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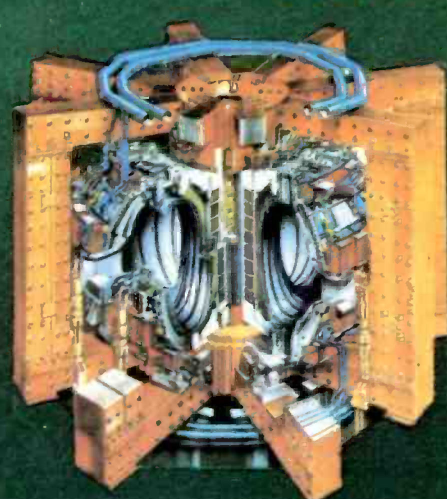
PRACTICAL ELECTRONICS

JUNE 1983

85p

PERCUSSION MICROSYNTH

Computing: PROGRAM CONDITIONER



FUSION: Towards Reality

Spacewatch • Equipment Bargains

EXTRA EDITORIAL PAGES!

PRACTICAL
ELECTRONICS

VOLUME 19 No. 6 JUNE 1983

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR JULY ISSUE WILL BE ON SALE FRIDAY, JUNE 3rd, 1983
(for details of contents see page 41)

WATFORD ELECTRONICS

33, CARDIFF ROAD, WATFORD, HERTS WD1 8ED, ENGLAND
Tel. Watford (0923) 40588. Telex: 8956095 WAELEC

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POLYESTER CAPACITORS: (Axial Lead) **400V:** 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 100n, 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n **60p**; 1µF **68p**; 2µ2, 4µ7 **85p**. **1000V:** 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **50p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V; 10n, 20n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1µ **23p**; 1µ5 **40p**; 2µ2 **46p**.

ELECTROLYTIC CAPACITORS (Values in µF). **500V:** 10µF **52p**; 47 **78p**; **63V:** 0·47, 1·0, 1·5, 2·2, 3·3, **8p**; 4·7 **9p**; 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **16p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V:** 68 **20p**; 100 **17p**; 220 **24p**; **40V:** 6·8 **15p**; 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V: 50p**; 3300 **76p**; 4700 **92p**; **16V:** 2·5, 40 **8p**; 47, 68, 100 **9p**; 125 **12p**; 220 **13p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END TYPE: 64V: 4700 **245p**; 3300 **198p**; 2200 **139p**; **50V:** 3300 **154p**; 2200 **110p**; **40V:** 4700 **160p**; **25V:** 4700 **98p**; 10,000 **320p**; 15,000 **345p**.

TANTALUM BEAD CAPACITORS:
35V: 0·1µ, 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 **30p**; 33, 47 **40p**; 100 **75p**; 220 **88p**; **10V:** 15, 22 **26p**; 33, 47 **36p**; 100 **55p**.

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

SIEMENS mulitlayer miniature capacitors.
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n, 15n, 22n **7p**; 18n, 27n, 33n, 47n **8p**; 39n, 56n, 68n **9p**.
100V: 100n, 120n, **10p**; 150n **11p**; 220n **13p**; 330n **18p**; 470n **23p**; 680n **30p**; 1µF **34p**; 2µ2 **50p**.

CERAMIC Capacitors: 50V
Range 1pF to 6800pF **4p**; 10nF, 15n, 33n, 47nF **5p**; 100nf/30V **5p**.

POLYSTYRENE Caps:

10pF to 1nF	8p
1n5 to 12nF	10p

POTENTIOMETERS: Carbon Track, 0·25W Log & Linear Values.

500Ω, 1K & 2K (LIN ONLY) Single	30p
5KΩ-2MΩ single gang	30p
5KΩ-2MΩ single gang D/P switch	78p
5KΩ-2MΩ dual gang stereo	88p

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track
5KΩ-500KΩ Single gang **70p**

PRESET POTENTIOMETERS

0·1W 50Ω-2·2M Mini Vert. & Horiz.	7p
0·25W 100Ω-3·3MΩ Horiz. larger	10p
0·25W 250Ω-4·7MΩ Vert.	10p

RESISTORS
Hi-stab, Miniature, 5%, Carbon.

	RANGE	Val.	1-99	100+
0·25W	2Ω2-4·M7	E24	3p	1p
0·5W	2Ω2-4·M7	E12	3p	1p
1W	2Ω2-10M	E12	6p	4p
1% Metal Film 51Ω-1M			8p	6p

RESISTORS S.I.L. Package: 7 Commoned, 100Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K **24p**.
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K, 100K **26p**.

TRANSISTORS

AC125/6	35
AC127/8	35
AC141/2	30
AC176	28
AC187/8	32
AD142	120
AD149	79
AD161/2	42
AF118	95
AF139	40
AF239	55
BC107/8	10
BC107B	12
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC117/8	20
BC140/42	30
BC147/8	9
BC147B	10
BC148C	10
BC149	9
BC149C	12
BC153/4	27
BC157/8	10
BC159	11
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179/81	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	28
BC212/3	10
BC212L	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14

BC307B	14
BC308B	16
BC327/8	15
BC337/8	15
BC441	34
BC461	34
BC477/8	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY70	16
BCY71/2	20
BD124	115
BD131/2	48
BD133	60
BD135	45
BD136/7	40
BD138/9	40
BD140	40
BD245	45
BD378	70
BD695A	125
BD696A	125
BF180	38
BF194/5	12
BF198/9	18
BF200	30
BF224	25
BF244A	28
BF244B	29
BF256B	35
BF257/8	32
BF259	35
BF336	40
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29/84	28
BFX85/86	26
BFX87/88	26
BFY50/51	23
BFY52	23
BFY56	23

BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX29	34
BU105	170
BU205	190
BU206	200
BU208	200
MD8001	250
MJ2955	70
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103/4	30
MPF105	30
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU55	60
MPSU56	60
OC23	170
OC28/36	220
OC41/42	75
OC44	75
OC70	40
OC76	35
OC81/82	50
OC83/84	40
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31C	37
TIP32A	38
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74

TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121	73
TIP141	105
TIP142	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44	45
TIS88A	50
TIS90	30
TIS91/93	32
VK1010	60
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301/2	16
ZTX303	25
ZTX304	17
ZTX320/26	30
ZTX451	23
ZTX500/1	14
ZTX502/3	18
ZTX504	25
ZTX531	25
ZTX550	25
2N696	30
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N914/5	32
2N918	35
2N930	20
2N1131/2	24
2N1303/4/5	
2N1307/8	65

2N1613	30
2N1671B	160
2N2160	295
2N2219A/20A/	
21A/22A	25
2N2369A	18
2N2646	45
2N2846	80
2N2904A/05A/	
06A/07A	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3442	140
2N3614	199
2N3615	199
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710	10
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3866	90
2N3903/4	15
2N3906/5	15
2N4069	45
2N4427	80
2N4859	78
2N4871	55
2N5135/6	20
2N5172	18
2N5179	45
2N5180	45
2N5191	75
2N5194	80
2N5305	24
2N5457	30
2N5458/9	30
2N5485	36
2N5777	45
2N6027	32
2N6109	60
2N6290	70
2SA636	250
2SA671	260
2SA715	60
2SC495/6	70

2SC1061	250
2SC1096	85
2SC1162	30
2SC1172	125
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1679	190
2SC1678	140
2SC1923	50
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	200
2SC2078	170
2SC2091	85
2SC2166	165
2SC2314	85
2SC2465	125
2SC2547	30
2SD234	75
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40100	215
40101	130
40250	95
40251	180
40311	60
40313	130
40315	90
40316	95
40317/20	80
40360	60
40361/62	70
40406/7	75
40408	75
40411	285
40412	90
40467	130
40468	85
40594	105
40595	110
40603	110
40673	70
40871/2	90

LINEAR IC's

555 CMOS	80
702	75
709C 8 pin	35
710	48
741	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
8037CJ	850
9400CJ	350
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	675
AY-3-8910	420
AY-3-8912	450
AY-5-1230	450
AY-5-1317A	630
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	200
CA3090AQ	375
CA3123	165
CA3130	90
CA3140	40
CA3160	95
CA3161E	100
CA3162E	450
CA3189	200
CA3240	110
HA1366	175
HA1388	255
ICL7106	690
ICL7107	975
ICL7204	550
ICL7611	99
ICL7660	248
ICL8038CC	300
ICL8211	350
ICM7204	850
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	220
LA4031P	240
LA4032	295
LA4400	295
LA4422	275
LC7120	350
LC7130	340
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301A	24
LM307	45
LM308	95

LM311	55
LM318	150
LM319	195
LM324	65
LM334Z	90
LM335	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	160
LM386	90
LM387	120
LM389	95
LM391	80
LM393	45
LM394CH	290
LM725CN	325
LM733	70
LM2917	195
LM3302	75
LM3900	50
LM3909	85
LM3911	125
LM3914	200
LM3915	200
LM3916	250
LM13600	110
LS7220	280
M51513L	230
M51515L	320
M706B1	125
MB3712	220
MB3756	440
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC1455	50
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423P	80
MF10	380
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE543	225
NE544	210
NE555	16
NE556DB	45
NE558	140
NE560	325
NE561	395
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567	140
NE570	410
NE571	400
NE5532	145
NE5534	105
OM335	760
RC4136D	60
RC4558	45
S566B	225
SAB3209	425
SAB3210	325

SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SL6270	150
SN76013N	350
SN76023N	350
SN76033	350
SN76477	420
SN76488	480
SP8629	299
TA7120	125
TA7130	125
TA7204	195
TA7205	175
TA7222	150
TAA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA540	275
TBA550Q	330
TBA641	290
TBA651	190
TBA800	80
TBA810S	95
TBA820	80
TBA920Q	380
TBA990	380
TCA270	350
TCA280A	220
TCA940	175
TCA965	145
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	380
TDA2002	325
TDA2003	198
TDA2004	495
TDA2006	330
TDA2020	320
TDA2030	295
TDB0791	420
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	24
TL072CP	45
TL074CN	100
TL081CP	24
TL082CP	45
TL083CP	75
TL084CP	90
TL091CP	55
TL170	50
TL430C	90
TL507	110
UA2240	100
UA78540	230
UAA170	180
UAA180	180
UAA1003-3	935
UGN3020T	160
ULN2001	80
ULN2003	75
ULN2004	75
ULN2068	290
ULN2802	200
ULN2804	150
ULN2283	100
UPC575	165
UPC1025H	265
UPC1032	95
UPC1182	270
UPC1156H	225
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419CE	180
ZN423E	130
ZN424E	130

ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	325
ZN1034E	200
ZN1040E	665
ZNA234E	850

COMPUTER IC's

1702	350
1802CP	650
2114L-200n	95
2147-3	425
2532-3	300
2564	£6
2708	225
2716-5V	225
2732	350
2764	425
3242	590
4116-150	85
4116-200	95
4118-250	325
4164-200	425
4532-3	350
4816-100ns	215
5101	220
6116-150ns	350
6116L-120ns	550
6117-100n	490
6167-6	795
6502 CPU	325
6502A	450
6503	600
6504-250	550
6520	100
6522 VIA	295
6530 RRIOT	£11
6532 RIOT	570
6545 CRTC	899
6551 ACIA	650
6592 PC	£20
68B54	780
6800	220
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	100
68B21	220
6821	100
6840	375
6843	00
6845	650
6847	650
6850	110
6852	250
6854	599
6875	500
68000 New msk	£70
74922	400
8080A	250
8085A	350
8088	£16
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8118-10	225
8123	125
8155	350
8156	350
8205	225
8212	110
8214	425
8216	100
8224	110
8226	250
8228	220
8243	270
8250	850

8251A	250
8253	400
8255	225
8256A	£35
8257A	400
8259	395
8271	£28
8279	385
8282	450
8283	450
8284	350
8285	365
8287	£17
8288	£10
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33A	125
AY-3-1015	300
AY-5-1013	300
AY-5-1350	388
AY-5-2376	600
AY-5-3600	750
COM8017	275
COM8116	700
DM8131	275
DP8304BN	250
DS3691N	320
DS8820	110
DS8830	110
DS8831	125
DS8832	250
DS88LS120N	275
E9365	£38
E9366	£35
FD1761	£15
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
HD26501	75
HMG167-6	795
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	675
MC14412	725
MC3446	250
MC3447P	315
MC3486	175
MC3487	175
MK3886-2M	£7
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	700
RO-3-2513L	650
RO-3-2513U	600
SFF96364E	800
SP0256AL2	£18
TMS2716-3	725
TMS6011	365
TMS4164-15	475
TMS4416-2	475
TMS4532-3	350
TMS9927	£14
TMS9928	£20
TMS9929	£16
TMS5100	£10
TMS6011	365
TMS4164-15	475
ULN2003	75
UPD7002	425
Z80CPU 2·5	299
Z80ACPU4M	300
Z80CTC	250
Z80ACTC	260
Z80B	875

Z80DART	495
Z80ADART	550
Z80ADMA	895
Z80DMA	675
Z80P10	260
Z80AP10	275
Z80S10-1	850
Z80AS10	900

74S Series

74S00	24
74S02	24
74S04	30
74S05	60
74S08	60
74S10	40
74S11	60
74S20	40
74S22	50
74S30	40
74S32	60
74S37	70
74S74	75
74S85	295
74S86	70
74S112	90
74S113	90
74S114	90
74S124	300
74S132	110
74S133	60
74S138	115
74S139	115
74S140	60
74S151	180
74S153	182
74S157	250
74S158	195
74S163	300
74S174	250
74S175	320
74S188	140
74S189	140
74S194	320
74S195	480
74S197	400
74S201	350
74S225	500
74S240	300
74S241	300
74S244	290
74S251	250
74S257	250
74S258	250
74S260	70
74S262	850
74S287	225
74S288	150
74S289	290
74S299	540
74S301	000
74S365	000
74S373	400
74S374	365
74S470	325
74S471	620
74S472	1150
74S474	400
74S475	800
74S571	620
74S573	950

75 Series

75107/8/9	95
75110	95
75150	125
75154	125
75159	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	72
75454	70
75491/2	65

TTL 74

7400	11
7401	11
7402	11
7403	12
7404	13
74L04	85
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	20
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	18
7428	25
7430	14
7432	20
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7444	90
7445	55
7446	60
7447	35
7448	40
7450	16
7451	16
7453	16
7454	16
7460	16
7470	30
7472	24
7473	24
7474	20
7475	25
7476	25
7480	40
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	25
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	28
74136	28
74141	55

74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	19
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	48
74192	46
74193	46
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	70
74490	95

74C

C244	195
C245	195
C373	240
C374	245
C922	420
C923	500
C925	400

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	12
LS08	12
LS09	12
LS10	12
LS11	12
LS12	12
LS13	16
LS14	26
LS15	12
LS20	12
LS21	12
LS22	12
LS26	12
LS27	12
LS28	14
LS30	12
LS32	13
LS33	14
LS37	14
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS95	40
LS96	95
LS107	40
LS109	23
LS112	22
LS113	16
LS114	20
LS122	36
LS123	38
LS124	90
LS125	24
LS126	25
LS132	35
LS133	30
LS136	24
LS138	25
LS139	25
LS145	70
LS147	100
LS148	70
LS151	35
LS153	40
LS154	80
LS155	30
LS156	36
LS157	27
LS158	30
LS160	32
LS161	37
LS162	37
LS163	37
LS164	43
LS165	80
LS166	52
LS168	65
LS170	70
LS173	55
LS174	50
LS175	40
LS181	90
LS183	180
LS190	36

LS191	36
LS192	36
LS193	37
LS194	33
LS195	33
LS196	45
LS197	45
LS221	55
LS240	55
LS241	55
LS242	55
LS243	55
LS244	50
LS245	70
LS247	50
LS248	55
LS249	55
LS251	32
LS253	32
LS257	30
LS258	35
LS259	55
LS260	22
LS261	100
LS266	18
LS273	54
LS275	126
LS279	30
LS280	90
LS283	40
LS290	53
LS293	40
LS295	75
LS298	80
LS299	150
LS320	200
LS323	160
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62
LS362	750
LS363	140
LS364	140
LS365	28
LS366	32
LS367	28
LS368	35
LS373	60
LS374	55
LS375	50
LS377	85
LS378	80
LS379	110
LS384	395
LS385	250
LS390	46
LS393	42
LS395	95
LS399	150
LS445	100
LS471	820
LS490	200
LS540	100
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	100
LS673	550

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16

4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4031	125
4032	80
4033	125
4034	140
4035	45
4036	275
4037	115
4038	110
4039	290
4040	40
4041	40
4042	40
4043	40
4044	40
4045	105
4046	46
4047	40
4048	40
4049	25
4050	25
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
4059	435
4060	45
4061	1195
4062	995
4063	85
4066	24
4067	245
4068	13
4069	14
4070	13
4071	13
4072	13
4073	15
4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	190
4098	75
4099	75
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	690
4412	790
4415	480
4419	280
4422	770
4433	770
4435	850

4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	35
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	46
4512	42
4513	199
4514	125
4515	125
4516	65
4517	275
4518	40
4519	30
4520	70
4521	130
4522	125
4526	60
4527	50
4528	50
4529	150
4530	90
4531	130
4532	50
4534	455
4536	275
4538	70
4539	90
4541	140
4543	70
4544	150
4548	40
4549	375
4553	245
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	36
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4599	290
40097	45
40098	42
40100	215
40101	140
40102	130
40103	175
40104	95
40105	115
40106	75
40107	60
40108	450
40109	100
40110	300
40114	240
40163	50
40174	45
40175	50
40192	95
40193	95
40194	95
40195	80
40244	195
40245	195
40373	240
40374	245
45106	595

SPEAKERS

8Ω, 0.3W, 2"; 2·25", 2·5", 3"	80p
0.3W, 2·5" 40Ω; 64Ω or 80Ω	80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
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	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

SCR's Thyristors

0.8A-100V	32
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

BRIDGE RECTIFIERS

(plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ZENERS

Range 2V7 to 39V 400mW **8p each**

Range: 3V3 to 33V 1.3W **15p each**

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

SOLDERCON PINS

100	75p
500	370p

OPTO

LEDS including Clips	
TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 ·2" Red	12
0·2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0·2" Flashing LED Red	56
0·2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0·2" Tri colour LEDs Red/Green/Yellow	85
0·2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90

7 Segment Displays

TIL321 ·5" C.An	115
TIL322 ·5" C.th	115
DL704 ·3" C.Cth	99
DL707 ·3" C.Anod	99
FND357 or 500	120
·3" Green C.A.	140
±1 ·3" Red or Green	150
Bargraph 10 seg. Red	225
Bargraph NSM3914	500

FERRIC CHLORIDE

Crystals 1lb

195p + 50p p&p

DALO ETCH RESIST

Pen plus spare tip 100p

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9·5"×8·5"
6"×6"	100p	125p	110p
6"×12"	175p	225p	

VEROBOARDS 0·1"

	Clad	Plain
2½×3¾"	85p	—
2½×5"	100p	—
3¾×3¾"	100p	—
3¾×5"	115p	95p
3¾×17"	390p	275p
4¾×18"	495p	—
Pkt. of 100 pins	55p	
Spot Face Cutter	150p	
Pin Insertion Tool	185p	

'VO' Board	180
'DIP' Board	374
Vero Strip	144

PROTO-DECs

Veroblock	405
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 350p
Spare Wire (Spool) **75p**; Combs **6p** ea.
Wire Wrapping Stakes 100 250p

0·5" LIQUID CRYSTAL DISPLAYS

3½ digit	495
4 digit	530
6 digit	625

BPX25	195
BPW21	295
BPX65	270
IL74	45
ILD74	99
ILQ74	185
TIL111	75
OCP71	120
ORP12	78
2N5777	45
4N33	135
Pin diode	610

OPTO SWITCH

Reflective TIL139 170
Slotted similar to RS 186

ALUM. BOXES

4×2½×2"	85
4×2¾×2½"	103
4×4×2½"	120
5×4×2	105
5×2¾×1½"	90
5×2¾×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

VOLTAGE REGULATORS

1A	T0220 Plastic Casing +ve		-ve	
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		
100mA	T092 Plastic Casing			
5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

ICL7660	248	LM317K	320
78H05 5V/5A	550	LM317P	99
78H12 12V/5A	580	LM323K	500
78HG+5 to +24V 5A	599	LM337T	175
		LM723	35
79HG −2.25V to −24V 5A	685	TBA625B	75
		RC4194	375
LM309K	135	RC4195	160

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40

PUSH BUTTON
Spring loaded
Latching or Momentary 6A

SPDT c/over	99
DPDT c/over	145

MINIATURE
Non Locking

Push to make	15p
Push break	25p

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

SUB-MIN TOGGLE 2 amp

SP changeover	60
SPST on off	54
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	75
DPDT C/OFF	88
DPDT on/on/on	185
DPDT Biased	145
3 pole c/over	205

★ SPECIAL OFFER ★

1 MEGABYTE DRIVES

Mitsubishi Slim Line. Uncased, Double track, Double density, 5¼". Track Density 96TPI, track to track. Access time: 3mSec. **Only £225.**

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

ROTARY: Mains 250V AC, 4 Amp 64p

DIL SWITCHES: (SPST) 4 way **65p**; 6 way **80p**; 8 way **87p**; 10 way **135p**; (SPDT) 4 way **190p**.

THUMBWHEEL Mini front mounting

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (pair)	75p

PROXIMITY Switch with magnet 125p

DIL SOCKETS

	Low profile	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	99p

ZIF DIL SOCKET

16 way	475p
24 way	575p
28 way	850p
40 way	975p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
40	195p	218p

RIBBON CABLE

(price per foot)

Ways	Grey	Colour
10	15p	28p
16	25p	40p
20	30p	50p
26	40p	65p
34	60p	85p
40	70p	90p
64	100p	135p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	90p	80p	80p	90p

IDC 25 way Plg. 385p, Skt. 450p

EDGE CONNECTORS

	0·1"	·156"
2×10 way	—	135p
2×15 way	—	140p
2×18 way	180p	145p
2×22 way	199p	200p
2×23 way	170p	190p
2×25 way	225p	220p
2×28 way	210p	—
2×30 way	245p	—
2×36 way	295p	—
2×40 way	315p	—
2×43 way	395p	—
2×75 way	550p	—

SIL Sockets 0.1"
20 way **65p**
32 way **95p**

ULTIMUM

WATFORD'S most versatile MICRO EXPANSION SYSTEM. Interfaces with: APPLE, ATOM, DRAGON, PET, RESEARCH MACHINE, SPECTRUM, SUPERBOARD, VIDEO GENIE, ZX81, etc. As published in P.E. starting from Nov., 1982.

Send SAE for details.

IDC CONNECTORS (Speed block type)

2 rows	PCB Male with latch Strt. Pins	Angle Pins	Female Header Socket	Female Card-Edge Connector
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	195p
20 way	145p	166p	125p	240p
26 way	175p	200p	150p	320p
34 way	205p	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS

	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2×32 way	275p	320p	220p	285p
DIN 41612 2·3×32 way	295p	340p	240p	300p
DIN 41612 3×32 way	360p	385p	260p	395p

TRANSFORMERS (mains Prim. 220-240V)

3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA **98p**

6VA: 2x6V-·5A; 2x9V-·4A; 2x12V-0·3A; 2x15V-·25A **220p**

12VA: 2x4V5-1·3A; 2x6V-1·2A; 2x12V-·5A; 2x15V-·4A **295p** (35p p&p)

24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A **330p** (60p p&p)

50VA: 2×6V-4A; 2×9V-2·5A; 2×12V-2A; 2×15V-1·5A; 2×20V-1·2A; 2×25V-2A; 2×30V-0·8A **465p** (60p p&p)

100VA: 2×12V-4A; 2×15V-3A; 2×20V-2·5A; 2×30V-1·5A; 2×40V-1·25A; 2×50V-1A **920p** (60p p&p)

JUMPER LEADS Ribbon Cable Assembly

DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	325p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

IDC FEMALE RECEPTACLE Jumper Leads 24"

	20pin	26pin	34pin	40pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

COMPUTER CORNER

- **SEIKOSHA GP100A** – Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. **FREE 500 Sheets** **£175**
- **SEIKOSHA GP 250X** Printer **£230**
- **ORIC-I**. 16K & 48K now available.
- **JUPITER ACE** Microcomputer **£78**
- **SOFTY – 2.** The complete Microprocessor development system. New powerful instructions. Accepts any 24 pin 5V single rail EPROM. Supplied fully built & tested. **£169**
- **WEMON.** Watford's 4K Ultimate Monitor IC for Superboard & UK101. **£10**
- **ZENITH 12" Hi-RES**, Green Monitor 40/80 column select switch, value for money. **£80**
- **SANYO 14" colour monitor, RGB & V.H. sync. screened metal cabinet** **£199**
- **MICROVITEC 14"** colour monitor, RGB input. Lead incl. **£249**
- **TEX EPROM ERASER** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with the Solid-State 30 minute Electronic Timer. **£43**
- **SOLID STATE** 30 minute Electronic **TIMER** for above UV Erasors **£14**
- **Spare** 'UV lamp bulbs **£9**
- **POWER SUPPLY** Regulated, Variable from +5V to +15V. 4A. Fully Cased **£39**
- **MULTIRAIL PSU KIT.** Output: +5V/5A; +12V; +25V; −5V; −12V @ 1A. **£40**
- **4 × 4 matrix keypad** (reed switch assembly) **£4**
- **C12 COMPUTER Grade BASF Cassettes** in Library Cases **40p**
- **8½" & 9½" Fan fold paper** (1000 sheets) **£7 (150p)**
- **Teleprinter Roll** (no VAT) **£3.50**

(P&P on some of the above items is extra)
Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

- **MICROLINE-82A.** 10" Tractor & Friction Feed. 9×9 matrix, 80 column, 120 CPS. Bi-directional **£320** (£7 carr.)
- **3NEC PC-8023BE-C**, 100CPS bi-directional, logic seeking, 80 column, 7×9 Dot matrix, super/subscript, underlining, true decenders Tractor/Friction, Hi-Res, 2K Buffer, Proportional Spacing, at a Special Price. Plus **FREE** 500 sheets paper. **ONLY £320** (carr. £7)
- **EPSON FX80 10"** 160cps, Tractor/Friction, Bi-directional, logic seeking, 9 × 11 matrix, Hi-res bit image, normal, italic & elite char. Super & subscript. Proportional spacing. **£399** (£7 carr.)

ANTEX Soldering Irons

C15W	450
CX17W	475
CCN15W	490
X25W	500
Spare bits	65
Elements	210
Iron stands	165
Heat Shunt	30

Access

Just phone your order through, we do the rest. 0923-50234

CRYSTALS

32·768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1·008M	275
1·28MHz	392
1·5MHz	420
1·6MHz	395
1·8MHz	395
1·8432M	200
2·0MHz	225
2·4576M	200
2·5MHz	225
2·56250M	220
3·2768M	150
3·57954M	98
3·6864M	300
4·0MHz	150
4·032MHz	290
4·194304M	200
4·433619M	100
4·608MHz	200
4·80MHz	200
5·0MHz	160
5·185MHz	300
5·24288M	390
6·0MHz	140
6·144MHz	150
6·5536MHz	200
7·0MHz	150
7·168MHz	250
7·68MHz	200
8·0MHz	150
8·08333M	395
8·867237M	175
9·00MHz	200
9·375MHz	350
10·0MHz	175
10·5MHz	250
10·7MHz	150
10·24MHz	200
12·0MHz	175
12·528MHz	300
14·31818M	170
14·7456M	175
14·765MHz	250
15·0MHz	200
16·0MHz	200
18·0MHz	180
18·432M	150
19·968MHz	150
20·0MHz	200
24·0MHz	170
24·930MHz	325
29·695MHz	150
26·670MHz	325
27·125MHz	295
27·145M	190
27·648MHz	300
38·66667M	175
48·0MHz	175
55·5MHz	400
100MHz	350
116·0MHz	300
145·8MHz	225

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	IDC	Solder
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ASTEC UHF MODULATORS

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- BBC Micro A **£299**; B **£399** (incl.)
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- CD50E – Twin Cased with PSU, 80 track, 5¼". Single sided, 400K **£475**
- **MITSUBISHI** Slim line, Single Cased with PSU, 5¼", 80 tracks, D.S.D.D. 1 Megabytes **£299**
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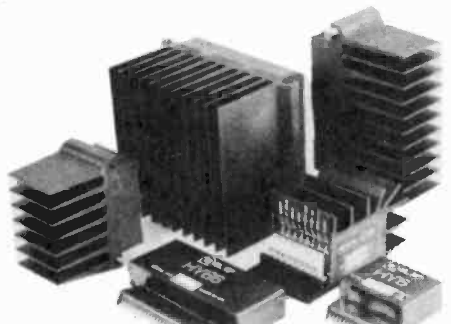
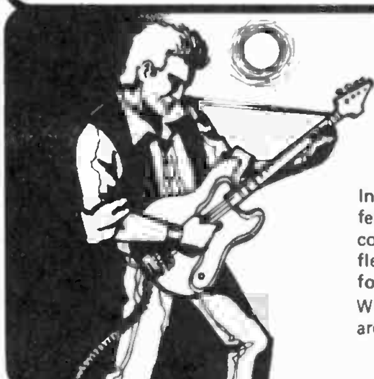
GET BIG POWER



ILP Modular Amplifiers

the third generation

Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line, Slew Rate: 15v/µs. Risetime: 5µs. S/N ratio: 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity: 500mV rms.
Input Impedance: 100K Ω. Damping factor: 100Hz >400.

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/µs. Rise time: 3µs. S/N ratio: 100db
Frequency response (−3dB): 15Hz – 100KHz. Input sensitivity: 500mV rms
Input impedance: 100K Ω. Damping factor: 100Hz > 400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the B6 for modules HY6–HY13 £1.05 (inc. VAT) and the B66 for modules HY66–HY78 £1.29 (inc. VAT).

'NEW to ILP' In Car Entertainments

C15

Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

Robust construction. **£9.14 (inc. VAT)**

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4Ω
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB, Load Impedance 3Ω
Input Sensitivity and Impedance (selectable) 700mV rms into 15KΩ 3V rms into 8Ω
Size 95 x 48 x 50mm, Weight 256 gms.

C1515

Stereo version of C15. **£17.19 (inc. VAT)**

Size 95 x 40 x 80. Weight 410 gms.

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

Please note: X in part no. indicates primary voltage. Please insert "O" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

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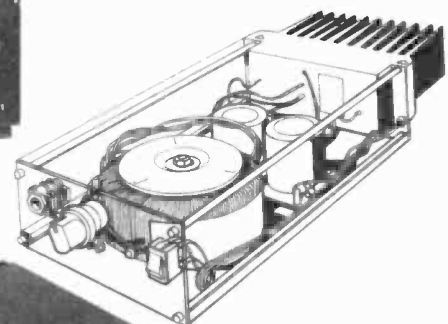
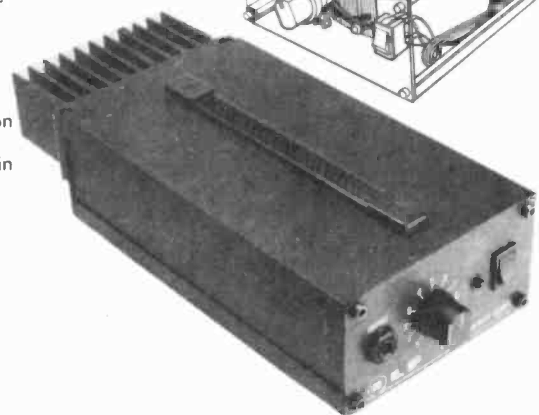
Unicase

Over the years ILP has been aware of the need for a complete packaging system for it's products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.





Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert '0' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

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Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. if sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

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Pak No.	Qty.*	Description	Price
SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed ¼-½ watt Carbon Resistors	£1
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SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm-2m2 Mixed	£1
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Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects.

*Quantities approximate, count by weight.

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SX18	100	Mixed Ceramics 1pf-56pf	£1
SX19	100	Mixed Ceramics 68pf-0.5mf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-1000mf	£1
SX24	20	Tantalum Beads, mixed	£1

*Quantities approximate, count by weight.

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

SX53 1 Power finned Heatsink. This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled.
TO-3 Size 45mm square x 20mm high. 40p

SX54 TO-66 size. 35mm x 30mm x 12mm. 35p

SX55 1 Heat Efficiency Power Finned Heatsink. 90mm x 80mm x 35mm High. Drilled to take up to 4 x TO-3 devices
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SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New.	£1
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Guaranteed Value over £10 at Normal Retail Price

yours for only **£4·00** Data etc. in every pak. Order No. SX56

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The Electronic Components and Semiconductor Bargain of the Year. A host of Electronic components including potentiometers — rotary and slider, presets — horizontal and vertical Resistors of mixed values 22ohms to 2M2 — 1/8 to 2 Watt. A comprehensive range of capacitors including electrolytic and polyester types plus disc ceramics etcetera Audio plugs and sockets of various types plus switches, fuses, heatsinks, wire, nuts/bolts, gromets, cable clips and tyes, knobs and P.C. Board. Then add to that 100 Semiconductors to include transistors, diodes, SCR's opto's, all of which are current everyday usable devices. In all a Fantastic Parcel. No rubbish all identifiable and valued in current catalogues at well over £25.00. Our Fight Against Inflation Price —
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MAKE AMAZING SOUND EFFECTS WITH YOUR ZX 81, TIMEX Sinclair 1000 or SPECTRUM

THE ZON X81
£25.95
incl p&p & VAT

- The ZON SOUND UNIT is completely self-contained and especially designed for use with the ZX 81, TIMEX Sinclair 1000 and Spectrum Computers. It just plugs in – no dismantling or soldering.
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- Standard Sinclair – 16K Rampack or printer can be plugged into ZON X Sound Unit without affecting normal computer operation.
- Huge range of possible sounds for Games, Music, Helicopters, Sci-Fi, Space Invaders, Explosions, Gun-shots, Drums, Planes, Lasers, Organs, Bells, Tunes, Chords, etc., or whatever you devise!
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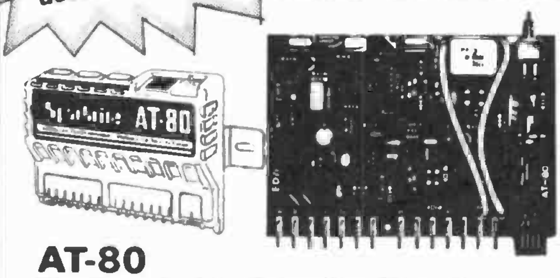

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- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
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- Over 250 components to assemble

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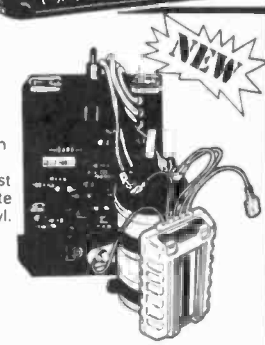
A real challenge for the electronics enthusiast!

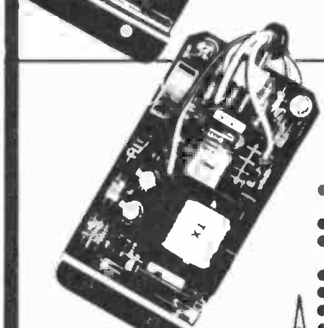
SX1000
Electronic Ignition

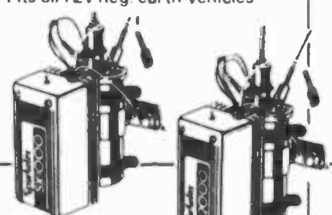
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

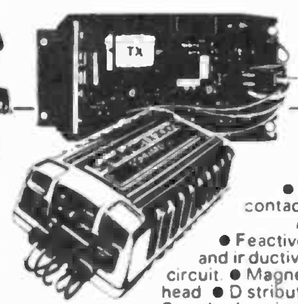
TX1002
Electronic Ignition

● Contactless or contact triggered ● Extended coil energy storage circuit ● Inductive Discharge ● Three position changeover switch ● Distributor triggerhead adaptors included ● Die cast weatherproof case ● Clip-to-coil or remote mounting facility ● Fits majority of 4 & 6 cyl. 12V. neg. earth vehicles ● Over 145 components to assemble.









SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless ● Three position switch with Auxiliary back-up inductive circuit ● Reactive Discharge. Combined capacitive and inductive ● Extended coil energy storage circuit ● Magnetic contactless distributor trigger head ● Distributor triggerhead adaptors included ● Can also be triggered by existing contact breakers ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles ● Over 150 components to assemble

All SPARKRITE products and designs are fully covered by one or more World Patents

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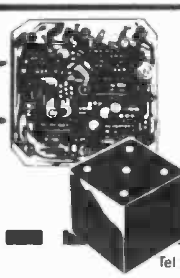

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- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
- Muting and Off switch on base
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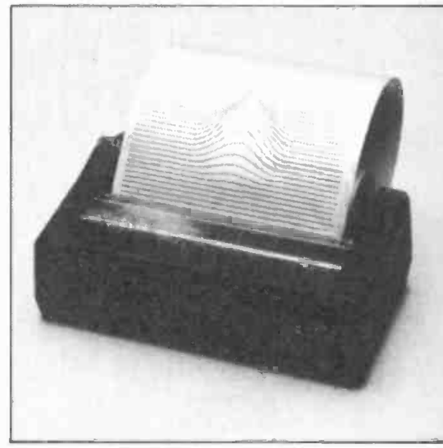

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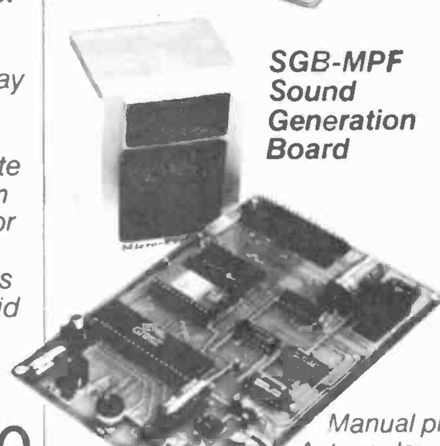

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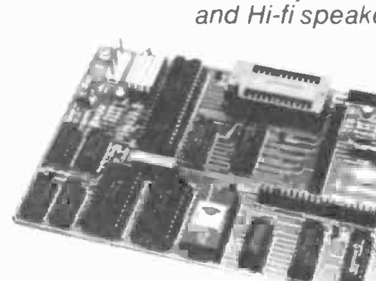

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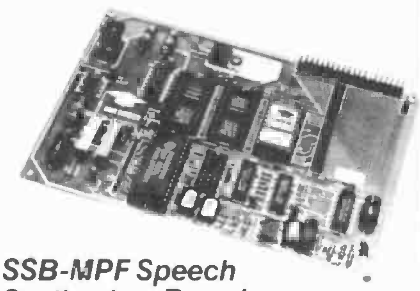

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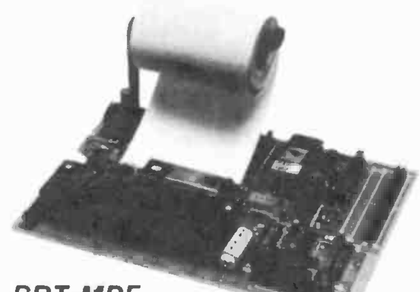

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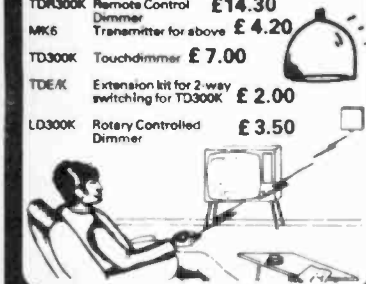

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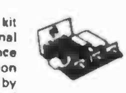

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78L12	0.30
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7805	0.40
7812	0.40
7815	0.40
7905	0.45
7912	0.45
7915	0.45
LM309K	1.20
LM317K	2.40
LM323K	4.50
LM338K	6.25

DATA CONVERTERS

UPD7002	*D1*	4.26
ZN425	*D1*	3.45
ZN426	*D1*	3.00
ZN427	*D1*	5.99
ZN428	*D1*	4.75
ZN429	*D1*	2.10
ZN432	*D1*	13.00
ZN449	*D1*	2.55

CRYSTALS

1M	2.75
1.008M	2.75
1.8432M	1.92
2.4576M	2.00
3.6864M	1.86
4M	0.84
6M	0.86
8M	0.86
9.8304	1.68
19.6608	2.48

DIL SOCKETS (TEXAS)

PINS	TIN	GOLD	WW
8	7	16	25
14	10	26	35
16	10	29	40
18	13	33	50
20	15	37	60
22	17	38	65
24	21	46	70
28	24	55	80
40	30	76	99

ZIF SOCKETS (TEXTOOL)

24 pin	5.75
28 pin	8.20
40 pin	9.75

CMOS 4000

4000	0.10
4001	0.10
4002	0.12
4006	0.42
4007	0.14
4008	0.32
4009	0.24
4010	0.24
4011	0.10
4012	0.16
4013	0.20
4014	0.40
4015	0.36
4016	0.20
4017	0.32
4018	0.36
4019	0.36
4020	0.36
4021	0.40
4022	0.40
4023	0.13
4024	0.32
4025	0.13
4026	0.74
4027	0.20
4028	0.32
4031	0.94
4033	1.80
4034	0.94
4035	0.36
4040	0.36
4041	0.36
4042	0.34
4043	0.36
4044	0.38
4045	1.35
4046	0.42
4047	0.70
4048	0.38
4049	0.23
4050	0.23
4051	0.38
4052	0.44
4053	0.44
4054	0.85
4055	0.85
4060	0.39
4063	0.85
4066	0.24
4068	0.14
4069	0.14
4070	0.13
4071	0.13
4072	0.13
4073	0.14
4075	0.13
4076	0.43
4077	0.13
4078	0.15
4081	0.13
4082	0.13
4085	0.50
4086	0.44
4093	0.20
4502	0.46
4507	0.32
4508	0.96
4510	0.40
4511	0.41
4512	0.40
4514	0.96
4515	0.96
4516	0.40
4518	0.40
4519	0.27
4520	0.40
4521	0.90
4522	0.52
4526	0.52
4527	0.52
4528	0.41
4532	0.72
4541	0.50
4543	0.50
4553	1.57
4555	0.35
4556	0.35
4585	0.75

74LS SERIES

00	0.11
01	0.11
02	0.11
03	0.12
04	0.12
05	0.12
08	0.12
09	0.12
10	0.12
11	0.12
12	0.12
13	0.12
14	0.25
15	0.12
20	0.12
21	0.12
22	0.12
26	0.12
27	0.12
28	0.12
30	0.12
32	0.12
33	0.12
37	0.12
40	0.12
42	0.28
47	0.35
48	0.45
49	0.12
51	0.12
54	0.12
55	0.12
73	0.16
74	0.16
75	0.18
76A	0.17
78A	0.18
83A	0.36
85	0.42
86	0.16
90	0.22
91	0.60
92	0.32
93	0.22
95B	0.40
109A	0.27
112A	0.20
113A	0.20
114A	0.22
122	0.28
123	0.34
125A	0.24
126A	0.25
132	0.34
136	0.25
138	0.25
139	0.27
145	0.57
148	0.70
151	0.40
153	0.40
155	0.30
156	0.35
157	0.25
158	0.30
160A	0.32
161A	0.35
162A	0.35
163A	0.35
164	0.40
165A	0.50
166A	0.60
173A	0.55
174	0.40
175	0.36
181	0.90
190	0.35
191	0.35
192	0.35
193	0.35
194A	0.35
195A	0.35
196	0.45
197	0.45
221	0.46
240	0.55
241	0.55
242	0.55
243	0.55
244	0.55
245	0.70
248	0.55
249	0.55
251	0.30
253	0.35
257A	0.30
258A	0.35
259	0.55
261	1.00
266	0.20
273	0.54
279	0.30
283	0.40
290	0.39
293	0.39
365	0.27
366	0.27
367	0.27
368	0.27
373	0.62
374	0.62
375	0.35
377	0.60
378	0.60
379	0.90
386	0.35
390	0.45
393	0.45

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40 PIN	3.80

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16 PIN	2.05	2.15	2.68
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40 PIN	4.65	4.90	6.18

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14 PIN	1.22
16 PIN	1.34
20 PIN	1.46
26 PIN	1.76
34 PIN	2.06
40 PIN	2.32
50 PIN	2.35
60 PIN	3.20

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14 PIN	1.82
16 PIN	2.10
20 PIN	2.46
26 PIN	3.24
34 PIN	3.80
40 PIN	4.90
50 PIN	5.48
60 PIN	6.38

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Extras available are 6502 disassembler retrofit . . £35, 6800 disassembler retrofit . . £35.
Thermal paper £9.00 box of 10 Clip-over PROBE (only needed if uP is soldered-in) . . £35.
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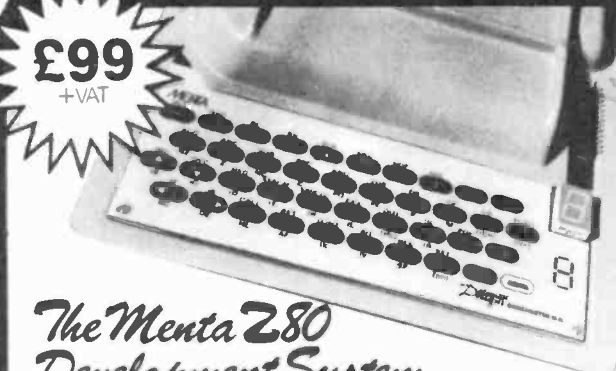

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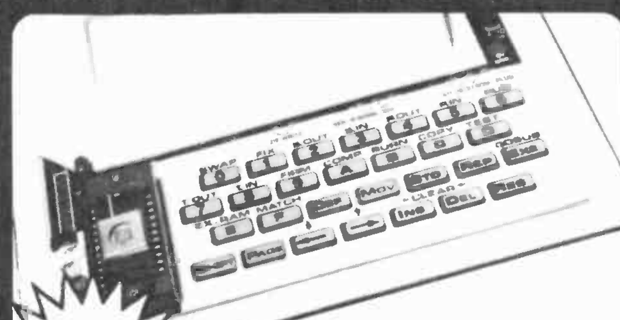

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PE VOLUME 19 No. 6 JUNE 1983

FEATURE

THIS issue of PE carries the first of a regular line of feature articles on various aspects of electronics and its applications. The first article could not get further from the hobbyist concept of PE. It describes a piece of equipment costing some £500 million to build, requiring 700 megawatts of power just to start it up and being quite simply gigantic in size.

No doubt some readers will be aware of the JET Tokamak, of the fact that its trials will be starting within the next month and that it has been built in the heart of Oxfordshire. But how many will know what it is designed to find out, the problems involved in generating and containing a plasma at 100 million degrees Centigrade and what impact it could have on our future energy supply? We must say that until recently we were not conscious of its existence and this article would not have appeared if our Technical Editor had not read a small piece in a newspaper he was standing on whilst decorating!

It is our intention on PE to bring you a wide range of feature articles, some relating directly to our hobby and some, like *Fusion,* giving a glimpse into the future and showing how the application of complex electronics can change our world. Next month our feature will investigate the *Fairlight Music Computer,* an instrument that has changed the world of music. Ray Hammond, author of the recently released book *The Musician And The Micro,* takes an in-depth look at what the Fairlight is, what it can do and just how it does it. The feature will make fascinating reading to anyone with any interest in electronics, computing or music.

After that we are planning to look at such things as robot vision, satellite TV, fibre optics, radio astronomy and one or two other exciting and possibly "unknown" areas. We will reveal more at a later date.

Most of the articles will be written by experts at the sharp end of the developments or researched and written by experienced technical authors. They will be revealing, factual and authoritative. In fact just what you have come to expect from PE.

CARTE BLANCHE

This issue also sees a new page from our very own "V.T.", Vernon Trent. We have given Vernon *carte blanche* to write what he likes about anything he likes, when he likes — provided it's linked to electronics and he does it every month (writes that is). Only his name has been changed to protect him from the wrath of anyone he takes to task!

Vernon Trent at Large should make entertaining reading, it will sometimes have a message or moral behind it. It might be instructive or informative, it could even be funny and it may well add to our post bag when all you "worthy sextons" start writing in. As we have said V.T. speaks for himself and not necessarily PE (or anyone else). Perhaps this is something you didn't expect from PE!

We hope these new features add to your enjoyment of the magazine.

Mike Kenward

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Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

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Items mentioned are available through normal retail outlets, unless otherwise specified. Prices correct at time of going to press.

Y's and Wherefores

Why QWERTY? Do we stop at Y because it sounds friendly? Full name, then: QWERTYUIOP! But this is the lesser mystery surrounding the conventional typewriter keyboard. Why are the letters *so* arranged to start with. Conflicting reports have been published as to the historical explanation of this configuration, but in *PE* we now present the truth (of course).

Over a century ago Frederick Sholes, E. P. Curry and G. W. Carr described the forerunner of today's typewriter in British patent 2418 of 1879. This is a fact stated in the UK PIN (Patents Information Network) Bulletin, and it is also a fact that the early keyboard was designed so that frequently adjacent characters in use are not adjacent mechanically. The letters E and F are an example of this, and by keeping them apart they will not jam together when the word "efficient" is typed rapidly. Sholes's typewriter comprised a circle of hammers, with T and H on opposite sides of the basket. It is a myth that the designer's intention was to avoid key jamming by deliberately slowing down the typist through the use of a *quirky* keyboard.

Why do we couple the high technology keyboard of today's word processor, for example, to a key layout philosophy governed by archaic mechanics? Answer: Commerce thrives on providing for people's needs, and people need what their fingers are familiar with . . . *when it comes to typing.*

Attempts to shatter the mould do exist. The first photograph shows PCD Maltron's ergonomically designed keyboard. Although this looks like a fire damaged item, it is shaped to accommodate the contours, and finger positions and lengths, of the human hand. The character positions are scientifically placed so that the most frequently used keys are the most convenient to press. Typing speed improvements of up to 40% have been achieved, and tests have shown that re-training the QWERTYite is surprisingly quick, leaving her confidently bidextrous. Humans, after all, are curvey, so this keyboard might be a guide to future architecture. Why should machines which we human beings have to work with be rigid, and squared off with sharp corners? Machines should *bend* to suit people, not vice versa.

Another key approach is the Microwriter, which completely abandons the concept of having a button to represent each alphanumeric character. Combinational use of only six keys enables one-handed operation. Imaginary linking of the shape of the required character, to the shape formed by the buttons to be pressed, allows the Microwriter to be mastered in as little as 20 minutes. A single-line display shows what has been keyed into this portable unit, and an integral word processor allows subsequent editing. Later the writer can be linked to a host computer to download the day's work. The reclined executive, typing on the Microwriter, takes on the appearance of

someone impatiently tapping his fingers on the desk. Pen and paper are endangered species!

ROBOTIC SHEEP SHEARING

Robotic sheep shearing is here (in Australia, at least Bruce), according to a report in Electronics Times. In it, John Mathews, of the National Institute of Agricultural Engineering is said to believe that robotic sheep shearing, and even robotic artificial insemination is a workable idea. The Australian Wool Board has issued contracts to researchers to look into these possibilities. Melbourne and Perth, it is claimed, already have robotic shearers.

Not for animal lovers, the Perth system takes a computerised picture of the sheep's contours as it moves along a conveyor belt. The computer then controls the shearing arm in accordance with this information, stored in its memory. In a demonstration, the sheep was held still whilst being shorn, using an electric current passed via an electrode in its mouth. This apparently freezes the animal's muscles, keeping nicks to a similar level to that of manual shearing. Mathews predicts that farmers will be using robotic sheep shearers by 1990.

"THAT'S A PRETTY VOLATILE RAM BRUCE ..... YER'LL NEED A BYTE CHECK ON YER BUFFER WHEN HE'S DONE WITH YER!!"

MARKET PLACE

Pollution Monitor

A personal pollution monitor in use by the Environmental Protection Agency in the USA has been designed to be worn by people as they go about their daily business in urban areas, the unit weighs only 2 lb and continuously sucks in air to measure the level of carbon monoxide. It stores and displays hourly averages of the pollution that its wearer has inhaled, and can later chart a graph. The system is far more indicative of pollution dangers than the conventional fixed point sampling method, and Federal officials say that the study could lead to changes in carbon monoxide regulations in 90 US cities.

DBS News

On March 7th, 1983, Bryce McCrirrick, BBC Director of Engineering, and Alan Jefferis, Managing Director of United Satellites Limited (Unisat), signed Heads of Agreement for provision by Unisat of two direct broadcasting by satellite television channels for the BBC DBS services due to start in 1986.

Unisat, jointly owned by British Telecom, British Aerospace and the General Electric Company, will be responsible for building and launching two satellites in 1986, the first to be operational and the second as a flying spare. A third spacecraft will be available on the ground as an additional safeguard. Launch will be by the European Ariane rocket or by the American Space Shuttle, the final choice to be made nearer the time. The satellites will be in geostationary orbit 36,000km above the equator and will provide signals of sufficient power for high-quality reception by individual households, with suitable receivers and small dish antennas less than 1 metre in diameter, within a 'footprint' covering the United Kingdom and parts of Western Europe. The agreement covers a period of operation of the satellite service of at least seven years.

The satellite will carry transponders for two BBC DBS services; DBS 1 will be a Subscription Channel carrying feature films and other attractions; and DBS 2 will have an international flavour. There will also be a number of digital sound channels affording stereo sound with television and some high-quality radio channels.

The signing of the Heads of Agreement represents a notable landmark in the development of British broadcasting. It will be followed later by completion of a full Agreement covering the finer details.

PE will be publishing an article on the proposed new system in a few months' time

SOLID STATE MICRO

Lamentably, Solid State Micro Technology (for Music Inc.) has no current UK outlet. Although the SSM2040 Voltage Controlled Filter (used in the Audio Sweep Oscillator of *PE* Oct. '82) is available from Digisound (14 Queen St., Blackpool), this is a residual stock, since that company is no longer an outlet for Solid State Micro.

However, we are informed by Solid State Micro that they will take overseas orders from hobbyists, for their popular range of i.c.s. They require prepayment in the form of a money order in US dollars, allowing $2 for p&p for small packets. Prices (1–24) are indicated:

SSM–2000, 2010, 2020, 2030, 2040, 2024, 2050	**$7.50**
SSM–2011, 2022, 2031, 2044, 2056	**$5.75**
SSM–2015, 2033, 2038	**$10**
SSM–2012/2012A	**$9.50**
SSM–2100	**$10**

Solid State Micro are on the lookout for a non-OEM outlet in the UK, but for the meantime, here is their US address: Solid State Micro Technology for Music Inc., 2076B Walsh Ave., Santa Clara, CA95050, USA.

Static Bike

One day, when the final tree has fallen, the last lawn has gone nylon, and the world is artificially oxygenated, people may wonder what it must have been like to go for a leisurely bicycle ride down a country lane. The technology to simulate this experience will be old hat by then, but today it's the very latest thing, if only for Americans with sufficient disposable income to accommodate the dismissal of $20,000.

The static exercise bike is connected to a laser video disc system which projects the way ahead onto a 45 inch screen. As the rider imbibes the fresh office air, the bike is electromechanically punched up and down to simulate bumps in the road. That's not all; a choice of directions accompanies each fork in the lane, selectable by push button. The video disc has the capacity to store many parallel route options from which the laser head can be instructed to select by computer.

Silicon News Corner

Bulletins announcing new semiconductor devices arrive at PE daily, so it is possible only to describe them briefly. Details of how to obtain further information are included, however.

National Semiconductor ➧ CMOS UART with near-NMOS speed. The NSC858 interfaces to NSC800, 8085 and 1802 µPs. Has internal diagnostics and Baud generator, and consumes 50mW.

➧ The NMC9306/COP494 is a low cost 256-bit serial Electrically Erasable Programmable Memory. Needing only 5V to operate, this TTL compatible, non-volatile 16 × 16 serial read/write memory has Microwire™ I/O. It employs floating gate technology and is compatible with COP400 processors

➧ Combined 4-digit alphanemeric display and CMOS driver i.c. is called the NSM 1416. It features a 4mm, 16 segment fount, and an onboard memory to store four 7-bit ASCII words (the four display chars), and an ASCII-to 16 seg. alphanumeric ROM decoder plus multiplexing. Other features: Cascade ability, µP bus compatibility with 300ns access time.

➧ New 4MHz version of NSC800 µP speed compatible with all Z80 4MHz 8-bit micros. The NSC800D-4 has 60% speed improvement over NSC800. Set of 158 instructions; consumes 16mA typical. Also houses internal DRAM refresh circuitry. National Semiconductor, 301 Harpur Centre, Horne Lane, Bedford.

Synertek (Honeywell) ➧ Low cost SY68045 CRT Controller. 5V device pin compatible with industry standard 6845. Although flexible, primarily for interface with 6500/6800/68000 µPs. Adds to Synertek's CRT device family, of which the SY6545R is addressable up to 16K of video RAM, incorporating light pen interface. Synertek, 3001 Stender Way MS-34, Santa Clara, CA 95054.

Mitel ➧ Complete monolithic DTMF receiver (18 pin) incorporating bandsplit filter and digital decoder functions. Called the MT8870, this ISO-CMOS device also includes differential amp, clock osc., and latched tristate bus interface. Power is 15mW at 5V. Pronto Electronic Systems Ltd., 466–478 Cranbrook Road, Gants Hill, Ilford, Essex.

Precision Monolithics ➧ 1983 Product Selection Guide. Bourns Electronics Ltd., Hodford House, 17/27 High Street, Hounslow, Middx.

Intersil ➧ Two-stage, differential output, wideband video amp, the NE/SE592 offers fixed gains of 100 and 400 using no external components, or variable gain. Bandpass capability makes this ideal for pulse amplification in floppy disc units. Pin-for-pin replacement for µA733.

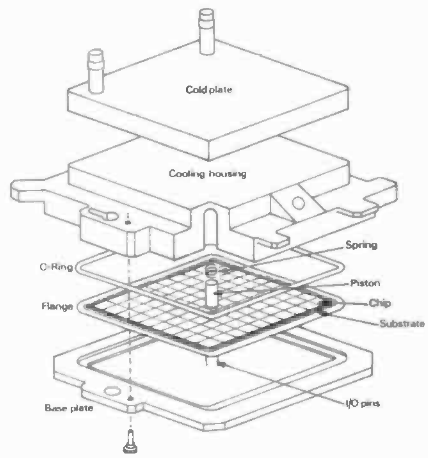
➧ ICL7415 is a 16-bit, µP compatible multiplying D/A converter. Has 16-bit resolution, linearity of 0·003% FSR, output current settling time of 3µs, and four quadrant multiplication. Intersil Datel (UK) Ltd, Snamprogetti House, Basing View, Basingstoke.

IBM's COOL CHIPS

Researchers at IBM's East Fishkill laboratories have found an ingenious way to remove heat from the silicon devices used in today's generation of fast computers. Their solution comes in the shape of a Thermal Conduction Module (TCM) which comprises up to 118 LSI chips mounted on a 30 layer ceramic substrate. The considerable heat generated in a densely packed TCM, typically containing over 25,000 logic circuits and 65,000 array bits of storage, is removed through a matrix of aluminium pistons, each spring-loaded against a chip. Backed up by water circulation, a TCM has a cooling capacity of up to 300 W.

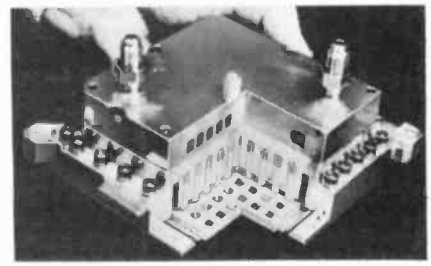
The ceramic layers carry interwiring between the chips, with power distribution dominating the lower levels, and signal routes occupying the upper levels. A key feature is the routing of all signal connections from each chip via an array of surface pads, which in turn are connected to internal wiring layers. In the event of modifications, connections to buried layers may be removed and substitute wires ultrasonically bonded to the gold-plated pads.

The same function of one typical TCM would, using the technology of the IBM 3033 processor, require 1,880 single-chip logic modules, 80 array modules with associated terminating devices, 52 multilayer printed circuit cards and four large



Exploded view of a TCM. Measures 15 x 15 x 6cm.

multilayer p.c.b.s with associated interconnecting cables. The reduction in hardware using TCM's results in greater reliability and cost saving. A reduction factor of 7:1 in interwiring length increases execution



Cut-away view of a TCM, revealing the pistons that bear down on each LSI chip. The TCM is used in IBM's new 3081 series processor.

speed by reducing what is called "time-of-flight" circuit delay. This also limits the drive circuit power requirements.

The Japanese are said to be working on water-cooled computers, but it is believed that IBM has a clear lead at this stage.

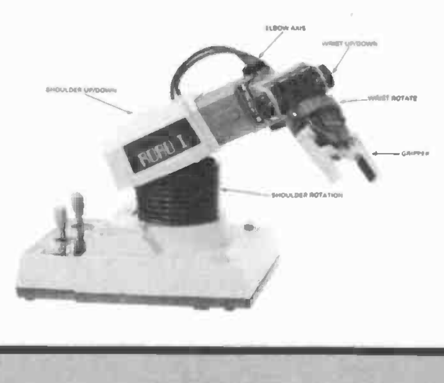
Robot Trainer

The robot arm shown in the photograph is called Armatron. It is manufactured by Tomy Corp, and has surprising flexibility due to the number of controllable axes. Armatron stands about 250mm high, being made out of blue/grey plastic, and comes with a set of important looking components for manipulation practice. This robot arm is intended to teach the geometrics of robot manipulation to youngsters, for it cannot be programmed and will not interface to a computer, but is operated entirely by way of two joysticks. It nevertheless is a fascinating and instructive gadget with which to experiment; any combination of axes can be simultaneously activated.

The robot's console has an integral timer switch that shuts off power from the battery (two D-cells) after a preset time period. One's progress can be monitored, or competitions held using this timer, during tasks using the "industrial components" supplied. The timer's lapsing "energy level" as it is called, can be seen through a row of windows on the robot's console, where orange squares disappear one by one.

Armatron is entirely mechanical, being powered from a single d.c. motor. Revolving drive shafts carry power through the arm to each axis, a system involving numerous differential gears. The joysticks operate into a drum of centrifugal gears which distributes power from a single drive shaft. The mechanics alone of Armatron are intriguing enough, but by the same token a disappointment to the micro/robotics buff. There's no rational way to interface Armatron to a micro (our original reason for examining the robot). In any case, the machine lacks the necessary precision for simple operation from a program of instructions, and would therefore require positional feedback, making the modifications still more disproportionate.

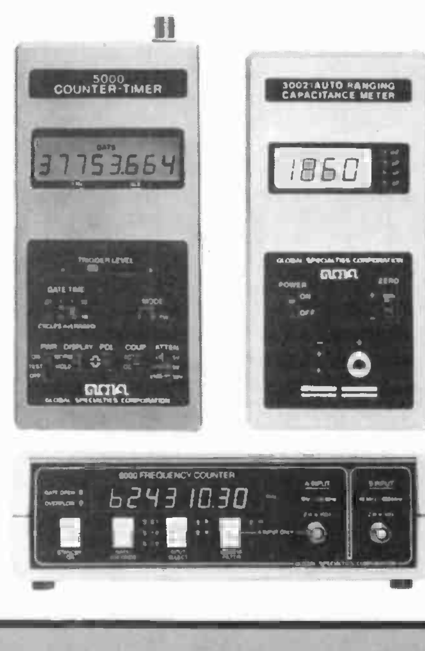
By the time this item is in print, Armatron (called Robo I outside the UK) should be available through high street shops at around £35.



GSC Launch

Global Specialties have just launched three new test instruments: an autoranging capacitance meter, a frequency counter and a handheld frequency counter-timer.

The autoranging capacitance meter, model 3002, incorporates a $3\frac{1}{2}$ digit l.c.d. and measures 193 x 95 x 44mm. The unit provides direct readings of capacitance from 1pF to 19990μF over eight automatically selected ranges with an accuracy within 0·2% (± one count) from 1pF to 199μF and 1·0% (± one count) between



MARKET PLACE

200µF and 19990µF. The 3002 is priced at £165.50 including VAT.

The frequency counter, model 6000, can measure from 50Hz to 650MHz and has an 8-digit l.e.d. display, simple push-button controls with l.e.d. indicators for selecting the input, gate time and low pass filter.

Two BNC inputs are provided: one covering the range 5Hz to 100MHz with a 1MΩ input impedance and the other for signals between 40MHz and 650MHz with a 50Ω impedance. Gate times of 0·1, 1·0 and 10 seconds are available. The instrument which measures 76 x 254 x 178mm is priced at £315.39 including VAT.

The last unit in the range is the model 5000 handheld counter-timer which is battery operated and includes pulse-width measurement facilities in addition to frequency and period.

The unit has an 8-digit l.c.d. and covers the frequency range from 0·1Hz to 50MHz incorporating a wide range of signal-conditioning facilities including attenuation, slope selection, a.c. or d.c. coupling and a variable trigger level.

The model 5000 is priced at £274.85 including VAT.

For complete details of these and the rest of the GSC range of instruments send a self-addressed envelope to GSC, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

Fair News

Those readers who came to the first Electronics Hobbies Fair last November will not want to miss the second one, so make a note of the dates now: October 27th to the 30th 1983. The event will take place in the same excellent venue (Alexandra Pavilion) and it will have all the best attractions of "number one" with plenty of new ones. Something for everyone with any interest in electronics.

The foremost consumer electronics exhibition goes forward so make sure you are there.

Briefly...

A team of scientists from Lockheed's Palo Alto Research Laboratory and Stanford University have achieved a breakthrough in understanding how radio waves interact with the Earth's magnetosphere and ionosphere. The SEEP (Stimulated Emission of Energetic Particles) study, sponsored by the Office of Naval Research, is said to have confirmed a long believed theory that man-made Very Low Frequency (v.l.f.) radio waves traverse earth's magnetic field lines to great altitudes and dislodge electrons. In a process identical to that caused by sunspot activity these electrons are dumped into the ionosphere, causing a miniature aurora borealis, and the release of X-rays. Remarkable improvements in radio communications could result from this discovery. It may be possible to use magnetic field lines to capture and amplify v.l.f. radio waves.

● ● ● ●

A new component, developed by Ferranti at Dalkeith, is believed to be the most accurate and first of its kind in the world. It is an encoder, Type 35HA, and is used to measure the rotation of a shaft down to 1/3000th of a degree. According to Ferranti News, *if you were to plot a triangle between the outer edges of a house brick and an observation point* 24 miles *away, this would be the angle formed at the observer's point!*

Encoders are used for radio telescope tracking, laser pointing systems and robotics. The computerised 35HA can work accurately up to 1000 r.p.m.

Countdown ...

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Compec Scotland May 17–19. Kelvin Hall, Glasgow. **Z1**
Welsh Amateur Radio, TV & Electronics Rally May 22. Barry Memorial Hall, S. Glam. **C**
Computers In The City (conf. & ex.) May 24–26. Barbican. **O**
Business Telecom May 24–26. Barbican. **O**
International Word Processing May 24–27. Wembley Conf. Cntr. **Z**
Motradex May 25–27. Sandown Exhibition Centre, Surrey. **Z1**
East Suffolk Wireless Revival May 29. Ipswich Civil Service Sportsground. **V1**
Russian Holography June–Sept. Inc. Light Fantastic Gallery. **A8**
Apple Exhibition June 3–5. Fulcrum Cntr., Slough. **J1**
Semlab June. Olympia. **I**
IBM Productivity (conf. & small ex.) June 14–16. Tara Hotel, London. **O**
The Computer Fair June 16–19. Earls Court. **Z1**
Compec North June 21–23. Belle Vue, Manchester. **Z1**
Transducer/Tempcon June 28–30. Wembley Conf. Cntr. **T**
Leeds Electronics Show July 5–7. University. **E**
Satellite TV & Cable TV July 5–7. Alex. Palace, London. **G4**
IBM User Show July 12–14. Wembley. **O**
BAEC Amateur Electronics July 16–24. Shelter, Esplanade, Penarth, S. Glamorgan. **B9**
Laboratory Edinburgh July 18–20. University. **E**
Acorn Exhibition Aug. 25–28. Cunard Int. Hotel, Hammersmith, London. **J3**
BARTAG Rally (radio teleprinter) Aug. 29. Sandown Park, Esher, Surrey. **E2**
Weldex Sept. 12–16. NEC B/ham. **I**
Testmex Sept. 13–15. Grosvenor House, Park Lane, London. **E**
Personal Computer World Show Sept. 28–Oct. 2. Barbican, London. **M**
Laboratory London Oct. 12–14. Barbican Centre. **E**
Drives/Motors/Controls Oct. 12–14. Leeds University. **E**
Computer Graphics Oct. 18–20. Wembley. **O**
PARC (computers in architecture, conf.) Oct. 18–20. Wembley. **O**
International Business Show Oct. 18–26. NEC. **T**
Business Efficiency Exhibition Oct. 22–26. Earls Court, London. **Z**
Electronics Hobbies Fair Oct. 27–30. Alex Pavilion, London. **Z1**
Compec Nov. 15–18. Olympia, London.
Northern Computer Fair Nov. 24–26. Belle Vue, Manchester. **Z1**

A8	Holographic Exhibitions ✆ 01-826 6423
B9	Cyril Bogod, British Am. Elect. Club ✆ 0222 707813
C	Reg. Rowles ✆ Cardiff 565656
E	Evan Steadman ✆ 0799 22612
E2	BARTG 89 Linden Gdns., Enfield, Middx.
G4	Intech Exhibitions, 55 London Rd., St. Albans
I	Industrial Trade Fairs ✆ 021 705 6707
J1	Database Publications, Stockport, Cheshire
J3	Computer Marketplace. ✆ 01-930 1612
M	Montbuild ✆ 01-486 1951
O	Online ✆ 09274 28211
T	Trident ✆ 0822 4671
V1	Jack Tootill, 76 Fircroft Rd., Ipswich IP1 6PX
Z	BETA Exhibitions ✆ 01-405 6233
Z1	IPC Exhibitions ✆ 01-643 8040

PROGRAM CONDITIONER

IAN HICKMAN

THE usual way to copy a personal computer program stored on cassette is to load the program into the computer and record it onto another cassette. This method has both advantages and disadvantages. On the plus side, only one cassette recorder is required, and the program listing can be checked for errors on the visual display unit screen—usually a TV set—as it loads. Further, when it is recorded, the new recording is retimed by the computer so that any timing imperfections on the original due to flutter or other cassette deck limitations are not compounded.

On the debit side, the computer is tied up whilst loading and recording are in progress. Also, it is sometimes found that the program won't load correctly in the first place, due to inadequacies in the original recording or in the cassette machine used for playback, or due to the combination of the two—there are fairly startling differences in performance between different models.

The circuit forming the subject of this article can often circumvent this problem and is thus useful as a signal conditioner to rescue poor recordings and enable them to be successfully loaded into a computer. Also, if two recorders are available, it permits programs to be copied directly without tying up a computer. The latter method is particularly useful for the enthusiast who is still saving up for a computer system but who wants to be able to collect programs from friends in the meantime.

The circuit consists of four sections—a selectable high-pass filter, an adjustable all-pass filter, an output stage providing clipping and shaping, and an audio stage driving a monitor loudspeaker. To understand the purpose of the various stages—particularly the all-pass filter (also known as a phase equaliser)—one needs to know a little of how tape recording works.

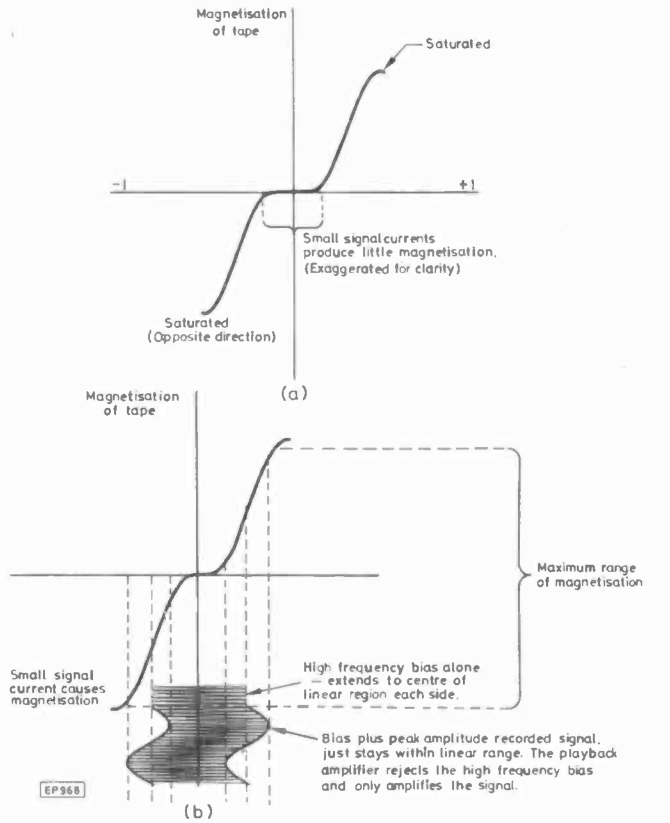


Fig. 1. Magnetic tape recording with (a) no bias and (b) the effect of bias

RECORDING ON TAPE

Magnetic recording tape consists of thin plastic, coated with finely divided iron oxide or other suitable magnetic powder. You may have noticed that once pins have been picked up with a magnet, they will tend to stick together even in the absence of a magnet. This effect is called remanence and is the basis of tape recording. Fig. 1 shows how a recording head records the signal onto the tape.

The relation between the record current and the remanent magnetism is nonlinear, so a high frequency (50 to 100kHz) bias current is added to spread the recording to the linear parts of the characteristic. On cassette recorders the same head is usually used for playback, so that monitoring from the tape is not possible. Another head uses the a.c. bias current at a much higher power to erase previous recordings. Quarter track heads are used in stereo cassette recorders, providing two tracks in either direction. Mono recorders use half track heads in the same way as older half track reel to reel recorders. With stereo cassette machines, the two tracks of the stereo signal are on the same side of the tape, and both are erased at the same time by the erase head. As with reel to reel recorders, the erase head is energised during recording and the tape passes over it first, before reaching the record head. Thus four track mono use is not available, but mono cassette recordings can be played on

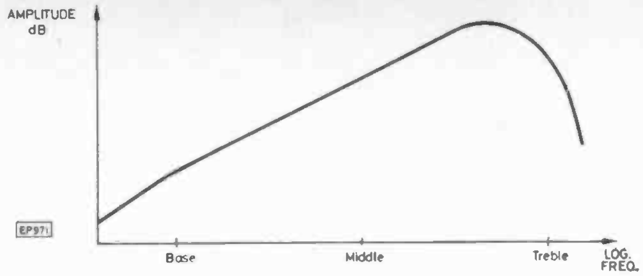


Fig. 2. Typical tape playback curve for constant peak recorded flux density

stereo cassette decks and vice versa. Of course the result is always mono except in the case of a cassette recorded on a stereo machine being replayed on a stereo machine.

There is nothing to prevent one using an older reel to reel recorder for storing personal computer programs on tape, though cassette machines are almost invariably used because of their greater convenience.

Also, the greater demands made on the tape by the very low tape speed ($1\frac{7}{8}$in per second) and narrow track of the heads used in cassette machines has resulted in the development of much better tape, suffering less from drop outs (random areas of low sensitivity along the tape) than older reel to reel tapes. However, whatever type of tape is used, one still has to cope with the basic frequency response of magnetic recording tape, as shown in Fig. 2. The 6dB per octave roll-off in the middle and lower frequency region is a result of the law of induction, the induced voltage on playback (for constant peak recorded flux level) is directly proportional to the rate of change of flux density, and hence to the frequency.

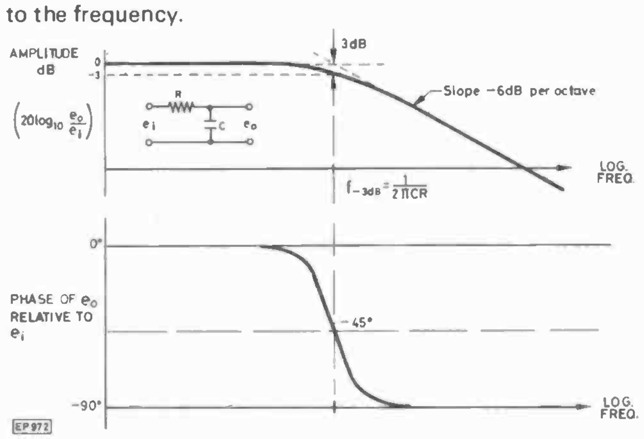


Fig. 3. Bode plot of phase and amplitude against frequency for a top-cut circuit

At higher frequencies, another effect takes over. The shorter and fatter a magnet, the greater the tendency to self-demagnetisation—which explains why, before the invention of modern improved magnetic materials, magnets were always long and thin. The same effect is observed in tape recording where the shorter recorded wavelength along the tape results in a falling high frequency response. The effect is compounded by the bias waveform, which unfortunately acts increasingly as an erase signal as the recorded frequency rises. The signal applied to the erase head is simply the bias waveform, but at a very much higher level.

To obtain a level overall response independent of frequency, on playback the middle and bass are boosted by 6dB per octave and the high frequencies, above the frequency of maximum response are also boosted. The rate of fall-off of the high frequency response is in fact faster than 6dB per octave, so boost is also applied during recording.

EFFECT OF PHASE

It is usually claimed that the phase response of audio equipment is unimportant as the ear is not sensitive to phase, and this is certainly largely true as otherwise tape recordings would all sound awful. The fact is that audio tape recorders of all types do dreadful things to the relative phase of the harmonics of, for example, a squarewave. To see why we must now digress a moment and look at phase and amplitude responses versus frequency for various circuits and processes, usually called bode plots.

Fig. 3 shows a top cut or high frequency roll-off circuit, together with its Bode plots. It can be seen that at low frequencies, where the response is level, there is little if any phase shift; whilst at high frequencies, where the response is falling off at 6dB per octave, the phase shift approaches 90° lagging. At the point where the 6dB/octave asymptote crosses the level asymptote, the amplitude response is −3dB, and the phase shift is −45° (45° lagging). Bode's relations show that generally a lagging or negative phase shift is associated with an amplitude response which is falling with increase of frequency, and a leading or positive phase shift with a rising amplitude response. The change in amplitude of response in dBs (decibels) between two frequencies f_1 and f_2 is proportional to the integral of the phase shift between limits f_1 and f_2, and the phase shift at any frequency is proportional to the rate of change of amplitude response. The going rate of exchange is 90° (lead or lag) for a 6dB/octave rate of change of amplitude (rising or falling with frequency respectively).

Does this apply universally? Well, almost; that is it applies to all "minimum phase" circuits and processes and this includes most tone control networks and filters. There are, however, "non minimum phase" networks. This can occur for example where there are two parallel paths through a network. In such cases Bode's relationships do not apply—a well known example is the twin tee network. There are a number of non minimum phase processes and two other examples are all-pass filters and tape recorders.

In tape recording, it has been explained that the high frequency roll off is due to self- and bias-demagnetisation, and in fact there is no associated phase shift involved—a non minimum phase process. The treble boost applied on both record and playback to maintain a level response is a minimum phase process and thus, overall, the amplitude response is level, but the phase advanced.

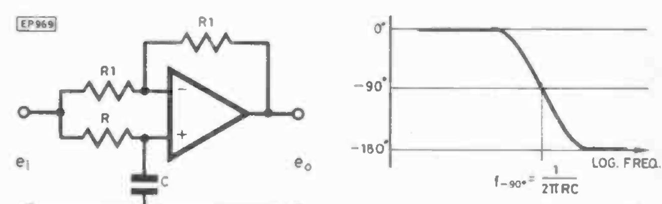


Fig. 4. An all pass filter and its phase response. Here gain is unity at all frequencies

The all pass filter in Fig. 4 has an amplitude response independent of frequency, but provides a phase response which varies with frequency. At very low frequencies, it is a non inverting amplifier with unity gain, i.e. 0° phase shift. At a frequency $f_{90}=1/(2\pi CR)$ it has a 90° phase lag and at high frequencies the phase shift becomes 180° lagging, all the while with a flat amplitude response. Fig. 5 shows the effect on a square wave of changing the product CR. When $1/(2\pi CR)$ is very much lower than the fundamental frequency of the square wave, f_f, all the frequency components of the square wave are shifted by −180°, so the waveform is unaffected. If f_{90} rises—say by reducing the value of R—the effect on the squarewave at first is not unlike the slope or tilt produced by an inadequate coupling capacitor—Fig. 5(a). As f_{90} approaches f_f, the effect is more marked, but as the fundamental is now shifted in phase relative to the harmonics without its amplitude being reduced, we see the waveform of Fig. 5(b), and as f_{90} becomes higher and then much higher than f_f we see waveforms like Figs. 5(c) and (d).

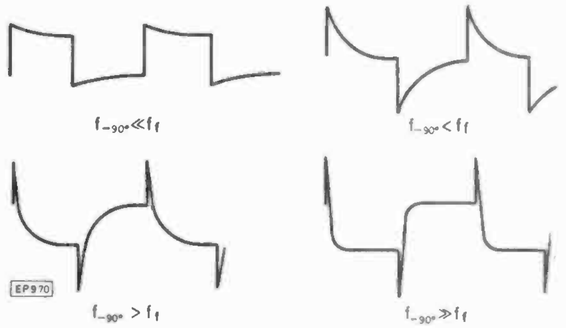


Fig. 5. Effect of the all pass filter on an ideal square wave of frequency f_f

RECORDING PROGRAMS

Returning now to the topic of recording programs on cassettes, the usual format is CUTS (computer users' tape system), also known as the Kansas City interface. This is an FSK (frequency shift keying) system where a frequency of 1200Hz represents a zero and 2400Hz a 1. As the signalling rate is 300 bauds (300 signal elements per second) one signal element consists of either 4 cycles of 1200Hz tone (a zero) or 8 cycles of 2400Hz tone (a 1). The format is a 1 as a start bit, eight data bits (1s or 0s according to the byte to be transmitted) and two stop bits. On replay, the computer looks for a 0 (start bit) following a long string of 1s, and thereafter for succeeding start bits following the two stop bits. Signal conditioning circuitry in the computer's CUTS input turns the two tones into 0 or 1 levels as appropriate.

Thus the system is asynchronous, and provided the difference in speed between the recorder used to make the recording and that used to reproduce it (allowing also for the effects of flutter and noise) is not more than a few percent then no problems should arise. Nevertheless, the phase distortion already noted is bound to occur in the cassette recording/playback process, so compensation for the phase advance of the harmonics is applied by a phase retard (top cut) circuit in the computer's CUTS output—Fig. 6(b). Allowing for the limited frequency response of most cassette recorders, this would ideally appear on playback as in Fig. 6(c).

Several deviations from the ideal playback waveform are commonly observed. The waveform often has superimposed hum at 50Hz (poor layout, induced hum from the recorder's mains transformer), at 100Hz (inadequate smoothing of full wave rectifier output), and at 150Hz (a third harmonic component of the mains transformer's magnetising current due to using the core laminations at a peak flux density approaching saturation). The smallish internal speaker used in many machines is relatively insensitive at 150Hz and completely dead at 50Hz, so the manufacturer has little incentive to worry over much about these hum components in the playback signal. To cope with this problem, the circuit described later has an active 2 pole high pass filter which can be switched into circuit if required.

Another problem one encounters is excessive phase distortion, due to a variety of causes. One commercially produced program appeared to have been recorded without sufficient phase retard, or maybe excessive peaking in the record circuitry. The result was that playback on the author's

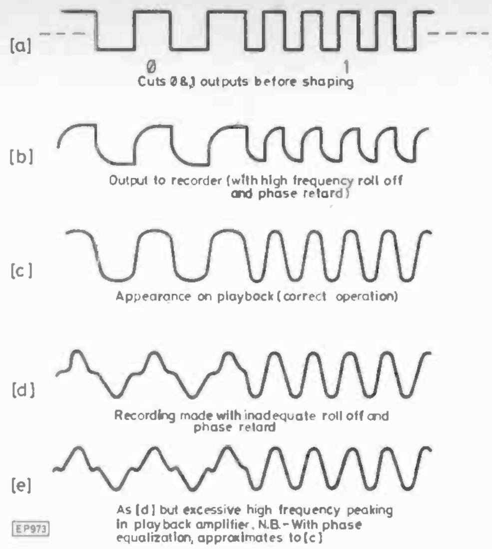


Fig. 6. Waveforms associated with cassette program recording

Trophy CR100 cassette recorder resulted in the 1200Hz tone appearing as in Fig. 6(d). The program loaded o.k., but on a colleague's cassette deck (which was evidently equipped with extra enthusiastic treble peaking in the playback equalisation section) the waveform appeared as in Fig. 6(e). The additional zero crossings got sliced in the computer's CUTS input circuit, turning occasional 0s into 1s and corrupting the program. The extraneous wiggles could be reduced with the aid of the tone control (which, like the volume control, controlled the output at the recorder's 5 pin DIN auxiliary socket) but that also had the undesirable effect of attenuating the 2400Hz 1 tone. The all pass filter in the signal conditioner described in this article permits the harmonics to be properly relocated in phase relative to the fundamental, resulting in the 1200Hz tone again resembling a squarewave, without attenuating the 2400Hz tone at all. So, having prepared the ground, let's look at the full circuit of the Program Conditioner, Fig. 7.

THE SIGNAL CONDITIONER

This uses a TL084 quad op-amp and the whole instrument fits in a small sloping panel plastic case, powered from an internal PP7 battery. Two input sockets are provided, the first (JK1) being a 3·5mm jack socket. This accepts a jack to jack lead from a cassette recorder's earphone socket, a suitable level being set with the recorder's volume control. The second input socket (SK2) accepts an input from the recorder's auxiliary socket. The latter is usually a 5 pin 180° DIN socket and to prevent the DIN plug to DIN plug lead from being connected the wrong way round, a 5 pin 270° DIN socket is used on the Program Conditioner. On the 180° DIN plug, the two signal output pins (usually pins 3 and 5) are connected in parallel so that a stereo cassette deck is used in the mono mode. Most recorders provide the AUX output signal at a fixed standard level, unaffected by the volume control or tone control (if any), but on some machines the AUX level is affected by these controls—in which case a medium volume setting (and no top cut) should be selected.

The input signal is applied to IC1b which acts as a non inverting buffer amplifier when S1 is closed, and as a high pass filter when S1 is open. In this mode, it provides, nominally, a 300Hz corner frequency with 12dB attenuation at 150Hz and 30dB at 50Hz, with little effect at 1200Hz —the lower of the two tones used in recording programs.

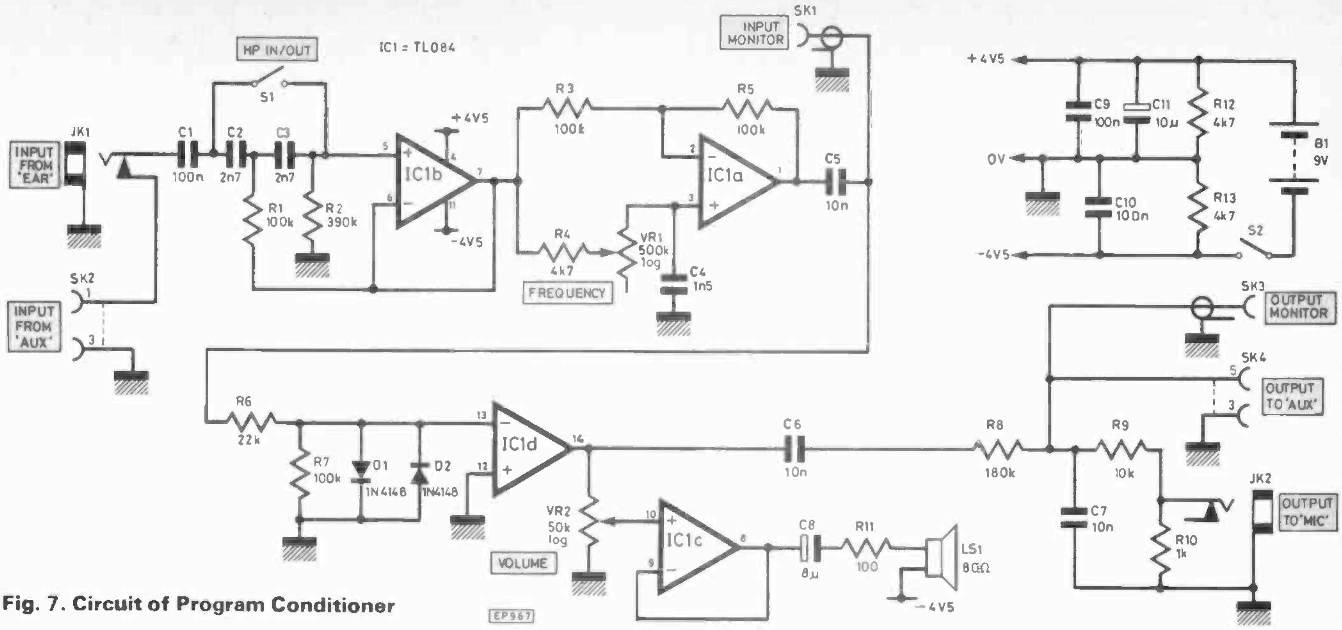


Fig. 7. Circuit of Program Conditioner

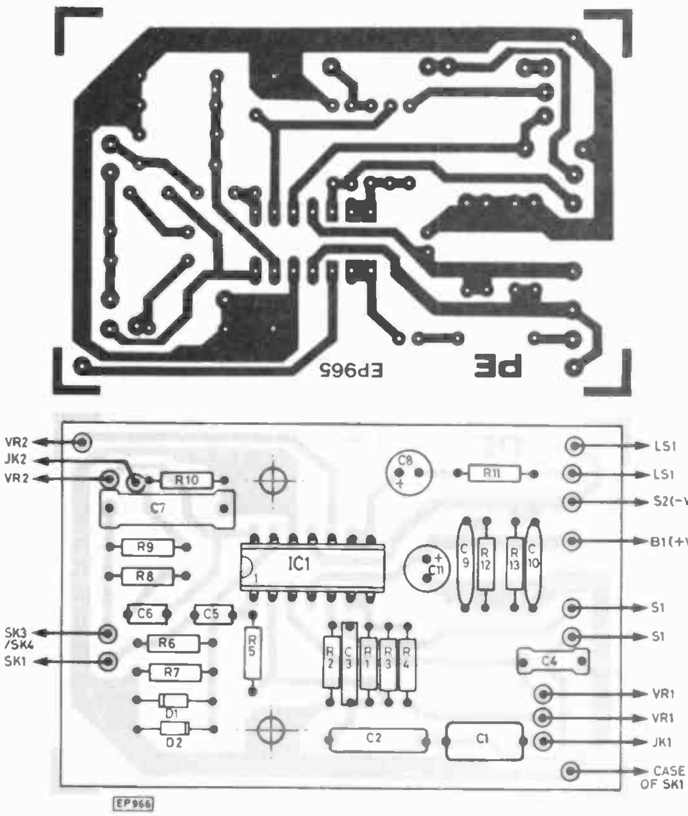


Fig. 8. Printed circuit detail and component overlay

COMPONENTS . . .

Resistors

R1	100k
R2	390k
R3	100k
R4	4·7k
R5	100k
R6	22k
R7	100k
R8	180k
R9	10k
R10	1k
R11	100
R12–R13	4·7k (2 off)

All resistors $\frac{1}{4}$W 5%

Capacitors

C1	0·1µ
C2–C3	2·7n (2 off)
C4	1·5n
C5–C7	10n (3 off)
C8	8µ 16V
C9–C10	0·1µ (2 off)
C11	10µ 16V

Integrated Circuit

IC1	TL084

Potentiometer

VR1	500k log
VR2	50k log

Switches

S1	S.p.s.t. miniature toggle
S2	S.p.s.t. miniature toggle

Battery

B1	PP7

Loudspeaker

LS1	80 ohm 2in

Sockets

JK1, JK2	miniature sockets
SK1, SK3	BNC connectors
SK2, SK4	5 way 240° chassis mounting sockets

The output of the high pass filter stage is applied to the all pass filter, IC1a. The turnover frequency of this stage (at which the phase shift is 90°) is adjustable by VR1 from about 200Hz to 20kHz. At the latter setting (VR1 fully anticlockwise) the all pass filter is effectively out of circuit since the vast majority of cassette recorders cannot reproduce frequencies this high. Thus, with VR1 set anticlockwise and S1 closed (high pass filter bypassed) the playback signal from the recorder can be observed by connecting an oscilloscope to SK1, the "Input Monitor" socket. Any hum or phase distortion can thus be observed, as can the corrective effect of the two filters. The filtered, phase corrected signal is fed to IC1d where it is sliced to produce a near ideal squarewave, as this op-amp is run open loop a.c. coupled as a comparator. IC1c, controlled by volume control VR2, provides a drive to the miniature loudspeaker, permitting audible monitoring. This is useful when using the EAR output of the cassette deck, as this cuts out the recorder's internal loudspeaker. R8, 9, 10 and C7 provide shaping, phase retard and level adjustment for the two outputs and the monitor output. The latter (SK3) is provided to permit viewing of the output waveform on a 'scope, whilst the output to a computer's cuts input (or to a second cassette machine for direct copying) is taken from SK4, or from JK2 if the cassette's microphone input is used instead of AUX.

CONSTRUCTION

With a quad op-amp and modern miniature components the circuit board takes up very little space and weighs very little. The p.c.b. assembly is stood off from the front panel as shown in Fig. 9 and the latter includes all circuit components

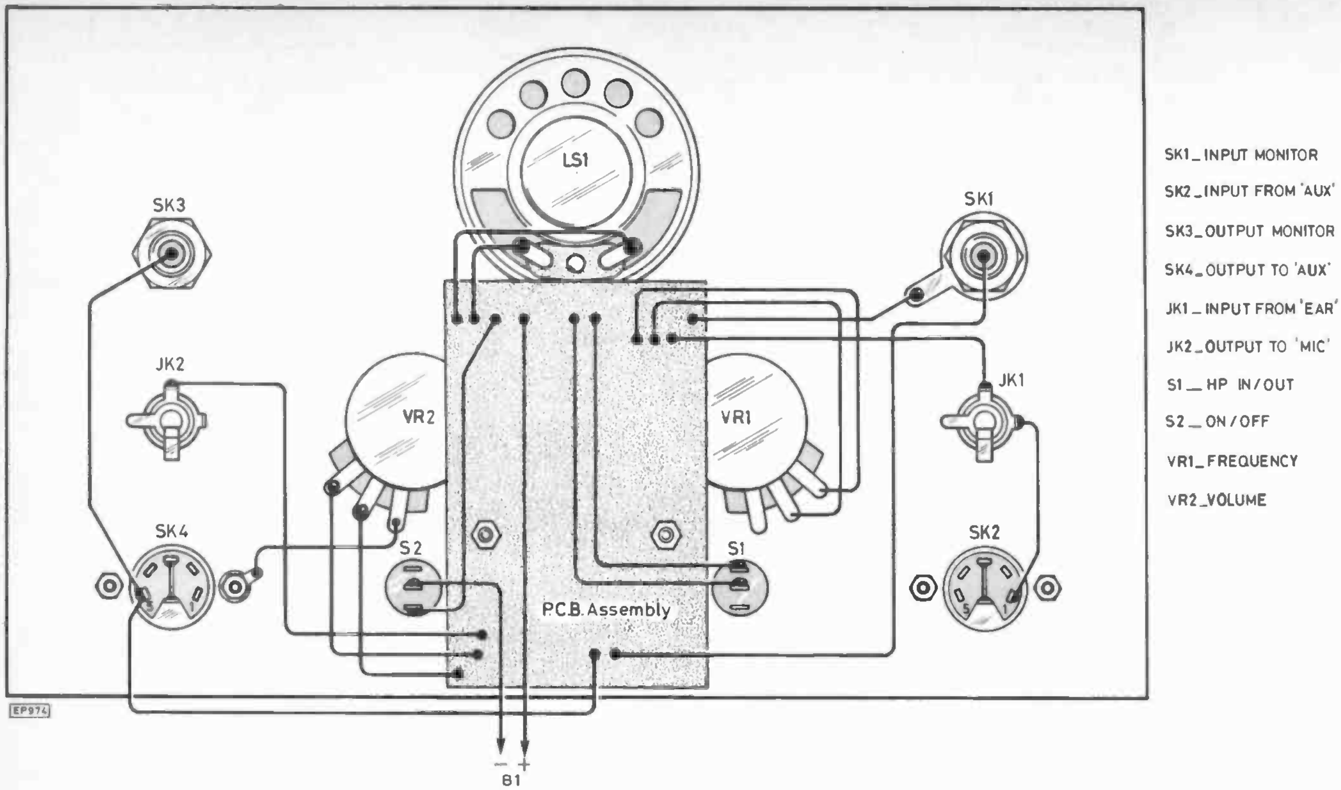


Fig. 9. Placement of case mounted components with board interwiring

except the battery. This combines for neatness and easy access if servicing is required.

Etching details for the printed circuit and the component overlay are shown in Fig. 8. Other layouts, such as on Veroboard, can be used but watch out for op-amp outputs running close to inputs—this could cause instability. The component assembly is built into a plastic box with a sloping front panel 12·5 by 21cm. This provides space for an uncluttered panel layout and just sufficient depth to accommodate a PP7 layer type battery. As the whole instrument draws only about 8 milliamps with intermittent use battery life should be almost indefinite. A photograph of the front panel is shown with appropriate legends.

USE

To obtain the best from the Program Conditioner one really needs to observe the signal at the input monitor socket on a 'scope. The simplest of these suffices, e.g. a single trace instrument with a bandwidth covering the audio band is quite adequate, though good triggering is, as always, important. One can soon tell from the appearance of the trace and the sound from the monitor speaker whether the playback signal is of good quality. If the trace is fuzzy in the vertical direction, this usually indicates hum, as can be verified by switching to a slow timebase setting—switching in the high pass filter should cure this. Fuzziness of the trace in the horizontal direction usually indicates speed variations (wow and flutter), either due to the machine which recorded the program in the first place, or due to the cassette deck being used for playback. The ear becomes quite good at detecting this with practice. There is little that can be done about this (other than using a better cassette deck if the flutter is due to playback) but it does make correct equalisation more important. If the 1200Hz tone looks a bit peaky and triangular, advance the phase equaliser control VR1 from the fully anticlockwise position. You should see the 1200Hz tone become squarer, with faster rise and fall times as it passes through the mean value, when the fundamental is correctly phased with respect to the harmonics.

This is the correct condition, over compensation will result in a return to the peaky, triangular waveform. There will be comparatively little effect on the 2400Hz tone on most small cassette machines as they will already be falling off considerably in frequency response at the odd harmonics of this frequency.

Use of this Program Conditioner can enable a program to be successfully loaded which otherwise might be difficult or impossible; it should then of course be recorded from the computer to avoid further problems. Alternatively, the Program Conditioner can be used to clean up and optimise a program on cassette for rerecording on another machine without tying up a computer at all. Providing the original recording loads, the rerecorded copies should likewise do so.

★

Patents Review

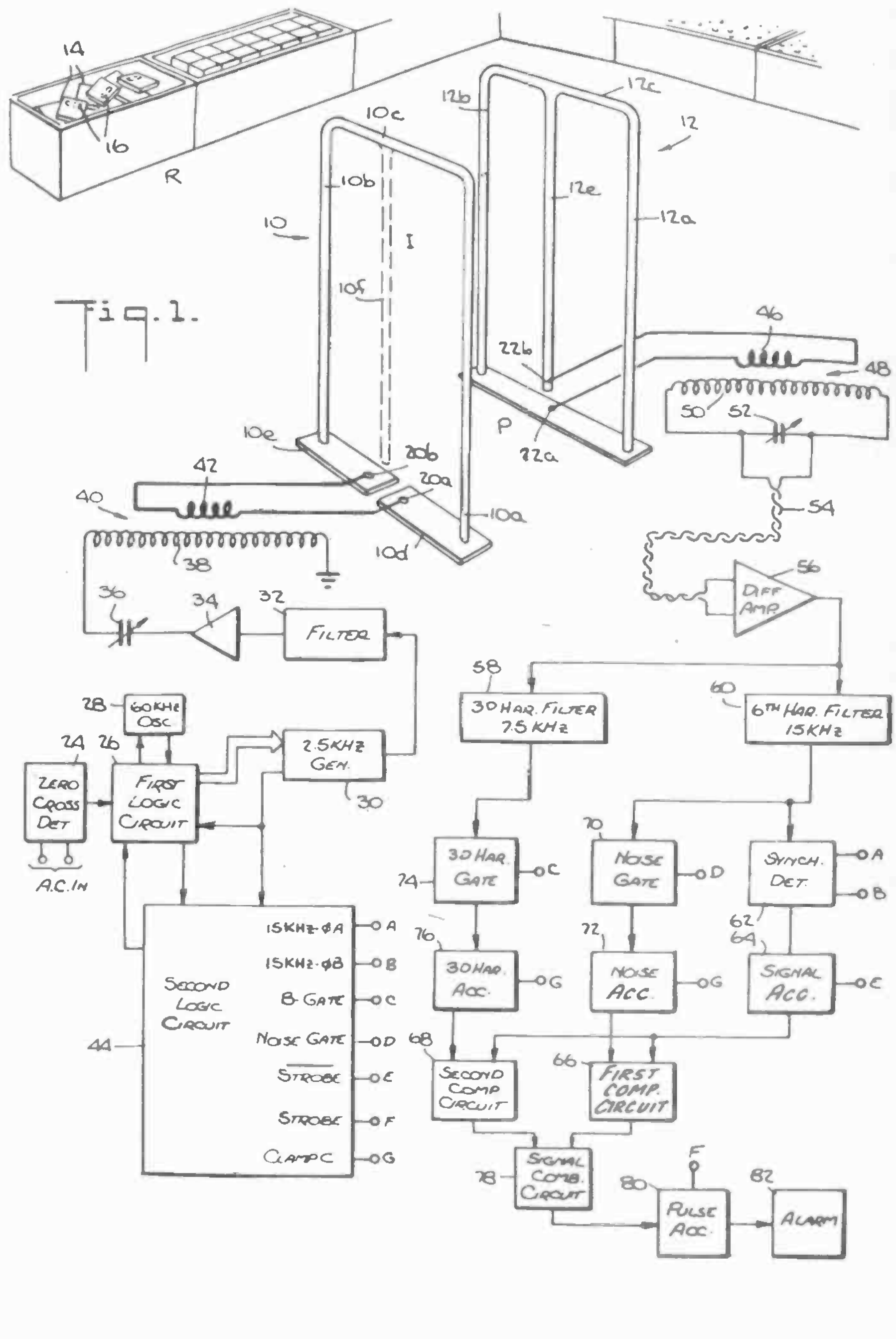
Copies of Patents can be obtained from:
the Patents Office Sales, St. Mary Cray, Orpington, Kent. Price £1.60 each.

THEFT DETECTOR

The Knogo Corporation of Hicksville USA (yes, there really is a Hicksville, USA!) has filed a British application, 2 101 454, on an elaborate approach to theft detection in shops. In Fig. 1 transmitter aerial 10 and receiver aerial 12 are arranged on opposite sides of a shop check-out point. All the goods in the shop carry targets 16 which are thin strips of magnetic material which is easily saturated in a strong field. The transmitter aerial 10 produces an alternating magnetic field of fixed frequency, around 2·5kHz, which is strong enough to cause a target strip in the check-out zone to become magnetically saturated and unsaturated in cycles synchronised to the alternating magnetic field. This makes the target emit its own alternating fields, which are at harmonics of the basic field frequency. A receiver, connected to aerial 12, responds to a selected harmonic e.g. the sixth at 15kHz, to set off an alarm when it senses a cyclically varying signal.

In practice the transmitter aerial 10 is a single one turn loop and the receiver aerial 12 is a pair of single turn loops. Mains power is fed through a zero crossing detector 24, which produces a pulse each time the voltage passes through zero. These pulses are applied through logic circuit 26 to an oscillator 28 which produces high frequency signal bursts. The oscillator output is divided down and converted into four separate 15kHz signals, each of different phase. The signals are fed to 2·5kHz generator 30 which divides them down again to produce square waves at 2·5kHz during the time periods when the oscillator 28 is on. The square wave outputs from the 2·5kHz generator 30 are filtered at 32 to produce a sine wave, which is applied to a series resonance circuit, made up from capacitor 36 and transformer primary 38.

Large currents, of over 100 amps r.m.s., are fed to the aerial 10. The receiver aerial 12 is in the form of two parallel loops, so a changing magnetic field applied uniformly to both loops induces bucking currents which cancel each other out. In this way the effect of direct transmission between the aerial 10 and 12 is eliminated. When a target strip 16 passes by the aerials it will always be closer to one of the two receiver aerial loops than the other. So its harmonic magnetic field gives a detectable current in receiver transformer coil 46. The signal is filtered to separate any sixth harmonic content. This is then pulsed and stored. When a pre-determined number of pulses, for instance two, have accumulated during successive transmitter signal intervals alarm 82 is tripped. The storage feature prevents false alarms through spurious harmonics getting into the system. The patent gives full details of the circuit, including component types and values.



ROCKTONE

THE ROCKTONE is intended as a versatile aid for technicians working within the music industry, such as soundcrew, DJs and engineers, and provides a compact and robust unit which allows accurate adjustment of tone controls, graphic equalisers and crossover units of a PA system or disco amplifier. It allows correct tonal balance to be obtained by pinpointing irregularities in frequency response thus achieving a true-to-life sound system.

A sinewave is injected into the input of the amplifier/mixer of the sound system to be tested or adjusted. This signal automatically sweeps through the audio band (20Hz–20kHz), and by adjusting parameters such as the graphics, speaker combinations, position and direction, tape or phono de-emphasis etc, a superior sound may be obtained. This method, unlike expensive real-time bandwidth analysers, which need a display and precision microphone and pre-amp set-up, requires only a trained ear to set up a complete PA system in minutes, free of any spurious resonances and dropouts that may occur.

GENERAL

The Rocktone is based on two i.c.s—the XR2206 and the LM324 quad op-amp. The XR2206 is a high-quality waveform generator which can produce sinewave frequencies ranging from a fraction of a Hz to several hundred kHz, and which may be swept over a large range using an external current source or variable resistance.

The swept frequency output is buffered/amplified and inverted by two of the op-amps to produce a balanced line output of 0dB. The other two op-amps form a comparator and monostable which produce a reset mechanism enabling the circuitry to automatically sweep and resweep through the audio band at an adjustable rate.

OPERATION

The output frequency of the generator is proportional to the current drawn from pin 7 of IC1, given a fixed value of C3. This variable current is generated by TR1, the base current of this device being supplied by the charge stored on C4 via a limiting resistor, R2. The discharge time of C4 is determined by the setting of VR1. D2, D3 and R5, D4 in this path produce a rate of discharge that allows even time spacing between octaves, as the frequency sweeps across the audio band. The voltage on C4 is monitored by IC2a which compares this to a preset value, determined by D6 and the variable potential divider, R7 and VR4. When the voltage on C4 falls to about 0·7 volts, i.e. the base-emitter threshold of TR1, the output of IC2a goes high which triggers IC2b, the monostable. The current through TR1 is now at a minimum and thus the output frequency also falls to a minimum value.

The monostable time period (approx 10ms) is determined by R15, C6 and the hysteresis produced by R13 and R14. D8 clamps the inverting input of IC2b pin 6, to a diode drop below 0 volts. When the monostable is triggered IC2b is switched on, charging up C4 via R3, and D1 to D5 producing a constant charging voltage. D1 is introduced to prevent C4 from discharging via the charging path. TR1 consequently conducts and the output frequency rapidly increases to its upper limit, determined by R1. The frequency then sweeps down as described earlier.

The automatic sweep may be disabled, and the frequency set manually by VR2. S2a disables the comparator, while S2b discharges C4 and switches in VR2. Note that VR2 is connected in the 'anti-log' configuration.

IC2c acts as a buffer/amplifier, the gain set at −1/3 by R16, 17. IC2d acts as an inverter and together with the complementary output of IC2c produces a balanced output at 'line' level, about 2·2V pk–pk.

CONSTRUCTION

Assemble the p.c.b. in the usual order, i.e. resistors first, then capacitors and diodes followed by semiconductors and i.c.s using the component layout in Fig. 3 as a guide. Check the polarity and orientation of the i.c.s, diodes and capacitors before soldering. On the prototype unit C5 was mounted on the track side of the p.c.b., care must be taken to ensure that the compo-

D. HEAD B.Sc.(Hons) **P. D'LEMOS** B.Sc.
(OF MAZTEK ELECTRONIC SYSTEMS AND INSTRUMENTS)

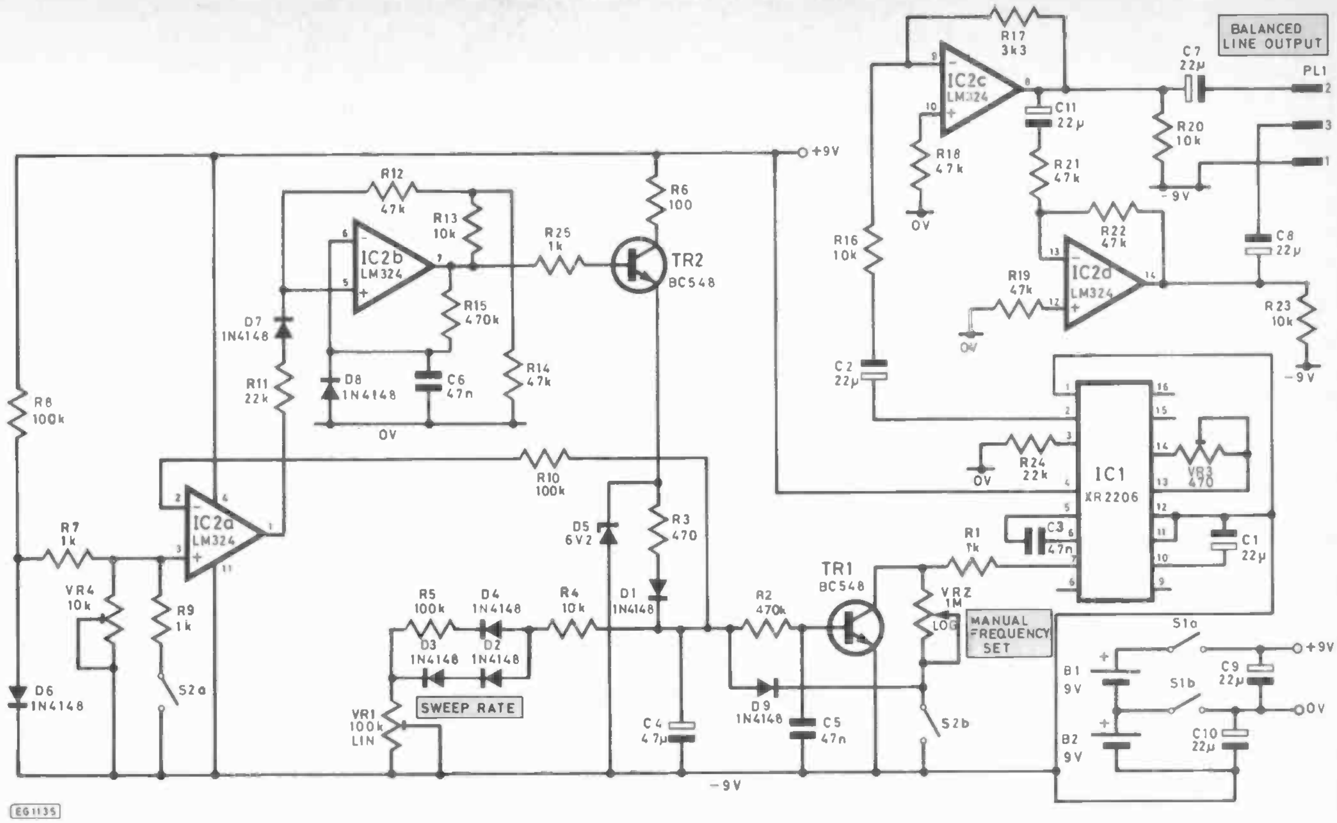


Fig. 1. Circuit diagram

nent body remains clear of the tracks. Once the p.c.b. has been assembled, solder in the connecting wires, battery clips and potentiometers, taking care to wire up VR2 in the 'anti-log' configuration, i.e. maximum resistance between the potentiometer connections in the 'off' position.

TESTING AND ALIGNMENT

Connect up the batteries and switch the unit on with the manual override control (VR2) set to 3/4 maximum. Monitor the output of IC1 (pin 2) with the aid of an oscilloscope and check that a 3V pk–pk 1kHz signal is present. If no signal is present, check IC1 and associated components.

Adjust VR3 for best sinewave purity, i.e. with least 'triangle ramping' distortion. Monitor the outputs of IC2c–d (pins 8 & 14), and check that there is just over 1V pk–pk of signal with respect to 0V and approximately 2·2V between outputs. If there is any variation check R16 and R17, and IC2d associated components. Adjusting VR2 should give a range of frequencies between 20Hz and 20kHz. Switch over to automatic sweep and monitor the falling frequency waveform with VR1 set maximum

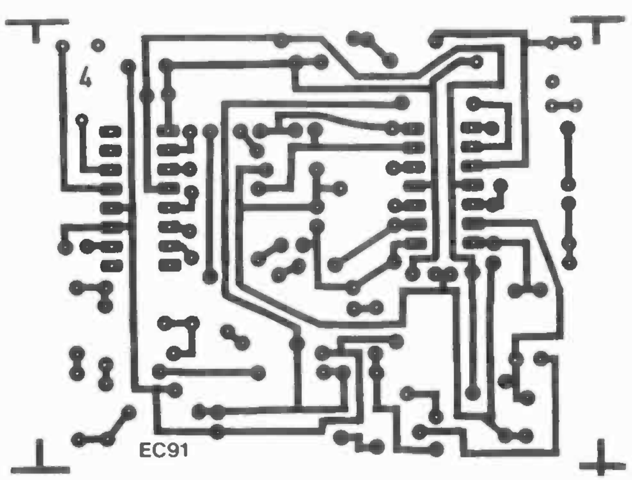


Fig. 2. P.c.b. design

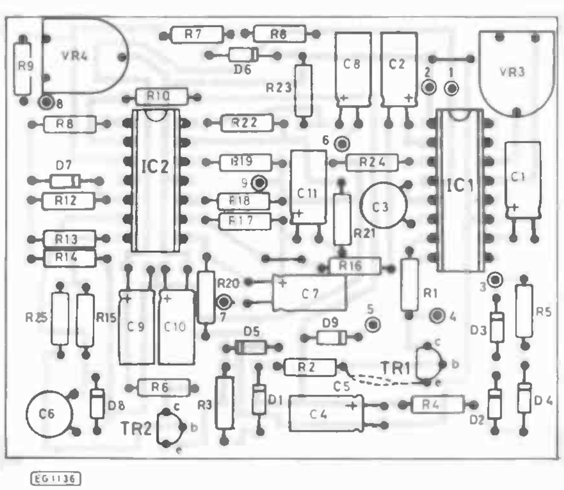


Fig. 3. Component layout

anticlockwise, i.e. slowest sweep rate. Adjust VR4 anticlockwise to decrease the lowest frequency output, which should be set at 20Hz. The sweep rate should be adjustable between about 5 and 20 seconds via VR1 and produce an even time span between octaves. If this is incorrect then check C4, TR1, VR1 and associated components.

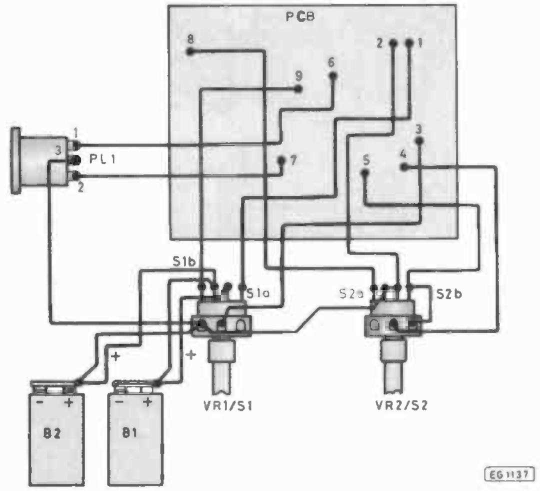


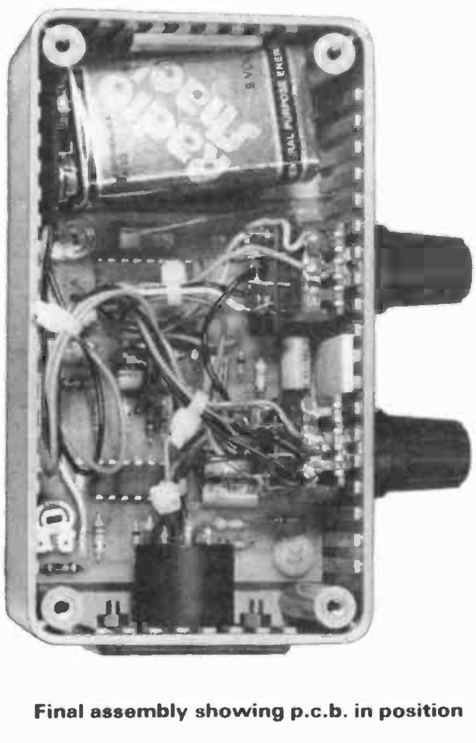
Fig. 4. Wiring details

USAGE

The PA should first be set up approximately using a vocal microphone or tape, the input equalisation being bypassed or set flat. Consideration should be given to the type of sound that is to be reproduced, thus providing a reasonable starting point for frequency analysis. The Rocktone can then replace the input to provide an accurate signal reference.

Using the Rocktone in its sweep mode and set to a long sweep time, the output of the speakers as affected by the acoustics of their environment can be heard. Careful attention to the volume present in the room as each frequency sweeps through will reveal resonances of loud peaks and weaknesses where response is poor or absorption is high. Output equalisation should now be readjusted to provide a smoother response. As the response becomes increasingly flat with adjustment, smaller variations will become audibly apparent. It is common with most sound systems to have frequency bands of particularly high irregularity, often at 100–300Hz, 1–2·5kHz, and at 5–6kHz as cross-over points, cabinets, drivers, filters and amplifiers peak. These points will produce a warbling sound during incorrect adjustment when swept.

Use should also be made of the manual frequency control facility to pinpoint the frequencies concerned, rolling the frequency back and forth over the band required. With some practice and attention to detail a smooth response will be obtained. As a final check, the whole band should be covered at a fast sweep rate. Professional use of this unit at major European and UK concerts has revealed several additional uses for the Rocktone. It has proved invaluable for testing speakers, filters, signal cables, channel and effects patching and in the workshop as a general purpose frequency generator. ★



Final assembly showing p.c.b. in position

COMPONENTS . . .

Resistors

R1, R7, R9, R25	1k (4 off)
R2, R15	470k (2 off)
R3	470
R4, R13, R16, R20, R23	10k (5 off)
R5, R8, R10	100k (3 off)
R6	100
R11, R24	22k (2 off)
R12, R14, R18, R19, R21, R22	47k (6 off)
R17	3k3

All resistors $\frac{1}{4}$W 10%

Capacitors

C1, C2, C6 to C10	22µ 16V electrolytic (7 off)
C3, C5	47n ceramic (2 off)
C4	47µ 16V electrolytic

Semiconductors

D1 to D4, D6 to D9	1N4148 (8 off)
D5	6V2 Zener, 400mW
TR1, TR2	BC548 (2 off)
IC1	XR2206
IC2	LM324

Potentiometers

VR1	100k Lin (miniature) plus dpst switch
VR2	1M Log (miniature) plus dpst switch
VR3	470 preset
VR4	10k preset

Miscellaneous

P.c.b. (see Constructor's note)
Case, about 40 x 65 x 180mm
PL11, XLR Series Connector, 3-pin plug
9V PP3 battery (2 off)
Battery clips (2 off)
Knobs (2 off)

Constructor's note

A complete kit of parts for this project is available from **Watford Electronics, 33 Cardiff Road, Watford, Herts (0923 40588)**. The kit is priced at £19.95 including VAT and p&p.

FUSION:

THE DREAM a few decades ago, of abundant cheap energy, began as a nightmare. The power of the atom first flashed its awesome might across two Japanese cities. Yet as the horror subsided into that dream of peacetime nuclear power, mankind's fleeting phantasm of a clean, cheap energy culture threatened to revert to a nightmare again. Many feel that the unstable dream, in its original form at least, now lies at the bottom of the sea in a cannister marked "Radio Active Waste". Some argue that it has been stamped "Unmanageable", and laid to rest on Three Mile Island. Whatever the case, in the 1980s energy is neither cheap, nor abundant. The great illusionist is *fission*—the process of splitting atoms to generate heat, to generate steam, to generate electricity. Fission produces high energy radiation, and creates spent fuel that is a menace for generations.

INCREDIBLE OBJECTIVE

Matter to energy! Is the alchemy not safely possible? Collectively, Europe intends to find out. Whilst the Sizewell debate radiates through the media, a far more portentious project which *really could* change our lives, is quietly forcing back the frontier of nuclear engineering. The project, based at Culham in Oxfordshire, is known as the Joint European Torus (JET). The complex houses the most ambitious *fusion* venture of the European Atomic Energy Community (Eurotom). As far as the fusion alternative is concerned, only one mechanism has the potential to produce enough heat to generate commercially viable electric power. This toroidal machine is called a Tokamak, and at Culham they have constructed a leviathan.

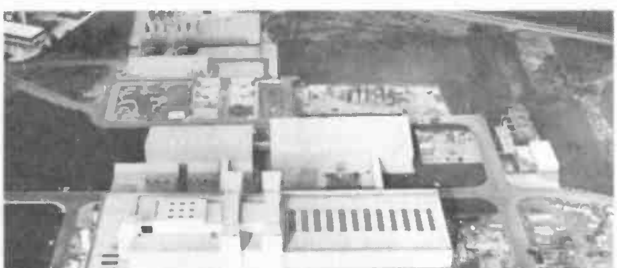


Fig. 1. Aerial view of the JET laboratories at Culham, in Oxfordshire

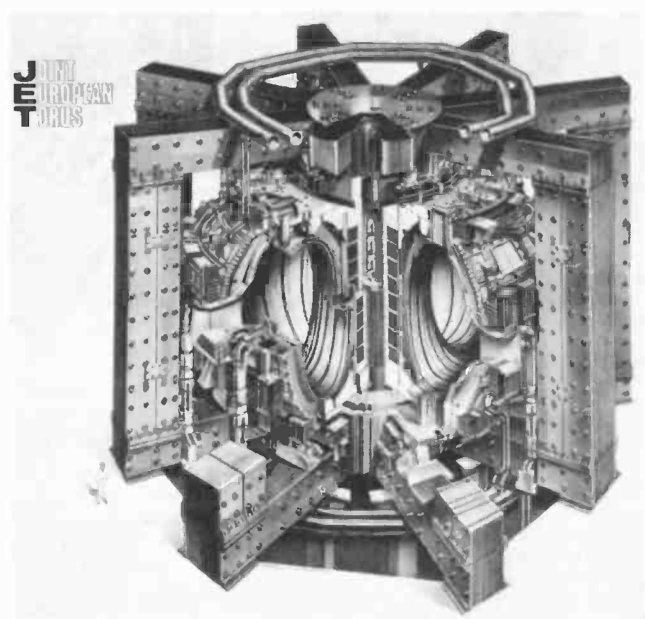


Fig. 2. The JET Tokamak. The scale of this machine will be appreciated by comparing it with the figure standing alongside

Fission's only attribute is the bare fact that it can generate electricity, but because of its deadly pollution it lacks widespread approbation. Fusion, on the other hand, could fulfil the promise of a renewable energy source *without* the need to handle and dump toxic wastes. An elegant, but demanding alternative, as you will see.

The objective of the JET project is to create a plasma with a size, density and temperature comparable to that required by a power producing reactor. This plasma will need to reach a temperature of 100 million degrees centigrade. The plasma column will be about two metres in diameter, and have a density 100 million million atoms per cubic centimetre. Although many other difficulties lie in the path towards an economic fusion power station, achieving these parameters on the JET will be a quantum leap forward.

Plasmas, and their physics are complicated, and not yet fully understood by scientists. There is no guarantee that the JET apparatus, designed in 1974, will be able to achieve the specified parameters. The *Joint European Torus* is nevertheless thought to be the most advanced Tokamak of its type in the world. In it incredible electric power is required to heat up the plasma. Even the 4·8 million amperes heating current is totally inadequate to generate the plasma temperatures necessary for nuclear fusion.

Towards REALITY

MIKE ABBOTT

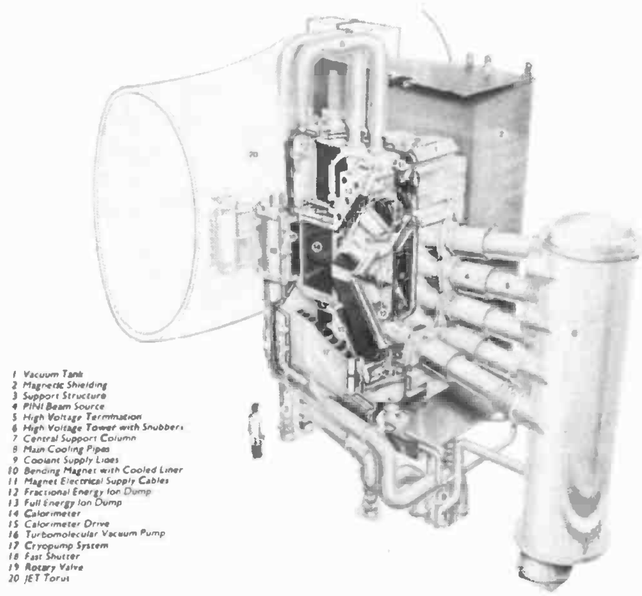


Fig. 3. The neutral injection system. This beams energetic neutral hydrogen atoms into the plasma. The power supply for this system is regulated and switched by large tetrode valves

Further heating must be introduced by squirting in highly energetic neutral atoms, a process called Neutral Injection heating (Fig. 3). Still more energy has to be found by way of high energy Radio Frequency heating (Fig. 4).

Over a period of some four years, starting in 1983, the plasma power capability of the Tokamak will be increased in stages until it reaches 25 megawatts. At full power, temperatures averaging 50 million degrees are anticipated; at which stage the thermonuclear reactions brought about by the introduction of deuterium-tritium plasmas, will push the temperature up to the required 100 million degrees centigrade. If ignition is achieved, the powerful external heating systems can be turned off, leaving the plasma temperature to rise by itself until the end of the pulse. The less fortunate outcome would be that the plasma simply does not reach a high enough temperature to justify the use of tritium.

WHAT IS FUSION?

At the centre of every atom is a nucleus comprising positively charged protons, and uncharged neutrons. Orbiting this cluster, as if in a microscopic solar system, are negatively charged electrons. The strength of the invisible force which holds together the cluster of protons and neutrons varies from element to element, but it is possible to create a nuclear reshuffle in which a surplus quantity of that binding energy is released. Fusion is such a reshuffle, for it is the *fusing* together of two or more elements into one or more heavier elements, during which there is a yield of surplus binding energy. In the case of deuterium (D) and tritium (T), helium, and a neutron are also released upon fusing.

Deuterium and tritium (the two heavy isotopes of hydrogen) are favoured because they have a high reaction rate whilst imposing the least stringent conditions. Deuterium could not be more plentiful on this planet, as it is obtained from ordinary water. Tritium, however, is rare, but can be manufactured from the fusion process itself. By bombarding a blanket containing lithium (which is plentiful) with those expelled neutrons, both tritium and helium are produced.

THE NEED FOR HEATING

Because the deuterium and tritium nuclei each have a positive electric charge they strongly repel each other. They simply will not come close enough together for a fusion reaction to occur. The way to overcome this obstacle is to impart sufficient energy to their nuclei to overcome the mutual electrostatic repulsion. Heating the gaseous fuels to a very high temperature will do just that, by ionising them—stripping the electrons away from their parent nuclei. The result is a mixture of positively and negatively charged particles. A gas in this disrupted condition is called a

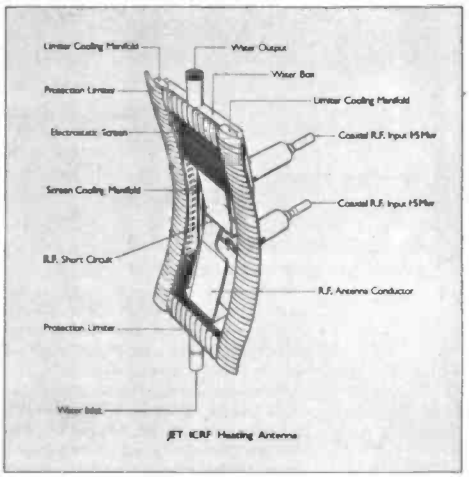


Fig. 4. Radio frequency heating antenna. Operates at the ion cyclotron frequency (25–55MHz on the JET)

plasma. See Fig. 5. At 100 million degrees centigrade, abundant fusion reactions occur in a deuterium-tritium plasma, releasing large amounts of energy.

WHAT IS A TOKAMAK?

There is no known material out of which a vessel could be made, to contain a one hundred million degree inferno without itself vapourising. Yet containment is essential if the amount of energy produced by fusion is to exceed the amount of power required to run the system. The latter requirement is an obvious precondition, and is expressed as the product of fuel density and confinement time (known as Lawson's Criterion).

Since a plasma is a mixture of charged particles it can be influenced by a magnetic field, and for over thirty years investigations into how to achieve the magnetic suspension of a fusion reaction have led to a machine called the Tokamak. In this configuration, even though high temperature plasmas have a natural tendency to expand, they remain in a compressed column, held there by a magnetic force for periods in excess of one second. The plasma's charges whirl around randomly, unable to escape. See Fig. 6. Because of this, heat is not lost, nor are impurities released through contact with any physical object—*in theory at least*. But even the Tokamak is only partially efficient in these aims.

THE JET TOKAMAK

A complex array of magnetic circuits are required to activate the JET Tokamak. The main component of the system is the set of *toroidal* field windings which are used to suspend the plasma. In shaping the plasma column, these toroidal coils, shown in Fig. 7, are assisted by *poloidal* coils. However, the most interesting field action is that of the transformer which induces the plasma heating current. Whilst the primary of this is also a poloidal winding, its secondary is the plasma itself. The toroidal circuit of plasma acts as a single-turn secondary winding.

The JET will use hydrogen plasmas during its early life, before moving on, if successful, to deuterium-tritium plasmas to obtain a fusion ignition.

ENGINEERING STATISTICS

The accompanying photographs show the standard of engineering required to build the 100 tonne vacuum vessel and its peripherals. The 32 toroidal field coils alone add up to 384 tonnes (12 tonnes a piece), and these are each 24 turns of heavy

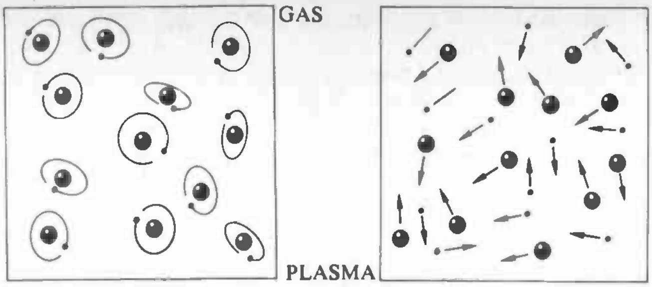


Fig. 5. Heat turns gas into plasma by dislodging the electrons from their orbits

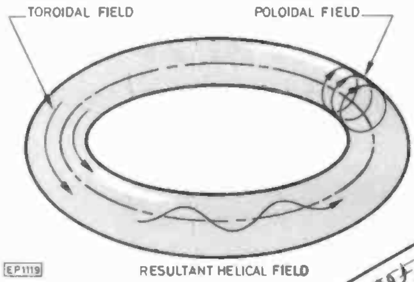
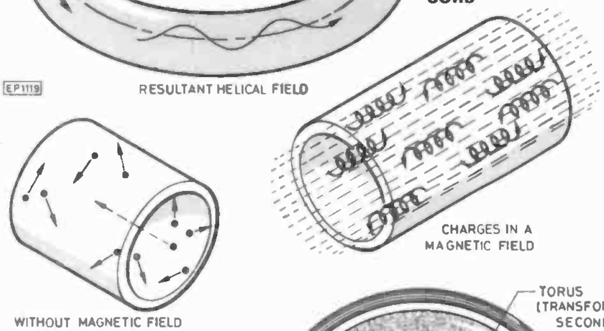


Fig. 6. The Tokamak is a toroidal vacuum container in which plasma is suspended away from the inside surface by a magnetic field set up by external coils



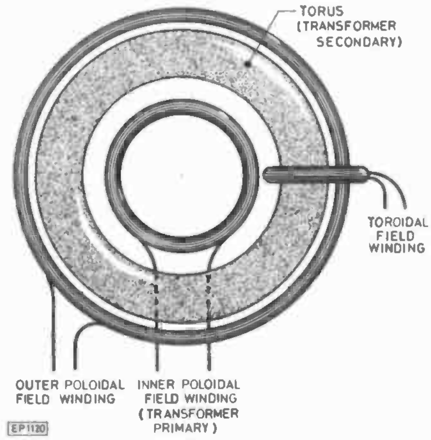
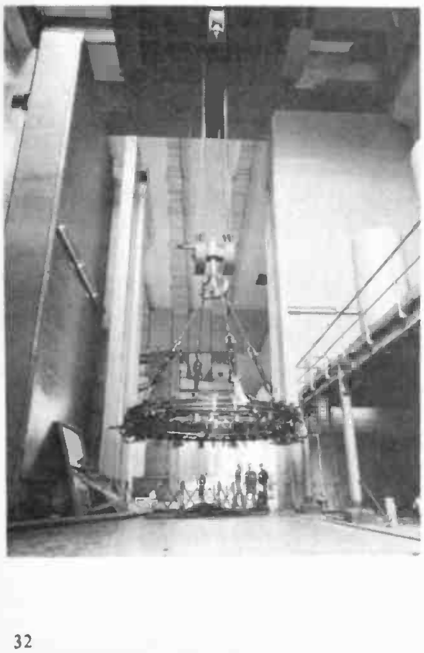


Fig. 7. The JET inductive system simplified. The plasma itself acts as a winding, to heat and shape the plasma



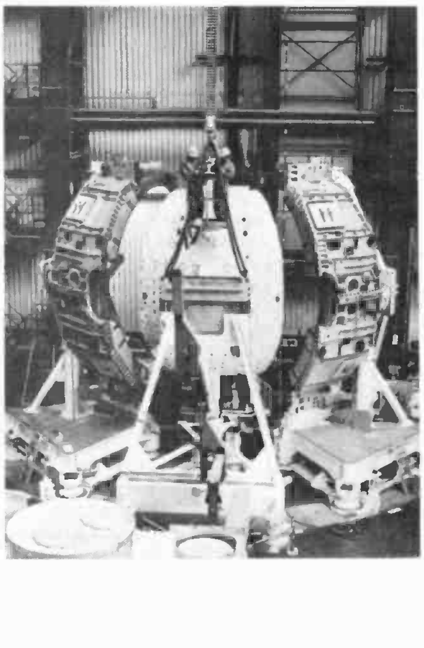
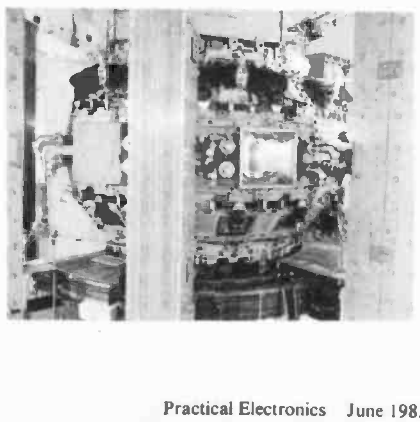


Fig. 8 (leftmost). A poloidal field coil suspended during construction

Fig. 9. An octant is seen being lowered into position

Fig. 10. Complexity of the JET hardware is apparent during construction



copper bar capable of conducting 66,000 amperes. It takes 700 litres of water per second to cool these coils. In the fully completed design, the total magnetic field at the plasma centre will be 3·4 Teslas. The coils are "D" shaped because this is the shape they would deform to, if flexible, under the 2000 tonnes of mechanical force developed by their own magnetic field. This geometry, therefore, gives rise to minimum stress. Magnetic effects produce an enormous twisting moment throughout the entire structure, which is designed to withstand up to 20,000 tonnes metre.

The torus hall is built around a pit housing the ring manifolds which supply water, the vacuum and hot carbon dioxide to the machine. The massive limbs of the magnetic circuit (Fig. 12), the bulkiest components of all, support the toroidal structure. This toroidal vacuum vessel is fabricated from eight welded sections, called octants. The vessel has to support a very high vacuum, and so before each run is baked at 500°C for several hours to "descale" its surfaces of potential gas forming particles, otherwise outgassing would offset the pressure. This is the purpose of the hot carbon dioxide supply. Welding between octants is so superb that it would take 3000 years for one litre of air to penetrate the system.

In use, conventional heating elements attached to the vessel help to achieve the base pressure of 10^{-10} torr. required to minimise the level of impurities in the plasma.

Materials and engineering parts for the JET have been manufactured by industry throughout Europe, and the project has cost around £500 million.

FLYWHEEL GENERATOR

It would be unfair to dim the lights of Oxfordshire every time the JET is pulsed. With its 700 megawatt thirst for power, a substantial part of the supply has to come from two flywheel generators, each accelerated by a 8·8 megawatt pony motor. Flywheels weighing 775 tonnes rotate at 225 rev/min to make 2600 megajoules available to the Tokamak (Fig. 14). Four rectifier stacks convert the first rotor's output to d.c. for the toroidal coils. In the case of the poloidal field, specially designed fast air-blast circuit breakers initially interrupt 80 kiloamperes to generate a back e.m.f. capable of ionising the gas. This system also allows reversal of the poloidal coil connections to obtain maximum flux change in the heating current transformer.

COMPUTER CONTROL

The JET is a learning tool, and because of this its computers have a dual task; the first being to control the operating parameters, the second being data acquisition and storage. A network of 25 Norsk Data ND-100 and ND-500 minicomputers is used in a hierarchical structure, in which each processor monitors its own part of the machine. Information is transmitted along fibre-optic loops at a rate of 5 million bits per second, and each pulse of the JET results in the collection of over one million datum entries.

The Control Room's ND-560 computer files the data for use by the experimentalists, before transferring it to Culham Laboratory's large computers for further analysis, and archiving.

DIAGNOSTICS

Gathering information about the behaviour of high temperature plasmas obviously cannot employ sensors requiring physical contact with it. Passive, and active particle beams, light, and electromagnetic radiations are used. Fig. 15 shows the complexity of the diagnostic equipment.

Plasma position within the vessel is detected using inductive coils integrated into the vacuum vessel wall.

Interferometers detect the delay, measured against a microwave or infra-red reference beam, caused by electrons in the plasma. This allows measurement of *electron density*.

The *type, density* and *temperature* of energetic atoms within the plasma determines the wavelength and intensity of emitted light. Spectrometers are used to detect this light emission.

Local values of electron density and temperature are discovered by a technique called Thomson Scattering. In this, the degree of scattering of high intensity, pulsed laser light is observed.

Plasma ion temperature is ascertained by observing the neutral particles escaping from the plasma. These particles have thermal equilibrium, and escape through the magnetic barrier because of their neutrality.

A bolometer measures the broad spectrum of *radiated energy loss*. A temperature-sensitive resistor mounted on a foil absorber acts as the detector.

Measurement of the plasma's X-ray emission yields information on *density, temperature* and *impurity content*.

Fig. 11. Octants awaiting assembly. A toroidal field winding assembly is in the foreground

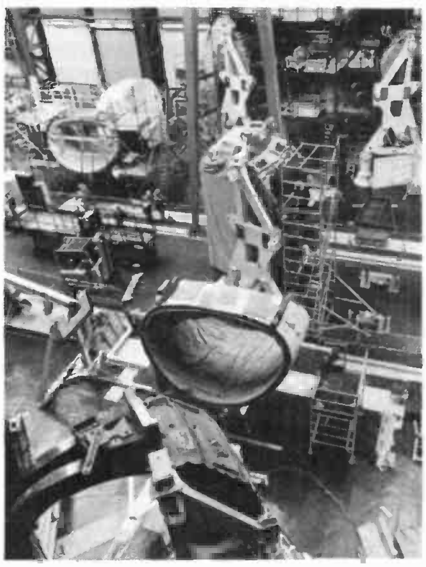
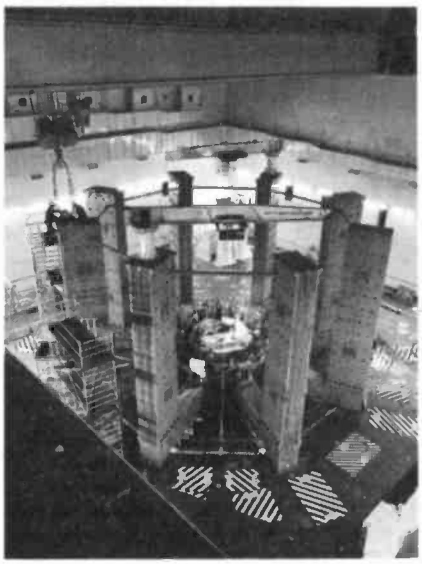


Fig. 12. Apparatus under construction, showing the massive transformer limbs



All photographs courtesy of the JET Joint Undertaking

Fig. 13. Octants in position between the transformer limbs

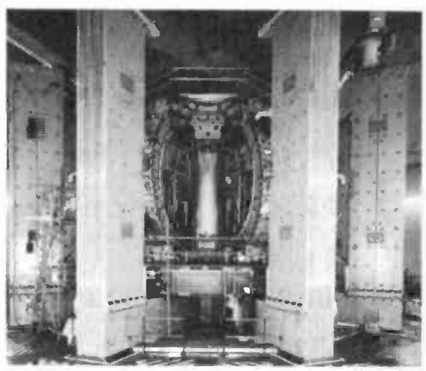


Fig. 14. One of the 400MW flywheel generators under construction. Two of these generators supply power to the Tokamak, which, when surge loaded, drop to half speed. The rotors weigh 775 tonnes each!

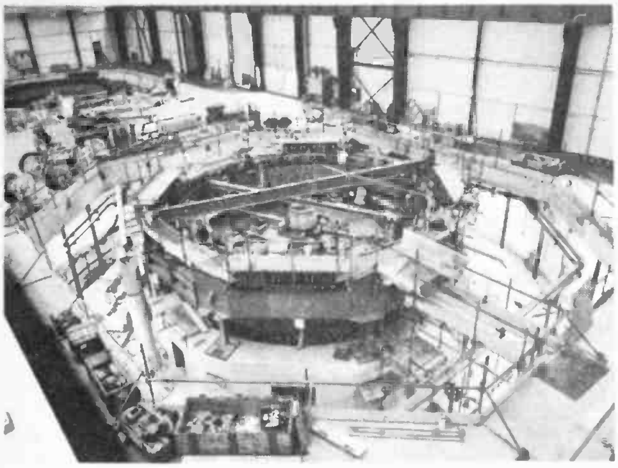
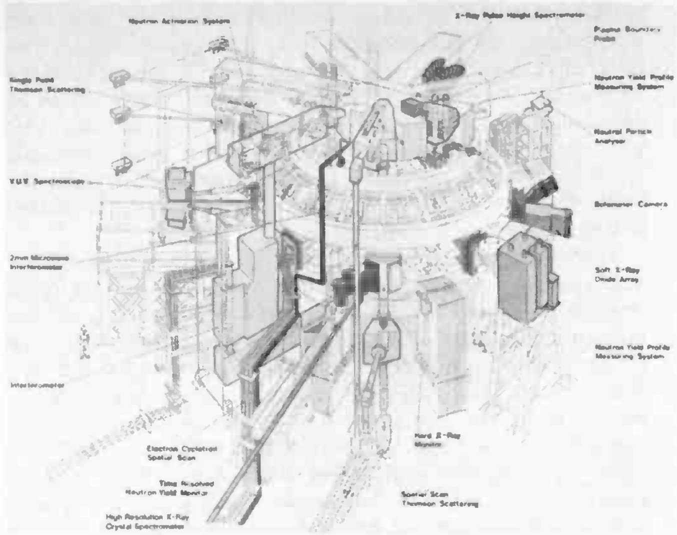


Fig. 15. JET diagnostic system



In the latter phase of the JET's life, measurement of the neutron emission during fusion will reveal the *reaction rate*.

Once deuterium-tritium fusion has occurred, this high energy neutron radiation will have activated the machinery, seriously restricting access by personnel. For this reason, all sensory transmitting and receiving equipment has been mounted outside the biological shield, despite the alignment exactitudes this imposed.

SERVOMANIPULATORS

Once irradiated, it will be unsafe for human beings to inspect the torus walls, or service the machine's auxiliary equipment. However, the unpredictable nature of the handling places this work outside the realm of programmable robots. It was decided to employ remote handling manipulators which operators control by viewing through closed circuit television links. The slave unit, at work in the radio active area, is designed to reflect back to the operator the forces exerted by its manipulator. This gives a "feel" to the operator as he remotely uses power tools, spanners and welding torches, etc.

LEAGUE OF FOUR

Only four large Tokamaks exist, either completed or under construction. Apart from the European torus, there is the USSR's T15, the USA's TFTR, and Japan's JT-60.

The release of energetic neutrons from this type of machine could be used to heat up a surrounding blanket, in order to raise steam for a conventional steam-turbine generator. No such provision to generate electricity has been made on the JET, as this will be the subject of study for the next generation of fusion experiments.

At the time of going to press, it was thought that the JET would be powered up for the first time in June 1983.

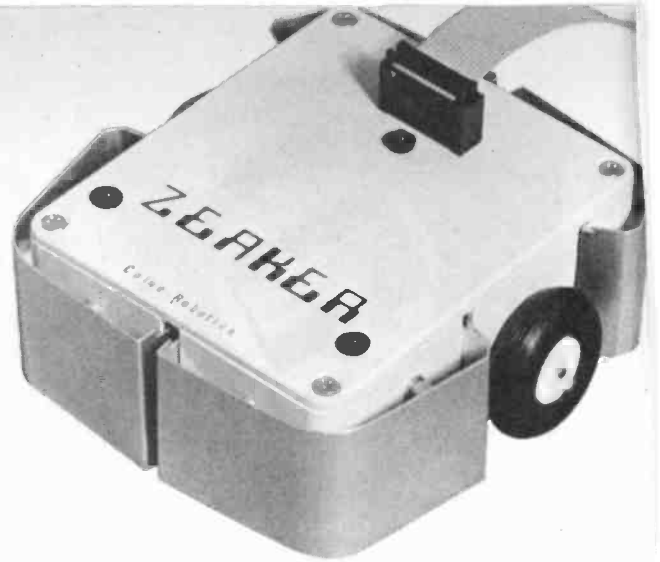
The Sun is a typical star, producing $3{\cdot}3 \times 10^{26}$ joules per second by fusion, and is consequently reducing in mass at a rate of $4{\cdot}2 \times 10^{9}$ kg/s (one millionth of its total mass every ten million years).

The thermonuclear reactions which make our sun shine will not be casually mastered; notwithstanding Culham's wrestling ground, the commonplace fusion power station is reckoned to be sixty years away. In the meantime, therefore, fission, with all its imperfections, will continue to serve in an era of its own. ★

ACKNOWLEDGEMENTS

The technical data in this article is based entirely on material supplied by the JET Joint Undertaking. All photographs and diagrams shown are courtesy of same.

ZEAKER



MICRO-ROBOT

PART 2 **DAVID BUCKLEY**

IN the Control Station the holder for the four C-cell Nicads is bolted to the bottom of the box (actually the lid, but the box is used upside down), offset towards one side to allow room for the power/charge lamp. The Nicad supply on/off switch and indicator l.e.d. are fitted to the front of the box. The 3·5mm jack socket for the ZX81 power supply and $2\frac{1}{2}$ foot link to the ZX81 are fitted to the rear.

The three 16 way ribbon cables (two to the computer interface board and the umbilical to Zeaker) leave the box through cut outs in what is now the lid, these should be of a size such that the ribbon cable is just clamped when the box is closed.

CONTROL STATION CIRCUIT DESCRIPTION

The circuit (Fig. 1) can be divided into two distinct parts: the computer READ port and the computer WRITE port. In the prototype both these ports are memory mapped at address 35000 decimal.

Dealing first with the READ port. Data lines D0 to D7 are normally held high by resistor pack IC3. Lines D6 and D7 terminate on pads inside Zeaker and are not used hence D6 and D7 are always high. The remaining lines D0 to D5 terminate at the insulated pillars set into the sides of Zeaker and indicate the state of the tactile sensor switches, a low data line implying that Zeaker is touching something (see table of sensor codes). All the fenders are connected to 0V and on impact with an obstacle a fender will move in and make contact with one or more pillars, hence shorting the respective data lines to 0V.

Turning now to the WRITE port. D0, D1 control the port drive motor; D1, D2 control the starboard drive motor; D4 the pen; D5 the lights; and D6 and D7 the horn.

One end of the port drive motor goes to the centre tag of the battery and the other to the junction of TR3 and TR4. Turning on TR3 will cause the motor to run forwards and turning on TR4 will cause it to run in reverse.

D0 high is port motor forwards and D1 high is port motor reverse. IC1a and IC1b are wired as a set reset latch which ignores the condition D0 high and D1 high, so preventing destruction of TR3 and TR4.

When D0 goes high the output of IC1a goes low, so turning on TR2 which turns on TR3, when D0 is low TR2 is held off by R2 and R3. TR1 is normally held on by R1 and R4 and so shorts TR4 base to earth but when D1 goes high the output of IC1b goes low and turns off TR1, TR4 is now able to turn on by base current through R5.

The operation of the starboard motor is similar except that forward and reverse are switched around so TR8 on gives starboard motor forwards. This evens out battery drain when going forwards or backwards.

Data line D4 high turns on TR9 which turns on TR10, switching on the solenoid which lowers the pen. The l.e.d. D3 provides indication that the solenoid is activated. Diode D4 is to short out the inductive high reverse voltage when current through the solenoid is halted by TR10 turning off.

Data line D5 high turns on TR11 which turns on TR12, lighting D1 and D2, the red and green l.e.d.s.

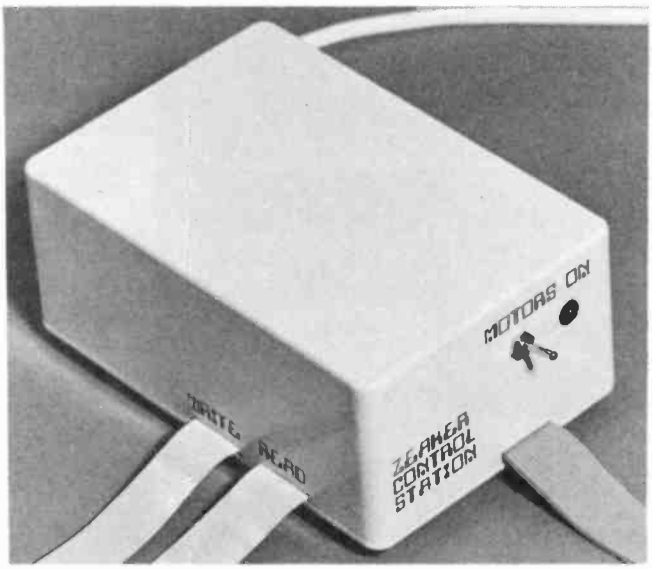
Data lines D6 and D7 control the horn, via the reset lines of IC2 which is wired as two astables. The frequency components R20, R21, C2 and R22, R23, C5 were chosen by experiment so that the tones sounded right when both are on together. C3 and C4 are the usual blocking capacitors.

CONTROL STATION PCB

The p.c.b. for the control station is shown in Fig. 2 with the component layout shown in Fig. 3. The resistors by the 556 are mounted on end but the others are mounted flat. There are a number of wire links to be soldered in place and these are best done with insulated wire. None of the transistors need heatsinks and are all mounted vertically. The three 16 way flying leads can be soldered directly into the p.c.b. but it is easier to use headers on the leads and plug them into the p.c.b.

CONTROL STATION CHECKOUT

The easiest way is to plug the read and write cables into the interface board, plug the ZX81 power supply into the back of the control station and plug the flying power lead



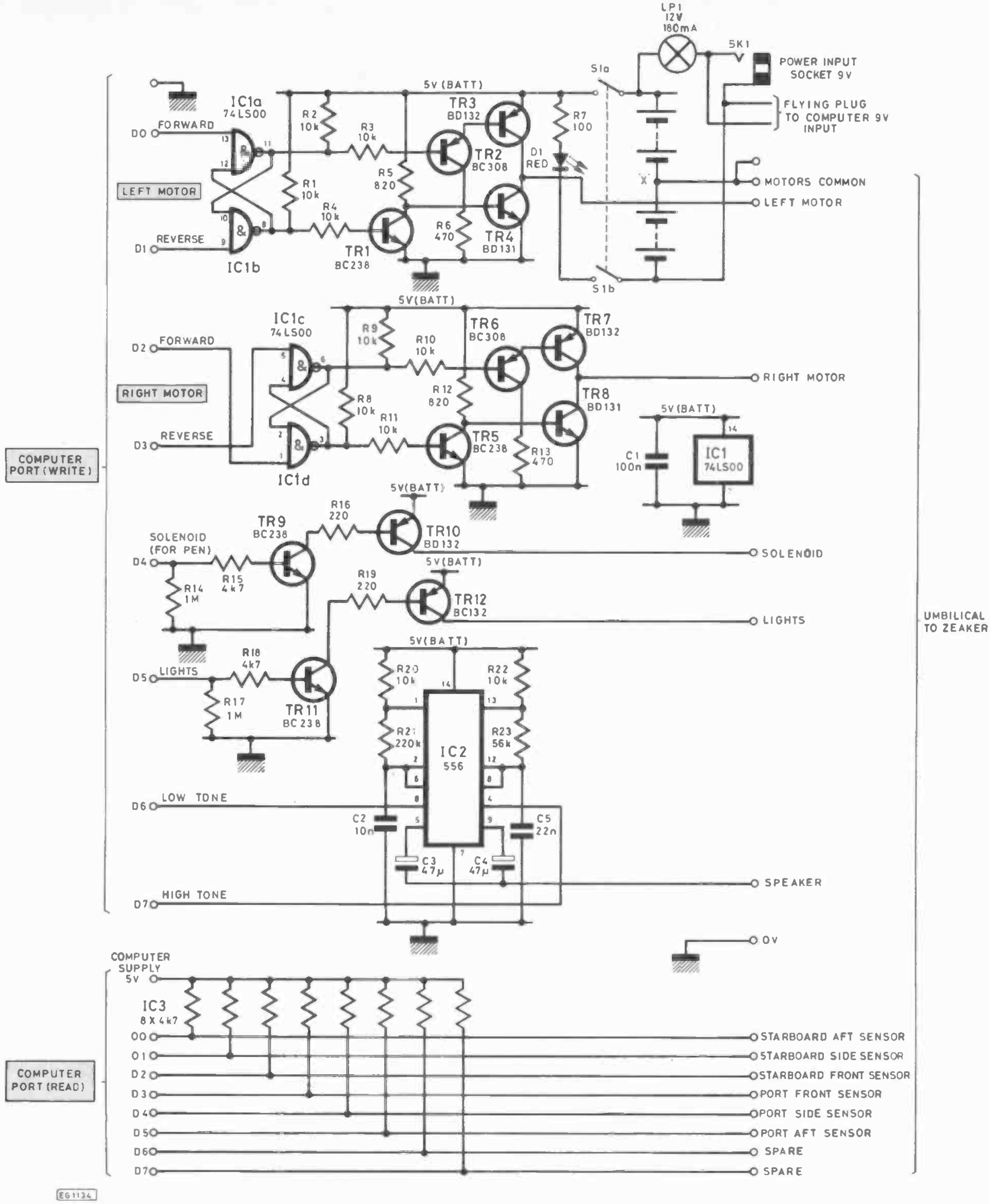


Fig. 1. Circuit diagram of the Control Station

into the ZX81 9V socket and check that the computer still works. The computer is only connected to the control station and Zeaker by the 0V line and the data lines from the buffer chips on the interface board so this shouldn't be a problem.

Plug the umbilical into Zeaker and POKE the interface board port with zero; this turns off all the outputs. Now switch on the 5V supply and nothing should happen. POKE the port with the various control codes (Table 1) and check that Zeaker functions. When any of the BD power transistors are turned on there should only be about 0·5 volt between collector and emitter and about 0·1 volt between collector and emitter of their driving transistors.

PROGRAMMING ZEAKER

To program Zeaker all that is needed is a computer with an 8-bit output latch and an unlatched input port with 6 or 8

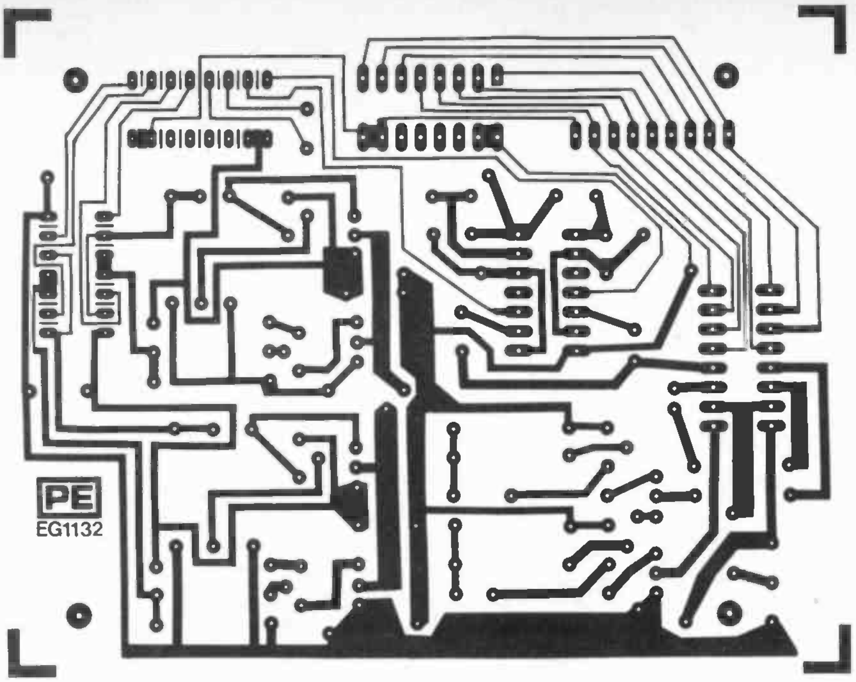


Fig. 2. P.c.b. design

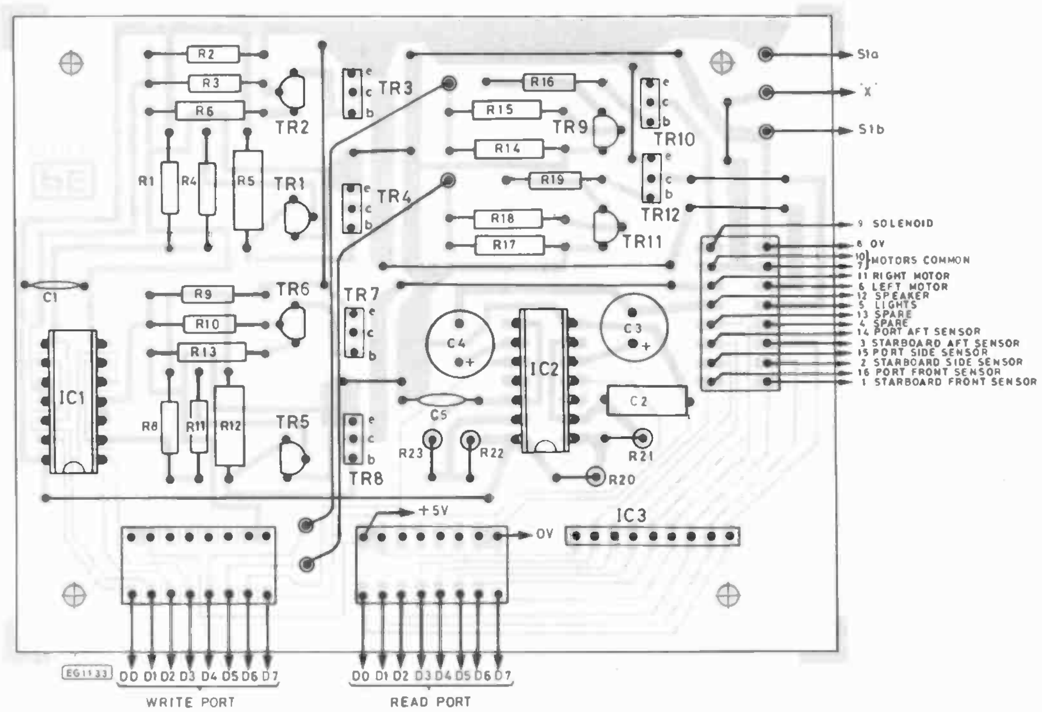


Fig. 3. Component layout

bits (6 for the unexpanded Zeaker). The particular way that these are available will depend upon the microcomputer and interface used. The signal allocation for the output and input connector leads are shown in Fig. 5.

Writing (POKEing for a memory mapped port) a word to the port sets the respective bits of the output latch. Reading (PEEKing) the port will return the status of the bump sensors.

A list of the control codes and their effect is given in Table 1. Any combination of control codes can be written to the port and Zeaker will be controlled by their combined effect e.g. writing a 1 will set the port motor to forwards and writing a 4 will sat the starboard motor to forwards, hence writing 5 (=4+1) will set both motors on forwards. Writing 37 (=5+32) will set both motors on forwards and also switch on the lights.

COMPONENTS . . .

CONTROL STATION

Resistors

R1,R2,R3,R4,R8,R9,R11, R19,R20,R22	10k (10 off)
R5,R12 ½W 10% carbon	820 (2 off)
R6,R13 ½W 5%	470 (2 off)
R7	100
R14,R17 ½W 2%	1M (2 off)
R15,R18 ½W 5%	4k7 (2 off)
R16,R19 ½W 2%	220 (2 off)
R21 ½W 5%	220k
R23 ½W 5%	56k

All resistors ¼W 5% carbon except where otherwise stated

Capacitors

C1	100n ceramic disc
C2	10n ceramic disc
C3,C4	47µ 16V elect (2 off)
C5	22n ceramic disc

Semiconductors

D1	red l.e.d.
TR1,TR5,TR9,TR11	BC238 (4 off)
TR2,TR6	BC308 (2 off)
TR3,TR7,TR10,TR12	BD132 (4 off)
TR4,TR8	BD131 (2 off)
IC1	74LS00
IC2	556
IC3	pack of 8 commoned resistors RS type 140 271

Miscellaneous

ABS plastic box 150 x 100 x 60mm
Battery holder for 4 C-cells
Nicad C-cells (4 off)
MES lampholder
MES 12V 280mA bulb
Double pole on/off switch
3·5mm jack plug and socket
16 pin d.i.l. IDC header (5 off)
16 pin d.i.l. sockets (3 off)
14 pin d.i.l. sockets (2 off)
3 metres of 16 way grey ribbon cable
Molex 16 pin JD connector to mate with the 5332 series connector on Zeaker

Constructor's Note

The toe cover cap is available from most hardware stores and the wheels and motor gearboxes assemblies are obtainable from hobby shops.

A complete kit of parts for the vehicle (including machined, cut and ready-bent items) and control station with a manual and software is available from Colne Robotics Ltd., Beaufort Road, off Richmond Road, Twickenham TW1 2PH (01-892 8197/8241). Price £59·95 inc. VAT.

Colne Robotics are also able to supply the separate parts, please write or phone for details.

The two longer programs mentioned in the text are available from Colne either on cassette or as a print-out. Please state the type of computer being used with Zeaker when ordering programs.

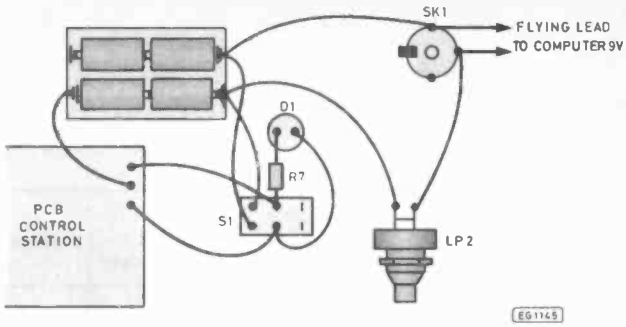
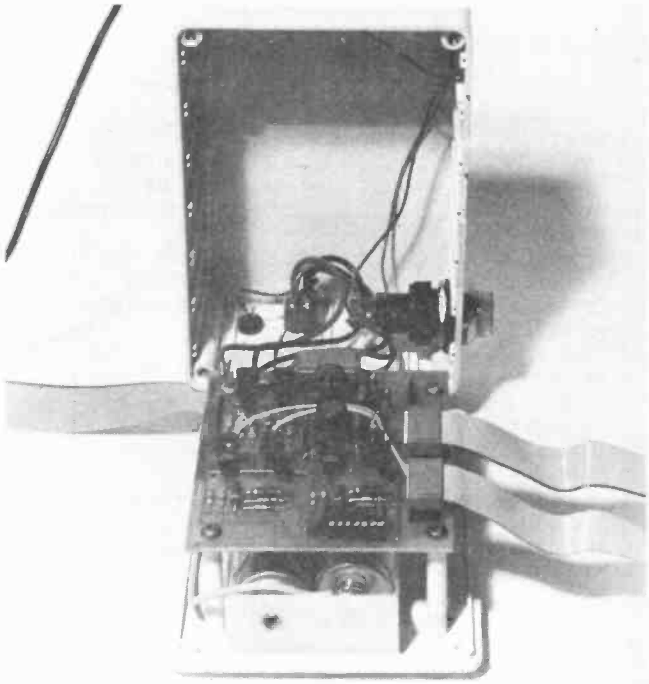
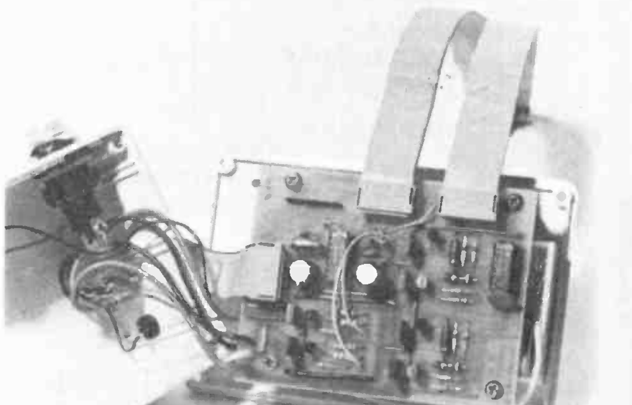


Fig. 4. Wiring diagram





Interior views of the Control Station showing the battery housing and the p.c.b. mounting details

FROM COMPUTER WRITE PORT

Pin 1

D7 0V	D6 0V	D5	D4	D3	D2	D1 5V	D0 5V

TO COMPUTER READ PORT

Pin 1

D7 0V	D6 0V	D5	D4	D3	D2	D1 5V	D0 5V

UMBILICAL CORD

0V	Motor Common 2·5V	Motor Starboard	Lights	Spare	Sensor Starboard Rear	Sensor Starboard Side	Sensor Starboard Front
Solenoid	Motor Common 2·5V	Motor	Speakers	Spare	Sensor Port Rear	Sensor Port Side	Sensor Port Front

Fig. 5. PSU DIL headers Signal Allocations

KEYBOARD TEACH PROGRAM
1K ZX81

```
                                     COMMENTS
 (1 REM TEACH/DOIT)
   5 FAST
  10 LET A=35000      ________ 35000 IS A PORT
                                 ADDRESS
  20 POKE A,O         ________ SWITCH OFF VEHICLE
  30 DIM M$ (10,2)
  40 LET K1=.6        ________ STRAIGHT RUN
                                 CONSTANT
  50 LET K2=.61       ________ TURN CONSTANT
  60 FOR S=1 TO 10
  65 CLS
  70 PRINT "TEACH", "STEP";S,
       "MOVE AND DIST/ANGLE/
       TIME"
  80 INPUT C$
  90 INPUT D
 100 IF C$="F" THEN LET
       M$(S,1)=CHR$ 5
 110 IF C$="B" THEN LET
       M$(S,1)=CHR$ 10
 120 IF C$="L" THEN LET
       M$(S,1)=CHR$ 6
 130 IF C$="R" THEN LET
       M$(S,1)=CHR$ 9
 140 IF C$="S" THEN LET
       M$(S,1)=CHR$ 0
 150 LET M$(S,2)=CHR$ D
 160 IF C$="F" OR C$="B"
       THEN LET M$(S,2)=CHR$
       (DxK1)
 170 IF C$="R" OR C$="L"
       THEN LET M$(S,2)=CHR$
       (DxK2)
 210 NEXT S
 220 PRINT "TO DOIT PRESS D"
 230 PAUSE 50000               WAIT UNTIL ANY KEY
                                 PRESSED
 240 FOR S=1 TO 10
 250 POKE A,CODE M$(S,1)
 260 PAUSE CODE M$(S,2)
 270 NEXT S
 280 POKE A,O
 290 GOTO 230
```

When a port is read the resulting number will depend on which if any of the six sensor switches are closed. If none are closed i.e. if Zeaker is not touching anything then all 8 bits will be high and a read will return 255. If say the starboard front sensor is pressed then from Table 3, D3 will be low and hence a read will return 247. If both front sensors are pressed in then both D2 and D3 will be low and hence a read will return 243.

RANDOM MOVE PROGRAM
1K ZX81

```
                                     COMMENTS
   1 REM RANDOM MOVE
  10 LET A=35000      ________ 35000 IS PORT
                                 ADDRESS
  20 POKE A,O         ________ SWITCH OFF VEHICLE
  30 PRINT "PRESS S TO STOP"
  40 IF INKEY$="S" THEN
       GOTO 200
  50 PAUSE 5
  60 POKE A,32+5      ________ SWITCH ON LIGHTS
                                 AND FORWARD
  70 PAUSE 5
  80 POKE A,5
  90 LET B=PEEK A
 100 IF B=255 THEN GOTO 40
 110 POKE A,64+10     ________ LOW HORN AND
                                 BACKWARDS
 120 PAUSE 30
 130 IF B>250 THEN GOTO 170
 140 POKE A,128+6     ________ HIGH HORN AND
                                 LEFT
 150 PAUSE 50xRND     ________ RANDOM TURN TIME
 160 GOTO 40
 170 POKE A,128+9     ________ HIGH HORN AND
                                 RIGHT
 180 PAUSE 50*RND     ________ RANDOM TURN TIME
 190 GOTO 40
 200 POKE A,O         ________ SWITCH OFF VEHICLE
```

CONTROL CODES

1	Port forward
2	Port back
4	Starboard forward
8	Starboard back
16	Solenoid on
32	Lights on
64	Horn 1
128	Horn 2
192	Horn 1 plus Horn 2

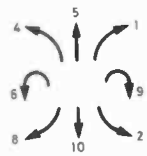


Table 1

SENSOR CODES

D0	Starboard sensor Aft closed
D1	Starboard sensor Side closed
D2	Starboard sensor Front closed
D3	Port sensor Front closed
D4	Port sensor Side closed
D5	Port sensor Aft closed
D6	Spare
D7	Spare

Table 2

It is reasonably easy to determine which sensors are closed by subtracting the return value from 255 and transforming the result into binary. For the previous example of both front sensors closed this returns 243. Now $255-243=12=8+4=2^3+2^2$ hence data lines 3 and 2 are at 0V which from Table 2 means that both front sensors are closed.

Although this may seem a complicated procedure to go through each time, remember a computer controls Zeaker and it will do all the tiresome calculations.

The initial software consists of two short programs, one which allows you to build a simple pattern and repeat it and the other lets Zeaker find its own way around obstacles, and two longer programs, which are available from Colne, one of which allows several patterns to be built up and joined together and the other allowing Zeaker to memorise its environment and to avoid obstacles sensibly.

For the initial ZX81 version of Zeaker the two short programs will each fit into 1K of memory and so can be run on an unexpanded ZX81. Writing a 1K program to control Zeaker from BASIC does not allow the full range of Zeaker's capabilities to be used. However, the two ZX81 1K programs here should give an idea of the ease with which Zeaker may be controlled from BASIC.

PROGRAM NOTES

Encoding the move code and time of move into the character array M$ saves 80 bytes over using the numerical array. Against this must be set the 18 bytes for the CODE, CHR $ and $ used in the listing, resulting in 62 bytes saved. The program just fits in 1K and can be edited and run. Report code 4 (out of memory) comes up most of the time but should be ignored. The program can store up to 10 moves and prompts for the move.

F=Forward	and	Distance millimetres
B=Backward		Distance millimetres
R=Rotate Right		Angle degrees
L=Rotate Left		Angle degrees
S=Stop		Time in 50th second

To escape from the program press break.

The constants K1 and K2 should be fine tuned to the particular vehicle. The maximum value of any entry in M$ is 255 and hence entering numbers greater than this in response to the prompt will cause the program to halt with an error code.

FURTHER DEVELOPMENTS

Although all 8 data read lines are connected to Zeaker only 6 of them are actually used, the remaining two terminate at pads by the Molex connector on the p.c.b. in the lid of Zeaker.

It is intended that these spare lines should be used to interface to add-on circuitry which will enable Zeaker to follow a white line, induction loop cable or simply seek or avoid light or heat.

Also instead of sending just the horn tones down the umbilical cord to the speaker it is possible to connect the output of a complex sound generator or a computer speech board to a pad by the umbilical cord connection on the p.s.u. board and Zeaker will be able to chuff along like a steam train or emit some more appropriate sound. It could also give a running commentary on its progress e.g. "Forward", "Right", "Left", "Ouch"! "Hit something at Left Front" etc.

Whilst Zeaker is relatively simple it is capable of quite complex interactions with its environment and in many respects it is only limited by the ingenuity of the controlling software. ★

Space Watch...

THE IRAS SATELLITE SUCCESS

If the International Infrared Astronomical Satellite continues as it has begun it will have added much to offset some of the other disappointing news in other directions. First then the good news.

Another pass of the satellite was witnessed by the Parliamentary Under Secretary of State for the Department of Education and Science, Mr. William Shelton MP. Certain initiating commands made from Chilton, Oxon, the control station for the satellite, were performed by Mr. Shelton. This second event to which the press were invited was also a great success. Already a large amount of data had been collected. It is clear that there may be quite a long gap between the cessation of operations and publication of all the data.

It was expected that the useful life of the satellite would be in the order of 200 days, but as the boiling off of the coolant (superfluid Helium) is slower than was expected it may be possible to extend the time to 300 days. Altogether this has been a most satisfactory scientific satellite. The actual planned survey was scheduled to be complete in 200 days and the principal scan may well be so completed. This will enable the bonus time to be used for extra scans by the Dutch special additional experiment (DAX). This was a special 'close-up' facility which means that if something unusual is seen it will be possible to look at it in greater detail. Already such a situation has arisen in that during the scan of the Greater Magellanic Cloud it was noticed that there was intense emission round the Tarantula Nebula. Also just one minute of time spent on surveying the Galaxy away from the Earth's atmosphere has yielded more than all previous surveys.

The wide range of the telescope enables it to assess the cool clouds and the hot new clouds. It has thus been possible to say that the cool clouds are large and extensive and that as they get hotter clouds or cloudlets formed are consistent with the present theories of the evolution of new stars. That is that the large and diffuse clouds at wavelengths of 100 micrometres are beginning to condense under gravitational pressure. As the clouds become smaller and are under the influence of the increased internal pressure giving rise to nuclear reactions they shine as stars in their own right. The telescope therefore can give extremely adequate proof of the theories of stellar evolution. It is no exaggeration to say that this 'eye' is another of those vital milestones that precede not only acceptance of recent thinking but provide the impetus for the thinking of the immediate future.

A footnote here might be appropriate. During a private conversation with Mr. Shelton and in answer to some of his questions about the publication of scientific progress the author took the opportunity to emphasise that the change of name from SRC to SERC (Science and *Engineering* Research Council) had already been reflected in a more useful spread of information which enabled the very efficient publicity section to spread its wings.

PROJECT UNIVERSE

This venture which involves the Orbital Test Satellite (OTS) was again a task for Mr. William Shelton to play the role of initiator of this new joint effort. In the early development of microelectronics there seemed to be much misapplication as well as a great deal of incompatibility and no doubt this was the partial cause of high prices. The new techniques and especially proper attention to the importance of compatibility has brought some order out of chaos, with the fall of prices and the increasing sophistication of both hardware and software, giving impetus to the number of users in business and at home, which now opens the way for real improvement and standardisation. In this regard the most exciting development has been the setting up of Local Area Networks. These set up communication links between computers and their peripherals whose performance in terms of speed and reliability is comparable to that of the computers themselves. Local Area Networks (LANs) can provide electronic mail, the sharing within an office of costly printers etc., and scope for integrating computer aided design and manufacture.

A single LAN can link scores of computers, work stations and peripherals. Like *LEGO* it can go on and on. All this means that computer technology is pushed to its limits. This is as it should be. There is in operation a ring LAN known as the Cambridge Ring. This was developed by the Cambridge University Computer Laboratory and can offer a capacity of 4·2 Megabits. In the literature this is the equivalent of 50 pages of the Concise Oxford Dictionary every second. Even so the Ring with all its facilities can only cope over short distances. To extend such a facility nationally or internationally requires another facility. This really is what Project Universe is all about. The name of that facility is provided by the consortium involved: The Universities Expanded Ring Experiment. The consortium comprises the Department of Industry, The Rutherford and Appleton Laboratory of the Science and Engineering Research Council, British Telecom, Cambridge University, GEC, Logica, Loughborough University of Technology and University College, London.

The operational set-up is as follows—the LANs at Rutherford, Loughborough, Cambridge, Martlesham (Telecom Research Laboratory), Chelmsford (GEC/Marconi Research Centre), and London (University College and Logica) with (a terrestrial link between them) are all linked via the Orbital Test Satellite, which provides the high bandwidth capacity required for fast transmission of data. To take data from a network and transmit it to a satellite requires a Satellite Bridge.

THE LINK DRIVING COMPUTER

This is a major element of the Satellite Bridge. In the Project Universe sites this is provided by the GEC 4065 mini-computer with 64K bytes of semiconductor memory, a four-channel synchronous communications controller and cartridge discs. The LDC applies the necessary procedures, holds enormous amounts of data in buffer stores to await transmission and keeps account of the amount of traffic the Ring wants to send. It of course provides complementary functions for incoming data.

For the outward path the next step involves the Computer Interface Module which is responsible for controlling access to the satellite. There is a master Earth station which establishes a time frame by broadcasting every 130 milliseconds a reference burst which lasts for 100 to 200 microseconds, available to lock all the stations. Full assurance of confidentiality is achieved. The data is transmitted via a 3 metre dish at a frequency of 14GHz transmitting and 11GHz receiving. The real time for the out and return time is approaching 0·25 seconds.

THE ORBITING SATELLITE

The European Space Agency satellite (Orbital Test Satellite), is a three axis stabilised geosynchronous satellite launched in 1978. It is in orbit 36,000km above equatorial Gabon. One of the purposes of the satellite was to prepare for the European Communications Satellite system with services such as British Telecom SatStream. It has a polar power transponder to re-broadcast up to 7,200 simultaneous telephone conversations. This project heralds the future in which the electronic office becomes truly international.

SPACE POWER EFFORT

Three Energy Agencies, the Defence Department, the Energy Department and the Aeronautics and Space Research Projects Agency have agreed to proceed with the high power project which will be known as SP-100 (solar power 100kW) for future deployment in space. The organisation controlling the project will be the Defence Advanced Research Projects Agency. This decision marks the end of a ten year delay in coming to agreement among the parties. The escalation, promoted by defence authorities for military considerations and fear that America has of a space war, has overcome the profitability point of view.

Because the new agency, DARPA, is responsible for the space-borne laser technology, particle beam technology and space-borne radar techniques, it is in a position to assess the needs of such activities; and more closely when they will be needed DARPA will have disposition control. The scheme has far reaching consequences because some of the thinking is in terms of nuclear units of hundreds of kilowatts, and further to tens of megawatts into the 21st century. It is envisaged that this work could result in 100 kilowatt units using a combination of systems; reactors could be available in the second half of this decade.

Frank W. Hyde

INDUSTRY NOTEBOOK

By Nexus

China Trade

Since writing a couple of months ago of prospects in China, more heartening news has emerged. At least two Racal Group companies are active in the market. Racal-Dana Instruments has concluded a deal with the Government of the People's Republic which involves assembly of the '99 series' frequency counters in Shanghai.

Kits will be shipped to Shanghai from the company's Windsor base, and although all details have not been revealed it is more than probable that the agreement includes provision of production aids including jigs, automated assembly and automatic test equipment. In fact a literal Chinese 'copy' of the UK production facility.

A couple of weeks after the instrument assembly deal Racal Recorders was able to announce that the Chinese Civil Aviation Authority had chosen the Racal International Communications Recorder as 'standard fit' at major airports. The ICR is a multi-channel (typically 20) long-play tape recorder which records all ground-air communications. Together with the aircraft-fitted 'black box' it provides major evidence in disaster enquiries. Thus, quality and reliability are all-important and it seems the Racal product was chosen after competitive trials with other makes.

At present such orders are marginal, a trickle rather than a flood of trade, and they need a lot of hard work and considerable investment in time and travel to obtain. Racal-Dana, for example, has been building bridges with 40 Import/Export Corporation branches in Shanghai, Beijing, Guanzhou and Harbin. Patience and dedication now could be richly rewarded by future business.

Cable & Wireless runs the hub of international telecommunications traffic in the Far East from its Hong Kong base. C & W's chairman and chief executive, Eric Sharp, asserts that the Far East is the region with fastest economic growth and that 'our involvement with the Chinese Telecommunications Authority is a major development of our established business there'. The extent of the involvement is not revealed but is probably already considerable and increasing if only because C & W have a highly trained and Chinese speaking staff on the spot. Again, growth potential is clearly enormous, the number of telephones in the world 30 years ago was 70 million—today it is over 500 million; and China must be near the bottom of the world league in telephone sales penetration.

Lesson

The recent water strike provided some much needed education. Few people outside the industry itself had the faintest idea of what is involved in gathering, purifying and distributing the precious liquid to our houses, offices and factories. Almost daily exposure on TV gave us a glimpse of the technology involved.

But the most potent lesson was in what didn't happen. City streets were not awash with sewage after a few days. Nor after a few weeks. Public health did not break down. Stand-by troops were never used.

Much of the credit for the maintenance of supply must go to automation, water supply may be the oldest of the distributive industries, preceding gas and electricity. Some of our town sewers are still 19th century but elsewhere the industry is far from old-fashioned, and new equipment and systems are going in all the while.

An example is a Marconi contract for radio monitoring and alarm for a network of 35 unattended sewage pumping stations in South Northamptonshire. The system is microprocessor-based and each pumping station is fitted with an 'intelligent' alarm to alert the control centre of any malfunction. A visual display and hard-copy printout of system status is at the control centre. Standard practice so far, except that the base control centre itself is open only in normal office hours.

To cover all contingencies Marconi is supplying two transportable control stations so that a duty controller can be in touch with system status from anywhere in the area and at any time.

We shall never know how long it would have been before public health became endangered. And we were lucky with the weather (fewer burst mains than expected) and with some essential maintenance carried out by management personnel. There was inconvenience to the public but no disaster. Which leaves us wondering whether the water industry might, perhaps, be a little overmanned.

Recession?

What recession? Where? The electronics industry is clearly a special case but here, for the record, are a few success stories.

Marconi Avionics has signed a contract worth £30 million for the supply of 'head-up' displays for use in General Dynamics F-16 combat aircraft. This however, is for initial development and production, signifying follow-on orders.

Applied Computer Techniques (ACT) is investing £10 million in a new plant at Glenrothes, Fife, said to be one of the world's biggest start-ups in microcomputers. Two hundred jobs this year, 400 by 1984.

Hewlett-Packard Ltd in the UK has enjoyed a 42 per cent increase in turnover. Exports were up 34 per cent and sales per employee have rocketed from £63,000 to £83,000 per year. Amazing!

IBM United Kingdom—Turnover up by 24 per cent to £1·24 billion. Pre-tax profits up 40 per cent to £225 million.

Standard Telephones and Cables—Turnover up 11 per cent, pre-tax profits up by 27 per cent. Exports at £143 million, 14 per cent up.

Plessey—Pre-tax profits up 29 per cent in the first nine months of the financial year.

Digital Equipment is spending £7 million setting up an office systems software development facility at Reading. Jobs for 250–300 in addition to the existing 120 in the present DEC software group.

Of course it's not all sweetness and light for every company but if these are hard times what's it going to be like in a boom?

Jobs and Pay

The Institution of Electrical Engineers 1983 Salary Survey is full of interest. The sample totalled 7616 Fellows, Members and Associates in the UK and Republic of Ireland. The dominant field of occupation remains 'Electronic or telecommunications equipment development or manufacture'.

Compared with the 1982 Survey, unemployment is down from 1·2 per cent to 0·7 per cent, reflecting continued and indeed increasing demand for qualified engineers. But there is a small shift in employment from the public sector to the private sector of industry, up 2·1 per cent at 56·1 per cent. In 1976 only 45·8 per cent were in the private sector.

Salaries, however, are still higher in the public than in the private sector although the gap is narrowing. Taking all members in all grades and types of job, the salary range is from £6,000 for a young Associate up to £25,000 p.a. for a Member or Fellow in a senior positon.

It's good to see salaries rising. But better still the low unemployment in the profession. Less than 1 per cent leads us to ask again, what recession?

Shifting Pattern

The personal micro boom is shifting the pattern of trade. Many electronic nobbyists are spending on factory produced micros money they would otherwise be spending on components or kits. But perhaps only a temporary diversion of funds. The hard core of home constructors get as much if not more satisfaction from the making of a project and the understanding of how it works as from its end-use.

My own view is, that out of the thousands of purchasers of personal micros, quite a proportion will feel encouraged to take an interest in home construction where no interest had hitherto been shown. In fact a wider general enthusiasm for electronics could add to the ranks of the d.i.y. hobbyist.

NEW SERIES

SEMICONDUCTOR CIRCUITS

TOM GASKELL B.A.(Hons)

HIGH QUALITY AUDIO PREAMPLIFIER (HA 12017)

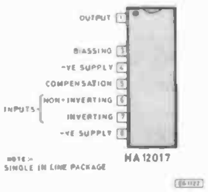
HI-FI preamplifier designs of recent years have tended to use one of two basic circuits for the 'disc' input amplifier; either a conventional high performance opamp, or a discrete transistor based design. Opamps are simple, cheap, and easy to use, but in the highest quality systems they can sometimes create problems of noise or distortion. Furthermore, their maximum supply voltage is normally limited to around +/− 15 volts, thus limiting their dynamic range and overload handling capability. Discrete transistor preamps, on the other hand, can be very complex to design and build. They are usually rather bulky, requiring large areas of Veroboard or p.c.b., and are often difficult to modify and experiment with. The performance, however, can be made very good indeed. The Hitachi HA 12017 is an i.c. which is specifically designed as a low noise, very low distortion audio preamplifier, and is able to offer the high performance of complex discrete designs with all the advantages and simplicity of integrated circuit technology. The i.c. has been developed from a similar device produced by Hitachi a few years ago, which has become somewhat of a standard in Japanese hi-fi equipment.

Although the i.c. can be used in a flat configuration (i.e. with no audible frequency dependent response characteristics), it is primarily designed and optimised for use as an R.I.A.A. equalised magnetic pick up preamplifier, for use with audio discs. (R.I.A.A. is the response characteristic standardised for use in record reproduction; it is the exact converse of the filtration which is applied to the cutting head when the master disc of the record in question is first made. By using such an arrangement of filtration, the modulation level recorded onto the disc can be made relatively high, improving the signal-to-noise ratio substantially.)

The pin configuration is shown in Fig. 1, and probably the most notable point to make about this is that the device comes in a single-in-line package; there is only one row of pins which stick straight out of the side so that when mounted on its circuit board, the package stands vertically off the board. For experimental purposes, you could plug the two i.c.s (for stereo) into one ordinary 16 pin i.c. socket, but for a permanent installation this is not recommended, since at very low signal levels the quality of the connection could be a little suspect.

The specifications for the HA 12017 are shown in Fig. 1, and they make interesting reading for all those interested in high quality performance! All the figures are based on the use of the i.c. in a complete R.I.A.A. equalised circuit, as shown in Fig. 2, so they are realistic indicators of the performance of the whole disc preamplifier stage.

Fig. 1 (right) HA12017 pin-out and (below) its specification. Note that this refers to the R.I.A.A. equalised circuit of Fig. 2



Characteristic	Notes	Min. value	Typically	Max. value	Unit
Supply Voltage	All specs below are measured at ±24V	±6	±24	±26·5	V
Quiescent current	No input signal		4·0	6·0	mA
Temp. range		−30		+75	°C
Dissipation				500	mW
Total harmonic distortion	20Hz–20kHz output 10V r.m.s.		0·002	0·01	%
Output voltage	Freq. 1kHz, THD—0·1%	13·5	14·7		Vrms
Open loop gain	Freq. 1kHz	95	105		dB
Max. input level	Freq. 1kHz, THD —0·1%		235		mVrms
Output noise A	Source resistance —43Ω Weighting curve used		11·5	15·6	μV
Output noise B	Source resistance —3k3 Wide band (20Hz–20kHz)		53	90	μV
Supply rejection ratios	+ve supply @ 100Hz ripple		56		dB
	−ve supply @ 100Hz ripple		45		dB

SUPPLY AND OUTPUT VOLTAGES

Although the supply voltage can be as low as +/− 6V, the recommended rails are +/− 24V. This is intended to allow a very high output level to be obtained from the device before clipping occurs; typically 14·7V r.m.s., or 41·6V pk/pk. The R.I.A.A. equalised circuit of Fig. 2 has a gain of 35·9dB at 1kHz (a voltage gain of 62 times), so the maximum input level is defined as 1/62 of the maximum output voltage; this works out as in input of 235mV r.m.s. Most magnetic pick up cartridges only produce a typical signal level of a few millivolts, so this may seem to be an unnecessarily large input signal handling capability. However, some audio sounds and effects, especially those of a percussive or synthesised nature, can include much higher voltage short duration spikes or transients, which generate cartridge outputs much higher in level than the nominal few millivolts. By allowing up to 235mV (664mV pk/pk) before clipping occurs, the i.c. allows plenty of headroom before these transients are distorted in any way. (Typically in the order of 30 to 40dB, depending on the cartridge used.) As a result, the audible quality is excellent, and the sound is very clean. Many low supply rail designs are somewhat lacking in this respect, so don't reduce the supply rails below +/– 24V unless it's absolutely necessary!

DISTORTION

A large signal overload handling capability is of very little use to us if the device produces unacceptable amounts of distortion. In fact, the distortion specification is one of the HA 12017's most impressive features; typically 0·002% (1kHz at 10V r.m.s. out). The actual graph of third harmonic distortion versus output signal level is shown in Fig. 5, and it can be seen that clipping (i.e. the sudden onset of large amounts of distortion) occurs at around 15V r.m.s. (as we have already established), and distortion slowly starts to rise at below 1 to 2V r.m.s., which is not unreasonable. The distortion of this i.c. is so low that it could well be used in audio test equipment; as a front end amplifier in a distortion measuring set, or even as the central building block of a low distortion oscillator, for example. In this type of application, its own distortion is so low that it will have virtually no effect on the measurements of most audio system performance.

Fig. 2. Audio preamplifier circuit

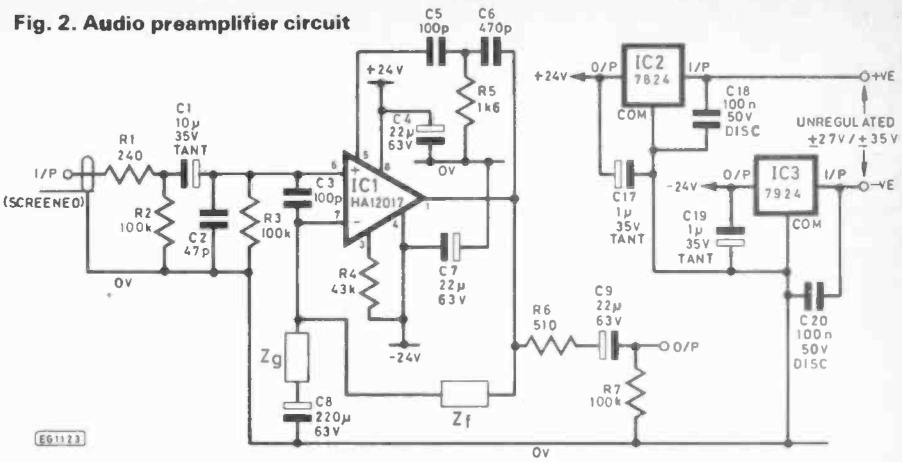
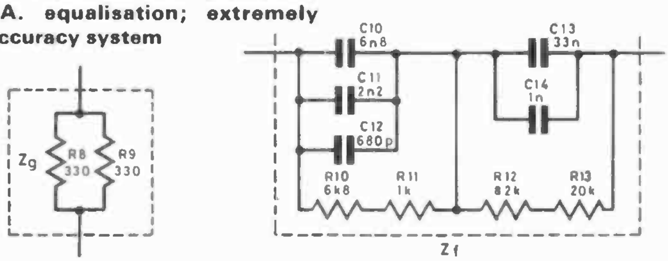


Fig. 3. Feedback components for R.I.A.A. equalisation; extremely high accuracy system



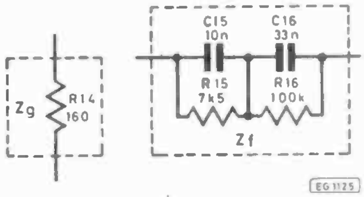


Fig. 4. Feedback components for R.I.A.A. equalisation; non-critical accuracy

NOISE

Noise is one of the most important and fundamental specifications in any audio system. Arguments may rage over the audibility of phase changes or certain types of distortion, but the undesirable and intrusive nature of noise in audio reproduction is not under dispute.

As the front end amplifier in the audio signal path, the disc preamplifier is required to add the most gain to the signal, and hence also adds the most noise, defining the overall noise level generated by the complete system. As with the other operational parameters of this device, the noise specifications are very good; with a source resistance of 3k3, and a 20Hz to 20kHz bandwidth, the output noise voltage is typically 53µV, or –83dBu. This gives a dynamic range of 109dB (i.e. the difference between the maximum output signal level and the output noise), and a signal-to-noise ratio for a typical magnetic cartridge, producing 5mV r.m.s. signal, of 75dB (assuming a cartridge impedance of 3k3). In practice, the prototype circuit gave an output noise, including residual hum, of –84dBu (49µV) with a 3k3 resistor across its input, and –90dBu (25µV) with the input short circuited; both these figures were measured for the range 20Hz to 20kHz. The equivalent input noise, as derived from the specifications, is 0·85µV, or –119dBu.

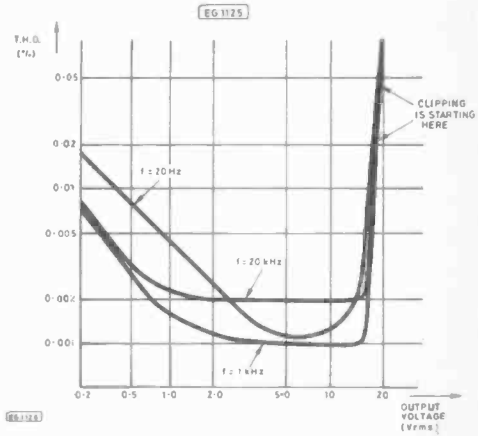


Fig. 5. Graph of distortion against output voltage for main circuit

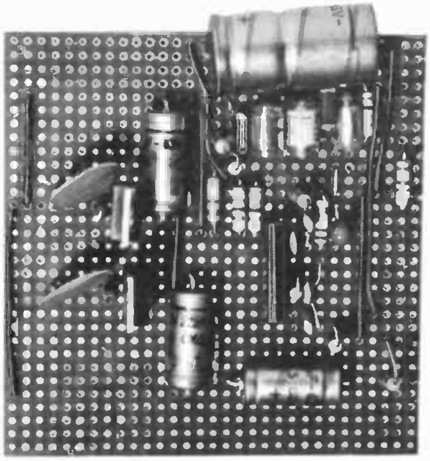
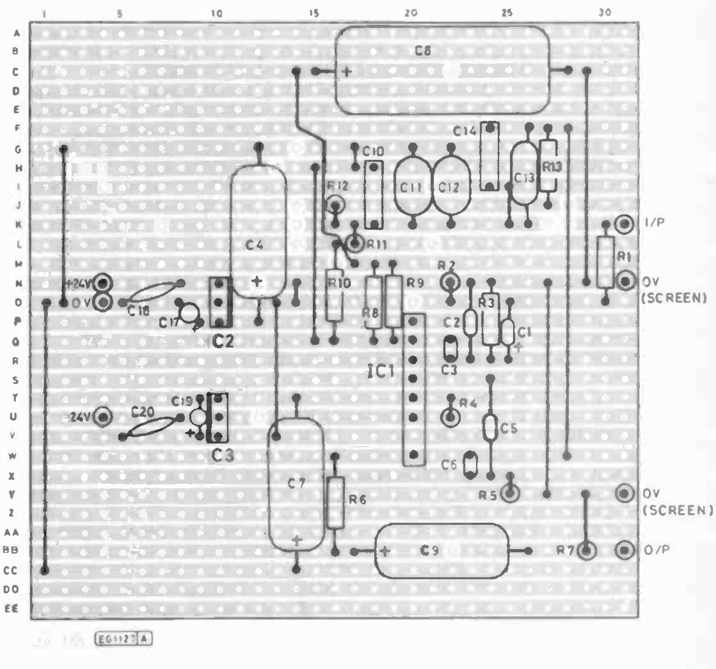


Fig. 6. Board assembly



CONSTRUCTION

Fig. 6 shows the Veroboard layout for a complete mono disc preamplifier. 24V power supply regulators have been added to allow any d.c. unregulated supply of +/– 27V to +/– 35V to be used. The regulated supplies can be used to feed a second preamplifier, of course, as in the case of a stereo system. The layout has been arranged to use the circuitry of Fig. 3, i.e. the high accuracy equalisation components, but the non-critical components of Fig. 4 could easily be fitted if preferred. For optimum performance, all resistors should be metal film types, and the capacitors should be as follows:

C2, C3, C5, C6 ceramic plate
C1, C17, C19 tantalum bead, 35V rating or more
C10, C13 (or C15, C16) polycarbonate
C11, C12, C14 polystyrene
C4, C7, C8, C9 electrolytic, 63V rating (50V will also do)
C18, C20 disc ceramic, 50V rating or more

All the normal rules and conventions of audio practice should be adhered to; plenty of supply decoupling, mains transformer far away from the preamplifier inputs, short signal leads, very thick earth wires, taken down to just one central common earth point, good quality connectors, etc. Some of the interconnections and layout of components in Fig. 6 may seem a little strange at first sight. Do beware of changing the layout arbitrarily, however, because some of the layout and linking is critical for achieving low hum and good stability from the system. Designing your own p.c.b. for the circuit, in that respect, offers the chance of achieving even better performance than the Veroboard layout, but be prepared for some experimentation! The input impedance of the circuit is approximately 47k, to match the most popular magnetic pick-up cartridges (change C2 to suit the loading requirements of the cartridge in question). No volume or tone controlling is shown, of course, since our primary concern is the preamplifier i.c. We'll look at devices to do these other audio functions at a later date! However, we do now have a very high quality, very low distortion, low cost disc preamplifier design based on the HA 12017. The only problem now is the designing of the power amplifier to fully do the preamp justice!

The HA 12017 is readily available from **Ambit International.**

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WANTED Lafayette HA-63 communication receiver. Send details to J. Heraty, 1 New Hall House, New Hall Street, Walsall, West Mids. WS1 3DY.

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ZN1034E	200
LOGIC ICs	
AY5-2376	590
MC1488	55
MC1489	55
MM5303	625
MM5307	1250
MM58174	700
TMS6011	365
ULN2003	75
8T26	99
8T28	120
8T95	90
8T97	90
81LS95	80
81LS96	80
81LS97	80
81LS98	85
6522	310
6532	675
6821	110
6845	650
6847	650
6850	110
6852	250
6875	485
8155	350
8212	110
8216	100
8224	110
8226	250
8228	220
8243	270
8250	865
8251	250
8253	400
8255	225
8257	400
8259	395
8279	385
8832	250
9602	220
Z80ACTC	260
Z80ADART	775
Z80ADMA	975
Z80AP10	270
ZN425E8	320
ZN426E8	320
ZN427E8	575
ZN428E8	395

CMOS	
4000	11
4001	11
4002	11
4007	14
4008	34
4009	24
4011	11
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4508	110
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4512	42
4514	110
4515	110
4516	50

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4539	80
4543	60
4555	35
4556	35
4561	100
4583	80
4584	40
4585	50
COMPUTER ICs	
1802	650
2650A	1175
6502	320
6800	220
6802	250
6809	615
8035	345
8060	1090
8080A	250
8085A	345
Z80A	315
MEMORIES	
2101	395
2114 (200ns)	85
2532	295
2564	1000
2708	225
2716 (5V)	210
2764	750
4116 (200ns)	80
4118-3	325
4164	420
5101 (450ns)	150
5204	725
6116 (150ns)	375
6514	330
6810	115
74LS	
LS00	11
LS01	11
LS02	11
LS03	11

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LS259	53
LS266	18
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LS290	40
LS293	40
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LS366	27
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LS368	27
MICRO-MINI 100V CERAMIC PLATE CAPS	
1pF 10nF	7

TANTALUM BEADS	
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0.22/35	12
0.33/35	12
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0.68/35	12
1.0/35	12
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2.2/35	16
3.3/35	17
10/25	18
15/25	28
2.2/16	14
3.3/16	14
4.7/16	16
6.8/16	16
10/16	18
15/16	27
22/16	27
33/16	40
47/16	40
100/16	75
15/10	22
22/10	24
33/10	30
47/10	35
100/10	55
100/6.3	42
63V MINI MONOLITHIC CERAMIC	
10nF	10
22nF	10
33nF	10
47nF	10
68nF	10
100nF	14
DIODES	
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1N4002	4
1N4003	5
1N4004	5
1N4005	6
1N4006	7
1N4007	7
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2A/200V	40
2A/400V	40
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78L12	30
78L15	30
78L24	30
7805T	36
7812T	36
7815T	36
7824T	36
79L05	60
79L12	60
79L15	60
7905T	42
7912T	42
7915T	42
7924T	42
LM309K	130
LM317K	270
LM317T	120
LM323K	350
LM723	35
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Carbon Film	
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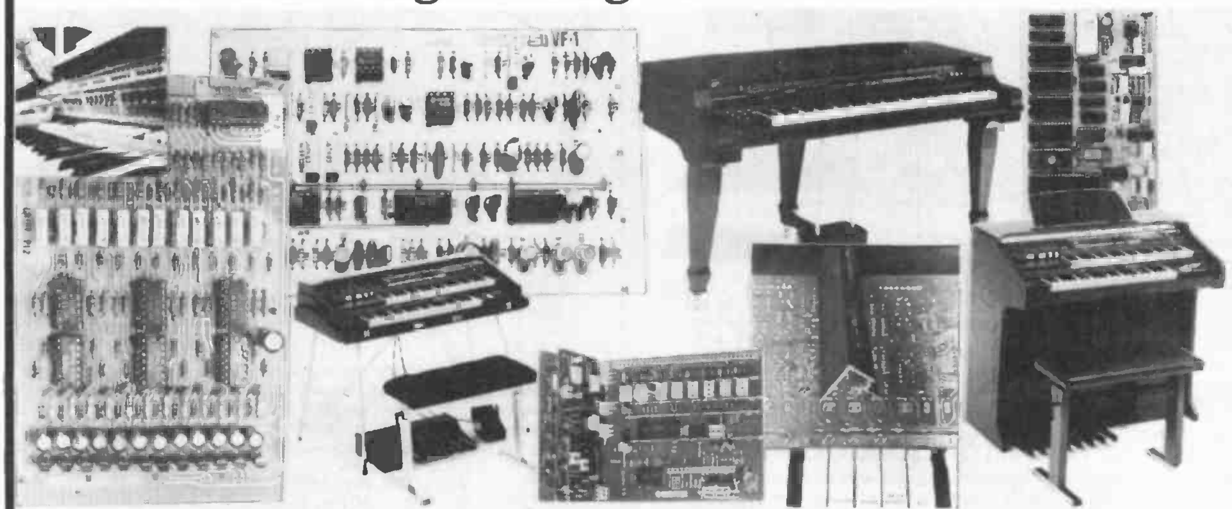

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T.V. SOUND TUNER

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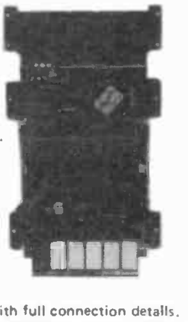
This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with P.E. (July '81). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System.

FEATURES: VHF, MW, LW Bands, Interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM-ferrite rod, FM-75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size 10½"x 2½" approx. Complete with diagram and instructions.

SPECIAL OFFER! £13.95 +£2.50p&p.

Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x8½"x3¼". £3.50 Plus £1.50 p&p.

STEREO CASSETTE DECK



Stereo cassette tape deck transport with electronics. Manufacturer's surplus — brand new and operational — sold without warranty.

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Just requires mains transformer and input/output sockets and a volume control to complete. Supplied with full connection details.

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

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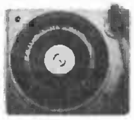

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a.c. V 10V, 30V, 100V, 300V, 1000V.
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dB from −10 to +61 in 5 ranges.
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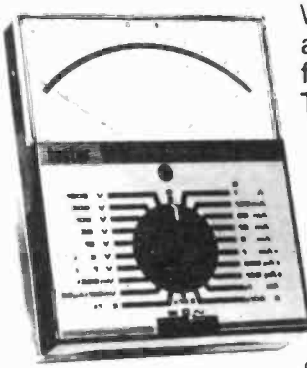

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VERNON TRENT at Large!

THE other night I had to go to one of those ghastly industry dinners. But for once it didn't turn out too badly. My table-mate chanced to be something of a high-flyer in the Patent Office and his witty conversation helped the steamed cod and mash down a treat. Over the brandy, which was extra (I could only afford one—he had three), he told me that his office cellars are full and running over with clever inventions which for some strange reasons never made it to the retail counters.

There was this harness for long-distance rail travellers. The idea was for the user to clamber into it and fix the free end to the luggage rack. Then whenever the train lurched he could go on snoozing without being shot into the lap of his unfortunate neighbour. I wonder why this excellent aid to passenger-comfort never rocked the market-place? Maybe it was blacked by ASLEF.

Another innovation was a pair of plastic sleeves for melon-eaters. It was to stop the succulent juice oozing down to their armpits. It's believed that this one failed because the inventor didn't bother to find out that your genuine melon-lover looks upon the juice-flow as part of the ecstasy.

Happily such piffling restraints have not, in the main, held up the acceptance of that particle which all of us in the business prefer, the electron. Yet though it has wormed its way into most walks of life, there are still one or two areas where it has tended to be given the big elbow.

An outstanding example is the Church. Now, let's face it. Apart from fringe elements who scorn the dog-collar in favour of the T-shirt with the rude inscription ("Good grief man. I'm one of the lads, just like you") and who back the twang of the guitar against the swell of the organ, there is no body more resistant to change.

That could be good for the soul. After all, there's much to be said for stability in a world where standards and values change with the speed of a mannequin.

For all that, it's time the Church stopped standing still and for those at the pinnacle to have another think. So let's have a quick word with the Archbishop of Canterbury, Cardinal Hume, the chaps on the Nonconformist front and, naturally, the chief Rabbi. We have a duty to make them aware of the ways in which modern technology can do nothing but good for their missions.

Every day you can read about the sad financial plight of churches all over the country. There's hardly a parish which hasn't its crumbling tower (almost always Norman), on-the-blink heating, a cracked font or a bronchitic organ.

What about a set of microprocessor-controlled doors which will not open until after the collection has been taken up? We all know the mean skivers who slip through the offertory net by pretending they've a bus to catch or feign an urgent need for the loo. This would stop them creeping out the minute the churchwarden picked up the plate.

A more sophisticated system would be one that linked the door-control to a collection-calculator, with a read-out in the vestry. Then all present would remain virtual prisoners until a previously-determined cash target had been reached.

One of the deadliest things that can happen to a clergyman—apart from dropping the first-born of the patron of the living in the font—is to watch horrified as members of his congregation nod off during what he thought was a pretty rivetting sermon. It's the sort of thing that's likely to happen at Sunday evensong. Dieticians reckon it's the lunchtime meat and two veg followed by spotted dick and custard that does it.

A low-voltage electric shock, controlled from the pulpit and applied via the pew seat, would jolly soon remind these laggards that if they want to get to the pearly gates they'd better pay more attention to the directions. This shock therapy could also be made to work the other way. A high-intensity infra-red beam—governed by a simple timer—would gently heat up the seat of the preacher's trousers if he droned on for longer than was decently acceptable.

Of course, you'd have to reckon with the wily old prelate—probably a reader of PE—who knew the drill and had equipped himself with a pair of pants insensitive to infra-red. One way to put him in his place would be to install an ejector apparatus under the pulpit floor instead. However, for reasons of sheer Christian charity it shouldn't be used on any incumbent over the age of 80.

You may think, if you have a business background, that a squad of robot choirboys is something of an extravagant capital investment yielding a small return. This is not so. Those clergymen who have been bold enough to take such a step are over the moon—which for them is a step in the right direction anyway.

One of them, a diocesan bishop no less, told me: "Ah, the blessed relief of witnessing the end of the placing of rude-sounding cushions on minor canons' stalls and the demise of bubble gum popping during the Venite." But, he admitted to me privately with a sigh, he did sometimes miss the pleasure of cuffing the little perishers round the lughole.

Baptisms have a special hazard for men of the cloth. They never know what to expect. All too often they are called upon to handle infants who are either equipped with Tannoy-type voiceboxes or who have forgotten to go before they came out. Frequently both.

Apart from stuffing his stole down the baby's throat, there's not much a parson can do about the former. But if he's technically-minded enough to insert moisture-detectors in his cassock sleeves, he has a sporting chance of whipping junior back into mum's arms before any damage arises out of the latter. Electronics saves pounds on cleaning bills.

Most clerics are like actors. They must have the smell of the crowd and simply cannot do their stuff well in the hollowness of half-empty churches. They become about as helpful to the propagation of the Word as a pork butcher is to a vegetarian. Their confidence can be speedily restored by the use of holographic laser techniques to project images of large congregations.

There are three standard features of church weddings: The nudge-nudge innuendo of the groom's mates; snivelling matrons; and an appeal by the old knot-tier about scattering confetti in the churchyard. ("Not only does it spoil the beauty of the church's environment, but we have to pay our worthy sexton overtime to clear it up. And that grasping swine doesn't come cheap.")

The solution is as simple to me as the theory of relativity was to our Albert. You get yourself an electrostatically-charged cat and chase it round until not a scrap of confetti remains.

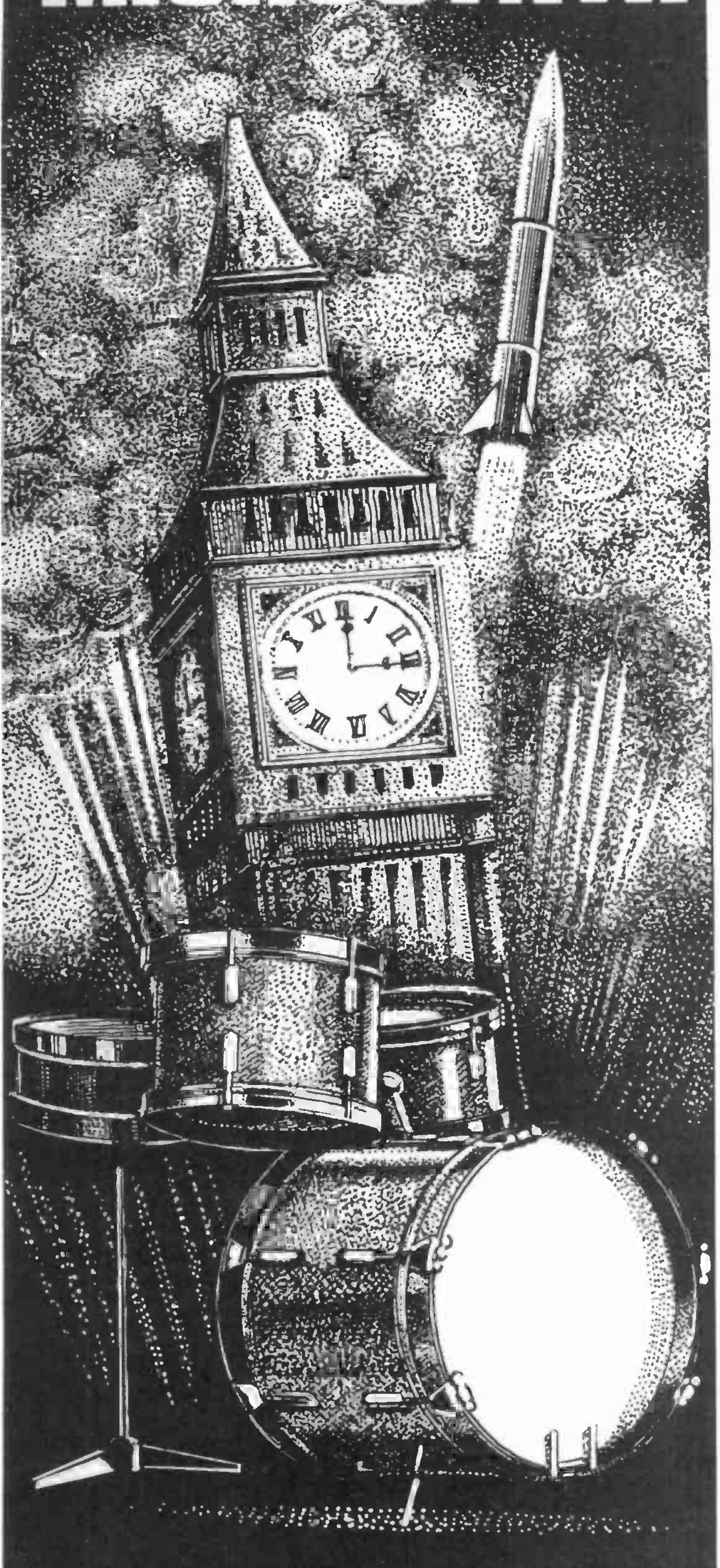
Satellite TV is something else that could also come in handy on the Church's march. Who knows? The way things move nowadays, it may eventually become possible to establish two-way communication (using triphonic techniques, of course, during Trinity) with Paradise. Such a facility would have to be used with dignity and care, being restricted in the first instance to ordained ministers only. We couldn't have laymen trying to get in by the back door.

I'm not daft enough to expect an early and positive response to my case, well-founded as it is. Down the centuries the Church has always moved in a pedestrian way its wonders to perform. There are, for example, still places with hand-pumped organs, reserved pews for the squire and his brood and venerable vergers who double-up as gravediggers and pull at their forelocks whenever the vicar comes within 50 yards. It takes a powerful electronic device to get through barriers like that.

But a seed has been sown. Let us trust that it has not fallen upon stony ground but will become fruitful and multiply.

V.T.'s views and opinions are entirely his own and not necessarily those of PE or anyone else.

PERCUSSION MICROSYNTH



Effectively two complete synthesisers in one package, together with a variable angle LFO to modulate the VCOs or filters, and a voltage controlled phaser to phase either or both synthesiser outputs

A.R. BRADFORD M.Sc.

THE Percussion Microsynth is provided with internal trigger pads of variable sensitivity so that it may be played with hands or drum sticks. Thus it may be used either to augment an existing drum kit (whether mechanical or electronic) or as a self contained free standing unit in the manner of a pair of electronic "bongos". While the unit is quite capable of imitating conventional drums, cymbals, etc, this is hardly the purpose for which it was conceived — it would for example be simpler and cheaper to use a real pair of bongos if this was all that was required. The strength of an instrument like this is that it is capable of creating a vast range of different sounds from bells to explosions, triangles to "Big Ben", gongs and metallic "dustbin lid" sounds, to rockets, marching feet, steam trains, wind and surf effects, as well as a vast array of abstract sounds. In this respect it should not be confused with the range of low cost "percussion synthesisers" currently on the market, which tend to be of extremely limited capability.

The Percussion Microsynth may also be triggered from an external microphone so as to respond to a particular part of a drum kit, as well as to voices, etc. It may also be triggered electronically from one output of a drum machine such as the *PE Master Rhythm*, as well as from the gate outputs of a sequencer. In relation to this, the 1V per octave control inputs to the VCOs enable the Percussion Microsynth to be used as a dual "slave" synthesiser in conjunction with a sequencer or a polyphonic keyboard controller.

In addition a dynamic sensitivity function is provided. That is, the harder you hit the drum pads, the greater the effect produced, be it loudness or sweep of pitch, etc.

In spite of the tremendous range of sounds available — greater than most commercial units — simple low cost circuitry has been employed throughout. The entire unit is built on one 16in x 5½in printed circuit board.

PRINCIPLES OF OPERATION

The general scheme of the unit is shown in Fig. 1. The signal from the transducer is used both to trigger the envelope shaper and to provide the control voltage which is the basis of the touch sensitivity. The latter part of the circuitry comprises an envelope follower and a sample and hold which samples the rectified voltage from the transducer instantaneously, each time a new signal is received from the transducer. The output voltage from the envelope shaper is then multiplied by the output voltage from the sample and hold, so as to achieve envelopes of amplitude proportional to the size of the signal received from the transducer. With the "Touch" switch off, the envelope is multiplied by a constant factor of 1. Although no provision has been made for it as such, the astute synthesist will spot here a facility for external voltage control of the envelope size, and a possible modification for implementing this will be mentioned later.

The envelope is hard-wired to the VCA to effect volume contours, and may also be switched in to the VCO or VCF to produce sweeps in pitch or harmonic content. The envelope shaper itself is of the Attack/Release type, the provision of

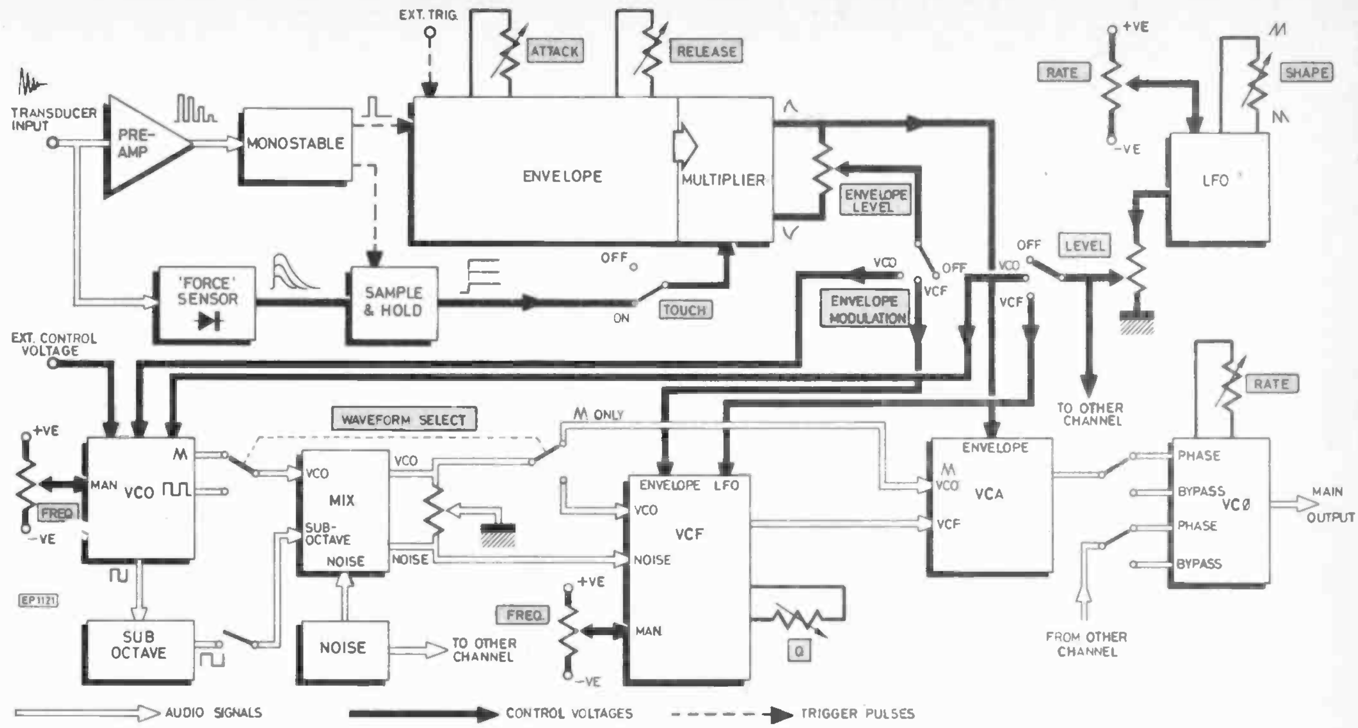


Fig. 1. Block diagram of one channel of the drum synth, plus phaser and LFO

an attack control greatly extending the range of sounds available (that is, they need not be percussive at all! They could for example be reversed starting slowly and finishing abruptly, or be of a gentle, singing quality).

The VCO produces either smooth sounding triangular, or harsh square waveforms, with provision for external voltage control of the pitch. A simple circuit provides a sub-octave. The triangle waveform goes straight to the VCA, while the square wave and/or sub-octave go to the VCF. In this way the instrument can produce warm sounds in which the VCF filters out the higher harmonics in the sub-octave waveform without affecting the triangular waveform an octave higher. The mix control cross-fades continuously from white noise (which is fed into the VCF) to oscillator output, including the sub-octave when it is switched in.

The VCF is a low-pass type with variable resonance, which has been modified so that it will also oscillate when the resonance control is turned fully clockwise. Thus the VCF can be used as an auxiliary sound source in conjunction with the triangle from the VCO, in order to produce bell-like sounds.

Each channel of the instrument may be switched through the phaser (VCØ), in which the phasing rate is manually controlled.

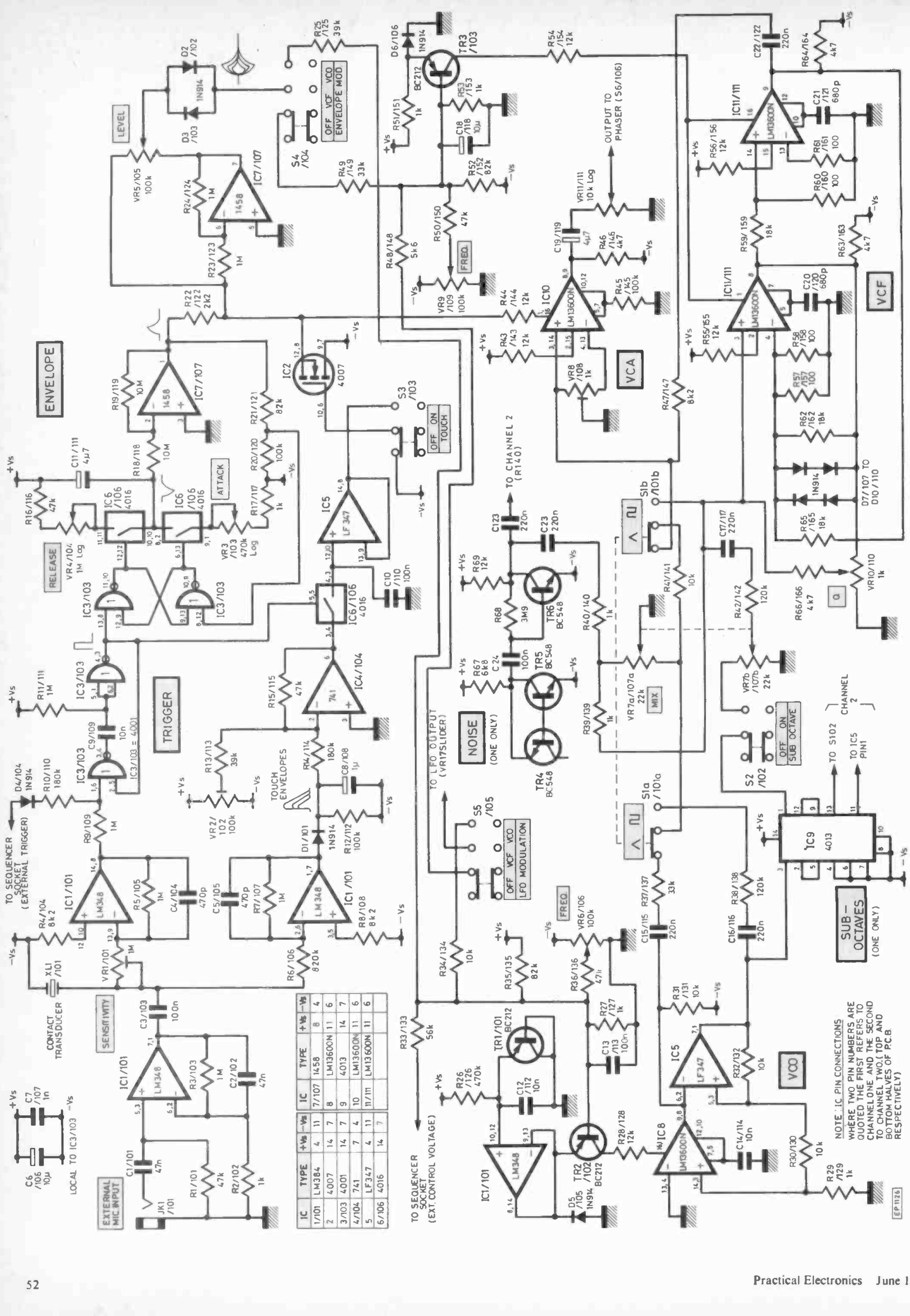
The LFO (low frequency oscillator) can be used to modulate either the VCO or VCFs, from 0·2Hz to 30Hz to any degree set by the "Depth" control. The LFO is of a novel design in which the "Shape" control varies the shape of the LFO waveform continuously from rising ramp, through triangular, to falling ramp, and many interesting effects can be obtained in the manipulation of this one control.

CIRCUIT DESCRIPTION

The complete circuit of one channel of the synthesiser is shown in Fig. 2. IC1 pins 5, 6, and 7 (IC101 pins 1, 2 and 3) is a microphone preamplifier with a sensitivity of about −50dB, catering for the low impedance microphones found in stage or studio environments, although high impedance microphones will work just as well. C1 to C3 (C101 to C103) form a band-pass network so that the unit responds neither to low frequency noises transmitted through the floor (vital on stage), nor to radio signals. The resultant signal is mixed with the output from the internal transducer which is of a high impedance crystal type. From here the signal takes two separate paths. IC1 pins 12, 13 and 14 (IC101 pins 8, 9 and 10) is a hard limiting amplifier and triggers the CMOS monostable (half of IC3, IC103), producing a 10 msec pulse, which in turn triggers the envelope shaper. VR1 (VR101) is the sensitivity control, while C4 (C104) removes radio pickup and local decoupling of the trigger circuitry also helps to eliminate spurious triggering.

The pulse from the monostable sets the set-reset flip-flop (the other half of IC3, (IC103) which turns on the CMOS switch connecting the "Attack" pot to C11 (C111). This capacitor therefore charges down from +8·5V towards −8·5V. The voltage on C11 (C111) is inverted by IC7 (IC107) to give a positive going envelope, and this is fed back via divider R20, R21 (R120, R121) to the reset input of the flip-flop. Thus the flip-flop is reset when the output of IC7 (IC107) reaches about +6V. The "Attack" pot is then disconnected from C11 (C111) and connected instead by the other CMOS switch to the "Release" pot. Thus C11 (C111) discharges back up to +8·5V at a rate set by VR4 (VR104). The positive going envelope from IC7 (IC107) pins 1, 2 and 3 is reinverted by the other half of IC7 (IC107), pins 5, 6 and 7, and the "Level" control VR5 (VR105) cross fades between positive and negative going envelopes, with the back-to-back diodes creating a dead band around the centre (zero) position. The output is used via S4 (S104) to modulate the VCO or VCF.

The voltage from the microphone input or transducer is also amplified to a lesser extent by IC1 pins 1, 2 and 3 (IC 101 pins 5, 6 and 7). D1, R12 and C8 (D101, R112 and C108) produce a d.c. envelope of the shape indicated and of amplitude proportional to the size of the signal coming from the microphone or transducer. This envelope, added to a d.c. offset from VR2 (VR102), is amplifed and inverted by IC4 (IC104).



IC	TYPE	+Vs	-Vs	IC	TYPE	+Vs	-Vs
1/101	LM384	4	11	7/107	1458	8	4
2	4007	14	7	8	LM13600N	11	6
3/103	4001	14	7	9	4013	14	7
4/104	741	7	4	10	LM13600N	11	6
5	LF347	4	11	11/111	LM13600N	11	6
6/106	4016	14	7				

Fig. 2. Circuit of one channel of the synthesiser

CMOS switch IC6 pins 3, 4 and 5 (IC106 pins 3, 4 and 5) together with C10 (C110) and IC5 pins 12, 13 and 14 (IC105 pins 8, 9 and 10) form a sample and hold circuit, sampling the "touch" envelope each time the CMOS switch IC6 pins 3, 4, and 5 receives a pulse from the monostable. The output of IC7 (IC107) pin 1 passes through a divider formed by R22 (R122) and a CMOS FET IC2 pins 9, 10 and 12 (pins 6, 7 and 8). With the "Touch" switch S3 (S103) in the off position the gate of this FET is connected to the negative rail so that the FET is biased off and the envelope shaper output is unattenuated. With S3 (S103) on, the resistance of the FET, and therefore the size of the envelope, is determined by the touch circuitry.

It has been mentioned that there is potential for externally controlling the size of the envelopes. This could be achieved by feeding a control voltage into pin 2 of IC4 (IC104) — say 0 to 10V positive via a 180k resistor. Alternatively the connection between S3 (S103) and the negative rail could be broken, and a control voltage fed in directly to the gate of the FET. In doing this the gate of the FET should be connected to the negative rail via a 1M resistor.

SOUND SOURCES

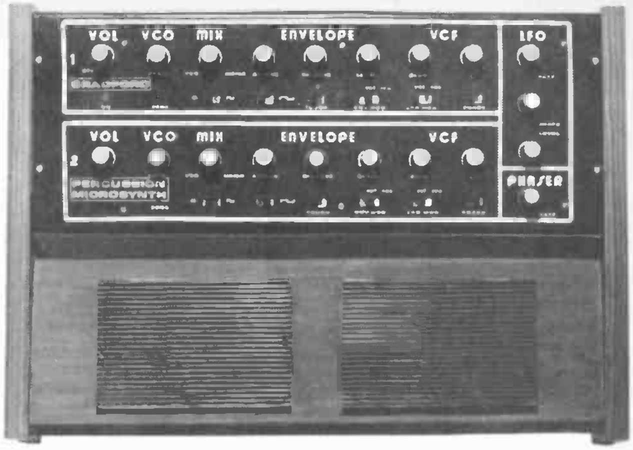
The VCO is a simple triangle/square oscillator. IC8 is a dual operational transconductance amplifier (OTA) configured as an integrator which ramps positive at a rate proportional to the current flowing into its control input, until the threshold of the Schmitt trigger IC5 pins 5, 6 and 7 (pins 1, 2 and 3) is exceeded. IC5 then changes state and the OTA output ramps downwards, and so on. The control current for the OTA is sourced by TR2 (TR102), temperature compensated by TR1 (TR101). The exponential law provided by the use of a transistor is not entirely necessary, but is preferred in this application as it renders the pitch of the VCO more controllable at low frequencies. Also it allows the control voltage inputs to be referenced to 0V instead of 1V above the negative rail, as is the case of OTA control input pins. In addition this arrangement allows the Percussion Microsynth to play musical scales when slaved to a standard 1V per octave sequencer or polyphonic keyboard controller. The external control voltage is applied via R33 (R133). (In connection with this usage, the sequencer or controller could also be made to determine the note length were it to provide the reset pulse, to the envelope flip-flop, instead of the resistive divider.) Such applications are however left entirely to constructors' ingenuity.

TR4, TR5 and TR6 form a white noise generator feeding both channels of the instrument, and VR7 (VR107) cross fades between noise and oscillator outputs.

IC9 contains two divide-by-two gates, each driven by the Schmitt output of its respective VCO in order to provide a square wave one octave below the VCO pitch. Each sub-octave may be switched into its respective filter, regardless of whether a triangular or square wave output is selected from the VCO.

FILTERS

Each VCF is a standard state-variable design built round a dual OTA chip IC11 (IC111). This provides a low pass output into the VCA, with the degree of resonance controlled by VR10 (VR110). Although basically the same as used in the Microsynth, here the VCF has been modified so that with VR10 (VR110) at maximum, the circuit will oscillate in the range of a few hundred hertz to 10kHz, depending on the setting of VR9 (VR109) as well as any other modulating voltages selected from the envelope and/or the LFO. This is achieved by increasing the feedback, that is decreasing the value of R66 (R166); at the same time the diode network



Showing control panel and trigger pads

around R62 (R162) limits the output excursions of IC11 (IC111) pin 8. The overall gain of the filter is fixed so that the output waveform is a reasonable facsimile of a sine wave.

The control current for the VCF is sourced by TR3 (TR103), temperature stabilised by D6 (D106). This arrangement is not accurate enough to drive a VCO for musical purposes, but is quite adequate for the filter in this application.

VCA

IC10 pins 1 to 8 (pins 9 to 16) is another OTA without the time constants in the form of R-C networks that would otherwise make it a filter. Thus it behaves as a current controlled amplifier, with the gain determined by the current supplied by the envelope shaper.

PHASER AND OUTPUT

The output from each VCA may be switched via S6 (S106) so that part of the output signal passes through the four stages of phase shift (IC12). The overall degree of phase shift is controlled by four CMOS FETs (IC15, IC2). Dual op-amp IC13 forms an oscillator providing a slow triangle waveform to sweep the phase shift at a rate set by VR15, while VR13 biases the FETs to the centre of their useful ranges. In order to actually create the phasing effect, the phase shifted signals are mixed back together with the original signals in TR7 (Fig. 3).

Three outputs are provided from the Percussion Microsynth: a line level output for feeding to a mixing desk or external amplifier, and two low impedance outputs, one for a speaker and the other for headphones. The line level is trimmed by VR12, and the amplified outputs by VR14, each of which is accessible by a screwdriver through holes in the front panel. IC14 is a monolithic power amplifier which can deliver 2 watts into 8 ohms. R101 and R102 attenuate this output to suit standard headphones.

LOW FREQUENCY OSCILLATOR

The standard integrator/Schmitt oscillator of Fig. 4 is fed alternately with positive and negative going control voltages, selected by the CMOS switches which are driven in antiphase by the Schmitt output. The "Shape" control VR18 varies the relative rates at which the integrator ramps up and down but the overall time period remains constant, being determined only by the input control voltage from the "Rate" control VR16.

The LFO oscillates over the range 0·2Hz to 30Hz, and is used to modulate the VCOs or VCFs as selected by S5 (S105), to a degree set by the "Level" control VR17.

COMPONENTS

Resistors

R1,101	47k
R2,102	1k
R3,103	1M
R4,104	8k2
R5,105	1M
R6,106	820k
R7,107	1M
R8,108	8k2
R9,109	1M
R10,110	180k
R11,111	1M
R12,112	100k
R13,113	39k
R14,114	180k
R15,115	47k
R16,116	47k
R17,117	1k
R18,118	10M
R19, 119	10M
R20,120	100k
R21,121	82k
R22,122	2k2
R23,123	1M
R24,124	1M
R25,125	39k
R26,126	470k
R27,127	1k
R28,128	12k
R29,129	1k
R30,130	10k
R31,131	10k
R32,132	10k
R33,133	56k
R34,134	10k
R35,135	82k
R36,136	47k
R37,137	33k
R38,138	120k
R39,139	1k
R40,140	1k
R41,141	10k
R42,142	120k
R43,143	12k
R44,144	12k
R45,145	100k
R46,146	4k7
R47,147	8k2
R48,148	5k6
R49,149	33k
R50,150	47k
R51,151	1k
R52,152	82k
R53,153	1k
R54,154	12k
R55,155	12k
R56,156	12k
R57,157	100R
R58,158	100R
R59,159	18k
R60,160	100R
R61,161	100R
R62,162	18k
R63,163	4k7
R64,164	4k7
R65,165	18k
R66,166	4k7
R67	6k8
R68	3M9
R69	12k
R70	2k2
R71	2k2
R72	68k
R73	68k
R74	1k
R75 to R87	100k (13 off)
R88	2M2
R89	1k
R90	4k7
R91	10k
R92	2M2
R93	1M
R94	15k
R95	47k
R96	100k
R97	1M
R98	¼ watt 10R
R99	2R7
R100	100R
R167	220R
R168	220R
R169	10k
R170 to R174	1M (5 off)
R175	10k
R176	1k
R177	820R
R178	270R
R179	820R
R180	270R
R181	820R
R182	4k7

Semiconductors

IC1,101	LM348
IC2	4007
IC3,103	4001
IC4,104	741
IC5	LF347
IC6,106	4016
IC7,107	1458
IC8	LM13600N
IC9	4013
IC10	LM13600N
IC11,111	LM13600N
IC12	LM348
IC13	1458
IC14	LM380N
IC15	4007
IC16	LM348
IC17	4016
IC18, IC19	LM317U
D1,101 to D10,110	1N914 (20 off)
D11 to D18	1N4001 (8 off)
TR1,101 to TR3,103	BC212L (3 off)
TR4 to TR7	BC548C (4 off)
D19	red l.e.d.

Potentiometers

VR1,101	preset 1M
VR2,102	preset 100k
VR3,103	pot log 470k
VR4,104	pot log 1M
VR5,105	pot lin 100k
VR6,106	pot lin 100k
VR7,107	dual pot lin 22k /
VR8,108	preset 1k
VR9,109	pot lin 100k
VR10,110	pot lin 1k
VR11	SW pot log 10k
VR111	pot log 10k
VR12	preset 22k
VR13	preset 100k
VR14	preset 22k
VR15	pot log 1M
VR16	pot log 100k
VR17	pot log 10k
VR18	pot lin 100k
VR19	preset 1k
VR20	preset 1k

Capacitors

C1,101	polyester 47n
C2,102	polyester 47n
C3,103	polyester 100n
C4,104	polystyrene 470p
C5,105	polystyrene 470p
C6,106	p.c. elec 25V 10µ
C7,107	polystyrene 1n
C8,108	p.c. elec 25V 1µ
C9,109	polyester 10n
C10,110	polyester 100n
C11,111	p.c. elec 16V 4µ7
C12,112	polyester 10n
C13,113	polyester 100n
C14,114	polyester 10n
C15,115	polycarbonate 220n
C16,116	polycarbonate 220n
C17,117	polycarbonate 220n
C18,118	p.c. elec 10V 10µ
C19,119	p.c. elec 16V 4µ7
C20,120	polystyrene 680p
C21,121	polystyrene 680p
C22,122	polycarbonate 220n
C23,123	polycarbonate 220n
C24	polyester 100n
C25	polyester 10n
C26	polyester 100n
C27	polystyrene 1n
C28 to C30	polyester 10n (3 off)
C31 to C35	p.c. elec 10V 4µ7 (5 off)
C36	polystyrene 100p
C37	tantalum 4µ7
C38	p.c. elec 25V 4µ7
C39	polyester 100n
C40	p.c. elec 25V 470µ
C41	polycarbonate 470n
C42, C43	polyester 100n
C44, C45	p.c. elec 25V 2,200µ
C46, C47	p.c. elec 16V 10µ
C48, C49	p.c. elec 16V 1,000µ
C50, C51	polyester 47n

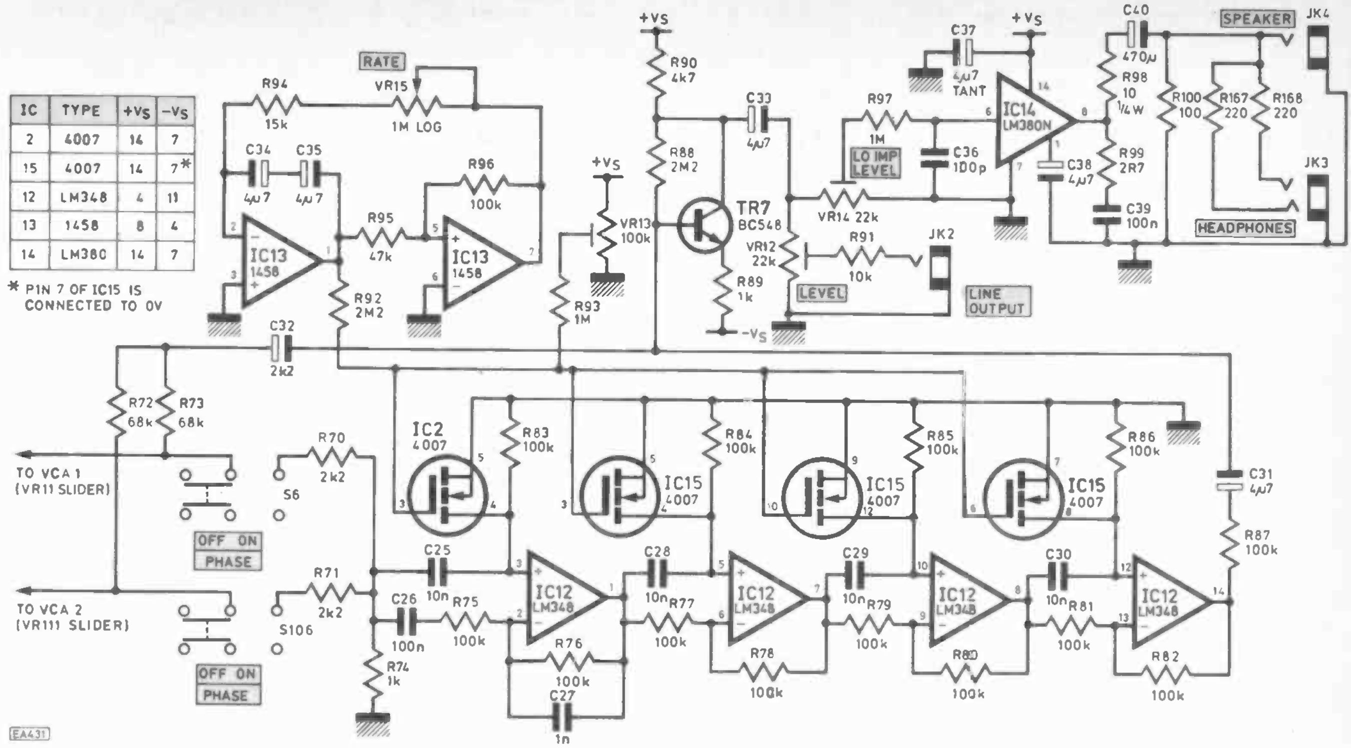
Switches

S1,101 to S3,103, and S6,106 are 2-pole, 2-position p.c.b. mounting slide switches (8 off). S4,104 and S5,105 are 2-pole, 3-position p.c.b. mounting slide switches (4 off).

Miscellaneous

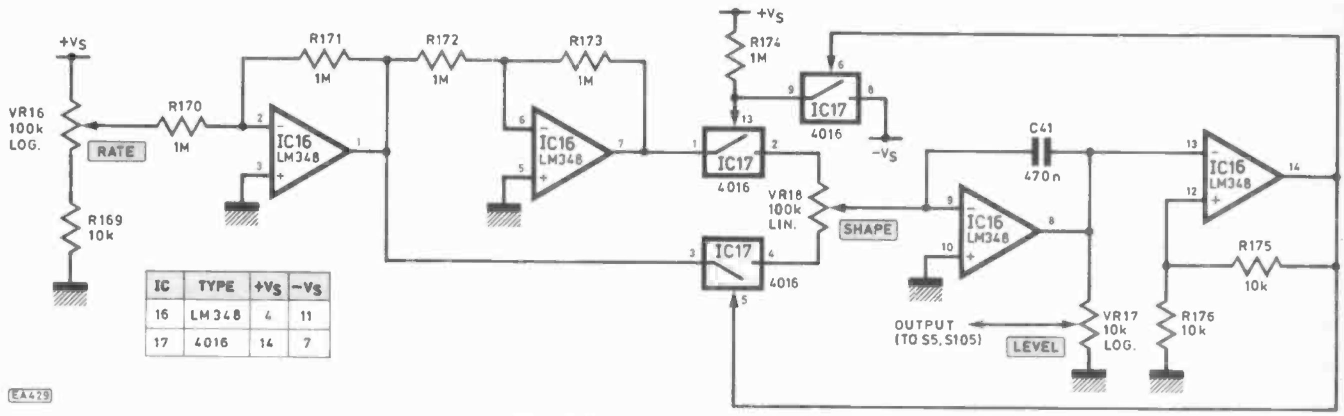
T1—Transformer 0-12V, 0-12V 500mA, solder tag, panel fuseholder 20mm, FS1—20mm fuse 500mA, mono jack sockets (4 off), stereo jack socket (1 off), Dinlatch 5-pin A socket (1 off), miniature mains cable and grommet (⅜in. dia) to suit, 0·5m 4-way ribbon cable, 1m miniature screened cable, p.c.b., front panel, Microsynth cabinet, Percussion Microsynth dual trigger pad assembly, push-on knobs plus colour coded caps to taste, R.S. type (20 off), 6BA ½in spacers (6 off), 6BA ¾in bolts (10 off), 6BA nuts (20 off), domed-head ½in self-tap screws (6 off), stick-on feet (4 off), crystal microphone inserts (2 off), M5 bolts ¼in. (4 off).

Parts and complete kits available from:—**Clef Products Ltd., 44A, Bramhall Lane South, Bramhall, Stockport, Cheshire SK7 1AH.**



IC	TYPE	+Vs	-Vs
2	4007	14	7
15	4007	14	7*
12	LM348	4	11
13	1458	8	4
14	LM380	14	7

Fig. 3. Phaser and output



IC	TYPE	+Vs	-Vs
16	LM348	4	11
17	4016	14	7

Fig. 4. Low frequency oscillator

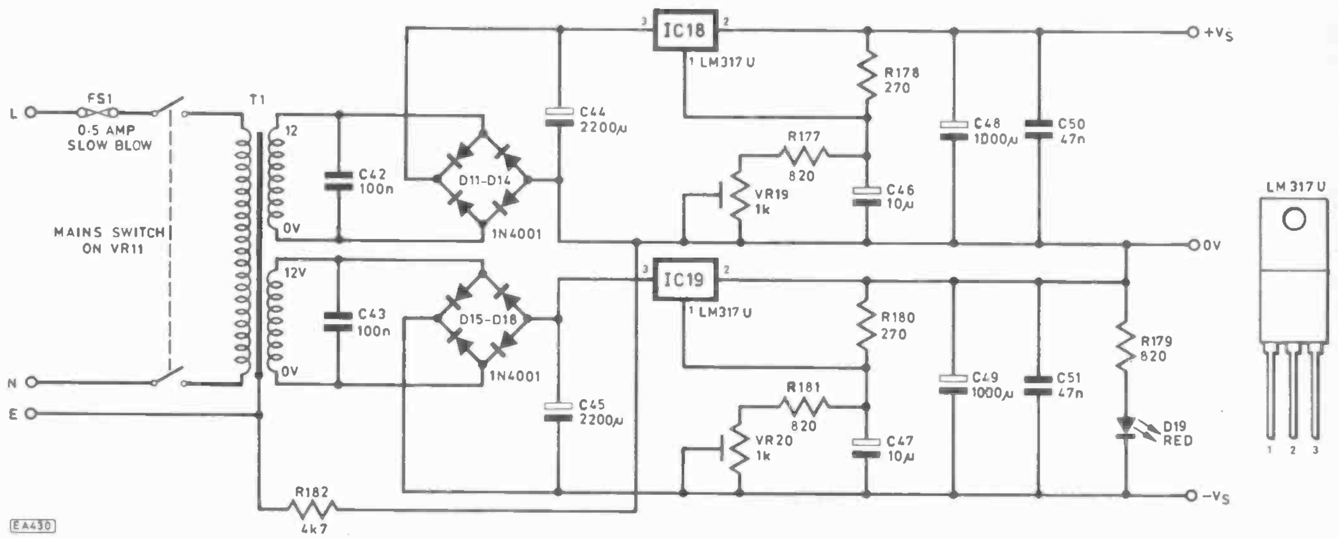
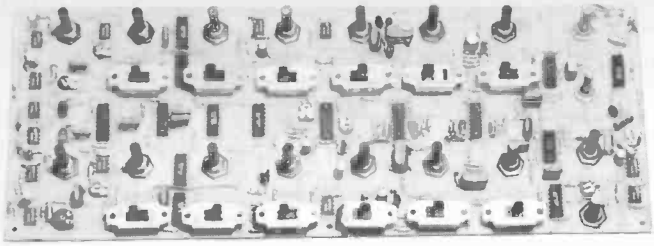


Fig. 5. Power supply unit



Board assembly

POWER SUPPLY

This is a highly stable, monolithic regulator type providing ±8·5V, trimmed by VR18 and VR19. *Since the CMOS i.c.s are run directly across the positive and negative supply rails for economy of design, on no account must these voltages be exceeded, and the power supply voltages must be set before connecting power to the main part of the circuit board.* Wire links are provided on the p.c.b. for this reason and these should not be inserted until the supply rails are set.

Next Month: Construction, setting-up and test programs.

Readout...

Help Sought

I wonder if any of your readers can come up with a design to overcome a problem in AV (Audio-Visual) presentation. In this, a minimum of two slide projectors are used with a fade unit to dissolve from one picture to another throughout a continuous sequence of colour transparencies, usually shown on a large screen to an audience. Rather than cine's frames-per-second, the AV viewer has so many seconds-per-frame to take in the picture, this being controlled by a programme stored on tape via an electronic fade unit.

The problem is that the lamp fade system has eclipsed the old iris diaphragm mechanism used to regulate the projector's light source. Basic though the iris mechanism is, it can be exploited to obtain a wide range of effects that the lamp fade system cannot. Unfortunately, as things stand at present, use of the iris method necessitates manual operation of the AV performance, for there is no way by which this mechanism can be automatically controlled from tape.

Although PE has never published an automatic iris controller, I wondered if any of its readers have cracked this problem, or would be interested in having a go at it. I have been told that radio control type feedback servos might do the trick, but to maximise the special effects capability of the iris, timing and positional instructions would need to be able to go into the taped programme.

Tony Hadfield
Wimborne, Dorset.

If anyone would like to contact Mr. Hadfield, would they please write to him c/o PE.

Greed

I noticed in your Nexus column (issue April 1983), the glee or should I say greed, at the sale of Cable & Wireless, and the proposed sale of British Telecom.

Do you not feel there are greater issues at stake than the prospect of lining ones own pockets?

To de-nationalise British Telecom means that the profit will instead be shared by the few lucky enough to be able to buy sufficient shares. Therefore, the British public will be robbed of the money.

Services such as call boxes, emergency services and telephones for the disabled will be threatened.

Despite these services which are loss makers, British Telecom is a profitable and efficient service. In the past ten years telephones have doubled while staff has increased by only six per cent. What private firm can boast this productivity?

British Telecom belongs to the people. Help to keep it that way.

R.G.A. Dewhurst,
Hoddesdon.

Nexus comments:—

The Littlechild Report on BT privatisation makes provision for safeguarding emergency and rural call box services. The objective is to inject private capital to provide a more efficient service with lower costs. Far from robbing the public, lower costs will benefit private as well as business subscribers. Cable & Wireless was not sold outright. The Government, representing the people, retained a majority shareholding. C & W's 57 percent profit rise in its first year of privatisation yielded extra tax revenue. Profit and social responsibility are not incompatible. Without generating profit from trade and industry there would be no funds for education, health and other social services.

Sexist

I have just ordered a back issue of PE: and noticed your preview of the Electronics Hobby Fair at Alexandra Pavilion.

In your description of the event, you mention that "For wives/girl friends there is the added attraction of the nearby Wood Green Shopping City . . . although we are sure they will find plenty to interest them in the special exhibits at the Fair".

Reaction such as "sexist!" and "promu patriarchy!" are probably a bit strong, but I feel that your comment might have caused offence to the many competent women electrical engineers who read PE.

At a time when the number of women entering the field is disappointingly low (and a quote from the IEE is appropriate: Extract from IEE booklet "Training Requirements", published 1979. "The Council of Engineering is concerned that few women take up electrical engineering as a profession, and is most anxious to see an increase in the number of women Members of the Institution") I feel that what you said was not encouraging.

I realise that at the moment, the majority of electronic enthusiasts are male, and that PE is targeted at this population, but I believe that such discrimination is to the disadvantage of expanding interest in the field.

Brian Carse,
Coventry.

No offence intended—Ed.

Slow Industry

With reference to the January edition of Practical Electronics concerning the slow approach to electronics of the motor industry. Isn't it the wrong way round? Isn't the electronic industry slow in taking in millions of pounds by designing and producing an all electric car (with one or two electric motors) with both speed and range (200 miles approx. before recharging). Are not the hybrid cars a sort of half way house?

I am quite confident that sooner or later an efficient electric car will arrive and the internal combustion engine will be an interested relic of the past.

Edwin R. Caruth,
Leeds.

This may well start to happen when Clive Sinclair launches his long awaited electric vehicle—Ed.

Excellent!

The recent issues of PE prompt me to send my congratulations to you and your staff on the excellent articles on microprocessors which have appeared.

Following the early articles on the *UK101* to the *Ultimum* and *Microfile*, all have proved very useful. The *Ultimum* motherboard will give my UK101 some more years of interesting work.

The *Microfile* series, giving the characteristics and applications of i.c.s, is most welcome—an essential addition to tense manufacturers' data sheets.

As well as a "hobby interest" in the subject I lecture at a college of technology, and PE is an essential ingredient in keeping up with the subject.

With best wishes for the future.

George Small,
Chesham, Bucks.

Thank you.

MICRO PROMPT

The hardware and software exchange point for PE computer projects

ULTIMUM UPDATE

We have now moved to Issue 2 of the Motherboard, to correct as many original errors as possible. As always, some anomalies have crept in.

The known errata for Issue 1 are as follows:

Link 11—Z80 position should be GND, not open (available near IC8, connects to IC8 pin 7).

Link 12—does not exist.

Link 13—located next to IC4 pin 11, should be open for Z80 systems and made for 65/68 systems.

There is insufficient provision for I/O mapping and external buffering close to the host.

The relevant part of the circuit in Issue 2 is as shown in Fig. 1, below.

Note that LK13 has been renamed LK14. LK12 now allows more reliable production of $\overline{BRD}$, $\overline{BWR}$ in exclusively memory-mapped Z80 systems: 'B' should be connected to 'A' for Z80 and to 'C' for 65/68 systems. If I/O mapping is required then the LK13 default 'M' connections should be cut and the 'I/O' connections made. Pins 10 and 11 of the 40-way host connector (SK1, 2, 3) have been assigned and connected to, respectively, data buffer gate and +5V to simplify buffering at the host end of a cable. R/W or WR should be used for the data buffer direction on such buffering.

Yes, we will produce a complete manual but it will be available only after the series is completed. We are very keen to see an Ultimum user group. At present due to lack of space at 33, Cardiff Road, Watford we can't start the ball rolling, but in the latter part of 1983 we shall certainly make sure one is organised (we have already spoken to West London and North London computer users' groups and they are both keen to help us).

William Edwards,
Watford Electronics.

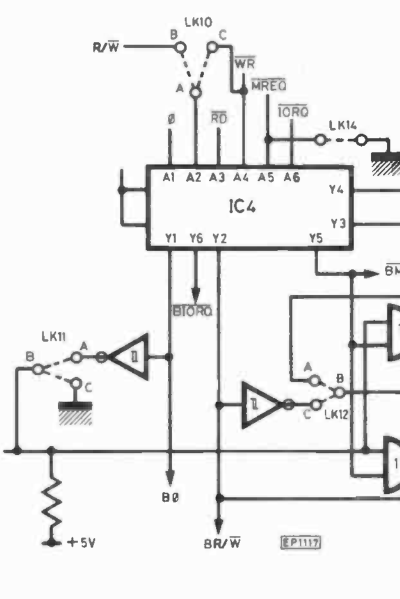


Fig. 1. Ultimum Motherboard update

ROMDOS TO VORTEX

Sir—This short machine code routine should be of interest to any UK101 superboard owners who have upgraded their systems to $5\frac{1}{4}$" floppy disks.

The routine allows users of the new Vortex Disk system to read program files from the ROMDOS Disk system.

The need for the program arises because:

1) the directory is on a different track on both systems, and

2) the BASIC work space is different on both systems.

The routine is instant compared to the alternatives i.e. saving the program to tape, then booting up vortex and reloading the tape or indirect files, which limits the size of program to be moved to less than half the size of the free BASIC workspace (about 10K in A32K system). This routine only requires 70–80 Bytes of memory anywhere in RAM and is totally relocatable.

The routine works by loading a ROMDOS program into Vortex workspace then updating all the pointers and line links, allowing you to run or reSAVE the program on a Vortex Disk.

To use the program

1) *Make a note of the starting tracks of BASIC programs to be transferred.*
2) *Boot up Vortex Disk.*
3) *Type in the routine and save on disk (the code is totally relocatable) i.e. it will run from anywhere in memory without modification.*
4) *Load the program required by using the !LO (Track No.) Command.*
5) *Execute code Reset M $7ØØØG or BASIC 5 and GO$7ØØØ.*
6) *You should now be in immediate mode and can SAVE/LIST/RUN the program.*

B. Brownhill,
Midlothian.

```
7ØØØ  A97F     LDA   #$7F
7ØØ2  B5FE     STA   $FE
7ØØ4  A927     LDA   #$27
7ØØ6  B5FF     STA   $FF
7ØØ8  AØØØ     LDY   #$ØØ
7ØØA  B1FE     LDA   ($FE),Y
7ØØC  AA       TAX
7ØØD  2ØF9FE   JSR   $FEF9
7Ø1Ø  B1FE     LDA   ($FE),Y
7Ø12  FØØE     BEQ   $7Ø22
7Ø14  18       CLC
7Ø15  6915     ADC   #$15
7Ø17  91FE     STA   ($FE),Y
7Ø19  85FF     STA   $FF

7Ø1B  8A       TXA
7Ø1C  85FE     STA   $FE
7Ø1E  A9ØØ     LDA   #$ØØ
7Ø2Ø  FØE8     BEQ   $7ØØA
7Ø22  2ØF9FE   JSR   $FEF9
7Ø25  A5FE     LDA   $FE
7Ø27  857B     STA   $7B
7Ø29  857D     STA   $7D
7Ø2B  A5FF     LDA   $FF
7Ø2D  857C     STA   $7C
7Ø2F  857E     STA   $7E
7Ø31  A927     LDA   #$27
7Ø33  857A     STA   $7A
7Ø35  A97F     LDA   #$7F

7Ø37  8579     STA   $79
7Ø39  6Ø       RTS
```

ULTIMUM CRUNCHER

Sir—I have been reading your Ultimum series and I am very impressed with the system.

However, for the benefit of myself and many others, could you please publish details of how to generate a signal similar to RFSH from an 8080/8085 system to allow the WE of the Dynamic RAM board.

I would also like to see a "number cruncher" board. Although chips such as the AM9511 and AM9512 are quite expensive, I feel that such a board would be worthwhile.

S. C. Winsor,
Kenilworth.

On the point of the Number Cruncher, Watford Electronics replies: At present the cost of available number cruncher i.c.s is prohibitive, in that a number cruncher board for the Ultimum based on one of these chips would be of a disproportionately high price. However, it is the view of W.E. that at some time in the near future these chips will come down in price to a more suitable level, at which point a number cruncher for Ultimum will certainly become a reality.

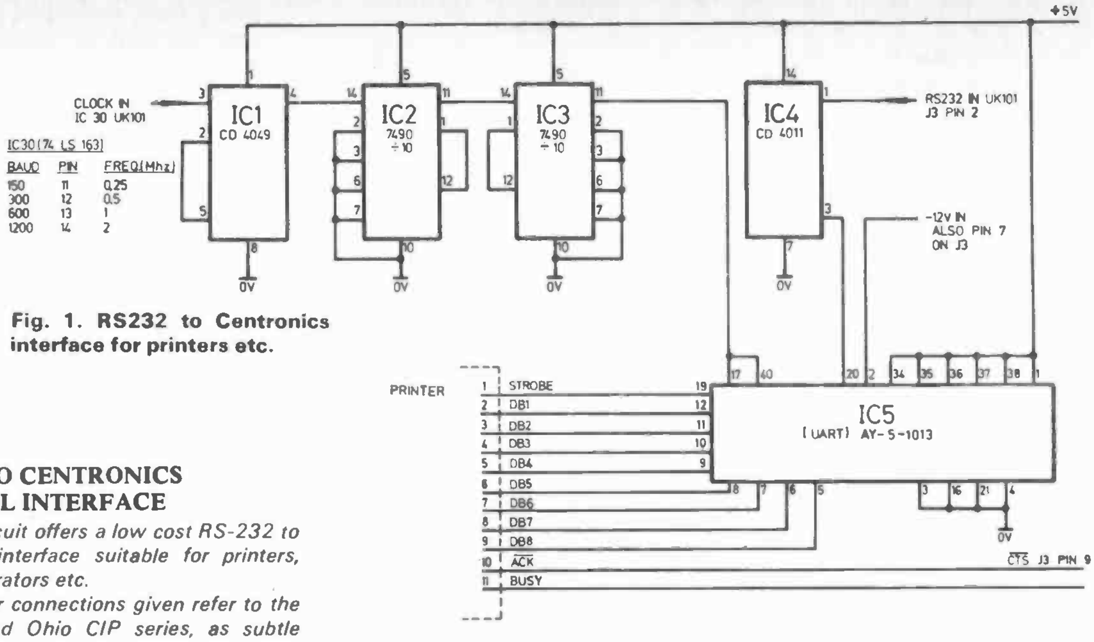


Fig. 1. RS232 to Centronics interface for printers etc.

SERIAL TO CENTRONICS PARALLEL INTERFACE

Sir–This circuit offers a low cost RS-232 to centronics interface suitable for printers, sound generators etc.

Computer connections given refer to the UK-101 and Ohio CIP series, as subtle clock chain differences may be noted the approximate baud/frequency relationship is shown on the circuit diagram.

The circuit is based on a low cost AY-5-1013 UART configured for even parity, two stop and eight data bits. A clock signal equal to sixteen times the baud rate is required at pins 17 and 40 (i.e. 300 baud × 16 = 4 800hz). It is recommended that a data sheet be obtained with the chip. This will allow the constructor to configure the circuit for any computer.

ICI provides a C-MOS buffer to the heavily loaded clock chain, whilst ICs 2 and 3 are divide–by–10 counters to feed the UART clock. The UART is frequency tolerant and a TTL clock could be constructed separately.

The RS-232 input is fed to the UART via an inverting gate IC4, this helps re-establish signal levels after the ribbon cable. The circuit is not critical and may be constructed on perforated board.

A –12 volt level is essential to proper UART operation. This can be provided with a small 12 volt transformer, bridge rectifier and 470µF/25 volt capacitor. A simple 12 volt Zener diode will ensure the recommended stability.

Ohio users must locate and cut the track connecting pin 7 of J3 to O volts. For those opposed to track cutting, the –12 volts may alternatively be fed to the collector of transistor (PNP) Q1 through a 1k 5% resistor.

The link between pin 9 of J3 (CTS) and O volts must also be removed, connecting a 1k 5% resistor between pin 9 and O volts will ensure computer operation with the peripheral disconnected.

Connections are best made with ribbon cable using the centronic recommendation, i.e. (1) O volts, (2) strobe, (3) O volts, (4) BDI, (5) O volts etc., this will minimise cross talk.

For cable lengths exceeding a metre, ICs 1–3 should be at the computer and ICs 4 and 5 at the peripheral.

Ohio/UK-101 users can turn on the interface with POKE 517,1 (or SAVE) and turn off with POKE 517,0. OS-65D users should use POKE 8994,1 to turn on and POKE 8994,2 to disable.

Owners of Series Two dual display format boards and OS-65D version 3.3 will note that the Baud rate doubles from 300 to 600 when the 48 character mode is selected.

A word of caution; semiconductor junctions take exception to negative voltage inputs so be careful where you connect the –12 volts. If in doubt consult your local users' group which will have a number of members willing and competent to help you.

Experimentation with Busy and ACK will show which is best for connection to CTS.

It has been found in some instances both may be connected to CTS each via a 120 ohms series resistor. POKE 13,40 for ROM BASIC or 21,40 with disc will allow running without the CTS handshake.

P. Whittaker,
Transvaal,
S. Africa

UK101 as clock

Sir—I have written a short program which displays a digital clock on the screen. Time is kept by the delay in line 190, which might have to be changed to suit other UK101's. The delay lasts approximately 1 second. At the beginning of the program you enter the current time, using the 24 hour clock, and then press return.

David C. Howarth,
Bathgate.

```
10 PRINTCHR$(12);:K=48
20 PRINT:PRINT:PRINTTAB(12)"D I G I T A L  C L O C K"
30 PRINT:INPUT"TENS OF HOURS .....";H2:H2=H2+K
40 INPUT"UNITS OF HOURS ....";H1:H1=H1+K
50 INPUT"TENS OF MINUTES ...";M2:M2=M2+K
60 INPUT"UNITS OF MINUTES ..";M1:M1=M1+K
70 INPUT"TENS OF SECONDS ...";S2:S2=S2+K
80 INPUT"UNITS OF SECONDS ..";S1:S1=S1+K
90 PRINTCHR$(12):POKE53325,32:PRINTTAB(12)"D I G I T A L  C L O C K"
100 POKE53732,58:POKE53727,58
110 POKE53735,S1:POKE53734,S2:POKE53730,M1:POKE53729,M2
120 POKE53725,H1:POKE53724,H2
130 S1=S1+1:IFS1=58THENS2=S2+1:S1=K
140 IFS2=54ANDS1=KTHENM1=M1+1:S2=K
150 IFM1=58THENM2=M2+1:M1=K
160 IFM2=54ANDM1=KTHENH1=H1+1:M2=K
170 IFH1=58THENH2=H2+1:H1=K
180 IFH2=50ANDH1=52ANDM2=KANDM1=KANDS2=KANDS1=KTHENGO
    SUB200
190 FORI=1TO1042:NEXT:GOTO110
200 M1=K:M2=K:S2=K:S1=K:H1=K:H2=K:RETURN
OK
```

MICROCONTROLLER KEYBOARD

Sir—I have found the keyboard of the Microcontroller awkward to use owing to the unusual layout of the hex keys. The method used to decode which key is pressed makes it a relatively simple process to alter the keyboard layout with software modifications, without affecting the rest of the controller, its routines, or any programs already being used.

The keycode converter starting at F877 uses a table of key addresses at F89C—F8BB to determine which key is pressed, the value from this table is then converted to the key code with the aid of a subroutine at F86D.

All that is necessary to modify the keyboard layout to suit your personal taste is to re-arrange the order of the key address table. Table 1 shows the present order of the key address table in the monitor. Table 2 shows the order necessary to give a keyboard layout as shown adjacent.

W.T. Baillie
Milton Keynes

TABLE 1. DISBUG KEY ADDRESS TABLE

ADDRESS	CONTENTS
F89C	00 01 11 12 20 21 22 30
F8A4	31 32 42 43 44 64 63 41
F8AC	33 23 13 03 35 17 27 37
F8B4	25 01 06 07 05 16 40 54

TABLE 2. MODIFIED TABLE FOR LAYOUT AS SHOWN BELOW

ADDRESS	CONTENTS
F89C	42 00 02 01 43 10 11 12
F8A4	44 20 21 22 64 30 31 32
F8AC	25 33 23 13 63 17 27 37
F8B4	41 03 06 07 05 16 40 54

PF1	C	D	E	F	BREAKPOINT	REGISTER	•	GO
PF2	8	9	A	B	PRESET		1/2	PROCEED
SHIFT	4	5	6	7	MEMORY	CANCEL	*	RESTART
#	Ø	1	2	3	ENTER		NEXT	PRIOR

M/C PROGRAM SEARCH

Sir—As this is my first attempt to write a program in machine code, it may be a little crude. But it works well and achieves the intended results.

*The program is for UK101 owners, who like myself save several programs on one tape. It enables you to leave the searching for the start of the program to the computer. The first line of each program should be the name or code for that program, e.g. 1REM * A123. In this case the code word is 4 digits long. But by changing the contents of 02AB it can be made to the length you require.*

To operate the program you just type LOAD as usual. Then you give the code number. The computer then searches for, and loads, the required program. At the end it displays the message "Program Loaded" and disables the load flag so the next program is not loaded.

The program works by altering the load vectors at 021E 021F to cause a jump to the search routine. This is done by poking 542, 75 and 543, 2. When the code is found, the program jumps back to the load routine (FF8B). Within the program, the addresses 0004 and 0005 are altered to contain the address 0222. This causes a jump at the end of loading to this address, instead of the usual syntax error signal, followed by OK. The message "Program Loaded" is displayed, and the load flag is set to 0.

Although this routine takes up pretty well all the unused RAM, I think it is very useful. And no doubt the more skilful programmers will be able to shorten it.

```
0222  A9  C3       LD#$C3
0224  85  04       STA$0004
0226  A9  A8       LDA#$A8
0228  85  05       STA$0005
022A  A9  00       LDA#$00
022C  8D  03  02   STA$0203
02F   20  5F  02   JSR$Z025F
0232  A2  00       LDX#$00
0234  20  B8  02   JSR$02B8
0237  A2  0A       LDX#$0A
0239  20  B8  02   JSR$0238
023C  A2  1F       LDX#$1F
023E  20  B8  02   JSR$02B8
0241  60           RTS
0242  A9  22       LDA#$22
0244  85  04       STA$0004
0246  A9  02       LDA#$02
0248  85  05       STA$0005
024A  60           RTS
024B  48           PHA
024C  8A           TXA
024D  48           PHA
024E  A9  42       LDA#$42
0250  85  04       STA$0004
0252  A9  02       LDA#$02
0254  85  05       STA$0005
0256  20  73  02   JSR$0273
0259  68           PLA
025A  AA           TAX
025B  68           PLA
025C  4C  8B  FF   JMP$FF8B
025F  A0  00       LDY#$00
0261  A9  20       LDA#$20
0263  99  00  D3   STA$D300, Y
0266  99  00  D2   STA$D200, Y
0269  99  00  D1   STA$D100, Y
026C  99  00  D0   STA$D000, Y
026F  C8           1NY
0270  D0  F1       BNE$0261
0272  60           RTS
0273  20  5F  02   JSR$025F
0276  A2  00       LDX#$00
0278  20  B8  02   JSR$02B4
027B  A2  11       LDX#$11
0270  20  B8  02   JSR$0238
0280  A2  00       LDX#$00
0282  20  00  FD   JSR$FD00
0285  C9  1C       CMP#$1C
0287  F0  EA       BEQ$0273
0289  20  2D  BF   JSR$BF2D
028C  C9  0D       CMP#$0D
028E  F0  07       BEQ$0297
0290  9D  F0  00   STA$00F0, X
0293  E8           INX
0294  4C  82  02   JMP$0282
0297  20  5F  02   JSR$025F
029A  A2  29       LDX#$29
029C  20  B8  02   JSR$02B8
029F  A2  00       LDX#$00
02A1  20  80  FE   JSR$FE80
02A4  DD  F0  00   CMP$00F0, X
02A7  D0  06       BNE$02AF
02A9  E8           INX
02AA  E0  04       CPX#$04
02AC  D0  F3       BNE$02A1
02AE  60           RTS
02AF  E0  00       CPX#$00
02B1  F0  EE       BEQ$029F
02B3  A2  00       LDX#$00
02B5  4C  A4  02   JMP$02A4
02B8  BD  CA  02   LDA$02CA, X
02BB  C9  00       CMP#$00
02BD  F0  07       BEQ$02C6
02BF  20  2D  BF   JSR$BF2D
02C2  E8           1NX
02C3  4C  B8  02   JMP02B8
02C6  60           RTS
02CA  0D  50  52   4F  47  52  41  4D
02D2  20  00
02D4  4C  4F  41   44  45  44  00
02DB  4E  55  4D   42  45  52  00
02E2  00  41  47   49  4E  00
02E9  0A  0A  0A   0A  0A  0A  00
02F0  53  45  41   52  43  48  49
02F7  4E  47  00
```

W. H. Ashworth,
Preston.

It should be emphasised that material presented in Prompt has not necessarily been proved by us. Neither can compatibility with *all generations* of the computer equipment to which it relates be guaranteed.

Software and hardware designs submitted should be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

AUTOMOBILE TEST SET

MICHAEL TOOLEY B.A. DAVID WHITFIELD M.A. M.Sc.

PART TWO

IN the first part of this article the principles of operation of the various functions of the Auto Test Set were described in detail, together with their usefulness to the troubleshooting and performance-conscious motorist. This article carries on from the detailed circuit description by covering the construction of the complete instrument, and concludes with a detailed series of tests and calibration steps, together with some fault-finding hints and suggestions.

CONSTRUCTION

A diecast box is used in the construction of the Auto Test Set to ensure that the final unit is rugged enough to with stand hard use. The majority of the small components are mounted inside the box on a single-sided printed circuit board. The copper foil pattern for the board is shown in Fig. 7, with the corresponding component layout in Fig. 8. The interconnection wiring points have been labelled for later identification. No special handling procedures need to be observed in mounting the components on the p.c.b., but constructors may wish to use 14-pin d.i.l. sockets for mounting IC1 and IC2. Care should be taken to ensure the correct orientation of all of the polarised components (semiconductors and electrolytic capacitors) before soldering them in place. The use of terminal pins is recommended for ease of installation of the interconnection wiring.

When all of the components have been mounted on the p.c.b., a careful visual inspection of the track side of the board should be made before proceeding. Particular attention should be paid to soldered joints, and all dry joints and solder bridges should be rectified at this stage. After a final check on the orientation of polarised components, the p.c.b. may be mounted in the base of the diecast box using four short pillars. When positioning the board, adequate clearance should be left for the d.c. supply sockets, SK3 and SK4, which should be mounted on the side of the box and adjacent to pins A and B. Short lengths of insulated wire should then be used to connect SK3 (red) to pin B, and SK4 (black) to pin A; the wire links used should be long enough to allow the p.c.b. to be easily removed from the box for troubleshooting.

The remaining components are mounted on the lid of the diecast box, as shown in Fig. 9. The assembly sequence is simplified if all of the necessary holes are cut before any of the components are mounted. Marking out of the holes is simplified if the lid is first covered with masking tape, and the hole positions marked on the tape before being centre-punched. The cutout for the meter is most easily made by drilling a series of holes around the circumference to remove the majority of the metal, and then cleaning up the hole with a file until the meter is an easy fit. When the meter, switches, terminals and l.e.d.s have been mounted, the next step is to fit the remaining components to the switch and meter terminals as shown in Fig. 9. It should be noted that, when making up the necessary values for R28 to R31, it may be easier to use a number of standard values in series/parallel, e.g. R28 may be made up from two 100 kilohm resistors in parallel.

The final assembly step is to install the interconnection wiring between the p.c.b. and the components mounted on the lid of the box. Ribbon cable provides one of the most convenient methods of installing the wiring, and it is suggested that one piece be used for each of the four groups of terminal pins. The cable lengths should be adequate to allow the lid to be laid flat alongside the box during calibration. The wire from S2 to one end of R33 should be connected as shown by the solid line, and R33 should temporarily be fitted as a short length of wire. A final check of the wiring should show that pins J and K on the p.c.b. are the only ones left unconnected; these may be used if an alternative buzzer is to be used off the board, but otherwise they may remain unconnected.

TESTS AND ADJUSTMENTS

The initial tests and adjustments require the use of a power supply or battery capable of delivering 12 volts at up to approximately 120mA. Ideally, the supply should have an electronic over-current trip, but if this is not available, an appropriately rated line fuse will suffice to protect against catastrophic failures or errors. Before connecting the supply, the controls on the Auto Test Set should be set to the following: S1 to the 'Carry' position; S2 to the '4 cyl' position; S3 to 'Off'. The power supply should be connected to SK3/SK4 via a multimeter set to the d.c. current range rated at a minimum of 100mA.

Switching on the supply to the Auto Test Set should cause the 'NOGO' and the 'Power' l.e.d.s to be illuminated; no other l.e.d.s should be illuminated. The supply current indicated should be approximately 40mA, but only significant variations from this value should be considered as significant. Should neither of the l.e.d.s be illuminated and no supply current be drawn, the polarity of D12 and the power supply wiring should be carefully checked. Moving the instrument sharply should show that the meter movement is significantly damped; if not, the wiring to S1 and ME1

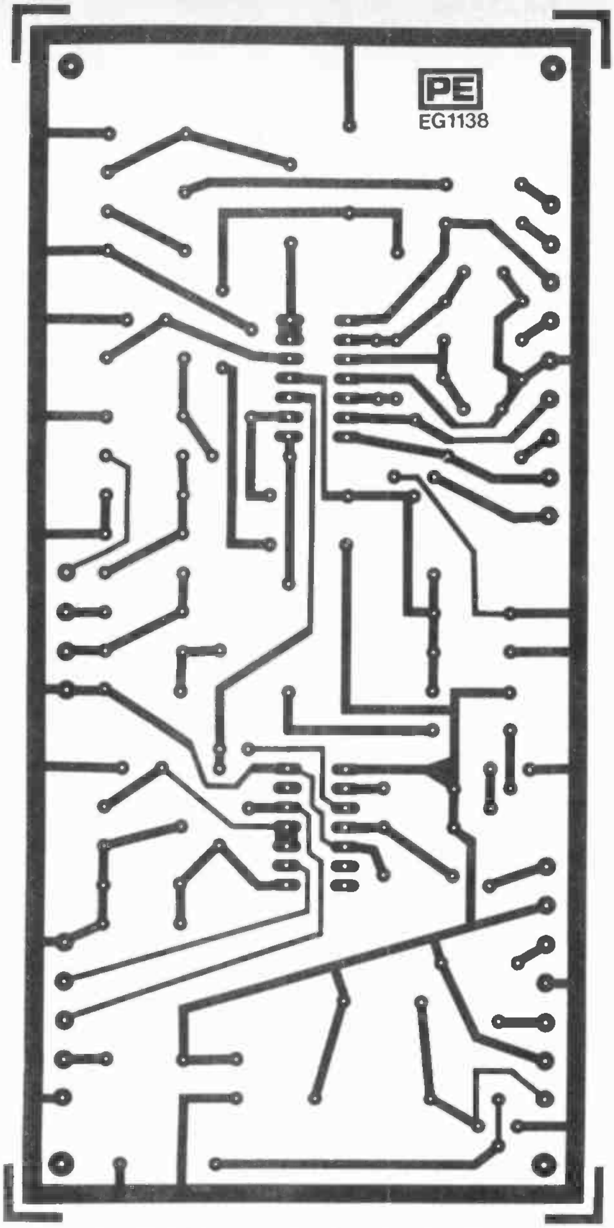


Fig. 7. Foil pattern for board underside

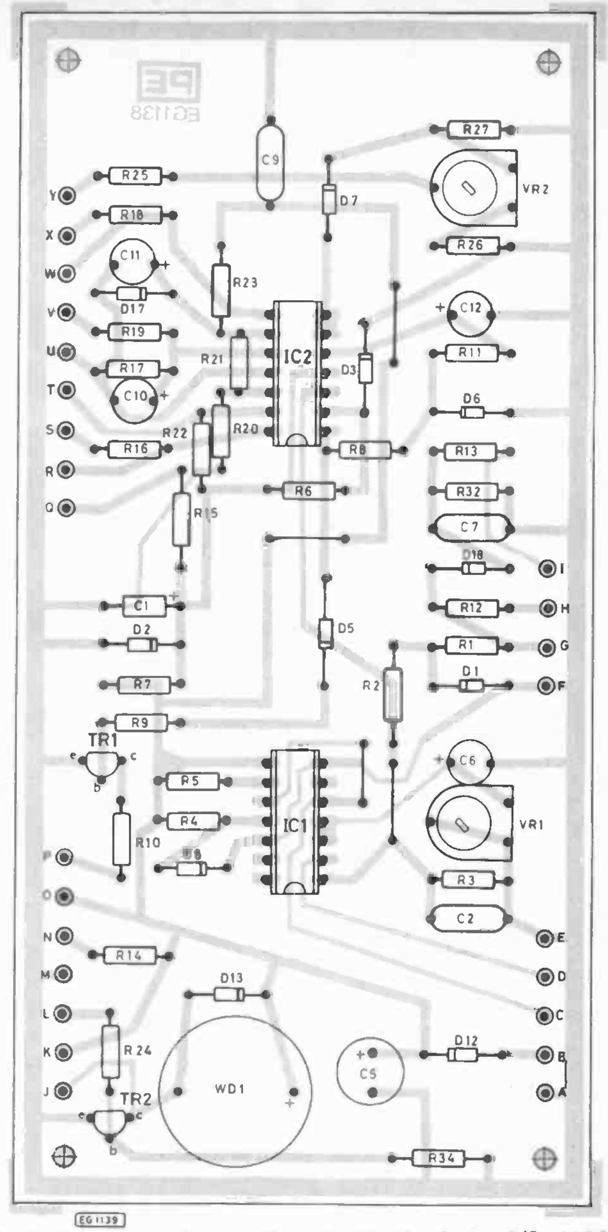


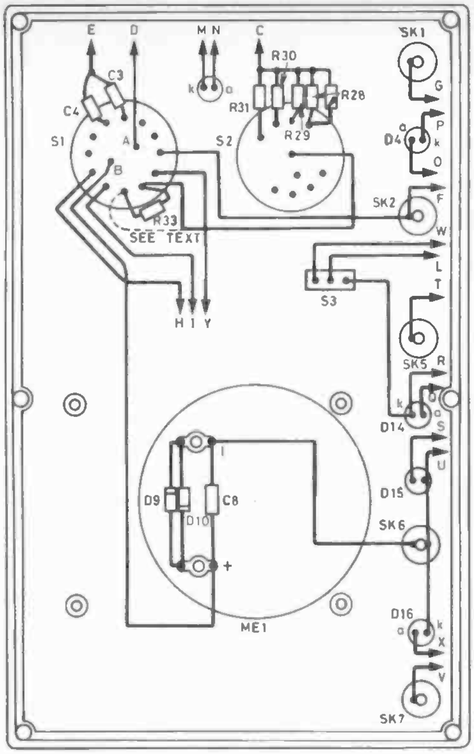
Fig. 8. Component layout. Note that in Fig. 2 pins 3/2 of IC2a should be reversed

should be re-examined. If the supply current is significantly lower than expected, and everything appears as normal except that no l.e.d.s are illuminated, then it is possible that the polarity of the l.e.d.s is incorrect. When these initial tests are satisfactory, the functions may be tested.

The function switch should now be moved to the '0 to 15V' position, and the circuit shown in Fig. 10 set up to allow testing of the two voltmeter ranges. As the potentiometer is varied from minimum to maximum setting, the meter indication should move over the full scale. Significant scale errors should lead to investigation of the wiring to ME1, S1, and the value of R12. As the setting of the potentiometer is increased from minimum, D4 should become illuminated at a potential of approximately 1V. Should the l.e.d. fail to illuminate, the polarity of D3, D4, D5 and TR1, and the power supply to IC2 should be checked to determine the source of the problem.

The offset zero voltage range is checked using the same arrangement as shown in Fig. 10, but with the function switch now set to '10 to 15V'. Varying the voltage applied to SK1/SK2 over the range 10 to 15V by means of the potentiometer, and comparing the measured voltage with that indicated by the test set should produce a response of the type shown in Fig. 11. Any significant movement of the curve up or down the axis, representing consistently high or low indications, should initially lead to a check on the value of R13. The most likely cause, however, is that the nominal Zener voltage of D18 is at one end (high or low) of the tolerance band, and this may be cured by either replacing the diode with an alternative, or by padding the diode.

Calibration of the dwell range involves selecting the 'Dwell' position on the function switch, and disconnecting all inputs from SK1/SK2. In this condition the meter should indicate very close to zero, and D4 should be extinguished. Possible problems in the l.e.d. circuitry should already have been eliminated, so any significant meter indication would suggest a fault around IC2b. Calibration of the range involves the correct adjustment of VR2, and this is done most easily by connecting a lead between SK1 and SK3. VR2 is then adjusted to produce a full-scale meter indication,



EG1140 **Fig. 9. Interconnection wiring**

equivalent to 100% duty cycle. With the component values and types specified, it is possible that the maximum indication which may be achieved by adjusting VR2 will be just below full-scale on the meter. In such cases D6 may be replaced by a diode rated at 6·2 volts, or a silicon diode (e.g. 1N4148) may be wired forward-biased in series with the existing diode. The calibration of the dwell meter scale is independent of the setting of S2, and depends only on the number of engine cylinders; Table 1 shows the way in which the meter markings correspond to the dwell angle. As a final stage in the calibration the scale may optionally be checked at mid-scale by applying a square wave signal, amplitude between 5 and 12V pk-pk and frequency between 10 and 300Hz, and verifying that a half-scale indication is obtained.

The tachometer ranges are calibrated by adjusting the setting of VR1, and determining the value and position of R33. The setting up procedure starts by selecting the '1500 RPM' position on S1, and ensuring that S2 is still set to '4 cyl'. A signal generator producing a signal at 50Hz (corresponding to a 4 cylinder engine at 1500 RPM) and an amplitude of 5 to 12V pk-pk should be applied to SK1/SK2. The circuit shown in Fig. 12 may be used in place of a signal generator if none is available. The setting of VR1 should now be increased from minimum until a full-scale indication is achieved. If such an adjustment is not possible, then the values of C3, VR1 and R28 should be checked, followed by a check to the wiring of IC1 and S1/S2 if this does not reveal

Table 1. Showing meter indication of dwell angle

Meter Indication (µA)	Equivalent Dwell Angle (°) 4 cyl	5 cyl	6 cyl	8 cyl
0	90	72	60	45
10	72	57·6	48	36
20	54	43·2	36	27
30	36	28·8	24	18
40	18	14·4	12	9
50	0	0	0	0

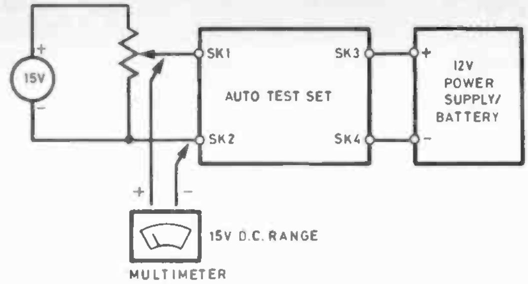
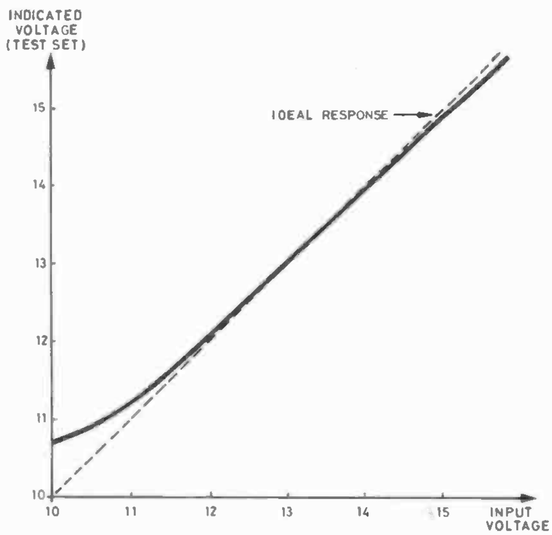


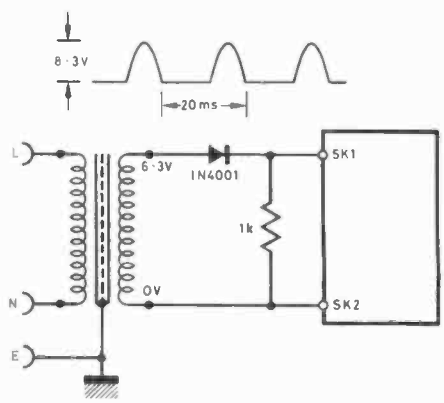
Fig. 10. Test configuration for the voltmeter ranges

the fault. When a full-scale indication has been obtained, S2 should be moved from the 4 cylinder position through the other positions. The meter indications should change from 1500 RPM (4 cylinders) through 1200 RPM, 1000 RPM to 750 RPM (8 cylinders) as the switch is rotated. Any errors would indicate that the values of R28 to R31 should be rechecked. The calibration of the basic range is now complete, but now the two ranges must be made to track correctly, and this involves R33. S2 should be set to the '4 cyl' position again.



EG1142

Fig. 11. Typical response for the offset zero voltmeter range



EG1143

Fig. 12. A tachometer calibration signal source

If moving S1 from '1500 RPM' to '5000 RPM' still produces an indication of 1500 RPM, then R33 is unnecessary, and the wire link should be retained in its place. The more likely result, however, is that the value indicated will be either too high or too low, by up to approximately 10%. If the new indication is too high, the temporary wire link should be replaced by a suitable fixed resistor (typically in the range 1 to 4·7 kilohms) to restore the correct reading. If the new reading is too low, the wire from S1 to S2 should be reconnected in the position shown by the dotted line, i.e. at the other end of where R33 will be. VR1 should now be re-adjusted to produce an indication of 1500 RPM. S1 should then be moved back to the '1500 RPM', where the reading will now be too high. R33 is now selected to return the reading to 1500 RPM, and a value in the same 1 to 4·7 kilohms range is to be expected. It should be noted that the use of a single tracking correction resistor is a compromise to simplify the interconnection wiring; ideally a different value should be used for each of the ranges selected by S2. However, the error introduced will be small enough to be ignored in most cases, but the unused half of S2 may be used if necessary to allow individual calibration of the four ranges.

Verifying the correct operation of the lamp/fuse testing facility requires two fixed resistors, having values of 100 and 270ohms, respectively. S2 should be set to the 'Z' position, and with nothing connected to SK5, D14 should be illuminated, D15 should be extinguished and the buzzer should be silent. With the 270ohm resistor connected between SK5 and SK6 there should be no change in this situation. Replacing the 270ohm resistor by the 100ohm resistor, however, should cause the buzzer to sound and D15 to become illuminated. It is quite normal for D14 not to be totally extinguished. Any deviation from this behaviour should lead to investigation of IC2d and its associated components. Moving S3 to the 'Off' or 'V' position while the 100ohm resistor is connected should silence the buzzer but have no other effect. If the buzzer remains on, a check of the wiring of S3, the value of R34 and the polarity of TR2 should be made.

The circuit tracer facility is the only remaining part of the Auto Test Set to be tested. The configuration of Fig. 10 may be re-used for this purpose, but with SK7 and SK6 substituted for SK1 and SK2, respectively. S3 should be switched to the 'V' position. As the input voltage is increased from zero, D16 should become illuminated and the buzzer should sound at a level of approximately 9 to 10 volts. Moving S3 to 'Off' should silence the buzzer. Any error in the operation of the circuit tracer should lead to an investigation of the circuitry associated with IC2c.

This completes the testing and calibration of the Auto Test Set, which is now ready for use.

BAZAAR

I1P audio modules Mullard f.m. modules i.c.'s cases switches many small components. All very cheap s.a.e. G.A. Noble, 50 Crofthill Road, Slough, Berks SL2 1HF.

CALSCOPE Super 10 dual trace. Function gen. DMM. Exchange four track, 15 i.p.s. reel/reel tape recorder. P. Cooper, 27 Leeswood, Ashurst, Skelmersdale, Lancs WN8 6TH.

ZX81 wanted must be in reasonable condition, have power supply and be in working order. 22 Primrose Drive, Haltons, Leeds 15. Tel: 641 505.

RARE collector's item; 1938 "Cossor" television set, walnut cabinet £150. F. Ashworth, 76 Hampton Road, London E7. Tel: 01-519 2286.

WEMON monitor for Superboard II series II £6. Old BASICS Mon, 1, 3, 4 ROMS. Any offers? J. Ellis, 44 Copthorne Road, Rickmansworth, Herts. Tel: Rickmansworth 772139.

WANTED video/audio/television test equipment in good condition and also service manuals. M. Patel, 46 Lockerbie Avenue, Rushymead, Leicester. Tel: (0533) 65009.

BINATONE 5-star 40 channel 4 watt FM-CB mobile transceiver. Full controls. New. £35. Call Chang 041-332 7695 after 8p.m.

PRACTICAL Electronics 1964 to 1982. Everyday Electronics 1971 to 1982 buyer collects. Offers to 01-274 5495.

WANTED XBug plus manual for Microtan 65 system. C.W. Murray, 21 Canterbury Rd, Ash, Aldershot, Hants GU12 65P. Tel: Ald 310661 after 6p.m.

UK101 8K Cegmon 32/16 x 48 new BASICS 1,3,4, 300/600B cased part built P.E. interface boards £80 o.n.o. Somerton (SOM) 72663 evenings.

CRYSTAL radios wanted from the 1920's and 1930's and other wireless and radio sets and material. J.L. Troe, 111 Skyline Drive, Morristown, New Jersey 07960 U.S.A.

OSCILLOSCOPE. Telequipment mod S43, good condition £40·00. Tel: Thatcham 64617 evenings and weekends. A. Napier, 1 Elmgrove, Thatcham, Berks.

GOLDRING turntable with Shure cartridge plus Amstrad amp., both need repair £25 o.n.o. both. Buyer to collect. G. Wheaton—Tel (Bolton) 591449.

AC 240V power unit—900V/·5A 213V/60mA 24V/4·5A 15V/750mA 25V/2·5A in sturdy metal case. S.a.e. for details £50. J.B. Carlile, 10 Cedric Ave, Romford, Essex. Tel: Romford 67627.

ATOM 12K, Acorn built, utility EPROM, leads. Manuals, magic book, 3A p.s.u., 2MHz option, software. Offers. G. Gray, 64 Lindisfarne Rd, Bessemar Park, Spennymoor, Co. Durham.

NEWBRAIN £199, Accessories available. Used for short time on systems communications and software tests. HX20 needed. Anthony Hode, 15 St Johns Court, Wakefield WF1 2RY.

ATARI Video computer 22 programs (Approx £400). Three sets controls £200 o.n.o. Tel: Derby 556294. G.H. Scott, 58 Buttermere Dr, Allestree, Derby.

SEVEN Digisound 80 modules for sale including keyboard controller, power amplifier, p.s.u. Offers. Will separate. Adam Rae, 34 Newtondale, Sutton Park, North Humberside.

ZX81 Sinclair computer, brand new including power supply. Only £32 inc. postage. Mr. C.E. Nicholas, "Sunrays", 37 Phernyssick Rd, St. Austell, Cornwall. Tel: 0726 63938.

EPSON TX80 friction feed dot matrix printer, connector and paper mint condition. £200. Tel: 021 350 8271. Mr. A. Webster, 30 Blounts Rd, Erdington, Birmingham.

PAIR Ditton 161 speakers £60. Wharfedale Denton speakers £25, Neal 4-channel resolver £10. w.h.y. Mr. Mel Saunders, 7 Drumcliff Rd, Thurnby Lodge, Leicester LE5 2LH.

PERTEC 6840-9-25 tape transport £40. Memorex 651 disc drive £40. Both with manuals, buyer collects. N.R. Horder, 24 Kinsbourne Ave, Ensbury Park, Bournemouth BH10 4HE. Tel: 0202 512062.

UK101 8K cased, programmable sound board, many programs; invaders, supertrek £100. Sean Carey, 82 Firs Rd, Winterslow, Salisbury, Wilts SP5 1SW. Tel: Winterslow 862 348.

BRAND new full size moving key QUERTY keyboard, 60 keys £8·00. Phone 061 330 1309. B. Curry, 21 Cranbourne Rd, Ashton under Lyne, Gr. Manchester.

WATFORD Phaser £16, fuzz boxes also other projects and components. Space needed. S.a.e. for list. Martin, 6 Downland Gdns, Tattenham Corner, Epsom, Surrey.

TRANCENDENT DPX must be sold now. £270. Please ring soon with an offer. J. Bedward, 21 Hartshill Rd, Olton, Birmingham B27 6PB. Tel: 021 706 9465.

SHUGART eight inch floppy drive with manual and diagrams for experienced constructor £75 o.n.o. J. McCarthy, 13 Gipsy Lane, Wokingham, Berks. Tel: Wokingham (0734) 789529.

FOR Compukit RAM/EPROM board £20, Sound Board £5, Toolkit £5 BASIC 5 £5 Mother £5. Mr. N. Odell, 31 Humphrey Rd, Greenhill, Sheffield S8 7SE. Phone (0742) 745027.

TE 20D signal generator £25. 680R Multimeter £12. Kamoden transistor tester £20. Goodmans Audiom 100/Axent 100 speakers £40. P.A. Joiner, Speyside Cottage, Old Distillery Rd, Kingussie, Invernesshire. Tel: 05402 677.

CHALLENGER 1P, 8K, Cegmon, 48x32, Four speed cassette save, software, lots of info. Bargain £140 o.n.o. John, Leics. Tel: Thistleton (057283) 332.

PE years 1966 to 1973 £5 p&p £4. Tel: St. Albans (0727) 39171 Ask for Martin.

SINCLAIR stereo-60 units. Preamp, active filter, 2x230 power amps, power supply £20 o.n.o. Tel: Wivenhoe (020622) 5671. C. Hellen, Vine Cott, Main Rd, Alresford, Colchester, Essex CO7 8DD.

PE/CLEF Bandbox music programmes Q/step, Waltz, S/fox, beat etc. Specials written also unlimited memory mod. Enquiries F.P. Jones, 20 Blunham Rd, Mogerhanger, Bedford MK44 3RA. Phone: 0767 40220.

SELMAR 50 watt valve guitar amp with 4 x 12 speaker cab £65. Ronn Ferguson, 11 Avondale High, Croydon Road, Caterham, Surrey CR3 6QJ. Tel: Caterham 46376.

GOOD prices paid for very old junction and point contact transistors and diodes. Write for details. Mr. Andrew Wylie, 18 Rue De Lausanne, 1201 Geneva, Switzerland.

TRS 80 PC-2 8K RAM pack. Brand new, unused, present. Normal price £79·95; selling for £51.00 including p&p. Zakariya Ahad, 92 Princes Park Ave., Golders Green, London NW11 0JX. Tel: 01 455 2800 (After 8p.m.).

DAMAGED Casio FX-602P required for spare parts reasonable price paid. M. Brown, 19 The Baulk, Worksop, Notts S81 0HU. Tel: 0909 485738.

RS signal injector £5, 30kV probe £10. Plenty strip board, prototype board £4. Phone Reading 694445. M. Harris, 32 Wilmington Cl, Woodley, Reading RG5 4LR.

RS Logic Pulser, RS CMOS Logic Probe, RS TTL Logic Probe £15 each. Phone Reading 694445. M. Harris, 32 Wilmington Cl, Woodley, Reading RG5 4LR.

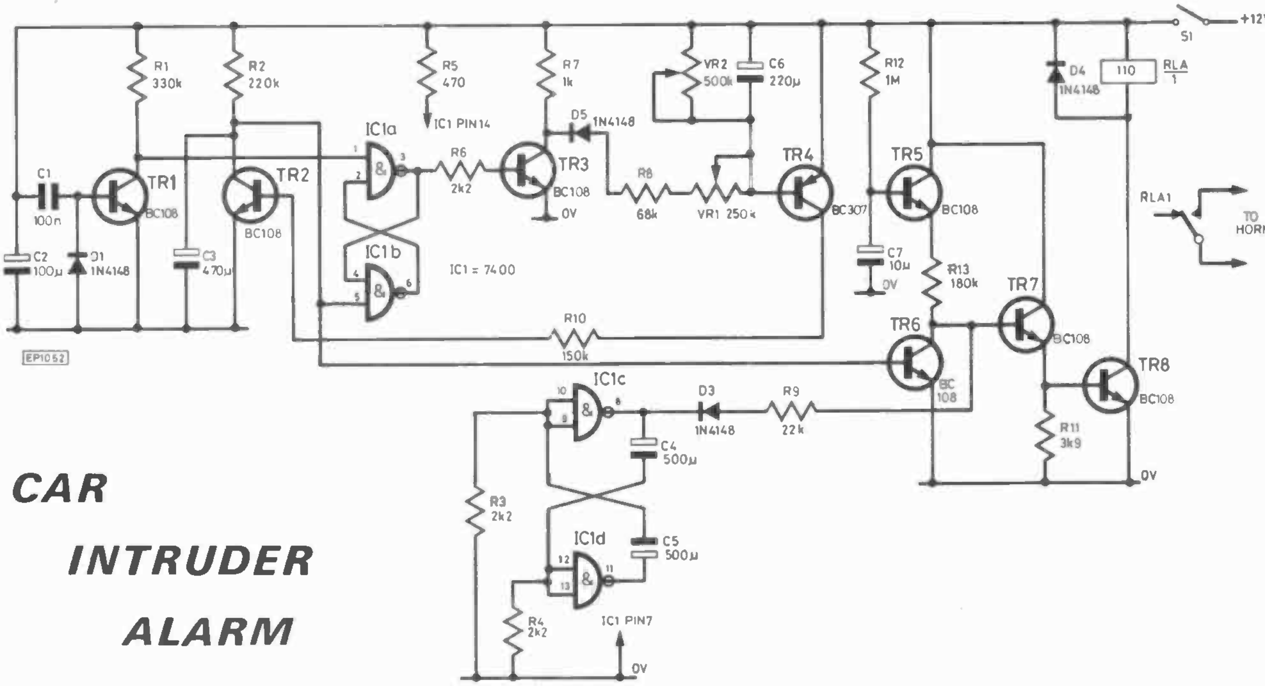
Ingenuity Unlimited

A selection of readers' original circuit ideas.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not in the text.



CAR INTRUDER ALARM

THE design requirements for this were as follows.

Able to be triggered by any electrical equipment in the car being operated, i.e. courtesy light, ignition, lights etc., but not the horn when being used to provide the alarm. To provide a delay of about 15 seconds to allow the car owner time to leave the vehicle after switching on the internal arming switch and a delay of about 8–10 seconds before the alarm operates to allow time for the owner to disarm on re-entry to the vehicle.

It must have a pulsating alarm which ceases after 30 seconds, but re-arms the circuit after 10–15 seconds.

On closure of S1 it takes approximately 10 to 15 seconds for C3 to become positively charged via R2. This puts a positive potential on pin 5 of IC1a and the base of TR6 which in turn makes the base of TR7 negative, which means that RLA1 is de-energised. R12 and C7 are included to stop TR6 collector going positive before its base goes positive.

On opening the car door the courtesy light operates, which causes a negative pulse at TR1 collector and pin 1 of IC1a. This causes the bistable to operate which turns on TR3 allowing C6 to charge, putting a negative potential on the base of TR4. The time for C6 to charge is determined by R8 and VR1. Discharge time is determined by VR2. The base of TR2 is now positive, causing the collector to go negative. This causes two functions.

The base of TR6 is made negative turning it off, which puts the base of TR7 positive, this is modulated by IC1b which is oscillating at about 1 hertz, thereby switching TR8 on and off allowing alternate operation of the relay.

The second function causes pin 5 of IC1a to be held negative thus preventing operation of the bistable whilst the relay is operating.

When C6 has discharged the relay ceases to operate and the bistable returns to an operational state.

The relay in the prototype was used to pulsate the horn but it could also be used to pulsate the headlights or operate a siren. The relay contacts must be capable of carrying the current demanded by the warning devices being used. VR1 is used to adjust the re-entry time delay and VR2 to adjust the relay operation time.

W. Fairhurst,
Anderton,
Chorley,
Lancs.

PWM MOTOR CONTROLLER WITH CENTRE OFF

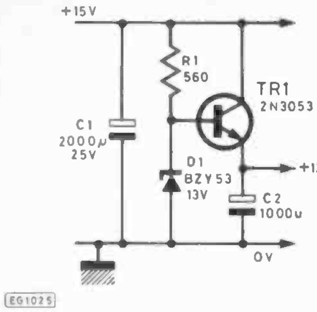


Fig. 1

THIS circuit was designed so that the direction in which a train speed potentiometer moves away from its centre off position controls the direction in which the train travels. The pulse frequency to the motor is obtained from an astable so can be any value (40 Hz used) and enables battery operation.

Fig. 1 shows the power supply used to supply two controllers. Fig. 2 shows the voltage decoding circuit in which VR1 is the speed potentiometer. The voltage on VR3 is modified by IC2 and 3 and appears at D as an increasing voltage whenever VR3 is moved further from its central position. An inertia network R16, VR4 and C3 gives simulated inertia which is shorted by S2 being closed. S1 is an emergency stop and IC4 buffers the voltage on C3. TR2 was included for remote or automatic switching and E for injecting a minimum voltage on C3 during automatic control. IC1's output swings positive or negative depending on the direction that VR1 is moved from the centre off position. R2 is a 10k trim potentiometer next to VR1 and a 4k7 resistor.

Fig. 3 shows IC5 the astable 555, which triggers IC6 the monostable 555. The period of the monostable 555 is controlled by the voltage on pin 5 and this comes from the output of IC4. This creates a pulse width modulated output from IC6 which is fed to the power transistor. IC6 needs to gate off when there is a minimum voltage of about 2V on pin 5. To achieve this the negative pulse arriving at IC6's trigger pin is prevented from reaching zero by R18 and VR5 on the output of IC5.

Fig. 4 shows a power stage using a relay for controlling the direction. D5, TR4 and R26 provide overload protection at 2A and TR5, R27 and l.e.d. provide indication. Due to slight differences in relays R23 and R24 may need some adjustments. Try to get TR3 to run at the same temperature in each direction.

To set up the decoder (Fig. 2) monitor the voltage at D. Set the dead band pots VR2 and VR3 to the mid point. Turn VR3 to full speed, adjust equally the trim pots each side of VR1 until the maximum voltage possible is obtained at D (10–11V). Turn VR1 to full speed in the other direction and check the voltage is the same as the other full speed voltage.

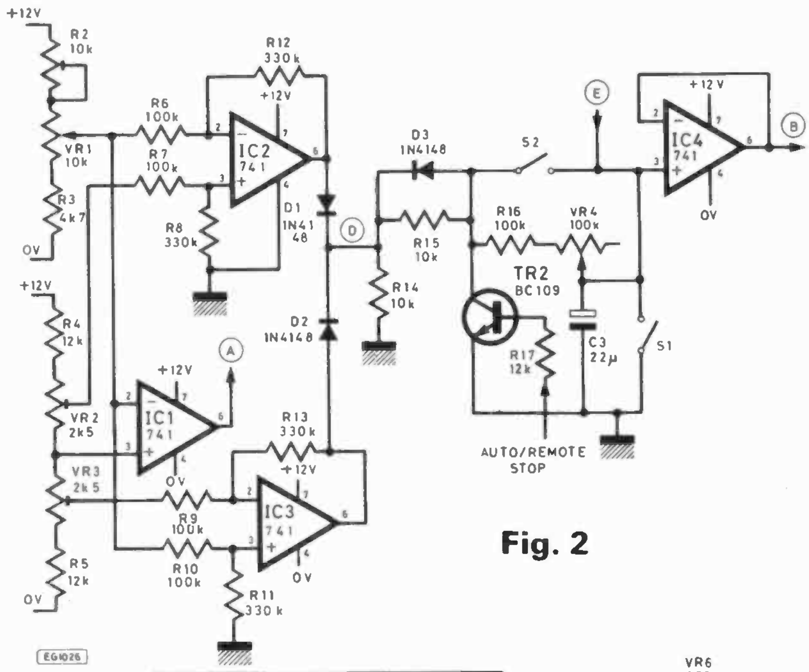


Fig. 2

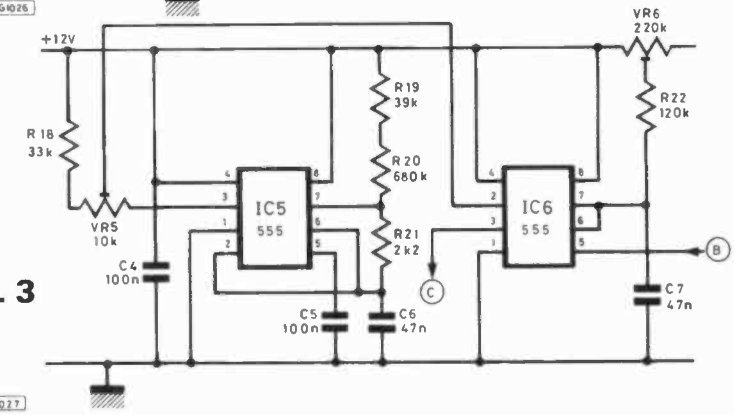


Fig. 3

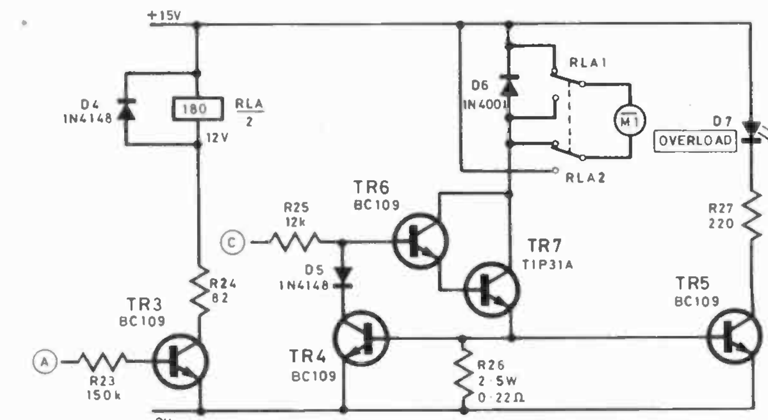


Fig. 4

To set up the PWM (Fig. 3) set VR6 to minimum, VR1 to full speed, monitor IC6's output and gradually increase VR6. As VR6 is increased a point will be reached when IC6's output suddenly falls to half its previous value. IC6 is now firing from every other pulse from IC5 and VR6 must be reduced slightly. Turn VR1 to off and adjust VR5 until IC6's output is just gated off.

S. Woodall,
Mangotsfield,
Bristol.

Ultimum Computer Interface Part 8

WILLIAM EDWARDS WATFORD ELECTRONICS

THE PORT card for the Ultimum system provides all the facilities one is ever likely to need for running printers, terminals and so on, plus a few extra goodies. A real-time clock with battery backup is included, allowing your system to always know the correct date and time. Both this, and all of the ports provided by the card have interrupt facilities, to allow any or all of them to be run in an interrupt-driven mode with all its attendant advantages of software efficiency. All handshakes on the two parallel ports are performed by hardware, again reducing the software load. The serial port provides and accepts both full V24 level and TTL level RS232 signals in full-duplex mode with complete modem handshaking provision.

HARDWARE

The circuit divides very neatly into four parts, as may be seen from the diagram (Fig. 8.1). The decoding section is fairly standard; ICs 7 & 8 compare the top eight address bits with those set up on link 1. IC6 decodes further using four more address bits to give sixteen outputs covering sixteen locations each, any of which is available (on link 2) for the master selects MS1 and MS2.

The 58174 real-time clock (IC2) consumes only ten microamps in standby mode and operates down to 2·2 volts. Since the trickle charge current for the battery is 1mA, rather odd but simple circuitry may be used in the backup supply. R9 charges the battery in normal operation and, when power is removed from the card, has very little effect on the 3·6 volts from the battery. The open collector output of IC5 combined with R10 ensures that the clock remains deselected under power-down conditions. Link 4 allows connection of the internal timer to the system interrupt line.

The serial port is handled by IC1, a 6551 asynchronous communications interface adaptor. This handles conversion between serial and parallel formats including some error checking features. Buffering and level conversion on the output side is provided by IC11. The CCITT recommendation V24 specifies a minimum ± 3V signal and a typical ± 12V. The EIA standard RS-232C is similar, and specifies in addition a maximum output slew rate of 30V/µs, data rate of 20kb/s and cable length of 50 feet. The purpose of the slew rate specification is to control emission (which causes crosstalk) and reflection problems. The capacitors C1-3 perform this function, the outputs of the line drivers being current limited. Input buffering and level conversion is provided by IC10. Resistors R14-17, which are not normally fitted, allow correct termination of electrically long transmission lines. The transition points of the line receivers are about 1·3 volts. This has two useful effects. First, an open or shorted input will be seen as continuous "mark" (as if no characters were being output by the remote transmitter) rather than noise, and secondly, a TTL specification input (<0·8V="0", >2·4V="1") can be correctly read. IC10 also provides for filtering (C4-7) and about 500mV of hysteresis to eliminate noise on the input. The value of capacitor given causes the receiver to reject a 3V noise pulse less than 400ns wide. If noise problems are experienced they may be increased, paying careful attention to the Baud rate in use.

The values of C1-3 may be similarly modified if necessary. The supply-line diodes around IC10 protect it from damage when a signal is received with the power supply off.

Both the parallel ports are handled by (surprise, surprise!) an 8255, IC3. The circuitry is designed to take best advantage of the 8255 using port B in mode 1, output, for the Centronics parallel port and port A in mode 2, bidirectional, for the auxiliary port. ICs 4 and 5 provide increased current driving capability for the Centronics output. Link 3 may be used to select BUSY for the handshaking if $\overline{\text{ACK}}$ is not available. In mode 1 the 8255 handles the required handshaking for the Centronics protocol on port B using lines 1 and 2 of port C. An interrupt request is available out of port C line zero; if interrupts will never be required for the Centronics port R5 may be omitted. Port A requires four handshake lines to run in full bidirectional mode; these are provided by port C lines 4-7 and consist of:

a) Output Buffer Full and Acknowledge (output operations)
b) Strobe and Input Buffer Full (input operations)

An interrupt request is available for the port on C3; R4 may be omitted if it will never be used. If no interrupts from the 8255 will ever be required then TR1 and R6 may also be omitted. It should be noted that the drive capability of port A is limited to 200µA (source), 1·7mA (sink) and buffering may be required for any particular application. The port may of course be used as a purely unidirectional one without modifying the 8255 mode (two parallel printers?).

CONSTRUCTION

The usual order of construction applies: Sockets first followed by discrete components. Then fit the i.c.s and finally solder the battery in, being careful at all times not to short it out. Try not to subject the crystals to excessive brutality; they don't appreciate it. Finally choose and fit your

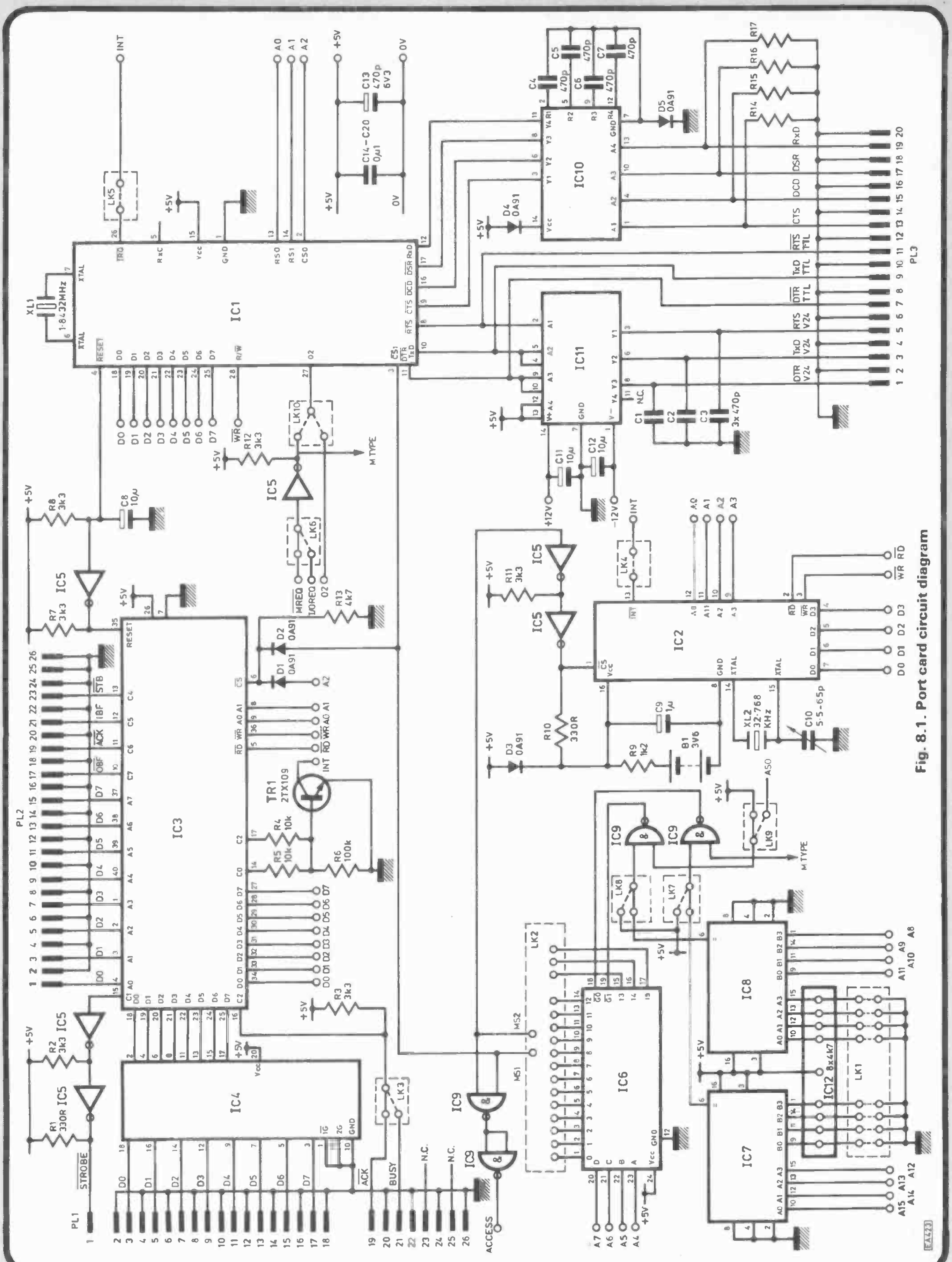


Fig. 8.1. Port card circuit diagram

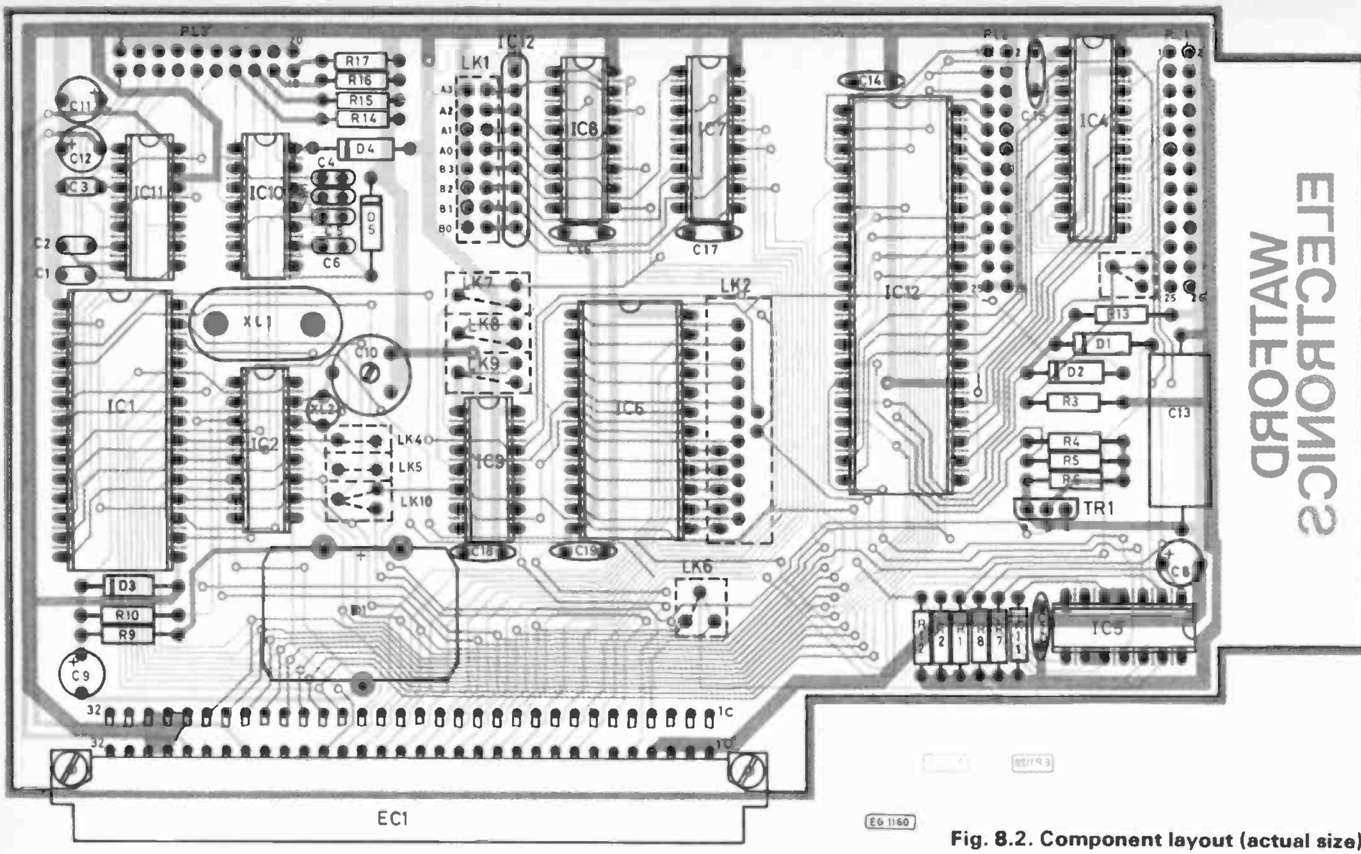


Fig. 8.2. Component layout (actual size)

COMPONENTS . . .

Resistors

R1,R10	330 (2 off)
R2,R3,R7,R8,R11,R12	3k3 (6 off)
R4,R5	10k (2 off)
R6	100k
R9	1k2
R13	4k7
R14–17	not supplied in kit

Capacitors

C1–7	470p ceramic (7 off)
C8,C11, C12	10µ/16V tant. (3 off)
C9	1µ/16V tant.
C10	5–65p trimmer
C13	470µ/6V3
C14–20	100n ceramic (7 off)

Semiconductors

D1–5	OA90 (5 off)
TR1	ZTX109
IC1	6551 ACIA
IC2	58174 RTC
IC3	8255 PPI
IC4	74LS244
IC5	74LS05
IC6	74LS154
IC7,IC8	74LS85 (2 off)
IC9	74LS00
IC10	1489 Quad line receiver
IC11	1488 Quad line driver
IC12	8 x 4k7 resistor s.i.l.

Miscellaneous

X1	1·8432MHz crystal
X2	32·768kHz crystal
B1	3V6 p.c.b. mounting Ni-Cad
EC1	2 x 32 A+C right-angled male DIN
PL1, PL2	2 x 13 male IDC pins
PL3	2 x 10 male IDC pins
sockets . . .	
14 pin	4 off
16 pin	3 off
20 pin	1 off
24 pin	1 off
28 pin	1 off
40 pin	1 off

Printed circuit board WE05PRT

Constructors' Note

Kits for all parts of the Ultimum will be available from **Watford Electronics**, 33 Cardiff Rd., Watford, Herts, WD1 8ED. Send SAE for price list of boards now available.

Table 8.1. Link options

1. Addressing: Top eight bits. Mode='0'. Marked end is least significant.
2. Addressing: Page subdivisions. Marked end is lowest address.
3. Centronics handshake: Default is $\overline{ACK}$. Alternative is BUSY.
4. Timer interrupt.
5. ACIA interrupt.
6. Address space: Default is memory-mapped. Alternative is I/O mapped.
7. Address space size: Make for 8-bit space and remove ICs 7 & 8.
8. Mapping: Default is 'permanent'. Alternative is 'mappable'.
9. Z80/65 or 68: No default.

Table 8.3. Year status codes for register 13 of 58174

Address 13 Write Mode

	DB3	DB2	DB1	DB0
Leap year	1	0	0	0
Leap year +1	0	1	0	0
Leap year +2	0	0	1	0
Leap year +3	0	0	0	1

Selected counter	Address bits AD3	AD2	AD1	AD0	Mode
0 Test only	0	0	0	0	Write only
1 Tenths of sec.	0	0	0	1	Read only
2 Units of secs.	0	0	1	0	Read only
3 Tens of secs.	0	0	1	1	Read only
4 Units of mins.	0	1	0	0	Read or Write
5 Tens of mins.	0	1	0	1	Read or Write
6 Units of hours	0	1	1	0	Read or Write
7 Tens of hours	0	1	1	1	Read or Write
8 Units of days	1	0	0	0	Read or Write
9 Tens of days	1	0	0	1	Read or Write
10 Day of week	1	0	1	0	Read or Write
11 Units of months	1	0	1	1	Read or Write
12 Tens of months	1	1	0	0	Read or Write
13 Years	1	1	0	1	Write only
14 Stop/Start	1	1	1	0	Write only
15 Interrupt and status	1	1	1	1	Read or Write

Table 8.2. Address decoding for clock registers of 58174

Fig. 8.3. Example clock program

```
10   MS2=address of clock
20   R=9:GOSUB 1000
30   R=8:GOSUB 1000
40   PRINT " ";
50   R=12:GOSUB 1000
60   R=11:GOSUB 1000
70   PRINT "   ";
80   R=7:GOSUB 1000
90   R=6:GOSUB 1000
100  PRINT ":";
110  R=5:GOSUB 1000
120  R=4:GOSUB 1000
130  PRINT ":";
140  R=3:GOSUB 1000
150  R=2:GOSUB 1000
160  PRINT
170  GOTO 20
1000 A=PEEK (MS2+R)
1010 IF A=15 THEN 1000
1020 PRINT A;
1030 RETURN
```

Table 8.4. Register 15 of 58174. Interrupt selection data

Address 15 Write Mode

Function	DB3	DB2	DB1	DB0
No Interrupt	X	0	0	0
Interrupt at 60 sec. intervals*	0/1	1	0	0
Interrupt at 5.0 sec. intervals*	0/1	0	1	0
Interrupt at 0.5 sec. intervals*	0/1	0	0	1

*±16.6 mS
DB3 = 0, single interrupt   DB3 = 1, repeated interrupt

Table 8.5. Internal registers of 6551

RS_1	RS_0	Write	Read
0	0	Transmit Data Register	Receiver Data Register
0	1	Programmed Reset (Data is "Don't Care")	Status Register
1	0	Command Register	
1	1	Control Register	

required link options. The card occupies two sixteen-location chunks of address space which must be in the same 256-location page. Link 1 sets (in binary, made="0") the page number and link 2 selects two of sixteen subdivisions of the page. In hexadecimal terms, link 1 defines the first two digits and link 2 the third of the four required to describe a 64K address space. If the I/O option is being used in a machine with only one page of I/O space, ICs 7 & 8 should be omitted.

SOFTWARE

The 58174 maintains sixteen internal registers (Table 8.2) and as such uses the entire address space selected by MS2. The counter registers (1 to 12) hold the date-time in BCD format. If a counter is being updated at the time it is read, the value 15 will be returned which is an illegal BCD code and thus may be detected. The most significant four data bits will be ignored on a write and are undefined on a read and should be masked out by software. Register zero is used during manufacture and should not be accessed apart from writing a zero to it at system initialisation time. The value *zero* when written into register 14 will stop the clock; the value *one* will re-start it. This allows time data to be loaded and the clock then to be started precisely. Register 13 may be used to set the year status according to Table 8.3. Register 15 is the interrupt status register. It may be set in accordance with Table 8.4 to request single or repeated interrupts in one of three time periods. Once set, the interrupt request will be cleared by a read of the status register. Fig. 8.3 is an example program which reads the date and time.

The 6551 has six internal locations mapped onto four addresses (Table 8.5). On the card these appear at MS1 + 4 to MS1 + 7. Figs. 4 to 7 give information on their function. The conditions reflected by bits 3 to 6 of the status register can cause an interrupt if enabled by bits 0 to 3 of the command register. The interrupt from status register bits 5 and 6 occurs on a *change* of state.

Note that CTS must be input to the 6551 for the transmit side to operate. If no suitable signal is available from the remote terminal then connect it to DTR/V24 at PL3. Fig. 8.8 gives an example program which uses the 6551 for output without using interrupts, and a suggested sequence of checks when interrupts are being used.

CONTROL REGISTER

The Control Register is used to select the desired mode for the SY6551. The word length, number of stop bits, and clock controls are all determined by the Control Register, which is depicted in Figure 6.

CONTROL REGISTER

7 6 5 4 3 2 1 0

STOP BITS

0 = 1 Stop Bit
1 = 2 Stop Bits
1 Stop Bit if Word Length = 8 Bits and Parity*
1½ Stop Bits if Word Length = 5 Bits and No Parity

WORD LENGTH

BIT 6	BIT 5	DATA WORD LENGTH
0	0	8
0	1	7
1	0	6
1	1	5

RECEIVER CLOCK SOURCE

0 = External Receiver Clock
1 = Baud Rate Generator

*This allows for 9-bit transmission (8 data bits plus parity).

BAUD RATE GENERATOR

3	2	1	0	
0	0	0	0	16x EXTERNAL CLOCK
0	0	0	1	50 BAUD
0	0	1	0	75
0	0	1	1	109.92
0	1	0	0	134.58
0	1	0	1	150
0	1	1	0	300
0	1	1	1	600
1	0	0	0	1200
1	0	0	1	1800
1	0	1	0	2400
1	0	1	1	3600
1	1	0	0	4800
1	1	0	1	7200
1	1	1	0	9600
1	1	1	1	19,200

	7	6	5	4	3	2	1	0
HARDWARE RESET	0	0	0	0	0	0	0	0
PROGRAM RESET	–	–	–	–	–	–	–	–

Fig. 8.4. Control register format

COMMAND REGISTER

The Command Register is used to control Specific Transmit/Receive functions and is shown in Figure 7.

COMMAND REGISTER

7 6 5 4 3 2 1 0

PARITY CHECK CONTROLS

BIT 7	BIT 6	BIT 5	OPERATION
–	–	0	Parity Disabled · No Parity Bit Generated · No Parity Bit Received
0	0	1	Odd Parity Receiver and Transmitter
0	1	1	Even Parity Receiver and Transmitter
1	0	1	Mark Parity Bit Transmitted, Parity Check Disabled
1	1	1	Space Parity Bit Transmitted, Parity Check Disabled

DATA TERMINAL READY

0 = Disable Receiver and All Interrupts ($\overline{DTR}$ high)
1 = Enable Receiver and All Interrupts ($\overline{DTR}$ low)

RECEIVER INTERRUPT ENABLE

0 = $\overline{IRQ}$ Interrupt Enabled from Bit 3 of Status Register
1 = $\overline{IRQ}$ Interrupt Disabled

TRANSMITTER CONTROLS

BIT 3	BIT 2	TRANSMIT INTERRUPT	$\overline{RTS}$ LEVEL	TRANSMITTER
0	0	Disabled	High	Off
0	1	Enabled	Low	On
1	0	Disabled	Low	On
1	1	Disabled	Low	Transmit BRK

NORMAL/ECHO MODE FOR RECEIVER

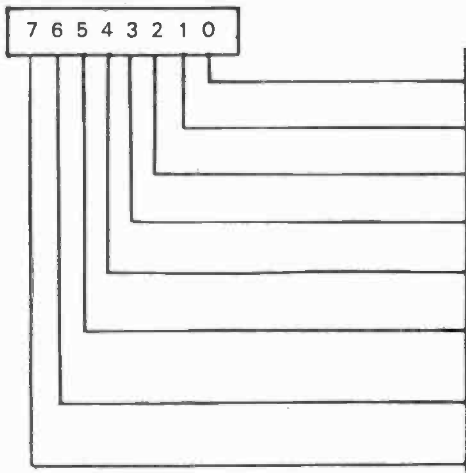
0 = Normal
1 = Echo (Bits 2 and 3 must be "0")

	7	6	5	4	3	2	1	0
HARDWARE RESET	0	0	0	0	0	0	0	0
PROGRAM RESET	–	–	–	0	0	0	0	0

Fig. 8.5. Command register format

STATUS REGISTER

The Status Register is used to indicate to the processor the status of various SY6551 functions and is outlined in Figure 8.



STATUS	SET BY	CLEARED BY
Parity Error*	0 = No Error 1 = Error	Self Clearing**
Framing Error*	0 = No Error 1 = Error	Self Clearing**
Overrun*	0 = No Error 1 = Error	Self Clearing**
Receive Data Register Full	0 = Not Full 1 = Full	Read Receive Data Register
Transmit Data Register Empty	0 = Not Empty 1 = Empty	Write Transmit Data Register
$\overline{DCD}$	0 = $\overline{DCD}$ Low 1 = $\overline{DCD}$ High	Not Resettable Reflects $\overline{DCD}$ State
$\overline{DSR}$	0 = $\overline{DSR}$ Low 1 = $\overline{DSR}$ High	Not Resettable Reflects $\overline{DSR}$ State
IRQ	0 = No Interrupt 1 = Interrupt	Read Status Register

*NO INTERRUPT GENERATED FOR THESE CONDITIONS.
**CLEARED AUTOMATICALLY AFTER A READ OF RDR AND THE NEXT ERROR FREE RECEIPT OF DATA.

	7	6	5	4	3	2	1	0
HARDWARE RESET	0	–	–	1	0	0	0	0
PROGRAM RESET	–	–	–	–	–	0	–	–

Fig. 8.6. Status register format

STATUS REGISTER OPERATION

Because of the special functions of the various status bits, there is a suggested sequence for checking them. When an interrupt occurs, the R6551 should be interrogated, as follows:

1. Read Status Register
   This operation automatically clears Bit 7 (IRQ). Subsequent transitions on $\overline{DSR}$ and $\overline{DCD}$ will cause another interrupt.
2. Check IRQ Bit.
   If not set, interrupt source is not the R6551.
3. Check $\overline{DCD}$ and $\overline{DSR}$.
   These must be compared to their previous levels, which must have been saved by the processor. If they are both "0" (modem "on-line") and they are unchanged then the remaining bits must be checked.
4. Check RDRF (Bit 3).
   Check for Receiver Data Register Full.
5. Check Parity, Overrun, and Framing Error (Bits 0–2).
   Only if Receiver Data Register is full.
6. Check TDRE (Bit 4).
   Check for Transmitter Data Register Empty.
7. If none of the above, then $\overline{CTS}$ must have gone to the FALSE (high) state.

```
 10  MS1=address
 20  TDR=MS1 + 4:STR=MS1+5
 30  CMR=MS1+6:CTR=MS1+7
 40  POKE STR, 0          ; Reset
 50  POKE CTR, 184        ; 2 step bits, 7 data bits, 1200 baud
 60  POKE CMR, 42         ; odd parity, transmit on, no
                              interrupts
 70  A$=characters to be output
 80  L=LEN(A$)
 90  FOR X=1 to L
100  IF (PEEK(STR) AND 16) =0 THEN 100;
     Wait for TDR empty
110  POKE TDR, ASC(MID$(A$,X,1))
120  NEXT X
```

Fig. 8.8. Example serial output program

These registers are used as temporary data storage for the 6551 Transmit and Receive circuits. The Transmit Data Register is characterized as follows:

- Bit 0 is the leading bit to be transmitted.
- Unused data bits are high-order bits and are "don't care" for transmission.

The Receive Data Register is characterized in a similar fashion:

- Bit 0 is the leading bit received.
- Unused data bits are the high-order bits and are "0" for the receiver.
- Parity bits are not contained in the Receive Data Register, but are stripped-off after being used for external parity checking. Parity and all unused high-order bits are "0".

Figure 9 illustrates a single transmitted or received data word, for the example of 8 data bits, parity, and 1 stop bit.

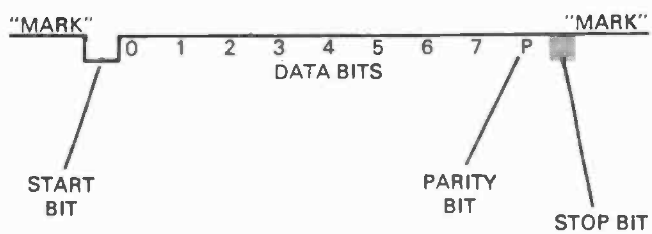


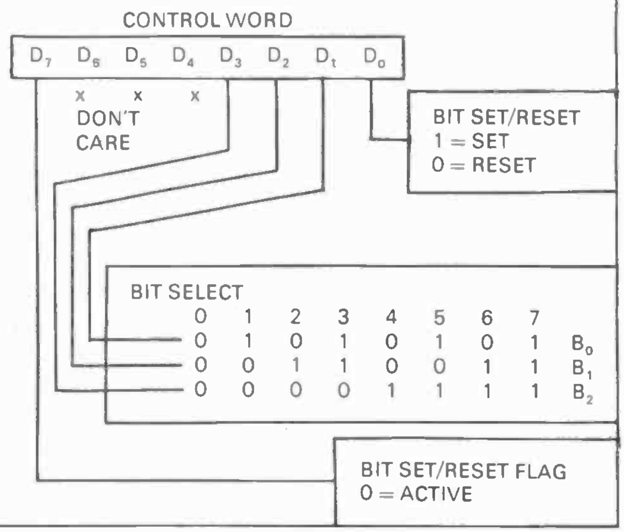
Fig. 8.7. Transmit and Receive data registers

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
OBF A	INTE A0	IBF A	INTE AI	INTR A	INTE B	OBF B	INTR B

INTE=Interrupt Enable
INTR=Interrupt Request

Fig. 8.9. 8255 status word, mode 2 + 1

Fig. 8.10. Bit Set/Reset format



The 8255 has the usual four registers, located in the address space at MS1 to MS1 + 3. Having defined ports A and B to be working in modes requiring handshaking, port C is dedicated to these control functions and attempting to use it normally does not make much sense. Bits in it however do have specific uses as is shown in Fig. 8.9. It will often be most appropriate to manipulate them using the individual bit set/reset capability which the 8255 provides for port C. The required format is given in Fig. 8.10.

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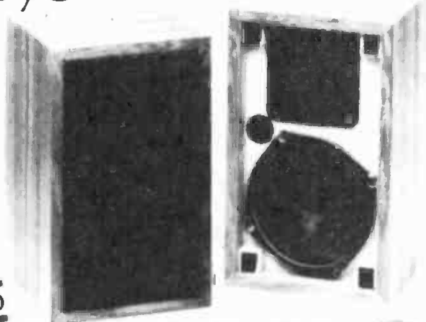

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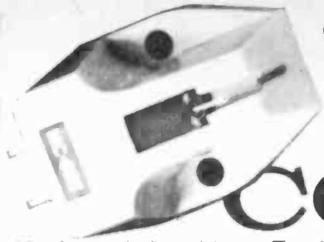

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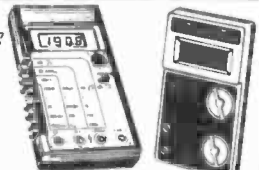

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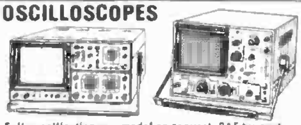

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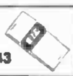

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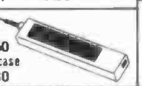

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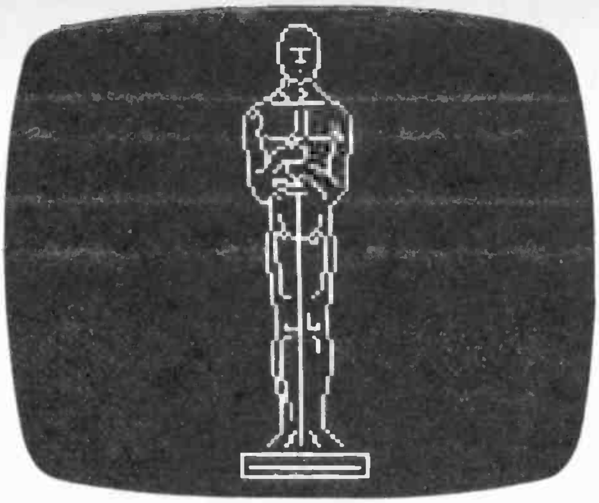

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15V 1A	7815	*40p	7912	45p
18V 1A	7818	*40p	7915	45p
24V 1A	7824	*40p	7918	45p
5V 100mA	78L05	30p	7924	45p
12V 100mA	78L12	30p	79L05	50p
15V 100mA	78L15	30p	79L12	50p
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BC179	18p
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BC184	10p
BC187	30p
BC212/3	10p
BC214	12p
BC237	10p
BC327	16p
BC337	10p
BC338	15p
BC461	30p
BC477/8	30p
BC516/7	36p
BC547B	12p
BC548C	12p
BC549C	12p
BC557B	14p
BC559C	16p
BCY70	20p
BCY71/2	20p
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BD132	40p
BD135	40p
BD136	35p
BD139	40p
BD140	40p
BD189	60p
BD242A	60p
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BD380	40p
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BF256B	50p
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BFR40/1	20p
BFR79	20p
BFR80/1	25p
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BFX30	34p
BFX84	25p
BFX85	30p
BFX88	25p
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TIP32A	40p
TIP32B	45p
TIP32C	50p
TIP33A	60p
TIP33B	65p
TIP33C	70p
TIP34A	65p
TIP34B	70p
TIP34C	80p
TIP35A	120p
TIP35B	140p
TIP35C	150p
TIP36A	140p
TIP36B	150p
TIP36C	160p
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TIP41B	50p
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2N2907A	25p
2N2926	9p
2N3053	25p
2N3054	55p
2N3055	48p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
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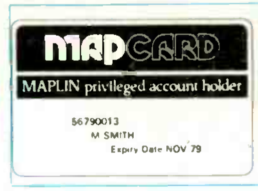

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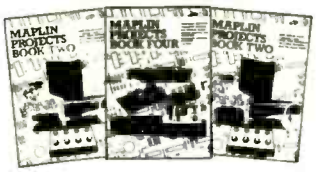

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