joined Dateline on the very same day as Fiona Martin, a pretty 25 year old from Penicuik, Midlothian. Widowed at a tragically young age, Fiona found that, with a small daughter, it was very difficult for her to get out to meet people. In Fiona's case it was her sister who pushed her into joining Dateline.

In spite of joining on the same day, Fiona received her results before Ron and, having made up her mind to make full use of her membership, she wasted no time in writing to three of the names on her list — one of which was Ron's. 'I got three replies back — including Ron's — and I went out with the first two but they didn't really appeal to me. Then I met Ron.'

Ron in the meantime, had received his first list of names from Dateline but he was destined never to use it. 'Before I got the list I got the letter from Fiona. I thought I would wait and see how that turned out before I met anyone else.'

Ron had written such a nice letter to Fiona, asking her to write again or to phone him, that she decided, 'being very brave,' to ring up. 'She sounded nervous,' said Ron, 'but I was impressed by the voice — she had a nice voice.'

Fiona too liked the sound of Ron and after sorting out a babysitter for Jacqueline, Fiona's daughter, the couple arranged to meet. Ron picked Fiona up from her house and took her for a drink. Initially that first meeting didn't go particularly well. 'I wasn't disappointed when I met her — I liked her,' explained Ron, 'but communication was very difficult because we were both nervous and I did most of the talking. I got the initial impression that she didn't like me very much!'

'And I didn't think he liked me either,' laughed Fiona.

After a couple of hours Ron took her home but he had already decided not to ask her for another date. Fortunately, Scottish hospitality saved the day because Fiona invited him in for coffee and cheese toasties! Once inside her own home, Fiona became much more confident and relaxed. 'She was just as nice,' said Ron, 'but easier to talk to.'

The couple sat and talked until after midnight. 'I liked him very much,' confessed Fiona, 'and he ended up staying the night. On the couch downstairs,' she added hastily.

Ron was still not convinced that Fiona liked him enough to go out with him a second time and was happily surprised the next morning when she agreed to see him again. From then on their relationship snowballed and the couple spent every available moment together.

'From the second time I met her I realised that she was terrific,' said Ron. 'When I was driving her home I knew then I really wanted to make a go of this.'

Fiona too quickly began to feel that this was something special. 'I don't know why I was so attracted to him — it was just the sort of person he was. He's very kind and gentle.'

Of course, Ron didn't only have to convince Fiona. Jacqueline also had to be won over. Not an easy matter, perhaps, for a single man with a limited experience of children. But Ron was a great success! My daughter took to him like...well, she can twist him round her little finger!' said Fiona.

'To be honest I never really expected to meet a girl with a baby,' said Ron, 'but I must admit I really enjoy Jacqueline's company and it makes me feel...fulfilled. I had no second thoughts about it because she's really a very nice little girl.'

Five weeks after they met, Ron skated warily around the subject of marriage. 'The night before we were engaged I just casually said that if I was to ask her to marry me one day, what would she say? She said she would think about it for a second and then say yes. So I left it at that!'

Less than 24 hours later, however, Ron returned to the subject. 'I simply said how would it be if this time next year we were married and she just kissed me and that was it!'

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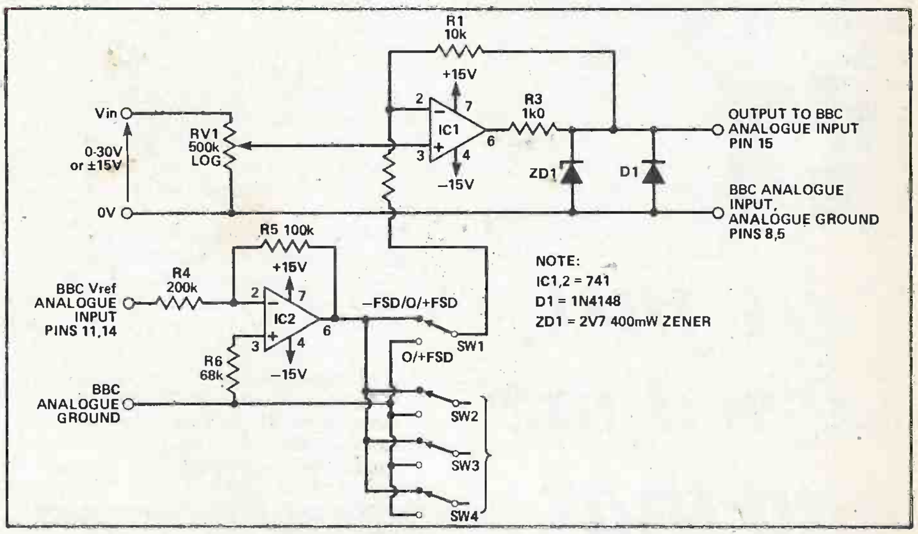
TECH TIPS

Buffer Amplifier For The BBC Microcomputer

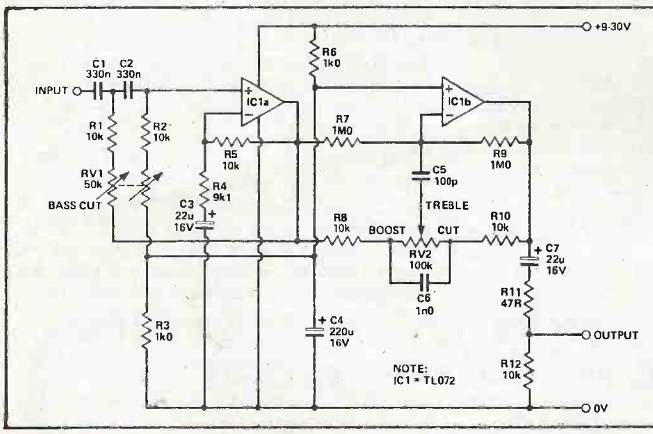
D. Bush,
Leamington Spa.

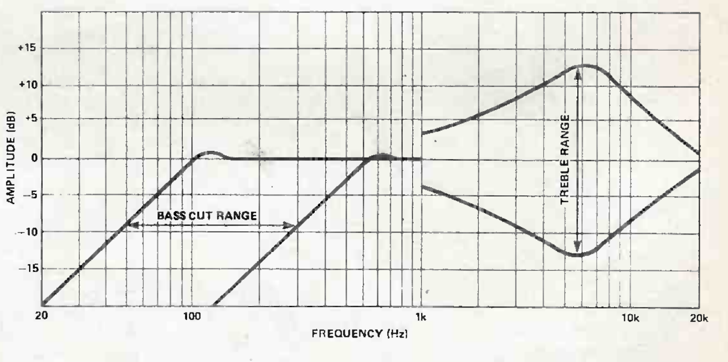


The four channel A to D converter on the BBC micro is limited in use by its fixed input range of 0 to +1.8V, its temperature drift and its susceptibility to damage by input voltages outside the range −1 to +5V. The variable gain buffer amplifier shown here was designed to minimise these problems and allow school children to incorporate the BBC micro into their electronics and technology projects without difficulty.

IC1 is a non-inverting amplifier with a gain of x2, the output being limited by D1, ZD1 and R3 so that it cannot exceed the limits −0.7 to +2.1V. These limiting components are placed within the feedback loop so as to maintain linearity over the output range. Input attenuation is provided by RV1 which can be calibrated for an input range of up to 30V depending upon the potentiometer used. This circuit is repeated for the other three channels.

IC2 is configured as an inverting amplifier with a gain of 0.5x. It takes its input from the Vref line on the BBC and provides an output of one half of this voltage which can be used to offset the buffer amplifiers. By switching this voltage in or out, the buffers can be set to accept inputs which range from either −FSD through 0V to +FSD or from 0V to +FSD only. In the − FSD to +FSD position, the buffer can be used to process input data for presentation in graphical form, with the graph axis remaining visually coincident with the 0V input.





PA Tone Control

R. Eggleton,
Catworth

Hi-fi tone controls commonly consist of the Baxandall circuit which provides maximum boost and cut at the frequency extremes; public address (PA) tone controls have different requirements.

For PA use only cut is required at the bass end to remove the proximity effect of close-up microphones and to protect horn loudspeakers which have a limited response below about 200Hz and may easily be damaged. At the treble end boost or cut may be required. However, this must be limited at very high frequencies to avoid speaker damage and amplifier overload.

The circuit shown provides the ideal response as can be seen from the accompanying frequency response graph. It uses a dual op-amp powered from 9-30V DC and consuming approximately 25mA. The first stage provides the bass cut at 12dB/octave, the turnover frequency being adjustable from 80Hz to 500Hz by means of the 50k dual linear potentiometer. The second stage provides ±13dB of treble boost or cut at 6kHz and is adjusted by means of the 100k linear potentiometer.

To alter the frequency turnover points the two 330n capacitors may be increased to lower the bass frequency or reduced to raise it. Similarly, capacitors C1 and C2 should be increased to lower the treble peaking frequency or reduced to raise it, mainting the ratio C2 = 10 x C1.

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- Where a project has apparently been constructed correctly but does not work, we will need a description of its behaviour and some sensible test readings and drawings of oscillograms if appropriate. With a bit of luck, by taking these measurements you'll discover what's wrong yourself. Please do not send us any hardware (except as a gift!);
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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.

Single Board Controller (March 1985)
There were a number of errors in the parts list. RP2 is listed as a 10k SIL pack but is actually four separate resistors, and the same applies to RP3. RP4 is also listed as a SIL pack but should consist of seven commoned resistors. R13 is always required, not just when a cassette interface is used as stated.

The Real Components (May 1985)
In Fig. 1 on page 20, the connections for the Texas L and 2N transistors are incorrectly shown. They should read B, C and E from the top.

Heat Pen (June 1985)
The instruction in the penultimate paragraph on page 49 should read "... adjust RV2 for 2.73V...", not 2.37V as stated.

Low Cost Audio Mixer (June 1985)
In Fig. 6 on page 39, the PCB foil pattern has been incorrectly shown as though from the copper side. The board is shown correctly from the copper side in the foil pattern pages. In Fig. 10 on page 40, the positive power rail at lower left should be shown connected to pin 8 of the TL072s, IC1-5).

Noise About Noise (July 1985)
In Fig. 5 on page 24, no connection should be shown between the cathode of the diode and the negative side of the 470u capacitor.

Printer Buffer (July 1985)
The case specified is actually larger than the one used for the prototype. It will, of course, work perfectly well, but if you want to a compact unit use a Verocase 202-21038H (180 x 120 x 65mm) rather than a Verocase 202-21035. The regulator IC17 should be bolted to the back of the case to provide heatsinking or, alternatively, fitted with a TO220 heatsink.

Please note that the designer, Nick Sawyer, has been in touch to inform us that the refresh problem we mentioned in September ETI is dealt with in the printer buffer software. In this case there is no need to replace the TMS 4416 dynamic RAMs, although as far as we know the replacement parts mentioned (Hitachi HM48416 DRAMs) will cause no problems. The full text of Nick Sawyer's letter will appear next month. Meanwhile, our apologies for any confusion caused.

Intel 8294 Data Encryption Unit (September 1985)
It should be apparent from the text, page 35, that an actual program has been omitted. This program is for use with the SDK 8085 kit only, and copies may be obtained from us on receipt of a stamped addressed envelope.

Tech Tips — Novel Input Stage (October 1985)
The caption against the lower figure should read "Low noise output at *minimum* gain", not maximum gain.

Chorus Unit (November 1985)
IC3 is shown on the circuit diagram on page 49 connected to the 9V supply. It should be connected to the 5V supply. The foil pattern connections to this IC are correct.

Foil Patterns (November 1985)
The foil patterns for the Modular Test Equipment Waveform Generator and the Chorus Unit are shown from the component side rather than the copper side.

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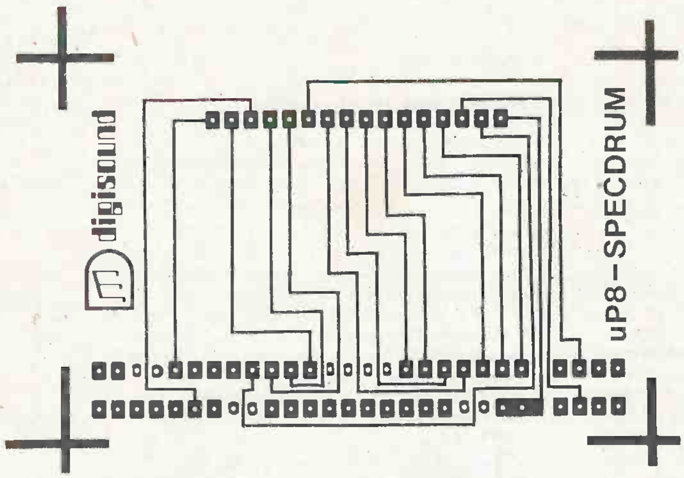
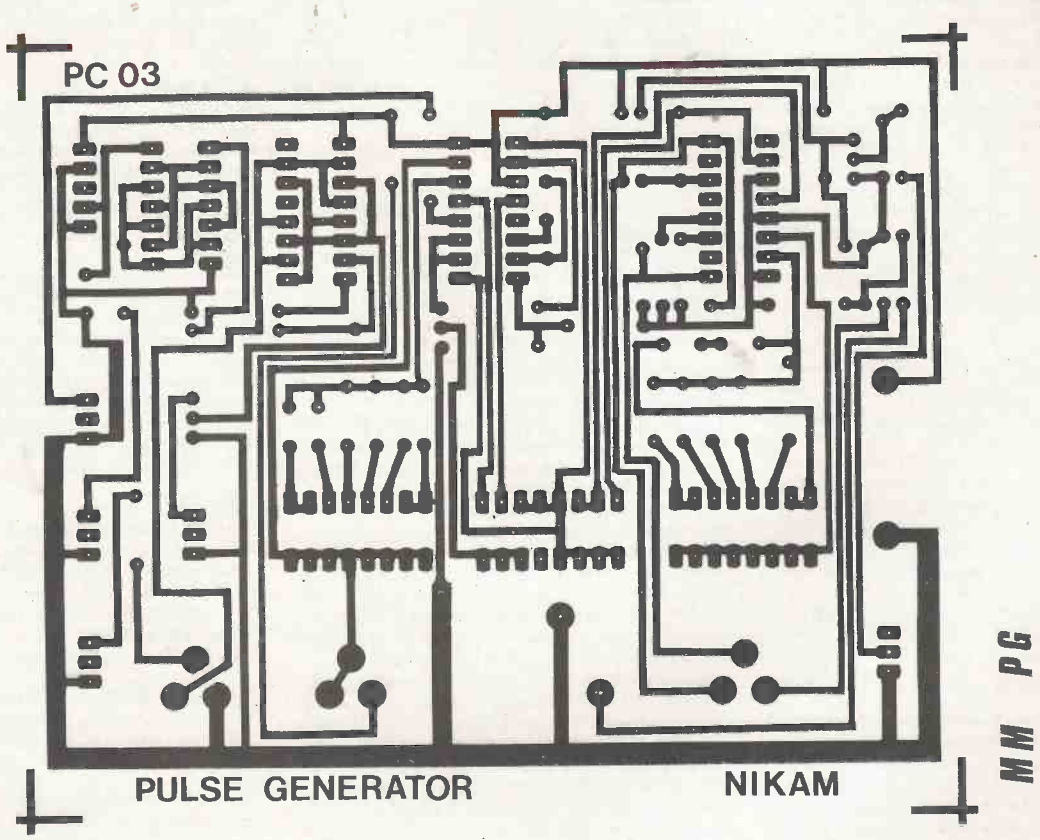
PCB FOIL PATTERNS



The foil pattern for the Specdrum connector board.



The Modular Test Equipment pulse generator board.

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Page 57

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Page 58

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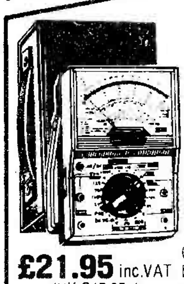

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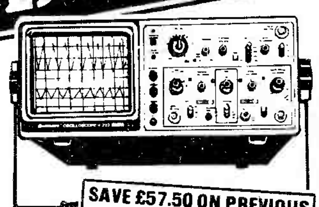

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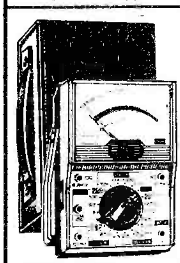

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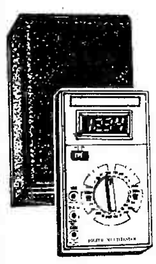

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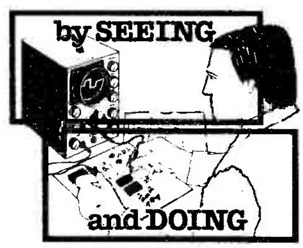

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TRAINS OF THOUGHT

Those of us who model railways for nostalgic reasons know full well that the sounds of full-size railways, especially those of the steam era, were a major component of the atmosphere that we seek to recreate. The addition of sound effects therefore provides an immediate boost to the realism.

There are dozens of ways in which sound can be added to a model railway, and some demand no electronic skills at all. Hidden speakers can reproduce disc or cassette recordings of full-size railways, while a miniature speaker in a station building can broadcast station announcements recorded on cassette. Computer buffs can generate quite convincing train sounds using the complex sound facilities of the BBC Micro or Commodore 64.

But if looking primarily at electronic hardware applications, train sound systems divide into two sorts: off-train and on-train reproduction.

In off-train reproduction the sound is reproduced away from the train, although it may be related to it. For example, the chuff rate of a steam train can be made proportional to the train speed as measured by a speedometer unit.

Many circuits for electronic chuffers and whistles have been published, some using discrete semiconductors and some using ICs. Some of the complex sound generator chips offer some useful facilities. The NS76477 and its 16-pin relative, the SN94281, offer hours of noisy experimentation. Sadly the SN94281 is hard to find nowadays — if any reader knows a source please let me know.

It is also possible to reproduce the sound on board the train. in O-gauge and larger scales it is usually easy to mount a small moving-coil speaker in a locomotive or tender — in HO and OO scales piezo-electric transducers of 20 to 25 mm diameter can provide reasonable reproduction. On-train systems divide into those where the sound is actually generated on board the train and those where it is generated remotely and transmitted to the train. On-train generation poses problems of space for the circuitry and of an adequate smoothed power supply. The track voltage can be monitored for a measure of train speed if needed.

Off-train generation solves the problems of space and power supply but leaves the questions of sound transmission to the train. The simplest method is through the rails, but this has its limitations. The controller must be a pure DC type or buzzes and hums will drown your sound, and the transducer must have a series capacitor to protect it from the controller voltage. Superimposing the audio on the traction voltage has its own special pitfalls for the unwary. I have used a special controller with complementary VMOS output which acted simultaneously as a DC power amplifier (controller) and audio power amplifier. Audio inputs were provided from both a cassette recorder and an SN94281-based electronic sound generator.

But beware the practical joker who swaps cassettes. You may find that, instead of chuffing and whistling, your 1930s' vintage GWR branch train delivers the latest 1980s' chart-busting hit!

Roger Amos

OPEN CHANNEL

I'm constantly amazed at the time it takes organizations — particularly larger ones — to take in and adapt to a new technology. Take, for example, the Central Electricity Generating Board. The CEGB's national grid is a wonderful thing: it provides a source of electrical power to every household and business in the land. But it really has more potential (pun intended) than just that. In effect it is a cable network which reaches every building throughout the nation. Think about it.

To date, this network is only capable of providing one-way transmission, the distribution of electrical power from power stations to users. But true transmission networks must be more powerful (yeuch, another pun) than this. They should allow two-way transmissions.

Let's look at the national grid in another way. It can be simplified, at least for this illustration, and thought of as a length of wire which reaches every consumer. Now any length of wire is a transmission medium, and any transmission medium can be used to transmit more than one individual point-to-point communication, merely by dividing the total communications spectrum available in the network up into a number of channels. Each channel is then used to transmit an individual communication between source and receiver. The principle I'm talking about is known as multiplexing, and has been acknowledged and used in various forms since the early days of radio communications.

There is little to stop the CEGB using the national grid purely as a communications network, if the multiplexed channels can be piggy-backed on top of the mains supply voltages. In a very simple way, an example can be seen in the proliferation of mains-powered, cordless intercoms now available, which only need to be plugged in at each required position in a building to allow efficient and good quality communications. ETI itself has published a number of project designs which use a building's mains wiring in this way.

On a larger scale, the whole national grid could be used similarly, but is presently under-utilised. The techniques and principles are all there and have been for many years. The only drawback remains the CEGB itself and its seemingly slow progress.

This Is The BBC

At the end of September BBC radio commenced using its first completely digital sound mixing desk. Reputed to be capable of the sort of tricks with sound that video paintbox-type machines can do with television pictures, the desk is computer controlled and 'totally' portable — it fits onto an outside broadcast trailer and so can be used around the country. No doubt, if you want it to, the desk will allow cricket matches on Radio 3 to sound that much more realistic in pure digital surreal sound, but are we talking of any significant advantage?

The digital desk will presumably make better recordings of concerts, operas and other musical extravaganzas, but is that of any benefit to the listener? Face it, quality of reception on either AM or FM is limited by the transmission system, not by the equipment. Existing mixing desks are every bit as good as they need to be to allow excellent sound reception. Even the UK FM transmission method doesn't allow the large signal-to-noise ratio which the digital desk will afford. The BBC might say they are taking the hiss out of radio broadcasts, but perhaps they are trying to take the hiss out of the licence payer.

Keith Brindley

ALF'S PUZZLE

Alf's dream

Alf is always keen to improve his education and over the last year he has been attending evening classes at the local Tech. He chose the United Education Guild combined diploma in circuit theory and basket weaving, with which you are no doubt all familiar. Last week, on the night before the final exams, he had a horrible nightmare.

In his dream, Alf entered the examination room and was confronted by a mass of resistors all woven together. The resistor tangle didn't stop at the bench, it trailed across the floor out of the window and far into the distance. There was only one question on the exam paper: Find the resistance at the terminals of this INFINITE resistor network.

Alf couldn't use the ohm meter the examiners had supplied because the electricity would take an infinite amount of time to travel around all the resistors. Nor did the idea of doing an infinite number of calculations appeal to him very much. What could he do? What IS the resistance of the network?

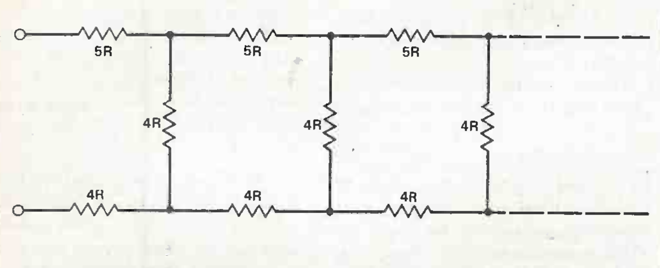
The answer to last month's puzzle:

Alf cheated a bit in describing the second waveform as a distorted 2kHz square wave. If you look at it closely you'll find it repeats itself exactly every two cycles of the 2kHz square wave above, so it really has a frequency of 1kHz. I think it's fairly obvious by inspection that the waves do, in fact, add up to give a 1kHz sine wave. From a mathematical point of view, without going into details, the situation would look something like this:

sine wave components of 2kHz square wave
PLUS
sine wave components of 180° phase-shifted square wave
PLUS
the extra 1kHz sine wave
EQUALS
a 1kHz sine wave by itself

The frequency components of the two square waves would cancel as they are 180° out of phase, leaving only the 1kHz sine wave.

The 'distorted' square wave could not, in fact, have been produced by feeding the square wave through any kind of linear circuit (in circuit theory, a linear circuit includes such things as filters and tuned circuits, which an amplifier designer would not think of as being very linear!) and could only have been produced by a sine wave being injected from somewhere else. Alf was leading you astray by describing it as a 'distorted square wave'.



One end of the infinitely long resistor ladder

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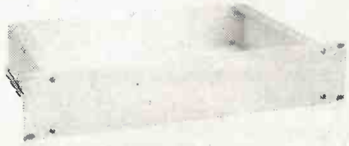

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SCRATCHPAD

by Flea-byte

I confess that I find the game of international espionage as mystifying as Ian Botham's haircut. Despite its high profile, I can't for the life of me figure out how it works or why it exists in the first place.

No doubt, as the news media remind us from time to time, spying is dastardly wickedness which endangers the fabric of society in the free world. (So much for the tempting offer to join GCHQ that I saw in 'another electronics magazine' recently. Disabled people, the ad said, were welcome to apply — although if your disability consisted of being a trade union member, forget it!)

It must be just as true that we don't have any spies on our side of the pitch, At least we don't have any *now*. We used to have some during the war and in John Le Carre books, but most of them worked for the Russians, and the ones that didn't weren't terribly keen on spying so they gave themselves silly, endearing names like Mole and Smiley and The Third Man. Now they're all retired or dead, which makes the game distinctly unfair, because with them on our team the Russians are bound to win.

What disturbs this cosy little picture is the fact that nobody seems to win or lose at all. In fact, I've never been able to work out what earthly difference all this spying business makes to anything. Spies exist, occasionally they're forced to take early retirement, a lot of hot air is emitted from the seats of power and things carry on much the same as before — with us knowing that they know that we know that they know that we know . . .

To take a case in point, there was the recent affair of Oleg Gordievsky's defection and the resulting poker game with 'undesirables' between Moscow and London. Apparently, Gordievsky had been what I believe is called a double-agent for some years. He would have been well able to tell his Western paymasters all about about the Soviet spies ferreting around among our secrets. Only the most cynical among you will have asked why the British government waited for so long to expel these spies and how it managed to feign such convincing shock when Gordievsky came in from the cold. (There I go again with the jargon.)

Among our boys to be thrown out of Moscow after the faeces hit the ventilating machine was the local office chief of Quest Automation — a company that represents the interest of firms like the Apricot computer manufacturers, ACT, in the Soviet Union. His employers categorically deny the charge, but then (in the immortal words of Mandy Rice-Davis) they would, wouldn't they? What I do know is that everybody says his expulsion will make no difference whatsoever to anything except the address on his headed notepaper. What I also know is that the government is apparently panic-stricken at the thought of British high technology finding its way to the Eastern bloc. The Customs and Excise have a thing called Operation Arrow going in order to bust the sanctions busters — the sanctions in question being embargoes on the sale of Western high-tech goods behind the Iron Curtain. And the Americans (from whom our government takes most of its cues) are really hot on the high-tech exports front. So, how come Quest Automation was in Moscow *at all*?

The kerfuffle is made even more pointed by a revelation, at around the time of the big spy-swap, that Operation Arrow had trawled the waters for sanctions busters and had arrested a number of people whose courtroom defence was that they couldn't be security risks because, while setting-up illicit high tech deals in Moscow, they were supplying the low-down on the Russians to MI5 or MI6 back in London. Gives a new meaning to the concept of information technology, doesn't it? The serious point remains, however: what are we after — information to feed the already bloated and unaccountable security services or trade to protect and build industry and people's jobs? In case you need reminding, it was Mrs Thatcher who described Mikhail Gorbachov as 'a man I can do business with'.

Export System

It might be worth reflecting on a piece of news that was quietly announced earlier this year, in the light of my previous item. The Soviet Computer Import Corporation said recently that it intended to import one million personal computer systems for use in technical training programmes in schools. The first 10,000 units will be supplied by Nippon Gakki (better known as Yamaha in this country) and, yes, they will be MSX machines. Another Japanese company, Star Micronics, hope to export 100,000 MSX-based systems, packaged with their own VDUs, printers and disk drives, at a unit price of around £250. The Soviet electronic products import company, V/O Electronorgtechnica, has already agreed to take 4000 systems. Meanwhile, we were expelling Viktor Logush of Electronorgtechnica's British office.

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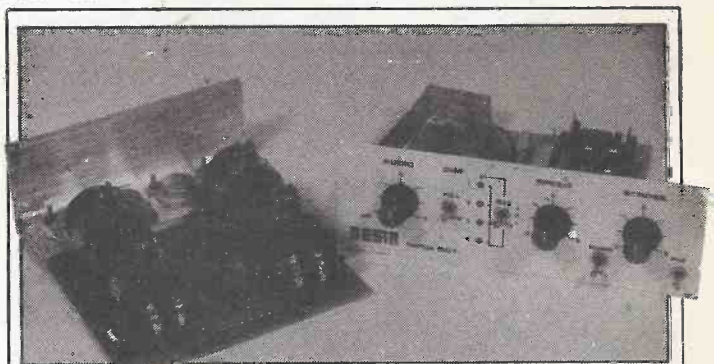

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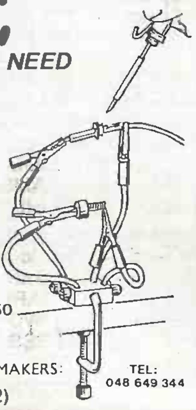

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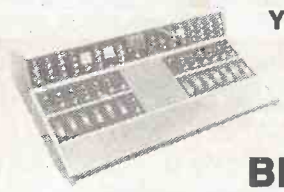

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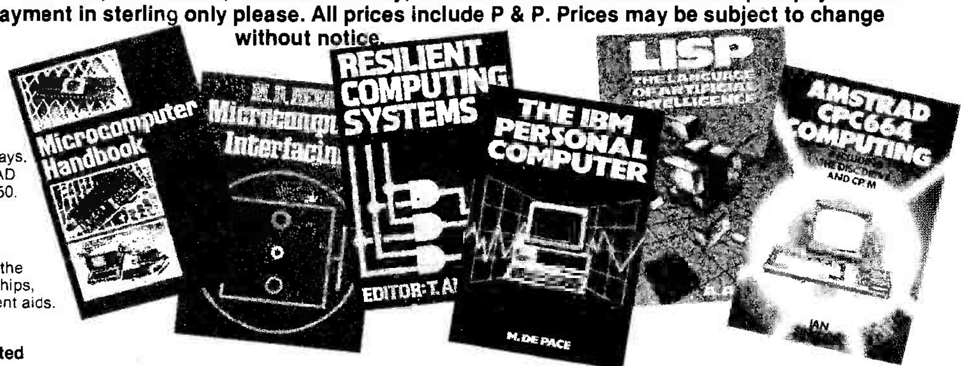

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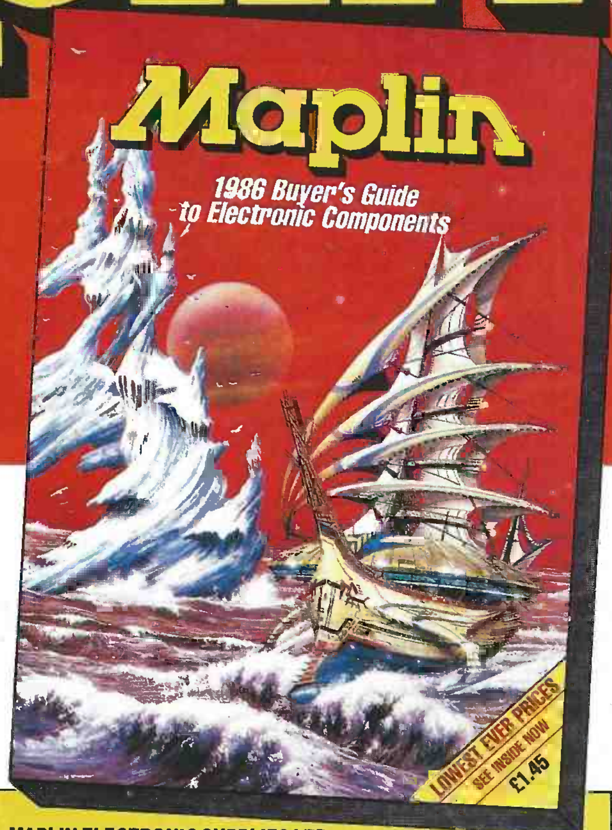

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