An Argus Specialist Publication

electronics today

INTERNATIONAL JUNE 1984 95p

SIMPLY THE BEST THAT YOU CAN BUILD

A new pre and power amp combination from John Linsley Hood

PLUS

PROJECTS TO BUILD;

Loudspeaker with novel drive unit

EPROM board for the Oric/Atmos

Centronics interface for the Cortex

SPECIAL AUDIO ISSUE

AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS...

High performance, low price kits for today's musicians

DIGITAL DELAY LINE

Digital delay circuitry is an absolute necessity for high quality studio work, but usually comes with a four-figure price tag.

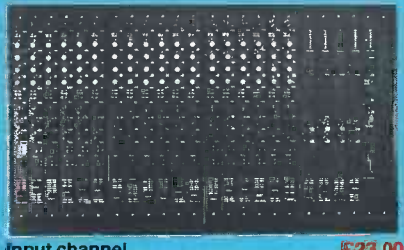
Powertran can now offer you digital quality for the price of a high analog unit. The unit gives delay times from 1.6mSecs to 1.6 secs with many powerful effects including phasing, flanging, A.D.T., chorus, echo and vibrato. The basic kit is extended in 400mSec steps up to 1.6 seconds simply by adding more parts to the PCB.

Complete kit (400mS delay) **£179**

Parts for extra 400mS delay (up to 3) **£19.50**

'DESTINY' MIXER

This versatile mixer offers a maximum of 24 inputs, 4 outputs, and an auxiliary channel. Input channels have Mic/Line, variable gain, bass/treble, and middle frequency equaliser. Output channels have PPM displays and record/studio outputs. There are send/return jacks, auxiliary, pan and fader controls, and output and group switching. There is also a headphone jack and built-in talk-back microphone.



Input channel	**£23.00**
Output channel	**£23.00**
Aux. channel	**£26.00**
Blank panel	**£3.50**
Base unit and front	**£33.00**
Pair of end cheeks	**£25.00**
Power supply and cabinet	**£22.50**

TRANSCENDENT 2000

ETI single board synthesizer.

This professional quality 3-octave instrument is transposable 2 octaves up or down, giving an effective 7-octave range.

There is portemento pitch bending, VCO with shape and pitch modulation, VCF with high and low pass outputs and separate dynamic sweep control, noise generator and an ADSR envelope shaper. Other features include special circuitry with precision components to ensure tuning stability.

Complete kit **£150**

MPA 200

100 watt mixer/amplifier

Here's a rugged, professionally finished mixer amp designed for adaptability, stability and easy assembly. Using new super-strength power transistors and a minimum of wiring, it offers a wide range of inputs (extra components are supplied for additional inputs), 3 tone controls, each with 15dB boost and 15dB cut, and a master volume control.

Complete kit **£79.50**

SP2-200

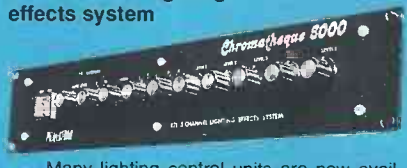
2-channel, 100-watt amplifer

The SP2-200 uses two of the power amplifier sections of the MPA 200 (above), each with its own power supply. A custom designed toroidal transformer enables both channels to simultaneously deliver over 100W rms into 8 ohms. Each channel has its own volume control, and a sensitivity of 0.775mV (OdBm) makes this amplifer suitable for virtually all pre-amps or mixers.

Complete kit **£99.50**

CHROMATHEQUE 5000

ETI 5-channel lighting effects system

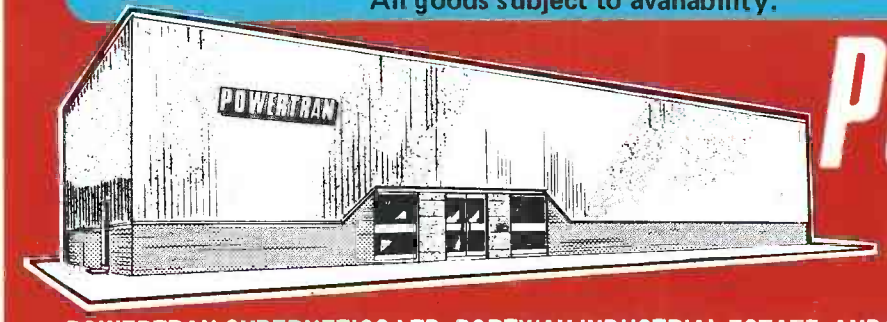


Many lighting control units are now available. Some perform switching and others modulation of light output according to musical input. The Chromatheque combines both functions. It controls 5 banks of lamps up to 500W each in either analog or digital mode. And the 5 channels give more colours and more exciting linear and random sequencing than is possible with 3 or 4-channel systems. Versatile light level controls enable the lights to be partially on to suit the mood of the occasion. Wiring is minimal and construction straightforward.

Complete kit **£79.50**

All goods subject to availability.

Allow 21 days for delivery



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electronics today INTERNATIONAL

JUNE 1984 VOL 13 NO 6

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PUBLISHED BY:
Argus Specialist Publications Ltd.,
1 Golden Square, London W1R 3AB.
DISTRIBUTED BY
Argus Press Sales & Distribution Ltd.,
12-18 Paul Street, London EC2A 4JS
(British Isles)
PRINTED BY:
The Garden City Press Ltd.
COVERS PRINTED BY:
Alabaster Passmore.

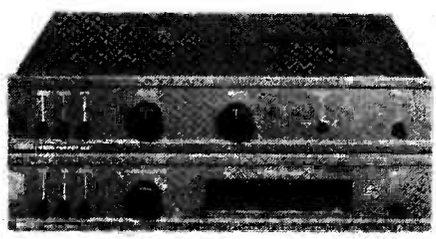
OVERSEAS EDITIONS and their EDITORS
AUSTRALIA — Roger Harrison
CANADA — Halvor Moorshead
GERMANY — Udo Wittig
HOLLAND — Anton Kriegsman

ABC **Member of the Audit Bureau of Circulation**

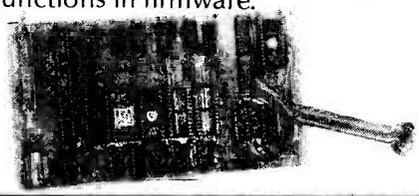
☐ Subscription Rates, UK £14.35 including postage. For further details and Airmail rates etc, see the Readers' Services page.

EDITORIAL AND ADVERTISEMENT OFFICE
1 Golden Square, London W1R 3AB. Telephone 01-437 0626.
Telex 8811896.

FEATURES



PROJECTS



INFORMATION

WATFORD ELECTRONICS

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

TAG-END CAPACITORS: 64V: 2200 **139p**; 3300 **198p**; 4700 **245p**; **50V:** 2200 **110p**; 3300 **184p**; **40V:** 4700 **180p**; **25V:** 2200 **90p**; 3300 **98p**; 4000, 4700 **98p**; 10,000 **320p**; 15,000 **345p**; **16V**: 22,000 **350p**.

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

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

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

FEED-THROUGH CAPACITORS
1000pF/450V **10p**

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

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

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

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

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm
5K — 500K single gang **80p**
Graduated Bezels for above **45p**

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

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

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

SILVER MICA (Values in pF)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF **15p each**
200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 **21p each**
100, 1200, 1800, 2200 **30p each**
3300, 4700pF **80p**

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

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

	RANGE	Val	1-99	100 +
0.25W	2R2 — 10M	E24	3p	1p
0.5W	2R2 — 4M7	E12	3p	1p
1W	2R2 — 10M	E12	6p	4p
2% Metal Film	51Ω — 1M	E24	6p	4p
1% Metal Film	51R — 1M	E24	8p	6p

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

RESISTORS NETWORK S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K, 100K **25p**
8 Commoned (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K & 100K **26p.**

RAM FOR BBC MICRO 4816AP 100ns 300p

TRANSISTORS

AC126/7	35
AC141/2	35
AC176	35
AC187	35
AC188	35
ACY19/21	75
ACY22/41	75
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	80
AF188	80
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
BC107	12
BC107B	14
BC108	12
BC108B	14
BC108C	14
BC109	12
BC109B	14
BC109C	14
BC114/5	30
BC117/8	25
BC137/9	40
BC140	38
BC142/3	38
BC147	12
BC147B	15
BC148	12
BC148B	15
BC149	12
BC149C	15
BC182L	10
BC183L	10
BC184	10
BC184L	10
BC186/7	28
BC188 6/7	25
BC12	10
BC212L	12
BC213	10
BC213L	12
BC214	10
BC214L	12
BC237/8	15
BC256B	35
307B	15
BC308	16
BC318	80

BC327	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	15
BC556/7	15
BC558/9	15
BCY39/40	85
BCY41/42	30
BCY45	50
BCY58/59	36
BCY70/71	18
1BCY72	25
BCY78	30
BD114	190
BD121	95
BD124	115
BD131/32	65
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	68
BD205/6	110
BD245	65
BD378	70
BD434	70
BD517	75
BD645	80
BD695A	150
BD696A	150
BF115	45
BF154/8	30
BF167	35
BF173	35
BF177	35
BF178	35
BF179	40
BF184/5	38
BF194/5	12
BF198/9	18
BF200	80
BF224A	40
BF224B	40
BF245	50
BF256A	45
BF256B	50
BF257/8	32
BF259	40
BF275	55

BF336/7	35
BF394	40
BF451	40
BF494/5	40
BF594/5	30
BFR39/40	30
BFR41/79	25
BFR80/81	25
BFR98	105
BFX29	35
BFX81	45
BFX84	35
BFX85/6	35
BFY50/51	30
BFY52	30
BFY53	35
BFY55/56	56
BFY64	40
BFY81	120
BFY90	80
BRY39	50
BSX20	30
BSX26/29	45
BSY26	35
BSY95	35
BU105	180
BU205	180
BU206	200
BU208	200
BUY69C	225
MO8001	250
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	85
MJE521	96
MJE2955	98
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	30
MPSA08	30
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	40
MPSU02	58
MPSU05	60

MPSU06	60
MPSU52	65
MPSU55	60
MPSU56	60
OC26	170
OC28	220
OC35	50
OC36/41	75
OC42/75	75
OC71/72	50
OC75/76	55
OC81/82	50
OC83/84	70
OC170/71	75
OC70	40
OC200	75
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	75
TIP34A	85
TIP34C	105
TIP35A	120
TIP35C	130
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	120
TIP147	120
TIP2955	70
TIP3055	70
TIS43	50
TIS44/5	45
TIS88A	50
TIS90/91	30
UC	65
VK1010	99
VN10KM	70
VN46AF	95
VN66AF	110
VN88AF	120
VN89AF	120

ZTX107/8	12
ZTX109	12
ZTX212	28
ZTX300	13
ZTX302	16
ZTX303	25
ZTX304	17
ZTX326	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	125
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	25
2N708	25
2N918	40
2N1131/2	40
2N1302	45
2N1307/8	70
2N1671B	160
2N2160	325
2N2219A	28
2N2220A	28
2N2221A	25
2N2222A	25
2N2368	25
2N2369A	18
2N2483/4	27
2N2646	46
2N2904/5	28
2N2906/7	28
2N2907A	28
2N2926G	10
2N3053	25
2N3054	55
2N3055	50
2N3252	46
2N3441/2	140
2N3614/5	180
2N3663	20
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	35

2N3820	60
2N3822/3	60
2N3866	90
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	60
2N4058	15
2N4061/2	15
2N4264	30
2N4286	25
2N4289	25
2N4314	78
2N4400	25
2N4427	80
2N4871	55
2N5135/6	30
2N5138	25
2N5172	25
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	180
2N6027	32
2SA671	250
2SA715	75
2SC495	85
2SC496	85
2SC1061	250
2SC1096	85
2SC1162	45
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	95
2SC1678	140
2SC1679	180
2SC1923	65
2SC1945	225
2SC1963	80
2SC1957	80
2SC1969	160
2SC2028	85
2SC2029	200
2SC2078	170
2SC2091	85
2SC2314	86
2SC2166	105

2SC2335	200
2SC2547	40
2SC2612	200
2SD234	74
2SK45	80
2SK288	225
2SJ83	225
2SJ85	225
3N128	115
3N140	115
40315	90
40316	95
40324	100
40326/7	70
40347	90
40348	120
40360	60
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40673	75
40871/2	90

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

COMPUTER ICs

2102L	160
2114	200
2147	395
2532	400
2532-4	400
25L32	450
2564	700
26501	75
2516	350
2716-5V	350
2732-4	450
2764-250	650
27128-250	£23
3242	590
4027	95
4116-200n	110
4164-150n	495
4416-2	475
4532-3	250
4532-4	350
4816-100ns	300
5514	250
6116-150	550
6116L-120	650
6117-100n	490
6167-6	795
6264L-15	£35
6402	350
6502CPU	325
6502A	490
6503	350
6503	650
6504	600
6504 250	550
6505	650
6505	600
6520PIA	175
6522VIA	325
6530	£11
6532RRIOT	650
6545RTC	899
6551ACIA	650
6592	00
6592PC	£20
6800	220
6802	295
6803	850
6805	670
6808	520
6809	650
6810	175
6821	190
68B21	220
6840	375
6843	£12
6845	750
6854SP	3750
6847	650
6850	175
6852	250
6854	650
68B54	800
6859	£4
6875	500
68000 New Mask	£50
8035	600
8080A	250
8085	550
8085A	425
8088	£18
8123	125
8131	275
8154	£9
8155	495
8156	360
81LS95	140
81LS96	140
81LS97	140

81LS98	120
8202	£25
8205	225
8212	300
8214	425
8216	390
8224	220
8226	250
8228	270
8236	00
8243	450
8250	950
8251A	440
8253	400
8255	950
8256AC	£36
8257-5	400
8253	395
8271	00
8272	£25
8279	440
8282	450
8283	450
8284	350
8288	00
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33	150
AY-3-1015	300
AY-5-1013	300
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DP8303	295
DP8304	250
DS3647	00
DS3691N	450
DS88LS120	595
DS8820	110
DS8830	110
DS8831	125
DS8832	250
E9364	800
E9365	£35
E9366	£35
FD1691	£15
FD1771	£15
FD1791	£22
FD1795	£28
HD26501	75
HM6845SP	755
IM6402	380
INS8060N	1050
MC1488	75
MC1489	75
MC14411	675
MC14412	725
MC3242	590
MC3446	250
MC3447P	315
MC3486	225
MC3487	225
IM6402	350
MC6845	625
MC6846	625
MK3886-2M	£7
MM5280D	696
MM5303	636
MM5307	1275
MM5387A	475
MM58174	700
MM74C922	420
RO-3-2513L	650
RO-3-2513U	650
SFF9364	800
SP0256	850

SPO256AL2	950
TMS2716-3V	725
TMS4047	100
TMS4164	395
TMS4416-2	475
TMS4500	£14
TMS4500	£14
TMS4532-3	350
TMS5100	600
TMS6011	500
TMS9927	£14
TMS9928	£20
TMS9929	£20
TMS9980	£20
TMS9995	£12
ULN2003	75
UPD7002	425
WD1691	£14
WD2143	975
Z80CPU 2.5	285
Z80ACPU 4M	375
Z80 CTC	285
Z8002CPU	00
Z80A CTC	335
Z80BCPU	£11
Z80 DART	698
Z80A DART	820
Z80B	£11
Z80 DMA	795
Z80ADMA	925
Z80 PIO	325
Z80A PIO	350
Z80 SIO-1	850
Z80A SIO	£9
Z80ASIO-2	£9

LINEAR ICs

555Cmos	105
702	75
709C 8 pin	35
710	48
741 8 pin	16
747C 14 pin	70
748C 8 pin	30
735 8 pin	185
810	158
9400CJ	375
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	400
Booklet for AY-3-8910	200
AY-3-8912	500
AY-5-1317A	630
AY-5-1350	366
CA3011	130
CA3012	175
CA3014	275
CA3018	85
CA3019	80
CA3020	210
CA3023	210
CA3028A	110
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3048	220
CA3059	325
CA3075	213
CA3080E	70
CA3081	180
CA3085	00
CA3086	60
CA3089E	200
CA3090AQ	375
CA3123E	165
CA3130	90

CA3140	45
CA3160	95
CA3161	160
CA3162	620
CA3189	275
HA1336W	175
HA1388	255
ICL7106	690
ICL7107	975
CA3085	00
ICL7611	99
ICL7660	248
ICL8038CC	300
ICL8211A	750
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216C	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	105
ICM7556	150
LA3550	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	320
LC7120	300
LC7137	350
LF347	150
LF351	48
LF353	90
LF355	95
LF356	99
LF357	110
LF398	495
LM10	350
LM301A	25
LM307	45
LM308T	95
LM311	65
LM318N	150
LM319	160
LM324A	50
LM334Z	90
LM335Z	135
LM337	00
LM339	40
LM348	64
LM349	125
LM358	60
LM377	215
LM379	495
LM380	90
LM381N	175
LM382	115
LM384	190
LM386	95
LM387	120
LM389	96
LM393	85
LM394	395
LM558	170
LM725CN	300
LM733	70
LM1458	35
LM1871	300
LM1889	350
LM2907	00
LM2917	200
LM3900	50
LM3909N	85
LM3911	150
LM3914	350
LM3915	350
LM3916	350
LM13600	125
LS7220	280
M706B1	150
MS1513L	230
MS1515L	320
MS1516L	475
MB3712	200
MB3756	440
MC1204	250
MC1301	90
MC1303	96
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1455	50
MC1458	35

MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	75
MC33040P	120
MC33060P	120
MC3340	145
MC33460	145
MC3401	50
MC3403	65
MC3404	85
MC3405	150
MC3422	00
MC3423	80
MC3442	00
MC3487	00
MC4016	00
MF10	350
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	140
NE543K	225
NE544	200
NE555	20
NE556	46
NE558	170
NE560	350
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	175
NE5534A	105
OM335	750
RC4136D	60
RC4558	60
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	585
SG3402	295
SL490	350
SL6270CD	150
SN76013	350
SN76023ND	240
SN76033	00
SN76227N	95
SN76477	470
SN76488	480
SP8629	350
SP0256AL	799
TA7120	140
TA7204	150
TA7205	80
TA7222	150
TA7310	125
TAA621AX1	296
TAA661A	190
TAA700	275
TAA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA920Q	200
TBA990Q	350
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	125
TDA1004	350
TDA1008	310
TDA1010	235
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	250
TDA2004	400
TDA2006	330

TDA2020	320
TDA2030	190
TDB0791	420
TL170	50
TL430C	90
TL507	110
TL509	110
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	35
TL072CP	54
TL074CN	100
TL081CP	30
TL082CP	46
TL083CP	75
TL084CN	90
TL091CP	56
UA2240	120
UA78540	230
ULN2003	75
ULN2004	75
ULN2283	100
UPC575	275
UPC1025H	375
UPC1156H	295
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	360
ZN414	90
ZN419E	180
ZN423E	130
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	480
ZN429E	210
ZN459	290
ZN1034E	200
ZN1040E	665
ZNA234E	925

TTL74

7400	20
7401	20
7402	20
7403	22
7404	35
7405	22
7406	125
7407	125
7408	25
7409	25
7410	25
7411	25
7412	25
7413	35
7414	50
7416	35
7417	35
7420	22
7421	22
7422	30
7423	30
7425	30
7426	45
7427	30
7428	30
7430	30
7432	60
7433	25
7437	30
7438	95
7440	25
7441	65
7442	55
7443	70
7444	65
7445	80
7446	78
7447	70
7448	75
7450	25
7451	25
7453	25
7454	25
7460	25
7470	35
7472	35

7473	35
7474	35
7475	60
7476	40
7480	55
7481	120
7482	100
7483	85
7484	90
7485	110
7486	40
7489	175
7490	40
7491	55
7492	45
7493	40
7494	80
7495	50
7496	60
7497	120
74100	100
74104	55
74105	55
74107	40
74109	50
74110	50
74111	60
74112	170
74116	100
74118	100
74119	105
74120	90
74121	40
74122	50
74123	80
74125	50
74126	50
74128	60
74132	60
74136	40
74141	75
74142	195
74143	200
74144	200
74145	80
74147	105
74148	105
74150	125
74151	50
74153	50
74154	100
74155	50
74156	50
74157	50
74159	130
74160	50
74161	50
74162	55
74163	55
74164	65
74165	65
74166	80
74167	200
74170	175
74172	280
74173	60
74174	100
74175	70
74176	50
74177	50
74178	80
74179	80
74180	50
74181	140
74182	55
74184	110
74185	110
74190	70
74191	75
74192	75
74193	60
74194	50
74195	50
74196	50
74197	50
74198	110
74199	110
74221	90
74246	120
74247	120
74248	175
74249	120
74251	55
74259	15
74263	75
74265	50

74273	170
74276	120
74278	120
74279	45
74283	65
74284	220
74285	180
74290	120
74293	75
74297	900
74298	100
74351	120
74365	60
74366	60
74367	60
74368	50
74376	90
74390	80
74393	120
74490	110

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	570
74C923	500
74C925	698

74S

S00	45
S02	45
S03	45
S04	60
S05	60
S08	60
S09	60
S10	40
S11	50
S15	60
S20	40
S22	50
S32	70
S37	60
S38	90
S40	45
S51	45
S64	45
S65	45
S74	75
S85	295
S86	85
S112	80
S113	90
S114	80
S124	300
S132	110
S133	60
S134	60
S135	110
S138	100
S139	115
S140	60
S151	180
S153	182
S157	225
S158	210
S163	300
S174	250
S175	320
S188	140
S189	140
S194	195
S197	400
S201	250
S225	240
S240	300
S241	250
S244	290
S251	170
S257	170
S258	250
S260	70
S262	850
S287	225
S288	210
S289	200
S301	350
S365	250
S373	400
S374	365

S412	380
S470	325
S471	620
S472	1150
S474	400
S475	800
S571	820
S573	950

74LS

LS00	30
LS01	18
LS02	18
LS03	18
LS04	45
LS05	18
LS08	40
LS09	18
LS10	30
LS11	25
LS12	20
LS13	30
LS14	45
LS15	25
LS19	00
LS20	30
LS21	25
LS22	25
LS24	50
LS26	25
LS27	30
LS28	20
LS30	35
LS32	50
LS33	25
LS37	25
LS38	60
LS40	25
LS42	40
LS47	50
LS48	50
LS49	60
LS51	25
LS52	25
LS54	25
LS55	25
LS63	55
LS73	50
LS74	60
LS75	40
LS76	30
LS78	40
LS83	45
LS85	70
LS86	34
LS90	30
LS91	60
LS92	35
LS93	35
LS95	40
LS96	80
LS107	40
LS109	40
LS112	40
LS113	35
LS114	35
LS122	60
LS123	120
LS124	150
LS125	45
LS126	45
LS132	40
LS133	40
LS135	28
LS136	30
LS138	60
LS139	60
LS145	80
LS147	120
LS148	110
LS151	50
LS153	50
LS154	150
LS155	35
LS156	35
LS157	45
LS158	35
LS160	50
LS161	50
LS162	50
LS163	85
LS164	55
LS165	65
LS166	120
LS168	140

LS169	90
LS170	100
LS173	100
LS174	60
LS175	90
LS181	110
LS183	110
LS190	55
LS191	50
LS192	55
LS193	55
LS194	45
LS195	45
LS196	55
LS197	55
LS221	90
LS240	120
LS241	100
LS242	75
LS243	75
LS244	250
LS245	250
LS247	65
LS248	65
LS249	65
LS251	45
LS253	40
LS256	175
LS257	45
LS258	40
LS259	120
LS260	35
LS261	150
LS266	30
LS273	120
LS275	165
LS279	45
LS280	175
LS283	45
LS290	45
LS292	900
LS293	45
LS294	999
LS295	70
LS298	70
LS299	160
LS320	180
LS322	200
LS323	185
LS324	150
LS325	150
LS326	290
LS327	290
LS347	65
LS348	125
LS352	65
LS353	65
LS356	180
LS363	175
LS365	45
LS366	45
LS367	45
LS368	45
LS373	180
LS374	180
LS375	80
LS377	120
LS378	85
LS379	100
LS384	475
LS385	180
LS386	50
LS390	60
LS393	120
LS395	85
LS396	300
LS398	120
LS399	100
LS445	125
LS447	50
LS465	140
LS490	110
LS540	100
LS541	120
LS624	150
LS629	150
LS640	200
LS641	200
LS645	200
LS668	60
LS669	60
LS670	120
LS673	000
LS674	800
LS678	275
LS682	250

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX	20
BY100	24
BY126	12
BY127	14
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	60

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	105

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	66
6A/100V	83
6A/400V	96
10A/200V	215
10A/600V	296
25A/200V	240
25A/600V	396
BY164	56
VM18 DIL	50

ZENERS

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

TRIACS

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

75 SERIES

75107/8	96
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75158	150
75159	195
75182/4	99
75188/9	75
75322	140
75324	360
75325	00
75361/3	150
75365	00
75450	86
75451/2	52
75454	70
75491/2	65

SCR THYRISTORS

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

DIAC

ST2	25

SWITCHES

TOGGLE 2A 250V

SPST	35p
DPDP	48p

SUB-MIN TOGGLE

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

SLIDE 250V:

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

PUSHBUTTON 6A
with 10mm Button

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

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch
Assorted Colours
75p each

ETI PROJECTS
We stock most parts

DIP SWITCHES

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

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way **48p**

ROTARY: Mains DP 250V 4 Amp on/off **68p**

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

WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 Way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**.

ROCKER SWITCHES

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

THUMBWHEEL Mini front mounting switches

Decade Switch Module	275p
B.C.D. Switch Module	298p
Mounting Cheeks (per pair)	75p

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	485p
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
36 inches	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36"

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

VEROBOARD 0.1in

2½ x 3¾	95p
2½ x 5	110p
3¾ x 3¾	110p
3¾ x 5	125p
3¾ x 17	420p
4¾ x 17	590p
Pkt of 100 pins	55p
Spot face cutter	150p
Pin insertion tool	185p

/A Board	195p
DIP Board	395p
Vero Strip	95p

PROTO DECs

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

VERO WIRING PEN

+ spool	340p
Spare spool	75p
Combs	8p

DALO ETCH RESIST PEN
Plus spare tip **100p**

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

ULTRASONIC TRANSDUCER
40KHz **350 pr**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double sided	S R B.P S. Speed
6" x 6"	100p	125p	9.5" x 8.5"
6" x 12"	175p	225p	110p

DILL SOCKETS

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

EDGE CONNECTORS

2x6 way	—	111p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	210p	175p
2x22 way	215p	250p
2x23 way	175p	—
2x25 way	285p	275p
2x28 way	190p	—
2x30 way	310p	—
2x36 way	360p	—
2x40 way	380p	—

SIL SOCKET 0.1" Pitch 20 way **65p**

ANTEX SOLDERING IRONS

C15W	510p;	CS17W	525p
C18W	530p;	XS25W	545p
Spare Bits	85p;	Elements	230p
Iron Stand	175p;	Heat Shunt	30p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	236p	160p	320p
40 way	220p	250p	180p	340p
50 way	235p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Socket Strt Pins	Female Socket Angle Pins	Male Plug Strt Pins	Male Plug Angle Pins
DIN41617 31 way	170p	—	—	175p
DIN41612 2 x 32 A + B	275p	320p	220p	285p
DIN41612 2 x 32 A + C	295p	340p	240p	300p
DIN41612 3 x 32 A + B + C	360p	385p	280p	395p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	90p
16 pin	48p	105p
24 pin	88p	178p
28 pin	290p	295p
40 pin	250p	255p

RIBBON CABLE
price per foot

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

ZIF DIL SOCKETS

24 pin	565p
28 pin	750p
40 pin	845p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	80p	105p	160p	250p
Angle pins	150p	210p	250p	355p
PCB pins	120p	130p	195p	295p
Female				
Solder lugs	105p	160p	200p	335p
Angle pins	165p	215p	290p	440p
PCB pins	150p	180p	240p	420p
COVERS	80p	75p	75p	90p

IDC 25 way 'D' Plug **385p**, Socket **450p**

25 way 'D' CONNECTOR (RS232)
Jumper Lead Cable Assembly

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

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	475p	470p
36 way Centronix	450p	475p
24 way Female	525p	490p

PANEL METERS

FSD
60 x 46 x 35mm
0–50mA
0–100mA
0–500mA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0 aA
0.2A
0.25V
0.50V AC
0.300V AC
"S"
"VU" **490p each**

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	265
455KH	370
1MHz	275
1.008M	275
1.28MHz	390
1.6MHz	395
1.8MHz	515
1.8432M	250
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	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
6.5538MHz	225
7.0MHz	150
7.168MHz	250
7.7328MHz	250
7.68MHz	200
8.0MHx	150
8.089333M	395
8.86723M	220
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	175
12.528M	300
14.31814M	170
15.0MHz	240
16.0MHz	220
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295
116.0MHz	300

RELAYS

Miniature, enclosed, PCB mount

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

DOUBLE POLE Changeover 6A 30V DC or 250V AC
RL-100 53R Coil 6V DC (5V4 to 9V9) **190p**
RL6-111 205R Coil 12V DC (10V7 to 19V5) **195p**
RL6-114 740R Coil 24V DC (22V to 37V) **200p**

ASTEC UHF MODULATORS

Standard 6MHz	325p
Wideband 8MHz	450p

BUZZERS

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

LOUDSPEAKERS
Miniature, 0.3W 8

2in, 3¼in, 2½in, 3in	80p
2½in 40, 64 or 80	80p

MONITORS

- ZENITH — 12" Green, Hi-Resulution Popular **£75**
- MICROVITEC 1431, 14" Colour RGB input. Connecting cable incl **£189**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£199** (car £7)
- KAGA 12". As above but Hi-Resolution **£259** (car £7)
- Connecting Lead for KAGA **£5**

Carriage £7 Securicor

BROTHER HR15 PRINTER

High quality Daisy Wheel Printer, 18CPS, Bidirectional, 3K Buffer, Proportional spacing, Underlining, Bold print and Shadow print. Centronics & RS232 interface standard. Carbon & Fabrick ribbon, Red & Black print.

Only: £349

TRANSFORMERS

3-0-3V, 6-0-6V; 9-0-9V, 12-0-12V; 15-0-15V @ 100mA **98p**
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A, 2x12V-0.12A; 2x15V-0.1A **200p**
6VA: 2x6V-0.5A, 2x9V-0.3A, 2x12V-0.25A, 2x15V-0.2A **270p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **250p**
12VA: 2x4.5V-1.3A, 2x5V-1A; 2x9V-0.6A, 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **345p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A, 2x12V-1A; 2x15V-0.8A, 2x20V-0.6A **385p** (60p p&p)
50VA: 2x6V-4A, 2x9V-2.5A, 2x12V-2A, 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A, 2x30V-0.8A **520p** (60p p&p)
Specially wound for Multirail computer PSUs
50VA: Outputs +5V/5A +12V, +25V −5V, −12V at 1A **620p** (60p p&p)
100VA: 2x12V-4A, 2x15V-3A, 2x20V-2.5A; 2x25V-2A, 2x30V-1.5A, 2x50V-1A **965p** (75p)

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

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	45p	7905	45p
12V	7812	50p	7908	60p
15V	7815	45p	7912	45p
18V	7818	45p	7915	45p
24V	7824	45p	7918	45p
			7924	45p

100mA TO92 Plastic package

5V	78LO5	30p	79LO5	50p
6V	78LO6	30p	—	—
8V	78LO8	30p	—	—
12V	78L12	30p	79L12	50p
15V	78L15	50p	79L15	60p

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

SOLDERCON PINS

Ideal for making SIL or DIL Sockets

100 pins	75p
500 pins	350p

ALUM BOXES

3 x 2 x 1"	85p
4 x 2½ x 2"	100p
4 x 2½ x 2½"	103p
4 x 4 x 2"	105p
4 x 4 x 2½"	120p
5 x 4 x 1½"	99p
5 x 4 x 2½"	120p
5 x 2¾ x 1½"	90p
5 x 2¾ x 2½"	130p
6 x 4 x 2"	120p
6 x 4 x 3"	150p
7 x 5 x 3"	180p
8 x 6 x 3"	210p
10 x 4 x 3"	240p
10 x 7 x 3"	275p
12 x 5 x 3"	280p
12 x 8 x 3"	295p

CMOS

		4072	25	4538	80
		4073	26	4539	90
4000	20	4075	25	4541	95
4001	20	4076	68	4543	70
4002	22	4077	25	4544	150
4006	65	4078	25	4548	40
4007	22	4081	25	4549	400
4008	48	4082	25	4553	245
4009	33	4085	60	4554	180
4010	33	4086	60	4555	35
4011	22	4089	125	4556	55
4012	25	4093	37	4557	250
4013	60	4094	70	4558	120
4014	80	4095	95	4559	395
4015	60	4096	100	4560	180
4016	40	4097	275	4561	104
4017	60	4098	80	4562	350
4018	60	4099	110	4566	165
4019	58	4160	95	4568	250
4020	90	4161	96	4569	175
4042	43	4162	96	4572	45
4021	58	4163	96	4580	255
4022	67	4174	96	4581	125
4023	30	4175	105	4582	99
4024	50	4194	105	4583	100
4025	22	4408	850	4584	40
4026	90	4409	850	4585	70
4027	43	4410	725	4597	330
4028	45	4411	750	4599	155
4029	60	4412	805	40085	90
4030	35	4415	590	40097	45
4031	130	4419	280	40098	42
4032	70	4422	770	40100	215
4033	130	4435	850	40101	130
4034	146	4440	900	40102	140
4035	70	4450	360	40103	412
4036	275	4451	350	40104	120
4037	115	4490	450	40105	220
4038	75	4500	395	40106	38
4039	280	4501	38	40107	38
4040	60	4502	60	40108	198
4041	57	4503	40	40109	100
4042	50	4504	99	40110	175
4043	42	4505	385	40114	240
4044	50	4506	100	40161	194
4045	110	4507	45	40163	50
4046	60	4508	130	40174	45
4047	60	4510	55	40175	50
4048	55	4511	55	40181	220
4049	38	4512	55	40182	80
4050	35	4513	150	40192	75
4051	45	4514	115	40193	95
4052	60	4515	115	40194	70
4053	60	4516	55	40195	75
4054	85	4517	275	40244	196
4055	85	4518	48	40245	196
4056	85	4519	32	40257	196
4057	1000	4520	53	40373	180
4059	435	4521	115	40374	180
4060	68	4522	125	45106	586
4061	500	4526	60		
4062	986	4527	65		
4063	85	4528	50		
4066	45	4529	150		
4067	245	4530	90		
4068	25	4531	130		
4069	25	4532	65		
4070	25	4534	400		
4071	25	4536	275		

OPTO

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

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2" Red	12
2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	65
Green/Yellow	78
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	58
High-Bri Green or Yel	68
Flashing red 0.2" red	55
Square LEDs. Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yellow	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH, Red 10 segments	275

ISOLATORS

ILD74	115
ILQ74	220
TIL11/2/4	70
ILCT6 Darlington	135
4N33 Photo Darlington	136

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	170
SLOTTED Optical Switch similar to RS Comp.'s	195

COMPUTER CORNER

- **EPSON RX80 PRINTER: 100 CPS,** 9 x9 matrix, dot addressable graphics, condensed & double width printing, Normal, Italics & Elite Char., Tractor Feed, Bidirectional, Logic seeking £235
- **RX80 F/T Epson Printer.** As above but has both Tractor and Friction feed facilities £259
- **EPSON FX80 PRINTER 10"** Tractor & Friction Feed, 160 CPS, bi-directional Logic seeking, 9 x 11 matrix, hi-res bit image, Normal, Italic & Elite Char. Super & Subscript. Proportional spacing £345
- **SEIKOSHA GP100A.** 10" Tractor Feed, 80 Colmn. 30CPS, Normal and Double width Char. Dot Res Graphics £144
- **SEIKOSHA GP250X.** 10", 50 CPS, Normal and Double width and height Char. RS232 and Centronix Intrl. standard .... £199 (£7 car)
- Printer Cable for our printers and BBC MICRO £12
- **TEX EPROM ERASER** Erases up to 32 ICs in 15-30 minutes £33
- **TEX EPROM ERASER** with a safety switch £35
- **SPARE 'UV' Lamp bulb** £8
- C12 COMPUTER GRADE CASSETTES in library cases 40p
- 8½" & 9½" Fan Fold paper (1000 sheets) .... £7 + 150p carr

Call in at our shop for demonstration. Be satisfied before you buy or write in for our descriptive Micro Peripherals Leaflet.

FLOPPY DISC DRIVES 5¼"

(BBC Compatible)

- **CS100** — Single Cased with PSU, 40 track, 5¼" S/S 100K £145
- **CD200** — Twin Cased with PSU, 40 Track, 5¼" S/S 200K £275
- **CS200** — Single Cased with PSU, 80 Track, 5¼" S/S 200K £210
- **CD400** — Twin Cased with PSU, 80 track, 5¼" S/S 400K £365
- **MITSUBISHI 5¼" SLIM LINE DISC DRIVES** Double Sided, Double Density. Track Density 96 TPI, Track to track access time 3msec.
- **MITSUBISHI Single Slimline.** 5¼" Cased with PSU DSDD, 1 Megabyte (400 K with BBC) £259
- **MITSUBISHI Twin Slimline,** 5¼" Cased with PSU. DSODD 2 Megabyte (800 K with BBC) £425

5¼" DISKETTES (Lifetime Warranty)

- **10 3M Diskettes Single side Double density** £17
- **10 3M Diskettes Double side Double density** £27

N.B Carriage on Drives £7 securicor

SPECTRUM 32K UPGRADE

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

£22

BBC SPEECH SYNTHESISER Unit	£44
BBC EPROM PROGRAMMER	£89
BBC 13 ROM SOCKET Board	£33
BEEBFONT ROM	£39
BEEBMON ROM	£19
BBC DISASSEMBLER ROM	£16
EPSON DUMP ROM	£16
DISC-DATA Database on Disc	£15

BBC & MICROCOMPUTER & ACCESSORIES

Model A .... **£299** Model B **£399** (incl VAT)

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

NEXT MONTH

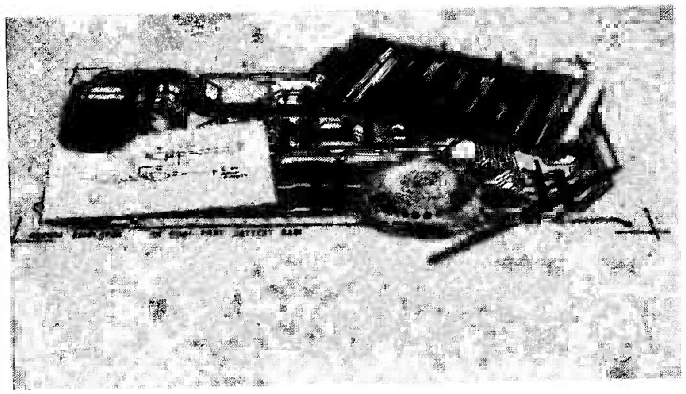
AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

Accept an Imitation!

Next month we shall be asking all our readers to accept an imitation — not for ETI, because we know that would never satisfy you — but for the common-or-garden EPROM. The project concerned is an EPROM emulator, and it is designed to work using a very large variety of host computers.

The idea of an EPROM emulator is that you should plug it into a system (which could be any sort of digital circuit, not just a microcomputer) in the place of an EPROM; to the circuit, the system 'looks like' an EPROM; however, the emulator is linked to a host computer, and this can be used to modify the emulator contents, with the minimum of fuss. Once you've got the data you want in the emulator, all you do next is to program this into your EPROM using the ETI EPROM programmer — couldn't be simpler, could it?



Communications Satellites

The first communications satellite — Telstar — was successfully launched over 20 years ago. There was, at the time, a popular 'hit', record by the Tornadoes, named after Telstar! Nowadays, satellite communications seem more mundane — do many people realise that, sometimes, when they dial a foreign number, their call will be going through space? Next month we'll be taking a look at the technology involved in satellite communications.

MOSFET Power Amplifier

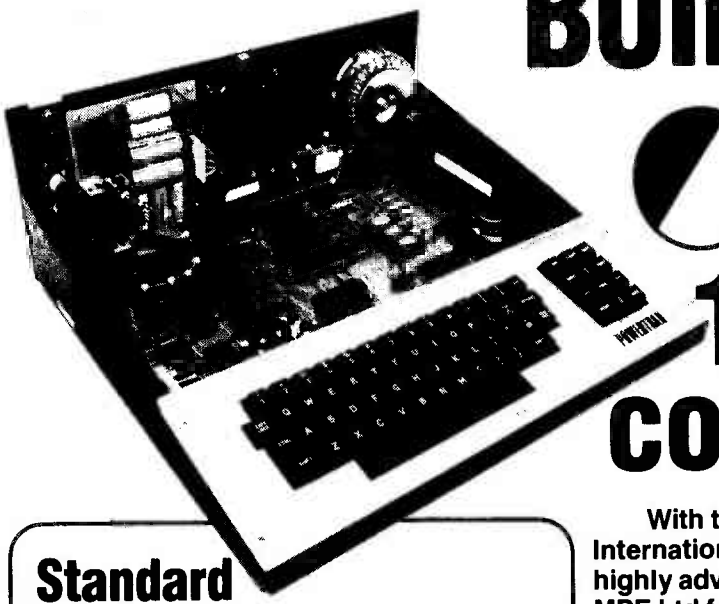
As you will see on page 24, John Linsley Hood has commenced his description of the 'Audio Design' amplifier system with the preamp section. Next month it will be the turn of the power amplifier . . . can the Editor's neighbours possibly wait until then?

Security

The July issue of ETI has been designated a 'Security Special', and this means that there will be features and projects aimed at helping you make your house or flat — and car — more protected from unwelcome attention. We hope to arrange a couple of rather good readers' offers, but details of these are still under negotiation as we go to press.

ALL IN THE JULY ISSUE OF ETI — ON SALE FRIDAY JUNE 1st. PLACE YOUR ORDER NOW OR RISK MISSING OUT!

BUILD YOUR OWN cortex 16bit,64k RAM colour computer



With this powerful machine (featured in Electronics Today International as a constructional project) you have access to highly advanced systems and software developed specially by MPE Ltd for the CORTEX. For business, education, R & D – or simply increasing your knowledge and understanding of computers – it beats comparably priced off-the-shelf machines hands down!

STATEMENTS	PRINT	TIME	RENUM	MAG	MWD	:	( )	INT	POS
IF	;	WAIT	BOOT	TOF	BASE	@	[]	LOG	COL
ELSE	?	SAVE	GRAPH	TON	**COMMANDS**	#	**FUNCTIONS**	SQR	MOD
ON	'	LOAD	TEXT	DIM	RUN	:	FNA-FNZ	SYS	RND
GOTO	1 UNIT	MOTOR	PLOT	LET	SIZE	?	ABS	TIC	KEY
GOSUB	BAUD	ESCAPE	UNPLOT	DEF	CONT	%	ADR	SGN	**OPERATORS**
POP	CALL	NOESC	COLOUR	NEW	MON	$	ASC	BIT	OR
REM	DATA	RANDOM	CHAR	END	**DELIMITERS**	,	ATN	CRB	LOR
FOR	READ	ENTER	SPRITE	BIT	TO	!	SIN	CRF	AND
NEXT	RESTOR	LIST	SHAPE	CRB	TAB	&	COS	MEM	LAND
ERROR	RETURN	PURGE	SPUT	CRF	STEP		EXP	MWD	NOT
INPUT	STOP	NUMBER	SGET	MEM	THEN		FRA	LEN	LNOT
								MCH	LXOR

= =	
=	
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>=	
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<>	
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+	
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^	

Standard features –

- High speed 24K byte extended basic interpreter
- Powerful TMS9995 16 bit microcprocessor
- 48 bit floating point gives 11 digit accuracy
- High resolution (256 x 192) colour graphics
- Screen memory does not use up user memory space
- 16 colours available on the screen together in graphic mode
- Fast line drawing and point plotting basic commands
- High speed colour shape manipulation from basic
- Full textual error messages
- String and Array size limited only by memory size
- Real time clock included in basic
- Interval timing with 10mS resolution via TIC function
- Named load and save of basic or machine code programs
- Auto-run available for any program
- Powerful machine code monitor
- Assembler and Disassembler included as standard
- Auto line numbering facility
- Full renumber command
- Simple but powerful line editor
- Flexible CALL statement allows linkage to machine code routines with up to 12 parameters
- Basic programs may contain spaces between key words to make programs readable without using more memory
- Over 34K bytes available for basic programs
- Extended basic includes IF-THEN-ELSE
- Interfaces for screen and cassette included.
- Supports bit manipulation of variables from basic
- Error trapping to a basic routine included
- Basic supports Hexadecimal numbers
- Separate 16K video RAM for graphics

Self assembly kit

£295

All prices exclusive of VAT. Carriage paid.

Optional Extras

Floppy disc interface electronics	**£86.50**
Hardware kit & connectors for disc drives	**£49.50**
RS232C interface kit	**£9.20**
Pair of 5¼" disc drives (SS)	**£300.00**
Pair of 5¼" disc drives (DS)	**£590.00**

Full assembly instructions and 216 page users manual.

All goods subject to availability.

POWERTRAN cybernetics ltd.

Portway Industrial Estate, Andover SP10 3ET. Tel: 0264 64455

to POWERTRAN CYBERNETICS LTD, Portway Industrial Estate, Andover, Hants SP10 3ET.

Please send me _____

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I enclose cheque for _____ or charge to: Access VISA

Access/ Barclaycard A/C No. _____

Allow 21 days for delivery

Name _____

Address _____

_____ Tel. _____

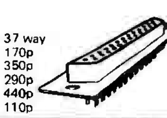
Rapid Electronics

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

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p



CONNECTORS

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

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . . 38p
Socket free hanging . . . 60p
Socket with 2m lead . . . 120p

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

VOICE SYNTHESISER!

Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesize speech. Allophone (extended phoneme) system gives unlimited vocabulary.
Easily interfaced with any digital system; ten TTL compatible signals are used to select the allophones.
SP0256 . 850p. Data: 50p.

SOLDERING IRONS

Antex CS 17W Soldering iron	495
2.3 and 4.7mm bits to suit	85
CS 17Wor XS 25W element	210
Antex XS 25W	525
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22swg solder	100

VERO

Verobloc ◀	375
Veroboard Size 0.1 matrix	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
New size 3.75 x 17	330
New size 4.75 x 17	415
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	130
Pin insertion tool	162
Wiring pen	330
Spare spool 75p Combs	6

SWITCHES

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

MICRO

2114L2	200	6116P3	600	6852	240	8228	220
2716	295	6502CPU	325	6875	495	8251	250
2532	290	6522VIA	295	6880	100	8253	390
27128-25	2150	6532	570	81LS95	85	8255	225
2732	350	6551 ACIA	650	81LS96	85	8259	390
2764-250	650	6800CPU	220	81LS97	85	MC1488	55
4116P20	85	6802CPU	250	8080A	250	MC1489	55
		6809CPU	620	8085AC	340	Z80ACPU	290
		6810RAM	115	8156	350	Z80APIO	260
		6821 PIA	110	8212	110	Z80ACTC	260
		6840	360	8216	100	Z80ASIO	900
		6850	110	8224	120	Z80ADMA	1150

SOCKETS

SOCKETS	Low profile	Wire-wrap
8 pin	6p	28p
14 pin	8p	45p
16 pin	9p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	16p	75p
24 pin	18p	82p
28 pin	23p	95p
40 pin	25p	135p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . . . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

CABLES

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

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

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	78H05	550
LM317T	90		
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mWzen	6
▶1N4148	3	1.3W zeners	13

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
ILD74	95	ILQ74	185
▶TIL38	40	TIL100	70
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100

10 bar DIL LED display, red 180.
LCD: 3½ digit 495p. 4 digit 520p.

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	30
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

EURO CONNECTORS

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

TRIACS

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

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP(header plug) jumper				
24 ins.	145	165	240	380
Dble ended DIP(header plug) jumper				
6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

COMPUTER CONNECTORS

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

RIBBON CABLE

Grey Ribbon cable. Price per foot

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

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p, 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p, 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

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

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	90	90	85	120
16 way	130	130	110	175
20 way	145	145	125	195
26 way	175	175	150	240
34 way	205	205	170	320
40 way	220	220	190	340
50 way	235	235	200	395
60 way	330	330	230	495

LINEAR

				LM339	40	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	225	▶NE567	100	TL071	30
				LM358	50	LM3915	225	▶NE570	370	TL072	45
555CMOS	80	ICL7106	680	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	75	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	40	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	90
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	90	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	70
AY-3-8910	370	ICM7555	80	LM393	40	ML926	140	SPO256AL2	850	ULN2004	70
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	80
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	325	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	50	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	140	TDA1008	320	ZN426E	300
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	600
CA3161E	100	LM324	30	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	410
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	100	LM335Z	125	▶LM3909	75	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

				BC517	40	BF337	40	MPSU56	60	ZTX108	10	2N3055	50
				BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	8
		BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	30	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	8
AC127	30	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
AC128	30	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	20
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	8
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	10	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	50	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	10	2N3054	55		

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 10M . . . 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each.
¼W 1% metal film E24 series 10 ohm - 1M . . . 6p each.

CRYSTALS

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

BOXES

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid		4 x 2¾ x 1½"	95
& screws		4 x 2½ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

		4016	30	4034	140	4054	78	4081	16	40193	90	4528	45
		4017	40	4036	270	4055	80	4082	16	4502	60	4529	150
		4018	50	4039	280	4059	430	4085	50	4503	35	4532	60
4000	16	4019	45	4040	40	4060	55	4086	50	4507	32	4534	400
4001	16	4020	50	4041	45	4063	80	4089	125	4508	120	4538	70
4002	16	4021	45	4042	38	4066	30	4093	28	4510	45	4543	60
4006	50	4022	50	4043	40	4067	240	4094	70	4511	40	4549	390
4007	16	4023	16	4044	45	4068	16	4095	95	4512	40	4553	215
4008	40	4024	40	4046	50	4069	16	4097	290	4514	115	4555	35
4009	30	4025	16	4047	50	4070	16	4098	70	4515	115	4556	35
4010	30	4026	85	4048	45	4071	16	4099	70	4516	55	4559	390
4011	16	4027	30	4049	30	4072	16	40106	35	4518	45	4560	140
4012	16	4028	45	4050	30	4073	16	40109	100	4520	45	4584	35
4013	30	4029	50	4051	40	4075	16	40163	50	4521	90	4585	60
4014	45	4030	16	4052	50	4076	65	40173	100	4526	60	4724	140
4015	50	4031	130	4053	50	4077	16	40175	50	4527	50		

LS TTL

		LS20	20	LS75	35	LS123	65	LS160	57	LS197	70	LS353	85
		LS21	20	LS76	25	LS125	33	LS161	57	LS221	70	LS365	38
		LS22	20	LS78	25	LS126	33	LS162	57	LS240	90	LS366	38
LS00	18	LS26	20	LS83	60	LS132	48	LS163	57	LS241	90	LS367	38
LS01	18	LS27	20	LS85	75	LS136	32	LS164	60	LS242	90	LS368	38
LS02	18	LS30	20	LS86	28	LS138	50	LS165	75	LS243	90	LS373	100
LS03	18	LS32	18	LS90	43	LS139	50	LS166	105	LS244	85	LS374	100
LS04	18	LS37	20	LS92	43	LS145	80	LS170	120	LS245	140	LS375	50
LS05	18	LS38	20	LS93	43	LS147	130	LS173	90	LS247	78	LS377	110
LS08	18	LS40	20	LS95	50	LS148	105	LS174	50	LS251	50	LS378	100
LS09	18	LS42	55	LS96	105	LS151	75	LS175	70	LS257	50	LS390	75
LS10	18	LS47	68	LS107	36	LS153	75	LS190	55	LS258	50	LS393	75
LS11	18	LS48	68	LS109	36	LS155	50	LS191	55	LS259	120	LS399	100
LS12	18	LS51	20	LS112	36	LS156	54	LS192	75	LS266	28	LS541	120
LS13	30	LS55	20	LS113	30	LS157	40	LS193	75	LS273	90	LS670	135
LS14	50	LS73	25	LS114	30	LS158	42	LS195	50	LS279	50		
LS15	20	LS74	25	LS122	50			LS196	70	LS283	58		

TTL

		7413	33	7444	70	7483	65	74122	50	74163	80	74192	120
		7414	48	7446	80	7485	100	74123	78	74164	90	74193	110
		7416	32	7447	85	7486	33	74125	40	74165	50	74194	80
7400	18	7417	32	7448	80	7489	165	74126	40	74167	200	74195	60
7401	18	7420	18	7450	22	7490	50	74132	55	74170	200	74196	110
7402	18	7421	22	7451	22	7491	60	74141	75	74173	100	74197	90
7403	18	7422	30	7453	22	7492	50	74145	80	74174	100	74198	180
7404	20	7427	30	7454	22	7493	50	74147	130	74175	80	74199	180
7405	20	7428	30	7460	22	7494	75	74148	110	74176	80		
7406	48	7430	20	7472	28	7495	60	74150	130	74177	80		
7407	48	7432	24	7473	35	7496	60	74153	60	74179	80		
7408	20	7433	25	7474	33	7497	120	74154	120	74180	85		
7409	20	7437	30	7475	55	74100	120	74157	70	74181	220		
7410	20	7438	30	7476	40	74107	35	74160	90	74182	80		
7411	20	7440	22	7480	45	74109	55	74161	80	74190	120		
7412	20	7442	60	7482	80	74121	38	74162	80	74191	120		

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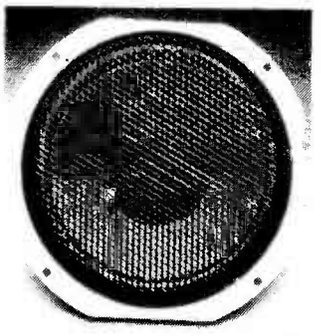
DIGEST

Speakers Corner

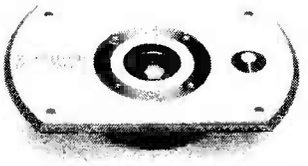
Compact loudspeakers are not, on the whole, noted for their extended bass response, and many owners of such systems must have sought ways to overcome this deficiency without going to the expense and trouble of purchasing larger loudspeakers. One solution is to add a single sub-bass unit, the idea being that, since very little directional information is carried at low frequencies, a single unit can handle the bass from both channels of a stereo system without serious loss of stereo imaging. The drawback with this approach is that a bass driver in a reasonably large cabinet is likely to be far more sensitive than the main loudspeakers, small systems being notoriously inefficient, resulting in a very poor balance across the frequency range. The only sure way to restore the balance is to use an active crossover and a second amplifier, thus greatly increasing the cost and complexity of the system.

With this problem in mind, Volt loudspeakers have introduced two new drive units whose sensitivity is tailored to match that of such popular small 'speaker systems as the LS3/5a (which sounds like a long-winded way of saying that they are not very sensitive), and which have dual voice coils so that the amplifier outputs can be combined using only simple crossover networks. The 8" DVC220DS is designed to be



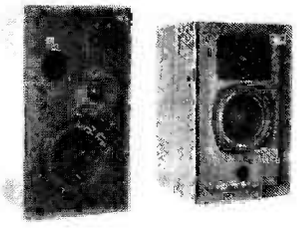
mounted directly into a wall or into a conventional loudspeaker enclosure. The 10" DVC250 offers a more extended bass response and is designed to be mounted in a conventional enclosure only, and both types can be supplied with or without fitted grilles. They are available from Wilmslow Audio, who can also supply computer optimised tuning details to suit your chosen cabinet volume.

Also available from Wilmslow are three new additions to the Wharfedale Speakercraft range of designs for the home constructor. They are the L50, L90B and L140 models, two way systems of 11, 17 and 20 litres respectively, all featuring the ferrofluid T/02/2 ¾" tweeter. They are all of 8 ohms



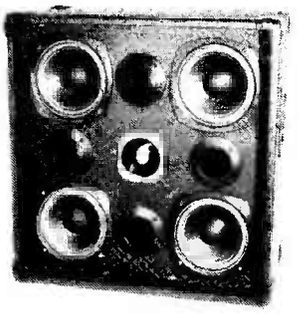
impedance, a change from the 6 ohms which has long been Wharfedale's standard for small 'speakers, and the full Speakercraft manual is available free-of-charge from Wilmslow.

Other recent additions to the range of products stocked by Wilmslow Audio are six new Loudspeaker kits and a novel high power, high efficiency PA loudspeaker, both using drive units manufactured by Peerless of Denmark. Wilmslow have been appointed UK distributors for Peerless, and the new kits employ four



polypropylene bass units which have not previously been available to the home constrictor, a 5" a 6½", an 8" and a 10". Full details of the new range, two of which are said to have been designed specifically for use in digital audio systems, are contained in the Peerless Manual For Loudspeaker Constructors which is available from Wilmslow, and a review of one of the new models appears elsewhere in this issue.

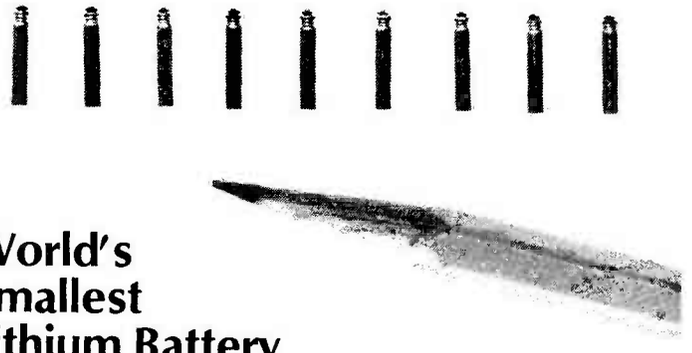
The new PA loudspeaker uses four high power 8" drive units and a bullet tweeter in an unusual



reflex configuration, and will handle 250 watts RMS with, it is claimed, high quality and very high efficiency. Suggested applications are folk bands, overhead disco 'speakers and side fill on large PA rigs, and it can be purchased as a kit with or without cabinet. For details of any of the items listed, send a 12" x 9" SAE to Wilmslow Audio Ltd, 35-39 Church Street, Wilmslow, Cheshire, tel 0625 - 529599.

Movits

Prism Consumer Products has launched a range of kit form electronic robots which they call Movits. There are five models in the range of varying complexity and with progressively more sophisticated guidance and sensory systems. They are all battery powered, making them safe for use by children, and Prism say the assembly instructions are so comprehensive that the whole family can take part in the construction. They cost from £9.99 to £34.99 and further information can be obtained from Prism Technology Holdings Ltd, Prism House, 18-29 Mora Street, City Road, London EC1V 8BT, tel 01-253 2277.



World's Smallest Lithium Battery

Matsushita have developed what they claim is the smallest pin-type lithium battery in the world. Designated the BR211, the new battery is rated at 3V, 5.4 mAh, measures 2.2 mm diameter by 11 mm high and weighs just 90 mg.

The BR211 has a poly-carbon monofluoride cathode and a lithium anode, and is specified for use over the temperature range −10 C to +60 C. Mutsushita say that the advantages of using a lithium battery are that it maintains a constant operating voltage when loaded, has a long shelf life and offers twice the voltage of silver-oxide and mercury cells, allowing a single battery to be used to light an LED. The new battery will initially be marketed for use in small fishing floats which have LEDs for night-time fishing, but Matsushita expect it to be widely adopted for use in wrist watches, calculators, microphones, hearing aids, etc.

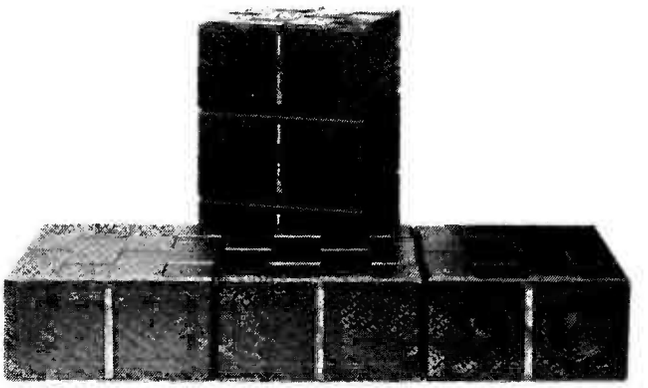
Panasonic UK Limited, 300-318 Bath Road, Slough, Berkshire SL1 6JB, tel 0753-34522.

See Hear

For reasons best known to themselves, Pioneer have decided that it is not enough for loudspeakers just to occupy space and annoy the neighbours. They want them to do useful things too. Why else would they attach a section of bathmat to front of their Decor'speakers and advertise them as bulletin boards?

Pioneer claim that the new loudspeakers are practical and attractive home accessories. They are available with either a cork facia for use as bulletin boards or with a glass panel behind which photos, etc, can be mounted. There is a lot in the press release about changing attitudes to home entertainment and narrowing the gap between home accessories and home entertainment, but precious little about how the new units perform as loudspeakers. All we are told is that they have a 140mm woofer, a 66 mm cone tweeter and can handle 60 watts music power. They cost £159.90 and should be in the shops by the time this issue appears.

Also new from Pioneer is a modular loudspeaker system called Adlib. Each 'speaker consists of three separate units which can be stacked on top of one another, side by side, or dispersed around the room to your taste. One unit contains a 66 mm tweeter and a 100 mm mid-range unit while the other two boxes contain rectangular, flat-diaphragm bass drivers. The crossover is contained in one of the two bass cabinets and further wiring carries the signal from it to the other two units. The cases come in a choice of silver or black finish and have an alternately raised and recessed surface pattern which is both decorative and allows them to interlock when stacked. The S-7MS (silver) and S-7MB (black) cost £289.90 and again, should be in the shops by the time this issue appears.



EHT-Insulated Tools

Toolrange have introduced a small range of handtools with double sheathing which provide electrical insulation up to 10,000 volts. The double sheath is bonded to the tool so that it cannot be removed in normal use, and the insulation and bonding properties remain constant over the temperature range −20 C to +60 C. Toolrange do not specify the tools available with this insulation and they point out that the range is limited, but they also say that virtually any tool can be double sheathed if required, presumably to special order. The 10,000 volt insulated tools are described in the 1983/84 Toolrange catalogue, along with over 3,000 other tools and production aids. Toolrange Ltd, Upton Road, Reading, Berkshire RG3 4JA, tel 0734-22245.

Gallium Arsenide ICs

Harris Microwave Semiconductor claim to have produced the world's first commercially available digital integrated circuits based on gallium arsenide (GaAs) technology. They will operate at up to five times the processing speed of the fastest silicon-based integrated circuits available today.

The new products are the first of a comprehensive family of GaAs integrated circuits being developed by Harris. They claim that the speed limitations of silicon in high-frequency communications equipment and very-high-speed computer systems are now being reached, and that the availability of GaAs-based equivalents opens up important new performance horizons.

Harris produces GaAs crystal material in-house to ensure the control of quality and technical performance. The company recently brought on-line the world's largest high-purity gallium arsenide ingot-growing capacity, which is producing single-crystal GaAs ingots up to five inches in diameter and 10 kgm in weight.

The first two devices in Harris' new family of GaAs digital integrated circuits are the HMD-11141-1, a four-bit universal shift register, and the HMD-11016-1, a divide-by 2/4/8 binary counter. A key design principle of this new Harris family is that all circuits are compatible in their signal levels, not only within the family but with the fastest available ECL silicon devices. This will allow access to slower speed circuitry for the less speed-critical portions of a system's processing task.

The GaAs shift register performs the standard operations of shift left, shift right, parallel outputs and hold, accepting either serial or parallel inputs. It operates with clock inputs of 1.4 GHz typical, and 1.0 GHz minimum. Silicon-based ECL products with similar functions operate at under 500 MHz. The GaAs binary counter provides simultaneous synchronous outpus at 1/2, 1/4 and 1/8 the data rate input, working with clock speeds of 2.2 GHz typical.

For further information contact Ralph Kaplan, Harris-MHS Semiconductor, 153 Farnham Road, Slough, Berkshire SL1 4XD, tel 0753 34666.

● The South Warwickshire College of Further Education is running a series of adult summer school courses from the 23rd to the 27th of April, including one entitled 'Hobby Electronics'. The course assumes no previous knowledge but promises advanced projects for the more adventurous, materials and tools provided, and the cost is £75. Details from Graham Winton, South Warwickshire College of Further Education, The Willows North, Alcester Road, Stratford-upon-Avon CV37 9QR, tel 0789-66245.

● Business Information company Dun and Bradstreet Ltd tell us that 189 electrical companies went into liquidation in the first quarter of this year, four more than in the previous quarter but 4% less than in the same quarter last year. There were 28 bankruptcies among firms, partnerships and individuals in the industry, 1 less than in the previous quarter but 9 more than in the same quarter last year.

● The University of Strathclyde are running a four-day course entitled "The Principles of Optical Systems" from the 19th to the 22nd June this year. The course is aimed at technical managers, engineers and recent graduates who plan to carry out research in this field, and the cost will be £445 less £50 for those who do not wish to take part in the laboratory work. Details from Katrina Flack, Department of Electronic & Electrical Engineering, University of Strathclyde, Royal College building, 204 George Street, Glasgow G1 1XW, tel 041-552 4400 extension 2543.

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VIDEO MONITORS

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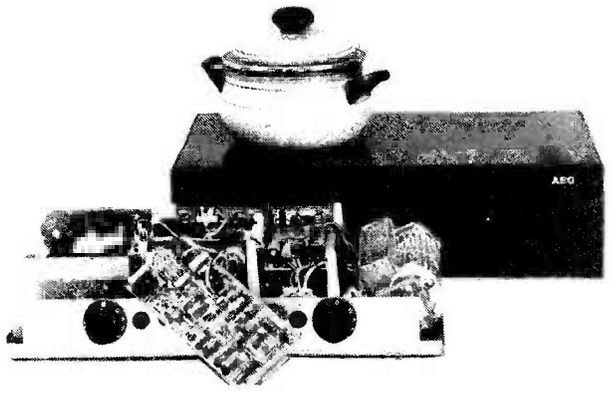


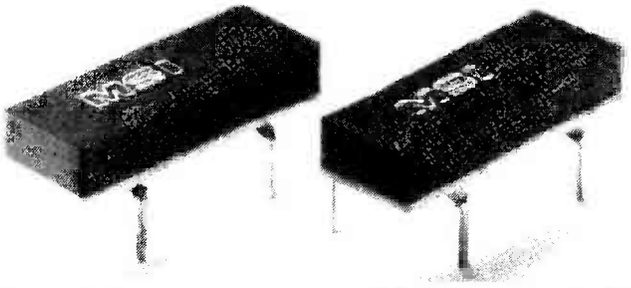
Induction Cooking

Traditional methods of cooking involve either an electrically heated 'hotplate' or a gas ring upon which the vessel containing the food to be heated is placed. A more recent innovation is the microwave cooker, in which there is no heated surface or area and heating takes place only in the food itself as a result of molecular vibrations set up by microwave activity. A third method, induction heating of the cooking pan, is shortly due to joint the existing methods and promises to combine many of their individual advantages.

Inductive heating of metallic surfaces has been used in some industries for over fifty years, but it is only now that the supporting technology exists to allow its use in the home. The principle is quite simple: the cooking pan is placed on an electrically and magnetically non-conductive plate underneath which is an induction coil. The coil generates an electromagnetic field in the base of the pan, thus causing it to heat up. There are a number of distinct advantages in this approach. The 'hotplate' itself remains virtually cold, receiving heat only by conduction from the bottom of the pan, and thus poses no danger of burning. Similarly, liquids spilled from the pan during cooking will not burn on contact with the cooking surface. The cooking time is considerably reduced compared with traditional hotplates, and since there is no heat accumulation in the hotplate itself and the induction energy can be precisely controlled, the cooking process can be regulated quickly and easily. A pan of milk which is on the verge of boiling can be saved from boiling over by switching off at the right moment.

Several manufacturers already have induction cookers in thier catalogues, but the cost is fairly high and this is probably why they are not selling in large quantities. With this in mind, AEG-Telefunken have developed a twin-hotplate table top induction cooker which they hope to have ready for volume production in a couple of years time and which should sell for rather less than currently available models. The AEG-Telefunken design will use an induction coil in a parallel tuned circuit fed at a constant frequency by an inverter, the current being controlled to provide regulation of the energy output. Most of the existing designs use a series tuned circuit and regulate power by adjusting the inverter frequency, an approach which leads to losses when the tuned circuit is not at resonance and which provides a limited range of control since the frequency range is limited by the switching properties of the semiconductors at the top end and the onset of audibility at the bottom end. AEG say the optimum frequency for use with thin sheet steel pans is 10kHz but they use a frequency above 25kHz which is beyond the audible range for both humans and domestic animals. They extend the range of control available by pulsing the supply to the coil when very low outputs are required and claim infinitely variable control down to about 2% of maximum output. The two hotplates in the cooker have maximum power consumptions of 1500W and 2000W and AEG claim that around 75% of the energy taken from the mains actually reaches the food being cooked, compared with about 60% for a ceramic hotplate and 58% for an iron hotplate.

The induction method is suitable for cooking, frying, heating-up and thawing, and combines some of the advantages of speed and electrical efficiency found in microwave cookers with the versatility and constant access during cooking enjoyed with conventional hotplates. AEG say that there are still a few problems to be overcome and that more development is needed, but now that the major problems such as radio interference have largely been overcome, it should not be too long before the benefits of this method of cooking can be made more widely available.



Miniature Solid-State Relays

Norbain Electro-Optics Ltd have launched a completely new range of Switch-DIP miniature solid state relays. Manufactured by MSI, the range consists of three DC and seven AC types covering a number of voltage and current options with opto or transformer isolation and synchronous or zero voltage switching.

Housed in standard 14 and 16 pin sealed ceramic DIL packages, the devices employ thick film hybrid techniques to achieve a high power handling capability. Heading the range is the E24E-2H 16 pin package which has a 1A RMS rating and input-to-output isolation of 400V RMS. The device switches at the zero voltage point of the AC wave form, requires an input signal of 8mA at 5V and has a peak voltage rating on the output switch of 600V. Anti-parallel SCRs in the power switch ensure enhanced DV/DT surge current and thermal characteristics.

Other devices in the range include the E40-1 capable of switching AC and DC currents to ± 80mA at ± 60V, the E41-2H rated at 1A RMS AC with a triac output rated at 600V, the E43-1 designed for DC switching a current of 500mA at 60V and E43-2 designed for 200mA current switching at 250VDC. Norbain Electro-optics Limited, Norbain House, Boulton Road, Reading, Berkshire RG2 0LT, tel: 0734 864411.

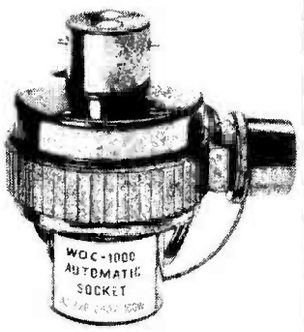
Triac With Integral Firing Circuit

United Automation have produced an 18mm x 16mm hybrid thick film which contains a 240VAC 6, 10 or 15 amp glass passivated triac together with a complete firing circuit integrated within a 3 terminal isolated package. A family of derivatives include a control pentiometer (open or enclosed) allowing single hole fixing and 2 wire connection, and extension to 35 Amps with 300 Amp surge capacity. Larger units up to 300 Amps with surge ratings to 3,000 Amps are also available to order.

Applications include control of heaters, ovens, furnaces, large lamp loads and many AC motors, giving potential energy savings and wide control ability to almost any function or process that is electrically powered. UA claim the cost of the device is lower than that of an equivalent triac and discrete firing circuit. Contact United Automation Sales/Publicity Dept, 17 King Street, Knutsford, Cheshire WA16 6DW, tel 0565 54863.

● The British Amateur Electronics Club have issued their April Newsletter which contains the usual range of features and articles plus details of the Amateur Electronics Exhibition which takes place in Penarth, South Glamorgan in July. Details from C. Bogod, "Dickens", 26 Forest Road, Penarth, South Glamorgan CF6 2DP.

● Axiom Electronics Ltd have published a quick reference guide and price list covering their range of components, tools and instruments. The guide has almost 200 pages, lists more than 10,000 product lines and is available free from Axiom at Turnpike Road, Cressex Industrial Estate, High Wycombe, Buckinghamshire HP12 3NR, tel 0494 - 442181.



Night Light

As we pointed out in our Automatic Light Switch project last month, a simple way of deterring would-be burglars when the house is empty is to arrange for the lights to come on at dusk, thus giving the impression that someone is at home. Our project allows you to do just that. CSR International have now introduced a similar device, and if it isn't quite as sophisticated as our design it is certainly a lot easier to fit.

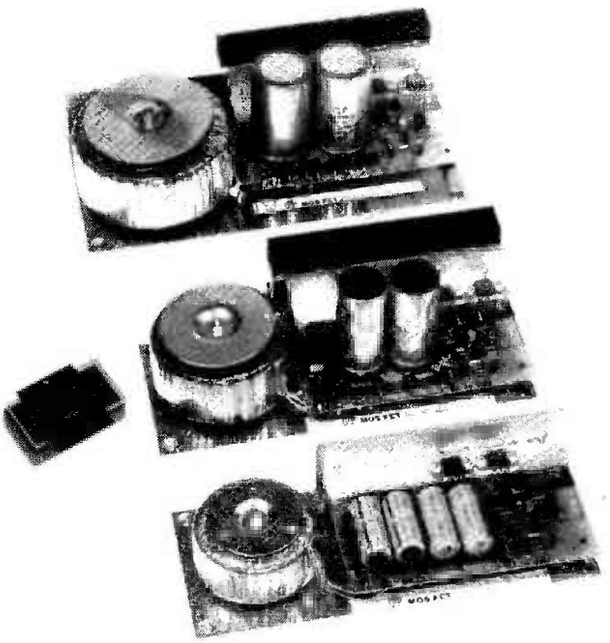
The TSAS Auto Socket is a light activated switch built into a small moulded housing which has a bayonet plug on one side and a bayonet socket on the other. The bayonet plug is inserted into a standard lamp socket, a light bulb of up to 60 watts is placed in the socket on the other side of the device, the supply is switched on and the Auto Socket then does the rest. A Cd-S cell senses the ambient light level, switching the bulb on when it gets dark and off again when it gets light. Just how they avoid the problem of reflected light from the bulb getting back to the Cd-S cell is not made clear, but we suspect this may be why they recommend a 60 watt bulb when the unit appears to have a rating of 100 watts (see illustration). The manufacturers say the case is fully weather-protected and that the device can be used with both indoor and outdoor light fittings.

CSR International are promoting the Auto Socket as a burglar deterrent, but an obvious drawback is that it will leave the lights on all night, perhaps attracting more attention than if the house were left in darkness. The design we published last month switched the lights on at dusk but off again four hours later, thus avoiding the problem. The Auto Socket would seem to be better suited for use with porch or path lights or any other light that you actually want to leave on all night. It costs £15.00 inclusive and is available by mail order from CSR International, Suite 26, Fourth Floor, Morley House, 320 Regent Street, London W1R 5AF, tel 01-636 8444.

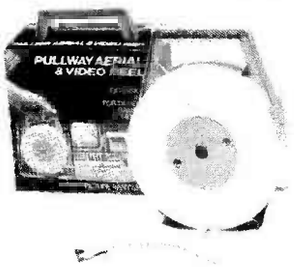
MOS-FET Amplifier Modules

Following on from their successful 100 watt bipolar power amplifier module, B.K. Electronics have introduced three new MOS-FET models. The OMP/MF100, OMP/MF200 and OMP/MF300 have power ratings of 100, 200 and 300 watts RMS respectively, come complete with power supply and feature an optional eleven segment LED VU meter.

The modules are completely self-contained, having a toroidal transformer, smoothing capacitors and heatsink all built onto the aluminium chassis. Specifications include a typical THD figure of 0.001% rising to 0.002% at full output, a signal-to-noise ratio of 125dB and a slew rate of 45V/us. The output impedance is 4 ohms and the input sensitivity is 500 mV, although models with a 775 mV input sensitivity can be supplied. The bandwidth is 1Hz to 100 kHz but models with a reduced upper frequency limit can be supplied to order. All models run from 240VAC mains, feature a glass fibre printed circuit board and have drive circuits to power the optional eleven segment LED VU meter. The OMP/MF100 measures 60 x 123 x 300 mm, the OMP/MF200 measures 100 x 150 x 300 mm and the OMP/MF300 measures 102 x 147 x 330 mm.



B.K. Electronics expect the new modules to find applications in the instrumental, PA, disco, hi-fi, DIY and studio and leisure industries. They are currently developing a pre-amplifier to complement the modules and also plan to offer stereo pairs in 19" racks with facilities to bridge the outputs. The modules are available direct from B.K. and, for the benefit of those in a real hurry, Barclaycard, Access and COD orders can be placed over the telephone. The OMP/MF100 costs £34.79 plus VAT and £2.50 postage and packing, the OMP/MF200 costs £54.80 plus VAT and £3.50 postage and packing, and the OMP/MF300 costs £69.59 plus VAT and £4.50 postage and packing. The LED VU meter is available separately and costs £7.39 plus VAT and 50p postage and packing. B.K. Electronics, Unit 5, comet Way, Southend-on-Sea, Essex SS2 6TR, tel 0702-527572.



A Reel-y Good Idea

The Pullaway Reeler is simply a length of TV aerial lead in a handy cable drum. It was designed principally for use with video recorders, to allow a portable TV to be operated in another room without moving the video recorder around, but is also likely to be of interest to home computer users, boating and caravaning enthusiasts and anyone else who wants to operate a TV set at a distance from the aerial or signal source.

The Reeler is available in two versions, having 30 or 45 feet of standard 75 ohm co-axial cable terminated in a free plug at one end and a socket mounted on the side of the drum at the other. The drum is made of tough ABS plastic and has an integral handle. The Reeler is available from Currys, W.H. Smiths, Sainsburys Homebase and Saracentres and costs around £7.95 including VAT.

Pullway Ltd, Venn House, 11 Clayton Road, Hayes, Middlesex, tel 01-848 7747.

● Bulgin now offer plugs and sockets moulded directly onto lengths of cable. The range includes standard 13A plugs with or without insulated pins and IEC plugs and sockets in both straight and right-angle versions, all moulded to either 2, 2.5 or 3 metres of black cable. Single ended or double ended moulded leads are available, allowing you to choose, for example, a 13A plug to IEC socket lead. Contact Brian Diggle, A.F. Bulgin and Company PLC, Bypass Road, Barking, Essex IG11 0AZ, tel 01-594 5588.

● VSO (Voluntary Service Overseas) is looking for electronics technicians to work in Africa, Asia and the Pacific Islands. The work involves repair of various types of electrical equipment and the period of service is for two years, starting in September. Applicants should hold a craft certificate, have at least five years experience, be aged between 20 and 65 and have a UK, EEC or Commonwealth passport and no dependents. Details from the Enquiries Unit, VSO, 9 Belgrave Square, London SW1, tel 01-235 5191.

● The Anglia Components Group have launched a subsidiary company, Anglia Consumer, which will supply semiconductors to the consumer market. The new company will have full access to the parent company's on-line ICL computer system and claims an order turnaround time of 15 minutes. A semiconductor wallchart will be sent free to customers, and those interested should contact Anglia Components, Burdett Road, Wisbech, Cambridgeshire PE13 2PS. ETI

01-452 1500 TECHNOMATIC LTD 01-450 6597

BBC Micro Computer System
OFFICIAL DEALER

Please phone for availability

BBC Model B **£348**
B + Econet **£389**
B +DFS **£429**
B + DFS + Econet **£470**
Carriage **£7**

Model A to Model B Upgrade Kit **£95**
Installation **£15**

LANGUAGE ROMs
BCPL ROM + Disc + Manual **£87**

UTILITY ROMs
BBC Ultracalc **£65** Toolkit **£20**
EXMON **£20**; DISC DOCTOR **£30**; FX Dump **£15**; Graphics ROM **£28**; Termi ROM **£29**

Software from ACORNSOFT/ PROGRAM POWER/GEMINI in stock

FLOPPY DISC INTERFACE
£84 + £15 installation

BBC COMPATIBLE DISC DRIVES
All drives are supplied with manual, form disc and cables.
Single Drive: 100k **£140**; 200k **£175***; 400K **£195**
Single Drive with PSU:100k **£165**; 200k **£210**; 400k **£225**
Dual Drive with PSU: 2 x 100k **£320**
2 x 200k **£400***; 2 x 400k **£420**
* These drives are switchable between 40/80 tracks. 40/80 Switch Module 1 x 400k and 2 x 400k **Drive £32**
DISKETTES: in packs of 10 W: Wabash M: 3M 40 track SSSD W: **£14** M: **£16.00**; 40 track DSDD M: **£22**;
80 track SSDD W: **£24** M: **£26**; 80 track DSDD W: **£26** M: **£30**;
FLOPPICLENE Drive Head Cleaning Kit **£14.50**

Phone or send for our BBC leaflet

TORCH Z80 DISC PACK

Your BBC computer can be converted into a business machine with the addition of a TORCH Z80 disc pack. The Torch pack with twin disc drive and the Z80 processor card greatly enhances the computer's data storage and processing capacity. The Z80 card comes complete with 64K RAM and a CP/M compatible operating system. In addition to BBC owner's user guide and a systems disc the package is supplied with PERFECT software package comprising of DATABASE WORD PROCESSOR & SPREADSHEET and COMANEX a interactive business management game. Complete Pakcage for **£730** + £8 carr.

CASSETTE RECORDERS

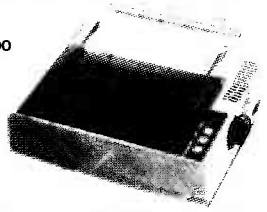
SANYO DR101 Data Recorder **£34** + **£2.50** carriage
DATEX SLIM LINE **£24** + **£1.50** carriage
BBC Tape Recorder **£28.50** + **£2.50** carriage
Cassette Lead **£3** + **£1** carriage
HOBBIT Floppy Tape **£135** + **£2.50** carriage
HOBBIT Zero Memory Option **£25** + **£1** carriage
Computer Grade C12 cassette **50p each.**
£4.50 for 10 +£1 carriage

MONITORS

MICROVITEC 1431P 14" RGB/PAL Std Res **£249**
MICROVITEC 1451 14" RGB Med Res **£299**
MICROVITEC 1441 14" RGB Hi Res **£420**
MICROVITEC 2031 20" RGB Std Res **£287**
KAGA VISION II 12" RGB HI Res **£260**
KAGA VISION III 12" RGB Super Hi Res **£358**
KAGA 12" GREEN Hi Res **£106**
SANYO DM8112CX 12" Green Hi Res **£99**
All leads included. Carriage £7

PRINTERS & PLOTTERS

EPSON FX80 **£350**
EPSON RX80 FT **£250**
EPSON FX-100 **£450**
PRINTER SHARER + cable set **£88.00**
SEIKOSHA GP 100A **£160**
JUKI 6100 Daisy Wheel **£350**
MCP 40 Col Printer/Plotter **£120**
Colour Graphics Plotter A3 size **£270**
GRAFPAD Graphics Tablet £125
Carriage £7



ACCESSORIES
Parallel Printer Lead **£10** + **£1** carriage
Serial Printer Lead **£8** + **£1** carriage
Epson Serial Interface 2K **£60** + **£1** carriage
Epson Serial Interface **£55** + **£1** carriage
NEC Serial Interface **£42** + **£1.50** carriage
Epson Paper Roll Holder **£17** + **£1.50** carriage
FX Tractor Attachment **£37** + **£1.50** carriage
Printer Sharer Parallel 3 Computers — 1 Printer **£65.00** + **£1.50**
Paper Fanfold 2000 sheets **£13.50** + **£2.50** carriage

'TIME-WARP'
BBC REAL-TIME-CLOCK/CALENDAR:
A low cost unit opens up the total range of Real-Time applications. With its full battery backup, possibilities include an Electronic Diary, automatic document dating, precise timing &°control in scientific applications, recreational use in games etc — its uses are endless and are simply limited by one's imagination. Simply plugs into the user port — no specialist installation required — No ROMS. Supplied with extensive applications software. **£29.00**

BBC EPROM PROGRAMMER

A fully self-contained Eprom Programmer with its own power supply, able to program 2516, 2716/32/32A/64/128 single rail Eproms.
★ Personality selection is simplified by a single rotary switch.
★ Programming voltage selector switch is provided with a safe position.
★ Warning indicator to show programming in progress.
★ Programmer can read, blank check, program and verify at any address/ addresses on the EPROM.
★ Simple menu driven software supplied on cassette (transferable to disc).
★ Full editor with ASCII disassembler.
Programmer complete with cables, software and operating instructions. **£89.00** - **£2** p. & p.

PRODUCTION PROGRAM: P8000

P8000 provides reliable gang programming of up to 8 EPROMS simultaneously with device sizes up to 16k x 8 bytes. Devices supported range from 2704 to 27128 in single and three rail versions. Simple menu driven operation ensure easy eprom selection and reliable programming in minimum programming times. **£695** + **£6** carriage.

BOOKS (no VAT; p&p £1)

Advanced User Guide (£2 p&p)	£12.95
Assembly Lang Prog. for BBC	£8.95
Assembly Lang programming on BBC Micro by Ferguson and Shaw	£7.95
Basic Prog. for BBC	£5.95
BBC An Expert Guide	£6.95
Easy Programming on BBC	£5.95
Further Programming on BBC	£5.95
Introducing BBC Micro	£5.95
Programming the BBC	£6.50
30 Hour Basic	£5.95
35 Educational Programs	£6.95
BBC Sound & Graphics	£7.95
Creating Adventure Programs	£6.95
Discovering Machine Code	£6.95
Structured Programming	£6.50
The Friendly Computer Book BBC	£4.50
Beyond Basic BBC	£7.25

Many more books in stock.

EPROM ERASERS

UV1T Eraser with a built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59** +**£2 p&p.**
UV1 as above but without the timer **£47** + **£2 p&p.**
UV140 up to 14 Eproms **£61**
UV141 as above but with timer **£79**

★ ★ ATTENTION ★ ★

All prices in this double page spread are subject to change without notice.

ACORN IEEE INTERFACE

This IEEE 488 standard interface is a general purpose system for exchanging digital data between a number of devices in a local area. The interface complies with the IEC 625-1 standard and can be connected to upto 14 other devices.
Interface board is suplied complete with software in ROM, interconnecting cables IEEE cable for connection to an external device and a comprehensive manual. **£282.50** + £2.50 carr.

SMARTMOUTH
Speech Synthesiser for BBC

The 'infinite vocabulary' self-contained speech synthesiser unit. Uses only 5-10 bytes per word – no ROMs required – simply plugs into the user port. (Has Aux. Audio output skt.). Supplied with Demo/Development programs and simple software instructions, **£37** + **£2** p. & p.

NEW COMPREHENSIVE CATALOGUE AVAILABLE – PLEASE SEND FOR PRICE LIST

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

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

D CONNECTORS

	No. of ways 9	15	25	37
MALE				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
FEMALE				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
Hoods	90p	85p	90p	100p

IDC 25-way plug **385p**. Socket **450p**

TEXTOOL ZIF

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

DIL SWITCHES

4-way **70p** 8-way **130p**
6-way **100p** 10-way **150p**

JUMPER LEADS
24 Ribbon Cable with Headers

	14-pin	16-pin	24-pin	40-pin
1 end	145p	165p	240p	350p
2 ends	210p	230p	345p	540p

24 Ribbon Cable with Sockets

	20-pin	26-pin	34-pin	40-pin
1 end	160p	200p	280p	300p
2 ends	290p	370p	480p	525p

Ribbon Cable with D Conn
25 way Male **500p** Female **550p**

RS 232 JUMPERS
(25 way D)

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

DIL HEADERS

	Solder Type	IDC Type
14pin	40p	100p
16pin	50p	110p
24pin	100p	150p
40pin	200p	225p

AMPHENOL CONNECTORS

36-way plug Centronics Parallel
Solder **£5.25** IDC **£5.25**
36-way socket Centronics Parallel
Solder **£5.50** IDC **£5.50**
24-way plug IEEE Solder **£5** IDC **£4.75**
24-way socket IEEE Solder **£5** IDC **£4.75**

PCB Mtg Skt
Any Pin 24 way Solder **600p**
36 way ZOC **650p**

EURO CONNECTORS

DIN 41612

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

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

TEST CLIPS

14-pin **375p** 16-pin **£4**
40-pin **£10.30**

RIBBON CABLE
(Grey/meter)

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

EDGE CONNECTORS

	0.1"	0.156"
2x6-way (commodore)	—	300p
2x10-way	150	—
2x12-way (vic 20)	—	350p
2x18-way	—	140p
2x23-way (ZX81)	175p	220p
2x25-way	225p	220p
2x28-way (Spectrum)	200p	—
2x36-way	250p	—
1x43-way	260p	—
2x22-way	190p	—
2x43 way	395p	—
1x77-way	400p	500p
2x50-way (S100conn)	600p	—

74 SERIES

7400	POA
7401	30p
7402	30p
7403	30p
7404	POA
7405	36p
7406	POA
7407	POA
7408	36p
7409	30p
7410	30p
7411	36p
7412	30p
7413	40p
7414	60p
7416	POA
7417	POA
7420	30p
7421	36p
7422	36p
7423	36p
7425	40p
7426	36p
7427	36p
7428	36p
7430	30p
7432	POA
7433	30p
7437	30p
7438	100p
7439	36p
7440	30p
7441	90p
7442A	60p
7444	70p
7445	90p
7446A	90p
7447A	90p
7448	90p
7450	30p
7451	30p
7453	30p
7454	30p
7460	60p
7470	60p
7472	40p
7473	36p
7474	60p
7475	50p
7476	40p
7480	60p
7481	160p
7482	120p
7483A	90p
7484A	180p
7485	120p
7486	40p
7489	250p
7490A	50p
7491	70p
7492A	60p
7493A	50p
7494	120p
7495A	55p
7496	75p
7497	250p
74100	180p
74107	45p
74109	45p
74110	90p
74111	55p
74116	150p
74118	150p
74119	150p
74120	100p
74121	45p
74122	55p
74123	90p
74125	50p
74126	60p
74128	70p
74132	60p
74136	60p
74141	90p
74142	225p
74143	250p
74144	250p
74145	90p
74147	120p
74148	120p
74150	150p
74151A	60p
74153	60p
74154	200p
74155	60p
74156	60p
74157	60p
74159	180p
74160	90p
74161	75p
74162	90p
74163	90p
74164	90p
74165	100p
74166	120p
74167	250p
74170	150p
74172	250p
74173	90p
74174	90p
74175	75p
74176	90p
74177	75p
74178	120p
74179	120p
74180	70p
74181	180p
74182	75p
74184	150p
74185A	150p
74190	90p
74191	90p
74192	90p
74193	75p
74194	60p
74195	65p
74196	60p
74197	90p
74198	150p
74199	150p
74221	100p
74251	60p
74259	150p
74265	70p
74273	170p
74276	150p
74278	150p
74279	70p
74283	70p
74285	225p
74290	100p
74293	90p
74298	120p
74351	150p
74365A	48p
74366A	60p
74367A	60p
74368A	60p
74376	120p
74390	100p
74393	150p
74490	150p

74LS SERIES

74LS00	POA
74LS01	36p
74LS02	36p
74LS03	36p
74LS04	POA
74LS05	36p
74LS08	36p
74LS09	36p
74LS10	36p
74LS11	36p
74LS12	36p
74LS13	40p
74LS14	50p
74LS15	36p
74LS20	36p
74LS21	36p
74LS22	36p
74LS26	36p
74LS27	40p
74LS28	36p
74LS30	36p
74LS32	POA
74LS33	36p
74LS37	36p
74LS38	60p
74LS40	40p
74LS42	55p
74LS47	90p
74LS48	90p
74LS51	36p
74LS54	36p
74LS55	36p
74LS73A	36p
74LS74A	100p
74LS75	50p
74LS76A	36p
74LS83A	60p
74LS85	100p
74LS86	40p
74LS90	40p
74LS91	75p
74LS92	55p
74LS93	40p
74LS95B	70p
74LS96	75p
74LS107	48p
74LS109	48p
74LS112	48p
74LS113	48p
74LS114	48p
74LS122	60p
74LS123	120p
74LS124/619	180p
74LS125	60p
74LS126	60p
74LS132	55p
74LS133	48p
74LS136	60p
74LS138	90p
74LS139	60p
74LS145	100p
74LS147	150p
74LS148	150p
74LS151	70p
74LS153	70p
74LS154	250p
74LS155	70p
74LS156	70p
74LS157	70p
74LS158	70p
74LS160A	90p
74LS161A	90p
74LS162A	90p
74LS163A	90p
74LS164	90p
74LS165A	120p
74LS166A	120p
74LS168	140p
74LS169	140p
74LS170	120p
74LS173A	120p
74LS174	75p
74LS175	75p
74LS183	180p
74LS190	75p
74LS191	75p
74LS192	75p
74LS193	75p
74LS194A	70p
74LS195A	70p
74LA196	80p
74LS197	70p
74LS221	120p
74LS240	120p
74LS241	120p
74LS242	75p
74LS243	75p
74LS244	300p
74LS245	350p
74LS247	70p
74LS248	70p
74LS249	70p
74LS251	70p
74LS253	70p
74LS256	200p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	70p
74LS261	90p
74LS266	70p
74LS273	140p
74LS275	175p
74LS279	75p
74LS280	180p
74LS283	80p
74LS290	80p
74LS292	900p
74LS293	75p
74LS295	100p
74LS297	900p
74LS298	90p
74LS299	200p
74LS321	240p
74LS323	250p
74LS324/624	200p
74LS348	200p
74LS352	100p
74LS353	100p
74LS356	220p
74LS363	180p
74LS364	180p
74LS365A	55p
74LS366A	55p
74LS367A	55p
74LS368A	55p
74LS373	POA
74LS374	POA
74LS375	75p
74LS377	140p
74LS378	120p
74LS379	120p
74LS390	90p
74LS393	150p
74LS395A	120p
74LS399	150p
74LS445	100p
74LS465	180p
74LS466	150p
74LS467	180p
74LS490	130p
74LS540	120p
74LS741	150p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	150p
74LS626	180p
74LS628	180p
74LS629	180p
74LS640	250p
74LS640-1	300p
74LS641	250p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	350p
74LS645-1	400p
74LS668	80p
74LS669	80p
74LS670	130p
74LS674	550p
74LS682	350p
74LS684	400p
74LS687	450p

74S SERIES

74S00	45p
74S02	45p
74S04	60p
74S05	60p
74S08	60p
74S10	45p
74S11	50p
74S20	45p
74S22	50p
74S30	45p
74S32	70p
74S37	80p
74S51	75p
74S74	75p
74S85	250p
74S86	90p
74S112	90p
74S113	90p
74S114	90p
74S124	400p
74S132	110p
74S133	60p
74S138	150p
74S139	120p
74S140	60p
74S151	180p
74S153	180p
74S157	250p
74S158	195p
74S163	300p
74S174	250p
74S175	320p
74S188	180p
74S189	225p
74S194	300p
74S195	300p
74S196	300p
74S200	450p
74S201	320p
74S225	650p
74S240	250p
74S241	300p
74S244	400p
74S251	250p
74S257	250p
74S258	250p
74S260	70p
74S261	300p
74S262	850p
74S283	300p
74S287	225p
74S288	180p
74S289	225p
74S299	650p
74S373	400p
74S374	400p
74S387	225p
74S472	475p
74S474	400p
74S475	450p
74S570	650p
74S571	300p
74S573	500p

4000 CMOS

4000	30p
4001	30p
4002	30p
4006	90p
4007	30p
4008	90p
4009	60p
4010	30p
4011	30p
4012	30p
4013	60p
4014	80p
4015	80p
4016	50p
4017	75p
4018	75p
4019	60p
4020	90p
4021	80p
4022	80p
4023	50p
4024	50p
4025	30p
4026	100p
4027	50p
4028	60p
4029	90p
4030	45p
4031	160p
4032	80p
4033	160p
4034	200p
4035	80p
4036	270p
4037	150p
4038	80p
4039	250p
4040	80p
4041	60p
4042	75p
4043	75p
4044	75p
4045	120p
4046	90p
4047	85p
4048	60p
4049	48p
4050	48p
4051	80p
4052	80p
4053	80p
4054	90p
4055	90p
4056	100p
4059	450p
4060	90p
4063	90p
4066	45p
4067	290p
4068	30p
4069	30p
4070	30p
4071	30p
4D72	30p
4073	30p
4075	30p
4076	90p
4077	30p
4078	30p
4081	30p
4082	30p
4085	60p
4086	70p
4089	125p
4093	48p
4094	100p
4095	90p
4096	90p
4097	290p
4098	90p
4099	90p
4501	40p
4502	60p
4503	60p
4504	90p
4505	400p
4506	120p
4507	45p
4508	160p
4510	75p
4511	75p
4512	75p
4513	140p
4514	130p
4515	130p
4516	75
4517	200p
4518	75p
4519	75p
4520	75p
4521	125p
4522	90p
4526	90p
4527	90p
4528	75p
4529	90p
4531	75p
4532	80p
4534	400p
4536	220p
4538	90p
4539	90p
4541	90p
4543	100p
4553	220p
4555	80p
4556	70p
4557	250p
4560	120p
4566	200p
4568	300p
4569	200p
4572	50p
4583	75p
4584	48p
4585	65p
4599	290p
4724	150p
14411	750p
14412	850p
14416	300p
14419	300p
14490	550p
14495	450p
14500	700p
14599	350p
22100	350p
22101	700p
22102	700p
40014	48p
40085	90p
40097	60p
40098	60p
40100	120p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AN103	200p
AY-1-5050	99p
AY-3-1270	750p
AY-3-1350	350p
AY-3-8910	400p
AY-3-8912	500p
CA3019A	100p
CA3028A	150p
CA3046	70p
CA3059	350p
CA3060	350p
CA3080E	80p
CA3086	60p
CA3089E	250p
CA3090AQ	3.75
CA3130E	90p
CA3130T	110
CA3140E	60p
CA3140T	110
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	120
CA3280G	225
D7002	450p
DAC1408-8	200p
DAC0808	200p
DG308	300p
HA1366	190p
HA1388	250p
ICL7106	700p
ICL7511	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM7216B	£24
ICM7217	900p
ICM7555	100p
ICM7556	140p
LC7120	300p
LC7130	325p
LC7137	350p
LF347	150p
LF351	60p
LF353	100p
LF355	100p
LF356P	100p
LF357	130p
LF13331	350p
LM10C	325p
LM301A	25p
LM307	45p
LM308CN	75p
LM310	120p
LM311	70p
LM318	150p
LM319	160p
LM319N	160p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	40p
LM348	65p
LM358p	60p
LM377	225p
LM380N-8	100p
LM380	120p
LM381AN	180p
LM382	120p
LM386	90p
LM387	120p
LM389	180p
LM391	180p
LM392	80p
LM393	100p
LM394CH	350p
LM709	50p
LM710	50p
LM711	70p
LM725C	300p
LM733	75p
LM741	20p
LM747	70p
LM748	40p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	500p
LM1889	350p
LM2917	250p
LM3302	75p
LM3900	50p
LM3909	120p
LM3911	180p
LM3914	350p
LM3915	350p
LM3916	350p
LM13600	110p
M51513L	230p
M51516L	500p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	100p
MC1458	40p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	200p
MC3401	50p
MC3403	65p
MF10CN	360p
MK50240	900p
MK50398	790p
ML920	500p
ML922	400p
MM57160	620p
MM6221A	300p
NE531	150p
NE544	190p
NE555	22p
NE556	50p
NE564	400p
NE565	150
NE566	150p
NE567	140p
NE570	400p
NE571	400p
NE592	75p
NE5532P	200p
NE5533P	180p
NE5534P	120p
NE5534AP	200
OP-07EP	600p
PLL02A	500p
S566B	300p
SAA1900	£18
SAD1024A	1150p
SFF96364	800p
SN76488	500p
SN76489	400p
SN76495	400p
SP0256AL2	800p
TA7120	150p
TA7130	180p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	100p
TBA820	80p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA940	175p
TCA965	120p
TDA1004A	£4
TDA1008	320p
TDA1010	250p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2002	325p
TDA2003	325p
TDA2004	300p
TDA2006	350p
TDA2020	320p
TD20300	250p
TDA7000	350p
TL061CP	50p
TL062	75p
TL064	100p
TL071	45p
TL072	60p
TL074	100p
TL081	45p
TL082	55p
TL083	75p
TL084	90p
TL094	200p
TL170	50p
TL430C	120p
UA2240	120p
UAA170	200p
ULN2003A	100p
ULN2004	100p
ULN2068	290p
ULN2802	200p
ULN2803	200p
ULN2804	200p
UPC575	275p
UPC592H	200p
UPC1156H	£3
UPC1185H	350p
XR210	400p
XR2206	400p
XR2211	575p
XR2240	120p
ZN414	80p
ZN419C	190p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E	210p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	200p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

1A		+ve		−ve	
5V		7805	40p	7905	45p
6V		7806	50p	7906	50p
8V		7808	50p	7908	50p
12V		7812	40p	7912	45p
15V		7815	40p	7915	45p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
6V	100mA	78L06	30p		
8V	100mA	76L08	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Rgulators		
LM309K	1A 5V	140p
LM323K	3A 5V	450p
78H05KC	5A 5V	600p
78H12	5A 12V	750p
78P05	10A 5V	900p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	100p
LM317K	TO3	250p
LM337T		225p
LM350T	10A+VAR	400p
LM396K	10A+VAR	1500p
LM723N		45p
78HGKC	5A+VAR	700
78GUIC	1A+VAR	200p
79HGGKC	5A−VAR	775p
79GUIC	1A−VAR	225p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

OPTO ELECTRONICS

2N5777	48p	TIL32	55p
OCP71	180p	TIL78	55p
ORP12	120p	TIL31A	120p
ORP60	120p	TIL81	120p
ORP61	120p	TIL100	75p

OPTO-ISOLATORS

ILD74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
ILQ74	180p		
6N137	400p		

LEDS

0.125"		FND357	120p
TIL209 Red	10p	MAN72	140p
TIL211 Gr	12p	MAN74	140p
TIL212 Yel	15p	MAN4640	200p
		MAN8910	250p
0.2"		NSB5881	570p
TIL220 Red	10p	TIL311	600p
TIL222 Gr	12p	TIL321/3	130p
TIL228 Yel	15p	TIL330	140p
Rectangular		TIL729	140p
LEDs(R,G,Y)	30p	TIL730	140p
		7750/60	200p
		TIL730	140p

DISPLAYS

DL704	140p
DL707Red	140p

DRIVERS

9368	250p
9370	300p

DIL SWITCHES

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

[illegible]

8 pin	30p
14 pin	42p
16 pin	45p
18 pin	50p
20 pin	66p
22 pin	75p
24 pin	75p
28 pin	100p
40 pin	130p

[illegible]

8 PIN	9p
14 pin	10p
16 pin	11p
18 pin	16p
20 pin	18p
22 pin	22p
24 pin	24p
28 pin	26p
40 pin	30p

DIODES

BY127	12p
BYX36300	20p
OA47	10p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/2	12p
1N5403/4	14p
1N5404/5	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A400V	200p
25A400V	400p

COUNTERS

74C925	£4
74C926	£5
74C928	£6
72168	£22
ZN1040	670p

REAL TIME CLOCK

MC6818P	550p
MM58174AN	800p
MSM5832RS	350p

TELETEXT DECODER

SAA5020	600p
SAA5030	700p
SAA5041	£16
SAA5050	900p

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	400p
6502A	650p
6800	290p
6802	300p
6809	650p
6809E	£12
68B09	£12
68B09E	£16
68000-LB	£48
68705-P3	£26
8035	550p
8039	550p
8080A	350p
8085A	950p
8086	£22
8088	£18
8748	£36
TMS1601	£12
TMS9980	£20
TMS9995	£12
WD55	£14.50
Z80	300p
Z80A	400p
Z80B	950p
TMS5220	£12
TMS9901	350p
TMS9902	350p
TMS9903	£25
TMS9911	£18
TMS9914	£14
Z80PIO	300p
Z80APIO	350p
Z80CTC	300p
Z80ACTC	350p
Z80DART	700p
Z80ADART	850p
Z80DMA	900p
Z80ADMA	£10
Z80ASIO-0/1/2 /9	900p

SUPPORT DEVICES

2651	£12
3242	800p
3245	450p
6520	300p
6522	350p
6522A	550p
6532	650p
6551	650p
6821	200p
68B21	250p
6829	£12.50
6840	375p
68B40	600p
6850	200p
68B50	250p
68705P3S	£26
6852	250p
6854	700p
68B54	850p
6875	570p
8154	950p
8155	£11
8156	750p
8212	300p
8216	200p
8224	200p
8226	250p
8228	250p
8243	550p
8251A	£10
8253C-5	£10
8255AC-5	£11.50
8256	£36
8257C-5	750
8259C-5	750p
8271	£45
8275	£29
8279	750p
8284	600p
8288D	£11
8755A	£18
TMS4500	£14

MEMORIES

2016-150	350p
2101	400p
2102	200p
2107B	500p
211A-35	300p
2112A-35	300p
2114-2L	220p
2114-4L	170p
2147	450p
4027-3	300p
4116-15	140p
4116-20	120p
4118-3	450p
4164-15	500p
4164-20	450p
4416-15	500p
4532-20	250p
4816AP-3	450p
5101/5501	300p
5516	£10
6116P-3	700p
6116LP-3	800p
6264-15	£35
6514-45	300p
6810	180p
74S189	225
74S289	225p

PROMs

74S188	180p
74S287	180p
74S288	140p
74S387	225p
74S473	475p
74S570	650p

EPROMs

2516 +5v	350p
2516-35	550p
2532	450p
2532 30	700p
2564	700p
2708	400p
2716 +5v	350p
2716-35	550p
2732	450p
2732A-2	900p
2732A-35	550p
2764-25	900p
27128-25	£22
27128-30	£25
TMS2716	700p

CRT CONTROLLER

CRT5027	£18
CRT5037	£18
CRT6545	£9
EF9364	£8
EF9365	£38
EF9366	£36
EF9367	£36
MC6845	650p
MC6845SP	750p
MC6847	650p
SFF96364	£8
TMS9918	£30
TMS9927	£18
TMS9928	£20
TMS9929	£16

INTERFACE ICs

AD558CJ	775p
AD561J	£20
AD7581	£15
ADC0808	1190p
AM25S10	350p
AM25LS2521	250p
AM25LS2538	250p
AM26LS31	160p
AM26LS32	160p
D7002	450p
DAC80-CB1-V	£28
DM8131	275p
DP8304	250p
DS3691	350p
DS8830	140p
DS8831	150p
DS8832	150p
DS8833	225p
DS8835	280p
DS8836	150p
DS8838	225p
DS8880	170p
LF13201	450p
MC1488	100p
MC1489	100p
MC3446	250p
MC3459	450p
MC3470	650p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	700p
MC14412	750p
ML922	400p
ULN2001	100p
ULN2003A	100p
ULN2004A	100p
ULN2068	290p
ULN2802	200p
ULN2803	200p
ULN2804	150p
75107	90p
75108	90p
75109	90p
75110	160p
75112	160p
75113	120p
75114	160p
75115	160p
75121	140p
75122	140p
75150P	120p
75154	140p
75159	220p
75161	350p
75162	400p
7536	150p
75451	72p
75452	72p
75453	72p
75454	72p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	120p
8T95	90p
8T96	90p
8T97	90p
8T98	90p
81LS95	180p
81LS96	180p
81LS97	180p
81LS98	180p
88LS120	400p
9602	220p
9636A	160p
9637AP	160p
9638	160p
ZN425E8	350p
ZN426E8	350p
ZN427E	600p
ZN428E8	450p
ZN429E	210p
ZN447E	900p
ZN459CP	300p

DISC CONTROLLER ICs

6843	£8
8271	£45
8272	£20
FD1771	£20
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
TMS9909	£12
WD2793	£42
WD2797	£42
WD1691	£15
WD2143	£8

CHARACTER GENERATORS

RO3-32513	
U C	750p
L C	700p
DM86S64	£12
MC66760	750p
SN74S262AN	1000p

KEYBOARD ENCODERs

AY52376	1150p
AY5 3600	750p
74C922	420p
74C923	500p

BAUD RATE GENERATORS

MC14411	£7
COM8116	£8
4702B	750p

UARTs

AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	380p
TR1602	300p

ZIF SKTS

(TEXTOOL)

24 pin	575p
28 pin	800p
40 pin	975p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p
Sound & Vision 12MHz	£12

CRYSTALS

32.768 KHz	100p
100 KHz	400p
200 KHz	400p
Freq in MHz	
1.00	325p
1.8432	300p
2.00	250p
2.45760(L)	210p
2.45760(S)	275p
2.5	250p
2.662	250p
3.276	150p
3.5795	120p
4.00	150p
4.194	200p
4.43	125p
4.608	250p
4.9152	250p
5.000	175p
6.00	150p
6.144	175p
7.00	150p
7.168	175p
8.00	175p
8.867	175p
10.00	175p
10.50	250p
10.70	200p
11.00	300p
12.00	150p
14.00	175p
14.318	175p
14.756	250p
15.00	200p
16.00	200p
18.00	200p
18.432	150p
19.969	150p
20.000	450p
24.000	300p
48.00	175p
116	300p
PX01000	£12

TRANSISTORS

AD161/2	45p
BC107/8	18p
BC109C	20p
BC169C	18p
BC172	18p
BC177/8	30p
BC179	30p
BC182/3	15p
BC184	18p
BC187	30p
BC212/3	18p
BC214	18p
BC237	18p
BC327	18p
BC337	16p
BC338	16p
BC461	40p
BC477/8	36p
BC516/7	50p
BC547B	20p
BC548C	12p
BC549C	18p
BC557B	14p
BC559C	24p
BCY70	30p
BCY71	36p
BD131	75p
BD132	80p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	40p
BF256B	50p
BF257/8	40p
BF337	36p
BFR39	32p
BFR40/1	32p
BFR79	32p
BFR80/1	32p
BFR96	180p
BFX29	45p
BFX30	45p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFX89	180p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	30p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ413	250p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	150p
MJE3055	120p
MPF102	40p
MPF103/4	40p
MPF105	40p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	30p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TI41C	55p
TIP42A	60p
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2N698	45p
2N706A	36p
2N708	36p
2N918	45p
2N930	30p
2N1131/2	50p
2N1613	36p
2N1711	36p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	30p
2N2484	30p
2N2646	50p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	12p
2N3053	36p
2N3054	60p
2N3055	55p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	16p
2N3704/5	18p
2N3706/7	16p
2N3708	16p
2N3773	200p
2N3819	40p
2N3823	30p
2N3866	90p
2N3902	700p
2N3904	18p
2N3906	18p
2N4036	65p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	60p
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2SC1957	90p
2SC1969	150p
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2SC2029	200p
2SC2078	160p
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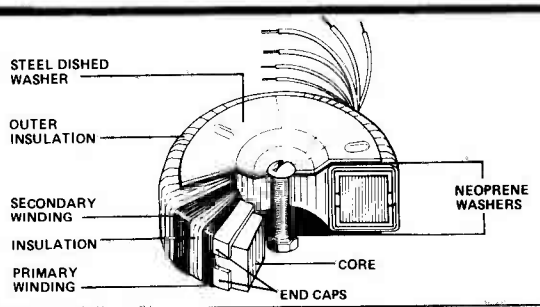

15 VA 62 x 34mm 0.35Kg Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA 70 x 30mm 0.45Kg Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA 80 x 35mm 0.9Kg Regulation 13%

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

80 VA 90 x 30mm 1Kg Regulation 12%

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

120 VA 90 x 40mm 1.2Kg Regulation 11%

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

160 VA 110 x 40mm 1.8Kg Regulation 8%

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

225 VA 110 x 45mm 2.2Kg Regulation 7%

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

300 VA 110 x 50mm 2.6Kg Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA 140 x 60mm 4Kg Regulation 4%

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

625 VA 140 x 75mm 5Kg Regulation 4%

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

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80	3	10.81	500	8	25.73
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STOP CRACKLE AND POP

No, this is not a plea for quieter breakfast cereals, but rather it is Vivian Capel's guide on how to eliminate interference on the car radio.

This time of year seems to send many of our readers out from their dens and onto the roads, to seek blue skies, the lonely trail and wide open spaces. What they find will be bank-holiday drizzle, traffic jams and, if they ever arrive at their destinations, crowded beaches. Never mind, there's that cheerful Terry Wogan on the radio to keep the spirits up! But what's this? Where is the crystal-clear reception that was heard when the radio was tried out at home? What are all the crackles and bangs?

The answer is not that it is the saviours of humanity, trying to save us from Wogan's dreadful jokes, but that it is the gremlins under the bonnet — we didn't try running the engine when we set up the radio, did we? And now all those interfering little gremlins are showing themselves in force.

Suppressing inteference is rather a hit-and-miss procedure, and often garage hands can do a good job based purely on experience of what has worked in the past. Also some cars and some radios are more prone to give trouble. However, a knowledge of the causes and possible cures for interference should help you to solve your own problems, even ones that defeat experienced mechanics — provided, of course you check them out before you set out on your Odyssey.

A Bit Of Theory

So, what is the cause of interference, and what can be done to avoid it? In the electrical circuits of a car, there is quite a lot of switching of electrical currents going on. These switchings can be regular, as in the case of the ignition system, or irregular, in the case of the instrument voltage stabiliser or battery charging regulator (although modern cars will have solid-state equivalents of the last two).

Nature doesn't like sharp ons and offs, and, as anyone familiar with Fourier analysis will know, treats these electrical signals as assemblages of lots of sine waves added together. In theory, to get an infinitely steep rise in a voltage, then sine waves of up to infinite frequency must be present; in practice, there is no such thing as an infinitely steep voltage rise, but the simple act of opening and closing a contact carrying a DC current into a resistive load can generate momentary RF signals well into the MHz region. These can be picked up by a car radio either as in-band signals, or as such strong out-of-band signals that they break through the tuned circuits.

Looking at the ignition system of the car, not only do we have the switching of current to and from the induction coil, but in the induction coil itself, we obviously have a fair amount of reactance. Added to this, we have leads on the primary and secondary side of the induction coil which will make excellent aerials. In fact, the modern car ignition bears such a similarity to Guglielmo Marconi's original spark-gap transmitter that it would be very surprising indeed if it did not radiate RF!

There are three ways that the RF can reach the radio from the interfering circuit, this being the ignition circuit or other source: firstly, it could be directly radiated from the source to the aerial or some other section of the signal input to the radio; it can be picked up and re-radiated to the aerial by some other metallic object, which could be either an adjacent electrical lead or some other object in the car such as a body panel (here the *secondary radiation*, as this is called, could be having a greater effect than the original radiation!); and finally, the RF could be reaching the radio via the supply leads — although, in theory, with competent design of the radio, this should never occur.

Aerial

A common cause of trouble can be something wrong with the aerial and associated circuit. For a start, is the aerial in the best position? People always seem to install it on one of the wings, which is right next to the sources of most of the interference (at least, on most cars). If you're just about to install your aerial there, you could save yourself a lot of trouble by putting it elsewhere, such as on the roof or at the back. At the very least, it should be on the wing furthest from the distributor. And if all the other solutions detailed below fail, it may be worth moving an existing aerial.

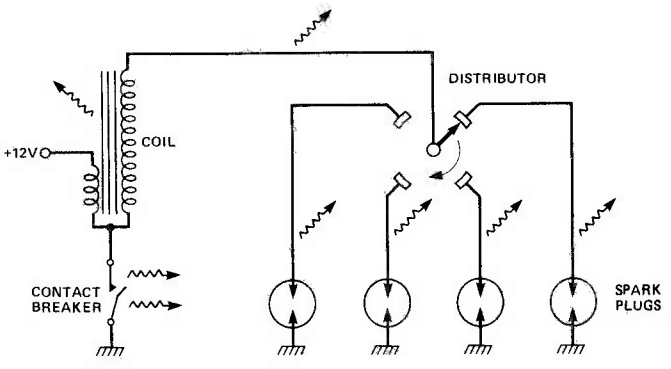


Fig. 1 Although some interference is radiated from the spark at the contact breakers, most is radiated by the supply lead which acts as an aerial.

SUPPRESSORS

There are a variety of suppressors available, each having a different effect, and each being most suitable for a particular type of circuit.

Resistive Suppressors

These are connected in series with the interference-producing circuit and impede the oscillatory current. Obviously, they also produce some power loss on the DC current and so can only be used in the HT ignition circuits. The resistance value must be something of a compromise in order to give adequate suppression of interference currents without significant degradation of engine performance. Common values are 5k and 10k.

Inductive Suppressors

Also connected in series with the offending circuit, they too work by impeding the interfering currents. However, having a low DC resistance, they have little effect on the normal DC currents in the circuit and so introduce virtually no power loss. Inductive reactance rises with frequency, so the impedance to RF is very high and it is strongly inhibited.

For the ignition circuit to work, it is necessary for a current flowing on the primary to build up fairly quickly to a maximum value and then be interrupted, which produces the spark in the secondary. Adding an inductor in series with the primary prevents this, and so inductive suppressors cannot be used for the ignition system.

A factor that affects the efficiency of inductor suppressors is self-capacitance. Each turn in a coil has a capacitance to the adjacent one, so the effect is of a string of capacitors in series. The combined capacitance is therefore a fraction of that of the single turn to its neighbour (the single turn capacitance divided by the number of turns, assuming all are equal). As the single turn value is not great, the total is much less; however, it can be sufficient to bypass the inductor at very high frequencies. Good suppressors are wound to minimise self-capacitance; however, inferior suppressors would have a poorer suppression factor for VHF, although they may be quite adequate for medium and long AM wavebands.

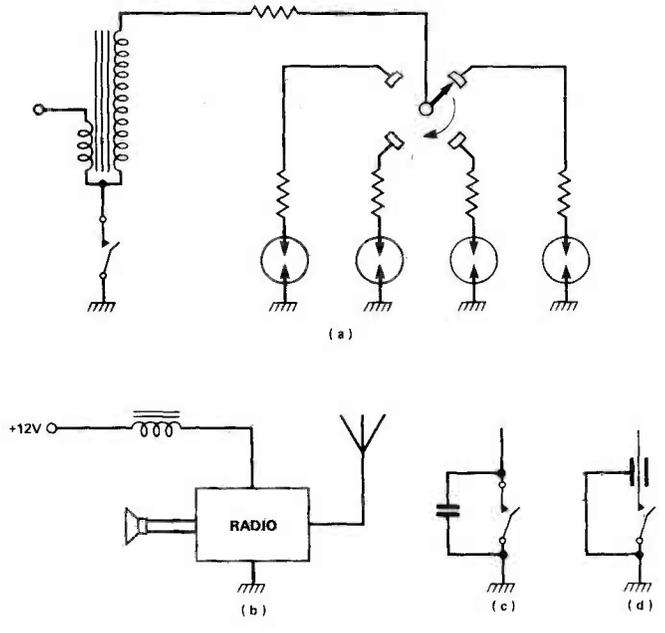


Fig. 2 Different types of suppressor: (a) resistive, impedes both AC and DC current, so can only be used on the high-voltage, low current spark circuit; (b) inductive, usable in most places except ignition coil primary; (c) capacitive, not suitable for EHT circuit (think about it!); (d) lead-through capacitive, minimum radiation for FM.

Capacitive Suppressors

These are wired across the interference source and thereby shunt RF currents without affecting DC. Connection must be to the actual terminal of the source so that no part of the circuit wiring is carrying RF. Also the lead to the capacitor should be as short as possible otherwise it will radiate, because it is conducting RF to the capacitor. Likewise, the point to which the suppressor is earthed should be to the casing of the source not a nearby earthing point because RF currents would flow from this point to the source-earth and thereby possibly radiate.

Even the inch or so of essential connecting wire may radiate at very high frequencies sufficiently to give some interference. Co-axial or lead-through capacitors are recommended for VHF. With these the lead-out wire passes through the centre of the capacitor which thereby can be positioned right up to the terminal. Circuit leads are connected to the other end of the lead-out. Thus the suppressor may appear to be in series but in fact is not.

Just as inductors possess capacitance so do capacitors possess inductance. This is often due to the rolls of metal foil used in many capacitor types. Such inductance, being in series with the capacitance, offers a high impedance to high frequencies and thereby reduces the shunting effect of the suppressor. Though inductance is low, it becomes significant at VHF. Low induction capacitors can be formed by doubling back the foil to give inductance cancellation, and these are the type that should be used for high-frequency suppression.

Earthing Straps

Heavy copper braid can be used to earth various parts, particularly the bonnet to the main frame or engine block. This inhibits secondary radiation. A point to watch with these is that the ends should be tinned with solder otherwise the contact between copper and steel in the presence of moisture could set up an electrolytic reaction which could start corrosion. Even if only mild, this would increase the contact resistance and could nullify the effect of the strap.

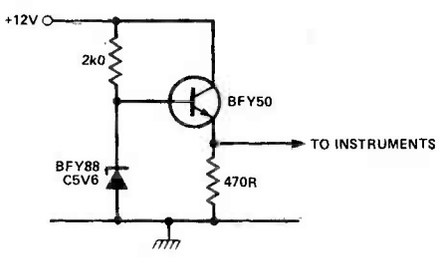


Fig. 3 A circuit for a simple voltage stabiliser to replace the mechanical vibrator type; of course, if you want to design something more complicated . . .

Water conducts electricity, and this can lead to problems if there is an ingress of moisture into the cable linking the aerial to the radio, or into the join between the aerial and the cable. Check also that there is a very low resistance between the top of the aerial and the aerial terminal — poor contact between sliding sections in a telescopic aerial can mean that only one or two sections are actually providing any signal to the radio!

Check, also, that there is a good connection between the aerial and cable earths, and the body of the car. It may be necessary to scrape off some paint from the concealed section of the bodywork around the aerial. With old aerials, corrosion can occur and impair existing contacts — an ohmeter can be very handy for checking this, provided it has a good low-ohms scale.

Ignition

The principal source of interference is undoubtedly the ignition system. This can be readily identified by revving the engine and then switching it off. Ignition interference consists of a stream of rapid crackling noise which varies with engine speed and stops immediately the engine is switched off. However, some other sources produce interference that dies down with the engine.

All new cars must conform to certain EEC regulations which provide for a minimum standard of interference suppression. To fulfill these, resistive HT cables are normally fitted. Older cars will probably not have these and either new leads or, depending on the state of the existing leads, separate in-line resistive suppressors should be fitted. For stubborn cases, especially for FM reception, suppression may be required in all plug leads as well as the HT cable from coil to distributor.

Before doing that, though, fit a 1 μF capacitive suppressor from the ignition coil terminal that takes the lead from the ignition switch to earth. For FM, use a non-inductive lead-through type. The coil itself should be encased in metal and the case should be well earthed to the engine block; the paint beneath the fixing clip may need to be removed to get a good contact. If a plastic encased coil is fitted, change it.

If the interference persists, listen with engine running with the bonnet open and with it closed. It should be much less with it closed; if not, there are two possibilities. One is that the bonnet is not well earthed and is acting as a secondary radiator. Earth it temporarily across the hinge with some heavy wire, making sure of good contact at both ends to bare metal. If there is now a difference with the bonnet closed, replace the wire with copper braid. This can be obtained from firms specialising in car radio installation. Screening stripped off some co-ax or other screened cable may not be heavy enough but can be worth trying.

Unabated interference, even with a closed, well-earthed bonnet suggests that it is not being picked up by the aerial at all. This can be checked by removing the aerial plug and fitting a dummy consisting of a plug with a 68 pF (or near) capacitor wired across it. Continuing interference shows that it is getting in by some other path.

The power lead to the radio is the prime suspect now, and an in-line inductive suppressor should be fitted in series. Loudspeaker wiring is another though less likely possibility. If this is so, wire the speaker circuit with twin screened wire and earth the screen at one point only.

Yet another path could be by secondary radiation from the steering column or gearlever. This has been found with some French-made cars. Try a temporary earth to check it, then fit a braid to the offending item from a near-by earthing point.

Electronic Ignitions

In theory, electronic ignitions should be a lot less troublesome than electromechanical ones; in practice, some models can be more troublesome. Assuming that yours is the type that doesn't replace the coil, the first step is to check that the leads between the coil and the ignition, and the ignition and earth (or the positive supply, depending on which way the coil current flows) are as short as is practicable.

Some systems you install yourself tell you to remove completely the coil suppressor capacitor. It may be necessary to reinstate the capacitor, and this should, obviously, be done fairly cautiously to avoid damaging the ignition output stage, so start with a fairly low value, say 100nF, and work up to whatever value the ignition will stand without mis-firing; the maximum you should need to use is around 3 μF and if this does not solve the problem, you will need to look elsewhere.

Interconnecting leads, already dealt with above, can be screened with metallic adhesive tape, such as is used for protecting windows in alarm systems; suitable tape can be obtained from security equipment shops. Wind the tape around the lead, leaving no gaps, in a spiral. Earth the screen by wrapping several turns of tinned copper wire around the tape at a convenient point, twisting together the ends, and connect to a near-by earth point.

Generator

This may be a dynamo with old models, but for recent ones will be an alternator. Interference from both is similar, a whine that varies with engine speed, but dies down rather than cuts out immediately when the ignition is switched off. Suppression is by means of a 1 μF capacitor from the output or D terminal in the case of a dynamo, or a 3 μF for an alternator.

Voltage Regulator

A whine or crackle that appears some moments after starting is the characteristic of interference from this source. It will disappear when a heavy electrical load is switched on such as headlights and fog lights or window demisters, and stops when the engine is just idling.

Suppression can be effected by fitting a 1 μF capacitor from the positive or D terminal to earth. Do not connect a capacitive suppressor to the F terminal. Should further suppression may be required, fit an inductive suppressor in series with the F terminal lead.

Instrument Stabiliser

The usual bi-metalic strip type of stabiliser can produce an intermittent burst of crackling which often can be provoked by tapping the dashboard. A 1 μF capacitor across this device or from its feed terminal to earth should cure it. If not, a series inductor in addition should do the trick. Actually, electronic stabilisers are available which can be fitted in place of the mechanical ones, or a simple circuit can be built up. This will generate no interference and as a bonus give more accurate instrument readings.

Electrical Fuel Pump

Interference from this can sound like a whine, crackling or ticking. It can be identified inasmuch as it starts as soon as the ignition is switched on but before the engine is started. 1 μF across the terminals plus a series inductor if required should suppress it.

Ancillary Equipment

This is simply identified by the fact that interference is present only when the particular item is switched on. Examples are: windscreen wipers, washer, heater fan, direction indicators, stop lamps and clock. The latter of course is on all the time and produces a characteristic ticking in the case of electro-mechanical types.

In each case the treatment is the same, a 1 μF from the feed terminal to earth, and if this does not completely cure it, an inductive suppressor in series with the supply lead.

Bodywork

Fibre-glass bodies can pose a lot of problems, in that the screening that would be present with a metal body is absent, unless some other allowance has been made. The result will be that all the forms of interference will come through much more strongly than otherwise could be the case. To get rid of this, as much of the engine compartment as possible should be lined with aluminium foil, including the bonnet, and all earthed to the main frame and engine block. Even with this treatment, some problems with FM may be experienced and other measures will have to be taken.

Static discharges between body panels, or exhaust system, suspension and differential units can give spasmodic interference. As vibration often triggers it, it can be identified by coasting down a long incline with the engine off. Pin-pointing the precise member is not as easy and can only be a matter of trial and error. Start off by bonding with braid everything that can be reasonably easily bonded, and go on from there.

If the noise has a regular repetition rate corresponding to the wheel rotation, it can be that one of the wheels has a poor earth through its bearings. Packing the offending bearing, when discovered, with graphite grease can effect a cure.

It is rarely necessary to suppress everything or to suppress to the fullest extent. With many vehicles the built-in suppression is sufficient especially for AM reception. For FM though as stated before, things are more critical.

And Finally . . .

Do not test in areas of high signal strength as this could give a false picture. Interference that is almost inaudible in such places will rise to annoying levels when the signal is weak, and in many holiday areas the signal is poor.

Interference is possible with tape players too, although they are much less vulnerable. In most cases the interference affects the playback head or associated circuitry from the power supply. Check to see if interference is the same with the player held in different positions; a cure is a series inductor in the power lead and/or an electrolytic capacitor from the power rail to earth inside the unit.

If the interference changes as the player is moved, the trouble is due to a magnetic field, most likely from the wiring harness. Often just moving the harness away will cure the trouble.

ETI

AUDIO DESIGN

This article, and the two parts that are to follow, provide the practical complement to John Linsley Hood's earlier, theoretical series of the same name. Many amplifiers have claimed to be the best ever published for the home constructor; but take it from us — this is.

The earlier parts of this series on Audio Circuit Design have mainly been aimed at explaining, in as simple a manner as I could, how circuits were designed, and their values specified, to do a specific job — in an engineering sense. Fifteen years or so ago, this would have been all that the user would have asked, and he would probably have been delighted with the performance given by what would be considered a run-of-the-mill design excercise. However, things have now changed.

As I mentioned in the article which dealt with audio amplifiers, I have an ambivalent attitude towards the whole 'hi-fi' scene, in the sense of that conspiracy which appears to exist between the editorial staff of 'hi-fi' journals, and the manufacturers of 'hi-fi' equipment, by which fulsome praise is lavished only upon rare items of audio exotica — which must be very expensive, in addition to being relatively infrequently seen — and staff writers are flown half way round the world to see, hear and inwardly absorb the latest propaganda in the cause of the most recent technological miracle.

Meanwhile, the bulk of the readers of the magazines continue to use, and frequently to enjoy, the equipment which they bought at a modest price from their local dealer or discount warehouse, and which never received any rave reviews from anyone, except a consumer magazine which said it was good value for money!

I am not so calloused, mentally, that I cannot recognise that some of these hi-fi exotica are indeed very good, and well designed and made, to boot. However, this presents a problem to the designer of any kit which is to be described in an electronics constructional magazine. Whatever it is, it must provide an incentive to the would-be constructor. Not only must it be sensible value for money, but it must also offer some quality advantage over the nicely made and prettily finished units offered at such tempting prices in the local High Street.

One advantage, which it is perhaps a little unkind to stress, is that the things you build yourself are repairable by you — the others may not be. However, if you are known, or mistakenly thought, to have any skills in the repair field, you are likely to have to fend off a kind of fan-club of friends and relatives who have bought some pretty tin-ware a few years ago, and now can't find a dealer who wants to know about it.

The other advantages may be those which are concerned with audio quality, in its various aspects. You may be able to include amenities or facilities which only you may want, but which are absent from the less expensive commercial gear, or it may be that you can gain some advantages in sound quality. This latter task is made a bit easier, certainly in respect of the equipment at the cheaper end of the market, by the fact that the need for a low sale price forces the manufacturer into the use of specialised, custom designed, circuit hardware which does an adequate though not marvellous job.

Many of the circuit designs which have been offered for the DIY constructor have relied for their appeal on the provision of a lot of electronic facilities, and I have been down this road myself, as testified by the JLH domestic preamp, published elsewhere. However, while it was fun to design and build the bits of gadgetry included in this design, the fact remains that most of these facilities are very seldom used. So, since I know that I can dispense with most of these, with very little real loss, and since I suspect that I could do those things which remain just a little bit better than I have done them so far, my intention here is to offer a fairly simple design in which all the small practical quality improvements are incorporated, in the hope that the final unit, within the power budget decided upon, will equal or exceed in sonic quality anything available anywhere else, at any price.

This may sound both vain, and impracticable; well perhaps it may be. But my problem, in the evolution of this design — and the problem of any other designer — is that unless one has a reasonable chance of matching the quality of the best, it is hardly worth while cluttering up the printed pages with yet one more design.

Design Philosophy

Like many of my readers, I suspect, I have read a lot about the recent tend in hi-fi thinking, in respect of Class A operation, and valves, and enormous power outputs, and the importance of connecting wires the right way round. Since I know that the people who espouse these causes are neither foolish nor easily led, I have had to try to work out a rational explanation for this collective attitude, in the hope of some design guidance emerging from this. For what it is worth, here it is.

Most of the audio quality judgments on audio amplifiers and ancillary equipment, made by the writers on this subject, are made on the basis of extended listening trials, most of which are at very high sound levels, with music of a type which has relatively few quiet passages. Valve amplifiers have the great advantage, because of their inherent tendency to 'soft' clipping, that when they are driven into overload they sound much

less awful than transistor designs which have a 'brick-wall' clipping characteristic. Also, with valves, their distortion products — of which there are usually quite a lot — are mainly 2nd and 3rd harmonic: these can, curiously, tend to enhance the sound of certain music, to make it sound 'richer'. Also, for practical reasons, not a lot of NFB can be employed, which makes LS load compatibility less demanding of design. Finally, the output transformer, which does so much to impair the electrical quality of the amplifier, does at least ensure that it can push a lot of current into a low impedance LS load.

Since most of the reviewers' auditioning is apparently done at very high sound levels, the preference for high powers is also understandable.

The case for class-A is harder to fault. With junction transistors, particularly, the sluggishness in operation of the higher current types makes crossover distortion an ever present problem, in class-B (no quiescent current) or class-AB (some zero signal level quiescent current) operation. Class-A (standing output stage current the same for zero or maximum power) operation makes for much better power output transistor HF response, and also has the big advantage that the HF characteristics of the power transistors are just as good at low signal levels as they are at high ones.

However, a class-A amplifier is unavoidably inefficient, with efficiencies in the range 25-30% being normal. This means that an 80 watts/channel class-A stereo amplifier must dissipate, perhaps, 640 watts of heat. This either implies enormous heat sinks, to keep the operating temperature down to 80 to 100°C, or fan cooling, which is noisy. Either way, such an amplifier will make quite a contribution to room heating. Now think of what life would be like with a 200 WPC class-A system! Sliding-bias class-A systems have often been tried, but never liked.

MOSFETs To The Rescue

So far as I am concerned, the availability of power MOSFETs is a nearly complete solution to the power amplifier design problem. The recent design types of this kind are so fast that the difficulties of output stage sluggishness are abolished, and the nature of the device ensures that the HF response is the same at all drain current levels, thereby avoiding the normal class-AB junction transistor problem of subtly different sound quality at low and high sound levels.

Power MOSFETs do have design problems, which is why, inspite of their many and conspicuous virtues, in comparison with junction transistors and transformer coupled valves, relatively few commercial designs exploit these qualities.

As for the third hi-fi fetish, connecting wires, this is less to do with the wires themselves than with the connections made to them, in interconnecting the component units of the complete audio system. It makes little sense to go to a lot of trouble in the circuit design, and then put the results in jeopardy by the use of cheap connectors. For the LS circuit, in particular, there is a great deal to be said for solid screw-down terminals.

So — to summarise the design thoughts so far. The amplifer should employ power MOSFETs in a suitable design, and have good quality wiring connectors. The preamp should have only the necessary facilities, but those that are there should be as good as possible.

The Necessary Facilities

In my own experience, a good quality RIAA input stage, an input selector switch, a volume control, a balance control, a rumble filter and some reproducible means of modifying the relative levels of bass and treble response — where both of the latter circuits must be capable of being switched out — are all that are really essential in the preamp. However, a separate class-A headphone amp is a desirable addition, and if this is included in the preamp, this unit can work on its own. You will infer from this that I prefer the preamp and the power amp to be separate units. This form of construction does make life a lot easier for the constructior. Also, for reasons of practical convenience, I think that it is sensible to house the moving coil head amp, if used, in its own separate enclosure. It can still be powered from the preamp to avoid the inconvenience of battery replacement.

So far as the power amp goes, I

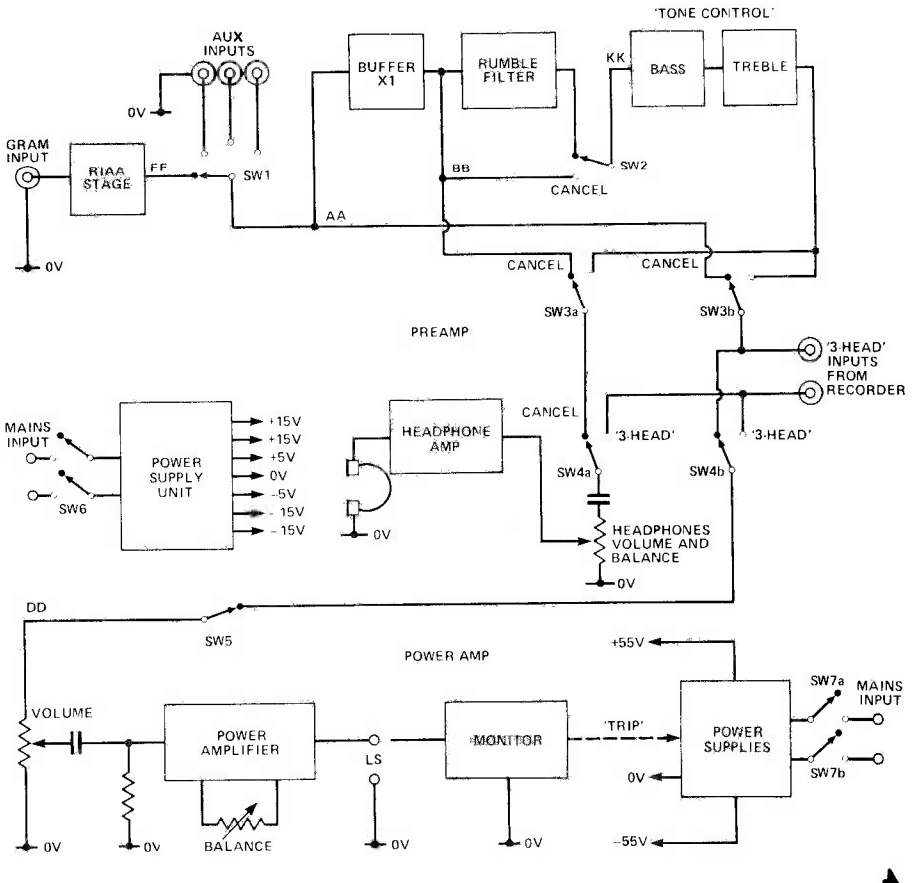


Fig. 1 Layout of the pre-/power amp system.

think that there is a lot to be said for designing this so that it has enough sensitivity (say 150mV for max output) that it can receive signals directly from ancillary units (cassette recorders, tuners and the like) without further amplification — on the grounds that the less one handles signals, the better the final result is likely to be. This implies that the volume control will be at the input to the power amp, and the channel balance control will also require to be included somewhere within the power amp. Fortunately this is easy to organise.

This arrangement also implies that the preamp needs to have provision for a 'straight through' path from the input selector to the power amp input position. The final layout is shown in Fig. 1. A minor point, occasionally exhorted by the hi-fi pundits, is that the overall system is non-inverting in signal phase, and that switching out sections does not affect the overall phase polarity.

Both the power amp and preamp are operated from stabilised power supplies. In the preamp case, these are voltage regulator ICs, and in the power amp, where higher voltages and currents are necessary, a discrete component unit is employed. LS protection is provided without the need for relays or fuses in the output line to the LS. (There are good relays with gold plated contacts, and some fuse holders also are soundly made, however, if one can do without them this must be better). This is accomplished by monitoring the DC offset on the LS line, and switching off the PSU electronically if this exceeds some predetermined value, averaged over a fraction of a second.

This doesn't confer on the circuit the useful facility of disconnecting the LS for a few seconds, following switch-on, to remove the normal switch-on 'plop', for which a relay is so useful, but it is possible, as an option, to connect a clamp circuit across the power amp input, to hold this down to the 0V line for a few seconds after switching on. A junction FET will do this job very well, since it conducts, bi-directionally, until a voltage is applied to its gate to cut it off, when it will become a very good quality open circuit.

This concludes the outline of the design 'architecture'. The only other point which seems worthwhile exploring before we get down to the detailed consideration of the circuitry is what kind of gain blocks we should use. I think that some of the new '741' pin connection op-amps such as the TL071, and the LF351 (or the PMI OP27 if money is less of a consideration) make excellent audio gain blocks. Moreover, for the convenience of the stereo enthusiast, these are available as dual op-amps in their TL072 and LF353 versions. Although I indicated earlier in this series that I thought that it was possible to do this job a little bit better by the use of discrete component 'gain blocks', the advantage is small, and the IC is simpler and more cost effective.

So, what I propose is that these 'discrete component' units should be restricted to the two input gain blocks in the RIAA stage, where their qualities may best be seen. In the case of the tone-control stage, or the rumble filter, my feeling is that if it is necessary to use these signal modifying elements there is an implied admission that the signal is less good than one would wish anyway, so the very slight tonal penalty (and it really is very small) which would be paid by using an op-amp is not likely to be enough to justify more complex and costly alternative circuitry.

Since I have already discussed, and analysed, the design techniques of most of the circuit blocks employed in the preamp (Audio Design. parts 1-7. ETI Sept. 1983 - March 1984), I will not examine them in detail again, except where some additional information would be useful, or where differences in application may modify the circuit choice somewhat.

RIAA Stage

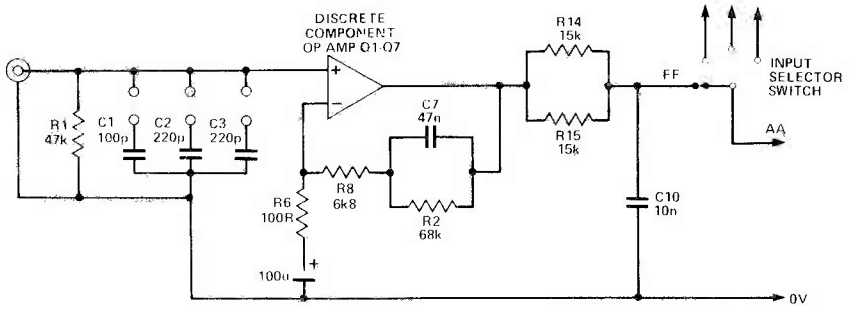
Although in normal circumstances, I would prefer a two-stage input system, using two consecutive active stages, of the type shown in Fig. 10 of part 3 of this series, there is no tonal difference between the use of a passive and an active network as the second stage integrator — it is simply that the passive network will have an attenuation of 10 at 20kHz, which will require the first gain block to have an output at least 10 times greater at this frequency.

However, in the circumstances of this preamp where the output signal level required for maximum power amplifer output is only 150mV, this is not a significant problem, especially in view of the 10V RMS output capability of the gain block used (Fig. 8b, part 3). So, since using the passive network to give the second part of the RIAA attenuation curve will save 16 transistors, it seems a sensible move.

The advantages of breaking down the composite 30Hz - 1KHz, 1KHz - 20KHz RIAA equalisation curve into two separate stages were discussed in part 3 of this series, and in earlier articles of mine, and other writers elsewhere. Unfortunately, there still remain designers to be convinced, I am sorry to say, and it is difficult, by remote control, to have them listen to the two choices so that one may say 'There you are. It does sound better, doesn't it?'. So, may I make the argument that very seldom, in human experience, can one make any device do two different jobs at once with as good a performance as two separate more specialised units. Why therefore should one expect a single gain stage to do two separate equalisation functions simultaneously with equal — let alone better — results than when these functions are separated.

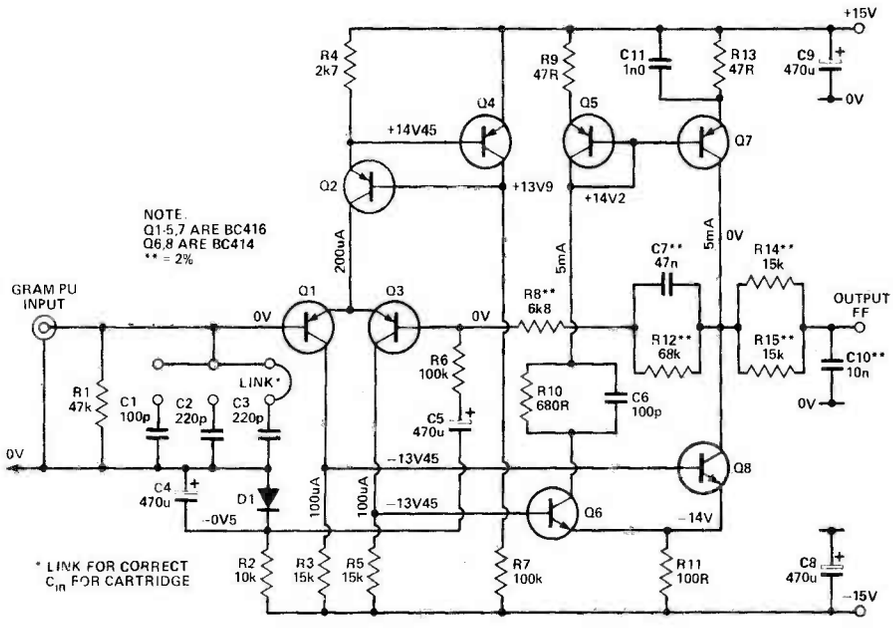
The final gramophone PU input stage therefore becomes as shown in Fig. 2 (Fig. 7 of part 2), and its complete layout as shown in Fig. 3, with the gain block instead of the schematic op-amp diagram. Since for optimum results many PU cartridges require a measure of cap-

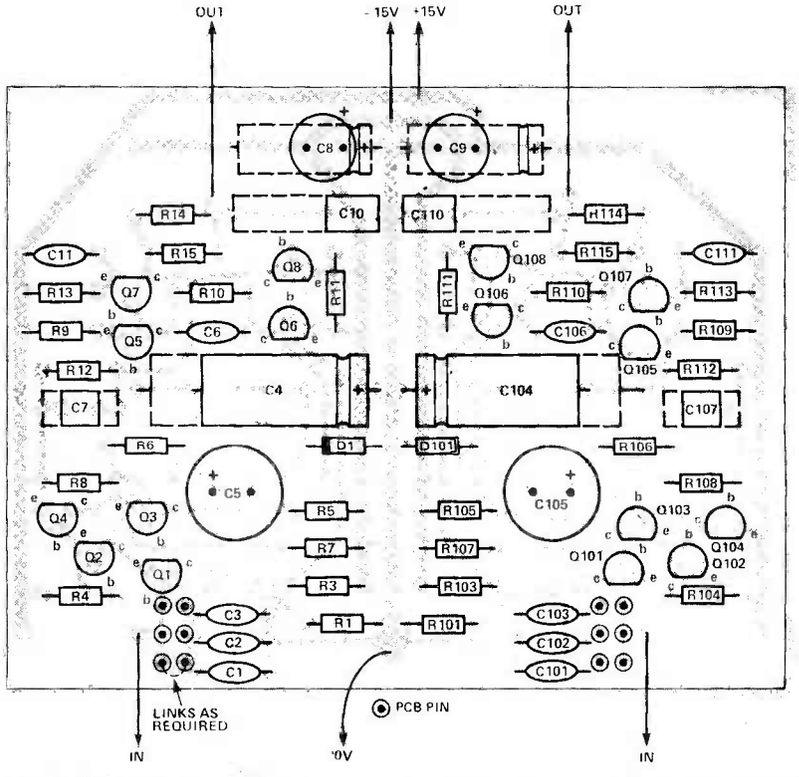
Fig. 2 Simplified circuit of the PU input stage.



PARTS LIST — RIAA STAGE

RESISTORS (all 2% 0.4W metal film)	
R1,101	47k
R2,102	10k
R3,5,103,105	15k
R4,104	2k7
R6,11,106,111	100R
R7,107	100k
R8,108	6k8
R9,13,109,113	47R
R10,110	680R
R12,112	68k
R14,15,114,115	15k
CAPACITORS	
C1,101	100p polystyrene
C2,3,102,103	220p polystyrene
C4,104	470μ 6V3 low ESR electrolytic, tubular
C5,105	470μ 6V3 low ESR electrolytic, PCB mounting
C6,106	100p polystyrene
C7,107	47n polycarbonate, 1%
C8,9	470μ 16V electrolytic
C10,110	10n polycarbonate, 1%
SEMICONDUCTORS	
Q1-5,7,101-105, 107	BC416
Q6,8,106,108	BC414
MISCELLANEOUS	
PCB, wire, etc	





acitative loading in addition to the 47K input resistor, a group of three capacitors are mounted on the board to allow the choice of input capacitance values from 100pF to 540pF by simple bridging of pins on the board.

Fig. 3 Full circuit of the PU input stage; note that if you're cutting costs by using 5% resistors, components marked with ** must be 2% or better.

Fig. 4 Overlay diagram of the PU input stage — note the allowance for different capacitor sizes.

Tone Control Stage

My experience with my rather more elaborate domestic preamp which has a tone control circuit which is capable of modifying the frequency response, in a series of 3dB plateau steps, up or down, at various frequencies, has encouraged me in the belief that this is the kind of tone control to have. However, I do not use all the possibilities it offers, and most of the time it is switched out of circuit. So, in the light of exerience I feel that a simpler, cheaper, and easier to build unit would have served me just as well.

My second thoughts on this stage are shown in Fig. 5. This is largely shown in Fig. 12 in part 4 of this series, but with a few modifications to the component values used. Because two inverting stages are employed, in cascade, the system is non-inverting in phase, and the cancel switch should make no audible difference to the sound if this stage is switched in or out when in its flat response position. Each switch, S2 - S9, generates a click-free modification to the frequency response, in a controlled and reproducible manner. (Note, each 'lift' switch operation should be accurately cancellable by the equivalent 'cut' button, to restore the status quo, as a test of the correct operation of this stage.)

I have only aimed at a small (3dB) step increment or decrement in frequency response given by this stage, because the intention in this design is to compete in the upper audio bracket. If a very large treble or bass cut or lift is needed, it would seem to imply that there is is something badly

amiss elsewhere in the system. It would, I think, be better to try to remedy this where it exists than to try to make the preamp compensate for it. The 3dB value has the merit, in practice, that is is just big enough to be noticeable, without being so big that it is intrusive.

Two LF353 dual op-amps are used to operate this circuit, and these are fed from the + and − 15V lines derived from a pair of IC voltage regulators, and used to power the remaining units in the preamp. Push-on, push-off switches actuate the frequency steps and cancel functions. The frequency response of this circuit is shown in Fig. 7.

PARTS LIST — BUFFER/FILTER

RESISTORS (all 2% 0.4W metal film)	
R1,101	100k
R2,102	330R
R3,4,5,103,104,105	6k8
CAPACITORS (all polycarbonate)	
C1,101	470n
C2,102	100n
C3,103	2μ2
C4,104	220n
SEMICONDUCTORS	
IC1,101	LF353
MISCELLANEOUS	
SW2	3p (min), 2w push-on, push-off
PCB, wire, etc	

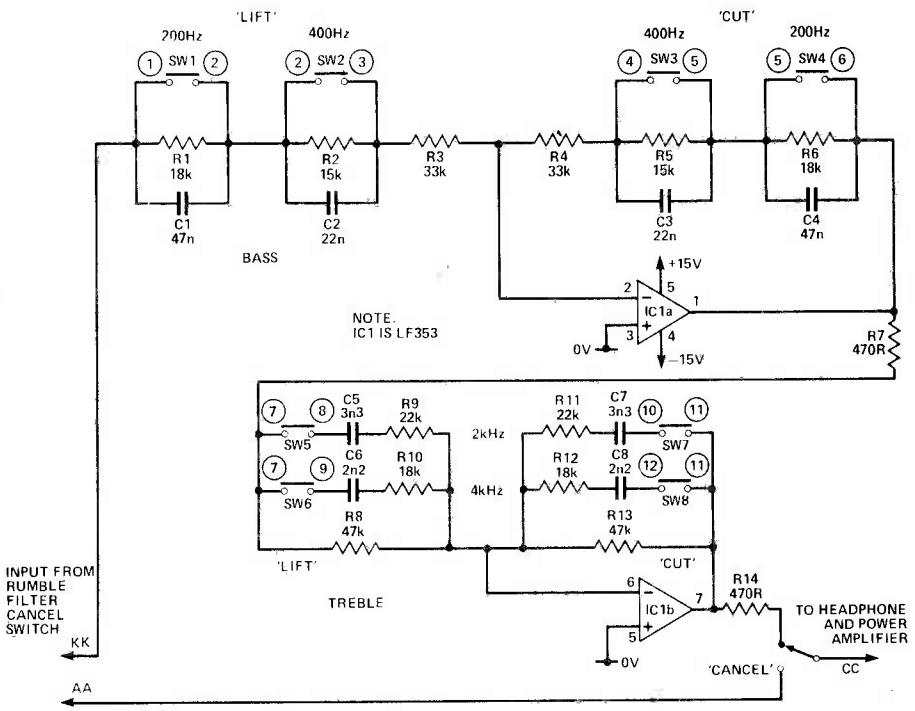


Fig. 5 Circuit diagram of the tone stage.

PARTS LIST — TONE STAGE

RESISTORS (all 2% 0.4W metal film)		**CAPACITORS (all polycarbonate)**	
		C1,4,101,104	47n
		C2,3,102,103	22n
		C5,7,105,107	3n3
		C6,8,106,108	2n2
R1,6,10,12,101, 106,110,112	18k	**SEMICONDUCTORS**	
R2,5,102,105	15k	IC1,101	LF353
R3,4,103,104	33k	**MISCELLANEOUS**	
R7,14,107,114	470R	SW5-12	DPST panel-mounting switches.
R8,13,108,113	47k	PCB, wire, etc.	
R9,11,109,111	22k		

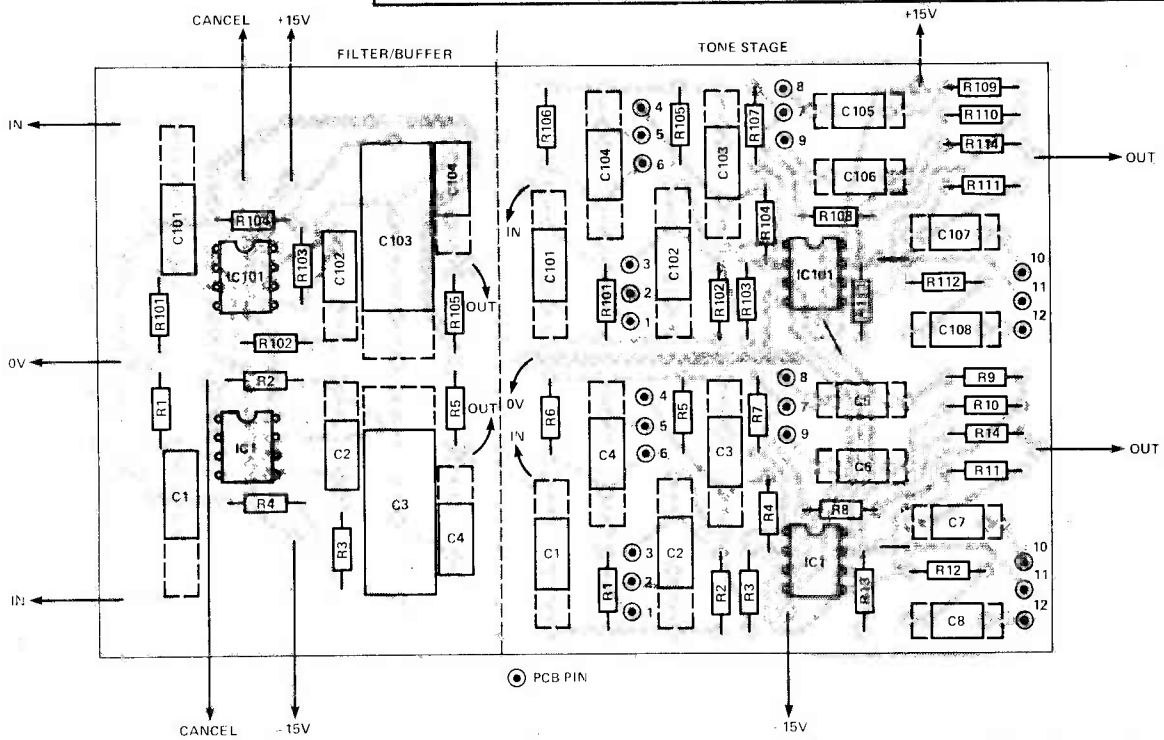
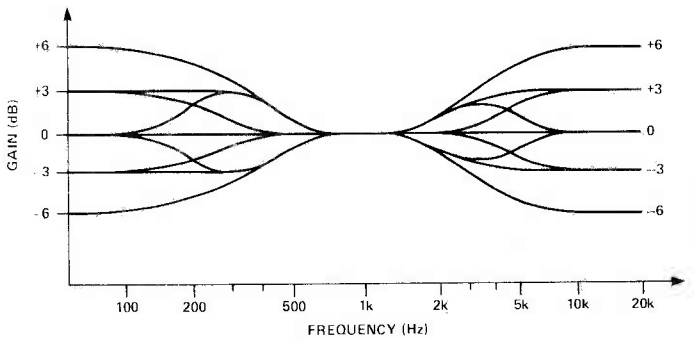


Fig. 6 Overlay diagram of the buffer/filter stage (left) and the tone stage (right). Be very careful not to get component numbering confused!



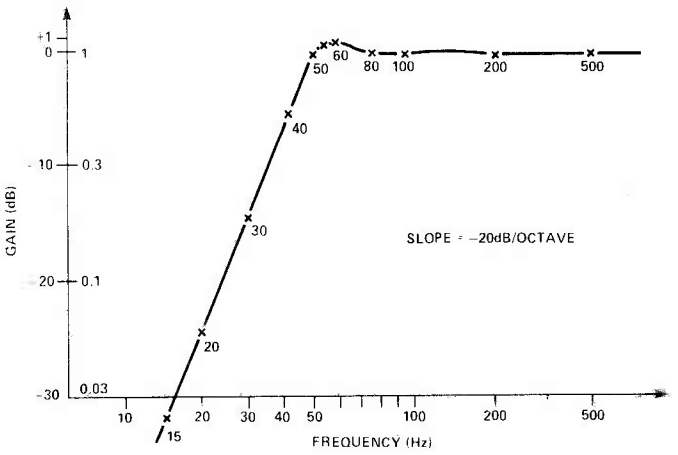
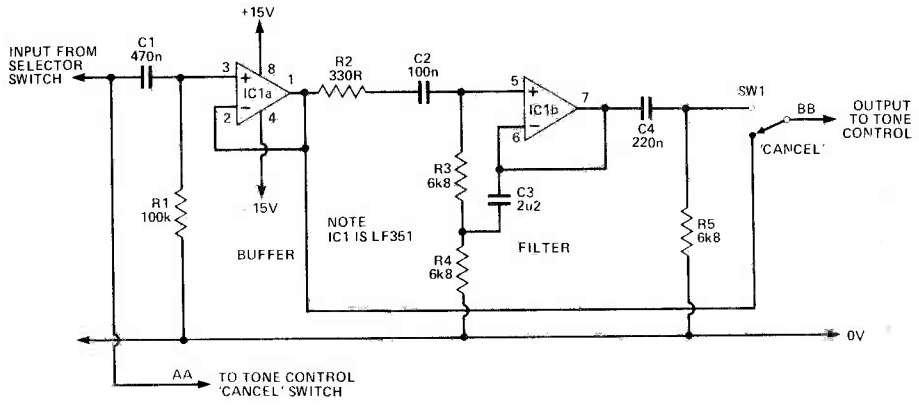


Fig. 7 (above) Response of tone stage.
Fig. 8 (below) Circuit of the buffer/filter.
Fig. 9 (right) Measured rumble filter response.



The Rumble Filter Stage

Some otherwise very good records can suffer from rumble in the recording, and even those played by the BBC are not always free from this fault. If one is lucky enough to have LS units with a good low frequency response, this can be a very irritating problem. My practice, in the past, has been to choose the LF turn-over point at 30-32Hz, on the grounds that, with a −20dB per octave filter slope, this should adequately deal with the rumble components in the 5-8Hz region. Well, I suppose it would, if this is where they were. Unfortunately, experience shows that the really irritating LF noises are often in the 20-25Hz region, and a turn-over frequency of around 50Hz is really needed to get rid of them.

So, where one has this nuisance, it is, in reality, much better to be without it than to try to hold on to such signals as may occur in the half octave between 32 and 50Hz.

The filter block employed is the bootstrap filter circuit shown in Fig. 19 of part 4 of this series, and the frequency response given by the circuit of Fig. 8 is shown in Fig. 9. Again, an LF353 dual op-amp is used to implement this stage, and, as before, a push-button cancel switch is wired to bypass it when better quality programme material is available.

The Headphone Amp

If the preamp is a separate unit from the power amp, it is a very useful thing to have a small headphone amp capable of driving a couple of pairs of phones, within the preamp box. However, if this amplifer is to be an accurate monitor of the signal delivered to the power amp and if, in the sort of architecture proposed for this unit, in many cases the signal from the auxiliary units will be routed directly to the power amplifier, the standard of accuracy and quality of the headphone amp must, if anything, be higher than that for the power amp itself.

Fortunately, the headphone amp has a much easier job to do, in that neither the output power requirements nor the load characteristics are so severe, since headphones typically have a load impedance of 100-2000 ohms, and only require 1-2V max RMS, for normal output. There are of course electrostatics, which may demand 5-10 watts, at loads down to a few ohms, but these are best driven from the power amp anyway, and the '8 ohm' headphones, will require a very low drive voltage anyway.

Since only a low power output is required, a class-A stage is perfectly feasible. Because only smallish output transistors are needed, 10MHz F_t devices are easily found, and, in any case, class-A operation makes the HF response good. The only other thoughts which commend themselves are that the design should be completely symmetrical, and direct coupled to the output, and that where NFB bypass capacitors of electrolytic type are used these should have a polarising voltage across them. It will also help sound quality if the amplifier has few stages, using discrete components, and no slew-rate limiting internal HF roll-off components are needed.

A design which meets these requirements, and gives an excellent sound quality, is shown in Fig. 10, with a suitable PCB layout in Fig. 11.

Since I haven't analysed this type of circuit earlier in the 'Audio Design' series, I will explain how it works, and how the circuit component values are worked out.

The basic amplifer system is as shown in the very simplified layout of Fig. 12. In this, a pair of push-pull input transistors, Q1 and Q2, drive a push-pull pair of output transistors, Q5 and Q6. Negative feedback is taken from the output point to the emitters of Q1 and Q2, and the load is connected between the joined collectors of Q5 and Q6 and the 0V line. For adequate class A operation the output transistors should pass, say, 100mA each. With a ±15V supply, this would mean 1.5 watts dissipation, so a smallish heatsink, perhaps 1.5" square, will be needed

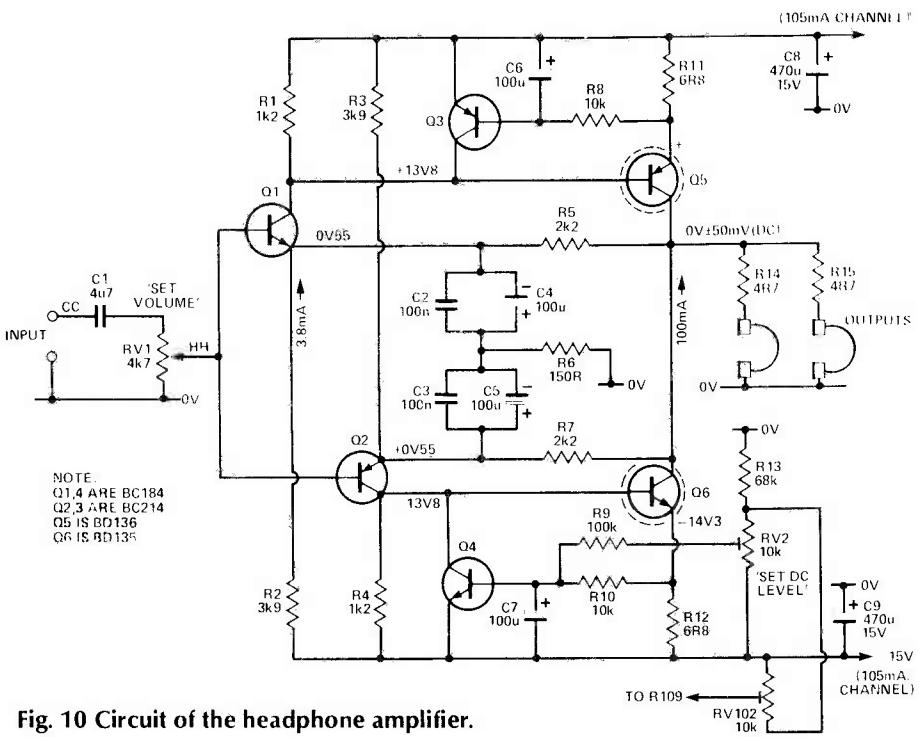


Fig. 10 Circuit of the headphone amplifier.

for each.

If the output transistors have a minimum current gain of 50, then each may require a maximum current input to their bases of 2mA. In order to provide this, with a bit to spare, the input transistors, Q1 and Q2 should normally pass about 4mA. If these have a current gain of 150, their base currents will be .004/150 = 26.7uA, which gives an input impedance of about 19k. The input gain control (and since this has to provide a 'balance' feature too, this should be the twin concentric spindle type) must therefore be a good bit less than this: a value of 4k7 will be fine. Unfortuantely, some of the aux input signal sources will have too high an output impedance to be able to drive this. It is therefore necessary that the input switching (Fig. 1) shall be organised so that the input buffer (incorporated to generate a low source impedance for the rumble filter and the tone control stages) is used also as the headphone amp input buffer, where otherwise a 'straight through' signal path would have been used. (A 3-head recorder system will normally have a 'line' output impedance (600 ohms) so this can drive the headphone amp without problems.)

Returning to the headphone amp circuit, we must now provide a source of emitter current for Q1 and Q2, and a means of controlling the current through Q5 and Q6. Looking now at the full circuit diagram of Fig. 10, the emitter current for Q1/Q2 is derived from the ± 15 volt lines through R2 and R3. For a 14.5V drop and 4mA flow, this would require a resistor value of 3625 ohms. The nearest preferred value is 3k9, which will pass a current of 3.7mA, though some 250uA will also flow through R6 and R8.

Looking now at Q5, (the circuit operation for Q6 is the same), a small resitor (6R8 ohms) in its emitter circuit senses the current flow. If this is too high, a forward bias is applied to the DC amplifier transistor Q3, through R11, (C5 removes all audio signals from this point), which will cause Q3 to conduct and steal drive current from Q5 base, holding the collector currents of Q5 (and Q6 for which the operation is identical) to the chosen average value.

Negative feedback is applied from the outputs of Q5 and Q6 to the emitters of Q1 and Q2. This gives a measure of DC output voltage control, but this can be fine-trimmed by R9, R10 and R12, which operate to adjust the collector current of Q6 relative to Q5. A

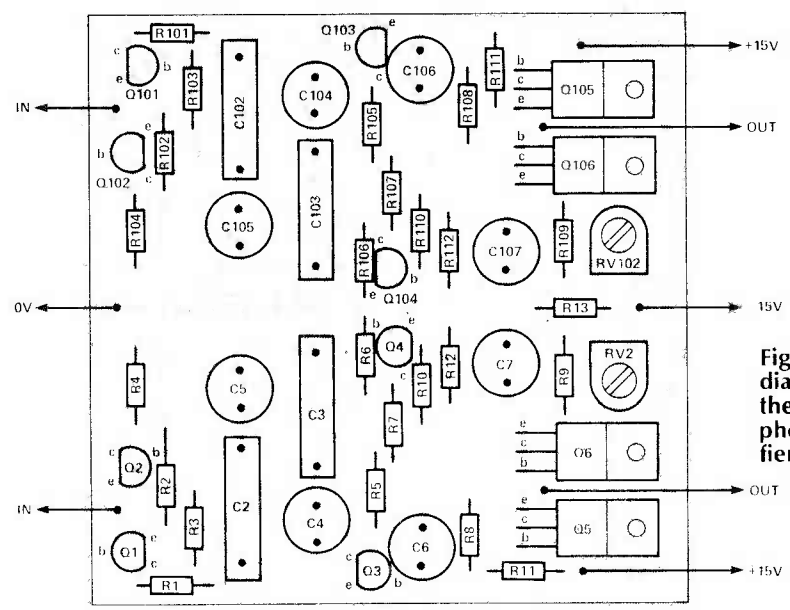


Fig. 11 Overlay diagram for the headphone amplifier.

PARTS LIST — HEADPHONE AMP

RESISTORS (all 2% 0.4W metal film)	
R1,4,101,104	1k2
R2,3,102,103	3k9
R5,7,105,107	2k2
R6,106	150R
R8,10,108,110	10k
R9,109	100k
R11,12,111,112	6R8
R13	68k
R14,15,114,115	4R7
RV1	2k2 twin concentric stereo log pot
RV2,102	10k lin preset, horizontal
CAPACITORS	
C1,101	4μ7 non-polarised
C2,3,102,103	100n polycarbonate
C4,5,6,7,104,105, 106,107	100μ 6V3 low ESR electrolytic, PCB mounting
C8,9	470μ 16V electrolytic
SEMICONDUCTORS	
Q1,4,101,104	BC184
Q2,3,102,103	BC214
Q5,105	BD136 or BD538*
Q6,106	BD135 or BD537*
MISCELLANEOUS	
PCB, wire, etc	

* BD538 and BD537 should only be used together.

DC output level of 0V± 50mV is adequate. Because the bases of Q1/Q2 are joined together, their emitters will sit at −0.55V and +0.55V respectively, which provides a standing 0.55V potential across C1/C2 and C3/C4. C3/C4 should be low ESR aluminium electrolytics bypassed by C1/C2 polypropylene or polycarbonate 100nF types.

On typical headphone load impedances, the output THD is substantially that of the input signal, as is the transient response.

Power supplies

These are quite straightforward, and use a 15-0-15V toroidal transformer, in the interests of low hum field, a bridge rectifier, and two pairs of 15V IC voltage stabilisers. Low equivalent series resistance electrolytic capacitors are used to bypass the output DC lines to the 0V rail, and similar capacitors are used as bypass elements at the supply line connections to the preamp circuit modules. A ±5V take-off point, from another pair of stabilisers is employed, optionally, to power a MC head amp module.

In the next part of this series, I will describe the power amp, its power supplies, and the protection circuits.

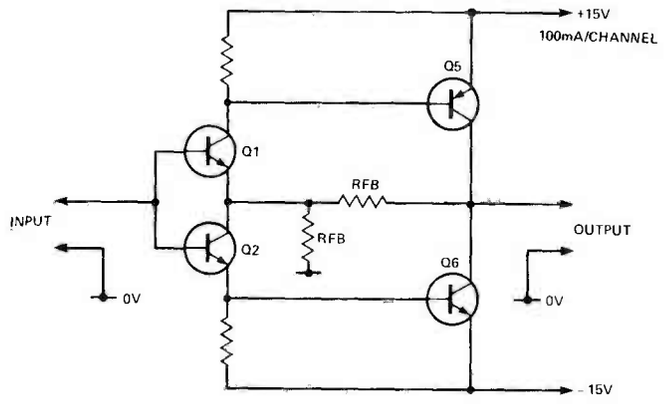
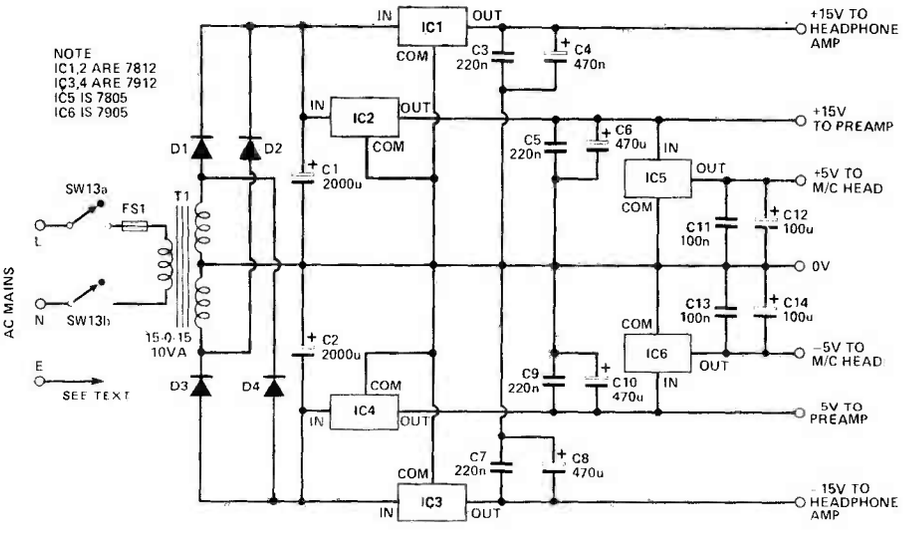
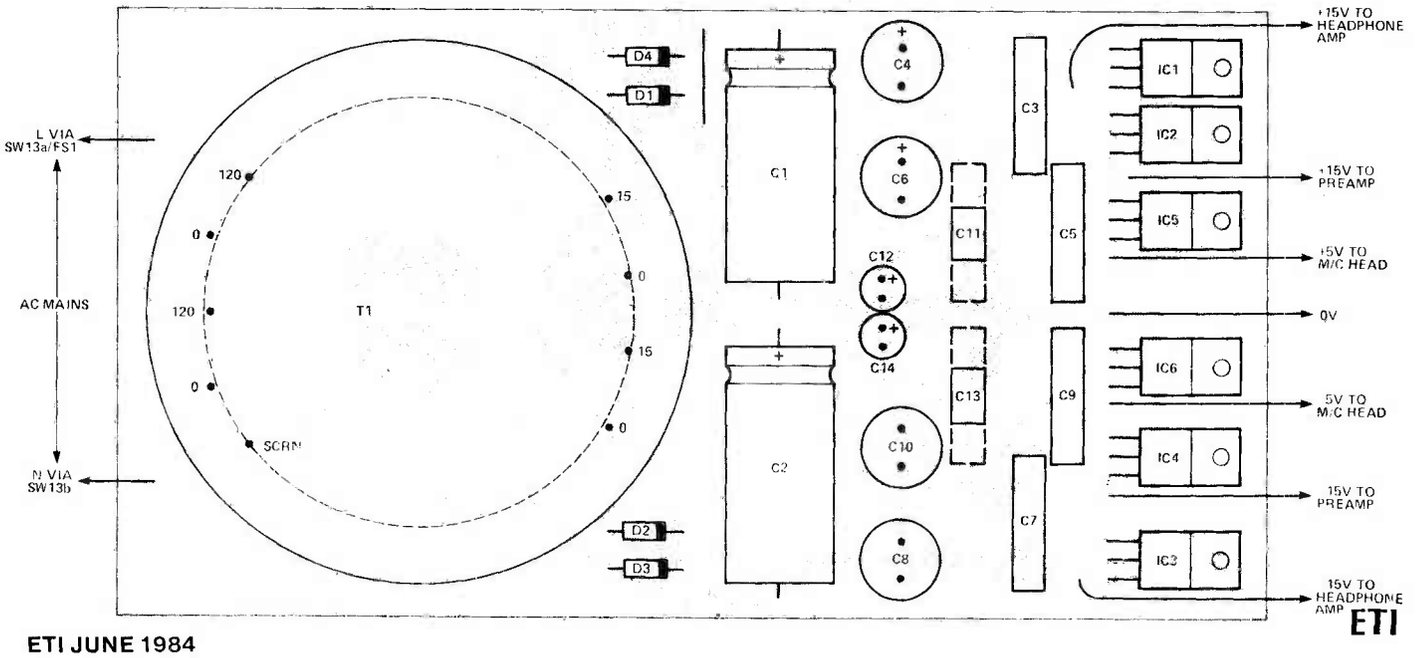


Fig. 12 (left) Simplified headphone amp.

Fig. 13 (below) PSU circuit.

Fig. 14 (bottom) PSU overlay.



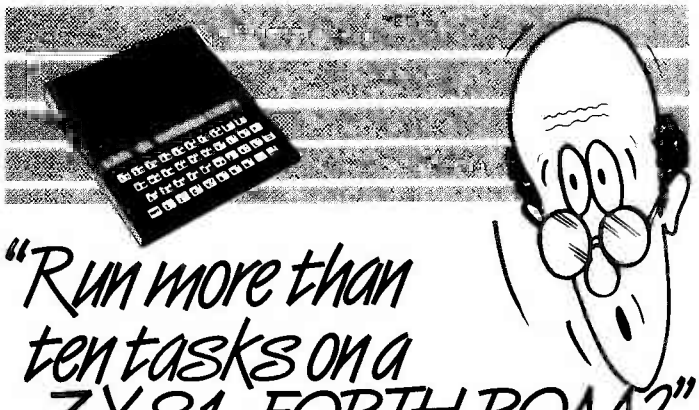


PARTS LIST — PSU

CAPACITORS	
C1,2	2000μ 25V tubular electrolytic
C3,5,7,9	220n
C4,6,8,10	470μ 16V electrolytic, PCB mounting
C11,13*	100n
C12,14*	100μ 10V electrolytic, PCB mounting
SEMICONDUCTORS	
IC1,2	7815
IC3,4	7915
IC5*	7805
IC6*	7905
MISCELLANEOUS	
T1	15-0-15V 10VA mains transformer, toroidal PCB mounting
FS1	100mA fuse + panel-mounting holder
SW13	double-pole mains switch to suit
PCB, wire, etc.	

* = not needed if M/C head amp not used.

ETI



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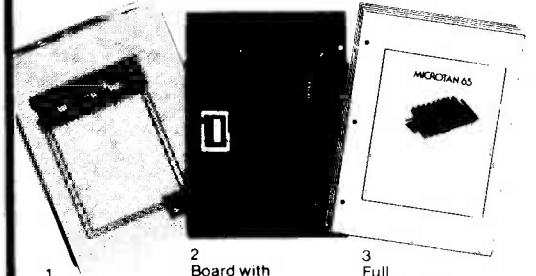

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THE WORLD OF MICROTAN-65

Mike Bedford concludes his survey of what's available for this computer-freak's machine.

TANGERINE USERS' GROUP

To all intents and purposes, Tangerine Users' Group is no more; outstanding creditors can contact the owner, Bob Green, at 1 Marlborough Drive, Worle, Avon. We strongly advise that no one should send TUG any further money. A former director of the company, Colin Nowell, would very much like to hear from those TUG software writers he has not already managed to contact, and from anyone who ordered, but did not receive, a TUG speech synthesiser board. Colin is prepared to help out anyone having any software or hardware problems; his number is 0934 510089, but please be considerate, this is a private number.

All is not lost, though, as regards TUG boards for the Microtan, because Microtanic Computer Systems Ltd, whom we talked of last month, intend to take over most of them. Details of the boards which are set to reappear are given below; however, at the time of writing, these are not yet back on the market, and it would be particularly worthwhile contacting MCS for further details. We have given the old TUG price, but this is **for guidance only:** MCS are having to re-negotiate all the agreements with suppliers and designers, and the prices may well turn out to be very different.

Finally, although MCS are a separate company from TUG, and therefore have no financial responsibility at all to TUG's members and creditors, they have said that they will attempt to deal sympathetically and helpfully with them.

Video 80/82

Although this product is essentially a high resolution graphics board, it is quite different in concept to the high resolution graphics card offered by Microtanic. The first difference is the resolution, this being DIL switch selectable to either the 256 x 256 offered by the MCS product or alternatively 256 x 512. This is not the most fundamental difference however — what makes this board totally different is that it is intelligent, having an on-board 6502A processor running at 2MHz. Used in conjunction with VBUG, the on-board firmware package residing in a 2732 EPROM, this processor removes much of the graphics software overhead from the main Microtan-65 processor.

The following functions are provided by VBUG: clear screen, set point, reset point, invert point, test point, draw vector, undraw vector, invert vector, cursor control, scrolling region control and alphanumeric characters in five widths with underlining, reverse video, superscript and subscript. It will be noted that these commands include the handling of text and since if the 256 x 512 option is selected the format would be 25 lines of 80 characters, this board makes an attractive alternative to the standard Microtan-65 display even without considering graphics.

One inevitable outcome of writing characters on a bit-mapped screen, however, is that scrolling of text is slower than on a dedicated text VDU. To simplify text handling, TUG also sells a TANBUG replacement called TUGBUG, one of the facilities of which is text output routine to the Video 80/82 board.

The board has 16K of 6116 RAM of which only 8K need be fitted for the 256 x 256 resolution. Since the board has its own processor with a memory map where this RAM resides, it does not take a large bite out of the Microtan memory map — in actual fact it only occupies two bytes in the I/O area through which all communication takes place.

There is no modulator on board so if this card is to be used with a monitor, the video signal will require patching through to the modulator on Microtan-65. As was suggested with the MCS high resolution card, three cards could be used in conjunction with a colour monitor to give a colour display.

Prices: board + VBUG V1.1 + manual — £59.25 + VAT; assembled excluding RAM — £137.50 + VAT; assembled including 8K RAM — £157.50 + VAT; assembled including 16K RAM — £172.50 + VAT.

Programmable Graphics Module

This card provides yet another option to obtain high resolution graphics in a Microtan system. This is undoubtedly the least expensive method and although this means it is also the least versatile, it can give effective results in many applications. The approach here is not to replace totally the display circuitry on Microtan-65 but to supplement it by an extra 64 characters which may be

defined under program control to any shape within the 8 x 16 character cell. This gives an effective resolution 256 x 256.

Although a little thought would reveal that this approach does not allow any possible high-resolution pattern to be drawn within the 256 x 256 framework, many applications do lend themselves to this method and animated graphics are in fact easier to implement on this board than on a Video 80/82 or Microtanic high resolution graphics card. In addition to the normal system connection via TANBUS, the PGM also requires a few connections to Microtan-65.

Price: 19.50 + VAT

Combo And EPROM Storage Card

The amount of EPROM space possible within the memory-map of the Microtan system can be a severe limitation to those users with a non-disc based system. Such users could well require access to languages other than BASIC, such as assemblers, word processors, etc, more quickly than loading from cassette would allow. Storing this software in EPROM is the obvious answer but all that is left in the way of EPROM space after installing XBUG and BASIC is 2K.

The purpose of the EPROM storage card (ESC) is to overcome this limitation by providing space for sixteen 2716s or 2732s — a maximum of 64K EPROM space. This space does not reside within the main memory map of Microtan, but instead each ESC has its own memory map, communicating with the system via PIAs and hence only occupying a few bytes within Microtan's I/O area.

To use software stored on the ESC, it is first loaded into RAM memory on TANEX or one of the expansion RAM cards in a similar way to loading from cassette or disc but much quicker. Routines to facilitate this downloading are provided in TUGBUG. The COMBO board is an extension to the ESC concept in which battery backed up 6116 RAMs may be used in place of the 2716s or 2732s hence giving read/write access to 32K with data retention on power down. Recently the 64K ESC has been discontinued in favour of the COMBO which of course may be used as such. In addition a 128K ESC is on the cards (sorry!) but as yet only in prototype form.

Price: COMBO — £20.75 + VAT; assembled — £69.25 + VAT.

64K Dynamic RAM Card

To some extent, one expansion RAM card is very much the same as another and this board's title describes exactly what it does; however a few comments are still appropriate. Unlike TANRAM, which fills in those portions of Microtan's memory map which are not already filled with RAM and EPROM on Microtan-65 and TANEX, this memory card overlays the complete memory map of the system. To avoid the possibility that would therefore exist of having two devices being accessed at the same address, this board has DIL switches which allow the memory to be enabled in 2K segments, hence allowing those blocks already used in the system to be disabled. This allows a large degree of flexibility in that a user may decide, for example, to remove all EPROMs (except TANBUG/TUGBUG) from TANEX, overlaying this area with RAM on the 64K Dynamic RAM Card and calling software into this memory from an ESC or COMBO board as required. The devices used are 4146 64K x 1 dynamic RAMs.

Price: £33.00 + VAT.

CP/M Card

This card has not yet been released and is mentioned here as a future product. The card however has been running for some time in a prototype form so it shouldn't be too long in making an appearance. Not much preliminary information is available as yet except for the fact that this card works on the lines of similar products for some other 6502 computers, utilising a Z80 processor to give a dual processor system which can run the industry standard disc operating system CP/M.

RALPH ALLEN ENGINEERING CO.

This company first became involved in Microtan a number of years ago when they marketed an interface between this machine and the IBM I/O typewriter. Recently, however the company has released an EPROM to RAM conversion card and other TANBUS compatible cards are under development. The address is Forncett End, Norwich, NR16 1HT.

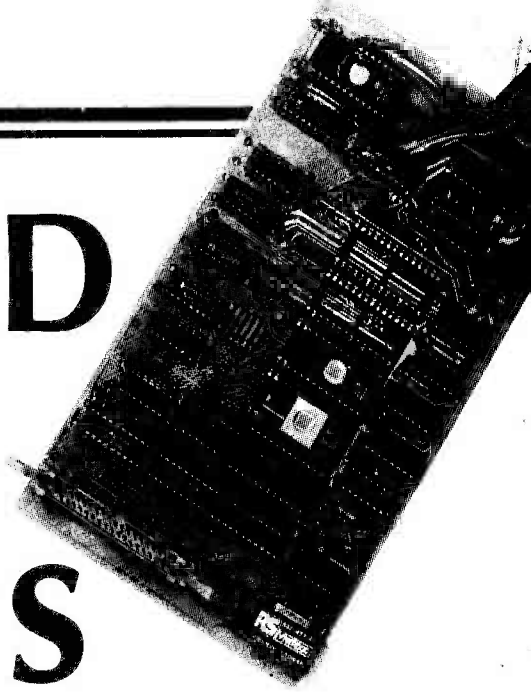
EPROM To RAM Conversion Card

The purpose of this board is to allow the EPROM address space on the TANEX board to be replaced by RAM hence giving the system a full 64K of RAM (less with I/O space and boot EPROM) when used in conjunction with TANRAM. This will be particularly useful to those wishing to use a disc operating system or those who have a library of software on EPROM storage cards which requires to be loaded into RAM. The method of using the card is to remove some or all of the TANEX EPROMs, configure the conversion card to overlay those address areas which are thereby released and plug the card into the system rack. The 14K of available RAM on board may be enabled in blocks of 2K. This card will be of particular interest to those already having a TANRAM card, for those not in this situation it may be a more economic solution to go straight for the 64K dynamic RAM card.

Price: bare PCB — £22.00; built (less 6116 RAMs and buffers) — £46.28.

ETI

EPROM CARD FOR THE ORIC/ATMOS



Phil Walker describes a card that can be used as a way of storing machine code routines, or simply as a computer-controlled EPROM programmer/verifier/duplicator.

An interesting feature of the Oric-1 and the new Atmos home computers is that they have two extra ways of adding machine code routines to BASIC programs. Most machines offer a USR statement which can pass parameters and control to machine code routines and some also have a CALL statement or equivalent. The Oric-1 and Atmos machines also sport ! and & which are recognised by the interpreter as extensions to its usual capabilities. On encountering one of these symbols in a program the interpreter transfers control to routines starting at locations in memory previously specified by the program. In addition parameters following the extension symbol are available to the routine. This makes them much more useful than the simple USR or CALL statements and more like a proper BASIC keyword.

This project is designed to enable the owner of one of these machines to develop machine code routines for graphics, games or other special purposes in non-volatile RAM and at some later date program it into EPROM. Routines already in EPROM may be transferred to the RAM, modified and incorporated into other programs before being put into EPROM. Another feature of this project is that the effective addresses of the EPROM sockets on the board can be modified under program control in 2K blocks. The effective RAM and programming sockets can also be similarly modified and the functions available in any block can be set up at any time by the use of a memory write operation to one of four locations.

The whole board appears to the computer as a block of memory occupying 8K from 8000h to 9FFFh and four locations BFFCh to BFFFh, the latter being the control locations for the configuration and EPROM programming functions. The main memory block was chosen both from the ease of decoding point of view and to be reasonably out of the way of normal use of the machine. However if hi-res graphics are used on a 48K machine there may be some conflict with the character sets between 9800h and 9FFFh.

Facilities

This project has been designed with machine code programming in mind but could be used equally well to provide access to blocks of data which are permanently stored in EPROM. It provides all the facilities needed to develop and store routines in association with one of the assembler programs available. A notable feature of the project is that up to four EPROMS can be accommodated on the board each up to 8K x 8. These can be selected in 2K blocks and used directly or copied into the on-board RAM for modification. This can be very useful if, for example, you have a large machine code program in a 8K x 8 EPROM; you can copy 2K of it into RAM, modify it and run it before programming the whole lot into another EPROM.

Another way to use this project is to build up a library of routines in EPROM, possibly up to 64K in total, and to select any of them at will with the minimum of fuss.

The project is not designed as a straight EPROM copier but it can perform that function too by way of the on-board RAM or the main memory and some simple software. The programming section operates on a one byte at a time basis and from one to 8192 bytes can be programmed into the target device with standard handshake operation. Timing in programming mode is derived from the mains input frequency (beware 60Hz areas!).

The main feature of this project is that the function performed by each 2K block of addresses in the 8K total can be programmed individually to be one of four functions. These can be:—

a) Read only from any one EPROM socket;
b) Read from an EPROM socket, write into the RAM;
c) Read and write to the RAM;
d) Read EPROM programming socket, program a byte into EPROM in socket.

Thus the RAM can be set to occupy any or all of the 2K slots, any EPROM socket can be enabled in any 2K slot, the RAM

and an EPROM socket can be selected for writing and reading respectively at the same address slot and the EPROM can be programmed at any or all address slots.

All these functions are selected by writing data into control addresses separate from the main address range. There are four of these control addresses, one for each 2K address slot. Each control address responds to four data bits: D7 and D6 control the function to be performed and D1 and D0 select which EPROM socket is to be used (if any). These codes are written into a fast bipolar memory and stored as four words of four bits each. When written, their location in the memory is determined by address bits A1 and A0 but when read for use by the control logic the required word is selected by address bits A12 and A11. It should be noticed that the data input and output terminals of this device are totally separate and are separately and independently controlled.

The use of such a device effectively allows the address-decoding of the board to be reconfigured at will with no hardware changes and a minimum of software intervention. In this circuit, the two data bits used to set the function are decoded with the addition of the R/$\overline{W}$, φ2 and $\overline{SEL}$ signals to give eight possible combinations. These are then combined to give the three main control signals for the EPROM sockets, RAM and programming logic.

The signal to the EPROM sockets is further decoded with the remaining two data outputs from the configuration RAM to select a particular socket. The RAM control signal goes to the RAM via the power fail circuitry. Lastly the programming signal passes to the programming logic where it and the state of the R/$\overline{W}$ line determine the next course of action.

Whenever the programming function is accessed, the state of the R/$\overline{W}$ line is sampled at the end of the cycle. If it is high throughout, then the relevant buffers are enabled to allow data to be read from the device in the programming socket. No other action is taken by the logic in this case. If, however, the R/$\overline{W}$ line is low during an access, then the current address on A0 to A12 and the contents of the data bus are captured in latches and, at the end of the cycle, the low state of the R/$\overline{W}$ initiates a programming sequence. This then puts the data in the latch into the EPROM at the address stored in the address latch. The logic is arranged such that no computer intervention is required or possible during a programming sequence. The only thing possible is for the computer to read any of the control addresses and set data bit 7 which will be high during programming and low when it has finished.

The programming section has been designed with the 25XX series of EPROMs in mind but 27XX series devices should be possible with a little modification to the wiring of the socket. Note that only single supply devices are permitted.

When using EPROMs in the non-programming sockets it is necessary to connect the associated links to reflect the type used.

Construction

The PCB for this project has been made with plated-through holes. Although this costs a little more than the same design without through plating, we feel that this is more than offset by the easier construction and lower possibility of missed links especially underneath IC sockets. From experience with the prototype, we know it takes a very long time to solder all the through-links on both sides of the board and it is easy to miss one or forget to solder a component on both sides where necessary. If you decide to make your own board you will find out what we mean!

The order of construction we recommend for this project would be to start with (through links on your own board then) IC sockets

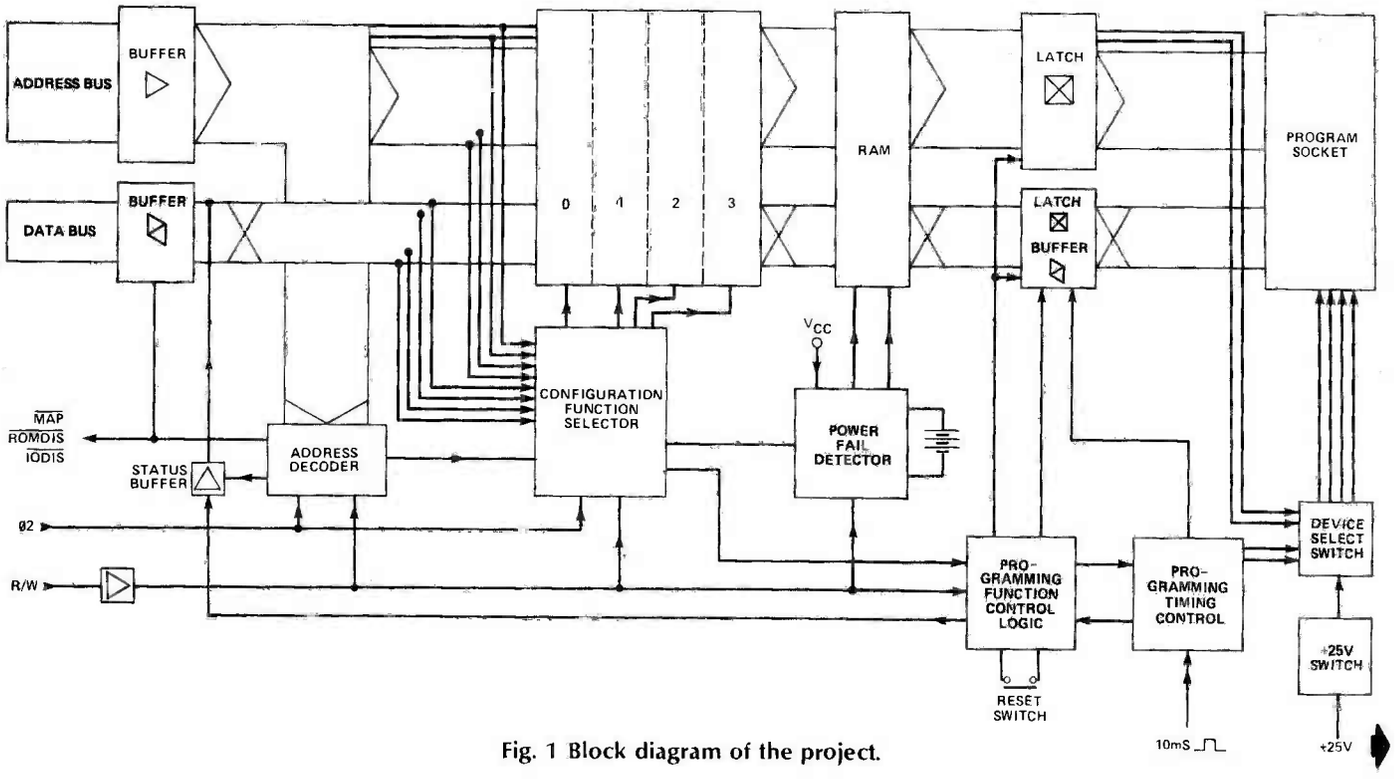
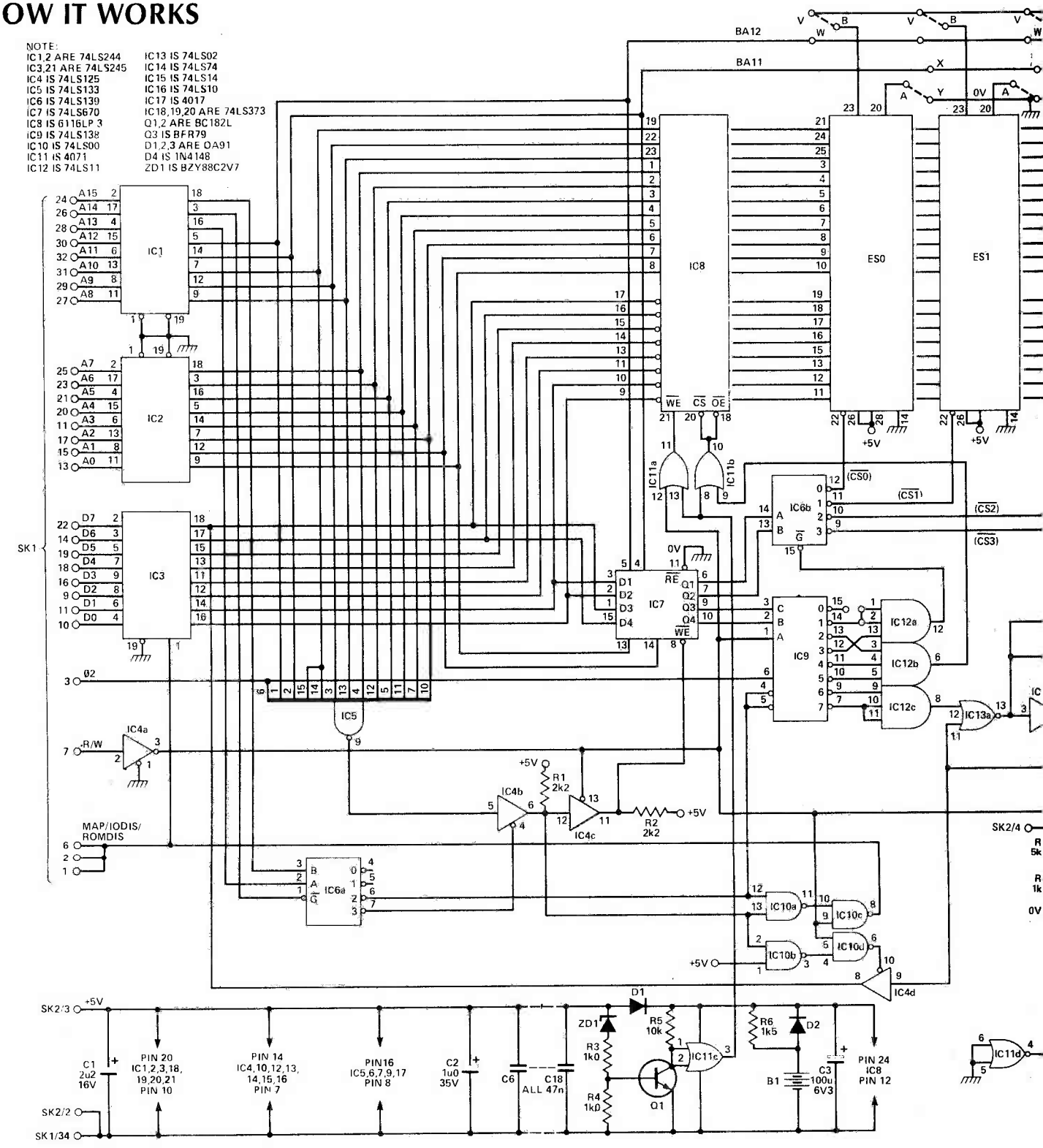


Fig. 1 Block diagram of the project.

HOW IT WORKS



This project divides into two major parts. The first is the memory and its associated control logic while the second is the programming socket and timing control.

All the address and data lines from the ORIC or ATMOS are buffered by IC1, 2 and 3. IC3 is a bi-directional buffer which is normally set to drive the board DATA bus rather than back into the computer. Only when a read operation is performed which accesses the on board memory or control function does IC3 drive towards the computer.

The R/$\overline{W}$ line is buffered by IC4a since there are six TTL inputs driven from this line and it would probably be overloaded. The φ2 line is not buffered as it only drives two TTL inputs and this is usually allowable. The same signal which controls the direction of IC3 also serves to disable the memory and I/O functions in the computer so that no disagreements occur with two devices trying to drive the data bus at the same time.

IC6a decodes the three top address bits to give outputs which are active in the ranges 8000h — 9FFFh and A000h — BFFFh. The first of these is used to activate the memory function while the second is used to enable IC4b. The other input to IC4b comes from IC5 which is a 13-input NAND gate. The inputs to this gate are φ2 and A2 to A12 inclusive. The output of IC5 will be low when φ2 is high and the address bus contents are:— XXX1 1111 1111 11XX (X=don't care). Only when the output of IC5 is low and the enable input to IC4b is low can the output of IC4b go low. The enable input will be low when the address bus pattern is:— 101X XXXX XXXX XXXX and therefore IC4b output is only low for addresses:— 1011 1111 1111 11XX which fall in the range BFFCh to BFFFh and the φ2 signal is also high. These four addresses are used to write into the control logic and read from the programming logic.

When a WRITE operation is performed to one of the four addresses, the output of IC4c will go low and allow data to be written into IC7. This device is a four-word, four bits per word memory. When writing data into it, the

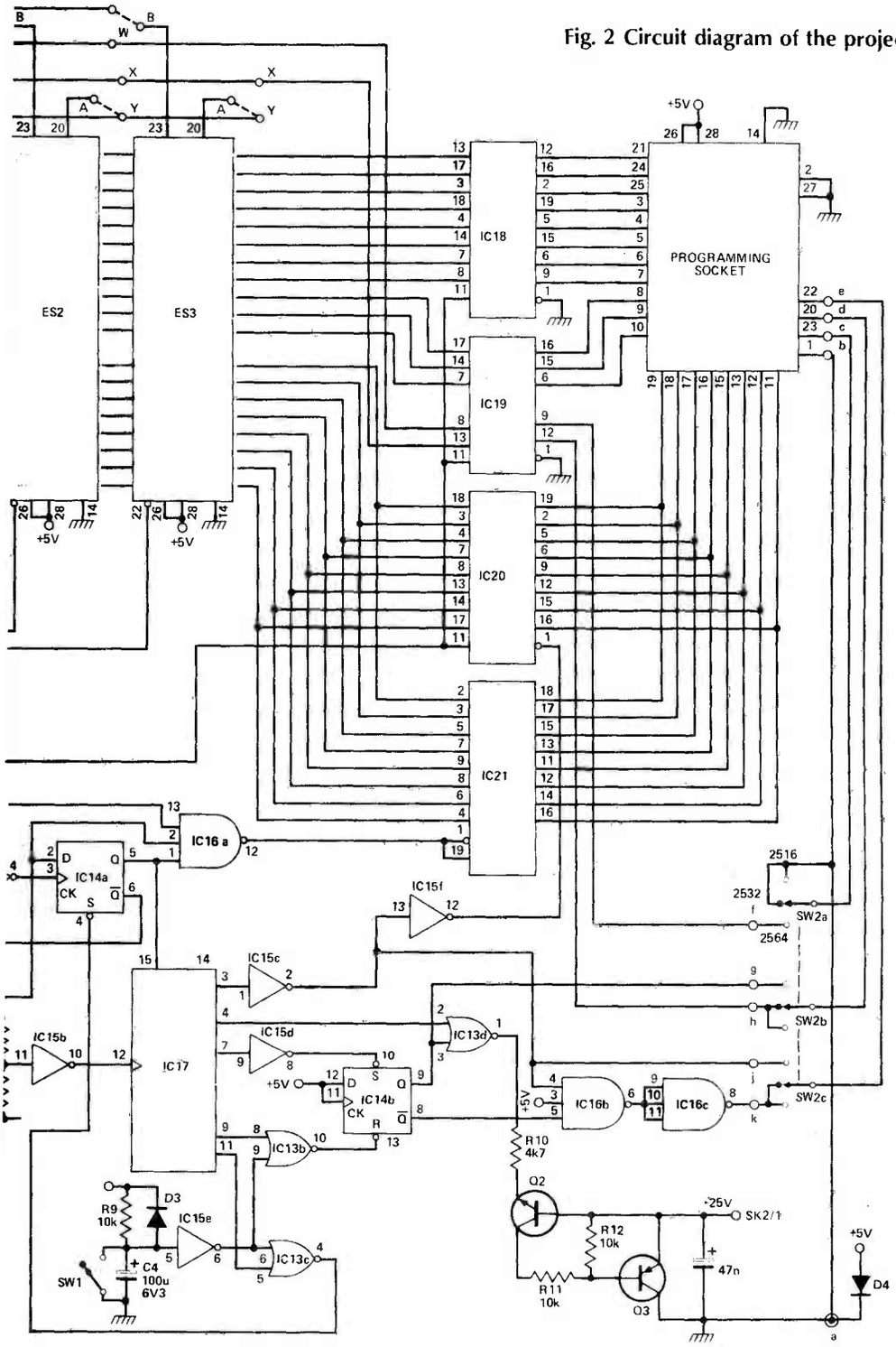


Fig. 2 Circuit diagram of the project.

See scan of centre circuit for more information

word to be written is selected by address bits A0 and A1 and the data is taken from data bits D0, D1, D6, D7. (Note that there is no way to read the stored data back into the computer!)

If a read operation is performed to any of the four control addresses it will cause IC4d to be enabled via IC10b and IC10d. This will put the state of the programming status logic on to bit 7 of the data bus.

When an address in the range 8000h to 9FFFh is written to or read from, the relevant output from IC6a activates IC9 and IC10a. The output from IC10a and the state of the R/$\overline{W}$ line will activate IC10c if a READ operation is in progress. This will set its output low causing IC3 to drive towards the computer and set the MAP, IODIS and ROMDIS pins on the computer connector low to turn off its internal memory and I/O functions.

Also, A11 and A12 connected to IC7 will select one of the four words stored in it and present it to IC6b and IC9. The bits presented to IC9 correspond to the original D6 and D7 and are used to select the function to be used. The two bits from IC7 and the R/$\overline{W}$ line cause one output from IC9 to go low when $\varphi 2$ is high and the address decode function from IC6a is low. These outputs are combined in IC12a, b and c to give outputs to enable the EPROM sockets, the RAM or the programmer. The two remaining bits from IC7 are passed to IC6b and select the EPROM socket to be accessed when enabled by the output from IC12a. These bits correspond to D0 and D1 of the original data and now represent 2K blocks of memory space.

The output from IC12a activates the EPROM sockets, from IC12b the RAM and from IC12c the programmer logic. The circuitry around IC11 and Q1 and D1, D2 and B1 ensures that the power supply to IC8 never drops too low and that the $\overline{WE}$, $\overline{OE}$ and $\overline{CS}$ inputs are held high and inactive when the main power supply is absent or low.

PROGRAMMER SOCKET FUNCTIONS

When IC7 has been programmed such that IC12c is activated by a read operation and no programming is in progress, the output of IC13a will go high and cause IC18, 19 and 20 to capture the current state of the address and data busses. Also as the R/$\overline{W}$ line will be high and IC14a Q output will be high, IC16a will be low and will enable the buffer IC21 to transfer data from an EPROM in the program socket to the data bus. At the end of the memory cycle as the output of IC13a goes low the state of the R/$\overline{W}$ line will be latched into IC4a. If this was a read operation then IC14a will stay in its set state (Q output high).

When the same conditions are set up but a write operation is in progress, the only difference is that IC16a output remains high and thus IC21 is not enabled. However at the end of the cycle, when the current state of the R/$\overline{W}$ line is clocked into IC14a, it will send the Q output low and the $\overline{Q}$ output high. The high level on the $\overline{Q}$ output holds the output of IC13a low and effectively prevents further read and write operations to the programming socket for the time being. This output also forms the status output from this part of the logic and a high level shows that the programmer is 'busy'.

When the Q output of IC14a goes low, this removes the reset signal from IC17. Now this device can respond to the 10ms pulses on pin 12 derived from the rectified mains by IC15b. The first pulse sets pin 3 low which in turn drives IC15c output high and IC15f output low. This last output enables the output from IC20 which has previously stored the data on the data bus to be programmed into the EPROM. The output from IC15c is also used to drive one pin of a 2516 EPROM or indirectly via IC16b and IC16c for 2532 and 2564 devices.

After the next 10ms pulse, IC17 pin 4 goes high and forces IC13d output high. This turns Q2 and Q3 on thus switching the +25V supply through to the EPROM.

The next pulse sends IC17 pin 7 high and hence IC15d output low. This sets IC14b Q output high and keeps the +V supply on via IC13d. The Q output forces IC16b output high and hence IC16c output low. The $\overline{Q}$ output is also used as input to 2516 devices.

The next four pulses cause no changes in the logic states, but the next pulse after these causes IC17 pin 9 to go high which then puts IC13b output low. This resets IC14b Q output low and $\overline{Q}$ output high and turns off the programming voltage.

The last pulse puts IC17 pin 11 high which forces IC13c output low which sets IC14a Q output high. This then resets IC17 to have pin 3 high and signals the end of a programming cycle by the $\overline{Q}$ output of IC14a going low.

IC15e, C1 and R9 form a power-on-reset function which forces IC13b and IC13c outputs low for a short time to ensure that IC14a, IC14b and IC17 are in the correct initial states.

SW2 is used to select the correct logic signals to program 2516, 2532 and 2564 EPROM devices. For 27XX devices some rearrangement of wiring may be required.

then terminal pins, resistors, diodes, capacitors (take care that there is enough space for ICs), transistors and connectors. Do not fit the battery yet. Check at this stage that the +5V supply line is not shorted to 0V and that it is connected to all the IC sockets except IC11 (there is a germanium diode in there). Check also that the 0V rail is connected to all IC sockets. Check carefully that the tantalum bead capacitors are the right way round and also check the diodes and transistors.

Once this has been done and any faults corrected you are ready to start inserting ICs and testing the board. It would be advisable to have a fine pointed soldering iron with a 15W element or temperature controlled if possible. A solder sucker is almost essential if you make a serious mistake on this type of PCB. Be very careful to avoid creating solder bridges between adjacent tracks or lifting tracks by excessive heat.

Setting Up And Testing

For the present you will need a supply to give 5 volts at up to 500 mA. Whenever you insert or remove ICs this power supply should be disconnected from the board.

The first stage in getting the project working (if you are not so reckless as to put all the ICs in, turn on and tune for minimum smoke) is to put IC1,2,4,5,6 and 10 into their sockets. Notice that all the ICs on the board are the same way round — make sure yours are too!

With a few miniature test probes connect SK1 pin 26 and 28 to 0V. With +5V applied to the board check that IC6 pin 6 and SK1 pin 1,2 and 6 are low. Connect SK1 pin 7 to 0V and check that SK1 pin 1,2 and 6 is now high. Remove the 0V connection from SK1 pin 28; no change should occur at SK1 pin 1,2 and 6 (still high) but IC6 pin 7, IC4 pin 6 should now be low and IC10 pin 6 high. Now remove the 0V connection from SK1 pin 7 and SK1 pin 1,2 and 6 should go low along with IC10 pin 6 and IC4 pin 11. If all went well remove the +5v supply and insert IC3,7,8,9,11 and 12.

Now you can connect the board to your computer using a length of ribbon cable and two IDC plugs. It is most important that the ribbon cable linking the board to the Oric should be only two or three inches long. Total failure to read EPROMs correctly was caused by a 12 inch cable, due, possibly, to capacitance loading as there does not seem to be any internal buffering on the address lines. Glitches on the address lines when the long cable was used caused the chip select for the EPROMs to be less than 200 ns wide — not enough to ensure that valid data was ready in time for the processor to read it.

Connect the +5V and power-up your computer and all should be well. Your ORIC or ATMOS should now display its normal start-up message and be ready for use. A POKE to addresses BFFCh to BFFFh will access the configuration memory IC7; each address in this range corresponds to one of the 2K blocks in the range 8000h to 9FFFh. For testing purposes, POKE 80h to all the control addresses which should allow access to the RAM in all locations (ie. the RAM repeats four times in the 8K memory space occupied by this project). It should now be possible to read and write to the RAM normally.

If a programmed EPROM is available, it can be inserted into one of the sockets on the board. Its associated links A and B should be set to the correct positions for its type. Now by POKEing 40h (if ES0 has been used or 41h, 42h, 43h for ES1, ES2 or ES3) into one of the control addresses, say BFFCh, the EPROM contents may be copied into the RAM by POKEing the data PEEKed from each location back into the same location.

POKEing 00h (01h, 02h or 03h) into the various control addresses causes their associated memory spaces to access the EPROM socket specified as read-only memory. POKEing 50h, etc, to the control addresses allows reading only from the EPROM sockets and writing only to the RAM at the same address. POKEing 80h, etc, accesses the RAM for reading and writing.

Now that the memory side of the board is working, it is time to start on the programmer circuit. With the power supply disconnected and the board unplugged from the computer, plug in the rest of the ICs but temporarily remove IC12. Connect the +5V supply but not the computer for the time being and monitor IC14 pin 5. Initially this should be at a logic high level, as should IC14 pin 8. Monitor IC16 pin 12 and momentarily connect IC13 pin 12 to 0V: this should cause IC16 in 12 to go low momentarily but IC14 pin 5 will stay at a high level. Repeating this with SK1 pin 7 held low, IC16 pin 12 should stay high but now IC14 pin 5 should go low. Also IC13 pin 13 should be permanently low, whereas with SK1 pin 7 high it should be the inverse of the input at pin 12. To get back to that situation, SW1 may be closed momentarily to reset the logic.

If possible, connect a low frequency oscillator to the junction of R7 and R8. Frequency should be about 1 Hz and amplitude +5V unipolar. Monitor IC15 pin 2, apply a logic low level to SK1 pin 7 and momentarily bring IC13 pin 12 low. IC15 pin 2 should start off low, go high for about 8 secs and then go low again. During this time, IC13 pin 1 will go low for 6 secs and IC14 pin 8 for 5 secs.

Control Address	Controlled Address block
BFFCh (49148)	8000h — 87FFh (32768 — 34815)
BFFDh (49149)	8800h — 8FFFh (34816 — 36863)
BFFEh (49150)	9000h — 97FFh (36864 — 38911)
BFFFh (49151)	9800h — 9FFFh (38912 — 40959)

Table 1 Relationship between control address and controlled address blocks.

Control Word Bits		Control Function
D7	D6	
0	0	Read only from selected EPROM socket*
0	1	Read only EPROM socket*, write only RAM
1	0	Read and write RAM
1	1	Read Programming socket or Program EPROM in it

Table 2 Function select bits of control word in control addresses.

Control Word Bits		EPROM socket selected
D1	D0	
0	0	ES0
0	1	ES1
1	0	ES2
1	1	ES3

Table 3 Socket select for

BUYLINES

Despite the complexity of this project, there are few problems here. The battery is the only one we can think of: we used an RS type (stock number 591-477); you may have to use your initiative! The PCB is, as ever, available through our PCB service.

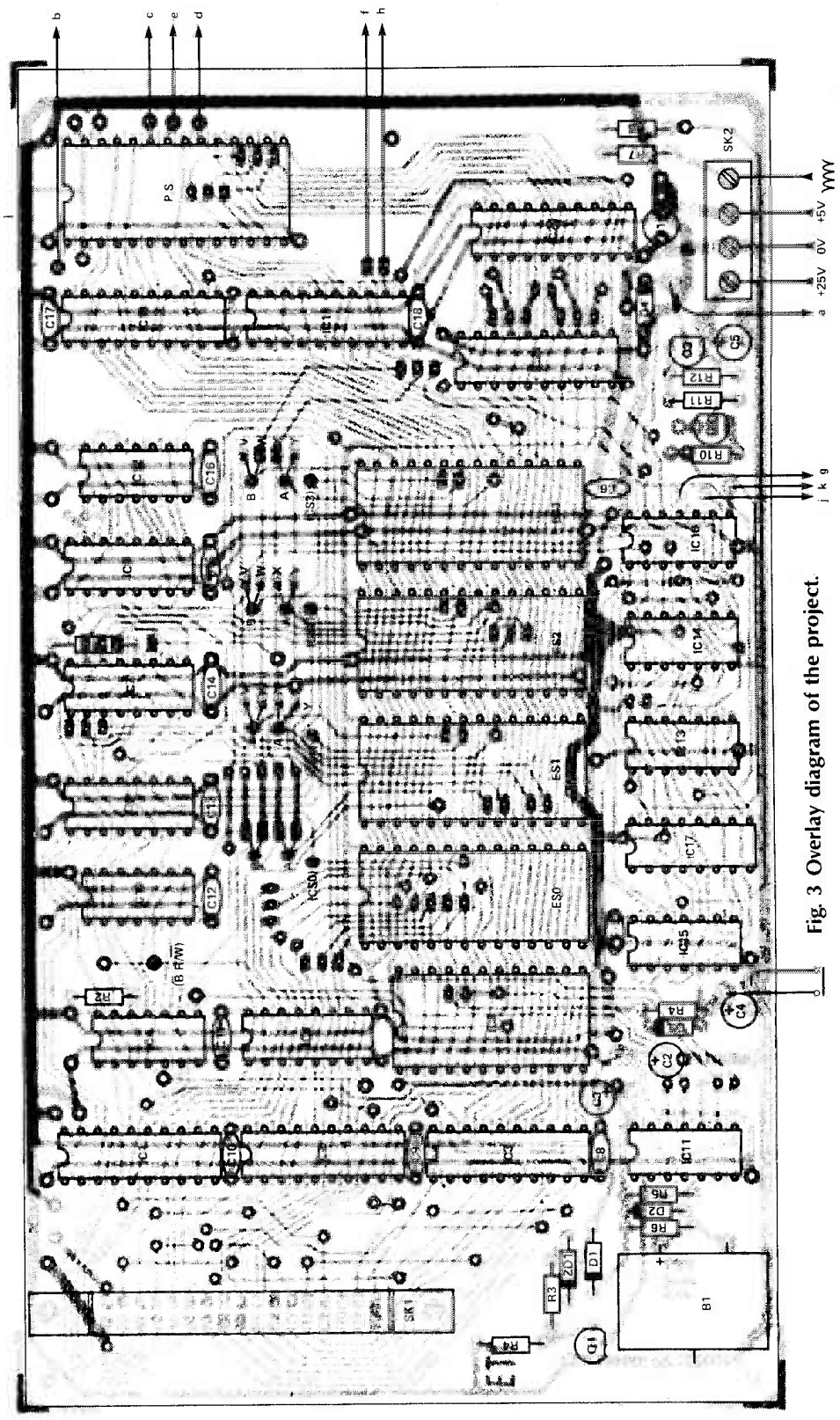


Fig. 3 Overlay diagram of the project.

PARTS LIST

RESISTORS (all 5% carbon film ¼ watt)

R1,2	2k2	
R3,4,8	1k0	
R5,9,11,12	10k	
R6	1k5	
R7	5k6	
R10	4k7	

CAPACITORS

C1	2u2 16V Tant. bead	
C2	1u0 35V Tant. bead	
C3,4	100u 6V3 Tant. bead	
C5-18	47n Min. ceramic disc (14 off)	

SEMICONDUCTORS

IC1,2	74LS244
IC3,21	74LS245
IC4	74LS125
IC5	74LS133
IC6	74LS139
IC7	74LS670
IC8	6116LP-3
IC9	74LS138
IC10	74LS00
IC11	4071
IC12	74LS11
IC13	74LS02
IC14	74LS74
IC15	74LS14
IC16	74LS10
IC17	4017
IC18,19,20	74LS373
Q1,2	BC182L
Q3	BFR79
D1,2,3	OA91
D4	1N4148
ZD1	BZY88C2V7

MISCELLANEOUS

B1	PCB mounting Ni-Cd 3V6 100mA-h if required
SW1	Single pole push button switch, normally open
SW2	3 pole 3 way switch (slide type or rotary wafer)
SK1	34-way IDC socket PCB mounting (also 2 off plugs plus ribbon cable)
SK2	4 way PCB mounting screw connector
	DIL sockets: 8 off 14 pin, 5 off 16 pin, 7 off 20 pin, 1 off 24 pin, 5 off 28 pin (one may be ZIF type): Veropins, wire etc; PCB.

Using the same procedure it should be possible to check that the correct signals appear on the programming socket via SW2.

If all is well so far, remove the oscillator and connect the programming suppy to SK2 pins 1 and 4 as shown on the diagram. Repeating the above procedure should not put pulses of +25V on the selected pin(s) of the programming socket and suitable logic levels on the others. The actual sequence is best checked with an oscilloscope if one is available.

Having reached this stage, IC12 can be replaced and you should have a fully operational board which can be reattached to your computer. If you wish to make the RAM on board non-volatile, the NiCad battery should be soldered onto the PCB. This battery should be charged, before serious use is made of the board, at 10mA for 14 hours. After this, periodic use should keep it topped up but occasional charges at 1 mA in addition are advisable.

If you find that the start up routine of the computer is corrupting the RAM contents then fit a switch across R4 and close it to protect the RAM. (You cannot read it with this switch closed.) Note, also, that the programming supply switches between +5v and +25v.

Programming 27XX Series Devices

Although the project was not designed for it, there should not be too many differences to take account of when programming 27XX series devices so long as single rail only types are used. In fact, 2716 devices should work in place of 2516 without modification. The details for other types should be as follows:

2732 types:
remove D3, connect 4k7 resistor from collector Q3 to 0V;
connect collector Q3 to pin 22 on socket;
connect IC19 pin 12 to pin 23 on socket;
connect IC16 pin 8 to pin 20 on socket;

2764 types:
cut tracks to pins 2 and 27 under PCB;
connect IC19 pin 9 to pin 2 of socket;
connect IC19 pin 12 to pin 23 of socket;
connect Q3 collector to pin 1 of socket;
connect pins 20 and 22 on socket to 0V;
connect IC14 pin 8 to pin 27 on socket;
The 2732 and 2764 connections are instead of the switch.

EPROM Type	Links
2516	A-Y, B-V
2532	A-X, B-V
2564	A-X, B-W
2716	A-Y, B-V (1)
2732	A-Y, B-X (1) (2)
2764	A-Y, B-X (1) (3)

Notes:
(1) To restore low current operation of 27XX series EPROMs connect A to the track feeding pin 22 of the socket instead of to Y;
(2) High current operation;
(3) High current; also need to connect pin 2 to W and cut track under board to isloate pins 2 and 27 from 0V and connect pin 27 to +5V.

Table 4 EPROM type selection links.

"ROM" Packs

If you have one of the non-volatile "ROM" packs which usually consist of CMOS memories together with a small battery, it is possible to 'program' one of these in one of the normal EPROM sockets by breaking the connection between IC12a pins 1 and 2 and linking IC12 pin 1 to IC9 pin 15 (C on the circuit diagram). This will select the EPROM sockets for read and write operations instead of read only. Note, however, that it is not advisable to have EPROMs in the sockets when this is done as this will mean that their outputs will conflict with the bus buffers during a write cycle.

The ETI PseudoROM (June '83) is a device of this type and could be used with minor modifications to take account of the difference in pin function. Do not try to program such a device in the programming socket!!!

Power Supplies

The power requirement for this project is fairly simple and can be derived from a transformer with two 12 volt secondaries and rated at about 15 VA. We used a toroidal type because it was convenient. The secondaries are connected in series and full wave rectified by a bridge rectifier. This gives in the region of 34 to 36 volts across the reservoir capacitor. This voltage is regulated down to the required 25V by a 7812 IC regulator and its associated resistor chain. The +25V supply to the main PCB goes via a relay switch which makes sure that this supply is not applied until a manual push button has been pressed. Another push button serves to turn the +25V off when not required.

The raw supply for the +5V rail is taken from the centre tap of the transformer windings via a diode and dropping resistors to a substantial reservoir capacitor. From here another IC regulator provides the +5V supply to the main board. The isolating diode is present so that an unsmoothed 100Hz waveform can be tapped off the transformer for use as a timing signal on the main PCB. The resistors are used to reduce power dissipation in the +5V regulator as it is operating with a high input voltage.

If alternative arrangements are to be used for these supplies, they should be able to deliver +5V at 0.5A, +25V at 0.1A and 12V RMS unsmoothed rectified (100Hz) at 10mA. Alternatively a 100Hz pulse generator could be used.

Also provided on our power supply design are facilities to charge the Ni-Cd battery at 1mA or 10mA if needed.

ETI

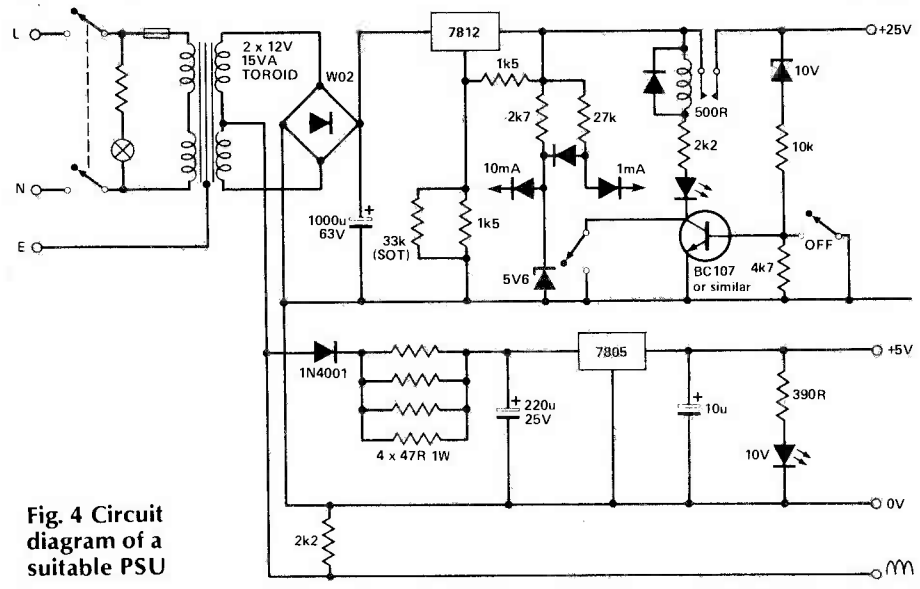


Fig. 4 Circuit diagram of a suitable PSU

hobbyboard

COMPUTING AND ELECTRONICS

Project development materials

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QED A230 STEREO AMPLIFIER

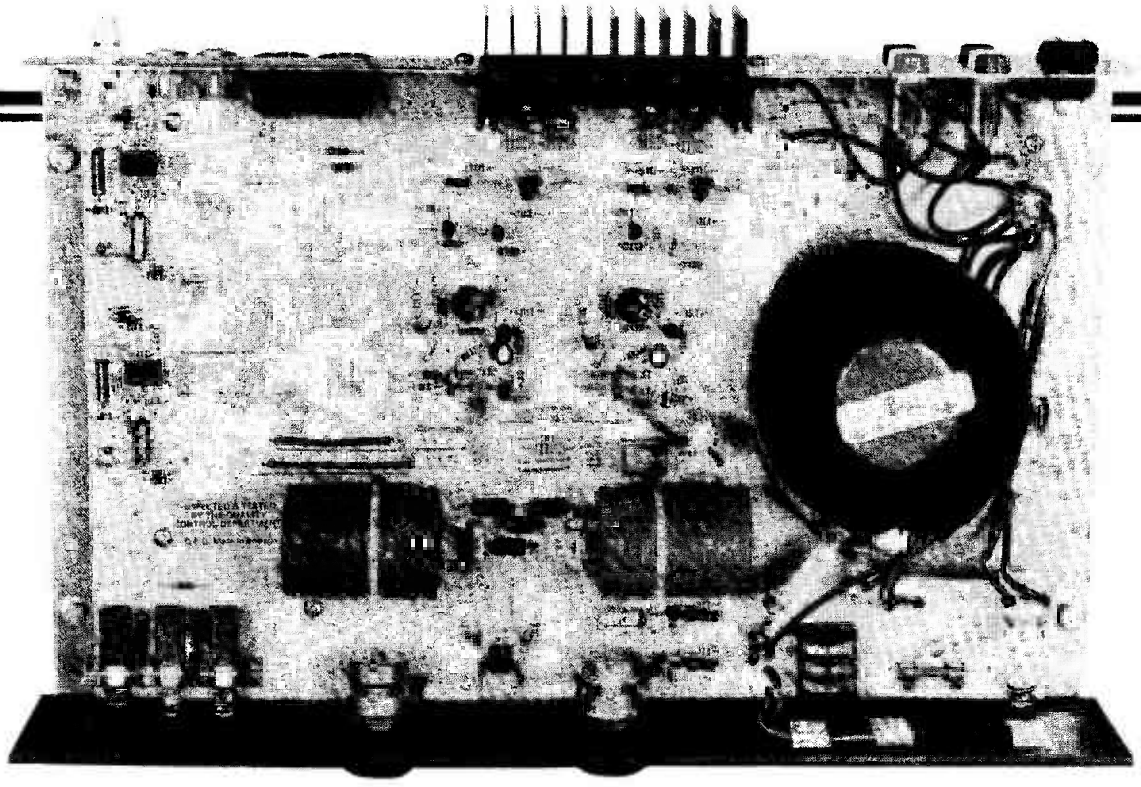
The A230 stereo amplifier heralds the arrival of a complete, British designed and built hi-fi system from QED. The ETI team have been putting it through its paces.

The A230 stereo amplifier is the forerunner of a complete new range of hi-fi components from QED Audio Products Limited. Over the next year or so they plan to introduce a turntable, a cassette deck and a loudspeaker system to complement the amplifier and the T231 tuner which has been launched alongside it. All the items will be designed and built in this country and there are plans to offer the turntable as a kit.

QED are perhaps best known at present for their 79 strand loudspeaker cable, but they actually manufacture a wide range of audio accessories including tape and loudspeaker switching units, headphone adaptors, mains suppression and distribution units, loudspeaker stands and a moving coil input amplifier. In extending this range to cover complete systems they have fixed their sights very firmly on the Japanese competition. The components are stackable, allowing them to compete with the rack and tower systems which are so popular at the less expensive end of the market, but they are also available in no less than seven different wood veneer finishes in addition to the basic metal-cased version, thus broadening their appeal considerably. The front panels have an attractive graphite-grey finish with light green legending, and this too is intended to set them apart from the standard silver finish found on most Japanese systems. The amplifier is also going to be sold at a price which will allow it to compete directly with the Japanese imports—£99 including VAT.

The same philosophy, that of beating the Japanese at their own game as QED put it, is extended to the actual design of the amplifier. The uncluttered front panel reflects an attempt to avoid all circuitry which is not absolutely essential, both to improve the overall sound quality and to make the amplifier as simple to operate as possible. There are no tone controls, no electrolytic capacitors in the signal path, no output fuses, and no output limiting circuit. There are two sets of loudspeaker output terminals, one of which is switched out when a jack is inserted into the headphone socket while the other remains in circuit permanently. It is thus possible to connect a pair of loudspeakers to the out-

The A230 with the matching T231 tuner, which, unfortunately, we didn't get our hands on . . .



Internal shot of the A230 showing the transformer and heatsink, whose sizes gave initial cause for concern.

put of the amplifier without any intervening switch contacts, fuses, limiting circuits or other potential source of signal degradation.

The A230 is built almost entirely on one large PCB which extends into every part of the case. A semi-circular cutout in it provides clearance for the toroidal transformer which is the only major component mounted directly to the case. The potentiometers, switches, reservoir capacitors and most of the sockets are all soldered directly to the PCB and the heatsink mounts through the back of the case to link up with the output transistors which are also on the PCB. 1% metal film resistors are used throughout and the PCB itself is made of a material called FRG 50 which QED claim is very tough.

The manufacturers' specifications for the A230 are given in the accompanying table. A peak output power in excess of sixty watts per channel is claimed and QED say that high peak powers are maintained even into difficult loads. Inputs for disc, tuner and tape are provided and the tape selector also provides a tape monitor function for use during recording. The disc input is equipped with phono sockets while DIN sockets are used for tuner and tape. 4mm sockets are used for the loudspeaker outputs. A jack socket on the front panel is provided for use with high impedance headphones only and this can be arranged to switch out the loudspeakers as explained earlier. The only remaining controls are the volume and balance potentiometers, the mains switch and a green LED to indicate power on.

RMS Power Outputs (both channels driven)	30 Watts per channel into 8 Ohms 48 Watts per channel into 4 Ohms
Single channel driven	36 Watts RMS into 8 Ohms 56 Watts RMS into 4 Ohms
Total Harmonic distortion	Less than 0.1% 20Hz to 20khz.
Power Bandwidth	-3db @ 10Hz and 30khz.
Signal to noise	Disc =-65db. Tape and tuner = -80db
Disc input overload	Better than 32db
RIAA Accuracy	+0db -½db (30Hz to 20khz)
Disc input sensitivity	3mV into 47K and 150pf
Tape and Tuner sensitivity	300mV (inputs and ouputs)
Headphone socket	Only suitable for use with high impedance headphones (600 Ohms etc)
Mains fuse	0.5 Amp (anti-surge)
Dimensions (mm)	355 x 237 x 64
Finish	Graphite grey
Weight (inc carton)	4.75 Kg.

Table 1. Manufacturers' specifications

On Test

One of the first things we did when the amplifier arrived was to take the cover off and have a look inside. The use of a single large PCB makes for a very clean layout with an absolute minimum of interwiring and just about everything is immediately visible and readily accessible. Good quality components do indeed seem to have been used throughout and the quality of the general construction is also high. The only things which caused us any concern were the toroidal transformer and the heatsink, both of which seemed very small in view of the output levels claimed by the manufacturers.

Rather than subject the amplifier to a group listening test in a single location, we decided to let each of the ETI staff try it out individually in their homes. This allowed us to compare it with four very different stereo systems (two largely home-grown and two made up of commercially available components) and to try it in differing domestic surroundings. It also enabled us to listen to the amplifier over an extended period and to find out what it is like to live with.

Bearing in mind our reservations about the size of the transformer and heatsink, we were pleasantly surprised at the QED's ability to supply high power levels without apparent effort. Dave Bradshaw found that very high volume levels could be coaxed from his relatively inefficient transmission line loudspeakers, and the volume had to be wound up very high indeed before the QED showed any signs of stress. Others were unable to try the amplifier to its limits in this direction (mainly for social reasons!) but all reported adequate power delivery up to the maximum required under normal domestic listening conditions.

Bass response drew a more varied set of reports, leading us to suspect that the amplifier behaved very

differently into the load presented by each set of loudspeakers. Phil Walker described the bass response as being a little light but clean, Ian Pitt found the level of bass similar to that achieved with his usual set-up and described it as dynamic and well-controlled, while Dave Bradshaw found the bass to be very extended and prominent, at times almost unnatural, as though a loudness control was in circuit. The difference may be explained in part by the material each chose to audition the amplifier on, but it does seem that the bass performance varies considerably from loudspeaker to loudspeaker.

There was more agreement about the frequency response across the rest of the audio spectrum. Everyone found it very clean and largely neutral, the treble was generally praised as being free from ringing and sibilance effects, and the mid-range was felt to be well-balanced, although Dave Bradshaw reported it seeming slightly recessed in relation to the prominent bass response.

All of the controls worked well and there were no problems in using the facilities. The only exception was the headphone output; QED say that only headphones of 600 ohms impedance or higher should be used, but in practice the solution is not as simple as that. Dave Bradshaw found that his 150 ohm Yamaha headphones worked perfectly well, but Ian Pitt found that the volume control had to be set to very low levels and the circuit noise became apparent when using his AKG K160/4 600 ohm headphones. Phil Walker reported similar problems and difficulty in balancing the channels when using lower impedance headphones. It was felt that some sort of attenuator circuit would be helpful here, either built into the amplifier or as an extra for use with those headphones that don't match it well.

The only other point which received any comment was the possible need for a mains filter. Phil Walker found that loud clicks were produced whenever mains driven equipment was switched on or off elsewhere in the house, but the problem was not felt to be a serious shortcoming and others found the performance no worse in this respect than their own equipment.

To sum up, the QED A230 was judged to be a very fine amplifier indeed and certainly well worth auditioning if you are looking for an amplifier in this price bracket. The sound is the equal of that provided by many more expensive amplifiers, and if you are more interested in this than in tone controls and other frills then the QED should be a very attractive proposition. It does seem to be affected quite critically in the bass region by the loudspeakers it is coupled to, so it would be a good idea to audition it carefully in this respect, and if you are buying a system from scratch, to listen to it with as many different loudspeaker systems as possible.

The QED A230 amplifier costs £99.00 including VAT in its basic (metal) case. Wood veneer cabinets in the following finishes are available for £20.00 extra: mahogany, pine, beech, light oak, teak and walnut. Rosewood is also available to order, price on application. The accompanying T231 tuner (not reviewed here) costs £119 in its basic (metal) case and can be ordered with the same range of wood finishes for the same extra charge.

ETI

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Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)
AC127	0.30	BC108	0.10	BC302	0.32	BD244A	0.65	BF258	0.30	BT101/300	1.15	BYX36/150	0.22	TIP32	0.40	2SC1507	0.63
AC128	0.30	A,B or C	0.12	BC303	0.32	BD375	0.32	BF259	0.32	BT101/500	1.25	BYX36/600	0.28	TIP32C	0.60	2SC1678	1.06
AC128K	0.34	BC113	0.14	BC307	0.10	BD410	0.76	BF262	0.30	BT102/300	1.35	BYX48/300	0.72	TIP33A	0.63	2SC1758	0.68
AC132	0.55	BC114	0.12	BC308A	0.10	BD434	0.68	BF263	0.30	BT102/500	1.65	BYX49/300	0.47	TIP34A	0.72	2SC1909	1.20
AC141	0.26	BC115	0.12	BC323	0.99	BD436	0.68	BF270	0.30	BT106	1.50	BYX55/350	0.29	TIP41C	0.46	2SC1923	0.30
AC141K	0.40	BC116	0.15	BC327	0.14	BD437	0.76	BF271	0.26	BT108	1.30	BYX55/600	0.33	TIP42A	0.52	2SC1945	2.88
AC142	0.26	BC117	0.22	BC328	0.14	BD438	0.75	BF273	0.18	BT109	1.18	BYX71/600	1.18	TIP47	0.60	2SC1953	0.74
AC142K	0.48	BC118	0.17	BC337	0.12	BD439	0.68	BF274	0.32	BT116	1.25	BYZ12	0.42	TIP110	0.88	2SC1957	0.76
AC151	0.45	BC119	0.30	BC338	0.12	BD507	0.48	BF323	0.92	BT119	3.62	C106D	0.80	TIP2955	0.60	2SC1969	2.88
AC152	0.45	BC125	0.12	BC350	0.14	BD508	0.53	BF336	0.26	BT120	3.60	E1222	0.40	TIP3055	0.60	2SC2028	0.73
AC176	0.28	BC140	0.28	BC440	0.30	BD509	0.54	BF337	0.26	BT121	3.02	E5024	0.30	TIS43	0.32	2SC2029	1.00
AC176K	0.46	BC141	0.42	BC441	0.32	BD510	0.48	BF338	0.26	BT138/600	1.30	GET872	0.48	TIS88	0.40	2SC2078	1.05
AC187	0.26	BC142	0.30	BC461	0.32	BD517	0.56	BF355	0.42	BT151/560R	0.90	ITT44	0.04	TIS90	0.25	2SC2091	0.73
AC187K	0.40	BC143	0.30	BC547	0.12	BD520	0.66	BF363	0.82	BT151/300R	1.15	ITT2002	0.11	TIS91	0.28	2SC2098	2.90
AC188	0.28	BC147	0.08	BC548	0.12	BD699	1.25	BF367	0.24	BTY79/400R	2.80	ME0402	0.20	ZTX108	0.12	2SC2122A	3.20
AC188K	0.40	A or B	0.10	BC549	0.12	BD707	0.88	BF371	0.27	BU100A	2.30	ME0404/2	0.24	ZTX109	0.12	2SC2166	1.20
ACY40	0.88	BC148	0.08	BC550	0.18	BDX18	2.35	BF422	0.38	BU104	2.00	MEU21	0.60	ZTX212	0.28	2SC2314	0.80
AD142	1.10	A or B	0.10	BC550C	0.18	BDX32	2.10	BF450	0.38	BU105	1.20	MJ400	1.25	IN4001	0.05	2SC2335	1.50
AD143	1.10	BC149	0.09	BC557	0.12	BF115	0.32	BF457	0.33	BU105/02	1.56	MJ2955	0.90	IN4003	0.05	2SC2749	2.70
AD149	0.98	BC157	0.10	BC558	0.12	BF117	0.54	BF458	0.36	BU108	1.80	MJ3000	1.98	IN4004	0.06	2SC2752	0.60
AD161	0.42	BC158	0.10	BCX34	0.27	BF119	0.82	BF459	0.44	BU124	1.75	MJE240	0.60	IN4006	0.07	2SD234	0.64
AD162	0.42	BC159	0.10	BCY70	0.15	BF120	0.38	BFR39	0.22	BU126	1.25	MJE340	0.54	IN4007	0.07	2SD348	3.30
AD161/AD162	0.98	BC160	0.30	BCY71	0.17	BF123	0.40	BFR40	0.22	BU133	1.80	MJE370	0.88	IN4148	0.05	2SD986	0.62
AF106	0.48	BC161	0.30	BCY72	0.18	BF125	0.42	BFR41	0.22	BU204	1.35	MJE520	0.48	IN5400	0.12	2SK134	3.80
AF114	2.10	BC168B	0.12	BCZ10	1.68	BF127	0.38	BFR51	0.30	BU205	1.30	MJE2955	0.99	IN5402	0.15	2SK135	1.90
AF115	2.10	BC169C	0.10	BCZ11	1.45	BF152	0.16	BFR61	0.32	BU206	1.70	MJE3055	0.70	IN5405	0.16	3N126	1.90
AF116	2.10	BC170	0.14	BD124P	0.80	BF154	0.23	BFR62	0.28	BU208	1.55	MPSLO1	0.28	IN5406	0.18	3N211	2.52
AF117	2.10	BC170B	0.12	BC130Y	0.68	BF157	0.40	BFR88	0.34	BU208A	1.63	OA47	0.10	IN5408	0.20	3SK45	0.76
AF118	0.85	BC171	0.10	BD131	0.34	BF158	0.22	BFR90	1.72	BU208/02	2.05	OA90	0.08	IS920	0.08		
AF121	0.62	BC171	0.10	BD132	0.34	BF159	0.24	BFT41	0.38	BU326S	1.75	OA91	0.09	2N697	0.55		
AF124	0.48	A or B	0.08	BD131/BD132	0.95	BF160	0.23	BFT43	0.38	BU407	1.65	OA95	0.18	2N706A	0.33		
AF125	0.48	BC172	0.08	BD135	0.32	BF167	0.30	BFW10	0.79	BU407D	1.80	OA200	0.06	2N2904	0.28		
AF126	0.48	A or B	0.12	BD136	0.36	BF173	0.25	BFW44	0.76	BUX80	3.70	OA202	0.15	2N2906	0.24		
AF127	0.48	BC177	0.20	BD137	0.36	BF177	0.42	BFX29	0.28	BUY20	1.75	OC25	2.10	2N2926G	0.10		
AF139	0.68	BC178A	0.22	BD138	0.38	BF178	0.30	BFX30	0.30	BUY69A	2.60	OC26	1.70	2N3053	0.22		
AF178	0.68	BC182	0.09	BD139	0.38	BF179	0.32	BFX80	3.56	BUY69B	1.98	OC28	1.50	2N3054	0.56		
AF239	0.68	A,B or C	0.09	BD140	0.38	BF180	0.35	BFX84	0.24	BY101	0.48	OC29	2.47	2N3055	0.45		
AF279S	0.75	BC182L	0.09	BD144	1.60	BF181	0.35	BFX85	0.26	BY118	1.10	OC35	1.75	2N3702	0.10		
AL100	2.50	A,B or C	0.09	BD145	1.82	BF182	0.32	BFX86	0.26	BY122	0.68	OC36	1.75	2N3704	0.10		
AL102	1.88	BC183	0.09	BD150A	0.51	BF183	0.32	BFX87	0.26	BY126	0.12	OC42	0.72	2N3708	0.10		
ALI13	2.20	A,B or C	0.10	BD159	0.65	BF184	0.32	BFX89	0.65	BY127	0.10	OC42K	1.40	2N3772	1.90		
ASY80	1.75	BC183L	0.08	BD160	1.65	BF185	0.32	BFY50	0.21	BY133	0.16	OC44	0.72	2N3773	2.70		
AU110	1.40	A,B or C	0.12	BD165	0.45	BF194	0.08	BFY51	0.21	BY135	0.25	OC45	0.58	2N3904	0.16		
AY102	4.32	BC184L	0.10	BD175	0.60	BF195	0.10	BFY52	0.21	BY164	0.44	OC71	0.50	2N3906	0.16		
BA102	0.34	A,B or C	0.10	BD182	1.00	BF196	0.10	BFY57	0.40	BY179	0.66	OC72	0.52	2N5294	0.48		
BA110	0.67	BC207	0.15	BD183	1.10	BF197	0.10	BFY90	0.90	BY182	0.87	OC81	0.68	2N6107	0.71		
BA121	0.40	BC208	0.16	BD184	1.20	BF198	0.14	BFY90S	1.34	BY184	0.40	OC200	2.46	2N6126	0.68		
BA129	0.38	BC212	0.09	BD201	0.72	BF199	0.16	BR100	0.20	BY187	0.72	OC202	2.20	2SB337	1.60		
BA148	0.16	A,B or C	0.10	BD202	0.87	BF200	0.26	BR101	0.44	BY189	4.75	ORP12	0.85	2SC1172Y	2.90		
BA154	0.08	BC212L	0.08	BD204	0.80	BF222	0.48	BR103	0.58	BY198	0.44	R2008B	1.50	2SC1173Y	0.82		
BA155	0.10	A,B or C	0.10	BD222	0.80	BF224	0.20	BRC4443	1.76	BY199	0.47	R2010B	1.52	2SC1302	1.40		
BA156	0.08	BC213	0.09	BD225	0.86	BF224J	0.16	BRY39	0.38	BYV26	0.24	SHG15	0.40	2SC1226	0.84		
BA157	0.28	A or B	0.10	BD232	0.45	BF240	0.20	BRY56	0.42	BYV27	0.24	TAG1/100	1.40	2SC1279	0.50		
BA164	0.14	BC213L	0.10	BD233	0.60	BF241	0.20	BRY61	0.86	BYV210/400	0.25	TAG3/400	1.78	2SC1306	0.92		
BB104B	0.52	A or B	0.10	BD234	0.62	BF244	0.26	BSS17	0.56	BYV210/600	0.26	TIC44	0.40	2SC1307	1.40		
BB105B	0.30	BC237	0.11	BD235	0.63	BF244A	0.28	BSS27	0.92	BYV210/800	0.30	TIC45	0.45	2SC1413A	2.70		
BB105G	0.48	BC238	0.12	BD236	0.63	BF244C	0.24	BSX19	0.34	BY223	1.20	TIC46	0.48	2SC1444	1.45		
BB110B	0.42	BC239C	0.14	BD237	0.65	BF245A	0.28	BSX20	0.34	BY227	0.26	TIC47	0.70	2AC1449	0.63		
BC107	0.10	BC251	0.12	BD238	0.56	BF254	0.15	BSX59	0.62	BY229	0.30	TIC106A	0.70				
A or B	0.12	A,B or C	0.14	BD241	0.60	BF256	0.40	BSX76	0.29	BY238	0.68	TIP30A	0.46				
		BC301	0.30	BD243A	0.80	BF257	0.32	BT100A/02	0.94	BYX10	0.24	TIP31C	0.54				

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ECF80	0.95
ECH81	0.75
ECH84	0.75
ECL82	0.75
ECL86	0.98
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EF86	1.60
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EF184	0.75
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PCC85	0.65
PCC89	0.74
PCC189	0.85
PCF80	0.75
PCF86	1.25
PCF200	1.95
PCF801	1.45
PCF802	0.85
PCF806	1.20
PCL82	0.90
PCL83	2.50
PCL84	0.90
PCL86	0.98
PCL805/85	1.35
PD500	3.75
PFL200	1.35
PL33	1.50
PL36	1.45
PL81	0.85
PL82	0.75
PL83	0.65
PL84	0.75
PL95	2.00
PL504	1.20
PL508	2.40
PL509/519	5.95
PY88	1.80
PY500A	2.40
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6J5GT	1.75
6SJ7	2.20
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2n2F1500VDC	60p
4n7F1500VDC	60p
10nF1000VDC	22p
10nF 500V AC	80p
15nF 300V AC	30p
22nF 300V AC	32p
100nF1000VDC	48p
470nF1000VDC	85p

HV Disc Ceramic

1kV 1.5nF	18p
8kV 10, 47, 82, 100, 120, 150, 180, 200, 220pF	30p
270, 300pF	39p
10kV 1nF	67p

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400mW Plastic 3V·75V **8p each** 10/75
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1.5W Flange 4.7·47V **£1.26 each**
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20W Stud 7.5·75V **£1.31 each**

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AN2140Q	3.88	SN76533N	1.80
AN715Q	2.90	SN76650N	1.05
CA3065	1.75	SN76660N	0.75
CA4031P	2.88	SN76666N	0.80
CA4102	3.30	STK015	6.50
CA4250	3.50	TA7108P	3.20
CA4400	2.98	TA7120P	3.20
CA4422	3.07	TA7129AP	3.85
LC7120	5.33	TA7130P	1.65
LC7130	5.26	TA7172	1.80
LC7137	5.16	TA7193	5.50
LM380N	0.80	TA7172P	1.80
LM1303N	2.52	TA7176	2.50
HA1151P	3.12	TA7202P	4.18
MC1307P	1.65	TA7204P	1.86
MC1310P	1.85	TA7205AP	1.50
MC1312P	3.25	TA7208P	3.27
MC1327P	1.25	TA7210P	6.50
MC1330P	0.83	TA7222P	1.88
MC1349P	1.85	TA7223P	3.68
MC1350P	1.20	TA7227P	5.60
MC1351P	2.50	TA7310A	1.80
MC1352P	1.50	TA7609P	4.28
MC1357P	2.88	TA7611AP	2.88
MC1358P	1.30	TAA263	2.46
MC1496P	1.15	TAA310A	2.68
ML231B	2.10	TAA550	0.50
ML232B	2.10	TAA570	1.99
ML237B	2.30	TAA611A12	3.50
NE555	0.25	TAA611B12	2.85
C-mos 555	0.88	TAA630S	3.90
NE556	0.80	TAA661B	1.70
SAA1024	5.35	TAA700	2.80
SAA5025	6.40	TAA840	3.38
SAS560A	2.50	TAD100	2.80
SAS560S	1.85	FM FILTER	1.20
SAS570S	1.85	TBA120A	1.00
SAS580	2.85	AS,S,SA,SB	1.20
SAS590	2.82	Q,T,U,UQ	1.32
SC9503P	1.10	TBA120B	1.30
SL432A	4.00	TBA231	1.45
SL9018	5.20	TBA281	2.65
SL917B	6.25	TBA395	1.20
SL1327Q	1.10	TBA480Q	1.50
SN76003N	2.44	TBA490	2.30
SN76013	1.90	TBA510	2.80
SN76023ND	2.90	TBA510Q	2.80
SN76033N	2.45	TBA520/Q	1.80
SN76110N	1.12	TBA530/Q	1.30
SN76115N	2.00	TBA540/Q	1.40
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SN76226ND	1.80	TBA560C	1.70
SN76227N	1.10	TBA560CQ	1.40
TBA570	1.50	UPC1158H	0.78
TBA641BX1	4.50	UPC1163H	0.98
TBA673	2.40	UPC1181H	1.60
TBA700	2.85	UPC1185H2	3.75
TBA750	2.80	UPC1212C	1.30
TBA800	1.80	UPC1230H	3.90
TBA810P	1.10	UPC1350C	3.90
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TBA890	3.88	UPC2002H	2.80
TBA920/Q	3.00		
TBA940/2A	3.05		
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TBA990	1.88		
TCA180C	3.90		
TCA270S	4.00		
TCA270SA	4.02		
TCA800	3.10		
TCA940	1.90		
TDA440	3.80		
TDA1002	1.90		
TDA1003A	5.50		
TDA1004A	2.90		
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TDA1044	4.30		
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TDA1190	3.50		
TDA1200	2.98		
TDA1270Q	3.70		
TDA1327A	1.68		
TDA1352A/B	1.56		
TDA1412	1.20		
TDA2002	2.80		
TDA2020	4.60		
TDA2030	2.78		
TDA2140	5.90		
TDA2521	4.10		
TDA2523	3.50		
TDA2530	2.70		
TDA2540	3.80		
TDA2541	3.80		
TDA2560	3.50		
TDA2571A	2.50		
TDA2581	3.20		
TDA2590	3.20		
TDA2591	2.98		
TDA2593	2.98		
TDA2610	3.20		
TDA2611A	1.94		
TDA2640	2.90		
TDA2680	3.40		
TDA2690	3.50		
TDA3950A/B	2.60		
UPC554C	1.32		
UPC557H	0.90		
UPC566H	2.95		
UPS75C2	3.20		
UPC1018C	1.10		
UPC1025H	2.90		
UPC1032H	0.90		
UPC1156H	4.20		

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100V	0.28
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400V	0.40
600V	0.50
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3A 100V	0.52
200V	0.55
400V	0.61
600V	0.67
800V	0.70
6A 100V	0.66
200V	0.68
400V	0.74
600V	0.80
800V	0.86
10A 50V	2.20
100V	2.24
200V	2.35
400V	2.50
600V	3.50
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RESISTORS — CARBON FILM 5%

¼W 1R0 to 10M (E12 Range)	**2p each. 15p/10. 75p/100**
½W 2R2 to 10M (E24 Range)	**2p each. 15p/10. 75p/100**
1W 10R to 2M2 (E12 Range)	**7p each. 65p/10. 6.00/100**
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RESITOR KITS — each value individually packed

¼W pack 10 each value E12 — 10R to 1M 610 pieces	4.80
¼W pack 5 each value E12 — 10R to 1 M 305 pieces	2.75
½W pack 10 each value E12 — 2R2 to 2M2 730 pieces	5.25
½W pack 5 each value E12 — 2R2 to 2M2 365 pieces	3.00
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15 amp 12 way	0.48
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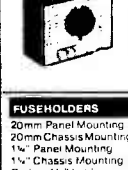

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Antistantic Spray	0.82
Plastic Seal	0.88
Excel Polish	0.76
Fire Extinguisher 640g	2.80
Video Head Cleaner	0.88
Silicone Grease (IC) 75g	1.00
Solda Mop (Std)	0.72
Solda Mop (L/Gauge)	0.72
Additional P&P on above 30p	

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2.5mm Chassis Socket	0.10
3.5mm Chassis Socket	0.10
2 pin ¼in Mono Chassis Socket	0.14
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Dil to Dil		
8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
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18 pin	0.14	1.60/10
22 pin	0.21	1.95/10
24 pin	0.25	2.25/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

Dil to Quil		
14 pin	0.30	2.75/10
16 pin	0.32	2.90/10
18 pin	0.34	3.10/10

Quil to Quil		
14 pin	0.30	2.75/10
16 pin	0.34	3.10/10

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SPECTRUM JOYSTICK INTERFACE

Feeling like using your Spectrum to zap the aliens, but put off by having to remember which keys to use? Discover the joy of a stick, using this interface by Mike Wynne-Jones

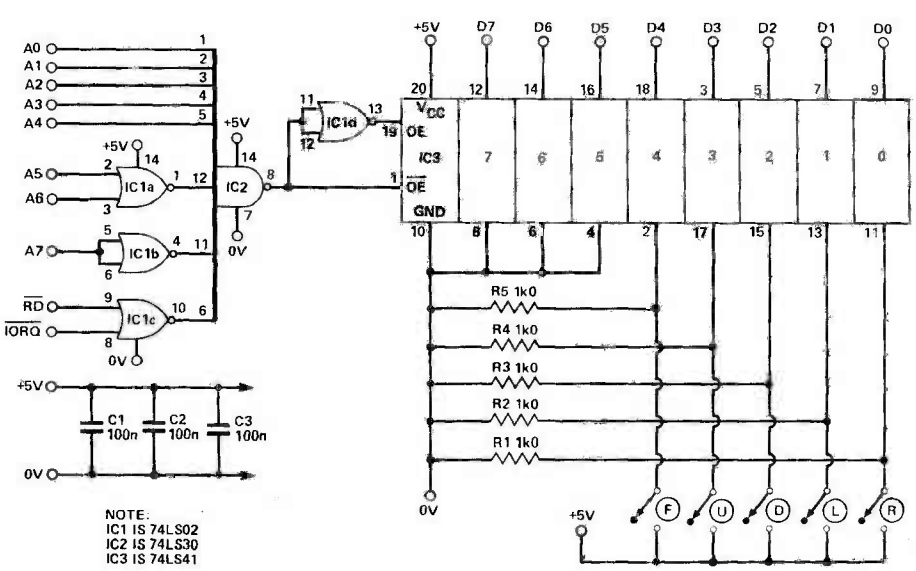
This interface can be used to connect any Atari or Commodore Vic compatible joystick to the Sinclair Spectrum. It is read by the function IN 31, like several other interfaces on the market (notably those made by Kempston and Quickshot) and can be used with any commercial software compatible with these and several other joystick systems.

The different movements cause a 1 to appear in different bits of the number read in, as follows:

POSITION	BIT
right	0
left	1
down	2
up	3
fire	4

Bits 5,6,7 are always 0.

So, for example, if the stick is in the top right corner, and the 'fire' button is pressed, the number read will be 25.



NOTE:
IC1 IS 74LS02
IC2 IS 74LS30
IC3 IS 74LS41

Fig. 1 Circuit diagram of the interface.

HOW IT WORKS

The circuit diagram is shown in Fig. 1. In an I/O operation with the Spectrum, address bus bits A0-4 must be high, to indicate that there is not a keyboard read taking place. To use IN 31, A5,6,7 must all be low, and for an I/O read, $\overline{IORQ}$ and $\overline{RD}$ must both be low.

Note that the joystick can also be read at addresses 31 plus any multiple of 256. This is extremely unlikely to cause a problem, as any software/hardware system which requires further address decoding would also, probably, need far more sophisticated analogue joysticks.

IC1a output goes high when A5, A6 are low, and IC1c goes high when $\overline{IORQ}$ and $\overline{RD}$ are both low. This means that when, and only when, the address busses hold all the correct signals, all inputs to IC2 are high. Under these circumstances, the output of IC2, an eight-input NAND gate, goes low.

IC3 is a 20-pin device consisting of eight tri-state buffers. Four have a common $\overline{OE}$ (output enable) pin, and the other four a common OE pin, enabling the chip to be used as a quad transceiver if required. Here, however, all buffers are required to switch on at the same time, so the $\overline{OE}$ is driven directly from the output of IC2 (low when all signals are correct) and OE is driven from the output of IC1d.

Whenever IC3 is activated, the inputs are buffered on to the outputs, ie on to the computer's data bus. Inputs 5,6 and 7 are permanently low, causing the signals on D5,6 and 7 to be low when the interface is activated, and inputs 0 to 4 are pulled low by R1 to R5, or high if the corresponding joystick switch is closed, putting a 1 or a 0 on the data bus.

When it is not activated, the outputs of IC3 will all be at their high-impedance state.

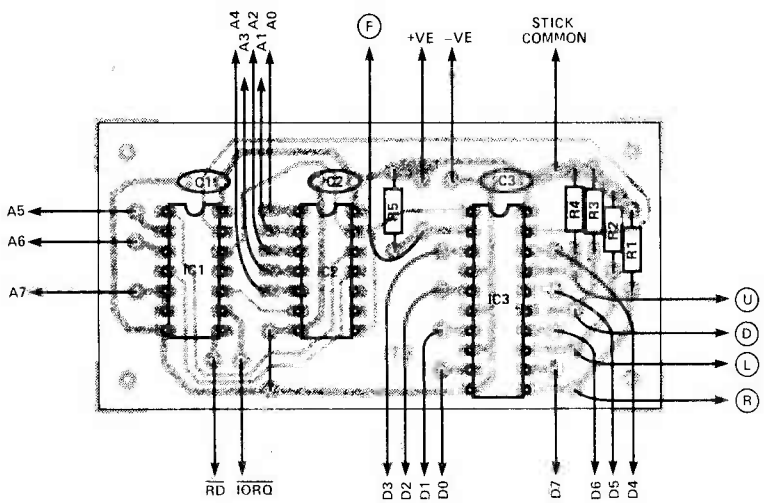


Fig. 2 Overlay diagram of the interface.

PARTS LIST

RESISTORS (all ¼W 5%)	
R1-5	1k0
CAPACITORS	
C1-3	100n ceramic disc
SEMICONDUCTORS	
IC1	74LS02
IC2	74LS30
IC3	74LS241
MISCELLANEOUS	

9-way D-type plug, panel-mounting; Sinclair edge connector (for Spectrum); PCB; case; wire, etc

Construction

A small PCB was used for the project, and the component overlay is as shown in Fig. 2. Whilst it would have been possible to design a PCB so that the edge connector could fit directly onto it, this would have required a much larger double-sided PCB, which would have made the unit rather costly to make. So we're afraid that neatness has been sacrificed for price!

The project was housed in a plastic case, with a slot cut for the edge connector and a hole for the D-type plug. The height of the plug in the case is fairly important, as otherwise it will be difficult to plug in the interface to the back of the computer. No edge connector has been provided at the back of the case as it was judged that joysticks are most likely to be used for game-playing when it is unlikely that other peripherals will be required. If this is found to be inconvenient, there is no reason why an expander plug could not be improvised. The edge connector itself should be glued in position using an epoxy adhesive.

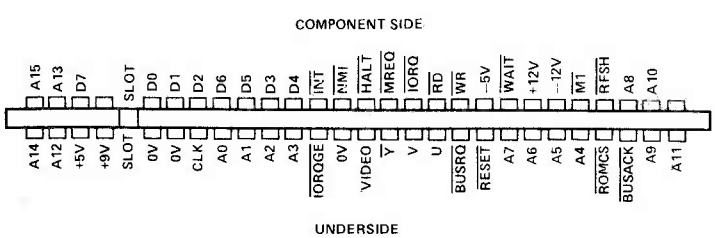


Fig. 3 Edge connector details for the ZX Spectrum.

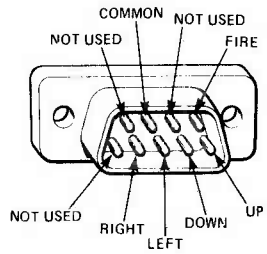


Fig. 4 Wiring details of the joystick socket.

Connections between the PCB and the socket can be made using either ribbon cable (although a bit of 'hacking' will be necessary) or with thin flexible wire. The D-type plug can be connected up in the same way, and for two-player use, another plug can be connected in parallel (although only one of you must use a joystick at any one time unless you are working co-operatively!).

Figure 3 shows which pins are which on the pin side of the D-type connector, and details of the Sinclair edge connector are given in Fig. 4.

Testing

Before inserting any ICs, make a thorough visual check of the board and the interconnections. Next plug in the computer and switch on; the copyright message should appear on the screen as usual. If this doesn't happen, there must be a fault on the board, so switch off quickly and start looking! If all is well, switch off the computer, insert IC1 and switch on again. If all is well, repeat for the remaining three ICs, checking each time.

When this is complete, run the following short program:

```
10 PRINT IN 31
20 POKE 23692, 100 : REM AUTO
   SCROLLING
30 PAUSE 10
40 GOTO 10
```

Check that moving the stick in different directions changes the numbers printed in the expected way. If the interface works satisfactorily, it's time to start zapping the aliens (or is it the fruit?).

ETI

BUYLINES

Well, here's a real initiative test — can you possibly find anything that it's hard to buy? Edge connector from Watford, Rapid, and others, PCB from our PCB service . . . you'll really have to work at this one!

WILMSLOW LOUDSPEAKER KIT

Loudspeaker kits appear to offer a genuine saving on your hi-fi system costs, but do they really match up to factory built units? Ian Pitt gets to grips with a new Peerless design from Wilmslow Audio.

My first stereo system consisted of the audio stages from two elderly, valve radios, the remains of two damaged BSR record decks out of which I conjured one, almost functional deck, and two loudspeakers which differed not only in size, shape, impedance and power handling but also in that one required a separate energising supply. The whole assembly was no better to look at than it was to listen to and I lost no time in planning its replacement. The only obstacle was my chronic lack of cash.

Being an essentially practical soul I approached the problem in the following way. Good quality turntables, I reasoned, could be purchased from discount houses quite cheaply, and if finances were really tight one could always purchase the chassis only, support it on a pile of brieze blocks and explain the resulting mess away as a product of the avant garde. Amplifiers could be built from scratch, and even though the fledgling ETI had not then produced its first hi-fi amplifier design there were still a number of published designs to choose from. That only left the loudspeakers. Here I adopted a more radical approach and decided to spend the majority of my remaining money on a pair of good quality headphones which could be used for 'serious' listening while putting the rest towards the purchase of some cheap drive units which could be built into home-made cabinets and used for 'background' music.

The surprising thing is that, conceit aside, those cheap, home-made loudspeakers actually sounded rather good, and this despite the fact that the cabinet design and dimensions were determined more by the materials that were to hand than by any degree of informed planning. I mention this mainly for the benefit of those who still believe that the only way to get acceptable sound quality is to spend around half of their hi-fi budget on a pair of ready-built loudspeakers. Great advances have indeed been made by the more innovatory loudspeaker designers, but the gap between the exotic (and expensive) and what you can build yourself is still not as large as some would have you believe. And now that there are loudspeaker kits available to save you doing the basic carpentry . . .

The Peerless CD825/2R

Having decided to review a pair of loudspeaker kits in this issue, we left the actual choice of system to Wilmslow Audio. They sent us a kit based upon one of the seven new designs in the Peerless Manual for Loudspeaker Constructors and using Peerless drive units. The particular model we were sent, the CD825/2R, occupies a position roughly in the middle of the new range and is one of two models said to be designed specifically for compact disc systems. Wilmslow explained that this is because the bass drivers in these two models have paper cones whereas the others have polypropylene cones; paper is regarded as having the better transient response, making it ideal for the fast attack and wide dynamic range of CD systems, while polypropylene is regarded as having the more neutral tonal balance. The bass driver unit in the CD825/2R is 8" in diameter and has a 38 mm voice coil, while frequencies above 1800 Hz are handled by a 1" dome tweeter. The enclosure is a bass reflex design of 25 litres volume, and the completed 'speakers have a nominal impedance of 8 ohms and are recommended for use with amplifiers rated at between 20 and 140 watts per channel (presumably peak although this is not stated).

The kit we received from Wilmslow included pre-cut and machined woodwork, the drive units, BAF wadding (which also serves as a packing material during transit), bituminous felt tiles for lining the interior of the enclosure, a roll of grille-cloth, the reflex tube, the crossover components, 4mm terminals complete with plugs to suit, and all the necessary screws, clips, and other fixings. There was some delay in sending out the 'speakers (Wilmslow had apparently intended to send us an even newer model, but this was not ready in time) and to help us get the review done as quickly as possible they assembled the crossovers for us.

The kit also included the Peerless Manual for Loudspeaker Constructors which contains individual information and constructional drawings on each of the models in the range, and a set of general instructions drawn up by Wilmslow. It is worth emphasising that the kits are only Wilmslow's realisations of the original Peerless designs. There is nothing to stop you obtaining the Peerless manual, doing your own carpentry and just purchasing the drive units from Wilmslow. Indeed, the Wilmslow kits differ slightly from the designs in the manual in that Peerless specify a chipboard enclosure assembled onto a batten frame while Wilmslow supply smooth-surfaced Medium Density Fibre (MDF) board which is grooved so as to make a frame unnecessary. In

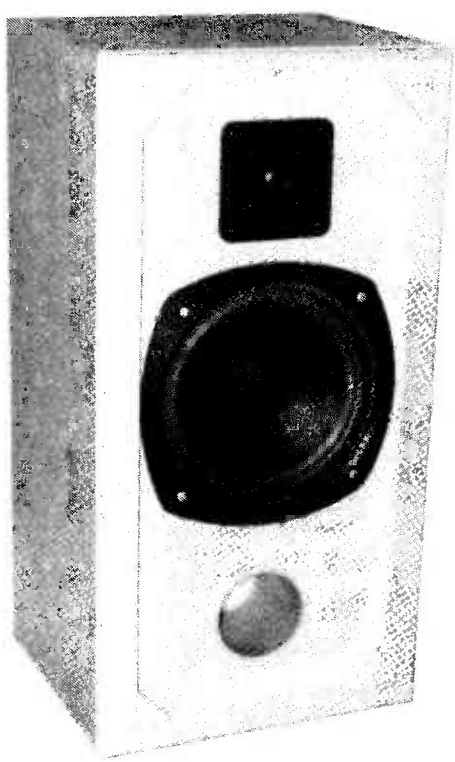
spite of this difference, the information in the Peerless manual remains helpful and relevant.

Construction

Having struggled manfully on rush-hour tubes to get the kit home, I opened it up and set about reading the instructions. As explained previously, there are both specific instructions from Peerless and more general instructions from Wilmslow in the kit. The Peerless manual is well presented on glossy paper but I was slightly disappointed by the Wilmslow instructions which simply consist of several photocopied sheets stapled together and which in places are almost unreadable. I was encouraged, however, to see that the Wilmslow sheets include a kit parts list on which each item has been ticked off by hand by the packer. I would recommend reading both the manual and the instructions through thoroughly first so as to get an idea of what information is presented in each.

Wilmslow recommend that you inspect all the panels for transit damage upon opening the kit, and then remove all dust, etc, with a vacuum cleaner. The next stage is to assemble the cabinets without gluing so as to check the fit, and then to swap around matching panels where this will achieve a better fit. This confirmed my original impression that the quality of the machining was generally very high, for the panels assembled readily with almost no visible gaps and the grooving was sufficiently positive to hold the whole assembly together with no external support. Wilmslow recommend that, if the baffle board is to be painted, the painting is done at this stage rather than when the cabinet is finally assembled and glued.

Evo Resin W wood glue is recommended for the cabinet construction, and you are advised to use plenty so as to ensure an airtight seal. In fact, the quality of the cabinet joints is such that only a comparatively small amount of glue is needed to seal them, and my first attempt left me with large quantities of wood glue issuing from every seam. This is not a problem as the glue can easily be removed with a damp cloth whilst still wet, but the stuff does have a tendency to get everywhere before you notice it.



One side of the cabinet has to be assembled at this stage but not glued, so that it can be removed later to allow you to install the bituminous felt tiles and the crossover. This is not quite as simple as it sounds because, as I have explained, the glue tends to seep along the joints as soon as you apply pressure. When the time came to remove this panel from the first of the two enclosures, I found that it required a considerable amount of force before it came free and that small chunks of panel remained attached to the glued cabinet. This can be overcome by inserting small pieces of paper between the side panel and the main cabinet opposite to the glued joints. Provided the paper is fairly thin it will not upset the tightness of the joint, and when the glue is dry and the side panel has been removed it can be pared away quite readily with a sharp knife.

While the glue is setting, the cabinets must be held together in some way. Wilmslow recommend the use of either clamps or masking tape, and I opted for the latter. Two bands of tape wound horizontally around the cabinet and two vertically, both pulled fairly tight, were sufficient to pull the panels tightly together during setting. The only slight drawback with this approach is that glue tends to seep under the tape, but again, this is fairly easy to pare away with a sharp knife later.

When the glue is dry and the side panel has been removed, the bituminous felt panels are cut to size and glued to the inside walls of the enclosure. Wilmslow suggest that they be held in place with panel pins while the glue dries. Mounting holes can then be drilled for the drive units and the grille-frame clips. As mentioned previously, Wilmslow suggest that if the baffle is to be painted it should be done before the cabinet is assembled, but I would be inclined to add that if you are going to use a fairly transparent grille-cloth and a light-coloured baffle it might be a good idea to drill the drive unit mounting holes also before assembling the cabinet. You can just rest the drive units in place and mark and drill the holes, but you stand a much better chance of getting the square tweeter bezel straight and the bass unit mounting holes neatly aligned if you take careful measurements across the baffle, and that might mean marking the painted surface.

Wilmslow provide you with two options for mounting the bass driver, a decorative fixing ring or four metal brackets. Both seem to secure the drive unit quite adequately, but I would recommend using the fixing ring when marking out your drilling positions since the resulting hole pattern will just as readily accommodate the metal brackets, while the positions obtained by using the brackets may not suit the fixing ring should you subsequently wish to use it.

The crossovers have next to be assembled into the cabinet. Although our crossovers were supplied ready-built, the accompanying instructions are excellent and I cannot imagine anyone who can handle a soldering iron having any trouble here. Each component position is identified in white lettering on the PCB itself and a series of black and white photographs show how the finished crossover for each model should look.

The crossover for the CD825/2 R comes with a choice of two tweeter series resistors, and an accompanying note explains that the lower value is intended to satisfy the requirements of continental listeners who reputedly favour a slightly brighter treble than their British counter-

parts. Our pre-assembled crossovers came with the higher value (giving a less-bright treble) already in place, and I decided to leave well alone until I came to the listening tests.

The other jobs which need to be done at this stage are the fitting of the reflex tube and the marking and drilling of the grille frame fixing holes and the input connector holes. The reflex tube and grille frame presented no problems when tackled in accordance with the instructions but I did have some difficulties with the input connectors. Peerless point out in the manual that the 4 mm input connectors do not have sufficient depth to pass right through the 18 mm thick panel, and that you will probably have to rebate the hole on one side in order to expose sufficient thread to attach the nut. It is easy enough to rebate the hole on the outside with the cabinet assembled but it is then difficult to stop the connector rotating while the nut is tightened, and this is not, in any case, a very satisfactory solution if the appearance of the finished job is important to you. Rebating the hole on the inside is a better idea but this is not easy when the cabinet is assembled, especially if you are relying upon only the most basic of tools. When I came to assemble the second enclosure I drilled and rebated these holes before assembling the cabinet, and this made life a lot easier. I also found it helpful to secure the nuts in the rebated holes with Araldite so that the connectors could simply be screwed into place from the back.

All that now remains is to fit the crossover in place, lead out the connections through the input connector and drive unit holes, fill the remaining space in the cabinet with the acoustic wadding and then glue the final side panel in place. No means of fixing the crossover is provided, but it seemed to be quite secure when simply wrapped in the wadding. When the glue on the side panel is dry, the drive units can be soldered to the trailing leads and then screwed into place.

The MDF panels have a smooth, plain surface and can be finished in a number of ways. Wilmslow suggest either painting the enclosure or covering it with iron-on veneer, plastic laminate or self-adhesive plastic film, although I suspect that painting would not be the most attractive approach since the exposed panel ends are, inevitably, not as smooth as the other panel surfaces and are probably more porous. I have not yet decided how to finish mine, but the raw end result is not unattractive and it saves me the trouble of steering the conversation round to my loudspeaker-building exploits when friends call.

Sounding Them Out

For the listening tests I was able to borrow the QED A230 amplifier and the Musician loudspeakers which are the subject of other articles in this issue. I was thus able to compare CD825/2Rs with these as well as with my own system, a home-grown 30 watt per channel class B amplifier and a pair of dual-cone drive units in sealed, 20 litre enclosures. These components were tried out in various combinations over a period of several days, using inputs from both disc and tuner, and listening mainly to choral/orchestral music and jazz with some folk, male and female solo vocal, and a little light rock.

The CD825/2Rs are the only system in this line-up with separate tweeters, so it should come as no surprise to find that they offer more sheer treble energy and handle high frequency transients better than either of the other systems. I am tempted to characterise their sound as being slightly bright, but I think the difference is not so much one of colouration as of attack. By comparison, the other two loudspeaker systems sounded slightly recessed, almost timid. I found the CD825/2Rs less easy to ignore, more forward and aggressive and very exciting on material with a wide dynamic range. I am not completely convinced of their tonal neutrality, but the sound is well balanced and never became tiring to listen to. The bass is well extended and tightly controlled and there is no suggestion of resonance or other unwelcome cabinet noise. Midrange is smooth and clear, while the treble is open and clean and has only the slightest tendency to 'tizziness' on cymbal clashes and the like.

More complex differences between the three systems emerged when I came to compare stereo imagery. Bearing out Carl Pinfold's views expressed elsewhere in this issue, I found the Musician loudspeakers easily the best in this respect with my own loudspeakers a little way behind and the CD825/2Rs offering the poorest performance. However, while the imagery offered by the Musician units was undoubtedly almost razor-sharp, the sound stage seemed remarkably compressed, wholly enclosed in the space between the loudspeakers and apparently lacking any vertical dimension. My own loudspeakers and the CD825/2Rs both offered a wider, if less well focussed sound stage, and with both there was a greater sense of physical depth. It's a pity that I was not able to compare the CD825/2Rs with an established, multi-drive-unit loudspeaker system, but I feel sure the imagery would compare well.

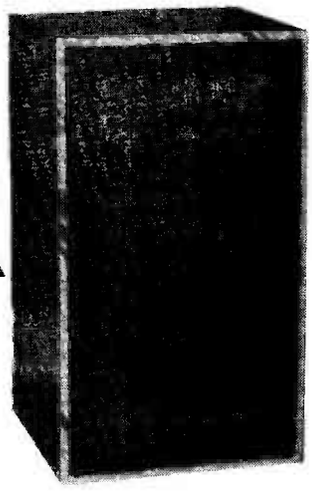
I was unable to listen to the three systems at very high volume levels for fear of being evicted, but a few brave moments of Pictures At An Exhibition at window-rattling volume convinced me that the CD825/2Rs can comfortably handle the highest volumes I am ever likely to be allowed to feed them with. They are also quite sensitive, something which makes high volume levels all too easy to achieve. The highest levels I dared use required no more than a quarter full-scale setting of my volume control, a fact which suggests mind-boggling implications should the remaining three-quarters of its travel ever be used.

In summary, perhaps the best thing I can say about the CD825/2Rs is that, since having them, I have started using my stereo system more. The sound is altogether more lively and arresting than that of my own loudspeakers, and if this has been bought at the expense of a slight increase in colouration the difference is marginal and the benefits easily outweigh it. I greatly regret not having been able to try them with a compact disc system, but I can readily imagine how well they would then sound. As far as I am aware, Peerless do not produce a ready-built loudspeaker which is the direct equivalent of this design so I cannot urge you to go along to a dealer and listen to it, but if you've been put off building your own loudspeakers by the thought of construction difficulties and eventual inferior sound, let me reassure you — kit loudspeakers are great!

The Peerless CD825/2Rs are available from Wilmslow Audio in three forms: the Basic Kit comprises the drive units and the crossovers for a pair of loudspeakers and costs £88.95 plus £5.00 carriage; the Plus Kit includes everything needed for a pair of loudspeakers except the woodwork and costs £104.50 plus £6.00 carriage; the Total Kit, as reviewed in this article, includes all woodwork and other parts and costs £128.50 plus £10.00 carriage. All prices include VAT. The Peerless Manual for Loudspeaker constructors will be sent free-of-charge on receipt of a 12" x 9" SAE. Wilmslow Audio Ltd, 35-39 Church Street, Wilmslow, Cheshire SK9 1AS, tel 0625 - 529599.

ETI

NOVEL LOUDSPEAKER DESIGN

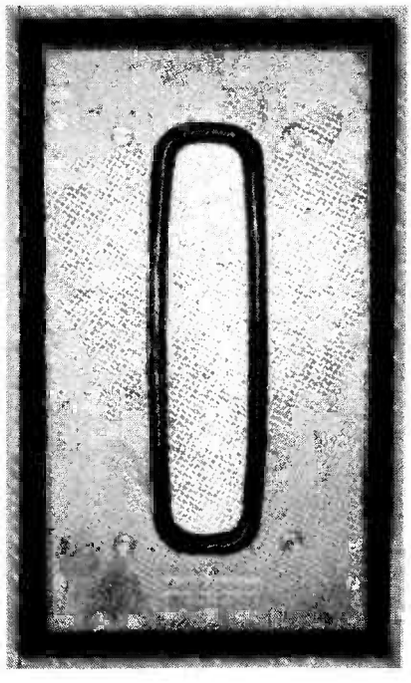


Carl Pinfold has created quite a stir in the hi-fi world with his full-range, flat diaphragm loudspeakers. This article covers the design philosophy of both the drive units and their enclosure, and goes on to describe the construction of similar enclosures for use with these or any other small-cone-area drive units.

The majority of loudspeaker designs currently available use a number of separate drive units fed through a crossover so that each handles only a discrete portion of the audible frequency spectrum. There are a number of advantages with such an arrangement but there are also a number of drawbacks. Where only two drive units are used, the crossover frequency will be between 2.5 and 3.5 kHz, the frequency band in which the ear is at its most sensitive and discriminating. The cone diameter of the drivers can be matched to the wavelength of the frequency bands over which they are operating, but this leaves a tweeter of no more than 5 cm^2 diaphragm area to handle the band of frequencies which often contain the greatest power levels in music, further compounding the problems of crossover design. The use of drive units with conventional cone-shaped diaphragms generates further problems in itself. The frontal volume forms a resonant cavity which introduces megaphone-like colourations, while the limited speed of the sound through the cone material results in a phase lag between the inner and outer areas, causing the cone to 'break-up' and producing an irregular response.

In designing the Musician Loudspeaker drive unit, Carl Pinfold has attempted to overcome the limitations inherent in multiple drive unit systems using conventional cone loudspeakers by employing a single, full-range drive unit using a flat diaphragm. He argues that the use of a single drive unit rather than a multiple system with crossover makes a lot of sense with the present, almost universal, use of direct-coupled amplifiers since it preserves a high electrical damping factor. He goes on to suggest that a valid alternative to present design philosophies is to start with a good mid-range unit and then concentrate on extending its performance in the upper and lower octaves. This will lead to a sharper stereo image since the most crucial musical and spatial information is carried in the middle frequency range, and he believes the effect will be best achieved by making the sound source substantially narrower than the distance between human ears.

The result of his endeavours is a drive unit with a flat, 'lozenge shaped' diaphragm driven by a similarly elongated coil. The long thin shape fulfils the requirement that, when positioned vertically, the diaphragm is considerably narrower than the distance between human ears, and in addition it ensures that the diaphragm is fairly evenly driven since no part of its surface is more than 10 mm from the coil. The flat diaphragm does not have the stiffness of a



A Musician drive unit in an enclosure made of the cement-based inorganic plastic, NIMS 127.

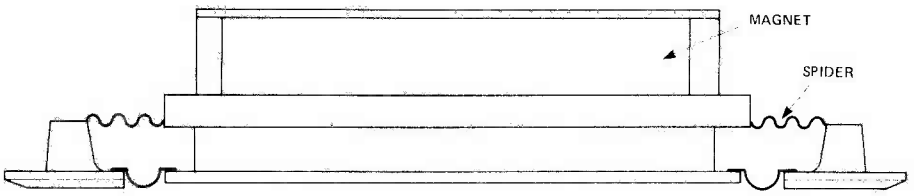


Fig. 1 Vertical cross-section through the Musician drive unit.

cone, but the more evenly-distributed drive overcomes this disadvantage to some extent, and the use of a stiff, lightweight, laminated plastic with a degree of self damping helps ensure that the inevitable flexing is not catastrophic.

The use of a large coil and relatively small diaphragm area does introduce certain limitations. Unless it is to make impossibly large excursions, a small diaphragm cannot produce high acoustic power levels. This prevents the unit delivering the power levels demanded by some heavy rock enthusiasts, but for most other tastes the sound level in a domestic room of average size should be satisfactory. The other limitation is the sensitivity. A low sensitivity is quite normal for small loudspeakers, and even with the substantial magnets used in the prototypes the sensitivity did not exceed 86 dB for 1 watt at 1 metre on axis. This simply means that the loudspeakers sould be driven by an amplifier offering in excess of 40 watts per channel, not an uncommon output level for a modern, high quality amplifier.

The Musician Loudspeaker, at the expense of introducing these minor limitations, has been designed to offer a sound which is largely free of colouration. There is little point, therefore, in mounting such a drive unit in a conventional resonant enclosure. There are two major sources of resonance in a loudspeaker enclosure, cavity resonance generated within the space and resonances set up within the panels of which the enclosure is constructed. Both of these sources have been considered and dealt with in arriving at a design which complements the low colouration of the drive units.

Considering first the question of cavity resonance, standing waves always occur in an enclosure which has flat, parallel

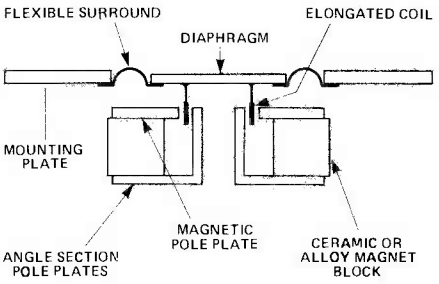


Fig. 2 Horizontal cross-section through the Musician drive unit.

interfacing surfaces. The wavelengths of the resulting resonances will be comparable to the distance between the faces.

Thus in a rectangular box 300 x 250 x 200 mm there will be resonances at approximately 1125, 1350 and 1700 Hz. Absorbent filling in the cavity will reduce these resonances but will not kill them altogether. The designers of musical instruments avoid the formation of standing waves by making their sound boxes in irregular shapes eg, the violin, the 'cello, the lute and the guitar. Reflections inside these soundboxes are so diffuse that standing waves cannot occur. An instrument with a rectangular sound box would produce some notes much more loudly than others.

It is inconvenient and impractical to house loudspeaker drive units in irregularly shaped enclosures but the same effect can be obtained by inserting an irregularly shaped object inside the cavity which similarly diffuses reflections between the inner surfaces. The 'sound splasher' used for this purpose is shown in Fig. 6 and simply consists of a number of lengths of square section timber glued together to form a spiral. BAF wadding is used in the normal way to fill the remainder of the cavity.

In a conventional box with mitred or butt jointed corners, each panel is rigidly held at all its edges and is readily excited into resonances, the frequencies of which will depend upon its mass, its stiffness and its dimensions. Again taking a lesson from the designers of musical instruments and noting that a piano string is damped by a resilient pad at one of its ends, the panels of the boxes are separated by a 1mm gap and fixed together with cork fillets, giving them a degree of acoustic independence and providing a small but useful amount of damping.

The enclosure material must also be carefully chosen if excessive resonance is to be avoided. The best materials are heavy and stiff, and concrete and sand filled panels are among those which have been tried. Glass, ceramics and heavy metal plate are all better than timber or common chipboard, and very good results have been obtained using large (300 x 200 x 8 mm) Italian ceramic floor tiles. The constructional techniques outlined above can be used with all these materials.

The material most favoured by Carl Pinfold is a cement-based inorganic plastic called NIMS 127 which has been developed by Professor Birchall working for ICI. Cement mortar normally has no tensile or compressive strength and is prone to crumbling, the result of having large spaces between its molecules. By mixing a polymer additive with simple cement, Professor Birchall has produced a material which has the strength of aluminium plate, can be readily machined, cast and extruded, and which can be produced in any colour simply by adding pigments into the mix. It is fireproof, waterproof and requires a minimum of energy in its manufacture, but its most attractive features from the loudspeaker designer's point of view are that it is both dense and stiff and hence acoustically very non-resonant. Unfortunately, this material is not yet available to the general public, so the enclosure design presented here is that of Carl Pinfold's 'Basic' enclosure which is constructed from Medium Density Fibre board. Ordinary particle board could also be used, but will not give quite such good results and will need to be at least 18mm thick.

The enclosure to be described is of the fully-sealed or 'infinite baffle' variety. It has been designed principally for use with the Musician drive units which have a free-air resonance at 42 Hz rising to a modest peak at 70 Hz when so enclosed. The peak is not pro-

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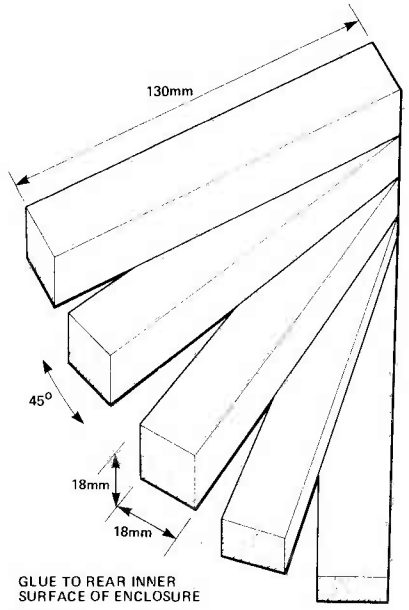
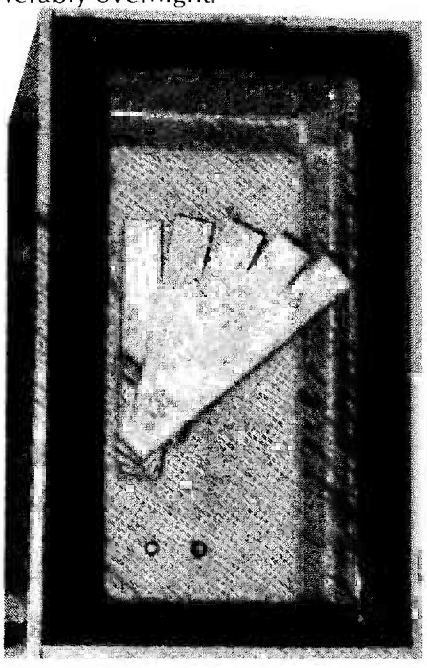


Fig. 6 The 'spasher'.

While the glue on the enclosure is drying, you can get on and produce the 'splasher'. As explained, this simply consists of five pieces of wood laid one-on-top-of-the-other at one end and staggered so as to form a spiral. You will need a clamp or a bench vice or some other means of holding the pieces in the correct position while the glue dries, although it should not be too difficult to devise another means of support if neither of these is available. As with the enclosure itself, the 'splasher' should be left to dry for a reasonably long time and preferably overnight.



Internal view of an enclosure made of NIMS 127 showing the cork fillets and the 'spasher'. The same construction is used for the MDF board version.

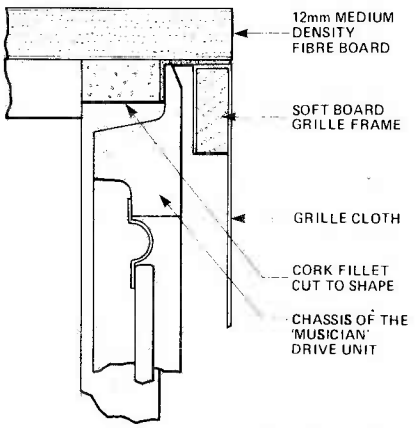


Fig. 7 Vertical cross-section through the enclosure with the Musician drive unit in position.

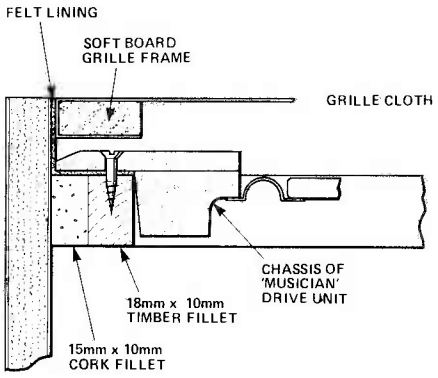


Fig. 8 Horizontal cross-section through the enclosure with the Musician drive unit in position.

When the glue on the enclosure is dry, remove the binding and then seal all of the inside joints with a flexible mastic sealant so as to make the final unit air tight. Depending upon the type of drive unit you are planning to use, identify the spot on the inside back panel directly opposite the driver coil and stick the 'splasher' down. The enclosure can be left on its back whilst the glue dries, but you will still need to tape the 'splasher' in place to stop it tipping over.

If you are using a drive unit other than the Musician loudspeaker, you can now glue the front panel into place. Remember to leave 1 mm gaps around the edges just as you have done with all the other panels. If you are using the Musician drive units, glue the two vertical timber pieces to the cork fillets at the front of the enclosure and support them in place until the glue is dry.

When the final glueing stage is over and the glue is dry, you can finish the exterior surfaces of the enclosure to your taste, either by staining the wood or painting it or by covering it with veneer or fabric. If you do cover the enclosure with something like veneer remember to expose the gaps between the panels and don't just cover over them. Stick a layer of felt to the inside faces of the front of the enclosure, and make up a simple wooden frame to hold the grille cloth. Provided you make the frame the right size, the cloth will bind against the felt and hold it in place and no other means of support will be necessary. The cloth itself should be as acoustically transparent as possible, and open-weave hessian or something similar is recommended.

The only tasks remaining are to install the drive unit and the input connectors and wire them up. Two 4 mm sockets are ideal as input connectors and only require two small (usually 5/16") holes. If you are using the Musician driver unit, position it within the front of the enclosure and line it up so that it is in the centre of the space. Six holes can then be drilled into the two vertical battens and wood screws used to hold the driver in place. If you are using any other drive unit you will have to devise your own mounting system but for obvious reasons you should avoid using a drive unit which can only be mounted from the rear of the panel. Finally, wire up the drive units to the terminals, loosely fill the cabinets with BAF wadding, secure the drive units in place and then sit back and enjoy them.

BUYLINES

Medium Density Fibre (MDF) board is widely available from DIY and timber shops, and if you don't have an old cork bathmat to hand you should have no trouble finding someone to sell you a new one. The BAF wadding and the hessian should both be available locally but if you encounter problems you could try Wilmslow Audio who certainly have the wadding and probably have a suitable grille cloth. The Musician drive units are available from Merseyside Acoustic Developments, Merseyside Innovation Centre, 131 Mount Pleasant, Liverpool L3 5TF, tel 051-709 0427, and cost £140.00 per pair inclusive of VAT, carriage and packing. If you don't feel like doing all the hard work but would still like a pair of Musician loudspeakers, they can be obtained from the same address and cost £240.00 inclusive in the 'Basic', MDF board enclosure and £320.00 inclusive in the NIMS 127 enclosures.

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DETAIL FOR DETAIL

There's a lot of talk about the 'detail' that any piece of hi-fi gives in its sound. However, there's another sort of detail in hi-fi — the sort that you've got to get right. Stan Thatcher takes a look.

After a house and a car, a quality hi-fi system is often the most expensive purchase many of us make. Whether your system is home constructed, bought, or a combination of the two, the amount of money you have spent or propose to spend makes it imperative to realise the full potential of every pound. In pursuit of this objective, there are several minor details to look for when buying and setting up your hi-fi which, for little or no extra expenditure, will greatly augment the detail and sound quality of your system.

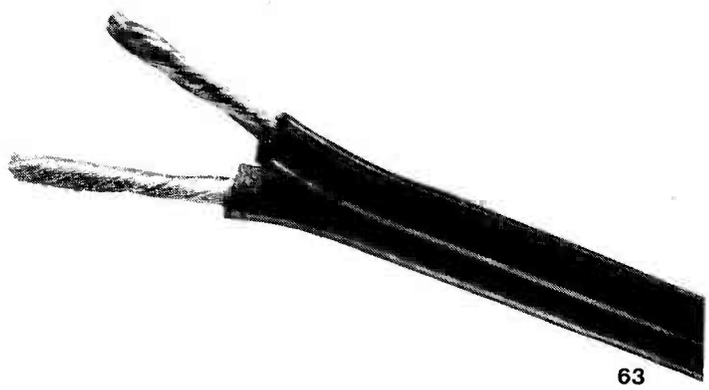
As a starting point, try to buy your equipment from a specialist dealer, whose business is installing good sound into peoples homes, and not also selling washing machines, videos and Pac Man games. He will let you listen to all the components of the system in a single speaker demonstration lounge — "A what?", I hear you ask. It is a lounge with just one pair of speakers in it. This is crucial if you are auditioning speakers, because if the pair you are listening to are stacked in a pile with a load of others, the drive units of the speakers you are not auditioning will move in sympathy with the ones you are listening to, seriously upsetting the stereo imagery. One final note on dealers. If the system sounds fine in the shop, but disappointing when you get it home, a serious, committed dealer will let you take the speakers back after a day and let you try another pair until you are completely satisfied.

Once your system is purchased or built, care and attention to details when setting it up in your room will prove well worthwhile. There are many obvious points. Ensure that the pick up arm is tracking at the right weight for the cartridge being used, and of course, don't use a worn stylus! You can get special alignment aids to set up the arm, and this may be well worth considering. Ideally your turntable should be shelf mounted, to isolate it as far as possible from sound vibrations. If you have a really good turntable, you might like to investigate the "coffee tables" which have been designed specifically for the purpose. I personally haven't tried one yet, though I am assured they offer sonic advantages over other, more conventional methods of mounting a turntable.

Given that you have set your turntable up correctly and are getting as much information out of the groove as possible, make sure the connections between the turntable and the amplifier are as tight as possible. For a few pounds you can buy high quality connecting leads which will see that more information gets through (and that you have fewer problems with bad contacts — Ed.). Any good dealer can supply these.

The information has now passed through the amplifier and is heading for your speakers, and it is this link in the chain, the speaker cable, where the most dramatic improvement can be made. To many this must sound an incredible claim, but, think about it, wires *do* differ in sonic quality as well as electrical qualities. Cable has varying amounts of capacitance, inductance and resistance, and, yes, you've guessed it, these all add to or, rather, subtract from the sound quality. An obvious example comes to mind if you consider the effect of resistance, ie wasted power. A thicker cable will carry the signal with greater ease, and less of the amplifiers efforts end up as wasted heat. Elementary electronics really! With inductance and capacitance putting their oar in, designing sonically superior cable has almost become as scientific as designing an amplifier! So what sort of cable should you use, and what is the effect on sound going to be?

Once the effect of cable was truly acknowledged, many manufacturers set out in pursuit of the perfect cable, with varying degrees of success, and at various costs to the consumer. There must be some twenty varieties on the market by now, with costs ranging from 25p per metre to, wait for it, £90! I do not recommend spending £90 on a metre of cable. I have auditioned a few cables of various costs and find the difference between them marginal compared to the difference between any of them and standard cable or bell wire, the most widely used type. My personal recommendation is QED 79-strand cable, which doesn't cost an arm and a

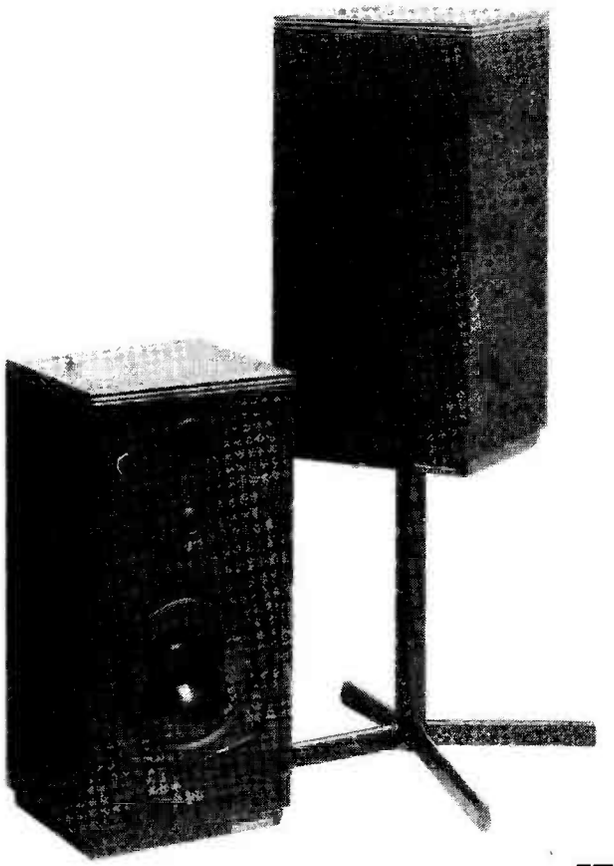


leg, and is I believe the best selling cable currently on the market. Retailing at a modest 77p per metre, the manufacturers claim: "QED 79-strand cable directly improves the amplifier's ability to control damping of the loudspeaker's drive units, thus avoiding the blurring effects". A tighter sound is therefore what they are claiming.

My own experience, having auditioned the cable (alongside a couple of others) is that the use of superior cable goes much further. Apart from tightening up the bass, the resultant sound is a greater feeling of naturalness and openness, with detail coming through that simply wasn't there with ordinary cable. It is as if previously there had been curtains in front of the speakers. Stereo imagery also seems significantly improved. If there is any doubt in your mind, then just listen for yourself. For a few pounds (I am not convinced of the superiority of more expensive cables) you will dramatically improve the sound of your system.

Finally, positioning the speakers themselves. Bookshelf speakers are intended to be mounted on a shelf; more than this, they are *designed* to go on a shelf, and in many cases, this means unless they are mounted with a wall close behind them, they will give a very poor bass performance if mounted on a stand. Not surprisingly, stand-mounted speakers give rather too much bass if mounted on a shelf or on the floor. It's not unknown for people to mount speakers sideways on the floor behind a settee, and then to complain about there being too little treble! It really can make a lot of difference to speaker performance if you follow the manufacturer's suggestions . . .

Finally, having tightened up all the details, it's time to put on your favourite record, sit back and enjoy the music, because that's what it's all about.



ETI

CORTEX CENTRONICS INTERFACE

Any follow-up on the Cortex is long overdue, for which we apologise. We're now about to start setting this to rights.

The Cortex 16-bit computer was designed in late 1982 and was featured by ETI in the November 1982, December 1982 and January 1983 editions. It is based on the TMS9995 16-bit microprocessor with a full 64K byte main memory and a separate 16K byte memory for the colour graphics display. The machine can be expanded by simply adding chips to provide features such as floppy disc support and an expansion bus for extra memory, input and output. This article details how to use the EBUS bus expansion to plug an external board into your Cortex to provide a parallel data interface for a Centronics printer.

The E-BUS was developed to provide a compact, high-performance and flexible interface for both memory and input/output expansion. The E-BUS system multiplexes both addresses and data information onto its lines at different times, so as to keep the number of lines needed as low as possible. It can be shared by multiple microprocessors for access to common memory or I/O.

With regard to I/O expansion, some explanation of the computer's operation is necessary. When doing input and output operations, the CPU does not communicate in eight or 16-bit words, in contrast to most common processors which support dedicated I/O commands. Instead, the 9995 sends and receives just one bit at a time. This means that multi-bit input and output functions, like those needed for a Centronics printer for instance, have to be built up or broken down one bit at a time. However, this operation is made simpler by the fact that each bit can be sent to or received from a unique address. So, to output eight bits to a peripheral, it is necessary to transfer the bits to a latch or similar device with eight successive single bit operations. Only then can the peripheral be told that the data is ready to be acted upon.

An input cycle occurs when the MEMEN (memory enable) control signal goes high (inactive); the bit address is output on the address/data bus and the single bit of data is sampled on the CRUIN signal. An output cycle is similar, except that the data bit is output on the CRUOUT signal and the CRUCLK control signal pulses active low. For multi-bit transfers, the cycle repeats with the address incrementing each time. A timing diagram for this is shown in Fig. 1.

During an I/O operation, the multiplexed address/data lines are forced to output the address throughout the I/O cycle so no address latches are required, consequently the ALATCH (address latch) control signal remains high. The data bit to be sent appears as the signal CRUOUT on the least significant address line (A15 by the TI convention) when an output operation is performed. The remaining 15 address lines define 32768 addresses to which it can be sent, although the Cortex and the 9995 CPU use some of these addresses internally (see Fig. 2, the Cortex I/O map).

A data bit to be read in is taken via the CRUIN line. Up to 16 bits can be input or output by a single instruction, the specified number of bits being processed serially to or from the target addresses.

The E-BUS

The kernel of the E-BUS interface on the Cortex is the 74LS-2001 gate array. This device is used to control access to the bus

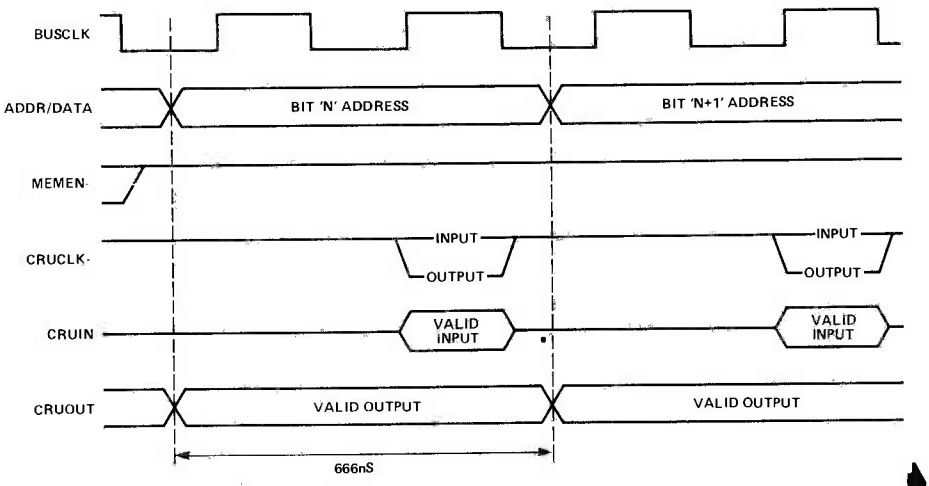


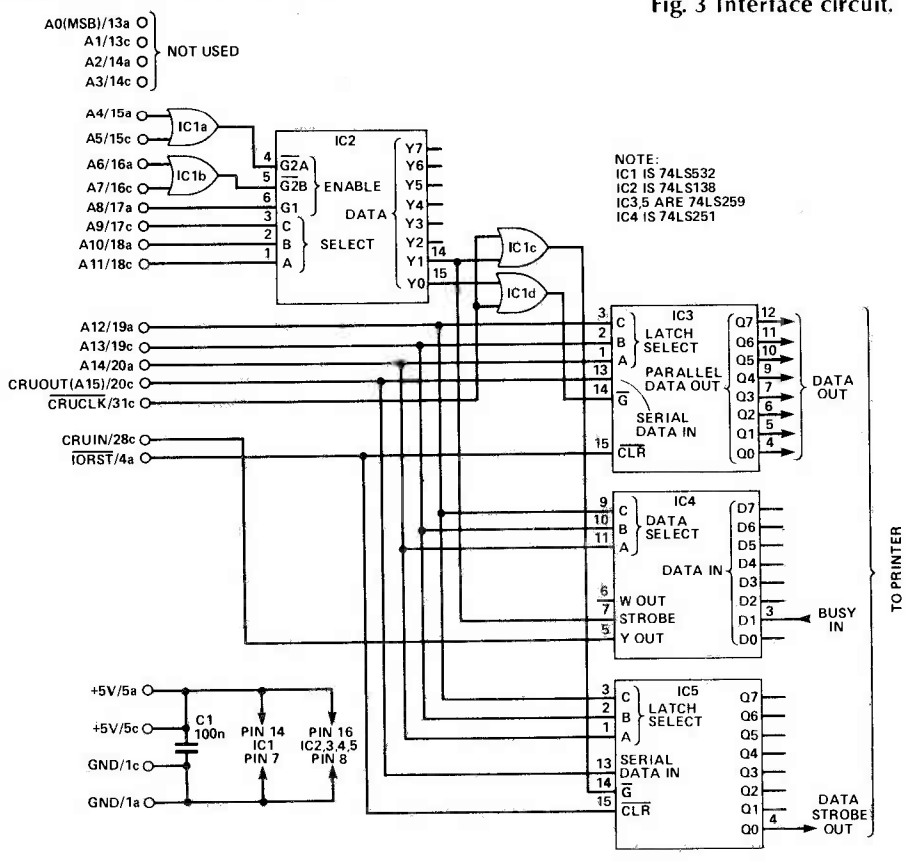
Fig. 1 Timing diagram for multi-bit transfers.

Address	Input Function	Output Function
0000	NOT USED*	"BASIC" LED
0002	NOT USED	KEYBOARD ACKNOWLEDGE
0004	DISK SIZE JUMPER	EBUS INTERRUPT ACK
0006	DISK DENSITY JUMPER	EBUS TIMEOUT ENABLE
0008	FLOPPY INTERRUPT FLAG	DISK SIZE
000A	KEYBOARD INTERRUPT FLAG	EPROM ON/OFF
000C	DISPLAY INTERRUPT FLAG	"BELL" ENABLE
000E	EBUS TIMEOUT INTERRUPT FLAG	NOT USED
0010 to 001E	KEYBOARD DATA	DUPLICATE OF ABOVE
0020 to 003E	DUPLICATE OF ABOVE	DUPLICATE OF ABOVE
0040 to 007E	NOT USED	NOT USED
0080 to 00BE	TMS 9902 RS232 PORT	TMS 9902 RS232 PORT
00C0 to 017E	NOT USED	NOT USED
0180 to 01BE	TMS 9902 CASSETTE PORT	TMS 9902 CASSETTE PORT
01C0 to 01FE	TMS 9911 DMA CONTROLLER	TMS9911 DMA CONTROLLER
0200 to 07FE	external via EBUS	external via EBUS
0800 to 080E	external via EBUS	Centronics data via EBUS
0810	external via EBUS	Centronics strobe via EBUS
0812	Centronics status via EBUS	external via EBUS
0814 to 1EDE	external via EBUS	external via EBUS
1EE0	CPU internal	CPU internal timer control
1EE2	" "	" " timer interrupt
1EE4	" " level 1 interrupt flag	" " enable
1EE6	" " " 3 " "	" "
1EE8	" " " 4 " "	" "
1EEA	" " **	" " **
1EEC	" " ***	" " ***
1F00 to 1FD8	" " not used	" " not used
1FDA	CPU internal MID flag	CPU internal
1FDC to FFFE	external via EBUS	external via EBUS

* Some systems may have this used for floppy disk interface
** Cortex Basic uses this bit to enable the display on the TV screen of all control characters.
*** Cortex Basic uses this bit to disable the scrolling of a text display on the TV screen.

Fig. 2 (above) Cortex I/O map.

Fig. 3 Interface circuit.



for multiple microprocessors and to synchronise all data transfers, as well as to provide time-out controls to avoid a permanent lock-up of the bus. However, for simple expansion of the Cortex facilities, it is possible to avoid using this device. Four changes to the main PCB have to be made, as follows:

1. Cut the connection to IC99 pin 18 and connect this pin to IC94 pin 11;
2. Connect IC94 pin 9 to IC11 pin 13;
3. Connect IC94 pin 19 to IC27 pin 2;
4. Connect IC89 pin 18 to IC89 pin 19.

For this modification to work, the

HOW IT WORKS

IC1a, IC1b and IC2 decode address bits A4 to A11 inclusive. Two outputs from IC2 are used each of which will go low when one of their particular group of eight addresses is accessed. Note that the address decoding is not complete and may well respond at other locations (2K interval). The Y1 output from IC2 (address 0088h to 008Fh) enables the output of IC4 (74LS251) the 1 of 8 selector. This device selects the signal on the input specified by the least significant address lines and passes it to the CRUIN line. This would normally be the printer status line in this case and its state will signal whether the printer is ready to receive data.

The data to be output to the printer appears on the CRUOUT line in serial form. This has to be converted to parallel form before being presented to the printer. This is done by IC3 which is an eight bit addressable latch (74LS259). Address lines A12, 13 and 14 determine which bit is to be written into IC3 and the output Y0 of IC2 gated with CRUCLK in IC1d actually causes it to happen. To write a complete eight bits of new data requires eight output cycles. Once this has been done the data is ready to be acted upon by the printer. IC5 is another 74LS259 like IC3 and one bit of its output is used as a strobe signal to tell the printer that the data is ready. Output Q0 is used in this case; it is normally low and is pulsed high under software control. This happens when a 1 and then a 0 is output to 0088h.

For the transfer of one character the sequence is as follows: eight bits of data are written into the eight locations in IC3. The data then appears in parallel form at its output and is available to the printer. The DATA STROBE is taken high and then low to signal to the printer that valid data is ready. The printer signals that is is BUSY by taking the BUSY STATUS line high. This is read by the computer and no further action is taken until it goes low again. Now new data can be sent to IC3 and the process repeated.

Note that some printers give a low on the status line to indicate the BUSY condition, this can be accommodated by connecting the EBUS CRUIN line to IC4 pin 6 instead of pin 5. More difficult is when the STROBE has to be inverted, this requires an additional inverter.

following devices must be present on the PCB (if your Cortex does not have all the options available, then some of these may be missing, so you will need to check): IC90 (74LS08), IC91 (74LS32), IC92 (74LS74A), IC93 (74LS00), IC94,95,96 and 99 (all 74LS244).

If you wish to use memory expansion, then you must break the links next to IC26 and drill out the shorting links next to IC94, and ensure that you have IC97 (74LS245) and IC26 (74LS612). Note that all the component numbers used here are those given in the original Cortex article.

It's Already There

Although the Cortex has an RS232 interface for a printer or terminal, it also has the software necessary to drive a parallel data printer port. The hardware necessary to implement this was left off the main PCB to save space. Building the interface described here will therefore free the RS232 for other tasks, and make it possible to use the more common Centronics printers.

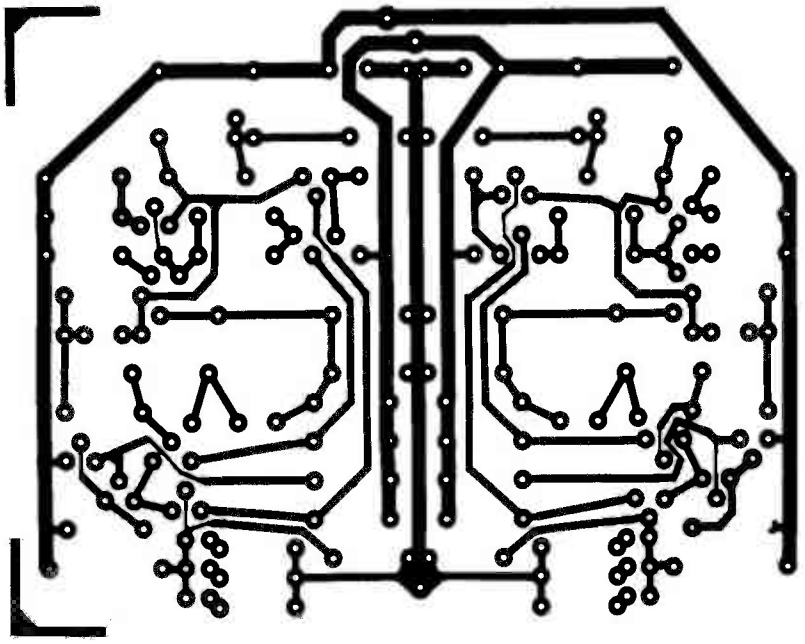
The circuit diagram for the interface is shown in Fig. 3 and the circuit itself is discussed in the 'How It Works' section.

I/O	ROW A	PIN	ROW C	I/O
	GND 0V	1	GND 0V	
I/O	PRES- (RESET-)	2	BUSCLK (3MHz)	O
	+12V	3	−12V	
O	IORST- (I/O RESET-)	4	NMI-(NON-MASKABLE INT)	I
	+5V	5	+5V	
	—	6	—	
	—	7	—	
	—	8	—	
	—	9	—	
I	INTEN- (LEVEL 1)	10	ALATCH (ADDRESS LATCH)	O
O	XA0 (MSB ADDRESS)	11	XA1	O
O	XA2	12	XA3	O
O	A0	13	A1	O
O	A2	14	A3	O
O	A4	15	A5	O
O	A6	16	A7	O
I/O	A8/D8 (DATA MSB)	17	A9/D9	I/O
I/O	A10/D10	18	A11/D11	I/O
I/O	A12/D12	19	A13/D13	I/O
I/O	A14/D14	20	A15/D15/CRUOUT (LSB)	I/O
	—	21	MEMEN- (MEMORY ENABLE)	O
O	DEN- (MEMORY READ)	22	READY- (MEMORY READY)	I
I	GRANTIN	23	GRANTOUT	O
	—	24	BUSY- (BUS BUSY)	I/O
	GND	25	GND	
	—	26	—	
	—	27	—	
	—	28	CRUIN (I/O INPUT)	I
O	WE- (MEMORY WRITE)	29	—	
	+5V	30	+5V	
	—	31	CRUCLK (I/O WRITE STROBE)	O
	GND	32	GND	

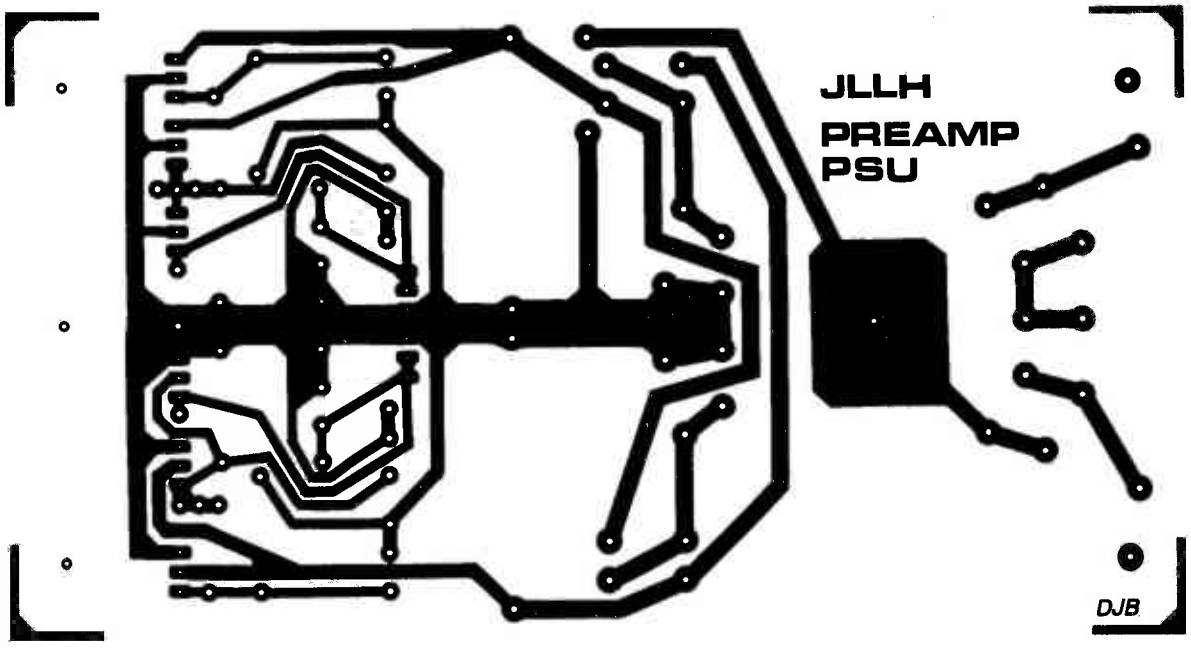
Fig. 4 EBUS signals and their uses.

Next month we will publish the PCB, overlay, parts list and buylines. **ETI**

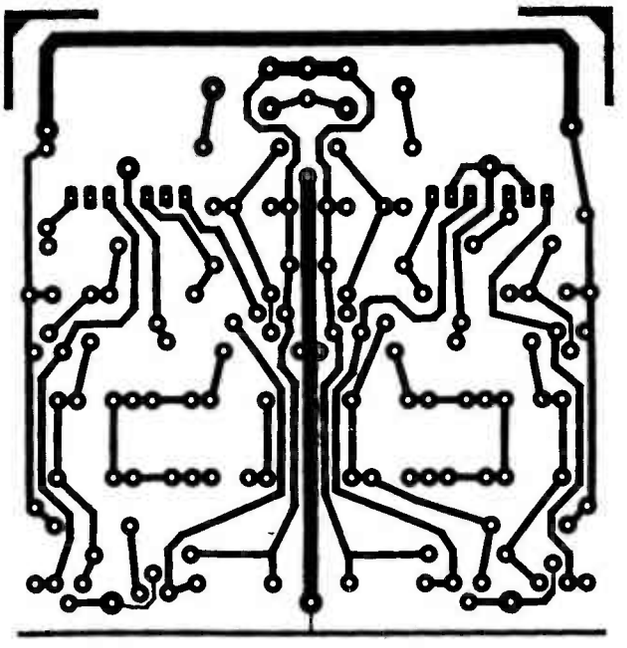
PCB FOIL PATTERNS



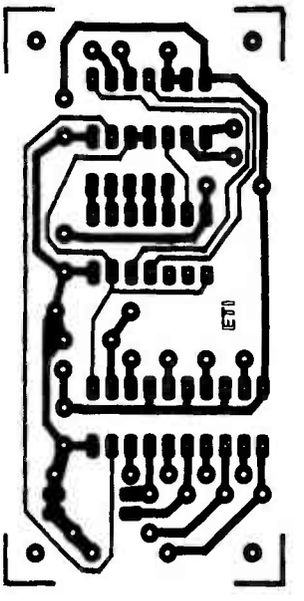
The RIAA input board of the JLLH amplifier.



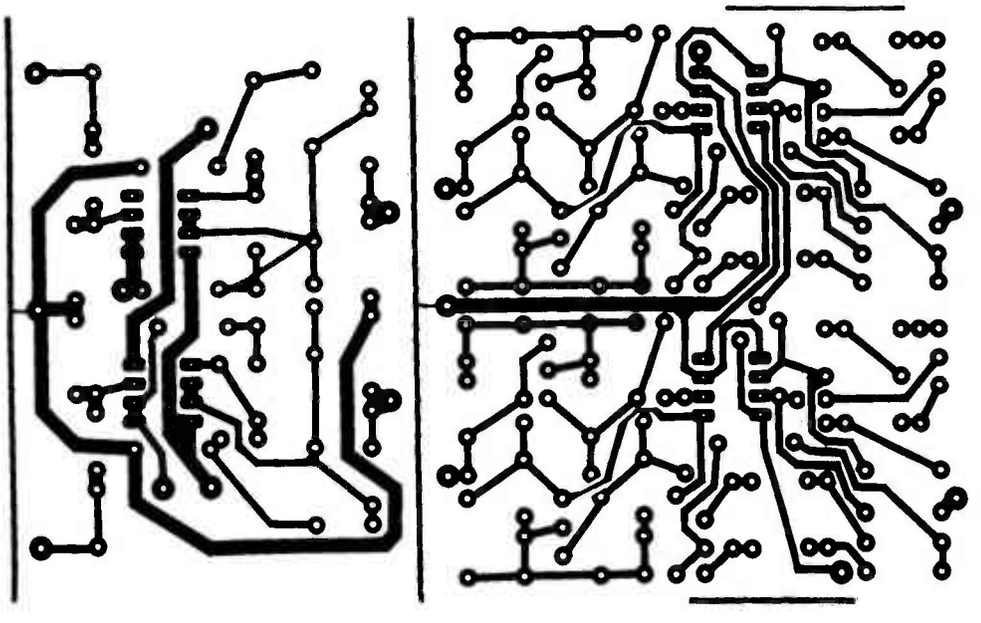
The PSU board of the JLLH amplifier.



The headphone amplifier board of the JLLH amplifier.



The Spectrum Joystick Interface board.



The buffer/filter and tone control board of the JLLH amplifier.

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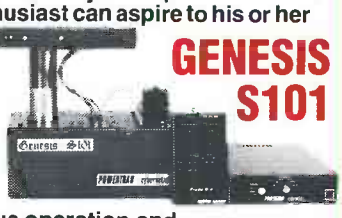

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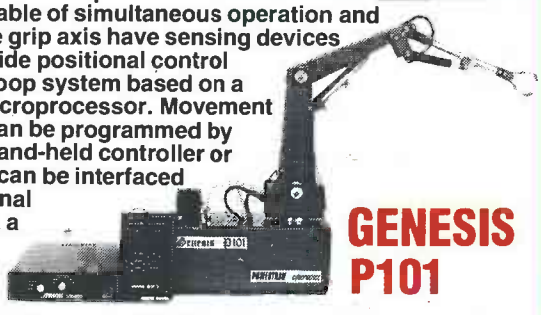
Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed loop system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link.



GENESIS P101

The top-of-the-range P102 has dual speed control, enhanced memory and double acting cylinders for increased torque on the wrist and arm joints. There is position interrogation via the RS232C interface, increasing the versatility of computer control and inputs are provided for machine tool interfacing.

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GENESIS P102

Cortex 16 bit microcomputer

HEBOT II Turtle-type robot

For a little over £100, Herbot II takes programming off the VDU and into the real world. Each wheel is independently controlled by a computer, enabling the robot to perform an almost infinite number of moves. It has blinking eyes, a two-tone bleep and a solenoid-operated pen to chart its moves. Touch sensors, coupled to its shell return data about its environment to the computer enabling evasive or exploratory action to be calculated.

The robot connects directly to an I/O port or, via the interface board, to the expansion bus of a ZX81 or other microcomputer.

HEBOT II

Weight 1.8kg
complete kit with assembly instructions **£95**
Interface board kit **£11**

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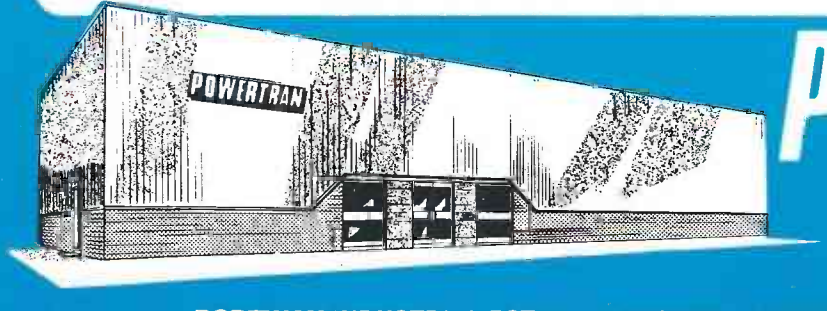

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2.	(3)	Modem	LW99H	£44.95	5 XA05F
		Case also available: YK62S Price £9.95.			
3.	(5)	ZX81 I/O Port	LW76H	£9.25	4 XA04E
4.	(4)	Car Burglar Alarm	LW78K	£6.95	4 XA04E
5.	(8)	Partylite	LW93B	£9.45	Best of E&MM
6.	(2)	Keyboard for ZX81	LW72P	£23.95	3 XA03D
		Case also available: XG17T £4.95. Complete ready-built: XG22Y £32.50			
7.	(10)	8W Amp Module	LW36P	£4.45	Catalogue
8.	(14)	VIC20/64 RS232 Interface	LK11M	£9.45	7 XA07H
9.	(7)	Syntom Drum Synthesiser	LW86T	£11.95	Best of E&MM
10.	(12)	Harmony Generator	LW91Y	£17.95	Best of E&MM
11.	(17)	Spectrum RS232 Interface	LK21X	£17.95	8 XA08J
12.	(6)	VIC20 Speech Synthesiser	LK00A	£22.95	6 XA06G
13.	(13)	ZX81 Sounds Generator	LW96E	£10.95	5 XA05F
14.	(11)	Ultrasonic Intruder Detctor	LW83E	£10.95	4 XA04E
15.	(15)	Logic Probe	LK13P	£9.95	8 XA08J
16.	(26)	Car Battery Monitor	LK42V	£6.25	Best of E&MM
17.	(18)	Hexadrum	LW85G	£19.95	Best of E&MM
18.	(21)	Synwave Sounds Synth	LW87U	£10.95	Best of E&MM
19.	(25)	Spectrum Keyboard	LK29G	£28.50	9 XA09K
		Also required: LK30H £6.50; Case: XG35Q £4.95 — Total £39.95.			
		Also available complete ready-built: XG36P £44.95.			
20.	(9)	ZX81 Speech Synthesiser	LK01B	£16.95	6 XA06G

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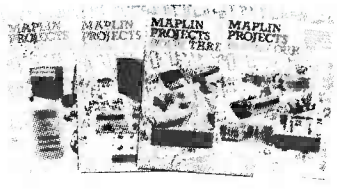

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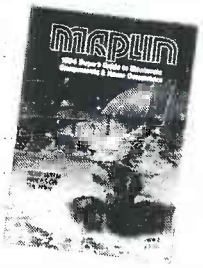

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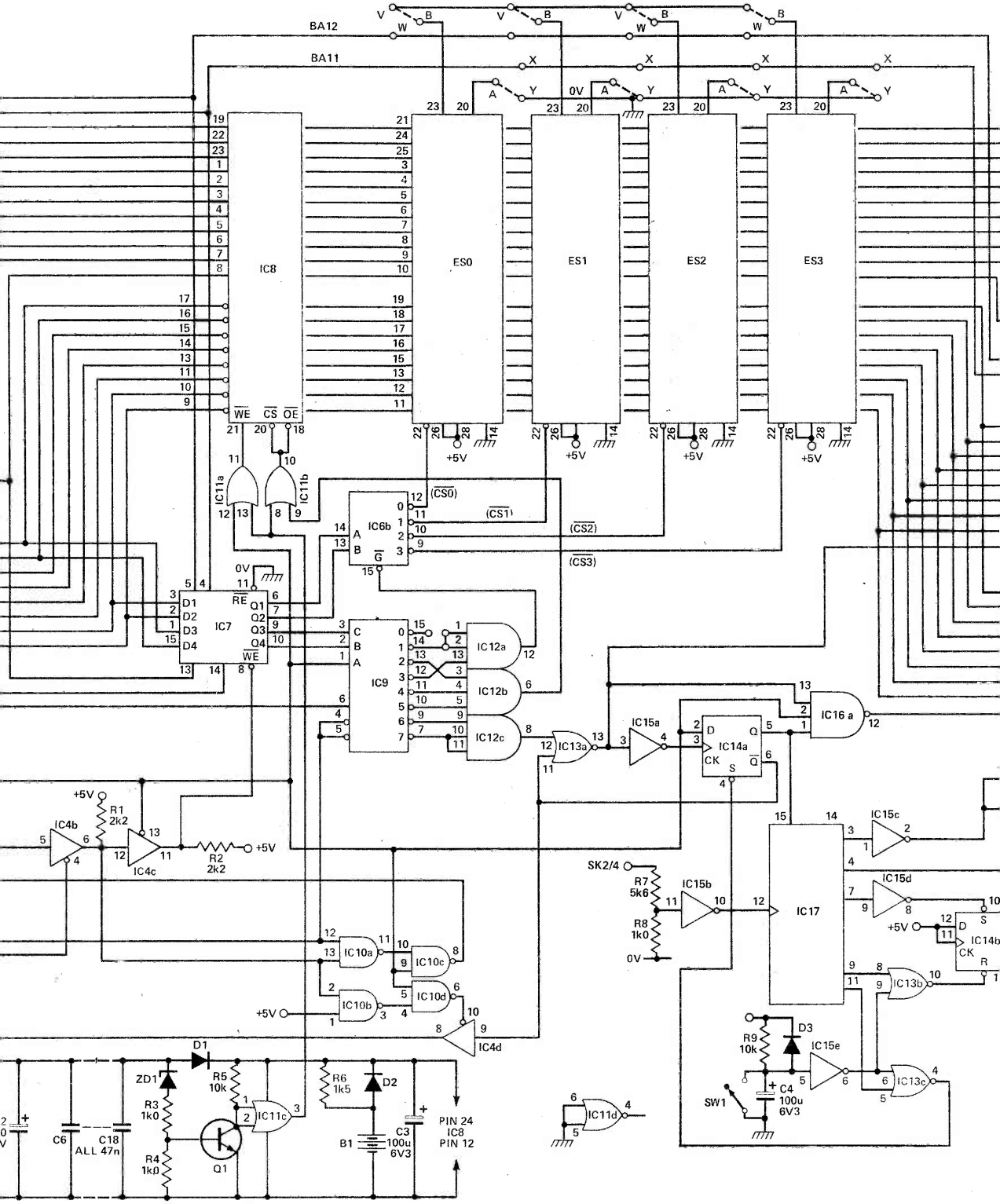

allowable. The same signal
e direction of IC3 also serves
mory and I/O functions in
hat no disagreements occur
trying to drive the data bus

he three top address bits to
ch are active in the ranges
d A000h — BFFFh. The first
activate the memory func-
ond is used to enable IC4b.
IC4b comes from IC5 which
ND gate. The inputs to this
2 to A12 inclusive. The out-
ow when $\varphi 2$ is high and the
nts are:— XXX1 1111 1111
11XX (X=don't care). Only when the output of IC5 is low and the enable input to IC4b is low can the output of IC4b go low. The enable input will be low when the address bus pattern is:— 101X XXXX XXXX XXXX and therefore IC4b output is only low for addresses:— 1011 1111 1111 11XX which fall in the range BFFCh to BFFFh and the $\varphi 2$ signal is also high. These four addresses are used to write into the control logic and read from the programming logic.

When a WRITE operation is performed to one of the four addresses, the output of IC4c will go low and allow data to be written into IC7. This device is a four-word, four bits per word memory. When writing data into it, the

word to be written is selected by a
A0 and A1 and the data is taken fro
D0, D1, D6, D7. (Note that there i
read the stored data back into
puter!)

If a read operation is performe
the four control addresses it will ca
be enabled via IC10b and IC10d. T
the state of the programming stat
to bit 7 of the data bus.

When an address in the range
9FFFh is written to or read from, t
output from IC6a activates IC9
The output from IC10a and the s
R/W line will activate IC10c if a R
ation is in progress. This will set its

ETI JUNE 1984