Australia $1.35 Malaysia $4.95 IR £1.26 (inc. VAT)

PRACTICAL ELECTRONICS

DECEMBER 1982

85p

PE Micrograsp

Stylochord

Also... MICRO-FILE Pull-out MICROPROCESSOR DATA

ELECTRONIC HOBBIES FAIR

50p Coupon Inside

PRACTICAL ELECTRONICS

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR JANUARY ISSUE WILL BE ON SALE FRIDAY, DECEMBER 10th, 1982
(for details of contents see page 66)

WATFORD ELECTRONICS

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

ALL DEVICES BRAND NEW. FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED (TEL. ORDERS BY ACCESS NOW ACCEPTED). TRADE AND EXPORT INQUIRY WELCOME. P & P ADD 50p TO ALL CASH ORDERS. OVERSEAS POSTAGE AT COST.

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

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

ELECTROLYTIC CAPACITORS (Values in µF) **500V**: 10µF **52p**; 47 **78p**; **63V**: 0.47, 1.0, 1.5, 2.2, 3.3 **8p**; 4.7 **9p**; 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **16p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V**: 68 **20p**; 100 **17p**; 220 **24p**; **40V**: 6.8 **15p**; 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V**: **50p**; 3300 **76p**; 4700 **92p**; **16V**: 2.5, 40 **8p**; 47, 68, 100 **9p**; 125 **12p**; 220 **13p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

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

TANTALUM BEAD CAPACITORS:
35V: 0.1µ, 0.22, 0.33 **15p**; 0.47, 0.68, 1.0, 1.5 **16p**; 2.2, 3.3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15 **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; 220 **88p**; **10V**: 15, 22 **26p**; 33, 47 **35p**; 100 **55p**.

SILVER MICA (pF)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 **15p each**
220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF **21p each**
1000, 1200, 1800 **30p each**
3300, 4700 **60p each**

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

CERAMIC Capacitors: 50V
Range 1pF to 6800pF **4p**; 10nF, 15n, 22, 33, 47nF **5p**; 100nf/30V **5p**.

POTENTIOMETERS: Carbon Track
0.25W Log & Linear Values

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

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm track

5KΩ-500KΩ Single gang	70p
10KΩ 500KΩ Dual gang	110p

PRESET POTENTIOMETERS

0.1W 50Ω 2.2M Mini Vert & Horiz	7p
0.25W 100Ω 3.3MΩ Horiz larger	10p
0.25W 250Ω 4.7MΩ Vert.	10p

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

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

POLYSTYRENE Caps:

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

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

TRANSISTORS

				BSX29	34	TIP42B	58	2N2904	28	2SC1679	190
				BSY95A	25	TIP120	70	2N2905A/6	26	2SC1678	140
				BU105	170	TIP121	73	2N2907A	26	2SC1923	50
AC125/6	35	BC477/8	40	BU205	190	TIP141	105	2N2926G	10	2SC1945	225
AC127/8	35	BC516/7	40	BU206	200	TIP142	105	2N3053	26	2SC1953	90
AC141/2	30	BC547/8	12	BU208	200	TIP147	120	2N3054	58	2SC1957	90
AC176	28	BC549C	14	MD8001	250	TIP2955	60	2N3055	48	2SC1969	140
AC187/8	32	BC556/7	15	MJ2955	70	TIP3055	60	2N3442	140	2SC2028	85
ACY17/18	70	BC558/9	15	MJE340	54	TIS43	32	2N3565	15	2SC2029	210
ACY19/20	75	BCY70	16	MJE370	100	TIS44/45	45	2N3614	199	2SC2078	170
ACY21/22	75	BCY71/2	20	MJE371	100	TIS48	50	2N3615	199	2SC2091	85
AD142	120	BD124	115	MJE520	95	TIS88A	50	2N3663	15	2SC2166	165
AD149	79	BD131/2	48	MJE2955	99	TIS90	30	2N3702/3	10	2SC2314	85
AD161/2	42	BD133	60	MJE3055	70	TIS91/93	32	2N3704/5	10	2SC2465	125
AF11B	95	BD135	45	MPF102	40	UC734	65	2N3706/7	10	2SC2547	30
AF139	40	BD136/7	40	MPF103/4	30	VK1010	80	2N3708/9	10	2SD234	75
AF239	55	BD138/9	40	MPF105	30	VN10KM	55	2N3710	10	2SK45	90
BC107/8	10	BD140	40	MPF106	40	VN46AF	78	2N3771	179	2SK288	225
BC107B	12	BD144	198	MPSA05	25	VN66AF	80	2N3772	195	2SJ83	225
BC108B	12	BD245	45	MPSA06	25	VN88AF	94	2N3773	210	2SJ85	225
BC108C	12	BD378	70	MPSA12	32	VN89AF	96	2N3819	22	3N128	112
BC109	10	BD434	55	MPSA55	30	ZTX107/8	11	2N3820	38	3N140	112
BC109B	12	BD695A	125	MPSA56	30	ZTX109	12	2N3822/3	45	40097	120
BC109C	12	BD696A	125	MPSA70	30	ZTX212	28	2N3866	90	40100	215
BC117/8	20	BDY56	180	MPSU02	58	ZTX300	13	2N3903/4	15	40101	130
BC140/42	30	BDY60	160	MPSU05	55	ZTX301/2	16	2N3906/5	15	40250	95
BC147/8	9	BF167	29	MPSU06	55	ZTX303	25	2N4037	46	40251	150
BC147B	10	BF177	25	MPSU52	65	ZTX304	17	2N4058	10	40311	60
BC148C	10	BF178	30	MPSU55	60	ZTX314	25	2N4061/2	10	40313	130
BC149	9	BF179	35	MPSU56	60	ZTX320/26	30	2N4069	45	40315	90
BC149C	12	BF180	38	DC23/26	170	ZTX451	23	2N4427	80	40316	95
BC153/4	27	BF194/5	12	OC28/36	220	ZTX341	30	2N4859	78	40317/20	80
BC157/8	10	BF196/7	12	OC41/42	75	ZTX500/1	14	2N4871	55	40360	60
BC159	11	BF198/9	18	OC44	75	ZTX502/3	18	2N5135/6	20	40361/62	70
BC167A	10	BF200	30	OC45/70	40	ZTX504	25	2N5138	18	40406/7	75
BC168C	10	BF224	25	OC71/72	40	ZTX531	25	2N5172	18	40408	75
BC169C	10	BF244A	28	OC76	50	ZTX550	25	2N5179	45	40411	285
BC170	15	BF244B	29	OC81/82	50	2N696	30	2N5180	45	40412	90
BC171/2	11	BF256B	35	OC83/84	40	2N697	23	2N5191	75	40467	130
BC173	11	BF257/8	32	OC170/1	50	2N698	40	2N5194	80	40468	85
BC177/8	16	BF259	35	OC200/2	50	2N699	48	2N5305	24	40594	105
BC179/81	20	BF274	42	TIP29A	32	2N706A	19	2N5457	30	40595	110
BC182/3	10	BF336	40	TIP29C	38	2N708	19	2N5458/9	30	40603	110
BC184	10	BF451	35	TIP30A	35	2N914/5	32	2N5485	36	40636	175
BC182L	10	BF594/5	30	TIP30C	37	2N918	35	2N5777	45	40673	70
BC183L	10	BFR39/40	23	TIP31A	38	2N930	20	2N6027	32	40871/2	90
BC184L	10	BFR41/79	23	TIP31C	37	2N1131/2	24	2N6109	60		
BC186/7	26	BFR80/81	25	TIP32A	38	2N1303/4	65	2N6290	70		
BC212/3	10	BFR98	105	TIP32C	42	2N1305/7	60	2SA636	250		
BC212L	10	BFX29/84	28	TIP33A	65	2N1308	68	2SA671	250		
BC213L	10	BFX85/86	28	TIP33C	78	2N1613	30	2SA715	60		
BC214	10	BFX87/88	28	TIP34A	74	2N1671B	160	2SC495/6	70		
BC214L	10	BFY50/51	23	TIP34C	88	2N160	295	2SC1061	250		
BC237/8	14	BFY52	23	TIP35A	110	2N2219A	28	2SC1096	85		
BC307B	14	BFY56	32	TIP35C	128	2N2220A	26	2SC1162	30		
BC308B	16	BFY64	35	TIP36A	130	2N2221A	26	2SC1172	125		
BC327/8	15	BFY81	120	TIP36C	140	2N2222A	25	2SC1173	125		
BC337/8	15	BFY90	80	TIP41A	50	2N2369A	18	2SC1306	100		
BC441	34	BRY39	40	TIP41B	52	2N2646	45	2SC1307	150		
BC461	34	BSX20	20	TIP42A	55	2N2846	80	2SC1449	85		

LINEAR IC's

555 CMOS	80	LF398	475	RC4136D	69	XR2206	300
702	75	LM10	325	S566B	225	XR2207	375
709C 8 pin	35	LM301A	24	SAB3209	425	XR2211	575
710	48	LM307	45	SAB3210	325	XR2216	675
741	14	LM308	95	SAB3271	485	XR2266	360
747C 14 pin	65	LM311	70	SAB4209	595	ZN414	80
748C 8 pin	36	LM318	150	SAS560	150	ZN419CE	190
753 8 pin	185	LM319	215	SAS570	150	ZN423E	138
810	159	LM324	30	SG3402	295	ZN424E	130
9400CJ	350	LM334Z	90	SL490	350	ZN425E-8	345
AY-1-1320	225	LM335	128	SN76003N	350	ZN426E-8	300
AY-1-5050	99	LM339	47	SN76013N	350	ZN427E-8	590
AY-1-5051	160	LM348	64	SN76018	195	ZN428E	410
AY-1-6720	210	LM349	115	SN76023N	350	ZN429E-8	210
AY-3-1270	730	LM358	115	SN76033	350	ZN459	570
AY-3-8910	375	LM377	175	SN76115N	215	ZN1034E	200
AY-3-8912	625	LM379	480	SN76131	125	ZN1040E	675
AY-5-1230	450	LM380	75	SN76227N	95	ZNA234E	850
AY-5-1317A	630	LM381N	145	SN76477	420		
AY-5-4007D	520	LM382	115	SN76488	480		
AY-5-8100	775	LM384	140	SN76660	120		
CA3011	130	LM386	90	SP8629	299		
CA3012	175	LM387	120	TA7120	150		
CA3014	275	LM389	95	TA7204	200		
CA3018	86	LM393	100	TA7205	90		
CA3019	80	LM394CH	290	TA7222	150		
CA3020	210	LM725CN	325	TA7310	150		
CA3023	210	LM733	70	TAA621AX1	295		
CA3028A	95	LM2917	195	TAA661A	190		
CA3035	255	LM3302	75	TAA700	275		
CA3036	270	LM3900	50	TAA900	395		
CA3043	275	LM3909	85	TAD100	159		
CA3045	365	LM3911	125	TBA120S	70		
CA3046	70	LM3914	180	TBA540	275		
CA3048	220	LM3915	250	TBA550Q	330		
CA3059	285	LM3916	250	TBA641-A12/BX1	290		
CA3075	213	LM13600	110	TBA651	190		
CA3080E	70	LS7220	280	TBA800	80		
CA3081	190	M252AA	625	TBA810S	95		
CA3086	48	M253AA	1150	TBA820	80		
CA3089E	215	M51513L	230	TBA920Q	200		
CA3090AQ	375	M51515L	320	TBA990	350		
CA3123	165	MB3712	220	TCA270	350		
CA3130	90	MB3756	440	TCA280A	220		
CA3140	40	MC1303	88	TCA940	175		
CA3160	95	MC1304P	260	TCA965	120		
CA3161E	160	MC1310P	150	TDA1004	290		
CA3162E	450	MC1445	250	TDA1008	310		
CA3189	200	MC1458	35	TDA1010	198		
CA3240	110	MC1469	300	TDA1022	499		
HA1336W	240	MC1494	694	TDA1024	115		
HA1388	255	MC1495	350	TDA1034	350		
ICL7106	750	MC1496L	70	TDA1490	325		
ICL7107	975	MC1596	225	TDA2002	325		
ICL7611	99	MC1648	290	TDA2004	495		
ICL7660	190	MC1709G	90	TDA2006	300		
ICL8038CC	300	MC3302	90	TDA2020	320		
ICL8211	350	MC3340P	120	TDA2030	295		
ICM7204	550	MC3360P	120	TDB0791	420		
ICM7205	1150	MC3401	65	TL061CP	40		
ICM7207	475	MC3403	75	TL062CP	60		
ICM7215	1050	MC3405	150	TL064CN	98		
ICM7216A	1950	MC3423P	80	TL071CP	24		
ICM72168	1950	MFC6040	75	TL072CP	45		
ICM7216C	1950	MK50398	635	TL074CN	100		
ICM7217A	790	ML924	275	TL081CP	24		
ICM7224	785	MSM5526	820	TL082CP	45		
ICM7240	300	NE515	275	TL083CP	75		
ICM7555	80	NE529	225	TL084CP	90		
ICM7556	150	NE531	140	TL091CP	55		
LA3350	250	NE543	225	TL170	50		
LA4031P	340	NE544	210	UA2240	120		
LA4032	295	NE555	16	UA78540	230		
LA4400	440	NE556DB	45	UAA170	170		
LC7120	300	NE560	325	UAA180	170		
LC7130	340	NE561	395	UAA1003-3	935		
LC7137	395	NE5628	410	ULN2003	85		
LF347	150	NE564	420	ULN2004	90		
LF351	48	NE565A	120	ULN2283	100		
LF353	95	NE566	155	UPC575	350		
LF355	85	NE567	140	UPC1025H	375		
LF356	96	NE570	410	UPC1182	330		
LF357	110	NE571	400	UPC1156H	290		
		NE5534	150	UPC1366	195		
		OM335	750				

COMPUTER IC's

1702	350	81LS95	80
1802CP	650	81LS96	80
2102-2	100	81LS97	80
2112-2	250	81LS98	85
2114L-300n	90	8118-10	250
2114L-200n	95	8123	125
2147-3	425	8155	350
2532-450n	350	8156	350
2564	£12	8202	£25
2708	225	8205	255
2716-5V	215	8212	110
2732-450n	350	8214	425
2764	999	8215-300	300
3242	590	8216	100
4027	190	8224	110
4116-150	85	8226	250
4116-200	80	8228	220
4118-250	325	8243	270
4164-200	500	8250	850
4334-3 (CMOS 2114)	325	8251A	250
4816-100ns	225	8253	400
4864-3 64K	500	8255	225
5101	220	8256A	£35
6116-150ns	390	8257A	400
6116L-120ns	550	8259	395
6117-100n	490	8271	£36
6167-6	795	8279	385
6502 CPU	325	8284	350
6503	600	8288	£10
6504-250	550	8T26A	99
6520	100	8T27	150
6521	100	8T28A	120
6522 VIA	300	8T31	350
6530 RRIOT	£11	8T95N	90
6532 RIOT	570	8T97N	90
6545 CRTC	899	9364AP	550
6551 ACIA	650	9602	220
6592 PC	£20	AM26LS31C	125
6800	225	AM26LS32A	125
6802	250	AY-3-1015	300
6803	850	AY-5-1013	300
6804	160	AY-5-1350	388
6805	670	AY-5-2376	600
6808	520	AY-5-3600	750
6809	630	COM8017	275
6810	115	COM8116	700
6820	100	DM8131	275
68B21	220	DP8304BN	250
6821	100	DS3691N	320
6840	375	DS88LS120N	275
6843	£12	FD1761	£15
6845	685	FD1771	£15
6847	650	FD1791	£22
6850	110	FD1793	£23
6852	250	FD1795	£28
6854	599	FD1797	£28
6875	500	HD26501	75
68000	£70	HMG167-6	795
74C922	420	IM6402	380
8080A	250	INS8060N	1050
8085A	350	INS8154N	£9
		MC1488	55
		MC1489	55
		MC14411	675
		MC14412	775
		MC3446	250
		MC3447P	315
		MK3886-2M	£7
		MM5280D	695
		MM5303	635
		MM5307	1275
		MM5387A	475
		MM58174	770
		RO-3-2513L	650
		RO-3-2513U	600
		SFF96364E	800
		TMS2716-3	725
		TMS6011	365
		TMS4164-15	475
		TMS9918	£35
		TMS9928	£35
		ULN2003	90
		UPD7002	440
		Z80CPU 2.5	299
		Z80ACPU4M	300
		Z80CTC	250
		Z80ACTC	260
		Z80B	£11
		Z80DART	495
		Z80ADART	550
		Z80ADMA	895
		Z80DMA	675
		Z80P10	260
		Z80AP10	275
		Z80S10-1	850
		Z80AS10	980

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420
74C923	500

74S Series

74S00	30
74S02	32
74S04	32
74S10	40
74S20	40
74S30	40
74S32	70
74S74	75
74S132	110
74S133	60
74S138	125
74S139	150
74S158	195
74S188	210
74S189	158
74S194	320
74S201	350
74S225	525
74S241	390
74S260	50
74S262	850
74S287	225
74S288	150
74S289	290
74S301	000
74S365	000
74S374	365
74S470	325
74S471	620
74S472	1150
74S475	825
74S571	620

75 Series

75107/8	95
75110	90
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	65

TTL 7400

7400	11	7412	18	74156	40
7401	11	7413	18	74157	30
7402	11	7414	20	74159	80
7403	12	7416	20	74160	60
7404	13	7417	20	74161	48
74L04	85	7420	15	74162	40
7405	15	7421	20	74163	40
7406	20	7422	20	74164	40
7407	20	7423	20	74165	48
7408	14	7425	18	74166	48
7409	14	7426	18	74167	150
7410	14	7427	18	74170	125
7411	16	7428	25	74172	250
		7430	14	74173	60
		7432	20	74174	54
		7433	22	74175	19
		7437	25	74176	40
		7438	22	74177	45
		7440	15	74178	80
		7441	55	74179	80
		7442	32	74180	40
		7443	90	74181	115
		7444	90	74182	60
		7445	55	74184	90
		7446	60	74185	95
		7447	35	74186	470
		7448	40	74188	250
		7450	16	74190	48
		7451	16	74191	46
		7453	16	74192	46
		7454	16	74193	45
		7460	16	74194	40
		7470	30	74195	40
		7472	24	74196	46
		7473	24	74197	40
		7474	20	74198	80
		7475	25	74199	84
		7476	25	74221	54
		7480	40	74246	120
		7481	120	74247	120
		7482	65	74248	120
		7483	38	74249	120
		7484	70	74251	65
		7485	60	74259	150
		7486	20	74265	55
		7489	170	74273	150
		7490	20	74276	120
		7491	35	74278	100
		7492	25	74279	50
		7493	25	74283	50
		7494	35	74284	155
		7495	35	74285	155
		7496	35	74290	105
		7497	90	74293	80
		74100	80	74297	236
		74104	50	74298	100
		74105	55	74351	195
		74107	20	74365	30
		74109	25	74366	30
		74110	35	74367	30
		74111	55	74368	30
		74112	170	74390	75
		74116	50	74393	90
		74118	55	74490	95
		74119	60		
		74120	60		
		74121	25		
		74122	35		
		74123	35		
		74125	35		
		74126	35		
		74128	35		
		74132	28		
		74136	28		
		74141	55		
		74142	175		
		74143	210		
		74144	210		
		74145	50		
		74147	75		
		74148	60		
		74150	50		
		74151	40		
		74153	40		
		74154	55		
		74155	40		

74LS

LS00	11	LS26	14	LS248	55
LS01	11	LS27	12	LS249	55
LS02	11	LS28	14	LS251	32
LS03	12	LS30	12	LS253	32
LS04	12	LS32	13	LS257	30
LS05	13	LS33	14	LS258	35
LS08	12	LS37	14	LS259	55
LS09	12	LS38	15	LS260	22
LS10	13	LS40	13	LS261	100
LS11	13	LS42	28	LS266	18
LS12	12	LS47	35	LS273	54
LS13	20	LS48	45	LS275	125
LS14	26	LS49	50	LS279	30
LS15	13	LS51	14	LS280	90
LS20	13	LS54	14	LS283	40
LS21	12	LS55	14	LS290	53
LS22	12	LS63	120	LS293	40
		LS73	18	LS295	75
		LS74	18	LS298	80
		LS75	20	LS299	150
		LS76	18	LS320	200
		LS78	18	LS323	160
		LS83	36	LS324	168
		LS85	42	LS325	295
		LS86	16	LS326	240
		LS90	24	LS327	240
		LS91	60	LS347	95
		LS92	32	LS348	90
		LS93	23	LS352	62
		LS95	40	LS353	62
		LS96	95	LS362	750
		LS107	40	LS363	140
		LS109	23	LS364	140
		LS112	22	LS365	28
		LS113	16	LS366	32
		LS114	22	LS367	28
		LS122	36	LS368	35
		LS123	38	LS373	60
		LS124	90	LS374	55
		LS125	24	LS375	50
		LS126	25	LS377	85
		LS132	35	LS378	80
		LS133	30	LS379	110
		LS136	24	LS384	395
		LS138	25	LS385	250
		LS139	28	LS390	46
		LS145	70	LS393	42
		LS147	100	LS395	95
		LS148	70	LS399	150
		LS151	40	LS445	100
		LS153	40	LS471	620
		LS154	80	LS490	200
		LS155	30	LS540	100
		LS156	36	LS541	80
		LS157	27	LS640	180
		LS158	30	LS641	180
		LS160	32	LS645	180
		LS161	37	LS668	125
		LS162	37	LS669	120
		LS163	37	LS670	100
		LS164	43	LS673	550
		LS165	50		
		LS166	52		
		LS168	85		
		LS170	70		
		LS173	55		
		LS174	50		
		LS175	40		
		LS181	90		
		LS183	180		
		LS190	36		
		LS191	36		
		LS192	36		
		LS193	37		
		LS194	33		
		LS195	33		
		LS196	45		
		LS197	45		
		LS221	55		
		LS240	55		
		LS241	55		
		LS242	55		
		LS243	55		
		LS244	55		
		LS245	70		
		LS247	50		

CMOS

4000	10	4022	40	4500	675		
4001	10	4023	13	4501	28		
4002	12	4024	32	4502	60		
4006	50	4025	13	4503	35		
4007	14	4026	80	4504	75		
4008	32	4027	20	4505	185		
4009	24	4028	39	4506	35		
4010	24	4029	45	4507	35		
4011	10	4030	15	4508	130		
4012	16	4031	125	4510	48		
4013	20	4032	80	4511	46		
4014	46	4033	125	4512	42		
4015	40	4034	140	4513	199		
4016	20	4035	45	4514	125		
4017	32	4036	275	4515	125		
4018	45	4037	115	4516	65		
4019	25	4038	110	4517	275		
4020	42	4039	290	4518	40		
4021	40	4040	40	4519	30		
		4041	40	4520	70		
		4042	40	4521	130		
		4043	40	4522	125		
		4044	40	4526	60		
		4045	105	4527	50		
		4046	46	4528	50		
		4047	40	4529	150		
		4048	40	4530	90		
		4049	25	4531	130		
		4050	25	4532	50		
		4051	45	4534	455		
		4052	60	4536	275		
		4053	50	4538	70		
		4054	85	4539	90		
		4055	85	4541	140		
		4056	85	4543	70		
		4057	1915	4544	150		
		4059	435	4548	40		
		4060	45	4549	375		
		4061	1195	4553	245		
		4062	995	4554	190		
		4063	85	4555	35		
		4066	24	4556	35		
		4067	245	4557	320		
		4068	14	4558	120		
		4069	13	4559	395		
		4070	13	4560	160		
		4071	13	4561	104		
		4072	13	4562	495		
		4073	15	4566	165		
		4075	13	4568	250		
		4076	50	4569	175		
		4077	13	4572	36		
		4078	15	4580	460		
		4081	13	4581	250		
		4082	13	4582	99		
		4085	50	4583	99		
		4086	60	4584	48		
		4089	125	4585	99		
		4093	20	4597	330		
		4094	70	4598	290		
		4095	95	4599	290		
		4096	70	40097	45		
		4097	190	40098	42		
		4098	75	40100	215		
		4099	75	40101	130		
		4160	95	40102	140		
		4161	99	40103	175		
		4162	99	40104	95		
		4163	99	40105	115		
		4174	99	40106	75		
		4175	105	40107	60		
		4194	105	40108	450		
		4408	790	40109	100		
		4409	790	40110	300		
		4410	725	40114	240		
		4411	690	40163	50		
		4412	790	40174	45		
		4415	480	40192	95		
		4419	280	40193	95		
		4422	770	40194	90		
		4433	770	40195	80		
		4435	850	40244	195		
		4440	999	40245	195		
		4450	350	40373	240		
		4451	350	40374	245		
		4490	350	45106	595		

SPEAKERS
8Ω 0·3W, 2"; 2·25", 2·5", 3" 80p
0·3W, 2·5" 40Ω; 64Ω or 80Ω 80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CR033	250
OA9	40
OA47	12
OA70	12
OA79	15
OAB1	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

BRIDGE RECTIFIERS
(plastic case)

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

ZENERS
Range 2V7 to 39V 400mW **8p each**
Range 3V3 to 33V 1·3W **15p each**

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

Noise Diode
Z5J 195

SCR's Thyristors

0·8A-100V	32
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

TRIACS

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

DIAC
ST2 25

SOLDERCON PINS
100 70p
500 325p

OPTO ELECTRONICS

LEDS including Clips	
TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 ·2" Red	12
0·2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0·2" Flashing LED Red	55
0·2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0·2" Tri colour LEDs Red/Green/Yellow	85
0·2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90

7 Segment Displays

TIL321 ·5" C.An	115
TIL322 ·5" C.th	115
DL704 ·3" C.Cth	99
DL707 ·3" C.Anod	99
·8" Orange C.A. FND357 or 500	250
	120
3" Green C.A.	140
±1·3" Red or Green	150
Bargraph 10 seg. Red	225
Bargraph NSM3914	500

0·5" LIQUID CRYSTAL DISPLAYS

3½ digit	495
4 digit	530
6 digit	625
BPX25	195
BPW21	295
BPX65	270
IL74	45
ILD74	99
ILQ74	185
TIL111	75
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

ALUM. BOXES

3×2×1"	65
4×2½×2"	85
4×2½×2½"	103
4×4×2½"	120
5×4×2"	105
5×2½×1½"	90
5×2½×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

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

DALO ETCH RESIST
Pen + Spare tip 90p

COPPER CLAD BOARDS

	Fibre Glass Single sided	Double sided	SRBP 9·5"×8·5"
6"×6"	90p	110p	95p
6"×12"	150p	195p	

VEROBOARDS 0·1"

	Clad	Plain
2½×3¾"	80p	—
2½×5"	91p	—
3¾×3¾"	91p	—
3¾×5"	105p	87p
3¾×17"	360p	232p
4¾×18"	470p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	135p	
Pin Insertion Tool	178p	

'VQ' Board	180
'DIP' Board	374
Vero Strip	144
S100 Board	£14

PROTO-DECs

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

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

SPECIAL OFFER

	1+	25+
2114L-2	90p	80p
2532	350p	330p
2716	215p	199p
2732	350p	330p
4116	85p	80p
4816-100ns	225p	205p
6116-150ns	390p	360p
6520/21	115p	105p
6522	300p	280p
6820/6821	100p	90p

PRINTERS

- **MX80T** 10" Tractor Feed, 9×9 matrix, 80 column, 80 CPS, Bi-directional, Centronic Interface. Baud Rate 110-9600. **£275**
- **MX80FT/3** Tractor & Friction feed. Has hi-resolution, bit image graphics, Subscript & Superscript, italics & underlining facility plus all the MX80FT features. **£325**
- **NEC PC-8023BE-C**, 100CPS bi-directional, logic seeking, 80 column, 7x9 Dot matrix, super/subscript, underlining, true decenders Tractor/Friction, Hi-Res, 2K Buffer, Proportional Spacing, at a Special Price **£295**

ANTEX Soldering Irons

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

Buy with Access

Just phone your order through, we do the rest.

ASTEC UHF MODULATORS
6MHz 280p
8MHz Wide Bandwidth 425p

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS

	Low profile	Wire wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

ZIF DIL SOCKET

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

DIL PLUGS (Headers)

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

RIBBON CABLE
(price per foot)

Ways	Grey	Color
10	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

ULTIMUM

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

IDC CONNECTORS (Speed block type)

2 rows	PCB PLUG with latch Strt. Pins	Angle Pins	female Header Socket	PCB Plugs Unshrouded Male Strat.	Male Angle
10 way	90p	99p	85p	60p	65p
16 way	130p	150p	110p	70p	78p
20 way	145p	166p	125p	80p	92p
26 way	175p	200p	150p	95p	110p
34 way	205p	236p	169p	110p	135p
40 way	220p	250p	190p	125p	150p
50 way	235p	270p	200p	150p	175p

EURO CONNECTORS

	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2x32 way	285p	325p	220p	295p
DIN 41612 2-3x32 way	300p	340p	240p	300p
DIN 41612 3x32 way	360p	385p	260p	400p

'D' CONNECTORS: Miniature

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS Top & Side Entry	95p	90p	100p	110p

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

TRANSFORMERS (mains Prim. 220-240V)
3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA 98p
6VA: 2x6V-·5A; 2x9V-·4A; 2x12V-0·3A; 2x15V-·25A 220p
12VA: 2x4V5-1·3A; 2x6V-1·2A; 2x12V-·5A; 2x15V-·4A 295p (35p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A 330p (60p p&p)
50VA: 2x6V-4A; 2x9V-2·5A; 2x12V-2A; 2x15V-1·5A; 2x20V-1·2A; 2x25V-2A; 2x30V-0·8A 465p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2·5A; 2x30V-1·5A; 2x40V-1·25A; 2x50V-1A 920p (60p p&p)

Amphenol Plugs
24 way IEEE 575p
36 way Centronics Parallel 550p

SIL Sockets 0·1"
20 way 65p

EDGE CONNECTORS
Two rows

	·1"	·156
2x10 way	—	135p
2x15 way	—	140p
2x18 way	180p	145p
2x22 way	199p	200p
2x23 way	210p	190p
2x25 way	225p	220p
2x28 way	210p	—
2x30 way	245p	—
2x36 way	295p	—
2x40 way	315p	—
2x43 way	395p	—
2x75 way	550p	—

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	380p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

ID HEADER SOCKET Jumper Leads 24"

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

COMPUTER CORNER

- **EPSON MX** Series Printers. Full range available. See box above for details.
- **SEIKOSHA GP100A** – Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. FREE 500 Sheets **£175**
- **EPSON HX20** Microcomputer. Portable, Full size Keyboard, LCD Virtual Screen, 5x7 Dot Matrix Printer incorporated **£1299**
- **SOFTY-2.** The complete Microprocessor development system. New powerful instructions. Accepts any 24 pin 5V single rail EPROM. Supplied fully built & tested. Price includes plug-in PSU, Watford's extended warranty & a FREE 2732. **£169**
- **WEMON.** Watford's 4K Ultimate Monitor IC for Superboard & UK101. **£10**
- **VIDEO MONITOR** 9" fully cased. B&W. Fully guaranteed. 15MHz bandwidth value for money. **£69**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with the Solid-State 30 minute Electronic Timer. **£43**
- **Spare** 'UV lamp bulbs **£9**
- **5V/5A PSU** Ready built and tested **£25**
- **MULTIRAIL PSU KIT.** Output: +5V/5A; +12V; +25V; –5V; –12V @ 1A. **£40**
- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£29**
- **Full ASC11** coded keyboard type '756' **£39**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 COMPUTER Grade Cassettes** in Library Cases **40p**
- **STACK-PACK.** Unique 10 section stackable Drawers rack including 10 x C12 Computer grade Cassettes. **550p**
- **8" Fan fold paper** (1000 sheets) (no VAT) **£7**
- **9½" Fan fold paper** (1000 sheets) (no VAT) **£7**
- **Teleprinter Roll** (no VAT) **£3.50**

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

VOLTAGE REGULATORS

1A	T03 +ve		-ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	150p		—
1A	T0220 Plastic Casing			
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		
100mA	T092 Plastic Casing			
5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
78H05 5V/5A	550	LM317K	320
78H12 12V/5A	580	LM317P	99
78HG+5 to +24V 5A	599	LM323K	500
		LM337T	175
79HG –2 25V to –24V 5A	685	LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40
4 pole c/over	240

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

PUSH BUTTON Spring loaded

Latching or Momentary 6A SPDT c/over	99
OPDT c/over	145

MINIATURE Non Locking

Push to make	15p
Push break	25p

SUB-MIN TOGGLE

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

ROCKER: 5A 250V SPST 28p
ROCKER: 10A 250V SPDT 38p
ROCKER: With neon lights red when on 10A 250V DPST 85p
ROCKER: (White) 10A 250V DPDT 72p
ROTARY: Make your own Multiway Switch Shafting Assembly accommodates up to 6 wafers 90p
Break before make Wafers Silver contacts 1 pole/12 way; 2 pole/6 way; 3 pole 4 way 4 pole/3 way 6 pole 2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 6p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way 2p/2 to 6 way 3 pole 2 to 4 way 4 pole 2 to 3 way 45p
ROTARY: Mains 250V AC 4 Amp 56p
DIL SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 87p; 10 way 135p; (SPDT) 4 way 190p.
THUMBWHEEL Mini front mounting
Decade Switch Module 220p
B.C.D. Switch Module 275p
Mounting Cheeks (pair) 75p
PROXIMITY Switch with magnet 125p

CRYSTALS

32·768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1·008M	275
1·28MHz	392
1·5MHz	420
1·6MHz	395
1·8MHz	395
1·8432M	200
2·0MHz	225
2·4576M	200
2·5MHz	225
3·2768M	150
3·57954M	98
3·6864M	300
4·0MHz	150
4·032MHz	290
4·194304M	200
4·433619M	100
4·608MHz	200
4·80MHz	200
5·0MHz	160
5·185MHz	300
5·24288M	390
6·0MHz	140
6·144MHz	150
6·5536MHz	200
7·0MHz	150
7·168MHz	250
7·68MHz	200
8·0MHz	150
8·08333M	395
8·867237M	175
9·00MHz	200
9·375MHz	350
10·0MHz	175
10·5MHz	250
10·7MHz	150
10·24MHz	200
12·0MHz	175
12·528MHz	300
14·31818M	170
14·765MHz	250
15·0MHz	200
16·0MHz	200
18·0MHz	180
18·432M	150
19·968MHz	150
20·0MHz	200
24·0MHz	170
24·930MHz	325
26·69M	150
26·670MHz	325
27·125MHz	295
27·145M	190
27·648MHz	330
38·6667M	175
48·0MHz	175
55·5MHz	400
100·0MHz	375
116·0MHz	300
145·8MHz	225

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Upgrade your BBC Micro with our upgrade kit and save yourself £ s s s . . .

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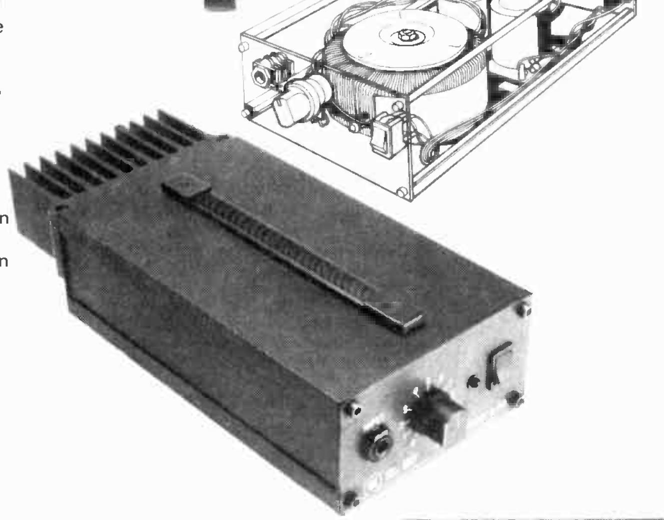

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Over the years ILP has been aware of the need for a complete packaging system for it's products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

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

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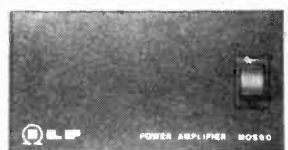
UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series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

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



Power Slaves

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

UNICASES

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

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

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NEW T.V. SOUND TUNER BUILT AND TESTED

£22.95 + £2.00 p&p.

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound.
Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction.
This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder.
Dimensions: 11¾" x 8½" x 3¼".

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

£32.95
+ £2.75 p&p.

• NOISE REDUCTION SYSTEM. • AUTO STOP. • TAPE COUNTER. • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS. • TWIN V.U. METER. • WOW & FLUTTER 0.1%. • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING. • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TAPES

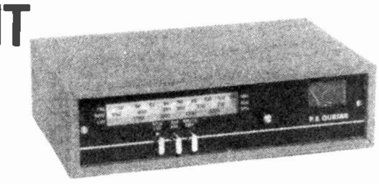
Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up wire.

Featured in April issue P.E.
Reprint 50p. Free with kit

Self assembly simulated wood cabinet – ONLY £4.50 plus £1.50 p&p.

ELECTRONICS ONLY!
Ideal for updating your existing cassette. Includes pcb diagram, all semiconductors, IC's, Capacitors, resistors. **£18.95** +£1.40p&p.

P.E. STEREO TUNER KIT



This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.
FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabalised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification, Front scale size: 10½" x 2½" approx. Complete with d diagram and instructions.

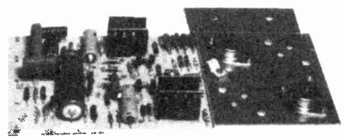
£17.95
Plus £2.50 p&p.

Self assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x 8½"x 3¼"
£3.50 Plus £1.50 p&p.

125W HIGH POWER AMP MODULES

KIT **£10.50** + £1.15 p&p
BUILT **£14.25** + £1.15 p&p

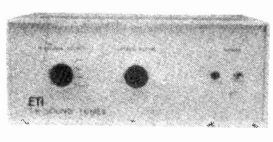
The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use.
Supplied with all parts, circuit diagrams and instructions.
ACCESSORIES: Suitable mains power supply kit with transformer: **£8.00** plus £2.00 p&p.
Suitable LS coupling electrolytic: **£1.00** plus 25p p&p.



SPECIFICATIONS:
Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
Frequency response measured @ 100 watts: 25Hz - 20KHz.
Sensitivity for 100 watts: 400mV @ 47K.
Typical T.H.D. @ 50 watts, 4 ohms: 0.1%.
Dimensions: 205 x 90 and 190 x 36 mm.

TV SOUND TUNER KIT

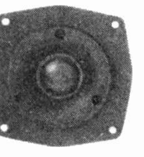
£11.45
+ £2.00 p&p.



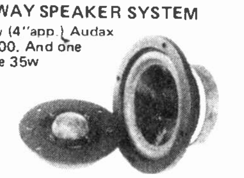
As featured in E.T.I. December '81 issue. Kit of parts including PCB, UHF tuner and selector switch with all components excluding case.
• Transformer £1.50 + £1.50 p&p (p&p free on transformer if ordered with kit).

HI-FI SPEAKERS AT BARGAIN PRICES

GOODMANS TWEETERS
8 ohm soft dome radiator tweeter (3¾"sq.) for use in up to 40W systems; with 2 element crossover.
£3.95 each (p&p £1) or
£6.95 each (p&p £1.50)



35 WATT MICRO 2-WAY SPEAKER SYSTEM
Unit comprises one 50w (4"app.) Audax soft dome tweeter HD100. And one 5" Audax bass/midrange 35w driver HIFI1JSM. Complete with 2 element crossover. Total impedance of system 4 ohms.



£8.95
PER SET + £2.70 p&p.

BIRD AUDIO STEREO CAR RADIO BOOSTER

To boost your car radio or radio cassette to 15W r.m.s. per channel.

£9.95 + £1.50 p&p.

PRACTICAL ELECTRONICS CAR RADIO KIT SERIES II

2 WAVE BAND
MW – LW

• Easy to build
• 5 push button tuning • Modern design
• 6 watt output • Ready etched and punched PCB • Incorporates suppression circuits.

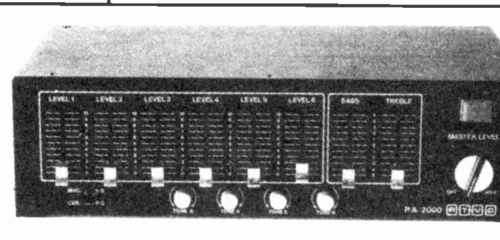
All the electronic components to build the radio, you supply only the wire and the solder, featured in Practical Electronics March issue. Features: pre-set tuning with 5 push button options, black illuminated tuning scale. The P.E. Traveller has a 6 watt output neg. ground and incorporates an integrated circuit output stage, a Mullard IF Module LP1181 ceramic filter type pre-aligned and assembled, and a Bird pre-aligned push button tuning unit.

£12.95
Plus £2.00 p&p.

Suitable stainless steel fully retractable aerial (locking) and speaker (6"x 4"app.).
available as a kit complete. **£2.50**/pack. + £1.50 p&p.

MONO MIXER AMP

Ideal for Church halls & Club houses. **£45.00** + £2.00 p&p.



50 WATT Six individually mixed inputs for two pick ups (Cer. or mag.), two moving coil microphones and two auxiliary for tape tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic. and aux. inputs. Size 13¼"x6½"x3¾"app. Power output 50 watts R.M.S. (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

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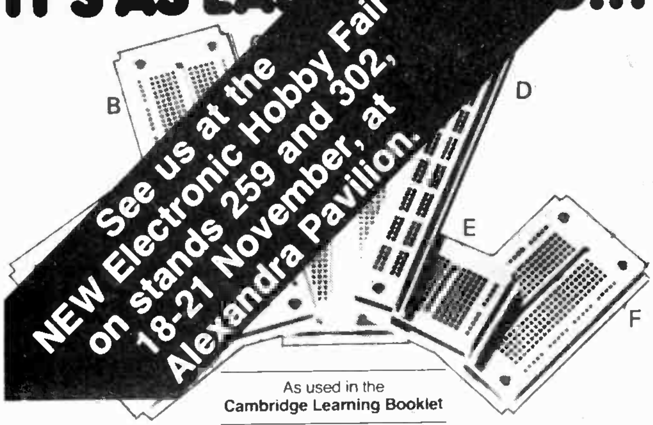
Readers wishing to import goods from the United Kingdom are advised to first obtain from the advertiser(s) concerned an exact quotation of the cost of supplying their requirements carriage paid home.

IT'S AS EAS...



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- F. **EXP 350** 270 contact points, ideal for working with up to 3 x 14 pin DIPS. **£3.30**
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The above prices do not include P&P and 15% VAT

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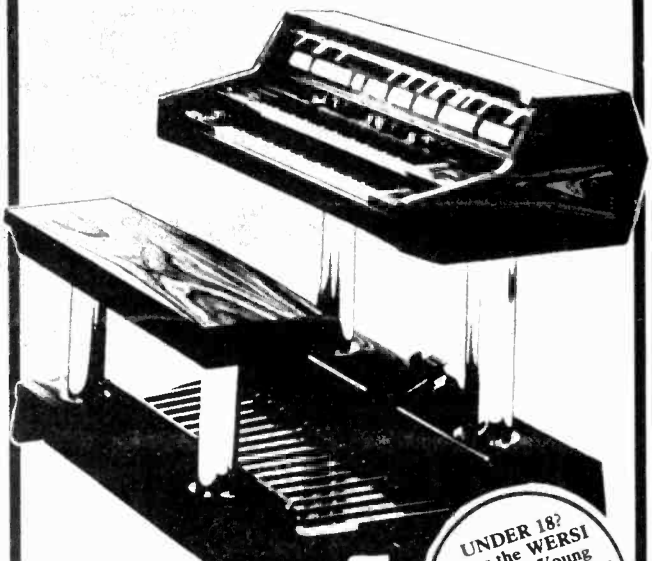
The WERSI Concept...



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ELECTRONIC HOBBIES FAIR

Alexandra Pavilion London November 18 – 21 1982

The biggest and best event ever to be staged for the electronic hobbies enthusiast!

Walk into a whole world of electronic equipment. – Everything from resistors, IC's to home computers, transmitting and receiving units, citizens band radio and peripheral equipment, video games, musical instruments, radio control models. . . . In fact whatever your particular electronic hobby you'll find this show will be the most interesting and informative way to discover all the latest developments in your particular field.

Other attractions will include radio and TV transmission, electric vehicles, radio controlled models, and demonstrations by local and national organisations.

This is the age of the train – British Rail are offering a cheap rate rail fare from all major stations in the country direct to Alexandra Palace – a bus will be waiting on your arrival to take you to the show. Ticket price also includes admission to the exhibition – so let the train take the strain to the Electronic Hobbies Fair.

Ticket prices at the door are £2 for adults, £1 for children but party rates are available for 20 people or more. To find out more, contact the Exhibition Manager, Electronic Hobbies Fair, IPC Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ. Tel: 01-643 8040.

Electronic Hobbies Fair is sponsored by Practical Electronics, Everday Electronics and Practical Wireless and is organised by IPC Exhibitions Ltd.

OPENING TIMES
Thursday 18 Nov. – 10.00-18.00
Friday 19 Nov. – 10.00-18.00
Saturday 20 Nov. – 10.00-18.00
Sunday 21 Nov. – 10.00-17.00

50p OFF

admission if you produce this coupon at the door of Electronic Hobbies Fair. Valid one per person only any day.

PE VOLUME 18 No. 12 DECEMBER 1982

E.H.F.

JUST one last reminder re. **Electronic Hobbies Fair** (November 18th to 21st Alexandra Pavilion), this will be the best event ever for the hobbyist in this country. Just about all the top names in the retail supply business will be there—some are arranging special offers for the Fair, our own 50p off coupon is on the opposite page. In addition to the trade stands there will be a number of special attractions; like the Luxor satellite TV receiver mentioned last month; a display of electric vehicles built by members of the Battery Vehicle Society (more about them later); a demonstration of holography by Holographic Developments (you will be able to purchase some examples); some working radio controlled models; an exhibit by the Royal Signals and an amateur radio talk-in station operating on the 2m band, channel S22 (145·55MHz).

You will be able to try out computers have a go at the latest video games and much, much more. There will be stands representing clubs and organisations—like the RSGB—and plenty to buy.

On the PE stand Editorial staff will be waiting to meet you and discuss the various projects on display. Among other things we will be showing *Micrograsp, Microsynth, Microcontroller* our *Semi-Professional Mixing Desk, Ultimum* and one or two future projects. The other sponsoring magazines PW and EE will have similar stands and the following IPC magazines will also have a presence at the Fair; Practical Hi-Fi, Television, Wireless World, Practical Computing, Your Computer, and CB World.

ACCESS

Access to the show is easy—there's plenty of car parking and a park-and-ride bus. The Victoria and Piccadilly lines provide fast access to and from the West End and British Rail main line stations—King's Cross, St. Pancras, Euston and Victoria. Finsbury Park and Wood Green underground stations are linked to Alexandra Pavilion by the London Transport W3 bus service which runs every 7 to 10 minutes on all the Fair days. Also Alexandra Palace British Rail station will be linked to the show by a free bus shuttle service; this station is close to Wood Green underground station and is on the BR main and suburban lines from King's Cross and Moorgate.

Special fares are available from all major British Rail stations direct to Alexandra Palace station and ticket price will include admission to the show—over 300 stations in the U.K. can provide access to Alexandra Palace with only one change of train. Through tickets to BR Alexandra Palace are available at underground ticket offices.

B.V.S.

Finally, a word about the Battery Vehicle Society. The B.V.S. was founded in 1973 to promote battery electric vehicles in all their forms and to provide a forum for everyone interested in this form of transport. The Society publishes a monthly magazine, Battery Vehicle Review, containing articles on the history, development and use of battery vehicles.

Following the 1979 Lucas 'How far can you get" competition for design and construction of lightweight electric vehicles, the B.V.S. competition section has monthly runs where the creations of members challenge each other to make the best of 56lbs of lead/acid battery. Some of these vehicles will form the special B.V.S. display at Electronic Hobbies Fair—see you there.

Mike Kenward

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We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to **one published project only.**

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

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

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'Now is the Winter for Public Debate'

Both the IBA and the BBC are concerned about the affects unregulated cable TV could have on the standard of British Broadcasting. The Independent Broadcasting Authority has called for a winter of public debate on the expansion of cable and satellite broadcasting. After its first Autumn meeting the IBA made the following statement.

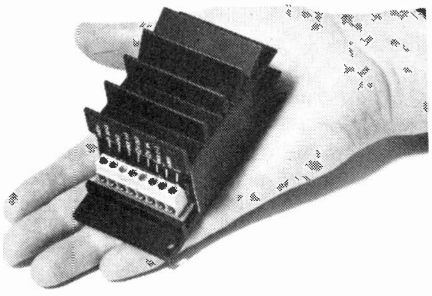
"The Independent Broadcasting Authority recognises the Government's commitment to the establishment of a national information grid through the expansion of broadcasting in the United Kingdom; and it is eager to use its many years of experience to contribute to the opportunities presented by this expansion of communications in the 80s while maintaining the high standards of British broadcasting. The unique quality of output which has earned a world-wide reputation for British programme-makers must not be eroded.

"The proposals of the Hunt Committee will be crucial to the expansion of broadcasting. Mistakes made now would take years to correct. It is for this reason that the Authority calls for a winter of public debate before the final decisions are taken. The Authority has no wish to delay the changes which clearly are on the way—on the contrary, the Authority believes that the creation of Channel Four was far too long delayed—but it believes that it is crucial to lay down the best possible framework for new developments and to ensure that meeting the challenge of wider choice need not mean lower standards."

Meanwhile the BBC in its evidence to the Hunt Committee said that unregulated cable TV would be "socially divisive, sacrifice hard won programme standards and coarsen popular taste". It also warns that it might lead to the disappearance of big sporting events such as the FA Cup Final and the Olympic Games from BBC and ITV screens because the BBC says cable operators concentrating their resources on 'blockbuster' attractions might well be in a position to outbid the BBC and ITV in the areas of sport and entertainment, thus posing the public service broadcasters with a cruel dilemma. "They must either commit a disproportionate amount of their resources to matching the bids of the cable operators—thus impoverishing other areas of programming—or see the majority deprived of such star attractions in favour of a paying minority". The BBC also pointed out that perhaps no more than 50% of British viewers will have access to the proposed cable systems and that individuals will have no power to affect the issue because access will be determined by economic or geographical status.

POWER MODULE

The C15 mono power booster amplifier from ILP is designed to increase the output of any in-car entertainment system to a nominal 15W r.m.s. The amplifier is encapsulated into an integral heatsink making it a very compact, robust unit.



The system features automatic supply switch-on which is activated when the radio or cassette is turned on. It also has a selectable input level facility so it can be driven from either the low signal levels of a pre-amp or straight from the existing units speaker leads. If stereo operation is required then two units can be used.

Priced at £9·14 inclusive of VAT and p&p the C15 is available from ILP Electronics Ltd., Graham Bell House, Roper Close, Canterbury, CT2 7EP (0227 54778).

AVO 2000

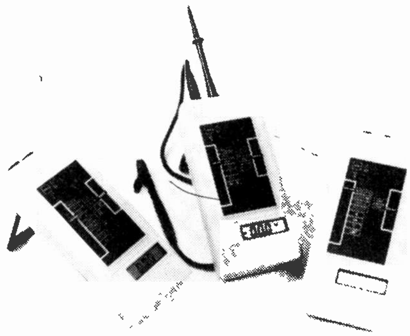
A new British design concept in hand-held digital multimeters—for a wide range of electrical maintenance, field servicing and vehicle testing applications—has been launched by THORN EMI Instruments Limited.

With the AVO 2000 Series the company has concentrated on providing a design offering a host of 'ease-of-use' features.

Initially, the AVO 2000 Series comprises three instruments for specific applications: the AVO Digiminor 2000; the AVOmeter 2001 and the AVO Vehicle Test 2002.

Each is housed in a tough ABS case and fitted with non-slip safety pads, the important new features of all three instruments include: Direct entry prods—giving true one-hand operation; A 3½ digit l.c.d. readout at the base of the housing; Positive action slide switching with dustproof, positive range selection; Improved safety, with fully shrouded plugs for the lead set; and a three-position stand—the instrument can be used in the hand, on a bench or while hung from a hook.

Ideally suited to maintenance applications, the Digiminor 2000 incorporates a special buzzer socket for simple continuity testing without reference to the display.



The AVOmeter 2001 is designed primarily for field servicing applications. Featuring more comprehensive ranges than the Digiminor 2000, it ensures correct mode and range selection by the inclusion of an audible alarm which signals any discrepancy. Both the unit and mode of measurement are displayed on the l.c.d.

The AVO Vehicle Test 2002 is unique: it is the first digital multimeter of its kind designed specifically to simplify the testing of electrical circuits of any road vehicle from a small saloon car to HGV.

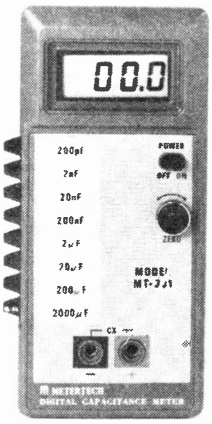
The AVO Digiminor 2000 is priced at £69.40, the 2001 at £85·40 and the 2002 at £97·00. Each multimeter is supplied with the appropriate lead sets, battery and operating instructions.

Thorn EMI Instruments Ltd., Archcliffe Road, Dover, Kent (0304 202620).

MARKET PLACE

CAPACITANCE METER

The Metertech model MT301 is a low cost hand held digital capacitance meter which is battery operated with a $3\frac{1}{2}$ digit liquid crystal display capable of measuring



capacitance values from 0·1pF to 2000μF over 8 push button ranges.

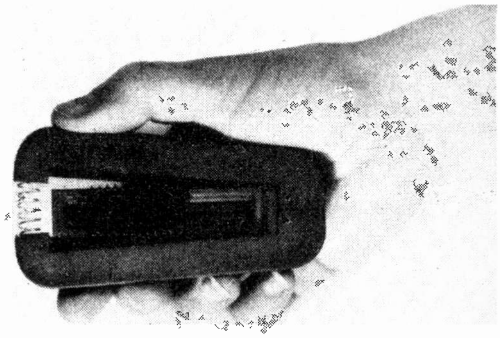
The unit is priced at £69 and is available from Centemp Instrument Co., 62 Curtis Road, Hounslow, Middlesex (01-894 2723).

CHIP LEG HAND TOOL

A simple hand tool that restores splayed-out legs on integrated circuits to the correct spacings has just been introduced by Aries Electronics. Called the DIP-R-SIZER, the new tool can handle integrated circuits with either 0·300in or 0·600in leg spacing.

When manufactured, the legs on integrated circuits are often outside the tolerances specified for centre spacings. The nominal 0·300in and 0·600in centres have a maximum tolerance of +0·020in. In practice a considerable proportion of integrated circuits leave the factory with spacings up to 0·095in above the nominal centre spacing. Particularly with high pin-count devices, attempts to insert out-of-tolerance legs into integrated circuit sockets or printed circuit boards often results in damage to the legs, the contacts in the socket or the holes in the printed circuit board.

The tool which has a pair of jaws hinged at one end is held open with a spring at the other. An anvil between the jaws is contoured to the correct angle and spacing for the integrated circuit legs. One side of the anvil takes 0·300in centre devices while the other takes the 0·600in size. To rectify splayed legs, the device is placed on the appropriate side of the anvil and the jaws squeezed lightly together. This presses the legs against the anvil, and brings them automatically into tolerance. While intended primarily for correcting leg spacings as received from the manufacturer, the tool can also be used to rectify legs put out of tolerance through mishandling. However, it cannot restore damaged devices where the legs have been displaced longitudinally—that is where the pitch between individual pins have been disturbed.



The tool which is priced at £10·50 including VAT and p&p. is available from Aries Electronics (Europe) Ltd., Metrostore House, Eastways, Witham, Essex CM8 3YQ. (0376 519318).

ENERGY SAVER

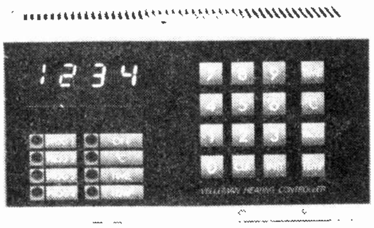
The Velleman Heating Controller is designed to control the temperature inside offices, factories, houses etc., enabling central heating systems to work more economically.

It provides a 4 program daily cycle controlling the temperature at any given period. The programs are totally independent and therefore it is possible to select day and night temperatures separately.

The display functions as a clock as well as a thermometer with the device replacing conventional mechanical thermostats without additional wiring. The unit can be manually over-ridden at any time without disturbing any of the preselected programs.

The system is available in kit form (£75·00 ex VAT) and also as a built and tested unit.

Velleman (UK) Limited, P.O. Box 30, St. Leonards on Sea, East Sussex, TN37 7NL. (0424 753246).



SUPERSWITCH HOME COMMAND CENTRE

The Superswitch Command Centre has been developed for the remote control of lamps and electrical appliances.

The unit which transmits high frequency coded signals along existing mains wiring is capable of controlling up to 16 appliances either manually or automatically. The centre can be pre-programmed up to 7 days in advance with a maximum of 24 programs.

The coded signals are received by modules which plug into the 13A socket outlets. Appliance modules operate electrical loads up to 13A whereas• lamp modules can control Tungsten lighting loads up to 400W.

Other features of the unit include the manual dimming and brightening of lamps, battery back-up and the ability to turn on all lamps simultaneously. The Command Centre is priced at £73·70 with the appliance and lamp modules priced at £24·00 each.

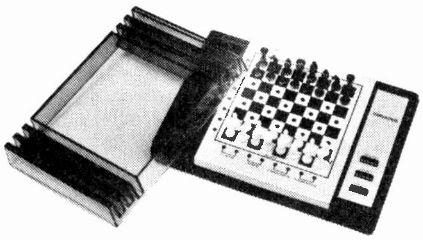
Another Superswitch system which uses mains wiring is the Plug-In Intercom. This FM unit can plug into any 13A socket anywhere on a ring main, and send messages using the mains wiring.

Up to 5 units can be used in conjunction with each other or a private conversation can be carried out between two units without the others on the system being able to hear. The intercom is priced at £37·45 per unit.

Superswitch, 7 Station Trading Estate, Blackwater, Camberley, Surrey.

CHESS SENSOR

The CG1 Sensor Computer chess game from Systema has 8 levels and is priced under £30. The unit measures only 175x120x47mm and can be either battery powered for up to 50 hours from a standard PP3 or mains operated.



The unit has a built-in sensory board which is operated by pressing down on the piece you are moving, a light shows your 'from' position and pressing down the piece on your 'to' position. The computer then records your move and indicates its reply.

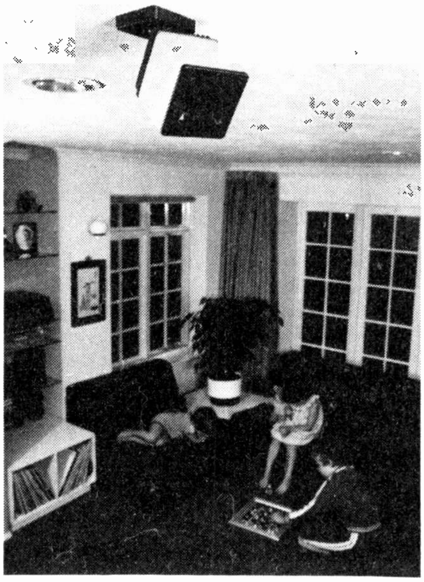
Other features include changeable levels during play, side changes during play, en-passant captures, castling and pawn promotion.

Systema (UK) Limited, 25 King's Road, Reading, Berkshire.

Sensalite

An automatic light switch called Sensalite enables a room light to be automatically switched on when someone enters a room where lights are needed and then automatically switches the lights off when the room is vacated.

The unit operates by looking for movement and then at the prevailing lighting condition.



When the unit detects movement it checks the natural light level and, if required, switches on the light. The level at which the lights are energised can be set by the user.

Sensalite, a 100mm cube which is linked into the existing lights has provision for an additional burglar alarm module.

The unit is priced at £85 including VAT. Leading Edge Technologies Ltd., 1-4 Kings Parade, Croydon, Surrey (01-686 0255).

● ● ● ●

A new 16K RAM pack for the ZX81 which overcomes the "wobble" or disconnection problems associated with many add-on units is also available with a keyboard sounder as an optional extra. The sounder enables a faster entry of programs from the keyboard by giving an audible feedback when a key is pressed.

The RAM pack is priced at £19·95 and with a keyboard sounder is priced at £24·95.

Ground Control, Alfreda Ave, Hullbridge, Essex, (0702 2303 24).

POINTS ARISING . . .

COMBO AMPLIFIER (Sept. '82)

The following winding details should accompany L1 in Fig. 2.8: Three layers of ten turns each (30 turns total) should be wound using 18 s.w.g. enamelled copper wire. Resistor R13 should be 15k. The drain and source annotations of TR8 and TR9 in Fig 2.1 should each be transposed.

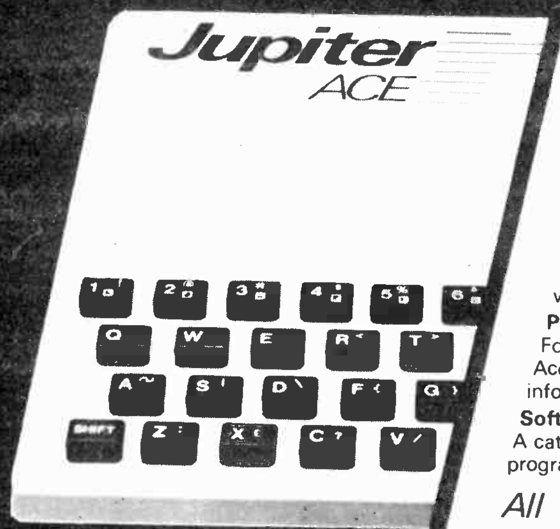
Countdown . . .

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

Compec Nov. 16–19. Olympia. **Z1**
Electronic Hobbies Fair Nov. 18–21. Alexandra Pavilion, London. **Z1**
INTRON Nov. 23–25. RDS Dublin, Ireland. **V**
BEX Bristol Nov. 24–25. Holiday Inn. **K**
Northern Computer Fair Nov. 25–27. Belle View, Manchester. **Z1**
Christmas Holography (+items for sale) Dec. 2–Mar. (1983) Light Fantastic Gallery, London. **A8**
ElectroNORTH Dec. 7–9. Harrogate Supercenter. **Q**
IT82 (Information Technology Year Conf.) Dec. 8–9. Barbican. **O**
Continuous exhibitions at the National Microprocessor & Electronics Cntr. (nr. tower of London). **L1**
Peripherals Feb 2–4 1983. Cunard Int. Hotel, Hammersmith, London. **Z1**
BEX Bournemouth Feb. 9–10 1983. The Pavilion. **K**
Microsystems Feb. 23–25 1983. West Cntr. Hotel, Fulham, London. **Z1**
CAD North Mar. 1–3 1983. Belle Vue Ex. Cntr., Manchester. **Z1**
Mailing Efficiency Mar. 1–3 1983. Bloomsbury Cntr. Hotel, London. **Z**
Local Networks Mar. 8–10 1983. Royal Lancaster Hotel, London. **O**
Laboratory Edinburgh Mar. 16–17 1983. Assembly Rooms, George St. **E**
Brighton Electronics March 1983. **T**
BEX Leeds Mar. 16–17 1983. Dragonara Hotel. **K**
INSPEX Mar. 21–25 1983. National Exhibition Cntr. Birmingham International. **Z1**
Sensors & Systems Mar. 22–24 1983. The Forum, Wythenshawe. **T**
Compec Wales Mar. 22–24 1983. Cardiff University. **Z1**
ETM (Electronic Test/Measurement) Mar. 22–24 1983. The Forum, Wythenshawe, Manchester. **T**
Laboratory Manchester Mar. 23–24 1983. New Century Hall, Corporation St. **E**
American Holography Mar.–June inc. Light Fantastic Gallery, Covent Garden, London. **A8**
All Electronics Show April 19–21 1983. Barbican Cntr. London. **E**
Fibre Optics April 19–21 1983. Porter Tun Rooms, The Brewery (!), Chiswell St., London EC1. **E**
International Materials Handling April 19–26 1983. Earls Court. **I**
International Packaging Exhibition April 25–29 1983. NEC B/ham. **I**

A8 Holographic Exhibitions ✆01-836 6423
E Evan Steadman ✆0799 22612
K Douglas Temple Studios ✆0202 20533
L1 World Trade Cntr., Europe Ho., London E1
O Online ✆09274 28211
Q Exhibitions For Industry ✆08833 4371
T Trident ✆0822 4671
Z BETA Exhibitions ✆01-405 6233
Z1 IPC Exhibitions ✆01-643 8040

Jupiter ACE



The Jupiter Ace uses FORTH

The Jupiter Ace personal computer runs in FORTH, an easily understood language, typically four times as compact and ten times as fast as BASIC. Before the Ace all personal computers used BASIC and FORTH was only available to a privileged few. The Jupiter Ace also features a full-size moving-key keyboard, high-resolution graphics, sound, floating point arithmetic, a fast and reliable cassette interface and 3K of RAM.

Available soon

Plug-on parallel printer interface.
For around £20.00 this will connect your Jupiter Ace to anything from high-speed dot matrix to letter-quality daisy wheel printers.

Plug-on 16K Memory Expansion
For around £30.00 you will increase the memory of your Jupiter Ace to 19K giving you instant access to enormous amounts of information.

Software
A catalogue will be sent with every machines, and includes, initially, programs for education and entertainment.

only £89.95

All inclusive price

For £89.95 you receive your Jupiter Ace, a mains adaptor, all the leads needed to connect to most cassette recorders and T.V.s (colour or black and white), a software catalogue and a manual.

The manual is a complete introduction to the world of personal computing and a course in FORTH programming on the Ace.

Even if you are a complete newcomer to computers, the manual will guide you step by step from first principles to confident programming.

The price includes postage, packing and V.A.T.

The Jupiter Ace is backed by a full 12 month warranty.

The **Jupiter Ace** is available only by mail order. Please allow up to 28 days for delivery.
Send cheque or postal order with the form to:—
JUPITER CANTAB, 22 FOXHOLLOW
BAR HILL, CAMBRIDGE CB3 8EP

Technical Information

Hardware
Z80A running at 3.25 MHz.
8K bytes ROM
3K bytes RAM

Keyboard 40 Moving-key keyboard with auto repeat on every key and Caps Lock.

Screen Memory mapped 32 column x 24 line flicker-free display with upper and lower case ascii character set.

Graphics Chunky graphics (64 x 46 pixels) may be plotted, unplotted or over-plotted (XOR operation). Also, the entire character set (128 characters and their video inverses) may be redefined allowing intricate shapes to be drawn with a resolution equivalent to 256 x 192 pixels.

Sound Internal loudspeaker may be programmed to operate over the entire audio spectrum.

Cassette Programs and data in the compact dictionary format may be saved, verified, loaded and merged. Blocks of memory can be saved, verified, loaded and relocated. All tape files are named. Running at 1500 baud, the Ace will connect to most portable tape recorders.

Expansion Port Contains D.C. power rails and full Z80 Address, data and control signals. May be used to connect extra memory and other peripherals. IN and OUT words allow port-based peripherals to be addressed.

Data Structures Integer, Floating point and String data may be held as constants, variables or arrays with multiple dimensions and mixed data types. There are no restrictions on names.

Control Structures **IF–ELSE–THEN, DO–LOOP DO–+LOOP, BEGIN–WHILE–REPEAT, BEGIN–UNTIL,** all may be mixed and nested to any depth.

The Jupiter Ace closely follows the FORTH 79 standard with extensions for floating point, sound and cassette. It has a unique and remarkable editor that allows you to list and alter words that have been previously compiled into the dictionary. This avoids the need to store screens of source, allowing the dictionary itself to be saved on cassette. Comprehensive error checking removes the worry of accidentally crashing your programs.

ORDER NOW!

Please send me:—

☐ JUPITER ACE MICROCOMPUTER(S) @ £89.95.

Name. Mr/Mrs/Miss ______________________

Address ______________________

______________________ PE

Designed by Jupiter Cantab

Computer Designers Steven Vickers and Richard Altwasser played a major role in creating the ZX Spectrum and then formed Jupiter Cantab to develop advanced ideas in personal computing. The Ace is the result, another all-British computer to lead the world.

STYLOCHORD

Stephen Ibbs

THE instrument popularised by Rolf Harris some years ago generated a plethora of similar designs, and many people clearly derived a great deal of enjoyment from these ingenious devices. With the inexorable march of progress, many ic.s have developed, and become cheap enough for new improved designs to be produced. However, all the designs seen by the author demanded accurate resistor chains, or several presets, making the tuning of the instrument difficult. They were also limited in the sound they could produce.

The project described here is a two octave keyboard, with only one tuning preset, no resistor chains, and eight different voices; 16′, 8′, 4′, 2′ Square-wave, and 16′, 8′, 4′, 2′ triangular wave. The footages refer to the approximate physical length of organ pipes, but are used to indicate octave pitch, 8′ being the standard, 16′ being an octave lower, and 4′ and 2′ being one and two octaves higher respectively. The whole instrument can be transposed by an octave by means of a switch, and so the unit has a total range of six octaves. It contains two stylii, each controlling four voices, to enable the playing of two notes at a time, and a further switch decides whether one stylus plays one or both waveforms. See Fig. 1 for a simplified block diagram. Regular readers will note that the project is a development from the 'Instrument Tuner' (July 82).

HOW IT WORKS

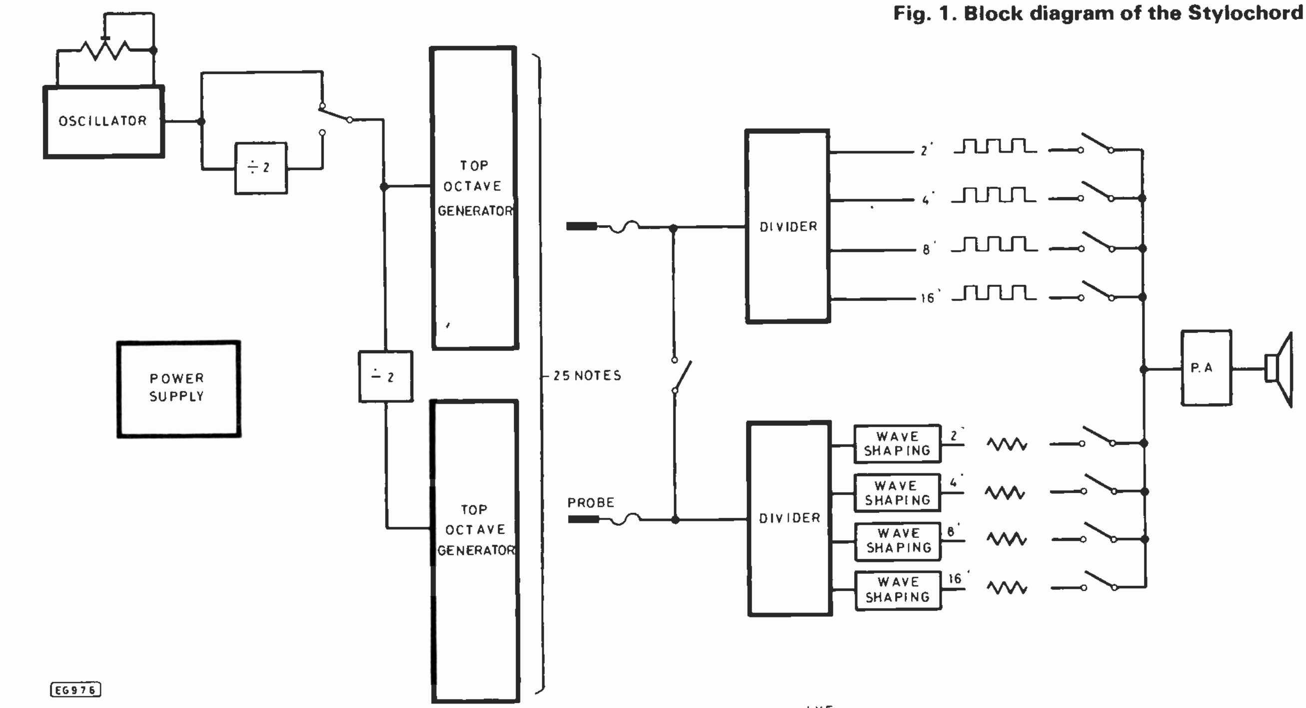
The main i.c. being used is the 5024 top-octave-generator, (also coded S50240 by Tandy). From a single frequency input of 2·0024 MHz it will produce thirteen semitones, equally tuned. This frequency is generated by the astable multivibrator IC1a and b, adjustment being made by VR1. If the input frequency is halved, the 13 outputs will also be halved, sounding an octave lower. Consequently IC2a (part of a 4013), is connected as a ÷2 divider which feeds 1·0012 MHz into another 5024 to give another lower octave of notes. The 4013 is a dual D type flip-flop, and contains two identical circuits. If the data pin is connected to the $\overline{Q}$ pin, and the set and reset pins are connected to earth it will divide the incoming frequency by two. See Fig. 2 for details. Thus half of the 4013 was still unused, and this can be utilised to divide the output of the multivibrator prior to entry into IC2b and IC3, giving the unit an octave-down shift. Originally IC1a and b fed IC2b and IC3 direct, but it was found during development that switching in the octave shift caused a slight shift in frequency, affecting the tuning, so IC1d was included to act as a buffer, and this cured the problem.

The outputs from the top-octave-generators are connected to the appropriate keys, (see Fig. 3) and selected by either of the stylii, with S2 selecting whether one or both of IC5 and 6 are connected to each stylus. R2 and R3 are included to make sure that the inputs of IC5 and 6 are grounded when not in use. These i.c.s further divide the frequencies to bring them into the required audio octave range. Four outputs of each can be selected by the switch bank S3-S6, being square waves from IC5 and triangular waves from IC6, the change in waveform shape being accomplished by the resistors R8-R15, and capacitors C2-C5.

If pin 12 of IC6 is taken as an example, a square wave comes out, but R8 controls the charging rate of C2, giving a slope to the leading edge of the square wave; and R12 controls the discharge rate, giving a slope to the trailing edge resulting in an approximate triangular waveform. None of these values are critical and constructors should experiment to find the most satisfactory result. Different values will affect the waveform shape and the amplitude (loudness) of each voice.

TWIN PROBE STYLUS ORGAN

Fig. 1. Block diagram of the Stylochord



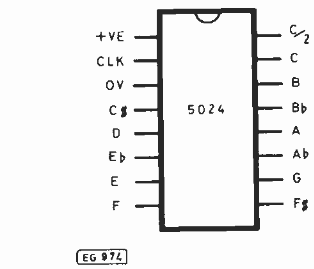


Fig. 2. 4013 in ÷2 mode (right)

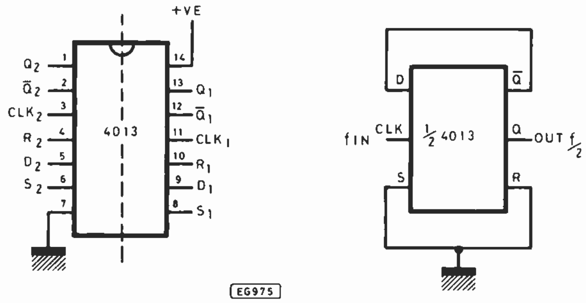
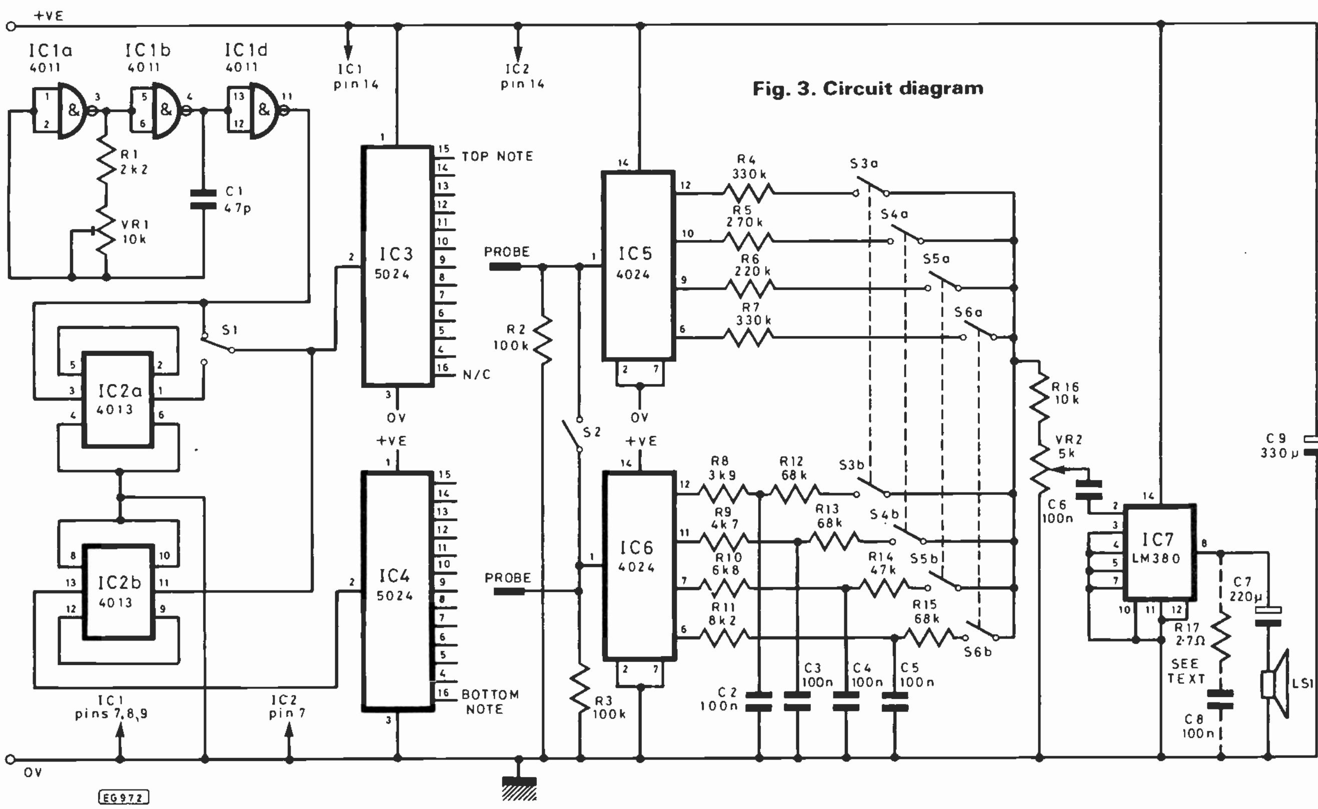


Fig. 3. Circuit diagram



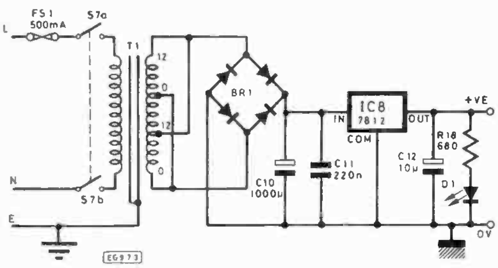


Fig. 4. PSU circuit diagram

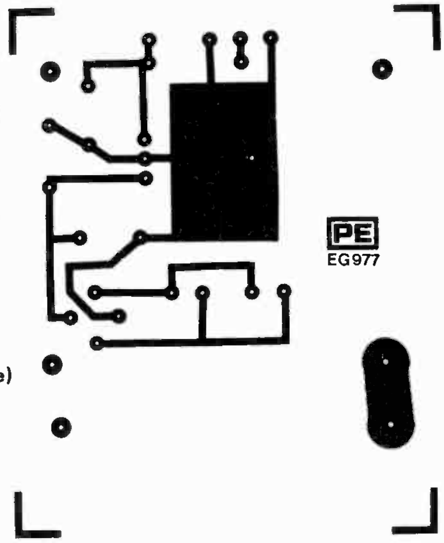
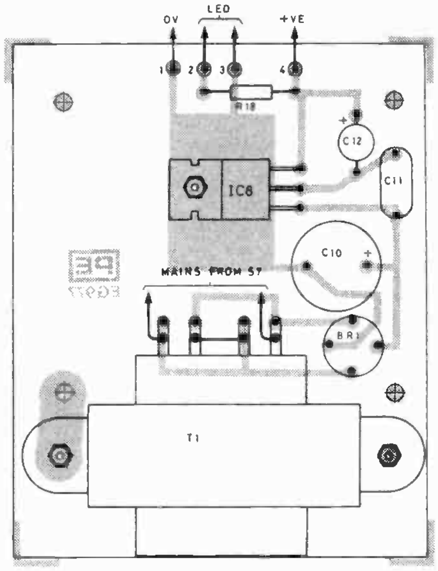


Fig. 5. PSU printed circuit (actual size)

Fig. 6. PSU component layout (right)



The outputs can be switched in via S3-S6 and the result goes via the potential divider VR2 acting as a volume control to the audio amp. IC7, an LM380 2 watt i.c. If high frequency oscillation occurs, a Zobel network consisting of a 2·7 ohm resistor and a ·1µ polyester capacitor in series from pin 8 to earth can be inserted, but this was not found to be necessary in the prototypes. However, space is made for these two components on the p.c.b.

The inclusion of a mains power supply may seem strange to readers, but there are several reasons for it. IC3 and 4 require 11-16 volts, so the convenient PP range of batteries couldn't be used, and with the volume control turned up, the battery drain would be quite high. Also a mains powered regulated supply ensures a reliable voltage source, preventing frequency stability problems. Readers can, of course, omit the power supply and replace it with batteries, and it is for this reason that the power supply p.c.b. is separate.

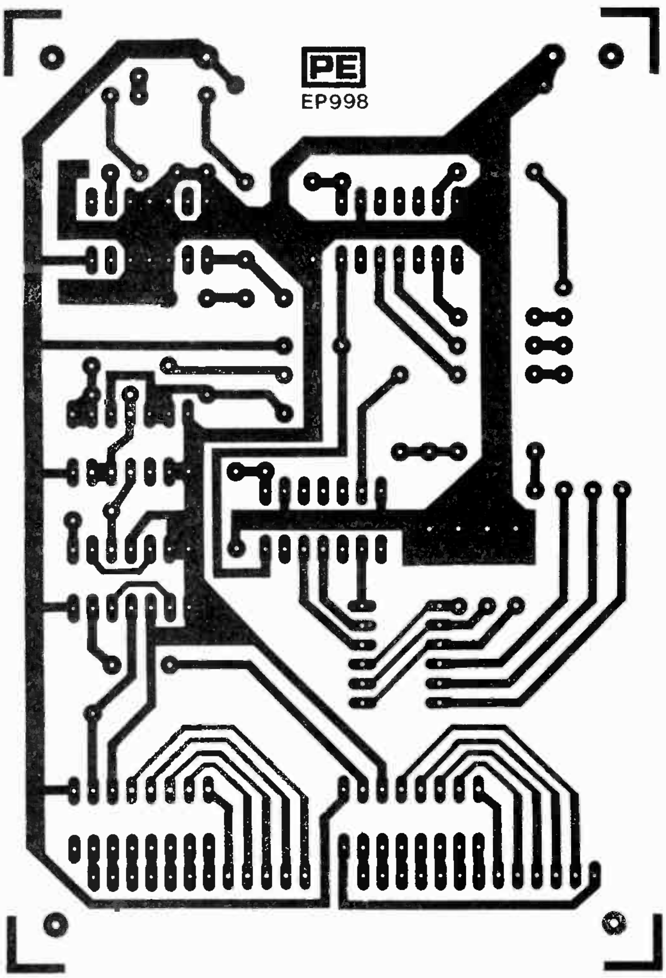


Fig. 7. Stylochord p.c.b. (actual size)

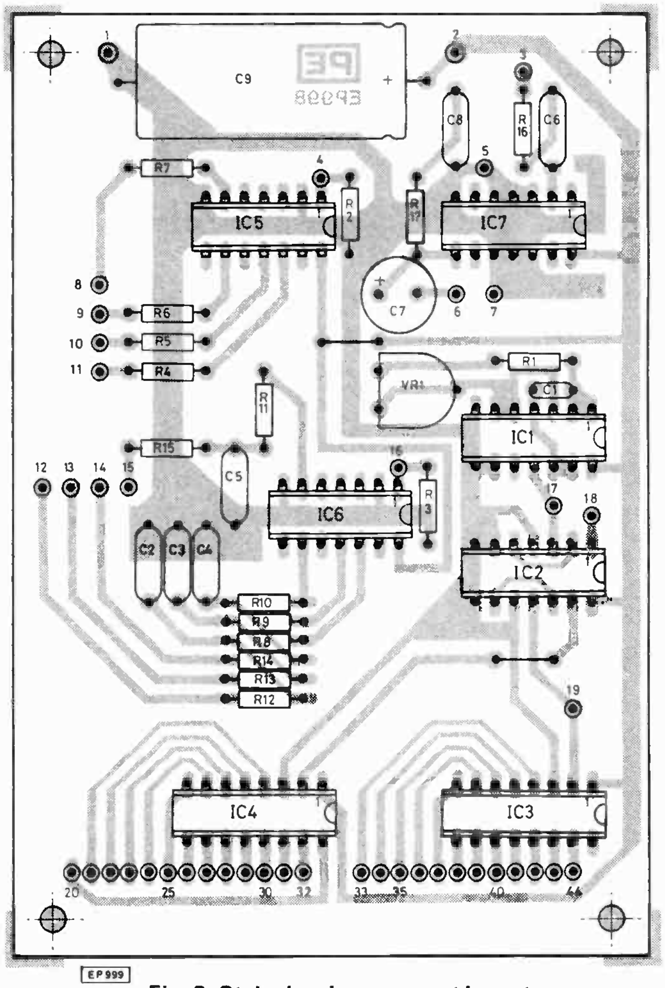


Fig. 8. Stylochord component layout

COMPONENTS . . .

Resistors

R1	2k2
R2, R3	100k (2 off)
R4, R7	330k (2 off)
R5	270k
R6	220k
R8	3k9
R9	4k7
R10	6k8
R11	8k2
R12,13,15	68k (3 off)
R14	47k
R18	680Ω
R16	10k
R17	2·7 Ohm (see text)

Capacitors

C1	47p ceramic
C2–C6	100n polyester (5 off)
C7	220μ elect.
C8	100n poly (see text)
C9	330μ elect 16V
C10	1000μ elect. 25V
C11	220n polyester
C12	10μ elect. 16V

Potentiometers

VR1	10k min horiz
VR2	5k log

Integrated Circuits

IC1	4011
IC2	4013
IC3,4	5024 (S50240 Tandy) (2 off)
IC5, 6	4024 (2 off)
IC7	LM380
IC8	7812

Miscellaneous

8 Ohm loudspeaker
0-12, 0-12V transformer (RS 196-303 for example)
Bridge rectifier (e.g. RS 262-141)
2 probes
6 off 2 pole *latching push-button* switches
8 way bracket, 15mm spacing
6 knots 'A' (4 red, 2 black)
SUE series (AMBIT)
L.e.d. + Holder
Vero case (Order Code 75-1715G)
D.p.d.t. toggle switch
Knob
20mm fuseholder and 500mA fuse
P.c.b.s
Ribbon cable
Veropins, grommet, nuts and bolts etc.

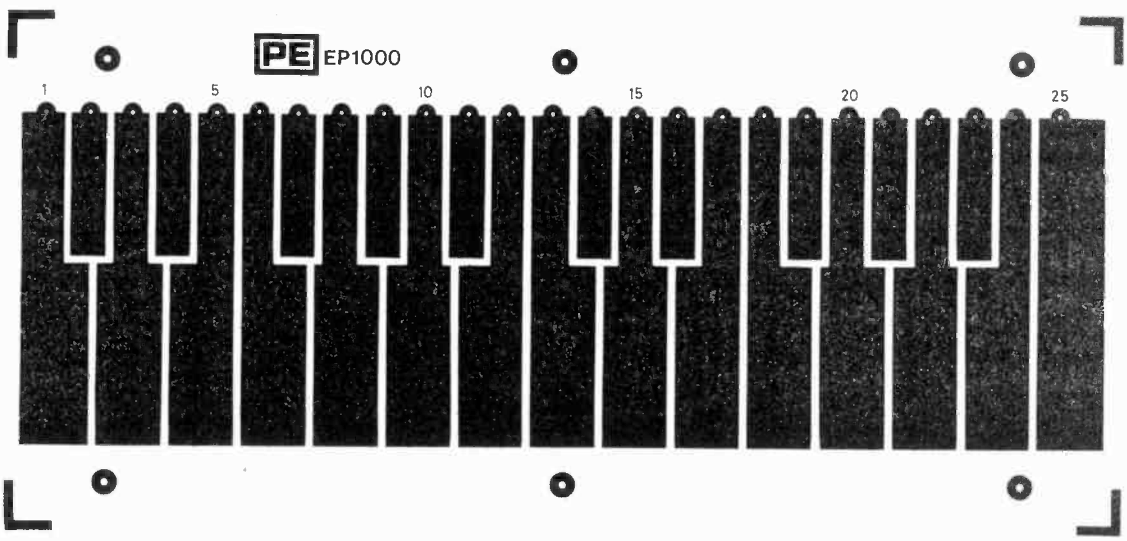


Fig. 9. Keyboard printed circuit

CONSTRUCTION

Readers are advised to use p.c.b.s, designs for which are given in Figs. 6 and 7, as this makes construction easier. There are quite a lot of interconnections to be made, and the prototype used ribbon cable, so that each wire is individually colour-coded and therefore easily traceable. Assemble the components, making sure that the i.c.s, diode, capacitors, and voltage regulator etc. are the correct way round. It is recommended that single-sided Veropins be used as solder terminals for all the wires.

The main p.c.b. and the power-supply p.c.b. are bolted to the base panel of the case, and the plastic housing is drilled to accept the cable retention grommet, fuseholder, speaker holes, switches, l.e.d., pot and probe sockets, see drilling details in Fig. 10.

The aluminium panel for the keyboard is cut and the keyboard mounted behind this with small spacers, nuts and bolts. The smaller aluminium panel is drilled to accept the switch bank. These switch modules are much cheaper than miniatures toggle switches, and the finished result looks extremely professional. Slot them into the 8-way bracket (positions 2 and 7 are left blank), bend the small tabs over to retain them, and then mount the unit behind the panel.

Make all wire interconnections (except those connecting the power supply to the main p.c.b.), taking care, as there are a number of them. See Fig. 11. Shielded audio lead was used where necessary, to avoid hum pick-up, and the case of the pot was earthed. When a final check has been made, turn on the mains and check that 12V is delivered by the regulator, and if so, turn off, connect up the two p.c.b.s

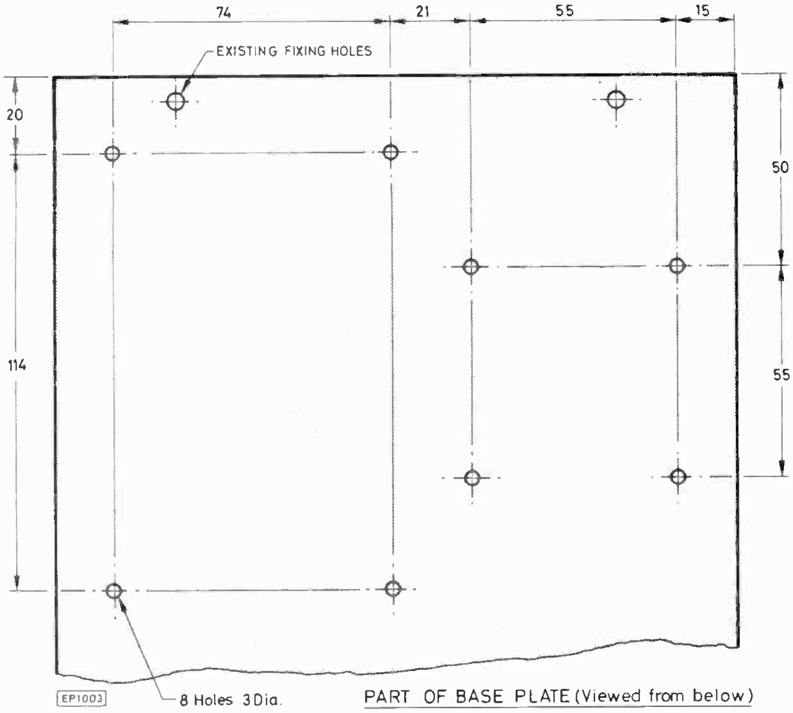
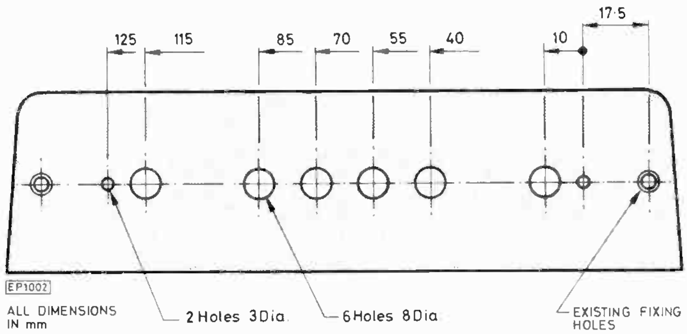


Fig. 10(a). Base plate drilling details

Fig. 10(b). Switch fascia drilling details



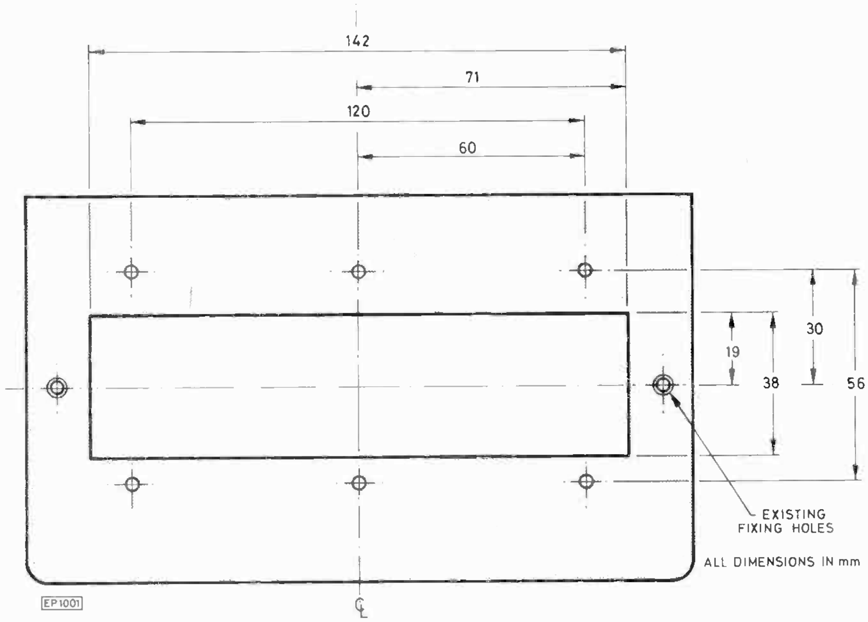


Fig. 10(c). Keyboard bezel details

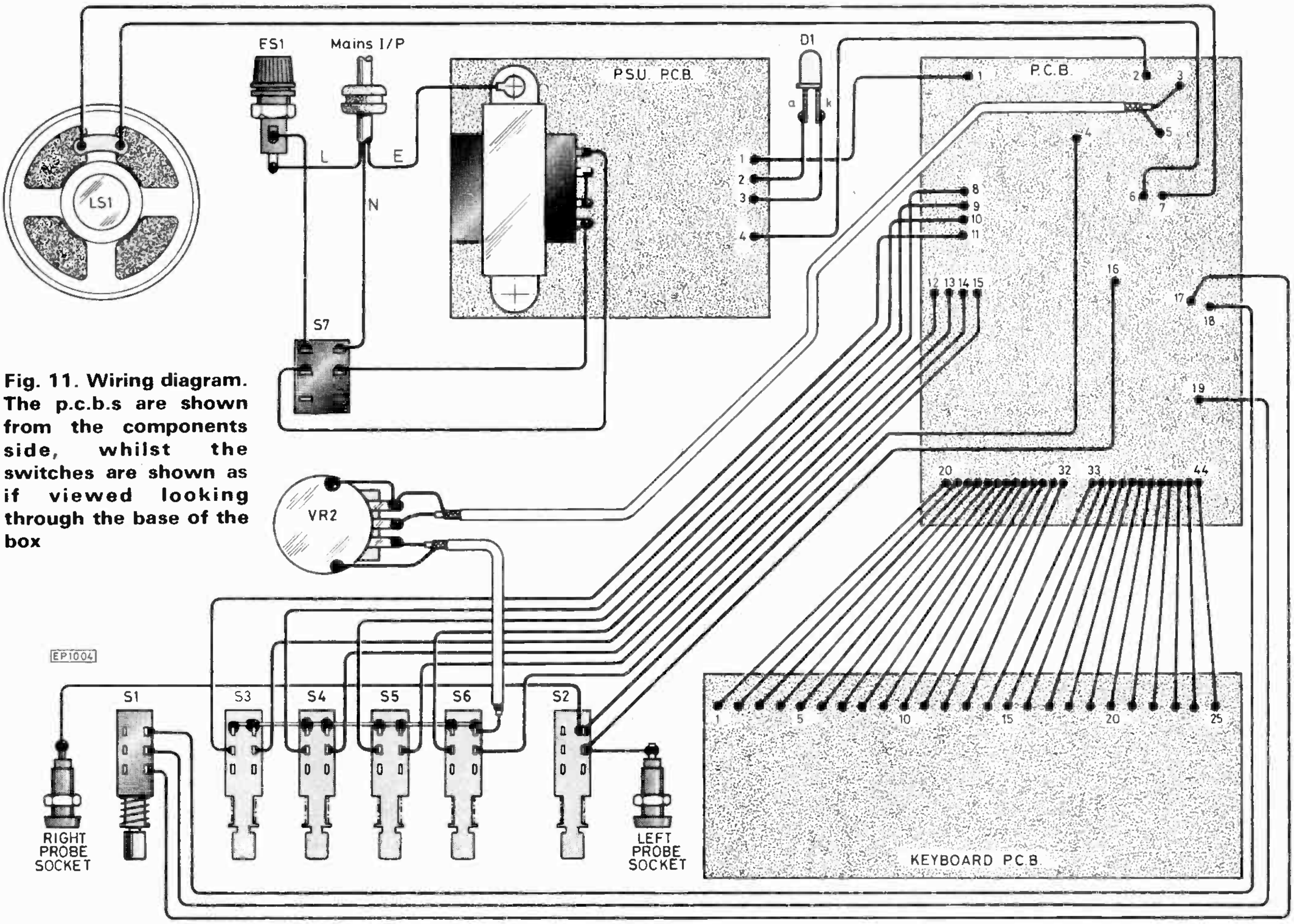
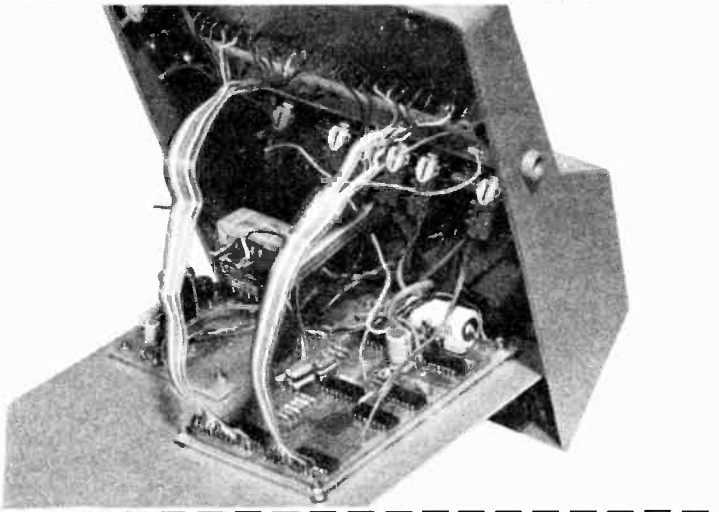


Fig. 11. Wiring diagram. The p.c.b.s are shown from the components side, whilst the switches are shown as if viewed looking through the base of the box

and turn on once more. Adjust the preset VR1 to tune the whole instrument up or down as necessary, and if all is well, bolt the unit together. You are now ready to start playing. If the probe switch is closed you cannot use both probes as you will try to put two different frequencies into ICs 5 and 6. A nasty sound will result!

CONCLUSION

The author has a prejudice against the vibrato effect, and so did not include one, but readers who are adventurous enough will find scope for development in this instrument, such as adding a phaser or a delay unit. However, the unit as described should give many hours of enjoyment, with various combinations of voices and stylii being possible. For greater variety, switches S3-S6 can be separated 'a' and 'b' to give e.g. 16′ square with 2′ triangular . . . a *pig-and-whistle* effect! ★



Space Watch...

ASTRONOMICAL OBSERVATIONS BY REMOTE CONTROL

Astronomers of the Royal Observatory of Edinburgh have achieved a technological superiority by remotely controlling the UKIRT (United Kingdom Infra Red Telescope) on the 14,000ft. high peak of Mauna Kea, Hawaii, from a computer terminal in Edinburgh. This experiment will lead to improved flexibility in the use of major astronomical facilities.

When this project was in its early stages there was great concern about the high cost of the movement of personnel to attain the best advantage from the site. Not only is it the best site from the reason of *seeing* but it has special advantages because of its height above sea level. The disadvantages lay in the cost of personnel movement, the difficulty of working at the height, even after long acclimatisation for any length of time and the limited hours that could be devoted to observations. Now this problem is solved and not only will personnel benefit but far more time will be available for the operation of UKIRT. For example all operations can be carried out from sea level and it will be possible to operate the telescope from Edinburgh during normal office hours for night time activities in Hawaii. The reason for this is, that the observers will be able to operate from any terminal connected to the SERC computer network, including all users of the STARLINK network.

Other advantages are that when unusual weather is prevailing the special observations, which can only be made at these times, may be undertaken. All this is now possible at a cost of normal leased lines and networks. Once again necessity provides not only the solution but also the expertise. It is perhaps worth noting that no longer can the cry of no money for essentials be raised. The remote control facility provides two levels of operation at the 1·8 metre UKIRT site. Almost all the operations that can be carried out at the Hilo laboratory in Hawaii including television reception are already available to the remote user via a 2-channel 9600bit/sec lines to the telescope. This facility is expected to be in use for extensive observations at the longer infrared wavelengths and also sub-millimetre wavelengths during daytime hours. The second level of operation, pioneered by the first breakthrough of this system, is a 1200 bit/sec intercontinental link to any United Kingdom astronomer with a terminal of the SERC computer network SERCNET.

For the purpose of the first experimental observations the terminal was linked via the GEC 4090 computer at the Royal Observatory in Edinburgh to the Regional centre then via SERCNET to the Rutherford Appleton Laboratory in Oxfordshire. Thence by the British Telecom PSS (Packet Switching Service) to the IPSS (international Packet Switching Service) through a transatlantic common carrier by TELENET. The nearest node centre of TELENET is at Honolulu. From there to the Hilo Laboratory of UKIRT by leased telephone lines. Though this sounds a little complicated the delay is only between 3 and 6 secs. This did not prove to be a difficulty in the first experiment. The entire communications during the preparation times were quite good according to the staff astronomers at Hilo, David Beattie and Dr. Ian Gatley. A significant point to be made here is that the total cost was some £80. The establishment of the remote facility had been achieved through the work of Peter Thanisch and Dr. Peredur Williams under the direction of Dr. Terry Lee in Hawaii, B. McNally at the Royal Observatory Edinburgh and Dr. P. Bryant at the Rutherford and Appleton Laboratory.

The Historic experiment took place on the 6th September this year when Malcolm Stewart secured an infrared photometric measurement and a spectrophotometric scan of the star HR 8824.

ARIANE

Following the great hopes, the Ariane launcher has again failed. There has now arisen a situation that the Insurance companies must face with current claims against losses having already reached very high figures. This is another of those hiccups which are usually very firmly pushed into the background. Such a long record of failure has dogged this enterprise that it is not easy to continue to hope for success. Is there perhaps a lesson to be learned from the history of the whole project? Are such questions as "is it wise to adopt the composite philosophy for the motors of a launcher" justified?

From an observer's point of view this seems pertinent enough, yet is it perhaps unfair to speculate without a great deal more first hand information. This is not just "one of those things", too many things seem to happen to this project. It suggests that there are areas of incompatability. Is it concerned with the materials or components. Are there different standards under the same specification. Is the real cause satisfactorily diagnosed. This raises many other questions also. Is the launching site viable. It would seem timely to begin some horizontal thinking. If as was stated, the vehicle was fully qualified at what stage did the onset of failure occur?

Other failures are also continuing in other places and if Insurer's raise the premiums or the operators under-insure then developing industries may fail. What of the computer modelling. How much of such technology has been applied. Many fantastic claims for such steps have been made especially *after* the events. Why not fund one of the claimants that continually pour out pamphlets, set up seminars at high cost and show little in practice. Is there too little hard practical engineering skill being applied. It is easy to cry wolf. This is true but perhaps such an emotional approach may inspire a defence.

TWENTY FIVE YEARS OF SPACE ACTIVITIES

For twenty-three years of this period the United States has made successful launchings of 44 vehicles for communications, weather and navigational activities. In addition there have been some 62 launches of a similar nature under International agreements. These particular satellites by the use of microwave techniques are able to function by line of sight since neither the atmosphere nor the curvature of the Earth are obstacles. Moving in straight lines, the signals can be acquired by earth based stations and passed on, or linked with other satellites. The now famous early suggestions by Arthur C. Clarke, made in the early forties and which earned him the universal credit for the invention of satellite communication systems, have become an active reality.

The most economic distance for profitable use, both technically and financially, is between 800 and 1,000 kilometres. The famous *Early Bird* was launched in 1965 and was the first of the communications satellites. *Early Bird* now renamed Intelsat 1, had a capacity for 240 channels of data or telephone and also had one television channel. The satellite had a life of three years and weighed 60 kilogrammes. Twenty five satellites later the Intelsat series 5 was launched in December 1980 and weighs 1,870 kilogrammes. Its life will be seven years and has 12,000 voice circuits and two television channels. Intelsat has 106 member countries and provides communications services to more than 150 countries.

The regulations of the United States Government prohibit the use of domestic satellites for overseas communications. All overseas communications in the Comsat network have to use the Intelsat network for the overseas link. It is getting crowded now and serious attention is being given to the difficulty which is a matter of rearranging the separation distances. This will be one of the subjects of the next issue of SPACEWATCH.

INDIA & SPACE

Russia has been assisting India to design and launch satellites for scientific studies including remote sensing and communications. During the late Yuri Gagarin's visit to India, soon after his epic mission, India determined she to would have a cosmonaut. Nothing was done about it though it was discussed at a meeting in Moscow in 1978 with Moraji Desai, the Prime Minister of India at the time. Now some 8 Indian pilots are queuing for a cosmonaut assignment.

Frank W. Hyde

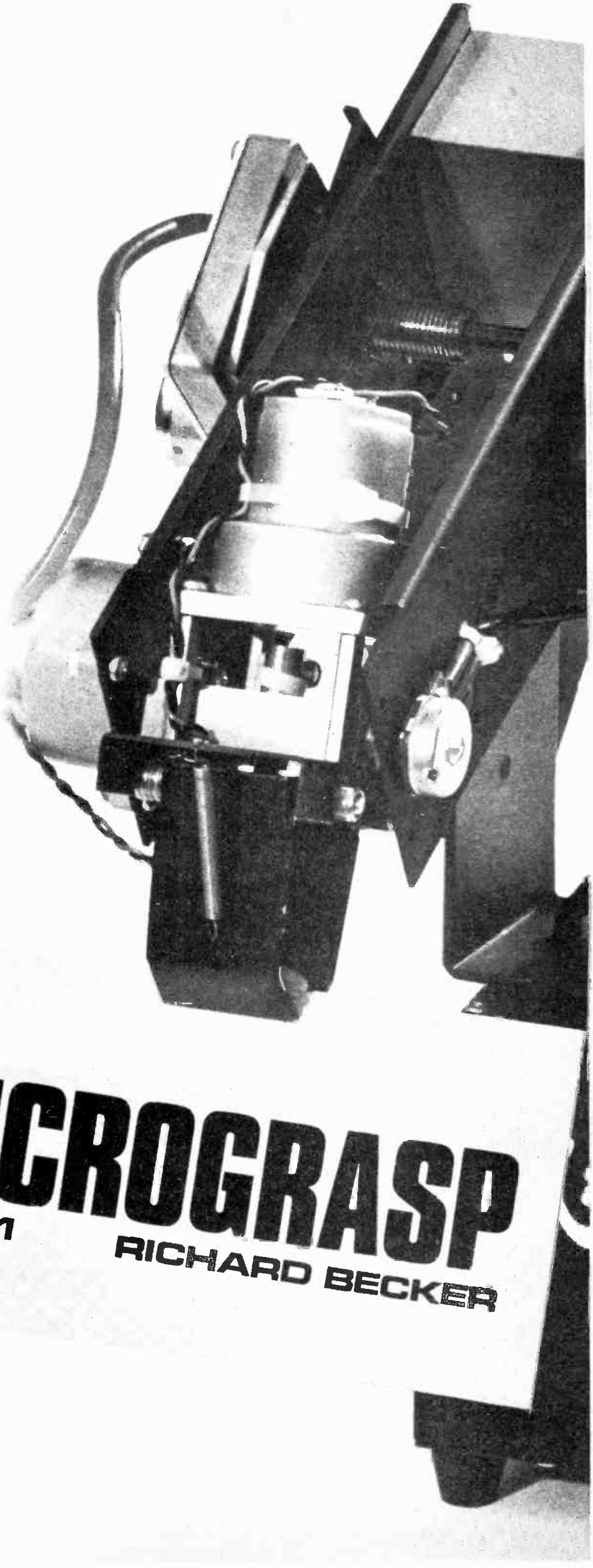
PE MICROGRASP

PART 1

RICHARD BECKER

The Genesis range of robots published in these pages last winter have most effectively filled their role of providing a low cost introduction to robotics. Although their price is well within the budgets of further education establishments, industrial production and research and development departments; state run schools and home constructors have found it more of a struggle to raise the funds. In order to provide them with hands-on-experience of robotics we have created the ultra low cost Micrograsp.

At the same time further development of the Genesis P101 has resulted in P102, a higher performance version.



MICROGRASP was designed to be priced at under £200 inclusive of power supply, computer interface board and even VAT! However, despite that restriction, it has some very powerful features. Driven by a simple computer, the ZX81 being eminently suitable, Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about the base and there is a motor-driven gripper. Each of the arm movements is servo controlled i.e. there are position sensors feeding back information to the interface board, where it is compared with the programmed-in intended position, and automatically taking corrective action. This servo action is independent of the computer, greatly simplifying the software to drive the robot and all programming is carried out with a small number of Basic commands.

MECHANICAL OPERATION

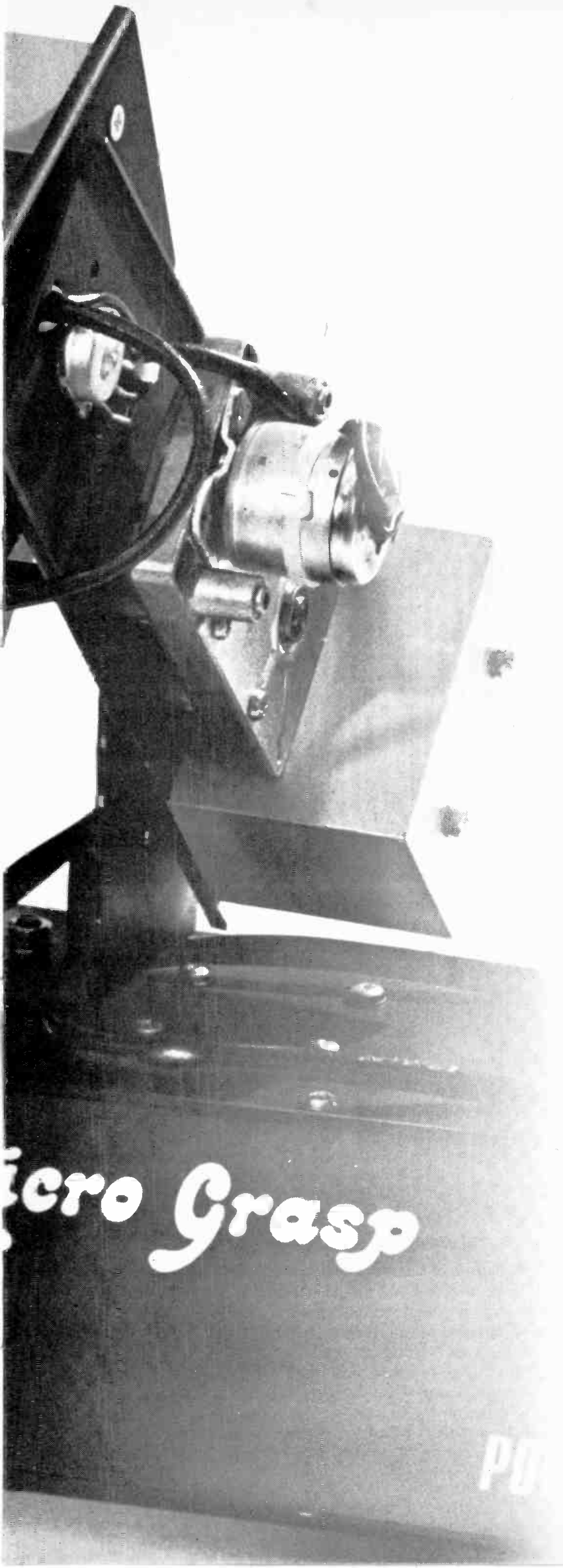
For each of the five axes there is a motor with integral gearbox. For the wrist and gripper motors small in-line gearboxes are used. The other axes use more powerful gearboxes in heavy duty zinc alloy castings. The shoulder and elbow joints are driven directly from the motors gearboxes with both motors mounted on the lower arm (Fig. 1). On the upper arm and the shoulder support bracket are steel bushes clamping the gearbox shaft so that when the motors are driven there is relative movement between the lower arm and the upper arm and the support bracket.

Also on the lower arm are the position sensing potentiometers. On the bushes of these are plastic bushes on which the arm rotates. The shaft of each potentiometer is held in the steel bush fitted to the upper arm or support bracket.

For rotating the arm (axis O) it is not possible to have the gear box shaft, the potentiometer and the shoulder support bracket all in line so the power is taken from the gearbox (Fig. 2) by a pair of spur gears which being of 2:1 ratio result in a doubling of torque. For this axis the gearbox shaft is taken out from the motor side of the gearbox.

For raising and lowering the wrist (axis 3) the gearbox shaft rotates a bar to which the potentiometer shaft and gripper mounting plate are fitted (Fig. 3). Through this bar the drive shaft for the gripper lead screw passes. When the screw turns clockwise the disc nut is moved in pulling the jaws together (Fig. 4). On turning anticlockwise the disc nut moves out and the springs pull the jaws apart.

The arms for the robot each have counterbalance weights so that no voltage needs to be applied to the motors to hold the arm in the desired position. This improves the accuracy of the servoing. Without balancing an error signal would



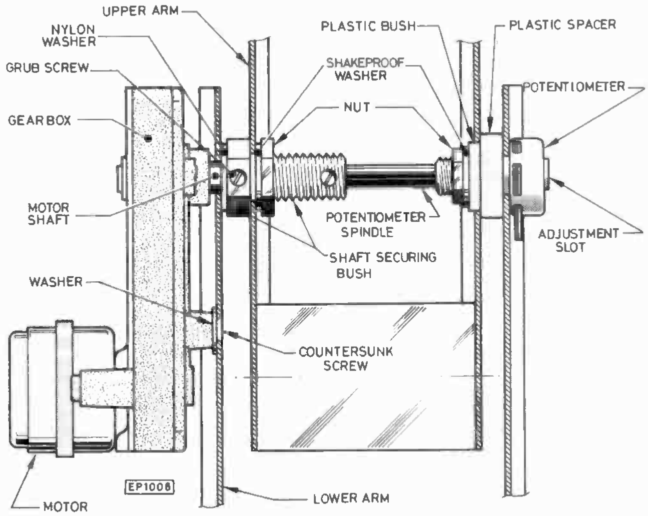
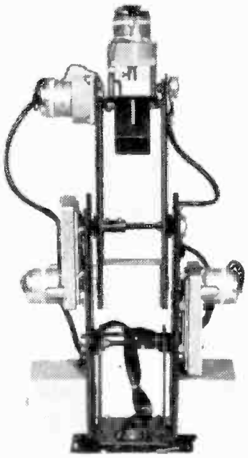
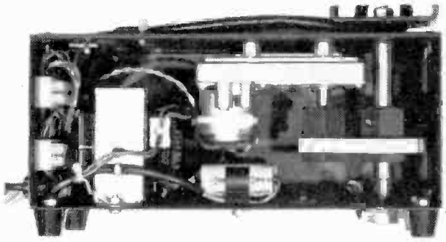


Fig. 1 Linkage between the motor, arms and potentiometer for axis 2 movement. Axis 1 operation is similar



(Left) Showing central position of the above linkage assembly

(Below) Interior of robot base showing Fig. 2 linkage and power supply



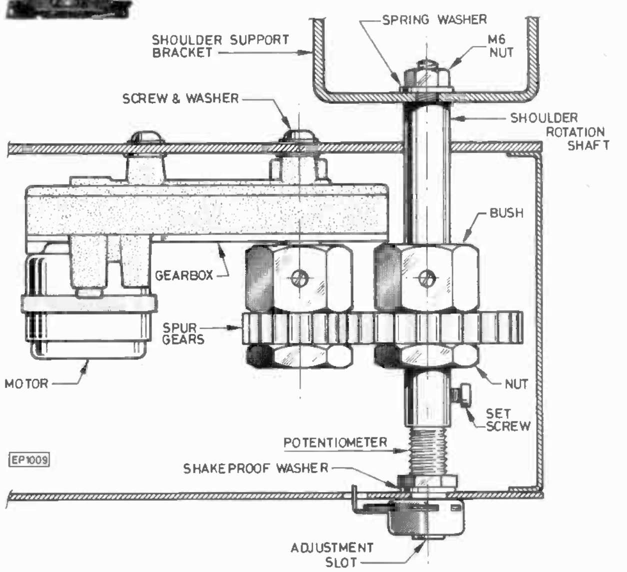


Fig. 2 Linkage between motor, spur gears, shoulder support bracket and potentiometer for axis 0 movement

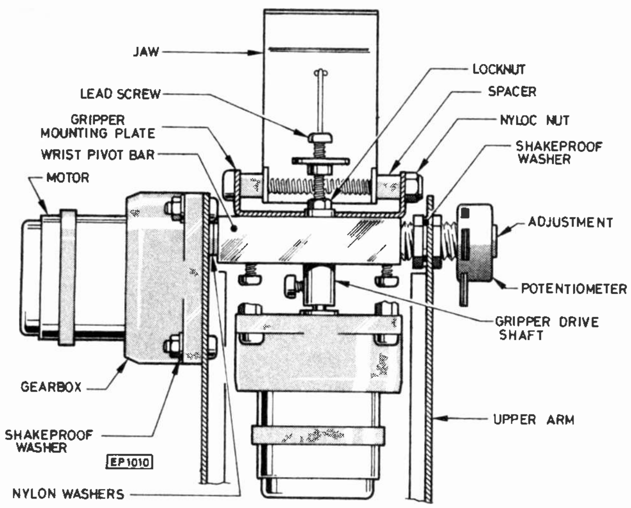


Fig. 3 Linkage between motor, gripper mounting bar and potentiometer for axis 3 movement

always be required for the arm to be motionless and a considerable torque would also have to be provided by the gearboxes causing an undue strain upon them.

CIRCUIT OPERATION

The interface board is designed to operate as a memory mapped peripheral of the controlling computer which generates the positional and manipulative commands whilst servoing is taken care of by linear circuitry on the interface board greatly simplifying the work of the computer and avoiding the requirement for extensive software specific to each type of machine. Some computers have I/O ports by which data could be sent to the robot, however the commonest and cheapest computer on the market, the ZX81 does not have this facility. It does however have an expansion bus giving access to all the address, data and control lines. Virtually all other micro computers also have this facility making practical a universal interface. The signals required are the address bus, data bus, $\overline{\text{WRite}}$ and $\overline{\text{Mem REQuest}}$. The connector format choice could have been arbitrary but in view of the particular cost effective suitability of the ZX81 the layout of that machine was selected and by using two back-to-back 23 way double sided connectors, a very neat connection with no wires can be made.

For any other computer a 23 way connector would be wired to one of the type recommended by that computers

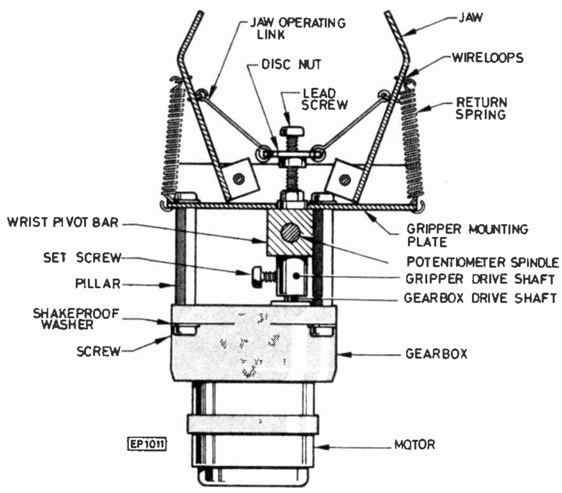


Fig. 4 Operating mechanism for the gripper

manufacturer. Using back-to-back connectors does however prevent the use of the 16K RAM pack limiting program length to about 30-60 lines. This restriction is avoided by use of the three way adaptor p.c.b. (Fig. 5) whereby the RAM pack lies neatly on top of the computer.

By setting the ten bank DIL switch (Fig. 6) any one of 1024 blocks of 64 bytes of the memory area can be selected. Actually only six bytes are required but to narrow down the memory area used would call for extra circuitry and with memory costs per byte of around 0.15p or less such extra complexity is pointless. IC2 is a ten bit comparator. The ten most significant address lines are compared with the +5V or 0V levels set up by the switch and when there is a match, i.e. when the computer selects an address within the 64 byte block, pin 13 goes high. The three least significant address lines are connected to IC3, a three into eight decoder, to select which axis is to be given a fresh command.

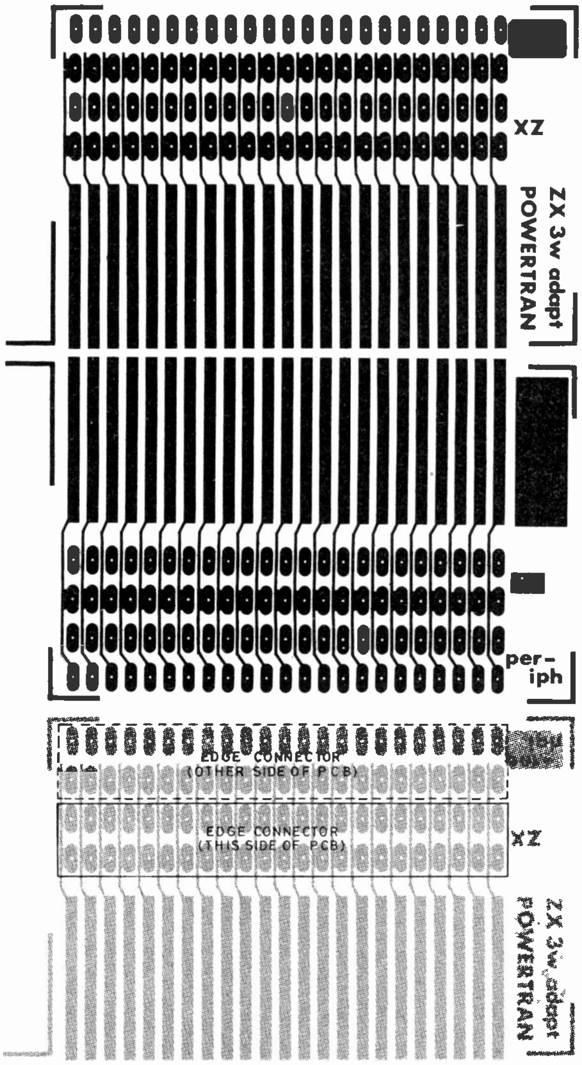


Fig. 5 Printed circuit of three way adaptor

The output of the decoder is enabled only when $\overline{\text{WR}}$ and $\overline{\text{MREQ}}$ are low and IC2 pin 13 is high i.e. when the computer is addressing the chosen axis as if it were a memory location into which data is to be written. For example if the top of the address space is to be used all the switches would be set to be open therefore addresses 65472–65535 are allocated to the robot. To move the rotation axis (servo circuit A) to the centre position the command would be POKE 65472, 128. 128 being the centre of the range of positions defined as 0

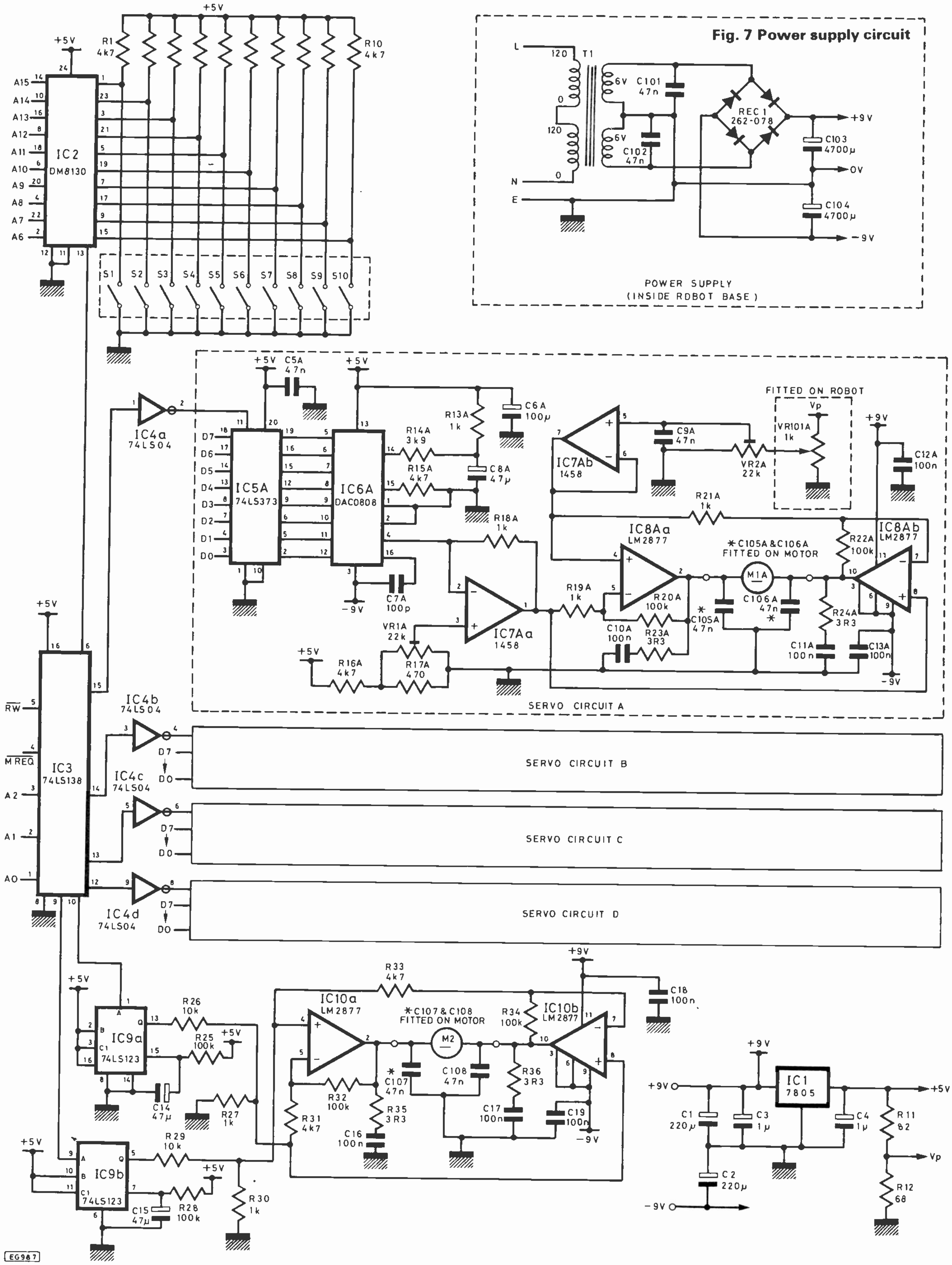


Fig. 6 Circuit of computer interface

COMPONENTS

INTERFACE BOARD

Resistors

R1, R2, R15A–D, R16A–D, R31, R33	4k7 (12 off)
R3–10	4k7 SIL network
R11	82R
R12	68R
R13A–D, R18A–D, R19A–D, R21A–D, R27, R30	1k (18 off)
R14A–D	3k9 (4 off)
R17A–D	470R (4 off)
R20A–D, R22A–D, R25, R28, R32, R34	100k (12 off)
R23A–D, R24A–D, R35, R36	3R3 (10 off)
R26, R29	10k (2 off)

Potentiometers

VR1A–D, VR2A–D	22k preset (8 off)

Capacitors

C1, 2	220μ/16V vertical electrolytic (2 off)
C3, 4	1μ/16V tantalum (2 off)
C5A–D	47n ceramic (4 off)
C6A–D	100μ/10V vertical electrolytic (4 off)
C7A–D	100p ceramic (4 off)
C8A–D	47μ/10V vertical electrolytic (4 off)
C9A–D	47n polyester (4 off)
C10A–D, C11A–D, C12A–D, C13A–D, C16–19	100n polyester (20 off)
C14, C15	47μ/6V3 tantalum (2 off)

Integrated Circuits

IC1	7805
IC2	DM8130
IC3	74LS138
IC4	74LS04
IC5A–D	74LS373 (4 off)
IC6A–D	DAC0808 (4 off)
IC7A–D	1458 (4 off)
IC8A–D, IC10	LM2877 (5 off)
IC9	74LS123

Miscellaneous

Printed circuit board
S1–S10–SPST 10 bank DIL switch
TV5 heatsink
8 pin i.c. socket (4 off)
14 pin i.c. socket
16 pin i.c. socket (6 off)
20 pin i.c. socket (4 off)
24 pin i.c. socket

ROBOT

Capacitors

C101, C102, C105A–D, C106A–D, C107, C108	47n ceramic (12 off)
C103, C104	4700μ/16V horizontal electrolytic (2 off)

Diodes

REC1	6A rectifier block

Transformer

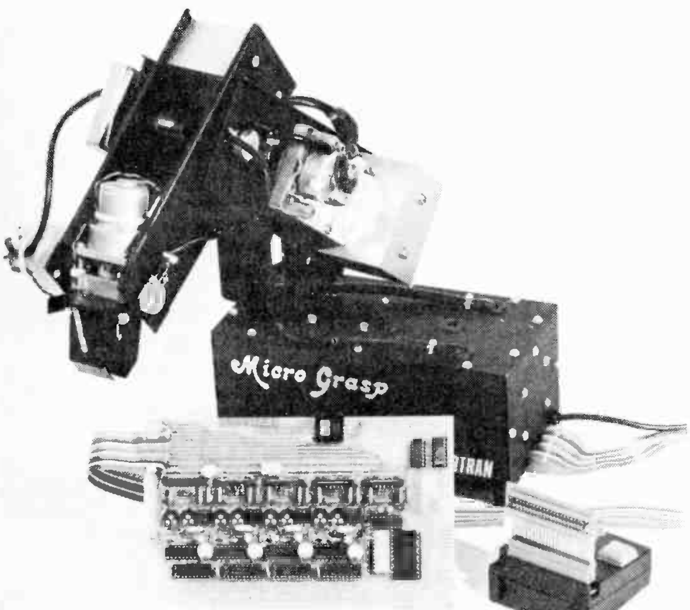
T1	0–120V, 0–120V primary 6–0–6V at 4A secondary

Potentiometers

VR101A–D	1k linear

Miscellaneous

Motors, mechanical parts, fixings etc.
A kit of parts is available from—
Powertran Cybernetics,
Portway Industrial Estate,
Andover,
Hants, SP10 3NN £125–Robot plus 15% VAT
£48·50–Interface plus 15% VAT.



Micrograsp with computer interface board, RAM pack and adaptor

to 255. Because of the redundancy in address selection 65480, 65488, 65496, 65504, 65512, 65520 and 65528 would be equally effective addresses.

The decoder enables IC4 which is an eight bit wide data latch which holds the data indefinitely after the writing-in process is completed. The data is converted into a d.c. level in the range 0V to 1V by IC6 which is a digital-to-analog converter and IC7a converts the current output of the DAC into a voltage, the feedback resistor R18 giving it a gain of 1 volt/ma. IC7a is also used to add in an offset voltage to balance out the residual voltage from VR101 when the axis is at its zero code position i.e. lowest or furthest left position. The position of the axis is sensed by VR101 to which is applied about 2V derived from the 5V rail via R11, R12. 1V corresponds to the position in the centre of the travel of that axis. VR2 is used in setting the range of movement and IC7b is a unity gain buffer enabling the low (1k) input impedance of the power amplifier stage to be driven without loading VR101 significantly.

IC8 performs two functions simultaneously. It compares the measured position of the axis with the programmed-in desired position and serves as a bridge output power amplifier to drive the motor either backwards or forwards with a voltage dependent on how far away from the desired position the axis has reached. To see how the circuit operates, first we consider the half with pins 7, 8, 10. The desired position voltage (DPV) is applied to pin 8, feedback via R22 makes pin 7 a virtual earth point elevated above ground by the voltage on pin 8. The measured position voltage (MPV) forces a current into this point via R21 resulting a voltage at pin 10 which is R22(DPV–MPV)/R21 i.e. pin 10 will go positive when MPV is less than DPV.

The other half of the i.c. behaves similarly except that pin 2 will go negative when MPV is less than DPV. As the circuit is symmetrical the voltage applied to the motor is therefore twice R22(DPV–MPV)/R21. The components selected resulting in a servo action which is close to critically damped.

R23 + C10 and R24 + C11 are the Zobel networks used almost universally to stop power amplifiers becoming power oscillators in the MHz region.

Capacitors C12, C13 are for local decoupling to also assist in ensuring stability and C105, C106 are suppression capacitors fitted as close as possible to the motor. Without these the interference from the motor brushes is sufficient to make the computer abort its program. Only four of the five axes are servo controlled as the gripper needs only to be either holding or releasing.

The gripper is activated by a motor turning a lead screw which then pulls together the jaws. To hold an object IC9a is triggered in a manner similar to the enabling of the data latches. This monostable then provides a signal for about 2 seconds, as determined by R25, C14, which causes IC10 to apply a voltage to the motor to pull in the jaws. When an object is seized the motor will stall but the amplifier is fully protected and as the stall period is less than 2 seconds no overheating occurs. On triggering IC9b the motor is driven the opposite way until it stalls at the jaws fully open position. Gripper operating commands could be POKE 65477,0 to hold and POKE 65478,0 to release, though this data as indicated by 0 is quite irrelevant and anything between 0 and 255 could be written. If the address allocated to axis 0 (servo circuit A) is A then axis 1 is A + 1, axis 2 is A + 2, axis 3 is A + 3, hold is A + 5 and release is A + 6.

The rotation shoulder and elbow motors take up to about 1A each and the other two motors up to about 0·5A each. The reference voltage for the DAC and the position sensing potentiometers comes from IC1 which provides excellent stability. The amplifiers requirements however are non-critical and an unstabilised supply is entirely adequate. The circuit shown (Fig. 7) provides ± approximately 9V. The supply is sited in the robot base where, as well as providing useful ballast at the rear of the base the mains connections are fully enclosed. The interface board is therefore free of mains and is safely operated whilst unenclosed and closely connected to the computer.

Next Month: Assembly, testing and calibration

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RADIO telephone Cambridge Boot Cambridge Dash Mount £25 each Vanguard No control unit £10. Edwards, 2 Beach Road, Burton Bradstock, Bridport, Dorset DT6 4RF. Tel: 0308 89625.

POCKET computer—Sharp PC1211 with cassette interface and printer only £50. Phone: 01-876 6661.

COMMUNICATIONS Receiver, 2–20MHz, Ex R.A.P., calibrator, variable selectivity, 3kHz readout, mains p.s.u., R1475, working well, £48. Tel: Cambridge 860150.

MULTIMETER with metal case £15 incl. postage. Tel: 01-554 2913 Evenings.

UK101 Mon 2, 8K, Marrick sound generator, software. Swap for PE string ensemble or similar. Tel: Newcastle 582449.

ZX80 Computer with leads transformer manual etc. £60 ono. Tel: Glyndwr 310 after 6p.m. Terry J. Bluck, 2 Maes Owain, Glyndyfrdwy, Nr. Corwen, Clwyd.

CB TRANSCEIVER, Commtron Nato CXX. £40 plus small straight forty rig or £85. Tel: 061 998 9109.

TANDBERG 3541X, Mint, unused, £90, SME FD200 Damper £12. Pair monitor audio 7·5m cable £12. Unopened. Tel: (07605) 402.

110V 1kW mains transformer with voltmeters/fully enclosed with sockets and carrying handle. Buyer collects. Offers. C. H. Kaufman, "Spring Grove", Sledgate Drive, Wickersley, S. Yorks S66 0AW. Tel: (0709) 548564.

CLEF Bandbox, fully complete working £265 o.n.o. Phone: 0233 812406. C. Maxwell, "Red Tiles", Brook, Ashford, Kent, TN25 5PG.

WANTED back issues Practical Electronics from June 1979—till July 81 any price paid. I. V. Olver, 11 Clarkes Close, Deal, Kent CT14 9JE. Tel: 03045-64445.

VOLTAGE tester probe £5. Transistor checker £12. Signal injector £6. Tel: 01554 2913 Evenings.

2708 EPROM's, little used, erased, still some left at £1·50 each. First come first served! Newnham, 21 Welbeck Avenue, Ilkeston, Derbyshire, DE7 4NL. Tel: Ilkeston (0602) 304339.

32K DYNAMIC RAM board, suitable for PET, UK101 etc. £40. Also PE/Technomatic interface boards £40. S. Riddle, St. Marshalswick Lane, St. Albans, Herts AL1 4UT.

SELENIUM bridges, One 25A, One 12A, fifty ½A, sell or swap for any working oscilloscope tube. Mark Daniels. Tel: Leicester 823249 (After 5p.m.)

CRT-lin GEC E4103/B/4 + Data £5; Morse-key £2; two Army hand-telephones No. 2 £6; Variac non-working £2. D. L. Buckley, 142A Lynton Road, West Acton, London W3. Tel: 01-993 3123.

Please publish the following small ad. FREE in the next available issue. I am not a dealer in electronics or associated equipment. I have read the rules. I enclose a cut-out valid date corner.

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PE BAZAAR DECEMBER '82

Ultimum Computer Interface Part 2

THE ULTIMUM is a motherboard organised universal interface system, the bus of which is broad based enough to allow it to interface with almost any microcomputer. It can also evolve to become a computer in its own right.

THE 16/64K RAM CARD

The first card available for the ULTIMUM is a dynamic RAM card. It may be configured as a 16 or 64Kbyte card, dependent on the RAM i.c.s used.

Fig. 2.1 shows the circuit diagram. This is a rather unconventional design as it has to cater for both Z80 and 68/65xx busses which have very different timing requirements.

The dynamic RAMs have to be refreshed to preserve their contents, and this is done when the microprocessor is not reading or writing to the memory. This kind of refresh is called transparent as it does not affect the processor.

65/68 series microprocessors never address memory when their clock output is low (the Q1 cycle) so this time slot is used for refresh. The Z80 on the other hand, provides a refresh timing signal to indicate that the memory is not being accessed. The Z80 also provides other refresh signals but these are not used in this design.

The refresh involves sequencing through a series of consecutive addresses on the RAM address lines. IC13 has a built in counter which is incremented on each memory refresh cycle.

Because dynamic RAMs are in 16 pin packages, there are not enough lines to fully address them. Consequently some of the pins have to have addresses multiplexed into them. IC13 will do this for 16K memories, but additional circuitry is needed for the 64K RAMs and this is provided by IC16 and IC17.

ULTIMUM is the missing link between your computer and the outside world! Just take a look at the interface board line-up.

WE01 RAM

A 16/64K Byte dynanic RAM card (detailed in this article).

WE02 BRR

A ROM/Battery back-up RAM card for use with 2516/2716/2732 EPROMS and 6116 static memory chips. There are two sockets available for 6116 RAMS with battery back-up allowing up to 4K per card of RAM to be stored permanently when the system is switched off.

WE03 PRG

An EPROM programmer designed for use in conjunction with the EPROM card above. This has hardware timers and EEPROM facilities.

WE04 FDC

This is perhaps the most complex of the daughter cards. It is a very comprehensive floppy disc controller for up to 5 disc drives per card. It has *its own* processor which performs all the standard disc read/write routines and communicates to the ultimum bus via a pia chip. This makes software patching for different computers possible. The card includes an operating system ROM programmed for each host computer.

WE05 PRT

A part card with RS232c, parallel and Centronics interfaces, and a real time clock.

WE06 ADC

An analogue card with 12-bit precision A>D and D>A capability. A fast conversion 8-bit A>D is also included.

WE07 SBD

A sound board using a brand new chip to give up to nine oscillators with programmable frequency, waveform, ADSR envelope shaping and band filtering.

WE08 SPK

A phoneme speech card which is software programmable from RAM or ROM.

WE09 RES

A terminal card which provides 80 column video output and a keyboard interface to allow for connection of up to eight keyboards. It has optional character sets including teletext and block graphics.

WE10 CPU

A second processor card based on the very powerful 6809 c.p.u. This card can share the other system cards with the host computer and can be used to control the terminal card for multitasking operations.

WE11 PRO

The system breadboarding card—an invaluable card for anybody wishing to experiment with their own daughter cards.

WE12 EMU

This card has facilities to emulate up to 4K of ROM. RAM is memory mapped into host computer, then software switched into emulation.

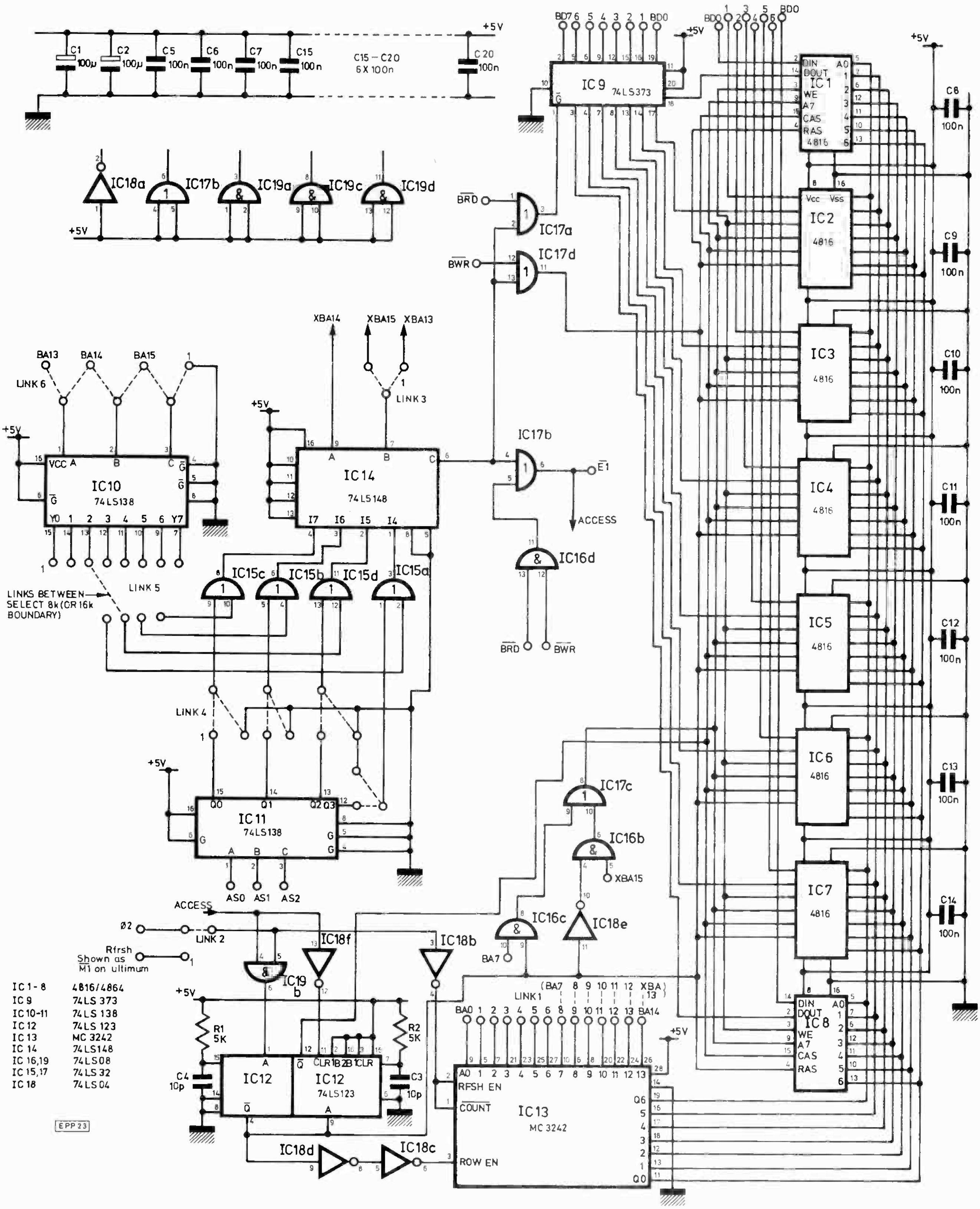


Fig. 2.1. Circuit diagram of the 16/64K Dynamic RAM board

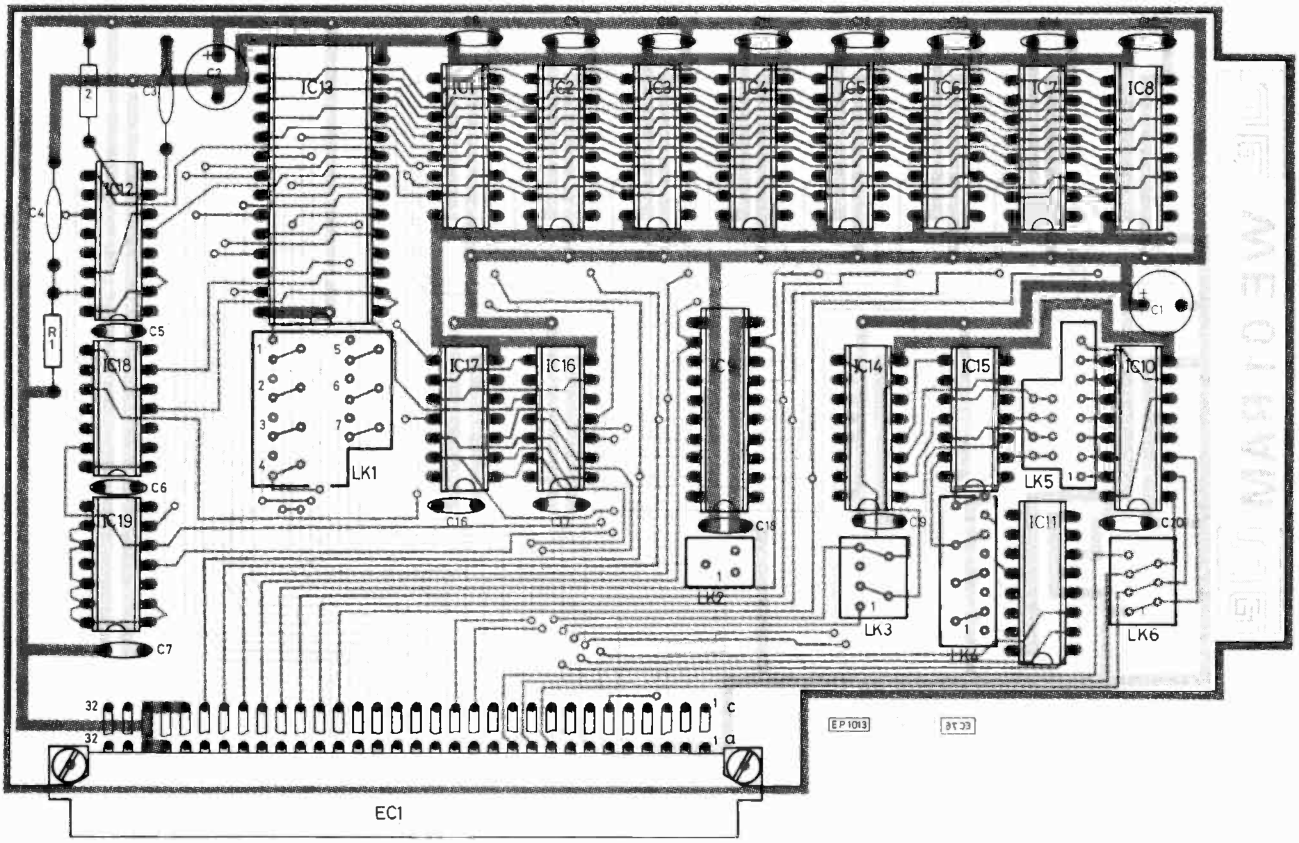


Fig. 2.2. Component layout of the RAM board

IC12 is used to provide the multiplex timing. The rest of the circuitry is decoding and buffering to allow paging and connection to the mother board.

ASSEMBLY

The component layout is shown in Fig. 2.2. As with the ULTIMUM, start with the sockets, then the capacitors and resistors and finally insert the i.c.s. taking special care with the static-sensitive memories.

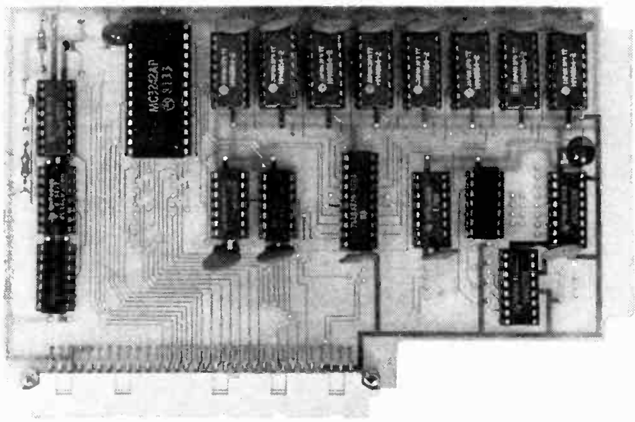
THE LINKS

There are several links to be set up. To make life a little easier, many are initially configured for 64K RAMs, as most people will opt for this capacity.

Link 2 is set to the Rfsh position for Z80 based systems and Q2 for 65/68xx computers.

To give the user a wide range of decoding options there are several links used for setting up the address space. The function of these links is given in Table 2.1. The paging facility can be used to allow the 64K RAM to be mapped in pages of 16K, and 4K blocks for the 16K. Many other configurations are possible. The paging may be omitted if not required.

If you are using 16K memories, link sets 1 and 3 require cutting and switching over. Cutting the set-up tracks is best done with a sharp blade. Applying a hot soldering iron will then remove the tracks between the cuts.



ULTIMUM is a motherboard configured universal interface system designed to work with *most* microcomputers

COMPONENTS . . .

16K/64K DYNAMIC RAM CARD

Resistors

R1, R2	5k1 ¼W 5% (2 off)

Capacitors

C1, C2	100µ/6V3 tant. (2 off)
C3, C4	10p disc ceramic (2 off)
C5-C20	100n disc ceramic (16 off)

Integrated Circuits

IC1-IC8	4816/4864* (8 off)
IC9	74LS373
IC10, IC11	74LS138 (2 off)
IC12	74LS123
IC13	MC3242
IC14	74LS148
C16, IC19	74LS08 (2 off)
IC15, IC17	74LS32 (2 off)
IC18	74LS04

Miscellaneous

14 pin d.i.l. socket (5 off)
16 „ „ „ (12 off)
20 „ „ „
28 „ „ „
Printed circuit board WE01
PL1 2 × 32 'A+C' DIN Euro Plug (right-angled pins)

Option*
a) For 16K RAM IC1-8=4816 (16384 × 1 bit i.c.)
b) For 64K RAM IC1-8=4164/4864 (65536 × 1 bit i.c.)

TABLE 2.1. Links for the RAM board. Some links are in sets

Link set 1 (7 links near IC13)
These links set for 64K RAM. Cut and change over for 16K option. Their function is to set up IC13 address multiplexer for 64K or 16K operation.

Link set 2 (one link)
Set to RFSH position for Z8Ø systems, to Q2 position for 68/65×× systems.
This all-important link tells the refresh circuitry when it may perform the refresh. It also gives the timing for read and write.

Link set 3 (2 links near IC14)
These links set for 64K RAM. Cut and change over for 16K operation.
These links determine whether the RAM is to be decoded in 8K or 16K blocks.

Link set 4 (4 links near IC11)
These links set for permanent (not paged) memory mapping. Cut one or more links and connect to QØ, Q1, Q2 or Q3 to allow AS lines (from 8255 port on mother board) to map in/out memory.

Link set 5 (four double links near IC15)
These are the main decoding links. YØ to Y7 of IC1Ø allow you to map the RAM in blocks of 16K (in the case of 64K RAM) to any 16K boundary. If 16K RAM is fitted and link set 6 set up (see below), the memory may be mapped to any 8K boundary, in 2 blocks of 8K each.

Link set 6 (three links near IC1Ø)
These are set up for 64K RAM. Cut and link the other way for 16K RAMs.
These links set the decoder up to decode in 8K or 16K blocks. If left in their default position, these only YØ, Y1, Y2, Y3 are available from IC1Ø. Linked the other way, all outputs are enabled each representing an 8K boundary.

ROM AND BATTERY BACK-UP RAM CARD

This card provides five sockets each of which may be configured to accept a 4K EPROM, a 2K EPROM or a 2K × 8 RAM. Two of the sockets have back-up power from a rechargeable battery, giving up to 4K of non-volatile RAM. All the necessary address decoding and selection is provided on the card.

OPERATION

This is a nice simple card. IC6 provides address decoding to 4K boundaries which is sufficient for 2732 EPROMS. The provision of the inverter on the A11 line and ICs 8 and 9 allows decoding to 2K boundaries for 2716/2516 PROMS and 6116 RAMs. Fig. 2.4 shows the link layout for setting up the addressing. The As lines allow for the overlaying in sophisticated systems of up to three 4K slots per Battery RAM/ROM card, accessible under software control by writing the appropriate data to the Motherboard 8255 AO acts as an enable. A1 as a disable. Care should be taken not to enable more than one chip into the same part of memory space at a time.

Sockets 4 and 5 are provided with the option of a battery back-up power supply of 3V. This is sufficient for low power 6116 RAMs to hold information for about a year—even if the card is unplugged. The power for normal-mode use and for the battery trickle charge is derived from the twelve volt rail by a Zener shunt regulator (R1 D2). Switching between main and back-up power is effected by diodes D3 and D1. The transistor circuitry on the $\overline{CS}$ lines ensures that they stay up with the back-up power line when the main power disappears, keeping the RAMs deselected and thus in low power mode. Links 6 and 7 provide for not using the battery back-up if this option is not required. Links 1 to 5 configure respectively sockets 1 to 5 for 2732s, 2716/2516s or 6116s. Fig. 2.4 shows the required layout of these links. Finally IC10 tells the motherboard when the data bus buffers must be activated.

CONSTRUCTION AND TESTING

Construction is straightforward. Links should be inserted and soldered in place first, discrete components next, and then the integrated circuits. The battery should be fitted last.

Testing the card requires an operational Motherboard and host computer. To test for EPROM you will require (a) an EPROM with known contents, and (b) a program to read it. If you have access to a PROM programmer and an eraser then life is made easy for you; simply copy your operating system or language system ROM into a spare EPROM drop this into the socket to be tested and write a little program to check the copy against the original. Mere mortals will have to make do with viewing their language ROMs first few bytes using operating system facilities, noting them down on a scrap of paper, moving the ROM in question to the socket under test and viewing them again in their new position in

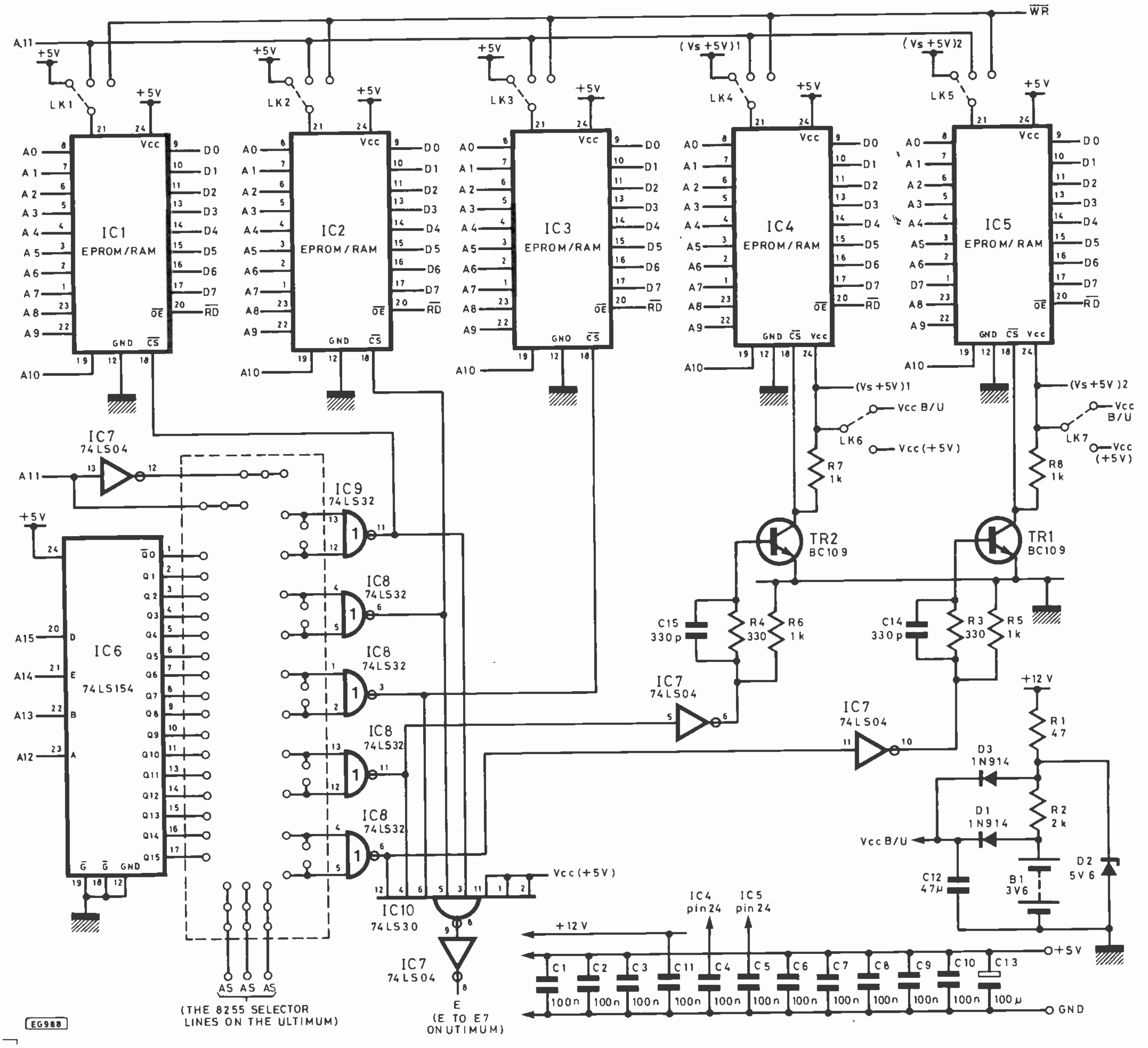


Fig. 2.3. Circuit diagram of ROM/Battery Back-up RAM board

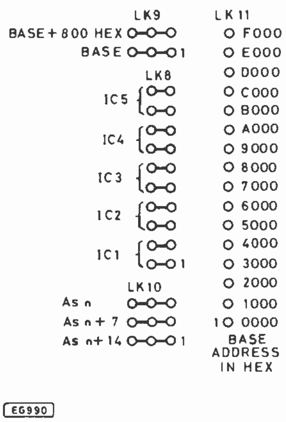


Fig. 2.4a. Addressing links on the Battery Back-up board. Link one of the pad pairs for each i.c. in L8 to the appropriate one in L11 to set the 4K base address. If the i.c. is only 2K, link the other pair to either of the L9 triplets to set the 2K boundary. Otherwise, link the two pad pairs together (unless you want to be clever and bring in an As line with L10! N is the number of the Euroconnector into which the card is plugged. The relationship between the As line numbers and the 8255 port bits was shown last month on the Motherboard circuit diagram)

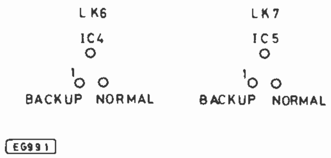


Fig. 2.4b. Power links

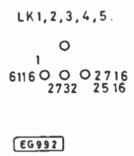


Fig. 2.4c. Configuration links

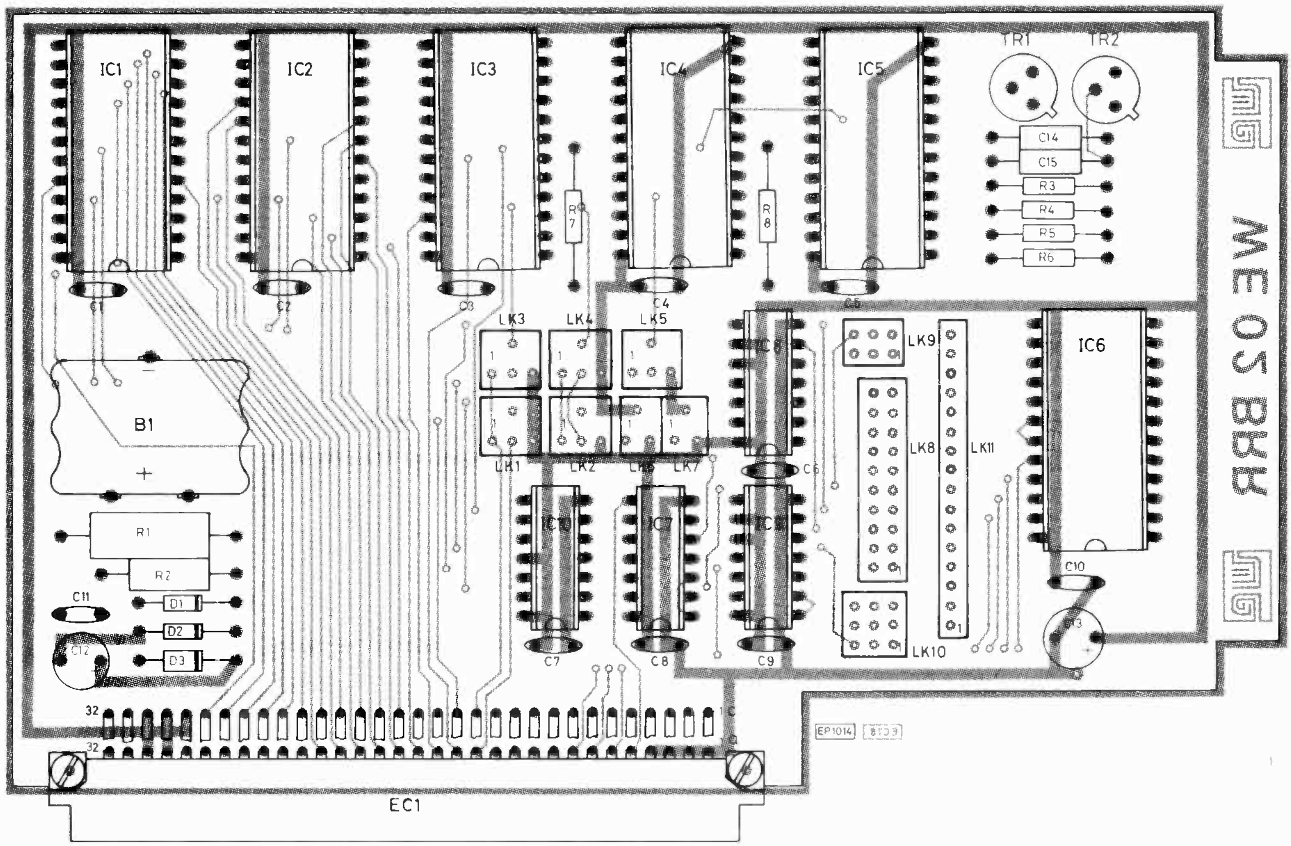


Fig. 2.5. Battery back-up board component layout

memory. If your system is such that you cannot move a ROM without losing your operating system then you have real problems!

Testing RAM is more simple; all that is required is to write a known pattern into a location (e.g. all zeroes or all ones), read it back to check it, and go on to the next one. Keep a count of the errors; it should be zero over several cycles through the RAM.

COMPONENTS . . .

BATTERY BACK-UP BOARD

Resistors

R1	47 1W
R2	2k ½W
R3, R4	330 (2 off)
R5–R8	1k (4 off)

All resistors ¼W 5% unless otherwise stated

Capacitors

C1–C11	100n disc. cer. (11 off)
C12	47µ/6V3 tant.
C13	100µ/6V3 tant.
C14, C15	330p polystyrene (2 off)

Semiconductors

TR1, TR2	BC109 (2 off)
D1, D3	1N914 (2 off)
D2	5V6/1W3 Zener

Integrated Circuits

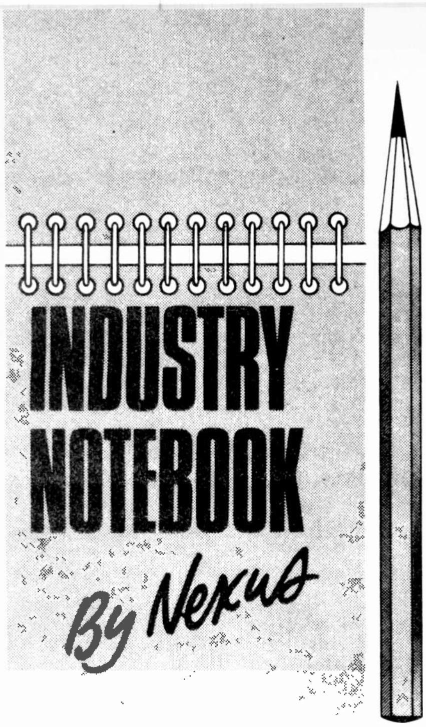
IC1/IC5	EPROM/RAM see text (5 off)
IC6	74LS154
IC7	74LS04
IC8, IC9	74LS32 (2 off)
IC10	74LS30

Miscellaneous

14 pin low profile d.i.l. socket (4 off)
24 pin low profile d.i.l. socket (6 off)
P.c.b. mounting battery 3V6
P.c.b. WE02 BRR
2 × 32 A+C DIN Euro-Angle plug

Constructors Note

All kits for the Ultimum system are to be available from **Watford Electronics** (See advertisers' Index). Send SAE for price list of boards now available.



Genesis

Overwhelmed by the profusion of electronics in daily life all the way from children's toys to giant computers, we tend to forget that in the beginning all we had was wireless telegraphy as distinct from telegraphy by wire. The 'wireless' in its then embryonic state had only one application where it could obviously score and that was in maritime communication where, quite clearly, it was impractical to link ships at sea by wires. Up to the advent of what we now call radio communications a ship's position could be reported only when visually sited and identified by a watcher on shore. Similarly, ships at sea could only communicate when in visual or hailing range of each other.

When Marconi formed the Wireless Telegraph and Signal Company Ltd on 20th July 1897 it was the maritime world which quickly saw new possibilities. The Italian navy was first off the mark in adopting the Marconi system but within months Lloyds of London, the great shipping insurance syndicate, also became interested. The impetus thus originated with both naval and mercantile shipping interests becoming enthusiastic supporters of a remarkable invention which was to blossom years later into the huge and exciting industry which we now call electronics.

Marine radio and electronics nowadays doesn't get much of a press. We take it for granted as 'old hat'—a remote and hazy background to more exciting and immediate developments such as the laser or optical fibres or the popular crazes for personal computers and video.

Although in the background, marine electronics remains big business and highly competitive. I was reminded of this as further details of maritime operations in the Falklands conflict came to light. A total of 51 warships and 52 merchant ships were employed together with 171 aircraft of the Fleet Air Arm. Eighteen thousand sailors and marines were at sea and at any one time during the operation the supply 'pipeline' of 8,000 miles length was carrying half a million tons of fuel and stores to sustain the armada.

One may imagine the organisation required and the level of efficiency of communications necessary to ensure smoothness, particularly as the sharp end was in perpetual flux of battle. And, as this was in every sense a war (albeit undeclared by either side as is today's custom) there would have been the additional complications of encryption to preserve secrecy and periods of radio silence to conceal ship movements.

The whole electromagnetic spectrum from VLF (for submerged submarines) to microwave (satellite communication to the operations centre near London) was employed. VHF and UHF to aircraft and between ships at short range. The bulk of naval ship-to-ship traffic, however, was on HF through the Marconi Integrated Communications System Mk 3 (ICS3), standard in the Royal Navy and adopted by other NATO and non-NATO navies. ICS3 is flexible both in frequency and power management and enables commanders to access the transmitter, receiver and antenna systems best suited to his communications requirement at any time with a number of different users working into the system simultaneously on different frequencies using voice, telegraphy or data.

ICS3 is also adaptable to new technology. It already has frequency agility from extensive use of broad-band techniques and auto-tuning enabling rapid change of frequency. Although unlikely to have been used in the South Atlantic it is also adaptable to frequency hopping.

In the merchant navy, too, we have come a long way from early spark transmission. Minimum radio requirements for vessels over 1,600 grt were established at the 1974 Safety of Life at Sea Convention (SOLAS 74). They include main and reserve MF telegraphy transmitters and receivers, automatic keyers, radiotelephone transmitter and receiver on the distress frequency with auto-alarm, VHF radiotelephone and portable lifeboat transceiver.

Most large vessels have far more than the minimum equipment with additional high-powered HF transmitter and telex and facsimile facilities, radio direction finders, and other radio navigation equipment which may include Loran C, Decca Navigator, Omega (a world-wide VLF positioning system), and Satellite Navigation. If we include radar (often a dual installation) and echo sounders, the total electronic package can approach £100,000.

Although world shipbuilding, including the UK, is in recession, ships are being built and the race is on to supply equipment. Marconi International Marine, who supply radio and electronic sea-going officers if required as well as hardware, have recently won orders for complete installations in ten new buildings under construction in India, Japan and Korea. Apart from proven quality of equipment, Marconi export successes in merchant shipping are due to the world-wide servicing network with a Marconi presence in every major port.

The slack caused by decline in the number of ships at sea has been taken up by large installations on oil rigs which, in addition to SOLAS requirements, have continuous need for commercial transmission and extra housekeeping requirements such as UHF/VHF radio paging and aero-nautical beacons for helicopter guidance.

Balance

Overseas sales of marine electronics equipment is just one area of industry that contributed to a record £6 billion surplus on current account balance of payments last year and helped repay £1·6 billion on foreign currency borrowing. Compare this performance with the rising total of virtually bankrupt countries unable to service interest charges let alone repay capital borrowed.

Surprise

There were plenty of raised eyebrows when Racal announced entry into the Pay-TV business. This was a company which had always shunned the entertainment sector of electronics. When Racal acquired Decca they couldn't get rid of Decca's domestic TV interests fast enough, eventually selling it off to a Far Eastern entrepreneur. Had Sir Ernest Harrison gone off his rocker doing a U-turn? Closer examination showed that he hadn't lost his touch or his sense of direction.

In fact Racal stays in the capital goods sector of the industry as an extension of traditional communications business and expect to generate billions of pounds in the next decade in cable and subscription TV. To get in on the act Racal has teamed itself on a 50/50 basis with Oak Industries of San Diego, California, who are already established with not only the technology but also operating experience with five Oak-owned STV systems and 610,000 paying subscribers. Old-timers in the industry will remember Oak switches which were the first products.

Oak moved into Pay-TV in 1977 and is now in all modes, cable, STV and direct broadcast by satellite (DBS). All use encryption technology to ensure that programmes can be received only by subscribers who have appropriate decoding apparatus. Racal have great experience in signal encryption and will no doubt contribute to the technology in the years ahead.

Immediately, however, Oak need to expand into international markets and the new joint company, Racal-Oak Communications Ltd, although based in the UK will cover the whole of Europe. The two equal partners are clearly delighted with their marriage which was blessed at the inauguration ceremony by none other than Mr Kenneth Baker, Minister for Information Technology, who hinted ever so slightly that he, himself, might have been the marriage broker following a meeting with Oak's chairman last June.

PE micro-file

R.W.Coles

FILESHEET 2 6800 · 6802

APPEARING hot on the heels of the Intel 8080A in 1974, the 8 bit NMOS Motorola 6800 soon established a significant following of designers who liked it for its single 5 volt supply operation and its elegant instruction set which had been modelled after the PDP11 minicomputer. By the end of the decade Motorola was building on its success and introducing several new devices, all described as "6800 family members" and all bearing a close resemblance to their parent. The 6802 was one of these, and was intended to directly replace the 6800 in new applications where its on-chip clock and RAM array would make it easier to use than the basic 6800 which was itself becoming obsolete.

The powerful 6801 is intended as a 6800 system-on-a-chip, with RAM, ROM, Clock, Multiplier, Serial and Parallel I/O all available in a single package. The 6803 is a ROM-less version of the 6801 but the 6805 goes the other way with a "sawn-off" version of the 6800 architecture for smaller single chip applications and low cost. The shortened registers and reduced memory addressing range of the 6805 allow it to fit into a 28 pin package complete with ROM RAM and parallel I/O. A CMOS version, the MC 146805 and an EPROM version, the 68705, are also available. Perhaps the thing to note about the 6801 and the 6805 is that they share, to a large extent, the instruction set and features of their ancestor.

Also in the 6800 family is the 6809 which represents an attempt to capture a slice of the data processing market for the Motorola family which until the 6809, could not compete well in this field with the 8080A or more particularly with the Z80. The 6809 is a very nice chip with most of the problems of the 6800 put right and with lots of new features and facilities, but unfortunately for Motorola, it turned up too late, when most of the data processing sockets had already been gobbled up by the 6502 made by MOS Technology. The 6502 is to the 6800 what the Z80 is to the 8080A, a successful attempt by outsiders to improve on the basic chip and to steal a march on the originators.

The 6800 and 6802, then, can be considered to be at the centre of a large and expanding family of devices which have a big following, and a large part of this success must be attributed to the original designers of the 6800 who came up with a simple but capable architecture and an elegant instruction set. The popularity of these devices should ensure their availability for many years to come.

REGISTERS

With so much going for it, you may be wondering why the 6800 lost out to the 8080 and its "messy" instruction set in many applications. Although there are many secondary reasons, the primary reason must surely be the 6800's lack of CPU registers. In some respects the 6800 register set is good. There are two general purpose accumulators, compared with the one on the 8080A, and there is a 16 bit index register where the 8080 has none, but that is as far as it goes. Where the 8080A has six general purpose 8 bit registers the 6800 has none, with the result that temporary data storage and counters usually have to reside in main memory. To be sure, the use of main memory for this purpose is well supported with extra instructions to allow register like operations to be performed there, and it could be argued that access is made available to a virtually unlimited register set by this method, but the net result is a reduction in flexibility and in speed of access to the temporary data and the counters.

Even more of a problem, according to some, is the provision of only one index register, since most programs need two. Although the 8080 has no true index registers, it is quite possible to use the DE and HL pairs as pseudo index registers at the cost of a few extra instructions. Achieving the same result with the 6800 would be a more difficult and time consuming job.

As can be seen from the file sheet, the 6800 and the 6802 share the same register set, which has two 8 bit registers ACCA and ACCB, and three special purpose 16 bit registers IX (Index register) SP (Stack Pointer) and PC (Program Counter). In addition there are 5 single bit flags which are for some operations grouped together as the 8 bit CCR (Condition Code Register).

The two accumulators are identical and are used as the focus of many of the instructions, particularly those which use the ALU (Arithmetic and Logic Unit). The accumulators may be added or compared with one another and either can be used to hold the result of arithmetic, logic, data test, and data handling instructions.

The Index Register is intended for use as a memory pointer and is used to implement register indirect addressing of data tables which are created in RAM by the programmer. Since only the Index Register is available as an indirect address pointer, this addressing mode is actually termed Indexed Addressing. The Index Register pointer can be moved through the full address range of 64K bytes by increment and decrement instructions, but the real advantage of this 6800 feature lies in the ability to add an offset value which is specifed in the instruction. In effect, the Index Register may be used to hold the base address of a table with access to individual table entries being gained by specifying a 0–255 offset value to be added to the Index Register value. The contents of the Index Register itself are not modified when this addressing mode is invoked. For example, the two byte instruction: ADDA 00H,X adds the content of the memory location pointed to by the Index Register to the accumulator, while: ADDA 08H,X adds the content of the memory location pointed to by the Index Register value plus 8, to the accumulator, leaving the Index Register itself unmodified. It is this offset capability which makes Indexed addressing so efficient; the 8080A programmer would have to use extra register arithmetic instructions to achieve the same result and would end up with a modified pointer value into the bargain.

The Stack Pointer register in the 6800 and 6802 works in exactly the same manner as the 8080A version, and is used to control access to a Last-In-First-Out (LIFO) stack in RAM memory. In comparison with the 8080A however, the 6800 stack instructions are more limited, the 6800 is restricted to pushing or pulling a single byte from one of the two accumulators. The stack concept is also important for automatically storing subroutine return addresses and processor status following an interrupt, and the 6800 comes out well here since on interrupt it saves *all* the CPU registers on the stack automatically whereas the 8080A saves only the Program Counter, leaving the programmer to save the rest using PUSH instructions.

The Program Counter holds no surprises and is virtually identical to the 8080A in terms of its addressing range and its operation.

The 6800 and 6802 flags are somewhat different to those of the 8080A. There is no Parity flag, and this is sometimes a drawback, but there are two extras, namely Overflow, which is set if arithmetic overflow occurs as the result of an ALU operation, and Interrupt, which indicates whether interrupts have been enabled or disabled.

INSTRUCTIONS

The 6800/6802 instruction set is regular and elegant, and this makes these processors easy to program and ideal for use in tutorial systems.

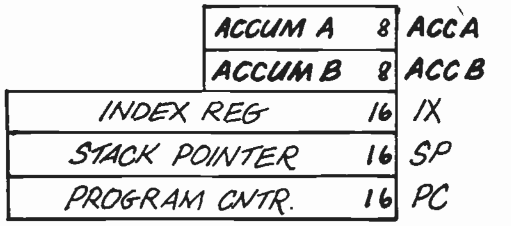
6800/6802 REFERENCE FILE SHEET

GENERAL

Although appearing shortly after the 8080A the 6800 never really caught on quite as well. This is mainly due to the more powerful architecture of the former but it is a pity because the 6800 has a more elegant instruction set and hardware which makes it a good device for beginners and a better device than the 8080A when it is capable of doing the job. The 6802 is a simple upgrade of the 6800 which has an on-chip clock generator and 128 bytes of RAM. The 6802 is recommended for all new designs.

REGISTERS

The 6800/6802 have two 8 bit general purpose data registers (ACC A & ACC B) and three specialised 16 bit memory pointers.

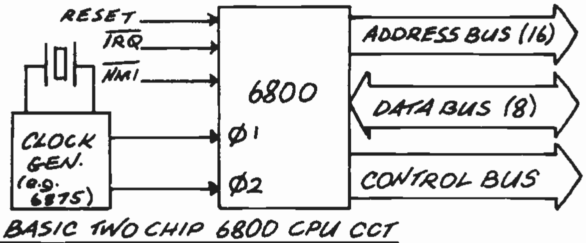


FLAGS:-

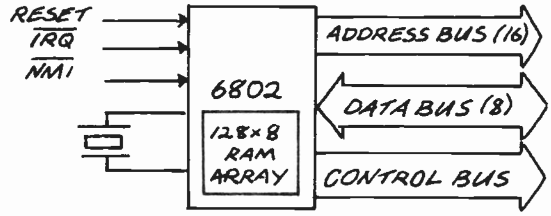
D7	D6	D5	D4	D3	D2	D1	D0
		AUX CARRY	INT	SIGN	ZERO	OVER. FLOW	CARRY

INSTRUCTION SET AND SOFTWARE

The 6800 and 6802 share a common instruction set which has been modelled after the PDP11 minicomputer as far as possible. The instruction set is more elegant and less messy than the competing 8080A/8085A but is hindered by a scarcity of CPU registers which is overcome to some extent by the "Direct" addressing mode which allows fast access to page zero (256 bytes) of memory. Reset causes branch to address which must be stored in address locations FFFE & FFFF. One, two and three byte instructions are used and "Direct, Extended, Immediate, Relative, Indexed and Implied" addressing modes are available. Chips are well supported in software including Tiny Basic.



BASIC TWO CHIP 6800 CPU CCT



BASIC SINGLE CHIP 6802 EQUIVALENT

PERFORMANCE DATA

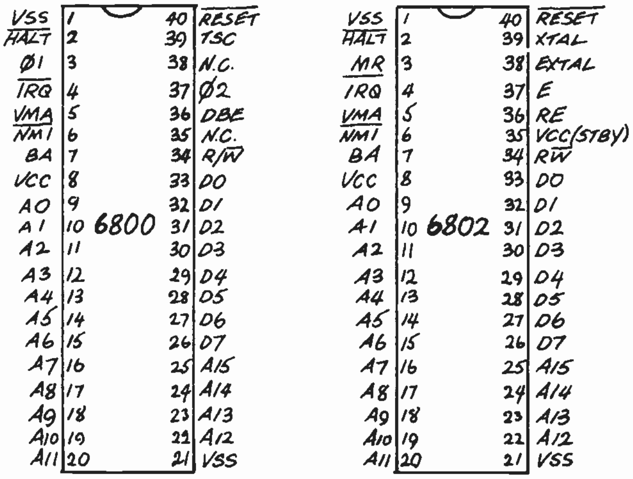
	6800	6802
MEMORY ADDRESS RANGE:-	64K	64K
I/O ADDRESS RANGE:-	(MEMORY	MAPPED)
CLOCK FREQUENCY*:-	1MHz	1MHz
POWER SUPPLIES:-	5V	5V
INTERRUPTS:-	$\overline{IRQ}$ $\overline{NMI}$	$\overline{IRQ}$ $\overline{NMI}$

*NOTE: 1.5 MHz & 2.0 MHz SELECTIONS OF BOTH CHIPS ARE ALSO AVAILABLE.

BENCHMARKS

	6800	6802
ADD REGISTER TO ACCUM	2µS	2µS
O/P ACCUM TO PORT ①	5µS	5µS
MOVE FROM MEMORY TO MEMORY ①	9µS	9µS

① EXTENDED ADDRESSING MODE



PIN DIAGRAMS

MANUFACTURERS

ORIGINATOR :- MOTOROLA
6800 2ND. SOURCES :- A.M.I, HITACHI, FAIRCHILD SESCOSEM
6802 2ND. SOURCES :- A.M.I, HITACHI, FAIRCHILD SESCOSEM + MITEL PLESSEY, MEDL (IN CMOS)

SUPPORT CHIPS

6800 needs an external 2Ø clock generator such as 6871 or 6875 and has a family of support devices including:- 6821 (parallel I/O) 6828 (interrupt controller) 6840 (timer-counter) 6844 (DMA) 6850 (UART) 6802 has ROM/timer/I/O combo chip (6846) In addition to above 6800 parts

6800–6802 INSTRUCTION SET

OPERATIONS	MNEMONIC	IMMED OP	IMMED ~	IMMED #	DIRECT OP	DIRECT ~	DIRECT #	INDEX OP	INDEX ~	INDEX #	EXTND OP	EXTND ~	EXTND #	IMPLIED OP	IMPLIED ~	IMPLIED #	BOOLEAN/ARITHMETIC OPERATION (All register labels refer to contents)	5 H	4 I	3 N	2 Z	1 V	0 C
Add	ADDA	8B	2	2	9B	3	2	AB	5	2	BB	4	3				A + M → A	↕	•	↕	↕	↕	↕
	ADDB	CB	2	2	DB	3	2	EB	5	2	FB	4	3				B + M → B	↕	•	↕	↕	↕	↕
Add Acmltrs	ABA													1B	2	1	A + B → A	↕	•	↕	↕	↕	↕
Add with Carry	ADCA	89	2	2	99	3	2	A9	5	2	B9	4	3				A + M + C → A	↕	•	↕	↕	↕	↕
	ADCB	C9	2	2	D9	3	2	E9	5	2	F9	4	3				B + M + C → B	↕	•	↕	↕	↕	↕
And	ANDA	84	2	2	94	3	2	A4	5	2	B4	4	3				A · M → A	•	•	↕	↕	R	•
	ANDB	C4	2	2	D4	3	2	E4	5	2	F4	4	3				B · M → B	•	•	↕	↕	R	•
Bit Test	BITA	85	2	2	95	3	2	A5	5	2	B5	4	3				A · M	•	•	↕	↕	R	•
	BITB	C5	2	2	D5	3	2	E5	5	2	F5	4	3				B · M	•	•	↕	↕	R	•
Clear	CLR							6F	7	2	7F	6	3				00 → M	•	•	R	S	R	R
	CLRA													4F	2	1	00 → A	•	•	R	S	R	R
	CLRB													5F	2	1	00 → B	•	•	R	S	R	R
Compare	CMPA	81	2	2	91	3	2	A1	5	2	B1	4	3				A − M	•	•	↕	↕	↕	↕
	CMPB	C1	2	2	D1	3	2	E1	5	2	F1	4	3				B − M	•	•	↕	↕	↕	↕
Compare Acmltrs	CBA													11	2	1	A − B	•	•	↕	↕	↕	↕
Complement, 1's	COM							63	7	2	73	6	3				$\overline{M}$ → M	•	•	↕	↕	R	S
	COMA													43	2	1	$\overline{A}$ → A	•	•	↕	↕	R	S
	COMB													53	2	1	$\overline{B}$ → B	•	•	↕	↕	R	S
Complement, 2's (Negate)	NEG							60	7	2	70	6	3				00 − M → M	•	•	↕	↕	①	②
	NEGA													40	2	1	00 − A → A	•	•	↕	↕	①	②
	NEGB													50	2	1	00 − B → B	•	•	↕	↕	①	②
Decimal Adjust, A	DAA													19	2	1	Converts Binary Add. of BCD Characters into BCD Format	•	•	↕	↕	↕	③
Decrement	DEC							6A	7	2	7A	6	3				M − 1 → M	•	•	↕	↕	4	•
	DECA													4A	2	1	A − 1 → A	•	•	↕	↕	4	•
	DECB													5A	2	1	B − 1 → B	•	•	↕	↕	4	•
Exclusive OR	EORA	88	2	2	98	3	2	A8	5	2	B8	4	3				A⊕M → A	•	•	↕	↕	R	•
	EORB	C8	2	2	D8	3	2	E8	5	2	F8	4	3				B⊕M → B	•	•	↕	↕	R	•
Increment	INC							6C	7	2	7C	6	3				M + 1 → M	•	•	↕	↕	⑤	•
	INCA													4C	2	1	A + 1 → A	•	•	↕	↕	⑤	•
	INCB													5C	2	1	B + 1 → B	•	•	↕	↕	⑤	•
Load Acmltr	LDAA	86	2	2	96	3	2	A6	5	2	B6	4	3				M → A	•	•	↕	↕	R	•
	LDAB	C6	2	2	D6	3	2	E6	5	2	F6	4	3				M → B	•	•	↕	↕	R	•
Or, Inclusive	ORAA	8A	2	2	9A	3	2	AA	5	2	BA	4	3				A + M → A	•	•	↕	↕	R	•
	ORAB	CA	2	2	DA	3	2	EA	5	2	FA	4	3				B + M → B	•	•	↕	↕	R	•
Push Data	PSHA													36	4	1	A → M_{SP}, SP − 1 → SP	•	•	•	•	•	•
	PSHB													37	4	1	B → M_{SP}, SP − 1 → SP	•	•	•	•	•	•
Pull Data	PULA													32	4	1	SP + 1 → SP, M_{SP} → A	•	•	•	•	•	•
	PULB													33	4	1	SP + 1 → SP, M_{SP} → B	•	•	•	•	•	•
Rotate Left	ROL							69	7	2	79	6	3				M	•	•	↕	↕	⑥	↕
	ROLA													49	2	1	A C ← b7 ← b0	•	•	↕	↕	⑥	↕
	ROLB													59	2	1	B	•	•	↕	↕	⑥	↕
Rotate Right	ROR							66	7	2	76	6	3				M	•	•	↕	↕	⑥	↕
	RORA													46	2	1	A C → b7 → b0	•	•	↕	↕	⑥	↕
	RORB													56	2	1	B	•	•	↕	↕	⑥	↕
Shift Left, Arithmetic	ASL							68	7	2	78	6	3				M	•	•	↕	↕	⑥	↕
	ASLA													48	2	1	A C ← b7 … b0 ← 0	•	•	↕	↕	⑥	↕
	ASLB													58	2	1	B	•	•	↕	↕	⑥	↕
Shift Right, Arithmetic	ASR							67	7	2	77	6	3				M	•	•	↕	↕	⑥	↕
	ASRA													47	2	1	A b7 … b0 → C	•	•	↕	↕	⑥	↕
	ASRB													57	2	1	B	•	•	↕	↕	⑥	↕
Shift Right, Logic	LSR							64	7	2	74	6	3				M	•	•	R	↕	⑥	↕
	LSRA													44	2	1	A 0 → b7 … b0 → C	•	•	R	↕	⑥	↕
	LSRB													54	2	1	B	•	•	R	↕	⑥	↕
Store Acmltr	STAA				97	4	2	A7	6	2	B7	5	3				A → M	•	•	↕	↕	R	•
	STAB				D7	4	2	E7	6	2	F7	5	3				B → M	•	•	↕	↕	R	•
Subtract	SUBA	80	2	2	90	3	2	A0	5	2	B0	4	3				A − M → A	•	•	↕	↕	↕	↕
	SUBB	C0	2	2	D0	3	2	E0	5	2	F0	4	3				B − M → B	•	•	↕	↕	↕	↕
Subtract Acmltrs.	SBA													10	2	1	A − B → A	•	•	↕	↕	↕	↕
Subtr. with Carry	SBCA	82	2	2	92	3	2	A2	5	2	B2	4	3				A − M − C → A	•	•	↕	↕	↕	↕
	SBCB	C2	2	2	D2	3	2	E2	5	2	F2	4	3				B − M − C → B	•	•	↕	↕	↕	↕
Transfer Acmltrs	TAB													16	2	1	A → B	•	•	↕	↕	R	•
	TBA													17	2	1	B → A	•	•	↕	↕	R	•
Test, Zero or Minus	TST							6D	7	2	7D	6	3				M − 00	•	•	↕	↕	R	R
	TSTA													4D	2	1	A − 00	•	•	↕	↕	R	R
	TSTB													5D	2	1	B − 00	•	•	↕	↕	R	R

LEGEND:

- OP Operation Code (Hexadecimal);
- ~ Number of MPU Cycles;
- # Number of Program Bytes;
- \+ Arithmetic Plus;
- − Arithmetic Minus;
- · Boolean AND;
- M_{SP} Contents of memory location pointed to be Stack Pointer;
- \+ Boolean Inclusive OR;
- ⊕ Boolean Exclusive OR;
- $\overline{M}$ Complement of M;
- → Transfer Into;
- 0 Bit = Zero;
- 00 Byte = Zero;

CONDITION CODE SYMBOLS:

- H Half carry from bit 3;
- I Interrupt mask
- N Negative (sign bit)
- Z Zero (byte)
- V Overflow, 2's complement
- C Carry from bit 7
- R Reset Always
- S Set Always
- ↕ Test and set if true, cleared otherwise
- • Not Affected

CONDITION CODE REGISTER NOTES:
(Bit set if test is true and cleared otherwise)

1. (Bit V) Test: Result = 10000000?
2. (Bit C) Test: Result = 00000000?
3. (Bit C) Test: Decimal value of most significant BCD Character greater than nine? (Not cleared if previously set.)
4. (Bit V) Test: Operand = 10000000 prior to execution?
5. (Bit V) Test: Operand = 01111111 prior to execution?
6. (Bit V) Test: Set equal to result of N⊕C after shift has occurred

Note – Accumulator addressing mode instructions are included in the column for IMPLIED addressing

INDEX REGISTER AND STACK POINTER INSTRUCTIONS

POINTER OPERATIONS	MNEMONIC	IMMED OP	IMMED ~	IMMED #	DIRECT OP	DIRECT ~	DIRECT #	INDEX OP	INDEX ~	INDEX #	EXTND OP	EXTND ~	EXTND #	IMPLIED OP	IMPLIED ~	IMPLIED #	BOOLEAN/ARITHMETIC OPERATION	5 H	4 I	3 N	2 Z	1 V	0 C
Compare Index Reg	CPX	8C	3	3	9C	4	2	AC	6	2	BC	5	3				X_H − M, X_L − (M + 1)	•	•	①	↕	②	•
Decrement Index Reg	DEX													09	4	1	X − 1 → X	•	•	•	↕	•	•
Decrement Stack Pntr	DES													34	4	1	SP − 1 → SP	•	•	•	•	•	•
Increment Index Reg	INX													08	4	1	X + 1 → X	•	•	•	↕	•	•
Increment Stack Pntr	INS													31	4	1	SP + 1 → SP	•	•	•	•	•	•
Load Index Reg	LDX	CE	3	3	DE	4	2	EE	6	2	FE	5	3				M → X_H, (M + 1) → X_L	•	•	③	↕	R	•
Load Stack Pntr	LDS	8E	3	3	9E	4	2	AE	6	2	BE	5	3				M → SP_H, (M + 1) → SP_L	•	•	③	↕	R	•
Store Index Reg	STX				DF	5	2	EF	7	2	FF	6	3				X_H → M, X_L → (M + 1)	•	•	③	↕	R	•
Store Stack Pntr	STS				9F	5	2	AF	7	2	BF	6	3				SP_H → M, SP_L → (M + 1)	•	•	③	↕	R	•
Indx Reg → Stack Pntr	TXS													35	4	1	X − 1 → SP	•	•	•	•	•	•
Stack Pntr → Indx Reg	TSX													30	4	1	SP + 1 → X	•	•	•	•	•	•

① (Bit N) Test: Sign bit of most significant (MS) byte of result = 1?
② (Bit V) Test: 2's complement overflow from subtraction of ms bytes?
③ (Bit N) Test: Result less than zero? (Bit 15 = 1)

JUMP AND BRANCH INSTRUCTIONS

OPERATIONS	MNEMONIC	RELATIVE OP	RELATIVE ~	RELATIVE #	INDEX OP	INDEX ~	INDEX #	EXTND OP	EXTND ~	EXTND #	IMPLIED OP	IMPLIED ~	IMPLIED #	BRANCH TEST	5 H	4 I	3 N	2 Z	1 V	0 C
Branch Always	BRA	20	4	2										None	•	•	•	•	•	•
Branch If Carry Clear	BCC	24	4	2										C = 0	•	•	•	•	•	•
Branch If Carry Set	BCS	25	4	2										C = 1	•	•	•	•	•	•
Branch If = Zero	BEQ	27	4	2										Z = 1	•	•	•	•	•	•
Branch If ≥ Zero	BGE	2C	4	2										N ⊕ V = 0	•	•	•	•	•	•
Branch If > Zero	BGT	2E	4	2										Z + (N ⊕ V) = 0	•	•	•	•	•	•
Branch If Higher	BHI	22	4	2										C + Z = 0	•	•	•	•	•	•
Branch If ≤ Zero	BLE	2F	4	2										Z + (N ⊕ V) = 1	•	•	•	•	•	•
Branch If Lower Or Same	BLS	23	4	2										C + Z = 1	•	•	•	•	•	•
Branch If < Zero	BLT	2D	4	2										N ⊕ V = 1	•	•	•	•	•	•
Branch If Minus	BMI	2B	4	2										N = 1	•	•	•	•	•	•
Branch If Not Equal Zero	BNE	26	4	2										Z = 0	•	•	•	•	•	•
Branch If Overflow Clear	BVC	28	4	2										V = 0	•	•	•	•	•	•
Branch If Overflow Set	BVS	29	4	2										V = 1	•	•	•	•	•	•
Branch If Plus	BPL	2A	4	2										N = 0	•	•	•	•	•	•
Branch To Subroutine	BSR	8D	8	2										See Special Operations	•	•	•	•	•	•
Jump	JMP				6E	4	2	7E	3	3					•	•	•	•	•	•
Jump To Subroutine	JSR				AD	8	2	BD	9	3					•	•	•	•	•	•
No Operation	NOP										01	2	1	Advances Prog. Cntr. Only	•	•	•	•	•	•
Return From Interrupt	RTI										3B	10	1		①					
Return From Subroutine	RTS										39	5	1	See Special Operations	•	•	•	•	•	•
Software Interrupt	SWI										3F	12	1		•	•	•	•	•	•
Wait for Interrupt*	WAI										3E	9	1		•	②	•	•	•	•

*WAI puts Address Bus, R/W, and Data Bus in the three state mode while VMA is held low

① (All) Load Condition Code Register from Stack. (See Special Operations)
② (Bit I) Set when interrupt occurs. If previously set, a Non Maskable Interrupt is required to exit the wait state.

CONDITION CODE REGISTER INSTRUCTIONS

OPERATIONS	MNEMONIC	IMPLIED OP	IMPLIED ~	IMPLIED #	BOOLEAN OPERATION	5 H	4 I	3 N	2 Z	1 V	0 C
Clear Carry	CLC	0C	2	1	0 → C	•	•	•	•	•	R
Clear Interrupt Mask	CLI	0E	2	1	0 → I	•	R	•	•	•	•
Clear Overflow	CLV	0A	2	1	0 → V	•	•	•	•	R	•
Set Carry	SEC	0D	2	1	1 → C	•	•	•	•	•	S
Set Interrupt Mask	SEI	0F	2	1	1 → I	•	S	•	•	•	•
Set Overflow	SEV	0B	2	1	1 → V	•	•	•	•	S	•
Acmltr A → CCR	TAP	06	2	1	A → CCR	①					
CCR → Acmltr A	TPA	07	2	1	CCR → A	•	•	•	•	•	•

R = Reset
S = Set
• = Not affected

① (ALL) Set according to the contents of Accumulator A

There are 72 basic instructions in the set, but the availability of more than one addressing mode for many of them results in a total set of 197 different instructions. Instructions may be one, two or three bytes in length, where the first (or only) byte contains sufficient information to identify the instruction and its addressing mode, and the other byte or bytes contain ancilliary information such as a memory address. Instructions are provided for binary and BCD 8 bit arithmetic, logic operations, shifts and rotates, data load, data store, conditional or unconditional branch, and interrupt and stack manipulation.

Two instructions of particular note are SWI and WAI. SWI stands for SoftWare Interrupt and is rather similar in operation to the 8080A Restart (RST) instruction with the exceptions that there is only one (as opposed to 8 RSTs) and SWI causes all registers to be stacked, not just the PC. The SWI vector is also in high memory (FFFAH and FFFBH) as opposed to low memory for the 8080A RSTs. WAI stands for Wait for Interrupt, and has no direct equivalent in the 8080A. It causes all CPU registers to be stacked and the processor to be halted while awaiting an interrupt. This provides a fast interrupt response but also nullifies some of the advantages to be had from asynchronous interrupts. A comprehensive set of addressing modes are available as follows:— Direct; in which a single byte page zero address is specified as part of the instruction; Extended; in which a two byte address is specified (like 8080A Direct!), Immediate; in which the instruction contains the data to be used, not an address reference, Inherent; (the same as 8080A Implied), Relative; which allows branching forwards or backwards in memory relative to the program counter value, and Indexed which uses the Index Register and an offset supplied by the instruction as already described. Both the Relative and the Indexed mode have no direct equivalent in the 8080A instruction set. The Relative addressing range is from −125 to +129 locations relative to the first byte of the two byte relative branch instruction, this mode reduces the size and the execution time of a program.

SOFTWARE

Like the 8080A family, the 6800 family has extensive software support because of its popularity and its long existence. It does, however, lack a universally accepted disc operating system such as the 8080A's CP/M. Perhaps the best known 6800 software is the Motorola MIKBUG monitor which was supplied with their evaluation board, the MEK68D2, but there are also a number of other software tools including Editors, Assemblers, Compilers (notably for FORTRAN) and Interpreters, including a TINY BASIC.

INTERFACING

The 6800/6802 have no need of the IO/M line of the 8080A family since there is no separate I/O address space. Also, instead of the separate $\overline{RD}$ and $\overline{WR}$ lines of that family the 6800/6802 have a single RD/$\overline{WR}$ line and a separate VMA (Valid Memory Access) line. By use of appropriate gating it is possible to convert the 6800 scheme to the 8080A version and vice-versa, and this is important if you ever wish to use peripheral chips such as UARTS from a different family to that of the processor itself.

The 6800 requires an external two phase clock generator, and two approaches to this are possible. The first approach to appear was a rather unconventional hybrid device, the MC6871, which included not only the clock generator electronics but also an appropriate crystal *inside* the package. Later on, the more conventional MC6875 appeared in a 16 pin DIL. This device provides some extra facilities but needs an external crystal.

The 6802 does not need an external clock generator, only a crystal, and has the added bonus of a 128 byte RAM array on the chip. The first 32 bytes of this array may be retained in a low power standby mode by using the additional supply pin, VCC Standby. These differences mean that the 6802 is not completely pin compatible with the 6800. The DBE (Data Bus Enable) and TSC (Three State Control) pins of the 6800 are not available on the 6802, and neither are the Ø1 and Ø2 clock inputs for obvious reasons. Since the Ø2 clock signal is used for systems control, an equivalent output is provided on the 6802 by E (Enable). Two other new 6802 pins (in addition to the crystal pins) are MR (Memory Ready) which when driven low causes the memory cycle to be extended to allow interface to slow memory or peripherals, and RE (RAM Enable) which is used to select the internal RAM array when required.

The interrupt schemes used by the 6800 and 6802 are identical and fairly simple. One advantage of the 6800/6802 over the 8080A is that the former have a Non-Maskable Interrupt (NMI) in addition to the standard maskable input available on all three. The NMI can never be disabled and is therefore useful in some systems to warn of power failure or other not-to-be-ignored happenings. Intel at first said that there was no need for an NMI, and then introduced one on their 8085A!

On the occurrence of an NMI, the processor stores the CPU registers on the stack and then loads the PC with the address stored in memory locations FFFCH and FFFDH. The maskable IRQ interrupt has the same general effect except that the vector is fetched from FFF8H and FFF9H. Note that only a single vector is normally available for each source and without an external interrupt controller chip, multiple interrupt sources have to be polled by software. The 8080A is difficult to compare directly, since it always needs at least some external gating to accept vectors, but thanks to the single byte RST instructions it is a comparatively simple matter to build a scheme to cater for up to 8 separate sources without polling. The 8085A has additional direct interrupt lines of course.

PERIPHERAL CHIPS

The 6800 series is blessed with an extensive family of peripheral devices capable of performing most of the commonly required functions and some of the rather more exotic ones.

Apart from the clock generators mentioned earlier, perhaps the most often specified peripheral device is the Peripheral Interface Adaptor or PIA for short. This function is performed by the 6821 device which has two 8 bit parallel ports useful for communicating with the full range of possible input and output devices such as switches, lamps, and line printers.

Communication with the CPU takes place over the bidirectional CPU data bus using standard 6800 or 6802 control signals, and two interrupt outputs (one for each port) are available for connection to an interrupt controller chip like the 6828 or to be Wire-OR'ed to the IRQ input of the processor. Each of the four possible sources of interrupt can be separately enabled or disabled by the processor if required. After the 6821 in popularity comes the 6850 Asynchronous Communications Interface Adaptor (ACIA) which most (Non-Motorola!) people call a UART. The 6850 is a simpler device than the Intel 8251 USART because while the 8251 provides asynchronous or synchronous serial communication, the 6850 is asynchronous only, with an additional part, the 6852, available if a synchronous link is required.

Other devices available include the 6840 triple 16 bit timer, the 6844 Direct Memory Access (DMA) controller, and the 6860 Modem. The 6802 also has its own special "Combo" peripheral device, the 6846, which provides 2K bytes of ROM, 10 parallel I/O lines and a timer. Since this device uses masked ROM it is not usually suitable for home projects.

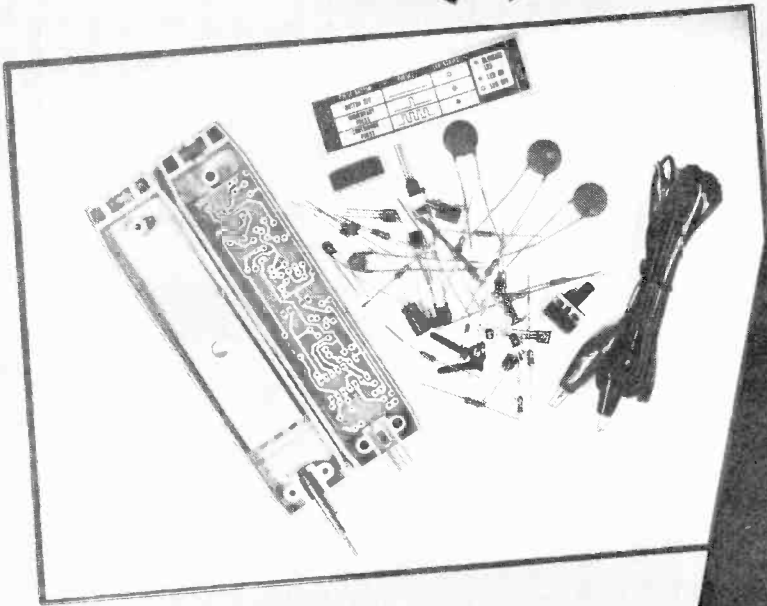
APPLICATIONS

As with the 8080A/8085 there would appear to be little point in using the 6800 in new applications now that the 6802 is available at a reasonable price. An added incentive to use the 6802 is the fact that CMOS versions are available from other manufacturers making it possible to build a low power consumption system when necessary for battery powered applications.

Both processors are ideal for learning about both the hardware and software aspects of microprocessors and the 6800 is widely used in tutorial systems for this reason. Neither chip can be recommended for data processing applications, however; if this is your requirement and you like the style of the 6800, then choose the 6502 or better still the 6809.

The 6800 and 6802 come into their own as controllers for small systems and are mostly used for this purpose. Their simple low-cost hardware approach and their elegant easy to use instruction set suit them ideally for jobs such as appliance control, vending machines, car computers, and PROM programmers. In the author's opinion, if a 6802 is powerful enough to perform a particular control task then it is probably wise to choose it in preference to the 8085A because the resulting system will probably be simpler, cheaper, and easier to program. All in all the 6800 or the 6802 are not a bad choice for the hobbyist because it will later be easy to move on to more powerful chips like the 6502 or the 6809.

SPECIAL OFFER



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SEMI-PROFESSIONAL
MIXING DESK
Part Three

THE p.c.b. design for the power supply unit is shown in Fig. 1 with the component layout shown in Fig. 2. Before the components are soldered, the 'L' shaped heatsink should first be fitted to the p.c.b.

All the components should then be soldered into position with mica washers being used on the two i.c.s. Carefully check the orientation of the semiconductors and the electrolytic capacitors.

The case components should be mounted as shown in Fig. 3 and all the mains wiring covered with rubber sleeving. The two output rails should be tested before the power supply is connected to the mixing desk.

PA MIXING—LIVE CONCERTS

Mixing the sound for a live music show differs considerably from mixing in a recording studio. Firstly everyone plays at the same time which means that there are many more mixer channels to be balanced and equalised etc. Secondly the high sound level on stage makes it difficult for the players to hear each other with any degree of sound balance. Fig. 4 shows how all the instrument amplifiers, drums and singers are set-up and fed to the mixer which is normally positioned in the audience where the sound engineer can hear clearly the sound of the PA system. It also shows how a separate sound system is provided for the players on stage, so that they can all hear what each person is playing. This other mix is derived from an auxiliary mixer output which is independent from the main stereo PA mix.

The mixer also adds effects to the overall sound, such as reverb and echo, using the other auxiliary outputs as well as taping the stereo mix for the inevitable post-mortem of the concert. Live sound mixing is certainly more liable to problems than studio recording, the most common one being feedback or howl-round between the microphones and the on-stage monitoring systems which are placed close to the players. Highly directional microphones are favoured for this reason. Also, because there is never any second chance with live sound it is essential to set up the system and balance the sound before the audience arrives, so that everything is ready when the players walk on to give their performance.

USING THE MIXING CONSOLE

The mixing desk is a modular system built up from sets of 6 input channel modules, individual output channels and the Auxiliary PFL/Headphone output channel. Its main applications lie in the small four-track recording studio where cassette systems are now available for around £600, and live music mixing with PA systems. However, it is flexible enough to be considered for almost any sound mixing requirement. A simplified description follows to illustrate how the mixer is used in the multitrack studio for recording and mixing down as well as in the live concert situation.

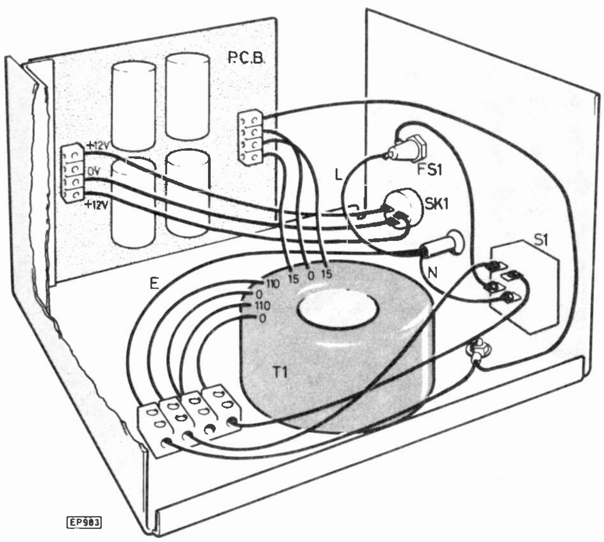

Fig. 3. Wiring diagram for the p.s.u.

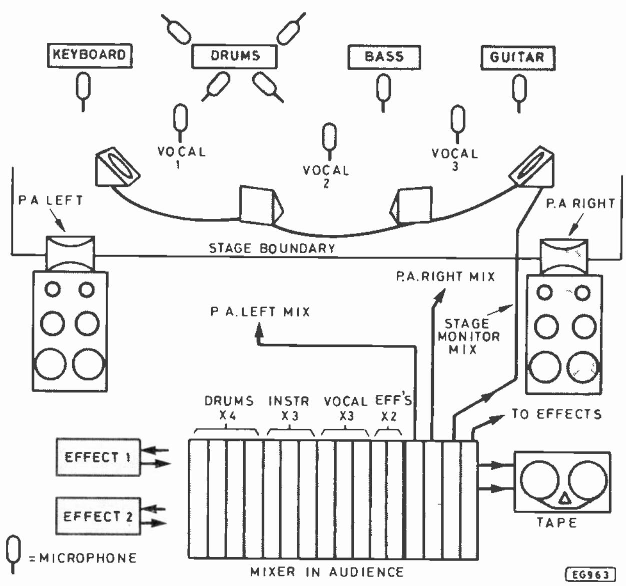

Fig. 4. Live concert mixing

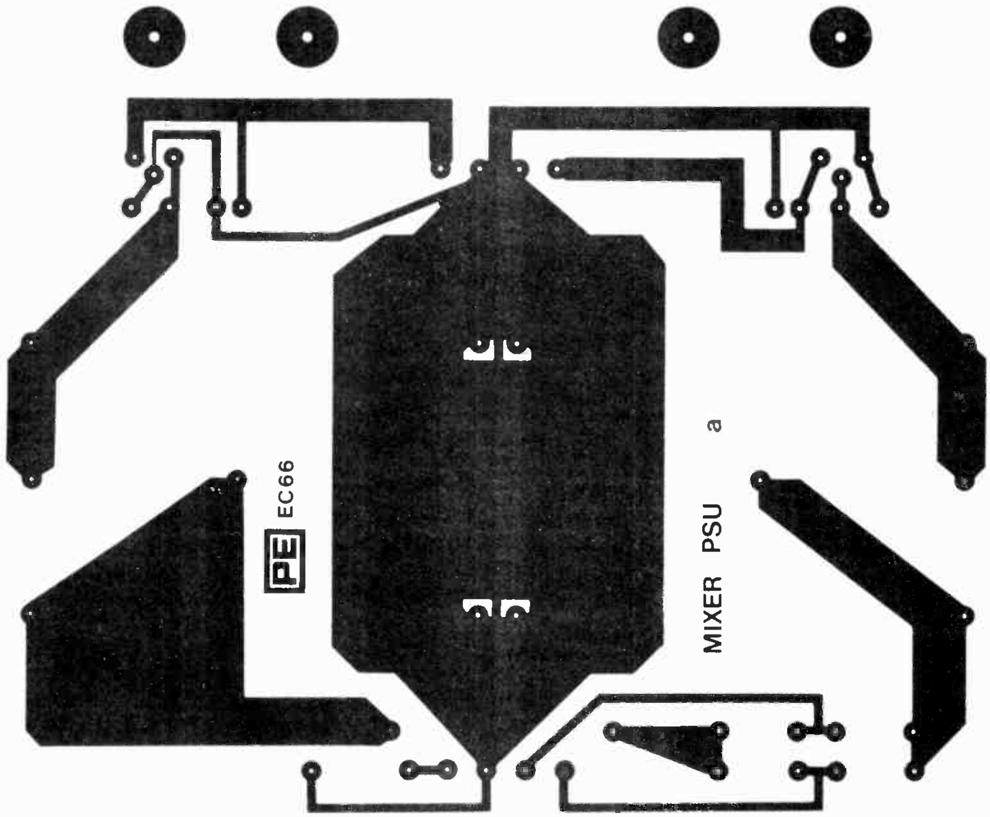

Fig. 1. P.c.b. design for the p.s.u.

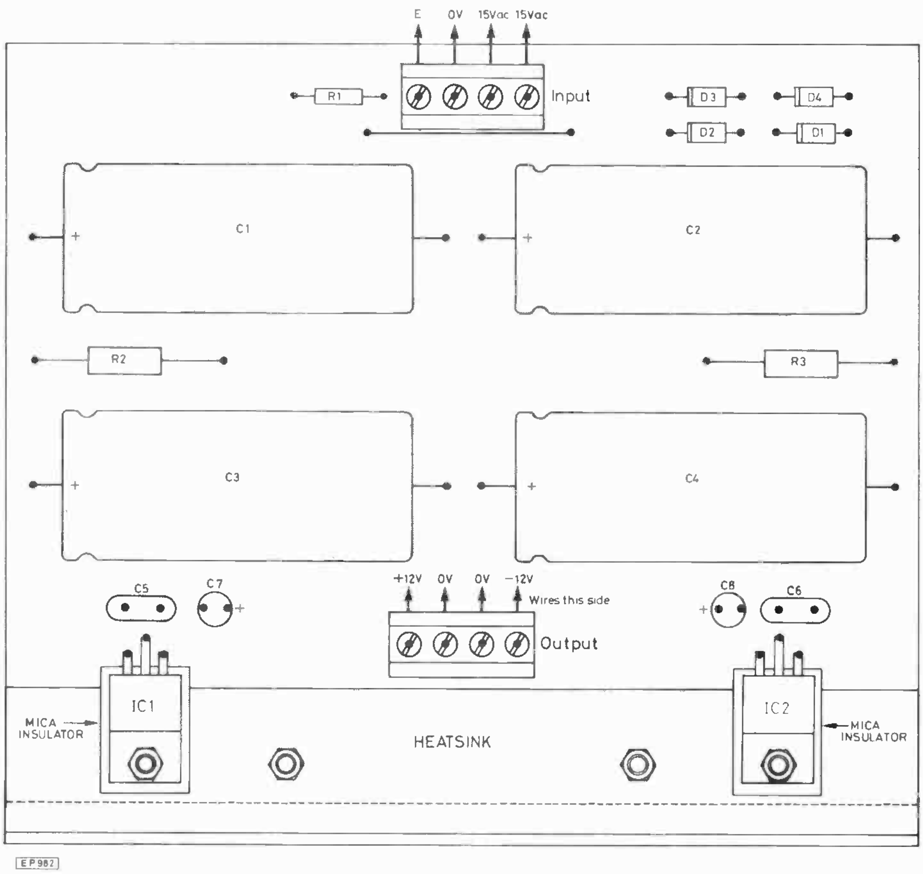

Fig. 2. Component layout

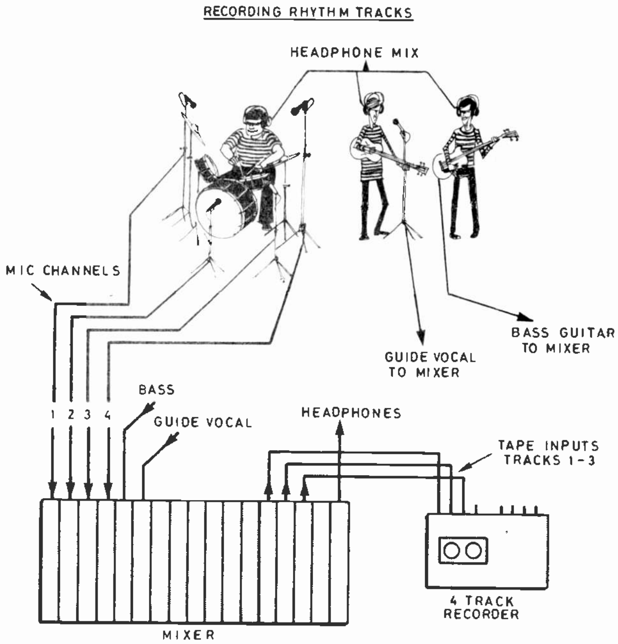

Fig. 5. Recording rhythm tracks

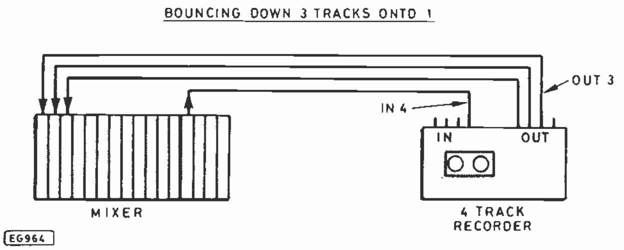

Fig. 6. Bouncing down 3 tracks onto 1

THE MULTITRACK STUDIO

Recording

The first stage of most music recording involves laying down on tape the basic rhythm structure. This usually means drums and bass guitar, along with a rough 'guide' track of vocals to help the rhythm players through the song's arrangement. Fig. 5 shows 4 microphones set up around the drum kit, the bass guitar and the vocal microphone which have all been connected to the mixer input channels. Listening on headphones the recording engineer uses the Pre Fade Listen (PFL) function to examine the sound coming in on

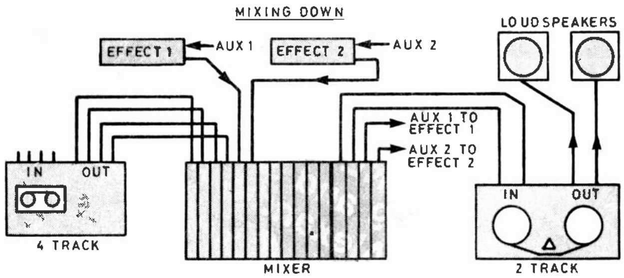

Fig. 7. Mixing down

each mixer channel, to check that all is well and to add equalisation to any sounds that need it. The drum microphones are all routed to one mixer output and recorded onto one tape track, while the bass and vocals are separately recorded on two other tracks. During this process the players listen to each other using headphones, driven from one of the auxiliary outputs of the mixer which allows them a balanced mix of what is being recorded onto tape. Next comes the addition of the other instrument sounds like guitars, keyboards and vocals, but because of the limited number of tracks available on tape a process known as 'bouncing-down' is used to conserve tape track space. Fig. 6 shows how the mixer may be used to mix three tracks together onto the one remaining track, which then makes room for three new tracks. In this way the recording is built up layer by layer until all the necessary ingredients of the sound are on tape and ready for the final 'mix-down'.

Mixing Down

In this final stage of the recording process the four tracks of sound are reduced to a two-channel stereo format which necessitates the use of a second tape recorder. Fig. 7 shows how the mixer is used to transfer the sound across from one recorder to the other, and in doing so it allows a number of useful enhancements to be made for the final result. Firstly there is the question of attaining the right balance between the four tracks and the positioning of each track within the stereo sound image. This is known as panning. Final alterations are also made to the equalisation of each track to highlight the overall tone quality, and there is a further opportunity to add special effects such as reverberation, echo, chorus and phasing etc. The auxiliary mixer outputs are used to send any mixture of the sounds to these effects, whose outputs are then brought back on the remaining mixer input channels. Finally the end result is reached with a stereo tape that may be played on any domestic sound system. Improvements in technique come with practice, and care is taken to ensure that maximum level goes onto tape wherever possible. ★

BAZAAR

MONOPHONIC Synthesiser 2 x v.c.o. Four octave keyboard interface facilities stereo outputs, sequencer effects voltage controlled panning £300. Mr. P. Redpath, 47 Corbett Road, Waterlooville, Hants. Tel: Waterlooville 53595.

MICROTAN 65 with Tanbug £40. Prog. graphics gen 256 x 256 £40. Documentation. M. Goonewardane, 241 Norbury Crescent, London SW16 4LF. Tel: 01-764 0839.

TELEQUIPMENT DB Scope Type D43 handbook, working £60 o.n.o. Wanted XTAL filter KIG XF51A for FT75 also golfball motor needed. Horndean (0705) 596058. J. McDonald, Mews Cottage, Pond Lane, Clanfield, Portsmouth PO8 0RG.

FRG 7000 £200. WW2 RAF 1132A £10. AVO valve tester £5, Taylor ditto 45A £5, plus carr. Edwards, 2 Beach Road, Burton Bradstock, Bridport, Dorset. 0308 89625.

REEL TO REEL tape recorders. Sony 250 stereo £40. Sony TC106 Mono £20. V.G.C. Derby 764373. Mr. J. F. Ashfield.

FOR COMPUKIT; AY-3-8910 sound board £20. Tool kit EPROM £10. BASIC 5 EPROM £12. 5V 3A supply £10. Mr. N. Odell, 31 Humphrey Road, Greenhill, Sheffield S8 7SE. Phone (0742) 745027.

ZX81 Unfinished 16K RAM. Full set chips worth £12 plus data for £6. Phone (0223) 832308. A. Fowke.

VALVE millivoltmeter, Marcank TF 899, £5.00. Holdway, Flat 9, Back No. 10, Westwood Road, Portswood, Southampton.

MINISONIC Mk. 11. Synth. Eaton Audio p.c.b.'s complete i.c. sockets unused £55 p.&p. Seon Smyth—0436 71181.

10 LM3900 quad. Op-amp new unused, £4, or 45p each. Please send s.a.e. T. Walters, 18 Herondale, Birch Hill, Bracknell, Berks RG12 42T.

UK101 10K metal case 48 x 32 screen sound joystick program graphics Cegmon 8K extra utility roms. £140 o.n.o. A. Smith—Poole (0202) 671659.

9V 100mA mains p.s.u. £3.50 o.n.o. Eight 4118 1K byte static RAM will separate. Offers. Mr. R. A. Boyce, 11 Jevington, Birch Hill, Bracknell, Berkshire RG12 4ZD. Tel: Bracknell 57903.

SINCLAIR ZX81, 16K RAM, 9 months old, complete, excellent condition, £80. Tel: Lyminge 862604. D. P. Harmer, Whitehall Cottage, Rhodes Minnis, Canterbury, Kent CT4 6YA.

TELEQUIPMENT D83 + D1016 for sale also DMM and components send s.a.e. for details. Wanted ZX81/ZX Spectrum. B. K. Jain, 17 Taylors Lane, London NW10 9JH.

NEW, used valves. Numerous types, instrument Crt's 6 inch, 5 inch, 2¾ inch dia. Large s.a.e. for details. A. D. Jones, Penwood, The Avenue, Ross-on-Wye, Herefordshire HR9 5AW.

WANTED Oscilloscope, ZX81, IBM typewriter. Send information and price to Petter Enge, Feltspatv, 3B, 3220 Haukerød, Norway.

HONEYWELL 520 X-Y recorder 30cm x 40cm bed. Working but needs pen arm. F.O.C. buyer collects. Tel: 01-577 3171.

AUDIOGENERATOR. Belco AG761. Sine/square waves, 19Hz–220KHz £30. Tel: 051 734 3908 (Liverpool).

ZX81 16K with p.s.u. plus 6 games cassettes. Galaxian, chess, 3D Maze, etc. £100 o.n.o. M. D. Smith, 52 Vesper Road, Leeds, Yorkshire LS5 3NX. Tel: 0532 757303 7p.m.

SMALL oscilloscope, working but needs attention £30 o.n.o. Also home built audio signal generator £15 o.n.o. D. Daniel, Flat 1, 78A Harehills Avenue, Leeds LS7 4EU.

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WANTED lightweight pair headphones, good quality 4-track R-TO-R tape recorder. Good quality Echo/Reverb unit, Synthesizer. Keith Edmunds, Orissor College, Corwen, Clwyd LL21 0DR. Tel: 0490 2791.

TELEQUIPMENT scope D67A 25MHz as new tv-field + line. 100% wkg £425.—Gould-Advance—J3A Audiogen. As new 100% wkg £125. G. Finke, Reading 23335 (Evenings).

ATARI Games system plus eleven cartridges including: adventure, invaders, soccer, chess. Worth over £300 only £230. Mr M. Ward, 9 St Andrews Avenue, Crewe, Cheshire CW2 6JJ.

EXCHANGE double beam scope 10MHz Philips. Mint condition for ZX81 16K with peripherals or sell £130. Roy Lowe, 43 Poplar Way, Leeds 13. Phone: Leeds 638678.

HEATHKIT SW717 shortwave receiver £85.00. Data Dynamics 390RO printer £85.00. West Hyde jubilee v.d.u. cabinet, keyboard £45.00. Mr. R. W. Hearn, 10 Speedwell Close, Pakefield, Lowestoft, Suffolk NR33 7DU. Tel: Lowestoft 66026.

UK101, cased, 8K RAM, 300/600 Baud, new mon, EASICOMP sound £120 Also Radofin teletext adaptor £100. Tel: 01-455 7544.

T.V. GAME electronics and case including 18 switches £8. D. Choi, 13 Highfield Drive, Davyhulme, Manchester M31 2AF.

COMPUTER CASE. Black Microtype model 3. Pre-cut UK101 keyboard. Space for fan, numeric keypad, add-ons. Unused, £20. Mr. D. Hunt, 1 Love St., Kilwinning, Ayrshire KA13 7LQ. Tel: 0294 52250.

SEMICONDUCTOR UPDATE

R.W. Coles

FEATURING MC1468705G2 D60T OP-22

ONE CHIP WONDER

I have always considered one chip microprocessors (that is to say those devices that cram CPU, RAM, ROM and I/O onto a single silicon chip), to be ideal for hobby projects. I say this because these devices are relatively simple to program and understand, and because they do not require any of the complex interconnections which would be necessary to support a multi-chip system based on, say, a Z80. All the budding designer has to worry about is interfacing to the outside world and program design, what could be easier?

Unfortunately there are some snags: The first one-chippers, such as the Intel 8048, had *masked* ROM which meant you had to buy them by the truck-load. These were soon followed by EPROM versions, such as the 8748, which improved things a lot, but even with these you still had to have a suitable PROM programmer. They also had the limitation of being made in NMOS only, so small battery powered systems were out because of the current drain. There has in fact always been at least *one* good excuse for not using them in the latest pet project!

Well the excuses have now run out, and as far as I can see there is absolutely no valid reason for not planning to build that pseudo-random, microprocessor controlled lawn sprinkler you have always promised yourself, thanks entirely to Motorola and their brand new MC1468705G2. (By the way, if you find that long part number off-putting, look at it this way: The MC14 bit just means its Motorola and CMOS, the 7 means that it has EPROM rather than masked ROM, and the G2 means that it is better than a G1(?) Take that lot away and you're left with a Motorola 6805, which my "Boys Wonder Book of Micros" tells me is just a sawn-off 6800 with added RAM, ROM and I/O).

The MC1468705G2 has 2106 bytes of U.V. erasable EPROM, 112 bytes of RAM, 4 eight bit I/O ports and a timer, all squeezed inside a 40 pin d.i.p. Enough to implement a pretty nifty sprinkler system! Even better, the chip has a 128 byte chunk of masked ROM pre-programmed with an EPROM programming algorithm so you don't even have to buy one of those. This means that you can make up a simple circuit board with a socket for the MC1468705G2 and a few external components which, given appropriate input data and a −13 volt programming supply, will act as your very own EPROM programmer.

Best of all though, the new chip is made in low power CMOS and has two additional instructions which also help to reduce supply current. The operating power consumption is typically 10 milliwatts, but execute a WAIT instruction and this drops to 4 milliwatts even though data is retained and the clock and timer continues to run. Execute a STOP instruction and everything does just that, causing the power consumption to plummet to just 10 microwatts *without* destroying memory or register data. After issuing a STOP you can get the whole thing running again by generating an external interrupt or using the RESET input.

Anyone who knows the 6800 will get on fine with the MC1468705G2, although there are some differences. The new device only has a 13 bit address width to cover RAM, ROM and I/O, but this is more than enough for the on-chip resources and even allows for the addition of external EPROM if ports can be sacrificed as busses.

WHOPPER

In these days of glamorous microprocessors and ever more complex integrated circuits, it is easy to forget the humble transistors and diodes which were of course the start of it all. But these simple components are still essential at the "business-end" of most systems, and the development of newer and better devices continues despite the fact that the lions share of research funding has been diverted towards producing the ultimate microprocessor or memory chip.

The designers at Westinghouse have certainly not neglected semiconductor development it seems, because their latest device, the D60T, has pushed the frontiers of power transistor technology further out than ever before by providing the capability to switch 40 amps and 650 volts at 20kHz! There is nothing simple about the D60T either. Its semi-conductor chip is nearly 1 inch in diameter for example, bigger by far than most microprocessor chips, and the manufacture involves a triple diffusion process. Even the package is bigger and better, because that massive chip is mounted in a hex-nut housing which measures over 1·5 inches across the points and stands nearly 2 inches above the heat sink surface. (Yes, you *definitely* need a heat sink if you want to get anywhere near the D60T's maximum 885W dissipation at 25 degrees C!)

But mere physical details do not do justice to the mighty D60T, and the real story can only be revealed by examining the electrical specs. Would you believe a maximum collector current of 100 amps? or a maximum *base* current of 20 amps? Well then, how about a sustained collector-to-emitter voltage (V_{CEO}) of 800 volts, or even 1200 volts if you reverse bias the base? Yes folks, the D60T can do all this and more!

Probably the most important feature of the D60T though, is not all those noughts after the amps and volts numbers, but the speed at which it operates. Switching at 20kHz may not sound fast to all you logic fans who are used to Shottky TTL switching in a nanosecond or two, but at 40 amps and 600 volts its *very* fast

There are two problems with D60T, and the first is what on earth can you use it for. The manufacturers intend people to use it in place of Thyristors for motor speed controllers hooked up to 30 horsepower induction motors, but maybe you could use it in a 25 kilowatt class D disco amplifier, or to control your arc welder or . . or . . or something.

The second problem is that a single D60T could set you back around £50. Makes microprocessors look like childs play, doesn't it!

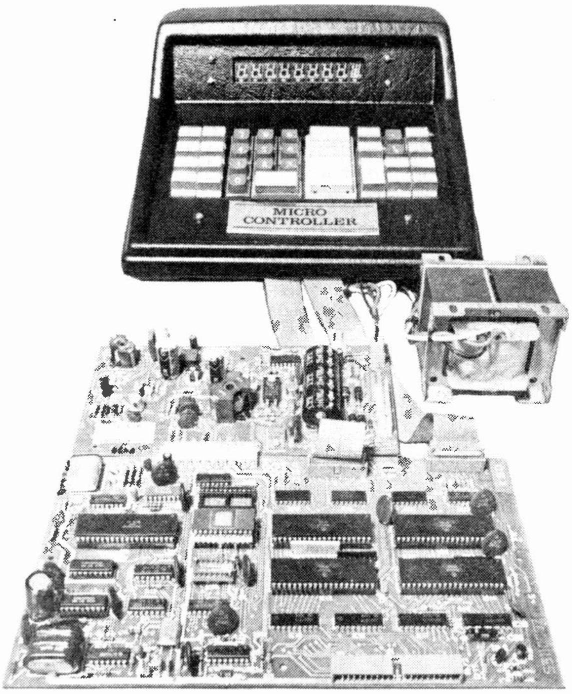
TIDDLER

Well if microprocessors make your head spin and the hairy-chested D60T makes you worry about your electricity bill, why not try an OP-22 from Precision Monolithics Inc?

PMI are famous, as their name suggests, for high grade analogue integrated circuits and especially op-amps. Their usual ploy is to take a standard design and to produce from it a higher performance version which they can sell to those who need that little bit extra and are prepared to pay a bit more for it. The OP-22 has been introduced as a high specification version of micropower op-amps like the National LM4250, with which it is pin compatible.

"Micropower" generally means supply currents of a few tens of micro-amps for battery supply applications, and the new PMI device brings precision operation to these areas for the first time. The supply current of the OP-22 can be set externally with a single resistor anywhere between 1 and 400 microamps, but as you may expect, bandwidth is also affected, so to get 10kHz you would need at least 300 microamps and even PMI cannot overcome that constraint.

Where PMI can deliver the goods however, is in the areas of open loop gain, input offset voltage, and common-mode rejection. The OP-22 has a gain of more than a million, a guaranteed offset voltage of 300 microvolts or less, and it can realise a common-mode rejection ratio of over 100dB for voltages to within 1·5 volts of the supply rails. Supplies of from 3 to 30 volts, single or split, can be used, and the OP-22 is available in either an 8 pin mini-d.i.p. or a TO99 metal can.



MICRO CONTROLLER

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

PART TWO

THIS month we describe in detail how to use the DISBUG monitor facilities. The instruction set for the 6800 is listed in full in Micro-file and there is a description given here of the full range of addressing modes. A step-by-step example of how to enter and run a program on the Microcontroller is included. Finally, the circuit and operation of the power supply module is described.

DISBUG MONITOR FACILITIES

The DISBUG monitor provides the user with facilities to allow the entry of programs into the user RAM area, the examination and change of memory locations (including PIA registers), the debugging of prototype routines, and the control of execution of developed programs. The user communicates with DISBUG via the keyboard, and the monitor uses the display to respond with prompts and information.

The Microcontroller contains 1024 bytes of read/write memory (addresses 0000 to 03FF inclusive). Some of this memory is required to allow DISBUG to operate, but the remainder (0000 to 03A0) is available for user applications. Fig. 2.1 shows the allocation of address space in the RAM area.

The DISBUG monitor facilities are grouped into editor modes (memory, register, preset and breakpoint) and command functions (go, proceed and restart). Each mode or function is invoked separately, and they are each described in detail below.

DISBUG DISPLAYS

The displays output by DISBUG follow a standard format. The normal prompt used when DISBUG is awaiting a command from the keyboard is ". . . dIS . . .". When an editor key (MEMORY, REGISTER, PRESET or BREAKPOINT) is pressed, the display will change to the form "p–aaaa–dd". The "p" field will contain a prompt character to remind the user what input is expected next (e.g. "A" for address), the "aaaa" field will hold the address value, and the "d" field will hold the data value. Initially the second and third fields will often be empty. e.g. when the preset editor is invoked, the display will show "L– – ", indicating that the lower address value is expected. The data field will sometimes be used to display advisory information, rather than a strict data value. Such information (e.g. the breakpoint number) will not use standard numeric representation, to avoid confusion.

The numbers which are mentioned in the descriptions which follow, and those which appear in the DISBUG displays, are all in hexadecimal notation. All addresses must comprise of four hex digits (e.g. 008F), and all data values must comprise of two hex digits (e.g. 07); leading zeroes *must* be used where necessary to fill the fields to the appropriate lengths.

THE MEMORY EDITOR

The contents of any memory location may be examined and (optionally) changed using the memory editor. The memory editor is also used for entering programs into the user RAM area (0000 to 03A0). Remembering that the 6800 treats PIA registers as memory locations, the memory editor may even be used directly to control the operation of the Microcontroller's PIAs; modifications to the programming of the keyboard and display PIAs, however, may interfere with the normal operation of DISBUG. Writing new values to

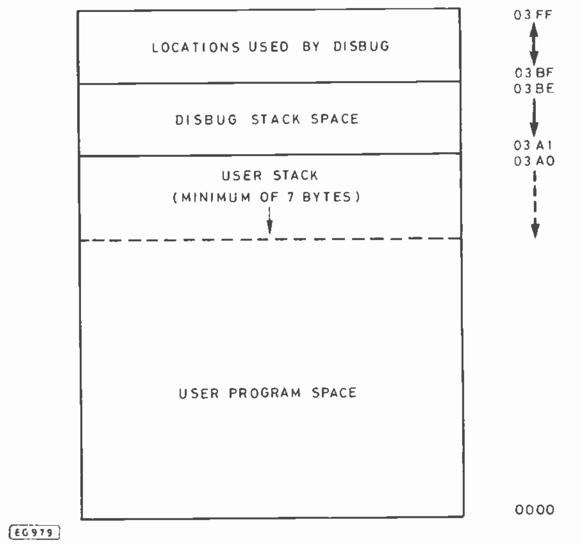


Fig. 2.1. Microcontroller RAM address allocations

EPROM addresses and unused addresses in the address map will have no effect, but beware of address images.

The memory editor may be invoked whenever the ". . . dIS . . ." prompt is displayed by pressing the MEMORY key. The display will then change to "A– – ", indicating that the memory editor is expecting the address of the memory location to be examined to be input. The numeric keys 0 to F are then used to specify the appropriate 4-digit address. After the fourth digit has been struck, the prompt character will change from "A" to "d", and the current contents of the specified location will be displayed in the data field of the display. The "d" prompt indicates that, if the user wishes to change the contents of this location, a new 2-digit value may now be input. When the first digit of the new value is entered, the data field will be cleared, and the new digit displayed, e.g. the display might show "d–01Fb– 7". No change is necessary, however, and by default the contents of the location will remain as currently displayed.

After any new value, if any, has been entered, the location may be closed with the ENTER key. This will cause the "A– – " prompt to re-appear, ready to examine another location. If the NEXT key is used in place of the ENTER key, the next sequential location will automatically be opened and displayed. The PRIOR key will cause the previous location to be opened and displayed.

The CANCEL key may be used at any time to abandon an uncompleted memory change and return to the ". . . dIS . . ." prompt. To exit from the memory editor when the "A– – " prompt appears, either the ENTER or CANCEL keys may be used.

To gain familiarity with the operation of the memory editor, readers are encouraged to step through the DISBUG EPROM (addresses F800 to FFFF), safe in the knowledge that the contents of these locations are permanently programmed.

THE REGISTER EDITOR

After a breakpoint has been encountered in a program under development, the contents of the CPU registers may be examined/changed using the register editor. The REGISTER key may be pressed to invoke the register editor whenever the ". . . dIS . . ." prompt is displayed. The register values with which the program will 'proceed' may then be examined, and optionally changed. Users should note that changing the address held in the program counter will affect the address from which the program will proceed.

The display of register contents used by DISBUG is cyclic in nature, and shows only one 8-bit (2 hex digit) value at a time. The sequence is as follows:

Start

rA	register A
rB	register B
In L	index register LS byte
In H	index register MS byte
SP L	stack pointer LS byte
SP H	stack pointer MS byte
PC L	program counter LS byte
PC H	program counter MS byte
CCr	condition code register

PRIOR

NEXT

The initial display will show the current contents of the A register. Typically the display would be "d– rA –32", indicating that the current contents of register A is 32, and that this may be changed by entering a new 2-digit data value (hence the "d" prompt character). The ENTER key will cause the currently displayed value to be saved and the register editor to be exited. The NEXT key will cause the current value to be saved, and the contents of the next register (B in this case) to be displayed. The PRIOR key will cause the displayed value to be saved and the contents of the previous register (the condition code register in this case) to be displayed. The previous value of any register will remain unchanged if no new value has been specified.

The CANCEL key may be used at any time to exit from the register editor, and this will abandon any change which has not yet been completed.

THE BREAKPOINT EDITOR

Temporary halts or breakpoints are often useful as an aid to debugging a program. They allow the programmer to split programs into convenient blocks so that each block may be tested separately. In practice, breakpoints are implemented by using the monitor program to replace instruction codes at the specified point(s) with software interrupt codes (3F's on the 6800). The replaced instruction codes, and their addresses, are remembered by the monitor so that the breakpoints may be removed when required. The software interrupt allows the contents of the CPU registers to be examined at the breakpoint because these are pushed onto the stack; users should remember to allow 7 bytes of stack to be used by the breakpoint editor.

Breakpoints are set and reset by pressing the BREAKPOINT key to enter the breakpoint editor. This may be done whenever the ". . . dIS . . ." prompt is displayed. DISBUG allows the user to insert up to four breakpoints in a program; these breakpoints are numbered from 0 to 3, and are identified in the displays as b0 to b3, respectively. It is important to note that, for 2-byte and 3-byte instructions, the breakpoint must be set at the FIRST byte of the instruction, i.e. at the op code byte.

When the breakpoint editor is entered it displays the address at which the first breakpoint (b0) has been set. A typical display of "A–01E5–b0" would indicate that breakpoint 0 has been set at address 01E5. If no breakpoint has been set, the address shown will be FFFF; this address is within the DISBUG EPROM, and is therefore not a possible breakpoint address. The address of the breakpoint may be changed by entering a new 4-digit address (hence the A prompt character), followed by ENTER, NEXT or PRIOR. These keys will respectively: change the current breakpoint address to any new value specified and then exit from the breakpoint editor; change the current breakpoint address to any new value specified and then display the next breakpoint; or change the breakpoint address to any new value specified and then display the previous breakpoint. A breakpoint is reset by specifying an address of 'FFFF'. No change to a breakpoint is required, however, and unless a new 4-digit address is specified, the breakpoint address remains unchanged. The CANCEL key may be used at any time to exit from the breakpoint editor; any uncompleted breakpoint change will be abandoned.

Start

Breakpoint 0

Breakpoint 1

Breakpoint 2

Breakpoint 3

PRIOR

NEXT

The display of breakpoints is cyclic, i.e. the next breakpoint from 3 (the last one) is breakpoint 0, and the prior breakpoint from 0 (the first one) is breakpoint 3.

THE PRESET EDITOR

Areas of read/write memory may be preset to the user-defined values using the preset editor. This is particularly useful for initialising RAM to known values, e.g. all zeroes, filled with NOP instruction codes (01's), etc.

The area of memory to be preset is specified by entering the lower and upper addresses for the block. If the two addresses are equal, only the specified address will be preset with the data value; in effect the same as using the memory editor, but much slower. If the lower address is specified as greater than the upper address, all memory locations *except* those between the two limits, but including the limits, will be preset. This will also have the effect of causing DISBUG to crash if the memory over-written includes the DISBUG RAM!

The preset editor may be entered whenever the normal DISBUG prompt is displayed. Pressing the PRESET key will cause the display to change from ". . . dIS . . ." to "L– – ". This indicates that the lower (start) address of the block of memory to be over-written should be entered. After the appropriate four digits have been entered, the ENTER key should be pressed to record the address. The display will then change to "U– – ", indicating that the upper (end) memory address should be entered. After the appropriate four digits have been entered, the ENTER key should again be used to record this address. DISBUG will then output a display of "d– – " to indicate that the data value to be written to memory should be entered. When the appropriate two digits have been entered, the ENTER key should be pressed. This will cause the data value to be recorded, and the block of memory identified to be over-written with the specified data value. Over-writing DISBUG EPROM addresses and "unused" addresses in the address map will have no effect. After the preset operation has been completed, DISBUG will return to its usual ". . . dIS . . ." prompt.

A preset operation may be abandoned at any stage by using the CANCEL key; no change to any address specified occurs until the ENTER following the data value is pressed.

THE GO FUNCTION

A user program is started using the GO function key. After GO has been pressed, DISBUG will prompt for the program start address by displaying "A– – ". The user should then enter the 4-digit address from which execution of the program should commence. After entering the four address digits, the program may be started by pressing the ENTER key. Alternatively, using the CANCEL key will abandon the start request.

When DISBUG starts a program the 6800's registers are set up to the following initial values:—

rA = 00
rB = 00
In = 0000
SP = 03A0 (Start of the user stack)
PC = The requested start address
CCr = 00 (Interrupts enabled and all status bits clear)

Before the user program is actually started, DISBUG inserts any breakpoints which may have been set. A breakpoint which has been set at the program start address will be ignored, but it will be remembered for a future occasion (e.g. for starting at a different address or proceeding from a breakpoint). DISBUG then starts the program from the address now held in the PC, with all of its other registers in the states specified above.

THE PROCEED FUNCTION

The proceed function allows the user to continue with the execution of a program after a breakpoint has been encountered. Alternatively, proceed can be used to start a program from a defined point, but with the CPU registers in user-defined states. This is achieved by first using the register editor to set up the required register values, with the start address in PC, and then using proceed to start the program. The proceed function may be called whenever the ". . . dIS . . ." prompt is displayed.

After the PROCEED key has been pressed, DISBUG will respond by producing a display of the form "E–aaaa–Pr". The "E" prompt indicates that the next input expected is the ENTER key. The "aaaa" value will show the address from which the program will resume execution. The "Pr" reminds the user that a proceed has been requested. Pressing the ENTER key will cause the program to proceed (after a brief delay). The display will go blank unless the user program writes to the display PIA. The CANCEL key in place of ENTER will abandon the proceed request and return to the ". . . dIS . . ." prompt.

If the user has changed any register contents since the last breakpoint, the program will resume with these new values; any change to the program counter will change the address from which execution restarts. Before DISBUG passes control back to the user program, any breakpoints which have been set (with the exception of any set at the restart address) will be re-installed.

When an executing program encounters a breakpoint (or other software interrupt instruction), it will cause control to return to DISBUG. The monitor will then remove all of the breakpoints which have been set, and replace the original op codes. Any SWI instructions inserted directly will remain. DISBUG will then output a display of the form "E–aaaa–Br", where "aaaa" specifies the address of the breakpoint, and "E" indicates that the ENTER key will cause the ". . . dIS . . ." prompt to re-appear. The address of the breakpoint (or other SWI) encountered may always be re-inspected by examining the PC contents with the register editor. A command key may be used in place of ENTER to enter an editor or function directly instead of via the prompt.

THE RESTART FUNCTION

The restart function is provided to allow the user to re-initialise the DISBUG monitor program. A restart will have the same effect as entering the monitor from switch-on, but without the need to interrupt the mains supply. The RAM area used by DISBUG (03A1 to 03FF) is reset to its start-up values, and the display and keyboard PIAs are correctly configured; the user RAM area is totally unaffected. Restarts are thus a convenient way of ensuring that user programs have not corrupted the DISBUG RAM or PIAs.

A restart may be requested whenever the normal ". . . dIS . . ." prompt is displayed. Pressing the RESTART key will result in the display of the restart prompt, " rEStArt ". The restart may then be activated by pressing the ENTER key, or abandoned by pressing CANCEL. ENTER causes the welcome message "dIS r1.0" to be displayed for approximately 2 seconds, followed by the normal DISBUG prompt of ". . . dIS . . .".

THE 6800 INSTRUCTION SET

The 6800 instruction set contains 197 different instructions which fall into four major categories:

(a) accumulator and memory
(b) index register and stack
(c) jump and branch
(d) condition code register

The full instruction set is shown in Micro-file. This table also summarises the op codes, number of bytes, number of machine cycles required for execution, and the effect of the instruction on the registers and memory. Each instruction is also represented by a mnemonic code (e.g. CLR for clear), which is of no significance to the 6800, but which provides a useful standard notation for writing programs.

In many cases, more than one instruction op code is associated with each mnemonic (e.g. LDA A can have op codes of 86, 96, A6 or B6). The actual op code selected will depend on the addressing mode required; in the case of LDA A the modes available are immediate, direct, indexed and extended, respectively. When an assembler is used to translate from mnemonic codes to hex op codes, and there is a choice of addressing modes, some means must be provided to indicate the mode required. This is usually specific to the assembler being used, but for example ♯ is often used to indicate the immediate mode. In manual translation, the programmer selects the appropriate op code from the table, but such a notation is still useful when writing the program in mnemonics.

The following sections describe the features of the six addressing modes which are available. When translating from mnemonic codes to op codes, the programmer should select the most appropriate mode, bearing in mind the length and flexibility of the resulting instruction. No attempt is made to provide a full description of the operation of each instruction; users are referred to a 6800 programming manual for further details. It should be remembered that the 6800 treats the peripheral registers in the PIAs as memory locations and the same instructions are used for manipulating their contents, e.g. B7 18 02 writes the contents of register A to the A control register in the display PIA.

INHERENT ADDRESSING MODE

Some instructions do not require additional address information for them to be completely meaningful since the required data is already present in the microprocessor's own internal registers. The following are examples of the inherent addressing mode:

CLRA	sets register A to zero (i.e. it clears the register).
PSHA	pushes data onto the stack. The contents of register A is stored on the stack at the address specified by the stack pointer and the stack pointer is then decremented by one.
INX	increments the index register by one.
SEI	sets the interrupt mask in the condition code register. The processor is then inhibited from servicing an interrupt emanating from a peripheral device, and will continue to ignore interrupts and execute the program instructions until interrupts are re-enabled by means of a clear interrupt mask instruction (CLI).
NOP	causes the program counter to be incremented without affecting any of the other registers. It is useful during program development as a "stand-in" for some other instruction that is to be determined during debug, and also for equalising execution time through alternate paths in a control program.

IMMEDIATE ADDRESSING MODE

In this addressing mode the operand immediately follows the op code, and may consist of one or two bytes. Two byte operands are only used for instructions relating to the index register and stack pointer (CPX, LDX, LDS). In all other cases a single byte follows the op code. Examples of immediate addressing are:

LDA A FF	this instruction loads register A with the value FF (the instruction would be coded as 86 FF).
LDX 0300	this instruction loads the index register with the value 0300 (the instruction would be coded as CE 03 00).

DIRECT ADDRESSING MODE

Using this mode of addressing the operand of the two-byte instruction is stored in a memory location with an address which has a most significant byte equal to 00, and the least significant byte equal to the second byte of the instruction. With direct addressing, the valid memory address range is 0000 to 00FF, and consequently only a restricted range of memory is accessible. This addressing range falls within the user RAM area of the Microcontroller.

Examples of the use of direct addressing are:

LDA A 43	this instruction loads the contents of location 0043 into register A (the instruction op code would be 96 43).
CMP B BC	this instruction compares the contents of register B with the contents of memory location 00BC, and sets the condition code register bits as appropriate (the instruction op code would be 91 BC).

EXTENDED ADDRESSING MODE

In this mode the memory address of the operand is specified by the second and third bytes of the instruction. The most significant byte of the memory address is specified by the second byte of the instruction, and the least significant byte of the memory address is specified by the third byte. Instructions using the extended addressing mode are able to access the full 64K bytes of the 6800's address range, i.e. 0000 to FFFF. Examples of instructions using the extended addressing mode are:

LDA B 00BC	this instruction loads register B with the contents of memory location 00BC (the instruction op code would be F6 00 BC). Note that this instruction would use only 2 bytes if it used direct addressing, but is a valid instruction, nevertheless.
INC 03B7	this instruction increments by one the contents of memory location 03B7 (the instruction op code be 7C 03 B7).
LDX 01A5	this instruction loads the most significant byte of the index register with the contents of location 01A5, and the least significant byte with the contents of location 01A6 (the instruction op code would be FE 01 A5). Note that the index register, like the stack pointer, is a 16-bit register and requires 2 bytes of memory to specify its contents.

RELATIVE ADDRESSING MODE

The relative addressing mode in the 6800 is used solely for branch instructions. These instructions allow the normal sequence of "one instruction following another" to be changed, and enable the implementation of decision making in programs. The instructions used for branching are two-byte instructions. The first byte contains the opcode which specifies the branch condition (e.g. BCS is used to branch if the carry bit is set), and the second byte contains the offset.

The offset is a 2's complement 8-bit number which is used to specify where the program will branch to if the branch condition is satisfied; in the example the branch will only occur if the carry bit is set when the instruction is encountered. The range of destination addresses is restricted to −7D to +81 relative to the branch instruction (hence the name). This range results from the fact that, when the branch instruction is executed, the program counter will be pointing to the next instruction, which will be two bytes on from the branch code. If A is the address of the branch instruction in memory, then the destination address, D, will be in the range:

$$[(A + 2) + 7F] \geqslant D \geqslant [(A + 2) - 80]$$

Two examples are given in Fig. 2.2 which illustrate how to calculate the two hex-digit offset value, J, which must be coded as the second byte of the branch instruction. With practice the values may rapidly be worked out by mental arithmetic!

INDEXED ADDRESSING MODE

Indexed addressing involves 2-byte instructions, and makes use of the contents of the 16-bit index register, in addition to op code, to specify the address of the source/destination of the instruction operand.

The address is calculated by taking the contents of the index register and adding the offset value contained in the second byte of the instruction. For example, if the current contents of the index register are 0300, an instruction of STA A 27,X (coded as A7 27) would result in the contents of register A being stored in memory location 0327. The offset in the second byte of the instruction may take any value in the range 00 to FF, and is assumed to be positive. The index register is unaffected by indexed instructions; thus STA A 27,X followed by STA B 28,X would result in registers A and B being stored in locations 0327 and 0328, respectively.

Special instructions are provided for loading, manipulating and storing the contents of the index register, as used by the indexed addressing modes of instructions. Typical instructions relating to the index register are LDX, INX, DEX, and STX. The use of indexed addressing is particularly useful for manipulating tables, and for jumping to addresses picked up from tables/memory locations (JMP nn,X and JSR nn,X); this is a technique much used internally by DISBUG.

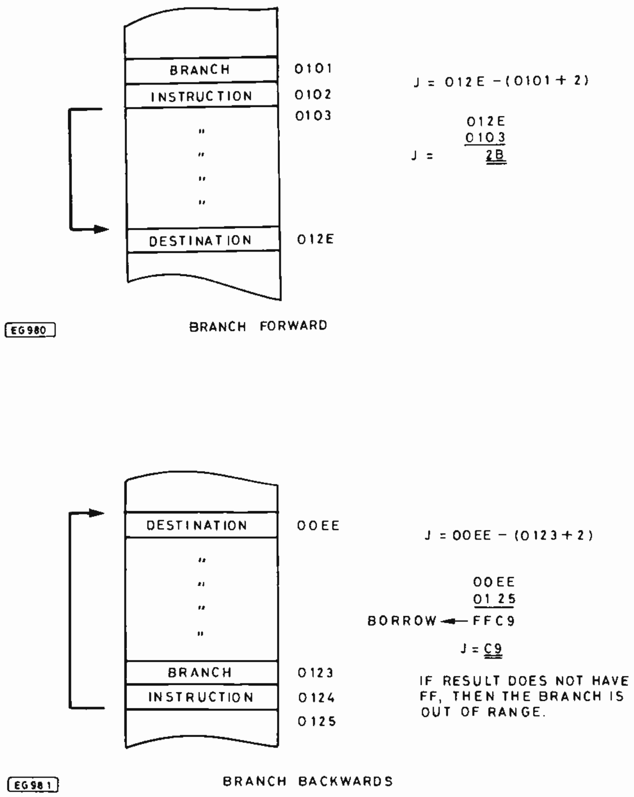


Fig. 2.2. Calculation of branch offset values

THE STACK

The 6800 uses part of its read/write memory to implement a stack. This stack is used for:

(a) storing subroutine return addresses
(b) temporary program data storage
(c) storage of CPU status (register contents) while responding to interrupts.

The stack works on a last-in first-out (LIFO) principle and a stack pointer (16 bits) is provided in the CPU to indicate the address of the next free stack location. When data (e.g. a return address) is "pushed" onto the stack, the stack pointer is *decremented* by the number of bytes pushed (e.g. two for a return address). When data is "pulled" from the stack, the stack pointer is correspondingly *incremented*.

The stack pointer must be initialised (via the LDS instruction) to the start (top) of the stack area. The amount of RAM allocated for stack operations must allow two bytes for each nested subroutine call, and seven bytes for each category of concurrent interrupt (NMI, IRQ, SWI). Additional allowance must be made if the stack is to be used for temporary variable storage (via PSHA and PSHB). Every stack push must have a corresponding stack pull if the stack is not to extend indefinitely! Once initialised, maintenance of the stack pointer is performed automatically by the CPU.

GETTING STARTED

A practical demonstration of programming the Microcontroller concludes the second part of this series. The program which is presented is used as a means of demonstrating the operation of DISBUG. However, it is not expected that readers will fully understand the detailed operation of the program since it uses a number of subroutines which are contained within DISBUG itself. In the next issue further examples of programs will be presented to illustrate how control programs may be constructed. Once the user has become familiar with the way in which programs are entered and controlled, it is but a short step to write a PIA control program. The sample program is:—

Address	Instruction Mnemonic				Op Code		
0000	LDA	A	#	15	86	15	
0002	JSR			F9BD	BD	F9	BD
0005	CLR			03FA	7F	03	FA
0008	LDX		#	03FB	CE	03	FB
000B	LDA	A		03E3	B6	03	E3
000E	JSR			F8F7	BD	F8	F7
0011	LDA	A		03E2	B6	03	E2
0014	JSR			F8F7	BD	F8	F7
0017	JSR			F814	BD	F8	14
001A	BRA			E4	20	E4	

When the Microcontroller is switched on, DISBUG outputs a display of "dIS r1.0" for approximately 2 seconds. After this time, the display changes to the normal prompt of "... dIS ..." to indicate that DISBUG is awaiting a user command from the keyboard. The memory editor is used to enter programs into the user RAM area of memory. The sequence of keystrokes required to enter the demonstration program is as follows:

KEYSTROKE(S)	DISPLAY
	.. dIS ...
MEMORY	A– –
0 0 0	A– 000–
0 8	d–0000– 8
6	d–0000– 86
NEXT 1 5	d–0001 – 15
NEXT B D	d–0002 – bd
NEXT F 9	d–0003 – F9
"	"
"	"
repeat for remaining codes	
"	"
NEXT E 4	d–001b – E4
ENTER	A– –
ENTER	...dIS...

EG985

The program is now stored in RAM. To demonstrate the use of the breakpoint editor, a breakpoint will now be placed at the end of the loop at location 001A. This is done as follows:

KEYSTROKE(S)	DISPLAY
	...dIS...
BREAKPOINT	A– FFFF – bO
0 0	A– 00 – bO
1 A	A– 001A– bO
ENTER	...dIS

EG982

The program is now run from the start address (0000) as follows:

KEYSTROKE(S)	DISPLAY
	...dIS...
GO	A– –
0 0 0 0	A– 0000 –
ENTER	

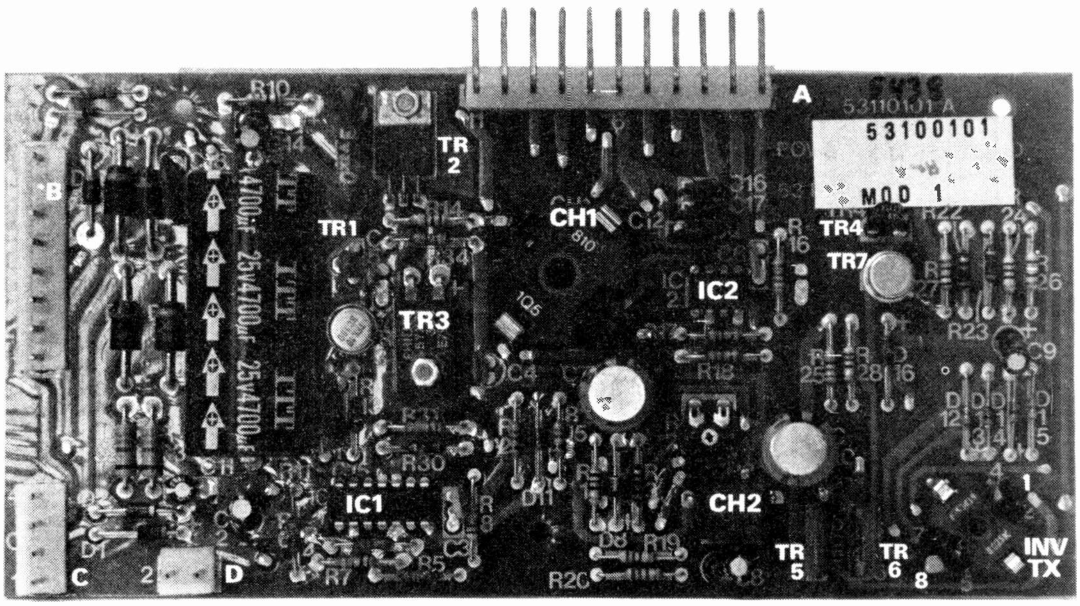
EG983

The display will now go blank, flash briefly, and then return with a display of "E–001A–bP" to indicate that it has found the breakpoint at location 001A. Pressing the ENTER key will cause "... dIS ..." to reappear. The PROCEED key is then struck to request that the program continue from the breakpoint:

KEYSTROKE(S)	DISPLAY
	...dIS...
PROCEED	E– 001A – Pr
ENTER	

EG984

The program will then restart from location 001A. The display will go blank for a short period, and then a four-digit running seconds count will appear in the centre of the display. The program, which uses the 1 second real time clock interrupt, must be stopped by interrupting the power.



P.s.u. board

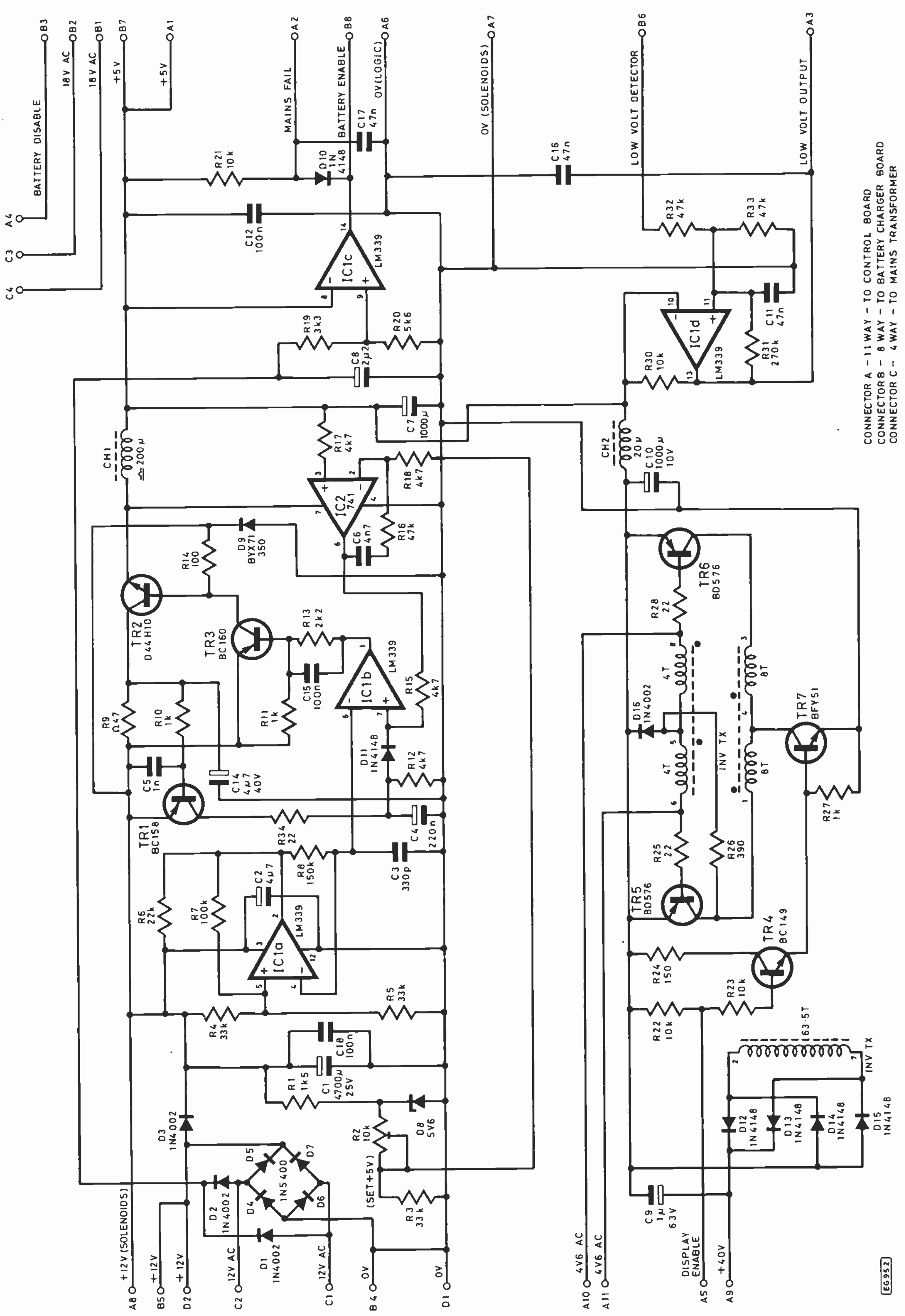


Fig. 2.3. Circuit diagram for the p.s.u.

POWER SUPPLY

The power supply provides the following outputs which are required for the Microcontroller:

(a) +12V high current supply (unregulated) for the four output interface buffers. Unloaded output is approximately 17V.
(b) +5V regulated supply for the CPU, RAM, ROM system clock, and control logic
(c) +40V supply for the gas discharge display
(d) 4·6V a.c. for the display filament.

In addition to the above supply rails, logic control signals are provided for detecting the presence of low-voltage or mains failure conditions.

The mains transformer has two series-connected 110V primary windings and two separate secondary windings. One of these provides 12V at approximately 2A for the bridge rectifier arrangement formed by D4, D5, D6 and D7. The other secondary winding provides approximately 17V at 0·5A and is not used in the basic Microcontroller system. It may, however, be used in conjunction with ancillary equipment or for system expansion.

The complete circuit diagram of the Microcontroller power supply is shown in Fig. 2.3. The unregulated d.c. output from the bridge rectifier is developed across reservoir capacitor, C1, and additional high frequency decoupling is provided by C18. The regulator operates on the switched mode principle with series-pass transistor, TR2. IC1a is connected as an oscillator which produces a square wave output at approximately 33kHz. The output of this oscillator is inverted by means of the comparator formed by IC1b. Over-current protection is provided by means of TR1 which effectively turns off the comparator stage. The output current is sampled by means of the voltage drop developed across R9 and trip operates at a load current of approximately 1·5A.

The voltage reference for the supply regulator is provided by D8 and associated components. Potentiometer, R2, provides accurate adjustment of the reference voltage to 5V. The reference voltage is compared with the output voltage of the supply using the comparator arrangement formed by IC2. Feedback components, C6 and R16, improve the stability of this stage.

Failure of the supply mains is detected by a further comparator arrangement formed by IC1a. Low voltage detection is similarly provided by IC1d. Both the mains failure and low-voltage control signals are used in the Microcontroller RAM control logic.

A simple inverter arrangement is used to provide the +40V rail. TR5 and TR6 are connected as an astable oscillator which operates at 12kHz and is gated by means of TR7. The secondary of the inverter transformer feeds the bridge rectifier, D12, D13, D14 and D15. Positive feedback to the bases of TR5 and TR6 is by means of two further secondary windings and these are also used to provide the 4·6V a.c. filament supply. The display is enabled by a logic 'high' which turns TR4 and TR7 'on'. Note that R22 acts as a pull-up which ensures that the inverter supply operates when the power supply is disconnected from the Microcontroller.

NEXT MONTH: *Programming the PIA's, writing control programs, controlling peripheral hardware and sample applications.*

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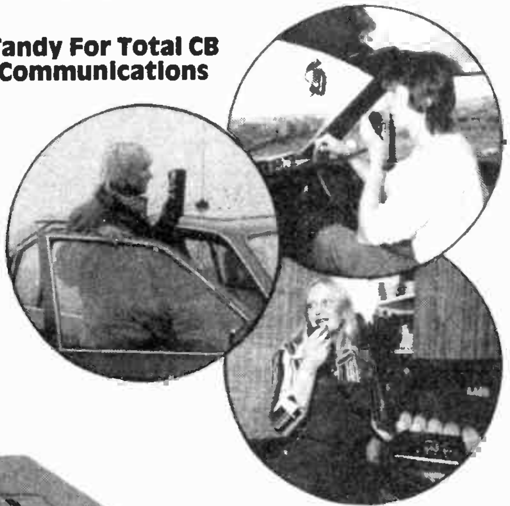

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PIN BULLETINS

At last something useful for nothing! Although surprisingly few people realise it, patents are often a wonderful source of first hand information on technology. A patent effectively freezes the inventor's original thoughts in print because, once filed and published, a patent can't be re-written, like the second edition of a book. Also patents remain perpetually in print. Even if all the printed copies have been sold you can still buy a photo-copy from the Patent Office. The problem of course is in finding the information you want from the literally millions of patents on file. A search by name (i.e. the name of the inventor, or the firm which filed the application for the inventor) is relatively easy, but still tedious because you have to search through annual alphabetical lists. And some firms file hundreds of patents a year. A subject matter search (i.e. all patents in a particular field of technology) is much more difficult and time-consuming. You first have to establish the classification mark for the technology that interests you, and then look up every patent that carries that mark. As often as not most of them are irrelevant, because it's only occasionally that your field of interest exactly coincides with a particular classification mark. Random searches, relying on pure serendipity, are like the football pools.

Now, the British Library is publishing a series of newsletters, called PIN Bulletins, which deal with interesting and important patents in popular and topical subject areas. These bulletins can be a very valuable short cut. Bulletin No. 2, for instance, discusses the patents on the Sinclair flat screen television research. Bulletin No. 3 looks at the patent coverage on Prestel-Viewdata, the war-time Enigma coding machines and satellite data communications. You can get copies of the PIN Bulletins free, from any of the libraries in the Patents Information Network. In practice this means any large library which keeps copies of published patents.

THE CRANFIELD PATENT

There's an interesting story behind British Patent 1 394 291. It was applied for in February 1972, by the Cranfield Institute of Technology, with Jack Dinsdale named as inventor. Dinsdale is a lecturer at Cranfield and hi-fi enthusiast, who had invented a clever bearing for a gramophone turntable. The patented bearing is like a fairly loose fitting piston and cylinder arrangement, but with helical grooves cut in the mating cylindrical surfaces. The bearing is filled with oil and when the central piston part (which carries the gramophone turntable) is rotated, the helical grooves create a hydrodynamic thrust which pumps the oil downwards. So the rotating parts float on oil. If the spindle is turned in the opposite direction the oil is pumped upwards and the bearing locks like a brake.

The patent application was accepted and published by the British Patent Office in May 1975 and in December that year Cranfield sold the patent rights to Plessey, then the parent company of hi-fi manufacturer Garrard. The sale price was said to be £5,000. At that time hi-fi sales were still reasonably strong and Garrard was a major name in British hi-fi. Garrard planned to incorporate the Cranfield bearings in a new, top range turntable. But hi-fi sales slumped and so did Garrard's fortunes. No turntable with the Cranfield bearing ever appeared. But even after Plessey shed loss-making Garrard, the Ilford company kept on paying the annual renewal fees necessary to keep the Cranfield patent in force. This has prevented other manufacturers from using the idea.

The Rock turntable made by Elite Townshend of Walton-on-Thames incorporates other Cranfield technology, such as artificial granite material for damping and a viscous fluid damped pickup arm. But Cranfield could not license Elite Townshend to use the patented bearing and had to design another, which relies on a cup of PTFE. It's unclear why Plessey kept the patent in force, because after the Garrard experience Plessey showed no further interest in hi-fi. Perhaps the patent was automatically renewed because no one thought to decide otherwise.

In April, 1982, however, Plessey sold the patent rights back to Garrard, for a nominal £1. So it is now up to Garrard to keep the patent in force and this will entail paying over £100 a year in renewal fees. After being sold off by Plessey, Garrard was bought by the Brazilian company Gradiente Electronica, but the future of Garrard is again in doubt. The company pulled out of the 1982 Harrogate International Festival of Sound and Video at the last minute, leaving the official exhibition catalogue with a glossy advert for Garrard on the front page, but no Garrard products on display. The next renewal fee for the Cranfield patent falls due for payment on February 2nd, 1983. Although there is a period of grace available for late payment it's likely that several hi-fi manufacturers will be checking with the Patent Office in February to establish whether or not Garrard is still keeping the Cranfield patent alive.

LOUDSPEAKERS

The Hohyu Rubber Company Ltd of Osaka, Japan has filed a British patent application for a new type of loudspeaker diaphragm. (2 087 688). Although patents for new speakers and new diaphragm materials, all supposedly offering perfect sound reproduction, are two a penny, this Japanese proposal is worth noting because of its radical thinking. This is probably due to the fact that the applicants are primarily involved in rubber technology, rather than loudspeaker design.

Traditionally a loudspeaker diaphragm is built as light and rigid as possible, so that it moves as a piston without isolated vibrations which cause cone breakup. The Japanese here suggest that this approach should be abandoned. Instead the diaphragm should be made of cured rubber with a very low rigidity so that it can vibrate freely, and not as a piston. The inventors liken their new cured rubber diaphragm to "artificial vocal cords".

Various rubber materials are listed, all highly flexible and formed by moulding and heat-curing under pressure. According to the patent the conventional diaphragms were stripped out of a three-way hi-fi speaker system and replaced by samples of the new floppy rubber units. Signals were then fed in from a hi-fi system (Sansui amplifier, Denon turntable and Shure V-15 type III cartridge) while a panel of "four trained listeners" made notes. Whereas the original system sounded only "ordinary" the system modified according to the invention sounded consistently "excellent".

European Patent Application 0 054 945 from the Nissan Motor Company offers a high level of sound in a motor car from a small loudspeaker drive unit. Most in-car systems, especially budget units factory-fitted prior to sale, rely on small loudspeaker drive units mounted in the door panels. These easily overload when the system is played loud, for instance on a motorway. They are also prone to irritating cavity resonances at specific frequencies in the high bass range. Nissan suggests the answer is to join the resonance problem rather than fight it. Instead of using a conventional loudspeaker, with drive coil and diaphragm, the Nissan unit has a driver which is coupled directly to a panel of the vehicle. So the vehicle panel acts as a diaphragm. Obviously the system is usable only at fairly low frequencies.

Ingenuity Unlimited

A selection of readers' original circuit ideas.

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

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

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

UNIVERSAL PROBE

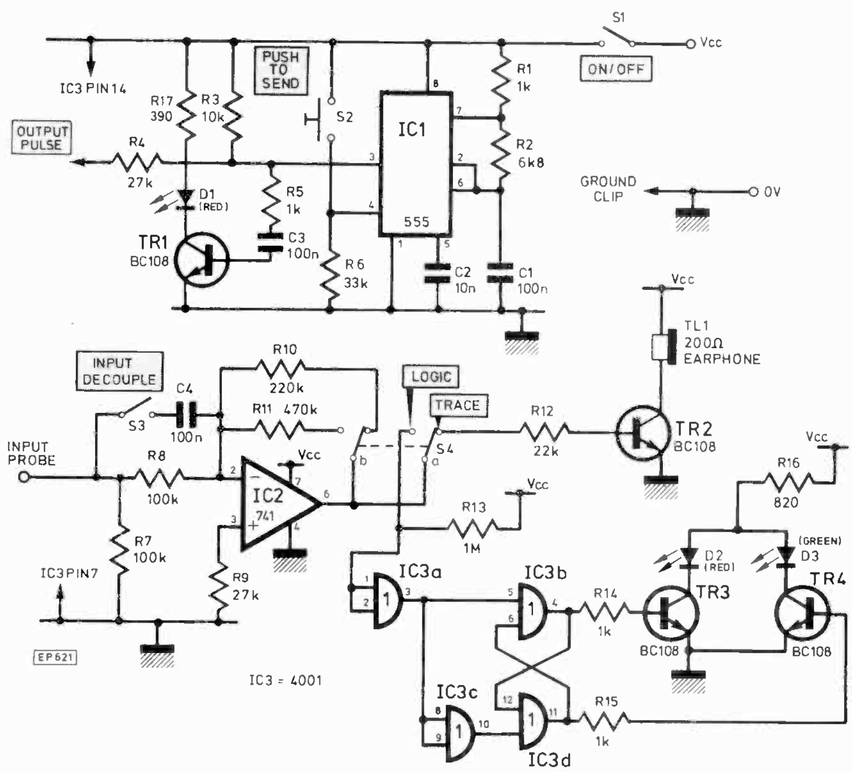
THIS unit consists of a square wave generator with a 27 kilohm output resistance. The frequency of oscillation is about 1 kHz.

Tracing is done through an operational amplifier with a gain of about 2.2. Further gain is obtained by use of TR2 which drives an earphone. This should be mounted on the circuit board, inside the unit, to avoid too many umbilical cords. The sound tube on the earphone should be removed. If low level signals, with a d.c. component, are to be traced, C4 and S3 provide decoupling of the input probe. This may load some high impedance circuits but is not likely to prevent testing for most applications.

S4 allows the unit to be switched from an analogue function to a digital function. It should be noted that for most digital uses, S3 should remain open.

The input voltage is fed to the inverting input of the 741, so that the output is normally high. As the input voltage of the amplifier rises, so the output voltage falls; as decided by the amplifier gain R11/R8. The high to low transition of the gates in IC3, was found to be approx. 3.6V; but if this varies, R11 can be set accordingly. When the output of the 741 falls below 3.6V the flip flop of IC3 changes state, and a logical high is indicated. Variations exist at the construction stage—precise voltage level change may be obtained by using a Schmitt device in place of IC3. The input voltage that causes a logical '1' to be indicated can be altered by changing R11. If R11 is reduced, the gain of the amplifier is reduced, and so the input voltage level which is necessary to cause a low to high change will rise. The object of the universal instrument is to use a voltage level suited to both TTL and CMOS.

As mentioned previously in the article, the Universal Probe may be used for other—more diverse applications. When S2 is open, the output lead, through R3 and R4, is at a logical '1' and so if used in conjunction with the input probe (Set to 'Logic' mode), continuity tests on high resistance circuits can be made; e.g. the instrument indicates logical '1' if the circuit is continuous.



If the output lead were connected to one side of a good capacitor and the input probe to the other side, the logical '1' indicator may flash momentarily but logical '0' should prevail. If now the 'Push to Send' button is pressed, an alternating current will pass through the capacitor and the logic l.e.d.s will indicate pulses. This test could be done with the unit set to 'Trace' and an audible indication of capacitor operation will follow. The square wave contains some high frequency harmonics so most capacitors can be tested in this way. High value electrolytic capacitors may take some time to charge through R3 and R4 before a logical '0' is shown. This fact could be used to estimate the value of an electrolytic capacitor. The unit should be calibrated with certain known values. Charging time to 1.5V can be counted since it will take 10s of seconds and differences will be noticed between capacitors of different sizes.

Semiconductor components may also be tested using the logical high at the output lead, and the input probe. Diodes will conduct and show a logical '1' when the output lead is connected to the anode and input probe to the cathode. Where reverse connection is made a logical '0' will result. Transistors may be tested in a similar way—testing base-emitter, base-collector junctions.

J. L. Gordon,
St. Helens,
Merseyside.

DISCO LIGHTS SEQUENCER

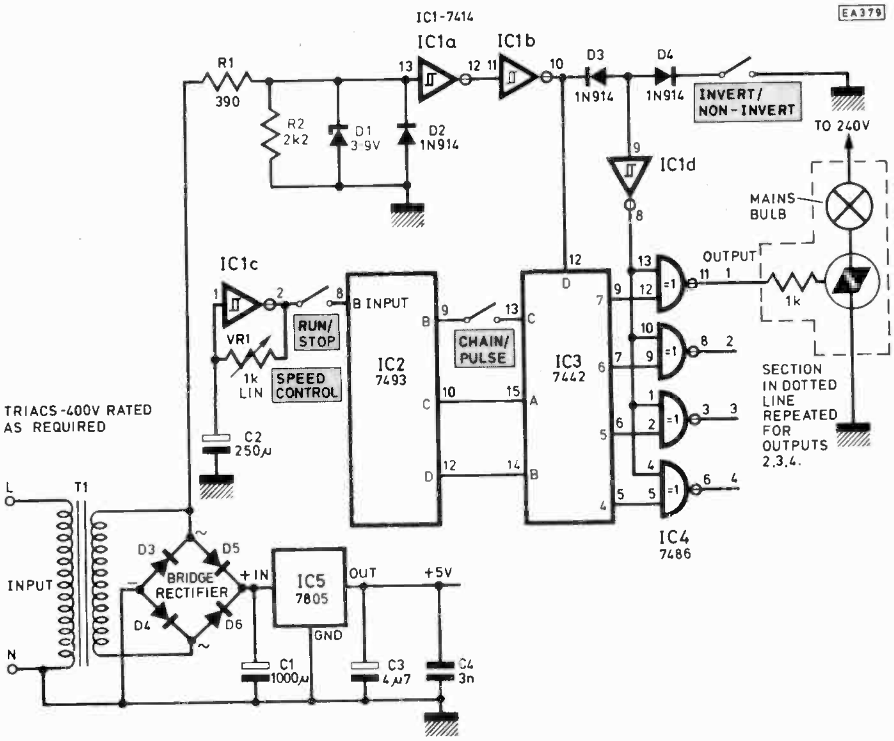
THE circuit shown is a Disco Lights Sequencer with four channels rated at whatever wattage the user chooses. The unit, as well as having the standard "1 bulb on, 3 bulbs off" operating mode has, in addition, two other operating modes, which makes it considerably more versatile and yet cheaper than the expensive units that are bought commercially.

The two new modes are:

(a) An invert mode where instead of "1 on, 3 off" there is the converse mode of "3 bulbs on, 1 bulb off" which gives a higher ambient light level.

(b) A pulse/chain mode which gives a pronounced effect of the bulbs being pulsed rather than the usual effect of switching instantaneously from one bulb to the next and results in a very convincing stroboscopic effect being obtained. This strobe effect is greatly enhanced if different coloured bulbs are used and an exciting strobe lighting display occurs when fast, lively disco music is being played.

From the technical viewpoint the circuit features some distinct advantages over some commercial units. It has zero voltage switching so essential if r.f.i. is to be avoided and has the unique feature of powering the bulbs on both the positive and negative swings of the mains supply which means that the bulbs have full power and give full illumination in contrast with many commercial units that supply only half-wave to the bulbs. In addition,



there is the all important safety aspect, because many commercial units require their circuitry to be live and so are inherently dangerous; however, the design given here has its circuitry tied to the neutral rail and so the circuitry is harmless if accidentally touched.

P. McChesney,
Wirral,
Merseyside.

BAZAAR

SONY TC377 open reel stereo recorder, mixing, s.o.s. echo £120. Swap UK101 plus/or expansion, printer etc. Mr. M. A. Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester LE5 2LH.

ORGAN keyboards, plastic keys, metal frame complete with contacts £13 plus postage. Rhythm unit £20 o.n.o. Mr. R. I. Tait, 114 Crabtree Lane, Bromsgrove, Worcs. Tel: Bromsgrove 71862.

FOR SALE Acorn Atom + extras. Engineering magazines 1978–80, for details write or see page 62 P.E. Sept. Pete Stephens, 49 King's Court, Bishops Stortford, Herts CM23 2AB. (0279) 52719 after 9p.m. and weekend.

WANTED information on a project on a Disco Desk with built in light effects built in front. £2. For information, J. R. Worton, 1 St. Giles Crescent, Willinhall Road, W/ton.

BACK numbers PE, Television, May 1980, August 1982. All good condition. Reasonable offers. A. Craig, 27 Dan's Road, Ballymena, Northern Ireland. Tel: Ballymena 42949.

VIDEO Recorder (Philips) CCTV camera, lens, modulator, tapes, etc. Ideal experimenters monochrome system. (Working) £90 o.n.o. David Palmer, 110 Ramsden Square, Cambridge, Cambs. CB4 2BL.

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WANTED IC's FDY7022P and FDY7023P used in Gross Desk Calculator 2131. Tel: 0495 245825 (after 6p.m.). J. Edwards.

MAPLIN 4600 Synthesiser offered around £450. Falkon R/C helicopter complete, offers around £185. Mr. R. Bailey, 52 Princess Street, Case Terrace, Nr. Walsall, Staffs WS7 8JN. Tel: 0543 77016.

WANTED. Charger and instruction manual for Tandy TRS 80 Printer cassette interface. Mr. K. Wenman, 2 Hythe Road, Sittingbourne, Kent.

MAGAZINES for sale, 4 bound volumes P.E. '64–'66, PE. '66–'68 plus 100 P.E., P.W., E.E., P.T.V. Dec. 1945 to 1980. £30. J. Jones, 10 West Harbour Road, Charlestown, Fife, Scotland. Tel: Limekilns 872118.

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UK101 8K rough case Mono 1 and WEMON. All RS232 components fitted. £150. S. Morgan, 17 Willenhall Road, Bilston, West Midlands WV14 6NW. Tel: Bilston 403416.

WANTED e.h.t. output transformer for a Teleton Anex 12" b/w portable television model TA-12. N. Kay, 4 Harland Close, Cosby, Leicester. Tel: Leic. 865037.

WANTED buy, loan, service manual or circuit diagram Civic radio XR5930 Hungarian Rhapsody. Will pay postage. D. Jackson, 77 Andover Road, Winchester SO29 6AU.

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ELECTRONIC continuity checker. New, audible tone, safe around semiconductors, sounds over 150kΩ valuable test piece £5·00. Paul Wilson, 2 Ramage Road, Carluke, Strathclyde, Scotland. Tel: 50374.

MAGAZINES for sale, P.E., P.W., E.E., Jan. 65–July 75. Details on request. Tel: 061 764 9684. Iain Kent.

12LBS electronic components inc. soldering iron. Also 13lbs. inc. ready made p.c.b.'s with batteries, £12·50 each. Ian Wilson, 10 Lowgate, Gosberton, Spalding, Lincs. Spalding 840256.

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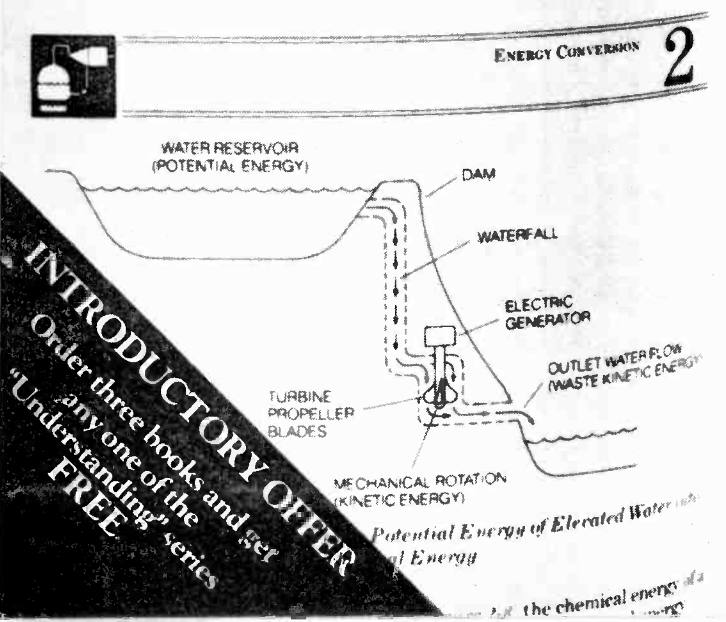

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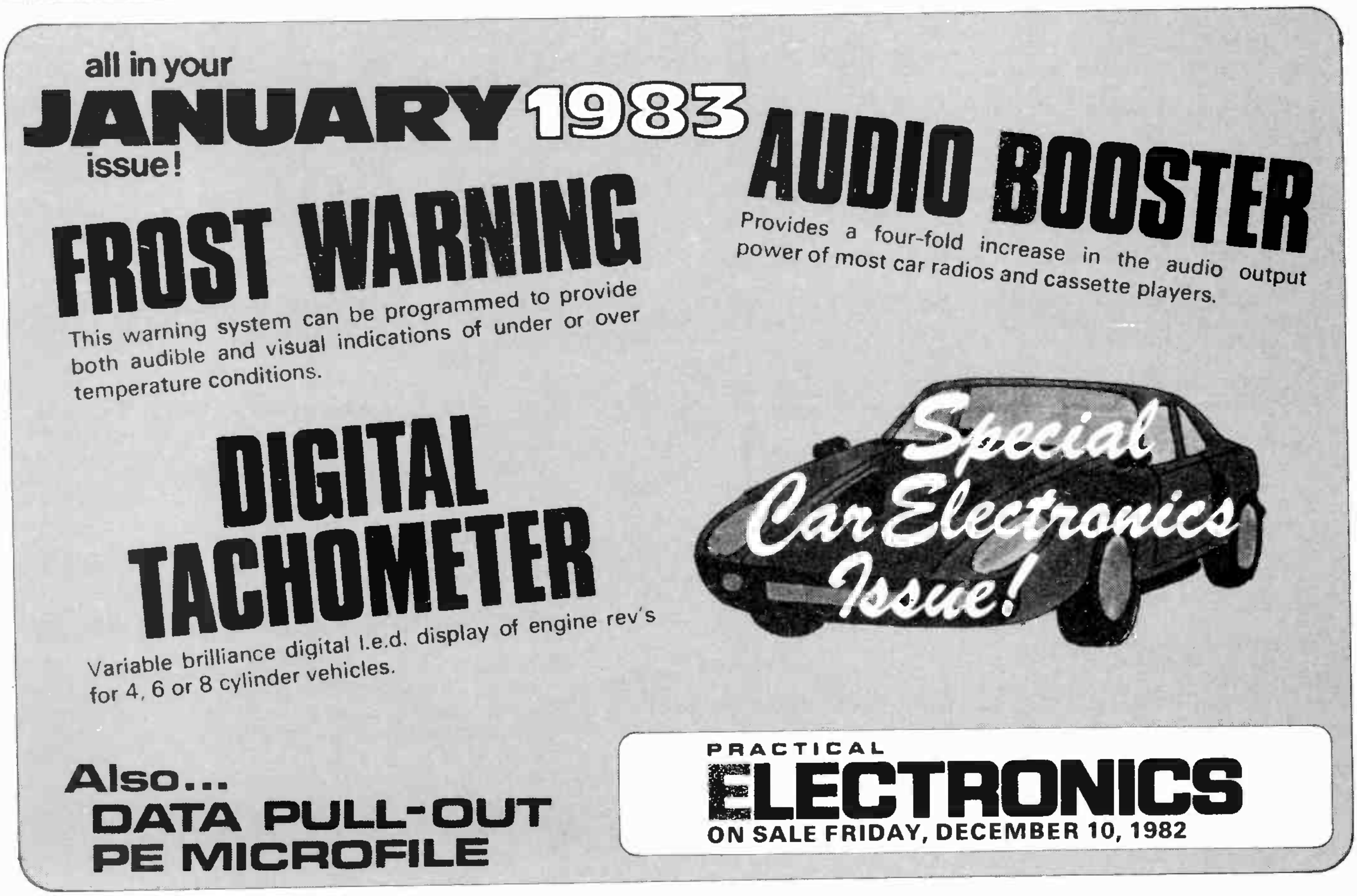

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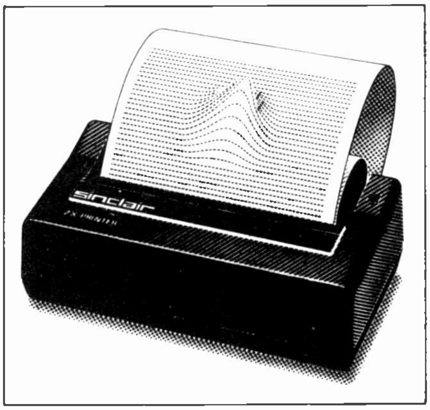

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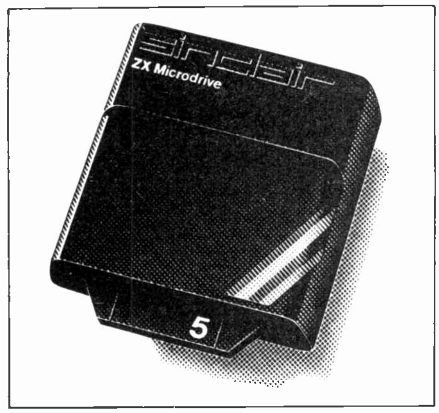

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D.P. C/O lever m/switch mfg. by Cherry Co. USA. Precious metal low resistance contacts. 10 for **£3.00** P. & P. 50p. **(£4.02** incl. VAT). (min. order 10). N.M.S.

A.C. Wkg. TUBULAR CAPACITORS.

Fraction of makers price. Motor start etc.

1.5 mfd.	440V.A.C.	60p	5 mfd.	400V.A.C.	£1.25
2 mfd.	250V.A.C.	60p	5.3 mfd.	160V.A.C.	60p
2 mfd.	450V.A.C.	75p	5.4 mfd.	280V.A.C.	75p
2.2 mfd.	440V.A.C.	75p	7.5 mfd.	200V.A.C.	£1.00
3 mfd.	440V.A.C.	£1.00	15 mfd.	440V.A.C.	£2.50
4.1 mfd.	440V.A.C.	£1.00			

P. & P. up to 2.5 mfd. 25p. 3 mfd. to 20 mfd. 50p. All plus VAT.
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24 volt. D.C. BLOWER UNIT

Precision 24 volt. D.C. 0-8 amp Blower that works well on 12V 0.4 amp D.C. Producing 30 cu. ft. min at normal air pressure. **£4.50** P. & P. 75p. (Incl. VAT **£6.04**). N.M.S.

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Test to I.E.E. Spec. Rugged metal construction suitable for bench or field work constant speed clutch Size L 8in W 4in H 6in weight 6lb. 500V. 500mohm. **£49.00** + £2.00 p&p (total incl. VAT **£58.65**). 1000V 1000MΩ. **£55** P. & P. £2.00. **(£65.55** incl. VAT). S.A.E. for leaflet.

Yet another outstanding offer.

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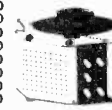
INPUT 230/240V a.c. 50/60 OUTPUT 0-260V



200 watt (1 amp inc. a.c. voltmenter	£15.00
0.5 KVA (2½ amp MAX)	£19.00
1 KVA (5 amp MAX)	£25.00
2 KVA (10 amp MAX)	£41.00
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Dual Input 200-240V, or 380-415V. Star connected.

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LT TRANSFORMERS

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National R. Relay 12V. D.C. high speed 1 c/o. 1 amp contacts. Magnetically shielded. 1 pitch. Price: **£1.25** post paid **(£1.44** incl. VAT).
Omron Type M. 24V. A.C. 4 c/o. h.d. Price: **80p** post paid **(92p** incl. VAT). Base **20p** post paid **(23p** incl. VAT).
220/240V. Primary; secondary 24V @ 4A. L.T. Transformer, fully shrouded. Price: **£4.50** + £1 p. & p. **(£6.38** incl. VAT).

INDUSTRIAL STROBE KIT

Suitable for both Industrial and Educational purposes. Kit when assembled produces a variable speed 1 to approx. 70 flash per second. Light output approx. 0.5 joules. Price, less cae. **£27.00** + £2.00 P. & P. (total incl. VAT **£33.36**).
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4ft. 40 Watt £8.70 incl. VAT **£10.00** (callers only).
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(For use in stan bi-pin fittings).
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9in. 6 Watt £2.50 P. & P. 45p **(£3.39** incl. VAT).
6in. 4 Watt £2.50 P. & P. 45p **(£3.39** incl. VAT).
Complete ballast unit for either 6", 9" or 12" tube 230V AC op **£5.50** P. & P. 55p **(£6.96** incl. VAT). Also available for 12V DC op **£5.50** P. & P. 55p **(£6.96** incl. VAT).

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Why waste money? Build your own EPROM ERASURE for the fraction of the price of a made-up Unit. Complete Kit of parts less case to include 12" 8 watt 2537 Angst Tube, Ballast Unit, pair of bi-pin leads, Neon Indicator, Safety Microswitch, on/off Switch, and Circuit. LESS CASE. Price: **£13.60** + 75p P&P (Total inc. VAT **£16.50**).
WARNING: Tube used in this circuit is highly dangerous to the eyes. Unit MUST be fitted in suitable case.

Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, embedded winding heavy duty brush assembly, continuously rated.
25 WATT 5/10/25/50/100/250/500/1kΩ/1.5kΩ **£3.10** P. & P. 30p. **(£3.91** incl. VAT).
50 WATT 250Ω **£5.50** P. P. 50p **(£6.90** incl. VAT).
100 WATT 1/5/10/25/50/100/250/500/1kΩ/1.5kΩ/2.5kΩ/3.5kΩ **£7.25** P. & P. 75p **(£9.14** incl. VAT).
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Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

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24V A.C. Sealed 3 c/o. 10a. 11-pin. **£1.50** + 25p P. & P. **(£2.01** incl. VAT).
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24V D.C. 2 c/o. 7 amp contacts. Sealed, octal base. **£1.30** P. & P. 30p **(£1.84** incl. VAT).

VERY SPECIAL OFFER 0-12V DC. 2 make contacts. NEW. 3 for **£1.75** + 25p P. & P. **(£2.30** inc. VAT).

D.C. Relays: Sealed 12V 1 c/o 7 amp octal base **£1.00** P. & P. 30p **(£1.50** incl. VAT). Sealed 12V 3 c/o 7 amp 11-pin **£1.35** P. & P. 30p **(£1.90** incl. VAT). 24V. Sealed 3 c/o 7 amp 11-pin **£1.35** P. & P. 30p **(£1.90** incl. VAT).

GEARED MOTORS

5rpm 240V A.C. Mf. by Carter. **£5.50** + £1.00 P. & P. **(£7.48** incl. VAT).
7½rpm Motor approx. 30 lb. in. 110V A.C. complete with Transformer for 240V A.C. **£9.25** + £1.50 P. & P. (total incl. VAT **£12.94**).

71rpm WYNSCALE motor approx. 20lb inch. A.C. supplied with auto transformer 240V. A.C. operation. **£9.75** P. & P. £1.50 **(£12.94** incl. VAT). N.M.S.

30 rpm. 230/240V. a.c. 50lb in. mf. **PARVALUX.** Price **£15.50** P. & P. £2.00 **(£20.13** incl. VAT). N.M.S.

42 R.P.M. 110 A.C. 50hz. 100lb incl. reversible will operate on 230 A.C. Speed remains at 42 R.P.M. but torque reduces by 50%. Price **£16.50** P. & P. £2.50 **(£21.28** incl. VAT). N.M.S.
Transformer for 240 Volt A.C. op. **£13.80** incl. VAT

38.3 rpm GEARED MOTOR, torque 35 lb. in reversible. 115V A.C., inc. start capacitor. Price: **£10.50** + £2.00 p&p (total incl. VAT **£14.38**).
Suitable Transformer 230V A.C. operation, Price: **£6.50** + 50p p&p (total incl. VAT **£8.05**). N.M.S.

N.E.C. GEARED MOTOR. 152 rpm 200 lb. in. 230V A.C. 50 Hz. Ratio 9.2 to 1. Non reverse. Incl. capacitors. Fraction of maker's price: **£37.50** + Carr. & VAT. N.M.S.

200 rpm. 35lbs. in. 115V. 50kH.
Price: **£16.50** P. & P. £2.00 **(£21.28** incl. VAT). N.M.S.
Suitable Transformer for 230/240V. a.c.
Price: **£6.00** P. & P. £1.50 **(£8.62** incl. VAT). N.M.S.

230/240V A.C. SYNCHRONOUS GEARED MOTORS

1rpm, 2rpm, 6rpm, 12rpm. 6 revs. per day. 12 revs. per day. Any type. Price: **£3.90** + 40p p. & p. **(£4.94** incl. VAT).

GEARED MOTOR. 120 rpm 1/10 hp approx. 15 lb.in. 230V. A.C. Cont. Rating. Non-reversible. Size 150mm × 90mm × 85mm spindle 8mm dia × 30mm long. Complete with capacitor and relay for max. load starting. Offered at mere fraction of mfrs. price **£11.50** incl. of p. & p. & VAT.

Brand new CASSETTE TYPE MOTORS

3 types – 6V, 7½V. Price: 3 for **£2.00** + 50p p. & p. (Total incl. VAT – **£2.88**)

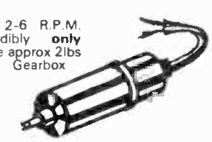
230V a.c. FAN ASSEMBLY

Powerful continuously rated a.c. motor complete with 5 blade 6½in. Price **£4.50** P. & P. 75p **(£6.04** incl. VAT).

24V. D.C. GEARED MOTOR

24V. D.C. 200 rpm 10lbs/ins. continuously rated geared Motor mfg. by either Parvalux or Carter. Easily removed from chassis containing 9×24V. D.C. Solenoids, microswitches, friction clutch, precision gearing etc. etc. Ex-equipment London Transport Ticket Printer. Price: **£8.00** P. & P. £2.00 **(£11.50** incl. VAT).

SUB-MINIATURE PRECISION BUILT GEARED MOTOR



3-9v. D.C. operation, speed 2-6 R.P.M. Current consumption incredibly **only 2-5 M.A.** Ratio 1670–1. Torque approx 2lbs inch plus. Motor – German, Gearbox Swiss.
Size: L. 48 mm. Dia. 16 mm.
Shaft L. 5 mm. Shaft Dia. 2 mm.
Price **£8.50** inc. P. & P.
(Total inc VAT **£9.78**).

THOMAS SINGLE DIAPHRAGM COMPRESSOR

Max. 20 psi 1½ C.F.M. approx. 100 volts A.C. Price **£16** + £2 p&p. Total **£20.70** inc. VAT or Total **£26.45** to include transformer for 230/240 volt A.C.

BLOWER/VACUUM PUMP.

3 phase A.C. Motor. 220/250V or 380/440V. 1,425rpm. ¼ h.p. cont. Direct coupled to William Allday Alcosa carbon vane blower/vacuum pump. 0.9 cfm 8 hg. Price: **£22.00** + £4.00 p&p (total incl. VAT **£29.90**).

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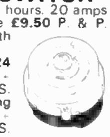
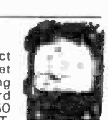
Type MG1636. 3 fig. countdown any number from 999 to 001. 230V A.C. 2 Wheel setting. Changeover Microswitch to inform external circuitry on completion of countdown. Size: Width 85mm. Ht. 65mm. Dpth. 70mm. Price **£4.00** + 75p P. & P. (Total incl. VAT **£5.46**).

SANGAMO WESTON TIME SWITCH



Type S251 200/250V. a.c. 2 on/2 off every 24 hours. 20 amps contacts with override switch dia. 4 × 3 price **£9.50** P. & P. £1.50 **(£12.65** incl. VAT). Also available with Solar dial. R. & T.
Type S288 **1 on, or 1 timed c/o every 24 hours,** day omitting device. Price **£11.00** + £1.00 p. & p. **(£13.80** incl. VAT). N.M.S.
Type S388. As above, plus 36-hours spring reserve. Less perspex cover. Price: **£13.00** + £1.00 p. & p. **(£16.10** incl. VAT). N.M.S.

VENNER TIME SWITCH



ERD Time switch 200/250V a.c. 30 amp contact 2 on/2 off every 24 hrs. at any manually pre-set time. 36 hour Spring Reserve and day omitting device. Built to highest Electricity Board specification. Price **£11.50** P. & P. £1.50 **(£14.95** incl. VAT). R.&T.

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80amp. 2-on/off Spring Reserve Timeswitch, Price **£15.50** P. & P. £1.50 **(£19.55** inc. VAT)

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UK Postages. Overseas extra.
Voltages stated are on full load
Continuous Ratings

30 V RANGE (2×15V tapped secs)
Sec Volt 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V.

Ref	Amps 30V	Amps 15V	Price	P&P
112	0.5	1	£3.19	£1.20
79	1	2	£4.32	£1.40
3	2	4	£6.99	£1.60
20	3	6	£8.10	£1.85
21	4	8	£9.67	£1.90
51	5	10	£11.95	£2.00
117	6	12	£13.52	£2.02
88	8	16	£18.10	£2.26
89	10	20	£20.88	£2.24
90	12	24	£23.20	O.A.
91	15	30	£26.60	£3.00
92	20	40	£35.64	£4.83

50 VOLT RANGE (Split Sec) Pri 120/240V (2×25V tapped secs) Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25-0-25V

Ref.	Amps 50V	Amps 25V	P&P	Ref.
102	0.5	1	£4.13	£1.40
103	1	2	£5.03	£1.40
104	2	4	£8.69	£1.84
105	3	6	£10.36	£1.90
106	4	8	£14.10	£2.12
107	6	12	£18.01	£2.34
118	8	16	£24.52	£2.70
119	10	20	£30.23	O.A.
109	12	24	£36.18	O.A.

MAINS ISOLATORS
Pri 0-120; 0-100-120V (120, 220, 240V) Sec 0-CT-120V twice,

Ref.	VA	Price	P&P
*07	20	£5.30	£1.50
149	60	£8.63	£1.60
150	100	£10.06	£1.84
151	200	£13.69	£2.12
152	250	£16.31	£2.64
154	500	£25.02	£2.90
155	750	£35.91	O.A.
156	1000	£45.89	O.A.
157	1500	£60.02	O.A.
158	2000	£72.43	O.A.
159	3000	£101.12	O.A.
160	6000	£207.92	

*Pri 0-240V Sec 115 or 240V only.
State sec volts required.

CASED AUTO TRANSFORMERS
240V cable in 115V USA flat pin outlets.

VA	Price	P&P	Ref.
20	£7.21	£1.25	56W
75	£9.35	£1.50	64W
150	£12.10	£1.84	4W
250	£14.73	£1.60	69W
500	£22.14	£2.24	67W
1000	£33.74	£2.80	84W
2000	£60.47	O.A.	95W

AUTO TRANSFORMERS
Volts out: 105, 115, 190, 200, 210, 220, 230, 240, for step up or step down.

Ref.	VA (Watts)	Price	P&P
113*	15	£2.39	£1.20
64	80	£4.85	£1.40
4	150	£6.48	£1.60
67	500	£13.30	£2.24
84	1000	£22.70	£2.80
493	1500	£28.17	O.A.
95	2000	£42.14	O.A.
73	3000	£71.64	O.A.
480	4000	£93.01	O.A.
57	5000	£108.30	O.A.

*0, 115, 220, 240.

Send 20p for catalogue. Prices correct 21/4/82.

96/48/36V RANGE
Pri 0-120/240V
Sec 2 windings 0-36-48V to give 36-0-36V or 48-0-48V or 96V.

Amps 72v/96v	Amps 36v/48v	Ref.	Price	P&P
1	2	431	£8.93	£1.64
2	4	432	£14.69	£1.60
3	6	433	£17.79	£2.40
4	8	434	£22.24	£2.40
5	10	435	£32.23	£2.40
6	12	436	£40.36	O.A.
8	16	437	£44.03	O.A.

60V RANGE (2×25V tapped secs)
Pri 120/240V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24V-0-24V or 30V-0-30V.

Ref.	Amps 60V	Amps 30V	Price	P&P
124	0.5	1	£4.70	£1.50
126	1	2	£7.15	£1.50
127	2	4	£9.20	£1.90
125	3	6	£13.31	£2.02
123	4	8	£15.15	£2.26
40	5	10	£19.16	£2.24
120	6	12	£21.86	£2.64
121	8	16	£30.72	O.A.
122	10	20	£35.76	O.A.
189	12	24	£41.22	O.A.

12 OR 24V OR 12-0-12V Pri 220-240

Ref.	12V (AMPS)	24V (AMPS)	Price	P&P
242	.300	.15	£2.19	£0.70
213	1.0	0.5	£3.19	£1.20
71	2	1	£4.25	£1.20
18	4	2	£4.91	£1.60
85	5	2.5	£6.78	£1.50
70	6	3	£7.69	£1.40
108	8	4	£8.98	£1.64
72	10	5	£9.82	£1.80
116	12	6	£10.89	£1.90
17	16	8	£12.97	£2.12
115	20	10	£17.46	£2.44
187	30	15	£21.69	£2.64
226	60	30	£44.45	O.A.

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	3.11	0.90
212	1A, 1A	0-6, 0-6	3.45	1.20
13	100	9-0-9	2.59	0.80
235	330, 330	0-9, 0-9	2.41	0.60
207	500, 500	0-8-9, 0-8-9	3.36	1.20
208	1A, 1A	0-8-9, 0-8-9	4.27	1.40
236	200, 200	0-15, 0-15	2.41	0.90
214	300, 300	0-20, 0-20	3.39	1.20
221	700(DC)	20-12-0-12-20	4.13	1.20
206	1A, 1A	0-15-20 (×2)	5.60	1.60
203	500, 500	0-15-27 (×2)	4.83	1.50
204	1A, 1A	0-15-27 (×2)	7.30	1.60
239	50	12-0-12	3.11	0.90
234	500	6-0-6	2.41	0.90

Constant Voltage Transformers
Clean mains to computers/peripherals
250 VA **£137.36** + **£6.50** VAT; 500 VA **£159.43** + £8.50 VAT; 1kVA **£239.12** £11.00
250VA 500VA 1kVA. Tap-changing types cased 400VA for mains fluctuations

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100VA cased (150VA tool rating) 12V DC to 240V A.C. outlet socket. For emergency lights, central heating boiler pumps etc. **£45.** P&P + VAT 15%.

15V CT Range (7.5V-0-7.5V)

Ref.		Price	P&P
171	500mA	£2.53	£0.90
172	1A	£3.59	£1.20
173	2A	£4.35	£1.20
174	3A	£4.54	£1.20
175	4A*	£6.93	£1.40

TOROIDAL'S now stocked 30 to 530VA

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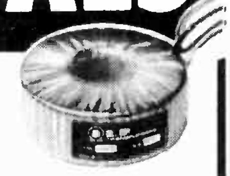

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	1x012	12+12	1.25	
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	1x014	18+18	0.83	
	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
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	2x012	12+12	2.08	
	2x013	15+15	1.66	
	2x014	18+18	1.38	
	2x015	22+22	1.13	
	2x016	25+25	1.00	
	2x017	30+30	0.83	
	2x028	110	0.45	
	2x029	220	0.22	
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	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0.36	
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	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA 110×40mm 1.8Kg Regulation 8%	5x011	9+9	8.89	£7.91 +p/p £1.67 +VAT £1.44 TOTAL £11.07
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0.72	
	5x030	240	0.66	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
225 VA 110×45mm 2.2Kg Regulation 7%	6x012	12+12	9.38	£9.20 +p/p £2.00 +VAT £1.68 TOTAL £12.88
	6x013	15+15	7.50	
	6x014	18+18	6.25	
	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA 110×50mm 2.6Kg Regulation 6%	7x013	15+15	10.00	£10.17 +p/p £2.00 +VAT £1.83 TOTAL £14.00
	7x014	18+18	8.33	
	7x015	22+22	6.82	
	7x016	25+25	6.00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA 140×60mm 4Kg Regulation 4%	8x016	25+25	10.00	£13.53 +p/p £2.35 +VAT £2.38 TOTAL £18.26
	8x017	30+30	8.33	
	8x018	35+35	7.14	
	8x026	40+40	6.25	
	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA 140×75mm 5Kg Regulation 4%	9x017	30+30	10.41	£16.13 +p/p £2.50 +VAT £2.79 TOTAL £21.42
	9x018	35+35	8.92	
	9x026	40+40	7.81	
	9x025	45+45	6.94	
	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5.68	
	9x029	220	2.84	
	9x030	240	2.60	

IMPORTANT: Regulation – All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

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CONNECTOR SYSTEMS

I.D. CONNECTORS (Speedblock Type)

No. of ways	Header Plug	Receptacle	Edge Conn.
10	90p	90p	200p
20	145p	125p	240p
26	175p	150p	300p
34	200p	160p	380p
40	220p	190p	550p
50	235p	200p	600p

D-CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
Solder	90p	130p	160p	250p
Angled	160p	230p	265p	425p
FEMALE				
Solder	110p	160p	210p	350p
Angled	175p	240p	310p	500p
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16 way	90p
20 way	105p
26 way	140p
34 way	220p
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1 end	160p	210p	270p	300p
2 ends	290p	385p	490p	540p

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EURO CONNECTORS (Indirect Edge Conn.)

DIN STD	Plug	Skt
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41617 31 way	180p	180p
41612 2×32 way	250p	320p
Angled 2×32 way	325p	375p
41612 3×32 way	275p	380p
Angled 3×32 way	—	400p
2×32 way IDC a+c		525p

(for 2×32 way specify a+b or a+c)

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	0.1"	0.156"
2×18 way	—	140p
2×22 way	200p	170p
2×23 way	210p	—
2×25 way	225p	220p
1×43 way	260p	—
2×43 way	395p	—
2×50 way	—	—
1×77 way	700p	—
S100 Conn	—	600p

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