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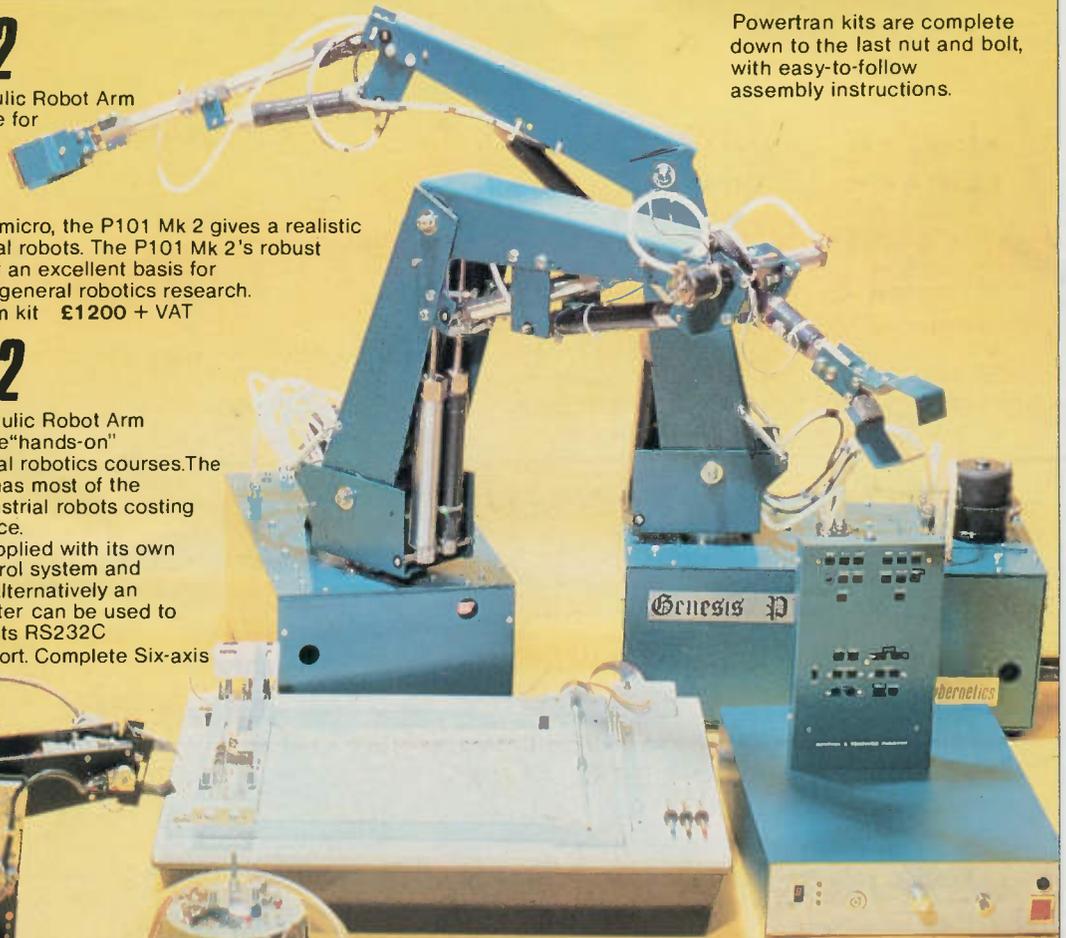
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This month's cover shows a digitised photograph, designed and created by Alex Kempkens, of a National Semiconductor 32-bit microprocessor. The Series 32000 Family from National includes the first commercially available 32-bit c.p.u.

SCOPE OFFER . . .

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OUR MAY ISSUE WILL BE ON SALE FRIDAY, APRIL 4th, 1985 (see page 43)

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ELECTROLYTIC CAPACITORS (Values in µF). 500V: 10µF 52p; 47 78p; 63V: 0.1, 0.15, 2.2, 3.3, 8p; 4.7 9p; 10 10p; 15 12 12p; 33 15p; 47 12p; 68 16p; 100 20p; 220 26p; 1000 70p; 50V: 68 20p; 100 27p; 220 24p; 40V: 6.8 15p; 22p; 33 12p; 330 40p; 330 40p; 1000 48p; 2200 90p; 25V: 4.7, 10, 22, 47 8p; 100 11p; 150 12p; 220 15p; 330 15p; 470 25p; 680, 1000 42p; 2200 50p; 3300 76p; 4700 92p; 250, 2.5, 40p; 47, 68, 100, 150p; 125 12p; 220 13p; 330 16p; 470 20p; 680 34p; 1000 27p; 1500 31p; 2200 36p; 4700 75p.

TAG-END TYPE: 64V: 4700 245p; 3000 145p; 2000 120p; 50V: 3300 155p; 2200 95p; 40V: 4700 160p; 2200 70p; 3300 85p; 4000, 4700 75p; 10,000 250p; 15,000 270p; 16V: 2200 80p; 2000, 25V: 4700 98p; 10,000 320p; 15,000 345p.

TANTALUM BEAD CAPACITORS: 0.1µ-0.1p, 0.2, 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 36p; 33, 47 50p; 100 95p; 220 100p; 10V: 15, 22 26p; 33, 47 50p; 100 75p.

SILVER MICRA (pF)
 2, 3, 3.4, 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; 220, 250, 270, 330, 360, 390, 470, 680, 800 & 820pF 21p; 1000, 1200, 1800 30p each; 3300, 4700 60p each

SIEMENS multilayer miniature capacitors.
 250V: 1nF, 1n5, 2n, 3n, 4n7, 6n8, 8n2, 10n, 15n, 22n 7p; 18n; 9p, 10nF 11p; 10µF 12p; 100V: 100n, 120n; 150n 11p; 220n 13p; 330n 18p; 470n 23p; 680n 30p; 1Mf 34p; 2Mf 50p.

CERAMIC CAPACITORS: 50V
 Range 10pF to 6800pF 4p; 10nF; 15n, 33n, 47n 5p; 100nF 80p 7p.

POLYSTYRENE Caps:
 10pF to 1nF 8p; 1n5 to 12nF 8p

RESISTORS S.I.L. Package: 7 Commoned, 100Ω, 470Ω, 680Ω, 1K, 2K, 4K, 10K, 47K, 100K 24p. 8 Commoned: (8 pins) 150Ω, 180Ω, 270Ω, 330Ω, 390Ω, 1K, 2K, 4K, 6K, 10K, 22K, 47K, 100K 26p.

TRANSISTORS

AC127/8	35	BC308B	16	BFR98	105	TP3C0C	37	2N9145	32	2N5458/9	30
AC141/2	35	BC327/8	15	BFX23/8A	35	TP31A	38	2N918	48	2N5485	36
AC176	35	BC337/8	15	BFX85/86	35	TP32A	43	2N920	24	2N5477	45
AC187/8	35	BC441	34	BFY50/51	30	TP33C	45	2N1131/2	40	2N6027	32
AC188	35	BC461	34	BFY52	35	TP33A	70	2N1303/4/5	10	2N6109	60
AD142	35	BC478	35	BFY55	35	TP33A	70	2N1307	70	2N6290	70
AD149	79	BC516/7	40	BFY65	35	TP33C	75	2N1613	75	2N6A36	250
AD161/2	42	BC547/8	12	BFY68	35	TP33C	75	2N1671B	50	2N6A71	250
AF118	95	BC549C	15	BFY90	80	TP35C	120	2N1915A/20A	10	2N6C15	75
AF139	40	BC556/7	15	BRV39	50	TP36C	130	2N1A22A	25	2N5C0961	250
AF239	55	BC558/9	15	BSX20	30	TP41A	50	2N2846	60	2N5C117/23	125
BC107/8	35	BC104/2	35	BSX29	45	TP41B	55	2N2934A/05A	10	2N5C1306	100
BC108B	14	BCY70	20	BSY95	35	TP42A	55	06A/07A	26	2N5C1307	150
BC108C	14	BCY71	20	BSY95	35	TP42B	58	2N52926G	10	2N5C1449	95
BC109	12	BCY78	30	BU105	180	TP42C	70	2N3053	25	2N5C1679	90
BC109B	14	BD131/2	65	BU205	190	TP42D	73	2N3054	55	2N5C1768	140
BC109C	14	BD133	60	BU206	200	TP42E	120	2N3055	50	2N5C1923	65
BC114/5	30	BD135	45	BU208	200	TP42F	125	2N3442	140	2N5C1945	225
BC117/8	25	BD136/7	40	MJE340	54	TP2955	70	2N3615	199	2N5C1953	90
BC140	38	BD138/9	40	MJE371	100	TP3055	70	2N3702/3	20	2N5C1969	165
BC142/3	38	BD140	40	MJE2955	99	TP3055	70	2N3704/5	10	2N5C2078	150
BC147/8	12	BD158	68	MJE3055	70	TP3055	70	2N3706/7	10	2N5C2092	200
BC147B	15	BD245	65	MPF102	40	TP3055	70	2N3708/9	10	2N5C2150	100
BC148C	14	BD434	70	MPF104	40	TP3055	70	2N3710	10	2N5C2151	100
BC149	12	BD695A	150	MPSA05	30	TP3055	70	2N3711	179	2N5C2166	165
BC149C	15	BD696A	150	MPSA05	30	TP3055	70	2N3712	195	2N5C2314	85
BC153/4	30	BF115	45	MPSA06	25	TP3055	70	2N3713	210	2N5C2325	100
BC157/8	14	BF154/8	45	MPSA08	30	TP3055	70	2N3714	35	2N5C2485	125
BC159	11	BF167	35	MPSA12	32	TP3055	70	2N3715	110	2N5C2544	60
BC167A	14	BF173	35	MPSA15	30	TP3055	70	2N3716	130	2N5C2672	200
BC168C	12	BF177	35	MPSA16	30	TP3055	70	2N3717	130	2N5C2673	200
BC169C	12	BF178	35	MPSA17	30	TP3055	70	2N3718	130	2N5C2674	200
BC171/2	12	BF179	35	MPSU02	58	TP3055	70	2N3719	12	2N5C2675	200
BC173	15	BF194/5	12	MPSU06	60	TP3055	70	2N3720	28	2N5C2676	200
BC177/8	16	BF198/9	18	MPSU06	60	TP3055	70	2N3721	13	2N5C2677	200
BC181	30	BF224	40	MPSU05	65	TP3055	70	2N3722	13	2N5C2678	200
BC182/3	10	BF244A	28	MPSU06	60	TP3055	70	2N3723	25	2N5C2679	200
BC184	10	BF244B	29	OC23	170	TP3055	70	2N3724	30	2N5C2680	200
BC182L	10	BF245	50	OC28/36	220	TP3055	70	2N3725	14	2N5C2681	200
BC183L	10	BF256B	60	OC40	142	TP3055	70	2N3726	18	2N5C2682	200
BC184	10	BF278B	32	OC71	40	TP3055	70	2N3727	25	2N5C2683	200
BC186/7	10	BF287	30	OC72	40	TP3055	70	2N3728	25	2N5C2684	200
BC121/2	12	BF394	40	OC75/76	55	TP3055	70	2N3729	25	2N5C2685	200
BC212L	10	BF451	40	OC76	55	TP3055	70	2N3730	25	2N5C2686	200
BC213L	12	BF494/5	40	OC81/82	50	TP3055	70	2N3731	23	2N5C2687	200
BC214	10	BF495/6	30	OC83/84	70	TP3055	70	2N3732	23	2N5C2688	200
BC214L	12	BF495/6	30	TP29A	32	TP3055	70	2N3733	32	2N5C2689	200
BC214L	12	BF495/6	30	TP29C	38	TP3055	70	2N3734	25	2N5C2690	200
BC307/8	15	BF808/01	25	TP30A	35	TP3055	70	2N3735	25	2N5C2691	200

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 1W 202 10M E12 6p 4p
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702	75	LM339	40	SN7603	350	8225	8224	£3	TMS9927	£14	74S262	£10	7450	30	LS85	70	LS322	360	4036	275	4520	53
709C 8 pin	75	LM348	60	SN76488	525	8228	8226	£3	TMS9928	£16	74S274	£10	7450	30	LS86	35	LS323	400	4037	115	4521	115
710	48	LM349	125	SP0256AL	625	8238	8238	310	TMS9929	£12	74S275	£10	7450	30	LS90	50	LS324	150	4038	75	4522	125
741	16	LM358	50	TA7120	140	8250	8250	£11	TMS9995	£12	74S280	£10	7470	50	LS92	50	LS325	290	4039	200	4523	60
747C 14 pin	70	LM377	210	TA7130	140	8255	8255	£11	TMS9995	£12	74S281	£10	7470	50	LS93	55	LS327	290	4041	57	4528	70
748C 8 pin	70	LM387	495	TA7204	150	8255	8255	£11	TMS9995	£12	74S282	£10	7470	50	LS95	55	LS327	290	4042	57	4529	150
753 8 pin	185	LM380	115	TA7205	90	8256A	8256A	£15	UPD7091	£25	74S288	£10	7476	45	LS96	90	LS348	140	4044	42	4530	90
810	159	LM381N	175	TA7222	150	8257A	8257A	£16	UPD7170	£19.95	74S299	£10	7480	175	LS97	100	LS352	110	4045	50	4531	130
9400CJ	375	LM382	200	TA7310	00	8258	8258	£16	UPD7170	£19.95	74S300	£10	7480	175	LS98	100	LS353	110	4046	50	4532	130
ADC0808	110	LM384	225	TA900	195	8259	8259	£16	UPD7170	£19.95	74S301	£10	7480	175	LS99	100	LS354	110	4047	50	4533	130
AY-1-1320	225	LM386	90	TA961	190	8272	8272	£15	Z80CPU 2.5	£50	74S302	£10	7480	175	LS100	100	LS355	110	4048	50	4534	130
AY-1-5050	99	LM387	210	TA970	275	8279	8279	£15	Z80CPU 2.5	£50	74S303	£10	7480	175	LS101	100	LS356	110	4049	50	4535	130
AY-1-6720	110	LM389	160	TA100	150	8282	8282	£15	Z80CPU 2.5	£50	74S304	£10	7480	175	LS102	100	LS357	110	4050	50	4536	130
AY-3-8910	390	LM393	85	TBA120S	70	8283	8283	£15	Z80CPU 2.5	£50	74S305	£10	7480	175	LS103	100	LS358	110	4051	50	4537	130
AY-3-8912	390	LM394CH	380	TBA540	275	8284	8284	£15	Z80CPU 2.5	£50	74S306	£10	7480	175	LS104	100	LS359	110	4052	50	4538	130
AY-5-1317A	630	LM558	170	TB550Q	330	8285	8285	£15	Z80CPU 2.5	£50	74S307	£10	7480	175	LS105	100	LS360	110	4053	50	4539	130
CA3011	130	LM725CN	300	TBA61	270	8286	8286	£15	Z80CPU 2.5	£50	74S308	£10	7480	175	LS106	100	LS361	110	4054	50	4540	130
CA3012	110	LM733	300	TBA62																		

SPEAKERS 8Ω, 0.3W, 2", 2.25", 2.5", 3" 0.3W, 2.5" 400Ω; 64Ω or 80Ω		OPTO LEDS price includes Clips TIL209 Red 3mm 14 TIL211 Green 3mm 10 TIL212 Yellow 14 TIL220 -2" Red 12 0.2" Yel, Grn, Amber Rectangular LEDs with two part clip, R, G & Y 45 Rectangi. Stackable LEDs 18 0.2" Red High Bright 56 0.2" Bi colour LEDs Red/Green 100 Red/Yellow 80 0.2" Tri colour LEDs Red/Green/Yellow 85 0.2" Red High Bright Yellow Bright Green or High 100 LD271 Infra Red (emit) 46 TIL32 Infra Red (emit) 52 SFH205 (detector) 118 TIL78 (detector) 55 TIL81 82; TIL100 90		0.5" LCD DISPLAYS 3 1/2 digit 495 4 digit 530 6 digit 625		VOLTAGE REGULATORS 1A T0220 Plastic Casing +ve -ve 5V 7805 45p 7905 55p 12V 7812 45p 7908 55p 15V 7815 45p 7912 55p 24V 7824 45p 7915 55p 100mA T092 Plastic Casing 5V 78L05 30p 79L05 50p 6V 78L62 30p 8V 78L82 30p 12V 78L12 30p 79L12 50p 15V 78L15 30p 79L15 50p		DIL SOCKETS Low profile Wire wrap 8 pin 8p 25p 16 pin 10p 35p 18 pin 10p 42p 20 pin 16p 52p 22 pin 20p 60p 24 pin 22p 65p 28 pin 25p 70p 30 pin 28p 80p 40 pin 30p 99p	
DIODES AA119 8 AA129 10 AA130 10 BA100 15 BY100 15 BY126 12 BY127 10 CRO33 198 OA3 10 OA47 10 OA70 9 OA79 10 OA81 10 OA85 10 OA90 8 OA91 8 OA95 8 OA200 8 OA202 8 TN974 4 TN916 5 TN4001/2 5 TN4003 6 TN4004/5 6 TN4006/7 7 TN4148 4 TN5401 12 TN5404 15 TN5406 15 TN5408 19 IS44 9 IS921 9 6A100V 40 6A400V 50 6A800V 65		BRIDGE RECTIFIERS (plastic case) 1A/50V 18 1A/100V 20 1A/400V 25 1A/600V 30 2A/50V 26 2A/200V 40 2A/400V 42 2A/600V 50 6A/100V 85 6A/400V 95 6A/600V 125 10A/200V 215 10A/600V 298 25A/200V 240 25A/600V 395 BY164 56		OPTO SWITCH Reflective TIL139 225 Slotted similar to RS 186		SLIDE SWITCH 1A DPDT 14 1A DPDT C/OFF 15 2A DPDT on/on/on 40		ZIF SOCKET (TEXT TOOL) 24 way 575p 28 way 695p 40 way 845p	
ZENERS Range: 2V7 to 39V 400mW 5p each Range: 3V3 to 33V, 1.3W 15p each		7 Segment Displays TIL321 5" C.An 140 TIL322 5" C.Ch 125 DL704 3" C.Ch 140 FND357 or 500 130 3" Green C.A. 140 ±1.3" Red or Green 150 Bargraph 10 seg. Red 275 Bargraph NSM3914 500		ALUMINUM BOXES 4x2 1/2x2 100 4x2 3/4x2 103 4x4 1/2x2 120 5x2 3/4x1 105 5x2 3/4x1 1/2 90 5x2 3/4x2 130 5x4 1 1/2 99 5x4 2 1/2 120 6x4 2 1/2 120 6x4 3 150 Push to make 15p 8x6 3 210 10x4 1/4x3 240 10x7 3 275 12x8 3 290		TOGGLE 2A 250V 1A DPDT 15 1A DPDT C/OFF 14 2A DPDT on/on/on 40		DIL PLUGS (Headers) Pins Solder IDC 14 38p 95p 16 42p 100p 24 88p 138p 28 185p 250p 40 195p 218p	
TRIACS 3A/400V 48 3A/800V 85 3A/100V 60 8A/400V 69 8A/800V 115 12A/100V 78 12A/400V 82 12A/100V 78 12A/800V 135 16A/100V 103 16A/400V 105 16A/800V 220 25A/400V 185 25A/800V 295 25A/100V 480		FERRIC CHLORIDE Crystals 1lb 195p 50p p&p		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 48p		RIBBON CABLE (price per foot) 10 15p 15 20p 20 25p 26 40p 34 50p 40 80p 64 90p		TRANSFORMERS (mains Prim. 220-240V) 3-0-3V, 6.0-6V 100mA 130; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA; 6VA: 2x6V-5A; 2x9V-4A; 2x12V-0-3A; 2x15V-25A 250p 12VA: 2x4V5-1-3A; 2x6V-1-2A; 2x12V-5A; 2x15V-4A 345p (35p p&p) 24VA: 6V-15A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-8A 15-8A; 20V-6A 20V-6A 385 (60p p&p) 50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1-2A; 2x25V-2A; 2x30V-0-8A 520p (60p p&p) 100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x30V-1-5A; 2x40V-1-25A; 2x50V-1-965p (60p p&p)	
SCR's Thyristors 0.8A-100V 32 5A/300V 38 5A/400V 40 5A/600V 48 8A/300V 60 8A/400V 65 12A/100V 78 12A/400V 82 12A/100V 78 12A/800V 135 16A/100V 103 16A/400V 105 16A/800V 220 25A/400V 185 25A/800V 295 25A/100V 480		COPPER CLAD BOARDS Fibre Single-sided 125p Glass 100p 6"x6" 175p		ROTARY: Mains 250V AC, 4 Amp 64p		MALE Solder 55p Angle 110p Straight 100p		FEMALE Solder 90p Angle 150p Straight 100p	
DIAC ST2 25		VERO BOARDING Clad Plain 180 "DIP" Board 395 Vero Strip 144 34x45 125 95p 34x45 17 420 275p 44x48 590 S-Dev Pkt. of 100 pins 55p Spot Face Cutter 150p Pin Insertion Tool 185p		AMPHENOL PLUGS 24 way IEEE IDC 485p 36 way Centronic IDC 475p 24 way Female IDC 480p 36 way Centronic Female IDC 500p		COVERS 75p 70p 85p IDC 25 way Fig. 385p, Skt. 450p		EDGE CONNECTORS 2x18 way 210p 2x22 way 215p 2x23 way 175p 0.1" 2x25 way 285p 2x28 way 190p 2x30 way 310p 2x36 way 380p 2x40 way 380p 2x43 way 450p 2x75 way 650p	
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265	
1.03MHz	275
1.28MHz	450
1.5MHz	420
1.8MHz	545
1.8432M	230
2.0MHz	225
2.4576M	200
2.5MHz	225
2.5625M	220
3.2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	180
5.185MHz	300
5.24288M	190
6.0MHz	140
6.144MHz	140
6.5536MHz	200
7.0MHz	150
7.168MHz	200
7.68MHz	200
8.0MHz	150
8.08333M	395
8.867237M	175
9.00MHz	200
9.375MHz	350
10.0MHz	175
10.6MHz	200
10.7MHz	150
10.24MHz	200
12.0MHz	150
12.528MHz	300
14.31818M	170
14.745M	175
14.765MHz	250
15.0MHz	200
15.0MHz	200
16.0MHz	200
18.0MHz	180
18.432M	150
19.3638M	150
20.0MHz	260
24.0MHz	170
24.930MHz	325
29.695MHz	180
26.670MHz	325
27.125MHz	295
27.145M	190
27.848MHz	300
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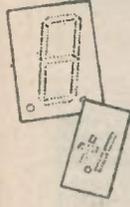
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748	30	ML529	1.80	4007	16	4046	60	LED CLIPS	3			tab	65	25A	2.10	PP3 Charger	3.50		3.50	Right Angle Plug 15W			1.80
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BANG GOES THE BOOM

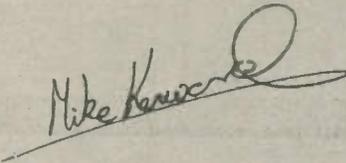
While the computer boom appears to be over and a price battle under way, interest in our computer projects is showing a steady increase. We believe that many thousands of computers have been bought by people with little real interest in them and virtually no idea of what to do with them apart from play games. It is likely that many good computers will appear on the secondhand market quite soon; that some of the manufacturers will go out of business or move out of the computer marketplace and that as many as half the software houses will disappear during the next year.

With such a down-turn in the industry why are our readers more interested in 'computer projects'? Our projects either add extra facilities, abilities or aid the understanding and testing of computer systems. It seems therefore that a significant number of hobby computer owners are what we might call serious users. They are interested in getting past the game playing, giving their computer a more educational role or putting it to use in control applications.

PE readers want to know how the system functions, how to interface it, how to control mains loads or how to provide mechanical ability. Many of you already have the ability to write software of a high standard, to blow your own EPROMS and connect your c.p.u. to other peripherals.

With all this in mind we have developed PE to meet your needs and we have planned some interesting projects and features for future months. They are not all directly aimed at computer buffs, indeed we will still be retaining our strong interest and involvement in all other areas, but items like switched mode power supplies, logic analysers and even sound effects units are all related to the wider area of computers these days.

For those that want more information on micro-computer systems, without perhaps wanting to buy a home computer or even to ever use one, we are planning an excellent introduction series for later in the year. We will also be widening our horizons and hopefully yours in the area of low cost educational robotics. While many readers have shown considerable interest in robotics, the relatively high initial outlay has been a stumbling block. We have been working on ways to overcome this and a series of educational ideas and designs, coming soon, is the result. We also have a mobile robot project designed to be developed in 'easy' stages which will soon be manoeuvring into our pages.



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Components are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Old Projects

We advise readers to check that all parts are still available before commencing any project in a back-dated issue, as we cannot guarantee the indefinite availability of components used.

Technical and editorial queries and letters to:
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We regret that lengthy technical enquiries cannot be answered over the telephone.

SECOND PROCESSOR

Cambridge Microprocessor Systems has developed a 'second processor' that will really open up the outside world for BBC micro owners. Via the tube interface the CMS 6502 2nd processor is programmed using BBC Basic (or using any other BBC language ROM) then disconnected from the machine to run as the 'hub' of a completely separate microprocessor system suitable for an unlimited range of control applications with a large analogue or digital I/O capability.

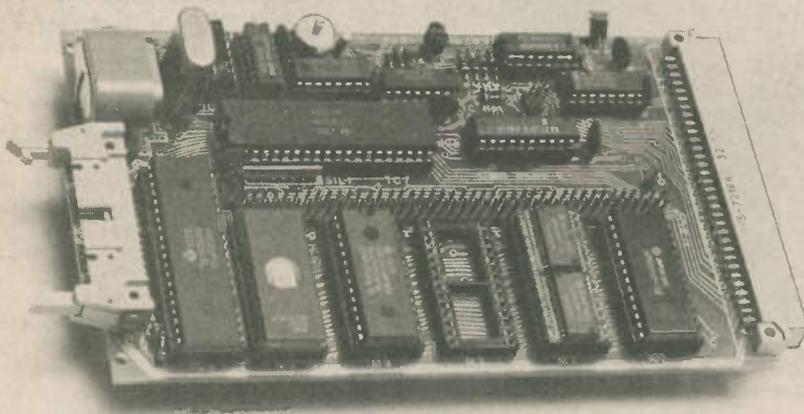
Feasibly such systems as intelligent alarms, machine control, experimental and domestic monitoring, etc. can be developed.

Relatively inexperienced programmers can write, develop and test application programs in BBC Basic and run them in the target environment before transferring the program to the 2nd processor's EPROM.

The real time calendar clock provides time of day, month, and year, interval timing and alarm facilities, and can also be configured as non-volatile battery backed-up RAM (8k). In the event of power failure,

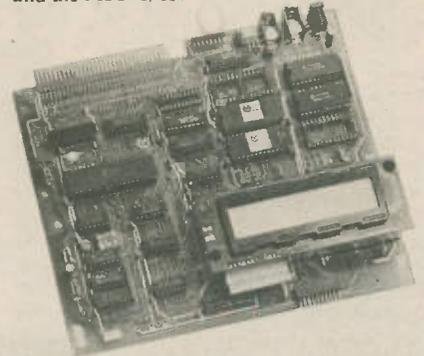
correct operation of the clock circuitry is maintained and the on-board battery is automatically recharged from the 5V power supply. PROM decoding allows the memory map to be re-defined.

The 64-way bus connector allows the user direct access to a comprehensive range of interface boards, all are Eurocard size (100mm x 160mm) and a complete racking system is available. The CMS 6502 costs £229 inc. VAT and the tube interface board £90 inc. VAT. Contact: Cambridge Microprocessor Systems, 44a Honson Street, Cambridge, CB1 1NL (0223 324141).



BYTE BY BYTE MICRO AID

Flight Electronics has a fine reputation in the field of microprocessor based learning aids, and has recently introduced two new products to their *microprofessor* range—the MPF-1/88 and the MPF-1/65.



The MPF-1/88 is a learning kit based on the Intel 8088 microprocessor, it teaches the 'fundamentals' of 16-bit microprocessing. The unique design approach enables the user to open the case and see the components, which aids hardware as well as software understanding. Three informative manuals are supplied ranging from an introduction for beginners to a complete specification.

The MPF-1/65 deals in a similar way with the 6502 microprocessor. Once again a comprehensive approach has been adopted and all aspects of hardware and software are dealt with. Both the Users Manual and the Monitor Program Source Listing Manual are written with both beginner and professional in mind.

These new products follow in the footsteps of their popular predecessors—the MPF-1B and the MPF-1 Plus, the subject of a review by M. Tooley in *PE* April 1984.

A catalogue containing more detailed information, full specifications and prices (including accessories) can be obtained free of charge from, Flight Electronics Ltd., Quayside Road, Bitterne Manor, Southampton SO2 4AD (0703 34003).



The Diamond Anvil

Take two diamonds, then squeeze them together with such incredible force so as to recreate the pressure levels at the centre of the earth. Using this method American scientists are reported to be close to a breakthrough in semiconductor technology.

Theoretically under these pressures (around 2.5 million atmospheres) hydrogen would be transformed into a metallic state that would be retained, even when normal conditions were resumed. Furthermore the resultant metal would possess superconductive

properties, enabling the conduction of electricity at the speed of light, without generating any heat caused by resistance.

Present technology can only employ the superconductive properties of metals by operating them at extremely low temperatures which is proving to be prohibitively expensive. The machine being used by the researchers at the Carnegie Institution of Washington has been nicknamed the 'diamond anvil'; so far it has managed to maintain the enormous pressures for forty consecutive days.

MARKET PLACE

VIDEO HEAD SWOP KIT

Whether it's *Star Wars* or *Raiders of the Lost Ark*, or even home-recorded re-runs, they all have one thing in common—slowly but surely they cause the video tape head to wear.

It is unlikely that most of us will adhere to the service industry's advice and replace our video heads 'every two or three years (or 1000hrs)'. It is likely, however, that sooner or later the job will have to be done. To have this work done professionally could cost over £100.

Monolith Electronics have an option for those of us who might like to do the job ourselves, in the form of a video head replacement kit. It is not an understatement to say that this kit is very comprehensive as the following list of inclusions will prove. The kit's storage box contains a novel head-concentricity gauge for the alignment of

Betamax heads to an accuracy of better than three hundredths of a millimetre, a stroboscopic tachometer disc which verifies the head speeds of VHS machines, a pair of handling gloves, a cross-head screwdriver, an anti-static cloth, 'cleaning fluid' and shaped spatulas, replacement service labels, and last but not least a mains soldering iron with solder.

A step-by-step instructions and stock list of available heads is also provided, and customers can make use of the telephone advisory service. The VMC-02 video head replacement and maintenance kit costs £22.45 inc VAT and p&p. The average cost of Monolith's replacement heads are—VHS £41 and Betamax £53, prices inc VAT. For further details contact, Monolith Electronics Co. Ltd., 5-7 Church Street, Crewkerne, Somerset (0460 743210).



LAST CHANCE FOR 11 YEARS

In these times of regular space travel most of us know what weightlessness 'looks' like having witnessed much television coverage of the Space Shuttle crews.

It is a little known fact, however, that once in every eleven years we can actually experience a level of weightlessness right here on earth.



At exactly 8.17 a.m. on Monday 1st April the planet Pluto will pass directly behind the planet Jupiter, bringing about a strong, albeit momentary, increase in the combined gravitational pull. At the precise moment when the planets are in exact spatial alignment, a sense of elation can be felt. Indeed jumping into the air at this exact moment will bring about a real sensation of weightlessness.

This phenomenon was originally discovered in 1899 when a Mr. Y. S. Dilloss made an incredible high jump of 3.47 metres, a record incidentally that has never been broken.

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.

The Northern Computer Show April 16-18. Belle Vue, Manchester. K2

British Electronics Week (includes: All Electronics, Circuit Technology & Fibre Optics) April 30-May 2. Olympia. E

IFSSEC (fire/security) April 15-19. Earls Court, London. S

Cast (Cable & Satellite) April 16-18. NEC, Birmingham. F5

Communications April 23-25. Olympia. I

Photoworld April 23-May 6. Earls Court. I

CAD April 26-28. Metropole, Brighton. K2

Fibre Optics & Lasers April 30-May 2. Olympia. E

Custom Electronics & Design Techniques April 30-May 2. E

All Electronics Show/ECIF April 30-May 2. Olympia 2. E

Field Service & Repairs April 30-May 2. Olympia 2. E

Automan (manufacturing) May. NEC. T1

IBM Computer User May 14-16. NEC B/ham. O

Business Telecom May 21-23. Barbican, London. O

A1 Institute Electronics ☎ 0706 43661

E Evan Steadman ☎ 0799 26699

F2 Pontefract Am. Rad. Soc. N. Whittingham ☎ 0977 792784

F5 ☎ 01-487 4397

I ITF ☎ 021-705 6707

K2 Reed Exhibitions, Surrey Ho., 1 Throwley Way, Sutton, Surrey

M Montbuild ☎ 01-486 1951

O Online ☎ 01-868 4466

S ☎ 01-387 5050

S2 Fairs & Exhibitions Ltd., ☎ 01-831 8981

T1 Cahners ☎ 0483 38085

Power Control Interface

R.A. PENFOLD

SIMPLE on/off control using a computer is a relatively straightforward affair with a digital output being used to control the load by way of a relay, triac, or other power switching device. Proportional power control, where intermediate power levels as well as on and off are required, represents a more difficult proposition, especially where a mains powered load is concerned. The high voltages involved with the mains supply do not in themselves represent a real difficulty since high voltage semiconductor control devices are readily available at quite reasonable prices. However, proper isolation of the computer from the mains supply is an important factor and one which must be adequately taken care of. This is not just to ensure that the computer comes to no harm, but is also necessary to safeguard the user against an electric shock.

face was designed. The interface is ideal for use in a high quality computer based thermostat.

Normally thermostats use simple on/off switching of the heating element, but with a proportional set up, a more sophisticated approach is possible, with the heat from the element being adjusted to match the heat loss from the system. This gives better stabilisation than is possible using a simple on/off thermostat.

SYSTEM OPERATION

The block diagram of Fig. 1 shows the arrangement used in the power controller.

A digital to analogue converter is fed from an 8-bit latching output of a computer. Several home computers, including the BBC model B, VIC-20, Commodore 64, and

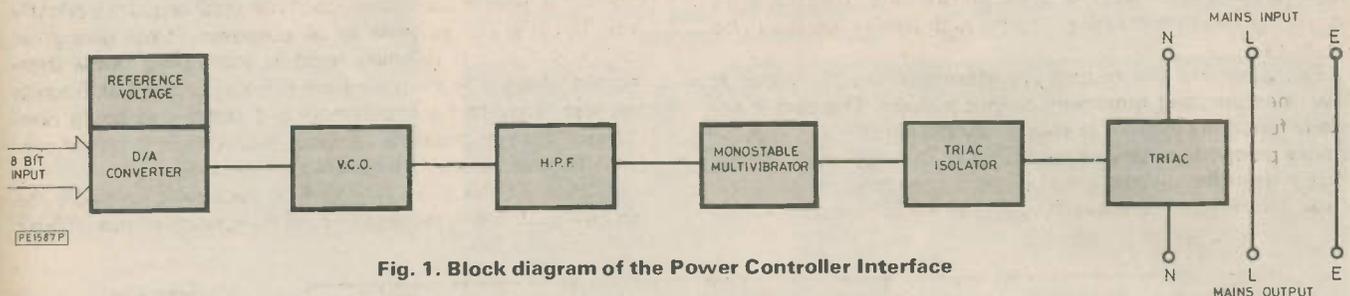


Fig. 1. Block diagram of the Power Controller Interface

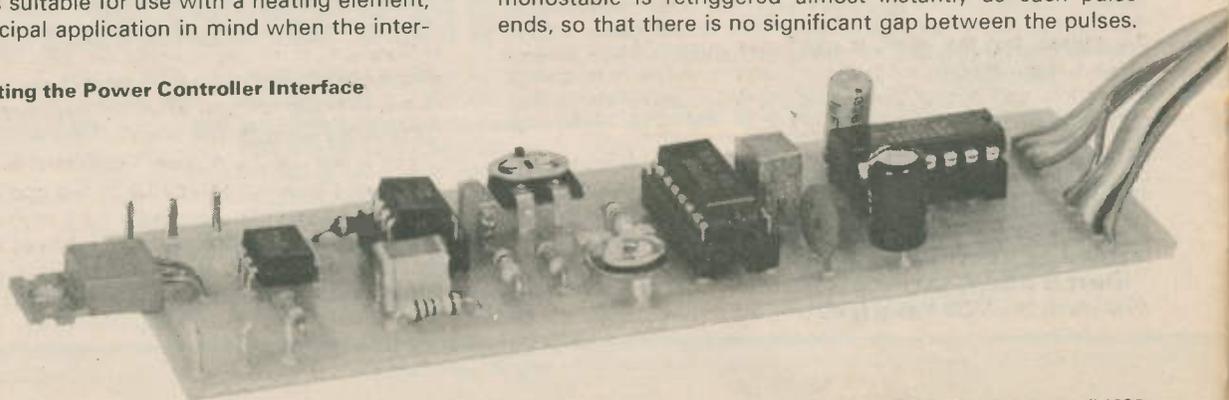
POWER CONTROL

The power controller circuit described here gives proportional control over a mains load, and with the specified triac which has a current rating of 10 amps (provided suitable heatsinking is used) the unit can handle loads of up to about 2 kilowatts or so. A triac-isolator (a form of opto-isolator device) ensures that the connections to the computer are properly isolated from the mains supply. As the unit is digitally controlled it does not give an infinite number of output power levels, but the use of an 8 bit input gives some 256 different power levels (including zero and maximum), and this should be more than adequate for the vast majority of practical applications. The simple method of power control used in the unit does preclude its use with some type of equipment, but it is suitable for use with a heating element, which was the principal application in mind when the inter-

Memotech MTX500 have a user port which provides a suitable output. For use with some machines, such as the Sinclair Spectrum and ZX81, the unit would have to be driven via an add-on parallel port. The converter requires a precision reference voltage, and in this case the built-in 2.55 volt reference source of the converter chip is used.

The 0 to 2.55 volt output of the digital to analogue converter is used as the control voltage for a VCO. The latter has an output frequency that is roughly proportional to the control voltage, with no output when the control voltage is zero. The squarewave output of the VCO is processed by a simple highpass filter circuit to give a series of brief positive and negative pulses. The negative pulses trigger a monostable multivibrator. With maximum control voltage to the VCO the monostable is retriggered almost instantly as each pulse ends, so that there is no significant gap between the pulses.

Photograph illustrating the Power Controller Interface



Lower control voltages and frequencies give greater gaps between pulses, and with zero control voltage the monostable is not triggered at all.

TRIAC ISOLATOR

The positive output pulses from the monostable multivibrator operate a triac-isolator. This is similar to a conventional opto-isolator where an infra-red light emitting diode drives a phototransistor, but the phototransistor is replaced by a triac. The gate terminal of the triac is not externally accessible though. When the l.e.d. is not activated and the triac is in darkness, the device is switched off and passes only small leakage currents. If the l.e.d. is provided with a suitably high current it produces sufficient "light" output to cause large leakage currents to flow in the triac. These currents produce a regenerative action that cause the device to conduct strongly, just as if it had been switched on in the normal way by a gate current. The triac remains in conduction for as long as the l.e.d. is activated, and like an ordinary triac, it will also remain in conduction until the current flow between the MT1 and MT2 terminals falls to a very low level (usually just a few milliamps).

The triac section of the triac-isolator has a current rating of only 100 milliamps, which represents just 24 watts with the 240 volt a.c. mains supply. This is obviously not sufficient for most power controller applications, but it is very easy to use the isolator to drive an ordinary triac having a much higher current rating so that high power loads can be controlled.

Fig. 2. shows the output waveforms of the controller at low, medium, and maximum output powers. The circuit actually functions in what is essentially the same way as an ordinary pulsed type power controller of the type that is commonly used for the control of small d.c. electric motors. The output waveform consists of bursts of a.c. signal rather than

that the mains signal is chopped up into bursts of several half cycles. It will not give the desired result if a higher VCO frequency is used, since the circuit can not chop up each half mains half cycle. This would not work because of the hold-on characteristic of a triac, which causes it to remain in conduction until the current flow through the device falls to a low level. Once switched on the triac must therefore remain in conduction until virtually the end of each mains half cycle.

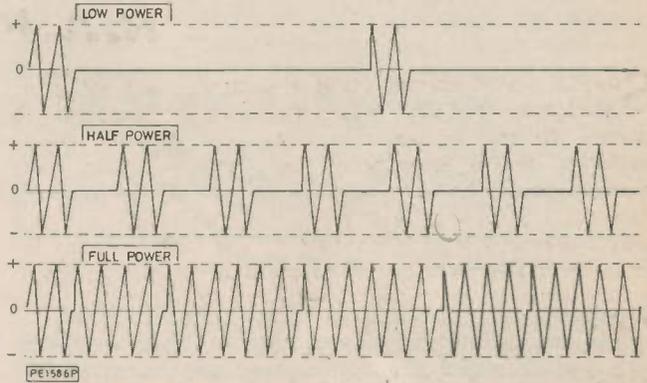


Fig. 2. Output waveforms at various power levels

In most practical power controller applications the simple method of power control adopted here will operate perfectly well, but it is not suitable for all purposes. It will give good results if the unit is being used in something like a thermostat where a heating element is being controlled. Results are less likely to be satisfactory if a lamp was being controlled, since at medium and low powers there would certainly be very noticeable flickering of the lamp.

As is often the case, it would be possible to simplify the hardware at the expense of more complicated and difficult

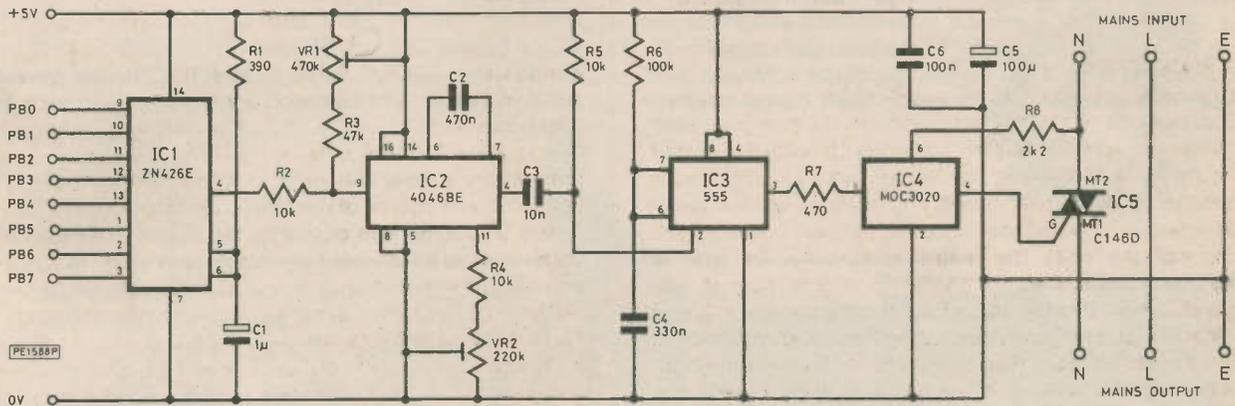


Fig. 3. The complete circuit diagram of the Power Controller Interface

d.c. pulses, but the effect is much the same. At low output powers there is no output for the majority of the time, giving a low average output power. At medium power levels the power is switched on for about half the time, giving an average output power of about 50 per cent. At maximum output the current is switched on for virtually all the time. There are actually brief gaps in the signal, but these are too small to significantly reduce the output power, and for most practical purposes can be ignored.

There is a limitation to this system in that it can only work properly if the VCO has a fairly low maximum frequency so

software. In this case it would be quite feasible to drive the triac isolator from a digital output of the computer, with the software being used to generate an output signal of suitable frequency and mark-space ratio.

For those who are more interested in hardware than in software the adopted approach has the obvious attraction of requiring very simple driving software with only one value to be written to the appropriate address in order to set the required output power. The alternative approach outlined above would make an interesting project for someone who is software orientated.

CIRCUIT OPERATION

The circuit is reasonably simple, as can be seen by referring to the circuit diagram which appears in Fig. 3.

IC1 is the digital to analogue converter, and this is a Ferranti ZN426E low current consumption type. This is a conventional converter having an R-2R resistor network and a bank of eight electronic switches. The integral 2.55 volt reference source requires load resistor R1 and decoupling capacitor C1. These are the only discrete components needed by the ZN426E.

The VCO is the oscillator section of a CMOS 4046BE low power phase locked loop (IC2). The phase comparators and other sections of IC2 are not used in this circuit. C2, R4, and VR2 are the timing components for the oscillator. R2 couples the output of the digital to analogue converter to the control input of IC2, and VR1 with R3 are used to give a small positive bias to the control input. Without this bias all values from about 0 to 50 would give zero output from the VCO, and therefore from the controller as well. With the correct bias added the circuit gives greatly improved results with low values giving low output powers.

TIMING

The monostable multivibrator uses a 555 timer device, IC3 in the standard 555 monostable configuration. R6 and C4 are the timing components for the monostable, and these set the output pulse duration at approximately 50 milliseconds. IC3 is triggered by taking pin 2 to less than one third of the supply voltage. However, the trigger pulses must be very brief as the monostable is a retriggerable type, and long trigger pulses could result in the output pulses being extended.

R5 is used to bias the trigger input of IC3 to the positive supply rail, and C3 couples the output signal of IC2 to this input. IC2 has a squarewave output signal, but the highpass filtering provided by C3 and R5 modifies this to a short positive pulse on each rising edge of the squarewave, and a brief negative pulse on each trailing edge. These negative pulses provide a suitable trigger signal for IC3.

IC3 has more than adequate current drive to operate the l.e.d. in the triac-isolator, and R7 is in fact needed to provide current limiting here. The triac section of the isolator is used to trigger the main triac via R8 which limits the gate current to a safe level.

CONSTRUCTION

The component layout and full-size track pattern for the printed circuit board are shown in Fig. 4. Construction of the board does not present any real difficulties, but as the mains supply is involved it is obviously essential to take great care to avoid errors, and to thoroughly check the finished board.

If desired the interface could be constructed as a self contained unit with the board fitted in a case with a multiway input socket and a mains outlet for the controlled equipment. Alternatively, it could be built into a larger system. This is something that must be varied to suit individual requirements. In either case the triac will need a heatsink if it is to control currents of more than about two amps, and for high currents of around six to eight amps a substantial heatsink (about 2.5°C per watt or better) with adequate ventilation would be needed. Bear in mind that the heat-tab of the triac connects to the MT2 terminal, and that the heatsink will therefore be connected to the mains supply unless it is properly insulated from the triac.

DRIVING THE UNIT

For use with the VIC-20, Commodore 64, and BBC model B computers the 8-bit input of the interface is fed from the eight data lines of the user port (PB0 to PB7). The 0V and 5V lines of the port are also connected to the interface. The two Commodore machines require a 2 by 12 way, 0.156 inch pitch edge connector, and as you are unlikely to be able to obtain a connector which has the appropriate polarising key, care must be taken to fit it to the computer the right way round. It is advisable to clearly label the top and bottom edges of the connector so that mistakes are avoided. Connections to the user port of the BBC model B computer are made by way of a 20 way IDC header socket. Connection details for the user ports of all three computers are provided in the relevant manuals.

Before data can be written to the interface the lines of the user port must be set as outputs. This is achieved by writing 255 to the appropriate address, as detailed below:—

?&FE62=255 (BBC model B)

POKE 37138,255 (VIC-20)

POKE 56579,255 (CBM 64)

Data is then written to address &FE60 in the case of the BBC model B, 37136 for the VIC-20, and 56577 for the CBM 64.

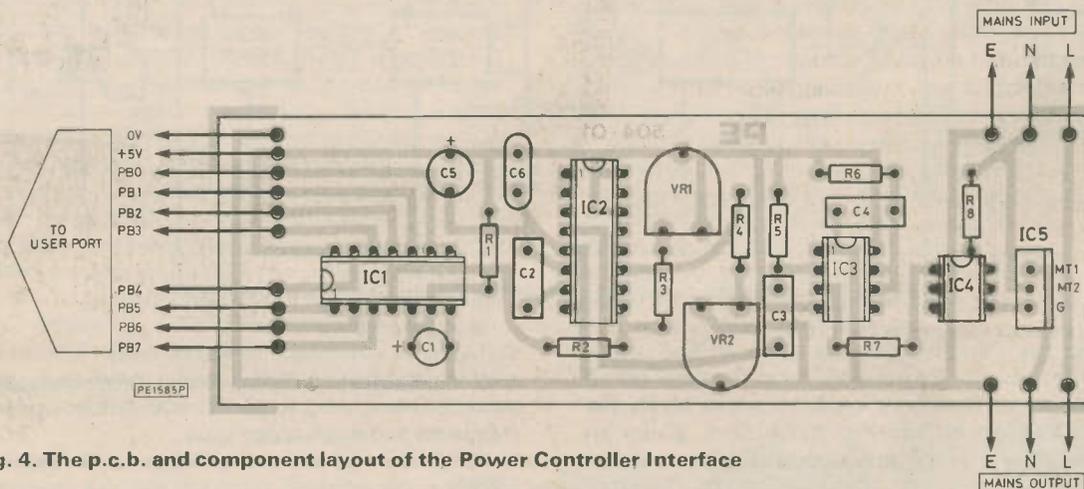


Fig. 4. The p.c.b. and component layout of the Power Controller Interface

The circuit requires a single 5 volt supply and has a current consumption of about 30 milliamps or so. The user or expansion port of most computers is capable of supplying this.

The connections to the user port of the Memotech MTX-500/512 computers (the 20 pin d.i.l. i.c. socket on the printed circuit board) are made via a d.i.p. plug. Rather than PB0 to PB7 lines POT0 to POT7 are used. These do not

COMPONENTS . . .

Resistors

R1	390
R2,R4,R5	10k (3 off)
R3	47k
R6	100k
R7	470
R8	2k2

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

Potentiometers

VR1	470k 0.1W horizontal preset
VR2	220k 0.1W horizontal preset

Capacitors

C1	1 μ 63V radial elect
C2	470n carbonate
C3	10n carbonate
C4	330n carbonate
C5	100 μ 10V radial elect
C6	100n ceramic

Semiconductors

IC1	ZN426E D to A converter
IC2	4046BE phase locked loop i.c.
IC3	NE555 timer i.c.

IC4
IC5

MOC3020 Triac-Isolator
C146D (400V 10A) or similar Triac

Miscellaneous

Printed circuit board (PE 504-01)
Heatsink (see text)
Computer connector and cable
16 pin d.i.l. i.c. holder
14 pin d.i.l. i.c. holder
8 pin d.i.l. i.c. holder
Veropins, wire, etc.

require any setting up software to set them as outputs, but the OTSTB line must be linked to the OV line in order to take the outputs into the active state. Data for the interface is sent from BASIC using the OUT instruction, and the user port is at address 7.

ADJUSTMENT

When setting up the interface ready for use it does not need to be connected to the mains supply, and in the interest of safety it is probably best not to do so. Write a value of 0 to the interface, and then adjust VR1 for the lowest resistance that does not produce oscillation from IC2 (i.e. set it as far in an anticlockwise direction as possible without

oscillation occurring). An oscilloscope, audio amplifier, or a crystal earphone can be used to detect the output pulses at pin 4 of IC2.

Next write 255 to the interface, and use a multimeter set to a low voltage range (about 5 or 10 volts f.s.d.) to monitor the output voltage at pin 3 of IC3. With VR2 set fully clockwise there should be only a fairly low voltage present, but adjusting VR2 in an anticlockwise direction should result in the voltage rising. Adjusting VR2 too far will cause the voltage to suddenly drop to about half its peak level. VR2 should then be backed off slightly to reinstate the peak reading. After repeating this procedure a couple of times the unit is ready for use. ★

FULL FEATURE MODEM KIT

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- * Full and Half Duplex – one or two-way simultaneous transmission.
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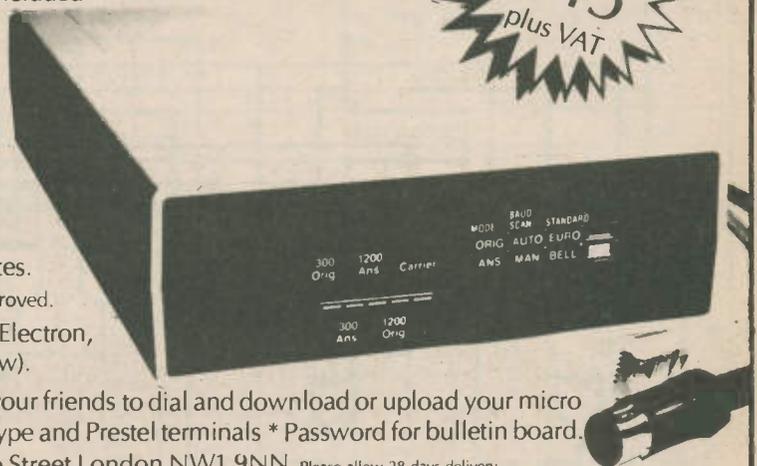
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Sequential Logic Techniques Part 7

M. TOOLEY BA and D. WHITFIELD MA MSc CEng MIEE

WE conclude our series on **Sequential Logic Techniques** with a brief look at binary full-adders. This topic was first introduced in our earlier series (Introduction to Digital Electronics) which described the characteristics and basic gate arrangements of both half and full-adders. As with most popular gate arrangements,

the TTL chip designer has come to our aid with d.i.l. packaged devices which provide the complete function of a full-adder. We shall examine one such device which can be readily cascaded to cope with binary words of any desired length.

THE 74283 BINARY FULL-ADDER

The 74283 is a high speed 4-bit binary full-adder with internal carry 'look-ahead', the pin connections and internal logic of which are respectively shown in Figs. 7.1 and 7.2.

The 74283 accepts two 4-bit binary words (A1 to A4 and B1 to B4) and a carry input (Cin). The sum of the two 4-bit words is combined with the carry input and presented as four sum outputs ($\Sigma 1$ to $\Sigma 4$) and a carry output (Cout). This arrangement permits

cascading of the device.

We shall begin our investigation of the 74283 with the simple full-adder shown in Fig. 7.3. This arrangement uses only three inputs; A1, B1 and Cin. The 'sum' output appears as $\Sigma 1$ whilst the 'carry' output appears as $\Sigma 2$.

The 74283 should be inserted into socket E of the Logic Tutor (taking care to align pin-1 with E1) and the following links should then be made:

- E1 to D3 (D3 shows the state of $\Sigma 1$)
 - E4 to D4 (D4 shows the state of $\Sigma 2$)
 - E5 to S1 (A1 input)
 - E6 to S2 (B1 input)
 - E7 to S3 (carry input)
 - E8 to OV (common)
 - E16 to +5V (supply)
- (a total of 7 links)

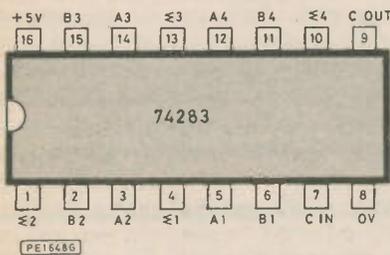


Fig. 7.1. Pin connections for the 74283

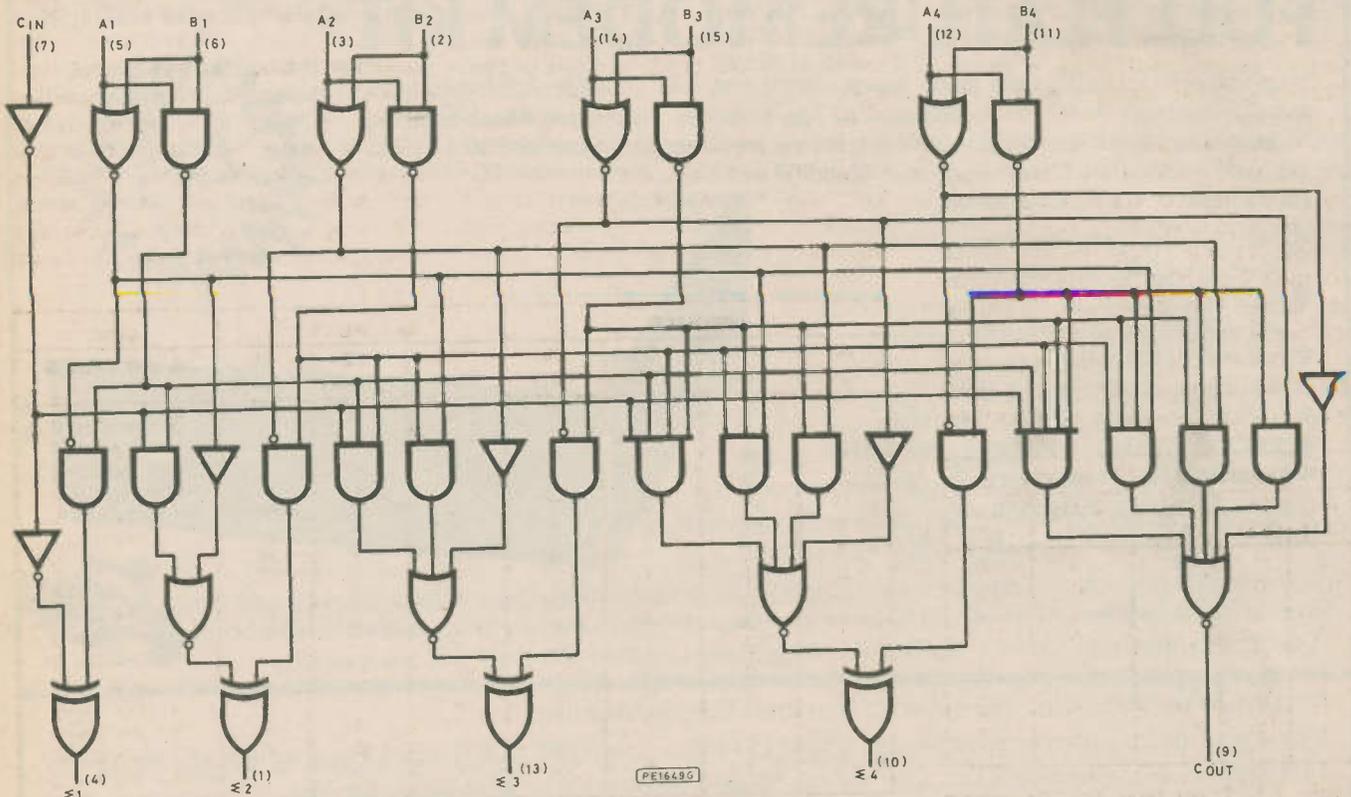


Fig. 7.2. Internal logic of the 74283

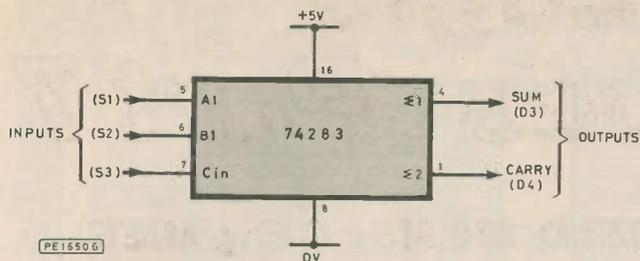


Fig. 7.3. Simple full-adder arrangement using the 74283

Logic Tutor switches S1, S2 and S3 should all be initially adjusted to produce logic 0 inputs on A1, B1 and Cin. In this condition D3 and D4 should both be extinguished showing that the 'sum' and 'carry' outputs are both at logic 0. Now depress, and hold down, momentary action switch, S1. This produces a logic 1 at the A1 input. D4 will then become illuminated whilst D3 should remain extinguished showing that the 'sum' is 1 whilst the 'carry' is 0.

S1 should now be released and S2 held down to produce logic 0 and logic 1 on the A1 and B1 inputs respectively. This should again produce 'sum' and 'carry' outputs of 1 and 0 respectively.

S2 should now be released whilst latching action switch S3 should be depressed. This produces a logic 1 on the carry input whilst the A1 and B1 inputs remain at logic 0. D4 will become illuminated whilst D3 should remain extinguished, again indicating 'sum' and 'carry' outputs of 1 and 0 respectively.

S3 should now be depressed a second time so that the carry input reverts to logic 0. S1 and S2 should now be held down to produce logic 1 on both A1 and B1. D4 should become extinguished whilst D3 should become illuminated. This shows a 'sum' output of 0 and a 'carry' output of 1.

S3 should now be depressed a third time in order to produce a logic 1 carry input. Now depress first S1 and then

INPUTS			OUTPUTS	
A1 (S1)	B1 (S2)	Cin (S3)	Carry (Σ2)	Sum (Σ1)
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Table 7.1. Truth table for the simple full-adder of Fig. 7.3

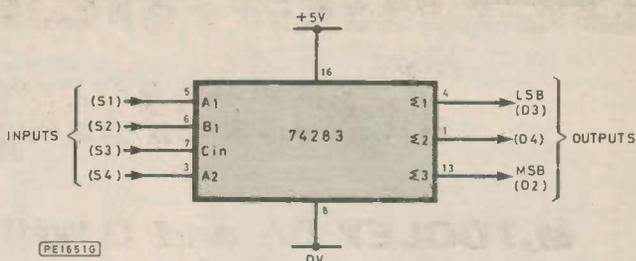


Fig. 7.4. A full-adder arrangement using all four logic Tutor switches as inputs

S2. Notice that both of these input conditions result in a 'sum' output of 0 and a 'carry' output of 1.

Finally, hold down both S1 and S2 to produce a logic 1 on all three inputs, A1, B1 and Cin. In this condition D3 and D4 will both be illuminated indicating that both the 'sum' and 'carry' outputs have become logic 1. The results of the investigation are summarised in Table 7.1.

Having shown how the 74283 can be used as a simple full-adder let's extend the arrangement to provide a fourth input derived from the remaining unused Logic Tutor switch, S4. Make the following extra connections:

- E3 to S4 (A2 input)
- E13 to D2 (D2 shows the state of Σ3)

This modified arrangement is shown in Fig. 7.4, and uses Σ1 and Σ3 to respectively denote the least (LSB) and the most (MSB) significant bits of the sum.

All four Logic Tutor switches should initially be adjusted for logic 0 inputs. D2 and D4 will be extinguished but D3 will have become illuminated to indicate a result of '010'. Clearly we must have forgotten something!

Unused inputs of TTL devices normally float 'high' thus, with the B1 input left unconnected, the B1 input receives a logic 1. We shall therefore need to 'hard-wire' this input to logic 0 using the following additional link: E2 to logic 0

All three output indicators should now be extinguished showing that the sum is '000'. Readers should experiment with all possible input combinations (there are sixteen of them!) and confirm that the arrangement conforms to the truth table that is shown in Table 7.2. It should be noted that the A2 and A1 inputs are the MSB and LSB of the two-bit number generated by S4 and S1 respectively, and that the remaining switches, S2 and S3, generate single bit inputs. For clarity, the equivalent decimal sum is also shown in the truth table with the leftmost digit corresponding to the two-bit A input.

A SIMPLE ADDING MACHINE

We shall conclude with an extension of the previous arrangement which forms a simple 'adding machine' and incorporates several of the techniques and devices introduced in the series. This simple arrangement accepts a 4 binary input (derived from the Logic

INPUTS				OUTPUTS			SUM
A2 (S4)	A1 (S1)	B1 (S2)	Cin (S3)	Σ3 (D2)	Σ2 (D4)	Σ1 (D3)	A + B + C = S
0	0	0	0	0	0	0	0 + 0 + 0 = 0
0	0	0	1	0	0	1	0 + 0 + 1 = 1
0	0	1	0	0	0	1	0 + 1 + 0 = 1
0	0	1	1	0	1	0	0 + 1 + 1 = 2
0	1	0	0	0	0	1	1 + 0 + 0 = 1
0	1	0	1	0	1	0	1 + 0 + 1 = 2
0	1	1	0	0	1	0	1 + 1 + 0 = 2
0	1	1	1	0	1	1	1 + 1 + 1 = 3
1	0	0	0	0	1	0	2 + 0 + 0 = 2
1	0	0	1	0	1	1	2 + 0 + 1 = 3
1	0	1	0	0	1	1	2 + 1 + 0 = 3
1	0	1	1	1	0	0	2 + 1 + 1 = 4
1	1	0	0	0	1	1	3 + 0 + 0 = 3
1	1	0	1	1	0	0	3 + 0 + 1 = 4
1	1	1	0	1	0	0	3 + 1 + 0 = 4
1	1	1	1	1	0	1	3 + 1 + 1 = 5

Table 7.2. Truth table for the arrangement shown in Fig. 7.4

SEQUENTIAL LOGIC

Tutor switches) and displays the resulting sum on a seven segment i.e.d. display.

The circuit of the 'adding machine' is shown in Fig. 7.5. The binary output from the 74283 adder, IC1, is fed to a 7447 seven segment decoder, IC2. Since only three bits are used, the fourth input to the 7447 must be wired to logic 0. The seven active low outputs of IC2 are connected to the display by means of a series resistor network comprising seven 150 ohm resistors contained within a single d.i.l. package. Where readers have difficulty in obtaining such a device, seven discrete 0.25W 150 ohm resistors may be substituted. These should be connected from B1 to B16, B2 to B15, B3 to B14, and so on, ending with B7 to B10. The pin-outs and characteristics of the 7447 and seven segment d.i.l. indicator were described in Parts One and Two and thus will not be repeated here.

The 74283 should be left in socket E of the Logic Tutor and the remaining devices inserted as follows: the 7447 in socket A, the 150 ohm d.i.l. resistor network in socket B, and the seven segment common anode i.e.d. indicator in socket C. The usual convention for connecting these devices should be observed.

The following links are required:

A1 to E1
A2 to E13
A6 to logic 0
A7 to E4

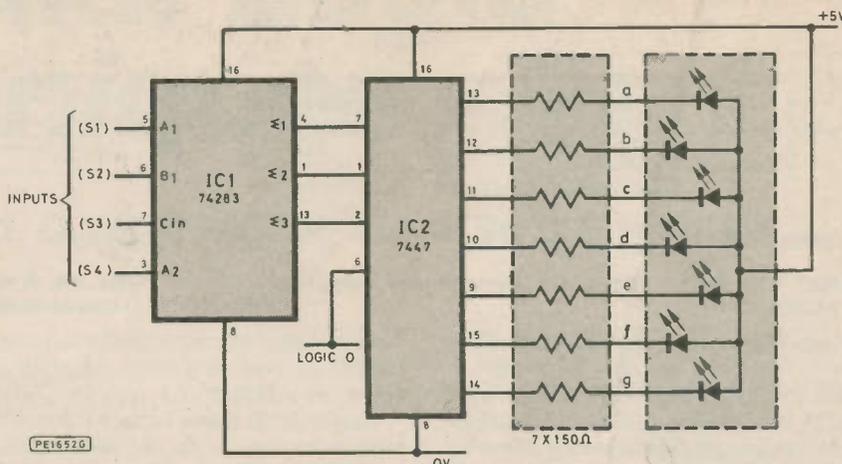


Fig. 7.5. The simple adding machine

A8 to 0V	(common)	E3 to S4
A9 to B5		E5 to S1
A10 to B4		E6 to S2
A11 to B3		E7 to S3
A12 to B2		E8 to 0V
A13 to B1		E16 to +5V
A14 to B7		
A15 to B6		
A16 to +5V	(supply)	

(A total of 28 links)

B10 to C13
B11 to C2
B12 to C7
B13 to C10
B14 to C12
B15 to C15
B16 to C1

C16 to +5V (common anode supply)

E2 to logic 0

Readers should confirm that the 'adding machine' produces a decimal indication of the sum of the two-bit number generated by switches S4 and S1, and the two one-bit numbers generated by switches S2 and S3.

This concludes our series on Sequential Logic Techniques. Readers wishing to progress further will, no doubt, be interested to learn that we shall be returning in the autumn with a new series designed to provide an introduction to microprocessor systems.★

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DISC DRIVE PSU

J.R.W. BARNES BSC

THE advantages of using a disc drive over a cassette recorder have been covered in great depth elsewhere and are well known. To obtain full benefit from the BBC computer a disc drive is essential. The cheapest, and the most popular solution is to add a single drive and power this from the computer's internal power supply. Whilst this arrangement is satisfactory under most circumstances, the addition of a second drive and/or a large number of sideways ROMs may result in the power supply being overloaded.

The unit described here is intended to provide the power for the extra disc drive. There is nothing particularly special about the power supply and constructors may find other uses for it. The prototype was made as a stand-alone unit but it may also be built inside a suitable disc drive housing.

REQUIREMENTS

The majority of disc drives require two power supply voltages, five volts for the logic integrated circuits and 12 volts for the various motors. The load on the five volt output is reasonably constant but, the load on the 12 volt output varies considerably depending whether the drive is idle or running. The output current required will also vary depending on the make and vintage of the drives. According to the label on the bottom of the BBC micro, 1.25A is available for the operation of external equipment. So as to allow a margin of safety this unit has been designed to provide 2A at each output.

Provision has been made so that the current limit can be reduced by changing the value of a resistor. The output voltages are variable by 10% either side of their nominal value.

CIRCUIT DESCRIPTION

The complete circuit diagram of the unit is shown in Fig. 1. The circuit can be split into two sections, the five volt output and the 12 volt output. These two sections are very similar in their mode of operation but there are some important differences.

Regular readers of PE will be surprised by the absence of three terminal regulator integrated circuits. While these can be used to provide simple regulated power supplies, those with high output current capability are relatively expensive and only the very expensive ones have facilities for being able to adjust the output voltage and current limit setting. The discrete arrangement as used here tends to offer better thermal stability. The reason for this, is that the series pass

transistor dissipates a large amount of power raising the chip's temperature. In this discrete design the voltage reference and the pass transistor are in thermal isolation.

CIRCUIT OPERATION

The control circuits used in both outputs are examples of classic feedback systems. The differences arise because in the five volt case, the required output voltage is less than the reference voltage, and in the 12 volt case the output is greater than the reference. Both regulators are based on the LM723 i.c.

The mains transformer, T1 has two output windings; a nine volt winding for the five volt supply and a 16 volt winding for the 12 volt output. The two bridge rectifiers, D1-D4 and D5-D8 convert the a.c. to d.c., and smoothing is provided by C1 and C2.

Consider the 12 volt output first. TR1 and TR2 are connected in the Darlington configuration and are used as an emitter follower. An emitter follower provides current gain only, i.e. the output voltage is the same as the input voltage minus ($2 \times V_{be}$). This is used to boost the output capability of the control i.c. Resistors R4 and R5 together with the preset potentiometer VR2 form a voltage divider and feed a percentage of the output voltage to the inverting input of the error amplifier.

VR2 allows the output voltage of the power supply to be adjusted to cope with small variations in the reference voltage. The non-inverting input is connected to the voltage reference output of IC1. This configuration provides negative feedback resulting in the output of the power supply being held constant for varying load conditions. The capacitor C3 provides frequency compensation for the error amplifier.

SHORT CIRCUIT PROTECTION

A constant current type of short circuit protection is implemented. R6 is used as a shunt to sense the output current. When the voltage across this resistor equals 0.7 volts the control i.c. reduces its output voltage to keep the current constant. Since $V = IR$ it is possible to select the maximum current by a suitable choice of R6.

$$R6 = 0.7 / I_{\text{output max}}$$

In the prototype the maximum output current was set to 3A. As with all linear regulators, short circuiting the output will cause the dissipation in the series pass transistor to rise. This will lead to the junction temperature of the transistor rising

COMPUTING PROJECT

and may lead to its eventual destruction. Whilst the power supply will withstand short term overloads it is not recommended that power supply is shorted for long periods.

Operation of the five volt output is very similar. The power supply for the control i.c. is derived from C1, this enables the five volt output to operate with a lower input to output voltage difference and leads to higher efficiency.

Constructors' note:—

T1—Mains transformer 9 volt and 16 volt secondaries on 50 V/A Core. (Available from **Samsons Electronics Ltd., 9-10 Chapel Street, Marylebone Road, London NW1.** Note that this transformer has been specially designed.

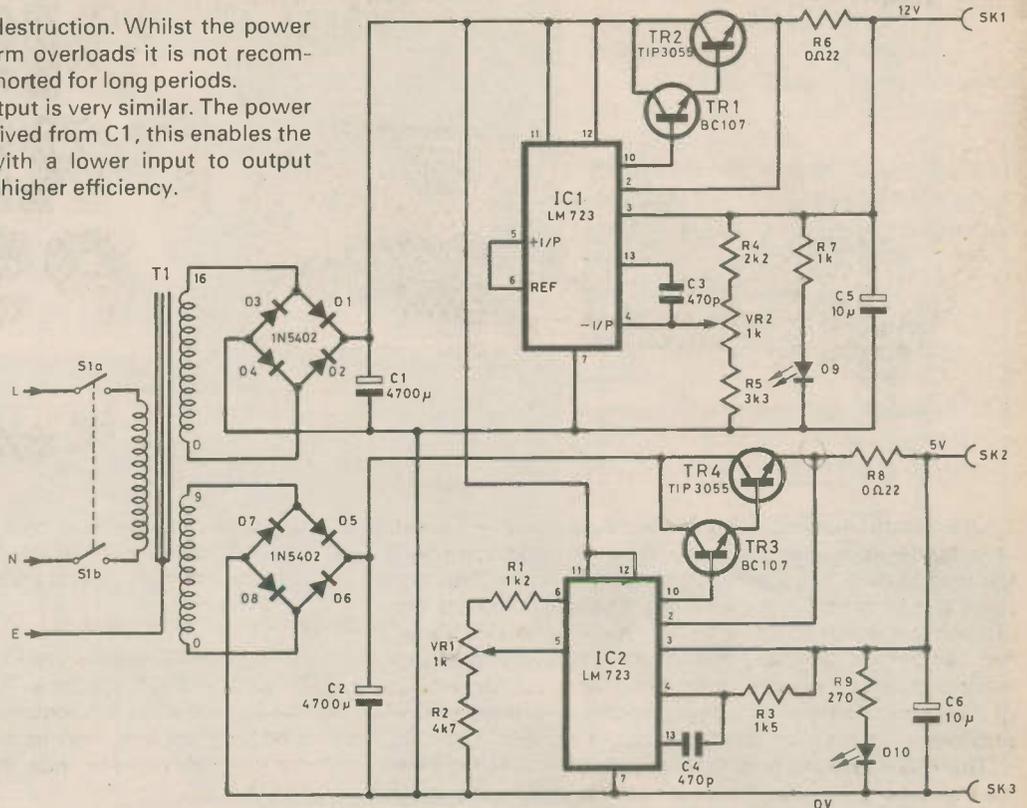


Fig. 1. The complete circuit diagram of the Disc Drive PSU

Because the desired output voltage is lower than the voltage reference a different configuration is employed. R1, R2 and VR1 act as a voltage divider on the reference voltage, the output of which is fed to the non-inverting input of the error amplifier. VR1 allows fine adjustment of the five volt output. The output voltage of the power supply is fed

back via R3 to the inverting input of the error amplifier. The output of the control i.c. is boosted by the Darlington consisting of TR3 and TR4.

Current limiting is provided by R9 in an identical way to the 12 volt output, and the two l.e.d.s and their limiting resistors give an indication that the outputs are on.

COMPONENTS...

Resistors

R1	1k2
R2	4k7
R3	1k5
R4	2k2
R5	3k3
R6,R8	0.22 3 watt WW(2 off)
R7	1K 0.5 watt carbon
R9	270 0.5 watt carbon
All resistors $\frac{1}{2}$ W \pm 5% unless stated otherwise	

Potentiometers

VR1, VR2	1k sub. min. pre-set pot. (2 off)
----------	-----------------------------------

Capacitors

C1,C2	4700µ 25 volt elect. axial (2 off)
C3,C4	470p disc ceramic (2 off)
C5,C6	10µ 25 volt elect. radial (2 off)

Semiconductors

D1-D8	IN5402 (8 off)
D9-D10	0.2 inch l.e.d.s with panel mounting clips (2 off)
TR1,TR3	BC107 silicon npn (2 off)
TR2,TR4	TIP3055 silicon npn plastic power transistors (2 off)
IC1,IC2	LM723 voltage regulator i.c.s (2 off)

Miscellaneous

S1	d.p.s.t. rotary mains switch
SK1-SK3	Binding posts colour to suit (3 off)
T1	Transformer, 9V and 16V secondaries
Verobox	
P.c.b.	PE 504-02
Knob for S1	
Heatsink	
Fixing screws	
Captive grommet	
Connecting wire	
Insulating kits for TR2, TR4	(2 off)

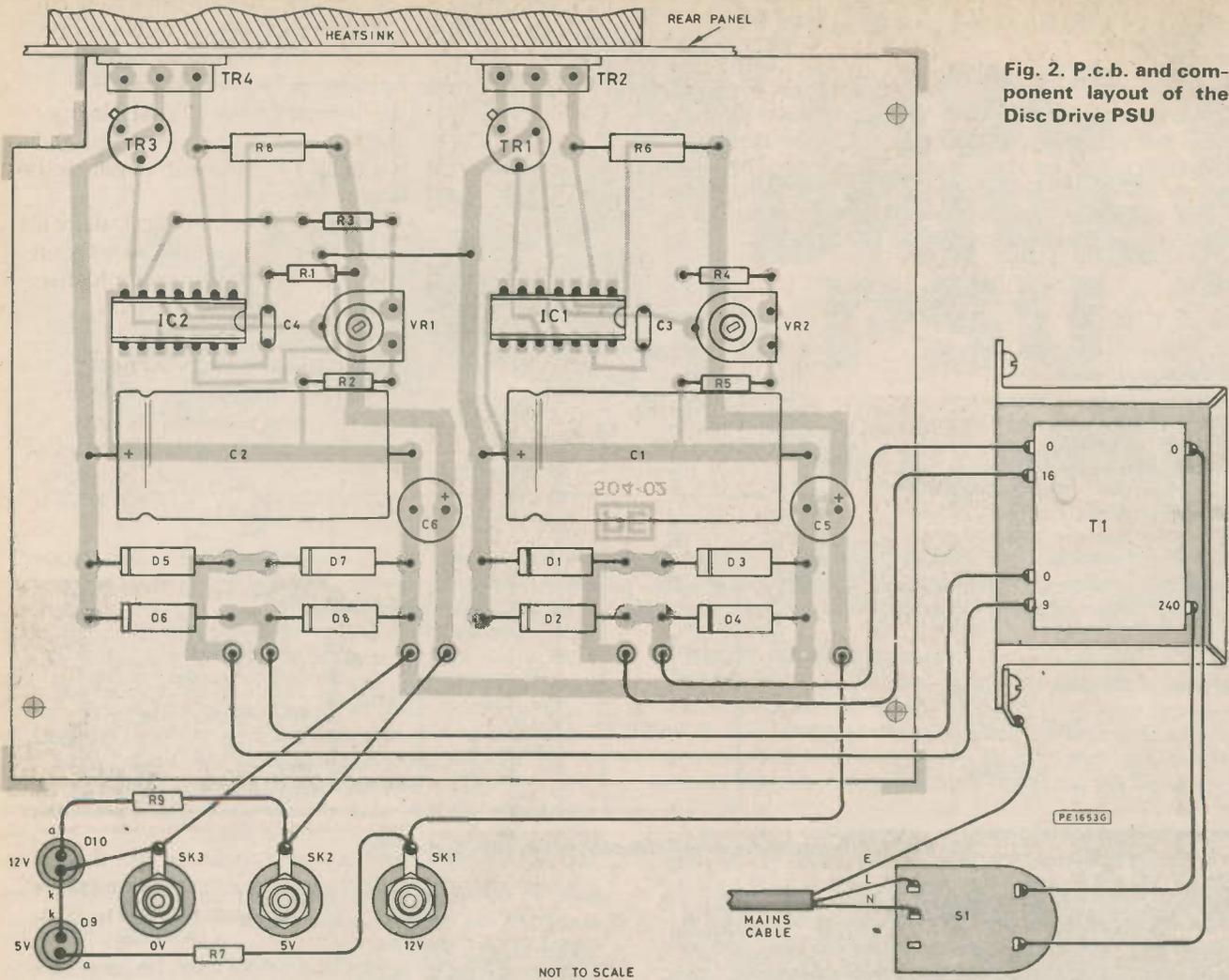


Fig. 2. P.c.b. and component layout of the Disc Drive PSU

CONSTRUCTION

With the exception of the mains transformer all the components are mounted on a single p.c.b. and front panel. The printed circuit board track layout is shown in Fig. 2. The design can be transferred to the circuit board by any of the usual methods and subsequently etched and drilled.

To allow some of the components to be mounted some of the holes may need to be enlarged. The normal practice of constructing circuit boards should be followed. The Veropins if used should be fitted first, then the wire links and the smaller components. It will assist if the bulky electrolytic capacitors are left till last. Care should be taken to ensure that all the polarised components such as capacitors and diodes are correctly orientated. Constructors are advised to use sockets for the two i.c.s.

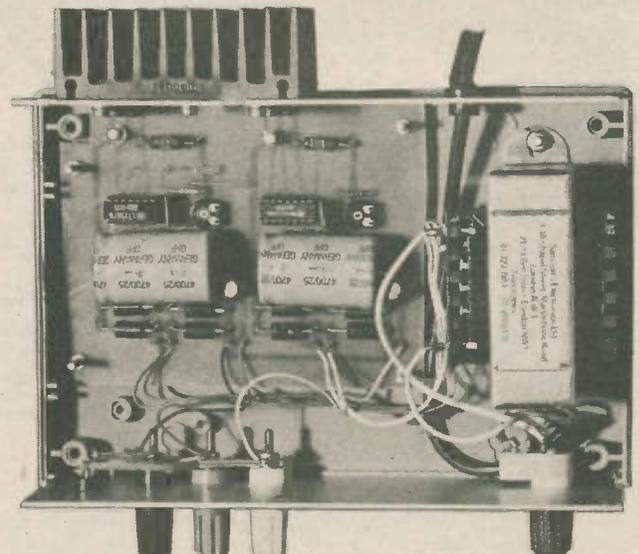
The prototype was built in a Verobox and before the transformer can be bolted in position, it is essential to remove some of the internal mouldings. This can be done with a large twist drill and then any remaining plastic should be removed using a sharp knife.

ADJUSTMENT

Before the power supply is connected to a disc drive it is essential to test it and adjust the output voltage. Connect an accurate volt meter to the five volt output and turn the unit on. The meter should read approximately five volts, adjust VR1 until the output is exactly five volts, switch off. Set the

meter to a range greater than three amps d.c. and connect this across the output and turn the unit on. If all is well the meter should read about 3A.

Repeat for the 12 volt output, but this time set the voltage with VR2. ★



Internal details of the Disc Drive PSU

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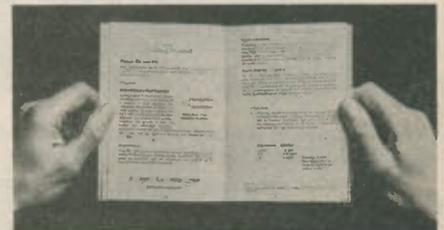
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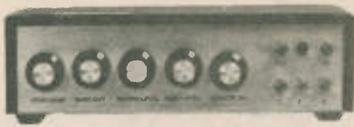
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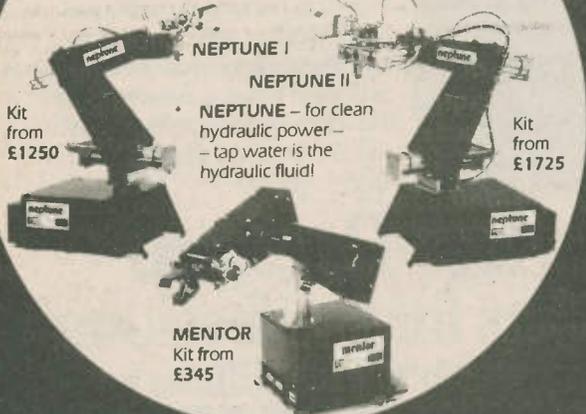
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AC128 0.150	BD125 1.100	BU210 0.900	TA830 0.800	2N 4443 1.000	2SA212 0.300	PC315 0.600	LED 5mm
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AD196 0.200	BD156 0.200	BU519 1.100	TA1430 0.600	2N 5317 0.400	2SC483 0.210	PC435 0.840	LED 5mm
AD197 0.200	BD157 0.200	BU520 1.100	TA1431 0.600	2N 5318 0.400	2SC484 0.210	PC440 0.850	LED 5mm
AD198 0.200	BD158 0.200	BU521 1.100	TA1432 0.600	2N 5319 0.400	2SC485 0.210	PC445 0.860	LED 5mm
AD199 0.200	BD159 0.200	BU522 1.100	TA1433 0.600	2N 5320 0.400	2SC486 0.210	PC450 0.870	LED 5mm
AD200 0.200	BD160 0.200	BU523 1.100	TA1434 0.600	2N 5321 0.400	2SC487 0.210	PC455 0.880	LED 5mm
AD201 0.200	BD161 0.200	BU524 1.100	TA1435 0.600	2N 5322 0.400	2SC488 0.210	PC460 0.890	LED 5mm
AD202 0.200	BD162 0.200	BU525 1.100	TA1436 0.600	2N 5323 0.400	2SC489 0.210	PC465 0.900	LED 5mm
AD203 0.200	BD163 0.200	BU526 1.100	TA1437 0.600	2N 5324 0.400	2SC490 0.210	PC470 0.910	LED 5mm
AD204 0.200	BD164 0.200	BU527 1.100	TA1438 0.600	2N 5325 0.400	2SC491 0.210	PC475 0.920	LED 5mm
AD205 0.200	BD165 0.200	BU528 1.100	TA1439 0.600	2N 5326 0.400	2SC492 0.210	PC480 0.930	LED 5mm
AD206 0.200	BD166 0.200	BU529 1.100	TA1440 0.600	2N 5327 0.400	2SC493 0.210	PC485 0.940	LED 5mm
AD207 0.200	BD167 0.200	BU530 1.100	TA1441 0.600	2N 5328 0.400	2SC494 0.210	PC490 0.950	LED 5mm
AD208 0.200	BD168 0.200	BU531 1.100	TA1442 0.600	2N 5329 0.400	2SC495 0.210	PC495 0.960	LED 5mm
AD209 0.200	BD169 0.200	BU532 1.100	TA1443 0.600	2N 5330 0.400	2SC496 0.210	PC500 0.970	LED 5mm
AD210 0.200	BD170 0.200	BU533 1.100	TA1444 0.600	2N 5331 0.400	2SC497 0.210	PC505 0.980	LED 5mm
AD211 0.200	BD171 0.200	BU534 1.100	TA1445 0.600	2N 5332 0.400	2SC498 0.210	PC510 0.990	LED 5mm
AD212 0.200	BD172 0.200	BU535 1.100	TA1446 0.600	2N 5333 0.400	2SC499 0.210	PC515 0.990	LED 5mm
AD213 0.200	BD173 0.200	BU536 1.100	TA1447 0.600	2N 5334 0.400	2SC500 0.210	PC520 0.990	LED 5mm
AD214 0.200	BD174 0.200	BU537 1.100	TA1448 0.600	2N 5335 0.400	2SC501 0.210	PC525 0.990	LED 5mm
AD215 0.200	BD175 0.200	BU538 1.100	TA1449 0.600	2N 5336 0.400	2SC502 0.210	PC530 0.990	LED 5mm
AD216 0.200	BD176 0.200	BU539 1.100	TA1450 0.600	2N 5337 0.400	2SC503 0.210	PC535 0.990	LED 5mm
AD217 0.200	BD177 0.200	BU540 1.100	TA1451 0.600	2N 5338 0.400	2SC504 0.210	PC540 0.990	LED 5mm
AD218 0.200	BD178 0.200	BU541 1.100	TA1452 0.600	2N 5339 0.400	2SC505 0.210	PC545 0.990	LED 5mm
AD219 0.200	BD179 0.200	BU542 1.100	TA1453 0.600	2N 5340 0.400	2SC506 0.210	PC550 0.990	LED 5mm
AD220 0.200	BD180 0.200	BU543 1.100	TA1454 0.600	2N 5341 0.400	2SC507 0.210	PC555 0.990	LED 5mm
AD221 0.200	BD181 0.200	BU544 1.100	TA1455 0.600	2N 5342 0.400	2SC508 0.210	PC560 0.990	LED 5mm
AD222 0.200	BD182 0.200	BU545 1.100	TA1456 0.600	2N 5343 0.400	2SC509 0.210	PC565 0.990	LED 5mm
AD223 0.200	BD183 0.200	BU546 1.100	TA1457 0.600	2N 5344 0.400	2SC510 0.210	PC570 0.990	LED 5mm
AD224 0.200	BD184 0.200	BU547 1.100	TA1458 0.600	2N 5345 0.400	2SC511 0.210	PC575 0.990	LED 5mm
AD225 0.200	BD185 0.200	BU548 1.100	TA1459 0.600	2N 5346 0.400	2SC512 0.210	PC580 0.990	LED 5mm
AD226 0.200	BD186 0.200	BU549 1.100	TA1460 0.600	2N 5347 0.400	2SC513 0.210	PC585 0.990	LED 5mm
AD227 0.200	BD187 0.200	BU550 1.100	TA1461 0.600	2N 5348 0.400	2SC514 0.210	PC590 0.990	LED 5mm
AD228 0.200	BD188 0.200	BU551 1.100	TA1462 0.600	2N 5349 0.400	2SC515 0.210	PC595 0.990	LED 5mm
AD229 0.200	BD189 0.200	BU552 1.100	TA1				

MODULAR AUDIO POWER SYSTEM

PART 3

M. TOOLEY BA
D. WHITFIELD
MA MSc CEng MIEE

In the series thus far we have assumed that all of the ancillary modules described have derived their d.c. supplies from an associated power amplifier module. Whilst this arrangement is convenient when pre-amplifier and power amplifier modules are assembled together within a common external enclosure, it is less attractive when the power amplifier module is remotely located.

A somewhat simpler, and far more flexible solution is that of including a 'local' power supply within the pre-amplifier enclosure, thus obviating the need to provide three additional conductors in order to convey the positive and negative supply rails and common earth.

Such a supply need only be capable of delivering a few tens of milliamps from symmetrical output voltage rails of between 15V and 30V. Furthermore, there is no need for electronic regulation of the d.c. output voltage as shunt Zener stabilisation is incorporated within each ancillary module.

The complete circuit diagram of the power supply module is shown in Fig. 1. This relatively straightforward arrangement is capable of supplying up to five parallel connected ancillary modules and employs a mains transformer, T1, having either two series connected 12V windings or a single centre tapped secondary of nominally 24V. In either case, a conventional plastic encapsulated bridge rectifier, REC1, is employed.

The power supply is built on a single sided p.c.b. measuring approximately 65mm x 115mm (i.e. identical in size to all other modules). The component overlay is shown in Fig 2.

Components should be assembled on the p.c.b. in the following sequence: terminal pins, transformer, resistors, capacitors, and bridge rectifier. As always, care should be taken to ensure the correct orientation of the polarised components (including the bridge rectifier).

When the p.c.b. wiring is complete, the underside of the board should be carefully checked for solder bridges and dry joints whereas the component side should be examined paying particular attention to the correct placement and orientation of components.

Although the power supply will normally be mounted in the same enclosure as that used for the pre-amplifier module (see last month) some constructors may prefer to use a separate enclosure. In such cases the authors strongly

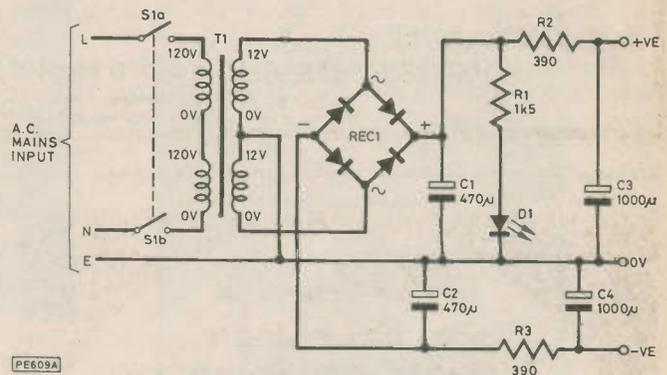


Fig. 1. Circuit diagram of the power supply module

COMPONENTS . . .

POWER SUPPLY

Resistors

R1	1k5 0.25W 5%
R2, R3	390 0.5W 5% (2 off)

Capacitors

C1, C2	470µ 50V p.c. electrolytic (2 off)
C3, C4	1000µ 16V p.c. electrolytic (2 off)

Semiconductors

REC1	50V 1A bridge rectifier
D1	Red l.e.d.

Miscellaneous

- P.c.b.
- Terminal pins (8 required)
- T1 3VA mains transformer with 2 x 120V primaries and 2 x 12V secondaries each rated at 120mA
- D.p.s.t. mains switch
- Mains connector



Power amplifier module

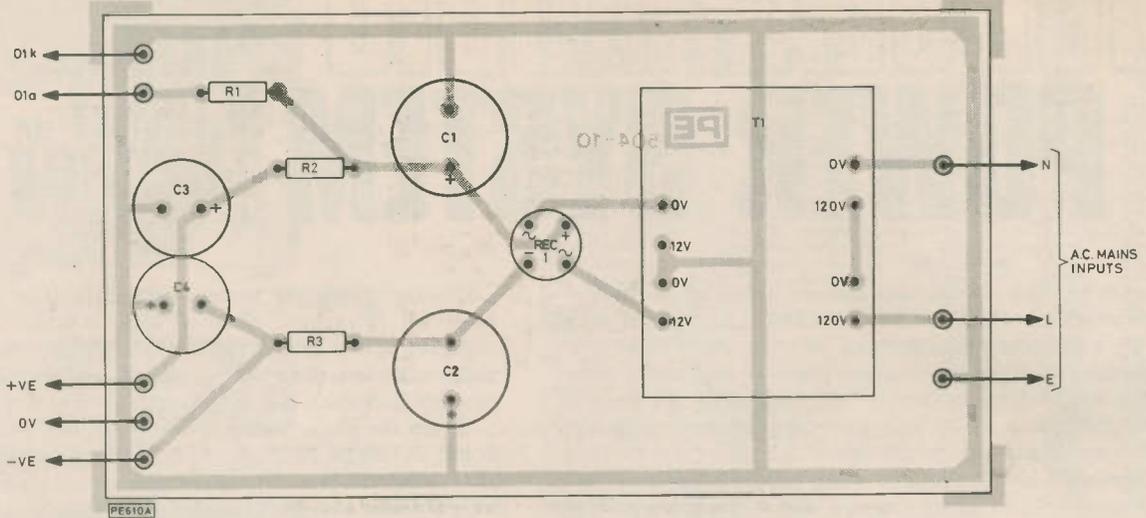


Fig. 2. Component layout of the power supply module

recommend the use of a small diecast box, being both neat and robust. Ventilation of such an enclosure will not normally be required.

TEST SIGNAL SOURCE

This final ancillary module generates a sinusoidal signal of reasonable purity at a frequency of approximately 1kHz. It thus not only provides a means of testing the complete power amplifier system but also enables a realistic measurement of the r.m.s. output power when used in conjunction with the test load described previously.

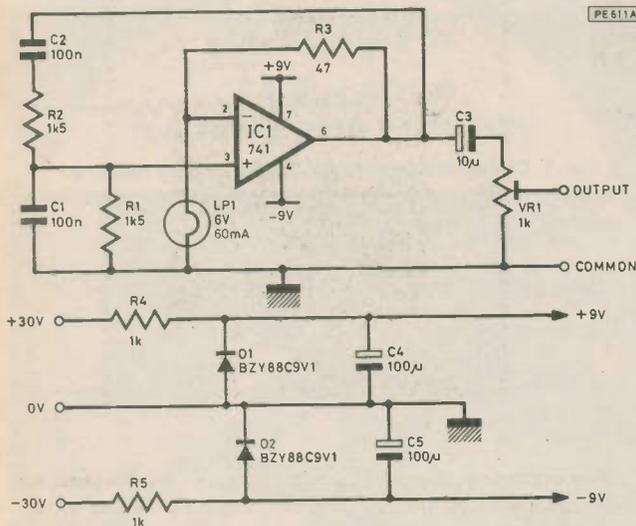


Fig. 3. Circuit diagram of the test signal source

The test signal source is based on a 741 operational amplifier and its complete circuit diagram is shown in Fig. 3. The oscillator uses a simple Wien bridge network, R1, C1 and R2, C2, with negative feedback amplitude control provided by means of R3 and LP1. This arrangement ensures reasonable purity without the need to use a more expensive thermistor device in the feedback network.

With the component values shown, the frequency of

COMPONENTS . . .

TEST SIGNAL SOURCE

Resistors

R1, R2	1k5 (2 off)
R3	47
R4, R5	1k 0.5W (2 off)
VR1	1k horizontal mounting min. skeleton pre-set

Unless otherwise stated, all fixed resistors are 0.25W 5%

Capacitors

C1, C2	100n polyester (2 off)
C3	10µ 16V p.c. electrolytic
C4, C5	100µ 16V p.c. electrolytic (2 off)

Semiconductors

IC1	741
D1, D2	BZY88 C9V1 (2 off)

Miscellaneous

P.c.b.
Terminal pins (5 required)
LP1 6V 60mA wire ended pilot lamp
8-pin low profile d.i.l. socket



Pre-amplifier

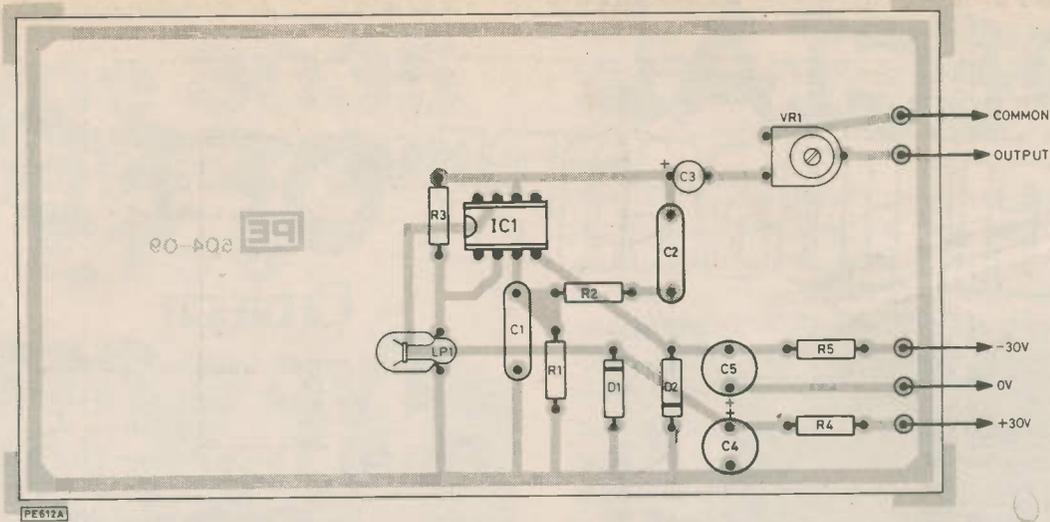
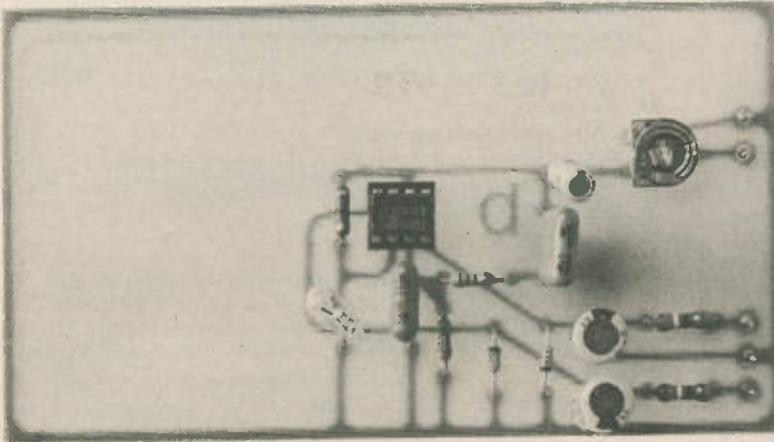
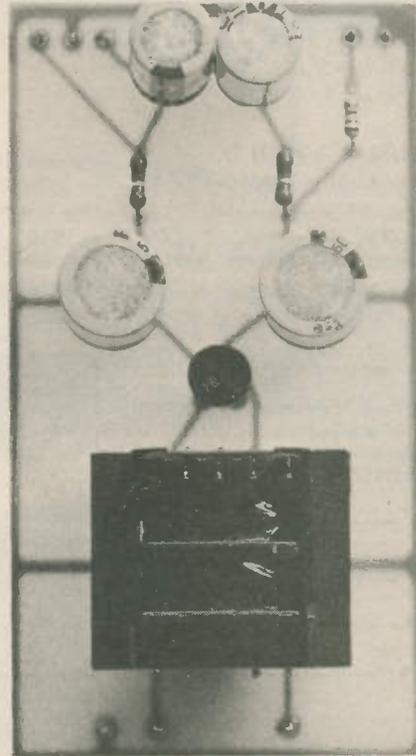


Fig. 4. Component layout for the test signal source



The photograph shown above is of the test signal source p.c.b. whilst the power supply p.c.b. is shown on the right.



operation is approximately 1kHz. If desired, however, constructors may readily change the frequency of oscillation by altering the values of R1, R2 and C1, C2. The frequency of oscillation is given by:

$$f = \frac{159}{C \times R} (\text{kHz})$$

Where $C = C1 = C2$ (expressed in μF) and $R = R1 = R2$ (expressed in kohm).

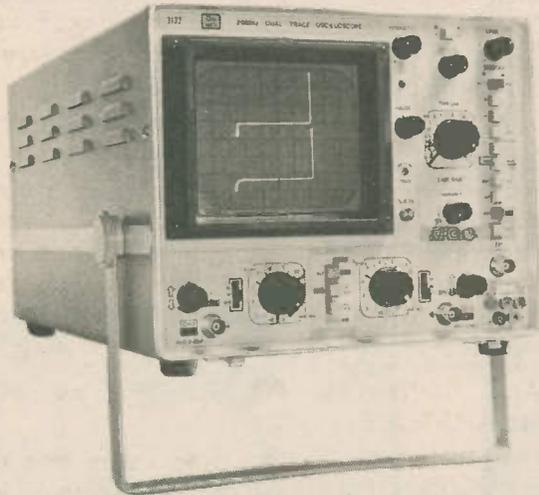
Adjustment of the output voltage level is provided by means of VR1. With this control in mid-position, the output voltage produced will be of the order of 1V pk-pk. As mentioned previously, simple Zener diode shunt regulators, D1 and D2, are provided to stabilise the incoming positive and negative supply rails.

The test signal source is again built using a single sided p.c.b. measuring approximately 65mm x 115mm. The component overlay is shown in Fig. 4. Components should be assembled on the p.c.b. in the following sequence; terminal pins, i.c. holder, resistors, capacitors, diodes, variable resistor and filament lamp. This latter component should be secured to the p.c.b. using a small drop of epoxy resin based adhesive.

When complete, the p.c.b. should be carefully checked for solder bridges, dry joints, and correct orientation of all polarised components. The test signal source may be tested by simply connecting its output to the input of any of the other modules and listening for a signal output from the system. If available, an oscilloscope may be used both to confirm that the output waveform is sinusoidal and to accurately set the level of the output signal.

In a practical system the output of the test signal source may either be made available at a standard jack or d.i.n. connector so that it may be 'patched' into the system when required or may be switched directly to any of the inputs of the pre-amplifier/line driver or pre-amplifier-mixer modules described last month. ★

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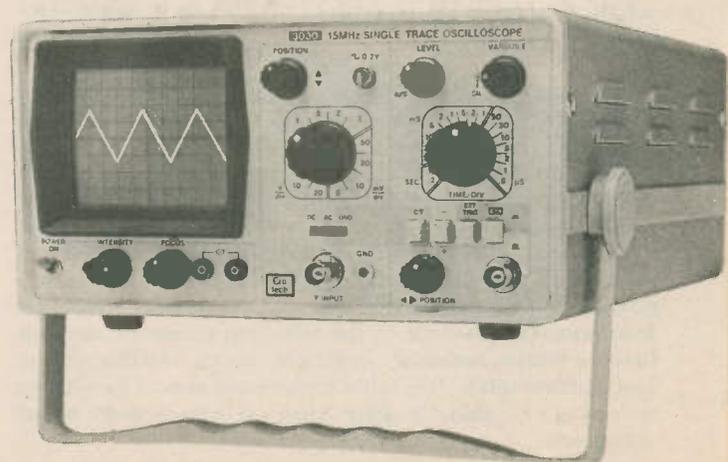
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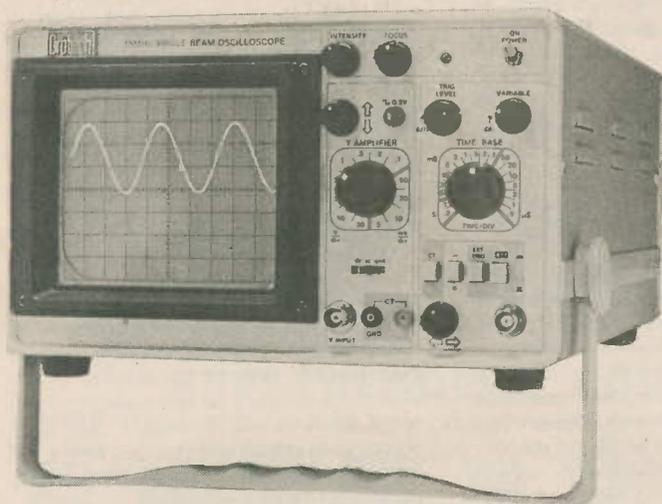
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DARK RINGS

Using a C.C.D. (Charge-Coupled Device) on the 100-inch reflector at the Las Campanas Observatory, in Chile, the American astronomers Richard Terile and Bradford Smith have succeeded in imaging the rings of Uranus, together with all five known satellites (Miranda, Ariel, Umbriel, Titania and Oberon). Infra-red images have been obtained by D. A. Allen and J. Crawford from the Siding Spring Observatory in New South Wales, but this is the first record of them at visual wavelengths.

The rings are quite unlike those of Saturn; instead of being bright and icy, they are made up of material which is as dark as coal-dust.

Meanwhile, occultation observations by F. Vilas and L. Elicer at the Cerro Tololo Observatory, also in Chile, give the first indications

that the outermost giant planet, Neptune, may also have a dark ring. Previously no signs of a Neptunian ring had been found, and it had been thought that none might exist because of the presence of Triton, a large satellite with retrograde motion. The Chilean observations are far from conclusive, but they are certainly very interesting.

Russia's two *Vega* probes to Halley's Comet are now on their way, first to rendezvous with Venus and then to encounter the comet in March 1986—at about the same time as the Japanese *Planet A*, and shortly before the European probe, *Giotto*, is scheduled to pass right into the heart of the comet on March 13, 1986.

HORSE SENSE

There has been an interesting suggestion with respect to the famous Horse's Head Nebula in Orion, which is spectacular when photographed and really does give the impression of a knight's head in chess—though it is hard to see visually (with my 15-inch reflector I always find it an excessively difficult object). B. Reipurth of Denmark and P. Bouchet of France suggest that it may be an embryo Bok Globule.

These Globules, named in honour of the late Bart J. Bok (who first drew attention to them) are formed when strong radiation from very hot stars strips away all but the compact centres of large interstellar clouds, and are believed to form into stars of rather low mass.

In the case of the Horse's Head, the radiating star is Sigma Orionis. Reipurth and Bouchet believe that eventually the Horse's Head will emerge from the surrounding nebulosity and become typically spherical in

form, though obviously the process will be a very slow one indeed.

MERCURY

March this year is the best time for seeing the rather elusive planet Mercury, which reaches its greatest eastern elongation (18 degrees) on the 17th. It is well north of the celestial equator, and should be visible above the horizon for about half an hour after sunset. On the evening of the 22nd, Venus, Mercury and the 30-hour-old crescent Moon will be almost in a straight line, pointing downward and to the left—photographic enthusiasts, please note!

The phase of Mercury decreases from almost 90 per cent at the beginning of the month to less than 12 per cent at the end. Mercury passes through inferior conjunction on April 3, about eight hours before Venus does so—though the two planets are not in conjunction with each other until April 18.

Ordinary telescopes will show practically nothing on Mercury apart from the characteristic phase. Maps of the surface were drawn by G. V. Schiaparelli in 1881-9 and by E. M. Antoniadi in 1934. Antoniadi, who used the great 33-inch refractor at Meudon Observatory, was probably the best planetary observer of his time, and his maps of Mars have proved to be remarkably accurate, but he was less successful with Mercury, and showed only some rather vague shadings.

He also believed that there could be an appreciable atmosphere, and that the rotation was synchronous—that is to say, equal to the planet's revolution period or 'year', amounting to 88 Earth-days. This would have meant that

THE SKY THIS MONTH

Several planets are on view this month, though only Mercury and Venus are well placed. Venus continues to dominate the western sky after sunset, and its magnitude at the beginning of the month is -4.3, far brighter than any other planet and about three magnitudes brighter than Sirius, the most brilliant star in the sky.

However, Venus sets earlier and earlier as the month progresses, and the phase decreases from 25 per cent on March 1 to only 4 per cent on March 30. Inferior conjunction is reached on April 3.

This is a good time to see whether the phase of Venus can be seen with the naked eye. Very keen-sighted people can do so (though I certainly cannot!) and of course binoculars will show the phase easily.

Telescopically, this is also the right time to look for the Ashen Light, or faint luminosity of the night side of the planet. Observations of it have been made so often that it can hardly be dismissed as a contrast effect—though we can hardly agree with the last-century German astronomer Franz von Paula Gruithuisen that it is due to fires lit on the planet's surface by the local inhabitants to celebrate the election of a new Government! More probably it is due to electrical effects in the upper atmosphere of Venus.

Mars, in the evening sky, is now only of magnitude 1½. Jupiter rises well before the Sun by mid-March, and so does Saturn, but both are low, as they are well to the south of the celestial equator. The Moon is full on March 7, and new on the 21st.

Halley's Comet, brightening steadily, is still beyond the range of any but very powerful telescopes; however, its nucleus is already showing marked signs of activity, and we may hope that the comet will be rather more of a spectacle than was originally feared. For the record: the position on March 1 is R.A. 4h 56m, dec. N.13°35'; on March 31, R.A. 4h 51m, dec. N.14°49'. This is close to the boundary between Orion and Taurus—roughly midway between Aldebaran and Betelgeux.

Orion, of course, is still the most striking constellation on view, though by the end of the month it is starting to run into the evening twilight. (Do not forget that Summer Time starts on March 31.) Capella is still very high, which means that Vega is low in the north and may not be seen at all even though it never actually sets over Britain.

The Great Bear, Ursa Major, is high in the north-east, and Leo, the Lion, has become prominent; to locate Leo it is helpful to use the Pointers in the Great Bear 'the wrong way' (that is to say, away from the Pole Star). Regulus, leader of Leo, is at the foot of a curved line of stars making up the pattern known as the Sickle.

Below Leo the sky appears rather blank; this is the region of Hydra, the Watersnake, whose only bright star, the reddish Alphard, may be found by using the Twins, Castor and Pollux, as direction indicators. Alphard is often nicknamed 'the Solitary One' because of its somewhat isolated position. It is of the second magnitude, but has been suspected of variability.

part of Mercury would be in constant sunlight and another part in constant darkness, with only a narrow 'twilight zone' in between over which the Sun would bob up and down over the horizon.

Antoniadi was wrong on both counts, though he can hardly be blamed. The Mercurian atmosphere is negligible, and the rotation period is only 58.6 days, two-thirds of the planet's 'year'—which means that each time Mercury is best placed for observation from the Earth, the same regions are turned in our direction.

MISSION ACCOMPLISHED

Virtually all our detailed knowledge of Mercury comes from a single space-probe, *Mariner 10*, which made three active passes of the planet: in March and September 1974 and March 1975. Since Mercury, with a diameter of 3030 miles, is not a great deal larger than the Moon, it was expected that the surface features would be basically of lunar type, and this proved to be correct. There are craters, mountains, valleys, scarps and ridges; some of the craters have central peaks, and some are

the centres of systems of bright rays. In fact, the first crater to be identified as *Mariner 10* drew in toward Mercury is a ray-centre; it has been named Kuiper, in honour of the late Dutch-American astronomer G. P. Kuiper, who placed such an important role in the early days of planetary probe research.

The most imposing formation is the Caloris Basin, which is a huge ringed structure. Unfortunately we have mapped only part of it. Each time *Mariner 10* by-passed Mercury the same regions of the planet were in sunlight, so that a large area remains unknown, though there is no reason to believe that these regions are basically different from those which we have been able to study.

Though the crater distribution on Mercury follows the same laws as on the Moon, with smaller formations breaking into larger ones instead of vice versa, there are no smooth 'seas' comparable with the lunar Mare Imbrium or Mare Serenitatis, and there are inter-crater plains of a type not found on the Moon.

One distinct surprise was that Mercury, unlike Venus, Mars or the Moon, has a detectable magnetic field, with a strength about 1/30 of that of the Earth's field. The field is

dipolar, with two equal magnetic poles of opposite polarity aligned with the rotational axis of the planet—which is almost perpendicular to the plane of the orbit.

Moreover, Mercury is about as dense as the Earth, with a specific gravity of 5.5. Presumably it has a large iron-rich core, which may in fact be larger than the whole globe of the Moon.

HOSTILE WORLD

Contact with *Mariner 10* was finally lost on 24 March 1975, though no doubt the probe is still in solar orbit and still makes regular close approaches to Mercury. No further missions have been announced as yet, though new launchings will probably be made in the foreseeable future.

Obviously Mercury is a very hostile world, and there is no chance of any life there; neither does it seem likely that manned landings will be practicable for a long time. However, it is always worth seeking out this curious, elusive little planet, and March this year provides an excellent opportunity.

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WANTED manual or circuit diagram to repair Sinclair R3000 amplifier. K. J. Steward, 8 Langley Close, Church Crookham, Aldershot GU13 0PX.

WANTED circuit diagrams on quality pre-amps and mosfets and Bipolar and p.c.b.s and special offer on components and 2 N3773 etc. Contact: A. Larr, 56 Becher St., Derby DE3 8NN.

FULL size keyboard from NCR accounting machine £20. Sinclair ZX80 complete with instruction book £20. Mr. W. E. Ames, 33 Beach Rd. West, Portishead, Bristol. Tel: 0272 848273.

WANTED manual or circuit for Heathkit EU-70A scope. Buy or copy. D. J. Looker, 96 Fernhill Road, Begbroke, Oxford OX4 2JP.

COMPLETE PE except for November 1973 and June 1983. First 12 volumes bound. Offers. Mike Hudson, 51 The Crofts, Little Paxton, Cambs. Tel: 0480 74919.

JVC AK10 amplifier 60 watts neat condition £45. Transistor not valve amplifier. C. Gooding, 01-385 3228 after 4 p.m. Anytime at weekends.

WANTED WKSP manuals video Genie and Sanyo reel to reel model MR939. Any information appreciated. Roy Morrish, 4 Allen Bank, Barnstaple, Devon. Tel: 0271 76908.

DRAGON 32K computer plus leads assemble editor and games for £55. Phone after 5 p.m. or weekend. S. Akhtar, 79 Mayola Road, London E5 0RF. Tel: 01-986 2658.

MULTICORE cable new 20 way telephone type. Any length cut 45p/metre (600m available). Tel: 021-472 3688.

TERMINET 300 Baud band printer with keyboard, RS232C interface, tractor feed. £100 plus carriage. Fully working. Tel: Wivenhoe (0206) 5671.

VARIAC 2KVA variable voltage 8A transformer. As new. £25. Buyer collects or carriage extra. Mr. J. Brearley, 26 Knowsley Avenue, Davyhulme, Manchester M31 2BT. Tel: 061-748 5307.

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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Please read the RULES then write your advertisement here—**one word to each box. Add your name, address and/or phone no. COUPON VALID FOR POSTING BEFORE 4 APRIL, 1985** (One month later for overseas readers.)

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TYNE 4 WEAR.			

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PRINTER BUYER'S GUIDE....

UNTIL recently, printers for computers were large, noisy and expensive pieces of equipment. This picture has changed, however, with the introduction of increasingly powerful small computers in business and the home. The different needs of these new groups of computer users have brought about a re-think in printer design, resulting in desktop printers which meet the needs, and fall within the price range of today's small computer systems. This month's printer survey looks at the wide range of printers currently on the market at around £500 or less. Before we do this, however, we will take a look at some of the basic features of these printers, and suggest some points to consider when choosing a printer.

WHO NEEDS A PRINTER

The need for a printer is not something which is immediately obvious when 'The Computer' first arrives in the home. If your computer is to be more than just a passing fancy, however, the pre-packaged games used to get things started will soon give way to an urge to 'have a go' yourself. Copying programs from magazines is usually the first step, but one which soon shows itself to have a few hidden snags. These usually take the form of the almost inevitable typing mistakes; the well-known 'finger trouble' syndrome. Tracking down these bugs can be a nightmare of "is that a '1' or is it a 'l'?", particularly if you are restricted to debugging on a shimmering TV screen. However, the problem can be greatly simplified if you are able to put down a printed listing of the program side-by-side with the original.

Next, you will probably move on from published listings to writing your own programs. Here a printer will help you to develop a clear and well-structured programming style, since these are features which will stand out clearly from your listings. By the time you reach this stage, however, you are really hooked, and a terminal case of computeritis is usually diagnosed!

The discussion so far has been restricted to using the resources of the computer itself. However, computers really come into their own when we can set them to work in our everyday lives. One of the best examples in this area is probably word processing, which is arguably the greatest advance since the introduction of the typewriter. With a word processing program running on your computer, you can type letters, correct your mistakes, change your mind as often as you like, and still end up with perfectly presented letters at the end of the day; all assuming of course that you have a printer!

Whatever your reasons for wanting a printer, choosing the right one can be as important as the selection of your computer. The decision to buy a printer can easily involve spending at least as much again as the computer itself (a printer will typically cost between £180 and £450), so it is important to choose one which really is suited to your needs. The choice available is now quite considerable, and the

range of facilities offered can be bewildering, so before looking at some of the printers available, we will start by looking at the basic features to be found on today's machines.

A FEW PRINTER BASICS

Inside the computer there are essentially two types of information which concern us when we talk about using a printer to produce a permanent copy; we usually think of these two types as characters and graphics. We will start by looking at characters, and will come back to graphics a little later.

Characters are the numbers, letters, and punctuation marks which make up the so-called character set of the computer. They also appear on the display screen and on the keyboard. Internally these characters are usually represented by a set of one-byte ASCII codes. When we want to print a sequence of characters, therefore, the computer simply has to send the corresponding stream of ASCII codes to the printer. There are two ways to transfer this byte stream from the computer to the printer; serial and parallel. The serial link transfers bytes one bit at a time, and usually conforms to the RS232C standard (or an equivalent). The more popular parallel interface usually conforms to the Centronics standard, and transfers a complete byte at a time. The important thing to bear in mind here is to make sure that the printer port on the computer is compatible with that on the printer!

At the receiving end, the printer decodes each byte as it arrives, and sends the appropriate commands to the printer mechanism to cause the corresponding character to be printed. The actual form of the printed character depends on the 'font' of the printer, and is something which may or may not be variable, depending on the type and model of the printer.

Many printers have a number of built-in fonts which are selectable by the computer, whilst others have a facility to allow the operator to change fonts when required. However, and at any instant, the currently selected font determines the way in which the printer will interpret each ASCII code sent by the computer. In the main these codes correspond to the keyboard and screen symbols, but there are ranges (particularly of the lower-numbered codes) which are usually reserved for commands from the computer to the printer, e.g. new page, change font. These control codes are often referred to as escape sequences because they frequently involve a pre-defined sequence of codes, starting with an 'ESCAPE' code (decimal 27).

So far we have seen how the computer tells the printer which characters it wants printed, and how it controls various features such as the font. We will now go on to look at how the characters themselves are actually printed.

PRINTER TYPES

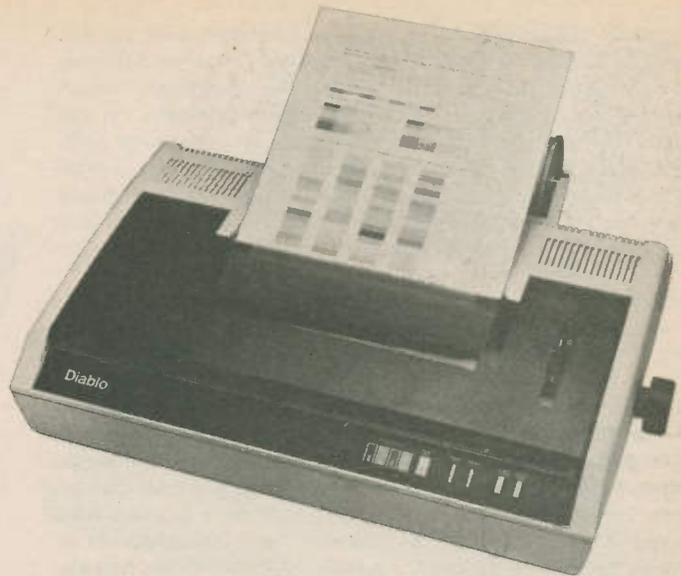
There are quite a number of different types of printing mechanism used today, but the major difference between them is the way in which the individual characters are formed on the paper. The most popular printers for small computers today are undoubtedly the daisywheel and dot matrix types. Printer technology is not static, however, and cheaper, quieter, and more versatile machines are constantly being announced. A particular driving force at present is the quest for low power printers suitable for portable computers. Below we look briefly at the features of today's popular types of printers which fall within our price range.

Daisywheel

The daisywheel printer works in a similar way to an electric typewriter. The font is on a plastic daisywheel with flat spokes (so called because of its similarity in appearance to the petals of a daisy), and the characters are embossed on



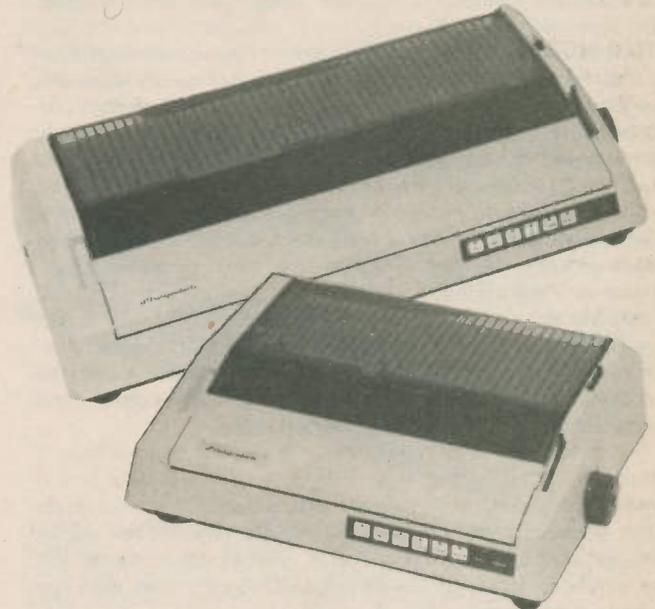
Model: Tandata M82A **Print format:** Dot Matrix **C.P.S.:** Variable **Interface:** Serial/Parallel **Paper:** Sprocket Feed **Notes:** Viewdata graphics **Price:** £299+VAT **Supplier:** Tandata, Albert Rd. North, Malvern, Worcs (06845 68421).



Model: Geveke C150 **Print format:** Dot Matrix **C.P.S.:** 20 **Interface:** Parallel **Paper:** Friction **Notes:** Optional Interface **Price:** £1095+VAT **Supplier:** Geveke Electronics, Unit 201, Landsbury Est., 102 Lower Guildford Rd., Knaphill, Woking, Surrey (04867 88676).



Model: DW12 **Print format:** Daisywheel **C.P.S.:** 12 **Interface:** Centronics **Paper:** 300mm Friction **Notes:** Tractor option **Price:** £275+VAT **Supplier:** X-Data, 750-751 Deal Ave., The Trading Estate, Slough, Berks (0753 72331).



Model: Paper Tiger, 8010, 8020 **Print format:** Dot Matrix **C.P.S.:** 180 **Interface:** RS232/Centronics **Paper:** 200, 305mm Tractor **Notes:** Block graphics **Price:** £469, £645+VAT **Supplier:** Data Products International, Data Products House, 136-138 High St., Evesham, Worcs (0784 31161).



Model: Tandata PPX Compact **Print format:** Thermal **C.P.S.:** Variable **Interface:** Centronics **Paper:** 110mm Thermal **Notes:** Viewdata **Price:** £171.35 inc. VAT **Supplier:** Tandata Marketing, Albert Rd. North, Malvern, Worcs (06845 68421).



the ends of the spokes. The wheel is rotated until the appropriate spoke is aligned with the print hammer. An electromagnetic hammer then strikes the character, which presses it against the ribbon, producing an imprint on the paper. The print head then moves across one character position, ready for the next printing operation. Daisywheel printers are capable of the very highest print quality, but are relatively slow and noisy in operation. Changing fonts is a simple matter of changing daisywheels.

Dot Matrix

A dot matrix printer is one which works by placing a pattern (matrix) of dots on the paper to form the characters. This is done by firing a vertical bank of fine wires (usually there are between seven and nine wires, but it can be just one) at the paper through the ribbon. The wires are fired by individual solenoids as the print-head moves across the paper. In this way each character is built up one column at a time, with the print-head moving across the paper one dot position at a time. The dot pattern for each character is usually held in ROM inside the printer; some models include more than one font, selectable by special codes from the computer. In addition, matrix printers usually allow more than one size of any particular font to be printed (again selected by the computer). This is usually done by changing the horizontal spacing and/or repeating each dot column twice, but the basic dot pattern (which defines the font) remains unchanged.

Typical matrix printers use an array of seven-by-nine dots for their standard character fonts, but larger matrix sizes are also available. In general, the larger the number of dots per line of print, the better the appearance of the characters; a typical figure is 480 dots per line. Many dot matrix printers now include a so-called near letter quality (NLQ) font. This usually makes use of columns of dots at a half-dot pitch (whereas most fonts use a whole-dot pitch), and although slower to print, the NLQ fonts do give a much smoother appearance to the printed characters.

Overall, matrix printers are typically 5 to 10 times faster than daisywheels, usually offer a good range of print styles, but are noisy and do not offer quite the same print quality as daisywheel printers. As we shall see later, many dot matrix printers also offer the possibility of graphics.

Ink Jet

Both daisywheels and dot matrix printers are inherently noisy because they work by physically striking the paper through a ribbon. Ink jet printers, on the other hand, are much quieter because they have no ribbon. Instead, they fire a stream of charged ink droplets at the paper. An electrostatic arrangement then deflects the stream in much the same way as a television tube, and causes the characters to be drawn on the paper.

A recent simplification of the ink jet principle is to do away with the electrostatic deflection, and use a bank of ink nozzles instead. In much the same way as an impact dot matrix print-head, the characters are then made up from a matrix of ink dots. This approach has also been cleverly adapted to allow printing in colour; each jet produces dots of a different colour, with the characters then being built up one row at a time. The result is rather slower than with single-colour printing, and the character fonts tend to be more limited, but colour printers of this type are a very cost-effective way of producing multi-colour hard copy.

Electro-sensitive

The electro-sensitive system uses a special paper which is a sandwich of aluminium foil, ink and paper. Printing is per-

formed by wires which are in contact with the foil side of this sandwich. When a wire is momentarily raised to a high voltage, a small hole is melted in the foil, exposing the ink below. The result is a black dot on a silvery background. Electro-sensitive printers are not widely used due to their need for special paper, but they are quite common in lower cost, narrow-paper applications.

Thermal Matrix

This is another type of printer which requires special paper. It is similar to the impact dot matrix printer discussed above, but instead of striking wires through the ribbon, the printhead burns spots directly on heat-sensitive paper. Thermal printers are very quiet and relatively cheap, but the cost and need for special paper can be a distinct disadvantage.

Thermal Transfer

Thermal transfer printers are a relatively new development. A special heat-sensitive ribbon is used with the same sort of print-head as used in the thermal matrix printers. Plain paper is used, however, and spots of dye are transferred from the ribbon to the paper when heated. Thermal printers are quiet in operation, but the ribbons are still rather expensive, and the technology would probably benefit from a chance to mature before they become a real force to be reckoned with.

PRINTER FEATURES EXPLAINED

When choosing a printer there are a number of features which we must consider carefully before making a final selection. Inevitably, any choice will involve some form of trade-off between those features which are desirable, those which are essential, and cost.

Paper Width

The paper width quoted in the manufacturer's specification usually relates to the maximum width that can be used in the printer. Some cheaper printers will only operate on a special size of paper (often supplied only in rolls), but most will now accept paper up to about 240 mm wide. This means that standard cut-sheet or narrow fan-fold paper can be used, depending on the type of paper feed fitted (see below), and usually allows up to 80 standard characters to be printed on a line.

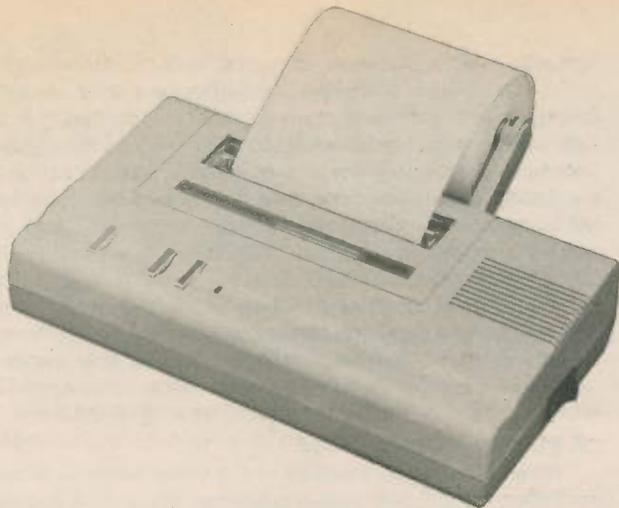
Paper Feed

There are two main types of paper feed in common use, and most printers support one or both types. Friction-feed relies on the same principle as used in typewriters, where the paper is squeezed between two rollers, one of which is driven by a motor. This type of paper feed allows the use of either cut-sheet or roll paper.

Tractor-feed requires the use of paper which has sprocket holes down its edges; the holes are often on perforated strips which can be removed after printing. The sprockets are fed over toothed (tractor) wheels which are driven by the paper feed motor. The separation between the wheels is adjustable, so different widths of paper can be used.

Pin-feed is a variation of tractor-feed, but with either a small or no range of width adjustment. A number of printers with pin-feed also have an optional tractor-feed accessory. If you need to use narrow paper (or sets of labels), it is important to check whether the range of adjustment is adequate for your requirements.

Tractor-feed printers are suitable for many applications, but they do mean that only sprocketed paper can be used.



Model: Commodore1520 **Print format:** 4-Colour Broken Line **C.P.S.:** 14 **Interface:** Serial (Commodore) **Paper:** 114mm Continuous Roll **Notes:** Interface available **Price:** £99.99 inc. VAT **Supplier:** Commodore, 1 Hunters Rd., Weldon, Corby, Northampton (0236 5608).



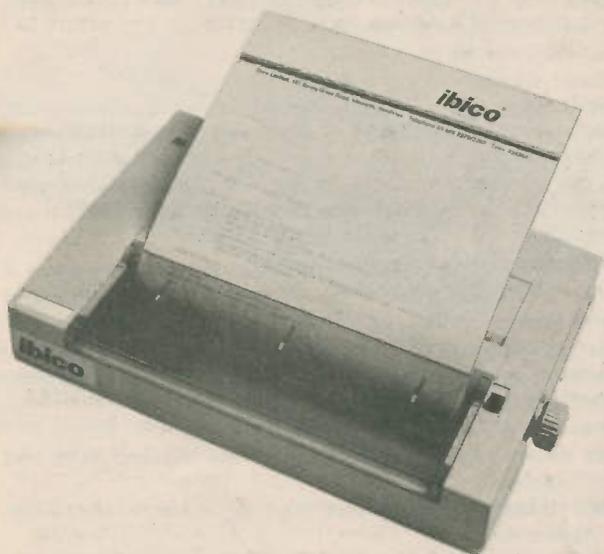
Model: Epson FX-100 **Print format:** Dot Matrix **C.P.S.:** 60 **Interface:** Centronics **Paper:** 210mm Friction **Notes:** Serial option **Price:** £569+VAT **Supplier:** Epson, Dorland House, 388 High Rd., Wembley, Middlesex (01-902 8892).



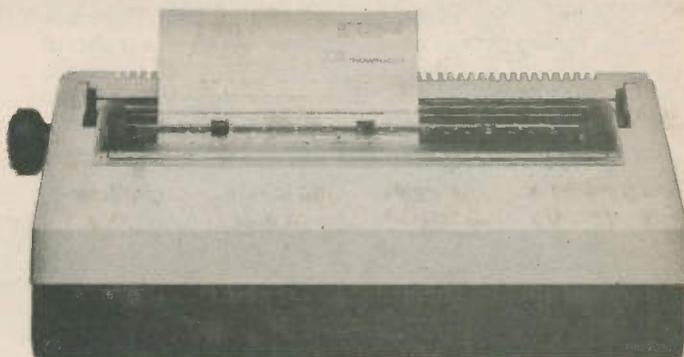
Model: Commodore MPS 801 **Print format:** Dot Matrix **C.P.S.:** 50 **Interface:** Serial (Commodore) **Paper:** 250mm Pin Feed **Notes:** Interface available **Price:** £200 inc. VAT **Supplier:** Commodore, 1 Hunters Rd., Weldon, Corby, Northampton (0236 5608).



Model: Fastext 80 **Print format:** Daisywheel **C.P.S.:** 80 **Interface:** Centronics **Paper:** Friction **Notes:** Tractor option **Price:** £195+VAT **Supplier:** Smith-Corona, Unit 23, Northfield Ind. Est., Beresford Ave., Wembley, Middlesex (01-900 1222).



Model: Ibico Mini **Print format:** Daisywheel **C.P.S.:** Not known **Interface:** Centronics **Paper:** Friction **Price:** Not known **Supplier:** Ibico Ltd., 181 Spring Grove Rd., Isleworth, Middlesex (01-568 2379).



Model: TRD 7020 **Print format:** Daisywheel **C.P.S.:** 20 **Interface:** RS232/Centronics **Paper:** 360mm Friction **Notes:** Tractor available **Price:** £375+VAT **Supplier:** Triumph Adler, Jordan House, 47 Brunswick Place, London (01-250 1717).

Print Styles

The range and ease of use of different print styles depends significantly on the type of printer. Changing styles on a daisywheel printer is a simple matter of changing the wheel, but this is not something which can usually be done in the middle of a print run. Mixing print styles with a daisywheel is therefore not usually possible, unless all of the characters are available on the same wheel.

Dot matrix printers normally have a small number of basic fonts (often only one). However, a variety of printing styles for the font(s) provided is usually possible on all but the most basic models. The change of style, in the same way as any change of font, is caused by a series of control codes sent by the computer. There is, unfortunately, little agreement between different manufacturers on the control code sequences used for this purpose.

Proportional Spacing

Proportional spacing is a facility which is available on some printers. Instead of treating each character as if it is of equal width, a proportional spacing facility takes account of the fact that, say, a 'W' is wider than an 'I'. This means that, instead of the gaps between letters being unequal, as usually produced on a computer display, there is a constant gap between adjacent letters. The result is very pleasing to the eye, and is the same as produced by conventional typesetting; the only problem is that few word processors are sophisticated enough to be able to produce both left *and* right margins aligned with such a print style!

Ribbons

Mundane maybe, but daisywheel and impact dot matrix printers all require ribbons in order to be able to operate. These are almost invariably now of the easily changed cartridge variety, and contain either a plastic film or an inked ribbon. The film types are common in daisywheel printers, where the highest quality print is to be expected. Inked ribbon still predominates for dot matrix printers, where they have the advantage of being re-usable (unlike the single-use films), and hence longer lasting.

GRAPHICS

As we mentioned earlier, characters are only one of the two types of potentially printable information which can be manipulated by a computer; the other is graphics. We will now look at some of the facilities which are available for producing graphical output on today's printers.

There are basically two types of graphics printing available, and these tend to complement the low-resolution and high-resolution graphics modes on computers. The first, known as a block graphics facility, is usually controlled by ASCII codes in the range decimal 128 to 192. The block graphics facility defines a set of shapes, based on a matrix of two blocks wide and three blocks high, which fill the space defined for a character. Each block within the matrix is either completely filled or empty. By printing a series of such graphics symbols, it is possible to build up a pictorial output, although it can require a significant amount of programming.

Block graphics is often available on daisywheel printers (although it may require a special wheel), and is offered on a number of other printers. Where a higher resolution facility is available, however, the block graphics facility is frequently omitted and the ASCII codes re-allocated for another purpose, e.g. the italic character set. Such printers also often allow the user to programme his own character set (although it must be said that working out the necessary sequence of control codes for the first time can lead to an acute case of mental indigestion!), and if need be, a block

graphics facility can then always be added by the user.

The second type of graphics involves the ability to be able to control the positioning of individual dots from the print-head. With such a capability, the programmer is able to produce any dot pattern he desires. With this type of graphics facility, the number of dots per line and the degree of control are critical to the performance. To achieve true screen images of high resolution displays will typically require a minimum of 640 dots per print line; more if the ability to produce shaded dumps of multi-colour displays is required. For a true high resolution graphics dump, therefore, a minimum of 640 dots, and desirably 960 dots per line are necessary.

A BUYER'S CHECKLIST

Now that we have looked at the basic features of today's printers, we will conclude this section of our printer guide by suggesting a buyer's checklist. The first step, however, before trying to decide on a printer, is to decide exactly what it is that you want to be able to do with it. Only then are you in a position to start the selection process in earnest. By answering the questions below, you should be able to narrow down your field of choice. Many printers will probably give you more facilities than the minimum that you require, but at least you will have narrowed the field, and cost will then probably also have an effect on your final choice.

Print quality—letter quality, NLQ, or is standard dot matrix quite adequate?

Paper width—wide, standard, or is a non-standard width acceptable?

Paper handling—friction (essential for cut sheet), pin-feed, tractor-feed, or a combination?

Paper—standard or special? If you want to use multi-copy stationery, then either a daisywheel or an impact dot matrix printer is essential.

Graphics—none, block or dot-addressable (matrix only)?

Print styles—more than one font (e.g. italics), number of styles for each font, facility to have user-defined characters, proportional spacing, sub-/super-scripts, underlining?

Interface—serial or parallel?

Speed—the figures quoted in Characters Per Second are always only a guide, but they are useful for comparisons; first ask how important is speed?

Size—will it fit on the bench?

Options/Extras—what is available?

Other—always check that what you expect is provided, e.g. true descenders (tails on g, p, etc.), and bi-directional logic-seeking printing are now usual but are not yet universal features.

EXTRAS

When you have made your choice and set out to buy a printer, it is worth thinking of a few extras which you might add to your shopping list to make life with a printer a little easier, sooner or later.

Interface cable—this is absolutely essential, but not likely to be cheap at around £15.

Paper—easy to forget!

Dust cover—keep the dust out of the moving parts and avoid problems.

Spare ribbons—keep spares; the shop is *always* shut when you need one!

Stand—allows paper to be kept under the printer, saving precious space.

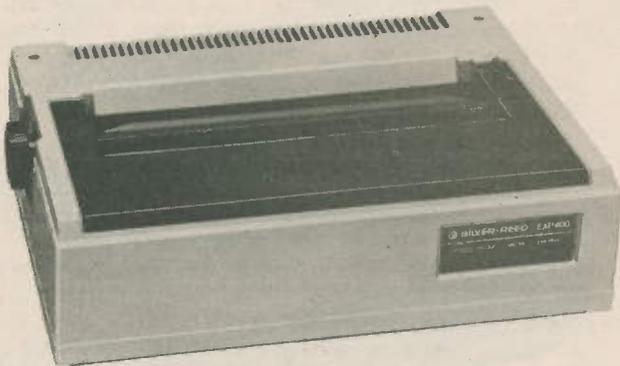
Software—word processors and screen dumps are easy to use, but difficult to write.



PRINTER BUYER'S GUIDE....

Model: X-Data Microline 82A, 83A **Print format:** Dot Matrix **C.P.S.:** 120 **Interface:** Centronics/RS232 **Paper:** 201mm, 308mm Friction **Notes:** Optional Interfaces **Price:** £299+VAT, £489+VAT **Supplier:** X-Data, 750-751 Deal Ave., The Trading Estate, Slough, Berks (0753 72331).

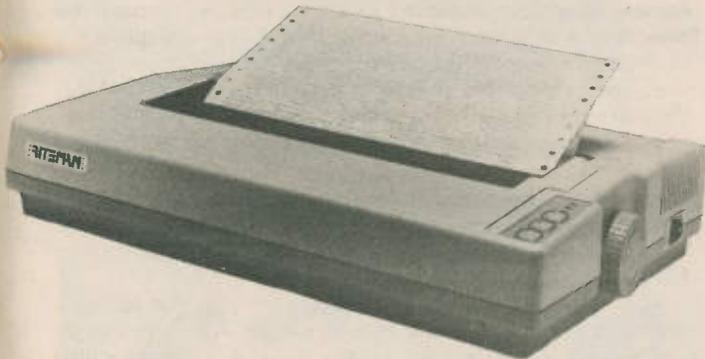
Model: Geveke L32 **Print format:** Dot Matrix **C.P.S.:** 150 **Interface:** Centronics compatible **Paper:** 381mm Friction/Tractor **Notes:** Adjustable tractor **Price:** Not known **Supplier:** Geveke Electronics, Unit 201, Landsbury Est., 102 Lower Guildford Rd., Knaphill, Woking, Surrey (04867 88676).



Model: Silver Reed EXP400 **Print format:** Daisywheel **C.P.S.:** 10 **Interface:** Centronics compatible **Paper:** 300mm Friction **Notes:** Tractor option **Price:** £275+VAT **Supplier:** Silver Reed (UK) Ltd., Silver Seiko House, 19-23 Exchange Rd., Watford, Herts (0923 35616).



Model: Aculab 1200DL **Print format:** Daisywheel **C.P.S.:** 25 **Interface:** Centronics/RS232 **Paper:** 103mm Friction **Notes:** Letter-guide option **Price:** £495+VAT **Supplier:** Aculab, Unit A, Station Approach, Leighton Buzzard, Beds (0525 371 393).

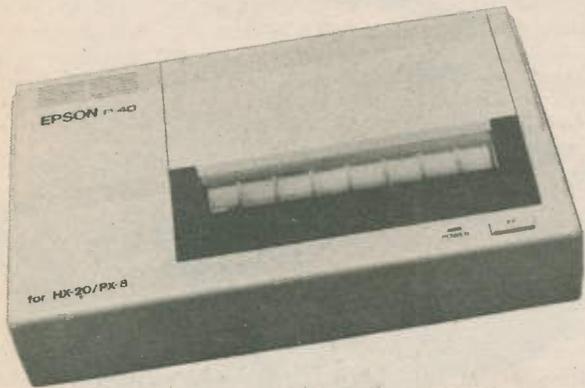


Model: Riteman Plus **Print format:** Dot Matrix **C.P.S.:** 120 **Interface:** Centronics **Paper:** 300mm Friction **Notes:** Tractor option **Price:** £249+VAT **Supplier:** Micro Peripherals, 69 The Street, Basing, Basingstoke, Hants (0256 473232).



Model: Datafax SCP 800 **Print format:** Colour Pen **C.P.S.:** 6-12 **Interface:** Centronics **Paper:** 220mm Pin feed **Notes:** 4-colour plotter **Price:** £199+VAT **Supplier:** Datafax House, Bounty Rd., Basingstoke (0256 64187).

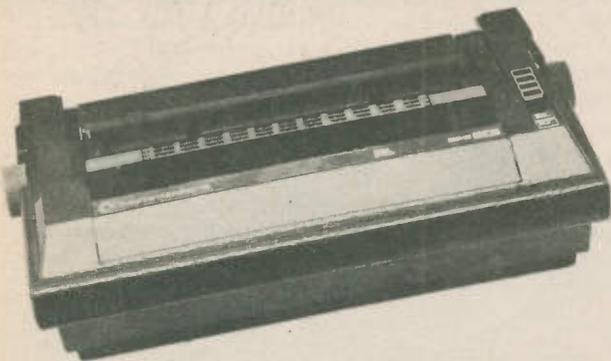
PRINTER BUYER'S GUIDE....



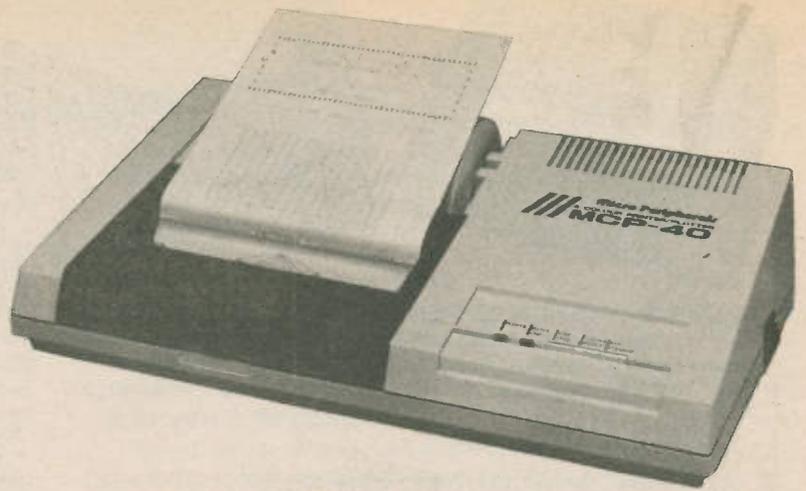
Model: Epson P-40 **Print format:** Thermal **C.P.S.:** 45
Interface: Serial/Parallel **Paper:** 250mm Thermal/Friction
Notes: Bit-image Graphics **Price:** £95+VAT **Supplier:**
 Epson (UK) Ltd., Dorland House, 388 High Rd., Wembley,
 Middlesex (01-902 8892)



Model: Electronic Compact RO **Print format:** Daisywheel
C.P.S.: 14 **Interface:** RS232/Centronics **Paper:** 305mm
 Friction/Tractor **Notes:** Software available **Price:**
 £399+VAT **Supplier:** Intelligent Interfaces, 436 Wood St.,
 Stratford-upon-Avon, Warwickshire (0789 296879).



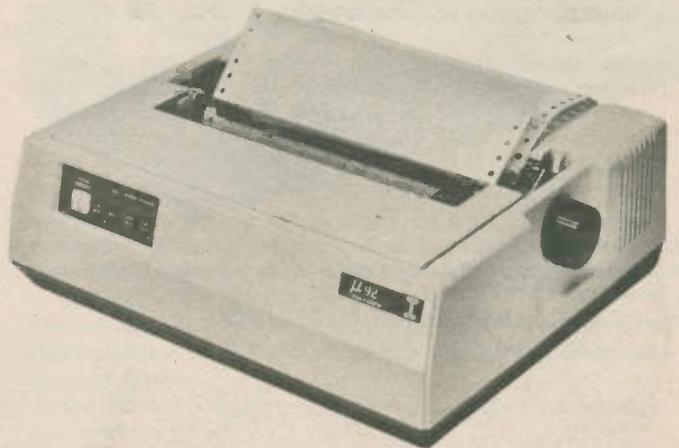
Model: Commodore DPS 1101 **Print format:** Daisywheel
C.P.S.: 18 **Interface:** Serial (Commodore) **Paper:** 303mm
 Friction **Notes:** Interface option **Price:** £399 inc. VAT
Supplier: Commodore, 1 Hunters Rd., Weldon, Corby,
 Northampton (0536 205252).



Model: Micro Peripherals CPP 40 **Print format:** Pens **C.P.S.:** 12
Interface: Centronics **Paper:** 115mm Friction **Notes:** MCP 40
 Illustrated **Price:** £99+VAT **Supplier:** Micro Peripherals, 69 The
 Street, Basing, Basingstoke, Hants (0256 473232).

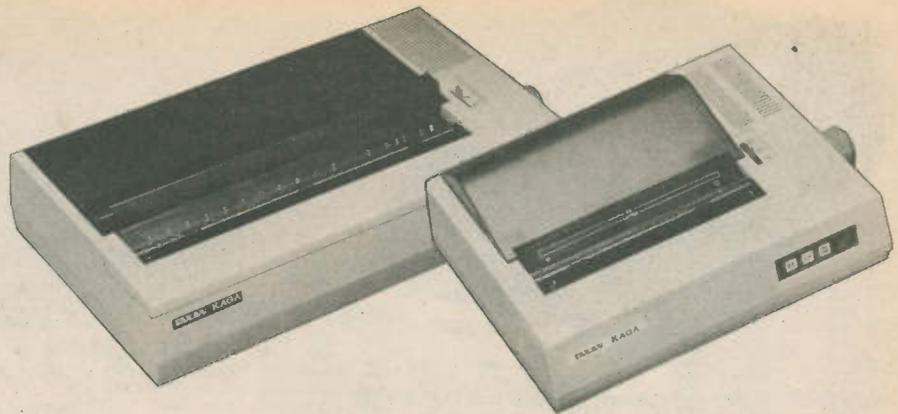


Model: Smith-Corona D100 **Print format:** Dot Matrix **C.P.S.:** 120
Interface: Centronics **Paper:** 270mm Tractor **Notes:** Friction option
Price: £249+VAT **Supplier:** Smith-Corona, Unit 23, Northfield Ind
 Est., Beresford Ave., Wembley, Middlesex (01-900 1222).



Model: X-Data Microline 92 **Print format:** Dot Matrix **C.P.S.:**
 160 **Interface:** Centronics **Paper:** 240mm Tractor/Friction **Notes:**
 Various interfaces and feeds **Price:** £429+VAT **Supplier:** X-Data,
 750-751 Deal Ave., The Trading Estate, Slough, Berks (0753
 72331).

**PRINTER
BUYER'S
GUIDE.....**



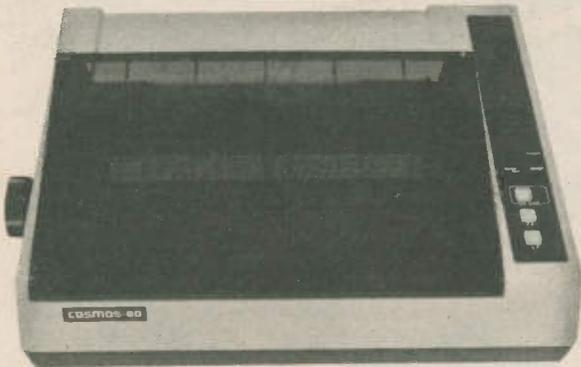
Model: Taxan Kaga KP 810, 910 **Print format:** Daisywheel **C.P.S.:** 140 **Interface:** Centronics **Paper:** 240mm Friction **Notes:** Serial option **Price:** £319, £399+VAT **Supplier:** Data Efficiency, Finway Rd., Hemel Hempstead, Herts (0869 253361).



Model: Diablo 620 API **Print format:** Daisywheel **C.P.S.:** 20 **Interface:** RS232/Centronics **Paper:** 309mm Friction **Notes:** Tractor option **Price:** Not known **Supplier:** Geveke Electronics, Landsbury Est., 102 Lower Guildford Rd., Knaphill, Woking, Surrey (04867 88676).



Model: Silver Reed EXP500 **Print format:** Daisywheel **C.P.S.:** 16 **Interface:** Centronics/RS232 **Paper:** 330mm Friction **Notes:** Tractor option **Price:** £329+VAT **Supplier:** Silver Reed (UK) Ltd., Silver Seiko House, 19-23 Exchange Rd., Watford, Herts (0923 35616).



Model: Comos 80 **Print format:** Dot Matrix **C.P.S.:** 80 **Interface:** Centronics **Paper:** Friction/Tractor **Notes:** Serial option **Price:** £199+VAT **Supplier:** Quad Eight/Westrex, Unit 1, Fairway Drive, Greenford, Middlesex (01-578 0957).



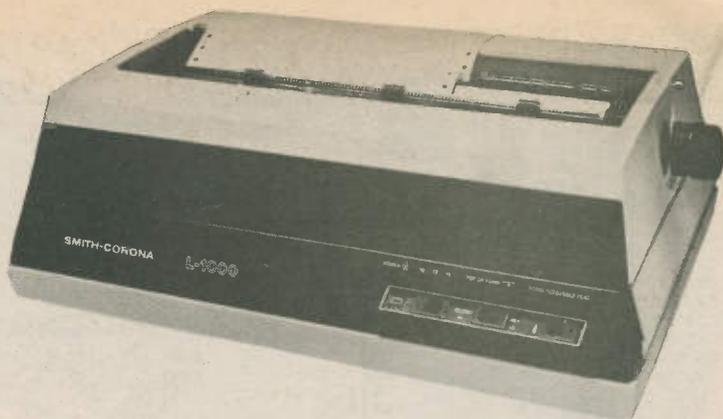
Model: Epson FX80 **Print format:** Dot Matrix **C.P.S.:** 160 **Interface:** Centronics **Paper:** 210mm Friction **Notes:** Serial option **Price:** Not known **Supplier:** Epson (UK) Lt., Dorland House, 388 High Rd., Wembley, Middlesex (01-902 8892).



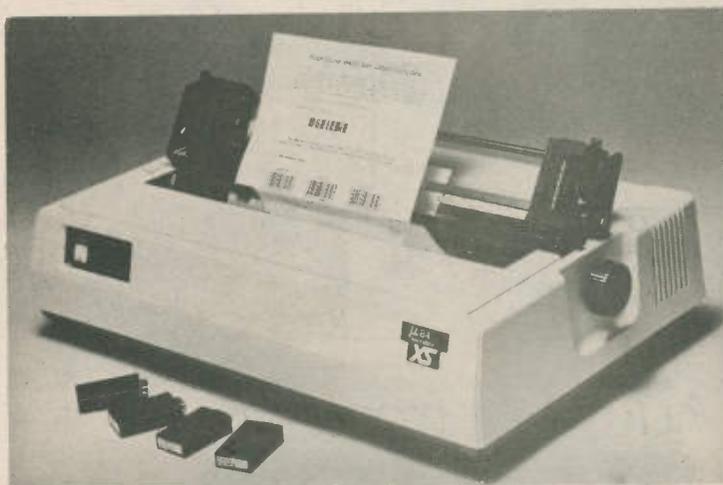
Model: Honeywell L38 **Print format:** Dot Matrix **C.P.S.:** 400 **Interface:** Centronics Compatible **Paper:** 381mm Tractor **Notes:** Adjustable tractor **Price:** £438+VAT **Supplier:** Geveke Electronics, Landsbury Ind. Est., 102 Lower Guildford Rd., Knaphill, Surrey (04867 88676).



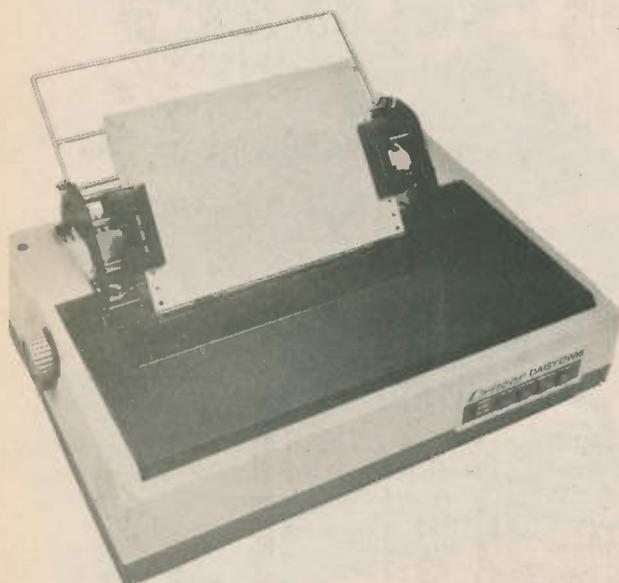
Model: PhiPrint **Print format:** Thermal Dot **C.P.S.:** 20
Interface: Centronics **Paper:** 112mm **Thermal Notes:**
 Bit-image graphics **Price:** Not known **Supplier:** Phi
 Mag Systems Ltd., Trigonigie Ind. Est., Falmouth,
 Cornwall (0326 76060).



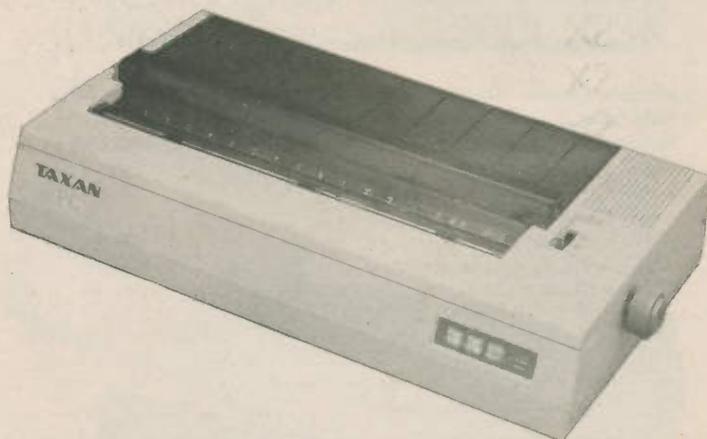
Model: Smith-Corona L1000 **Print format:** Daisywheel
C.P.S.: 12 **Interface:** Centronics/Serial **Paper:** 330mm
Friction Notes: Tractor option **Price:** £260+VAT **Supplier:**
 Smith-Corona, Unit 23, Northfield Ind. Est., Wembley,
 Middlesex (01-900 1222).



Model: X-Data Microline 84 **Print format:** Dot Matrix **C.P.S.:** 200
Interface: Centronics **Paper:** 308mm **Friction Notes:** Serial interface option
Price: £489+VAT **Supplier:** X-Data, 750-751 Deal Ave., The Trading
 Estate, Slough, Berks (0753 72331).



Model: X-Data DW16 **Print format:** Daisywheel **C.P.S.:** 16
Interface: Parallel/Serial **Paper:** 300mm **Friction Notes:**
 Tractor option **Price:** £329+VAT **Supplier:** X-Data, 750-751
 Deal Ave., The Trading Estate, Slough, Berks (0753 72331).



Model: Taxan KP 910PC **Print format:** Dot Matrix **C.P.S.:**
 140 **Interface:** Centronics **Paper:** 390mm **Friction/Tractor**
Notes: Various types **Price:** £499+VAT **Supplier:** Data
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BBC Micro Forum...

David Whitfield MA MSc CEng MIEE

THIS MONTH, in *BBC Forum*, we are looking at how to build an 8-line driver for the user port. The interface described will allow you to drive a range of external hardware (such as relays and lamps, etc.), and will also serve as a useful buffer between your micro and the outside world. Then, if anything does go wrong, it is an external interface in need of repair, rather than a micro which requires return to a service centre for attention.

As mentioned last month it is our intention in these pages to look at the hardware behind the port, so that the why and the how of the interfacing techniques become a little clearer. We will begin, therefore, with a look at the user port. To do this, however, an introduction to the system as a whole is necessary.

INSIDE THE BBC MICRO

What goes on inside the BBC Micro is often a complete mystery to many owners. Indeed, the fear of an invalidated warranty often prevents even the lid being taken off for inspection. On the other hand an engineer has been described as someone whose first action with a new 'toy' is to dismantle it. Most owners fall somewhere between these two extremes, although your scribe tends towards the latter extreme. If you venture inside the case, however, the view is of a keyboard, power supply, and a large double-sided printed circuit board, and you may be left little the wiser. The problem here is the traditional one of not being able to discern the wood for the trees. The components may be familiar, if only by repute, but what do they all do?

In simple equipment, the usual approach is to try to work out the design by seeing what everything is connected to, but this seems rather inappropriate in this case. Anyone trying this with anything as complex as a micro is assured of hours of entertainment, but may be left little the wiser if the exercise is undertaken without at least a few hints and pointers.

Fig. 1 shows the overall block schematic for the BBC Micro. We shall be referring back to parts of this complete picture many times in the future when we look at the various interface ports, but for the moment the drawing is presented in its entirety to serve as a reference. Rather than attempt to describe the system's configuration in one month, we will confine ourselves to looking at any new area as we meet it, month by month. For readers who wish to look further into the design of the micro, there are now many good books available, and we shall be including brief reviews of a selection of useful books in future columns. For the moment our concern is with

the user port, so let us look a little closer at what lies behind the port.

THE USER PORT

The hardware in the BBC Micro is memory mapped, which means that the registers in the hardware devices (i.e. in the interface hardware inside the computer) appear as addresses in the main memory. It also means that the registers may be set-up/read-back using ordinary CPU write/read instructions. There are in fact 3 pages of addresses which have been reserved for memory mapped hardware operations; a page is 256 bytes of memory, starting at an address which is a multiple of 256. The addresses from &FE00 to &FEFF (page &FE) are reserved specially for the system hardware. This page of memory has been given the name 'SHEILA', while two other pages (&FC = 'FRED' and &FD = 'JIM') have been reserved for use with the 1MHz bus. Be assured that these names are not misprints! The 256 addresses within Sheila are allocated as shown in Table 1.

Address (Hex)	Description
FE00-07	Video controller
FE08-0F	Serial controller
FE10-1F	Serial ULA
FE20-2F	Video ULA
FE30-3F	Paged ROM selector
FE40-5F	System VIA
FE60-7F	User VIA
FE80-9F	Floppy disc controller
FEA0-BF	ECONET controller
FECO-DF	A-to-D converter
FEEO-FF	Tube interface

Table 1. Sheila addresses

Looking at Fig. 1 and Table 1, we see that the user port is connected to the user VIA (Versatile Interface Adaptor), which is allocated addresses FE60-FE7F. This VIA has two sections (A and B) which are used for the printer and user ports, respectively. As shown last month, all of the port B lines (i.e. PB0-PB7 and CB1/2) appear on the user port connector (on even-numbered pins 6-20 and 2/4, respectively). The circuit behind the connector (see p. 503 of the User Guide) shows that there are *direct* connections from the VIA pins to the user port's connector.

The 6522 is a 40-pin pack which contains two 8-bit programmable bidirectional ports (A and B), two 16-bit programmable timer/counters, a serial-parallel shift register and latched I/O registers. It must be said that the VIA is

an extremely complex device, *but* its basic features are really quite easy to use for most applications. Let us have a look therefore at some of the VIA's basic features to see how they can be used.

The 8 lines in the B port can be individually programmed as inputs or outputs using the Data Direction Register (DDRB). When the VIA is reset (as when the BREAK key is pressed, for example), all of the lines are programmed as inputs. Table 2 shows that DDRB is VIA register 2, which appears as address &FE62 (i.e. &FE60 + register number). Setting a bit to a 0 in DDRB configures the corresponding I/O line as an input, while a 1 makes it an output. Thus, for example, writing &F0 to DDRB will set PB7-4 as outputs and PB3-0 as inputs. Each time a new byte is written to DDRB, it overwrites the previous settings.

Address (Hex)	Register Number	Designation
FE60	0	ORB/IRB
FE61	1	ORA/IRA
FE62	2	DDRB
FE63	3	DDRA
FE64	4	T1C-L
FE65	5	T1C-H
FE66	6	T1L-L
FE67	7	T1L-H
FE68	8	T2C-L
FE69	9	T2C-H
FE6A	10	SR
FE6B	11	ACR
FE6C	12	PCR
FE6D	13	IFR
FE7E	14	IER
FE7F	15	ORA/IRA

Table 2. User VIA Registers

The data lines which have been configured as outputs may be set high or low by writing 1 or 0, respectively, to the output/input register ORB/IRB at address &FE60. Writing a value to a line configured as an input will have no effect. Sensing the state of a line configured as an input is accomplished by reading from &FE60. So much for how to control the PB0-PB7 data lines, but how can we use them as outputs to drive real loads?

8-LINE DRIVER

The I/O lines on the B port are capable of sourcing up to 1mA at 1.5 volts in output mode, while in the low state they can sink up to one standard TTL load of 1.6mA at 0.4 volts. This is not enough to drive the majority of 'real-life' loads, but it does allow the

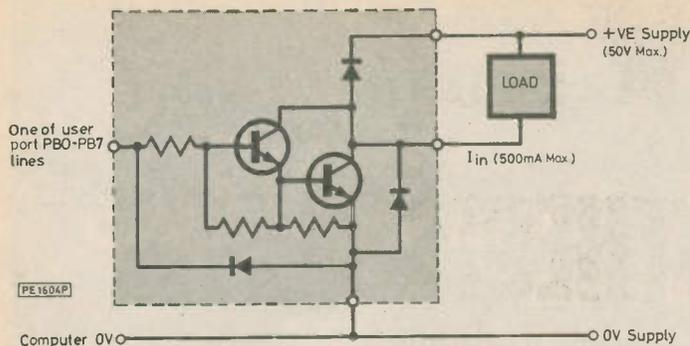


Fig. 2. Darlington driver

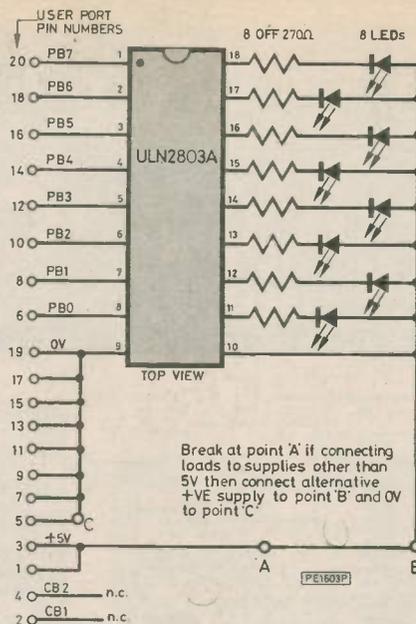


Fig. 3. 8-line output driver

month, this type of direct programming of the hardware is not the only way to control the system's hardware (and is certainly not the recommended method for compatibility with 2nd processors, etc.), but it is a simple and effective demonstration (after all this is not a software column!). A reminder in passing is that, at start-up, PB0-7 are configured as inputs, and the driver behaves as if these are outputs set to logic 1, so beware that the loads will all be on! The driver described next month will overcome this problem.

FINALLY

It is now over to you to develop some practical applications for this unit. Your scribe's test project involved some flashing lights for the festive season, but the range of applications for this simple interface is enormous.

NEXT MONTH

We have looked at how to connect the computer to the outside world. Next month we look at a more sophisticated interface, and then move on to connecting inputs to the micro.

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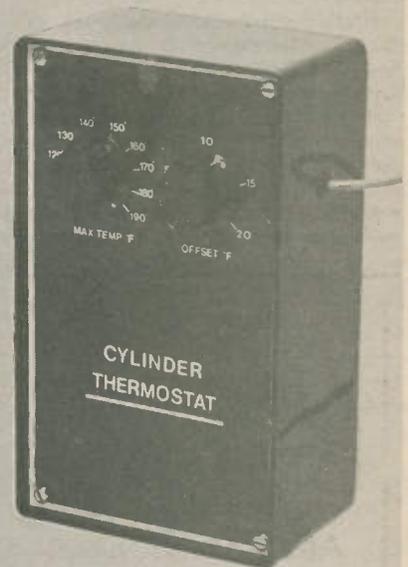
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THE LEADING EDGE

BLACK WATCH ON WHEELS?

What surprises me about the Sinclair car, or more accurately pedal-powered side-car with battery on board, is how no-one seems to have done the obvious and simple sums. It brings to mind one of Sir Clive Sinclair's past disasters, the 'Black Watch'. People who bought construction kits found the component parts too large to fit into the housing.

No launch in history can ever have been so widely leaked as the Sinclair vehicle. But even after the launch, at which a very nervous Sir Clive corrected the press, people were still reporting that the drive motor is a modified Hoover washing machine motor.

It is *not*. It is a 12V d.c. brush motor made by Polymotor, an Italian subsidiary of Philips. This motor uses ceramic permanent magnets, a 2-pole commutator and a pair of brushes.

To comply with the Government 1983 regulations for electrically or assisted cycles, which allow untaxed, uninsured, untrained, unbelted, unhelmeted, 14 years olds or disqualified drivers to drive and park with impunity, the onboard motor must have a maximum power consumption of 250 watts.

The Polymotor drive has a maximum free running speed of 4100 rpm; the 250W rating is for continuous running at 3300rpm. This is geared down in two stages (epicyclic and belt) by a ratio of 13:1. Obviously this is necessary to increase torque.

The front brake is a bicycle calliper and the rear brake is a drum. There is no attempt at recharging the battery with regenerative braking. So all inertial energy is lost as heat when the brakes are applied.

For no-load 250W running, the motor is drawing just over 20 amps from a 12 volt battery. When the motor starts to work, for instance over grassy ground or up a slight incline, the current drain increases to 80 or 90 amps.

When the motor is labouring, it gets slower and slower with increasing torque until there is maximum torque at stall speed. At this point 140 amps are running through the windings.

Obviously this would very soon burn out the motor and drain the battery, probably buckling the plates. So the Sinclair vehicle has a chip which integrates current and time whenever the battery is connected.

At stand still with 140A drain, this circuit trips a relay after around 4 seconds. At 80 or 90A consumption it trips in two or three minutes. At high running speed, with minimal load, there is no need for tripping. Warning lights tell the driver to "get pedalling" as an early warning before switching the relay.

Because the vehicle body and component parts are moulded from plastics, which will melt and might even burn if there is

serious overheating, there are two back up systems for the control chip. The first back up is a temperature sensitive thermistor mounted in a probe inside the motor housing. The second back-up is a primitive bi-metallic strip on the housing.

PEDAL POWER

The battery is a 35 ampere hour lead acid unit. This is around the size of a car battery. The press and media have talked about 20 or 24 miles per charge. Sinclair's own publicity material puts the range for a single battery charge at "up to 20 miles" and promises "one thousand miles running for the average price of a gallon of petrol".

Although strictly true these claims are very misleading and are bound to be mis-reported by the popular media. There is no way in the world that a 35 ampere battery can run the vehicle over average terrain for 20 miles on a single charge, unless the driver is doing most of the work with pedals. Without pedalling, and with starts, stops and slopes without regenerative braking, the driver will be lucky to get more than a few miles.

Sinclair might just as well have claimed 200 or 2000 miles per charge, for all the sense the 20 mile claim makes. With almost 100 per cent pedalling, the battery could stay charged for hundreds of miles.

Is this a joke? someone said to me at the press conference. Someone else had a wonderful idea. Summer holiday camps should buy a fleet of these vehicles, keep them permanently on charge and let campers drive them round the safe private roads and pathways, like dodgem funfair cars.

A nice idea, but by no means what Sir Clive Sinclair has in mind. He says he stands to lose around £7 or £8 million of his own money. Personally I should think that loss is a guaranteed certainty.

VIDEO CHANGE

Watch out for a major change in policy from Philips over LaserVision. The company is now going to stop trying to flog a dead horse and sell its videodisc system as a dumb carrier for feature films.

If videodisc had come on the market before video tape, everyone would have raved about the clear pictures, clean sound and convenience of use. They would have bought a videodisc player first and then bought a video tape recorder when they later became available.

But because videodisc came late on the market there was already a large park of video recorders in people's homes. Libraries by then were renting feature films on pre-recorded video tape. Not surprisingly only a very few people were prepared to buy videodisc instead of, or as well as, video tape.

Foolishly RCA and Hitachi tried launching their technically primitive, grooved capacitance disc system, CED. Predictably it failed commercially.

Wisely Thorn EMI decided not to launch JVC's VHD grooveless capacitance disc system on the domestic market. Instead Thorn invested money in producing interactive programmes, so that industry and education could use VHD players under computer control with interactive programmes. But still Philips spent a fortune trying to persuade the public to watch films on optical videodisc.

In 1984 Philips cut player prices to less than half the original 1982 launch price of £500. Because film companies didn't think it was worth issuing and distributing programmes on videodisc for the few people buying players, Philips cooked up a convoluted subsidy system.

The film company pays Philips' disc pressing plant in Blackburn to press discs. Philips then buys the discs from the film company and tries to sell them to the public through trade dealers. In return for making programmes available, the film companies get guaranteed payment and Philips shoulders the burden of selling the unsaleable mountains of discs.

In July 1984 Philips claimed that LaserVision sales were "double" those for the corresponding period for 1983 and that disc purchases had "greatly increased". But the company would not say double what or quantify the great increase!

Now the Philips headquarters in Eindhoven has taken a hand. It has sold a large quantity of players to China, which uses the same PAL TV system as Britain, and has cancelled a domestic launch in France.

Philips subsidiaries in Britain, Germany, Holland, Austria and Switzerland, where LaserVision is already on sale, have been told that they must adopt a completely new strategy. Instead of pushing the system for feature films, they must spend money on developing its potential for interactive video, and at the same time try to sell to specialist markets. This is exactly what Thorn EMI has been doing all along.

Philips in Britain has struck a deal with the BBC, whereby Philips puts up £0.5 million to help the BBC produce a modern version of the Doomsday Book on videodisc. Philips has also mailed out 90,000 direct advertisements to opera and ballet lovers, using the subscription lists from Covent Garden, Glyndebourne and the National Opera, offering them performances on disc at around £20 a time.

Now Philips is looking at other specialist groups, like fishermen, naturalists, sports enthusiasts and car buffs. Although Philips says bravely that some feature films will still be issued, it's clear that this market is being phased out.

The specialist ploy could well work. The only puzzle is why Philips spent so long and so much money flogging what was so obviously the dead horse of feature film release.

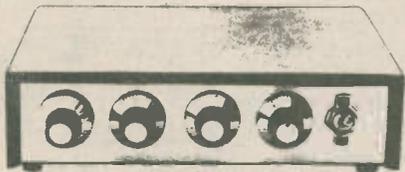
BARRY FOX

BAKERS DOZEN PARCELS

All the parcels listed below are brand new components. Price per parcel is £1.00, but if you order 12 you get one extra free.

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- 2 - 5 13 amp ring main spur boxes
- 3 - 25 13 amp fuses for ring mains
- 4 - 5 surface mounting switches suitable insulated for mains voltage
- 5 - 3 flush electrical switches-intermediate type, will also replace 1 Or 2 way switches
- 6 - 5 in flex line switches
- 7 - 4 in flex line switches with neons
- 8 - 2 80 watt brass cased elements
- 9 - 2 mains transformers with 6v 1a secondaries
- 10 - 2 mains transformers with 12v 1/2a secondaries
- 11 - 1 extension speaker cabinet for 6 1/2" speaker
- 12 - 5 octal bases for relays or valves
- 13 - 12 glass reed switches
- 14 - 4 OCP 70 photo transistors
- 15 - 25 assorted germanium transistors OC45 etc
- 16 - 4 tpaee heads, 2 record, 2 erase
- 17 - 2 ultra sonic transmitters and 2 ditto receivers
- 18 - 2 15000 mfd computer grade electrolytics
- 19 - 2 light dependent resistors similar ORP12
- 20 - 5 diff micro switches
- 21 - 2 mains interference suppressors
- 22 - 2 25 watt crossover units
- 23 - 1 40 watt 3 way crossover unit
- 24 - 250 various screws and self tappers
- 25 - 1 of each wafer switches - 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
- 26 - 2 tape deck counters
- 27 - 16 digit counter 12v
- 28 - 1 6 digit counter mains voltage
- 29 - 1 BOAC in flight stereo unit (second hand)
- 30 - 2 Nicad battery chargers
- 31 - 1 key switch with key
- 32 - 2 humidity switches
- 33 - 2 aerosol cans of ICI Dry Lubricant
- 34 - 96 x 1 meter lengths colour-coded connecting wires
- 35 - 4 battery operated model motors
- 36 - 2 air spaced 2 gang tuning condensers
- 37 - 2 solid dielectric 2 gang tuning condensers
- 38 - 10 compression trimmers
- 39 - Long and Medium wave tuner kit
- 40 - 4 x 465 KC IF transformers
- 41 - 8 Rocker Switches 10 amp Mains SPST
- 42 - 6 Rocker Switches 10 amp Mains SPDT
- 43 - 5 Rocker Switches 10 amp SPDT Centre Off
- 44 - 4 Rocker Switches 10 amp DPDT
- 45 - 1 24 hour time switch mains operated
- 46 - 1 6 hour clockwork timeswitch
- 47 - 2 lever switches 4 pole changeover up and ditto down
- 48 - 2 6v operated reed switch relays
- 49 - 10 neon valves - make good night lights
- 50 - 2 x 12v DC or 24V AC AC0 relays
- 51 - 1 x 12v 2C 0 very sensitive relay
- 52 - 1 x 12v 4C 0 relay
- 53 - 2 mains operated relays 3 x 8 amp changeovers (secondhand)
- 54 - 10 rows of 32 gold plated IC sockets (total 320 sockets)
- 55 - 1 locking mechanism with 2 keys
- 56 - Miniature Uniselfactor with circuit for electric jigsaw puzzle
- 57 - 5 Dolls' House switches
- 58 - 2 telephone hand sets incorporating ear piece & mike (s/hand)
- 59 - 2 flat solenoids - ideal to make current transformer etc.
- 60 - 5 ferrite rods 4" x 5/16" diameter aeriols
- 61 - 4 ferrite slab aeriols with L & M wave coils
- 62 - 4 200 earpieces
- 63 - 1 Mullard Thyristor trigger module
- 64 - 10 assorted knobs 1/4 spindles

SOUND TO LIGHT UNIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/4" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested.

MINI MONO AMP

on p.c.b., size 4" x 2" (app.) Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.



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Some of the features are: long wave band 115 - 270 KHz, medium wave band 525 - 1650KHz, FM band 87 - 108MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod is included for medium and long wave bands. All made up on very compact board Offered at a fraction of its cost: **only £6.00** + £1.50 post + insurance.

25w SPEAKER SYSTEMS

By Amstrad

25 watt RMS loading 8" woofer, 4" tweeter with crossover. £12.00 per pair + £4 post. New and unused but cabinets slightly damaged hence this low price, carry our normal guarantee.

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By LAMDA (USA) - Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% - load regulation 1% from no load to full load - or full load to no load. Complete in heavy duty case - Models available: 5v .9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

25A ELECTRICAL PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake - switch on lights to ward off intruders - have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50.

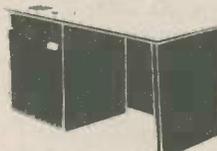
THIS MONTH'S SNIP

TOP OF THE POPS LIGHTING if you use our disco switch

These have 12 x 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately one third of cost. **ONLY £6.90**

COMPUTER DESKS

Again available. Computer desks - size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 - you must collect - hundreds supplied to schools.



FROZEN PIPES. Can be avoided by winding our heating cable around them - 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price 28p/metre or 15m for £3.95

FLEXIBLE EXTENSION LEAD twin rubber 5mm ideal grass cutter etc. 250 metre coil £25.00. 50 metre coil £6.75.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphones/microphones, nicad charger, power unit, 90% are unused components. **YOURS FOR ONLY £11.50 plus £3.00 post.**

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 - 4"x 4" Muffin 115v. £4.50. 230v. £5.75. Post 75p.
- All the above ex-computer, those below are unused. 4" x 4" £8.50. Post 75p. 9" American made £11.50. post £2.00. Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.



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A/12	— Assembled	£21.85			
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AV 15	Final Stage Amplifier 15 Watts	£3.30	5000µF 12v Radial	10 for £1.00	
AV 22	Final Stage Amplifier 22 Watts	£12.56	1000µF 10v DC Radial	15 for £1.00	
AV 50	Final Stage Amplifier 50 Watts	£14.61	220µF 40v Axial	15 for £1.00	
LNG 33	Power Supply Unit 2-30 V/2A	£15.84	25µF 50v Axial	20 for £1.00	
K 13	— Cabinet	£7.98	47µF 63v Axial	20 for £1.00	
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C 4000	C-Mos Trainer	£37.23			
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"Rugby"

PART 1 · Stephen Ibbs

Controlled Clock

THE National Physical Laboratory at Teddington in Middlesex contains one of the master time standards that exist around the world, others being in Germany, Canada, U.S.A., etc. These are maintained and referenced to each other so that all precision timings can be related to a known constant. The actual definition of the SI unit of time, the second, was decided in 1967 at the 13th General Conference of Weights and Measures as: "the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the Caesium 133 atom" . . . out goes Big Ben!!

The 1Hz signal derived from the standard is transmitted as a radio signal from Rugby, and is coded by interrupting the carrier wave with 100 or 200ms breaks to indicate a binary 0 or 1, the binary code containing information about the time, date, year, etc. The code is transmitted during each cycle of 1 minute, and becomes correct at the following 60th or 0 second, when the same information is sent again as a fast code on second 0. Originally, only the fast code was sent, with carrier interruptions only marking the start of each second, but the introduction of the slow code has enabled decoders to be designed with relative ease.

The time transmitted is UK CIVIL TIME, i.e. changing automatically for GMT and BST, and each minute contains the following information: minute, hour, day, date, month, year. In addition, data about GMT/BST indication, parity checks, etc., are sent by continuing some carrier breaks for an extra 100ms and seconds 1-16 transmit data about Universal time as obtained from the Caesium standard, and the time obtained from the earth's rotation.

Because the earth's rotation is not exactly uniform, the time obtained by these two forms of measurement varies, and the difference is transmitted as double carrier breaks, the number of seconds affected being multiples of 0.1 secs. in difference. Double breaks of seconds 1 and following show a positive difference . . . i.e., earth's rotational time is ahead of Universal time, and double breaks from seconds 9 and following show a negative difference. When either ex-

ceeds 0.8 secs., a 'leap' second is inserted or deleted at the 16th second during June or December. This happens every few years and readers may remember such an occurrence a short time ago. At the time of writing, the earth's rotational count is 0.1 sec. ahead of Universal time, indicated by one double break at the 1st sec. If the Rugby transmitter requires maintenance, this is scheduled for a few hours on the first Tuesday of the month.

This project will show how you can decode the time pips to produce a digital display of the date, hours, minutes and seconds. Further options will show how you can obtain the day information as well. It has been deliberately kept quite simple; consequently it will not be able to tell valid from invalid data, e.g., caused by radio interference, and it will obviously not display the correct time when 'Rugby' is off the air for maintenance. However, it will always reset itself as soon as it has received correct data. Green and yellow 7-segment displays have been used, and with a 'G' range Vero case, the result is a very smart and accurate clock that will baffle people because it has no setting buttons!

CIRCUIT DESCRIPTION

The circuit (Fig. 1) for this receiver was designed by John Robinson, to whom many thanks are extended for permission to publish it here. It should be stated at the outset that if readers have not had any experience of building an RF project, they might find some of the construction details a little awkward. For this reason the decoder has been designed to accept a receiver kit that can be purchased from 'Cirkit' and built without special test equipment.

This design is not difficult to build and align if an oscilloscope is available. L1, C1 and C3 form a resonant circuit, tuned by C3 to 60kHz, the frequency of the Rugby transmission. Pin 11 and 10 of IC1e are joined together and, being an inverter gate, the only stable state it can maintain is exactly $\frac{1}{2}$ supply voltage. Thus it acts as a very stiff bias source for pin 9 of IC1d, L1 providing the d.c. path. This causes IC1d to perform within its linear region, acting as an



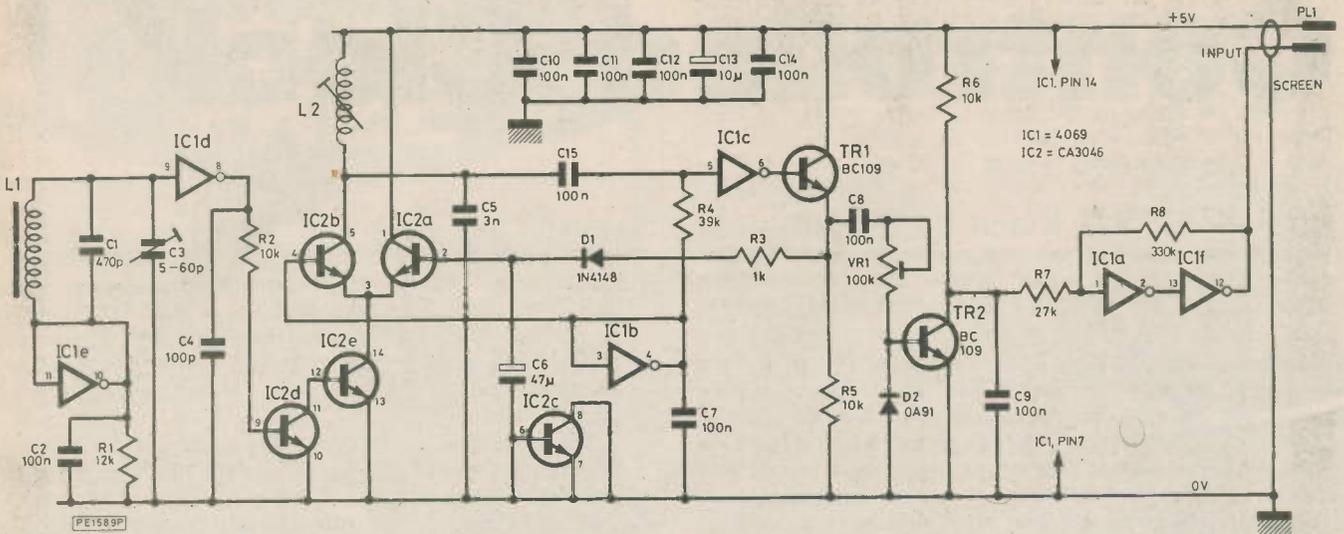


Fig. 1. Circuit diagram of the Receiver

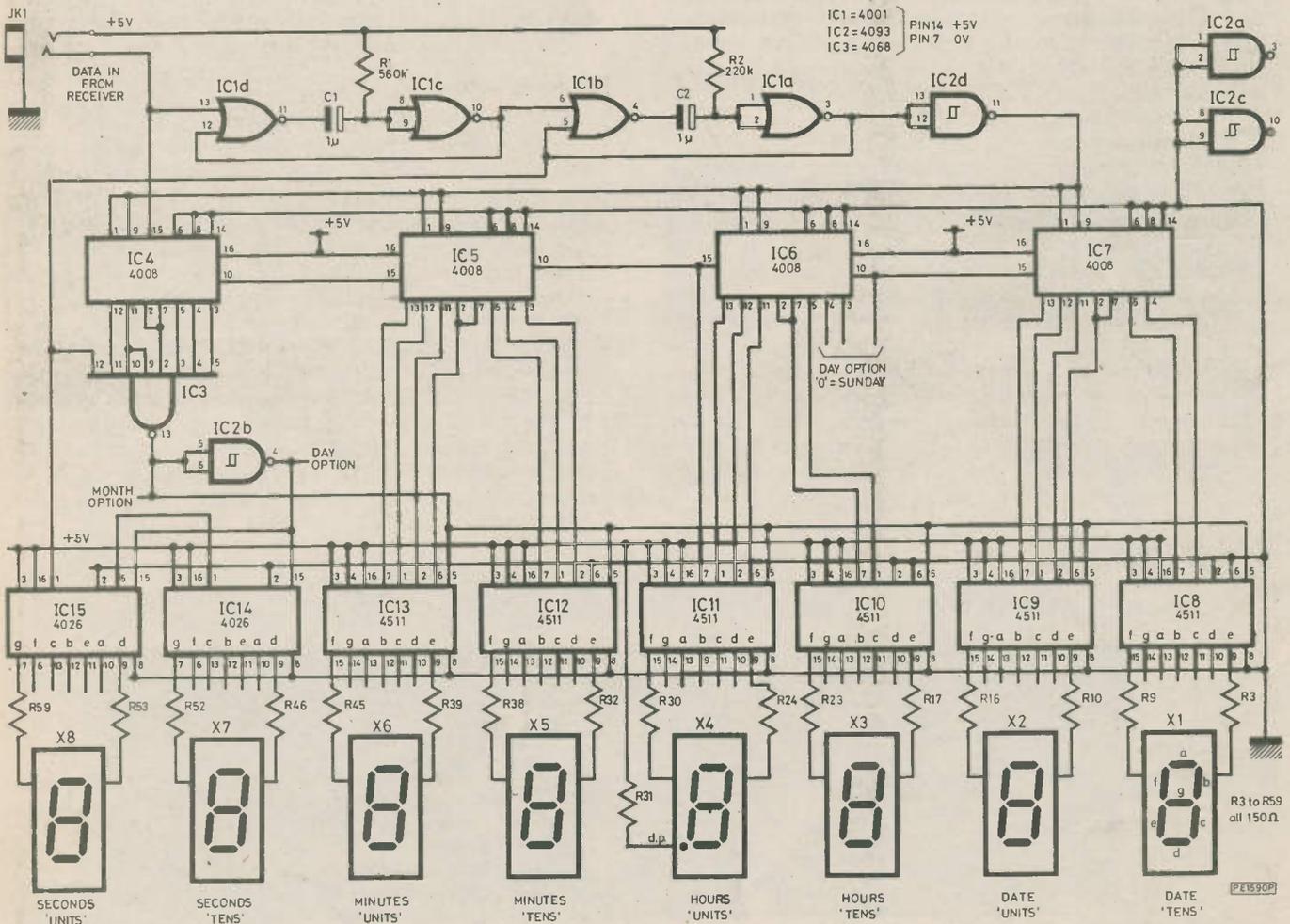


Fig. 2. Circuit diagram of the Decoder

amplifier for the received signal. The signal is further amplified by two transistors contained within the 3046 before being fed to the emitters of the long-tailed pair of transistors, one of which has L2 as its collector load, tuned to 60kHz by a ferrite core.

The signal then goes to IC1c, again biased into its linear region by IC1b, where it is amplified before being fed into the emitter-follower TR1, acting as a buffer. Feedback is provided by R3, D1 and C6 for stability, and the signal goes into TR2. VR1 acts as a gain control, and D2 cuts off the negative peaks. The Rugby pulses consist of breaks in the otherwise very pure carrier wave, and so during these breaks

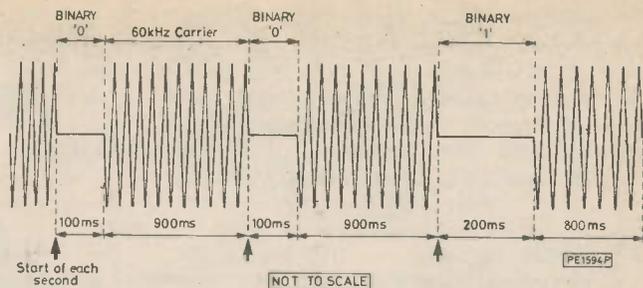


Fig. 3. The 'Rugby' pulse waveforms

COMPONENTS ...

DECODER BOARD

Resistors

R1	560k
R2	220k
R3-R59	150 (57 off) or 8 off d.i.l. resistor packs (RS 140-322)

Capacitors

C1, C2	1 μ tant (2 off)
--------	----------------------

Semiconductors

IC1	4001
IC2	4093
IC3	4068
IC4-IC7	4008 (4 off)
IC8-IC13	4511 (6 off)
IC14, IC15	4026 (2 off)

Miscellaneous

AEG/Telefunken yellow displays D353 (4 off)
 AEG/Telefunken green displays D352 (4 off)
 Soldercon pins
 P.c.b.s.
 Vero case G-range 3G
 3.5mm stereo jack plug and socket
 20mm fuseholder and fuse (250mA)

POWER SUPPLY

Capacitors

C1	2200 μ 16V elect
C2	220n
C3	2 μ 2 tant

Semiconductors

REC 1	1A bridge rectifier
IC1	7805

Miscellaneous

9V 1A transformer
 P.c.b.

DAY OPTION

Resistors

R1	150
----	-----

Semiconductors

IC1	4029
IC2	4051
7 red l.e.d.s	

RECEIVER

Resistors

R1	12k
R2, R5, R6	10k (3 off)
R3	1k
R4	39k
R7	27k
R8	330k
VR1	100k min. 3mm preset (Cirkit)

Inductors

L1	Ferrite rod (F14, 200mm, 10mm dia. Maplin) 40 s.w.g. wire
L2	CAN1A350EK (Toko)

Semiconductors

D1	1N4148
D2	0A91
TR1, TR2	BC109 (2 off)
IC1	4069
IC2	3046

Capacitors

C1	470p (see text)
C2, C7, C8, C9, C10, C11, C12, C14, C15	100n min, ceramic (9 off)
C3	5-60p trimmer
C4	100p ceramic
C5	3n ceramic
C6	47 μ tant
C13	10 μ tant

YEAR AND MONTH OPTION

Resistors

R1-R28	150 (28 off) or 4 off d.i.l. resistor packs
--------	---

Semiconductors

IC1	4015
IC2, IC3, IC4, IC5	4511 (4 off)

Constructor's Note

The Rugby receiver and Toko coil is available from Cirkit, Park Lane, Broxbourne, Herts. Receiver stock no. 40-06002.

The displays are available from AEG/Telefunken, 217 Bath Road, Slough, Berkshire.

TR2 will have nothing to amplify; consequently its collector will be pulled high by R6, taking with it pin 1 of IC1a. This gate, along with IC1f, is arranged as a Schmitt trigger to ensure a clean, fast rise and fall time to the final pulse train which then goes to the decoder board. When the carrier resumes, after either 100ms or 200ms, TR2 conducts, pulling pins 1 and 12 of IC1 down to 0V (Fig. 3).

DECODER

The circuit diagram of the Decoder is shown in Fig. 2. The reason for so many i.c.s is to avoid multiplexing the data into the display drivers. This can produce so much noise with the digits constantly switching, causing sudden current-dumping, that the 'Rugby' signal would be swamped by the noise.

The pulses coming from the receiver enter pin 13 of the first monostable formed by IC1c and d. This acts as a latch to prevent the circuit being triggered twice (by the double pulses), by lasting for approx. 600-700ms. Its output changes state at the same time as the trigger pulse, and fires another monostable, IC1a and b, which, after approx. 150ms, via IC2d, clocks the shift register formed by IC4 to 7. Note that a Schmitt trigger is specified for IC2d to ensure that the rise time is fast enough.

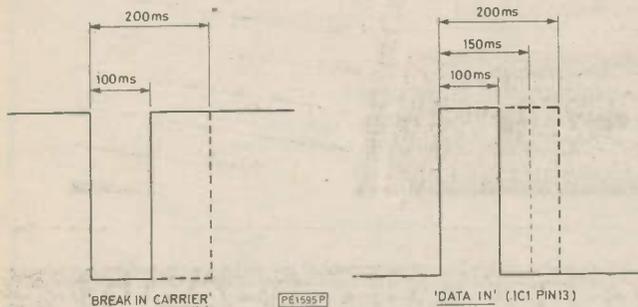


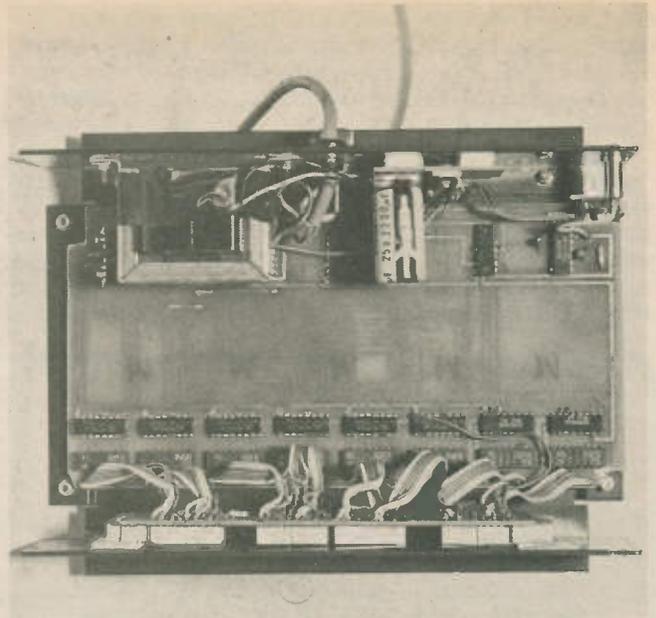
Fig. 4. Data level at pin 13 IC1

It will be seen from Fig. 4 that the data level sampled at pin 13 of IC1 (pin 15, IC4), 150ms after triggering will be the required '0' or '1'. On each subsequent clock-pulse, this serial data stream shifts through the eight outputs of each of the four registers cascaded together. Thus IC4 to 7 act almost as a serial to parallel converter because, on the 59th sec., the 32 output pins will be displaying the state dictated by the last 32 secs. of 'Rugby' pulses.

The six '1's from the framing pattern will form six of the outputs of IC4, and these are connected to seven of the inputs of a 4068 NAND gate. The 8th and final NAND input comes from the rising edge of the 60th sec. data pulse (taken from the 150ms monostable to avoid double-loading of data caused by the double pulses), at which point the output of the 4068 goes low, latching the data from the register outputs into the display drivers, providing the date, hours and minutes display.

SECONDS DISPLAY

The seconds display is produced by using the data pulses from the 150ms monostable to clock two cascaded BCD counters with built-in 7-segment decoders and display drivers. The '60th sec.' pulse from the 4068 is inverted and used to reset the counters so that they constantly re-cycle through 0-59. All the display drivers require current-limiting resistors and readers can either use separate resistors (150 ohms), which is the cheaper alternative, or, as in the



Internal view of the Decoder

prototype, d.i.l. resistor packs which are more expensive but much quicker to install, and give a neater finish. The decimal point of one of the displays is activated to mark the separation of the hours from the minutes.

POWER SUPPLY

The power supply (Fig. 5), being a standard transformer, bridge rectifier and regulator circuit needs little comment, but it is mounted on its own p.c.b. for safety reasons.

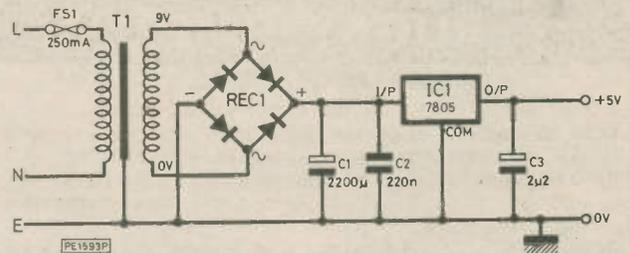


Fig. 5. Circuit diagram of the p.s.u.



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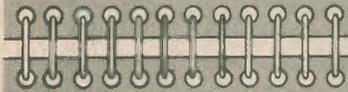
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INDUSTRY NOTEBOOK

By Nexus



Value for Money

The ever-rising cost of defence equipment is, or should be, a matter of concern for every taxpayer. The Ministry of Defence has, in fact, a newly aggressive stance to ensure value for money for every taxpayer's pound. The Minister himself, a successful businessman needs no lessons from the Chancellor or the Prime Minister in economic discipline.

Thus the move to open competitive tender of which the contract for Type 2050 sonars for the Royal Navy is a fine example. They are destined for Type 22 Batch 3 and Type 23 frigates.

The competition was won by Ferranti's Cheadle Heath Division who submitted four different proposals, that with Marconi as subcontractor being the Ministry selection. For Ferranti the contract is worth £24 million if successfully completed plus the possibility of export orders which could bring the total to £50 million or more.

Heady stuff, indeed! Ferranti has now become the prime contractor for Type 2050, the successor to Type 2016 in which the company was only subcontractor to Plessey. But all is not yet in the bag. When Ferranti has completed the first set to Ministry satisfaction the production of the remaining sets will still be open to competitive tender so that everyone will still need to be alert on performance not only in design and development but also on production.

The principal advances in technology to be incorporated in Type 2050 sonars are a switch from a single large mainframe computer to distributed processing using microcomputers and the use of digital instead of analogue signal processing. The latter will lean heavily on original work of the Admiralty research establishment.

Another welcome development in defence procurement is Thorn EMI's involvement in the development of a terminally guided warhead for the US Multiple Launch Rocket System (MLRS). Thorn EMI is in a consortium of French, West German and US companies on the project with

Thorn EMI's share being worth some £15 million.

It is the first major co-development programme under a Memorandum of Understanding between the four nations. The two-way street across the Atlantic which has been virtually one-way for many years could now start to have real substance.

Social Responsibility

Ferranti is actively recruiting engineers for the sonar contract and, in fact, most defence equipment contractors are constantly searching for new talent. But in the background is a debate that has been running for a number of years. Should an engineer use his talent for potentially destructive activities or, on principle, undertake only constructive or humanitarian work?

A number of the early atomic scientists, shocked at the monster bomb they created, pulled out. An extreme case, perhaps, but illustrating the point. It is estimated that 40 per cent of the world's scientists and engineers are engaged in one form or another on designing and building military equipment. So clearly very large numbers are prepared to tolerate if not actually relish such employment.

Social responsibility is very much a matter of personal conscience. The IEE lays down rules of conduct for professional engineers. A member's work should constitute no avoidable danger of death or injury or ill health to any person.

A member must also take all reasonable steps not to waste natural resources, and not to damage the environment. But lawful work in connection with equipment intended for the defence of a nation is not considered an infringement of the guidelines although it obviously, if the equipment is used in anger, kills people, wastes natural resources and damages the environment.

If one works in a munitions factory the choice is clear cut. One helps make shells, bullets and bombs or, if a pacifist in the true sense, one finds more congenial employment elsewhere.

For the scientist and engineer the position is ambiguous. The laser scientist is interested in lasers. They have many beneficial applications in fields as diverse as surveying and eye surgery. But also as military target markers and rangefinders, not to mention potential use in the US Strategic Defence Initiative, popularly described as 'Star Wars', although in this case they would be purely protective against incoming missiles and thus arguably humanitarian.

The communications engineer is in equal difficulty. His military radios may be used to order a salvo to be fired, aiding destruction. Or to call up an ambulance to save a life. Even civil broadcasting is used by many countries to poison the mind (evil) as well as to educate and entertain (good).

Sonar and radar have both peaceful and aggressive applications and the same may be said of any engineering discipline or any type of product. Even the humble toilet roll

gives aid and comfort to those engaged in military operations just as much as to those in the home.

It is worth remembering that the armed services have beneficial use in other than military operations. Hundreds of lives are saved annually by air-sea and mountain rescue military helicopters. Armies throughout the world are employed in natural disasters, building temporary bridges, providing transport and other relief facilities. Naval craft are often first on the scene of a shipwreck.

It is right that social responsibility should be a subject of discussion among engineers, always bearing in mind that even good intentions can have evil consequences. It could be argued from a high moral stand-point that the whole of Britain's defence industry should be closed down and the armed forces disbanded. But the resultant unemployment and economic disturbance would be disastrous for thousands of families immediately and for the whole nation in the event of attempted subjugation by a foreign power.

Cellular War

No moral dilemma was involved in Racal's decision to sponsor Grand Prix yachting as part of the publicity campaign for Vodafone. The 45ft craft with its 12-man crew is to compete under the name of Vodafone Venture '85 and is expected to provide a strong challenge in the classic Admirals Cup as well as other races during the working-up period.

Racal won the race to get Vodafone cellular radio into service a few days before rival Cellnet. No doubt Cellnet will be responding with some publicity ideas of like nature.

With so many new names around it is good to see that cellular radio has brought back a real old timer, Marconiphone. This brand name was popular in the 1930s on domestic radio receivers made in the Hayes factory of EMI alongside the HMV models. Both had the same chassis internally, the difference being in cabinet styling when a radio was a piece of furniture as well as a source of entertainment.

Marconi, the original owners I suspect, must have reacquired the brand name because it now appears as Marconiphone cellular products in a range of telephones for the cellular market.

How commercially successful the new service will be is anyone's guess at the moment. The other much-heralded innovation, the cabling of Britain, is proceeding more slowly than anticipated with no overnight fortunes being made. Cellular radio has the advantage of being directed, initially at least, to the professional person where the cost benefit equation is fairly easy to work out. Also to the well-heeled such as fellow competitors to Vodafone Venture '85. I recall yacht-racing once described as equivalent to standing fully clothed under a cold shower tearing up £5 notes. Cellular radio costs peanuts in comparison.

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

MY WELL-THUMBED copy of *Collins English Dictionary* which, I may have mentioned before, doubles as a doorstop, defines the word 'materialism' as 'interest in and desire for money and possessions rather than spiritual or ethical values'.

This is why I hesitated at first to label an old friend of mine, Dr. Max Smollett, a materialist. Nevertheless, that's what he is alright. But in quite another and much more complimentary sense of the moniker.

Dr. Smollett heads a tight-knit 45-strong team, of which 25-30 are qualified scientists and engineers, which forms the Central Materials Laboratory of the Philips organisation in the UK. In these modest numbers the Laboratory serves in many vital ways the 20-odd establishments that make up the manufacturing side of the group.

But let Max take up the story which puts into perspective the key role that materials research has played and is still playing in the forward march of electronic technology.

"We're organised into a number of groups," he said. "One of the most important in this safety-conscious age deals with hazardous materials and environmental hygiene. Here we're intimately concerned with the proper protection of the company's employees."

"Our hazardous materials adviser assists local plant managements on all aspects of the measurement and control of potentially dangerous situations arising from the use of various chemical products. He also works closely with the company's medical advisers and sites are visited regularly to inspect and advise on current procedures. Backing this activity we have an environmental hygiene co-ordinator whose field covers the legal situation, modification of production processes to reduce the quantity of materials discharged, the design of effluent disposal and treatment processes, air filtration, the storage of hazardous materials on site, water treatment, soil pollution and so on."

"Our development group works on what I'd call non-standard projects"

"The analysis and measurement of various materials used in the manufacture of Philips products is another of our responsibilities. We also undertake short-run pilot production of components and devices on an experimental basis. Particularly we concentrate on metals, chemicals, PCBs and ceramic boards."

"Our development group works on what I'd call non-standard projects. In other words,

those which do not fall easily into any other category. This group's job is to exploit new technologies in order to provide devices either for selling in the market place or for use in our plants. And all along the line we are adding to our knowledge and experience of new materials as they come into use.

"A wide range of services is provided by the metallurgical section. They include the manufacture of trial quantities of experimental alloys, the production of microsections for examination and interpretation, microhardness testing and advice on the metallurgical suitability of components and materials and quality checks in terms of mechanical properties and dimensions.

"Finally, there is our technical photography section which, among other tasks, produces high-precision artworks which have a role in the manufacture of thick film circuits, thermoelectric coolers, high-precision gratules and the photo-chemical etching of components."

New materials, many with exciting potentialities, are always coming on to the scene. At present CML is taking a long hard look at lithium niobate, used in the manufacture of surface wave filters. When suitably processed it can replace inductors, capacitors and resistors. And it can make a solid contribution to the continuing crusade for smaller size and volume of equipments.

With such a wide range of responsibilities and interests, CML needs and has an equally wide range of disciplines in its ranks. "Of course," said Max, "we have physicists. We also have chemists, some specialising in analysis, and other 'general' chemists who are undaunted by any problem, organic or inorganic, whether or not it involves materials to which they are accustomed. They really thrive on investigation. Then there are our metallurgists, plastic technologists and 'natural' engineers who are able to design engineering and mechanical processes."

Talking of the contribution made to electronics by materials research, Max said: "The range of materials in direct use in electronic equipment is far wider than you might suppose and stretches from silicon and germanium to high-grade plastics with electronic properties. But getting some of these materials into active use in equipment is no overnight job. It can take 10-15 years from conception to inception."

What does Max recall in the way of milestones in materials research? "There are several," he said. "One of them is the progress made in the purification of silicon. The present standard was undreamed of 20 years ago. The same goes for cadmium mercury telluride, used in the infrared sector. Here again, we have achieved remarkably high standards of

purity. But there are still problems to be licked. And licked they will be."

Anything exciting on the stocks? Currently CML is looking at the new molecular beam epitaxy machines (costing £500,000 a throw) which have the ability to build up a material atomic layer by atomic layer, thus revealing all kinds of properties that lie in the quantum mechanical field.

An example of this is to build up a material in such a way that instead of giving out an invisible ray of light when a voltage is applied, it can be constrained to emit light for different wavelengths. This means an entirely new dimension in physics. It means that materials can be tamed and controlled to a remarkable degree.

★ ★ ★ ★ ★

It seems likely, therefore, that the physicists of today will have to start learning new tricks. This, I suspect, is unlikely to put off Max Smollett. A man in his fifties, with a lifetime's association with electronics, he has seen plenty of changes, accepted them and added to his store of knowledge and experience.

"It seems likely that the physicists of today will have to start learning new tricks"

He took his doctorate at the Imperial College, London, in solid state physics, with a concentration on epitaxial layers, conditions of growth and stability, etc. Then, feeling he might benefit by getting out of his own backyard for a time, he applied for and won a 2-year scholarship in theoretical physics at the Sorbonne in France.

After that he began, at the ripe old age of 26, to think about a job. He hankered after an academic career, but jobs were scarce and the pay was low. So he offered his experience in semiconductor physics to the Mullard (now Philips) Research Laboratories at Redhill, Surrey, and joined them in 1953.

Then as the commercial markets began to open up he moved to the company's purpose-built semiconductor plant at Southampton. There he held a number of posts of great diversity working in the infrared field, in transistors and then, more recently, integrated circuits.

To his latest appointment he has brought an intimate acquaintance with many of the triumphs, setbacks, but always challenging phases in the development and high-speed advance of electronic technology.

Like others who take the reasoned view, Max Smollett believes that the standards of quality, reliability and long life that both manufacturers and consumers are seeking, in a greater degree than ever before, have their roots in the materials that industry sells and the public buys.

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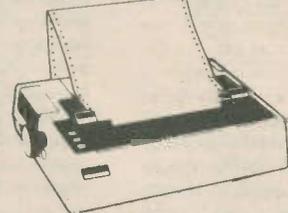
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PROGRAMMABLE VOLTAGE DETECTORS (ICL8211CPA & ICL8212CPA)

LAST month we looked at an i.c. which could monitor four voltage levels simultaneously in a very sophisticated way. This month we stay on the theme of voltage monitoring and look at a couple of fairly simple yet extremely useful programmable voltage detectors made by Intersil.

The ICL8211 and ICL8212 (the 'CPA' suffix simply refers to their temperature range and package type) are very low power bipolar i.c.s intended for precise voltage detection or generation. Each device contains an accurate voltage reference, a comparator, and a pair of output buffer/drivers. Fig. 1 shows the pinout for both i.c.s, and Fig. 2 their specifications.

BASIC OPERATION

The internal voltage reference for both i.c.s is nominally 1.15V. The voltage which is fed to the threshold input (pin 3) by the external circuitry is compared with this internal reference voltage. In the case of the 8211, when the threshold input voltage drops below the reference, the output turns on. The 8212 operates in the inverse mode; when the threshold input voltage rises above the reference, its output turns on.

The output for both i.c.s is an open collector npn transistor, with its emitter connected to 0 volt. Hence, when the output turns on, current will be sunk from the load into pin 4. The output of the 8211 is current limited to typically 7mA, which makes it suitable both for general use and for directly driving an indicator l.e.d. without the need for a series resistor. The output of the 8212 has no current limit, so care must be taken to avoid exceeding the 30mA maximum current shown in the specification. (An upper limit of 25mA is recommended in practice.) In both cases the load should be connected between a positive supply rail (not necessarily the i.c.'s own supply: the load supply should not exceed +30 volts, however) and pin 4.

TYPICAL USE OF THE I.C.s

Fig. 3 shows a typical application of the 8211. (Assume that R3 is omitted for the moment.) A potential divider, R1 and R2, across the supply rails feeds a voltage to the threshold input of the i.c. If this voltage drops below 1.15V the output of the i.c. turns on, sinking typically 7mA from the 'low voltage' warning l.e.d. into pin 4. The values of R1 and R2 are chosen to scale the voltage at pin 3

such that the i.c. output turns on at the required supply voltage. The i.c. itself can work over a range of 2.2 to 30V, allowing considerable flexibility in the range of voltages which can be monitored. The values of R1 and R2 are determined by:

$$\text{Supply voltage to cause i.c. to 'trip'} = \frac{1.15(R1 + R2)}{R1}$$

The current which is allowed to flow down the resistor chain could be as high as 50µA. On the other hand, an obvious application of the i.c. is in monitoring battery voltages, where high current consumption is undesirable. Both i.c.s are optimised for low quiescent current consumption in their 'output turned off' state (22µA for the 8211 and 20µA for the 8212) to minimise their effect on battery life. Hence, a very low resistor chain current is to be aimed for when designing within battery powered systems. The practical minimum is 6µA, since currents below this become comparable with the input current at pin 3 of the i.c., and inaccuracies can result. In conjunction with the equation shown above for the 'trip' voltage, we can therefore add the current determining equation:

$$\text{Resistor chain current} = \frac{\text{supply voltage}}{(R1 + R2)}$$

(i.e. 0.00006A up to 0.00050A)

HYSTERESIS

Both i.c.s have a low current switched output, the 'hysteresis' output, connected to pin 2. This is an open collector pnp transistor with its emitter connected to the positive supply rail, and is switched on (causing pin 2 to be pulled up to near the positive supply) for input voltages to pin 3 in excess of the nominal 1.15V. It can be used with simple feedback arrangements (for example, R3 in Fig. 3) to provide some positive feedback, or hysteresis, around the i.c. The hysteresis ensures that once the i.c. output has turned on, the input voltage has to change by a considerable amount before the i.c. will turn off again. This is very useful in stopping oscillation or 'hunting' around the threshold point. In the case of 8212 without hysteresis, for example, the i.c. turns on as soon as the threshold input exceeds 1.15V. This causes the output to be turned on, sinking current from the load, which as a result might cause the supply voltage to drop slightly, turning off the i.c.

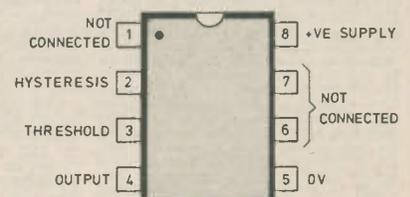
again . . . etc, etc! Hysteresis establishes a 'dead band', helping to prevent or reduce this oscillatory effect.

There are several ways of introducing hysteresis into the system, the two most common ones being shown in Fig. 4. The circuit of Fig. 4a requires that all of the current flowing in the resistor network should be able to be sourced by the hysteresis output, which is capable of supplying 15µA according to the specifications. For the circuit of Fig. 4b, the current to be sourced by the hysteresis output will be defined by the values of the two trip voltages. For low values of hysteresis, circuit (b) is to be preferred. The equations shown define the low and high trip voltages; the low trip voltage is the voltage at which the i.c. output changes state when the supply voltage is decreasing, and the high trip voltage is the voltage at which the output changes when the supply is increasing. If used for other purposes in the circuitry (other than simply switching the threshold resistor network as shown in Fig. 4), it is recommended that the hysteresis output current should be limited to 10µA.

USING THE I.C.s

Although any voltage between -5V and the positive supply rail may be applied to the threshold input (pin 3), it is advisable to limit it to below +6V, since above that voltage the input current increases dramatically. Prolonged operation above this voltage can cause a decrease in performance of the i.c. When resistive dividers are used to feed the threshold input, the monitored voltage can be higher than the i.c.'s own supply voltage, as long as the voltage at pin 3 (and pin 2 if appropriate) is kept below the i.c. positive supply, and preferably below +6V as explained above.

If the output is to be used to feed into logic circuitry, a pull-up resistor must be provided



ICL8211CPA & ICL8212CPA

Fig. 1. Pinout

Characteristic	Notes	ICL8211CPA			ICL8212CPA			Units
		Minimum Value	Typically	Maximum Value	Minimum Value	Typically	Maximum Value	
Supply Voltage	0 to +70°C (Spec's are measured at +5V unless otherwise stated)	2.2		30	2.2		30	V
Quiescent current	Voltage at Pin 3 (V_T) = 1.3V	10	22	40	50	110	250	μ A
	Voltage at pin 3 (V_T) = 0.9V	50	140	250	10	20	40	μ A
Temperature range	Spec's are measured at +25°C unless otherwise stated	0		+70	0		+70	°C
Output current, max	Sunk into pin 4 (or out of any pin), absolute maximum	4	7	12	15		30	mA
Current into any pin of I.C.				± 30			± 30	mA
Output voltage	At pin 4	-0.5		+30	-0.5		+30	mA
Threshold input voltage (pin 3)	For supply voltages of 2.2 to 25V	-5		(+ve supply)	-5		(+ve supply)	V
	For supply voltages of 25 to 30V	(+ve supply -30)		(+ve supply)	(+ve supply -30)		(+ve supply)	V
Hysteresis voltage	i.e. voltage at pin 2	(+ve supply -10)		(+ve supply +0.5)	(+ve supply -10)		(+ve supply +0.5)	V
Threshold trip voltage (at pin 3)	Output current +ve supply = 2.2V = 4mA	0.98	1.145	1.19	1.00	1.145	1.19	V
	Output voltage +ve supply = 5V = 2.0V +ve supply = 30V	0.98	1.15	1.19	1.00	1.15	1.19	V
Threshold voltage temp. coefficient	Output current = 4mA, output voltage = 2.0V	1.00	1.165	1.20	1.05	1.165	1.20	V
Threshold line regulation	Variation in threshold voltage for $\pm 10\%$ supply change		± 1.0			± 1.0		ppm/°C
Threshold input current (into pin 3)	Voltage at pin 3 = 1.15V		100	250		100	250	nA
	Voltage at pin 3 = 1.00V		5			5		nA
Maximum Hysteresis current	i.e. Available from pin 2 (voltage at pin 3 = 1.3V)	15	21		15	21		μ A
Hysteresis saturation voltage	7 μ A flowing from pin 2 (voltage at pin 3 = 1.3V)	(+ve supply -0.2)	(+ve supply -0.1)		(+ve supply -0.2)	(+ve supply -0.1)		V
Hysteresis leakage current	+ve supply = +10V, pin 2 = 0V, pin 3 = 1.0V			0.1			0.1	μ A
Output saturation voltage	Pin 4, output current = 4mA		0.17	0.4		0.17	0.4	V
Output leakage current	+ve supply = +5V			1.0			1.0	μ A
	+ve supply = +30V			10			10	μ A
Power dissipation	Up to 50°C			300			300	mW

Fig. 2—Specifications

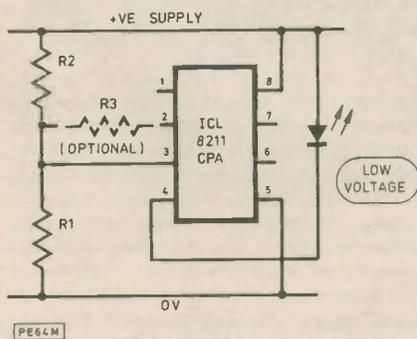
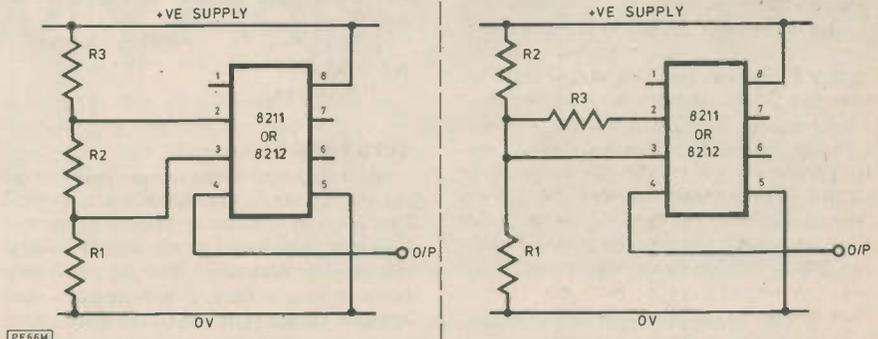


Fig. 3. Low voltage supply indicator

between pin 4 and the logic positive supply rail. For TTL use 1k, for LSTTL use 4k7, or in the case of CMOS logic use any suitable value, typically between 10k and 1M. The 8211 is guaranteed to be able to drive 2 conventional TTL or 8 LSTTL inputs, and the 8212 to drive 4 conventional or 16 LSTTL inputs.

APPLICATIONS

There are many applications of the ICL8211CPA and ICL8212CPA which are



$$\text{Low trip voltage} = \left(\frac{(R1 + R2) \times 1.15}{R1} \right) + 0.1$$

$$\text{High trip voltage} = \left(\frac{(R1 + R2 + R3)}{R1} \right) \times 1.15$$

$$\text{Low trip voltage} = \left(\frac{R2 R3}{(R2 + R3)} + R1 \right) \times \frac{1.15}{R1}$$

$$\text{High trip voltage} = \left(\frac{(R1 + R2)}{R1} \right) \times 1.15$$

Fig. 4. Two alternative methods of adding hysteresis

in the area of voltage monitoring, supply monitoring, transducer level detection, etc. Such is the versatility of these i.c.s, however, that more diverse uses for them are possible. Fig. 5, for example, shows a simple voltage regulator using an external npn power tran-

sistor as the series pass element. The output voltage is defined by:

$$V_{\text{out}} = \frac{1.15 (R1 + R2)}{R1}$$

The two capacitors are necessary to ensure

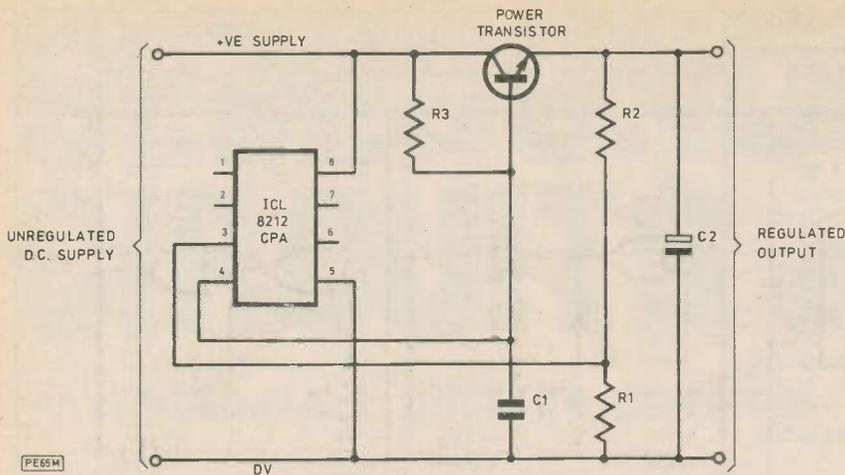


Fig. 5. Simple voltage regulator

stability, since the 8212 has no internal frequency compensation. This regulator can be used with lower input voltages than most commercially available regulators, and uses less power than almost any commercially available device. It is ideal, therefore, for use as a supply regulator in battery powered systems.

Fig. 6 shows the 8212 being used as a 'programmable Zener diode'. R2 is the resistor which would normally be provided between the positive supply rail and the Zener's cathode. VR1 and R1 set the 'Zener' output voltage, and C1 stabilises the circuit, again due to the lack of internal compensation in the i.c. The value of the Zener voltage is given by:

$$V_{\text{Zener}} = \frac{1.15(R1 + \text{the set value of VR1})}{R1}$$

Typical 'Zener' equivalent impedances over the current range 300µA to 25mA will vary from 4 to 7 ohms.

Finally, the i.c.s can be used as a constant

current source or sink, as shown in Fig. 7. The 8211 will provide approximately 130µA, and the 8212 approximately 25µA of current. The equivalent parallel resistance is in the tens of megohms, making them fairly accurate current sources and sinks which are suitable for many biasing applications in differential amplifiers, comparators, etc.

Although nominally intended as voltage monitoring devices, especially in low power or battery powered systems, the ICL8211 and 8212 can be seen to have numerous applications in different types of circuitry. The ICL8211CPA is widely available, although the price seems to vary considerably so shop around. It is sometimes referred to as the ICL8211A, or even just the ICL8211—these usually do mean the 8 pin d.i.l. version described here. Both the ICL8211CPA, and the ICL8212CPA, are available from Hawke Electronics, Amotex House, 45 Hamworth Road, Sunbury-on-Thames, Middlesex.

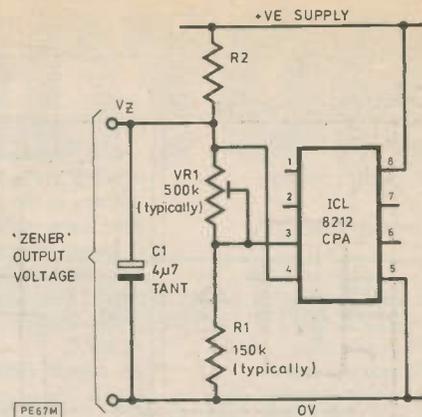


Fig. 6. 'Programmable Zener' (voltage reference)

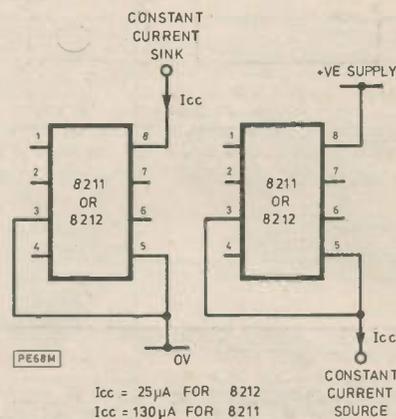


Fig. 7. Using the i.c.s as constant current sources

A POWER SUPPLY 'WATCHDOG'

Last month's applications project provided us with a very comprehensively monitored three rail power supply system. One of the things that it couldn't do, though, was to warn us if the power failed completely. Fig. 8 shows a circuit which is capable of warning us of both over- and under-voltage conditions on a supply, even if that supply has dropped to zero.

IC1 is used to monitor over-voltage conditions, and IC2 to monitor under-voltage conditions. Normally, the outputs of IC1 and IC2 are both turned off, and hence the logic output is at logic 1 (a high level). If an excessively high voltage appears on the supply, the voltage at pin 3 of IC1 rises above 1.15V and the output of IC1 turns on, taking pin 4 down almost to 0V. This forces the threshold input of IC2 (pin 3) almost to 0V, which turns on the output of IC2 providing a logic 0 (low level) on the logic output. Likewise, a very low voltage on the supply will cause IC2 to trip of its own accord since the voltage presented at pin 3 by the network R3, R4 and R5 will drop below 1.15V.

Hysteresis is provided for IC2, as shown in Fig. 4a. The high trip voltage (i.e. the voltage at which the i.c. turns off when the power supply voltage is increasing) is chosen to be higher than the voltage at which IC1 trips. The low trip voltage is chosen to be the voltage at which the power supply is considered to be excessively low. By this means the 'watchdog' circuit is non-volatile—once tripped it cannot reset itself, even if the power supply has gone down to 0V and back up again, since the voltage applied to the IC2 resistor chain would have to exceed the voltage necessary to turn IC1 on if IC2 were to be turned off, and this in turn would force IC2 to turn hard on again! A momentary reset switch is provided to set up the system when power is first applied. It must be pressed to reset the system after every occasion on which the circuit is tripped.

THE ALARM

IC3 with its associated components forms an audible alarm to warn that the circuit has been tripped. IC3a and IC3b act as a slow

running oscillator with a wide mark/space ratio, which in turn gates on and off the audio oscillator formed by IC3c and IC3d. The audio oscillator directly drives a small piezo sounder X1. The slow running oscillator is arranged to turn on the audio oscillator for only a fraction of a second, once every few seconds, providing a slow regular 'blip' sound. R8 determines the 'off' time, and R9 the 'on' time; varying either of these will vary the respective durations of the silence and the audible tone. This has been arranged to minimise power consumption, since the triggering of the alarm indicates that the power supply might be failing—a situation which might be made even worse by a dramatic increase in power consumption of the circuit.

D1 and D2 allow for a standby battery to be provided for the audible alarm, to allow it to function even with the main power supply turned off. The alarm battery should preferably have a voltage just below that of the main power supply, so that it will only be used if the main supply drops significantly in

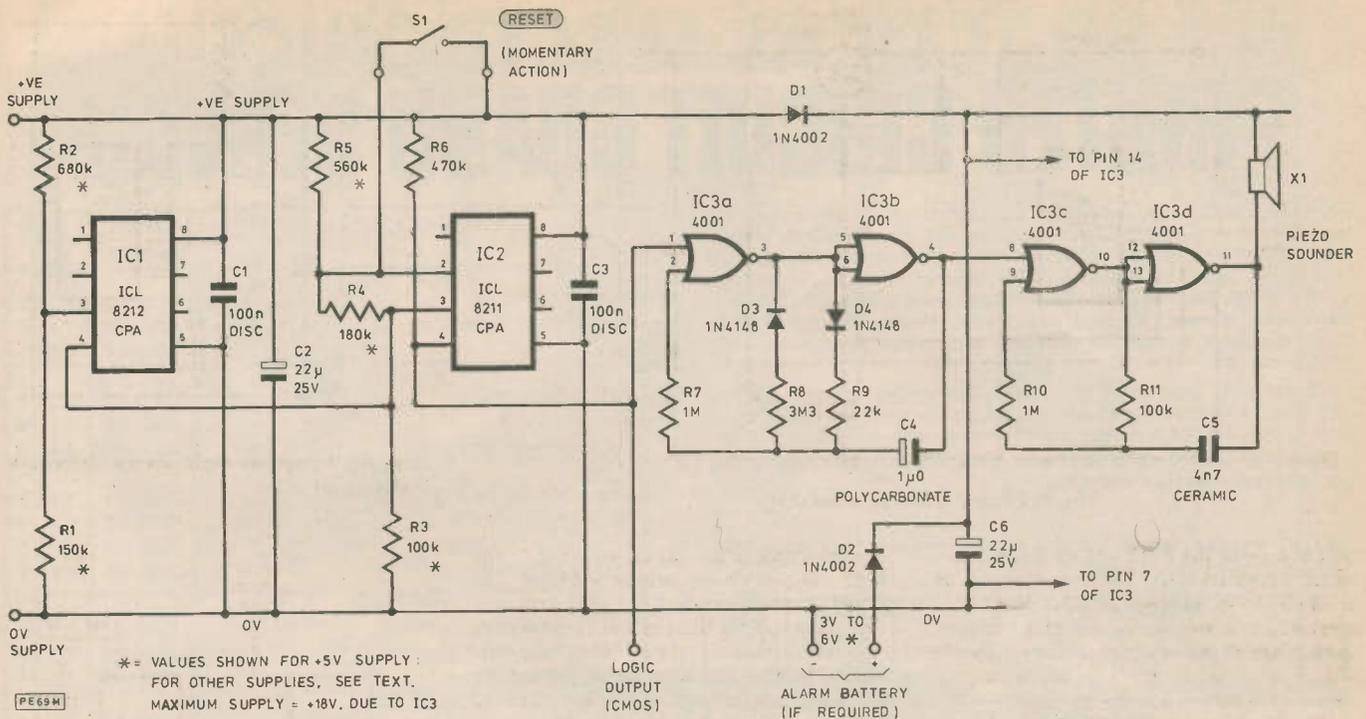


Fig. 8. Power supply 'Watchdog'

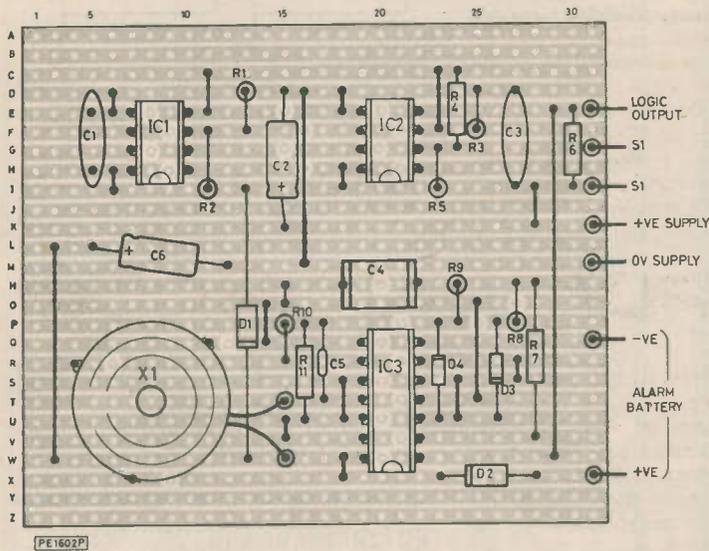
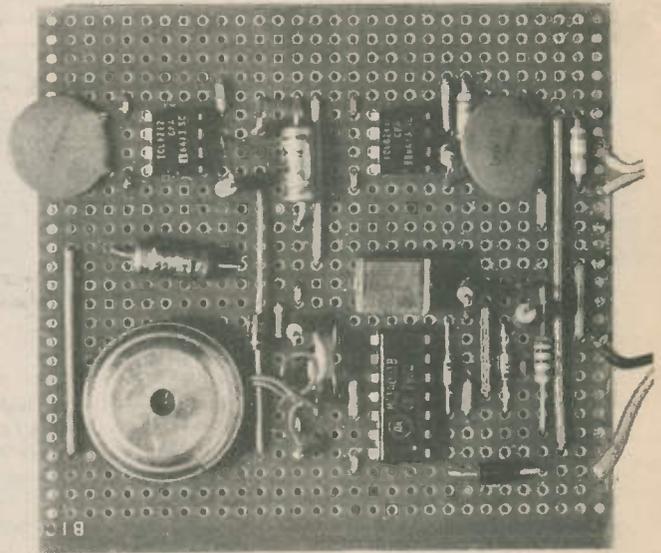


Fig. 9. Veroboard layout



Photograph of Veroboard layout

voltage. Although it may be allowed to exceed the main supply in voltage, it should not do so by more than 25% or so, since there is a danger of a high level at pin 1 of IC3a not being sufficiently high to act as a valid logic 1 level.

APPLICATIONS

This circuit is ideal for long term monitoring of a supply which must be continuously present. For example, this could be a battery backup supply for an otherwise volatile

memory system or a comprehensive timing circuit. Any failure of the supply, either high or low, will cause a logic 0 to appear at the logic output and the alarm to sound, even if the supply is quickly reinstated, until the reset button is pressed.

Resistors R1, R2, R3, R4, R5 and the alarm battery, are all shown for a 5 volt supply rail, but they can all be scaled for other voltages using the principles described earlier. With such high values used for the resistors, the trip voltages can be a little in error from those predicted by the equations, so some ex-

perimentation may be necessary. Variations in the 1.5V internal reference should be borne in mind, also; these are shown in the specifications, Fig. 2. The logic output should feed into CMOS logic, or into suitable buffering prior to TTL circuitry, since the input of TTL or LSTTL, if connected directly to the logic output, could feed a logic 1 into IC3 pin 1 in the absence of a power supply to IC1 and IC2, preventing correct alarm operation. This circuit is ideal for use in battery systems, largely due to its low current consumption (well under 100µA) in the 'normal' state.

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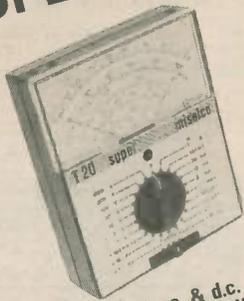
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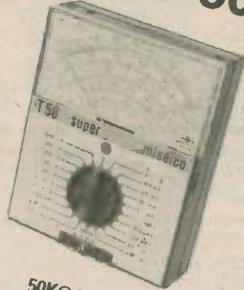
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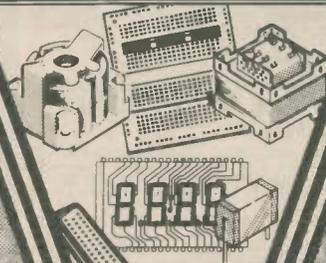
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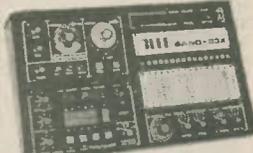
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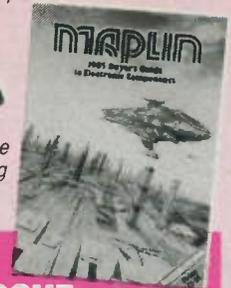
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