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INTERNATIONAL

DECEMBER 1984 99p

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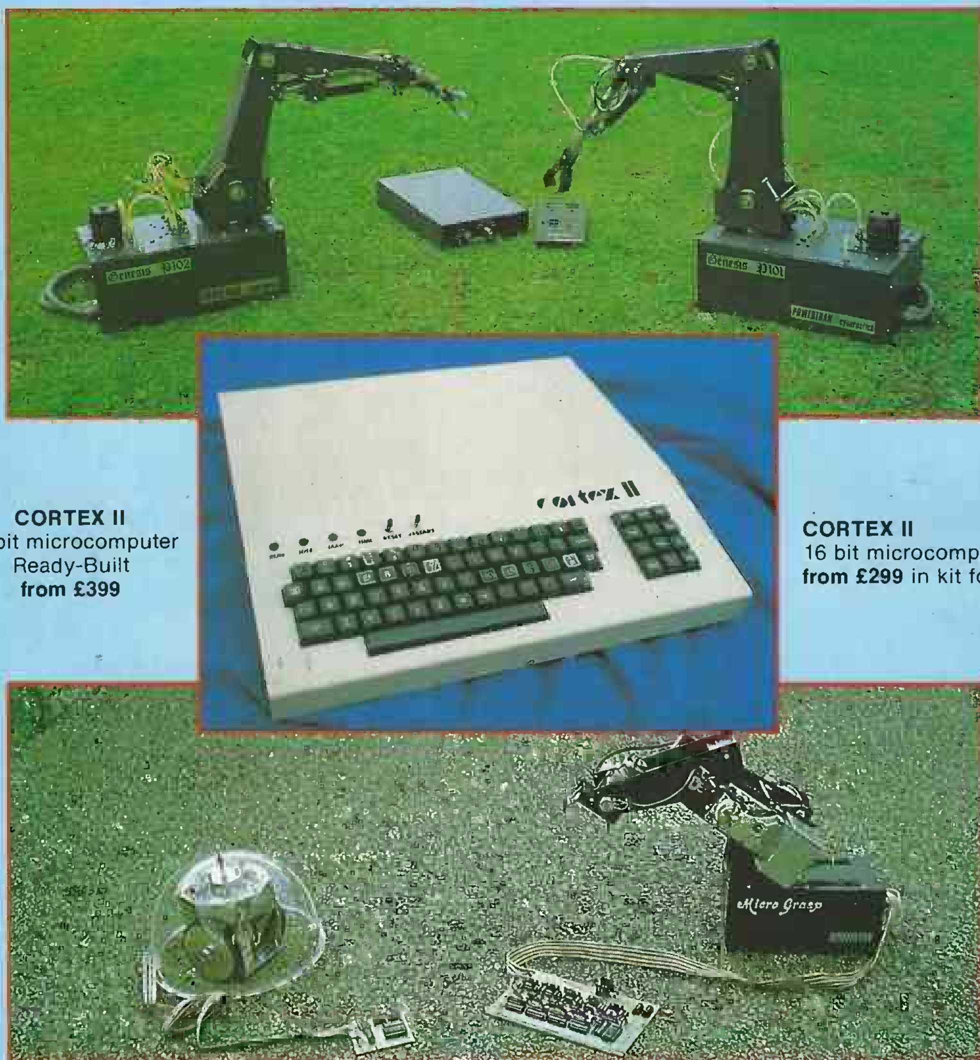

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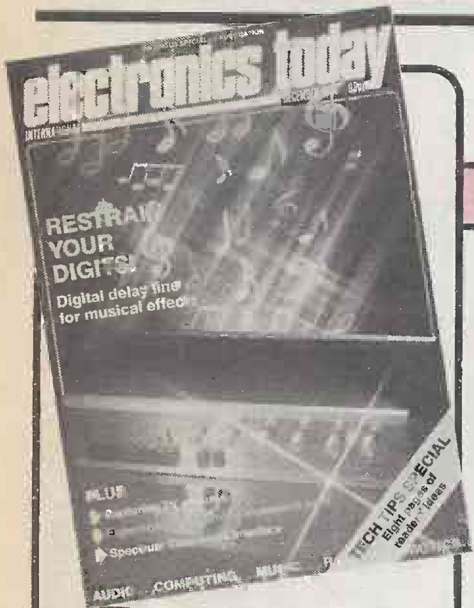
INTERNATIONAL DECEMBER 1984 VOL13 NO12



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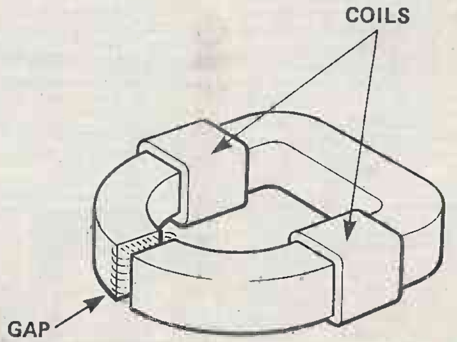
FEATURES



PROJECTS

Our apologies to readers who have been holding their breath since last month in anticipation of John Linsley Hood's promised distortion meter design. Due to lack of space we have decided to hold part one over until next month when we will present both parts together.

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.

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

FEED-THROUGH CAPACITORS
1000pF/450V 10p

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

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

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

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

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

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

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

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

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

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

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

Hitachi 256K DRAM 150ns £49
2764 250ns £4.70
27128 250ns £16

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

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

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

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

TRANSISTORS

AC126/7	35	BC327	15	BF336/7	35	MPSU06	60	ZTX107/8	12	2N3820	60	2SC2335	200
AC141/2	35	BC337/8	15	BF394	40	MPSU52	85	ZTX109	12	2N3822/3	60	2SC2547	40
AC176	35	BC441/61	34	BF451	40	MPSU55	60	ZTX212	28	2N3866	90	2SC2612	200
AC187	35	BC477	40	BF494/5	40	MPSU56	60	ZTX300	13	2N3903/4	18	2SD234	74
AC188	35	BC516/7	40	BF594/5	30	OC26	170	ZTX302	16	2N3905/6	15	2SK45	80
ACY19/21	75	BC547/8	12	BFR39/40	30	OC28	220	ZTX303	25	2N3906	17	2SK288	225
ACY22/41	75	BC556/7	15	BFR41/79	25	OC35	50	ZTX304	17	2N4037	60	2SJ83	225
AD142	120	BC549C	15	BFR80/81	25	OC36/41	75	ZTX326	30	2N4058	15	2SJ85	225
AD149	79	BC558/9	15	BFR98	105	OC42/75	75	ZTX451	23	2N4061/2	15	3N128	115
AD161	42	BCY39/40	85	BFX29	35	OC71/72	50	ZTX500	14	2N4264	30	3N140	115
AD162	42	BCY41/42	30	BFX81	45	OC75/76	55	ZTX501/2	15	2N4286	25	40315	90
AF115/6	80	BCY45	50	BFX84	35	OC81/82	50	ZTX503	18	2N4289	25	40316	95
AF188	80	BCY58/59	36	BFX85/6	35	OC83/84	70	ZTX504	25	2N4314	78	40324	100
AF124/26	70	BCY70/71	18	BFY50/51	30	OC170/71	75	ZTX531	125	2N4400	25	40326/7	70
AF139	40	1BCY72	25	BFY52	30	OC70	40	ZTX550	25	2N4427	80	40347	90
AF178	75	BCY78	30	BFY53	35	OC200	75	2N697	23	2N4871	55	40348	120
AF186	70	BD114	190	BFY55/56	56	TIP29A	32	2N698	40	2N5135/6	30	40360	60
AF239	55	BD121	95	BFY64	40	TIP29C	38	2N699	48	2N5138	25	40361/2	70
BC107	12	BD124	115	BFY81	120	TIP30A	35	2N706A	25	2N5172	25	40407/8	75
BC107B	14	BD131/32	65	BFY90	80	TIP30C	37	2N708	25	2N5179	45	40411	285
BC108	12	BD133	70	BRY39	50	TIP31A	38	2N918	40	2N5180	45	40412	90
BC108B	14	BD135	45	BSX20	30	TIP31B	39	2N1131/2	40	2N5190/1	75	40467A	130
BC108C	14	BD136/37	40	BSX26/29	45	TIP31C	45	2N1302	45	2N5194	80	40468	65
BC109	12	BD138/39	40	BSY26	35	TIP32A	43	2N1307	70	2N5305/8	30	40594	105
BC109B	14	BD140	40	BSY95	35	TIP32C	45	2N1671B	160	2N5457/8	30	40603	110
BC109C	14	BD144/45	198	BU105	180	TIP33A	70	2N2160	325	2N5459	30	40673	75
BC114/5	30	BD158	80	BU205	180	TIP33C	75	2N2219A	28	2N5485	36	40871/2	90
BC117/8	25	BD205/6	110	BU206	200	TIP34A	85	2N2220A	28	2N5777	45		
BC137/9	40	BD245	65	BU208	200	TIP34C	105	2N2221A	25	2N5879	180		
BC140	38	BD378	70	BUY69C	225	TIP35A	120	2N2222A	25	2N6027	32		
BC142/3	38	BD434	70	MD8001	250	TIP35C	130	2N2368	25	2SA671	250		
BC147	12	BD517	75	MJ2955	90	TIP36A	130	2N2369A	18	2SA715	75		
BC147B	15	BD645	80	MJE170	150	TIP36C	140	2N2483/4	27	2SC495	85		
BC148	12	BD695A	150	MJE180	150	TIP41A	50	2N2646	46	2SC496	85		
BC148B	15	BD696A	150	MJE340	54	TIP41B	52	2N2904/5	28	2SC1061	250		
BC149	12	BF115	45	MJE370	100	TIP42A	55	2N2906/7	28	2SC1096	85		
BC149C	15	BF154/8	30	MJE371	100	TIP42B	58	2N2907A	28	2SC1162	45		
BC182L	10	BF167	35	MJE520	85	TIP120	70	2N2926G	10	2SC1173	125		
BC183L	10	BF173	35	MJE521	98	TIP121/2	73	2N3053	25	2SC1306	100		
BC184	10	BF177	35	MJE2955	98	TIP141/2	120	2N3054	55	2SC1307	150		
BC184L	10	BF178	35	MJE3055	70	TIP147	120	2N3055	50	2SC1449	95		
BC186/7	28	BF179	40	MPF102	40	TIP2955	70	2N3252	46	2SC1678	140		
BC188 6/7	25	BF184/5	38	MPF103	30	TIP3055	70	2N3441/2	140	2SC1679	180		
BC12	10	BF194/5	12	MPF104	30	TIS43	50	2N3614/5	180	2SC1923	65		
BC212L	10	BF198/9	18	MPF105	30	TIS44/5	45	2N3663	20	2SC1945	225		
BC213	10	BF200	80	MPF106	40	TIS88A	50	2N3702/3	10	2SC1963	80		
BC213L	12	BF224A	40	MPSA05	30	TIS90/91	30	2N3704/5	10	2SC1957	80		
BC214	10	BF224B	40	MPSA08	30	UC	65	2N3706/7	10	2SC1969	160		
BC214L	12	BF245	50	MPSA12	32	VK1010	99	2N3708/9	10	2SC2028	85		
BC237/8	15	BF256A	45	MPSA55	30	VN10KM	70	2N3713	140	2SC2029	200		
BC256B	35	BF256B	50	MPSA56	30	VN46AF	95	2N3771	179	2SC2078	170		
3078	15	BF257/8	32	MPSA70	40	VN66AF	110	2N3772	195	2SC2091	85		
BC308	16	BF259	40	MPSU02	58	VN88AF	120	2N3773	210	2SC2314	86		
BC318	80	BF275	55	MPSU05	60	VN89AF	120	2N3819	35	2SC2166	105		

RF CHOKES Miniature PCB type
1mH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u 30p
1mH, 1m5, 2m2, 4m7, 10mH 35p
22m, 33m, 43m 80p
100m 75p

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

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

75 SERIES

75107/8	96
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75158	150
75159	195
75160	420
75162	650
75182/4	99
75188/9	100
75322	140
75324	360
75325	00
75361/3	150
75365	00
75450	88
75451/2	52
75454	70
75491/2	65

ZENERS

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

SCR THYRISTORS

5A/40V	32
5A400V	40
5A600V	48
8A300V	80
8A600V	90
12A100V	78
12A400V	96
12A800V	188
BT106	150
BT116	180
C106D	36
TIC44	24
TIC45	29
TIC47	36
2N5062	32
2N5064	38
2N4444	130

TRIACS

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

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	105

DIAC

ST2	25

COMPUTER ICs

2102L	160	8202	£25	TCM3101J	£13
2114	325	8205	225	TMS2716-3V	725
2147	395	8212	495	TMS4047	100
2516	350	8214	495	TMS4164	395
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26501	75	8228	270	TMS5100	600
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6116L-120	425	8T26A	99	Z80BCPU	£11
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6167-6	795	8T31	350	Z80A DART	820
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6402	350	8T97N	90	Z80 DMA	795
6502CPU	355	9602	220	Z80ADMA	925
6502A	545	AM26LS31C	125	Z80 PIO	325
6503	350	AM26LS32A	125	Z80A PIO	350
6503	650	AM26LS33	150	Z80 SIO-1	850
6504	600	AM7910	£30	Z80A SIO	£9
6504 250	550	AY-3-1015	300	Z80ASIO-2	£9
6505	650	AY-5-1013	300		
6505	600	COM8017	275		
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6522VIA	340	D8748	£55		
6530	£11	DM8131	275		
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6545R1C	899	DP8304	350		
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6592	00	DS3691N	595		
6592PC	£20	DS88LS120	495		
6800	220	DS8820	110		
6802	275	DS8830	198		
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6810	175	FD1691	£15		
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6847	650	IM6402	380		
6850	175	INS8060N	1250		
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6859	£4	MC14412	725		
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		SFF9364	800		
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LINEAR ICs

555Cmos	105	CA3123E	165	MC1458	35	TL430C	90
702	75	CA3130	90	MC1469	300	TL507	110
709C 8 pin	35	CA3140	50	MC1494	694	TL509	110
710	48	CA3160	95	MC1495	350	TL061CP	40
741 8 pin	16	CA3161E	199	MC1496L	70	TL062CP	65
747C 14 pin	70	CA3162E	525	MC1596	225	TL064CN	98
748C 8 pin	30	CA3189	275	MC1648	290	TL071CP	40
735 8 pin	185	HA1336W	175	MC1709G	90	TL072CP	76
810	158	HA1388	235	MC3302	75	TL074CN	150
9400CJ	375	ICL7106	690	MC3401	50	TL081CP	35
ADC0808	885	ICL7107	975	MC3403	95	TL082CP	60
AY-1-1320	225	ICL7611	99	MC3404	85	TL083CP	75
AY-1-5050	99	ICL7660	248	MC3405	150	TL084CN	120
AY-1-5051	160	ICL8038CC	360	MC3422	00	TL091CP	60
AY-1-6720	210	ICL8211A	750	MC3423	80	UA2240	120
AY-3-1270	730	ICM7205A	1150	MC3442	00	UA78540	230
AY-3-1350	350	ICM7207	475	MC3487	00	ULN2003	90
AY-3-8910	400	ICM7215	1050	MC4016	00	ULN2004	90
Booklet for AY-3-8910	390	ICM7216AJ	£22	MF10	350	ULN2283	100
AY-3-8912	500	ICM7216C	£22	MFC6040	75	ULN2803	190
AY-5-1317A	630	ICM7217A	750	ML924	275	UPC575	275
AY-5-1350	366	ICM7224	785	NE515	275	UPC1025H	375
CA3011	130	ICM7240	300	NE529	225	UPC1156H	295
CA3012	175	ICM7555	105	NE531	140	UPC1182	425
CA3014	275	ICM7556	150	NE543K	225	UPC1366	195
CA3018	85	LA3550	250	NE544	200	XR2206	375
CA3019	90	LA4031P	340	NE555	25	XR2207	400
CA3020	210	LA4032	295	NE556	65	XR2211	575
CA3023	210	LA4400	350	NE558	170	XR2216	675
CA3028A	130	LA4422	320	NE560	350	XR2266	360
CA3035	255	LC7130	320	NE562B	410	ZN414	80
CA3036	270	LC7120	300	NE564	420	ZN419E	180
CA3043	275	LC7137	350	NE565A	120	ZN423E	130
CA3045	385	LF347	150	NE566	155	ZN424E	130
CA3046	70	LF351	70	NE567V	140	ZN425E	595
CA3048	220	LF353	90	NE570	410	ZN426E	200
CA3059	325	LF355	95	NE571	400	ZN427E	620
CA3075	213	LF356	99	NE5532	175	ZN428E	450
CA3080F	75	LF357	110	NE5534A	160	ZN429E	245
CA3081	180	LF398	495	OM335	750	ZN459	615
CA3085	160	LM10	325	RC4136D	60	ZN1034E	200
CA3086	60	LM301A	35	RC4558	60	ZN1040E	695
CA3089E	200	LM307	45	S566B	225	ZNA234E	925
CA3090AQ	375	LM308T	95	SAB3209	425		
		LM311	65	SAB3210	325		
		LM318N	150	SAB3271	485		
		LM319	195	SAB4209	585		
		LM324A	55	SG3402	295		
		LM334Z	115	SL490	350		
		LM335Z	135	SL6270CD	150		
		LM337	275	SN76013	350		
		LM339	50	SN76227N	95		
		LM348	64	SN76477	470		
		LM349	125	SN76488	525		
		LM358	60	SP8629	350		
		LM377	240	SPO256AL	475		
		LM379	495	TA7120	140		
		LM380	120	TA7204	150		
		LM381N	175	TA7205	90		
		LM382	200	TA7222	150		
		LM384	225	TA7310	125		
		LM386	110	TAA621AX1	296		
		LM387	160	TAA661A	190		
		LM389	145	TAA700	275		
		LM393	85	TAA900	395		
		LM394CH	385	TAB1042	110		
		LM558	170	TAD100	159		
		LM725CN	300	TBA120S	70		
		LM733	70	TBA900	395		
		LM1458	35	TAB1042	110		
		LM1871	300	TAD100	159		
		LM1889	350	TBA120S	70		
		LM2907	395	TBA920Q	200		
		LM3900	70	TBA990Q	350		
		LM3909N	85	TCA220	350		
		LM3911	185	TCA270Q	350		
		LM3914	445	TCA280A	220		
		LM3915	350	TCA940	175		
		LM3916	350	TCA965	180		
		LM13600	150	TDA1004	350		
		LS7220	280	TDA1008	310		
		MS1513L	230	TDA1010	235		
		MS1515L	320	TDA1022	499		
		MS1516L	475	TDA1024	115		
		MB3712	200	TDA1034	350		
		MB3756	440	TDA1490	350		
		MC1204	250	TDA2002	325		
		MC1301	90	TDA2003	250		
		MC1303	96	TDA2004	300		
		MC1304P	260	TDA2006	330		
		MC1310P	150	TDA2020	320		
		MC1445	250	TDA2030	190		
		MC14510	695	[illegible]	420		
		MC1455	50	[illegible]	50		

TTL74

7400	40	7481	200	74366	90
7401	30	7482	100	74367	90
7402	30	7483	120	74368	90
7403	30	7484	140	74376	175
7404	65	7485	120	74390	120
7405	40	7486	50	74393	145
7406	70	7489	225	74426	120
7407	70	7490	75	74490	150
7408	30	7491	70		
7409	30	7492	75		
7410	40	7493	75		
7411	30	7494	120		
7412	30	7495	70		
7413	50	7496	90		
7414	70	7497	230		
7416	50	74100	200		
7417	50	74104	70		
7420	30	74105	70		
7421	30	74107	50		
7422	40	74109	75		
7423	40	74110	80		
7425	40	74111	80		
7426	60	74112	170		
7427	40	74116	175		
7428	55	74118	110		
7430	45	74119	180		
7432	50	74120	100		
7433	40	74121	65		
7437	40	74122	70		
7438	95	74123	90		
7440	45	74125	65		
7441	150	74126	60		
7442	80	74128	60		
7443	110	74132	80		
7444	110	74136	75		
7445	110	74141	100		
7446	110	74142	260		
7447	115	74143	280		
7448	110	74144	280		
7450	40	74145	125		
7451	40	74147	180		
7453	40	74148	145		
7454	40	74150	190		
7460	60	74151	90		
7470	60	74153	90		
7472	50	74154	190		
7473	50	74155	90		
7474	55	74156	95		
7475	70	74157	90		
7476	48	74159	195		
7480	70	74160	120		
		74161	120		
		74162	120		
		74163	120		
		74164	125		
		74165	120		
		74166	170		
		74167	250		
		74170	200		
		74172	430		
		74173	150		
		74174	120		
		74175	110		
		74176	110		
		74177	110		
		74178	150		
		74179	150		
		74180	110		
		74181	350		
		74182	150		
		74184	190		
		74185	190		
		74190	145		
		74191	140		
		74192	140		
		74193	140		
		74194	110		
		74195	90		
		74196	140		
		74197	120		
		74198	245		
		74199	250		
		74221	120		
		74246	130		
		74247	135		
		74248	175		
		74249	175		
		74251	100		
		74259	100		
		74263	75		
		74265	80		
		74273	210		
		74276	150		
		74278	180		
		74279	100		
		74283	120		
		74284	350		
		74285	350		
		74286	90		
		74290	120		
		74293	100		
		74297	175		
		74298	200		
		74351	210		
		74365	90		

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	750
74C923	645
74C925	775

74S

S00	70
S02	60
S03	60
S04	60
S05	60
S08	60
S09	60
S10	40
S11	50
S15	60
S20	40
S30	60
S22	50
S32	70
S37	70
S38	90
S40	45
S51	45
S64	45
S65	45
S74	85
S85	295
S86	115
S112	80
S113	90
S114	80
S124	300
S132	110
S133	60
S134	60
S135	110
S138	195
S139	195
S140	60
S151	180
S153	182
S157	225
S158	210
S163	300
S174	250
S175	320
S188	200
S189	320
S194	320
S197	400
S201	250
S225	525
S240	430
S241	430
S244	520
S251	270
S257	250
S258	250
S260	70
S262	£12
S287	200
S288	180
S289	200
S301	350
S365	250
S373	400
S374	490
S412	380
S470	325
S471	620
S472	1150
S474	400
S475	800
S571	820
S573	950

74LS

LS00	30	LS194	100
LS01	30	LS195	80
LS02	30	LS196	100
LS03	30	LS197	100
LS04	35	LS221	105
LS05	35	LS240	100
LS08	30	LS241	100
LS09	30	LS242	100
LS10	30	LS243	100
LS11	30	LS244	100
LS12	30	LS245	200
LS13	35	LS247	115
LS14	60	LS248	115
LS15	30	LS249	115
LS19	45	LS251	80
LS20	30	LS253	80
LS21	30	LS256	175
LS22	30	LS257	75
LS24	80	LS258	80
LS26	30	LS259	130
LS27	30	LS260	80
LS28	30	LS261	190
LS30	35	LS266	60
LS32	95	LS273	140
LS33	25	LS275	380
LS37	25	LS279	75
LS38	45	LS280	195
LS40	30	LS283	95
LS42	65	LS290	85
LS47	100	LS292	850
LS48	100	LS293	90
LS49	80	LS294	999
LS51	25	LS295	140
LS52	25	LS297	900
LS54	25	LS298	110
LS55	25	LS299	240
LS63	55	LS320	230
LS73	35	LS322	360
LS74	40	LS323	360
LS75	50	LS324	150
LS76	40	LS325	150
LS78	40	LS326	290
LS83	75	LS327	290
LS85	100	LS347	130
LS86	40	LS348	200
LS90	55	LS352	125
LS91	100	LS353	125
LS92	65	LS355	220
LS93	80	LS356	220
LS95	80	LS363	180
LS96	100	LS264	180
LS107	50	LS365	60
LS109	55	LS366	50
LS112	55	LS367	60
LS113	50	LS368	60
LS114	45	LS373	110
LS122	75	LS374	140
LS123	120	LS375	80
LS124	150	LS377	145
LS125	55	LS378	120
LS126	55	LS379	150
LS132	75	LS380	310
LS133	50	LS382	310
LS135	28	LS384	457
LS136	45	LS385	330
LS138	70	LS386	50
LS139	70	LS390	90
LS145	120	LS393	120
LS147	195	LS395	135
LS148	150	LS396	300
LS151	75	LS398	195
LS153	75	LS399	150
LS154	200	LS445	125
LS155	75	LS447	80
LS156	75	LS465	150
LS157	70	LS490	160
LS158	80	LS540	145
LS160	75	LS541	145
LS161	75	LS624	150
LS162	75	LS629	150
LS163	85	LS640	200
LS164	95	LS641	200
LS165	130	LS645	200
LS166	195	LS668	90
LS168	140	LS669	90
LS169	90	LS670	190
LS170	175	LS673	890
LS173	110	LS674	800
LS174	100	LS678	275
LS175	80	LS682	250
LS181	210		
LS183	200		
LS190	100		
LS191	75		
LS192	100		
LS193	100		

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

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 **8p**.

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

GAS/SMOKE DETECTORS
TGS812 or TGS813

£6 each

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

VA 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	380p
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 **475 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"	110p
6" x 12"	175p	225p		

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	525p	CS17W	545p
C18W	550p	XS25W	570p
Spare Bits	85p	Elements	230p
Iron Stand	175p	Heat Shunt	30p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	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	180p	320p
40 way	220p	250p	180p	340p
50 way	235p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

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

ZIF DIL SOCKETS

24 pin	575p
28 pin	695p
40 pin	845p

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

'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 CONNECTORS

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

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	545
200KHz	370
455KH	370
1MHz	275
1.008M	275
1.28MHz	450
1.6MHz	395
1.8MHz	545
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
6.5536MHz	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	375p
Wideband 8MHz	550p

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-Resolution Popular **£75**
- MICROVITEC 1431. 14" Colour RGB input. Connecting cable incl. **£174**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£195** (car £7)
- KAGA 12". As above but Hi-Resolution **£259** (car £7)
- Connecting Lead for KAGA **£5**

Carriage £7 Securicor

BROTHER HR15 PRINTER
A high quality Daisy Wheel printer at the price of a Dot Matrix printer.

Price £339

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 **235p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **280p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **250p**
12VA: 2x4.5V-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	50p	7905	50p
12V	7812	50p	7908	60p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	50p	7918	50p
			7924	50p

100mA TO92 Plastic package

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

4000	20	4072	25	4536	275
4001	25	4073	26	4538	80
4002	25	4075	25	4539	90
4006	75	4076	68	4541	95
4007	25	4077	25	4543	70
4008	60	4078	25	4544	150
4009	45	4081	25	4548	40
4010	60	4082	25	4549	400
4011	25	4085	60	4553	245
4012	25	4086	60	4554	180
4013	60	4089	125	4555	35
4014	60	4093	37	4556	55
4015	60	4094	70	4557	250
4016	40	4095	95	4558	120
4017	60	4096	100	4559	395
4018	60	4097	275	4560	180
4019	58	4098	80	4561	104
4020	90	4099	110	4562	350
4042	43	4160	95	4566	165
4021	58	4161	96	4568	250
4022	67	4162	96	4569	175
4023	30	4163	96	4572	45
4024	50	4174	96	4580	255
4025	22	4175	105	4581	125
4026	90	4194	105	4582	99
4027	43	4408	850	4583	100
4028	45	4409	850	4584	60
4029	75	4410	725	4585	70
4030	35	4411	750	4597	330
4031	130	4412	805	4599	155
4032	70	4415	590	40085	90
4033	130	4419	280	40097	45
4034	146	4422	770	40098	42
4035	70	4435	850	40100	215
4036	275	4440	900	40101	130
4037	115	4450	360	40102	140
4038	75	4451	350	40103	412
4039	280	4490	450	40104	120
4040	60	4500	395	40105	220
4041	57	4501	38	40106	60
4042	50	4502	60	40107	55
4043	42	4503	40	40108	325
4044	50	4504	99	40109	100
4045	110	4505	385	40110	235
4046	60	4506	100	40114	240
4047	60	4507	45	40161	194
4048	55	4508	130	40163	75
4049	38	4510	55	40174	75
4050	35	4511	55	40175	75
4051	70	4512	55	40181	220
4052	60	4513	150	40182	80
4053	60	4514	115	40192	75
4054	85	4515	115	40193	95
4055	85	4516	55	40194	70
4056	85	4517	275	40195	75
4057	1000	4518	48	40244	196
4059	435	4519	32	40245	196
4060	68	4520	53	40257	196
4061	500	4521	115	40373	220
4062	986	4522	125	40374	220
4063	85	4526	60	45106	586
4066	45	4527	65		
4067	245	4528	68		
4068	25	4529	150		
4069	25	4530	90		
4070	25	4531	130		
4071	25	4532	65		
		4534	400		

OPTO

OCP71	120
ORP12	85
ORP61	86
BPX25	250
BPW21	320
[illegible]	225

OPTO ELECTRONICS
LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2" Red	12
2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	100p
Green/Yellow	115p
0.2" Tri colour Red/Green/Yellow	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

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

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
.3" [illegible] Red CA	150
.3" [illegible] 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.	195

COMPUTER CORNER
- **EPSON RX80 Printer** £229
- **EPSON RX80 F/T Printer** £245
- **EPSON FX80 Printer** £316
- **EPSON FX100 Printer** £435
- **KAGA/TAXAN KP810 Printer** £235
- **KAGA/TAXAN KP910 Printer** £339
- **SEIKOSHA GP100A Printer** £339
- **BROTHER HR15 Daisywheel** £339

  Cable for above printers to interface with BBC Micro £7
- **TEX EPROM ERASER** — Erases up to 25 Eproms. Has a built-in safety switch £30
- **SPARE 'UV' Lamp bulb** £8
- C12 Computer CASSETTES in Library cases 36p
- **8½" & 9½" Fan Fold paper (1000 sheets)** .... £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)

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

DISC DRIVES
(CUMANA)
DRIVES CASED with PSU & CABLES

- **CS100** — Single Cased with PSU, 40 track, 5¼" S/S 100K £129
- **CD200** — Twin Cased with PSU, 40 Track, 5¼" S/S 200K £265
- **CS200** — Single Cased with PSU, 80 Track 5¼" S/S 200K £175
- **CD400** — Twin Cased with PSU, 80 track 5¼" S/S 400K £349
- **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) £199
- **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** £28

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

SPECTRUM CENTRONICS/RS232 PRINTER INTERFACE
★ It was the first! It is still the best!
★ Centronics and BI-DIRECTIONAL RS-232 with full hand-shaking.
★ Obeys SPECTRUM LLIST and LPRINT.
★ Split-Speed Operation for RS-232.
(Use it to communicate with the BBC MICRO or OTHER PERIPHERALS)
★ Interface 1, Interface * & Microdrive compatible.
★ Configuration program creates customised M/C driver to suit your printer.
★ HI-RES screen dumps in 2 sizes on EPSON, SEIKOSHA, STAR, SHINWA, MANNESMAN TALLY, NEC, RITEMAN, KAGA, etc. This is a STANDARD FEATURE! Not an extra.
★ Compatible with TASWORD TWO and most professional programs.

Complete Unit incl. Software tape + manual **£29.95**
Special Interface Cable **£8**

BBC & MICROCOMPUTER & ACCESSORIES
BBC Model B Only **£315**

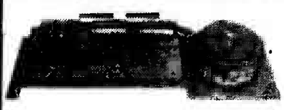
We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet)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

OMP POWER AMPLIFIER MODULES

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

OMP POWER AMPLIFIER MODULES

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



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

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

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

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

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

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

19" RACK CASED MOS-FET STEREO AMPLIFIERS with twin power supplies and L.E.D. Vu meters plus X.L.R. connectors.
Three models (Ratings RMS into 4 ohms)
MF200 (100 + 100w) £182.85
MF400 (200 + 200w) £228.85
MF600 (300 + 300w) £274.85
Securicor Delivery £10.00

LOUDSPEAKERS

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

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

POWER RANGE

8" 50 WATT R.M.S. Hi-Fi/Disco. 20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £9.90 Available with black grille £10.90. P&P £1.50 ea.

12" 100 WATT R.M.S. Hi-Fi/Disco 50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £26.00 + £3.00 P&P ea.

15" 100 WATT R.M.S. Hi-Fi/Disco 50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq 20Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. PRICE £34.00 + £3.00 P&P ea.

McKENZIE

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

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

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

WEM

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

8" 150 WATT R.M.S. Multiple Array Disco etc. 1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £27.00 + £1.50 P&P ea.

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

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

SOUNDLAB (Full Range Twin Cone)

5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc. 1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £8.99 + £1.00 P&P ea.

6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc. 1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £9.99 + £1.50 P&P ea.

8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc. 1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £11.99 + £1.50 P&P ea.

PANTEC

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

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

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

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

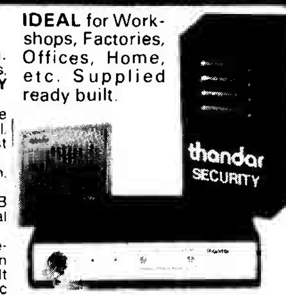
3 watt FM Transmitter

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

BURGLAR ALARM

Better to be **'Alarmed'** then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**
Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
Indoor alarm — Electronic swept freq. siren. 104dB output.
Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

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



SAVE £148.00 Usual Price £228.85
BKE's PRICE £79.99 + £4.00 P&P
? Why buy a collection of self-assembly boards!

OMP LINNET LOUDSPEAKERS

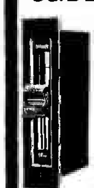
The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full Range 45Hz - 20KHz.
OMP 12/100 watts 20" × 15" × 12" **£125.00** per pair
OMP 10/200 watts 18" × 15" × 11" **£145.00** per pair
OMP 12/300 watts 20" × 15" × 11" **£169.00** per pair

Delivery: Securicor £8.00 per pair

STEREO CASSETTE DECK

STEREO CASSETTE DECK Ideal for installing into Disco and Hi-Fi cabinet/Consoles. Surface mounting (Horizontal). Supplied as one unit with all electronics including mains power supply.
★ Metal top panel Black finish
★ Piano type keys including pause
★ Normal/Chrome tape switch
★ Twin Vu Meters
★ 3 Digit counter
★ Slider Record Level control
Size 171 × 317 mm Depth 110 mm
PRICE £35.99 + £3.00 P&P

1 K-WATT SLIDE DIMMER



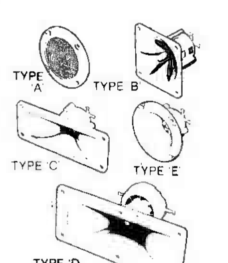
★ Control loads up to 1Kw
★ Compact Size 4⅔" × 1" × 2½"
★ Easy snap in fixing through panel/cabinet cut out
★ Insulated plastic case
★ Full wave control using 8 amp triac
★ Conforms to BS800
★ Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.
PRICE £12.99 + 75p P&P (Any quantity).

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias) device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price £33.60 each. + £3.00 P&P ea.
ADC Q4 mag. cartridge for above. **Price £4.99 ea.** P&P 50p.

PIEZO ELECTRIC TWEETERS - MOTOROLA

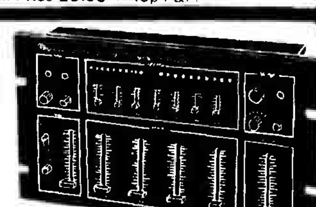
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each** + 40p P&P.
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.49 each** + 40p P&P.
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.49 each** + 40p P&P.
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £8.99 each** + 40p P&P.
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.49 each** + 40p P&P.
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. **Price £3.99** + 40p P&P.

STEREO DISCO MIXER

STEREO DISCO MIXER with 7 band graphic equaliser and 10 segment L.E.D. Vu Meters. Many outstanding features.
5 Inputs with individual fader controls:—
2 Mag. turntable, 2 Aux. plus Mic. with talk-over switch. Headphone monitor. Master output control with Hi-Low outputs. Compatible with our OMP Power Amplifiers.
Size: 360 x 200 x 120 mm. Supply 240V/50Hz AC.

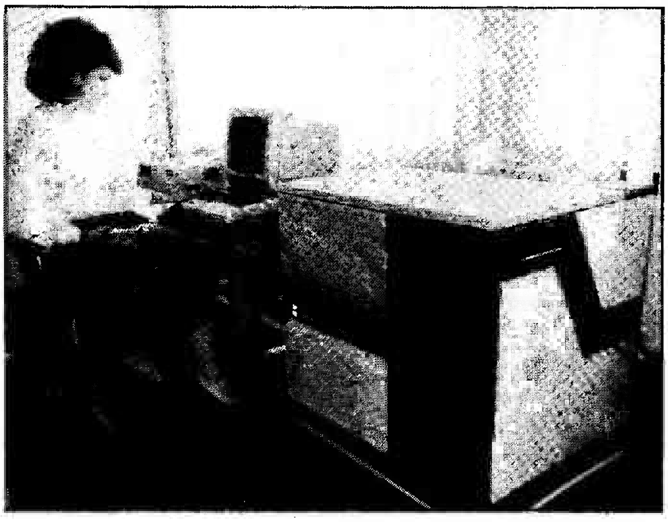


PRICE £119.99 + £3.00 P&P

B. K. ELECTRONICS

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

DIGEST



BT Voice Mail

Is your 'phone call a shot in the dark? You know the situation — you call them but they're not there so you leave a message. They call back but you've nipped out for a few minutes and so it goes on.

For a mere £30,000 the basic VM600 Voice Mail system could revolutionise your communications. The system works like an electronic pigeon hole array in which voice messages can be dictated, edited to get the sense right and deposited in the machines memory. At some later date the intended recipient can call up the memory and will receive whatever messages have been left.

The hardware consists of a free-standing equipment rack which contains the heart of the system and a number of pocket tone generators. The system can be connected directly between an existing push-button telephone system and the PABX without the need for any extra equipment. Users of the attached telephones can then access the VM600 using a personal password to place and retrieve messages. From other telephones or when calling in over the public network, the small tone generator is used.

When access to the system has been gained, spoken messages guide the user through the process of leaving or locating messages. This removes the need for typing or other skills, allowing the whole procedure to be carried out using only a button.

The VM600 is built around a dedicated microcomputer and the basic version has a 32M byte disc store which caters for up to 60 users and gives three hours worth of message storage. The system can be expanded to handle up to 600 users and give 30 hours of storage time. A separate console which can be sited up to 100m away from the main unit is used to set up the passwords and the facilities available to each user, and it can also be used to obtain statistics on usage and other operational information.

In addition to the facilities outlined above, the VM600 can send stored messages to up to sixty users or can be instructed to leave a message dormant until a certain date and time. For authorised users there are useful facilities like giving one message priority over others, checking that a message has been received, repeat calling for urgent messages and security coded messages for sensitive information.

The system is expected to be of interest to companies with sales or service staff who spend a lot of time away from the office but frequently need to send back information or receive instructions. It would also be useful for companies who deal regularly with people in other time zones as there are frequently only short periods during which business hours coincide.

For more information on the Voice Mail contact the local British Telecom sales office or ring 01-725 5577.

Personal Radiation Monitor

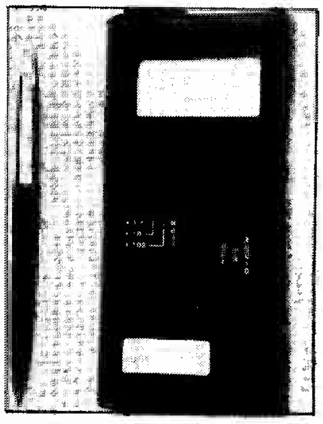
Impulse have recently introduced a simple to use, pocket-sized personal radiation monitor. Monitor 4 combines new electronic techniques with simplicity to provide an effective radiation alert which gives maximum user protection.

Monitor 4 has no external wires or probes and is sensitive to a broad spectrum of ionizing radiation including alpha, beta, gamma and X-Rays. The level of radiation is indicated by an easy-to-read meter, a count light and a bleeper that can be switched off for silent monitoring.

The monitor reads in three ranges from 0-50mr/h and uses an industry standard halogen-quenched GM tube with a mica end window. It is easily calibrated and runs for up to 2,000hrs on one 9V alkaline battery at background radiation levels.

The unit detects alpha down to 2.5 MeV and typical detection efficiency at 3.6 MeV is more than 80%. Beta is detected at 50 keV with 35% typical efficiency; typical efficiency of 150 keV is 75%. Gamma and X-rays are detected down to 10 keV typically through the end window and 40 keV minimum through the case.

For further information contact Impulse Sales & Marketing, 29a Egerton Street, Chester CH1 3ND.



Don't look now, but that handsome bloke standing between Cirkit Chief Executive Christopher Sawyer (right) and Richard Bulgin, Head of Consumer Services, is your very own editor, Dave Bradshaw. The occasion was the launch of Cirkit's first catalogue which contains all the products listed by their predecessors, Ambit, as well as a number of new lines. It costs 85p and includes three vouchers worth one pound each when presented with orders worth £15 or more. The catalogue is on sale at branches of W.H. Smith throughout the country or may be obtained direct from Cirkit, Park Lane, Broxbourne, Hertfordshire EN10 7NQ, tel 0992-444111.

AM/FM Radio

Upon reflection, we realise that we should have quoted the order numbers for the inductors and filters in this project as they're rather hard to find in Cirkit's catalogue! The order numbers are as follows:
YMRS 16726 (L4) 35-67260 (42p); CFU 050D (L5) 16-05006 (84p); YMCS 2A740 (L6) 35-07400 (42p); CLNS 30569 (L7) 35-05690 (66p); SFE10.7MA (F1, 2) 16-10755 (49p); CDA 10.7MA (F3) 16-10770 (84p). Prices quoted here are taken from Ambit's most recent catalogue, but need VAT and p&p.

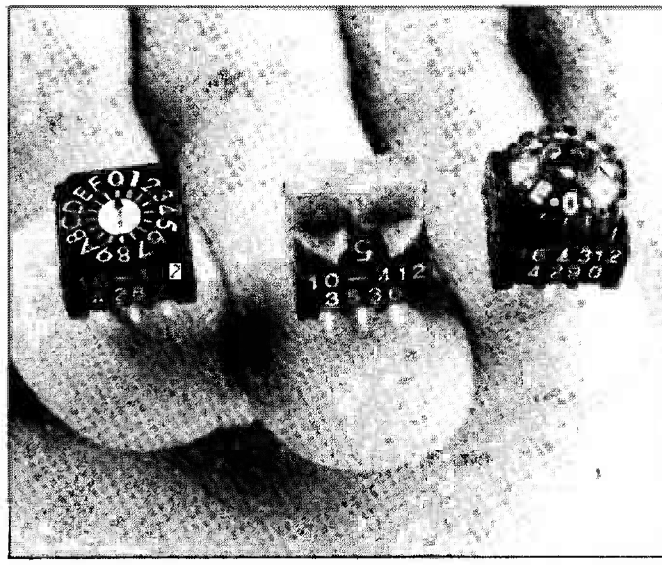
Rotary Coded Dilswitches

A range of 10 position and 16 position ERG dual-in-line switches for PCB mounting is now available from Semiconductor Supplies International. The switches are expected to find employment in a wide range of control applications, and their memorability has been further enhanced by the adoption of a punning title almost worthy of ETI — they are to be called dial-in-line switches!

Three types are available, two with knob operation and one with a screwdriver slot. One type is suitable for vertical or horizontal mounting on the edge of a PCB and all are fully sealed and suitable for flow soldering and solvent cleaning.

Contact ratings are 125 mA, 30 VDC with an initial contact resistance of typically 50 mΩ maximum at 10 mVDC/10 mA. The insulation resistance is 100 MΩ minimum at 240 VDC for one minute, and the life within rated load is 20,000 rotary detent steps.

The dimensions are 10 × 10 × 6 mm for screwdriver operation and 10 × 10 × 11 mm for the switch with the large knob. Maximum contact resistance found when testing to five million dry circuit switching operations monitored at 10 mVDC/10 mA was less than 20 mΩ. Semiconductor Supplies International Ltd, Dawson House, 128-130 Carshalton Road, Sutton, Surrey SM1 4RS, tel 01-643 1126.



Sound Moves

The re-organisation of A.F. Bulgin and Company PLC, one of the results of which is the recent re-appearance of Ambit under the new name of Cirkit, continues apace. Soundex Ltd, manufacturers of peak programme meters, drive amplifiers and audio measuring sets, have been purchased from Bulgin by professional broadcast equipment suppliers Allotrope Ltd. Allotrope plan to extend the Soundex range with the addition of complementary products in the near future and have appointed Cirkit as distributors. The re-organisation allows Bulgin to concentrate on its traditional manufacturing interests and the newly-formed Power Conversion Division while Cirkit Holdings PLC undertakes distribution.

Allotrope Ltd, 114 Wardour Street, London W1V 3LP, tel 01-434 3344. A.F. Bulgin and Company PLC, Bypass Road, Barking, Essex IG11 OA2, tel 01-594 5588.

● Marco Trading have issued a 124-page catalogue which lists their range of electrical fittings, connectors, test equipment, semiconductors and general components and even valves. The catalogue comes with an order form, reply-paid envelope and special offers list and is available from Marco Trading, The Maltings, High Street, Wem, Shropshire SY4 5EN, tel 0939-32763.

BBC Loudspeaker Agreement

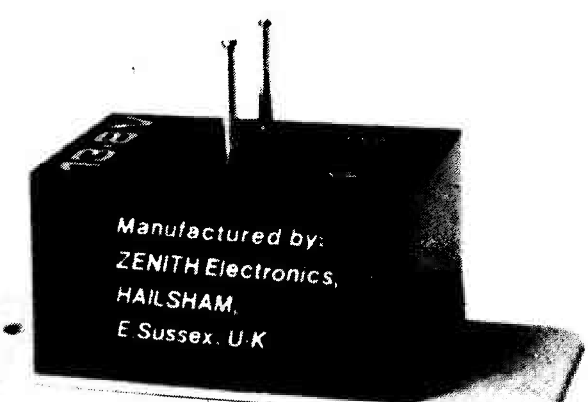
The BBC has signed a licence agreement with the two British companies, Spendor Audio Systems Ltd and Swisstone Electronics Ltd, which allows them to manufacture the medium size, high quality, LS5/9 Studio Monitoring Loudspeaker. The agreement will enable these two companies to market the loudspeaker worldwide.

The LS5/9 cabinet is only a quarter of the volume of the BBC's principal, much larger, high quality monitor the LS5/8, but the sound reproduction is a close approximation. The dimensions are 280mm wide, 460mm high, and 275mm deep, and the weight is only 14kg. As a result it is ideal for use where portability is required or where space is limited.

The loudspeaker uses two drive units with a passive crossover, and an equaliser which provides a flat, free-field axial response over the range 50Hz to 16kHz. The tweeter is a proprietary soft dome type, and the low frequency unit is a BBC design which uses a polypropylene diaphragm. The levels of coloration and harmonic distortion are very low. A 50W amplifier is required to obtain the maximum sound level output of 105dB relative to 20μPa at 1m.

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

● Rockwell international have brought out the second edition of their 1984 data book. Its 1362 pages cover their entire line of solid-state devices and board-level micro-computer products and there are sections on 8 and 16 bit microprocessors, memory products, intelligent display controllers and integral and stand alone modems. Contact Rockwell International Ltd, Semiconductor Products Division, Heathrow House, Bath Road, Hounslow TW5 9QQ, tel 01-759 2366.



Hybrid Protector Modules

Zenith have introduced a range of overvoltage protection modules (OVPs) which are designed to protect sensitive electrical and electronic circuits from supply voltage transients. The modules come in nine standard voltage trip ratings and simply connect across the output terminals of any current-limited DC supply.

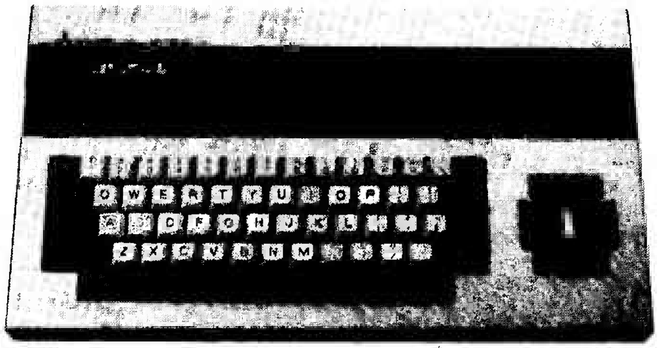
The modules employ circuitry that contains hybrid thick-film integration and are potted in epoxy compound for thermal stability. There are four basic models available rated at 3, 5, 15 and 25 amps, each of which can be supplied with any of the nine standard trip voltage ratings between 5 and 30V DC. Special versions operating at other voltages are also available to order. The modules measure 30 × 20 × 15mm and connection is via twin Molex connector pins or 6mm spade terminals.

Zenith Electronics, 21 Station Road Industrial Estate, Hailsham, East Sussex BN27 2EW, tel 04353-2647.

Mitsubishi MSX Micros

Mitsubishi Electric (UK) Limited, the UK manufacturing and marketing Division of the Mitsubishi Electric Corporation, has announced its version of the MSX range of home computers. Developed in conjunction with Microsoft in America, the MSX range was conceived to provide a common standard in home computing and Mitsubishi is the only company so far to offer a choice of MSX computers.

The two systems — ML-F80 and ML-F 48 — are based on a Z80-equivalent chip. The ML-F 80 has 64KB RAM, the ML-F 48 32KB, and both systems have 32KB ROM, with the ML-F 48 being expandable to its larger stablemate. The keyboards are ASCII layout and include full alphanumeric and special characters. There are also five special function keys, which, using the shift key, give the home programmer ten possible programmable functions.



The screen display is 40 characters × 24 lines in text mode and 192 × 256 dots in graphics mode. Both systems also provide a range of sound effects. A number of socket outlets are incorporated on the computers, including a Centronics printer interface. Others are for joystick, ROM cartridges, audio, video and cassette units and of course TV.

A range of games software is already available for MSX computers, and the fact that Mitsubishi offers two systems provides the user with a greater choice of programs. Software packages include home budget, word processing and database programs, language courses and games. The computers also run Microsoft extended Basic.

Mitsubishi's two MSX systems will be available from its existing video and hi-fi outlets from November, at £299 for the ML-F 80 and £249 for the ML-F48. Mitsubishi Electric (UK) Limited, Hertford Place, Denham Way, Maple Cross, Rickmansworth, Herts WD3 2BJ, tel 0923-770000.

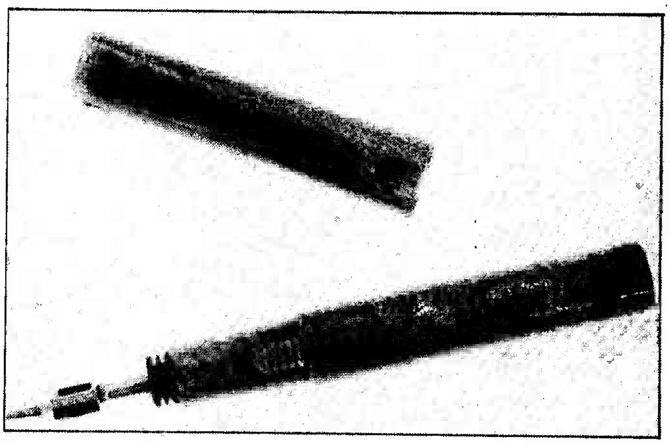
Multipurpose Function Generator

New from Global Specialties Corporation is the Model 2005 multipurpose function generator which provides sine, triangle, square, ramp and TTL pulse waveforms with variable amplitude, symmetry and offset over a 50mHz to 5MHz frequency range. The output can be continuous, gated or triggered either by an external signal or by a front panel manual switch.

When the instrument is used as a sweep generator, an internal ramp with a variable duration provides a recurring linear sweep over a 1000:1 (linear) or 10,000:1 (logarithmic) frequency range. The maximum output amplitude is 20V into an open circuit or 10V into 50Ω and the signal can be attenuated at 20dB, 40dB or 60dB.

Other features include an adjustable DC offset voltage of ±10V into open circuit or ±5V into 50Ω, and the ability to be frequency modulated with an external signal using V_{co} IN as the frequency modulation input. With a dial accuracy of ±5% of full scale and jitter of less than 0.1%, the instrument has a 1ms to 5s sweep rate and a sweep output of 0 to 5V ramp.

The Model 2005 costs £632.50 inclusive of VAT and postage and is available from Global Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ, tel 0799-21682



Portable Butane Soldering Iron

Greenwood Electronics is launching a new butane powered portable soldering iron, the Oryx Portasol. Little bigger than a felt tip pen, the Portasol works on entirely different principles from conventional gas-powered irons. There is no flame during operation, the chemical energy of the butane gas being converted directly to heat by means of a patented catalytic converter in the solder tip. Conversion rate is adjustable to provide control over tip temperature and, at its maximum setting, the iron delivers power equivalent to a 60 watt electric soldering iron, the tip temperature being adjustable between 250 and 450°C.

The Oryx Portasol iron will run for up to 60 minutes on its internal gas supply and refuelling, which takes seconds, is identical to filling a gas cigarette lighter. The same principles that make gas cigarette lighters safe are applied to the Portasol.

The Portasol can be carried in the pocket. It is supplied with a protective cap and is immediately ready for use, the cap including an igniter to start the catalytic conversion.

The dimensions of the Portasol are 175mm long × 19mm diameter, and replacement tips — which include the converter — are readily available. Greenwood Electronics, Portman Road, Reading, Berkshire RG3 1NE, tel 0734-595844.

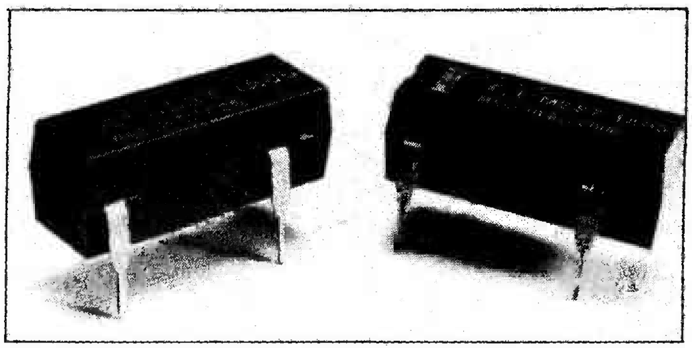
2kV Isolation DIL Relays

C.P. Clare have introduced two new dual-in-line relays to complement their established DIL product families. Both versions have 2000 VAC isolation between coil and contact to cater for the growing number of applications where a high isolation is required.

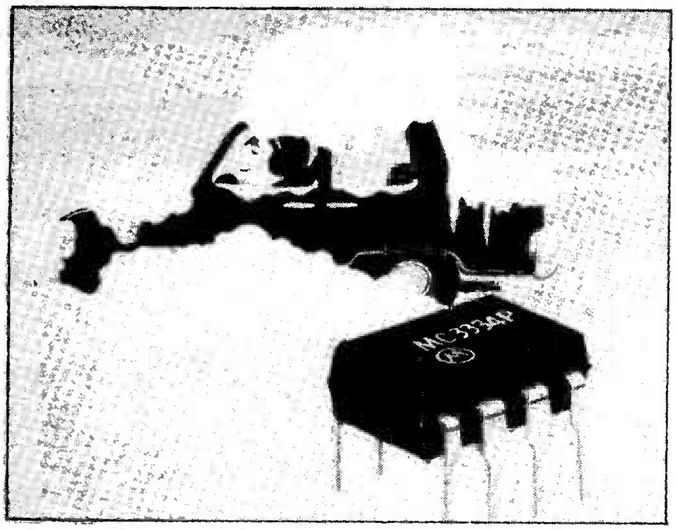
The first type, designated DSS7, incorporates a standard 10VA rated dry reed switch as used in the established PRMA/PRME series. Standard coil resistances are 500-2150 ohms.

The second, designated MSS7, incorporates a unique MMR mercury reed capsule which is completely non-position sensitive, thus allowing full PCB mounting flexibility for OEM equipment. MSS7 is rated at 30VA switching with a maximum contact resistance of 100 milliohms throughout its life of 200 million expected operations.

Both relays have single, normally open contacts and are available with nominal operating voltages of 5, 12 and 24V DC. An optional modification, the addition of a transient suppression diode to the coil, is available on both types.



For further information contact Ron Bannister, C.P. Clare Division, General Instrument (UK) Ltd, tel 08956-39901.



Auto IC

Motorola have added a high-energy ignition circuit to their range of automotive linear ICs. Originally designed to suit Delco five-terminal ignition applications, the MC3334 is said to meet the circuit timing and current control requirements of modern advanced ignition systems and offers optimised spark energy at minimum power dissipation.

The circuit is designed to process a control signal from a reluctor (magnetic) type pick-up and generates a precisely-controlled ignition coil drive voltage via an external Darlington transistor. Features include adjustable dwell angle for optimum stored energy with minimum waste, adjustable peak output coil current and a rugged design which has input and output transient protection to reduce the risk of damage to the IC and Darlington. Very few external support components are required and none of the resistors are critical.

The MC3334 is available in an 8-pin plastic DIP package for PCB mounting, a chip version and a 'flip' or 'bumped chip' version for inverted reflow assembly. Motorola claim that the pin-out adopted suits both thick-film and printed circuit module designs and allows layouts to be produced without crossovers.

Also new from Motorola is a series of DC-DC converter ICs which are said to offer twice the output current capability of existing 8-pin DIP DC-DC converters. The MC34063 series are intended for step-up or step-down voltage conversion over the range 2.5 to 40 volts and offer an output current of 1.5 amps. Quiescent current is a mere 2.4mA. All functional circuitry is contained within the ICs including temperature-compensated reference, oscillator, cycle-by-cycle current limiting and feedback sense for voltage regulation.

For information on these devices contact Motorola, quoting release number 30/84 for the ignition IC and 32/84 for the DC-DC converters. Motorola Ltd, European Literature Distribution Centre, 88 Tanners Drive Blakelands, Milton Keynes MK14 5BP, tel 01-902 8836.

Carrying Bags for Apples, Apricots and Acorns

For people who really can't put their micros down, Inmac now stock a series of specially designed carrying bags for the Apple II, Apple II Plus, Apple IIe, Apricot and BBC Micro Computers.

Made from strong, tear-proof Cordura nylon and thick, high density foam padding, these bags are tailored to provide a safe means of transportation. The wide-grip handles and the adjustable shoulder strap are made of seat-belt strength webbing for safety, and the zips are heavy duty industrial grade that will not rust and open completely for easy loading.

A matching bag is available for the Apple II disk drive which can carry two drives and has a foam lined "wallet" that protects cables and provides padding between the drives. There is also a matching bag for an Apricot Monitor. All bags are lined with anti-static material and prices range from £17.00 to £27.50 each.

Delivery is ex-stock and can be same day for the London, Greater Manchester and Merseyside areas or next day for the rest of the country. The bags are available on a thirty day, risk-free trial period and are guaranteed for a year.

Further details can be found in Inmac's full-colour catalogue of over 1000 accessories for mini- and micro-computers which is available free from Inmac UK Limited, Davy Road, Astmoor, Runcorn, Cheshire WA7 1PZ, tel 09285-67551.

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

ACORN COMPUTER SYSTEMS:
BBC Model B Special offer..... **£320** (a)
BBC Model B + Econet........ **£389** (a)
BBC Model B + DFS........... **£409** (a)
BBC Model B + DFS + Econet.... **£450** (a)

UPGRADE KITS
A to B Upgrade Kit.............. **£75** (c)
DFS Kit......................... **£95** (c)
Econet Kit...................... **£45** (c)
Speech Upgrade Kit.............. **£47** (c)

ACORN ADDON PRODUCTS:
Z80 2nd Processor............ **£265** (a)
6502 2nd Processor........... **£175** (b)
Teletext Adaptor............. **£190** (b)
IEEE Interface............... **£282** (b)
Prestel Adaptor.............. **£99** (b)
RH Light Pen................. **£39.50** (c)

BBC FIRMWARE:
1.2 Operating System ROM ... **£7.50** (d)
BASIC II ROM .... **£22.50** (d)
VIEW Word Processor Rom.**£48.00** (c)
WordWise Word Processor Rom........ **£34.00** (d)
BCPL ROM/Disc............ **£88.00** (c)

Utility ROMS:
Disc Doctor/Gremlin Debug Rom... **£28 ea** (d)
EXMON/TOOL KIT ROM..... **£20 ea** (d)
Printmaster (FX80)/Graphics ROM...... **£28 ea** (d)
VIEWSHEET ROM............... **£52** (c)
ULTRACALC spreadsheet ROM.... **£69 ea** (c)

COMMUNICATIONS ROMs
Terml Emulator............... **£28** (d)
Communicator................. **£59** (d)
Commstar..................... **£29** (d)

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

PRINTERS

EPSON

RX80FT **£225 (a)** FX80 **£315 (a)** FX100 **£450 (a)**

KAGA TAXAN

KP810 **£249 (a)** KP910 **£369 (a)**
JUKI 6100 **£345 (a)** **BROTHER** HR15 **£349 (a)**

ACCESSORIES

EPSON

Serial Interface: 8143 £28 (c) 8148 with 2K £58 (c)
Paper Roll Holder £17 (c) FX80 Tractor Attachment £37 (b)
Ribbons: FX/RX/MX 80 £5 (d) FX/RX/MX 100 £10 (c)
RX/FX80 Dust Cover £4.50 (d)

KAGA TAXAN

RS232 with 2K Buffer £85 (b) KP810/910 Ribbon £6.75 (a)

JUKI6100

RS232 with 2K Buffer £60 (b) Ribbon £2.50 (d)
Tractor Attachment £99 (a) Sheet Feeder £199 (a)
BBC Parallel Lead £7 (d) Serial Lead £7 (d)
2000 Sheets Fanfold Paper with extra fine perforation
9.5" x 11" £13 (b) 14.5" x 11" £18 (b)
Self Adhesive Labels 2 ¾" x 1 7/16"
Single Row £5.25/1000 (d) Triple Row £5/1000 (d)

MODEMS — All modems listed below are BT approved

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

TELEMOD2:
Complies with CCITT V23 1200/75 Duplex and 1200/1200 Half Duplex standards that allow communications with VIEWDATA services like PRESTEL, MICRONET etc. as well as user to user communications. Mains powered. **£64(b).**

BUZZ BOX:
This pocket sized modem complies with V21 300/300 Baud and provides an ideal solution for communications between users, with main frame computers and bulletin boards at a very economic cost. Battery or mains operated, **£52(c).** Mains adaptor **£8(d).**
BBC to Modem data lead **£7.**

DISC DRIVES

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

1x100K: TS55A TEAC 40 Track	**£100(a)**	CS55A TEC with psu	**£135(a)**
1x200K: TS55E TEAC 80/40 Sw	**£155(a)**	CS55E TEC with psu	**£155(a)**
1x400K: TS55F TEAC 80/40 Sw	**£175(a)**	CS400 Mit. with psu	**£185(a)**

2x100K TD55A 40T TAEC with psu **£275(a)**
2x200K TD55E 80/40 Sw TEAC with psu **£350(a)**
2x400K TD55F 80/40 Sw TEAC with psu **£400(a)**
2x400K TD55M 80T Mitsubishi with psu **£375(a)**

3M 5¼" FLOPPY DISCS

High quality discs that offer a reliable error free performance for life. Each disc is individually tested and guaranteed for life. Ten discs are supplied in a sturdy cardboard box.
Price per pack of ten:
40T SS DD **£15(c)** 40T DS DD **£21(c)**
80T SS DD **£24(c)** 80T DS DD **£28(c)**

DRIVE ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives .... **£14.50(c)**

Single Disc Cable.............. **£6(d)** Dual Disc Cable............ **£8.50(d)**
10 Disc Library Case.......... **£1.95(c)** 30 Disc Storage Box.......... **£6(c)**
30/40 Disc Lockable Box........ **£14(c)** 70/80 Disc Lockable Box........ **£19(b)**

MONITORS

MICROVITEC 14" RGB:
1431 Std Res .... **£195(a)**
1451 Med Res .... **£260(a)**
1441 Hi Res................................ **£420(a)**
1431 AP Std Res PAL/AUDIO.............. **£215(a)**
1451 AP Std Res PAL/AUDIO.............. **£325(a)**
1451 DQ3 Med Res .... **£239(a)**
Above monitors are now available in plastic or metal cases
KAGA Super Hi Res Vision III RGB Monitor .... **£345(a)**

MONOCHROME MONITORS12":
Kaga Green KX1201G.................. **£106(a)**
Kaga Amber KX1201A.................. **£116(a)**
Santo Green DM8112CX .... **£99(a)**
Swivel Stand for Kaga Monochrome .... **£22.50(b)**
All monitors are supplied with leads suitable for the BBC Computer. Spare leads available.

ATTENTION

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

ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

SPECIAL OFFER

2764-25.......... **£4.90**
27128-25.......... **£18**
27128-30.......... **£16**
6264-15........... **£28**
6262LP-15......... **£31**
6264-12........... **£35**

GANG OF EIGHT INTELLIGENT FAST EPROM COPIER

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

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II................................ **£195(b)**
Adaptor for 2764/2564. **£25.00(c)**

UV ERASERS

All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time.... **£47(c)**
UV1T as above but with a timer .... **£59(c)**
UV140 erases up to 14 eproms at a time.**£61(b)**
UV141 as above but with a timer......... **£79(b)**

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

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

D CONNECTORS

No of Ways

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

TEXTOOL ZIF

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

EDGE CONNECTORS

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

EURO CONNECTORS

DIN 41612

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

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

AMPHENOL CONNECTORS

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

GENDER CHANGERS 25 way D type

Male to Male............ **£10**
Male to Female **£10**
Female to Female........ **£10**

RS 232 JUMPERS

(25 way D)

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

DIL SWITCHES

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

TELEPHONE CONNECTORS

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

RIBBON CABLE

(grey/metre)

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

DIL HEADERS

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

MISC CONNS

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

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	40p
7437	30p
7438	40p
7439	40p
7440	30p
7441	90p
7442A	70p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	1.75
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	80p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p
7443A	100p

74LS SERIES

74LS00	28p
74LS01	28p
74LS02	28p
74LS03	28p
74LS04	28p
74LS05	28p
74LS08	28p
74LS09	28p
74LS10	28p
74LS11	28p
74LS12	28p
74LS13	34p
74LS14	52p
74LS15	28p
74LS20	28p
74LS21	28p
74LS22	28p
74LS24	50p
74LS26	28p
74LS27	28p
74LS28	28p
74LS30	28p
74LS32	28p
74LS33	28p
74LS37	28p
74LS38	28p
74LS40	28p
74LS42	55p
74LS43	150
74LS47	90p
74LS48	90p
74LS51	30p
74LS54	30p
74LS55	30p
74LS73A	30p
74LS74A	38p
74LS75	48p
74LS76A	43p
74LS83A	70p
74LS85	80p
74LS86	35p
74LS90	54p
74LS91	90p
74LS92	60p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	43p
74LS109	43p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	90p
74LS124/629	140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	60p
74LS139	60p
74LS145	110p
74LS147	175p
74LS148	140p
74LS151	70p
74LS152	200p
74LS153	70p
74LS154	200p
74LS155	70p
74LS156	70p
74LS157	60p
74LS158	70p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	130p
74LS170	160p
74LS173A	110p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	90p
74LS191	90p
74LS192	80p
74LS193	90p
74LS194A	75p
74LS195A	75p
74LS196	90p
74LS197	90p
74LS221	100p
74LS240	90p
74LS241	90p
74LS242	90p
74LS243	90p
74LS244	90p
74LS245	160p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	125p
74LS260	75p
74LS261	320p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	85p
74LS290	85p
74LS292	900p
74LS293	90p
74LS295	140p
74LS297	900p
74LS298	100p
74LS299	250p
74LS321	370p
74LS323	330p
74LS324/624	350p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	52p
74LS366	52p
74LS367	52p
74LS368A	50p
74LS373	100p
74LS374	110p
74LS375	75p
74LS377	140p
74LS378	110p
74LS379	140p
74LS381	450p
74LS390	80p
74LS393	110p
74LS395A	110p
74LS399	140p
74LS445	180p
74LS465	140p
74LS467	180p
74LS490	150p
74LS540	140p
74LS541	140p
74LS608	700p
74LS6101	900p
74LS6121	900p
74LS6241	350p
74LS626	225p
74LS628	225p
74LS629	140p
74LS640	300p
74LS640-1	300p
74LS641	200p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	180p
74LS682	320p
74LS684	650p
74LS687	550p

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	100p
74S30	50p
74S32	60p
74S37	60p
74S38	75p
74S40	50p
74S51	45p
74S64	45p
74S74	75p
74S85	450p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	550p
74S132	100p
74S133	60p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	210p
74S158	200p
74S163	400p
74S169	700p
74S174	300p
74S175	320p
74S188	180p
74S189	225p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S262	1100p
74S283	270p
74S287	225p
74S288	200p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p
74S472	475p
74S473	475p
74S474	400p
74S475	450p
74S570	650p
74S571	300p
74S573	500p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	35p
4008	60p
4009	45p
4010	50p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	1125p
4032	100p
4033	1125p
4034	250p
4035	70p
4036	270p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	35p
4050	35p
4051	65p
4052	60p
4053	60p
4054	80p
4055	80p
4056	850p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	90p
4095	90p
4096	90p
4097	270p
4098	75p
4099	90p
4501	35p
4502	55p
4503	35p
4504	95p
4505	360p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	90p
4541	90p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	150p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14416	300p
14419	280p
14430	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584/40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	80p
40110	225p
40114	225p
40147	280p
40163	100p
40173	120p
40174	100p
40175	100p
40192	150p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AM7910DC	£24
AN103	200p
AY-1-5050	100p
AY-3-1270	750p
AY-3-1350	350p
AY-3-8910	400p
AY-3-8912	500p
CA3019A	100p
CA3028A	110p
CA3046	70p
CA3059	325p
CA3060	350p
CA3080E	70p
CA3086	60p
CA3089E	210p
CA3090AQ	375p
CA3130E	90p
CA3130T	100p
CA3140E	45p
CA3140T	100p
CA3160E	90p
CA3161E	160p
CA3162E	160p
CA3189E	270p
CA3240E	150p
CA3280G	270p
D7002	£10
DAC1408-8	225p
DAC0800	225p
DAC0808	225p
DG308	300p
HA1366	190p
ICL7106	675p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM7216B	£22
ICM7217	750p
ICM7555	100p
ICM7556	140p
LC7120	300p
LC7130	300p
LC7137	350p
LF347	50p
LF351	60p
LF353	90p
LF355	90p
LF356N	90p
LF357	100p
LF13331	350p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	225p
LM311	60p
LM318	150p
LM319	180p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	180p
LM339	40p
LM348	60p
LM358P	50p
LM377	210p
LM380N-8	150p
LM380	120p
LM381AN	170p
LM382	200p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM389	180p
LM391	180p
LM392N	110p
LM393	85p
LM394CH	375p
LM709	35p
LM710	48p
LM711	100p
LM723	80p
LM725CN	300p
LM733	65p
LM741	18p
LM747	70p
LM748	30p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	600p
LM1889	450p
LM2917	300p
LM3302	75p
LM3900	80p
LM3909	100p
LM3911	180p
LM3914	350p
LM3915	340p
LM3916	340p
LM13600	150p
M51513L	230p
M51516L	450p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	90p
MC1458	45p
MC1495L	250p
MC1496	70p
MC3340P	200p
MC3401	50p
MC3403	65p
MF10CN	340p
MK50240	900p
MK50398	790p
ML920	500p
ML922	400p
MM6221A	300p
NE531	120p
NE544	190p
NE555	22p
NE556	60p
NE564	400p
NE565	120
NE566	150p
NE567	125p
NE570	400p
NE571	300p
NE592	90p
NE5532P	150p
NE5533P	160p
NE5534P	120p
NE5534AP	150p
OP-07EP	500p
PLL02A	500p
RC4136	55p
RC4151	200p
RC4558	55p
S566B	300p
SAA1900	£18
SAD1024A	1150p
SFF96364	800p
SL490	300p
SN76013N	300p
SN76023N	300p
SN76033N	300p
SN76115N	215p
SN76477	600p
SN76489	400p
SN76495	400p
SP0256AL2	700p
SP8515	750p
TA7120	120p
TA7130	140p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA641BX1	400p
TBA231	120p
TBA800	80p
TBA810	90p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TDA1004A	300p
TDA1010	225p
TDA1022	450p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	290p
TDA2004	240p
TDA2006	320p
TDA2020	320p
TDA2030	180p
TDA2541	400p
TDA2593	400p
TDA2653	700p
TDA3560	990p
TDA3810	750p
TDA7000	350p
TEA102	700p
TL061CP	40p
TL062	60p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	35p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
TL430C	120p
UAA1003-3	935p
UA759	320p
UAA240	120p
UAA170	170p
UCN4801A	350p
ULN2001A	90p
ULN2002A	90p
ULN2003A	90p
ULN2004A	90p
ULN2068	290p
ULN2802	190p
ULN2803	180p
ULN2804	190p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	350p
XR210	400p
XR2206	350p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	175p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	350p
ZN426E8	300p
ZN427E	600p
ZN428E	450p
ZN429E8	225p
ZN450E	750p
ZN459CP	200p
ZN1034E	200p
ZN1040E	660p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

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

OTHER REGULATORS

Fixed Rgulators		
LM309K	1A 5V	140p
LM323K	3A 5V	350p
78H05KC	5A 5V	540p
78H12	5A 12V	640p
78P05	10A 5V	900p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T		225p
LM350T	10A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	575
78GUIC	1A+VAR	225p
79HGGKC	5A−VAR	675p
79GUIC	1A−VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

OPTO-ELECTRONICS

FND357	100p
FND500/TIL730	100p
FND507/TIL729	100p
MAN74DL704	100
MAN71DL707	
MAN3640	174p
MAN4640	200p
MAN6610	200p
NSB5881	570p
TIL311	650p
TIL729	100p
TIL730	100p
MAN8910	250p

OPTO-ISOLATORS

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

LEDS

TIL209 Red	12p
TIL211 Green	16p
TIL212 Yellow	20p
CXQ95 (bi-colour)	100p
TIL220 Red	15p
TIL222 Green	18p
TIL226 Orange	22p
MV57164 Red Array(10	225p
MV54164 Green Array(1)	225p
Rect Leds R,G,Y	30p

COUNTERS

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

COMPUTER COMPONENTS

CPU's

1802CE	650p
2650A	£12
6502	350p
6502A	550p
65C02A	£15
6502B	800p
6800	250p
6802	260p
6809	650p
6809E	£12
68B09	£12
68B09E	£16
68000-LB	£36
8035	500p
8039	500p
8080A	420p
8085A	550p
8086	£22
8088	£17.50
8748	POA
TMS1601	£12
TMS9980	£12
TMS9995	£12
WD55	£14.50
Z80	280p
Z80A	375p
Z80B	800p

SUPPORT DEVICES

2651	£12
3242	800p
3245	450p
6520	300p
6522	350p
6522A	550p
6532	520p
6551	550p
6821	150p
68B21	220p
6829	£12.50
6840	375p
68B40	600p
6850	160p
68B50	250p
6852	250p
6854	650p
68B54	800p
6875	500p
8154	850p
8155	500p
8156	400p
8205	225p
8212	250p
8216	160p
8224	300p
8226	300p
8228	270p
8243	450p
8250	950p
8251A	500p
8253C-5	600p
8255AC-5	£19
8256	£25
8257C-5	£11
8259C-5	£11
8271	£45
8275	£29
8279	£11
8284	750p
8288D	£11
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75108	90p
75109	120p
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75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	120p
75159	220p
75160	500p
75161	350p
75162	400p
75172	300p
75182	90p
75188	60p
75189	60p
7535	150p
75451	70p
75452	70p
75453	70p
75454	70p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	120p
8T95	120p
8T96	120p
8T97	120p
8T98	120p
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2.45760(S)	250p
2.5	250p
2.662	250p
3.276	150p
3.5795	100p
4.00	150p
4.194	200p
4.43	100p
4.608	250p
4.9152	250p
5.000	150p
5.066	250p
6.00	140p
6.144	140p
7.00	150p
7.168	175p
8.00	150p
8.867	175p
10.00	175p
10.50	250p
10.70	150p
11.00	300p
12.00	150p
14.00	175p
14.318	160p
14.756	250p
15.00	200p
16.00	200p
17.734	200p
18.00	170p
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BC177/8	30p
BC179	30p
BC182/3	15p
BC184	16p
BC187	30p
BC212/3	16p
BC214	18p
BC237	16p
BC327	16p
BC337	16p
BC338	16p
BC461	40p
BC477/8	30p
BC516/7	50p
BC547B	20p
BC548C	16p
BC549C	16p
BC557B	16p
BC559C	24p
BCY70	30p
BCY71	36p
BD131	75p
BD132	80p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	80p
BD233	75p
BD235	85p
BD241	60p
BD242	80p
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	20p
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	50p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	180p
TIP55	160p
TIP120	75p
TIP121	75p
TIP122	80p
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ZTX752	70p
2N697	35p
2N698	45p
2N706A	36p
2N708	36p
2N918	45p
2N930	30p
2N1131/2	50p
2N1613	36p
2N1711	36p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	30p
2N2484	30p
2N2646	50p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	12p
2N3053	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
2N3904	18p
2N3906	18p
2N4036	65p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	60p
2N5485	36p
2N5975	250p
2N5883	375p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
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OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
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1N5403/4	14p
1N5404/5	14p
1N5404/7	19p
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2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

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6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	220p
16A 500V	130p
T2800D	130p
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8A 600V	180p
12A 400V	180p
16A 100V	180p
16A 400V	180p
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DIGITAL DELAY LINE

Delay things a little — or anything up to a few seconds — by building this versatile, quality delay unit. Design and development by Ray Lowe.

This delay line has been designed and developed with value for money as the pre-requisite, and the unit presented must be the best value around for the ambitious music maker or sound recordist. It is a high quality unit and contains some novel circuitry in the digital/analogue conversion stages which could be useful elsewhere.

The unit offers some features not found on many lower-end commercial products such as percussion, freeze and full control over bandwidth versus maximum delay time.

Words

The input signal is represented as nine bit data words. This has been found to give good dynamic performance without resorting to compansion and its undesirable 'pumping' or 'breathing' type side effects. The minimum memory requirement is 4 K, ie the number of memory chips that have to be present for the unit to operate is two, which helps keep minimum construction cost low.

This minimum configuration gives a maximum useful delay of a couple of hundred milliseconds, plus associated effects such as chorus, flanging, etc. However, the basic PCB can accept a further 13 K bytes, enough for 350 milliseconds at a full bandwidth of about 16.5 kHz through to (continuously variable) 1.3 seconds at 5 kHz bandwidth.

An optional memory expansion board may be easily added, giving a total of 36 K bytes capacity which will double the above delay figures.

Effects

Many interesting and useful effects can easily be obtained including chorus, flanging, vibrato, reverb (pseudo), slapback and long echoes, single or multiple echoes decaying over many seconds, scrambling, double tracking, etc. In addition, a sound from any source may be sampled and frozen in memory, much like a continuous tape loop, to be recalled or triggered either internally or externally (by a sequencer or drum contact for example) at any time; also there are various ways that the same can be modified. On a different tack, if you have a scope then, by using the freeze facility, you could give it audio frequency storage capability!

Inputs

Since it has a high input impedance, the unit will accept inputs from most sources, including electric guitar, synthesiser, microphone, hi-fi tape output, and many others. Input signals in the range 200 mV to 2.5 V P-P are suitable.

The frequency characteristics of the pre-emphasis used have been tailored for electric guitar as well as normal signals so as to keep quantisation distortion at bay on low strings (see later for more details) whilst a hi-fi tape signal will be virtually indistinguishable from the original when using the maximum bandwidth setting.

A switch is also available which doubles the nominal sampling rate; this can be used for special effects or for enhanced fidelity when using only short delay.

Emphasising Pre-emphasis

The average music signal, or voice, is bass-heavy as far as amplitude is concerned, although most information is carried by mid-range frequencies. This is in general terms, and a fair spread exists in the power spectrums of everyday audio signals.

In the case of electric guitar, the process of converting mechanical to electrical energy strongly favours the thicker, lower strings. A strong twang on a low string may well overload an input stage, whereas the same twang power on a top string will generate a much smaller voltage. However, the signal amplitude produced will decay very rapidly (exponentially) with time so that, unless a sustain/compression unit is used, the guitar signal has a large dynamic range.

This problem is especially relevant if the circuitry following the input has a limited dynamic range that it can handle, which is the case when using relatively short data words to represent musical signals in an analogue to digital conversion. Compact disc players use 16 bits per sample word to achieve their dynamic range but the design presented here uses nine. Why not use more? Because the cost of A/D converters escalates rapidly above eight bits.

In order to give both high and low frequencies a better chance of simultaneously being within dynamic range, high frequencies are boosted, with special consideration given to the mid-range; in other words, the signal is pre-emphasised before the analogue to digital conversion stage. The

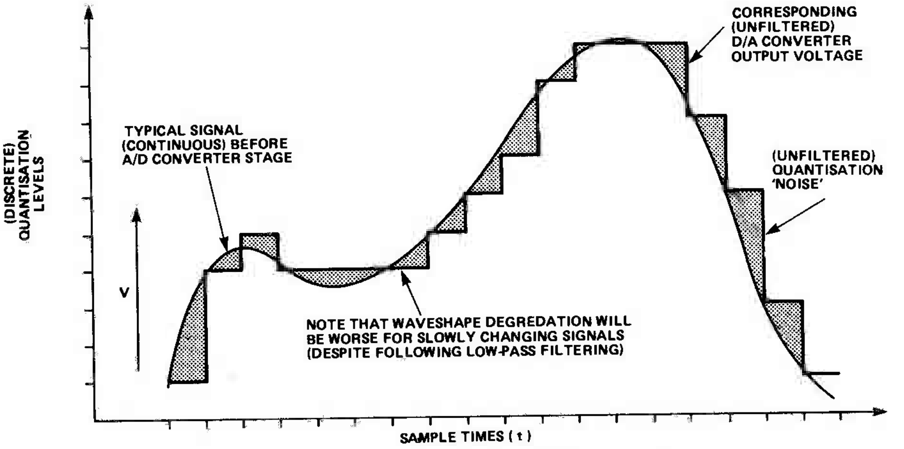


Fig. 1 The generation of quantisation noise during A-D conversion.

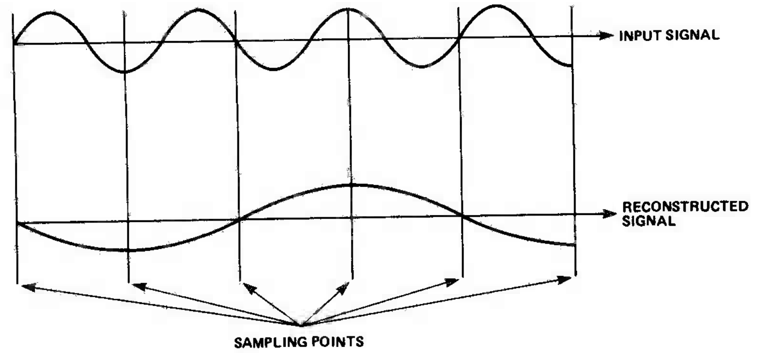


Fig. 2 How the use of too low a sampling rate leads to the reconstruction of a different 'alias' frequency.

pre-emphasis characteristic used has been determined by experiment over a wide range of signal sources.

Quantisation

Use of pre-emphasis has another benefit, namely that of killing off most of the quantisation noise.

Quantisation noise arises as a result of the finite number (2^n, where n is the word length) of analogue levels available with which to represent real (continuous) signals using pulse code modulation. Real signals are thus rounded up in the conversion process to the nearest discrete value mapped by a digital code. When the digital code is converted back to analogue, the resultant errors are ramp-like excursions away from the original waveform — see Fig. 1.

These error excursions sound like noise, called quantisation noise, accompanying the signal proper. Since these error excursions have fast leading edges, the resultant noise has a wide frequency spectrum (from elementary Fourrier analysis) and it is particularly objectionable when superimposed upon low frequency sinusoidal type waveforms, emerging as an annoying buzz in the background.

Buzz Off!

Use of pre-emphasis before A/D conversion obviously requires that de-emphasis be used after D/A conversion. Fortunately this 'treble cut' operates on the quantisation noise as well, thus reducing its high frequency content and therefore its overall unpleasantness.

Sampling Complications

There is a well-known theorem, called the Nyquist sampling theorem, which says that to get an accurate representation of a signal as a stream of sample values, the samples must be taken at a rate that is at least twice the maximum frequency present in the signal. Failure to meet the requirement of the theorem will result in a phenomenon known as *aliasing*, which is demonstrated in Fig. 2. Although this diagram misses out many of the technical niceties (for instance, the reconstructed signal would not be a nice, clean sine wave), it does show what happens — that if a frequency higher than half the sampling frequency is input, it will actually appear at the output as a different, 'alias' frequency, which is lower than half the sample frequency. In audio terms, the sound becomes noticeably 'gurgled'; obviously, we must limit the bandwidth of the signal before it is sampled.

In this design, the sampling rate and the bandwidth limit are coupled by the choice of a switched-capacitor filter to do the low-pass filtering. The same master clock is used to drive both the filter and the sampling, so that as one changes, the other changes to keep pace; the particular filter used is configured as a sixth-order low-pass filter.

In the real world, infinite cut-off filters are not available, so some aliasing always exists; however, with the filter used here, the level of the aliasing is such that it is masked by other imperfections such as quantisation distortion.

The Unit Together

The block diagram of the whole unit is shown in Fig. 5. The pre-emphasis and anti-aliasing filters have already been explained. To make signal-handling easier, the signal is made uni-polar (ie, rectified) and a polarity bit, bit 9 (or D8), is generated by the polarity remover. It may seem rather a waste of effort to do this here, but the equivalent would be to use a nine-bit A-to-D rather than an eight-bit device (obviously the D-to-A would also have to be nine-bit too), and this would add quite a lot to the cost.

The final analogue stage before conversion is the sample and hold and the purpose of this unit is to ensure that the A-to-D sees a steady voltage while it is doing a conversion; this will help to prevent errors occuring.

The next stage in the signal path is the A-to-D itself; this is a continuous approximation device, which means that it works by testing to see which bits should be on or off, starting with the most significant bit (MSB) and working to the least significant (LSB). It takes about 10 µs to do a conversion. The converted signal is passed to the static memory.

The address counter points to the memory location in use at any one time, and while the unit is working normally it will con-

The voltage-controlled oscillator used, and from which all the system timing is derived, is contained within a 4046 phase-locked-look chip, IC37; only the VCO is used from this device. With no external capacitor connected between pins 6 and 7, the VCO will run at about 1 MHz, its maximum frequency with a 5V supply. Normally pin 5 is held low by R69, enabling the oscillator (but see later).

The master clock, CLK, is fed directly to the switched capacitor filter stages on the analogue board to control their cut-off frequency, the mark/space ratio of CLK being adequate even for this purpose. The CLK frequency is divided by either 1 or 2, selection being made by SW10, before it drives decade counter IC35. In this way the sample rate/filter frequency ratio can be selected as either 2.5:1 or 5:1 approx.

IC35 is a five-stage Johnson decade counter, and is used to produce most of the timing requirements of the memory read/write and the A-to-D and D-to-A converters — see the timing diagram Fig. 4. The complete control cycle occupies 10 CLK cycles. For the purpose of explanation, let us assume that a control cycle begins with 0_6 output high.

The address of the memory location currently being accessed is given by the contents of (non-synchronous) ripple counters IC32, IC33. Suppose that at the start of a cycle the address is n. Upon receipt of the next rising CK edge the decade counter, IC35, will advance to '7'. Provided that SW9 is open, IC29 pin 8 will be high and IC29 pin 10 will pulse WR low, writing the result of the last A-to-D conversion into memory location n. (Assume for the time being that data is available, etc.) If SW9 is closed then IC29d is disabled and the contents of memory are not overwritten.

It is now time to start the next A-to-D conversion process. The ZN427 specification states that the active negative edge of SC must not occur within 200 ns of a CK clock edge. On receipt of the next CK edge, IC35 is clocked so that 0_8 is the high output. 0_8 is gated via IC29c with CK to produce a negative-going pulse for only the first half of a CK cycle. Passing this pulse through two inverting stages made from CMOS quad-input NOR gates delays it for the required minimum amount, due to the long propagation delays of the 4002. The SC pulse is applied to the start conversion input of the A-to-D converter. The next CK edge of the cycle puts 0_9 high and is also the point at which the A-to-D, a successive approximation type, decides on the MSB value for this conversion. When 0_0 goes high, on the next CK edge, 0_9 goes low, which clocks the memory address counter (-ve edge triggered) to n+1.

The next event in the cycle occurs when 0_3 goes high; this output is inverted by IC29b and then used to latch the current data bus words into the D-to-A converter's register.

The carry (CY) output of IC35, pin 12, is used to control the data bus direction, after inversion by IC29a (the carry output from IC35 is high when outputs 0_0 to 0_4 are high, and low when outputs 0_5 to 0_9 are high). When OE is tri-state, the data bus outputs from the A-to-D are driven into the high impedance state, while the RAM outputs are enabled.

To summarise, the control cycle runs as follows: start A-to-D conversion; advance address; transfer contents of addressed memory location to the D-to-A; wait for A-to-D conversion to complete; write new data into addressed location; start A-to-D conversion; advance address; and so on.

The ZN427 A-to-D has an accurate band-gap voltage reference diode on chip and this is used to provide the A-to-D, D-to-A and peak level indicator with a full scale reference. The A-to-D requires that a small negative bias current be applied to pin 5 for internal transistors to operate properly.

The analogue board provides step-like positive samples to V_{in} and if these exceed V_{ref} in amplitude, comparator IC27's output will go -ve and LED1 will glow. Note that this peak indicator is fairly crude and is frequency sensitive to some extent, due to the limited full gain bandwidth of IC27, hence it should be used for guidance only. However, if desired, a higher quality op-amp can be used here.

SW11-SW8 select the maximum address count before IC32, IC33 are reset to zero via IC26, etc, and hence these control memory usage. By this means, only one of IC15-IC22 need be present for the unit to work, albeit with limited delay capability. The maximum selectable memory usage corresponds to twice the on-board memory capacity, and an optional memory expansion board will be described later.

The four most significant address lines are used to perform memory chip selection via IC24, which is a 1-of-8 multiplexer with common input connected to ground. Whenever A14 goes high, on-board memory is deselected and its outputs tristated. In this condition IC30d pin 11 goes low to uninhibit or select the expansion memory, if present.

The address count is reset to zero whenever IC30 pin 10 goes low, which occurs if all IC26's inputs go high, as is the normal case, or in an external trigger signal is applied to the trigger input; reset can, therefore, be externally overridden at any time.

In percussion mode, ie, with SW11 connected to IC37's EN then address counting will continue until the address selected by the delay switches is reached, at which time all action ceases since the oscillator is disabled. Action can be restarted by externally resetting via the trigger input or by moving SW11 to normal; thus a one-shot function is possible. Note that the contents of memory are retained during this time since static memory (based on flip flops) is used. D7, D8, R65 etc, are present to protect the NOR input.

Bit 9 is stored independently in a 6116 type memory, whose eight bit words are multiplexed into eight single-bit locations. The ceramic capacitors provide temporary charge storage during read then write cycles which of course are common to all 8 bits simultaneously, and thus avoids data corruption.

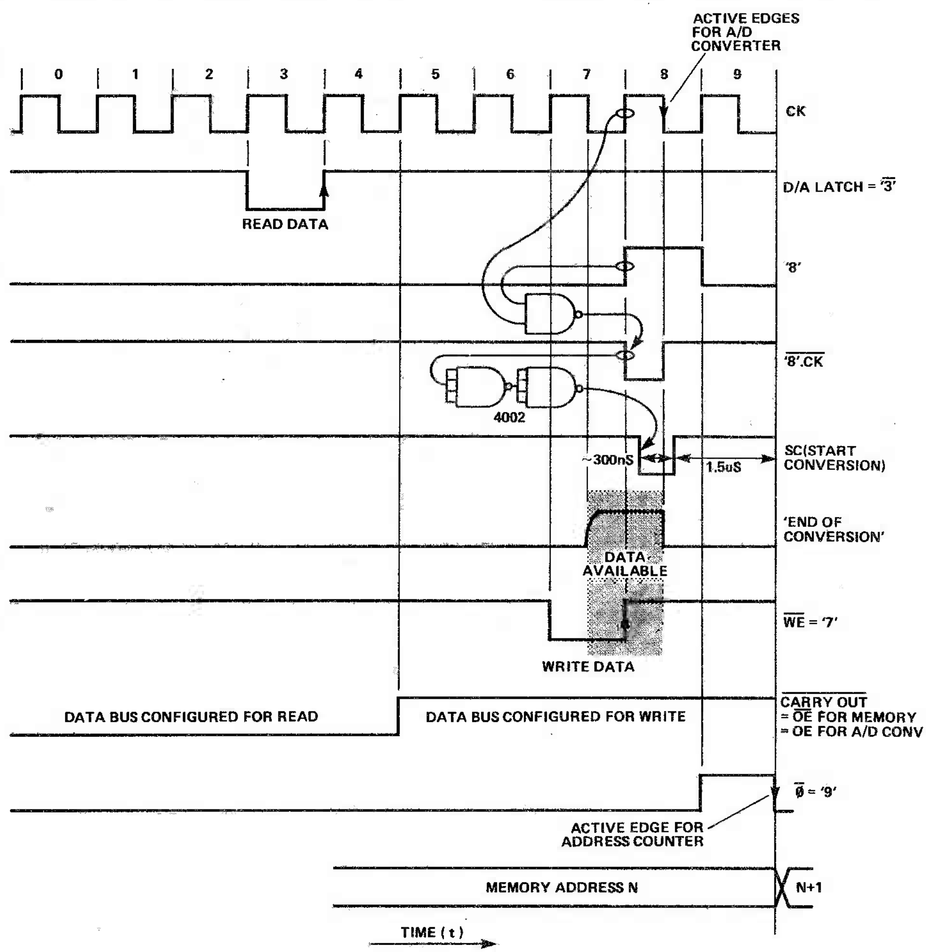


Fig. 4. Timing diagram for the logic.

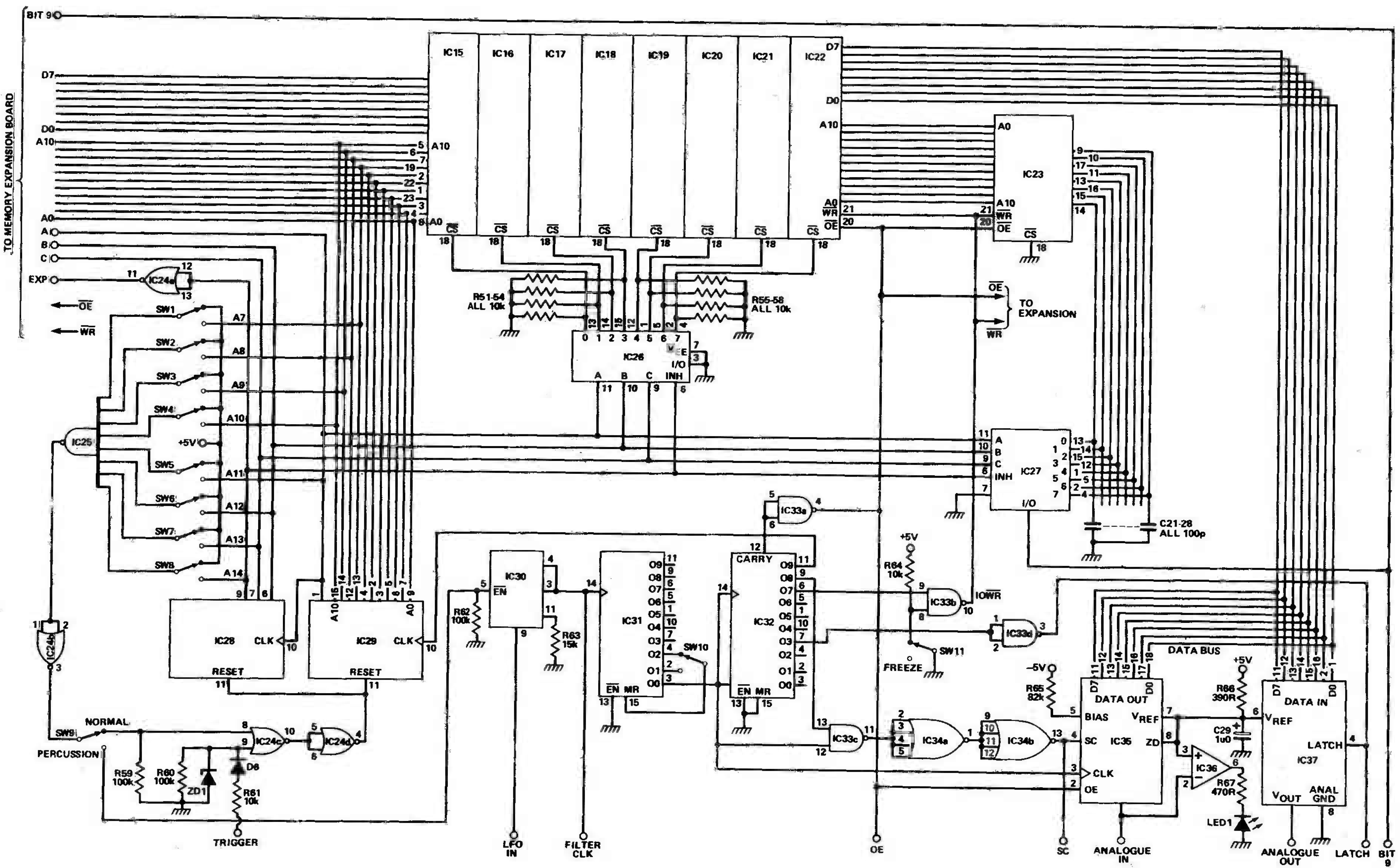


Fig. 3 Circuit diagram of the logic board.

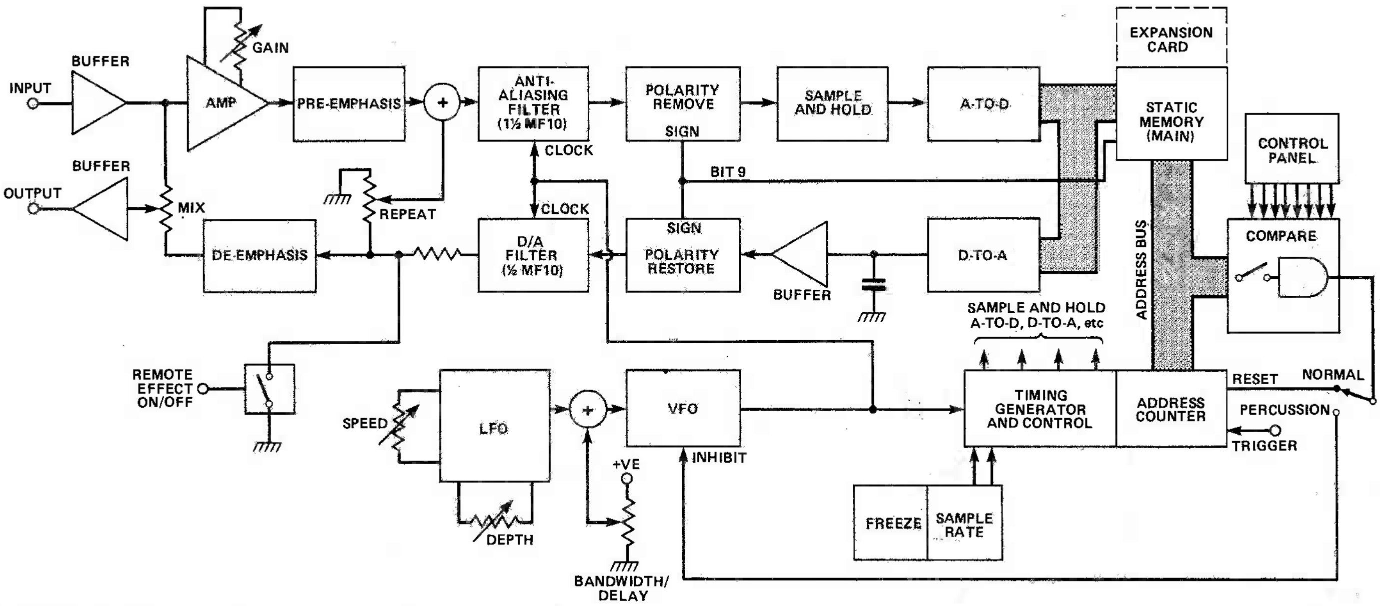


Fig. 5 Block diagram of the complete digital delay unit.

tinuously increment up to the maximum amount of memory selected by the switches in the block marked 'compare'; obviously, you shouldn't select more memory than you have installed! In the percussion mode, the address counter will cycle once through the memory then stop until it receives a trigger signal. This makes the unit able to capture a signal and then play it out on demand.

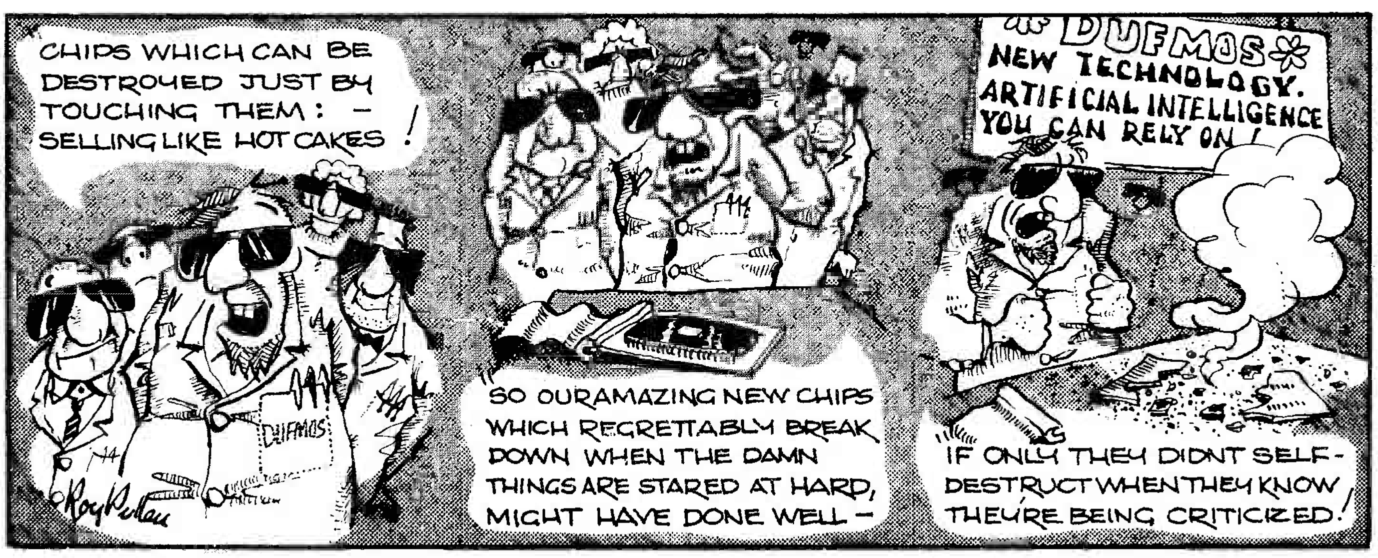
Obviously closely involved in the playing out of captured signals is the D-to-A unit, after which there is a simple single-capacitor filter to remove the worst of the artificially generated HF components and a buffer stage. The polarity restorer uses bit 9 to restore the signal's negative-going section.

The clock filter removes the clock pulses from the audio. A switched-capacitor filter is used here because this can be automatically locked to the A-to-D conversion rate in the same way as the anti-aliasing filter; the anti-aliasing filter will have removed any audio signals above this breakpoint, so anything above this frequency at the input to the clock filter will be an artefact of the system, and should be removed.

The final elements in the audio chain are the de-emphasis and buffer stages; however, there are a few controls that might bear examination. Firstly, the repeat control allows a portion of the delayed signal to be fed back to the start of the system. The mix control allows you to mix the delayed signal with the undelayed signal. And the remote effect on-off input allows the output from the delay section to be muted entirely.

The control of the unit is performed by the timing and control generation section, and the speed at which this operates is set by the frequency of the variable frequency oscillator (VFO). This is controlled by the bandwidth/delay control, but this can be modulated by the low-frequency oscillator (LFO) to give various effects.

To be completed next month.



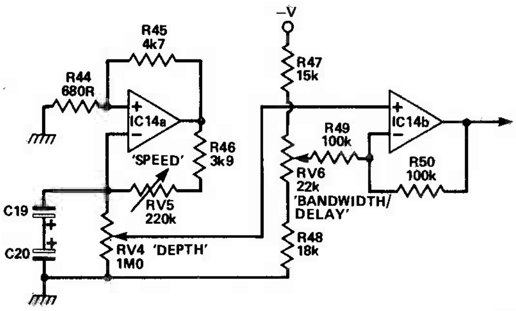


Fig. 6. Circuit diagram of the low frequency oscillator.

HOW IT WORKS

LOW FREQUENCY OSCILLATOR

IC14a is a slow running astable, the hysteresis in the switching point being determined by the ratio R44/R45. This ratio is kept small so that the waveform appearing at the inverting input is a relatively linear triangle wave since C19, C20 are allowed to charge or discharge only a small way along the exponential capacitor charging curve before IC14a's output changes state.

The rate of charging of the capacitors and hence the astable running frequency is determined by RV5 and R46 and is adjustable between about 0.15 and 8 Hz. C19, C20 are back-to-back to provide effectively a non-polarised capacitor. RV4 insignificantly loads the capacitors and attenuates the triangular waveform before passing it to the high input impedance non-inverting input of IC14b. A potential divider is formed by R47, RV6 and R48, the potential of RV6's slider being variable over a limited range. This negative voltage is applied to IC14b and is unity gain inverted. IC14b's output is a steady positive voltage level which may be modualted by the signal on its non-inverting input ie, the size of which is set by adjustment of RV4.

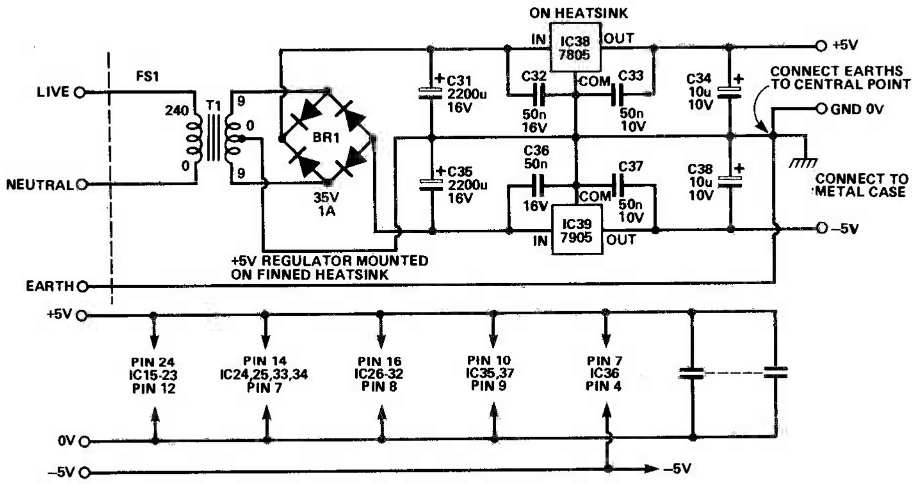


Fig. 7 Circuit diagram of the power supply.

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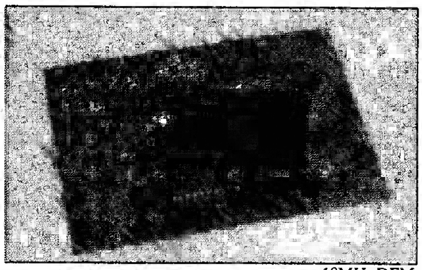

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D	1.2V	1.2AH	01-12044	2.00	2.00
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CH/4/50
To recharge up to 4 AA size NiCads.
Size; 112 x 71 x 37mm 01-00409 4.95

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Size; 70 x 50 x 32mm 01-00159 4.30

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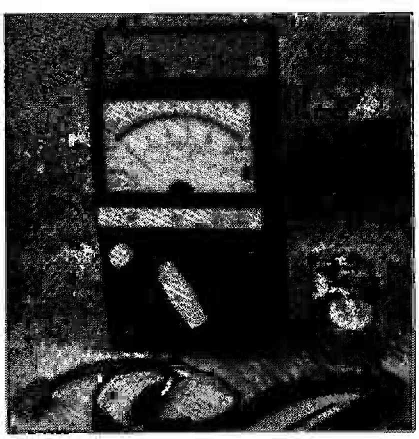
Will recharge AA, C, D and PP3 size cells with automatic voltage selection. Will recharge following combinations: 4xD, 4xAA, 4xC, 2xPP3, 2xD + 2xC, 2xD + 2xAA. 2xD + 1xPP3, 2xC + 2xAA, 2xC + 1xPP3, 2xAA + 1xPP3. Charge rate: 11mA for PP3, 45mA for AA size, 120mA for C and D size, for 16 hrs. Power: 240V 50Hz. Output Voltage: 2.9V for AA, C and D size, 11.0V for PP3 size. Weight: 0.475kg. Size: 199 x 109 x 55mm.
01-02204 9.45



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DC Volts: 0.1V, 0.5V, 2.5V, 10V, 50V, 250V, 1kV (20kΩ/V). AC Volts: 10V, 50V, 250V, 1kV (18kΩ/V).
DC current: 50μA, 2.5mA, 25mA, 250mA.
Resistance: 2k, 20k, 2M, 20Mz. AF Output: −10dB to +22dB for 10VAC (0dB/0.775V, 600Ω). Leakage (Iceo) 15μA, 15mA, 150mA. Hfe: 0-1000 (Lc/Tb). Weight: 410gms. 56-83201 14.00

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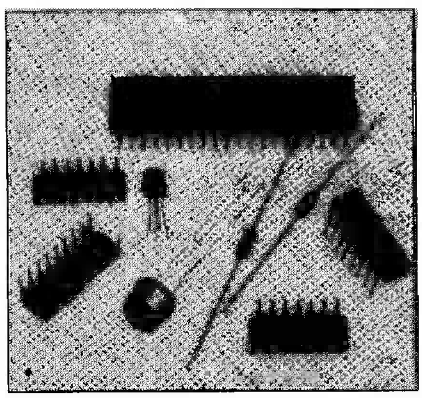

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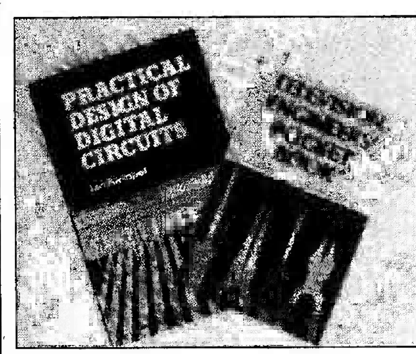

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ACTIVE-8 LOUDSPEAKER

Warning! This introduction contains a pun which may be harmful to readers of a sensitive disposition! Barry Porter sets his active imagination to work once more and brings this series of articles to a tri-amp-hant close (Ouch! — Ed.)

Once completed, the units should be tested. Initially, remove the plug-in boards, switch on and ensure that the correct voltages appear where they should. Having established that the mother board is operating correctly, in particular that the 15-0-15 V supply rails are present, the plug-in boards should be inserted one at a time. It should be possible to connect a signal generator to the input and verify that each board is working by checking its output. If any problems appear, make sure that the IC voltages are correct — namely that +15 V and −15 V are on the supply pins and that both inputs and the output are within a few mV of 0 V. Non-working stages should be carefully inspected for faulty soldering and component insertion, and if no obvious error can be seen, the IC should be changed.

Once everything is working, the response of the two outputs should be plotted and compared to similar measurements taken from the second unit. If these agree to within about 0.25 dBm, it is safe to assume that no major errors are present, and proceed with the final connection to the speakers.

The high and low frequency outputs of the filter unit are connected to the two channels of a stereo power amplifier. A number of factors will probably decide the choice of amplifiers, not the least being cost. It is important that the four power stages of a stereo pair of Active-8 units are as identical as

PARTS LIST —

DELAY UNIT

RESISTORS (all ¼ W 1% metal film)

R32, 34, 35, 37, 38, 40, 41, 43	33k
R33, 36, 39, 42	10k
R44	430R
R45	1k
R46, 47	22R

CAPACITORS

C36-39	1n5 polystyrene
C40	100n polycarbonate
C41	22μ 16 V non-polarised electrolytic
C42, 43	100μ 25 V radial electrolytic
C44, 45	100n polyester

SEMICONDUCTORS

IC6, 7	NE5532

MISCELLANEOUS

PCB; 10-way PCB socket.

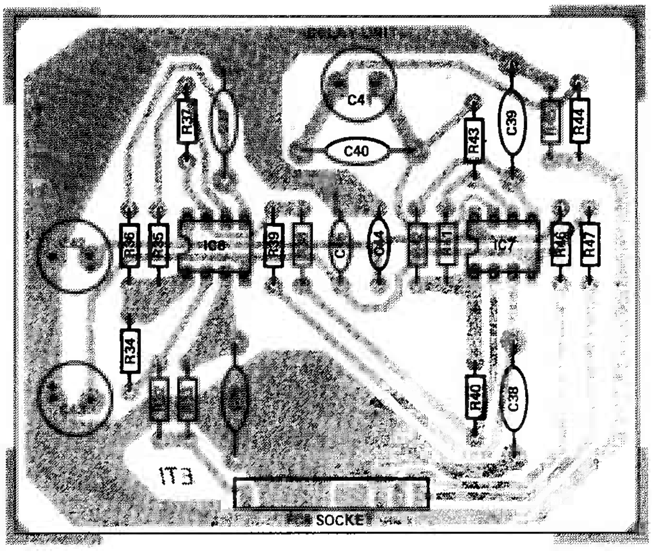


Fig. 1 The missing link — the PCB overlay we didn't have room for last month.

possible. Regarding amplifier power, the speakers will operate at their best when driven by good quality units in the 100-150 watts region; anything below 50 watts per channel should be avoided, as transient clipping is likely to happen too often for comfort. At the top end, providing they are used with caution, there is no reason why 200 or 250 watts should cause any problems.

Before making the final connections the protection relay RL1, should be fitted — preferably inside the cabinet where, if an octal based version is used, the base can be screwed to the cabinet with 20mm chipboard screws passing through 10mm tubular spacers.

Once everything is connected up, the complete unit should be tested, making sure that both relays operate correctly so that a delay of about 6 seconds occurs at switch-on, and RL1 is released before RL2 when the units are switched off.

If everything is working, connect the speakers to your pre-amplifier using good quality screened cable. When fed from a balanced output, the connecting cable should contain a twisted pair of conductors within an outer screen. The conductors carry the signal to the inverting and non-inverting inputs, the screen being connected to the 0V contact. For unbalanced operation, the signal should be applied to the non-inverting (+) input, and the inverting (—) contact of the connecting plug should be connected to the cable screen. If you are using a pre-amplifier with a high output capability it may be advantageous if there is less gain in the system, and this can be achieved by leaving the inverting input unconnected. Some amplifiers (such as the Quad 303 and 405) invert the signal phase, so if you are using such a power stage the overall phase integrity may be maintained by connecting the pre-amplifier output to the inverting input of the buffer amplifier, with the non-inverting and N contacts joined to the screen of the connecting cable. Of course, if your pre-amplifier is also of the inverting type, this will cancel the power amplifier inversion, in which case the non-inverting input of the buffer should be used.

All that now remains is to put stylus to groove, sit back, and discover the joys of being 'Active-8-ed'!

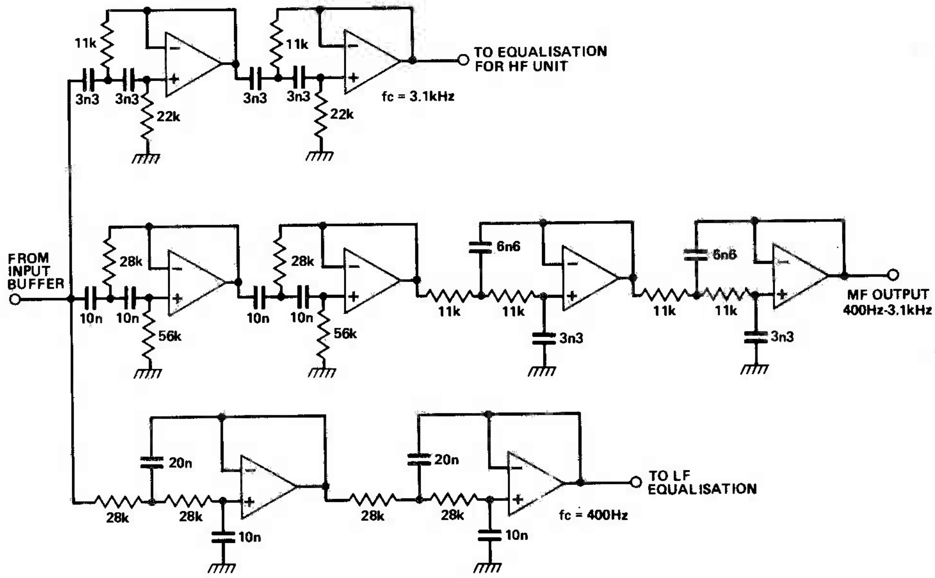


Fig. 2 Basic circuit diagram for a three-way cross-over. You'll have to work out the details (and the PCB) yourself.

Three Ways To Improve The System

The Active-8 was designed to be used with a stereo power amplifier providing power for each channel, which limited the number of drive units that could be used to two. Experimentation is the essence of speaker building (it is one form of building that doesn't require planning permission, except of the matrimonial kind) and most speaker builders go through a phase of Bigger is Better thinking. If, for reasons of sound output level or to impress the next door neighbours, you decide to use a larger than 200mm bass driver — say a 250 or 300mm unit — you will have to start thinking in terms of tri-amplifcation and mid range units. Although a few manufacturers claim to have produced 300mm units that will operate up to 2 or 3 kHz, in practice they leave much to be desired, so the additional complexity of adding a mid range driver is certainly worthwhile.

There are several good units available, but the author has always favoured the KEF B110 in its high power handling form (KEF part no. SP1057).

Depending upon the parameters of the chosen bass unit, you are likely to be using a cabinet of 60 to 120 litres. The basic rules are to keep the cabinet as narrow as possible with drive units close together and vertically in line. If your cabinet building ability is above average, you may like to consider putting the mid and high frequency units in a small enclosure separated from the main cabinet, which allows the acoustic

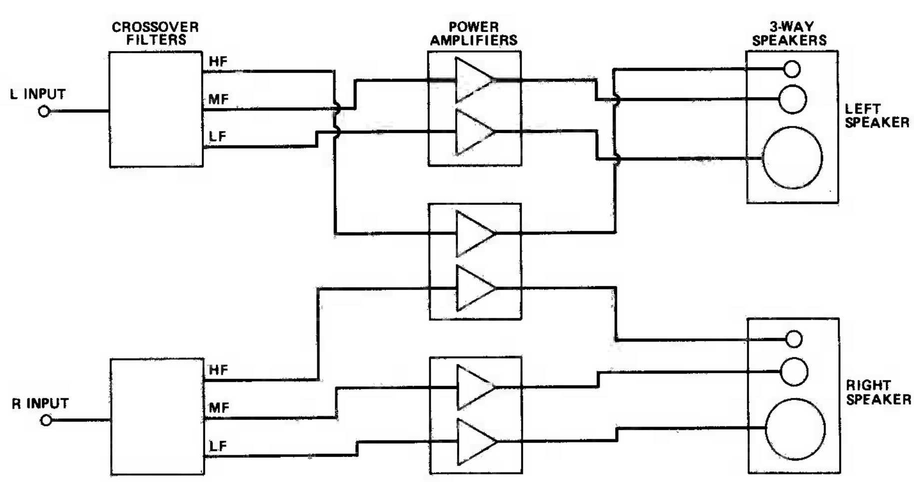


Fig. 3 Suggested set-up for a tri-amped system.

centres of all three units to be in-line and removes the need for signal delay. So what if it looks like a B&W 801 or KEF105 — you're not planning to go into competition with them, are you?

Using a 300mm bass driver such as the KEF B300.B or SEAS 33F-ZBX/DD (about the only unit to have the same transient attack as a JBL 15" monitor, but at about a quarter of the price), a B110 mid range and T33A high frequency unit, the network filters should be 24db per octave using the series Butterworth arrangement previously explained. A basic circuit diagram of the filters is shown in Fig. 2. Equalisation should not be required for the B110, but the bass unit and T33A will require treatment similar to that provided in the Active-8.

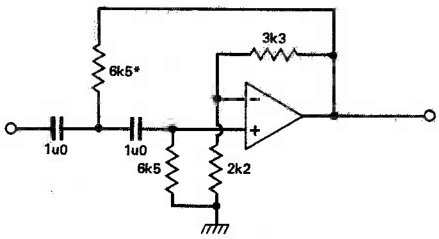
As the name suggests, you will require three stereo amplifiers for a tri-amplified set-up. These should all be of the same type to avoid system gain differences, and should be connected as shown in Fig. 3. Note that we have given no constructional details or PCB layout for this modification — it is intended purely as a starting point for those wishing to experiment further.

Sixth Order Bass Alignment

One of the drawbacks of the equalised closed box form of the Active-8 is the rather excessive cone excursion caused by subsonic signals — and there are plenty of those to be found on the average analogue record. Most record playing systems have some degree of subsonic filtering, but often this is too gentle to be effective, or begins to roll-off at a frequency well into the audio band. If you want to obtain very low bass output without subsonic excursion problems, you may like to experiment with a sixth order alignment. The basic requirement for this is that the reflex cabinet resonance (f_B) is lowered by half an octave, and that an active two-pole filter is introduced into the signal path, this having a Q value of 2 and a cut off frequency the same as the revised cabinet frequency. The Active-8 therefore has its f_B reduced from 34.7 to a new value given by:

$$f_B(\text{new}) = \sqrt{\frac{f_B^2}{2}}$$
$$= 24.5\,\text{Hz}$$

This requires that the tuning vent length becomes almost 500mm which is likely to be a problem. A quick calculation shows that a vent with 50mm internal diameter should be 207mm long, which is a bit more manageable. You will find that if you select the appropriate grade of plastic pipe, one with a 50mm internal diameter will slide comfortably into a 75mm one. It also has sufficient wall thickness of glue the outer end to a new escutcheon, so it is quite possible to have interchangeable 4th and 6th order alignments.



* 6k5 is 2 x 13k in parallel

Fig. 4 Circuit for a second-order filter.

The 2nd order filter shown in Fig. 4 should be inserted in the low frequency path in place of the closed box equalisation circuit. It is tuned to 24.5Hz ($f = 1/2\pi RC$) with a Q of 2 being set by the gain of 2.5 from the relationship:

$$\text{Gain} = 3 - (1/Q)$$

The main problem with a 6th order system is the amount of phase shift that it introduces. Although this can cause some types of bass sound to become less solid, there is no sign of this with low organ notes, so perhaps this alignment is best recommended to those who are turned on by that sort of thing.

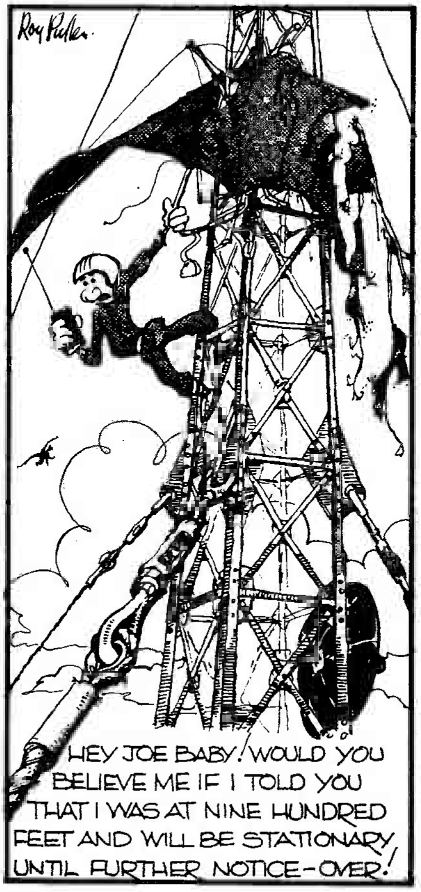
ETI

References

Linkwitz S.H., Loudspeaker System Design. Wireless World May, June & December 1978.
Linkwitz S.H., Active Crossover Networks for Noncoincident Drivers. JAES January 1976
Margows G. & Small R.H., Loudspeaker System Design. JAES, June 1981
Marshall-Leach Jr. W., Active Equalisation of Closed Box Loudspeaker Systems. JAES, June 1981
Snyder P.F., Design of Vented Loudspeaker Systems. JAES reprint 1307
Thiele A.N., Loudspeakers in Vented Boxes, JAES, May & June 1971

BUYLINES

1% metal film resistors are available from a number of suppliers in almost all of the values required, the only difficult item being the 15k4 specified for R51 and R52. We don't know of a supplier for this so we can only suggest you use two resistors in series and stand them on end on the PCB. A 13k and a 2k4, both available from Maplin, should do the trick; ordinary mortals may well find that a 15k 1% is perfectly adequate on its own. The NE5532 and NE5534 are available from Watford, Technomatic, Rapid, etc, and the PCB-mounting transformer and most of the capacitors are also widely available. Non-polarised electrolytics in radial form are not readily available to the amateur, but Maplin and Cirkit both stock 50V axial components which could be mounted end-on. These two companies are also among those which stock the PCB plugs and sockets used, but note that there are some interesting discrepancies in stocking habits here and that you may need to order from more than one supplier to get the matching plug and socket halves you need. RL2 is also a Maplin type, and any relay with the correct contact arrangement and coil voltage can be used for RL1. The XLR type audio connectors recommended in the text are available from numerous suppliers including Electrovalue, Cricklewood, Maplin and Cirkit, and the PCBs are all available from our PCB Service.



Turn to page 71 for details of how to update your Vario!

'THE USUAL PROBLEMS OF MAN MEETS WOMAN'

* solved by Dateline!

Michael Wheeler is an articulate, good-looking businessman in his mid-thirties. Born and bred in London, his work has taken him all over the world. Despite his busy life-style he found time to marry, but unfortunately his marriage failed and he found himself back in London, trying to rebuild his social life.

'My cousin, who lives in London, suggested that I should join Dateline. I must admit, I found the idea appealing because I was aware of Dateline. In fact, I had been a member way back in the sixties. I found no great romantic successes at that time but many, shall we say, nice encounters, so when my cousin suggested the idea again I thought 'Why not, I'm only going to live once, why not make the best of it?'

Michael didn't join Dateline to find 'the woman of my dreams'. 'I joined because after a long absence from a city like London you tend to find that your friends and acquaintances have married or moved away. Although I obviously missed female company, I also found that I had no circle of friends left at all.'

'When my first list of names from Dateline arrived and I began to receive calls from women with whom I had been matched on the computer, my social life improved out of all recognition almost overnight! My only problem was time, because all of the women I spoke to were so pleasant that I felt I had to meet them. In the event, I met four from my first list of names. Two I felt I could quite happily be friends with; the other two meant rather more.'

Michael doesn't mind people knowing he is a member of Dateline. 'There's not the adverse reaction from family and friends that I think some people may expect,' he said. 'I did perhaps feel, as many people probably do, that there's some sort of stigma about admitting to feeling lonely. But that's rubbish as loneliness affects every person at some stage of their life, no matter what their circumstances. It's something that has to be overcome by any means available to us. Dateline may sound cold-blooded to some people, but I have found it certainly isn't. It may perhaps be more socially acceptable to meet people of the opposite sex in pubs or clubs, but really Dateline wins above those places. I don't like competing with smoke and noise, and it's far nicer to know that the woman you're telephoning has the interests and desires you're looking for. It provides a basic understanding before you even say hello. Obviously, all the usual problems of man meets woman are still there, but you have conquered quite a few of the barriers that so often make a relationship fail before its really started.'

He stopped to consider for a moment. 'I don't know what you need from life. All I really want is happiness, and a large part of the happiness I seek is the happiness that can be gained from the relationship between a man and a woman. At least two of the women I have met directly through Dateline have become friends and it's good to know that if I am at a loose end there's someone I can 'phone for a chat or to arrange an evening out.'

Michael has recently suspended his membership of Dateline. He has met a young woman who is a friend of one of his Dateline introductions. Their relationship has blossomed into love and they are now engaged to be married.

If you would like to be one of the many thousands of people nationwide who have been enjoying a new social life, and finding love and happiness through Dateline, complete the simple questionnaire below. We will send you confidentially and completely free, full details about Dateline and how it works, and details of just one of the Dateline members who are compatible with you. Send to:
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TBP24SA10N	1.40
TBP24SA41N	4.40
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TBP28LA22N	4.14
TBP28S166N	19.00
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TBP28S46N	4.50
TBP28S86N	5.00
TBP28SA42N	4.50
TBP28SA46N	4.50
TBP28SA86N	8.62
AM27S13PVC	3.74
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75150P	0.86
75154N	1.05
75159	2.30
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75162AN	4.08
75172NG	1.96
75173N	1.44
75174	2.82
75175	1.96
75182	0.50
75183	0.50
75188	0.86
75189	0.86
75451BP	0.22
75452BP	0.29
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75454BP	0.22
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LM339N	0.48
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LM748CN	0.30
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MC14412	14.20
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TL071-CP	0.28
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TL074-CN	1.10
TL081-CP	0.29
TL082-CP	0.49
TL084-CN	1.02
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TL092-CP	0.72
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TL489-CP	0.59
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ZN433CJ-10	25.00
ZN434	0.98
ZN435	4.38
ZN436E	1.26
ZN440	55.00
ZN441	46.80
ZN447	7.80
ZN448E	6.66
ZN448J	12.48
ZN449	2.72
ZNA134J	22.50
ZNA234E	9.40

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ZN404	0.50
ZN423	0.98
ZN458	0.92
ZN458A	0.92
ZN458B	1.12
ZNREF 025	1.90
ZNREF 040	1.90
ZNREF 050	1.90
ZNREF 062	1.90
ZNREF 100	3.05

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74F138PC	0.52
74F138PC	1.26
74F139PC	1.26
74F151	1.26
74F153	1.26
74F157	1.30
74F158	1.17
74F161	2.34
74F164	1.68
74F175	1.82
74F181	3.90
74F189	5.10
74F190	3.20
74F191	3.20
74F194	1.68
74F20PC	0.52
74F240	3.16
74F241	2.42
74F243	2.80
74F244	2.96
74F245	6.08
74F251	1.26
74F253	1.26
74F257	1.26
74F258	1.34
74F280	1.74
74F283	1.74
74F32PC	0.52
74F352	1.26
74F353	1.26
74F373	3.16
74F374	3.16
74F379	1.83
74F381	6.62
74F382	4.22
74F398	3.16
74F399	2.70
74F521	2.76
74F533	3.16
74F534	3.16
74F537	6.02
74F538	4.38
74F539	4.38
74F64PC	0.52
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74F86PC	0.77

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74HC02N	0.42
74HC03N	0.64
74HC04N	0.44
74HC08N	0.42
74HC107N	0.78
74HC109N	0.50
74HC10N	0.64
74HC112N	0.86
74HC113N	0.86
74HC132N	1.28
74HC137N	1.81
74HC138N	1.20
74HC139N	0.78
74HC151N	1.16
74HC153N	0.90
74HC157N	1.02
74HC158N	1.02
74HC160N	0.90
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74HC162N	1.51
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74HC164N	0.95
74HC165N	2.24
74HC173N	1.35
74HC174N	0.80
74HC175N	0.78
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74HC195N	1.28
74HC20N	0.40
74HC237N	1.80
74HC240N	1.38
74HC241N	1.34
74HC242N	2.24
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74HC244N	1.32
74HC251N	1.03
74HC253N	1.03
74HC257N	1.03
74HC266N	0.92
74HC273N	2.24
74HC27N	0.80
74HC280N	3.26
74HC32	0.40
74HC373N	2.40
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74HC393N	1.78
74HC4002	0.64
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74HC4075	0.64
74HC42N	0.90
74HC4511	2.51
74HC4514	3.76
74HC4538	2.36
74HC4543	3.04
74HC51N	0.64
74HC533N	2.40
74HC534N	2.40
74HC589N	1.72
74HC58N	0.64
74HC595N	1.84
74HC597N	1.72
74HC73N	0.84
74HC74N	0.84
74HC75N	0.92
74HC76N	0.64
74HC85N	2.02
74HC86N	0.80
74HCU04N	0.80

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74LS00	0.25
74LS01	0.25
74LS02	0.25
74LS03	0.25
74LS04	0.25
74LS05	0.25
74LS08	0.25
74LS09	0.25
74LS10	0.25
74LS109	0.54
74LS11	0.25
74LS112	0.54
74LS113	0.42
74LS114	0.44
74LS12	0.25
74LS122	0.75
74LS123	0.95
74LS124	2.30
74LS125	0.49
74LS126	0.49
74LS13	0.46
74LS132	0.73
74LS136	0.46
74LS138	0.77
74LS139	0.77
74LS14	0.80
74LS145	1.23
74LS148	1.50
74LS15	0.25
74LS151	1.10
74LS153	1.10
74LS155	0.77
74LS156	0.77
74LS157	0.62
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74LS160	0.80
74LS161	0.80
74LS162	0.80
74LS163	0.80
74LS164	1.10
74LS165	1.30
74LS166	1.95
74LS173	1.13
74LS174	1.30
74LS175	0.96
74LS181	2.09
74LS190	0.98
74LS191	0.75
74LS192	1.10
74LS193	1.10
74LS194	0.78
74LS195	0.78
74LS196	1.10
74LS197	1.10
74LS20	0.25
74LS21	0.25
74LS22	0.25
74LS221	1.08
74LS240	1.40
74LS241	1.40
74LS242	1.36
74LS243	1.36
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74LS245	1.95
74LS248	1.16
74LS249	1.16
74LS251	0.78
74LS253	0.78
74LS257	0.78
74LS258	0.78
74LS259	1.77
74LS26	0.30
74LS261	2.60
74LS266	0.35
74LS27	0.25
74LS273	1.35
74LS279	0.77
74LS28	0.25
74LS283	1.00
74LS290	0.86
74LS293	0.86
74LS30	0.25
74LS32	0.25
74LS33	0.30
74LS365	0.55
74LS366	0.55
74LS367	0.55
74LS368	0.55
74LS37	0.25
74LS373	1.50
74LS374	1.50
74LS375	0.75
74LS377	1.50
74LS378	1.22
74LS379	1.50
74LS38	0.25
74LS386	0.50
74LS390	1.10
74LS393	1.10
74LS40	0.25
74LS42	0.85
74LS47	1.00
74LS48	1.00
74LS49	1.00
74LS51	0.25
74LS54	0.25
74LS55	0.25
74LS670	2.30
74LS73	0.30
74LS74	0.35
74LS75	0.50
74LS76	0.35
74LS78	0.35
74LS83	0.90
74LS85	1.16
74LS86	0.42
74LS90	0.66
74LS91	1.30
74LS92	0.66
74LS93	0.66
74LS95	0.77

CMOS 4000 Series

4000	0.25
4001	0.52
4002	0.25
4006	0.90
4007	0.25
4008	0.92
4009	0.25
4010	0.25
4011	0.30
4012	0.25
4013	0.45
4014	0.50
4015	0.65
4016	0.46
4017	0.63
4018	0.46
4019	0.39
4020	0.45
4021	0.56
4022	0.42
4023	0.34
4024	0.66
4025	0.25
4026	0.74
4027	0.52
4028	0.34
4031	0.93
4033	2.40
4034	1.00
4035	0.54
4040	0.65
4041	0.36
4042	0.76
4043	0.64
4044	0.62
4045	2.00
4046	0.77
4047	0.50
4048	0.40
4049	0.50
4050	0.49
4051	0.52
4052	0.48
4053	0.66
4054	1.30
4055	0.72
4060	0.68
4063	0.60
4066	0.50
4068	0.25
4069	0.40
4070	0.40
4071	0.40
4072	0.40
4073	0.40
4075	0.46
4076	0.48
4077	0.40
4078	0.25
4081	0.40
4082	0.25
4085	0.66
4086	0.40
4093	0.32
4099	0.50
4502	0.86
4507	0.47
4508	0.96
4510	0.68
4511	0.69
4512	0.40
4514	1.76
4515	1.84
4516	0.68
4518	0.40
4519	0.25
4520	0.96
4521	1.32
4522	0.84
4526	0.52
4527	0.52
4528	0.48
4532	0.68
4541	0.82
4543	0.60
4553	2.40
4555	0.48
4556	0.44
4585	0.48

CRYSTALS

A111B	1MHz	4.50
A112A	1.008MHz	4.00
A113A	1.8432MHz	3.50
A116A	2.4576MHz	2.00
A120B	4MHz	1.25
A132A	6MHz	1.70
A140A	8MHz	1.25
A169A	3.6864MHz	2.00
A173A	9.8304MHz	2.75
A182A	19.6608MHz	2.50

DIL SKTS TIN

		1+	100+
07070802	8 PIN	0.07	0.05
07071402	14 PIN	0.09	0.07
07071602	16 PIN	0.09	0.07
07071802	18 PIN	0.15	0.10
07072002	20 PIN	0.19	0.14
07072202	22 PIN	0.21	0.15
07072402	24 PIN	0.24	0.16
07072802	28 PIN	0.26	0.17
07074002	40 PIN	0.29	0.18

DIL SKTS GOLD

06060802	8 PIN	0.16
06061402	14 PIN	0.20
06061602	16 PIN	0.21
06061802	18 PIN	0.22
06062002	20 PIN	0.28
06062202	22 PIN	0.32
06062402	24 PIN	0.42
06062802	28 PIN	0.46
06064002	40 PIN	0.66

DIL SKTS W/WRAP TURNED PIN

9090802	8 PIN	0.36
9091402	14 PIN	0.75
9091602	16 PIN	0.86
9091802	18 PIN	0.96
9092002	20 PIN	1.08
9092202	22 PIN	1.18
9092402	24 PIN	1.28
9092802	28 PIN	1.50
9094002	40 PIN	1.70

ZIF SOCKETS

08082402	24 PIN	5.70
08082802	28 PIN	6.90
08084002	40 PIN	8.25

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ISULATION DISPLACEMENT ONNECTOR SYSTEM

EADERS	SHROUDED 90°	OPEN 90°	OPEN — STRAIGHT PINS
way	0.86	0.65	0.47
way	1.22	0.83	0.59
way	1.34	0.92	0.65
way	1.36	1.13	0.77
way	1.70	1.40	0.95
way	2.04	1.78	1.19
way	2.28	2.07	1.37
way	2.70	2.54	1.67
way	3.20	3.02	1.96

CABLE ASSEMBLIES

IDC JUMPERS SINGLE ENDED

36" cable	IDC socket
10 way	1.72
14 way	2.07
16 way	2.22
20 way	3.14
26 way	3.75
34 way	3.98
40 way	4.23
50 way	5.36
60 way	6.36

DIP JUMPERS

Single Ended

	— 24" cable
14 pin	1.73
16 pin	1.90
24 pin	2.73
40 pin	3.96

Double Ended

	6" cable	12" cable	18" cable
14	2.74	2.84	2.94
16	3.03	3.14	3.25
24	4.18	4.36	4.55
40	5.89	6.18	6.47

OCKETS

way	0.88
way	1.06
way	1.16
way	1.38
way	1.66
way	1.94
way	2.08
way	2.78
way	3.34

DIP PLUGS

14 way	0.92
16 way	1.06
24 way	1.60
40 way	2.40

TRANS. CONNS.

10 way	0.86
16 way	1.17
20 way	1.37
26 way	1.67
34 way	1.87
40 way	2.23

D-TYPE PLUGS

9 way	1.38
15 way	1.85
25 way	2.52
37 way	3.34

ARD DGE

way	1.84
way	3.14
way	3.80
way	4.90
way	5.52
way	6.68
way	8.06

D-TYPE SOCKETS

9 way	1.47
15 way	2.02
25 way	2.90
37 way	3.97

DISC DRIVE CONNECTING CABLES

34 way card edge to 34 way card edge 1M	11.30
34 way card edge to 2 × 34 way card edge 1.5M	18.00
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34 way card edge to 2 × 34 way IDC KT (BBC) 1.5M	14.50
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BBC Power Cable — Dual Drive	4.75

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	GREY	RAINBOW
9	0.16	0.25
10	0.16	0.25
14	0.21	0.35
15	0.22	0.37
16	0.23	0.39
20	0.28	0.48
25	0.34	0.60
26	0.35	0.62
34	0.45	0.80
40	0.52	0.92
50	0.64	1.14
60	0.76	1.35

BBC MICRO CONNECTORS

DIN PLUG 7 PIN	0.40
DIN PLUG 6 PIN	0.40
DIN PLUG 5 PIN 180°	0.40
DIN PLUG 5 PIN DOMINOE	0.40
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ANALOGUE INPUT PLUG	2.25
5 WAY DIN SKT 180°	0.90
5 WAY DIN SKT DOMINOE	0.90
6 WAY DIN SKT	0.90
7 WAY DIN SKT	0.90
15 WAY DIN SKT	2.15

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comprehensive range of high quality interconnecting cables for popular micro computers. All cables tilise high quality connectors and are individually tested to ensure trouble free use.

art number	Description	Computer	
ideo cables			
ON100	Phono plug to phono plug (2M)		1.20
ON101	Phono plug to BNC plug (2M)		2.95
ON102	BNC plug to BNC plug (2M)		3.95
ON107	6 pin DIN to open end (1M)	BBC	1.05
ON108	6 pin DIN to 6 pin DIN (1M)	BBC	1.50
ON119	Phono plug to coax plug		1.35
ON160	DIN plug to 2 phono plugs	Dragon	1.20
assette recorder cables			
ON109	7 pin DIN to open end	BBC	1.25
ON110	7 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	BBC	2.50
ON111	7 pin DIN to 5 pin DIN + 2.5mm J/plug	BBC	2.50
ON118	5 pin DIN to 2 × 3.5mm J/plugs	Spectrum/ZX	2.50
ON117	5 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	Dragon	2.50
arallel printer cables			
ON130	36 way plug to 36 way plug (2M)	Sirius/Apricot	18.00
ON131	36 way plug to 36 way plug (5M)	Sirius/Apricot	26.50
ON132	36 way plug to 36 way socket (2M)		18.00
ON133	36 way plug to 36 way socket (5M)		26.50
ON144	36 way plug to 25 way male D type (2M)	IBM/TI PC	19.00
ON145	36 way plug to 25 way male D type (5M)	IBM/TI PC	27.50
ON134	36 way plug to 25 way male D type (2M)	RML/Apple	19.00
ON135	36 way plug to 25 way Male D type (5M)	RML/Apple	27.50
ON142	36 way plug to 20 way IDC socket (2M)	Dragon	13.95
ON139	36 way plug to 26 way IDC socket (2M)	BBC	9.95
ON140	36 way plug to 26 way IDC socket (5M)	BBC	22.95
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ON143	36 way plug to 34 way IDC socket (2M)	TRS80 Lev.2/ Memotech	10.95
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ON106	25 way male D type to 5 pin DIN	BBC	5.85
ON128	'Universal' RS232 cable (pins 1-8, 20 connected and 20 jumpered as required) 2M		15.95
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ON120	25 way male to male 1-25 connected (2M)		16.95
ON121	25 way male to male 1-25 connected (5M)		22.50
ON122	25 way male to male 1-25 connected (10M)		32.50
ON123	25 way male to male 1-25 connected (30M)		68.00
ON124	25 way male to female 1-25 connected (2M)		15.45
ON125	25 way male to female 1-25 connected (5M)		21.00
ON126	25 way male to female 1-25 connected (10M)		31.00
ON127	25 way male to female 1-25 connected (30M)		66.50
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ON163	25 way male to 5 pin DIN	RML 480Z	14.95

PART NO.	DESCRIPTION	MAIL ORDER PRICE
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ANB02	BBC Model B Micro with Econet I/F	£385.00
ANB03	BBC Model B Micro with Disc I/F	£406.00
ANB04	BBC Model B Micro with Disc & Econet	£445.00
ALA01	Acorn Electron	£139.00
ANB21	DNFS ROM	£17.91
ANB23	Disc Interface Kit	£71.65
ANB14	Speech Interface	£40.00
ANK01	IEEE488 Interface Adaptor	£277.75
ANB22	Econet I/F Kits	£35.00
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SRE1	Sideways ROM Expansion Board	£25.95
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BBC30	Single 100k TEC 40 track single sided	£99.95
BBC31S	Single 100k TEC (expandable to dual) 40 track	£115.00
BBC31D	Dual (2 × 100k) TEC 40 track single sided	£225.00
BBC34	Single 400k TEC 80 track double sided	£174.00
BBC34S	Single 400k TEC (expandable to dual) 40/80 track switchable double sided	£194.00
BBC34SW	Single 400k TEC 40/80 track switchable double sided	£184.00
BBC34D	Dual (2 × 400k) TEC 40/80 track switchable double sided	£310.00
BBC34S/80	Single 400k TEC (expandable to dual) 80 track double sided	£184.00
BBC34D/80	Dual (2 × 400k) TEC 80 track double sided	£300.00
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BBC30P	Single 100k TEC 40 track single sided with P.S.U.	£130.00
BBC31SP	Single 100k TEC (expandable to dual) 40 track with P.S.U.	£150.00
BBC31DP	Dual (2 × 100k) TEC 40 track single side with P.S.U.	£250.00
BBC34P	Single 400k TEC 80 track double sided with P.S.U.	£209.00
BBC34SP	Single 400k TEC (expandable to dual) 80 track with P.S.U.	£229.00
BBC34DP	Dual (2 × 400k) TEC 40/80 track switchable with P.S.U.	£345.00
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FB501	TEC 100k single sided	£91.00
FB504	TEC 400k double sided	£150.00
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MD-1C/B	Nashua single sided, single density 40 track (10 discs)	£12.00
MD-1DC/B	Nashua single sided, double density 40 track (10 discs)	£13.00
MD-2DC/B	Nashua double sided, double density 40 track (10 discs)	£15.50
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12MON	12 inch green screen high resolution NEC high quality monitor	£135.00
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1441	Microvitec 14" RGB colour monitor high resolution	£410.00
1451	Microvitec 14" RGB colour monitor medium resolution	£295.00
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SBB03	View Rom	£45.00
SBB04	View Printer Driver	£7.50
AES20	Fileserver Level 1-40 track	£80.50
AES21	Fileserver Level 2-80 track	£202.00
SNB08	Acornsoft Invoicing program	£16.00
SNB09	Acornsoft Mailing System program	£16.00
SNB10	Acornsoft Accounts Receivable program	£16.00
SNB11	Acornsoft Stock Control program	£16.00
SNB12	Acornsoft Order Processing program	£16.00
SNB13	Acornsoft Acounts Payable program	£16.00
SNB14	Acornsoft Purchasing program	£16.00
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SNL02	Lisp — 40 track	£15.00
SNL04	Microtext — 40 track	£47.50
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RX80F/T	Epson RX80F/T 100 cps matrix printer friction or tractor feed	£231.00
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HR25	Brother HR25 Daisy wheel printer (23cps)	£550.00
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11241P160	11×9½ 1 part plain listing paper (2,000)	£11.25
11241P2CI	11×9½ 2 part (otc) plain listing paper (1,000)	£14.00
11241P3CI	11×9½ 3 part (otc) plain listing paper (700)	£16.25
11370R160	11×14½ 1 part ruled listing paper (2,000)	£13.50
11370R2NC	11×14½ 2 part (ncr) ruled listing paper (1,000)	£22.50
11370R2CI	11×14½ 2 part (otc) ruled listing paper (1,000)	£15.00
12235P160S	12×9½ 1 part plain listing paper with side perfs (2,000)	£12.00
HR1R	Brother HR1 ribbon	£2.20
RIB119	Diablo Hytype II Multistrike film ribbon	£1.75
GP205	Diablo Hytype II fabric ribbon	£2.50
MX80	Epson MX80, RX80, FX80, fabric ribbon	£3.00
MT80	Mannesmann Tally MT80 film ribbon	£6.50
RIB117	Uchida DWX305 multistrike film ribbon	£2.75
HR5R	Brother HR5 ribbon	£2.20
HR15R	Brother HR15 multistrike ribbon	£4.00
HR25R	Brother HR25 multistrike ribbon	£4.00
	Brother daisy wheels	£14.00
	Uchida/Qume daisywheels	£4.00
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. . . or just those of you who sometimes think "I could do better than that!"

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EXPERIMENTERS' 64K DRAM CARD

Gnosis: knowledge of spiritual mysteries (Concise Oxford Dictionary); Gnos-ex: expandable memory system (ETI Dictionary). Phil Walker tries again for the obscure pun of the year award.

The ETI GNOS-EX is the expandable, flexible dynamic memory system for the keen experimenter. Using the 4416 16K X 4 dynamic memory devices, the system can be populated and configured for from 16K to 64K blocks with the capability of deleting or including memory in 1K blocks.

Last time we published a DRAM card for the 6502, we used the 74LS608 memory controller. Since then, we've discovered there are problems with this device (don't worry if you're trying to get that board going — we're working on a fix!). So this system was designed to do without any very special control devices and rely, so far as possible, on absolutely standard ICs which will be (we hope!) readily available for some time to come and cheap. In the final design the most unusual devices are the 4416 memories and the PROM. This latter device is not actually absolutely essential for the operation of the project and could be replaced by suitable logic.

The layout of the PCB is intended to be such that it will plug into a Microtan system bus, although at the time of writing this it has not been tested. The original development work was carried out on the author's Ohio Superboard, somewhat modified with the processor running at 1.25MHz.

The Circuit

The basic ideas behind this project are much the same as any other which makes use of dynamic memories. There are two distinct phases of operation; the first, and most important as far as the user is concerned, is the reading or writing data, ie actually using the memory. The second is the periodical refreshing of the stored data to make sure that it is remembered correctly. Ideally, the refresh operation should not be apparant to the user, and so it must take place when the processor is not using the memory.

In the case of the 6502 microprocessor, for which this project is designed, the processor is concerned with accessing the memory for only half the time. The remaining time can be used for refreshing the memory with no effect on the processor. With the 6502 running at 1MHz there is about 500ns in which the processor will read or write data as necessary, followed by 500ns or so in which the processor is doing internal operations and not interested in the outside world; this is the time we use to do a refresh operation.

The 4416 specification requires that the whole memory be refreshed at least every 4ms. To do this, 256 different addresses must be put on the address lines and the RAS input pulsed low for a certain time for each one. All this must be done within the 4ms allowed. In this design it will be done every 256µs with a 1MHz processor clock.

The circuit consists of several elements. First, there is an address multiplexer which takes the 16 address lines from the processor and switches them to the eight address lines of the memories during the processor access cycle. Only 14 of the address lines are used, eight are latched into the memory ICs by the $\overline{RAS}$ signal and six by the $\overline{CAS}$ signal.

Second, and allied to the above, there is the refresh address counter and buffer. The eight-bit counter is incremented at the end of each refresh cycle and provides the 256 addresses necessary for the complete operation. The tri-state bus buffer puts the output from the counter on the memory address pins starting mid-way through the previous processor

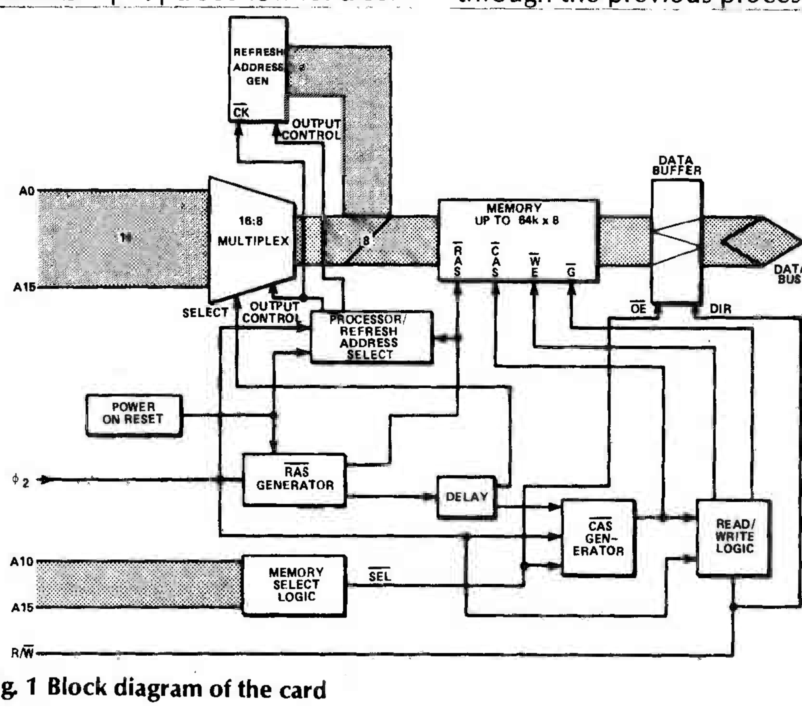


Fig. 1 Block diagram of the card

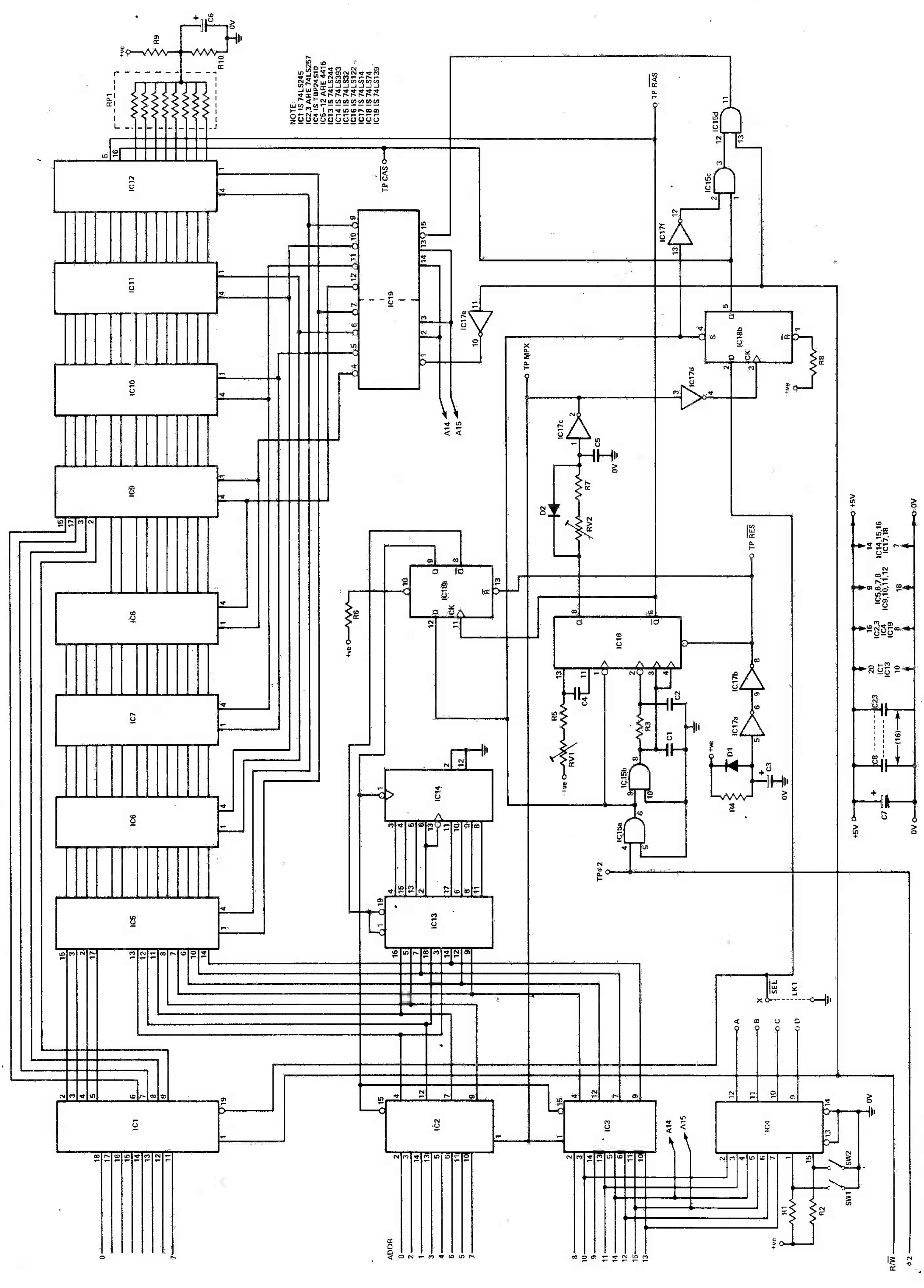


Fig. 2 Main circuit diagram

HOW IT WORKS

In this section we shall dispose of the simpler functions first. IC1 is an eight bit bi-directional data buffer. Its direction of transmission is determined by the state of the R/W line from the processor. It is enabled by the SEL signal from the address decoding PROM when the processor requires access.

The address decoder PROM is about the easiest way of providing full decoding of the address space into 1K byte blocks. As supplied by the manufacturers the TBP24S10 has all its memory cells at a logic high level. In this project this corresponds to the board not being selected. In order that the memory will respond to any block of addresses, the corresponding locations in the PROM must be blown to the low state. Since the PROM has four bits per location, three more memory maps can be blown into the device to cater for future modifications to your system and link LK1 moved to use the appropriate bit. Also, since only six of the eight address lines are used for the decode, SW1 and 2 are provided so that you can have up to four address maps for each link position.

If the blowing of a PROM is difficult for you then a 74LS151 one of eight selector IC can be used to simulate some of its operation.

In order to ensure that the circuit starts up correctly when power is applied, R4 and C3 together with IC17a and b form a power-on-reset circuit which gives a logic low for 25ms or so after the power is first applied. D1 across R4 ensures that C3 is discharged rapidly when power is removed and also protects the input circuitry of IC17a.

IC2 and 3 are quadruple two-to-one multiplexers which are used to switch the 16 processor address lines onto the eight memory address lines at the right time. 'LS257s are used here instead of the more usual 'LS157s because they have outputs which can be made high impedence by the state of a single input pin. By using this facility the processor address bus is applied to the memory at the start of the processor access cycle. At the end of the processor cycle the outputs of IC2 and 3 are turned off and IC13 outputs are turned on, allowing the state of the refresh counter IC14 to be applied to the memory address inputs in readiness for a refresh cycle.

IC13 is an eight-bit bus buffer while IC14 is a dual four-bit binary counter connected to provide the eight bit refresh address. To ensure that the outputs of IC14 are steady while the refresh cycle is in progress, IC14 is clocked as the outputs of IC13 are disabled thus the transitions of IC14 will be over long before the next refresh address is gated onto the memory inputs.

The next part of the circuit is where the main work is done. The main timing signal φ_2 from the processor goes to IC15a where it is buffered; from IC15a output it passes through IC15b where it is delayed a little and through R3 and C2 where it is delayed a little more. When φ_2 goes low the falling edge at IC16 pin 1 causes IC16 to generate a pulse at its output. IC16 is a monostable whose period is set by RV1, R5 and C4. Note that due to the delays in IC15b and R3/C2, pins 2, 3 and 4 will still be at a high level when this occurs. This satisfies the trigger conditions for the device in this case.

When, on the other hand, φ_2 goes high, pin 1 will go high first followed by pins 3 and 4 and then pin 2. The combination of pin 2 low and pins 3 and 4 going high is another valid triggering combination for IC16 and it will trigger again. This arrangement gives a pulse at both the rising and falling edges of the φ_2 input signal.

The low-going output from the Q output of IC16 is used as the RAS or row address strobe signal for the memories. Its falling edge causes the first eight bits of the address to be latched internally.

The high-going signal from the Q output of IC16 is somewhat delayed by RV2, R7 and C5 and inverted by IC17c. This signal causes the address multiplexers IC2 and 3 to apply the other eight address bits to the memory inputs ready for the next operation. The output from IC17c is inverted and, incidentally, slightly delayed by IC17d before going to the clock input of IC18b.

Normally the Q output of IC18b is set to the high state every time φ_2 is low, but if φ_2 is high and the clock input goes high, the state of the SEL signal is transferred to the Q output. If the memory board is selected, SEL will be low and IC18b Q output will go low, otherwise it will remain high.

The output from IC18b is used as the CAS or column address strobe signal for the RAMs. Its falling edge causes six more addresses to be latched into the memories, making the total up to the 14 necessary to access one of the 16384 locations.

A little while later, the monostable IC16 finishes its pulse. The delay network RV2, R7 and C5 is reset quickly via D2 ready for the next RAS cycle. As the Q output or RAS signal goes high it also clocks IC18a. This transfers the state of the φ_2 signal to its outputs which in turn control the outputs of the refresh buffer and processor multiplexers.

If φ_2 is high the next RAS cycle will be a refresh and IC13 will be enabled. If φ_2 is low the next RAS cycle will be a processor access if required and the outputs of IC2 and 3 will be enabled.

Note that the power-on-reset circuit ensures that the control logic starts up with the RAS generator disabled and the multiplexers enabled. It must be arranged that the software allows at least eight RAS only cycles of the memory before it is accessed. This would normally occur while the processor registers are being initialised.

The remaining logic is concerned with reading and writing the memories. The design of the project does not aim for minimum power consumption so all the memories are accessed during each cycle. However, to read data from one pair of them, its G input must be low. This signal is derived by simply inverting the R/W signal from the processor and passing its through IC19a. This is half of a one-of-four demultiplexer and its output driven is determined by the states of the two most significant address lines. The selected output then enables one of the four pairs of memories and allows it to output its data.

To write data into the memories, the WE input must be taken low. To accomplish this, the R/W signal is gated with the inverted φ_2 signal from IC17f and the CAS signal. This is done to ensure that it cannot occur at the wrong time. The outputs from IC15c and d then enable IC19b which routes it to the WE inputs of the pair of memories determined by the states of A14 and A15 of the address bus. This arrangement also delays the write command a little and allows a little extra time for the data to arrive from the processor.

The last components on the PCB worth a mention are the resistor pack and R9, 10 and C6. These are provided to terminate the address lines and suppress reflections of the signals travelling back along them. On this size of board, they may well not be necessary.

The final point to note is that the top address lines A15 and A14 are multiplexed onto the memory address inputs during the CAS cycle, but the memory ICs ignore them. This may prove useful if 64K by 4 bit devices become available (with eight multiplexed address pins) in the near future.

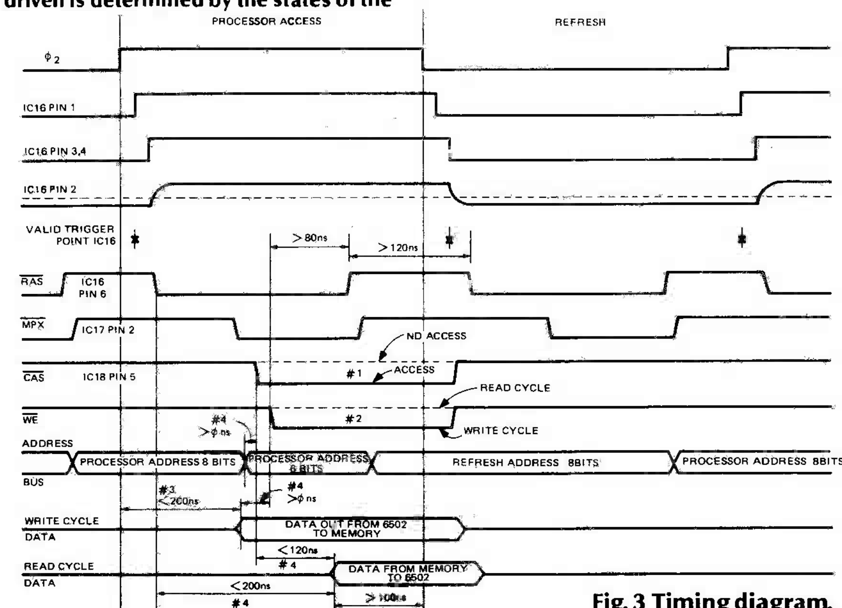
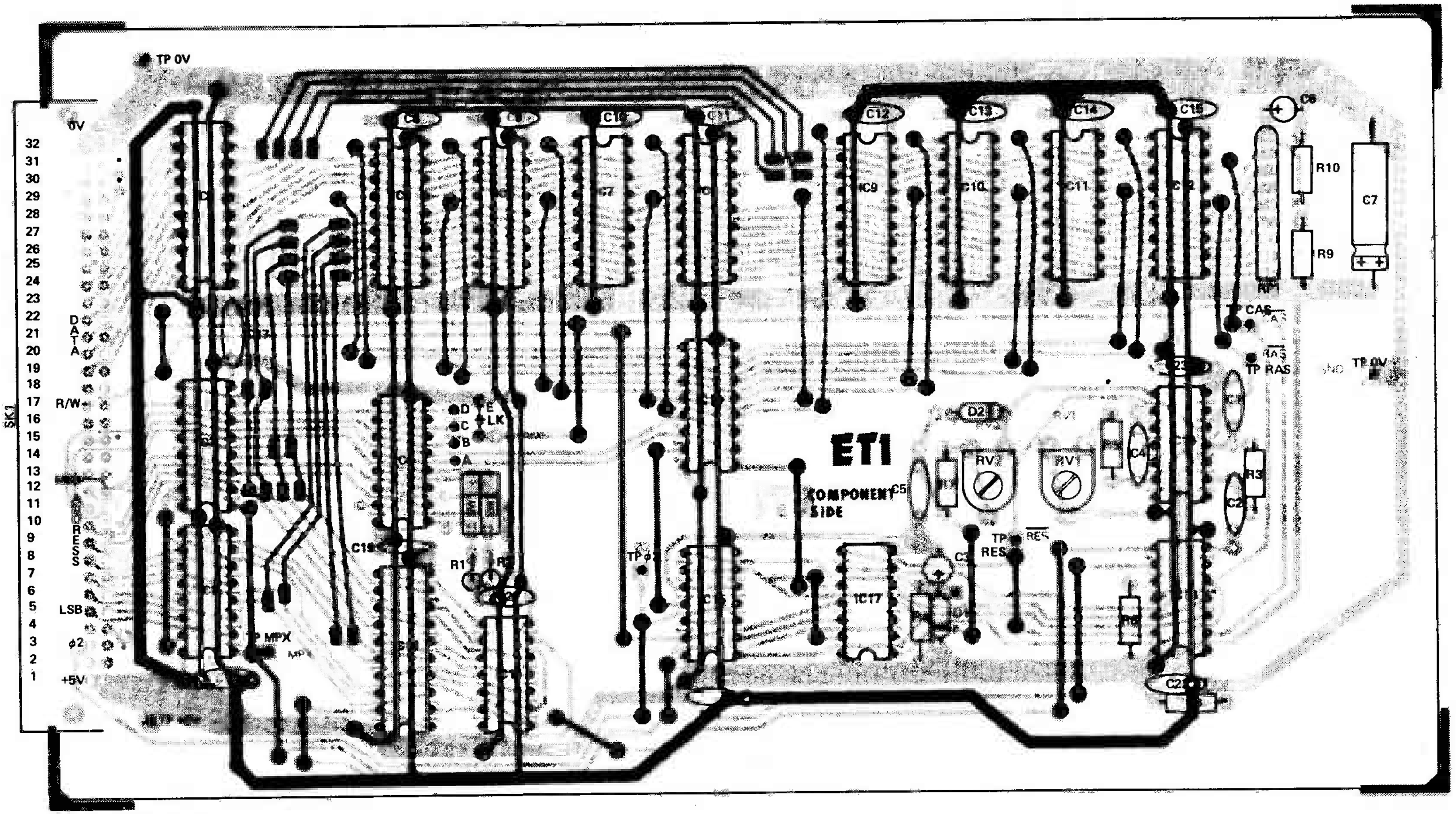


Fig. 3 Timing diagram.



*PROVISION TO MAKE USE OF BUS SIGNALS IN MICROTAN 65 IF REQUIRED

● = TEST POINT PINS
✱ = THROUGH BOARD LINKS

Fig. 4 Overlay for the PCB

PARTS LIST

RESISTORS (¼ watt 5% carbon film)

R1, 2, 6, 8	2k2
R3, 7	470 R
R4	10k
R5	5k6
R9, 10	330 R
RP1	SIL resistor pack 8 x 1k0
RV1	10k min. preset (horiz.)
RV2	4k7 min. preset (horiz.)

CAPACITORS

C1, 2, 5	100p 1 or 2% silver-mica
C3	10μ tantalum bead
C4	22p 1 or 2% silver-mica
C6	100μ tantalum bead
C7	100μ aluminium electrolytic axial
C8 to 15 inc.	47n (8 off) ceramic disc
C16 to 23 inc.	100n (8 off) ceramic disc

SEMICONDUCTORS

IC1	74LS245
IC2, 3	74LS257
IC4	TBP24S10 (if required — see text)
IC5, 6, 7, 8, 9, 10, 11, 12	4416 (150ns preferred)
IC13	74LS244
IC14	74LS393
IC15	74LS32
IC16	74LS122
IC17	74LS14
IC18	74LS74
IC19	74LS139
D1	1N4148
D2	OA91

MISCELLANEOUS

SW1, 2	2 section DIL switch 2x single pole
SK1	64 way a-b DIN 41612 card connector

2 x 20 pin, 8 x 18 pin, 4 x 16 pin and 5 x 14 pin DIL sockets; tinned 20swg wire for links; PCB, wire, etc.

cycle until mid-way through the refresh cycle. During this time, the outputs from the multiplexer ICs are made high impedence to avoid conflict.

The next section, and possibly the most important as far as this design is concerned, is the $\overline{RAS}$ generator. This is basically a monostable but with extra logic to make it trigger from both the rising and falling edges of the φ_2 signal. The φ_2 signal is the main timing output from the 6502 processor. The dual triggering capability enables the circuit to generate the row address strobe ($\overline{RAS}$) signal for both refresh and processor access with one device and one adjustment.

Following on from the $\overline{RAS}$ generator, there are two functional blocks, one of which determines the memory address source for the next cycle from the current state of the φ_2 signal. The other provides a short delay in which the first eight bits of the processor address are held steady before switching over to the next six bits in readiness for the $\overline{CAS}$ signal.

The delay circuit also triggers the column address strobe ($\overline{CAS}$) generator which, if all its input conditions are correct, will provide a low output signal to the end of the cycle. Note that this signal will only occur if φ_2 is high and the select logic output is low. The state of the select logic is sampled after a delay from the $\overline{RAS}$ signal falling edge; if it is low then the $\overline{CAS}$ output may go low. If, however, φ_2 is low then $\overline{CAS}$ will stay high. This occurs during a refresh cycle. If, during a processor cycle, the $\overline{CAS}$ output does go low it will remain low until the end of the cycle when φ_2 going low will force it high again. This allows data to remain available at the output of the memories until the end of the processor cycle without the use of a separate latch.

The last major section of the circuit consists of the read/write select logic. This also performs the function of selecting which pair of memory chips is accessed. Each memory device has a write enable ($\overline{WE}$) input and an output control ($\overline{G}$). The latter has the effect of allowing data to be output from the device only when this line is low. The former causes data to be written into the memory matrix when it is taken low provided that the $\overline{RAS}$ and $\overline{CAS}$ signals have been properly set up. The $\overline{WE}$ signal is allowed to be generated only if a $\overline{CAS}$ signal is present, and so will occur only in a processor cycle when the select logic output is low and the R/$\overline{W}$ is also low.

In order to keep the loading on the processor data bus low and to avoid handling problems due to static on the memory data pin, a data buffer is provided. Its direction of transmission is determined by the state of the R/$\overline{W}$ line and it is enabled when required by the SEL signal from the select logic.

The select logic on the board is intended to be a TBP24S10 256 x 4 bit PROM. Only the six MSBs of the address bus are connected to the PROM and thus only 64 of

Programming The PROM

As already stated, the PROM address lines are not used in order, the connections are as follows:

Address Line	PROM Pin	PROM Pin Designation
A15	5	A0
A14	4	A3
A13	7	A2
A12	6	A1
A11	3	A4
A10	2	A2

When you come to do the programming, program one location at a time. The manufacturers do not recommend manual programming of this device, but you may get away with it. The recommended programming procedure is as follows:

1. Address the word to be programmed, apply 5 volts to V_{CC}.
2. Verify the status of a bit location by checking the output level.
3. Decrease V_{CC} to 0 volts.
4. For bit locations that do not require programming skip steps 5 through 11.
5. Increase V_{CC} to $V_{CC(pr)}$ with a minimum current capability of 250 milliamperes.
6. Apply $V_{S(pr)}$ to all the S, E or G inputs. $I_I < 25$ milliamperes. Active-high enables may be left high.
7. Connect all outputs, except the one to be programmed, to V_{IL}. Only one bit is to be programmed at a time.
8. Apply the output programming pulse for 20 microseconds. Minimum current capability of the programming supply should be 250 milliamperes.
9. After terminating the output pulse, disconnect all outputs from V_{IL} conditions.
10. Reduce the voltage at S, E, or G inputs to V_{IL}.
11. Decrease V_{CC} to 0 volts.
12. Return to step 4 until all outputs in the word have been programmed.
13. Repeat steps 2 through 11 for each word in memory.
14. Verify programming of every word after all words have been programmed using V_{CC} values of 4.5 and 5.5 volts. Note that registered PROMs must be clocked to verify the output condition.

$V_{cc(pr)} = 6 \pm 0.25\,V$

$V_{s(pr)} = 9.75 - 11\,V$

$V_{IL} = 0$ to $0.5\,V$

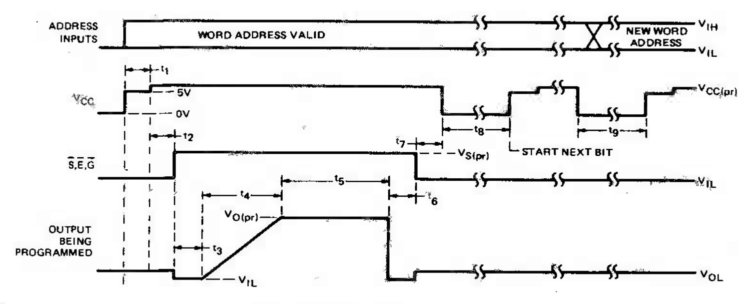


Fig. 5 PROM programming timing

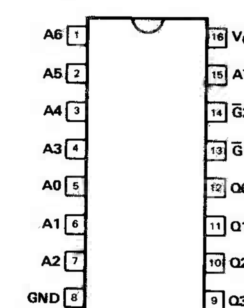


Fig. 6 PROM pin-out

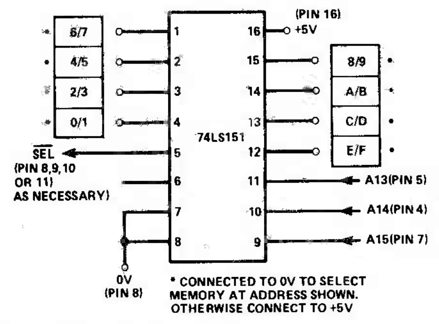


Fig. 7 Use of 74LS151

the locations are available. SW1 and SW2 can be used to gain access to three others sets of 64 locations. Also, only one of the four output bits of the PROM is used — selected by LK1 — so a total of 16 different memory maps can be held by each PROM. Note that unlike a previous design for a memory board using this device, the output of the PROM must be programmed LOW to enable the appropriate part of the memory map. Note also that the address lines are not used in order.

If desired it should be easy to wire one or two chips to a 16 pin DIL plug for use in place of the PROM.

Construction

This stage of the project is not difficult but just seems exceedingly tedious. Step one is to check that all the components will fit their holes. Note that the DIN 41612 connector usually needs 1mm holes for its leads as does C7. All the other components, except RV1 and 2 which need 1.2 to 1.5mm holes, will fit into 0.8mm holes.

Step two is to take all the components off the PCB (you didn't solder them on — did you?) and make all the through-board links. The easiest way we know of doing this cheaply is to take a length of 22swg tinned copper wire, stretch it a little to make it straight and stiff, squeeze the very end with pliers to flatten it out so that it will not fall through the holes in the PCB and then cut off about ¼ inch (6mm). Repeat this process until you have enough pieces to go through all the link holes.

Support the PCB clear of the table top with the component side uppermost. Working from one end of the board, put about a dozen of the links in the proper holes and solder them in place. Turn the board over and put it flat on the table with a piece of kitchen tissue for protection, and solder all the links on this side as well. Clip off all excess wire and repeat until all the links are made.

Step three is to fit all the IC sockets. Note that IC5 to 12 are the opposite way round to the others. Then fit the DIN 41612 edge connector and the other passive components except R9. Make sure that the diodes and electrolytic capacitors are the right way round.

At this stage it is advisable to check that there is not short circuit on the power supply lines. If this test is OK then R9 can be fitted. Check also that 0V and +5V supplies are connected to each IC socket. Examine the PCB tracks carefully, especially around the edge-connector socket, for breaks or solder bridges, as these will be very difficult and possibly expensive to find later.

Step four is to insert IC15, 16, 17 and 18. Apply power to the board and check that it does not draw more than 100mA or so. Now connect a 1MHz TTL compatible square wave signal to the φ_2 test point. With an oscilloscope (or otherwise, as equipment allows) monitor the $\overline{RAS}$ test point and adjust RV1 such that the high time is about 150ns. If this cannot be done, check your PCB again and verify the component values of RV1, R5 and C4. Also check that there are two pulses per 1μs — check C1, 2 and R3 if not. $\overline{CAS}$ testpoint should be continuously high.

If you have got this far successfully, remove power from the PCB and link X to E. Reapply power and check RAS signal again. Now check that the $\overline{CAS}$ testpoint has a low pulse while the φ_2 signal is high. Adjust RV2 if necessary to see this. If this signal does not appear check RV2, R7, D2 and C5 and the signals at IC17c and d.

If all is correct, adjust RV2 such that the $\overline{CAS}$ signal goes low about 100ns after the $\overline{RAS}$ signal goes low. This should set the main timing to about the right area for normal operation.

Switch off the power again and insert IC2, 3, 13, 14 and 19. Switch on again and check that all eight outputs of IC14 are counting. Check that the outputs of IC18a are switching on the rising edge of the $\overline{RAS}$ signal. Check also that IC19 pin 4 is permanently low and all other outputs from IC19 are high. Now connect the R/$\overline{W}$ input to the board to 0V and check that all outputs from IC19 except pin 9 are permanently high. Pin 9 should be pulsing low with approximately the same signal as that on the $\overline{CAS}$ testpoint. Pulling A14 or A15 inputs low should alter the pin numbers but not the signal.

If you have got this far successfully there is only one more thing to do before inserting the memory devices. This is to check the power-on-reset circuit. Incidentally if this does not work correctly it could have given you problems earlier. Temporarily short-circuit C3 and monitor the output of IC17b. This should be low. Remove the short from C3 and check that the output of IC17b stays low for at least 200ms (probably nearer 500ms). During this time the $\overline{RAS}$ and $\overline{CAS}$ signals will be high. Note that φ_2 signal should be present as early as possible to ensure that the $\overline{CAS}$ signal is forced high, although the φ_2 line being low will also accomplish this.

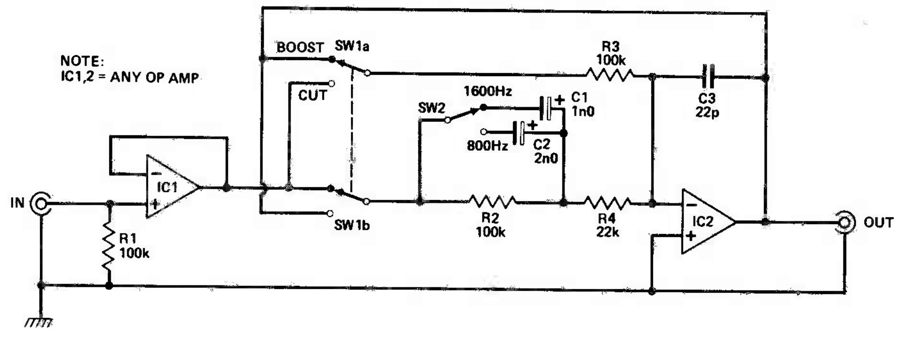
The last thing to do now is to insert the 4416 memory devices and IC1. The memory ICs are accessed in pairs, so if you are not using the full complement you must insert IC8/9, 7/10, 6/11 and 5/12 in pairs. This is also the order in which they appear in the memory space. Remove the X-E link and insert a TBP24S10 suitably programmed into the IC4 socket and link X to A, B, C or D as appropriate. Alternatively, plug a 16-pin header into IC4 socket with, for example, a 74LS151 connected up to select the memory in 8K blocks. However you do it, the $\overline{SEL}$ signal at X must be low to read or write to or from the board.

A feature of this design is that the $\overline{SEL}$ signal needs to be low only a short time before the $\overline{CAS}$ signal is generated in order to activate the memory control but must be held until the end of the φ_2 cycle for a read operation or the end of the $\overline{RAS}$ signal for a write cycle in order for valid data to be read or written by a 6502 processor. This should not be a problem for any normal address decoder logic. **ETI**

BUYLINES

Everything you need is readily available. Technomatic, Watford, Cricklewood and others suppy all of the semiconductors (but note that the TBP24S10 is usually listed simply as a 24S10) and the PCB is available from our PCB Service.

TECH TIPS



Tape Noise Reducer

W. Wirth
Sri Lanka

Amateur-made multi-track recordings often suffer from tape noise caused by the accumulated noise floors of individual tracks and multiple generations of tape to tape transfers. Encode/decode units like Dolby and dbx are effective but are costly and critical in alignment and use. Playback only noise reducers are also sensitive to alignment errors and have side effects such as "breathing".

This simple circuit uses the principle of pre- and de-emphasis to obtain its noise reduction. The treble frequencies are boosted during recording and given a complementary cut on playback so that the signal remains flat but high frequency noise is reduced by 8—10 dB.

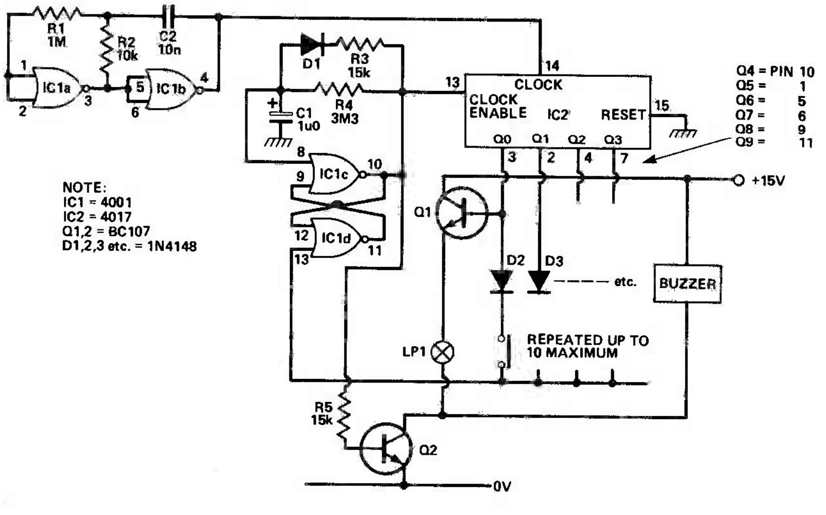
IC1 is a high impedance buffer which prevents loading of the input and interaction with the reactive components R2, 3, 4 and C1, 2 which are configured around IC2. Switch SW1a, b selects either the boost or cut mode. SW2 chooses a turnover frequency of 800 or 1600 Hz.

Fixed frequency/amplitude units such as this work best on signals with restricted high frequency content like bass, acoustic guitar and vocal tracks. The greatest noise reduction (10 dB @ 10 kHz) can be obtained with these signals using a turnover of 800 Hz. Drum, synth, and similar high frequency content signals can be processed but it would be best to use the 1600 Hz turnover and set the recording level conservatively.

C3 reduces gain at very high frequencies to help avoid saturation. Its presence in both boost and cut modes causes a tracking error resulting in a 3 dB loss at 20 kHz. This was felt to be insignificant. Although any op-amp can be used, best results are obtained from low noise devices; an RC4136 is a good choice for a two channel unit.

Quiz Machine

G. J. Phillips
Durham



The circuit shown has been designed for use in a quiz where each contestant has a button and the first person to press causes his light to illuminate, thereby cueing the question master. The circuit can be used for any number of buttons from two to ten. The design features automatic reset after a preset time delay so that no intervention is required by the question master.

IC1 (pins 1 to 6) is connected as an astable multivibrator which feeds the clock input of a decade counter IC2. As the counter cycles, each of its outputs Q0, Q1, etc goes to logic 1 in turn.

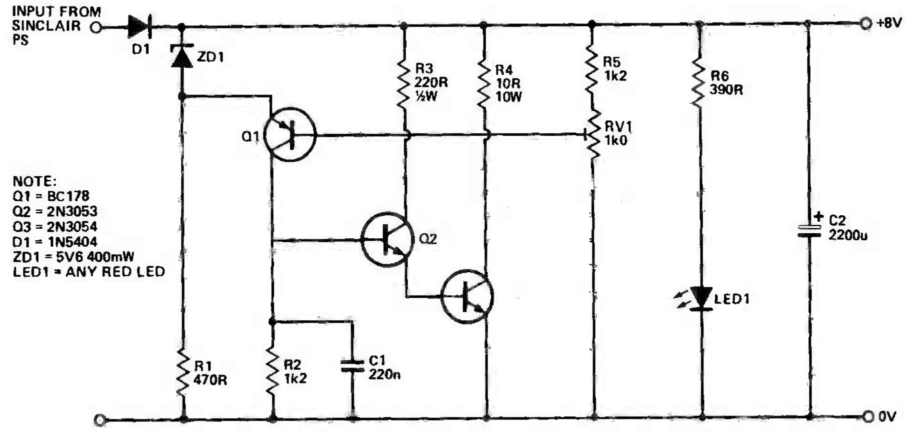
When a contestant presses his button, the bistable formed by IC1 (pins 8—13) is reset thereby inhibiting the clock of IC2 and effectively freezing the counter at the Q output associated with the button pressed. For example if button PB1 is pressed, the counter freezes at Q0 causing Q2 to turn on. Q1 is turned on also irrespective of which button is pressed. Lamp LP1 is therefore lit indicating that PB1 has been pressed. LP1 remains lit for a time period set by C1, R4 (approx. 3 seconds) after which the bistable is set via pin 8. Lamp LP1 is then extinguished and the circuit is ready for another round.

The cyclic nature of IC2 ensures that two or more lamps can never be lit simultaneously. It may be argued that the circuit is unfair in that if the counter has just cycled past Q0 and PB1 is pressed before say PB3, then PB3 will win even though it was pressed later. In practice, however, the counter is cycling very fast and the "who pressed 1st" judgement is made in a fraction of a millisecond, many times faster than human judgement can be made.

A buzzer is connected between the collector of Q1 and the +15V rail to give audible indication that a button has been pressed.

Shunt Regulated Spectrum Power Supply

A. S. Hughes
Holywell



The Sinclair Spectrum power supply unit has an unregulated output which is capable of operating both the computer and the Sinclair printer. Consequently, when it is used to power the computer alone, the supply voltage can rise to well above 9 volts. A friend of mine has 12 volts supplied to his 16K model.

Since the computer takes about 0.8 A, the internal 5 V regulator has to dissipate $(12 - 5) \times 0.8 = 5.6$ watts. This, together with high ambient temperatures causes the computer to become very warm. This shunt regulator circuit, when interposed between supply and computer, will reduce the Spectrum working temperature.

As we all know, the 5 volt regulator is perfectly happy with an input voltage of 8 volts. I have also learnt that the printer does not object to 8 volts either. It therefore makes sense to supply the spectrum with 8 volts to achieve the lowest possible operating temperature.

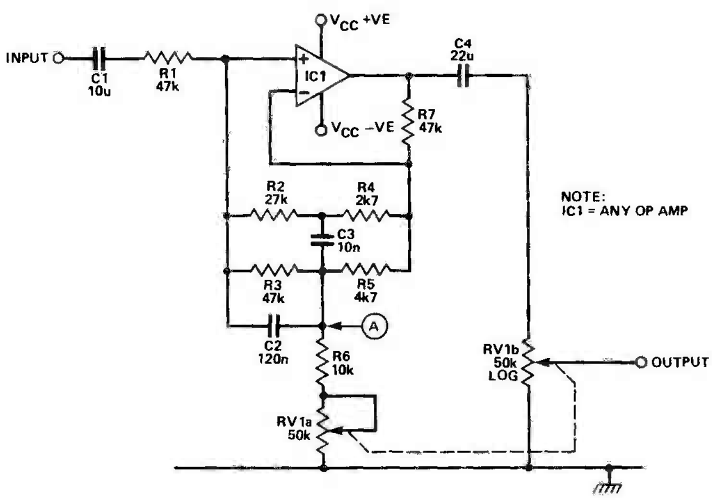
The advantage of shunt regulation, as opposed to the more usual series regulation, is that there is no significant voltage drop across the supply circuit in series with the computer. Therefore, on full load, when there is no voltage to spare, this circuit can cope.

Q1 emitter is clamped at 5.6 volts below the positive supply rail. The base of Q1 goes to the potential divider formed by R5 and RV1. If the supply voltage should rise, the bias to Q1 increases, causing Q2 collector current to rise, which in turn increases Q3 collector current. The large current taken by Q3 tends to keep the supply voltage down. If the load current should increase, Q3 reduces its collector current to compensate.

D1 drops 0.8 volts thereby ensuring that the Sinclair supply unit is not overloaded. R4 reduces the dissipation in Q3 to less than 3 watts. If the unit is left switched on with no load connected the power dissipated in R4 will be about 8 watts.

I took the opportunity to include a few luxuries in this circuit, such as the power on indicator (LED1) and extra smoothing capacitor C2.

To set up the circuit, connect the output to an 8 ohm 10 watt power resistor (4 R7 and 3 R3 in series) and adjust RV1 for an output of 8.2 volts.



Loudness Control

R. Leach
Reading

Most audio amplifiers equipped with a loudness control employ a tapped volume control to allow bass and treble boost at low volume settings. This is intented to account for the non-linearity of the ear at these levels.

The circuit shown allows the same effect to be obtained using only an ordinary 50K dual-gang potentiometer. A four-gang potentiometer would be required for stereo operation (Cirkit supply one) or alternatively two dual-gang ones could be used, one for each channel.

The IC could be a 741 or any similar device but for best results a high quality op-amp such as the TL071 is preferable. The gain of the circuit is effectively unity at 1 kHz but approximately 10 dB bass boost is provided at 100 Hz and high frequency attenuation in the feedback loop gives approximately 5 dB gain at 10 kHz. As the setting of volume control RV1 b is increased, so also is that of RV1 a which reduces the effects of the frequency selective networks around the op-amp. At maximum volume the amplifier frequency response is flat over the audio spectrum.

The unit could be arranged so that it might be switched in and out, either by re-routing the signal path or by inserting a switch at point A. This would isolate the frequency selective networks from ground and leave the IC functioning as a unity-gain amplifier with a flat frequency response.

Memory Map Simplification

P.M. Buckley
Leeds

Although very simple, this idea speeds up I/O processing and shortens machine code programs considerably.

In microsystems using the 6821, selection of the internal registers in the PIA is usually achieved by attaching A0 & A1 of the address bus to RS0 & RS1 on the 6821. This gives the memory map shown in Table 1.

A1	A0	REGISTER SELECTED
0	0	DDRA AND I/O REGISTER A
0	1	CONTROL REGISTER A
1	0	DDRB AND I/O REGISTER B
1	1	CONTROL REGISTER B

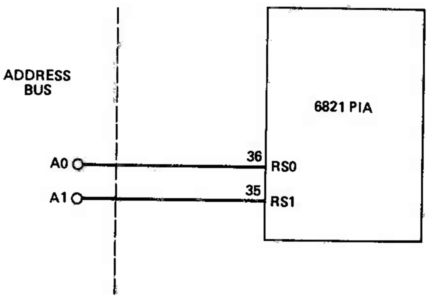
Table 1

This is awkward as the I/O registers are two bytes apart, which means 16 bit registers such as the index register in the 6800 cannot be used to read and write to the I/O ports. Instead two eight bit operations have to be used.

By simply swapping over the connections to RS0 and RS1 the memory map changes to that shown in Table 2.

A1	A0	REGISTER SELECTED
0	0	DDRA AND I/O REGISTER A
0	1	DDRB AND I/O REGISTER B
1	0	CONTROL REGISTER A
1	1	CONTROL REGISTER B

Table 2



Square/Triangle Generator with Variable Mark/ Space Ratio

P. J. Thompson
Lancashire

The problem with most methods of obtaining a variable mark/space ratio from normal astable circuits is the tendency of the ratio to alter with frequency and vice-versa. With this circuit both adjustments can be made independently of the other. It also produces constant amplitude outputs.

IC1 a, IC1 b and associated components form a fast (non-saturating) Schmitt trigger. Trigger voltage is set by the current, to virtual earth, through R2 multiplied by the input resistance RV2a and R8.

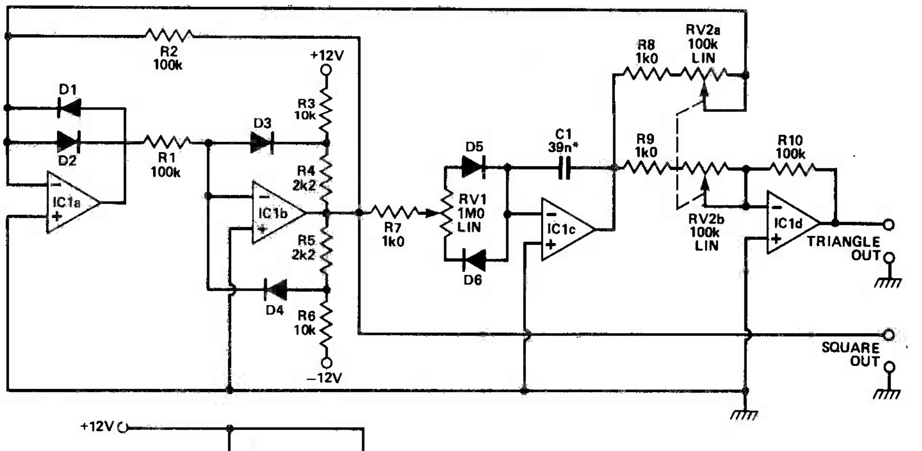
The potentiometer RV1, IC1 c, C1 and associated components control the mark-space ration. The rate at which C1 charges is controlled by the resistance between the output of the Schmitt (IC1 b) and the virtual earth of IC1 c. Hence over one cycle the average value of resistance equals (RV1/2) + R7 eliminating the effect of this control on the frequency.

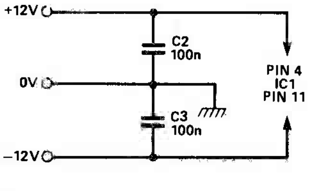
When the output of IC1 c rises to the positive trigger voltage IC1 b's output switches to a positive value determined by R3 and R4, thus the output of IC1 c starts to fall as it discharges C1. Upon reaching the negative trigger voltage IC1 b switches to its negative value (R5 and R6) so IC1 c's output starts to rise, and the cycle is repeated.

The frequency is controlled by RV2 a, which determines the trigger voltages and hence the time taken to charge (discharge) C1. (Large RV1 a = Large trigger voltages = Long times = Low frequency).

The triangle (ramp) waveform is derived from the output of IC1 c. However, as the amplitude at this point is determined by the trigger voltages, use is made of a dual-ganged potentiometer. The first side (RV2 a) controls the frequency, and the second (RV2 b) corrects the triangle amplitude; the peak input current to the Schmitt trigger equals the current through R2, (a constant) and as RV2 a should equal RV2 b the peak current into IC1 d's virtual earth is constant, and therefore so is the output amplitude. As R2 = R10 the square and triangle amplitudes are the same.

It is recommended that FET input op-amps are used because of their superior slew-rate; a poor slew-rate would degrade the high frequency performance and cause the mark-space to alter the frequency.





NOTE:
IC1 = TL074
D1-6 = 1N4148
*C1 = 390n for 2Hz-200Hz
= 39n for 20Hz-2kHz
= 3n9 for 200Hz-20kHz

Square wave amplitude (V = Supply voltage). $= \pm\left(R4\left[\frac{V+0.7}{R3}\right]+0.7\right)$ Volts

Frequency $= \frac{(V_{IC1b}-0.7)\ R7}{2.V_{IC1b}\ (RV2a+R8)\ C1\left(\frac{RV1}{2}+R7\right)}$ Hz

$=$ approx. $\frac{0.08}{(RV2a+R8)\ C1}$ Hz

Simple ZX80/81 Tape Mod.

S. Beet
West Kirby

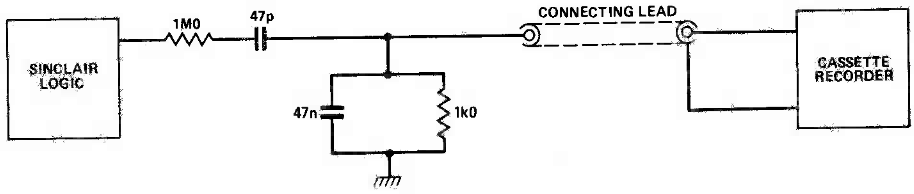
The recently published ZX80/81 tape mods are both simple and cheap, but I have used an even simpler, and completely free, modification for several months without any problems.

Most of the problems associated with saving programs on cassette, are due to mains-induced hum in the connecting leads. The ETI mods overcome this by increasing the signal level so that the mains hum becomes less significant. However, by transferring the 1 kΩ resistor from across the output of the ZX80/81 to the input of the tape recorder, the hum is still attenuated by a similar amount but, since the mains hum is much smaller than the 5V logic level, the input signal-to-hum ratio becomes very large and reliable data transfer is much more likely.

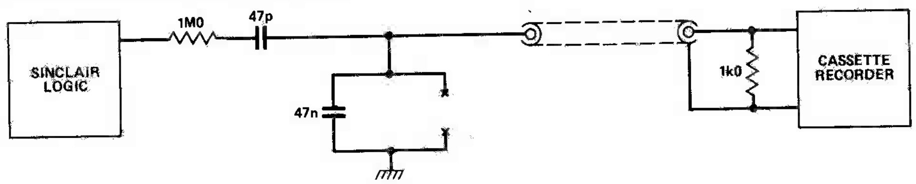
Ideally the 47 n capacitor should also be removed, but its impedance at 50Hz is negligible so this is not usually necessary.

The resistor can either be placed inside the cassette recorder or in the plug at the cassette end of the lead.

ORIGINAL SINCLAIR CONFIGURATION



REVISED ARRANGEMENT TO AVOID HUM PICKUP

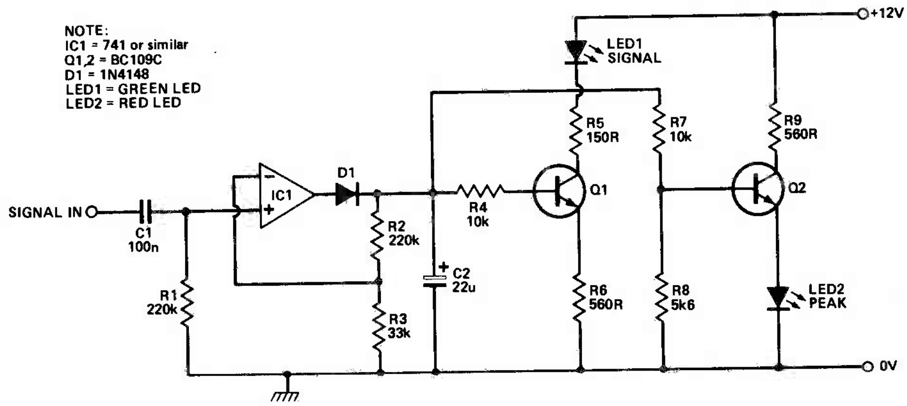


Signal/Peak Indicator

R.M. Bland
Rugby

This circuit was designed as a cheaper version of the normal LED bargraph type VU meters and uses only two LEDs. The green one is a "signal present" indicator which starts to glow with an input signal of about −30dBm and glows progressively brighter with increasing input signal. At around 0dBm the red "peak" indicator switches on.

The input is AC coupled into 220k ohms to avoid loading the signal source. The op-amp is any standard 741 type (non-latching), and functions as a half-wave rectifier with a gain of about 7. The signal is then smoothed by C2. Q1 functions as a voltage controlled current sink and controls the brightness of LED1. Q2 operates in the switching mode and switches on LED2 when its base reaches about 2V.



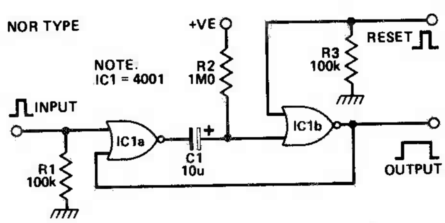
CMOS Monostables

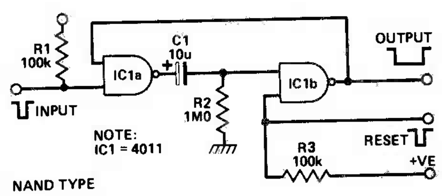
P. Harding
Exeter

The circuits presented here are a further variation on the basic CMOS monostable design; the NOR type is reset by a positive pulse and, the NAND type by a negative pulse. Hence the reset pulse polarity matches that of the trigger pulse.

Circuit operation is simple. Taking the reset input of the NOR version high forces IC1 b's output low, removing the feedback to IC1 a. The original trigger signal must have been removed before the monostable can be reset. Operation of the NAND version is similar to that of the NOR type, but with reversed logic polarity.

With the values shown, the circuit has a period of about 6s, although component tolerances (in C1) will have a large effect on the actual period. Care must be taken when using high values of R2 with an electrolytic for C1; leakage currents may prevent the capacitor charging to the CMOS high threshold so that the monostable never times out.



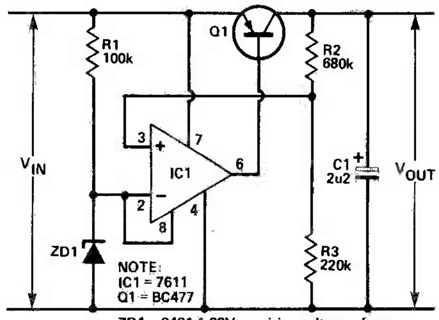


Micropower 5 Volt Regulator

B. Hunter
Dundee

The voltage regulator shown here was designed to supply a CMOS microprocessor data logger which had to run for several days from Ni-Cad cells without recharging. An ordinary low power voltage regulator such as a 78L05 consumes several milliamps and in a circuit with a very low quiescent current would contribute quite significantly to the battery drain. The regulator shown here requires a little over 100μA, giving a considerable saving in battery current. The common or garden low power regulator also requires an input voltage about 2 volts above the output voltage; the design given here will work with an input only 0.5 volts higher than the output voltage so fewer cells can be used to power the circuit.

The 9491 is a bandgap voltage



ZD1 = 9491 1.22V precision voltage reference

reference which gives a very stable 1.22V and can operate from a current as low as 50μA. This reference voltage is fed to the inverting input of a CMOS op-amp where it is compared with a fraction of the output voltage. The output of the op-amp drives the base of the BC477 and this transistor increases the output current of the amplifier.

If the output voltage starts to decrease due to increased load, then the fraction of V_{out} on the non-inverting input of the op-amp decreases. This causes the output voltage of the op-amp to fall and thus turn the PNP transistor on more to compensate for the increased load.

Pin 8 of the op-amp sets the quiescent current of the device to one of three values. If it is connected to v+ then the quiescent current is 10μA, if connected to v− the quiescent current is 1 mA, and if connected to a voltage between v− +0.8V and v+ −0.8V, then the quiescent current is 100μA. Thus connecting pin 8 to the reference voltage gives a quiescent current of 100μA. The capacitor across the output prevents any oscillation of the circuit.

Using the component values given, the circuit performs as follows.

For Vout = 5.06 volts:–

Vin minimum = 5.27 volts with 10mA load

Vin minimum = 5.57 volts with 40mA load

No load current = 112μA

Desoldering Tool Improvement

S.S. Norman
Sunbury-on-Thames

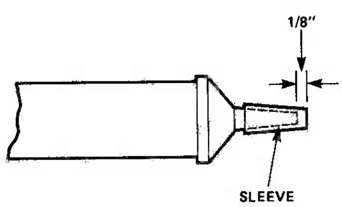
The following idea is a method of making de-soldering tool nozzles last forever.

If a neoprene sleeve (RS Components Part No. 399-729) is fitted over the nozzle as shown, with the sleeve protruding about an eighth of an inch over the end, it can be seen that the nozzle will never get hot enough to melt and eventually wear out. The sleeve also improves the efficiency of the tool by forming a seal over the iron and joint to be de-soldered, which results in more solder being removed in one operation.

When the end of the sleeve gets worn it can either be turned around or cut back, so a single sleeve can be used at least two or three times.

The price for one sleeve is about one hundredth of the cost of a new PTFE nozzle, thus the use of the sleeves can produce quite a saving where these tools are used frequently and in large numbers.

If it proves difficult getting the sleeve on, a tiny amount of sleeving lubricant (RS Part No. 544-077) can be used to ease it on.

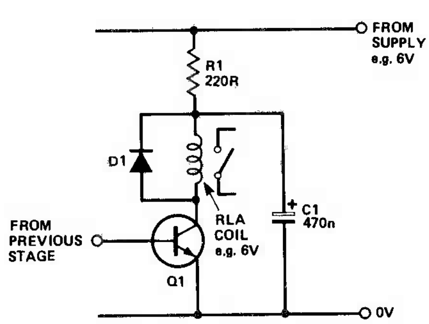


Note: RS Components will only supply trade and professional customers. If you are unable to use them because of this and can find no other source of neoprene sleeving, Crewe-Allan & Company of 51, Scrutton Street, London EC2 will order the RS parts you need for a small extra handling charge.

Reducing Relay Power Consumption

S.T. Jones
Solihull

Most relays need much more current to 'pull-in' than to stay closed. For example, a six-volt relay may need 80mA to pull-in but only 20mA to stay closed, so the extra



60mA is wasted current. In the circuit shown, current consumption is reduced by limiting the current drawn to 20mA with a suitable resistor. Normally this would prevent the relay closing at switch-on, but capacitor C1 charges to the supply voltage when the relay is off and discharges to provide a high current at switch-on. When the switching transistor turns on, this current pulse is sufficient to close the relay. D1 provides the usual back-EMF protection and can be almost any general-purpose type. C1 is electrolytic and should be of 200u or more.

ADSR For Electronic Organ

C.A. Van Latum
Rotterdam

While constructing an organ based on the SGS-Ates M108 organ chip, I found the normally used ADSR circuits far too expensive to construct.

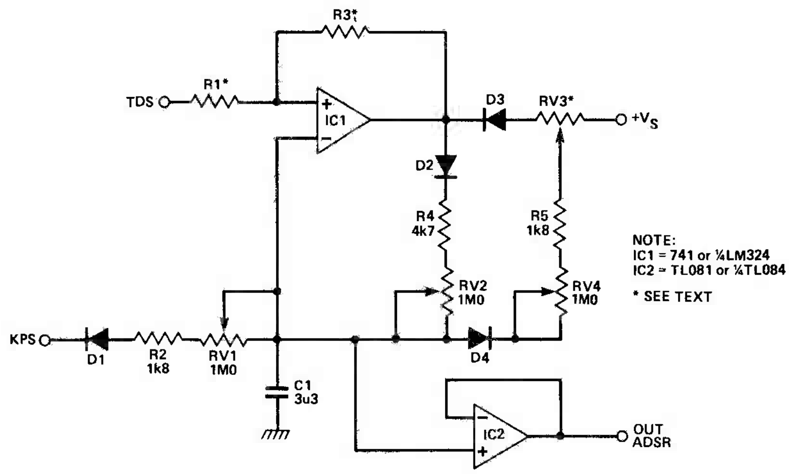
The ADSR-unit described below incorporates all the normal ADSR functions and is very cheap and simple. The whole circuit is based on one op-amp wired as a comparator.

The trigger outputs of the M108 are first inverted and buffered (not included in the circuit diagram as one inverter-buffer circuit can be used to trigger all ADSR-blocks). As a key is pressed TDS will become high for about 9 ms. The output of the comparator IC1 will turn high and capacitor C1 will be charged at a rate determined by R4/RV2 (attack). When C1 has reached a voltage

$V = V$ supply. R1/(R1 + R3)

the comparator output will turn low. C1 will then be discharged via R5/RV4 (decay) to a level determined by RV3 (sustain level).

All this assumes that the key is still pressed, so KPS is high. As the key is released KPS will turn low and C1 will discharge via R2/RV1 (release). As C1 must not be given the chance to discharge via the output op-amp a high input resistance device must be used, for example a TL081. Note that IC1 must not be an open-drain output op-amp.



As quad op-amp ICs can be used, four independent ADSR units can be constructed with just two ICs. The connections to the control panel can be made very easily as only four wires are required per unit!

The necessary equations to calculate the component values are:

$V_{max\,out} = V_{supply}.R1/(R1+R3)$

$= x.V_{supply}$

Attack time $t_a = R.C.Ln(x)$

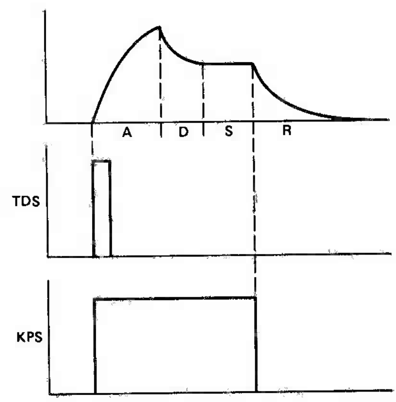
Sustain level $V_s = P.V_{supply}/20$

where P = fraction of RV3 (0—10)

Decay time $t_d = 2{,}3.R.C.$ where R is $R5+RV4+R_p$ (volt. divider res.)

Release time $t_r = 2{,}3.R.C$

Voltage divider resistance $R_p = 100.P.(20-P)/20$



The timing component values chosen give the following periods:–

$t_a = 0{,}01$ to 2 Sec.
$t_d = 0{,}01$ to 5 Sec.
$t_r = 0{,}01$ to 7 Sec.

Note that the decay time varies with the sustain level but this was found to be quite acceptable.

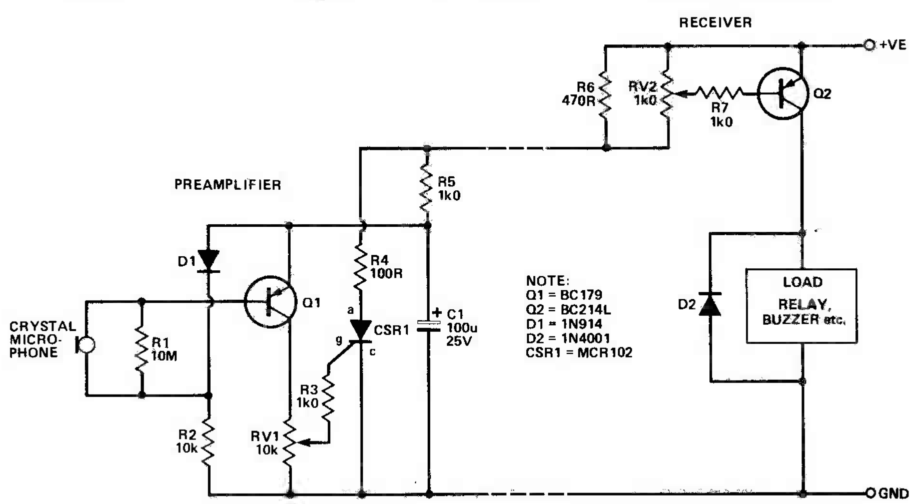
Remote Noise Alarm

S. Huckstepp
Colchester

This alarm allows a microphone to be placed at a great distance from the alarm and power supply circuitry yet includes a preamp at the microphone end to reduce noise pickup along the line and uses only two wires.

Q1 amplifies the voltage induced in the microphone while D1 provides a reference voltage 0.6V less than the supply to overcome the transistor's base-emitter voltage drop. When the level of the amplified signal tapped off by RV1 exceeds the thyristor gate threshold, CSR1 conducts and increases the current consumed by this part of the circuit. C1 and R1 provide a delay to prevent CSR1 triggering at switch-on.

The voltage at the bottom end of R6/RV2 is usually less than 0.6V below the supply voltage, but when CSR1 conducts this is pulled down and Q2 conducts. RV2 is adjusted to ensure that Q2 saturates.

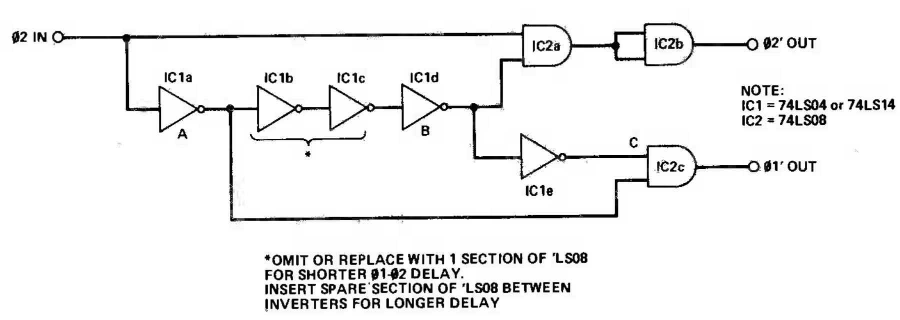


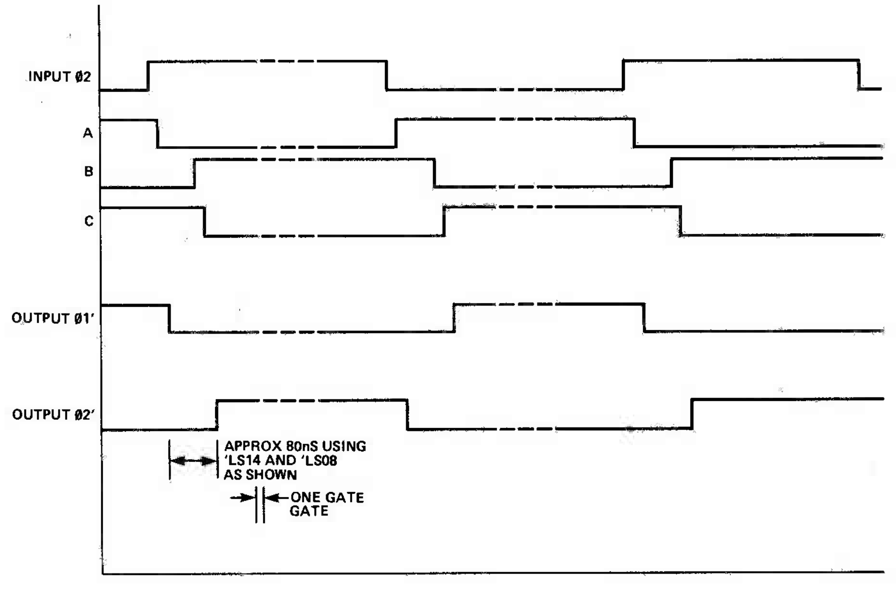
TTL Clock Delay

Phil Walker

Some circuits require non-overlapping clocks for their operation, notably the 6500 series microprocessors and certain audio delay lines. It is not always easy to obtain this type of waveform without special chips so this circuit was devised using TTL gates as delay devices. The original circuit was intended to reconstruct the φ_1 and φ_2 from a 6502 based micro when only the φ_2 signal was available at the connector interface.

As shown the circuit will give a period of about 50 to 80 ns from the time one output goes to 0V until the other goes to the high level. Omitting IC1 b and c will shorten the time while inserting the spare section of IC2 between IC1b and c will lengthen it. The operation of the circuit is not dependent on the input clock frequency but the rise and fall times should be better than 10ns if possible. If this is a problem, use the spare section of IC1 to sharpen the input signal (74LS14 preferred) and swap the designations of the outputs. This will add a gate delay to the reconstructed signals.





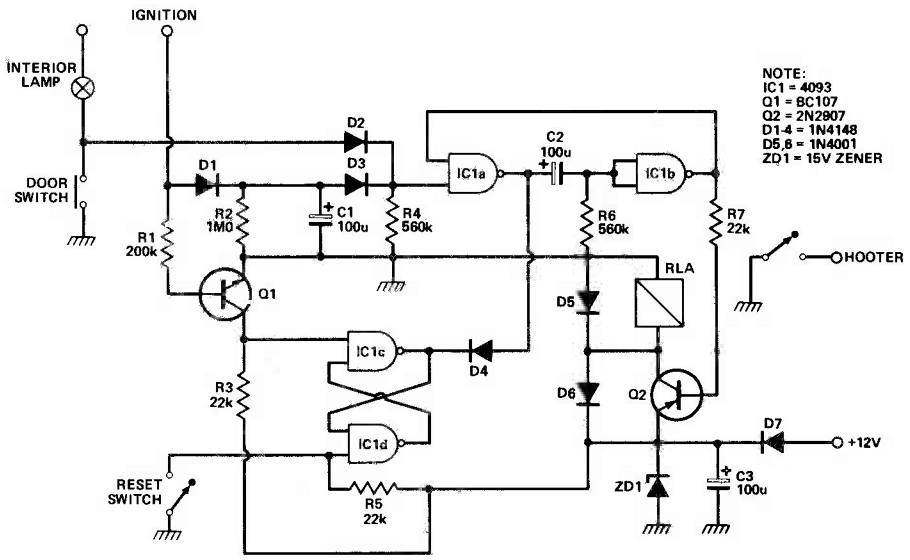
Automatic Car Alarm

G. Landry
Natal, S.A.

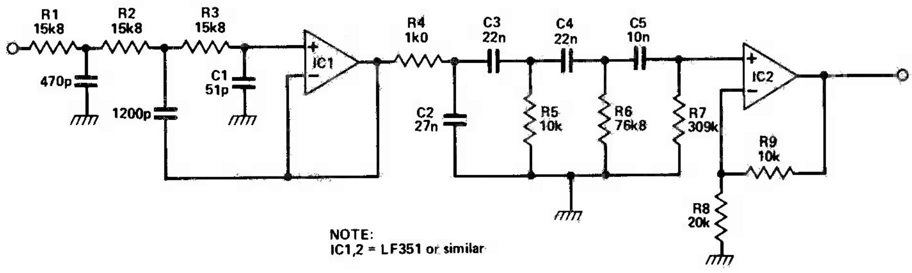
The problem with most car-burglar alarms is that one tends to forget to activate them. This little circuit does so automatically.

Upon switching the ignition off, Q1 turns off and C1 starts discharging through R2. This maintains the output level of the OR gate (D2, D3, R4) high. During this discharge period (set at two minutes by the values of R2 and C1) the driver can leave his car without setting the alarm off. However, after this period, the voltage across C2 is lower than the Schmitt NAND gate IC1a threshold. If an intruder opens a door, the OR gate goes low and the monostable around IC1a, IC1b is turned on. This in turn switches on Q2 which operates the relay for a period depending on C2 and R6 (set for 1 minute).

The only way to disable the alarm is to operate the external switch (a magnetic switch was used in the prototype). This causes the NAND latch around IC1c and IC1d to set, putting an earth on D4 which will reset the monostable. The car can now be entered without fear of setting the alarm off as the NAND latch will only reset when the ignition is turned on again. The circuit is protected against transients by D7, C3 and ZD1 and consumes about 20μA when on standby.



'A' Weighting Filter



B. Porter
Kings Lynn

The 'A' weighting is used to compensate for the unevenness in the average human hearing. Human beings are, for the most part, much more sensitive to middle range frequencies than to either extremely low or extremely high frequencies.

This circuit will match the official 'A'-weighting curve very closely indeed and can be used in conjunction with an audio millivoltmeter to give an indication of the apparent loudness of a signal.

The resistor values given are for 1% types but if accuracy is not too important you can use 5% types and select the nearest available value. If you do use 1% types you may find it necessary to do a little substitution. A 15k and an 820R in series will prove an acceptable substitute for the 15k8, an 82k and a 1M2 in parallel can be used instead of the 76k8, and a 330k and a 4M7 in parallel can be substituted for the 309k. A 47p capacitor and a 4p7 in parallel will prove a sufficiently close approximation to the 51p specified.

Ultra Low Cost Light-Pen

G. Parker
London

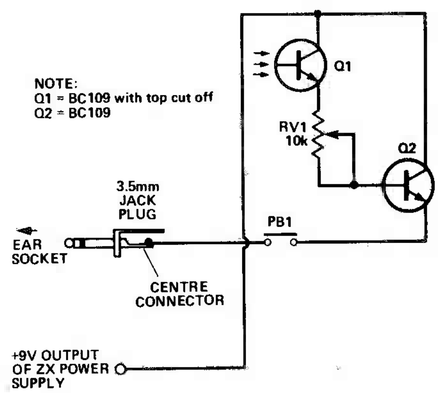
This light-pen is intended for use with a ZX Spectrum and is the cheapest, simplest design you're ever likely to find: it does not even need an edge connector.

The unit (which can easily be housed inside an opaque biro case) is connected to the EAR socket and the +9V line. The latter can be obtained by either soldering a wire to the 9V socket inside the computer or adding an extra socket and plug to the power supply line.

The advantage of using the EAR socket is, aside from cutting out the expense of an edge-connector, that no address decoding or data isolating is needed. You can put pulses on the Ear socket and unless the computer is performing that particular IN command it will ignore them with no damage to the circuitry.

To see what state the pen is in, an IN84 command should be used.

Photo-transistor Q1 is a BC109, the top of which has been cut off with a pair of stout scissors. It has a high dark impedance and in the dark transistor switch Q2 will be off and when PB1 is pushed no current will flow. In the light, the transistor Q2 will switch on, allowing a positive voltage to flow through PB1. The amount of light required for switch-on can be adjusted by RV1 to suit different colours on the screen.



Casio fx-180P Resistor Decoder

R. Hutchison
West Kilbride

This program is designed to convert resistor colour codes to their correct numerical value. It works with both four and five band resistors, and, although designed for use with the fx-180P, should be easily adaptable to suit most other programmable calculators.

The program listing is as shown in Table 1. In order to make the best use of this system, part of the keyboard has to be colour coded. The easiest way to do this is to make a colour template to fit around the 0 − 9, √, and +/− keys. This is really quite straightforward if drawn out on 1mm squared paper. Once you have got the template to fit correctly, it is a good idea to sandwich it between two layers of clear Fablon. The colour coding for the template is given in table 2. A 2mm wide coloured band around each key is very effective.

Use of the system is as follows. Firstly load the program into the machine, then fit the template. Enter the colours of the first two (or three) bands; press RUN: enter the colours of the third (or fourth) band; press RUN. The calculator will now display the value of the resistor in engineering notation, i.e. 10^3 (kΩ); 10^6 (MΩ); etc.

Examples:

green-blue-red-yellow: display shows 5.62^{06}, i.e. 5.62 MΩ.

yellow-violet-gold: display shows 4.7^{00}, i.e. 4.7Ω.

Note that it is necessary to press both gold or silver coloured keys when a gold or silver band is encountered.

```
ENG
ENT 47
x
1
EXP
ENT 3
=
INV RTN.
```

Table 1. Program Listing

Key	Colour
0	Black
1	Brown/Gold
2	Red/Silver
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Grey
9	White
+/−	Gold/Silver

Note that the √ key is included in the template even though it is not used in this program.

Table 2. Template Colouring

ETI

MIND YOUR HEAD!

How many heads do you have? Are they laminated or solid? And how wide are the slits in them? Vivian Capel reveals all that you need to know about your tape heads (what else?)

While it is easy to understand the mechanical aspects of tape recording, and the electronic ones are quite straightforward, the operation of the heads and the various factors affecting them are generally less readily understood. In this article, we do not intend to go deeply into magnetic theory, but rather to explore some of the practical whys and wherefores, so that the recorder user will have at least a nodding acquaintance with the head and what it does.

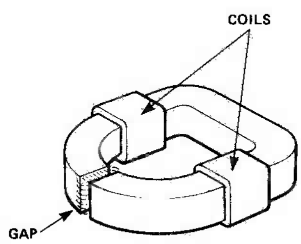


Fig. 1 Magnetic recording head showing core, gap and coils.

Construction

The construction of a tape head is really quite simple, see Fig. 1. In essence it consists of a squared-off ring of magnetic material on which is wound one or two coils. One end of the ring is rounded and in the centre of this is a fine vertical slit or gap which is filled with a shim of non-magnetic material.

In the case of a stereo head there are two ring-cores and sets of coils, one stacked above the other, separated by a magnetic shield to reduce cross-talk between them.

When a current is passed through the coils a magnetic field is set up through the core and across the gap; the two sides of the gap form the poles of an electromagnet, one north and the other south, depending on the direction of the current through the coils.

Most of the magnetic field passes through the gap via the shortest path, that is from one gap face to the other, but not all. There is also an external field which forms a roughly hemi-cylindrical pattern around the outside of the gap. It is through this external field that the tape passes.

As the tape travels across the gap it is magnetized in sympathy with the signal currents through the coils, and thus a series of magnetic zones are created along the tape track. The height of these (which is the width of the track) is the same as the height of the gap and so is fixed, but the width along the tape depends on the frequency recorded: high frequencies produce narrow zones while low frequencies give rise to wide ones.

During playback, the magnetized zones passing back over the gap induce varying fluxes in the core which in turn generate corresponding EMFs in the coil windings; the recording process is the reverse, approximately.

Two Heads?

Obviously, the same head that made the recording can serve to play it back, and in the majority of recorders this is the practice. It would in fact seem that this was an ideal arrangement, as there thus can be no alignment or azimuth differences with the same head gap doing both jobs. Yet we find that in the more expensive machines two heads are provided (in addition to the erase head) one for record and the other for playback. Where space is limited as it is in the audio cassette recorder, the two heads may be mounted side-by-side in the same casing. If one head seems to do the job well enough in most machines, why go to the trouble of having two? Suspicious-minded individuals may wonder if this is just a ploy to hike the price and sell the goods, rather like those early "10-transistor" radios that had three of them soldered to the printboard doing nothing.

In this case, there are several advantages in having separate record and playback heads. Firstly it makes AB monitoring possible, whereby you can switch from the source to the playback head whilst actually recording, and compare; any deficiencies in the recording can be immediately detected. However, some machines have separate heads but do not give the AB monitoring facility, so there must be other reasons.

To appreciate the playback head, we need to take a closer look at it, and in particular, its gap. We have already mentioned that high recorded frequencies are represented by narrow magnetic zones. To read them accurately, we need a narrow gap that is less than half-a-wavelength of the highest recorded frequency wide.

To see why this is so, imagine a complete cycle of a high frequency recorded on the tape; it has two sections, the positive half cycle and the negative, which are represented by corresponding north and south pole regions along the tape. If the playback gap is a whole wavelength wide, as in Fig. 2a, both sections appear across the gap at the same time and the flux cancels, giving no output. The gap width then, is one of the main limiting factors to the highest frenquencies that can be replayed.

When the gap width equals half a wavelength, output is at maximum, Fig. 2b. We can then calculate the theoretical upper limit for a particular gap width, or alternatively specify a maximum width to obtain a given

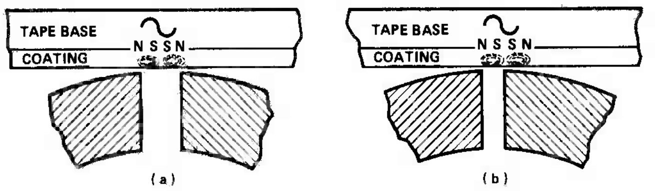


Fig. 2 When the playback gap is equal to a whole recorded wavelength, the fields of opposite half-cycles cancel and produce zero output (a). When the gap is equal to half a wavelength (b), output is at maximum.

upper limit. The standard compact cassette tape speed is 1⅞ inches per second, or 47,500 microns per second. Dividing that by any particular frequency will give its recorded wavelength in microns. So for 20 kHz, the wavelength on tape is 2.4 microns. Half of this is 1.2 microns which is therefore the maximum width for a gap which would be required to record up to 20 kHz.

Actually there are various losses which take place that affect the high frequencies more than the low. These cause a fall-off from around 4 kHz, but electronic equalization can boost the signal above that point so that a resonably level response is achieved toward the theoretical maximum. Boosting beyond the limit set by the gap width is useless because cancellation occurs and boosting nothing produces nothing — except noise.

A Wide Gap

One might, therefore, assume that a narrow gap in the region of 1.2 microns is necessary to obtain a good HF response from the record head too. Some surprise may be caused by the discovery that dedicated record-head gaps are much wider, up to 10 microns in many cases. According to our above calculations, for a 10 micron gap the half-wavelength frequency is a mere 2.4 kHz. How does it manage to record wavelengths many times shorter than its width, and why is the gap made so wide?

Fig. 3a shows the goings on at the head, but an analogy might help us to see how it is done. Supposing a long strip of material is required to be painted in alternate inch-wide black-and-white stripes. It is moved past a machine which has two spray guns filled respectively with quick-dry black and white paint, at a speed of one inch in two seconds. The machine fires the spray guns through a mask with an inch-wide slot alternatively every two seconds. Thus one stripe is just beyond the mask as the next one is sprayed.

Could half-inch stripes be obtained? Yes, by simply operating the guns every second. The first stripe is an inch wide, but it has only travelled halfway across the mask before the next one is sprayed. So it overlaps the first, and in the same way the third overlaps the second. The result is a series of half-inch stripes. Even narrower ones could be obtained by firing the guns more frequently, yet with the same 1-inch mask.

In the recording head, for frequencies having a shorter wavelength than the gap, the flux partially erases what has gone before, leaving only that which has passed beyond the range of the gap; the trailing edge of the gap effectively 'writes' the recording.

Actually, the audio signal is superimposed on a steady high-frequency bias signal which carries it over the non-linear low-level portions of the magnetizing curve. The bias signal magnetizes the tape but is almost completely self-erased by succeeding half-cycles, leaving the superimposed audio. The bias frequency ideally should be has high as possible to avoid intermodulation distortion with the high audio frequencies, but this raises problems in the head as we shall see later.

Why A Larger Gap?

As we have seen earlier, the external field from the record head gap extends in an approximately hemi-cylindrical configuration around it. The presence of the tape, being a magnetic material, modifies this somewhat. However, the distance that the field extends from the gap is proportional to the width of the gap, being roughly half that of the gap width.

With a narrow gap, there is only a small external field, hence a shallow penetration of the magnetic coating on the tape, Fig. 3b. On the other hand, a wide gap, Fig. 3c, produces a more extensive field and deeper penetration. Deeper penetration in turn means more of the coating is utilized and gives a better signal-to-noise ratio and a higher magnetic saturation point. Hence, by employing two heads, the optimum gap can be used for each, a narrow one in the playback head to obtain maximum HF response, and a wider one for the record head to achieve deep penetration and utilization of the tape coating.

This, incidentally, explains a phenomenon which has puzzled some recorder users. Dirty heads prevent intimate contact between head-face and tape, and have a similar effect to widening the gap. Tapes replayed suffer from a loss of high frequencies, and with really dirty heads, sound badly muffled. If a recording has been inadvertently made with a dirty head and subsequently played back it might be thought to have been hopelessly ruined. Not necessarily so: after cleaning the head and re-playing it is often found to be not as bad as feared. While the signal level is lower and noise higher than normal, the HF response is reasonable, and the recording may be passable.

If then you have gone to a lot of trouble to record a computer programme and then find it turns out more SIC than BASIC because of a dirty head, try cleaning and reloading before giving up! Better still, make sure the head is clean beforeheand!

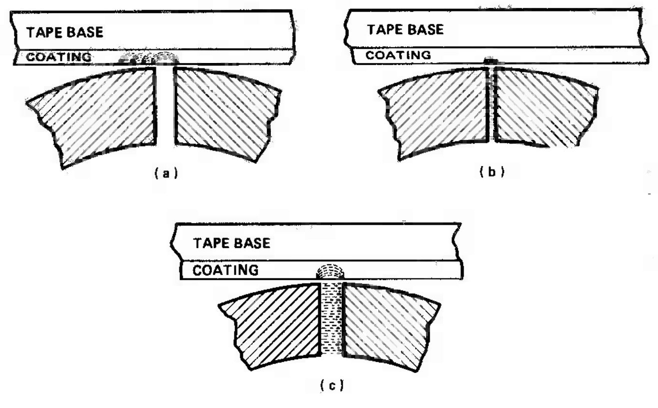


Fig. 3 A wide gap in a recording head can record short wavelength signals by overlapping and partially erasing the previous half-cycles. External gap from the field is roughly hemi-cylindrical (semi-circular when viewed from the top) and the depth of the field in the tape is roughly half the gap width (the gap is the diameter of the circle and the depth the radius) A narrower gap (b) leads to a smaller depth than a wider gap (c).

Perpendicular Or Horizontal?

When recording medium to low frequencies, the recorded wavelength is long in comparison with the field depth and the resulting internal field produced in the tape-coating is mainly longitudinal, that is, it lies along

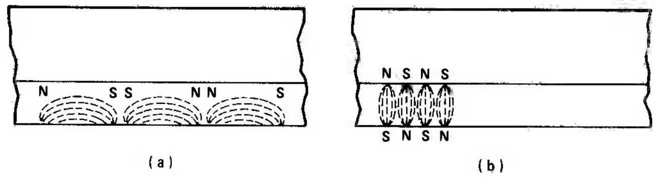


Fig. 4 Conventional recording heads produce longitudinal magnetic zones in the tape coating, with NS, SN, NS polarity, (a). Perpendicular recording in which the tape passes between the recording poles gives a greater packing density, and N, S, N, S adjacent pole polarity.

the tape in the direction of travel, Fig. 4a. Only at the ends of each zone does the flux have a vertical component and become perpendicular to the tape surface.

To achieve a strong field in the longitudinal direction, the active magnetic particles in the coating are not of random shape like gravel chips, but acicular (needle-shaped). When the coating is applied during manufacture, it is passed through a powerful magnetic field before it dries to align all or most of the needles along the length of the tape.

At present, much research is being conducted in various fields to pack as much information as possible in the smallest space. Video and digital audio systems demand high information packing densities so stimulating the search. Attention has turned to making the recording field principally perpendicular, Fig. 4b. Just as you can get more people in a high-rise block of flats than in bungalows of the same ground area, more information could be stored by perpendicular fields.

This would mean orientating the needle particles so that they would all be standing on end. Though not impossible it would pose problems for the tape makers. The recording field would be applied by passing it through rather than across the tape, which would mean the tape travelling through the gap. One way of doing this would be to construct a head having a very fine magnetic pole-piece surrounded by non-magnetic material, with a permalloy plate behind the tape to complete the magnetic circuit.

The magnetic zones thus created would alternate NSNS and resemble a collection of bar magnets arrayed side by side with opposite poles adjacent. This is much less prone to self de-magnetization than the present system whereby the zones NSSNNS are equivalent to bar magnets assembled end-to-end with similar poles adjacent.

Information packing densities closer than the wavelength of visible light are possible, which makes feasible many applications that could not be seriously considered with the present technology. Linear video recordings may be possible, thus eliminating the mechanical complexity of rotating head-drums and helical scan.

Bias

So we may see radical changes in tape-head design in the future. But now back to the present, and in particular, tape bias. We have already alluded to HF bias, but why is it necessary and what exactly is its effect?

When any magnetizable material is magnetized, the process does not proceed at first in a linear manner; in fact the plot of magnetism against magnetizing force is quite curved. After this initial non-linearity though, the plot straightens and the characteristic becomes linear. The effect is similar to the operating curves of valves and transistors but with one exception, the magnetic curve has a negative component. The material can just as well be magnetized in the opposite direction, whereas of course you cannot reverse the current through a transistor.

A typical curve is shown as part of Fig. 5a; the negative section is identical but opposite to the positive section. One point to note is that this is the curve for an (initially) unmagnetized piece of tape; if the tape were magnetized, the magnetic field would, obviously, not be zero when the magnetizing force was zero, and we'd have a completely different curve; this sort of situation is dealt with in detail by text-books on electricity and magnetism.

If we applied a signal to the recording head in the form of sine wave, the resulting magnetization (and hence the resulting signal on replay) would be grossly distorted, due to the non-linear central portion of the characteristic, Fig. 5a. The simplest solution is to appply a DC bias current to the record head in addition to the AC signal, so that the AC signal sits entirely with the relatively linear section of the curve, as shown in Fig. 5b.

This works well enough in practice, but it is wasteful of the tape's recording potential. With the negative portion unused, the maximum recordable signal is less than

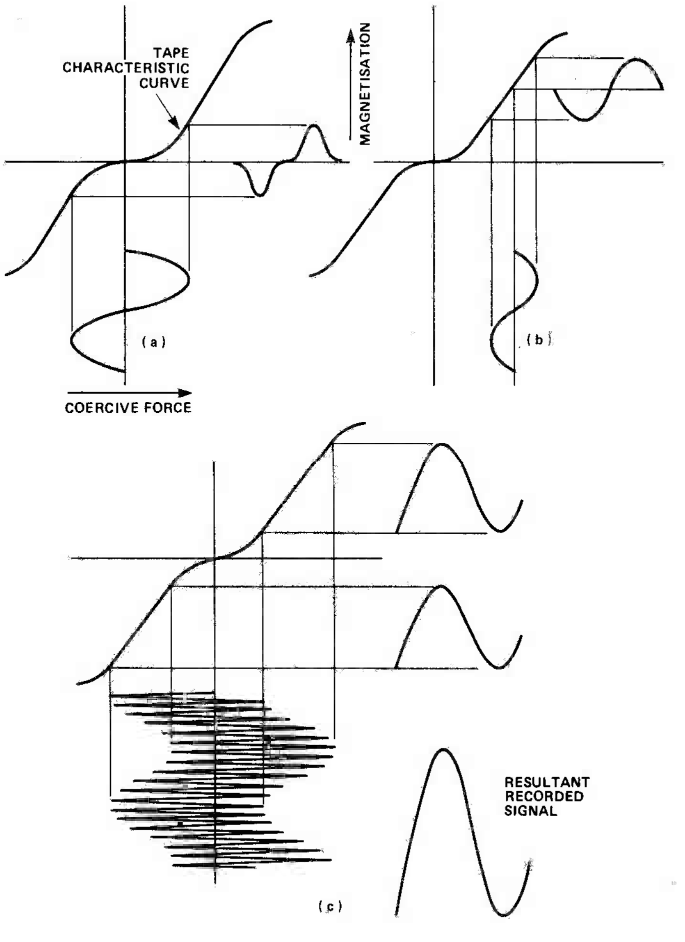


Fig. 5 Initial magnetizing characteristic of recording tape. (a) A sine wave signal recording over the curved lower portions of negative and positive characteristic, resulting in distortion and low volume. (b) DC bias lifts the operating point to the middle of upper striaght portion giving linear output, but limited amplitude. (c) AC high-frequency bias bridges the curved non-linear portions so presenting the superimposed audio to both straight sections. The result is a linear, large amplitude recorded signal.

half what it could be if both portions were used and the signal-to-noise ratio is also less than half what it would be. For this reason, DC bias is used only on cheap cassette recorders.

AC bias is used in all the better and hi-fi recorders, and it does make use of the whole magnetisation curve. The audio signal is added to a high-frequency (several times the maximum audio frequency, and typically 30-100 kHz) sine wave, to give the effect shown in Fig. 5c (note that this is *not* amplitude modulation, and Fig. 6 shows the difference!)

When this composite signal is applied to the tape, distortion occurs where the composite signal traverses the non-linear parts of the curve. But the distortion is only of the lower portions of the HF bias; the audio which is riding on the crest of the bias waves is unaffected. The upper and lower portions of the composite wave affect the positive and negative parts of the characteristic, producing complementary audio signals. These add to produce the final recorded audio signal of large amplitude.

What happens to the bias signal? It has been said that it is not recorded because the frequency is too high. Well, it *is* recorded on the tape, otherwise it could have no effect on the tape's magnetization curve; the bias frequency is recorded by the 'paint stripe' effect already described for high-frequency audio.

However, it does not **remain** on the tape for more than a few microseconds. This is due to self-erasure. A magnetic field does not have hard and fast boundaries; it diminishes rapidly beyond the main field, but it does exist outside it. Hence the field from the gap extends along the tape for a very short distance; so even though the tape has passed it, it is still within a quickly diminishing field.

Now this has little or no effect on long wavelengths because most of the recorded half-cycle has passed well beyond the reach of the field before the next and opposite half cycle starts to build up. With very short wavelength is not so; the field from the gap at one half-cycles extends sufficiently to erase the preceding one, and as the tape proceeds away, the diminishing field zeros out, until there is nothing left.

We end up with nothing on the tape except the audio signal. This effect accounts for another phenomenon. Self erasure can also occur with high audio frequencies, although to a lesser extent than with the bias. At the high signal levels, the stray field is stronger and so erases further along the tape, affecting longer wavelengths than with low signals. Hence the high frequency response taken at 0 VU on the recording level meter is always poorer than when taken at a lower level.

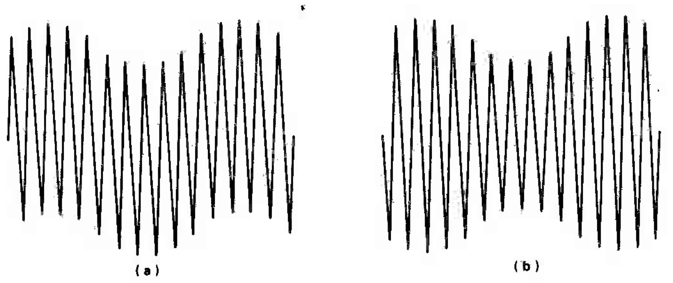


Fig. 6 The difference between a superimposed signal (a) and a modulated one (b). With the superimposed signal, the amplitude of the high-frequency component remains unaffected, hence it is not modulated.

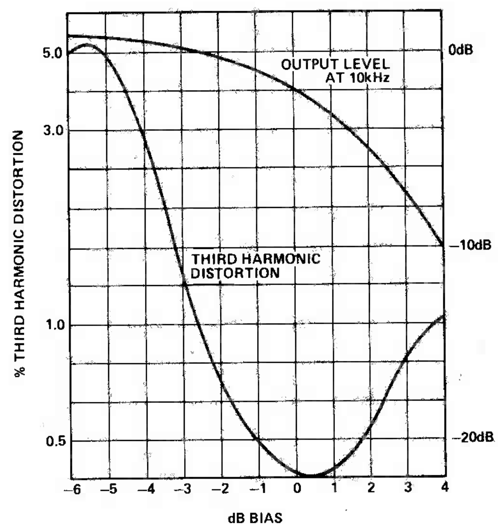


Fig. 7 Relationship between distortion and frequency response with a change of bias level. Optimum point for minimum distortion also produces a drop of 3 dB in the 10 kHz signal level (for one brand of C120; tapes vary in amount of distortion and HF loss).

Another associated effect is that too high a bias level curtails the audio high-frequency response. This is a rather unfortunate effect because there is an optimum bias level at which the distortion is at a minimum, and going either higher or lower will increase distortion. Unfortunately this optimum level for distortion is too high for maximum HF response, as self-erasure by the bias signal will have begun to make inroads into the higher audio frequencies.

So, bias can be set for either maximum HF response or minimum distortion, but the two settings do not coincide, see Fig. 7. Usually a compromise setting is chosen someway between the two. Each make of tape has its own bias requirements so a tape that performs well on one machine may not give of its best on another which has a different bias setting. Understandably, makers tend to set the bias for best results on their own make of tapes, if they also manufacture tape. If desired, bias can be re-set using suitable test equipment, to optimise for a particular brand of tape.

Head Materials

Various head materials are currently being used by the manufacturers and are often specified in their brochures. What are the characteristics of these materials and which, if any, is the best?

The standard material used in the majority of ordinary cassette recorders and many hi-fi decks is Permalloy which is an alloy of about 78% nickel and iron with a small proportion of molybdenum. It accepts a high flux density without saturating which means that it will take high recording levels without distortion. It also has a high permeability, which gives a good flux at the tape.

Unfortunately, the permeability drops as frequency increases so that at 10 kHz it is between a fifth and a tenth of its value at 1 kHz. Hence, the head response falls with increasing frequency, with poor results at the upper end of the range. As self-erasure and other losses affect the high frequencies too, this characteristic is particularly unwelcome.

Another problem is caused by eddy currents. When an electrical conductor is situated in a changing magnetic field, currents are induced in it. So the flux produced by the signal currents in the coil when recording, or by the tape during playback, produce currents within the core itself, because Permalloy is a good conductor. These eddy currents give rise to heat and therefore losses; furthermore, they increase as the frequency rises. So here is another factor that impairs the high-frequency response. In particular, such losses set a limit on the highest frequency that can be used for the bias. A high bias frequency reduces the possibility of intermodulation distortion, but this advantage cannot be realised with Permalloy heads.

To reduce eddy currents, Permalloy cores are assembled as a stack of laminates, similar to an iron-cored transformer. Unfortunately this brings another snag: it is almost impossible to assemble a stack of laminates so that the sides are perfectly in line; they may appear so to the naked eye, but through a microscope, they can be seen to be staggered to varying degrees. This matters little around the periphery of the core, but it does at the gap, where, owing to the small size of the gap itself, any staggering can increase the effective gap width (Fig. 8) which is especially detrimental in the case of the playback head where a narrow gap is essential.

A further drawback with Permalloy is its softness. It rates 130-140 on the Vickers hardness scale and wears rapidly compared to other materials, in the order of 120 microns per thousand hours, and 1,000-2,000 hours is about the average life before performance deterioration dictates a replacement. The non-magnetic shim which fills the head gap and thus prevents it becoming clogged with magnetic material shed from the tape, is chosen to have similar rate of wear as the core material. For Permalloy it usually is beryllium copper foil.

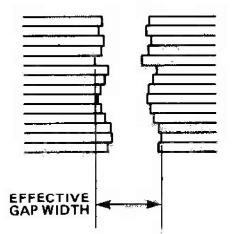


Fig. 8 Laminated stack with imperfect alignment. Effective gap width is increased. With widths of little more than one micron, small irregularities matter.

So as to avoid the various disadvantages of Permalloy, sintered-ferrite was developed as a head material. This is a combination of various oxides, mainly iron oxide, zinc oxide, manganese oxide, and nickel oxide, in fine grain form with a ceramic filler and binder.

At first glance the material seems inferior to Permalloy; it permits about half the maximum flux density, and has only around a tenth of its permeability. However, the permeability is less dependent on frequency, being three-quarters at 10 kHz of its 1 kHz value. It has a comparatively high electrical resistance which means minimal eddy currents, so the HF response is well maintained and the bias frequency can be high, reducing distortion levels. Absence of eddy currents means that the core can be solid instead of laminated, making it easier to make an accurate gap. Finally, a major advantage is the hardness, which at 400 on the Vickers scale, is three times harder than Permalloy.

There are, however, a number of disadvantages. As already noted, the permeability is much lower as is the maximum flux density. Also, the material is brittle and liable to chip. Tiny air bubbles can sometimes be found in it, which could result in cavities in the face when it is machined into shape. Residual magnetism tends to be higher, requiring a larger coercive force to overcome it which can result in a higher noise level.

These and other disadvantages have led to the search for a method of improving the characteristics of ferrite, and the development of HPF (hot-pressed ferrite). As its name implies, this is produced by compressing ferrite at high temperature during manufacture, pressures of 7,000 lb per square inch at 1,400°C being typical.

The permeability of HPF is not only better than ferrite but greater even than Permalloy, while the permeability consistency with frequency is as good as sintered-ferrite. Residual magnetism too is far better, being less than ferrite and Permalloy. Maximum flux density though is the same as ordinary ferrite which is less than Permalloy.

As regards hardness, HPF scores again being even harder than ferrite at 650-700 on the Vickers scale, making it five times harder than Permalloy. To give comparable hardness, the gap filler is usually made of hard glass. One manufacturer claims a wear factor of 0.4 micron per 1,000 hours which is very good indeed. HPF heads are also used in video recorders, but they have a much shorter life there because of the high head-to-tape speed. A life of 1,000-2,000 hours is the normal expectation.

No bubbles can remain in HPF heads so the possibility of unexpected cavities is eliminated. Like ordinary ferrite it can take a high polish and so ensure intimate tape/head contact with minimum drag.

It might seem that HPF has nearly everything going for it but there is a major problem — metal tape. This needs a much higher flux density both to record and erase, and as we have seen ferrites are inferior to Permalloy in this one respect.

So the search continues for the ideal tape-head material and various substances have been tried. One of these is Sendust, which has the sensitivity of Permalloy and the hardness of ferrite. The snag is low electrical resistance though, leading to eddy currents. This has been overcome by making it in ribbon form by blasting it through rollers when hot, then rapidly cooling. Laminates are made from the ribbon, so we are back to laminated stacks and their problems of staggered gaps.

However, as the high permeability is most needed during recording on metal tape, and as recording-head gaps are wider than playback ones, gap accuracy is less of a problem. Laminated Sendust can be used for the record-head while a solid HPF head can be used for playback.

	Permalloy	Ferrite	HPF
Constituents	Ni Fe Mo	MnO Fe_2O_3 ZnO NiO	MnO Fe_2O_3 ZnO NiO
Permeability:			
1 kHz			
10 kHz	18000	1200	20000
Max Flux Density	1500	900	10000
(gauss)	7000	4000	4000
Coercive Force	0.02	0.5	0.015
(oersteds)			
Specific Resistance	5×10^{-5}	>100	>100
(ohm.cm)			
Vickers Hardness	135	400	700

Table 1 Head materials and characteristics.

Azimuth

Correct positioning of the head or heads is essential. Firstly, the height must be such that the tape is in a perfectly straight line across the head assembly. If one head is out of line, the tape-guide on the side of the head will pull the tape up or down at that point, resulting in damage to the tape edge or a weaving motion producing regular variations of signal level and HF response.

Next, the head must be vertical from front-to-back. A backward lean, for example, results in imperfect contact between the top half of the tape and the head, increasing the likelihood of drop-outs.

Finally, the azimuth or side-to-side angle must also be vertical. Theoretically, the azimuth doesn't matter as long as the playback setting is the same as the recording. This is obviously the case with single-head machines when tapes recorded on the same machine are played back. However, problems occur when tapes recorded on other machines are played back on the faulty machine (or tapes recorded on the faulty machine are played on others) and also with pre-recorded tapes.

The reason is that a slanted record head produces corresponding slanted magnetic zones on the tape. A vertical playback azimuth will bridge across the narrow slanted zones, as a slanted head will bridge across vertical zones (see Fig. 9a). In both cases, the effect is that of increasing the head gap width. As it is only the narrow zones that are so affected, the result is a loss of short-wavelength high frequencies, the loss increasing with increasing angle difference.

This effect is quite well known, but there is another which is less commonly appreciated. When a stereo head is incorrectly set the two playback gaps are not exactly one above the other. The top one will be slightly in advance or behind the bottom as the tape runs past, hence one channel is delayed.

The delay is too small to be noticeable as such, but it will result in phase-differences in the high and higher mid frequencies, which will lead to poor stereo image. Also, switching to 'mono' and combining the two stereo channels into one can lead to a severly curtailed high-frequency response — this can happen even when the stereo doesn't sound too bad! So, if a recorder gives poor stereo image from pre-recorded tapes but a good image with tapes recorded on it, then the likely cause is the playback head azimuth setting.

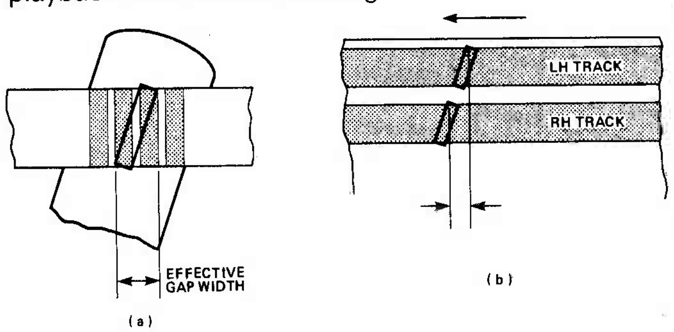


Fig. 9 When azimuth is not vertical, gap bridges across short wavelength zones, increasing its effective width and thus losing the high frequencies, (a). With a stereo head, (b), incorrect azimuth produces a delay between channels which can impare stereo image by upsetting the phase relationships. Azimuth errors shown here are exaggerated for the purpose of illustration.

To conclude, although the heads in your recorder are quite simple devices, there is rather more involved than you may think. We will undoubtedly see further developments as times goes on.

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SPECTRUM CENTRONICS INTERFACE

It may seem boring to keep publishing Centronics Interfaces (although we assume that the users of the relevant computers will be quite interested!); however, they all use different methods — this one uses a PIO. Design by Mark Purcell.

One of the main reasons for buying a printer is to complete a word-processing system so that decent hard copies of files or letters may be made. Printers are available with two types of interface: RS232 (serial) and Centronics (parallel), each of which have their advantages and disadvantages. For the hobbyist, it doesn't really matter which interface is used as long as the price is low. RS232 printers tend to be anything from £20 to £40 more expensive, and less available, than their Centronics equivalents, because of the added circuitry needed for serial communication, and it would therefore seem logical to go for a Centronics printer when on a low budget.

One of the most popular word processing packages available for the Spectrum is the excellent Tasword Two from Tasman Software. This package has Centronics printer-driving software written-in. The rest of this article describes the design and construction of a simple, cheap, Tasword Two compatible Centronics interface for the 48K Spectrum.

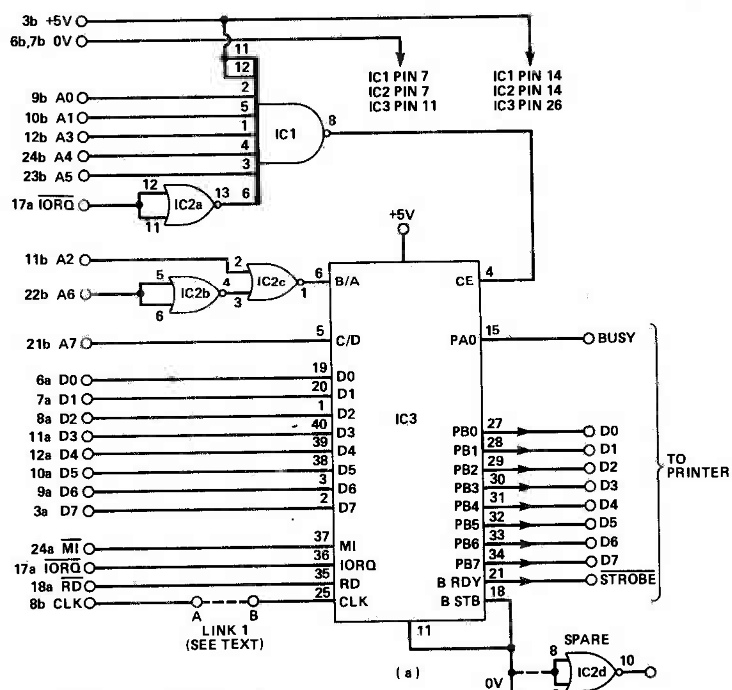
Using this interface with your home-spun software should not be difficult, although the exact details will be left up to you. The data to the Centronics printer is straight ASCII, although sometimes with the top one, two, or even three bits lopped off (particularly with daisy-wheel printers that are not capable of graphics). As the Spectrum uses ASCII to represent characters, this makes life very easy. Also the handshaking with Centronics interface is very simple: the STROBE line is taken low when data to be printed

D7	D6	D5	D4	D3	D2	D1	D0
M1	M0	X	X	1	1	1	1
MODE WORD				SIGNIFIES MODE WORD TO BE SET			

M1	M0	MODE
0	0	0 (OUTPUT)
0	1	1 (INPUT)
1	0	2 (BIDIRECTIONAL)
1	1	3 (CONTROL)

X = UNUSED BIT

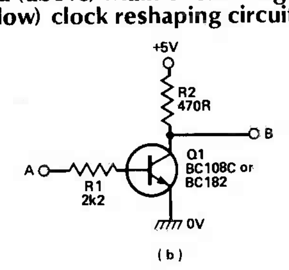
Table 1 Selecting an operating mode; only Port A may be used for mode 2 operation.



HOW IT WORKS

Most of the work of the interface is done by the PIO, so, without going into the intricacies of the workings of the PIO itself, and how it ties into the Z80 CPU, there is not a great deal we can say! There are plenty of books around on the Z80, and one we'd suggest if only on the grounds of price is called 'A Z-80 Workshop Manual', by E A Parr, published by Bernard Babani (publishing) Ltd, at £2.75 (ISBN 0 85934 087 2).

Fig. 1a (above) Main circuit diagram; b (below) clock reshaping circuit.



is stable, and the printer takes the BUSY line high when it has read the data.

Design Details

The final design is based on the Z80A parallel input/output chip. Only two other chips, ICl and 2, are used in the interface, making it cheap and easy to construct.

The PIO has two data ports, A and B, and two control registers (one for each port). Each port can be set to either input or output (or a combination of I/O) by programming its control register (see Table 1). It was decided to make port A input, so that the BUSY signal from the printer could be monitored (bit PA0), and port B output so data could be sent to the printer. The PIO generates its own data valid, or STROBE, signal.

Address Decoding

Table 2 gives the port addresses used by Tasword Two, and if you are designing your own software, you will have to use these addresses in your software. It can be seen that there are three outputs and one input. Since we are using a Z80A PIO, the STROBE signal is automatically generated so the data output to port 59 can be ignored. Similarly, the control words for a Z80A PIO will be different from any other interface so the data output to port 127 should also be ignored.

The DATA should obviously be directed to port B on the PIO and the BUSY input from port A. The only bits of the address that vary between port addresses are A2 and A6; hence by directing all unwanted output data to port A (which is configured in input mode) the data will be ignored. This is achieved with IC2b and IC2c. We also wish to be able to program the PIO initially, so A7 is used as a control/data select. Note that A2 is used by Tasword Two so the ZX printer should be disconnected when using the interface.

Figure 1(a) gives the full circuit diagram of the interface. With Interface 1 connected, the clock output from the Spectrum is inadequate to drive the PIO directly and requires some reshaping. Figure 1(b) gives a simple waveform-shaping circuit that can be used with Interface 1.

Construction

A PCB has been designed to accommodate the interface, and this is shown in Fig. 2. This has been designed so as to be fairly small, so some care will be

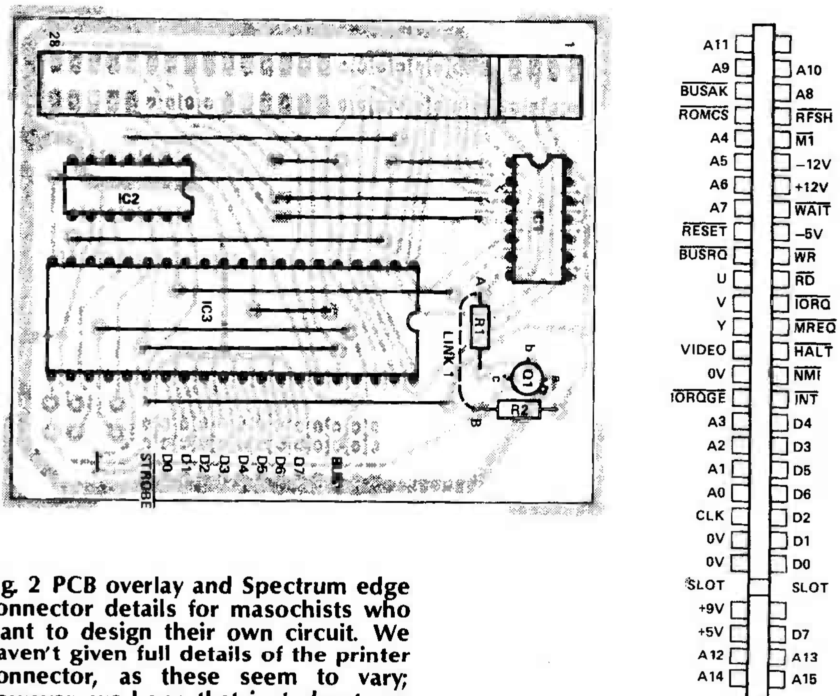


Fig. 2 PCB overlay and Spectrum edge connector details for masochists who want to design their own circuit. We haven't given full details of the printer connector, as these seem to vary; however, we hope that just about any socket will fit the board!

required when soldering! Another point to watch is that many of the links pass beneath IC1, and whether you use a socket or not, you will have to remember to insert these links before anything is soldered in the IC1 position. Components R1,2 and Q2 may be used, or the link used instead, as required.

Using the Interface

Before the interface can be used it is necessary to program the port control registers of the PIO. Port A's control register is selected when all eight address lines are high — this corresponds to port 255. From Table 1 the 'input' mode word is 4Fh or 79 decimal, hence OUT 255,79 will put port A into input mode. Similarly port B's control resister is selected when all address lines except A2 are high, or port 251. From Table 1 the 'output' mode word is 0Fh or 15 decimal, hence OUT 251,15 will put port B into output mode.

The easiest way to make sure that the ports are initialised before attempting to dump a file is to incorporate the control register programming into the Tasword Two BASIC; that way it will auto-run on loading and perform the necessary initialisation: first load Tasword Two and enter BASIC by pressing STOP, b and ENTER, EDIT line 10 and add OUT 255,79; OUT 251,15: to the beginning of the line, then RUN, STOP, t and ENTER to save the modified program. Any text file can now be printed out by loading the file into Tasword (if it is not already there) and using the 'print text file' option in the menu.

ETI

PARTS LIST

SEMICONDUCTORS

IC1	74LS30
IC2	74LS02
IC3	Z80PIA

MISCELLANEOUS

PCB; Spectrum edge connector; connectors for Centronics printer.

ADDITIONAL PARTS FOR USE WITH INTERFACE 1

R1	2k2 ¼W 5%
R2	470R ¼W 5%
Q1	BC108C or BC182

BUYLINES

There shouldn't be much to cause you any problems here; the PCB is available through our PCB service, and everything else is fairly easy to get hold of.

		A7	A6	A5	A4	A3	A2	A1	A0	PORT NO
STROBE	OUTPUT	0	0	1	1	1	0	1	1	59
DATA	OUTPUT	0	1	1	1	1	0	1	1	123
BUSY	INPUT	0	0	1	1	1	1	1	1	63
CONTROL	OUTPUT	0	1	1	1	1	1	1	1	127

Table 2 Ports used by Tasword Two software.

DIGITAL FRAMESTORE

This project definitely rates the tag 'experimental'; and with the necessary ADC at around £100, and 48 64K DRAMs included, it isn't going to be cheap either! However, we think that our readers will be interested in the techniques involved. Design by Daniel Ogilvie.

A framestore is a device that can capture an entire image from a TV screen and freeze it electronically. The captured image can then be manipulated or combined with or compared to others.

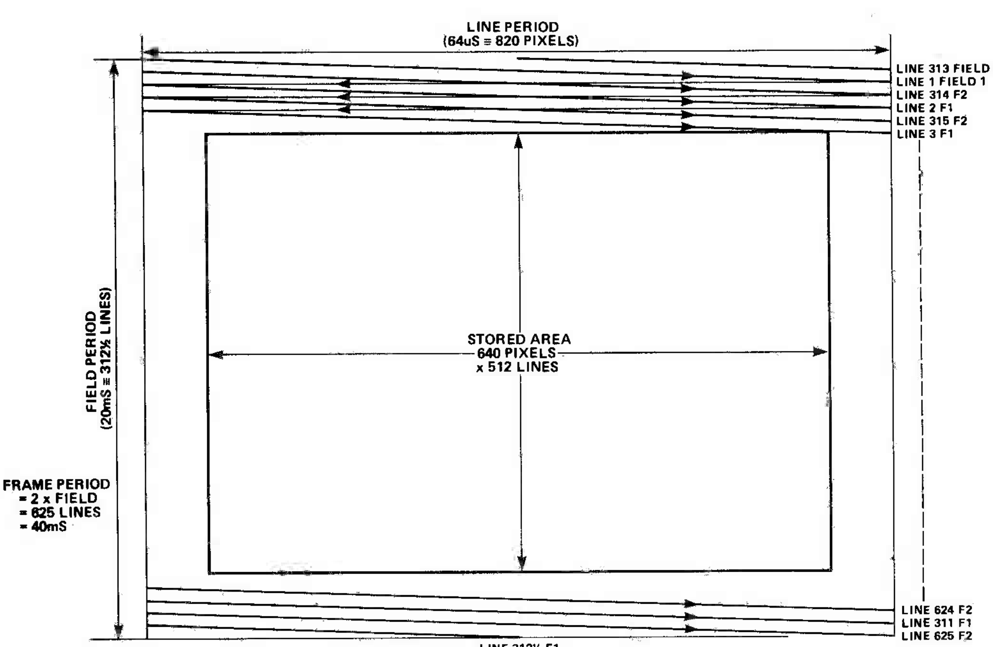
Using a framestore, one TV camera could be used to fade between two images; one would be captured on the framestore, then the TV camera pointed at the second. A video mixer would be used to fade from one image to the other. More complex effects could be achieved by using the same image for both, with minor changes or manipulations between the two images.

Storage of the image can be synchronised with one-off events; for example, it could be synchronised with a flash gun going off; the flash is synchronised to occur during the field blanking (flyback) time and the resultant image is read into the store on the next frame scan.

A technique known as target integration can be used; here the electron beam in the camera is shut off and a feint image is built up over a period of time on the target, then the beam is turned back on again to read it into the framestore. This is similar to long exposure photography — and uses of this include astronomy.

In the design described here, the image is stored in digitial form, which makes it possible to analyse or manipulate the picture using a home computer; this will be discussed at length in a future article.

Camera tubes are available which can see into the infra red or the ultra violet, which enables us to extend our view of the world beyond conventional visible optics. For example, finger prints can be viewed under UV light, stored in the framestore, enhanced by computer and then compared with a library of finger prints for a match. Also, inks can be made to be luminous in the infrared making it possible to check for cheque or passport forgeries.

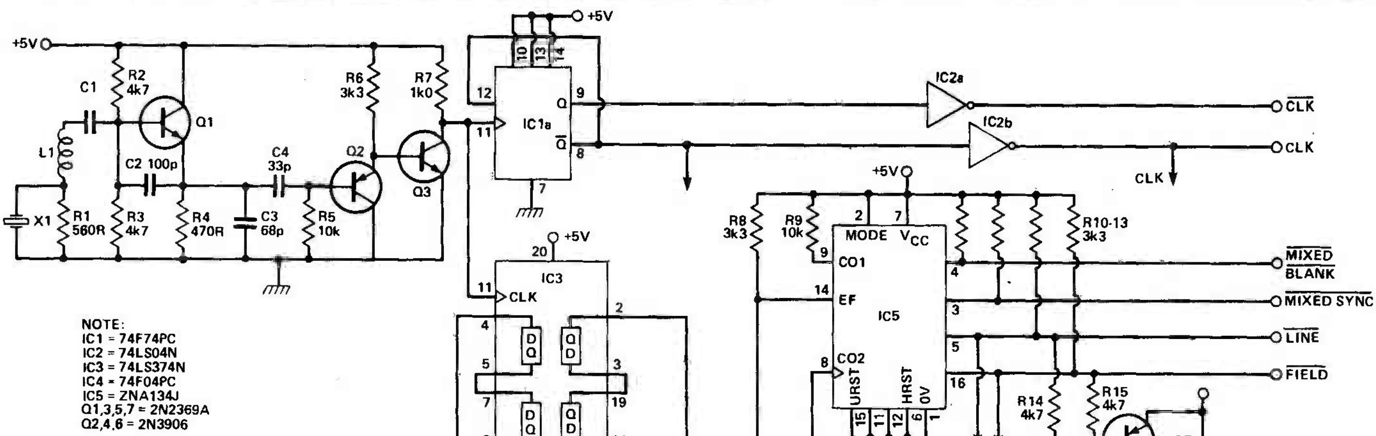


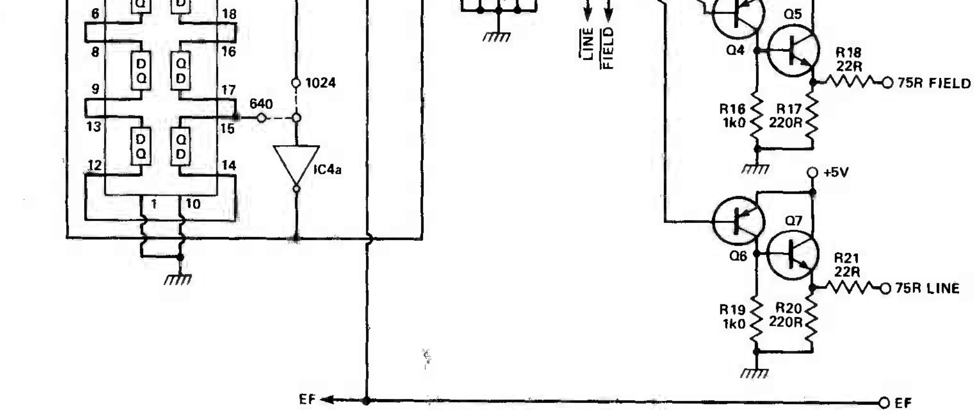
Some Television Fundamentals

Most readers will be familiar with the conventional television system used in this country which is raster scanned. The information on the brightness of the camera lense's field of view is encoded in a serial form and superimposed on synchronizing pulses which enable it to be easily recovered. Looking at your television screen, the trace starts at the top left hand corner and moves across horizontally until it reaches top right where it resets back to the left, a little bit down, and scans across again.

The time taken for the horizontal line scan is 64us and this is known as the line period. The line scan is performed 312½ times, until the trace reaches the bottom of the screen when it returns to the middle top of the screen. The trace performs a further 312½ line scans, filling in the gaps between the first 312½ line scans, see Fig. 1.

Each set of 312½ line scans is called a *field* and requires 312½x

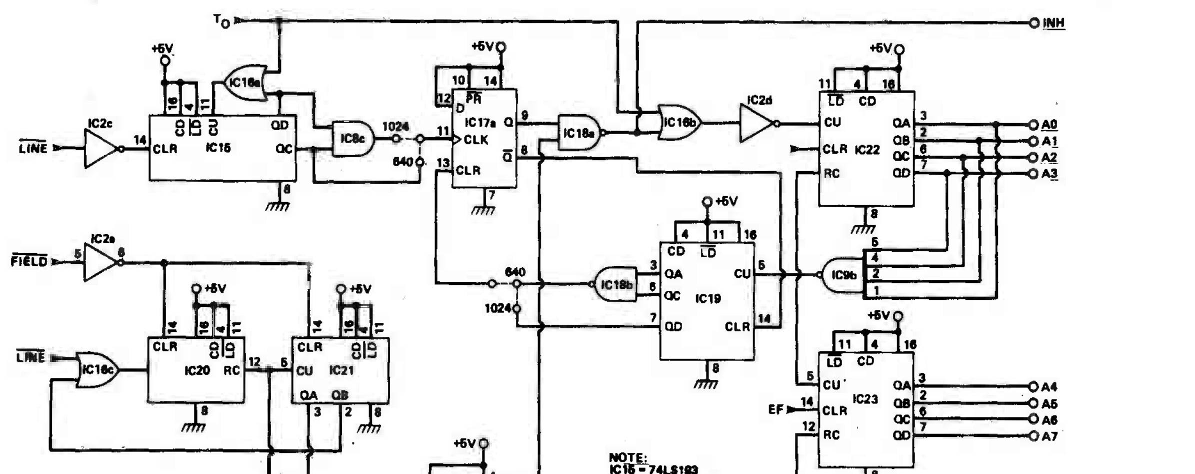


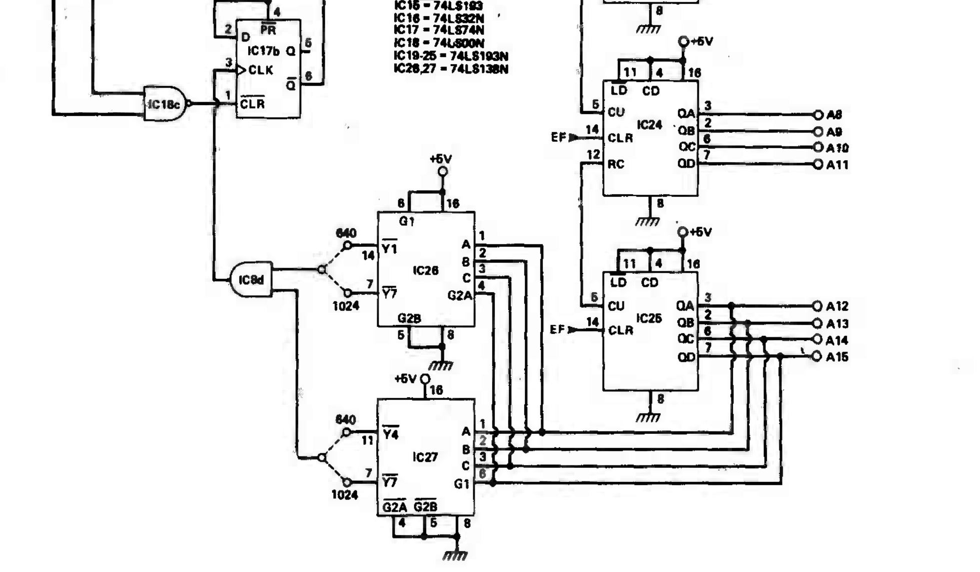


Q1 forms a 25.625 MHz oscillator; this is rather more complicated than usual because the crystal has to work in the third overtone mode and so the signal has to be filtered to ensure that oscillation occurs at the correct frequency. The signal is buffered by Q2 and amplified to TTL levels by Q3. (For 1024 pixels to be stored, the crystal has to be 41.0 MHz.)

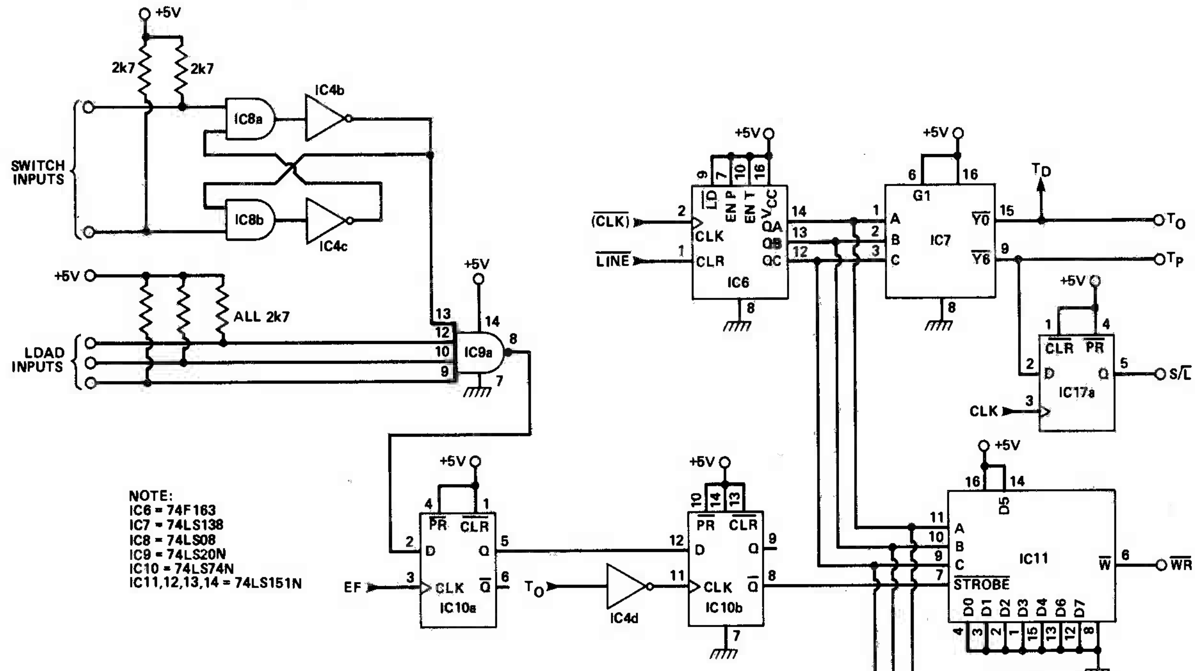
The 25.625 MHz clock is divided by two by IC1, to generate (CLK) and ($\overline{CLK}$) (brackets here donoting that these are unbuffered and prompt); IC2a and b buffer and invert these to generate $\overline{CLK}$ and CLK, both at 12.8125 MHz (nominal 13 MHz). The 25.625 MHz clock is also fed to the clock input of the octal flip-flop, IC3; either five or eight latches may be strung in series, and, with the inverter, this produces a division of either ten (640 pixels) or sixteen (for 1024 pixels and 41.0 MHz clock). The divided-down clock frequency is fed to IC5, (a special-purpose device) which generates the $\overline{MIXED\ BLANK}$, MIXED SYNC, $\overline{LINE}$ and $\overline{FIELD}$ outputs; the latter two are inverted and buffered by Q6/7 and Q4/Q5 respectively, to give 75 ohm FIELD and LINE signals for the video camera. IC5 also generates the even field, EF, signal.

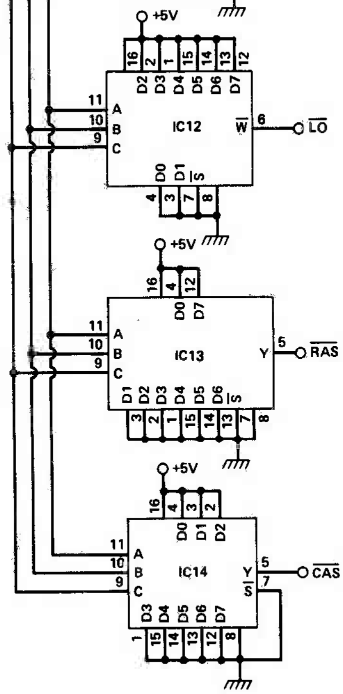
The ($\overline{CLK}$) line is used to drive a divide-by-eight counter, IC6, and the bottom three binary outputs from this are used to select which one of decoder IC7's outputs is to be pulled low. IC6 is synchronously reset by





CONTROL CARD



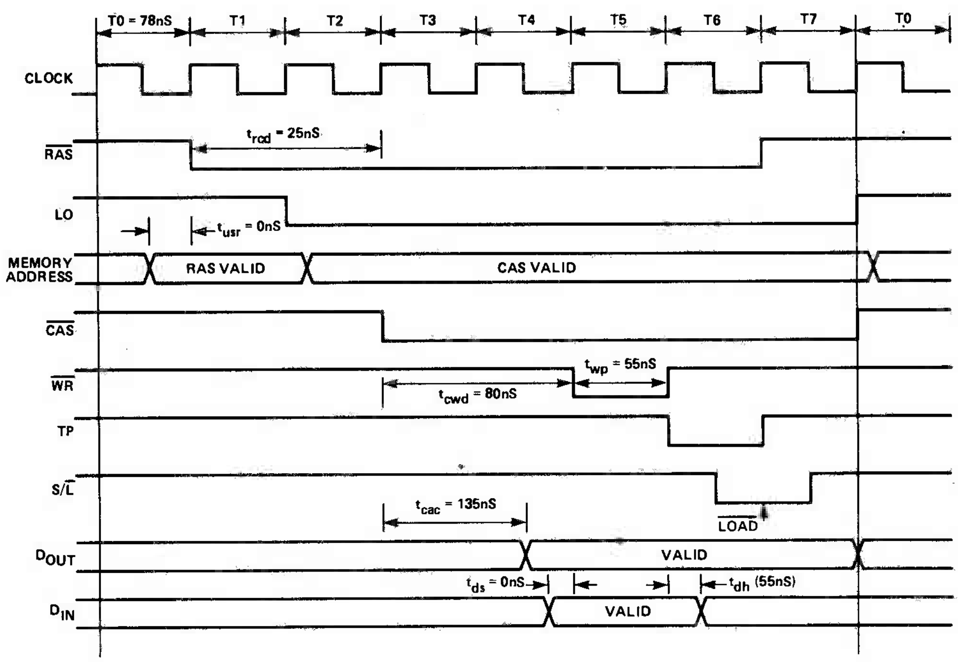


$\overline{LINE}$ to ensure that it starts in the same position every time. The $\overline{Y0}$ output is used as the timing reference, $\overline{T0}$, for the first of the eight memory access cycles while $\overline{Y6}$ provides the transfer pulse, $\overline{TP}$, for the memory buffer section.

The binary outputs of IC6 are also used to drive four data selectors, IC11-14, which generate the $\overline{WR}$, $\overline{LO}$, $\overline{RAS}$ and $\overline{CAS}$ memory control lines.

The switch inputs are de-bounced by IC8a and b and IC4b and C, and gated with the load inputs of IC9a. Latches IC10a and IC10b prevent the load signal reaching IC11 until EF and $\overline{T0}$ have both gone high; as IC11 generates the $\overline{W}$ line, this means that a write cannot commence in the middle of a frame.

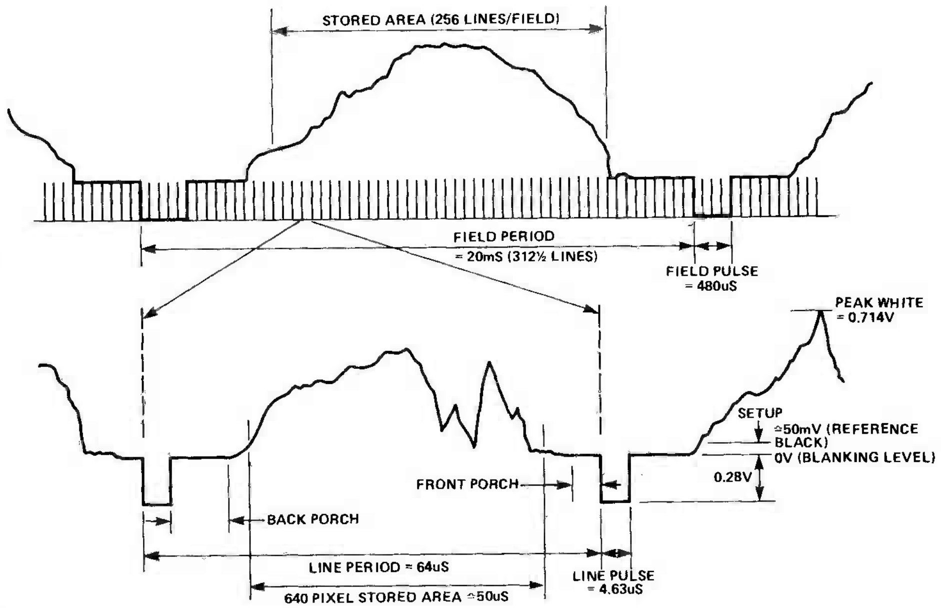
The $\overline{LINE}$ pulse resets counter IC15 which then proceeds to count six $\overline{T0}$ pulses, to generate the left-hand margin (78ns × 8 × 6 = 3.74 us), which then allows the sixteen-bit counter, IC24-27, to count the $\overline{T0}$ pulses via IC1b. Every sixteen $\overline{T0}$ pulses, all the outputs from IC24 will go high; this is gated by IC9b. When this has occured five times (when 640 is selected) or eight times (when 1024 is selected) the count will be stopped, because the right-hand margin has been reached. The number of pixels stored per line is therefore 8 × 16 × 5 = 640 (or 8 × 16 × 8 = 1024 for 1024 selected).



The top and bottom margins are generated by ICS 20 and 21, which count the $\overline{LINE}$ pulses; when 32 line pulses have occurred, the flip-flop IC17b is cleared va IC18c; this takes its Q output high, allowing IC18a output to go low, so that $\overline{T0}$ pulses can pass through IC16b and be counted; so the address counters can only increment while IC17b remains cleared.Decoders IC 26 and 27 monitor the top four address lines to provide a line counter. When the counters reach 4x4906x8/640 counts = 256 lines the Y4 output of IC26 clocks IC17b via IC8d which sets this latch and halts the count until the 32 lines of the second field have elapsed when IC27 performs similarly (9x4096x8/640 counts = 512 lines). The counters are reset by the EF (even field) pulse which indicates the start of the new frame.

64us =20ms to be completed. The two fields are related in that the information in the second field augments the information in the first. The two fields together are called a frame and this requires 2x20ms = 40ms to be completed.

The two fields are said to be *interlaced.* The reason for this interlace is to provide a fast enough screen refresh rate without just resorting to sending the information faster which would result in the need for a higher bandwidth.



The Video Waveforms

As I have already mentioned, the information broadcast is superimposed on synchronizing pulses, which indicate where the top and left of the screen are. A typical video waveform is shown in Fig. 2, which shows line synchronizing pulses. Each pulse initiates a flyback of the trace across the screen from right to left ready for the next line of information. The field pulses caused the trace to reset to the top left of the screen and initiated the slower vertical scan downwards which ensures each line appears below the previous one.

The video waveform superimosed on the sync pulse represents the brightness of the scene. The higher the voltage at any particular point in the waveform, the whiter the corresponding point on the screen. The set-up voltage is defined as black and is about 45mv above the 'back porch' of the line wave-form (see Fig. 2.). The sync pulses are, therefore notionally, darker than black and this ensures that the flyback is not visible on the screen. We derive a pulse during the period of the back porch to clamp the incoming video to black to ensure we obtain a stable grey scale to our stored picture.

There are a number of other features regarding the video wafeform that will concern us, but we will deal with these as we need to.

We are concerned with the storage of one frame of this information. The method we shall use is to convert the TV screen into little packets of information and store them into a digital memory as values representing the brightness of the scene.

Memory Needs

With 625 lines to store, if we stored only one byte representing the average brightness across each line, we would require 625 bytes of memory. Obviously this is not very representative of the scene we may be looking at.

Well, let's store 625 values across the line and see what that requires, assuming that each value stored will be in the form of an eight-bit byte. We now need enough memory to store 625 lines of 625 elements (the elements are called *pixels*); this requires 625^2 bytes, ie 390,625 bytes: rather a lot!

There is an additional consideration. The line duration is 64us, and we want to break this up into 625 pixels which means we have only 64us/625=120ns to convert the video into a digital word and store it.

Looking at the sync waveforms again we can see that there is a left and right, top and bottom margin to the screen. Storing the video waveform from these parts of the screen is a waste because there is very little useful information there. It is at the extremes of linearity of the camera scans, the lense and the television screen. We would lose little by storing only the 512 central lines.

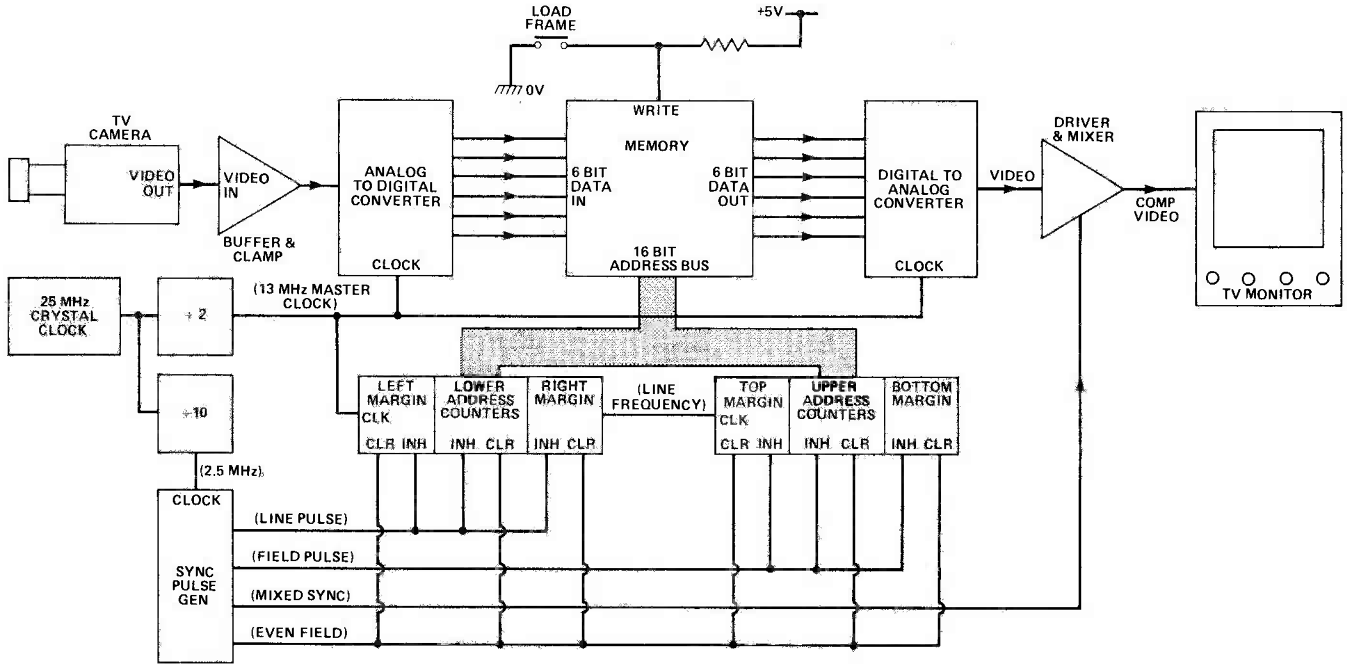
Similarly the line scans contain little of use at the edges, so we need only store the central section of the lines. The screen is wider than it is deep (it has a 4:3 aspect ratio), so to maintain a similar horizontal resolution to the vertical resolution, we will need to store more than the 512, say around the 625 pixels first envisaged. Actually, the generation of the clock signals is eased considerably by prudent choice of numbers (you'll have probably already noticed the 512 lines!), and in practice it was found that 640 pixels stored across a nominal total line length of 820 pixels (much of the residue being taken up with sync and fly-back) worked out reasonably neatly. Putting these numbrs together, we arrive at a memory store requirement of 640 x 512 = 327, 680 bytes.

The memory requirement has been reduced to some extent, but we have increased the speed requirement of the A-to-D converter and of the memory. This is unfortunate because speed is costly in both these areas. It also makes the design of the timing and control logic more critical. The conversion and storage of each pixel will have to take place in 64us/820 = 78 ns.

It's Been Framed!

A block diagram of the whole system is shown in Fig. 3. The crystal clock generates the pixel clock rate — which is our highest frequency. We require 820 pixels across a line which gives us a crystal frequency of 1/64us x 820 or 12.81225MHz. We generate twice this, (25.625MHz) to ensure an even square wave master clock waveform. This is sent through the lower address counters which divide the 12.8125MHz by 820 and generate a binary address for the memory. The output from this counter will be at line frequency; the left and right margins are also generated by these counters.

The line frequency is fed to the upper address counters which divide the line frequency by 625 to provide the upper address lines to the memory, and also generate the top and bottom margins. At the



end of a frame the address counters are reset by the sync pulse generator and the process continues again.

Most of the time, we will be using the framestore to read out of memory; while this is happening, data is being sent from the memory to the DAC for conversion back to analogue and, after mixing with synchronising pulses, display on the monitor.

To store video, from, for example, a video camera, the write line on the memory is held down for the duration of one frame, while the input signal is converted by the ADC. As already mentioned, the ADC will be converting at a rate of 12.8125MHz.

To be completed next month.

ETI

Please mention E.T.I. when replying to all adverts

READ/WRITE

Standing Physics On Its Head

Dear Sir,

It is a well-known mathematical paradox that a perfect low-pass filter must begin to react to a pulse on its input before that pulse is applied. However, this piece of mathematics has eluded physical realisation — until now. Look at the oscillogram you display in your review of the Bridage scopes in the September ETI. The bottom trace clearly shows the SB121 overshooting before every edge of the square wave input.

There would be many applications for a circuit which detects pulses before they happen. Clicks could be removed from audio recordings without using a delay-line buffer. Delicate equipment could be protected from mains surges. Digital circuit designers need no longer worry about clock skew — just insert a few endochronous filters into the longer signal paths. But the most obvious use is in oscilloscopes themselves: a predictive trigger to capture those intermittent events which conventional trigger circuits cannot handle. The absence of such a documented feature from the scopes under review suggests that it is an accidental phenomenon which has gone unnoticed by the manufacturers. Perhaps one of their component suppliers is making his capacitors out of resublimated thiotimolines?

Yours faithfully,
Richard Kennaway
Norwich

Fascinating as the possibilities outlined by Mr. Kennaway are, we have succeeded in tracking down the source of this phenomenon and found the problem to be a surprisingly simple one — our photographer was holding his camera upside down!

The One That Got Away

Dear Sirs,

I refer to your article in ETI of June 1984 in the Digest section, concerning a new battery developed by Matsushita and marketed by Panasonic UK Limited. This is the BR 211 Lithium battery.

As an angler, not an electronics follower, this item interested me very much from the point of view of illuminating fish-rod tips, with which I have been experimenting for several years now. Also, as press offficer of the Bournemouth based BAC Angling Club, my experiments are of interest to a good number of local anglers.

With this in mind, I wrote to Panasonic UK Ltd enclosing details, drawings and observations, regarding my strugglings with batteries and LEDs etc, and enquiring where I may track down a supplier of their advertised battery. This letter was sent at the end of May this year.

Since we are now well into August, I feel it is fair to assume that I am not likely to receive a reply or even acknowledgement from Panasonic UK Ltd. I wonder if you could help. I am no longer concerned whether they are interested in my dabblings or not, but I would like to know where to buy 'The World's Smallest Battery' as it was described. Perhaps it is so small that nobody can find it?

Yours faithfully,
Martin Hursthouse
Bournemouth

We telephoned Panasonic UK but no-one there seemed to know much about the BR211. They passed us on to Panasonic Industrial, who told us that the information we published must have come directly from the Japanese arm of the company. There are plans to distribute the BR211 in this country but no agents have yet been appointed and it is unlikely to be available before the beginning of next year at the earliest. In addition, because they are concerned only with industrial electronics, Panasonic Industrial were unable to assure us that the agents appointed would include a company prepared to sell directly to the public in small quantities. We can only suggest that you drum up as much support in the angling world (and elsewhere) as you can and keep lobbying Panasonic — if it becomes clear to them that there really is a demand for the BR211 in the domestic market they may feel encouraged to appoint a suitable distributor as quickly as possible.

Beating The Common Code

Dear Sir,

I have recently purchased and installed a home security system that you reviewed in the July 1984 issue of ETI. The article was entitled 'Housewatch 2000 Burglar Alarm' (page 50) and featured the Coloroll Ltd/Munford & White Control Panel.

I have therefore been in a position to practice button pushing on the control panel and have found a serious fault in the ULA that comprises the system security. It is possible, with the panel in the Day condition where it can be operated by any person or villain, to find out the 4 digit control code within 2 minutes and without tampering with the unit in any way. The average time to crack the code is only 1 minute.

I have written the method on a separate sheet which is in a form that I present to visitors to play at code-cracking when they visit the house.

Yours sincerely,
M. Brandligt
Oxford

Whilst we agree that it is quite easy to find the code of the alarm when it is in the 'day' state, this doesn't actually affect the security of the alarm. Let's look at the arithmetic.

With the alarm in the 'day' state, there are nine possible first digits in the code and eight possible second digits making a total of $9 \times 8 = 72$ combinations, only one of which will put the alarm into its test state.

To get the alarm out of the test state there are seven possible first digits (the third digit of the full code) and six possible second digits, making a total of $7 \times 6 = 42$ possible combinations.

It is relatively easy to find this code provided:

1) you know how the alarm operates in the first place — a clever, professional thief will have done his or her homework, but aren't the majority of domestic break-ins the work of opportunist amateurs?

2) you are allowed to play with the alarm in the 'day' state.

It is on this second point that your argument falls down. If the alarm is armed, the thief will have to find the full four-digit code in one go. There are $9 \times 8 \times 7 \times 6 = 3024$ possible combinations, far more than a thief could hope to try in the twenty-five seconds allowed after arriving through the entry-zone, and if a thief gets in by some other route the alarm will go off immediately anyway. We think your home is secure — unless any of your

invited visitors return later, uninvited!

Of course, if you do suffer a break-in at a time when the alarm is un-armed, it would be sensible to change the code as well as changing all the locks. However, changing the code is very straightforward.

Disc-usted

Dear Sir,

I have been reading Linsley Hood's articles on audio amplifiers for many years and good as his latest design is I don't think I will be making it. He seems not to have heard of the Compact Disc.

Yours Truly,
B.A. Thacker
Crewe

Although this was not brought out in the series of articles, the design was produced with Compact Disc very much in mind. This is one of the reasons why the volume and balance controls have been placed in the power amplifier rather than the pre-amplifier and why that unit has been provided with an unusually sensitive and high-impedance input. Signals from Compact Disc units can thus be fed directly into the power amplifier without having to pass through unnecessary connectors, switching, and signal handling stages in the pre-amplifier. This being so, the Audio Design amplifier is probably better suited for use with Compact Disc players than almost any other amplifier around.

Tip Of The Iceberg

Dear Sir,

I hope you have a few minutes to spare, because I am about to relate the Saga of the Missing Tech-Tip.

Once upon a time (14/1/84) an intrepid ETI reader (me) sent what he thought was a rather elegant piece of software to the Mighty ETI Tech-Tips Feature. His idea was a program to read resistor colour codes using the Casio fx-180P calculator. The reader waited, with bated breath (he had run out of Polo mints) for a reply from ETI. He waited for three months, and then wrote to ETI again, along the lines of "Oi, mush, wot's happened to me software?" or words to that effect.

Still no reply having plopped on his doormat (it wasn't house-trained) by the middle of June '84, he was prompted to write again. Which is why he is now writing to Heap Big Boss Man of ETI.

I think it's safe to assume that my design has gone astray, encountered a time warp or been half-inched by the Vogons (remember them?). If you could write and reassure me that two-way communication via letter is still possible, I would be much obliged. I would also be pleased to re-submit the design, assuming that it doesn't turn up in the ETI offices.

I look forward to hearing from you (please).

Yours Faithfully,
Ronald Hutchison
(State Registered ETI Reader)
West Kilbride

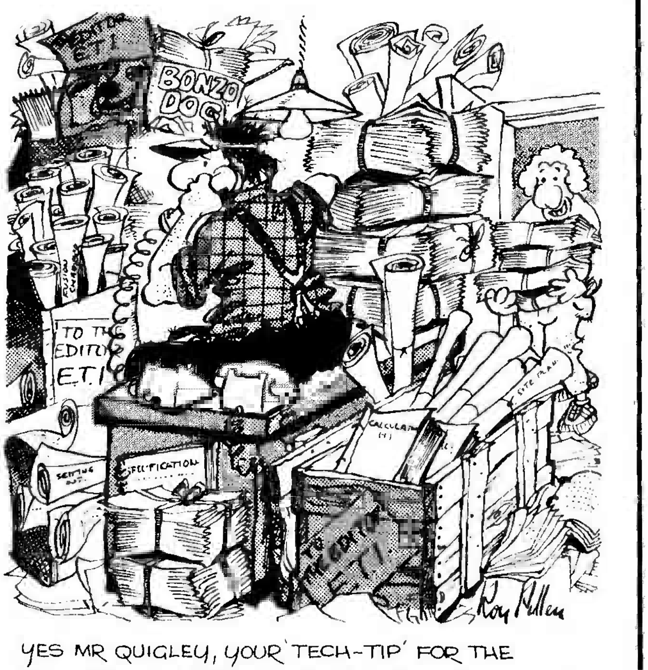
Sadly, Mr. Hutchison is not the only reader to have experienced this upsetting phenomenon of Tech Tips apparently vanishing into the fourth dimension (otherwise known as the ETI filing system). We hope that he and the others affected will accept our apologies and the following explanation.

The problems with the Tech Tips feature arose partly because of its success. We have had so many sent to us that we now have two bulging files full and contributions are still arriving at the rate of a dozen or so a month. This flood of items has coincided with a period during which we have frequently not had enough space to put all the things we wanted to in the magazine, and Tech Tips has often been left out to make room for other articles. Not having the staff to cope with the filing necessary to keep such a large number of contributions in order, the whole system has become rather disorganised and letters querying the whereabouts of particular Tech Tips have all too often vanished themselves!

Rather belatedly we have got around to doing something about all this. The Tech Tips special in this issue marks our first assault on the ever-growing file and we intend to include the feature on a far more regular basis from now on.
Mr. Hutchison may also like to note that his program is amongst the items featured.

We will also be looking closely at the conditions under which Tech Tips are accepted to see if they can be tightened-up slightly. It would obviously be better to reject a few more items in the first place than to have them on-file for months, being considered and then rejected.

In the meantime, why not consider if your Tech Tip could actually be a project. We do quite often ask readers to re-vamp their ideas because they are substantial enough to be full-blown projects, and we and our sister magazines, Electronics Monthly and Digital and Micro Electronics, are always looking for good projects.



YES MR QUIGLEY, YOUR 'TECH-TIP' FOR THE BUILDING OF A TWENTY MILE DIAMETER ANTI-MATTER PARTICLE ACCELERATOR WITH NUCLEAR FUSION CHAMBER AND GRAVITATION DEFLECTION STORAGE RING HAS INDEED BEEN RECEIVED!

ETI

The MC6804 P2

Remember our article on Motorola's MC68020, the world's first true 32-bit micro (depending on what definition of a 'true' 32-bit micro you adopt)? Well, Motorola have been busy at the other end of the scale, with a four-bit micro too. A sequel to the story of its bigger brother, we'll be taking a little look at the world of the Micro-microprocessor — and its one device that could well find itself used quite heavily by hobbyists in the none-too-distant future.

Active Bass Speaker

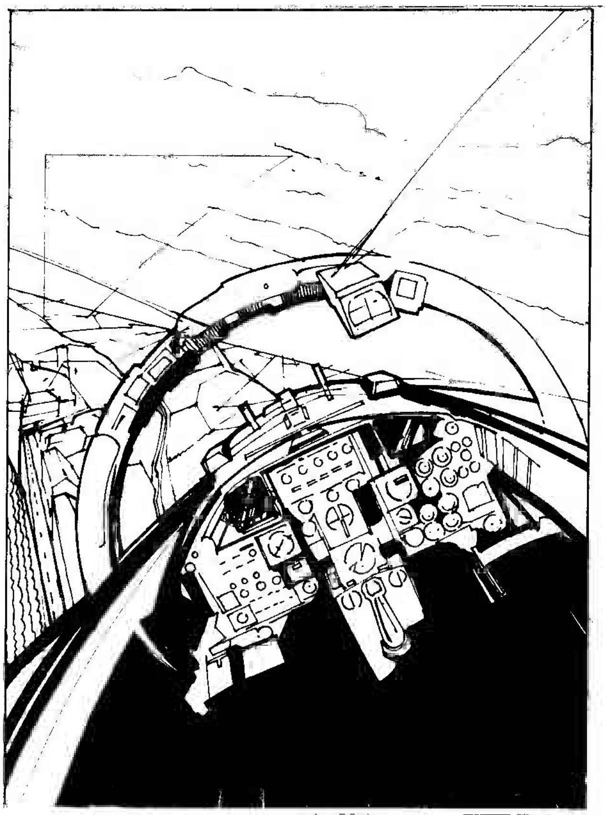
Just in case you might have got the impression that all the next issue will be features, here's a project for you. Mind you, your neighbours may well sink to bribing your newspaper deliverer to hang onto your copy of ETI, because this sub-resonant speaker should certainly rattle a few walls and floor-boards!

Readers' Survey

The time to seek your opinions has rolled around once again, with the added bonus of the possibility of winning a year's subscription.

Distortion Meter

Well, this item got squeezed out of this issue, for which we apologise, there just wasn't room to get in everything we wanted to get in. However, we promise, cross our pulse generators and hope to die, that it will be in the next issue.



IS ELECTRONICS RELIABLE?

There are a number of question marks over the performance and reliability of electronics, not a few of which have turned up in ETI projects! The space shuttle fails to get off the ground. An IC will not work within its specifications, and duplicates also fail to work. The Nimrod 'eye in the sky' radar system won't work as it was designed to do and is sent nearly all the way back to the drawing board. A leading semiconductor company admits that many of its ICs have not been properly tested, and initiates a hastily assembled crash testing programme. Anyone who reads the electronics trade press will have seen these stories; next month's ETI will attempt to get them in perspective.

ALL THIS AND MORE IN THE NEXT ISSUE OF ETI. RESERVE YOUR COPY OF THE JANUARY ISSUE NOW!

All the articles listed above are at a late stage of decay in the Editor's in tray. However, the availability of space and other factors beyond our control (like the Assistant Editor being strangled by an innocent passer-by after one of his appalling puns) may limit our ability to bring them to you.

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43	Marconi UHF FM Signal Generator Type TF 2012	1	£350
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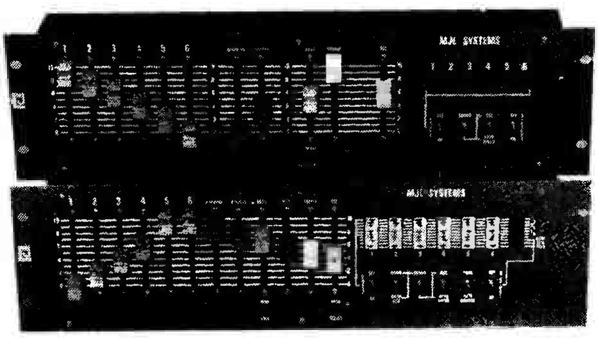

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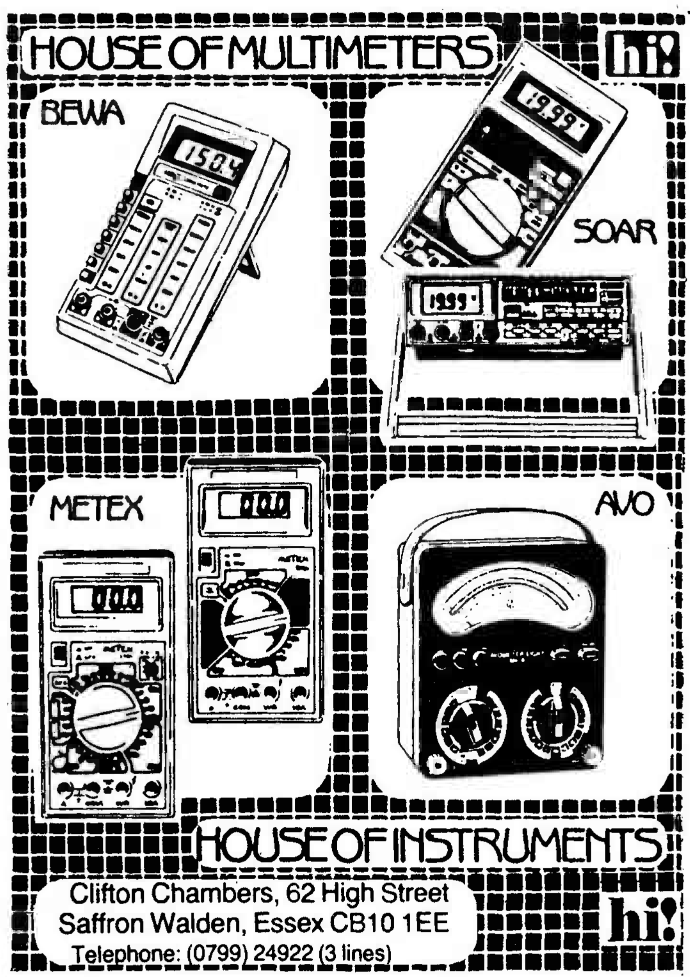

VARIO UPDATE

Lindsay Ruddock's vertical speed indicator project in our April and May issues aroused considerable interest. Here the author replies to some of the suggestions made by readers regarding the design.

One modification which has been suggested is the addition of 'total energy' compensation (see Read/Write, August '84 ETI, page 62). It is the author's intention to develop such a system at some stage, but it would require such extensive modifications that it might be better to think in terms of designing a new vario from scratch. There seems to be little demand for total energy compensation from hang glider pilots, probably because of the extra complication introduced by the need to plumb in a source of pitot pressure and because hang glider pilots are more aware of their airspeed than are sailplane pilots. There is, in any case, at least one variometer on the market with total energy compensation, and interested readers might like to contact the manufacturers at the address given at the end of this article.

That having ben said, there may still be a few readers who really are interested in total energy compensation and who are prepared to do a little experimenting in order to achieve it. The following notes may be of some help to them.

The ETI design senses only static pressure, which it feeds directly to the differentiator. To provide total energy compensation, the input to the differentiator should be modified to:—

$P - \frac{1}{2} pv^2$ .... (1)

where p = static pressure
P = air density
v = velocity of glider

The quantities "p" and "v" are not directly available so more manipulation is necessary:

$p - \frac{1}{2} = 2p - p - \frac{1}{2} pv^2$ .... (2)

$= 2p - (p + \frac{1}{2} p)$ .... (3)

= 2×(STATIC PRESSURE) − PITOT PRESSURE

This expression is realizable, since the quantity ($p + \frac{1}{2}pv^2$) is, in fact, the pitot pressure which can be sensed by a second pressure transducer plumbed into a pitot source.

Pitot pressure is the extra pressure that arises in a tube when the mouth of the tube faces into a stream of air. It appears in books on aerodynamics and fluid flow, and is well-known to amateur fliers and aerodynamicists — but not to ETI's assistant editor, who carefully ammended 'pitot' to 'pilot', all the way through the original script, then wondered why the author had so consistently made the same rather curious typing error - t and l being well-removed from each other on a conventional QWERTY keyboard. We're ashamed to add that the editor, despite his background in physics, had little more idea as to what pitot pressure was!

What is required, therefore, is to modify the input to the differentiator by subtracting the right amount of pitot pressure in accordance with expression (3). One possiblity is to place a summing amplifier between the static pressure transducer buffer and the differentiator, as shown in Fig. 1.

It should be emphasised that this is only a suggestion aimed at those willing and able to develop their own circuitry. The author has not tried the system and cannot offer any further practical information. Readers who are particularly interested in total energy compensation should obtain a copy of the September 1975 issue of "Soaring" magazine in which the subject is fairly well covered.

Temperature Compensation

In an effort to present as straightforward a circuit as possible in the ETI vario design, temperature compensation of the transducer was kept simple.

Better temperature compensation of the Sensym LX0503A can be easily achieved by 'tuning' the regulated voltage to the device. Since the vario circuit is not sensitive to supply voltage, it is convenient to make the regulated voltage to the complete circuit adjustable. This is implemented by replacing the 78L05A regulator chip with an adjustable op-amp regulator based on the LM10.

The original PCB was designed so as to leave space for a satellite board carrying the LM10 regulator circuit just above the transducer and to the left of the existing 78L05A regulator. There is also some space available on the underside of the transducer PCB and this can be used if there is insufficient space above, as might be the case if one of the larger transducer types has been used.

A suitable veroboard layout for the new regulator circuit is shown

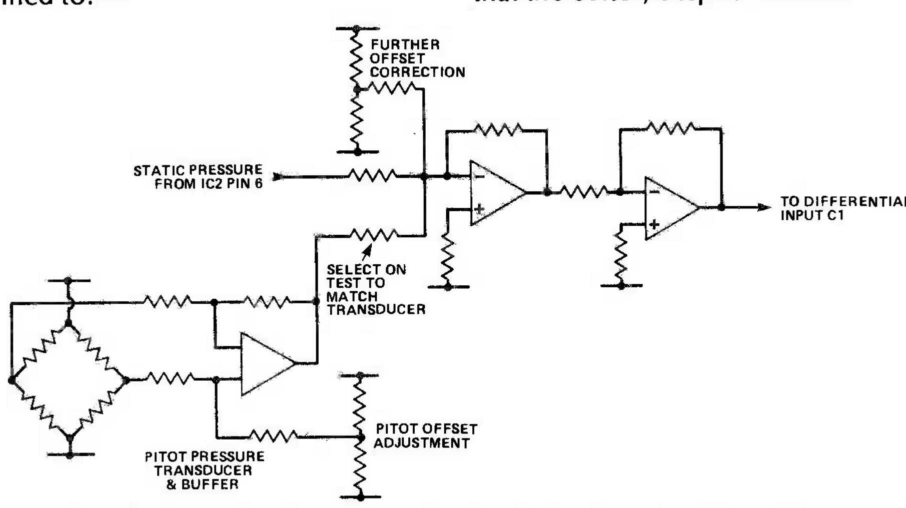

Fig. 1 Suggested modification to the original vario circuit to give total energy compensation.

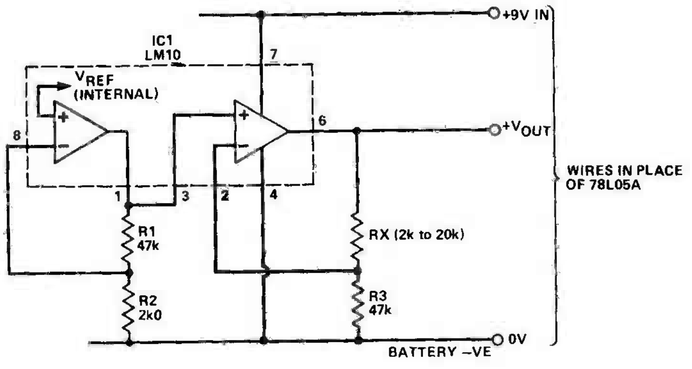

Fig. 2 Adjustable regulator arrangements to replace the 78L05A.

in Fig. 3. It was not considered worthwhile producing a PCB layout for such a small board and so simple a circuit. Note, when you come to assemble the board, that one of the links is underneath the IC and don't forget to break the tracks in the positions indicated. Do not use an IC socket as this would make the board too deep to fit easily in the available space. It is quite a good idea to solder short leads in place of R_x to begin with as this will save you having to remove the board to try different values of resistance and will also reduce the risk of damage to the tracks caused by repeated solering and desoldering.

When complete, the new board is wired directly in place of the original 78L05A regulator. A little tape or a sticky pad should be sufficient to hold it in place and prevent it from touching any other part of the circuitry. Note that the previously optional 100uF decoupling capacitor, C4, should now be fitted.

The resistor R_x sets the regulated voltage. eg R_x = 1k, V = 5V, R_x = 13k, V = 6.25V

$$V = 4.9 \times \left(\frac{R_x + 47k}{47k} \right) V$$

A good starting voltage is 5.5V, R_x = 5.6K.

R_x is adjusted downwards if the vario reads sink as it cools (use the fridge to find out) and vice versa. A large percentage of LX0503A devices end up with satisfactory temperature compensation with supply voltages of between 5 and 5.5 volts, which explains why the LX0503A is shown wired across 5V in the original design.

Further benefits of using the LM10 are that battery life is tripled to a hundred hours from an alkaline battery and ordinary zinc carbon types may also now be used, giving about 50 hours. This is because not only is battery drain halved (the 78L05A draws 3mA standing current), but the battery endpoint voltage is lowered — the LM10 regulator requires only 0.2 volts input to output differential compared to 2.5V for the 78LO5A. Other adjustable regulators can be used, but have not been checked out.

Note that while tuning the supply voltage is recommended as a method of temperature compensation for the LX0503A, the alternative transducer, the MPX100A, can only be compensated by the single series resistor/constant supply excitation voltage method as outlined in the original article.

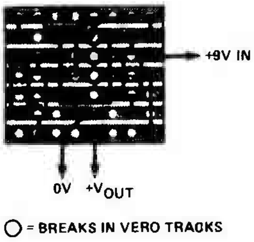

Fig. 3 Veroboard layout for the regulator circuit. The component values are given in Fig. 2.

Some people have acquired Foxboro transducers. For these, and Druck-Keller types, constant current excitation is best. The precise current affects sensitivity but for compensation purposes the absolute value does not matter. A suitable circuit is shown in Fig. 4.

All the compensation methods mentioned compensate explicitly only for span. Since the operating pressure range is not too great, it is not worth considering offset errors separately.

A word of explanation for all these compensation methods is probably in order. The major temperature dependent parameters of a piezoresistive pressure transducer are:

1. temperature coefficient of bridge resistance (approx. +2000ppm/C.).

2. temperature coefficient of gauge factor or pressure sensitivity (approx. −2000ppm/C.).

Note the opposite signs of these coefficients.

In the best transducers, eg Foxboro, Druck-Keller, these coefficients are equal as well as opposite, which explains why constant current excitation provides automatic compensation.

In the case of the MPX100A, constant current excitation causes over compensation as the magnitude of the temperature coefficient of bridge resistance is greater than the temperature coefficient of gauge factor. Something in between has to be used, which is why a compensating resistor in series with a constant voltage is recommended. Adjustment is easy and the method gives very satisfactory compensation, even for use as an altimeter.

In the case of the LX0503A, the least consistent of all the low-cost transducers on the market, the gauge factor temperature coefficient is much greater than the bridge resistance temperature coefficient. Compensation must be by some other method such as using the internal Vbe multiplier.

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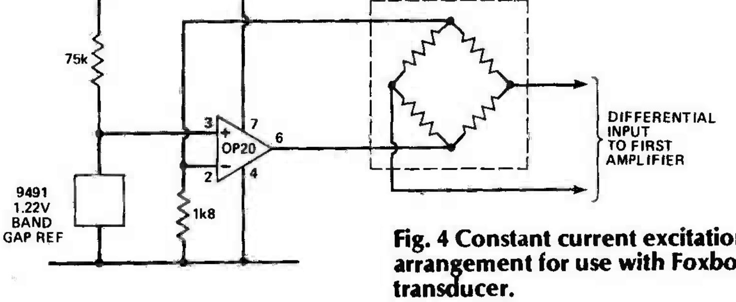

Fig. 4 Constant current excitation arrangement for use with Foxboro transducer.

The total energy compensated variometer mentioned in this article is manufactured by Thunderbird Electronics Ltd, 20 Buttgarden Street, Bideford, Devon, tel 02372-5133.

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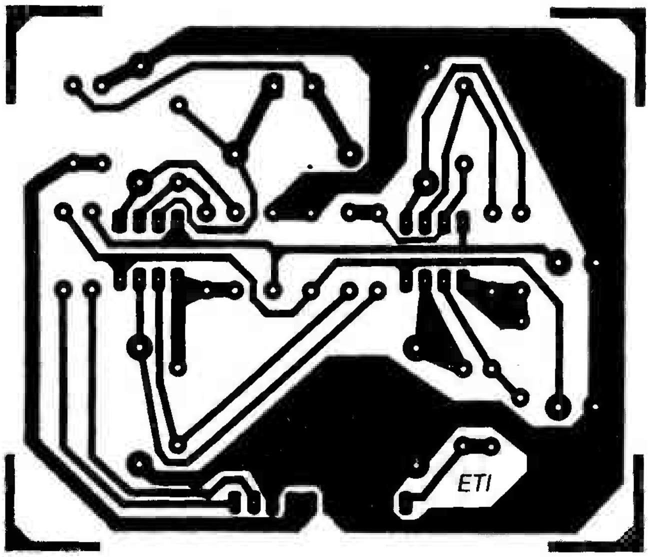

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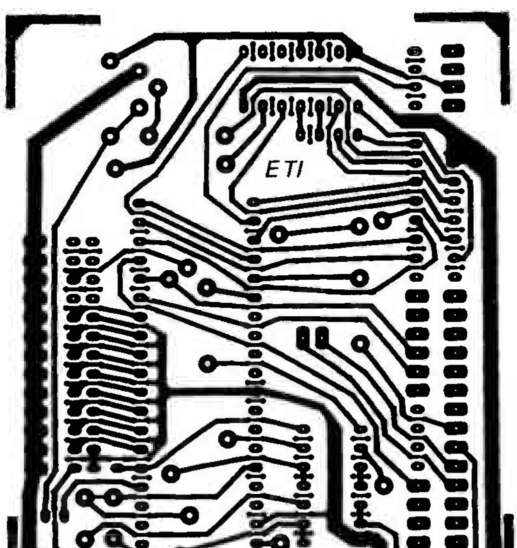

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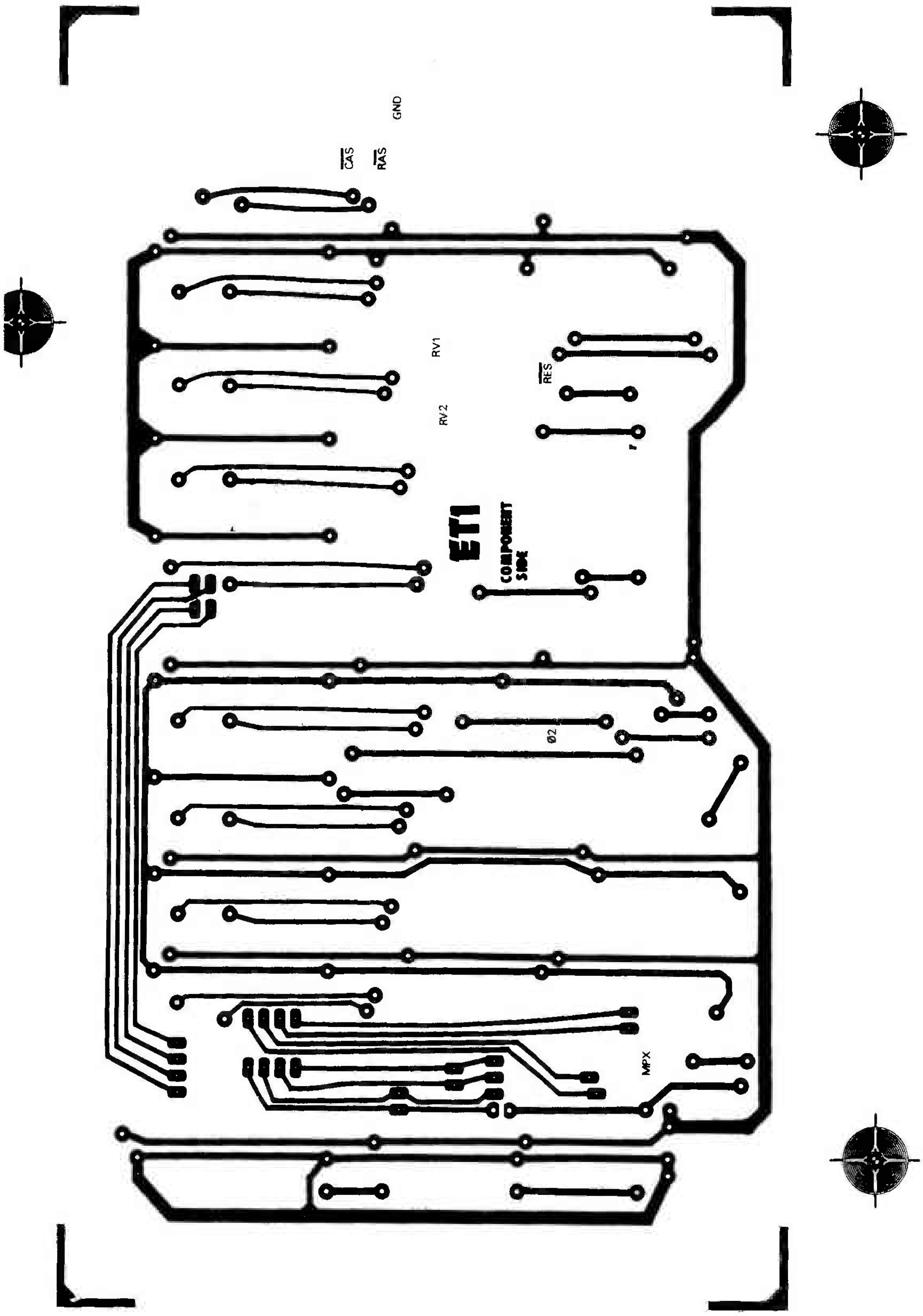

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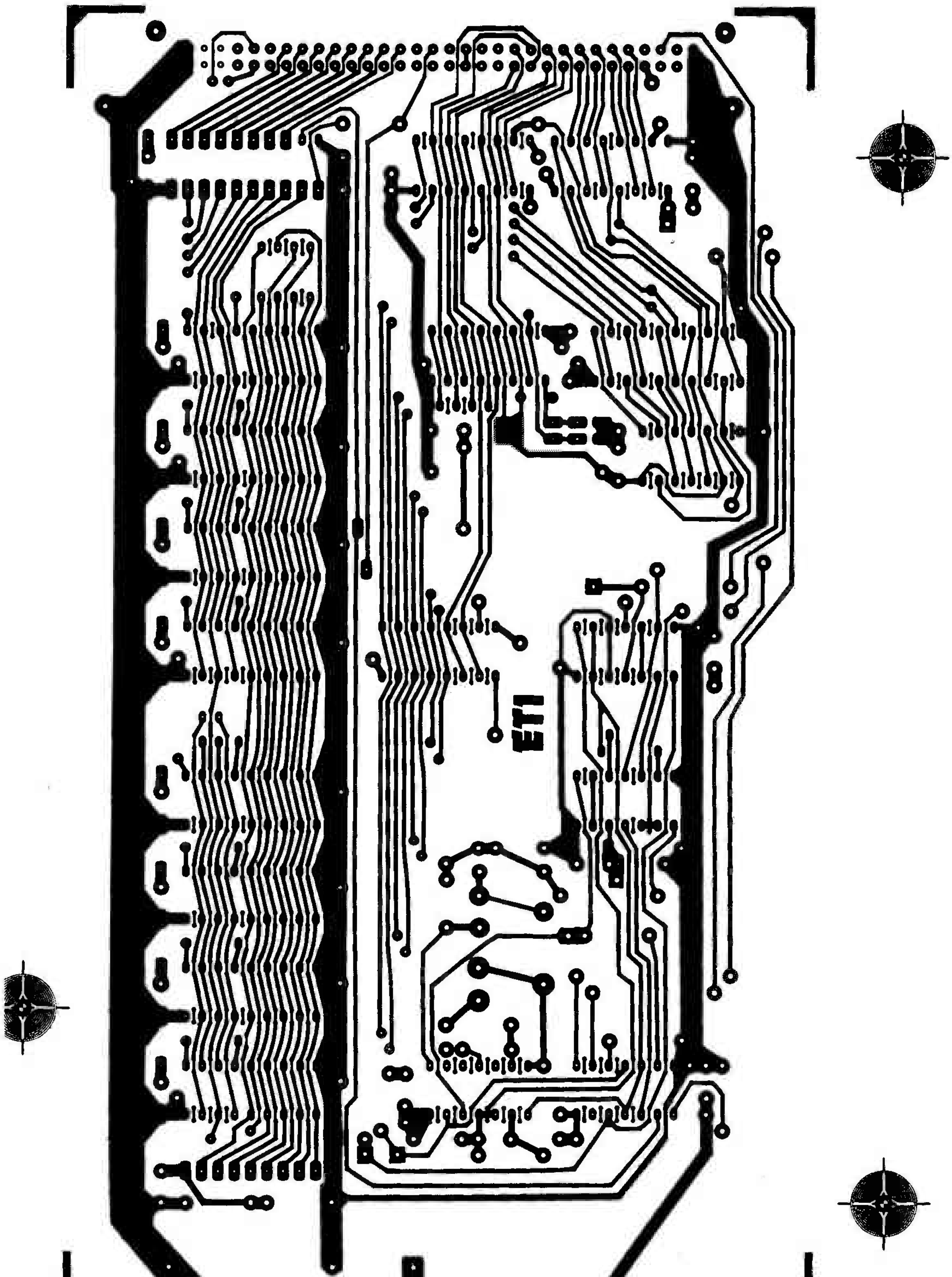
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