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PRACTICAL ELECTRONICS

MARCH 1982 75p

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PRACTICAL
ELECTRONICS
VOLUME 18 No. 3 MARCH 1982

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 12th MARCH 1982
(for details of contents see page 39)

WATFORD ELECTRONICS

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POLYESTER CAPACITORS: (Axial Lead) 400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2, 4µ7 85p. 160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n 38p; 1µF 42p; 1µ5 45p; 2µ2 48p; 4µ7 58p. 1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n, 100n 50p.

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

ELECTROLYTIC CAPACITORS (Values in µF). 500V: 10 52p; 47 78p; 63V: 0·47, 1·0, 1·5, 2·2, 3·3, 8p; 4·7 9p; 6·8, 10 10p; 15, 22 12p; 33 15p; 47 12p; 100 19p; 1000 70p; 50V: 47 12p; 68 20p; 220 24p; 470 32p; 2200 90p; 40V: 4·7, 15, 22, 9p; 330 90p; 4700 120p; 25V: 1·5, 6·8, 10, 22 8p; 33 9p; 47 8p; 100 11p; 150 12p; 220 15p; 330 22p; 470 25p; 680, 1000 34p; 2200 50p; 3300 76p; 4700 92p; 16V: 40, 47, 100 9p; 125 12p; 220 13p; 470 20p; 680 34p; 1000 27p; 1500 31p; 2200 36p; 3300 74p; 4700 79p.
TAG-END TYPE: 70V: 4700 245p; 64V: 3300 198p; 2200 139p; 50V: 3300 184p; 2200 110p; 40V: 4700 160p; 25V: 10,000 320p; 15,000 345p.

TANTALUM BEAD CAPACITORS:
35V: 0·1µ, 0·22, 0·33 15p; 0·47, 0·68, 1·0, 1·5 16p; 2·2, 3·3 18p; 4·7, 6·8 22p; 10 28p; 16V: 2·2, 3·3,16p; 4·7, 6·8, 10 18p; 15 36p; 22 30p; 33, 47 40p; 100 75p; 220 88p 10V: 15, 22 26p; 33, 47 35p; 100 55p.

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

500Ω, 1K & 2K (LIN ONLY) Single	29p
5KΩ-2MΩ single gang	29p
5KΩ-2MΩ single gang D/P switch	78p
5KΩ-2MΩ dual gang stereo	88p
1W Wire-wound 50Ω-20K	115p

SLIDER POTENTIOMETERS

0·25W log and linear values 60mm track	
5KΩ-500KΩ Single gang	70p
10KΩ-500KΩ Dual gang	110p
Self-Stick graduated Alum. Bezels	40p

PRESET POTENTIOMETERS

0·1W 50Ω-2·2M Mini Vert. & Horiz.	7p
0·25W 100Ω-3·3MΩ Horiz. larger	10p
0·25W 250Ω-4·7MΩ Vert.	10p
Precision Cermet 1W 100Ω-100K	80p

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

SIEMENS multilayer miniature capacitors.
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n, 12n, 15n, 22n 7p; 18n, 27n, 33n, 47n 8p; 39n, 56n, 68n 9p.
100V: 100n, 120n, 10p; 150n 11p; 220n 13p; 330n 18p; 470n 23p; 680n 30p; 1µF 34p; 2µ2 50p.

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

	RANGE	Val.	1-99	100+
0·25W	2Ω2-4·7M	E24	2p	1p
0·5W	2Ω2-4·7M	E12	2p	1p
1W	2Ω2-10M	E12	5p	3p
2% Metal Film 10Ω-1M			6p	4p
1% Metal Film 51Ω-1M			8p	6p

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

MYLAR Film CAPACITORS

100V: 1nF, 2n, 4n, 4n7, 10	6p
15nF, 22, 30, 40, 47n	7p
56nF, 100, 200n	9p
50V: 470nf	12p

POLYSTYRENE Caps:

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

CERAMIC Capacitors: 50V

Range 1pF to 6800pF	4p
10nF, 15n, 22, 33, 47nF	5p
100nf/30V 7p; 220nf/6V	8p

Sound Generator
AY-3-8910 £6
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TRANSISTORS

AC107 35	BC307B 14	BFX29/84 28	TIP30C 58	2N1131/2 24	2N5777 45
AC125/6 35	BC308B 16	BFX85/86 28	TIP31A 45	2N1303/4 65	2N6027 32
AC127/8 30	BC327/8 15	BFX87/88 28	TIP31C 55	2N1305/7 60	2N6109 60
AC141/2 30	BC337/8 15	BFY50/51 23	TIP32A 48	2N1308 68	2N6290 70
AC176 28	BC441 34	BFY52 23	TIP32C 60	2N1613 30	2SA715 60
AC187/8 32	BC461 34	BFY56 32	TIP33A 65	2N16718 160	2SC495 70
ACY17/18 70	BC477/8 40	BFY64 35	TIP33C 78	2N2160 295	2SC496 70
ACY19/20 75	BC516/7 40	BFY81 120	TIP34A 74	2N2219A 28	2SC1096 85
ACY21/22 75	BC547/8 14	BFY90 80	TIP34C 88	2N2220A 26	2SC1172 125
ACY28 75	BC549C 14	BRY39 40	TIP35A 160	2N2221A 26	2SC1173 125
AD142 120	BC556/7 15	BSX20 20	TIP35C 185	2N2222A 25	2SC1306 150
AD149 79	BC558/9 15	BSX29 34	TIP36A 170	2N2369A 18	2SC1307 220
AD161/2 42	BCY70 18	BSY95A 25	TIP36C 199	2N2646 45	2SC1449 85
AF118 95	BCY71/2 20	BU105 170	TIP41A 55	2N2846 80	2SC1678 140
AF139 40	BD121 95	BU108 240	TIP41B 60	2N2904 28	2SC1923 50
AF178 75	BD124 115	BU109 210	TIP42A 60	2N2905A/6 26	2SC1945 225
BC107/8 10	BD131/2 48	BU205 190	TIP42B 75	2N2907A 26	2SC1953 90
BC107B 12	BD133 60	BU206 200	TIP120 90	2N2926G 10	2SC1957 90
BC108 10	BD135 45	BU208 200	TIP121 99	2N3053 26	2SC1969 198
BC108B 12	BD136/7 40	E421 250	TIP141 120	2N3054 58	2SC2028 85
BC108C 12	BD138/9 40	MD8001 250	TIP142 120	2N3055 48	2SC2029 200
BC109 10	BD140 40	MJ2955 90	TIP147 120	2N3442 140	2SC2078 175
BC109B 12	BD144 198	MJE340 54	TIP2955 60	2N3565 15	2SC2091 85
BC109C 12	BD205 110	MJE370 100	TIP3055 60	2N3614 199	2SC2314 85
BC117/8 20	BD245 45	MJE371 100	TIS43 32	2N3615 199	2SC2166 165
BC140/42 30	BD378 70	MJE520 95	TIS44/45 15	2N3663 15	2SC1679 190
BC143 30	BD434 55	MJE2955 99	TIS48 50	2N3702/3 10	2SD234 75
BC147/8 9	BD517 75	MJE3055 70	TIS88A 50	2N3704/5 10	2SK45 90
BC147B 10	BD695A 99	MPF102 66	TIS90 30	2N3706/7 10	3N128 112
BC148B 10	BD696A 99	MPF103 36	TIS91/93 32	2N3708/9 10	3N140 112
BC148C 10	BDY56 180	MPF104 36	UC734 65	2N3710 10	40097 88
BC149 9	BDY60 160	MPF105 36	VK1010 80	2N3711 10	40100 215
BC149C 12	BF115 35	MPF106 40	VN10KM 45	2N3771 179	40101 130
BC153/4 27	BF167 29	MPSA05 25	VN46AF 78	2N3772 195	40250 85
BC157/8 10	BF173 27	MPSA06 25	VN66AF 85	2N3773 270	40251 97
BC159 11	BF177 25	MPSA12 32	VN88AF 94	2N3819 22	40311 60
BC160 45	BF178 30	MPSA55 30	ZTX107/8 11	2N3820 45	40313 130
BC167A 10	BF179 35	MPSA56 30	ZTX109 12	2N3822/3 65	40315 60
BC168C 10	BF180 38	MPSA70 30	ZTX212 28	2N3866 90	40316 95
BC169C 10	BF194/5 12	MPSU02 58	ZTX300 13	2N3903/4 18	40317/20 60
BC170 15	BF196/7 12	MPSU05 55	ZTX301/2 16	2N3905 15	40360 40
BC171/2 11	BF198 16	MPSU06 55	ZTX303 25	2N3906 17	40361/62 50
BC173 11	BF199 18	MPSU52 65	ZTX304 17	2N4037 46	40406 75
BC177/8 20	BF200 30	MPSU55 60	ZTX314 25	2N4058 10	40407 60
BC179 20	BF224 25	MPSU56 60	ZTX320/26 30	2N4061/2 10	40408 70
BC181 20	BF244A 28	OC23/26 170	ZTX341 30	2N4069 45	40411 285
BC182/3 10	BF244B 29	OC28 130	ZTX500/1 14	2N4427 80	40412 65
BC184 10	BF256B 35	OC36 120	ZTX502/3 18	2N4859 78	40467 130
BC182L 10	BF257/8 35	OC41/42 120	ZTX504 25	2N4871 55	40468 85
BC183L 10	BF259 35	OC44 120	ZTX531 25	2N5135/6 20	40594 105
BC184L 10	BF274 42	OC45/70 40	ZTX550 25	2N5138 18	40595 110
BC187 26	BF336 40	OC71/72 40	2N696 30	2N5172 18	40603 110
BC212/3 10	BF451 35	OC76 50	2N697 23	2N5179 45	40636 175
BC212L 10	BF594 30	OC81/82 50	2N698 40	2N5180 45	40673 95
BC213L 10	BF595 39	OC83/84 40	2N699 48	2N5191 75	
BC214 10	BFR39/40 23	OC170/1 85	2N706A 19	2N5194 80	
BC214L 10	BFR41/79 23	OC200 85	2N708 19	2N5305 24	
BC237/8 14	BFR80/81 25	TIP29A 36	2N914/5 36	2N5457 36	
	BFR98 105	TIP29C 52	2N918 35	2N5458/9 36	
		TIP30A 48	2N930 20	2N5485 36	

Access

LINEAR IC's

555 CMOS 80	LC7130 340	NE544 210	TL081CP 25	6545 CRTC 1450
702 75	LF347 150	NE555 16	TL082CP 45	6551 ACIA 785
709C 8 pin 35	LF351 48	NE556D8 45	TL083CP 75	6592 PC £20
710 48	LF355 85	NE560 325	TL084CP 95	6800 300
741 14	LF356 95	NE561 395	TL091CP 55	6802 400
747C 14 pin 65	LF357 110	NE562B 410	TL170 50	6803 £12
748C 8 pin 36	LM10 425	NE564 420	UA2240 245	6804 160
753 8 pin 185	LM301A 26	NE565A 120	UAA170 170	6805 670
810 159	LM308 95	NE566 155	UAA180 170	6808 520
9400CJ 350	LM311 70	NE567 140	UAA1003-3 935	6809 999
AY-1-0212 675	LM318 200	NE570 425	ULN2003 85	6810 120
AY-1-1313A 660	LM319 215	NE571 420	ULN2004 90	6820 175
AY-1-1320 225	LM324 30	NE5534 150	ULN2283 100	6821 125
AY-1-5050 99	LM335 128	RC4136D 69	UPC575 350	6840 420
AY-1-5051 160	LM339 54	S5668 245	UPC1025H 375	6843 £14
AY-1-6720 210	LM348 64	SAB3209 425	UPC1182 330	6845 975
AY-3-1270 840	LM349 115	SAB3210 295	UPC1156H 290	6847 850
AY-3-8500 390	LM358 65	SAB3271 485	XR2206 300	6850 150
AY-3-8910 600	LM377 175	SAB4209 595	XR2207 375	6852 255
AY-3-8912 625	LM379 480	SAS560 150	XR2211 575	6875 500
AY-5-1224A 235	LM394 320	SAS570 150	XR2216 675	8080A 350
AY-5-1230 450	LM725CN 325	SL490 350	XR2240 245	8085A 550
AY-5-1317A 630	LM733 100	SG3402 295	XR2266 750	81LS95 90
AY-5-4007D 520	LM379 415	SN76003N 350	ZN414 88	81LS96 90
AY-5-8100 775	LM380 75	SN76013N 350	ZN419CE 190	81LS97 90
CA3011 110	LM381N 145	SN76023N 350	ZN423E 138	8166 00
CA3012 175	LM382 125	SN76033 350	ZN424E 130	8123 125
CA3014 157	LM384 140	SN76115N 215	ZN425E-8 345	8202 £25
CA3018 68	LM386 90	SN76131 125	ZN426E-8 300	8212 170
CA3019 70	LM387 120	SN76227N 95	ZN427E-8 600	8214 425
CA3020 186	LM389 95	SN76477 175	ZN428E 478	8216 70
CA3023 191	LM393 100	SN76660 120	ZN429E-8 210	8224 200
CA3028A 120	LM394CH 290	SP8629 299	ZN1034E 200	8226 250
CA3035 235	LM2917 195	TA7120 150	ZN1040E 675	8228 250
CA3036 115	LM3302 95	TA7130 160		8251 320
CA3043 275	LM3900 50	TA7204 225		8253 799
CA3045 365	LM3909 85	TA7205 220		8255 295
CA3046 70	LM3911 125	TA7222 175		8257 800
CA3048 214	LM3914 210	TA7310 175		8T26A 99
CA3059 225	LM3915 220	TAA621AX1 295		8T27 150
CA3075 213	LM3916 220	TAA661A 190		8T28A 115
CA3080E 65	LM13600 125	TAA700 275		8T31 350
CA3081 190	LS7220 280	TAA900 00		8T95N 99
CA3086 48	M252AA 625	TAA960 00		8T97N 99
CA3089E 215	M253AA 1150	TAD100 159		9364AP 550
CA3090AQ 375	M51513L 230	TBA540 275		AM26LS31C 125
CA3123 150	M51515L 320	TBA120S 70		AM26LS32A 125
CA3130 90	MB3756 440	TBA550Q 330		AY-3-1015 300
CA3140 48	MC1303 88	TBA641-A12/8X1 or BX11 350		AY-5-1013 300
CA3160 95	MC1304P 260	TBA651 190		AY-5-2376 600
CA3161E 135	MC1310P 150	TBA800 80		FD1771 £18
CA3162E 450	MC1445 150	TBA810S 95		IM6402 380
CA3189 200	MC1458 40	TBA820 80		MC1488 55
CA3240 110	MC1494 694	TBA920Q 290		MC1489 55
HA1336W 240	MC1495 350	TBA950 300		MC14411 695
ICL7106 750	MC1496L 70	TBA990 350		MC14412 795
ICL7107 975	MC1596 225	TCA270 350		MM5280D 695
ICL8038CC 300	MC1648 290	TCA940 175		RO-3-2513L 700
ICL8211 450	MC1709G 90	TCA965 120		RO-3-2513U 600
ICM7204 550	MC3302 150	TDA1004 290		SFF96364E 800
ICM7205 1150	MC3340P 120	TDA1008 310		SFC71301 820
ICM7207 475	MC3360P 120	TDA1022 530		TMS2716-3V 875
ICM7215 1050	MC3401 65	TDA1024 105		TMS6011 365
ICM7216A 1950	MC3403 110	TDA1034 250		ULN2003 100
ICM7216B 1950	MC3405 150	TDA1490 290		Z80CPU 2·5 350
ICM7217A 790	MC4016 00	TDA2002 325		Z80ACPU 4M 385
ICM7224 785	MFC6040 97	TDA2020 320		Z80 P10 290
ICM7555 80	MK50398 635	TDA2030 320		Z80A P10 320
ICM7556 00	MM5303 635	TD80791 420		Z80 CTC 300
LA3350 250	MM5307 1275	TL061CP 40		Z80A CTC 325
LA4031P 340	MM5387A 475	TL062CP 60		Z80DMA 999
LA4032 295	MSM5526 820	TL064CN 98		Z80S10-1 £15
LA4400 440	NE515 278	TL071CP 30		Z80AS10 £23
LC7120 300	NE529 225	TL072CP 50		Z80 DART 726
	NE531 140	TL074CN 100		Z80A DART 775
	NE543 225			

COMPUTER IC's

1702	299
1802CP	700
2101-2	110
2112-2	250
2114L-300n	87
2114L-200n	87
2118-4	250
2147-3	425
2532-450n	450
2564	£20
2708	175
2716-5V	210
2732-450n	400
2764	£19
4027	240
4116-150	95
4116-200	75
4118-250	400
4164-200	620
4315-4K	795
4334-3 (CMOS 2114)	325
4864-3 64K	785
6116-3	500
CMOS RAM	700
6502 CPU	399
6503	600
6504-250	550
6505	600
6520 PIA	175
6521	150
6522 VIA	350
6530 RRIOT	1350
6532 RIOT	670

74S Series

74S132	138
74S133	60
74S138	210
74S188	210
74S189	158
74S194	360
74S201	350
74S225	525
74S241	540
74S262	850
74S287	300
74S288	210
74S289	290
74S387	300
74S470	325
74S471	620
74S472	1150
74S475	825
74S571	620

75 Series

75107	95
75110	115
75108	350
75150	125
75154	150
75182	115
75183	115
75188	65
75189	65
75322	165
75450	95
75451/2	70
75454	225
75491/2	70

TTL 7400 (TEXAS)

7400 11	7441 68	74173 65	LS42 35	LS251 40	4023 20	4435 850	
7401 11	7442 38	74174 72	LS47 40	LS253 40	4024 45	4440 999	
7402 11	7443 90	74175 72	LS48 80	LS257 48	4025 19	4450 350	
7403 14	7444 90	74176 55	LS49 60	LS258 60	4026 130	4451 350	
7404 14	7445 65	74177 75	LS51 15	LS259 85	4027 38	4490 350	
7405 18	7446 55	74178 95	LS54 15	LS260 21	4028 58	4500 675	
7406 28	7447 50	74179 68	LS55 30	LS261 195	4029 77	4501 28	
7407 28	7448 50	74180 65	LS63 150	LS266 25	4030 50	4502 90	
7408 16	7450 16	74181 140	LS73 25	LS273 90	4031 170	4503 50	
7409 16	7451 16	74182 75	LS74 25	LS275 290	4032 125	4504 105	
7410 14	7453 16	74184 99	LS75 28	LS279 88	4033 165	4506 65	
7411 20	7454 16	74185 99	LS76 20	LS280 250	4034 195	4507 40	
7412 20	7460 16	74188 290	LS78 24	LS283 45	4035 95	4508 265	
7413 24	7470 35	74190 70	LS83 50	LS290 57	4036 275	4510 68	
7414 32	7472 30	74191 70	LS85 70	LS293 46	4037 115	4511 68	
7416 25	7473 30	74192 70	LS86 38	LS295 215	4038 110	4512 75	
7417 25	7474 25	74193 65	LS90 35	LS298 130	4039 290	4513 199	
7420 16	7475 40	74194 75	LS91 80	LS299 420	4040 59	4514 195	
7421 20	7476 30	74195 65	LS92 36	LS300 175	4041 78	4515 198	
7422 20	7480 48	74196 65	LS93 36	LS302 175	4042 60	4516 75	
7423 22	7481 120	74197 65	LS95 36	LS320 270	4043 70	4517 415	
7425 28	7482 70	74198 99	LS96 120	LS323 270	4044 65	4518 42	
7426 30	7483 50	74199 99	LS107 43	LS324 200	4045 170	4519 29	
7427 27	7484 80	74221 80	LS109 30	LS325 320	4046 75	4520 78	
7428 28	7485 95	74246 150	LS112 30	LS326 330	4047 75	4521 200	
7430 18	7486 26	74247 150	LS113 40	LS327 315	4048 55	4522 125	
7432 26	7489 205	74248 150	LS114 35	LS347 150	4049 30	4526 95	
7433 27	7490 28	74249 150	LS122 44	LS348 190	4050 30	4527 115	
7437 27	7491 45	74251 80	LS123 55	LS352 185	4051 78	4528 80	
7438 27	7492 30	74259 195	LS124 105	LS353 185	4052 78	4529 150	
7440 17	7493 30	74265 65	LS125 30	LS365 37	4053 78	4530 90	
	7494 34	74273 195	LS126 30	LS366 37	4054 125	4531 130	
	7495 50	74276 150	LS132 45	LS367 37	4055 125	4532 110	
	7496 45	74278 160	LS133 35	LS368 37	4056 120	4534 500	
	7497 120	74279 90	LS136 28	LS373 75	4057 1915	4536 295	
	74100 85	74283 90	LS138 35	LS374 75	4059 480	4538 115	
	74104 54	74284 199	LS139 38	LS375 48	4060 90	4539 115	
	74105 55	74285 199	LS145 75	LS377 90	4061 1225	4541 140	
	74107 32	74290 105	LS147 199	LS378 69	4062 995	4543 135	
	74109 35	74293 125	LS148 99	LS379 65	4063 99	4544 150	
	74110 40	74297 236	LS151 39	LS384 395	4066 36	4549 395	
	74111 55	74298 100	LS153 39	LS385 378	4067 399	4553 299	
	74112 170	74351 195	LS155 39	LS390 62	4068 22	4554 190	
	74116 88	74365 55	LS156 39	LS393 60	4069 20	4555 50	
	74118 80	74366 55	LS157 35	LS395 199	4070 26	4556 55	
	74119 90	74367 55	LS158 36	LS399 220	4071 20	4557 320	
	74120 75	74368 55	LS160 41	LS445 140	4072 20	4558 120	
	74121 30	74390 99	LS161 41	LS471 620	4073 20	4559 395	
	74122 45	74393 99	LS162 41	LS490 245	4075 20	4560 180	
	74123 50	74490 120	LS163 41	LS541 135	4076 60	4561 104	
	74125 42		LS164 48	LS640 225	4077 26	4562 495	
	74126 40	**74LS**	LS165 145	LS641 225	4078 26	4566 175	
	74128 42	LS00 12	LS166 85	LS645 210	4081 26	4568 250	
	74132 48	LS01 13	LS168 85	LS668 175	4082 21	4569 175	
	74136 35	LS02 14	LS170 170	LS669 150	4085 65	4572 36	
	74141 70	LS03 14	LS173 72	LS670 175	4086 70	4580 460	
	74142 190	LS04 15	LS174 72	LS673 550	4089 140	4581 250	
	74143 250	LS05 15	LS175 58	LS674 750	4093 43	4582 99	
	74144 250	LS06 15	LS181 130	**CMOS**	4094 168	4583 99	
	74145 70	LS08 15	LS183 275	4000 14	4095 90	4584 48	
	74147 99	LS09 15	LS190 58	4001 14	4096 90	4585 99	
	74148 75	LS10 15	LS191 58	4002 14	4097 320	4597 330	
	74150 80	LS11 15	LS192 58	4006 66	4098 88	4598 290	
	74151 45	LS12 15	LS193 65	4007 18	4099 95	4599 595	
	74153 45	LS13 30	LS194 40	4008 62	4160 95	40097 88	
	74154 75	LS14 48	LS195 40	4009 35	4161 99	40100 215	
	74155 75	LS15 15	LS196 58	4010 40	4162 99	40101 130	
	74156 75	LS20 15	LS197 85	4011 15	4163 99	40102 180	
	74157 45	LS21 15	LS200 345	4012 18	4174 99	40103 175	
	74159 99	LS22 15	LS202 345	4013 34	4175 99	40104 95	
	74160 60	LS26 18	LS221 60	4014 75	4194 105	40105 115	
	74161 60	LS27 15	LS240 96	4015 66	4408 790	40106 75	
	74162 62	LS28 20	LS241 96	4016 36	4409 790	40107 60	
	74163 64	LS30 18	LS242 85	4017 48	4410 725	40108 450	
	74164 64	LS32 15	LS243 85	4018 68	4411 695	40109 100	
	74165 62	LS33 16	LS244 80	4019 42	4412 800	40110 300	
	74166 65	LS37 16	LS245 90	4020 61	4415 480	40114 240	
	74167 185	LS38 16	LS247 40	4021 70	4419 280	40163 108	
	74170 168	LS40 16	LS248 65	4022 66	4422 770	40193 108	
	74172 290		LS249 68		4433 770	45106 595	

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

DIODES	
AA119	15
BA100	15
8Y100	24
8Y126	12
8Y127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

Noise Diode
Z5J 195

SCR's Thyristors	
0·8A-100V	32
1A/200V	58
1A/400V	70
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC
ST2 25

BRIDGE RECTIFIERS (plastic case)	
1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	350
25A/200V	240
25A/600V	395
BY164	56
VM18	50

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

VARICAPS	
MVAM2	165
MVAM115	158
BA102	30
BB105B	40
BB106	40

TRIACS	
3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120
2N5777	45
4N33	135
OCP71	120
ORP12	86
ORP61	95

OPTO ELECTRONICS

LEDS including Clips	
TIL209 Red 125"	13
TIL211 Green 125"	18
TIL212 Yellow	18
TIL220 ·2" Red	15
0·2" Yel, Grn, Amber	18
Red, Green and Yellow Rectangular LEDs.	29
Triangular LEDs R&G	18
0·2" Flashing LED Red	55
0·2" Bi colour LEDs Red/Green	65
Green/Yellow	65
0·2" Tri colour LEDs Red/Green/Yellow	85
0·2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	91
TIL78 (detector)	54
TIL100	90
7 Segment Displays	
TIL321 5" C.An	115
TIL322 ·5" C.th	115
DL704 ·3" C.Cth	99
DL707 ·3" C.Anod	99
DL747 ·6" C.Cathod.	180
·8" Orange C.A.	250
FND357 or 500	120
·3" Green C.A.	140
±1·3" Red or Green	150
Bargraph 10 seg. Red	225

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

DALO ETCH RESIST
Pen + Spare tip 90p

0·5" LIQUID CRYSTAL DISPLAYS
3½ digit 550
4 digit 650
6 digit 750

NEONS
Red or Amber Round or Square **30p each**

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

ALUM. BOXES	
3x2x1"	65
4x2¼x2"	85
4x2¾x2½"	103
4x4x2½"	120
5x4x2	105
5x2¾x1½"	90
5x2½x2½"	130
5x4x1½"	99
5x4x2½"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4¼x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

SPECIAL OFFER

	1+	50+
NE555	16p	14p
2114L-3	87p	80p
2114L-2	87p	80p
2708	175p	160p
2532	450p	375p
2716	210p	195p
2732	400p	375p
4116	75p	68p
6116	580p	550p
6522	350p	320p
7805 1A/5V	45p	35p

CUSTOMER: How can Watford sell full spec devices so cheaply?
WATFORD: It's simple. By bulk buying (direct from manufacturers where possible), low overheads and smaller margins which give us an edge over our competitors.

DIL SOCKETS (TEXAS)

	Low profile	Wire wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	22p	60p
22 pin	25p	70p
24 pin	25p	70p
28 pin	28p	80p
36 pin	—	105p
40 pin	30p	99p

DIL PLUGS (Headers)
14 pin 44
16 pin 49
24 pin 88
40 pin 255

Ribbon Cable ft.
10 way 22p
24 way 50p

SPEAKING CLOCK
Full Kit of parts now available **Only: £37.50**

ZERO Insertion Force DIL Sockets
24 way 595p; 28 way 850p; 40 way 975p

WATFORD'S Ultimate Monitor IC.

A 4K Monitor Chip specially designed to produce the best from your; Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk In Practical Electronics, June 1981.
Price only £15.95 + 50p P&P.

EPSON MX Series PRINTERS
Now available from stock at very competitive prices.

- **MX80T** 10" Tractor Feed, 9×9 matrix, 80 column Speed 80 CPS bi-directional. Centronics Interface, Baud rate 110-9600 (RS232) **£340**
- **MX80FT** Has Friction & Tractor Feed plus all the MX80T's facilities **£375**
- **MX80FT2** Has high resolution Graphics option plus all the MX80FT's facilities **£420**
- **MX100** 132 Column plus all the facilities of MX80FT2. Value for money. **£550**

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9·5"x8·5"
6"x6"	90p	110p	95p
6"x12"	150p	195p	

SOLDERCON PINS
100 pins 70p 500 pins 325p

VEROBOARDS 0·1"

	Clad	Plain
2½x3¾"	73p	52p
2½x5"	83p	—
3¾x3¾"	83p	—
3¾x5"	95p	79p
3¾x17"	325p	211p
4¾x18"	425p	—
Pkt. of 100 pins		50p
Spot Face Cutter		118p
Pin Insertion Tool		162p

'VQ' Board	150
'DIP' Board	330
Vero Strip	144
S100 Board	£14
PROTO-DECs	
Veroblock	375
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	1350

VERO WIRING PEN and Spool 310p
Spare Wire (Spool) 75p; Combs 6p ea.

ANTEX Soldering Irons

C15W	410
CX17W	425
CCN15W	425
X25W	440
Spare bits	50
Elements	200
Iron stands	160
Heat Shunt	25

Buy with Access
Just phone your order through, we do the rest.

GAS & SMOKE DETECTORS
TGS812 & 813 575
Sockets 40

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 395p/pair

'D' CONNECTORS mini.,(Cannon type) Solder Bucket

	Plugs	Sockets	Covers plastic
9 way	95p	125p	145p
15 way	135p	198p	150p
25 way	170p	230p	130p
37 way	290p	398p	185p
PCB Pins			
25 way	200p	245p	—
PCB Pins (right angle)			
25 way	210p	275p	—

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

EDGE CONNECTORS
Two rows

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

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA **98p**
6VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V-·25A 15V-·25A **220p**
12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2, 6V-1·2A 12V-·5A 12V-·5A **275p (30p p&p)**
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A **320p (44p p&p)**
50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A **395p (60p p&p)**
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A **920p (60p p&p)**
(N.B. P&P charge to be added above our normal postal charge).

JUMPER LEADS Ribbon Cable Assembly
Single ended DIP, 24" length Cable
14 pin **145p** 16 pin **165p;**
24 pin **240p;** 40 pin **380p.**
Double ended DIP

	14 pin	16 pin	24 pin	40 pin
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

COMPUTER CORNER

- **VIC 20 MICROCOMPUTER.** Connects directly to a colour TV. 5K RAM expandable to 32K PET type graphics. **£165**
- **CASSETTE DECK** for VIC20 including a free 6 programme Cassette. **£34**
- **EPSON MX SERIES PRINTERS:** see top right hand side of this advertisement.
- **SEIKOSHA GP80A** – Unihammer Printer, gives normal and double width characters as well as dot resolution graphics 8" Tractor feed. Parallel Interface standard. **£195**
- **SOFTY–2.** As reviewed in PE September 1981. The complete microprocessor development system for Engineers & Beginners. New powerful instruction. Accepts any 24 pin 5V single rail EPROM. Supplied fully built, tested & enclosed in a black ABS case. Price incl. encapsulated plug in power supply. **£169**
- **VIDEO MONITOR 9"** fully cased. B&W. Fully guaranteed. Excellent value for money at only **£69**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with integral 30 min. Electronic timer **£45**
- **Spare** UV lamp bulbs **£9**
- **5V/5A PSU** Ready built and tested **£25**
- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£26**
- **Extra 4K of RAM** (8 off 2114L-300nS) **£7**
- **Space Invaders** for Superboard **£6**
- **Full ASC11** coded keyboard type '756' **£39**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 Cassettes** in Library Cases **40p**
- **8½ Fan fold paper** (500 sheets) (no VAT) **£6**
- **9½" Fan fold paper** (500 sheets) (no VAT) **£6**
- **Teleprinter Roll** (no VAT) **£3.50**

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

VOLTAGE REGULATORS

1A	T03	+ve		−ve
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	150p		—
1A	T0220 Plastic Casing			
5V	7805	50p	7905	55p
12V	7812	50p	7912	55p
15V	7815	50p	7915	55p
18V	7818	50p	7918	65p
24V	7824	50p		
100mA	T092 Plastic Casing			
5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM309K	135
LM304H	160	LM309KP	99
LM305H	140	LM317H	280
78H05 5V/5A	550p	LM317K	350
78HG+5 to +24V 5A	599p	LM323K	500
79HG −2.25V to −24V 5A	785p	LM326N	240
		LM327N	270
		LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V		TOGGLE 2A 250V	
1A DPDT	14	SPST	33
1A DPDT C/OFF	15	DPDT	44
½A DP on/on/on	40	4 pole on off	54

PUSH BUTTON Spring loaded		SUB-MIN TOGGLE	
Latching or Momentary 6A		SP changeover	60
SPDT c/over	99	SPST on off	54
DPDT c/over	145	SPDT c/off	85
		SPDT Biased	105
MINIATURE Non Locking		DPDT 6 tags	75
Push to make	15p	DPDT C/OFF	85
Push break	25p	DPDT Biased	145
		3 pole c/over	205

ROCKER: 5A, 250V, SPST 28p
ROCKER: (white) 10A 250V SPDT 38p
ROCKER: With neon lights red when on. 10A 250V, DPST 85p
ROCKER: (White) 10A/250V DPDT 72p
ROTARY: Make your own Multiway Switch. Shafting Assembly accommodates up to 6 wafers. 90p
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 6p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 45p
ROTARY: Mains 250V AC, 4 Amp 56p
DIL SWITCHES: (SPST) 4 way 70p; 6 way 85p; 8 way 90p; 10 way 145p; (SPDT) 4 way 190p.

CRYSTALS	
32·768KHz	100
100KHz	270
200KHz	295
455KHz	370
1MHz	295
1·28MHz	392
1·6MHz	395
1·8MHz	395
1·008M	290
1·8432M	220
2·0MHz	240
2·4576M	220
3·2768M	220
3·57954M	150
3·6864M	300
4·0MHz	200
4·032MHz	290
4·80MHz	200
4·194304M	200
4·433619M	120
5·0MHz	200
5·185MHz	300
5·24288M	390
6·0MHz	220
6·144MHz	240
6·5536MHz	200
7·0MHz	200
7·168MHz	250
7·68MHz	200
8·0MHz	200
8·08333M	395
8·867237M	240
9·00MHz	200
9·375MHz	350
10·0MHz	200
10·7MHz	220
10·24MHz	200
12·0MHz	290
12·528MHz	300
14·31818M	320
16·0MHz	250
18·0MHz	240
18·432M	240
19·968MHz	325
20·0MHz	325
24·0MHz	200
24·930MHz	325
26·69M	290
26·670MHz	325
27·648M	330
27·145M	240
27·125MHz	295
38·66667M	290
48·0MHz	270
100·0MHz	375
116·0MHz	300

ASTEC UHF Modulators
6MHz 280
8MHz Wide-bandwidth 425

WATFORD'S UNIVERSAL MICRO EXPANSION SYSTEM

Designed by Watford Electronics, this extremely versatile and economical Expansion System as published in E.T.I., starting from Dec., 81 issue, offers a low cost flexible expansion facility for **ZX81,** UK101, SUPERBOARD, ACORN ATOM, PET, TANGERINE, VIDEO GENIE, ECT.

The Motherboard (Interfaces with the Computer) has capacity to accept up to five daughter cards and can be paralleled for even more daughter cards.

All PCBs are of Computer grade finish and are supplied in Kit form.

Just look at the expansion possibilities:

MOTHERBOARD – Accepts up to five Daughter Cards **Full Kit: £36.50**

SOUND CARD – Utilising up to three AY-3-8910 Sound chips. (one supplied with every Kit) **Full Kit: £24.95**

PIO CARD – Using two 6520 PIA chips, this Board offers Centronics parallel printer driver, digital to analogue converter and a host of other out-put facilities. **Full Kit: £19.95**

PROM PROGRAMMER – This simple but extremely useful card can blow 2716 or 2732 single rail EPROMS. **Full Kit: £19.95**

PROM CARD – P.C.B. cards for housing four 2716 or two 2732 EPROMS.
(4x2716) **Full Kit: £9.95**
(2x2732) **Full Kit: £9.75**

RAM CARD – 8K RAM card. Accepts 16x2114 RAMs. The Board is supplied fully populated. **Full Kit: £28.50**

(N.B. PCBs may be bought separately)

WATFORD ELECTRONICS
Tel. (0923) 40588 Telex. 8956095

CLEF ELECTRONIC MUSIC

COMPLETE KIT £358.70

COMPLETE KIT £345

ELECTRONIC PIANOS

SPECIALISTS SINCE 1972

Clef Pianos adopt the most advanced form of Touch Sensitive action which simulates piano Key inertia using a patented electronic technique.

7¼ OCTAVE DOMESTIC MODEL

COMPONENT KIT £244
COMPLETE KIT £395.70
MANUFACTURED £675

Two Domestic Models are available including the 88-note full-size version. Four intermixable Voice Controls may be used to obtain a wide variation of Piano tone, including Harpsichord. Both Soft and Sustain Pedals are incorporated in the Design and internal Effects are provided in the form of Tremolo, Honky-Chorus, and Phase/Flanger. A power amplifier integrates into the Piano top which may be removed from the Base for easy transportation.

SIX OCTAVE DOMESTIC MODEL

COMPONENT KIT £217
MANUFACTURED £595

Component Kits include Keyboard, Key-switch hardware, and all electronic components and may be purchased in four stages at no extra cost. Complete Kits further contain Cabinets, wiring harness, Pedals and in the case of Domestic Models both Power Amplifier and Speaker. The Six Octave Stage Piano has the same range of Voices and Effects and is designed for use with an External Amplifier and Speaker.

SIX OCTAVE STAGE MODEL

COMPONENT KIT £217
MANUFACTURED £530

Since 1972 Clef Products have consistently produced leading designs in the field of Electronic Musical Instruments, many of which have been published in technical magazines. With musical quality of paramount importance, new techniques have been evolved and the latest musically valid technology has been incorporated into projects which have been successfully completed by constructors over a wide range of technical capability. Back-up TELEPHONE advice to our customers is available from the Designer of all Kits advertised.

STRING ENSEMBLE

(As Published in conjunction with 'Practical Electronics')

A very popular Keyboard Synthesizer Kit, for Group or Home use, with a four octave compass and split Keyboard facility. The instrument is fully polyphonic and has two rich Multi-String Voices plus Woodwind and Brass Effects for individual or Mixed use. Variable Attack and Sustain Controls give a good Orchestral Mix with the added concert hall reverberation effect produced by sustain coupled with phase modulation in the Chorus Unit. The Component Kit includes Keyboard, Key-switch hardware, and all electronic components plus tone generator linking wire and Volume Pedal. A copy of the P.E. project series can be supplied for £3.00 inc. post.

COMPONENT KIT £179.00

ROTOR-CHORUS

Comprehensive two - speed organ rotor simulator plus a three phase chorus generator on a single 8" x 5" pcb. The kit includes all components for mains operation and a stereo headphone driver pcb. Easily integrated with existing organ/amplifier system.

COMPONENT KIT £89.00

KEYBOARDS

Our Square Front Keyboards are chosen for their superior feel to the discerning musician whilst giving adequate physical strength for the high impact playing present in the Piano application.

88 NOTE (A-C) £57.00
73 NOTE (F-F) £47.00
FIVE OCTAVE £38.00
FOUR OCTAVE £28.75

EXPERIMENTERS

A number of our Sub-Kits are of interest to Electronic Music and COMPUTER Experimenters. These include the 6502 based MICRO-CONTROLLER and Music system kit used in the BAND-BOX, plus a 49 note four pitch diode Keyswitch system. See our lists for Sub-Kit prices.

PRICES INCLUDE VAT, UK CARRIAGE & INSURANCE (CARRIAGE EXTRA ON MFD PIANOS). Please send S.A.E. for our complete lists, or use our telephone VSA/ACCESS Service. Competitive quotations can be given for EXPORT orders – in Australia please contact JAYCAR in Sydney.

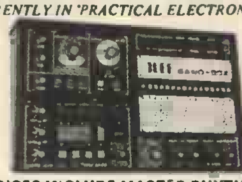
CLEF PRODUCTS (ELECTRONICS) LIMITED
(Dept. P.E.) 44A Bramhall Lane South, Bramhall, Stockport, Cheshire SK7 1AH 061-439-3297

"THE ELECTRONIC BAND-BOX"

CURRENTLY IN 'PRACTICAL ELECTRONICS'

COMPLETE KIT £289

£399 MANFD.



PRICES INCLUDE MASTER RHYTHM

A revolution in the field of Computer Music Generation!

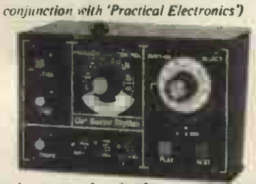
A MUSICIANS INSTRUMENT FOR:
SOLOISTS – SINGERS – RECORDING – PRACTICE
LIVE PERFORMANCE –COMPOSITION

The BAND-BOX provides an Electronic Backing Trio consisting of Drums, Bass, and a Chord Instrument (one of 16 Waveform/Enevelope combinations), with the capicity to store over 3,000 User Programmable Chord Changes on more than 120 different Chords. Using advanced Microprocessor technology, Playback of 50-100 Scores can be executed in any Key and at chosen Tempo. Complete Music Pad is electronically Indexed and stored on secondary battery back-up. Facility exists for composition of Intro, Repeat Chorus, and Coda sections including Multiple Score Sequences. Sockets are provided for Volume Pedal and Footswitch plus separate and mixed instrument Outputs. Total size 19" x 11" x 4¼" incorporating Master Rhythm.

THE Programmable DRUM MACHINE

(As Published in conjunction with 'Practical Electronics')

EIGHT TRACK PROGRAMMING /TWENTY-FOUR PATTERNS/ TWELVE INSTRUMENTS SEQUENCE OPERATION.
COMPLETE KIT £79.00
MANFD. £119.00



The Clef Master Rhythm is capable of storing 24 selectable rhythmic drum patterns, invented, modified, and entered by the Operator on to Eight Instrumentation tracks. A three position Instrumentation control expands the number of instruments available to twelve, grouped into sounds typical of playing with Drumsticks, Brushes, or Latin American Bongos and Claves. Sequence operation allows two rhythm sections to be coupled with the second (B) section appearing at four, eight or sixteen Bar repetition. All drums can be adjusted for level and resonance on internal controls to suit individual taste, thus producing good musical sounds in a battery driven unit 8¼" x 5" x 2¼".

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The unit is housed in a custom designed box with high quality printed panels having an overall size of 165 x 50 x 80mm deep, and can be fitted above or below the dashboard. The display is liquid crystal for clarity in all lighting conditions.

The kit includes all sensors, wiring, etc and is suitable for all cars except those fitted with diesel or fuel injection engines.

Kit price: £78.50 Assembled Price: £88.50
+ £1 p&p includes VAT.
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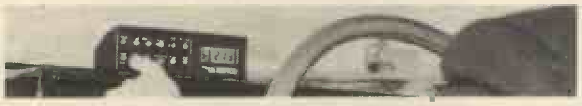
Please allow 14 days for delivery.



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EP4000 EMULATING PROGRAMMER

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P4000 PRODUCTION PROGRAMMER

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- ★ COVERS SAME EPROMS AS EP4000
- ★ INDEPENDANT BLANK CHECK/VERIFY PROGRAM MODES
- ★ SIMPLE TO USE
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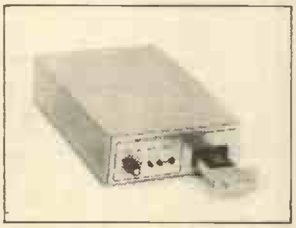
UV141 EPROM ERASER



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Device	Price
MEMORIES	
2114L-200ns	1+0.93
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2708 450ns	1+1.75
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2716 350ns	6.95
2532 450ns	1+4.50
	25+4.25
2732 450ns	1+3.99
	25+3.80
2732 350ns	7.50
4116 200ns	1+0.74
	25+0.70
	100+0.67
4116 150ns	1+0.93
	25+0.89
4118 200ns	1+3.90
	25+3.45
4118 150ns	6.00
5516 200ns	12.50
6116 200ns	7.95
6116LP 200ns	9.50
6116LP 150ns	9.95
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EF6845P	9.50
EF9364P	5.94
EF9365P	62.90
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81LS96	0.90
81LS97	0.90
81LS98	0.90
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8T28A	1.40
8T95	1.35
8T97A	1.35
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ZN426E-8	3.00
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ZN428E-8	4.75
ZN429E-8	2.10
ZN432CJ-10	28.09
ZN433CJ-10	2.59
ZN440	56.63
ZN432E-10	14.75
ZN447	9.14
ZN448	6.85
ZN449	3.20
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FD1771	17.12
FD1791	32.61
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FD1795	35.33
WD1391	45.50
WD1393	45.50
WD1395	45.50
WD1397	45.50
WD2143-01	5.45
WD1691	10.87
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AY-3-1270	7.95
AY-3-8910	6.95
AY-5-1013	3.45
AY-5-3600	7.95
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DP8304	4.50
MC1488	0.59
MC1489	0.59
MC3446	2.95
MC3448A	4.25
MC3480	7.95
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MC14411	6.94
MC14412	7.99
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ULN2803A(L203)	0.84
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ZN450E DVM KIT	25.00
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LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.20
LM324N	0.30
LM348N	0.59

Device	Price
LM555CN	0.16
LM556CN	0.49
LM725CN	3.20
LM741CN	0.14
LM747CN	0.70
LM748CN	0.34
REGULATORS	
7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
79L05	0.59
79L12	0.59
79L15	0.59
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Z80A SIO-0	11.99
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Z80A SIO-2	11.99
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6800	2.99
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6810	1.25
6821	1.25
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68488	9.11
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68B02	19.11
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68B10	2.00
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68000C4	110.00
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6502	4.25
6520	2.99
6522	4.75
6532	6.95
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8085A	5.50
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8224	1.95
8228	3.95
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Device	Price
CMOS 4000 'B' SERIES	
4000	0.11
4001	0.11
4002	0.13
4006	0.60
4007	0.15
4008	0.55
4009	0.28
4010	0.35
4011	0.12
4012	0.15
4013	0.29
4014	0.58
4015	0.58
4016	0.25
4017	0.45
4018	0.58
4019	0.29
4020	0.58
4021	0.60
4022	0.62
4023	0.17
4024	0.35
4025	0.16
4026	0.99
4027	0.30
4028	0.55
4031	1.65
4033	1.60
4034	1.55
4035	0.72
4040	0.54
4041	0.69
4042	0.54
4043	0.59
4044	0.64
4045	1.65
4046	0.68
4047	0.68
4048	0.54
4049	0.26
4050	0.26
4051	0.59
4052	0.68
4053	0.59
4054	1.20
4055	1.20
4060	0.79
4063	0.95
4066	0.34
4068	0.17
4069	0.17
4070	0.17
4071	0.17
4072	0.17
4073	0.19
4075	0.17
4076	0.62
4077	0.22
4078	0.24
4081	0.14
4082	0.19
4085	0.63
4086	0.69
4093	0.39
4502	0.69
4507	0.39
4508	1.90
4510	0.60
4511	0.49
4512	0.60
4514	1.49
4515	1.49
4516	0.69
4518	0.40
4519	0.28
4520	0.69
4521	1.49
4522	1.20
4526	0.70
4527	0.89
4528	0.70
4532	0.85
4541	0.99

Device	Price
4543	0.99
4553	2.90
4555	0.39
4556	0.44
4585	0.62
74LS SERIES	
74LS00	0.10
74LS01	0.11
74LS02	0.12
74LS03	0.12
74LS04	0.12
74LS05	0.13
74LS08	0.12
74LS09	0.12
74LS10	0.12
74LS11	0.12
74LS12	0.12
74LS13	0.22
74LS14	0.39
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS26	0.15
74LS27	0.12
74LS28	0.15
74LS30	0.12
74LS32	0.12
74LS33	0.16
74LS37	0.15
4LS38	0.15
74LS40	0.12
74LS42	0.34
74LS47	0.39
74LS48	0.60
74LS49	0.59
74LS51	0.14
74LS54	0.15
74LS55	0.15
74LS73	0.19
74LS74	0.16
74LS75	0.24
74LS76	0.20
74LS78	0.19
74LS83	0.44
74LS85	0.65
74LS86	0.15
74LS90	0.30
74LS91	0.75
74LS92	0.34
74LS93	0.34
74LS95	0.43
74LS109	0.21
74LS112	0.21
74LS113	0.23
74LS114	0.19
74LS122	0.39
74LS123	0.39
74LS124	0.99
74LS125	0.25
74LS126	0.25
74LS132	0.45
74LS136	0.28
74LS138	0.34
74LS139	0.35
74LS145	0.75
74LS148	0.90
74LS151	0.39
74LS153	0.29
74LS155	0.39
74LS156	0.38
74LS157	0.31
74LS158	0.31
74LS160	0.39
74LS161	0.39
74LS162	0.39
74LS163	0.39
74LS164	0.47
74LS165	0.99
74LS166	0.84
74LS173	0.70
74LS174	0.47
74LS175	0.49
74LS181	1.28

Device	Price
74LS190	0.49
74LS191	0.49
74LS192	0.49
74LS193	0.46
74LS194	0.39
74LS195	0.39
74LS196	0.59
74LS197	0.65
74LS221	0.54
74LS240	0.89
74LS241	0.89
74LS242	0.79
74LS243	0.79
74LS244	0.65
74LS245	0.89
74LS247	0.63
74LS248	0.63
74LS249	0.63
74LS251	0.40
74LS253	0.39
74LS257	0.44
74LS258	0.39
74LS259	0.79
74LS261	1.95
74LS266	0.23
74LS273	0.75
74LS279	0.39
74LS283	0.44
74LS290	0.54
74LS293	0.45
74LS365	0.34
74LS366	0.36
74LS367	0.34
74LS368	0.49
74LS373	0.74
74LS374	0.74
74LS375	0.47
74LS377	0.89
74LS378	0.69
74LS379	0.64
74LS386	0.28
74LS390	0.54
74LS393	0.59
DIL SOCKETS LOW PROFILE - TIN	
8 pin	0.07
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16 pin	0.09
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24 pin	0.19
28 pin	0.25
40 pin	0.29
NEW LOW PROFILE - GOLD	
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14 pin	0.29
16 pin	0.31
18 pin	0.33
20 pin	0.35
22 pin	0.40
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28 pin	0.54
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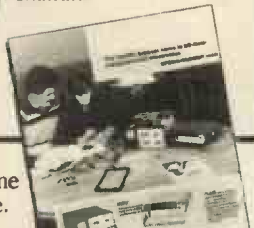

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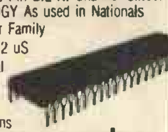

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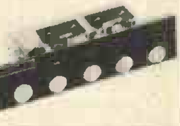

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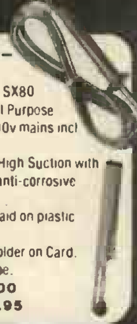

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Max indication	1999 or – 1999
Polarity indication	Negative only Positive readings appear without + sign
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Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	– 5°C to 50°C
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155 x 88 x 31mm

RANGES
DC Voltage 0-200mV
0-2-20-200-1000V Acc 0.8%
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Acc 1.2% DC Current 0-200uA
0-2-20-200mA 0-10 A. Acc 1.2%
Resistance 0-2-20-200K ohms
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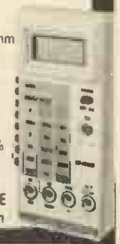

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This small cast iron quality made vice will clamp on to any bench or table having a max thickness of 1⅛". The 2½" jaws open to max of 1⅝". Approx size 80 x 120 x 66mm.
Bi-Pak's Mini Vice at a Mini Price only

£2.

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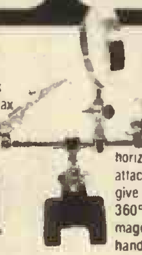
This helpful unit with Rod mounted horizontally on Heavy Base. Crocodile clips attached to rod ends. Six ball & socket joints give infinite variation and positions through 360° also available attached to Rod a 2½ diam magnifier giving 2.5 x magnification. Helping hand unit available with or without magnifier.
Our Price with magnifier as illustrated ORDER NO. T402 **£5.50**
Without magnifier ORDER NO. T400 **£4.75**



EXPERIMENTOR BOXES – ALUMINIUM – PLASTIC

ALUMINIUM BOXES

Made with Bright Aluminium folded construction with deep lid and screws

SIZE "L	W	H	Order No.	Price
5¼	2¼	1½	159	**83p**
4	2¼	1½	161	**83p**
4	2½	2	163	**83p**
3	2	1	164	**57p**
8	6	3	166	**£1.68**
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Plastic Boxes

Coloured Black. Close fitting.
Flanged Lid, fixing screws into brass bushes.

SIZE "L	W	H	Order No.	Price
4	2	1	141	**£1.00**
4¼	2½	1½	143	**£1.30**
6	3¼	2	144	**£1.50**

Plastic as above but with aluminium top panel

4	2¾	1	146	**£1.40**

Plastic sloping front

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All measurements for boxes are shown in inches. L = Length. W = Width. H = Height

MW398 NI-CAD CHARGER

Universal Ni-Cad battery charger. All plastic case with lift up lid. Charge/Test switch. LED indicators at each of the five charging points.

Charges –	Power: –
PP3 (9V)	220-240V AC
U12 (1.5V penlite)	Dims: –
U11 (1.5V "C")	210 x 100 x 50mm
U2 (1.5V "D")	**£6.95**

POWER SUPPLY OUR PRICE £3.25

Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug
Input: – 240V AC 50HZ Output. –3, 4.5, 6, 7.5, 9 & 12V DC Rating: – 300 ma MW88

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Pak No.	Qty.*	Description	Price
SX10	400	Mixed "All Type" Resistors	£1
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SX14	150	½ watt Resistors 22 ohm 2m2 Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm-2m2 Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects
Quantities approximate, count by weight.

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Pak No.	Qty.*	Description	Price
SX16	250	Capacitors Mixed Types	£1
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SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
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*Quantities approximate, count by weight.

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25 pieces of Audio Plugs Sockets and Connectors to include DIN 180°-240°, Inline 3-6 Pin, Speakers, Phono, Jack, Stereo and Mono etc etc Valued at well over £3 normal Order No SX25 Our Price £1.50 per pak Guaranteed to save you money

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Maximum Ratings:
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There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember, Bi-Pak's policy has always been to sell quality components at competitive prices and THAT WE STILL DO.

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Positive +	Negative +
7805 – 50p	7905 – 55p
7812 – 50p	7912 – 55p
7815 – 50p	7915 – 55p
7824 – 50p	7924 – 55p

(please state voltage required)

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2	PB 100	760	10	11.80	14.72	Kit
3	PB 101	940	10	17.20	21.21	
4	PB 102	1240	12	22.95	27.83	
5	PB 103	2250	24	35.95	43.06	
6	PB 104	3060	32	47.95	56.86	
7	PB 203	2250	24.	59.95	70.66	5V @ 1A
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9	PB 203AK	2250	24	69.00	81.07	5V ± 15V & Kit

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Sinclair ZX81 Personal Comp[uter] the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive, specially- written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

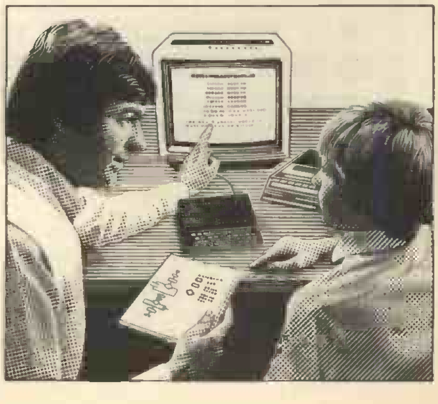
The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification
- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



PE VOLUME 18 No. 3 MARCH 1982

FREE

While reading the local paper recently, the thought occurred that there must be hundreds of electronics hobbyists with odd bits of test gear, audio equipment, or components stacked away that they could sell in an "under a tenner" column of the type now found in many local papers. During discussions in the editorial office it was thought to be an excellent idea and that we could run advertisements with no price limit, provided the service was only available to private readers and not to the trade or anyone making money from buying and selling anything to do with electronics. After all, the trade can advertise in our pages or take a classified space, but with the cost of classifieds rising it is not a viable proposition for the reader who would like to sell a few components, a speaker or a meter.

We think a readers free ad. page will be of interest to most readers, will encourage an interface between hobbyists and could realise some cash to help with our hobby. We want to encourage you to buy, sell or swap anything to do with electronics from a bag of resistors to a printer, computer, organ, TV or oscilloscope but we have decided that we cannot accept ads. for computer software. After all, if you're writing and selling software you are "in business" and if you're selling someone else's you're probably infringing their copyright!

PE BAZAAR

We have decided to call the feature *PE Bazaar* as we feel this term describes perfectly just what it's all about. As we have said it is for **PE readers only** and we have thus instigated a coupon system for sending in ads. This means that you must have an up to date issue to send in your ad. and you must sign a declaration to say you are not running a business dealing with electronics in any way. We have reserved the right to refuse ads. if we are worried about the contents or the private reader/business situation.

In order to give everyone a chance we can only accept one ad. per coupon and we have limited the number of words in each ad. so that we can get a good variety on a page, or in any small space we may have—say at the end of an article. Full details of *PE Bazaar* and the first ad. coupon can be found on page 31. If we get some ads. back very soon after the publication of this issue, we hope to be able to get them in next month—it's first come, first served.

RESPONSIBILTY

One final point, we must make it quite clear that PE cannot be held responsible for any errors in the free ads. or for any transactions that take place between readers as a result of a free ad. We will not enter into correspondence concerning free advertisements, their contents or transactions.

However, we must say that in our editorial dealings with our readers we have found you to be a wonderfully reliable, trustworthy and honest lot. We have often sent odd items to readers, requesting payment on receipt and almost without exception have received prompt payment. We would like to take this opportunity to thank you—it saves us all time, trouble and money when things work in this way. Let's hope *PE Bazaar* is popular, helps as many of you as possible and leads to some useful exchanges and friendships within our hobby. It's up to you now!

Like everything else, it seems to be such a good idea, we wonder why we didn't think of it months ago?

Mike Kenward

Editorial Offices:
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Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
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We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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King's Reach, Stamford Street, SE1 9LS
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Technical Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or international reply coupons, and each letter should relate to **one published project only**.

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

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders
Binders for PE are available from the same address as back numbers at £4·60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £13·00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

...NEWS &

Edited by Jasper Scott

Public consultation on radio frequencies

Wider public consultation on proposals which could affect frequency allocations for some aircraft and shipping radio services has been announced by the Home Office.

The Home Secretary was giving details of the United Kingdom's preparations for the 1983 World Administrative Conference for Mobile Telecommunications, to be held in Geneva, in answer to a Parliamentary Question from Mr. Peter Viggers MP. The decisions made at the Geneva Conference will govern frequency allocations for certain maritime and aeronautical mobile radio services.

The Home Secretary pointed out that non-government organisations had already been consulted about the UK's provisional proposals for the conference, but he had decided that views should be sought from a broader public so that no significant point was overlooked.

The UK proposals deal mainly with two major items:

Regulatory provisions for the introduction and development of the Inter-Governmental Maritime Consultative Organisation's Future Global Distress and Safety System; and the drawing-up of channelling plans for the maritime mobile service in the medium-frequency (MF) and high-frequency (HF) bands. Other UK proposals seek improvements in the regulation of the aeronautical mobile service, and cover miscellaneous points on the agenda.

Copies of the proposals can be obtained from: Home Office Radio Regulatory Department, Room 804, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

Grand Prize

British Telecom's Prestel world viewdata service is offering a £1000 prize to the designer of the best Prestel adaptor for the top-selling Sinclair ZX81 personal computer.

Sinclair Research, which is to provide one of the judges, strongly supports the competition and believes that a successful design will offer its established 150,000 UK users a valuable new application. Although a number of microcomputers can already receive Prestel, these numbers would mark a very significant service extension for British Telecom.

Telesoftware—computer programs distributed via teletext or viewdata to computers in schools, homes and offices—is now a major Prestel growth area, and many program publishers are becoming active and establishing libraries that can hold up to 1,000 pages following the Department of Industry's initiative in funding the Educational Telesoftware Project.

The prize will be awarded to the adaptor which best combines 'low price, elegant design and practical robustness', and the working design submitted must be capable of being modified to receive approval for attachment to the telephone network.

Closing date is March 14th, 1982, and further details, specification and entry forms are available from Tony Sweet, Prestel Headquarters, Telephone House, Temple Avenue, London EC4 0HL (01-583 9811).

AM CB: AN APRIL FOOL

Following numerous rumours that the Government is considering legalising CB on 27MHz AM, the Home Office has issued the following statement:

"Don't be misled by unfounded rumours claiming that the use of illicit 27MHz AM sets will be legalised. The Government has no intention of making any changes to the new legal 27MHz FM CB service."

Reports abound of AM sets carrying labels stating that the apparatus cannot be used "until April 1982". Any such stickers are quite simply hoaxes.

POCKET MICROSCOPE

Can't quite make out that dry joint or broken p.c.b. track? What you may need is a pocket microscope, and Stotron Ltd. have recently introduced one which could be just what you need. With 20X magnification and a graticule showing linear and angular measurements, the unit is only 125mm long. Illumination is powered by standard 1·5V penlight batteries, and a micro-stand with spring clips for sample slides is also available, so the microscope can be used like a conventional model.

Priced at £16.99 plus £2.80 for the stand, the 'scope is available from Stotron Ltd., Unit 1, Haywood Way, Ivyhouse Lane, Hastings, East Sussex (0424 442160).

CAR COMPUTER

Pimac Systems Ltd., who supply kits for the PE Car Computer, inform us that they have been able to reduce the price for the complete kit to £78.50 plus £1 p&p. The unit is also available ready built, price £88.50 plus £1 p&p. Both prices include VAT. Pimac Systems Ltd., 20 Bloomfield Road, Moseley, Birmingham B13 9BY.

MARKET PLACE

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

Briefly...

This year, the All-Electronics/ECIF show will be doubled in size and held at the Barbican Exhibition Centre in the City of London. It will run from Tuesday April 20th to Thursday April 22nd, and, say the organisers, will offer the largest and most comprehensive display of the electronics industry that the capital has seen for many years.

• • •

Tempus—often featured in these pages as suppliers of Casio products—have moved from their premises in East Road, Cambridge. Their new address is: 38 Burleigh Street, Cambridge CB1 1DG.

• • •

Barrie Electronics Ltd. inform us that they have been appointed a franchised distributor for the "budget range" of toroidal transformers manufactured by Cotswold Electronics Ltd.

The fifty-eight toroidal transformers will complement the 150 stacked laminated types stocked by Barrie Electronics on an off-the-shelf basis.

Barrie Electronics Ltd., 3 The Minories, London EC3N 1BJ (01-488 3316).

• • •

PCB DRILL OFFER

Due to demand for this exceptionally priced tool which was on Special Offer in our January issue, the offer closing date has been extended to March 26th 1982. Please contact Watford Electronics to ensure supply. Price is £8.60 inclusive.

WERSI'S COMET

Recently unveiled by Aura Sounds in London, the Wersi Comet is the latest addition to the increasingly popular range of Wersi Organs. The Comet is a completely new model—not a modification or development of any other Wersi organ, and has been designed to give the best possible sound quality and features at a budget price.

As well as traditional drawbar and orchestral sounds, the Comet provides a wide range of other voices, including various guitars, synthesiser and percussion. Numerous effects are incorporated, including three way vibrato, slalom and the Wersivoice rotating speaker sound. A totally new feature is the Comet's facility to accept connection of up to four 'satellite' keyboards, so that up to five musicians can play the one organ together.

As with all other Wersi instruments, the Comet is available ready built or as a kit. If you choose to build a Comet yourself (which is a very straightforward operation estimated to take only 100 hours, due to the use of plug-in circuit boards and ribbon cable wiring) you can save almost half the cost of the ready built unit.

The Comet is available either as a home console model (W10S) or as a portable unit with detachable legs (W10T). Prices are as follows: W10S £3,620—ready built; £1,899—complete kit. W10T £3,592—ready built; £1,971—complete kit. Further information is available from Aura Sounds Ltd., 14–15 Royal Oak Centre, Brighton Road, Purley, Surrey (01-668 9733).

Countdown...

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below.

BEX Bournemouth Feb. 17–18. K
Microsystems Feb. 24–26. West Centre Hotel, London. Z1
Seminex Mar. 29–Apr. 2. Imperial College, London. H1
Laboratory Edinburgh Mar. 30–31. Ass. Rooms, Edinburgh. E
CAD Mar. 30–Apr. 1. Metropole, Brighton. Z1
Sensors & Systems Mar. 30–Apr. 1. The Forum, Wythenshawe, Manchester. T
ETM Mar. 30–Apr. 1. The Forum, Wythenshawe. T
Peripherals Mar. 31–Apr. 2. West Centre Hotel, London. Z1
Laboratory Manchester Apr. 7–8. New Century Hall, Manchester. E
All Electronics Show Apr. 19–21. Barbican Centre, London. E
BEX Brighton Apr. 28–29. K
Compec Europe May 4–6. Centre Int. Rogier, Brussels. Z1
Scotelex. Jun. 8–10. Roy. Highland Ex. Hall, Ingliston, Edinburgh. A1
BEX Leeds Jun. 9–10. K
Transducer/Tempcon Jun. 29–Jul. 1. Wemb. Conf. Centre. T
BEX Croydon Jun. 30–Jul. K
Leeds Electronics Show Jul. 6–8. University. E
Laboratory London Sep. 14–16. Grosvenor House. E

A1	Institute of Electronics, Rochdale, Lancs.
E	Evan Steadman, Saffron Walden ✆ 0799 22612
H1	Seminex Ltd., Tunbridge Wells ✆ 0892 39664
K	Douglas Temple, Bournemouth ✆ 0202 20533
L1	World Trade Centre ✆ 01-488 2400
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WERSI and AURA — The Winning Combination

INDUSTRY NOTEBOOK

By Nexus

Salaries

A new year always brings thoughts of what lies ahead and reflection on the past. A main preoccupation is the personal one of jobs and salaries. On the broader front there is the anxiety that political hot-heads will rock the industrial boat and put all our jobs at risk. But assuming, hopefully, that militants can be bought off or otherwise contained then 1982 could still be a good year for recovery.

Barring political upheaval, any competent person in electronics can expect to hold his job. The adventurous may well rapidly improve their position and prospects by changing jobs. There are plenty of openings available and industry personnel managers are still complaining that good people are hard to find and how much it costs in advertising and interview time to find them.

The lowest advertised salary I have spotted recently is for R & D engineers at £5,176 for a junior starting post. But this was in Government service carrying some advantage in security and rising to £8,589.

A BBC call for transmitter and planning engineers gave a range of £9,000 to £11,000. An instrument engineer in South Wales is offered circa £9,000, another similar post in Essex up to £12,000. A development engineer in television was promised £10,000, his laboratory supervisor £16,000.

Overseas the salaries are higher and most enjoy tax advantages. A quick sample threw up a salesman (Middle East) £18,000, telecomms engineer (Saudi Arabia) £20,000 tax free, electronics lecturers (Hong Kong) circa £20,000, branch manager (Iraq) up to £24,000.

Everyone will hold his own views on the value of the salaries in relation to environmental factors, separation from family etc. I have known people move job to a lower salary in a different area to secure better education for their children. It seems that salaries in general are holding up well and that the variety of jobs and locations in electronics gives far more choice and opportunity than most other industries.

Backward Glance

Last year was pleasurable in the number of success stories I was able to record. And it finished up with the giants of the industry continuing to improve not only their sales (including exports) and profits but also their order books. GEC-Marconi, for example, managed another scoop with a £500 million contract for the Royal Navy's heavyweight torpedo. On the technological front there were also gains with many new equipments and systems on offer.

Personality of the year was unquestionably Sir Ernest Harrison, mastermind of the Racal Electronics Group, who was heaped with honours, principally a well-deserved Knighthood but also Honorary Doctorates from Cranfield Institute of Technology and the University of Surrey. He finished the year with a flourish, winning the Businessman of the Year Award.

The citation of the latter mentioned the acquisition and subsequent turn-round in fortune of Decca but I think the last part would have pleased Sir Ernest best. It added, "And for providing a rallying point for industry, a much-needed demonstration that where the will is present, British companies, their managements and their products can equal the best in the world, even in the toughest high-technology markets which are too often considered to be the preserve of Japan and the USA."

Another well-deserved honour, the Gold Medal of the Royal Aeronautical Society, went to J.E. (Jack) Pateman for 'building-up British technical and industry leadership in the avionics field'. Pateman is managing director of Marconi Avionics and in ten years he created 8,000 new jobs, tripling the size of the company to become Europe's largest producer and top exporter of aviation electronics.

In case you imagine these men are nothing but workaholics I should mention that Jack Pateman enjoys gardening and sailing and Sir Ernest shares Jack's enthusiasm for gardening but also lists wild-life, all sports, but particularly soccer (I recall he was an Arsenal fan at one time and maybe still) among his interests.

Up North

With the great bulk of the electronics industry concentrated in the South and South East, the Midlands and Northern regions get less attention than they deserve. I recently had the opportunity of visiting three companies in regions which are generally described as depressed. This is certainly true of the inner city areas I saw on the trip but there was nothing depressing in the companies.

Maybe I was lucky in my choice but all three had expanded during the recession, had new products and services in planning, and all believed in a great future. One of the companies, to my astonishment, had been running three shifts round the clock throughout the whole of the recession. None of them had had an easy time but there were no complaints. Just enthusiasm to get on with the job.

Energy

It seems only yesterday that we were all talking of the energy famine. Today we have a glut of oil and coal. But yesterday's scare triggered a surge of activity in developing alternative sources of energy.

One result is IBA's experimental sun-and-wind powered TV relay station at Bossiney on the north Cornish coastline. All power for the transposers and receivers come from natural sources. The idea of a hybrid sun-and-wind system is that if the sun isn't shining there is more than a fair chance that the wind will be blowing, and often both will be generating at the same time. When nature is not generous the system is backed up by a reservoir of three dozen lead-acid batteries with a capacity of 1,000Ah. The windmill produces 150W at wind speeds of 15 m.p.h. and 864 solar cells produce up to 780W in peak sunlight. The TV relay equipment consumes 150W.

To get Channel Four available to a target of 99·9 percent of the population some extra hundreds of such low power relay stations will be needed. But energy conservation is only part of the reason for the self-contained station. The other, often more compelling, reason is that these low-power relays, sometimes serving as few as 500 people or less, are on difficult and remote sites where the capital cost of running power lines to them is out of proportion.

Inmos

The Inmos factory at Newport, Gwent, some 85,000 sq.ft. of it, is now becoming a reality. Building has been in progress for a full year and the 30,000 sq.ft. clean area should be installed by March.

The Newport plant appears to be definitely scheduled for wafer fabrication and an eventual workforce of 1,000 is still envisaged. But assembly might still take place in the Far East.

A number of questions still overshadow the Inmos project, not least the departure of Paul Schroedor who as Executive Director, corporate development, was clearly a key man. The product strategy and future funding remain unclear. Obviously there are elements of commercial security involved. Anyway, with so much now invested and a tentative foothold in the market we can do no more than wish Inmos the best of British luck.

Vigorous ATE

Automatic Test Equipment (ATE) is still a blossoming market under vigorous attack by all the leading manufacturers. Typical is Marconi Instruments System 80X, unveiled at the ATE Exhibition in Brighton last December. The 80X has been designed with the US market in mind and MI has opened an ATE facility at Sunnyvale in an attempt to gain a larger market share. Prices start at £80,000 and rise to £150,000 for a complex system with up to 2,000 test points.

THE cost of electrical energy consumption has become increasingly significant in recent years as the price of primary fuels has risen more quickly than the average increase in the cost of living. In order to control costs in the house, it is necessary to know which appliances cost the most to use and to what extent savings can be made by reduced usage, turning thermostats down, etc. The watt-hour meter provided by the electricity supply authority does give a means of calculating total consumption and hence the staggering quarterly bill. However, it gives no indication of the rate at which costs are being incurred or which appliances are consuming energy at the greatest rate and what the individual cost is.

All appliances are supplied with a label indicating their power rating but to calculate the cost of running a washing machine through a 45 minute cycle with intermittent motor running, thermostatically controlled heating, pumping and spinning would be almost impossible for the average person.

The device described in this article continuously measures the current being consumed by such an appliance and having previously had the latest cost per unit of electricity keyed into it, displays the charge as it is being incurred. It was designed about three years ago and is the subject of a UK Patent application. Only recently has the cost of the components used reduced to the level where a home construction kit has become an attractive proposition.

TELECTRIC BASICS

The basic operation of the Telectric can be explained with reference to the block diagram of Fig. 1. The current consumed by the appliance plugged into the 13A socket flows through the primary turns of the current transformer and the secondary voltage induced forms the input to IC3 in order to measure this current. The PSU provides a 5 volt supply and also a sync pulse which occurs at the zero crossing of the a.c. mains voltage. The microprocessor reads the control keys, provides the display drive and multiplexing and samples the output of IC3 at the peak of the mains voltage waveform on both negative and positive half cycles. From the stored value of the cost per unit the incremental cost per half cycle is calculated and added to the running total for display.

There is one control switch and four push button keys. When the switch is in the cost per unit position the display initially reads Ent. and a single push of any key increments the display digit directly above it in order to enter the cost per unit in pence to three decimal places. When the control switch is in the electricity bill position the four push buttons assume their control functions. These are:

Start Resets the accumulated charge and elapsed time to zero and starts new sequence.

Pause Holds the current reading of charge and time. A second push of this key restarts from the previous readings.

Time/Cost Toggles the display between displaying time and charge.

Check Whilst held down, the current value of the cost per unit is displayed as a check on operation.

DISPLAY FORMAT

In the cost per unit position the decimal point is located between the two left hand digits and the display indicates the unit cost in pence.

With the control switch in the electricity bill position the display is auto ranging, the device having been designed to accumulate up to £99.9 in cost and 99.9 days in time. The ranges and examples of their display formats are as follows:

Cost

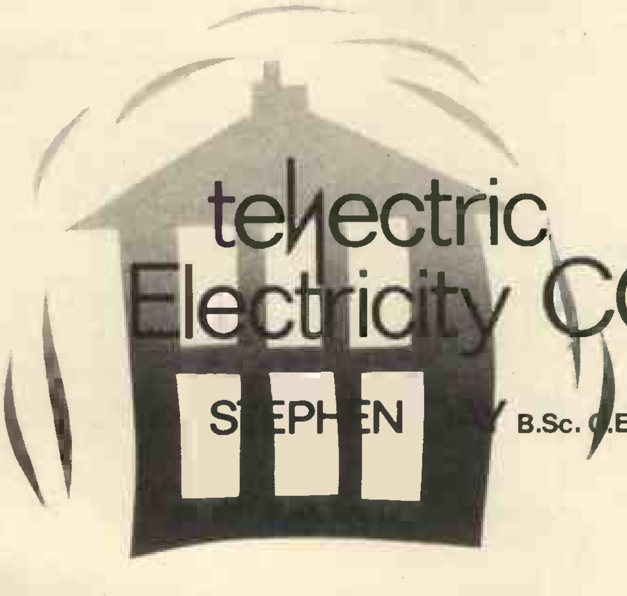
up to 9.99p	e.g. 2.14P	pence and decimals of pence
10p to 99.9p	e.g. 47.1P	pence
£1.0 to £9.99	e.g. L7.85	pounds and pence
£10.0 to £99.9	e.g. L90.6	pounds and decimals of pounds

Time

1 second to 1 hour	e.g. 27.59	minutes and seconds
1 hour to 1 day	e.g. 14.27	hours and minutes
1 day to 99 days	e.g. 9.9d	days and decimals of days

CIRCUIT DESCRIPTION

All the circuitry in the device uses a 5 volt supply and the circuit diagram is divided into two parts; Fig. 2 showing the power supply and sync pulse generator and Fig. 3 showing the processor, etc. The 5 volts is generated using a 9V (6VA) transformer, bridge rectifier and a 7805 i.c. regulator. The sync pulse generation can be described with reference to Fig. 5 which shows the waveforms through IC8. The full wave rectified input to IC8a is inverted and produces a positive going pulse about 2ms wide and symmetrical about the zero crossing of the a.c. mains waveform. This is delayed by R21, C6. The output of IC8b is a negative going 2ms pulse with its leading edge corresponding approximately



telectric Electricity COST MONITOR

STEPHEN B.Sc. C.Eng. M.I.E.E.

SPECIFICATION

Display
4 digit 7 segments l.e.d.s 0·5" high with decimal points.

Controls

S1	Cost per Unit/Electricity Bill Output socket power switch (No effect on metering function)
S2-S5	

Functions

A) Switch in 'Cost per Unit' position

S2	Most significant digit increments every time key is pressed, 0–9
S3, 4, 5	As S2 for digits 2, 3, 4 of pence per unit figure. This position of the switch serves only to enter the pence per unit figure. The decimal point second from left is illuminated. The electricity cost is not monitored. Cost and elapsed time functions are set to zero

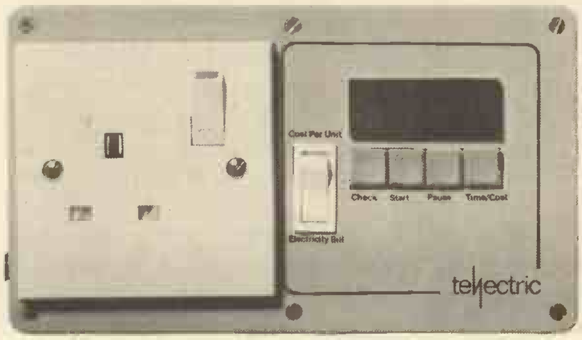
B) Switch in 'Electricity Bill' position

S2 ('Check')	While pressed pence per unit is displayed (operational check) Otherwise S5 controls display
S3 ('Start')	Each depression of key zeroes electricity bill and time elapsed. Electricity bill begins to total from moment of depression Subsequent depression zeroes and restarts.
S4 ('Pause')	Depression of key halts totalling of cost and elapsed time Subsequent depression restarts from previous reading without zeroing
S5 ('Time/Cost')	Display shows electricity bill initially. First depression causes display to show elapsed time. Second depression electricity bill, etc.

Maximum cost per unit 9.999 pence
Maximum electricity bill total £99.9
Maximum elapsed time 99.9 days
Accuracy better than 1% for 13A load

with the zero crossing. IC8c speeds up these edges and C8 couples them to IC8d which is biased below its threshold by R22 and R23. Thus the output from IC8d is a negative pulse approximately 20µs wide corresponding to the zero crossing and this forms a synchronising pulse.

The microprocessor controlling the Telectric is the 8035 which contains its own clock generator, reset, and interrupt input pins. It has 64 bytes of on chip RAM, an 8 bit data/address bus, two 8 bit I/O ports and external memory read and write timing signals. It also has an on chip timer which is used to time the ADC sampling at the peak of the a.c. voltage waveform.



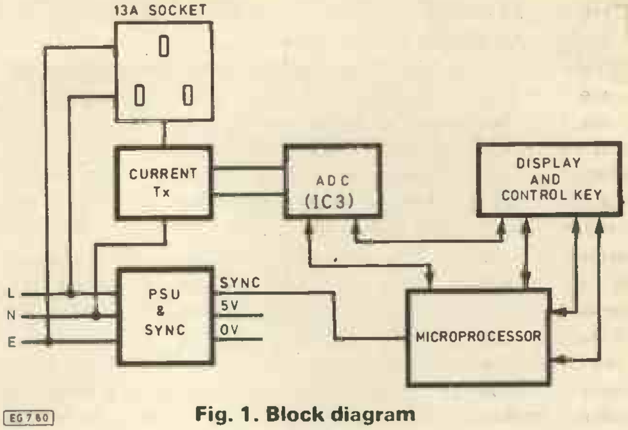


Fig. 1. Block diagram

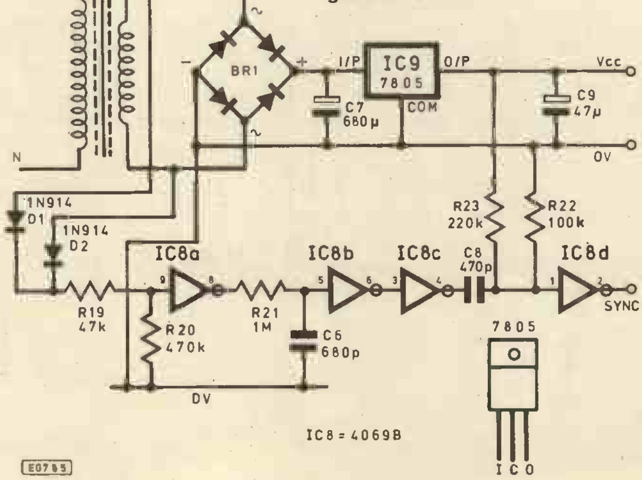
Details of the microprocessor, bus timing and software will follow next month, however, it is worth mentioning that the displays are of the common anode l.e.d. type and their pin connections are shown in Fig. 4. *Pnp* transistors are used to drive the common anode of each display and the multiplex frequency is 200Hz. The cathodes of the individual segments are driven via open collector gates and the microprocessor controls the display decoding in order to provide the special characters not normally available in a standard decoder.

CURRENT MEASUREMENT

In measuring mains current, the simplest way would be to use a series resistor but this has several drawbacks. The ADC requires a 5 volt peak-to-peak voltage waveform at its input for maximum current corresponding to a 40 amp peak to peak sinusoidal current or 14.14 amps r.m.s. The power developed in such a resistor would be 25 watts at peak load which is obviously not desirable. A smaller resistor could be used with an op-amp to multiply up the voltage generated but this technique still requires the circuitry to be connected to the mains and faults could be catastrophic. It was therefore decided to use a current transformer to provide full isolation.

Purpose designed current transformers are quite expensive and so a 3VA mains to low voltage transformer is used in the Telectric. This has its low voltage winding removed to enable one and a half turns of the mains neutral lead to be threaded onto the transformer before connection to the output socket.

Fig. 2. P.s.u. and sync pulse generator



Components . . .

Resistors

R1, R10, R12, R14, R16, R18	10k (6 off)
R2 to R9	220 (8 off)
R11, R13, R15, R17	2·2k (4 off)
R19	47k
R20	470k
R21	1M
R22	100k
R23	220k
R24/R25	(see construction notes)

Capacitors

C1	68p
C2, C3	22p (2 off)
C4	1µ tant bead
C5	0·1µ
C6	680p
C7	680µ 16V
C8	470p
C9	47µ tant bead

3 off 0·1µF disc ceramic and 2 off 0·01µF disc ceramic decoupling capacitors as per layout diagram.

Semiconductors

Bridge rectifier (REC1)	50V, 1A
D1, D2	1N914 or equivalent
TR1 to TR4	BC213L or equivalent (4 off)

Integrated Circuits

IC1	2716 2K × 8 UVEPROM
IC2	74LS373
IC3	ADC0804 (National Semiconductors)
IC4	8035 microprocessor
IC5, IC6	7401 (2 off)
IC7	74LS365
IC8	4069B
IC9	7805 (regulator + 5 volts)

Displays

DL507B (Litronix)	Common anode 7 segment l.e.d. displays (4 off)

Miscellaneous

4 push buttons; 1 rocker switch; 1 switched 13A mains socket; 1 grey moulded ABS box, 190 × 110 × 60mm; 1 mains transformer 9 volt, 6VA, 10% regulation; 1 mains transformer 3VA to convert to current transformer; 1 crystal 3·579MHz (NTSC subcarrier); 1 heatsink for 7805; 2 metres 13A mains cable; 3 metres connecting wire; 8 i.c. sockets (3 × 14 pin, 1 × 16 pin, 2 × 20 pin, 1 × 24 pin, 1 × 40 pin); 1 p.c.b., double sided but designed for pin through as well as plated through holes; 1 display p.c.b.

A complete constructor's kit for the Telectric is available from **Response Co., Stoner End, Froxfield, Petersfield, Hants (0730 3063).** Price £47.50 + VAT (£54.62). A limited number of fully assembled Telectrics are also available at £64 + VAT. All parts are also available separately. Send SAE for details.

Fig. 3. Complete circuit

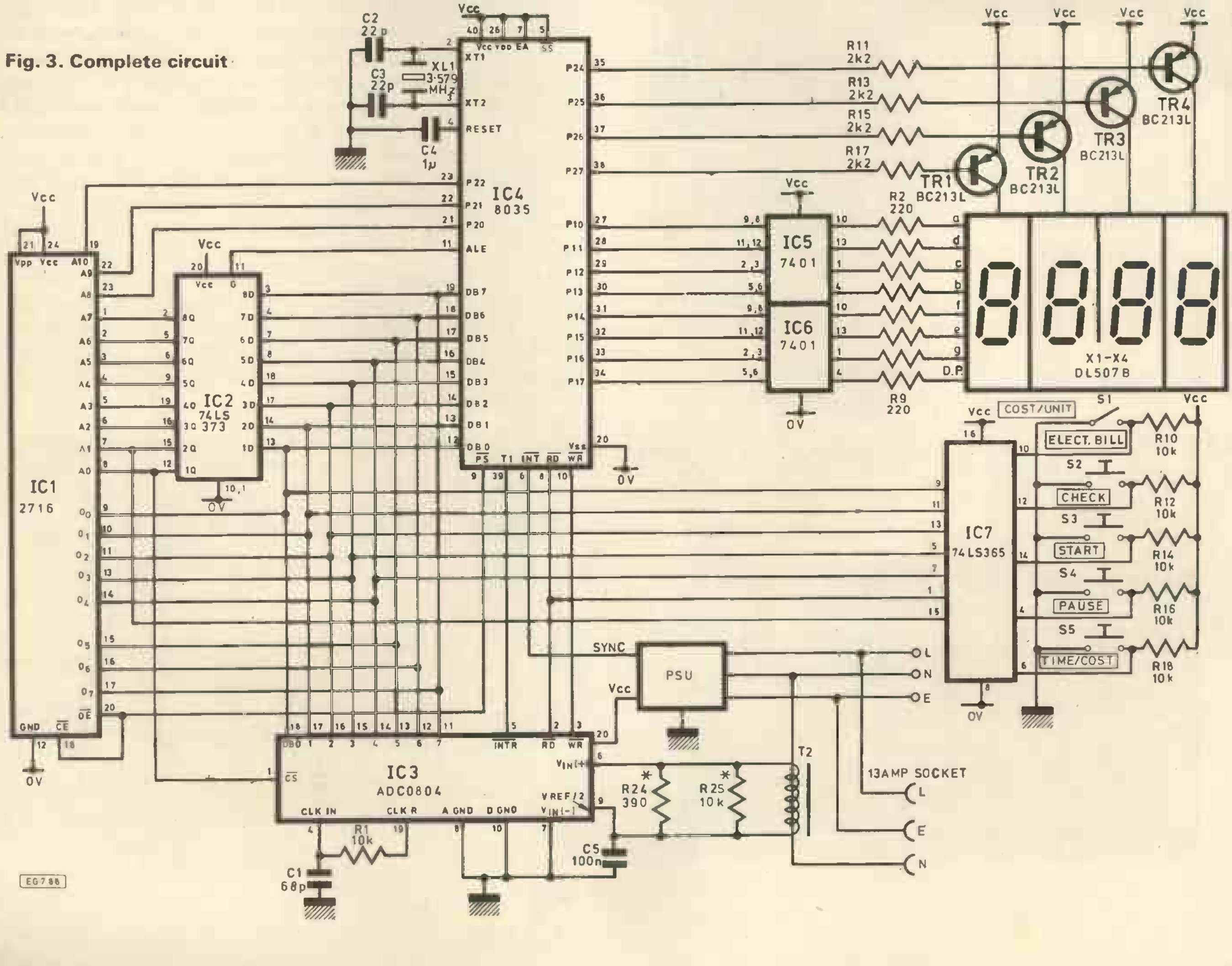
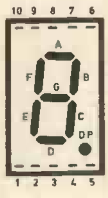


Fig. 4. The pin connections to a display digit



Pin	FUNCTION
1	E CATHODE
2	D CATHODE
3	COMMON ANODE
4	C CATHODE
5	DP CATHODE
6	B CATHODE
7	A CATHODE
8	COMMON ANODE
9	F CATHODE
10	G CATHODE

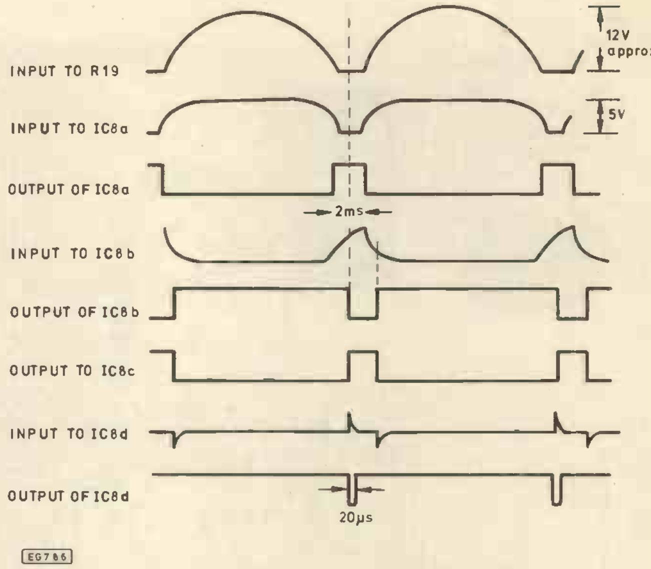
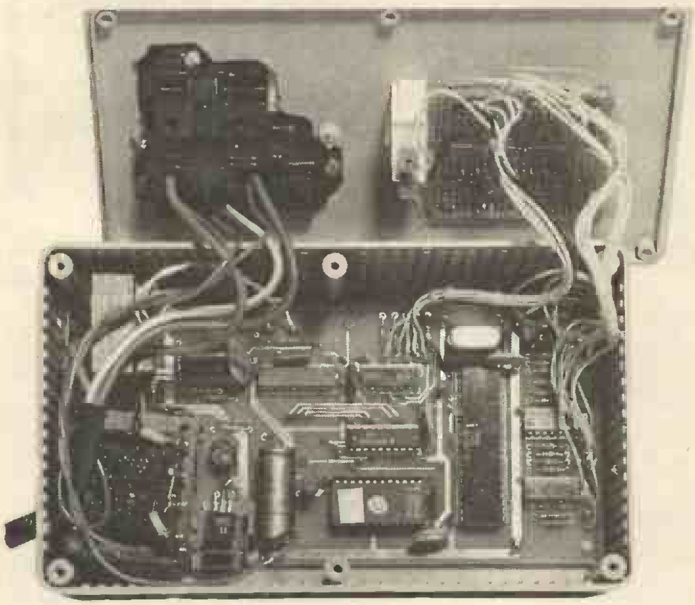


Fig. 5. Showing the waveforms through IC8



Internal assembly

CONSTRUCTION

All of the components except the display and switches are mounted on the main p.c.b. which is double sided. The foil layouts are shown in Figs. 6 and 7 and the component layout in Fig. 8. Although the p.c.b. is double sided it has been designed with no through connections on i.c. pins and the position of these is shown by large dots in Fig. 8. Also shown are some extra decoupling capacitors which do not appear as components in the circuit diagrams. The p.c.b. should preferably be assembled using i.c. sockets for all i.c.s so that faults can be easily rectified.

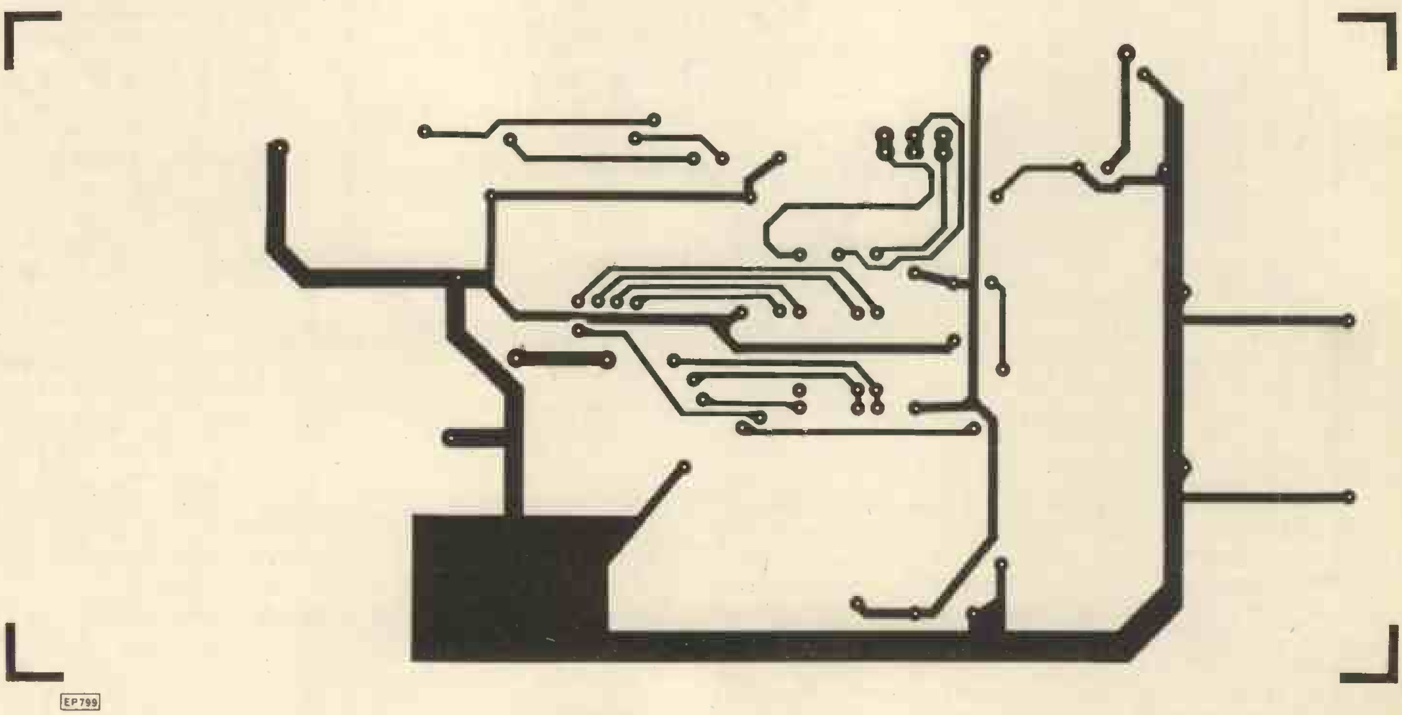


Fig. 6. Topside of p.c.b.

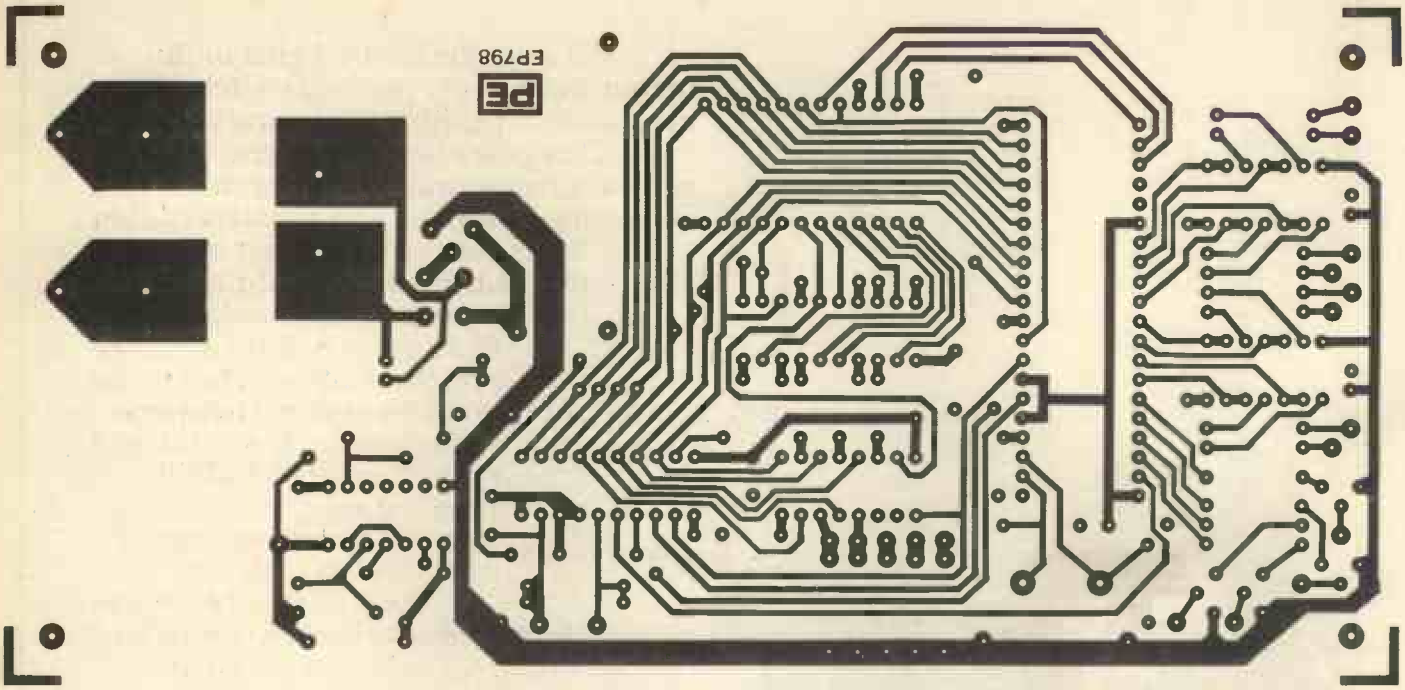


Fig. 7. Underside of p.c.b.

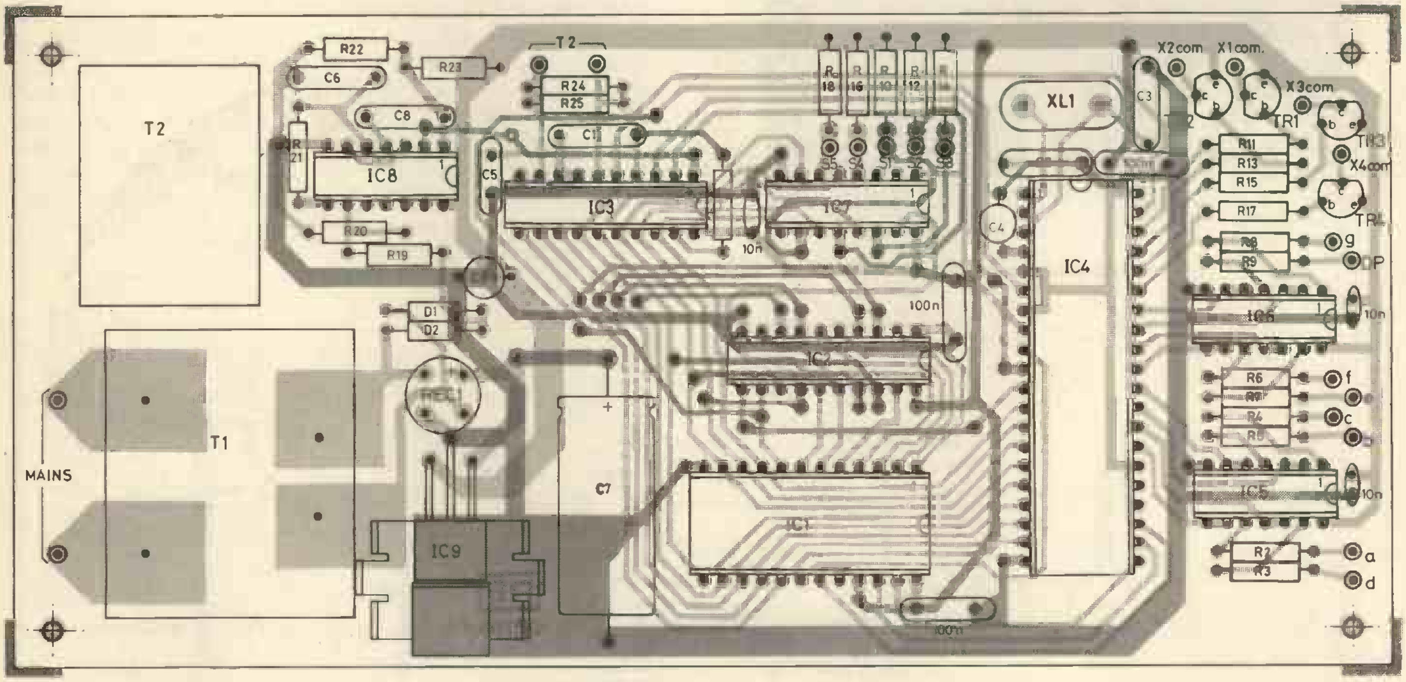


Fig. 8. Assembly details of board

The pads for the mains transformer have been made quite large to accommodate a variety of pin arrangements. The current transformer load resistors must be fitted before the ADC is plugged into the circuit. Without these resistors a high voltage may be generated which could damage or destroy the ADC. The values of R24 and R25 are found experimentally (they are supplied correct value with the kits) by using a one kilowatt load such as an electric fire. The exact current is measured with an Avo or similar and will be around 4 amps r.m.s. The voltage across the load resistors is then given by the relationship V(r.m.s.) = I x 0.125 volts, where I is the exact current. R24 can now be selected to produce a slightly high voltage reading and R25 will be a higher value resistor to provide the final trim.
(R24 may be 390 and R25 10k giving a total equivalent load of 376).

NEXT MONTH Detailed discussion of the microprocessor circuitry and software and more construction details.

EMERGENCY LIGHT

STEPHEN IBBS

WHERE WERE *YOU* WHEN THE LIGHTS LAST WENT OUT?

For around £20 and a little d.i.y. you could be *automatically* cut into the limelight with our rechargeable Emergency Lamp! Alternative? The next power cut might be your darkest hour.

IT IS likely that most householders will experience at least one power failure. This can be very inconvenient, because it is *then* that the candles and matches can't be found, *because of the dark*! However, such a failure can be more serious, as the author found when carrying a tray of crockery on the stairs at the moment of failure. The shock alone was enough to send both flying, resulting in a painful fall. The idea for this project was thus conceived during convalescence. It obviously needed to be automatic, pleasing and cheap.

The project described here is intended to enable constructors to build a ni-cad powered emergency light, drawing no battery current in its quiescent state (less than 1mA from the rectified supply), switching on automatically in the event of a mains failure. When mains is restored, the ni-cad can then be recharged, and a built-in timer lights an l.e.d. when the batteries should be charged (assuming they were fully exhausted to start with). Two switches are provided, one to act as an on/off control and as a reset switch, the other to activate the charging and timing circuits.

HOW IT WORKS

Mains voltage is reduced by the transformer, and then rectified by the diodes D4-5 (4-7). The resulting d.c. is then smoothed to a degree by C1 and flows via R1 to light l.e.d. 1. This d.c. also ensures that pins 1 and 2 of IC1a (used as an inverter) remain high, so that its output pin 3 is low, preventing the thyristor from turning on. When the mains does fail C1 rapidly discharges with R1, l.e.d. 1, R2 and R3, and pin 3 goes high, providing gate voltage to the thyristor which then fires, allowing current to flow via the three bulbs. C1 has to be relatively low in value, otherwise it would take a long time to discharge, causing a delay before the light came on. S1 now acts as a simple on/off switch. When mains is restored the lights will stay on, because once fired, gate voltage can be removed from a thyristor. However, briefly opening S1 disconnects the anode from the battery which does reset the thyristor ready for the next failure.

When S2 is closed current flows through R5, which acts as a current limiting resistor to protect the batteries. D1 prevents battery voltage from reaching pins 1 and 2, as does D2. The purpose of D2 and D3 is to provide voltage to the supply pins of the i.c.s. Because the rectified d.c. voltage is higher than the battery voltage, D3 is normally reverse-biased, so no current flows out of the battery. However, in the event of a mains failure D3 is now forward biased, maintaining supply to the i.c.s.

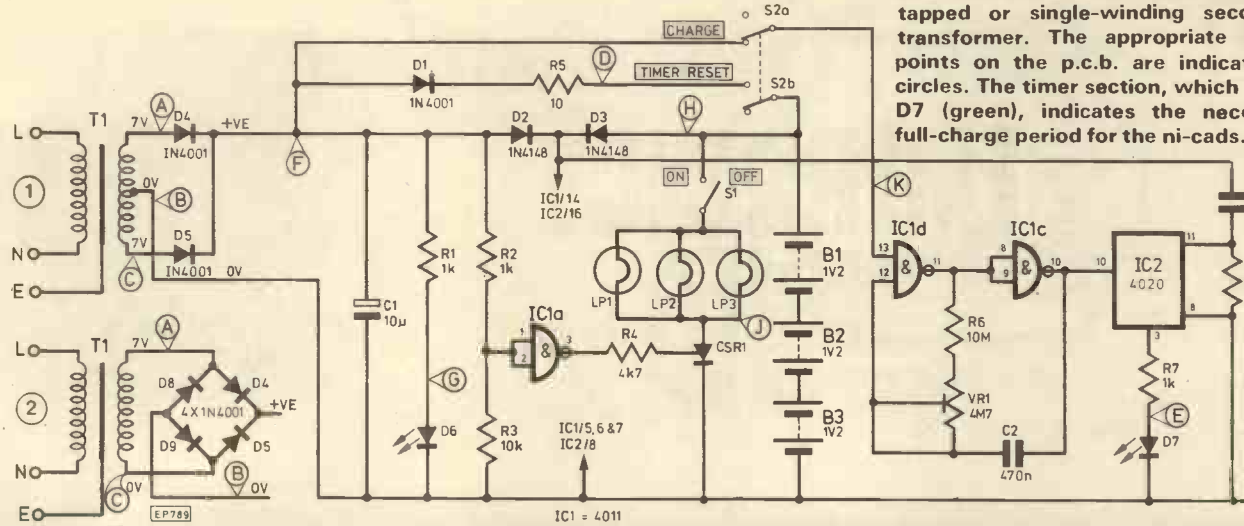
The closing of S2 also gates the slow oscillator constructed around IC1c and d. The frequency is adjustable to a certain extent by VR1. The output clocks IC2, a ripple counter, and after 16384 pulses pin 3 goes high, lighting l.e.d.s.

CONSTRUCTION

Assembly of the p.c.b. is straightforward. The plastic case used is the widely available Pifco "Everywhere Wall Light". It is first necessary to modify this case in the following way: The large bulb holder must be removed by drilling out its mounting rivets. Next, drill out the cord operated on/off switch. Drill two holes to accommodate the miniature toggle switches (see Fig. 1). These holes should be one above the other in the side of the case, directly opposite the "cord hole". This cord hole will be used to admit the mains cable. Two holes should also be drilled into the lens cover to take the l.e.d.s and (preferably) their bezels. Similarly, two further holes will need to be drilled through the internal diffuser to pass the l.e.d. wires (these wires should be fairly lengthy for lid removal). Hole diameters are dependent on switch and l.e.d. sizes, the former being subminiature types.

Only three nickel-cadmium cells are to be used, the mains transformers taking up one of the former battery positions. Various small transformers of the type needed are frequently seen advertised for as little as £1, therefore this component has not been rigidly specified. For this reason the rectification system has been made versatile to accommodate differing types, but the space available and the dimensions of the transformer must be taken into account. A little more spatial

Fig. 1. Circuit diagram. The PSU section may incorporate either a centre-tapped or single-winding secondary transformer. The appropriate wiring points on the p.c.b. are indicated in circles. The timer section, which drives D7 (green), indicates the necessary full-charge period for the ni-cads.



★Components

Resistors

R1, R2, R7	1k (3 off)
R3	10K
R4	4k7
R5	10 2 watts
R6	10M
R8	100k

All resistors ¼ watt 5% unless otherwise specified

Potentiometers

VR1	4M7

Capacitors

C1	10µ 16V electro.
C2	470n polyester
C3	100n polyester

Semiconductors

D1	1N4001
D2, D3	1N4148 (2 off)
D4-5 (4-7)	1N4001 (2 off)
D6-7	l.e.d.s (2 off)
IC1	4011
IC2	4020
SC1	C106

Miscellaneous

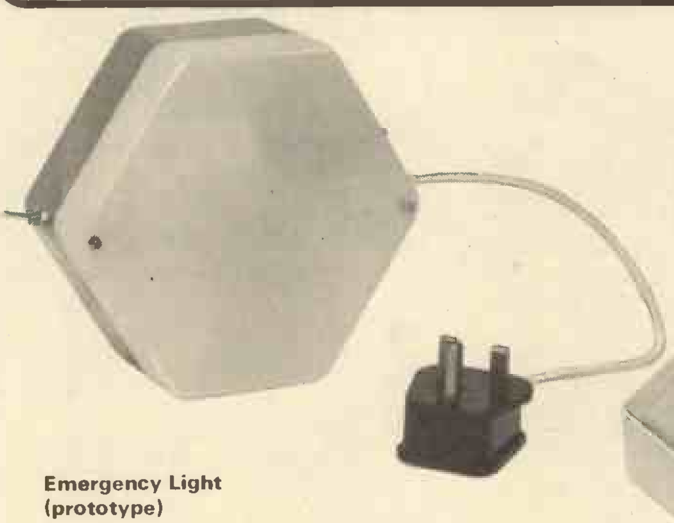
3 bulb holders (cat. No. PLH2 Home Radio)
3 torch bulbs 3V5
3 x 4AL V2 equiv. ni-cads
1 SPST) } miniature toggles
1 DPST) }
p.c.b.
Transformer 7-0-7 Volts at 200mA
Pifco Everywhere Wall Light, Model No. 1644

Constructors' note

The MES bulb holders are available from: Home Radio Components, 240 London Rd., Mitcham, Surrey, CR4 3HD. They may be second-sourced from: Electrovalue, 28 St. Judes Road; Englefield Green, Egham, Surrey, TW20 0HB. (Order skeleton lampholder type MSS36.)

The transformer's electrical requirements are less critical than its physical dimensions. For example, a 6-0-6V 250mA transformer will suffice so long as its measurements do not exceed 55mm wide, by 40mm high, by 35mm (the latter dimension to *include* any tags etc.).

If a 0-6V or 0-7V single-winding secondary transformer only, can be found, then the bridge rectifier arrangement may be used (insert D8 and D9 on p.c.b.). The Pifco lamp is available in high street shops.



Emergency Light (prototype)

Pifco Wall Light before modification, showing the lens cover and its removable diffuser/reflector.

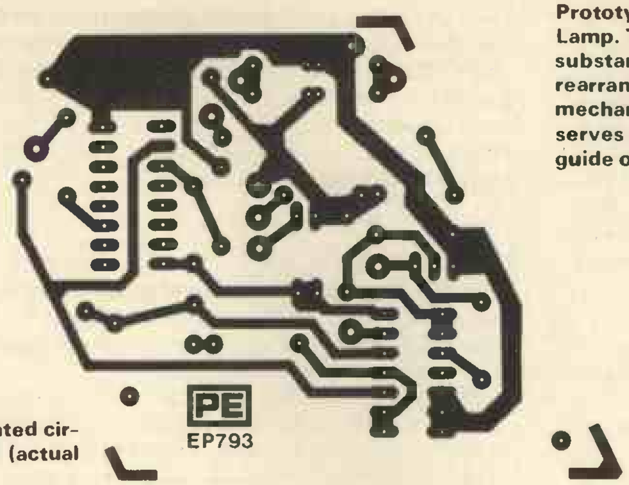
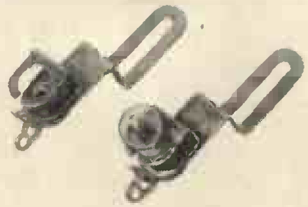
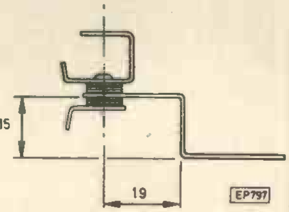


Fig. 2. Printed circuit board (actual size)

Prototype Emergency Lamp. This has been substantially rearranged mechanically, and serves as a guide only.

Skeleton MES bulb-holders which have been bent to the dimensions shown below.





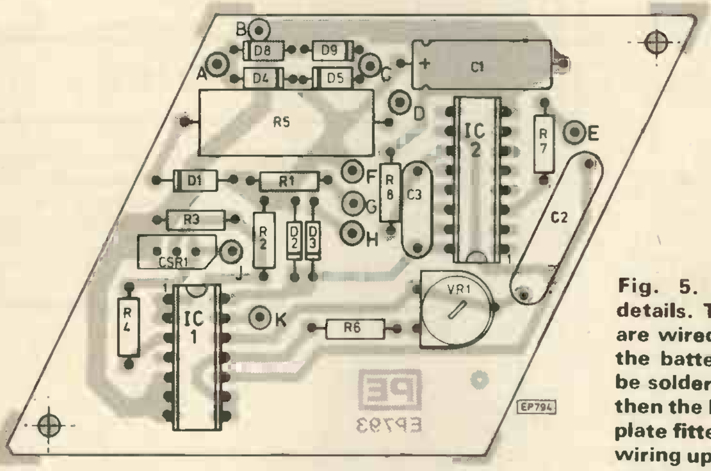


Fig. 3. Component layout for the p.c.b. If T1 has a centre-tapped secondary, leave D8 and D9 off the board. If T1 has a single-winding secondary, use terminals A and C only, and include D8 and D9.

Fig. 4. The Pifco "Everywhere Wall Light" showing the necessary modifications to be made.

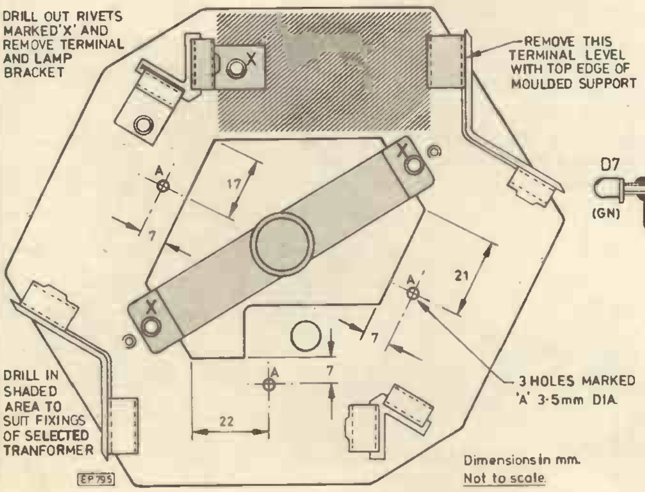
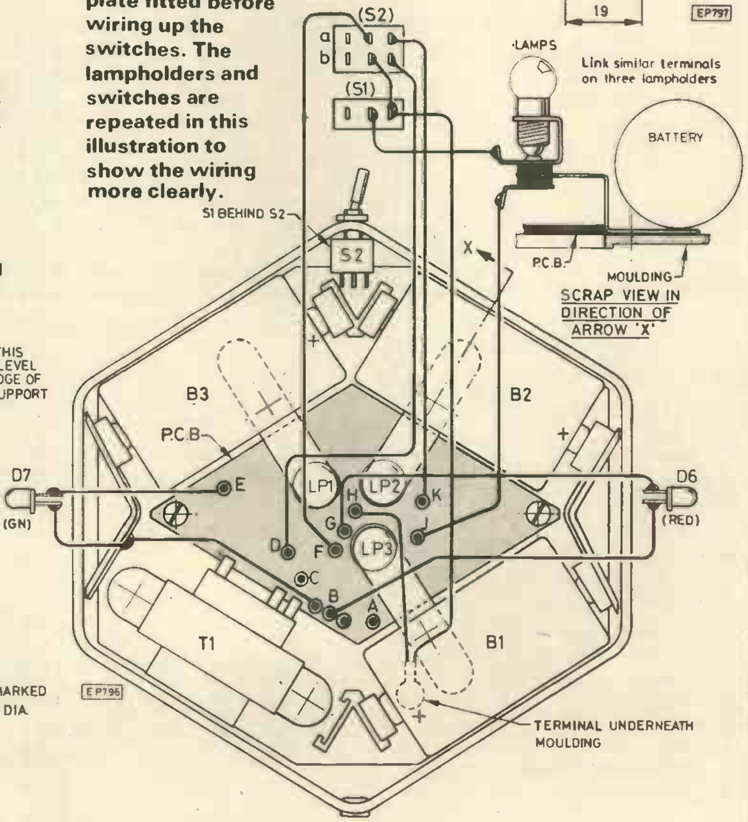


Fig. 5. Wiring and layout details. The three MES bulbs are wired in parallel. Wires to the battery base-plate should be soldered first, then the base-plate fitted before wiring up the switches. The lampholders and switches are repeated in this illustration to show the wiring more clearly.



flexibility will be allowed if the two contact springs originally intended for the battery, are snipped out. Be careful how this is done. Do not remove the part which provides anchorage!

The three skeleton bulb-holders should be formed to the shape illustrated, and fixing holes drilled through the battery base-plate for mounting these. This shape has been conceived to aid the retention of the heavy nickel-cadmium cells. The round hole at the centre of the diffuser will not be large enough to clear the three MES bulbs in our new system, and therefore should be opened out using a knife or abra-file. It may be found necessary to bore some ventilation holes in the vicinity of the transformer to prevent gradual discoloration of the plastic.

When wired, the bulbs should light if S1 is closed. Switch on the mains, and the light should stay on; however, briefly opening S1 will extinguish them. Ensure that S1 is left in the closed (on) position, turn off the mains and the light should come back on.

To check that the batteries receive charge when S2 is closed, the most simple technique is to push a small piece of double sided p.c.b. in between the +ve of the battery and the battery holder. Attach pulses from a current meter (black to the +ve battery side because charge should be flowing from the more positive rectified d.c. side into the battery) and check that charging is taking place. Also check that when the mains is on S2 is open, that no current flows out of the battery (with the lights out of course!) To set the timer for 18 hours, monitor pin 7, which should change state every 63 seconds (63-27 secs—approx!)

CONCLUSION

One of these lights at the head of the stairs is a real safety feature at home. It makes an ideal present, perhaps particularly for elderly people who may find a sudden blackout more difficult to cope with.

The only component possibly to cause problems when purchasing the parts is the case. It is manufactured by PIFCO and is called the "Everywhere Light" (model 1644) though other cases may, of course, be used. Because the batteries are not being trickle-charged, it is good practice to check the state of charge every so often. ★

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PE BAZAAR MARCH '82

FREE TRANSISTOR PROJECTS...

AUTOLIGHT

The 'in' thing for absent residents

HERE is a light that will deter a burglar in your absence as it automatically switches on at dusk and off at dawn. As such, it is ideally suited as a porch light, giving the impression that the premises are occupied.

Whilst the supply requirements are low, the period when the unit is in operation is long, so the use of the mains voltage was considered imperative and anyway, if the light was not powered from the mains it would probably give the game away.

CIRCUIT

In Fig. 1, a mains transformer T1 is used to step down the 240V supply to the operating potential. The secondary winding supplies the rectifier pair D1/D2 to provide rough d.c. which is further smoothed by the electrolytic capacitor C1.

TR1 is used as a switching transistor having the relay coil as its load. The diode strapping this is to suppress the transient high reverse voltage which would normally develop when the relay is switched off. Its action is to simply short circuit the high voltage spike, which could damage the transistor, reducing it to a value of about half a volt.

Bias is provided to the switching transistor by a resistive chain which includes a cadmium sulphide light dependent resistor, the resistance of which reduces as the light falling on the device increases. Typically, for an ORP12 this resistance ranges from 10M in total darkness to less than 100 ohms in bright conditions, and around a few kilohms for a cloudy day.

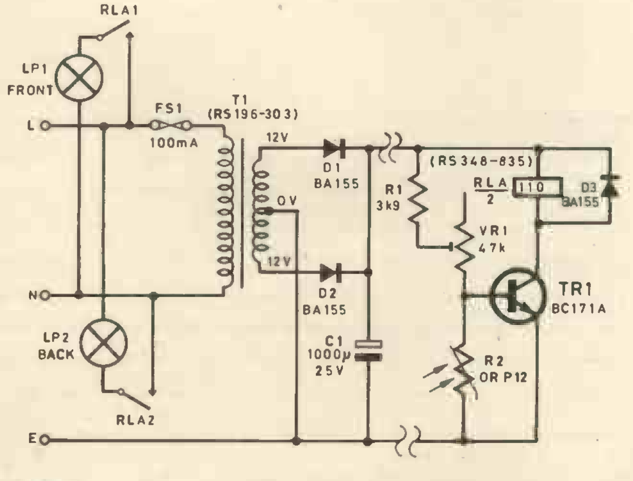


Fig. 1. Circuit of Autolight

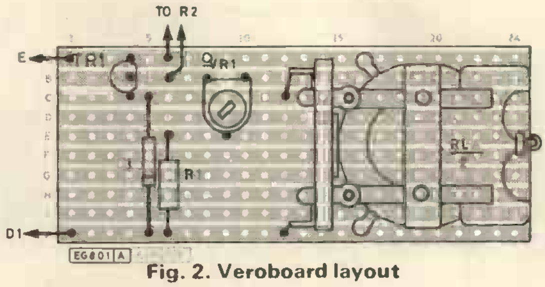
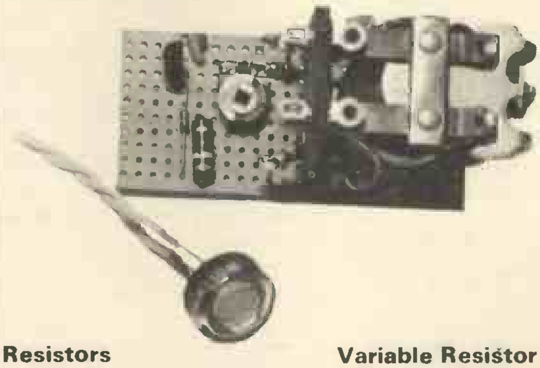


Fig. 2. Veroboard layout

COMPONENTS



Resistors
R1 3k9

Capacitors
C1 1000µ 25V

Semiconductors
D1–D3 BA155
TR1 BC171A

Transformer
T1 12–0–12V (RS 196–303)

Relay
RLA 110

Lamps
LP1–LP2

Variable Resistor
VR1 47k

Light Dependent Resistor
R2 ORP 12

Fuse
FS1 100mA

LIQUID ALARM

TRANSISTOR FREE PROJECT

A sensor that sounds for liquid or vapour

ONE of the simplest and most versatile of direct coupled circuits is the super-alpha or Darlington pair. Super alpha derives from the gain multiplication produced by connecting transistors this way, so that the composite pair shown in Fig. 1 have a very high current amplification which for the transistors being used approximates to 125^2.

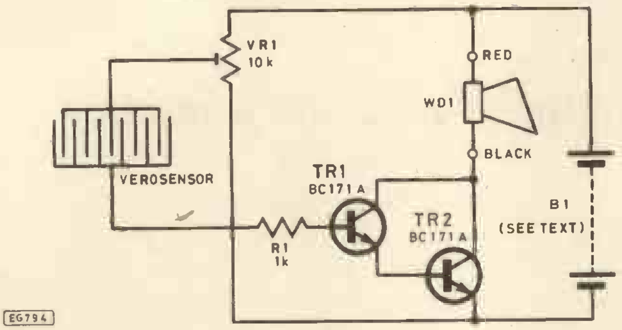


Fig. 1. Circuit of Alarm

VEROSWITCH

A piece of 0·1in matrix Veroboard with the alternate track layers commoned (Fig. 1) makes an ideal sensor as liquid or vapour bridging these will form a base input to TR1.

In the initial setting up, the sensitivity of the device is set by VR1. If steam is applied to the parallel copper strips of the sensor, VR1 is rotated until the alarm sounds. At this point the adjustment is for maximum sensitivity.

In its appointed role as a laundry protector, obviously the housewife will only be concerned with rain that has started falling so that she can make the quick rescue, so a high sensitivity adjustment should be made.

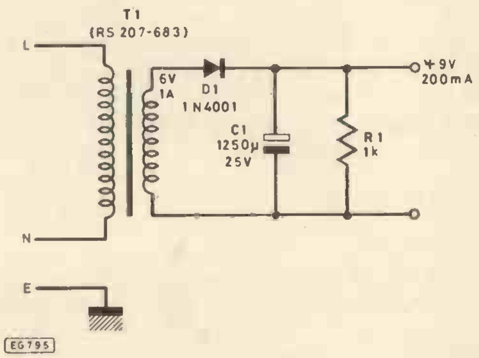


Fig. 2. A mains supply that can be used

LIQUID LEVEL

If a liquid level switch is intended, where two stiff conductive probes are substituted for the Veroboard, then the simple expedient is to use lengths of 16 s.w.g. tinned copper wire for the probes, these being terminated with the input connections to the device.

The retainer for these stiff wires could be a five-way terminal so that adjustment for probe separation, and therefore liquid level, would reduce to loosening the screws of the block and moving the wires relatively as required.

To complete the assembly, the two outer connectors of the block could retain a suspension hook of wire.

Obviously the probes could be manually adjusted for any liquid level rise or simply left with the tips adjacent to detect a level.

ALARM

The choice of supply was deliberately kept low for battery conservation, as the current consumption of the alarm rises almost linearly with the voltage applied. For the circuit shown and the alarm arranged for pulsed tone operation (3·2kHz approximately pulsed at 5Hz), the current is an intermittent 10ma. Nevertheless, sound output is strident and will almost certainly be heard anywhere around the house. However, if you do need a bigger output then you can simply raise the supply voltage to 9V. There are no circuit changes to be made, but remember, whilst the db output level rises so does the current consumption.

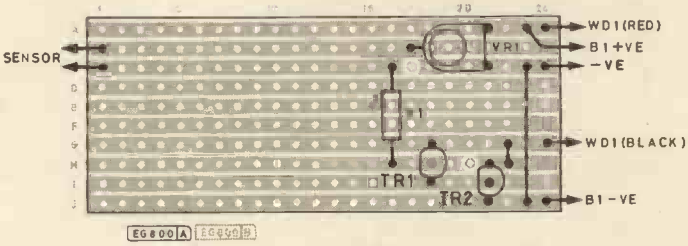


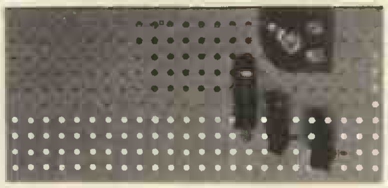
Fig. 3. Veroboard layout

OUTPUT ALTERNATIVES

With the alarm specified the output alternatives are continuous or pulsed tone depending on whether the yellow sense lead is connected. The instruction for this is to leave it unconnected for pulsed operation or to connect to battery negative for a continuous tone. The remaining two leads (red and black) are connected as shown in the circuit.

With its obvious long-term utility there is a need to substitute a simple mains supply for batteries and a suitable 9V circuit is given in Fig. 2.

COMPONENTS



Resistors
R1 — 1k
10% ¼ watt carbon

Potentiometer
VR1 — 10k preset

Transistors
TR1–TR2 — BC171A (2 off)

Warning Device
WD1—Surface mounting audible alarm (RS 248–788)

Battery
B1—see text

DOUBLE SIREN

Alarm options with one transistor

THIS project makes use of only one of the free transistors but offers two siren options: an American police siren with the characteristic short rise and longer fall and alternatively the urgent rising bursts of sound reminiscent of the alarm status signals of the starship Enterprise. It should be noted that although the component count is small the sound output is large.

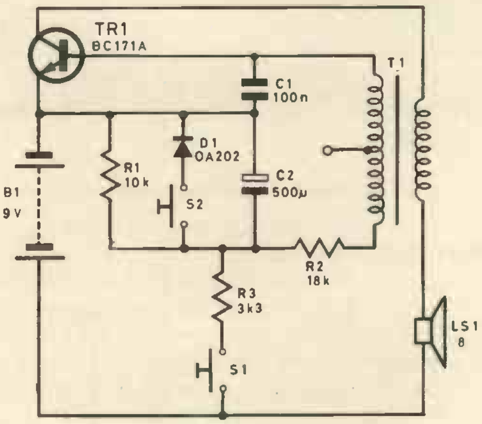


Fig. 1. Circuit of Siren

BLOCKING OSCILLATOR

Both these sounds are initiated by S1 and S2 respectively, but for the starship alarm S1 must be kept closed while pressing S2. Power consumption is relatively low—about 24mA—but if batteries are heavy on the pocket then there is the simple expedient of knocking up the simple 9V power supply given previously in this supplement.

This circuit has the rather formidable description of a blocking oscillator. Here, the transformer provides regenerative feedback by phase inversion from the collector to the base of TR1; so remember, if your unit does not work just reverse the connections to the primary or secondary of T1.

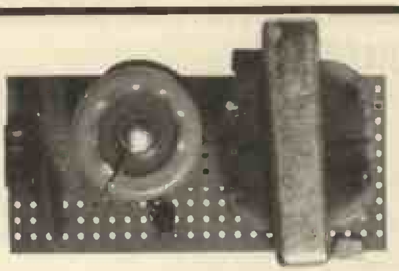
When S1 is pressed the tone produced through components C1, T1, R1 and R2 is raised by the charging of C2 through R3. When S1 is released the charge in the electrolytic capacitor leaks away so that the tone gradually falls. By introducing the diode with the switch S2, C2 is very rapidly discharged so that with operation of this switch you only have a series of rising tones.

OUTPUT

In introducing this project it was stated that the sound output is large. This statement is true if a large speaker is used, anyway, you can have fun experimenting. I used a 4in type and found the output adequate.

Since sound expansion has been touched upon there

COMPONENTS



Resistors		**Transistor**	
R1	10k	TR1	BC171A
R2	18k	**Loudspeaker**	
R3	3·3k	LS1	4in 8Ω
All ¼W 10% carbon		**Battery**	
Capacitors		B1–9V	
C1	100n		
C2	500µ 25V elect		
Switches			
S1–S2	Press switches		
Transformer			
T1	T/T7 output (RS)		

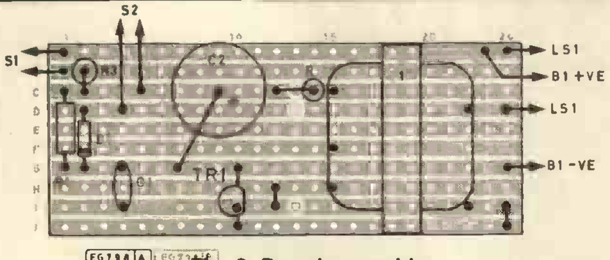


Fig. 2. Board assembly

could possibly be a requirement for changing the decay period or frequency. Although I have endeavoured to simulate the sounds set out in the introduction, I certainly am not gifted with perfect pitch so there might be some among you who require a little more accuracy in the reproduction, then the guidelines for sound tailoring are that increasing R1 will increase the siren's fall period and increasing C2 will lower the frequency and, of course, vice versa.

AF/RF GENERATOR

TRANSISTOR FREE PROJECT

Broad band signal source

THIS little generator makes no pretentions towards a high specification, but with it you could quite easily troubleshoot a radio covering the medium and long wavebands, which includes the r.f. and a.f. components, or any audio entertainment equipment.

FREE RUNNING

The circuit shown in Fig. 1 is a free running square wave generator which produces a basic tone of frequency 1/(1·4CR) cycles where C is the single coupling capacitance (farads) and R the base bias resistance (ohms), which works out to 1kHz.

To reduce signal output the simple expedient of starving the circuit is used via VR1.

ACTION

When power is first applied to the circuit from the battery, since there is no means of maintaining a permanent voltage at the base of either transistor the circuit has no stable state. The unbalance between each half of the circuit induces one transistor towards current cut-off and the other towards full conduction. However, there is no d.c. stable state and the current alternates between the two quasi-stable states at the previously mentioned rate fixed by the 200k/5n pairs. As the value of these are equal the output forms a symmetrical square wave.

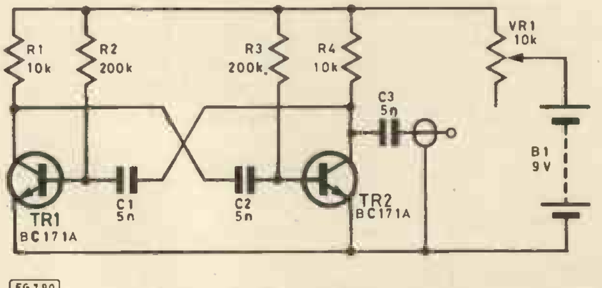


Fig. 1. Circuit of Generator

HARMONICS

The harmonics produced to cover the r.f. bands mentioned are the normal components of a square wave. How far they extend upward being set by the characteristic of the wavefront. The shorter the time of the rise the higher the harmonics extend upwards.

OUTPUT

Since the transistors are switched hard on the output voltage is that of the supply. To vary this output it is convenient to vary the supply with the potentiometer VR1, since the current drawn from the battery is extremely low. In fact, the generator will work with nothing more than a meagre 0·5V.

The output coupling capacitor C3 has a working voltage which has been chosen deliberately high for any valve circuit applications. Make sure the signal lead from this is coax suitably terminated with crocodile clips.

USING IT

Assuming you have no test equipment, when applying the generator to entertainment equipment fitted with its own loudspeaker the rule is always to work back from the output stage to the input. The evidence of stage and then component failure in proceeding in this logical manner is loss of signal.

With, say, a radio, this should be tuned off a station with the volume turned up. You should then work back through the a.f., i.f., and r.f. stages to locate the faulty component. A good set will produce a loud tone if the generator output is brought close to the ferrite aerial.

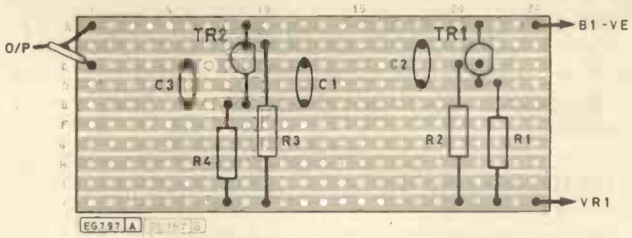
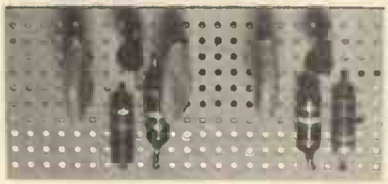


Fig. 2. Showing board assembly

COMPONENTS



Resistors

R1	10k
R2	200k
R3	200k
R4	10k

All ¼W 10% carbon

Capacitors

C1–C2	5n
C3	5n

Transistors

TR1–TR2	BC171A (2 off)

BENT WIRE GAME

TRANSISTOR FREE PROJECT

Touch tournament with a memory

HERE is a constructional variation of the old 'steady hand' game where a loop of wire has to be run along another piece of wire bent into an irregular pattern. The object of the game is to run the loop from one end of the shaped wire to the other without making contact between them. If this is done, then the loop is returned to the start and the next competitor makes his move.

Since any number of people can compete and presumably complete the course, the winner must be the one who does it in the shortest time.

MORE DIFFICULT

The difficulty of the game can be improved upon by any

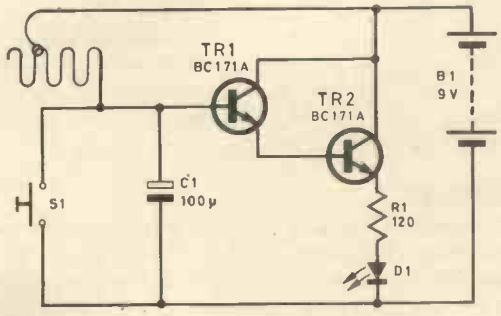


Fig. 1. Circuit of Game

one of the following changes, which are a) making the curves of the wire length more irregular, b) lengthening the run, and c) decreasing the diameter of the loop. These are all variations which can be tailored to suit the age and skill of the competitors and which cost very little in time or money to arrange.

HOW IT WORKS

The circuit shown in Fig. 1 is that of a compound emitter follower which has a characteristically high input impedance seen from the base of TR1 and the cathode of D1.

If, say, there was a short between the competitor's loop and the shaped wire the light emitting diode would switch on and in the absence of the electrolytic capacitor C1 this would switch off as soon as contact was broken.

You can imagine, then, the argument that would ensue if the offending party refused to own up to the instantaneous flicker, so C1 was introduced to remove any conflict.

In practice, the l.e.d. will remain lit for periods in excess of five minutes for the slightest touch so it does arbitrate conclusively. The switch S1 discharges C1 in preparation for a new game.

CONSUMPTION

The unit consumes no current in the stand-by condition and 40mA when switched on. This is, in fact, the maximum forward current of the l.e.d. specified and if a battery is to be used some might like to conserve power with a reduction of light emission.

To do this, resistors from the one specified up to a value of 1k can be used. The 1k limit provides a visible lamp but considerably reduces the consumption to about 5mA.

POWER SUPPLY

Once again we can solve the problem of battery cost by building the p.s.u. shown in the Liquid Alarm project.

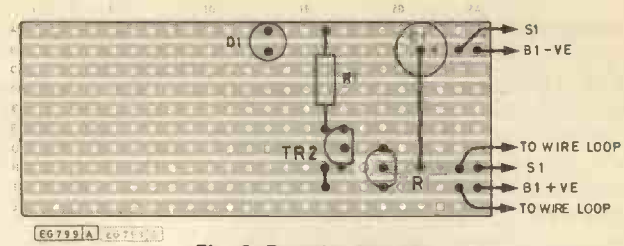
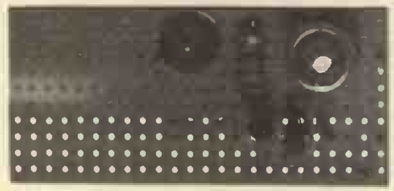


Fig. 2. Board assembly

COMPONENTS



Resistor

R1	120
All $\frac{1}{4}$W 10% carbon	

Capacitor

C1	100µ 15V

Transistors

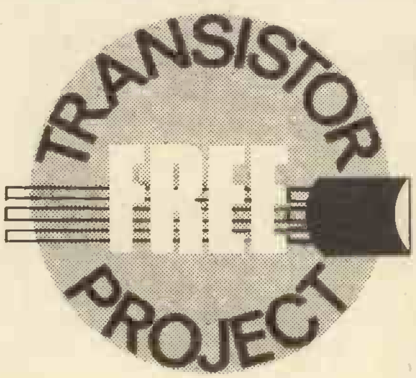
TR1–TR2	BC171A

Diode

D1	0·2in green l.e.d. (RS 586–481)

Battery	B1—9V

CAR BATTERY CONDITION INDICATOR



Lights the way to happy motoring

MOST car manufacturers pay scant attention to dashboard indicators in the charging department. A red light that comes on and goes off when you start the journey leaves you electrically ignorant in its absence until something like a broken fan belt occurs.

Just over a generation ago the voltmeter and ammeter were standard equipment for the motorist so that he was constantly aware of what was happening to the battery, dynamo and regulator when the vehicle was started or running.

Today's economies reduces all electrical awareness of a satisfactory circuit to the standard ignition warning light, which, apart from a perfunctory introductory glow, tells you nothing about the battery state of charge.

FULL INDICATION

This three l.e.d. alternative will continuously monitor the general state of the battery from 'poor' (red l.e.d. lights), when suspicion should be cast on the battery voltage regulator or dynamo or combination of these. For this condition the battery voltage is below 11·6V.

A battery terminal voltage above this would light D4, the yellow l.e.d. This condition warrants an investigation if it does not charge up after a few minutes and is marked 'fair' on the circuit.

Indication of a satisfactory circuit with a battery voltage of above 12·6V is given by the green l.e.d. lighting. This is labelled 'good' in Fig. 1.

There are transitional states between these as when the yellow lamp reduces in brilliance and transfers to a brightening green lamp, as a battery is charging, and vice-versa as it is discharging.

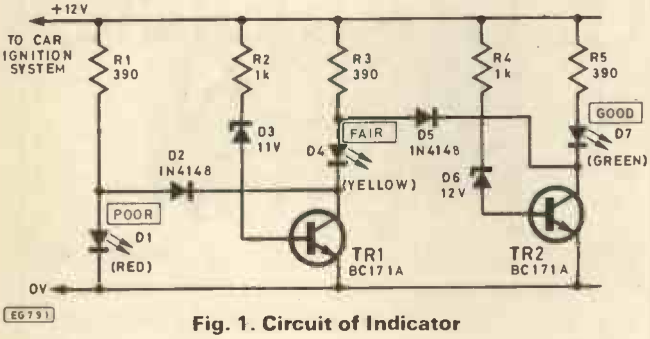


Fig. 1. Circuit of Indicator

IN GENERAL

Broadly, the green light on indicates all is well; red, the battery is defunct and yellow the output voltage is low which will be confirmed by poor light from the lamps, low hydrometer reading and lack of power to the starter motor when the battery is switched in.

This condition may be due to the dynamo not charging or giving a low or intermittent output in which case D4 will flicker.

POSSIBLE REMEDY

To remedy this latter condition the charging and field circuit wiring should be examined. Tighten any loose connections, particularly those at the battery, also renew any damaged cables. Check the tension of the dynamo driving belt also the regulator setting and adjust if necessary.

MOUNTING

The small board can be mounted directly on the car dashboard using the black panel clips supplied with each l.e.d. These suit a 6·35mm (0·25in) panel and will retain the circuit board when fitted.

A layout with equally spaced light emitting diodes is shown in Fig. 2. The viewing angle for the specified l.e.d.s is 30° which might produce a relatively low light output in bright conditions, so I am proposing an alternative device, the 'stackable l.e.d.' from RS Components, which has a viewing angle of 100° and provides a clear colour contrast when viewed at even oblique angles.

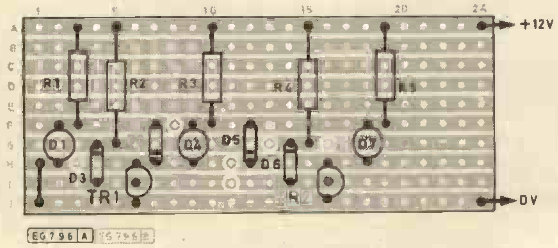
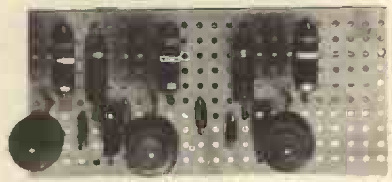


Fig. 2. Veroboard layout

COMPONENTS



Resistors

R1	390
R2	1k
R3	390
R4	1k
R5	390
All ½W 10% carbon	

Semiconductors

D1	Red 0·2in l.e.d. (RS 586–475)
D4	Yellow 0·2in. l.e.d. (RS 586–497)
D7	Green 0·2in l.e.d. (RS 586–481)
D2, D5	IN4148 (2 off)
D3	11V 500mW Zener
D6	12V 500mW Zener
TR1, TR2	BC171A (2 off)

ANOTHER ADVANTAGE

An additional advantage of this indicator is that being 'in circuit' continuously means that the battery condition can be tested as different loads are applied such as operation of car lights, starter motor, accessory items, etc. This way one can readily keep an eye on a deteriorating battery and know the time for replacement rather than be caught unawares.

CIRCUIT ACTION

In the circuit, at voltages below 11·6V, the brightness of the l.e.d. D1 is set by R1. As 11·6V is approached then D4 starts to light as TR1 conducts, the latter subtracting current from D1 causing it to extinguish.

This same procedure is repeated as the line voltage moves up to 12·6V when D7 will be lit. So you can see that there is always a continuous visual indication of battery state, and in living with it you should become extremely adept at interpreting impending problems.

CHECKING IT

When checking over the completed unit a variable power supply is useful to make sure the unit is switching through its ranges.

If dry batteries are used for this purpose it should be borne in mind that for a 'good' indication the total current drawn is around 80mA, which is largely made up of shunt current through D5.

The l.e.d.s chosen for this project are for panel mounting and could be attached to the car dashboard but first you should view these in daylight when the unit is powered up (take the 12V line from the ignition switch) for optimum positioning as brightest viewing is directly over the lens.

NEXT MONTH

ULTRASONIC VISION SYSTEM

This project is an advanced ultrasonic vision system which is within the means of the amateur constructor, yet is sophisticated enough to enable experimentation with computer measurement, image recognition, object tracking, and robot vision.

STEREO CASSETTE DECK

The PE Quasar stereo cassette deck is a versatile low cost system designed around a single p.c.b. which features a variable bias control for optimum recording of all tapes, a gate noise reduction system, twin VU meters and electronic switching.

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PRACTICAL
ELECTRONICS

APRIL ISSUE ON SALE FRIDAY, MARCH 12th

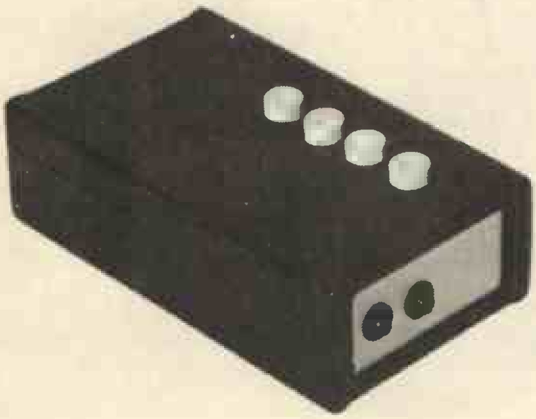
IR REMOTE CONTROL

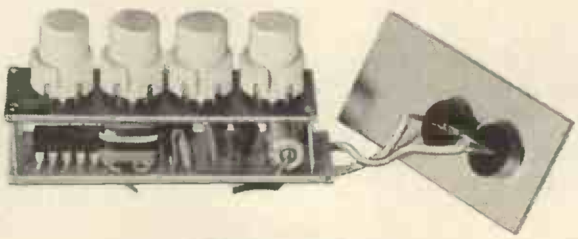
Part 2 Bart Trepak

THE transmitter circuit is built on a small printed circuit board as shown in Figs. 1 and 2 which holds all the components except the l.e.d.s and the push switches. Care should be taken to ensure that transistors and electrolytic capacitors are mounted the correct way around. Although the i.c. is a bipolar device and, therefore, not prone to static damage, it is wise to mount this in a socket. If only one switch is to be used, a panel mounted push to make type may be fitted directly on to the box and connected to the appropriate pads on the transmitter board by wires. If more than one switch is required, these should be mounted on the switch board (Fig. 3), which is designed to fit "piggy back" style on the transmitter board using four stiff wires (pins). Care should be taken to ensure that the switches are positioned as shown in Fig. 4 and firmly seated on the p.c.b. before soldering.

The complete circuit may be housed in a small box together with the battery. The l.e.d.s should be mounted on the front of the box using l.e.d. clips or the reflectors if a greater range is required. If the box specified is used then these would be mounted on the aluminium front panel and soldered to the p.c.b. using flexible wires. The wires to the l.e.d.s should be kept as short as possible as relatively large currents will flow in these leads and any inductance will have a detrimental effect on the range. Since there are no heavy components on the p.c.b., the transmitter circuit may be secured to the box with a double-sided adhesive pad. The distance between the main p.c.b. and the keyboard will have to be carefully chosen to ensure that the switches are free to move when the box is clipped together. If the assembly is made too high, one or more of the switches may be depressed permanently, which would, of course, result in the transmitter operating continuously. When the correct height has been ascertained, the connections between the two p.c.b.s may be made using tinned copper wire or discarded component leads. The two p.c.b.s have been designed so that the holes for the interconnections line up when the two assemblies are mated. Only the connections for which holes are provided should be made, the spare holes on the main p.c.b. (which are for use with other keyboards) should be ignored.

The battery clips should be assembled in the box battery compartment and connected to the p.c.b. pads marked + and − with wires. If there is any danger of incorrect battery connection, it is wise to place a diode (type 1N4001) in the positive lead to avoid damage. The circuit is powered by a 9V PP3 battery and draws an average current of 20mA when operating. Since the standby current consumption is only a few micro-amps, no on/off switch is required. A piece of polystyrene or similar material may be required to hold the battery in place within the battery compartment.





Switch assembly

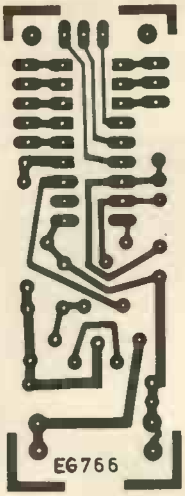


Fig. 1. P.c.b. design for the transmitter

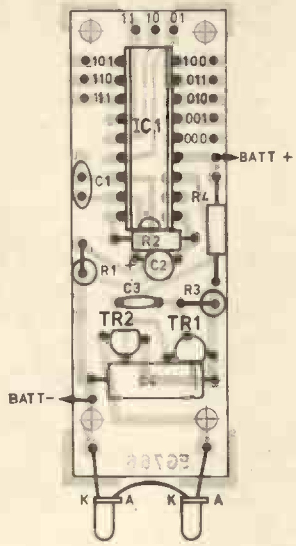


Fig. 2. Component layout

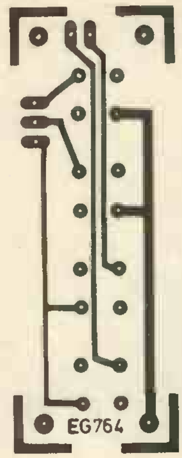


Fig. 3. Switch p.c.b.

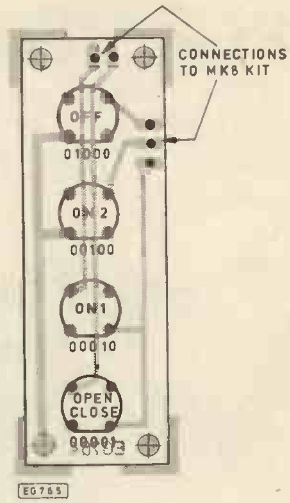


Fig. 4. Switch layout

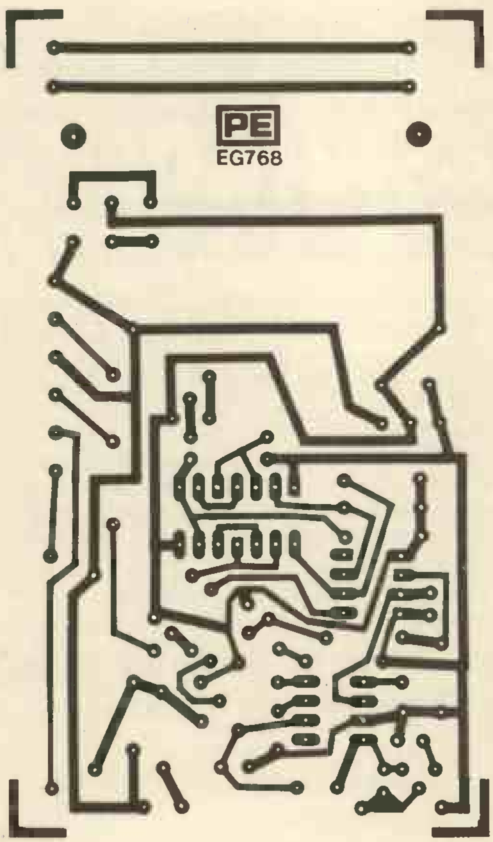


Fig. 5. P.c.b. design for the Receiver board

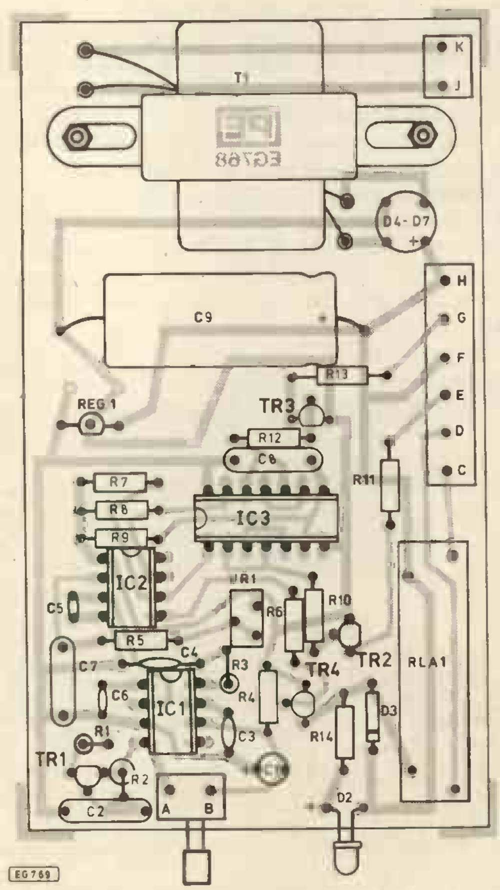
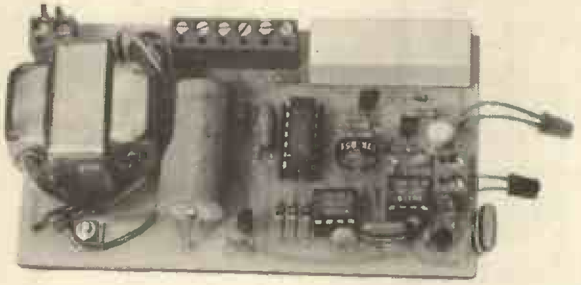


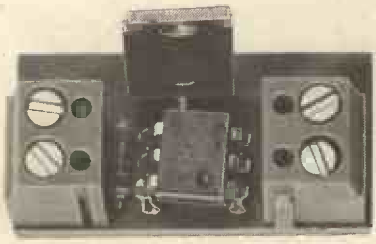
Fig. 6. Component layout

The receiver is built on one printed circuit board as shown in Figs. 5 and 6 with all the components, including the transformer, mounted on it. (Construction on Veroboard or other p.c. layouts is not recommended as the high gain amplifier IC1 may become unstable.) Only D1 and the opto isolator and triac are mounted remotely. D1 may be connected to the p.c.b. with wires although the length of these should be kept as short as possible to avoid noise pickup. A screend lead is best although the length should be kept to less than 6 inches as any capacitance across the photodiode will reduce the sensitivity of the circuit to the transmitted IR pulses. As the photodiode will need to be mounted externally, some form of protection from the weather will be needed.



The sensitive face of the diode is the curved one and this should be arranged to face in the direction from which the IR radiation is expected. Any transparent or translucent enclosure of the type supplied for panel mounted neons would be suitable provided the diode is mounted against the front of the moulding to avoid making the unit too directional. If the unit is to be used in a room to control lamps or appliances, the photodiode mounting will not be so critical as multiple reflections occur from walls and ceilings making the controller largely non-directional.

The unit may be tested by connecting the mains to terminals J and K and transmitting the open/close code. VR1 should be adjusted until l.e.d. D2 lights and remains lit while the transmitter button is pressed. The other codes may be tested by connecting l.e.d.s directly to terminals E F and G H, with the l.e.d. cathodes connected to E and G. Transmitting ON 1 and ON 2 will switch each l.e.d. on while pressing OFF will cause both l.e.d.s to switch off.



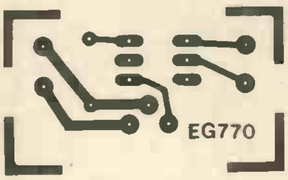


Fig. 7. P.c.b. mains switch

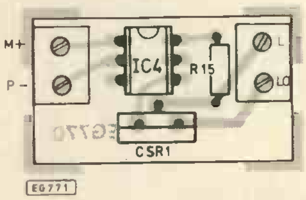


Fig. 8. Component layout

The layout of the mains switch is shown in Figs. 7 and 8. The triac CSR1 specified is an 8 Amp device which can control up to 2kW at 240V a.c., although a suitable heatsink will be required to keep the triac case temperature to below 70°C. Without a heatsink, a load of up to 1·5A (300W) may be switched. If higher power loads are to be controlled a TIC236D (12A r.m.s.), TIC246D (16A r.m.s.) or TIC263D (25A r.m.s.) may be fitted without any circuit modifications. Note that the load must be connected in series with terminal Lo. Since the input is an l.e.d., the correct polarity must be observed with terminal M connected to the positive line, i.e. F or H.

APPLICATIONS

The obvious application for the unit and indeed the purpose of the design is in the control of motorised garage doors. In this context the momentary output would be used to trigger the open or close sequence while the two latched outputs could control mains lamps (via the slave switches) to illuminate the drive and garage if required.

The circuit could of course be used for a multitude of other functions around the house. As mentioned, the ON/OFF outputs could be used to switch virtually any appliance on or off such as radios, tape recorders, lamps, etc. The momentary output controlled by the open/close button could be used to change the channel on a suitably modified TV receiver. An interesting application would be to control room lighting. Many modern touch controlled lamp dimmers incorporate an input for connecting to slave touch plates. These normally require a momentary low current connection to the live terminal to effect switching or dimming of the light.

For the elderly or disabled, the unit could be used to control heating or lighting. Since the connections to the power switch of Fig. 4, shown last month, need only to be low voltage/low current wires, it would be easy to arrange for the controller to be situated in one room and control an appliance in another location, enabling, for example, the central heating or an electric blanket to be switched on or off without the necessity of leaving the living room. ★

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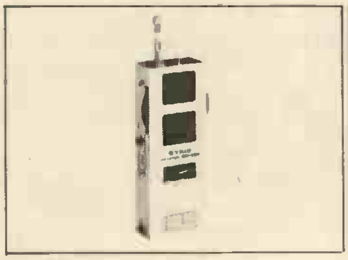

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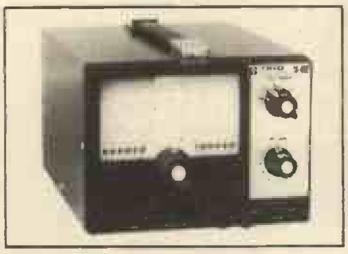
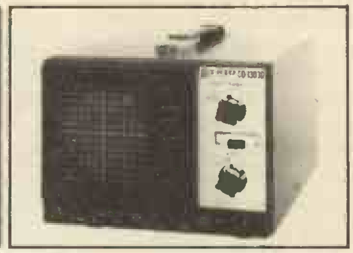
AG203 Low Distortion Oscillator — < 0.1% distortion — 10Hz to 1MHz in 5 ranges.



SG 402 30 MHz A.M. SIG. GEN. £59

CO 1303D 5 MHz OSCILLOSCOPE £108



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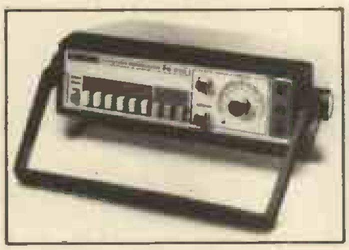

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PE RANGER BASE STATION

Michael Tooley B.A.
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PART THREE

THE purpose of the S-meter module is to provide a d.c. output proportional to the amplitude of the 455kHz IF signal. The module samples the level of the IF signal in the Ranger preceding the amplitude limiting stages within IC100. At this point (the output of FL100) the IF signal is only at a relatively low level and hence some amplification is essential before detection. To prevent instability the module must be housed within the Ranger transceiver and its output taken via the 7-way ancillary connector to the Base and Mobile Adaptor. Where signal strength indication is not required, the S-meter module may, of course, be omitted. In this case there will simply be no meter indication on 'receive' but otherwise the performance and operation of the unit will remain unchanged.

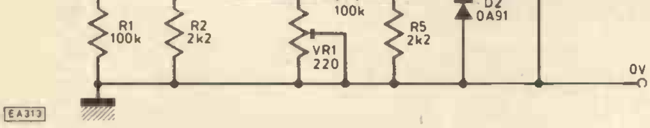


Fig. 3.1. Circuit diagram of the S-meter module

The circuit diagram of the S-meter module is shown in Fig. 3.1. Source follower, TR1, provides impedance matching and its high value of input impedance minimises loading of the IF amplifier at the point where the signal is derived. This is an important consideration as the filter needs to be accurately matched in order to obtain optimum performance. TR2 and TR3 form a voltage amplifier with gain adjustable by means of VR1, D2 and D3 rectify the amplified IF signal and the supply voltage is held constant by means of D1.

The S-meter module is assembled on a small single sided p.c.b. for which the foil layout is given in Fig. 3.2. The corresponding component layout is shown in Fig. 3.3. The completed p.c.b. should be wrapped in a polythene sleeve and located at right angles to, and on the right hand side of, the main p.c.b. in the area adjacent to IC100 and IC101. Only four connections need to be made to the Ranger and these should again be kept as short and direct as possible.

Fig. 3.2. P.c.b. design for the S-meter module

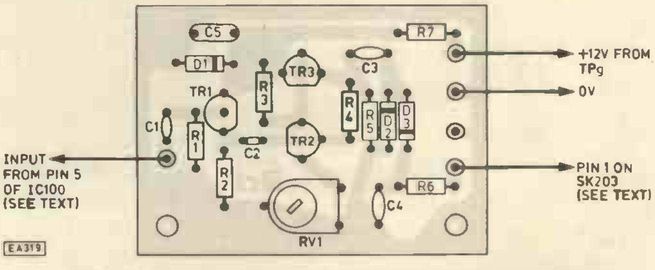


Fig. 3.3. Component layout for the S-meter module

The input is taken from the junction of R111 and FL100. This connection may most conveniently be made by soldering to the left-hand end of R111 (the end nearest FL100) on the top side of the p.c.b. The positive supply is derived from test point G and the common rail is taken from pin-2 of SK203 (or any other convenient 0V point). The output of the module is taken to pin-1 of SK203 and note that, regardless of whether the S-meter module is fitted or not, some minor modifications to the wiring of SK203 are necessary and these are covered in the next section.

TESTING AND ALIGNMENT

During the test and alignment procedure it is recommended that a current limited regulated d.c. power supply be used. The supply should be set to give 12V d.c. (±0·5V) and its current trip set to 1A (±100mA). The Base and Mobile Adaptor does have its own internal 1A fuse but this should not be relied upon in the initial stages. Protection is essential in order to minimise the risk of damage to both the external power supply and to the Base and Mobile Adaptor in the event of incorrect component connection or faulty assembly (e.g. solder bridges between p.c.b. tracks). Under no circumstances should the external supply be allowed to exceed 17V as this may result in permanent damage to both the Ranger and the Adaptor.

Two interconnecting leads are required. Both need be no more than 160mm long since it is envisaged that the two units will normally be operated 'piggy-back' rather than 'side-by-side'. Constructors should, however, make the connecting cables long enough to allow the two units to be operated 'side-by-side' during the setting-up process. The RF connecting lead (at the front of the set) should use good quality 50ohm coaxial cable. (e.g. UR43 or UR76) terminated with PL259 plugs. The correct method for fitting these plugs is shown in Fig. 3.4. and 3.5. The control lead (at the rear of the set) has seven ways and should be terminated with 7-pin DIN plugs. Care must be taken to ensure that the pins are correctly linked and this is best done by checking pins 1 to 6 with an ohm-meter both for continuity and for the presence of short circuits between adjacent pins.

Make the following adjustments and connections in the order given before connecting the external d.c. supply:

(a) Ensure that the interconnecting leads are in place.
(b) The channel selector should be switched to channel 14.
(c) The 10dB attenuator should be switched 'off'.
(d) The RF gain control should be set to maximum (fully clockwise).
(e) VR1 should be set to minimum resistance.
(f) The cores of L1/L2 and L3 should all be set two full turns from the furthermost position into the former.
(g) The variable capacitors should be set as follows:
VC1 and VC2; plates 20% meshed.
VC3 and VC4; plates 50% meshed.
(h) If the filter modules have been fitted they should be temporarily removed and replaced by shorting links.
(i) Connect an external loudspeaker (of between 4 and 16 ohms impedance) to the Adaptor via SK3.
(j) Switch the 'squelch' on the Ranger 'off'.
(k) Connect a matched 50ohm aerial to the Adaptor.

The external d.c. supply should now be connected and the steps which follow should permit alignment of the Base and Mobile Adaptor:

COMPONENTS . . .

S-Meter Module

Resistors

R1, R4	100k (2 Off)
R2, R5	2k2 (2 off)
R3	4k7
R6	1k5
R7	1k

All resistors ¼W 5% Carbon.

Capacitors

C1	22p
C2	1n
C3, C4	4n7 (2 off)
C5	100n

All capacitors ceramic disc or plate

Semiconductors

D1	BZY 88 C5V6
D2, D3	OA91 (2 off)
TR1	2N 3819
TR2, TR3	BC 548 (2 off)

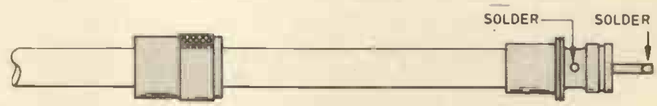
Miscellaneous

VR1	220 min preset skeleton (hor)

Cut end of cable clean. Remove outer covering 19mm from the end.

Slide coupling ring and reducer onto cable.

Bare 19mm of centre conductor. Fan braid slightly and fold back over reducer.



Screw plug body onto reducer and tighten. Solder braid through holes and ensure that a good electrical contact is made. Solder centre conductor.

Final plug assembly with coupling ring free to mate with a socket.

Fig. 3.4. Method of fitting PL 259 connector and reducer to RG 58/U, UR76 or similar 0·2in diameter co ax cables.

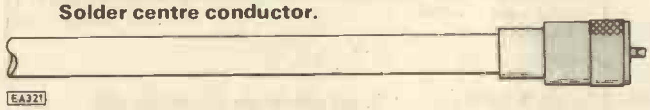
Cut end of cable clean. Remove outer covering 28mm from end.

Bare 16mm of centre conductor. Trim braid to 12mm. Slide coupling ring onto cable. Tin centre conductor.

STEP NUMBER	PROCEDURE	NOTES
1	Switch 'on' the external d.c. supply. Switch 'on' the Ranger and the Adaptor unit.	The 'receive' l.e.d. indicator on the Adaptor should be illuminated and noise should be heard from the Adaptor's loudspeaker when the volume control on the Ranger is advanced
2	Adjust the core of L1/L2 for maximum indication on the S-meter using the signal from a fairly strong local station. If a full-scale reading has been obtained reduce the setting of the RF gain control and continue to adjust L1/L2.	If the S-meter is not fitted adjust for minimum background noise (maximum quieting).
3	Select a channel on which there is a weak but stable signal. Adjust the RF Gain control to provide a reading of about $\frac{1}{3}$ to $\frac{1}{2}$ scale. Re-peak L1/L2 for maximum.	Only a slight adjustment, if any at all, should be necessary.
4	Disconnect the RF (coaxial) cable linking the Ranger and Adaptor. Connect the aerial directly to the Ranger thus bypassing the Adaptor. Note the S-meter reading obtained when a weak but stable signal is present.	
5	Re-connect the Adaptor and note the new S-meter reading with the RF gain control turned to maximum. (The same signal should be present as in step 4.)	If the RF stage has been correctly aligned and is working properly there should be an increase of approximately two S-units (around 12dB). If no discernible change is obtained or if there is a reduction in signal strength check the RF stage and repeat steps 1 to 5.
6	Replace the aerial with a 50ohm resistive dummy load capable of dissipating 5W. (Such devices are available from most CB accessory stockists.) Operate the Ranger on 'transmit' by either using the 'press-to-talk' facility on the microphone or by using a shorting link as described in the Ranger alignment procedure.	The 'transmit' indicator l.e.d.'s should be illuminated on both the Ranger and the Adaptor, and the noise from the loudspeaker should cease.
7	Adjust VC1, VC2, L3, VC1 and VC2 in the sequence given for maximum output power indication from the meter. Repeat several times and adjust the setting of VR1 to reduce the indication on the meter if necessary.	The adjustments are fairly critical and there is interaction between them.
8	Adjust VC3 and VC4 for maximum meter indication. Repeat several times for maximum output. Again adjust VR1 if necessary.	These adjustments are faily broad with some interaction between them.
9	If an RF power meter (or SWR bridge which incorporates power measuring facilities) is available, check the output power delivered to the load. This should be between 3W and 6W. (See Fig. 3.6.)	If this is not the case repeat steps 7 to 9 inclusive.
10	Insert the filter modules and carefully adjust the ferrite cores for maximum output. Some minor re-adjustment of VC3 and VC4 may be beneficial.	The output power will be somewhat less than that obtained previously and should be typically between 2W and 5W.
11	Adjust VR2 in the Ranger for an output power of 4W.	Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary.
12	Switch the 10dB attenuator 'on' and note the effect on the output power. This should fall to approximately 400mW.	If the output power is greater than 500mW the value of R9 should be increased to 100 ohm 2W. If the output power is less than 300mW the value of R9 should be decreased to 47ohm 2W.
This completes the setting-up procedure and the Adaptor is now ready for 'air-testing'.		

Testing and Alignment procedure

Screw plug onto the cable. Solder braid through holes and ensure that a good electrical connection is made. Solder centre conductor.



Final plug assembly with coupling ring free to mate with a socket.

Fig. 3.5. Method of fitting PL259 connector to RG 8/U, UR67 or similar 0·4in diameter co ax cables.

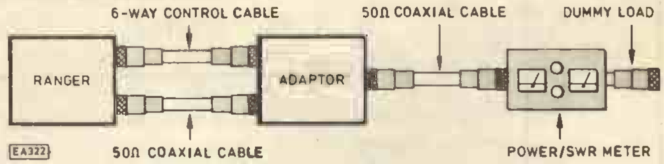


Fig. 3.6. Arrangement used for output power measurement

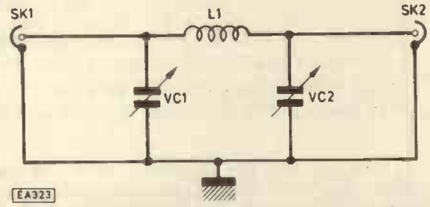


Fig. 3.7. Circuit diagram of the aerial matching unit

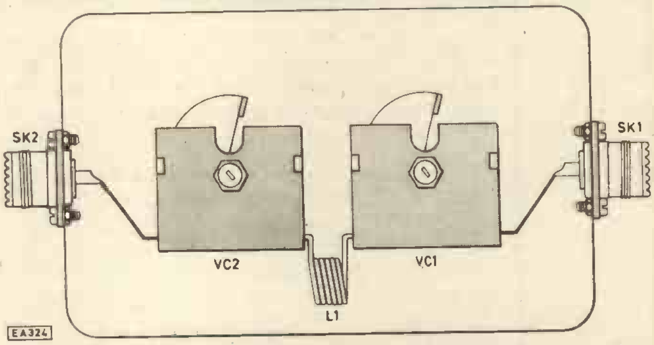


Fig. 3.8. Internal layout of the aerial matching unit

AERIAL MATCHING UNIT

There will doubtless be many occasions where, for one reason or another, it is not possible to achieve a good match between the transceiver and an aerial system. Usually this is because the radiating element is not cut to the correct length; either it is too long or too short. Aerials with adjustable radiating elements are obviously to be preferred but they can be tiresome and inconvenient to adjust, particularly when they are mounted at some considerable distance from the rig. A most useful accessory, therefore, is a device for accurately matching the transceiver to any aerial system. The effect of providing an accurate match between the transceiver, feeder and aerial is to guarantee a low value of SWR. This helps to improve the radiation efficiency by eliminating additional SWR losses in the feeder and maintains the performance specification of the transceiver itself. The matching unit consists simply of a pi-network of two variable capacitors and a fixed inductor. An added bonus is the reduction of harmonic radiation associated with the low-pass characteristic of the network.

The circuit diagram of the aerial matching unit is shown in Fig. 3.7 together with an internal layout and wiring diagram

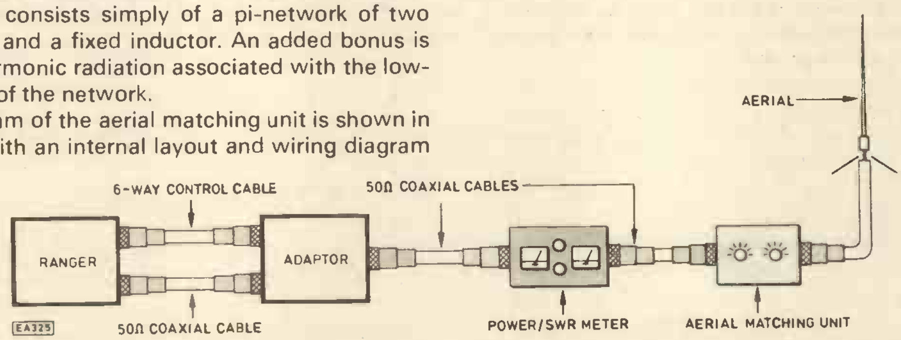


Fig. 3.9. Use of an aerial matching unit to improve SWR (Note. The matching unit should be mounted as close to the aerial as possible in order to reduce feeder SWR losses)

COMPONENTS . . .

Aerial Matching Unit

SK1, SK2	S0239 sockets (2 off)
VC1, VC2	Air spaced variable, max. capacity in the range 365 to 500pF, see text
L1	8 turns 18 s.w.g. enamelled copper wire, inside diameter 10mm, winding length 10mm approx.

Metal case or diecast box
Pointer knobs (2 off) fitted with '0–10' scale, see text

in Fig. 3.8. A metal screening enclosure is essential to the correct operation of the matching unit and this can take the form of a diecast or aluminium box measuring approximately 150×80×50mm. The variable capacitors may be difficult to obtain but fortunately their exact maximum value is unimportant and can be anywhere between 365pF and 500pF. The prototype employed dual gang 176 and 208pF capacitors with the two gangs connected in parallel to make a total maximum value of approximately 384pF. Capacitors of this type were commonplace in AM (medium and long wave) transistor portable radios of some 10 to 20 years vintage. Whatever type of capacitor is used they MUST be air spaced types and should be fitted with a pointer knob and scale. This is important for providing accurate reference points for re-setting the matching unit when it is to be used with several aerial systems. The unit should preferably be fitted as close to the aerial as possible. This is particularly important when a high SWR (greater than 2:1) is present. In many situations, however, this may not be practicable and it will be necessary to place the unit in the vicinity of the transceiver and SWR bridge. This is a less efficient arrangement (due to the high SWR in the feeder) but it will at least provide a reasonable match for the transceiver. A typical arrangement is shown in Fig. 3.9 and the aerial matching unit is simply adjusted for minimum VSWR. In practice, and with careful adjustment (both controls need to be used) it is possible to obtain an SWR of 1.1:1 or better with even the most difficult aerial systems. ★

Digital Design Techniques...

Tom Gaskell B.A.(HONS) ELEC. ENG.

Part 8 Memories & Microelectronics

IN the series so far we have looked at the design of logic systems, from simple combinational and sequential circuits up to multiplexing and bus-orientated networks. It's only a small step now into the world of microcomputing and microprocessors. We need only one more 'building block' of circuitry; the memory.

BASIC REQUIREMENTS OF MEMORY

Essentially, 'memory' is a collection of logic 1's and 0's which are stored in a system. There must be some way to 'write' these logic states into the memory, and some way to 'read' the logic states out of the memory and into other circuitry.

In some cases it might not be necessary to write information into the memory more than once. If a fixed set of binary numbers was to be stored, always the same and never requiring modification, then a 'Read Only Memory' or 'ROM' could be used; in its simplest form this would be a set of wire links or switches permanently set to give a logic 0 or logic 1 where required. In many cases, though, it is necessary to be able to frequently write information into the memory, as well as being able to read it. Such a memory is known as a 'RAM', which stands for 'Random Access Memory', meaning that all bits stored in the memory can be directly and independently written into, or read from. 'RAM' is actually a bad name for the device; all bits can be accessed randomly in a ROM, too. Unfortunately, this is a terminology that we'll have to live with!

In both ROMs and RAMs we want to be able to choose a specific point in the memory, known as the "address', and read (or write) the information present there into the rest of our system. The memory device, therefore, will have a number of binary inputs which together form the address, and a number of binary outputs (or inputs/outputs in the case of RAM) which together form the data output (or input). Each value of the binary number on the address inputs is known as an address 'word'. In the case of RAMs, there is a read/write control input, and in many devices an 'enable' input is provided, to allow all functions of the device to be turned on or off. The timing of the logic signals can be very important; in many memory systems there must be certain minimum time periods allowed between data changing and the logic state of the read/write control being changed. Failure to observe this can cause incorrect data storage and retrieval, and is an important consideration when designing with many different types of memory device.

STORAGE DURATIONS

Systems which lose their information when the power supply is turned off are known as 'volatile', while those that retain their information are 'non-volatile'. In some cases it is possible to use battery back-up supplies with a volatile memory to provide short term storage with the power off. In other instances it is possible to specifically design non-volatile memories, although this is usually done at the expense of performance or memory cost.

Frequently, the use of memories can be broken down into 'bulk storage', and temporary or general purpose storage, often known as 'scratchpad memory'. The former is usually a non-volatile technology, often with relatively slow access or operating speed but capable of holding a massive amount of information for permanent records, storage, filing, etc. The latter is used on a 'day-to-day' basis by the circuitry it serves, mostly for short term storage of information, rather in the manner of a jotter or scribble pad on a writing desk. (Hence the term 'scratchpad' memory). In order to avoid slowing down the surrounding circuitry, this memory has to be a fairly high speed type, although it does not usually need to store a very large amount of information.

MEMORY TECHNOLOGIES

Memories can be implemented by using various different technologies; electromechanical devices (relays, uniselectors, and the like) being one of the simplest, although these are far too slow, bulky, and cumbersome for the majority of applications. In early computers the non-volatile 'magnetic core' was used. This consisted of a large number of small ferrite rings with wires passing through their centres. By passing impulses of current through selected wires, the ferrite rings could be magnetically saturated and hence these cores were written into. By passing current pulses of the opposite polarity into the selected wires, and measuring the resulting e.m.f., the saturation of the cores could be determined and the memory could be read. Although a widely used technique several years ago, the magnetic core has now all but disappeared. More recent magnetic technologies are those of tape, disc, and bubble.

Magnetic tape is familiar to us in the form of audio cassettes, and indeed these are often used in small 'personal' computers as bulk storage, with differing frequencies of tone being recorded in bursts to indicate logic 0's and logic 1's as appropriate. Larger computers use larger tape; many times the thickness, width and length of cassette tape, running at very high speed, and with many tracks used in parallel to increase the speed of reading and writing of the memory.

Magnetic tape can store fantastic amounts of information, but is inherently very slow; if the data that you want is at the opposite end of the tape it can take several minutes to get there! A natural progression, therefore, was to use a magnetic disc. With this system, a circular disc coated with a thin ferromagnetic material (similar to that used on tape) is continuously rotated at high speed. In the large, solid, 'hard' disc units, the read and write heads float on an air cushion fractionally above the disc, whereas in the case of the smaller flexible 'floppy' discs, the head and disc actually touch, the disc being coated with a lubricating material to reduce friction.

Information recorded anywhere on the disc can be accessed in a fairly short time by moving the heads inwards or outwards along a radius from the centre of the disc, and then by waiting for the disc to rotate sufficiently to bring the required information directly underneath the heads. In this respect, the disc is analogous to an LP record; you don't have to play the whole LP to reach a track that you want to hear—the pickup can be placed on that track directly, manually, saving a great deal of time. This method of bulk storage is fairly fast, and can store large amounts of data; typically between 0·1 and 1 Megabytes (a 'byte' is a group of eight bits) for a floppy disc and over 10 Megabytes for a hard disc.

A fairly recent development in non-volatile bulk storage is the 'Bubble Memory'. This device consists of a very thin layer of garnet crystal, grown on a non-magnetic substrate, wrapped with flat wire coils, and enclosed within a pair of permanent magnets. A large number of geometric 'shapes' are deposited on the surface of the garnet, in a soft magnetic material. Tiny magnetic 'bubbles' can be generated in the garnet; these are small areas only a few micro-metres in diameter, in which the magnetic field is opposite to that in the rest of the crystal. Magnetic fields generated by the coils produce and control the magnetic polarisation of the deposited geometric 'shapes', which in turn manipulate the bubbles. The presence of a bubble represents a logic 1, and the absence of one a logic 0.

Bubbles can be sensed by monitoring the resistance of extra 'detector' shapes. As the bubbles pass under these detectors, the resistance of the deposited shapes changes, and this can be amplified by a suitable detection circuit. The circuitry needed to control a bubble memory is complex and expensive, and the whole technology at the moment is a rather specialised one. In its favour, it is fairly compact, non-volatile, low power, and has reasonable speed performance. Of all the memory technologies in current use, it has perhaps the greatest potential for improvement and developments.

The memories that we've looked at so far have had attractions for bulk storage, but even the fastest floppy discs or bubble memories are much slower in operation than most logic families. The problem is not so much the rate of transfer of data, but rather the 'access time', i.e. the time taken between deciding that you wish to read or write to a specific location in memory, and actually being able to read or write that data. Although discs may be able to transfer data at many hundreds of thousands of bytes per second, it can take many tens of milliseconds to begin that data transfer. This is an unacceptably long time if it is to be repeated often within a system. As a result of this, extensive use is made of a much faster accessing memory technology.

SEMICONDUCTOR MEMORIES

Looking first at the RAM, its implementation is very straightforward since all that is required is an array of flip-flops or latches! Any flip-flop or latch can be used to store a 1 or a 0, can be written into (by changing the logic state of the clock), and can be read from by simply looking at the logic state of the Q output. However, the design of typical CMOS flip-flops and latches is rather over-complex for a large memory system; too much space on the i.c. 'chip'

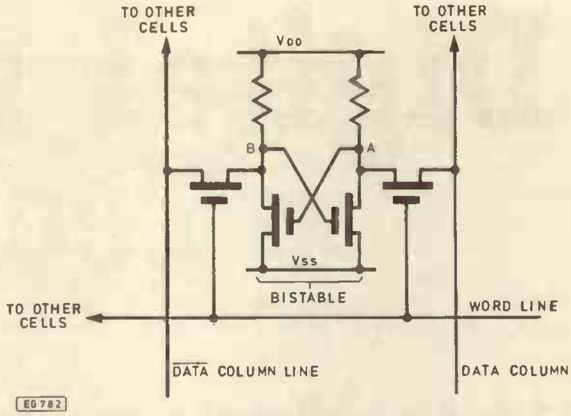


Fig. 8.1. The static memory cell

would be taken up with each device, and the total power consumption of the large numbers of devices involved would be prohibitive. As a result, a far simpler design of memory element or 'cell' is used, based on the 'bistable' circuit design. This is shown in Fig. 8.1, and is known as a 'static' RAM cell. ('Static' refers to the fact that data is stored in the cell for as long as power is applied; there is no decaying away of charge, or any other effect which may cause the cell to lose its data after a time.)

The memory is arranged in a matrix form; rows and columns of cells selected by control logic. To write a logic 1 into the static cell, the DATA column line for the column in question is taken to logic 1, and the $\overline{\text{DATA}}$ column line to logic 0. The word line, which determines the row in which the cell sits, is pulsed to logic 1, then back to 0 again. This forces the bistable into the state where point A is at logic 1 and point B at 0. (To write a logic 0, $\overline{\text{DATA}}$ column line = 1, DATA column line = 0, and again the word line is pulsed from 0 to 1 and back again). To read from the memory cell, the word line is pulsed again, but this time the logic states on the relevant column lines are monitored. If the DATA column line pulses to logic 1, then the bit stored was a logic 1. If the $\overline{\text{DATA}}$ column line pulses to logic 1, then the bit stored was a logic 0.

DYNAMIC MEMORY

The static memory cell contains four MOS transistors and two 'resistors' (also formed from MOS transistors), and hence is fairly bulky when used in quantity on an i.c. 'chip'. Supply current requirements are also relatively high, and this also restricts how closely packed the cells can be; too close together, and the resultant heat generated cannot be dissipated by the i.c. package, causing heat damage. Because of these restrictions, a lower power and more compact memory design is frequently used; the 'Dynamic' memory cell, as shown in Fig. 8.2.

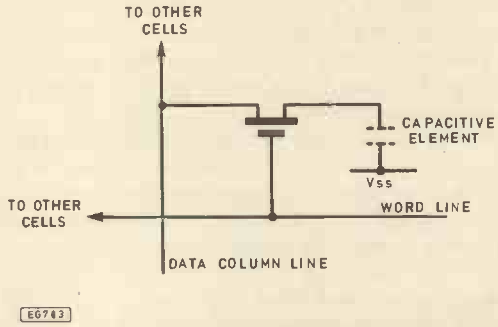


Fig. 8.2. The dynamic memory cell

To write a logic 1 into the cell, the DATA column line is held at logic 1, and the word line is pulsed from logic 0 to 1 then back to 0 again. This stores a charge on the 'capacitive element', which is actually another MOS transistor since capacitors are very difficult to fabricate effectively on an i.c. chip. To write a logic 0, the process is repeated with the DATA column line at logic 0. To read from the cell, the word line is again pulsed and the logic state of the DATA column line is monitored; if it pulses to logic 1, the stored bit was also a 1, if it does not change at all then the stored bit was a 0. (The logic 1 pulse is caused by the 'logic 1 charge' on the capacitive element discharging, via the MOS transistor, into the circuitry monitoring the DATA column line).

There are two inherent weaknesses of this design. The first is that, unlike the static cell, reading is 'destructive'; any charge stored on the capacitive element is discharged into the control circuitry upon readout, so the memory has been lost. The second weakness is that the charge on the capacitive element leaks away after a very short time (the actual capacitance value is very small), so the memory is lost after a short time anyway—well under a second! To overcome both these problems, 'refresh' circuitry is used to re-write any memory which has just been read with its 'own' data again, and to continually re-write all the data out of the memory and back into it again. These days, many popular dynamic RAMs have all the refresh circuitry built in, so they appear to the user to be static; no external refreshing is necessary.

THE ROM

Although the ROM is supposedly little more than a large array of pre-set switches, in practice it has a complexity similar to that of the RAM. This is necessary, to ensure that it can be addressed in a similar way to the RAM, that it can have a very high speed (i.e. the data should be fed out of the i.c. as soon as possible after the address has been selected), and in many cases that it can be programmed; it becomes a programmable read only memory, or 'PROM'. Naturally all ROMS have to be programmed at some time or other, so the term ROM is used for 'Mask Programmed' devices, i.e. those which have fixed programs built in during manufacture, and which are unalterable. 'PROM' refers to a device which is purchased 'blank', and is then written into; by applying high-voltage pulses into the device at the relevant address, the memory locations can be 'blown', rather like fuse links, to create the required pattern of 0's and 1's. Because it is easy to make errors while programming in this way, most PROMS are made erasable; 'EPROMS'. Erasing such devices restores all the 'fuse links', enabling the programmer to start again from scratch, and is most usually done by exposing the i.c. chip, via a transparent window in the top of the i.c. package, to a specific wavelength of ultra violet light for typically between 10 minutes and an hour. This sets all the bits to a logic 1 state; when memory locations are subsequently 'blown', this sets the bits in question to logic 0 states. 'EEPROMS', or electrically erasable PROMs, have recently started becoming available, and use electrical erase signals; they become, in effect, a non-volatile semiconductor memory of fairly large size, although their erase and write times can be very long.

Non-volatile semiconductor stores are available in their own right, the Plessey 'NOVOL' range being a prime example. This is a range of counters, counters with 7-segment decoders, and one latch circuit, which have non-volatile circuit elements built in to retain the last logic states of the device for up to one year in the absence of power. In these devices, of course, only small numbers of bits are involved, so they are only a very small-scale memory in terms of ROM, RAM and bulk storage techniques.

MEMORY ORGANISATION

Most semiconductor memories are organised in terms of 1 bit, 4 bits, or 8 bits per address word. Hence, a memory device which claimed to be 256 words x 8 bits would have a total of 2048 cells within it, i.e. a total storage of 2048 bits. We refer to a unit of 1024 bits as '1K' bits (1024 being equal to 2^{10};) hence, 2048 is 2K bits, 4096 is 4K bits etc. When memory devices are grouped together in a microprocessor or microcomputer system, we arrange them to suit the number of bits that the microprocessor uses. For example, the majority of microprocessors today work on an 8 bit system, so our memory will be arranged to be 8 bits 'wide' also. (By putting two 4-bit memories side by side, with common address lines, or eight 1-bit memories, etc.) Each set of eight bits is known as a 'BYTE', so a 4K Byte memory consists of 4 x 1024 x 8 bits i.e. 32,768 bits. Often, computer jargon shortens the term '4K bytes' to just '4K', which could cause confusion with 4K bits. It is usual to talk about individual memory i.c.s. in terms of bits, but assemblies of memory devices, memory systems, and microcomputers in terms of bytes. Typical 'personal' or 'home computers' are available with between 1K and 48K (bytes) of RAM, and up to 12 or 16K (bytes) of ROM.

THE MICROPROCESSOR

The 'micro', as it is known, is a very complex and technically advanced electronic device, and there certainly isn't room in this article to go into detail about its design and operation. However, we can take a look at the basics, to give an idea about the way that the technology is used, and the sort of facilities that can be provided. Two months ago, we looked at bus-orientated systems, and gave an example of some data manipulation in an A.L.U. using such a system. Let's now take those principles further, and look at a greatly simplified 8-bit microprocessor system. (Note that a microprocessor will often be referred to as a 'Central Processing Unit' or CPU.)

A block diagram of a simplified microprocessor is shown in Fig. 8.3. The internal 8-bit data bus, ALU, accumulator, and general purpose registers have all been met before in Part 6 of this series. The data and address bus controllers are basically bi-directional register and latch arrangements to permit the feeding of data and addresses to and from external switches, transducers, bulk memory, displays, etc. The address bus controller normally uses 16 bit words, which are made up from two separate 8 bit words obtained from the internal 8 bit data bus. Most of the general purpose registers are 8 bit, but there are some specific exceptions; the 'Program Counter' and 'Stack Pointer' registers are both 16 bit, for example.

The 'Instruction Register' is used, together with the Control Unit, to identify and verify specific binary numbers called 'Instruction Codes', which are fed into the microprocessor from the program written in the external ROM or RAM. These numbers provide specific instructions to the microprocessor; 'reset the accumulator' or 'increment' (add 1 to) register B, etc. When identified and decoded by the control unit, each instruction causes a specific number of control and timing signals to be sent out to the relevant registers and areas of circuitry, in order to cause that instruction to be implemented. The number of different instructions that can be performed by a micro is a very good indication of the 'power' of that micro, along with the number of registers that it makes available to the user. The popular Intel 8080A, for example, has 78 instructions in its instruction set, whereas the Zilog Z80 (acknowledged as one of the most powerful 8 bit microprocessors available) has 158 instructions, including all 78 of the 8080. The Z80 is also well sup-

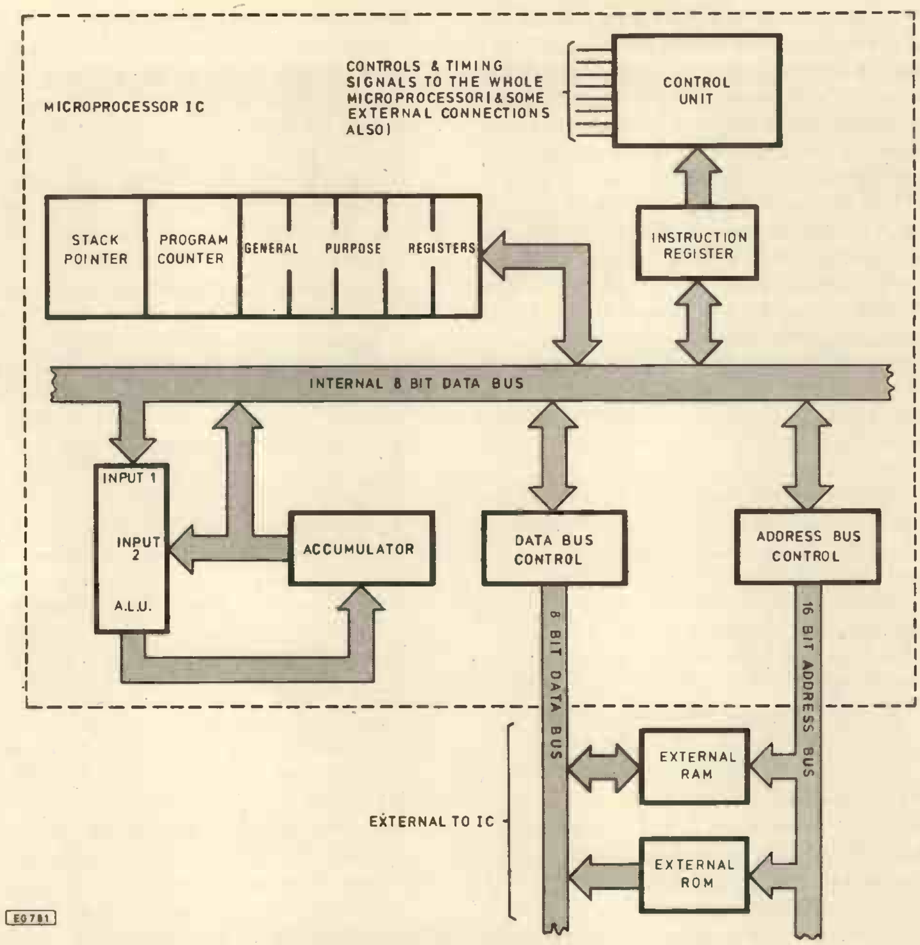


Fig. 8.3. Simplified 8-Bit microprocessor block diagram

ported with registers; a total of 18 8-bit and 4 16-bit registers are provided.

Unlike a conventionally designed piece of circuitry, the microprocessor based system is incapable of functioning, even when mechanically complete and apparently finished. The mechanics—p.c.b., power supply, i.c.s resistors, etc., are collectively known as 'hardware'. What is needed is a 'program'; a set of binary numbers which instruct the microprocessor what to do, and how to do it. Such programs or lists are known collectively as 'software', they are, in effect, the paperwork involved in the system. Programs, of course, can be written into ROM, RAM, or bulk storage. In this case, these devices consist of both hardware and software, and so any memory device containing a program is known as 'Firmware'; half way between being hard and soft!

PROGRAMMING

A program contains a series of instructions, and often data too, although in many systems the data is provided externally by switches, transducers, etc. The microprocessor executes each instruction in sequence, one at a time, although there can be built-in jumps such that upon receipt of a specific instruction the microprocessor will 'move' to a different area of the program, before or after the point which it has just 'left' and continue executing the program from there. The sequence of instructions given at the end of Part 6 of this series, covering the addition of two numbers together and the putting of the result in register 'D', is an example of part of a very simple program.

Programs can be shown diagramatically by a 'flow chart'; a set of symbols and text, which is the software equivalent of a block diagram used to represent the hardware. Let us take, as an example, the requirement to flash an l.e.d. on and off for a certain number of times as determined by a thumbwheel switch. The simplified flow chart for this program is shown in Fig. 8.4. The 'loop' is gone round as many times as the l.e.d. is flashed on. The type of instruction causing the program to jump from the question "is the content of register B zero?", to the "turn on l.e.d." sequence is known simply as a 'jump' instruction. In fact, the probable instruction would be "jump if not zero", which is an example of a 'conditional' jump. These conditional jumps make programming very much easier, because they effectively test for a specified condition ("accumulator = zero", or "a certain logic state = 1", etc.,) then either jump to a different part of the program, or continue to the next program step in the list, depending on the result.

The turning on of the l.e.d. would be accomplished by an external circuit driven from the microprocessor's 8 bit data bus, and the thumbwheel input would likewise be fed into the micro. The half second delay could be created by using an external monostable circuit, again, via the data bus, or by software methods; the computer takes a finite time to perform each program step, so by making it do a 'trivial' exercise a few tens of thousand of times, then time can be wasted, and a suitable delay created. In all programs, the most important thing to remember is that within the circuitry in question, both the instructions and the data are being represented as logic 0's and 1's; simple binary numbers.

THE USE OF MICROPROCESSORS

There are, essentially, two ways of using a 'micro' within a system. The first is 'dedicated' usage; the microprocessor has a single fixed program held in ROM, which it always per-

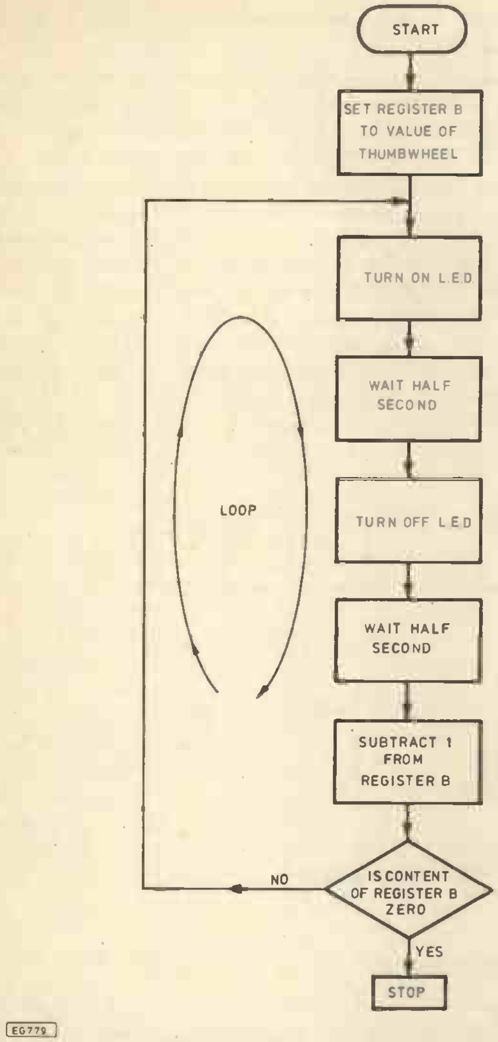


Fig. 8.4. Simplified flow chart of l.e.d. flasher

forms in the same way, while using small amounts of RAM for temporary storage if necessary. The user will have no means of re-programming this device. The microprocessor in this application is simply replacing large amounts of conventional logic circuitry. Test instruments, hand held electronic games, sewing machines, washing machines, cassette recorders; etc., whenever they use a microprocessor, they do so on a dedicated basis, and in each case the micro gives a fixed set of responses to a fixed set of stimuli, or inputs.

'Non-dedicated' use introduces us to the domain of the microcomputer, where the full performance, instructions, and capabilities of the microprocessor are fully at our disposal.

THE MICROCOMPUTER

The term 'microcomputer' means more than just a small computer. It is a computer in which the CPU is manufactured as a single i.c.; a microprocessor. Unlike the dedicated micro-based systems, it requires definite operator interaction before it can be of very much use at all! It is a programmable device, so without the program written into it, it can do very little. The constituent parts diagram of a typical microcomputer is shown in Fig. 8.5.

The video output of the microcomputer is normally in the form of a 9 to 12 inch CRT; often a portable domestic television set. This video monitor is usually arranged to display a number of ASCII characters corresponding to the binary numbers held in a particular part of the memory. Imagine the

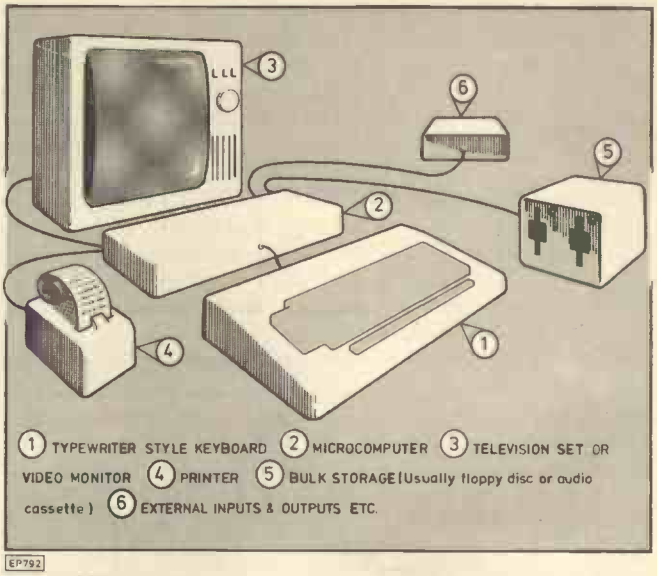


Fig. 8.5. Constituent parts diagram of a microcomputer system

screen being divided up into a matrix of squares, with each square having a specific and unique address. There are typically around one thousand (1K) of these. Part of the RAM known as the 'Video RAM' is usually dedicated for this use, and the display is then known as 'memory mapped'. The keyboard enters ASCII codes into the computer, which are normally fed up onto the screen as the program is being written. The bulk storage, printer, and external outputs and inputs are all fairly self-explanatory.

The microprocessor has many extra circuits and devices surrounding it; encoders and multiplexers to feed the keyboard information in, character generators and modulators to enable the memory to be displayed on the screen, and (of course) ROM and RAM. The ROM in a microcomputer normally carries the 'monitor program' (not to be confused with the video monitor); this is the 'apparent intelligence' of the computer, and is the interface point between the microprocessor logic, and the human operator and keyboard. Depending on the size and complexity of this monitor program, the facilities offered to the user can be considerable. The monitor contains basic and fundamental information within the computer, to tell it to scan the keyboard for any keys pressed, then to feed the ASCII character corresponding to the key pressed into the section of video RAM corresponding to the relevant position on the screen. It also enables, editing of the video RAM; deletion of characters, moving the display up and down ('scrolling'), etc.

Although the microprocessor operates on binary numbers, known as 'machine code', the human operator can program the computer in the hexadecimal equivalent to those binary numbers, making it quicker to type in, and easier to understand. This hexadecimal listing is known as 'object code'. Some systems help still further, by allowing the program to be written in 'mnemonics', which is a means of writing hex instructions in an abbreviated English language format. For example, 'JP' could be used to represent a jump instruction, the hex code for which might be C3, or 'INC B' might be used to represent the instruction 'increment the contents of register B', who's hex code might be 04. By using mnemonics (pronounced 'nimonics'), the program (when written down or typed in) can be much easier to follow and understand; the instructions all mean something and are no longer a collection of fairly arbitrary looking letters and numbers!

To produce machine code from the mnemonic program, an 'assembler' program must be used, which acts as a 'converter' between mnemonic and binary. (To translate back from binary to mnemonic, a program called a 'disassembler' is brought into use.) Much of the programming for dedicated microprocessors is written on microcomputers in object code or mnemonics, because this level of computer operation is very fast; the computer operates very efficiently when using these codes. However, programming can still be a complex, slow, and difficult task, as the detailed internal operation of the microprocessor is still dominant; programs are written in terms of registers, clock signals, ALUs, flags, etc. To bring the program one step higher in level, to a nearer approximation to the English Language, we must use a 'high level language'.

HIGH LEVEL LANGUAGES

The high level language raises programming to a fairly easily understood level. Instruction such as 'GO TO', 'PRINT', and 'IF X = Y . . .' are used, and enable people who are not immediately familiar with the computer or program in use to make sense of it all fairly quickly. There are many different languages; FORTRAN, COBOL, ALGOL, BASIC, PASCAL, FORTH, etc., the most commonly used of these (in the case of microcomputers) being BASIC, which stands for 'Beginners Allpurpose Symbolic Instruction Code'. Although there are several 'dialects' of BASIC they all share many common properties, and BASIC programs for one make of computer can usually be run on other computers with only a small amount of modification, if any at all. The opposite is true of object code and mnemonics, since these are specific to the microprocessor and monitor program in use, and can be quite difficult to translate for other systems. A special program must be used within the computer to convert programs, written by the user in BASIC, into machine code, and to convert machine code 'replies' from the computer back into the relevant BASIC statements and comments. This special program is normally held in a ROM, as firmware.

High level languages, because of the extra complexity involved, are relatively slow in use; each step of the program takes longer to execute than in the case of machine code based programs. Even so, the operation can be fast enough for all but the most demanding applications.

GETTING TO GRIPS WITH THE 'MICRO'

Unfortunately, the microprocessor is not something that you can just 'dabble' at; you can read all that you like about it, but until you get 'hands on' experience with a micro-based system you will still know very little about the practicalities of the subject. By far and away the best learning aid is a microcomputer itself, which will cost a significant amount of money, so it is important to shop wisely. There are microcomputers on the market that may seem attractive because of their very low cost, and some good publicity. Indeed, they demonstrate considerable engineering achievement in squeezing so much circuitry into remarkably small spaces, for a reasonable price. However, they can be very restricting in performance; the keen user will find that the capabilities of the machine, even with 'expansion' (more memory), can be very limiting. For what they are, they are excellent, but they are not fully fledged microcomputers in the same class as machines costing over £200. It is strongly suggested that if you are serious about learning about microprocessing and computing, you spend more money to avoid disappointment in the very near future. As a compromise, some computers in kit form can enable you to start off with a simple and inexpensive system (working on the object code level), then build it up slowly, and add a high level language, to finish up with a system which is worth several hundred pounds.

The machine to buy is very much a personal choice, to be made in combination with a study of magazine reviews, advice gleaned from other, more experienced microcomputer users, and a trip or two to your local dealer. Obviously, you get what you pay for, but to a certain extent you can pick and choose your approach. For those interested in the hardware side of the subject, the kit computers mentioned earlier can be a good starting point, but only if your standard of construction, especially soldering, is very good. Kit computers are NOT for beginners! Nascom 1, Nascom 2 and Tangerine products, amongst others, can certainly be recommended. Ready-built computers are for those less confident in the hardware side; Tangerine, Video Genie, Sharp and Tandy all have ready-built products, and the new 'BBC micro' is attracting a lot of attention at the moment, although at the time of writing it is not yet on the market. Paying out still more can provide small business computers such as the PET, APPLE or Tandy, but these represent a considerable investment and are not necessary unless you are likely to need their very advanced facilities later. A choice in the microprocessors used comes down to 6502 versus Z80 in the case of most microcomputers mentioned. The Z80 is undoubtedly more powerful, but the 6502 is somewhat more widely used, so once again the choice is a personal one.

Another point to make is in the interest of domestic harmony! Computing can take up a surprising amount of time. 'De-bugging' programs has kept most people busy into the early hours on a number of occasions, and you should be aware that demands on your time can be considerable, especially at first. Computing is not something that you can do a little at a time; several hours at a stretch is needed to get to grips with the problems, and preferably in peace and quiet, too. Don't let this put you off, though—it's a useful and fascinating subject, and well worth spending time and effort on!

In conclusion, if microcomputing or microprocessors are of interest to you, then the only real way to learn is to buy a microcomputer, and spend some time with it. Before committing yourself, why not see if the local school or technical college has evening classes in computing or microprocessors, or even runs a suitable club? This would enable you to try out various machines before buying, learn more about the subject, and ask the advice of other enthusiasts.

IC TECHNOLOGY

As technology has advanced through the years, so the number of active devices on an i.c. chip has increased. We can define the 'scale' of integration as follows (remember that each gate is made up of a number of transistors or MOS devices):

Small Scale Integration (SSI); up to 12 gates per i.c. Most NAND, NOR, inverter, and similar combinational logic i.c.s. fall into this category.

Medium Scale Integration (MSI); from 12 to 100 gates per i.c. This covers the range of counters, registers, decoders, flip-flops, etc.

Large Scale Integration (LSI); from 100 to several hundred gates per i.c. Multiplexed counter/driver i.c.s. digital clock i.c.s, and similar complex devices all fall into this category.

Very large Scale Integration (VLSI); from several hundred to several thousand gates per i.c. This is the realm of the microprocessor and the large memory i.c.s. Some micros even have memory i.c.s. both ROM and RAM, built in! Many 'accessory' i.c.s to the microprocessor are needed, such as programmable timers, peripheral management devices, memory controllers, input/output controllers, etc., and most of these are LSI or VLSI devices in their own right. In many cases, the microprocessor is only a very small part of the whole system; its support i.c.s can take up a lot more space and cost more than it does itself!

To help cut down on the number of 'accessory' i.c.s in any logic circuit or system, the 'Uncommitted Logic Array', or 'ULA' has been developed. This is a very large collection of logic gates which have no pre-determined interconnections. By designing a suitable pattern of interconnections of these gates, a custom-built i.c. can be created which will do the job of a large number of 'off the shelf' devices. Because the ULA is a standard device, with only the final interconnection layer being customised for each application, it is considerably cheaper than having an entire i.c. designed and built, and this approach, therefore, holds great promise for further miniaturising circuit designs in the years to come.

DIGITAL ELECTRONICS IN THE FUTURE

The pace of technological advance is so fast at the moment that it is difficult, if not impossible, to predict developments in the medium or long term future. However, it is possible to extrapolate current trends and developments, and to fairly accurately assess the changes that we can expect to see in the next few years.

In terms of microprocessors, the trend is towards larger and larger numbers of bits being used in a device. The industry 'standard' is currently 8 bits. 16 bit micros are now readily available and are starting to be used in large quantities, yet already we have seen the first appearances of the 32 bit micro; an incredibly powerful i.c. which will enable us to out-perform the much larger 'mini-computers' with single board VLSI microcomputer systems. 64 bits is still long way off, but is far from being an unrealistic or impossible dream. To keep pace with the speed and power of these large devices, memory manufacturers will continue increasing the number of cells per chip, and increasing their operating speeds, probably with dynamic RAM, EEPROMS, and bubble memories showing the greatest improvements.

The 'in' subject at the moment is voice synthesis and speech recognition systems. Cheap, high quality synthesis i.c.s are readily available at low cost but have the severe restriction of a very limited vocabulary. Infinitely variable 'phonetic' synthesisers are more expensive, and most of them suffer from a very poor quality of speech. However, the i.c. manufacturers and designers seem determined to thrust the 'talking hot drink vending machine', and similar ideas, upon us, so this is sure to be an area of considerable future expansion! Speech recognition is a much more difficult task, due to the subtle nuances, inferences, dialects and idiosyncrasies that punctuate the speech of all of us. Again, systems are available with limited performance, and these will be improved upon considerably in the years to come.

Combining speech synthesis and recognition will allow direct communication between the computer and the 'man-in-the-street', which offers vast scope for technological advance and integration of the computer into our everyday life. From the other angle, the man-in-the-street is becoming more familiar with the subject of computing in its own right. All British schools are being equipped with at least one microcomputer, and already many schoolchildren are achieving stunning levels of proficiency and knowledge about computing. The 'electronic office' is with us; word processing, facsimilie machines, electronic filing, and data transfer systems are all available and are being used in many of the large companies. Expensive, yes, at the moment, but as with most electronic goods a continued demand will result in dramatically lowered costs.

Returning to technological advances at the device level, the Uncommitted Logic Array, as mentioned earlier, will help in the miniaturisation of circuit assemblies, which in turn will increase the number of everyday products which have electronics incorporated into them. Speed limitation is a major problem in many microprocessors and computers, and advances are already being made towards providing the technological basis for the next generation of devices. Gallium Arsenide semiconductors, and those using the 'Josephson Junction', both of which need very low temperature cooling systems to operate, offer considerable decreases in gate propagation delays, with the resultant increase in computing speeds, and show great potential for the future. The one thing that seems certain about the times ahead is that they will be filled with change, challenge, and interest, just as the last few years have been. The profession, and hobby, of electronic engineering is guaranteed to have a colourful future for many years to come!

DIGITAL DESIGN TECHNIQUES

We now conclude this series on digital design techniques; there's no 'mini-project' this month because of the level of complexity that we have now reached, and the resultant limitations of space, so for the final project see next month's issue. In the past few months we have worked through from binary logic and combinational gates, all the way up to microprocessors. The pace has been swift, and to get full benefit from the series it is strongly suggested that you follow up the points made, and do further reading, experimenting, and designing of your own. There is much to be learnt and a great deal of fun and enjoyment to be had, so start putting together your own projects today!

ACKNOWLEDGEMENT

I would like to express my grateful thanks to my father, Peter Gaskell, and to my friend and colleague John Miller, for all their help, criticism, and suggestions in the preparation of this series.

T.A.G.

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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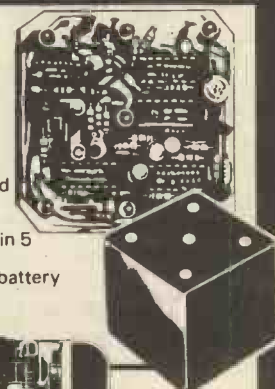

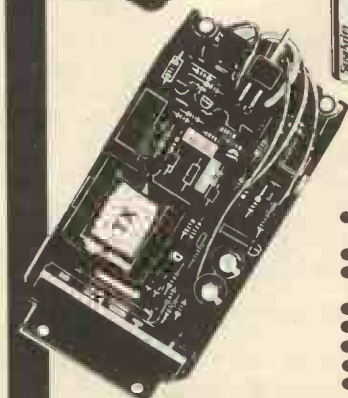

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- Three position changeover switch
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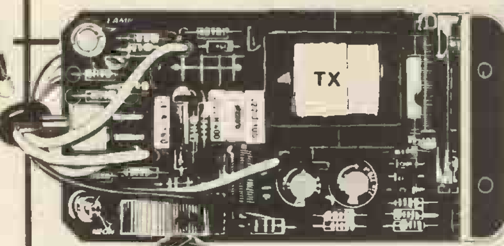

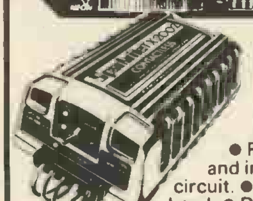

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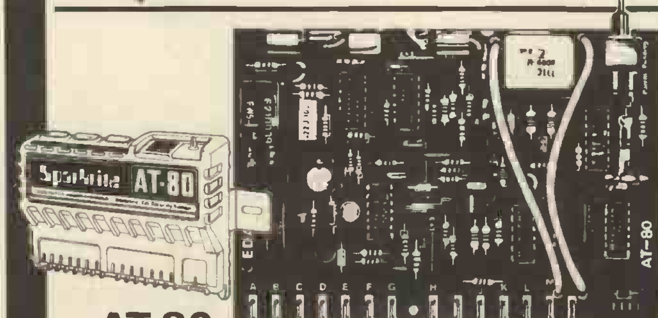

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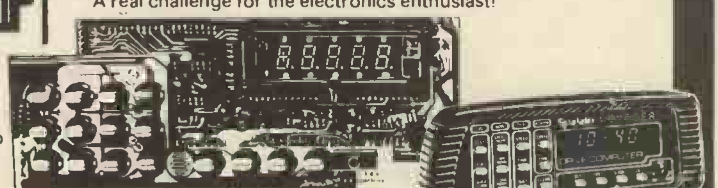

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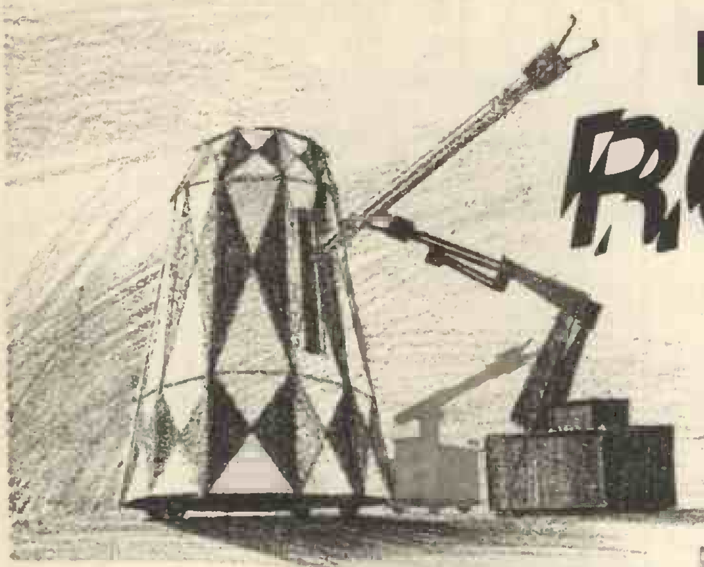


PE ROBOTS

PART 5

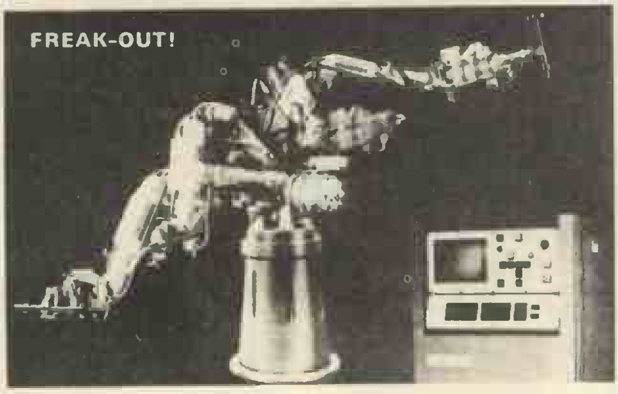
RICHARD BECKER · TIM ORR
RICHARD MONKHOUSE

Two photographs are shown here; one of the Genesis Mobile unit, M101, and the lower photograph which illustrates through multiple exposure photography, the level of robot technology with us today, by way of the Cincinnati Milacron machine. This latter machine (photo courtesy of Cincinnati) is in a somewhat prohibitive price range for the student. *Education* is quoted as an ideal application for the Genesis robots because they are *inexpensive* reprogrammable multi-tasking machines: and *light industry* because they are also engineered to a professional standard.

RESUME

Genesis is a series of hydraulic computer controlled robots ideal for education, light industry and as microcomputer peripherals.

Features are: extremely low cost, up to six controllable axes, positional sensing, servo control, continuous path motion, learning ability, RS232 interface, and IR remote control for the mobile unit.



Constructor's Note

Complete kit of parts for this project can be obtained from Powertran Cybernetics, Portway Industrial Estate, Andover, Hants SP10 3WN. ✆ Andover (0264) 64455.

Prices are as follows . . .

Genesis M101 4 axis model (excluding wheel base)	*£295.00*
Genesis M101 5 axis model (excluding wheel base)	*£345.00*
Genesis M101 wheel base	*£79.00*
Genesis P101 4 axis model	*£450.00*
Genesis P101 6 axis model	*£545.00*
Genesis S101 4 axis model	*£355.00*
Genesis S101 5 axis model	*£405.00*
Position detector coil set for M101, S101 4 axis models	*£15.00*
Position detector coil set for M101, S101 5 axis models	*£19.00*
Position detector coil set for P101 4 axis model	*£15.00*
Position detector coil set for P101 6 axis model	*£24.00*
Position detector board for M101, S101 4, 5 axis models	*£6.50*
Position detector board for P101 4, 6 axis models	*£7.50*
Motor drive board for M101 wheel base (2 required per machine)	*£11.50*
Control electronics for M101 (microprocessor board, interface board, display board and mounting bracket)	*£135.00*
Processor box for S101, P101 (microprocessor board, interface board, display board, power supply, interface cables, conduit, cabinet)	*£175.00*
Parts for RS232C interface (fits on microprocessor board)	*£14.50*
Hand held controller box for M101 (includes infra red transmitter and rechargeable battery)	*£47.00*
Hand held controller box for S101	*£33.00*
Hand held controller box for P101	*£33.50*

All prices subject to 15% V.A.T.

Components . . .

CONTROL BOX (MOBILE)

Resistors

R1, R4, R6	180k (3 off)
R2	120k
R3, R5, R23, R29	47k (4 off)
R7	470
R8	3k9
R9, R12, R14, R15, R28	10k (5 off)
R10, R11	1M (2 off)
R13	2k2
R16	33
R17	1
R18, R22, R24	100k (3 off)
R21, R27	560k (2 off)
R19, R20, R25, R26	12k (4 off)

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

Potentiometers

VR1	100k slider (linear)
VR2	47k slider & centre indent (linear)
VR3	470k preset
VR4, VR5	1M preset (2 off)
VR6, VR7	100k preset (2 off)

Capacitors

C1	1n Siemens B32560
C2	10n ceramic Piher
C3, C4	39p ceramic Piher (2 off)
C5, C6	100μ/16V elect. Axial lead (2 off)
C7, C8	10n Siemens B32560 (2 off)

Transistors and Diodes

TR1	BC184L
TR2	TIP31A
TR3, TR4, TR5	BC182L (3 off)
D1–6, D9–14, D17, D18, D21, D25–30, D33–38, D43	1N4148 (28 off)
D41, D42	TIL 38 (2 off)
D44, D45	9491BJ (1V2 Band Gap) or LM385 (2 off)

Integrated Circuits

IC1, IC2	4051B (2 off)
IC3	4024B
IC4, IC9	4013B (2 off)
IC5	40106B
IC6	4023B
IC7	4011B
IC8	LM324
IC10	ICM7555 IPA
IC11	10k s.i.p.

Miscellaneous

Printed circuit board (RTX)
M101 metal cabinet and fixing screws
PP3 stud connector
PP3 rechargeable battery
Slider knob
Pot knob
8-pin d.i.l. socket
14-pin d.i.l. socket (7 off)
16-pin d.i.l. socket (2 off)
Switches (27 off)
Slide switch
3·5 jack socket
Jack-to-jack lead (1 metre)

COMPONENTS . . .

CONTROL BOX (P101 & S101)

Resistors

R1, R4, R6	180k (3 off)
R2	120k
R3, R5	47k (2 off)
R7	470
R10, R11	1M (2 off)
R12	10k
R13	2k2

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

Capacitors

C1	1n Siemens B32560
C2	10n ceramic Piher
C3, C4	39p ceramic Piher
C5	100μ/16V axial lead

Transistors and Diodes

D1–6, D9–14, D18, D21, D25–30, D33–38, D43	1N4148 (27 off)
D46	5V6 Zener
TR3	BC182L

Integrated Circuits

IC1, IC2	4051B
IC3	4024B
IC4	4013B
IC5	40106B
IC6	4023B
IC7	4011B
IC10	ICM75551PA
IC11	10k SIP

Miscellaneous

Metal cabinet and fixing screws
Printed circuit board
DIN plug 5-pin 240°
5-way cable (3 metres)
Slide switch
push-button switches
8-pin d.i.l. socket
14-pin d.i.l. socket (5 off)
16-pin d.i.l. socket (2 off)

Note: In part 2, Interface board components list, under Miscellaneous—SIP1 and SIP2 should be considered as IC22 and IC23. SIP3 is IC24.

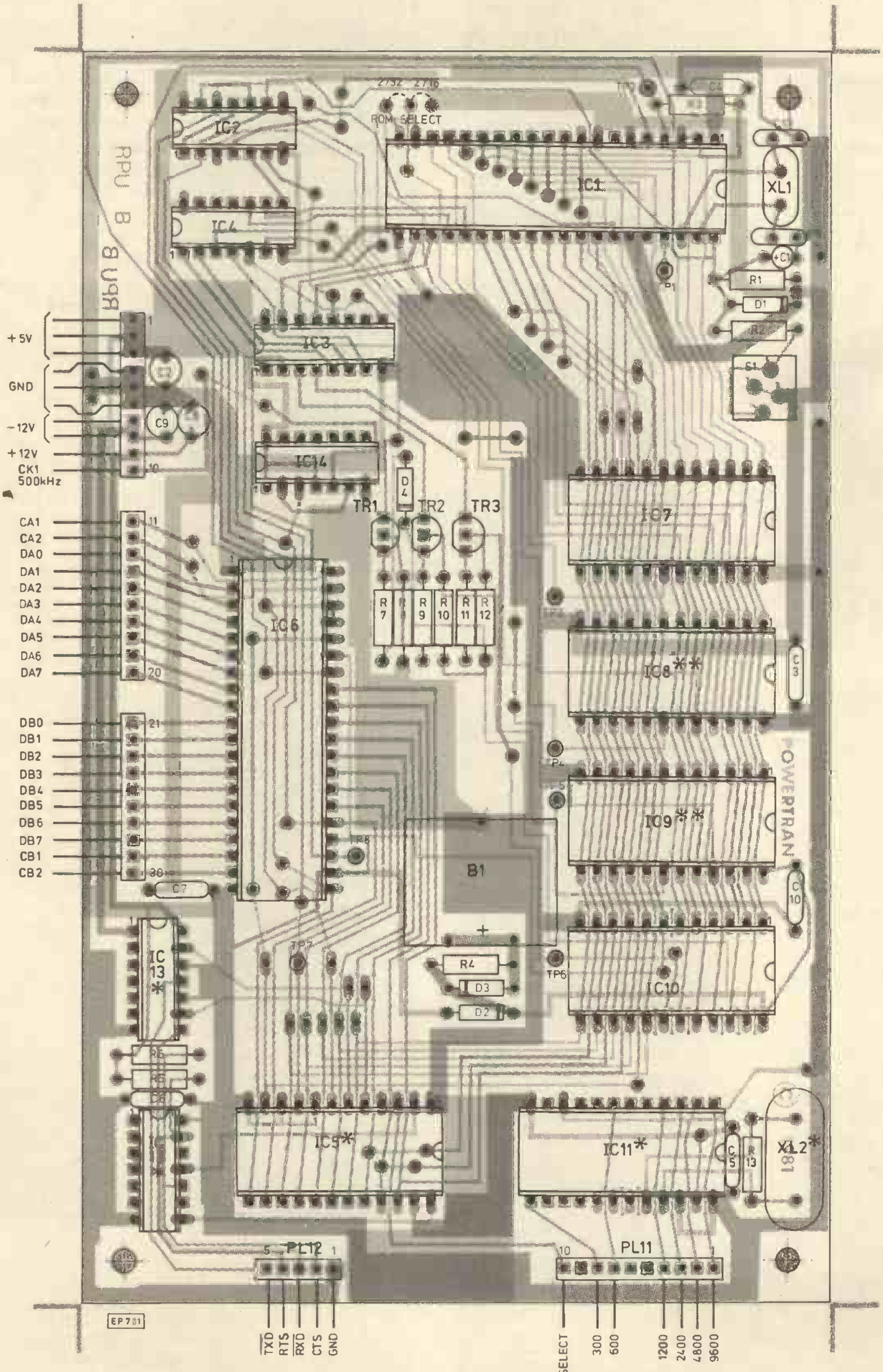


Fig. 1. Robot controller *RS232 version only. **Not used at present

INTERFACE BOARD

The Robot requires many more than the 20 I/O lines available from one PIA. To obtain these without going to multiple PIA's, the interface board uses a secondary 8 bit bus connected to one side of the PIA whilst the other side generates latch clocks for output latches or output enables for system inputs. Although careful attention to detail was necessary in the software to avoid bus clashes, this method makes efficient use of board space and means that the software can be debugged easily from an external computer.

The outputs from the expanded I/O scheme comprise two sets of 8 bits for controlling the solenoids and the motors, 8 bits for the display and bleeper and 8 bits for extra devices. On the input side there are 2 bits for the keyboard decoder interface one bit to signify RS232 connection and 5 bits for extra inputs.

SYSTEM DESCRIPTION

On manual control which is available in the EDIT mode, the robot arms can be moved around using the appropriate control buttons on the control box. There is logic to prevent both solenoids for an axis being activated simultaneously. The robot is taught by being moved under manual control to the desired position. Pressing the INSERT button enters the position and the microprocessor stores it in the battery backed-up CMOS RAM.

When a position is to be remembered, a combination of an analogue multiplexer and an eight bit analogue-to-digital converter (interface board — IC25 and IC24) selects each of the 5 transducer voltages in turn, and digitises them.

On replay, the ADC/multiplexer combination is constantly scanning the 5 inputs under software control, the measured positions of the five axes being compared by the microprocessor with the current target positions. These comparisons are used to activate the correct solenoids to achieve the target positions.

Manual control of the drive motors (on the mobile unit) is made variable by mark/space modulation of the motor drive switching transistors. These mark/space modulation timings are derived by the program from an internal look-up table that gives the mark/space ratios for the left and right motors from the position of the panel Speed slider and the Steering pot. These timings are themselves also generated by the microprocessor.

RS232 input

To control the robot from an external computer, an RS232 input is provided. If the RS232 lead is plugged in when the unit is powered up, the unit will ignore the keyboard and wait for a command from an external computer.

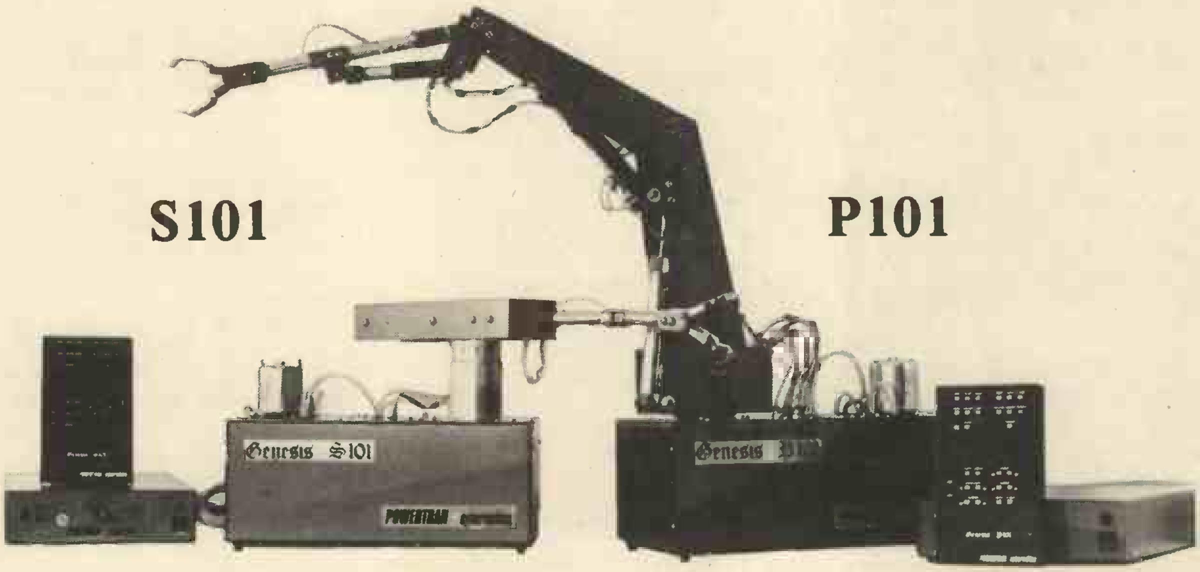
A move command is simply sent as a string of ASCII characters. The format consists of an "M" followed by six pairs of hexadecimal digits (each pair representing a number between Ø and 255 — the desired position for each axis). The last pair is the jaw command, and should be ØØ for "jaws open", and FF for "jaws closed", e.g. M8Ø8Ø8Ø8Ø8ØFF will move all axes to a central position and close the jaws.

When the move has been completed the robot will send back a "*" down the RS232 line to inform this to the sending computer.

On five axis units, the format is the same, but the last-but-one pair of digits is ignored.

P.E. ROBOTS

This concludes the hardware and control of the robots. NEXT MONTH we embark on the software description and routines, and final constructions.



S101

P101

MICRO-BUS

Compiled by DJD.

THE TWO topics in this month's Micro-Bus show how micros can be used in amateur radio. The first program receives fax transmissions, and displays them on a computer screen. The second program acts as a Morse-code tutor, for those trying to learn Morse code. Both programs were developed by ***Steve Platt***, a radio amateur in Cambridge (G6AZI).

RECEIVING FACSIMILE PICTURES

Pictures can be transmitted over channels normally used for speech, such as the telephone, or over the air by radio, using a system known as 'facsimile' or 'fax'. This system is used by radio amateurs to send diagrams such as weather maps and charts on the HF and VHF bands, but one problem faced by amateurs wishing to try their hand at fax is displaying the received pictures without expensive equipment.

The program to be described solves the problem by using the high-resolution four-colour graphics on an Acorn Atom computer to display fax transmissions on a TV screen straight off the air from a receiver. It was developed by ***Steve Platt*** of Cambridge (G6AZI), and what follows is based on his description.

"Radio amateurs generally use fax on the HF bands (short waves) where many commercial transmissions can be received. Fax is also used on the popular VHF 'two-metre' band where the calling frequency is 144·700MHz. A sample fax picture, of a street scene, is shown in Fig. 6; it is composed of three brightness levels, and has a total resolution of 128 × 192. It was received on 144·675MHz FM using the program of Fig. 7 with the receiver output connected directly to the Atom's cassette input!

Fig. 1. Facsimile picture decoded and displayed by the program of Fig. 2

```
  10 DIM LL(18),JJ(3),B(100)
  20 DIM D(100)
  30 FOR N=0TO18; LLN=TOP; NEXT
  40 FOR N=0TO3; JJN=TOP; NEXT
 105 PRINT $12,"FAX"'
 110 PRINT "ENTER COUNT AND SYNC"
 115 PRINT '"TRY 77 & 8"'
 120 INPUT C,S
 125 GOSUB 2000
 130 FOR N=0 TO S; B?N=2; NEXT
 140 B?(S+1)=0
 150 FOR N=S+2 TO 100; B?N=3; NEXT
 200 REM DO IT !
 210 CLEAR4; COLOUR 1
 220 DO
 225 DO UNTIL?#B001<>#FF
 230 ?#84=0; ?#85=#80; LINKJJ3
 240 UNTIL 0
2000 REM - COUNT CYCLES
2004 PRINT $21
2005 FOR N=1 TO 2
2007 DIM P(-1)
2010 [
2020:LL1 LDA @0
2030 STA #82; LDA @C; STA #80
2035 LDA @1; STA #81
2040 LDA @#20
2050 BIT #B002
2060 BEQ LL2
2070:LL4 DEC #80
2080 BEQ LL9
2090 NOP
2100 JMP LL10
2110:LL10 JMP LL11
2120:LL9 DEC #81
2130 BEQ LL3
2140:LL11 LDA @#20
2150 BIT #B002
2160 BEQ LL6
2170 JMP LL15
2180:LL15 JMP LL5
2190:LL5 JMP LL4
2200:LL6 INC #82
2210 JMP LL2
2220:LL2 DEC #80
2230 BEQ LL12
2240 NOP
2250 JMP LL13
2260:LL13 JMP LL14
2270:LL12 DEC #81
2280 BEQ LL3
2290:LL14 LDA @#20
2300 BIT #B002
2310 BNE LL7
2320 JMP LL16
2330:LL16 JMP LL8
2340:LL8 JMP LL2
2350:LL7 INC #82
2360 JMP LL4
2370:LL3 LDA #82
2380 RTS
2400:LL17 LDX @0
2410:LL18 LDA @C;STA #80
2420 LDA @1; STA #81
2430 JSR LL1
2440 STA D,X; INX
2450 CPX @101
2460 BNE LL18
2470 RTS
2500:JJ3 JSRLL1; CMP@S; BCC JJ3
2505:JJ2 JSRLL1; CMP@S; BCS JJ2
2510:JJ0 LDX @4
2520:JJ1 JSR LL1; TAY; LDA B,Y
2530 RORA; ROL#83; RORA; ROL#83
2540 DEX; BNEJJ1
2550 LDA#83; STA(#84,X); INC#84
2560 LDA#84; AND@31; BNEJJ0
2570 LDA#84; BNE JJ3; INC#85
2580 LDA#85; CMP@#98; BNE JJ3
2590 RTS
2960]
2970 NEXT N
2980 PRINT $6
2990 RETURN
3000 END
```

Fig. 2. Program for the Atom displays facsimile pictures

"The picture was transmitted (by G8RYL) using a surplus fax machine fed into the transmitter microphone socket. The picture is wrapped around a rotating drum, and scanned with a photocell. The photocell moves slowly along the drum to give a vertical scan, while the drum's rotation provides the horizontal scan. The output from the photocell is then used to vary the frequency of an oscillator with the brightness of the picture. Drum speeds of 60, 90, 120 and 240rpm are most popular; the program to be described works with 120rpm. The picture's "aspect ratio" is varied by setting the number of drum rotations for each inch that the photocell moves. Further details may be found in *Radio Communication*, August 1978, and *Wireless World*, December 1976 and March 1977.

PROGRAM DESCRIPTION

"The main task of the program is to determine the audio frequency of the incoming fax signal. This is done by counting "zero-crossings" during fixed intervals of time. The number of zero crossings is then related to a scale of brightness levels, and a point of the corresponding brightness is put on to the Atom screen by poking directly into the graphics memory.

"First the vectors and labels are declared, and the labels are cleared (lines 10 to 40). Variables C and S are parameters which can be varied to tune the progam to the machine being received; the values given, C = 77 and S = 8, seem to work best. The time interval over which zero crossings are counted is determined by C, and S determines the number of zero crossings that correspond to the fax sync-pulse level; i.e. the lightest part of the picture. The call to subroutine 2000 in line 125 assembles the machine code; note that this code uses C and S as constants, so these must be set before assembly.

"Vector B is a look-up table of brightness values. If X zero-crossings are counted, the colour of the point plotted will be B?X. Values of 2, 0 and 3 correspond to white, grey and black respectively. The brightness levels are set up in lines 130 to 150, based on the value of S selected.

"The main program loop, in lines 210 to 240, first waits for a key-press; locations # 84 and # 85 are then pointed to the start of the screen memory (line 230), and the machine-code routine JJ3 fills the screen.

ASSEMBLER ROUTINE

"Lines 2000 to 3000 constitute the assembler routines to receive a fax transmission, and display it in three brightness levels on an Atom screen. Routine LL1, from 2020 to 2380, is the key subroutine and is actually much simpler than it looks; it acts as a software frequency meter, counting the number of zero crossings on the cassette input in a fixed time interval.

"Each time the main loop is executed it reads the cassette input, and increments location # 82 if the input has changed. The main loop takes 32 usec, and is balanced with NOPs so that each decision branch takes the same number of cycles. The number of times the loop is executed is determined by locations # 80 and # 81; these are set to C in lines 2030 and 2035, and although in the present application C was only 77, a two-byte counter was used to allow expansion to longer measurement times. With this value of C the routine counts zero crossings for about 2·5 msec, before returning with number of zero crossings in location # 82.

"As a debugging aid, lines 2400 to 2470 will dump 100 samples of the input frequency in the vector D. Typing:

LINK LL17

followed by printing the values D?0, D?1 . . . D?100 will allow the input to be checked. If the values are not the range 7 to 12 the value of S may need to be changed.

DISPLAY ROUTINE

"The display routine, JJ3 in lines 2500 to 2590, is called from the main BASIC loop. It waits for the synchronising pulse which precedes each line of video information (lines 2500 and 2505), and then fills a line on the screen. To do this it calls the LL1 routine to sample the input frequency, then looks up the corresponding brightness value in vector B (line 2520). This is a 2-bit pixel value which is shifted into the screen memory via a work byte, # 83, in line 2530. When four pixels have been packed the byte is updated in the graphics area (line 2550). At the end of a line (when the address is a multiple of 32-line 2560) the program goes back to wait for another sync pulse.

"The remaining part of the routine updates the upper byte of the screen address, and checks for reaching the bottom of the screen, address # 9800 (line 2580).

POSSIBLE EXTENSIONS

"The facsimile system described above is similar to the slow-scan television (SSTV) system used by amateurs, employing modified TV cameras, and the same program has been used, with slight modification, to receive SSTV "conversations" on the HF bands. Since the sync levels are reversed, lines 2500 and 2505 should be exchanged, and the values of C and S may need to be altered.

"Thought is also being given to an Atom-based fax transmission system built around some sort of art/graphics sketchpad program. This would allow the user to sketch a pictorial reply to the received image on the Atom screen, using keyboard input.

MORSE-CODE TUTOR

Many radio amateurs are put off from using the short-wave bands because of the need to learn Morse code to obtain a licence, and the main problem is finding a source of slow Morse to learn from. The program for the Acorn Atom, shown in Fig. 3, acts as a Morse tutor by producing a continuous stream of letters in Morse code.

The Tutor program lets you learn a subset of the alphabet, starting with the letters which have the shorter codes. In addition, the speed and spacing of the Morse produced can be varied to cater for different abilities. The program presents letters in groups of five, separated by a single space. This is similar to the test format used in the amateur radio examination, and so the program can be used to test whether the required standard has been reached. The program can also be used to learn letters, by watching the words on the screen as the Morse is played.

Many people have their own theories as to the best way of learning Morse code. Generally it is thought to be better to hear the letters at full speed from the beginning. This way you identify the sound of each letter without thinking of a written pattern of dots and dashes, which can be a distraction when trying to gain speed! It is therefore best to start with the speed set to your target speed, and have extra time between letters, over and above the normal spacing. The Post Office test for radio amateurs requires a speed of 12 words per minute, where words are defined as having five letters; other tests may need less.

CODE STORAGE

The code for each letter occupies two bytes, in vectors C and L. The byte in C holds a binary sequence which gives the code for that letter, with '0' for a dot (short bleep) and '1' for a dash (long bleep), starting with the lowest bit. The byte in L gives the total length of the code; i.e. how many bits to use from C. As an example, take the letter Z, which is letter 26. The value of L?26 is 4, so taking the bottom 4 bits of C?26 we have 0011. Thus the Morse code for Z is:

— — · ·

Only the codes for the letters are stored, although the program could easily be extended to numerals and punctuation.

PROGRAM DESCRIPTION

Lines 10 to 25 allocate space for vectors, C, L, S, and A, for labels VV0 to VV8, and for the machine code at P. The values of C and L for the Morse codes of the letters A to Z are set up in lines 100 to 170, and the assembly code is then assembled (line 180). The string S contains the alphabet in the order of shortest letters first; i.e. in rough order of difficulty. The program presents subsets of the alphabet starting with the first letter, S?1.

The main control loop of the program, from line 200 to line 295, determines how the codes are presented, and this could be altered to suit individual requirements. For example, the program could present codes one letter at a time, with you typing in your guess. K determines how many different letters from string S are being taught; thus, with K = 3, only letters E, T, and A are presented. G can be set to a value greater than 0 to give extra spaces between letters when learning (line 205). The program then presents a total of 24 'words', each of which is a 5-letter group (lines 210 and 220) picked at random from the first K letters in string S (lines 240 and 250). Each letter is 'bleeped' in Morse code by subroutine 'c' (line 260), followed by any extra spaces wanted between letters (line 265). After each word there is an extra space (line 275), and the word is printed to the screen (line 280).

BLEEP ROUTINE

The assembler code in lines 900 to 995 of Fig. 3 is a routine to bleep the Atom's speaker, and is similar to the one in the Atom operating system. Location # 80 gives the pitch of the tone and location # 81 the length. The same routine is used for dots, dashes, and gaps, with location # 82 set to 4 for a tone and to 0 for silence; this ensures that tones and gaps are all exactly the right length.

An additional assembler routine at VV3 (line 982) gets the ASCII value of the next key pressed in location # 83.

```
   5 PRINT $12,"MORSE TUTOR"'
  10 DIM C(26),L(26),S(27)
  25 DIM A(5),VV(8),P(-1)
 100 REM SETUP TABLES
 110 C!0=#5010200;L!0=#4040200
 120 C!4=#3040001;L!4=#3040103
 130 C!8=#50E0000;L!8=#3040204
 140 C!12=#7010302;L!12=#3020204
 150 C!16=#0020B06;L!16=#3030404
 160 C!20=#6080401;L!20=#3040301
 170 C!24=#30D09;L!24=#40404
 180 GOSUB 900; REM ASSEMBLE BLEEP
 190 SS=" ETANIMSURWDKGOHVFLPJBXCYZQ"
 195 INPUT "SPEED (WORDS PER MINUTE)",W
 196 T = 1059/W - 10
 197 IF T*3>255 THEN PRINT"TOO SLOW"';GOTO 195
 200 INPUT '"HOW MANY LETTERS DO YOU WANT TO LEARN",K
 205 INPUT "HOW MANY SPACES BETWEEN LETTERS",G
 210 FOR W=1 TO 24
 220 FOR J=1 TO 5
 240 I = ABS(RND)%K+1
 250 A?J=S?I; I=A?J - 64
 260 GOSUB c
 265 IF G>0 THEN I=0;FOR B=1 TO G;GOSUB c;NEXT B
 270 NEXT J
 275 I=0; GOSUB c
 280 FOR J=1 TO 5;PRINT $A?J;NEXT J
 290 PRINT "   "; NEXT W
 295 GOTO 200
 900 P.$21;[
 910:VV0 LDA #B002
 915 LDY #81
 920:VV1 LDX #80
 930:VV2 DEX
 940 BNE VV2
 950 EOR #82
 960 STA #B002
 965 DEY
 970 BNE VV1
 980 RTS
 982:VV3 JSR #FFE3; STA #83; RTS
 985]; P.$6
 990 ?#80=200
 995 RETURN
1000cREM O/P MORSE CHAR "I"
1003 IF I<1OR I>26;?#81=2*T;?#82=0;LINK VV0; RETURN
1005 M=C?I; IF L?I<1 RETURN
1010 FOR N=1 TO L?I
1020   IF M%2=1 GOTO b
1025   ?#81=T
1030   ?#82=4; LINK VV0
1040   GOTO d
1050b  ?#81=3*T
1052   ?#82=4; LINK VV0
1060d M=M/2
1065   ?#81=T
1070   ?#82=0; LINK VV0
1075 NEXT N
1080   ?#81=2*T
1085   ?#82=0; LINK VV0
1090 RETURN
```

Fig. 3. Morse-code tutor for the Atom

MORSE CODE OUTPUT

The final routine, 'c', outputs the code for the letter in I, where I = 1 gives A, up to I = 26 for Z; any value outside this range is treated as a space (inter-letter gap). The routine uses vectors C and L, set up as described above. Each dot is a bleep of length T (lines 1025–1040), and each dash a bleep of length 3*T (lines 1050–1052). There is a gap of length T between each dot or dash (lines 1065–1070), and a gap of length 3*T at the end of the letter (lines 1065–1085).

This routine could form the basis of a program to generate automatic Morse code from messages typed in at the keyboard. However, writing the complementary program to receive and decode Morse is a much tougher problem, and this would provide an interesting challenge to any radio amateurs with micros.

TV CAMERA

PHILLIP GAFFNEY

Part 3

IN THIS, the final part of the camera, we first catch up on some Logic Board constructional notes. The f.e.t. TR20 (VN66AF) should have its heatsink doubled over, as shown in Fig. 3.1, to clear its headroom.

Scrape a small amount of track off the top-right hole where the coil is situated on the p.c.b. Link the coil to the casing as shown in Fig. 3.2. There are two links, and C50 (15µ/16V) to be mounted. The coil board is then mounted with C50 going to the lower part of the board (near IC3).

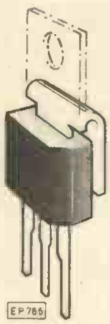


Fig. 3.1. Reshaping the heatsink of TR20

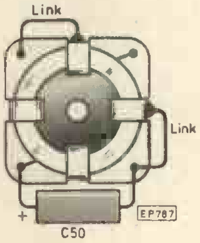


Fig. 3.2. Coil sub-assembly

FINAL ASSEMBLY INSTRUCTION

Having completed the construction of the individual boards of the camera, the final assembly consists of fitting the boards together and making the necessary interconnections. The vidicon tube and scan coil assembly is supplied complete with connecting wires to make assembly simpler.

The individual component boards may be sent for testing and setting up to **Security Electronics and Engineering** (Printoid Ltd.), 20/21 Alfric Square, Woodston, Peterborough. ✆ 0733 329111. All components are available separately. Technical and supply problems should be sent direct to: PE/Seescan Camera Project, Security Electronics and Engineering, 20/21 Alfric Square, etc.

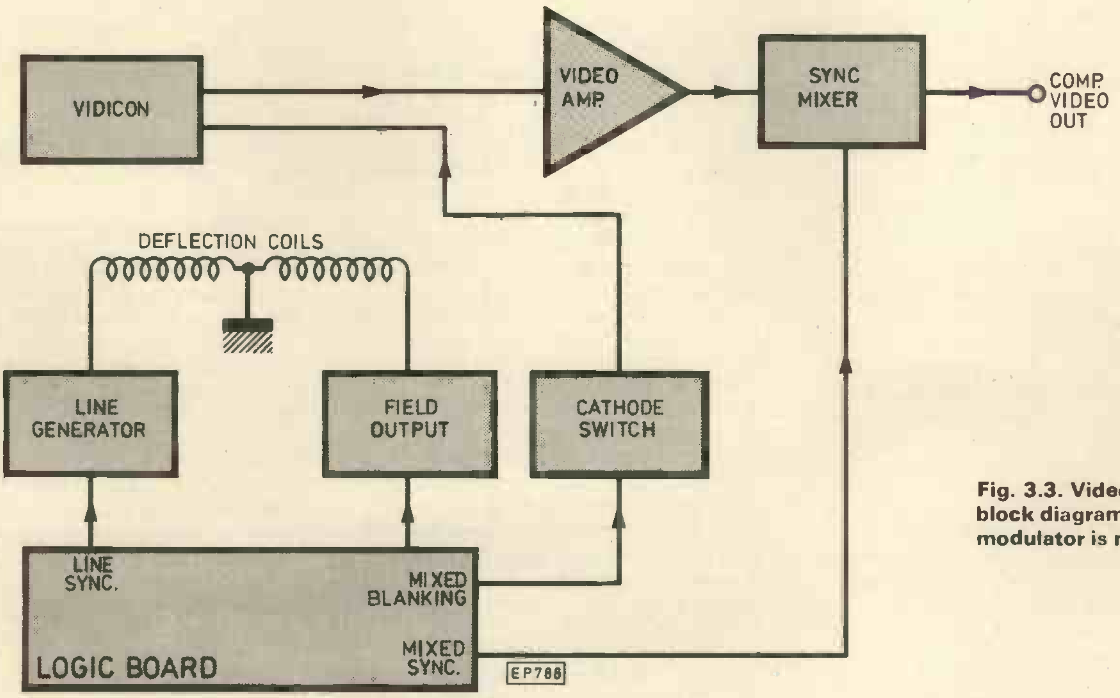


Fig. 3.3. Video and logic block diagram. The UHF modulator is not shown

Connect the four boards together using the varelco connectors—these are polarised so that the connectors will only mate correctly in one position. Check that all connectors are making good contact.

Mount the inner rear panel to the rear of the camera chassis using four M3 6mm screws. Mount the co-axial socket on the inner face of the rear panel using two countersunk M3 screws, one tag washer and two M3 nuts. The tag washer fits on the screw in the red hole.

Using heavy gauge tinned copper wire, connect the co-axial socket core and the tag washer to the points indicated on the diagram of Fig. 3.4.

Connect the three wire plug from the video board to the logic board so that the black wire is near pin 8 or IC9 on the logic board.

Mount the tube/coil assembly onto the front of the camera chassis using four M3 20mm screws with M3 nuts, ensuring that the coil and tube are orientated as shown in Fig. 3.5.

Plug the scan coil connector onto the logic board so that the blue wire is nearest to the scan coils.

Fit the tube base connector to the tube ensuring that the short tube pin fits in the unnumbered hole of the connector.

Solder the earthing connections from the scan coil assembly to the earth rail on the video board, as shown in Fig. 3.6.

Solder the screened target connection to the video board as shown.

Screw the lens into the front of the camera. The camera chassis is now complete.

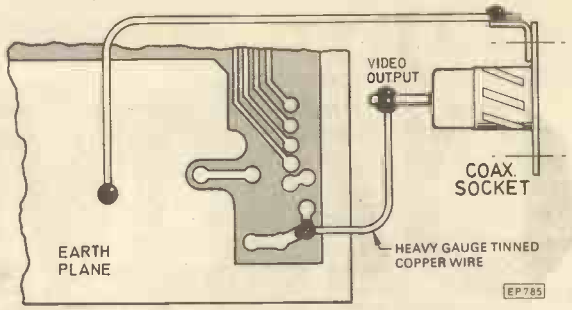


Fig. 3.4. Connection to the VHF modulated video output socket

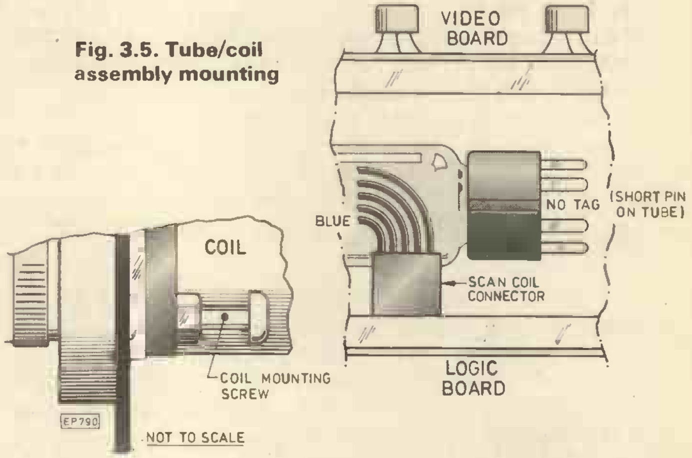


Fig. 3.5. Tube/coil assembly mounting

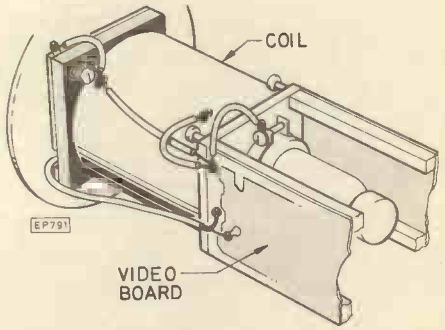


Fig. 3.6. Earthing to the scan coil assembly

SETTING UP

The general description of the camera electronics, and of the methods of setting up have been left until last, as it was felt that it would be easier to visualise the camera as a whole once the individual sub-assemblies had been constructed. In making final adjustments to the camera, it is essential that a clear understanding of the function of each control has been achieved.

We hope to show how these units inter-connect and work together to form a high quality black and white television camera.

VIDICON TUBE

The inverter and high voltage power supply boards provide all the necessary dc voltages for the correct operation of the vidicon tube. When correctly adjusted, the vidicon will produce a voltage at its target ring which will be proportional to the intensity of light falling on the centre of the target window. In the absence of scanning wave-forms, the electron beam will produce a focussed spot near the centre of the target window. *On no account should the tube ever be allowed to operate in this fashion as it will result in a spot being burnt onto the vidicon target.*

If the video amplifier were connected to the target ring, it would amplify this smaller voltage, and an amplified signal would be fed to the UHF modulator. The purpose of the logic/scan board is twofold. First, it scans the electron beam across the target of the vidicon tube. Line scan moves the beam from left to right, field scan from top to bottom. These two scan waveforms are precisely locked together, and are carried out at the same speed as the electron beam moves across the monitor screen. Therefore, the voltage at the target ring of the vidicon will be continually changing—at any instant being proportional to the intensity of light at a particular spot over the surface of the vidicon target upon which the optical image of the scene is focussed. We now therefore have picture information available at the output of the video amplifier ready to send to the monitor. However, at the moment, the scanning of the vidicon tube is not linked to the scanning of the monitor cathode ray tube. We need to ensure that when the camera starts a scan at the top left hand corner of the picture the monitor is also scanning at the top left hand corner. To do this we send out a pulse (called a sync. pulse) at the start of each line and field. The monitor is forced to keep in step by these pulses, ensuring that a stable fully locked picture is obtained. Our line and field sync. pulses are obtained from the logic board, and are mixed with the video signal in the video amplifier. The waveform handled by the last two stages of the video amplifier, and then fed to the modulator is a composite containing both the video signal and synchronisation pulses. As mentioned in part four, blanking signals are also added to prevent the electron beam retracing its steps across the picture when it rapidly flies back to start the next line or field. These signals fed to the cathode of the vidicon tube cut off the electron beam between lines and at the end of fields preventing it reaching the rear of the target surface.

In testing the camera, it is important to ensure systematically that each of the sub-assemblies are correctly working.

PRESET CONTROLS	
Logic Board	Master clock oscillator Width Magnetic focus Height
Video Board	Automatic light control Pedestal Sync DC level
High Voltage Power Supply Board	Target Beam Electrostatic focus

SETTING UP

Before applying power, turn all presets to midway position, with the exceptions of beam current, target voltage and automatic light control. The beam control should be adjusted for maximum negative voltage on its wiper, the target control turned fully anticlockwise until zero volts is on the wiper. The automatic light control should be fully anticlockwise. With these settings, the vidicon tube is fully cut off, and it will not be possible to damage the face of the tube in the event that the scan waveforms are incorrect.

Switch camera on; line frequency whistle should be heard immediately from the inverter transformer; if not, switch off and recheck connections. Set the height and width controls to maximum, i.e. fully clockwise. At this stage, if the camera is connected to a TV set tuned to channel 36 a pattern of lines should be seen on the screen. Adjust the master oscillator control to stabilise the pattern as far as possible. If no pattern is visible, just a blank, noise free raster, try altering the position of the pedestal black level control. Place a finger on the target connection; a great deal of noise (random patterns) should be visible on the TV screen. Adjust the pedestal control for the strongest display. Use an oscilloscope to check that correct scan wave forms are present at coil plug. See Fig. 2.11.

Set beam current control to give 30V at its wiper, and target control to $\frac{3}{4}$ maximum. By adjusting the beam control carefully, it should now be possible to detect some sensitivity to light when the camera lens is wide open. Now set the camera lens to about f.8 in normal illumination, then adjust the electrostatic focus control to give the crispest image. Aiming at an object 2 metres away, with a lens set at 2 metres, slacken off the tube retaining clamp and slide the tube carefully backwards and forwards to obtain the sharpest focus. Adjust the height and width controls until the edges of the picture just exclude the target windows; readjust the electrostatic focus, and beam controls, for the best picture. Trim the pedestal control for best picture with no crushing of dark greys into blacks. Adjust sync. control for best contrast and stability; or use oscilloscope and set up video output wave-form to CCIR standard. Adjust all the presets one at a time for optimum picture quality. Finally, advance the automatic light control preset until it just has an effect on the picture; back off this setting slightly. This is the correct setting for normal use. ★

PATENTS REVIEW...

JAPANESE IDEAS

The Nissan Motor Company of Japan has been toying with the idea of building a factory in Britain to make cars. Already the company is filing patents in Britain. The latest (British patent application 2 074 313) suggests an interesting new application from Nissan for light links.

Currently any switches on the steering wheel of a motor car, for instance the horn button, produce electrical control signals. These are fed to the main car wiring harness via electro-mechanical slip rings between the moveable steering wheel and stationary steering wheel column. But slip rings suffer from wear. Also the contacts are bulky, and this limits the number of connection paths and thus the number of switches which can be accommodated on the steering wheel. Nissan proposes replacing this electrical path with a light path.

Figure 1 shows the basic layout. A bank of switches 17 on the steering wheel 13 controls the engine or ancillary equipment. The electrical output of the switch bank is encoded at 21 to control the pulsing of a LED 22. The pulsed light is beamed at light-transmitting ring 23, made for instance of acrylic or polycarbonate. Light pulses emerging from the ring are picked up by photo-diode 24 which is secured to the steering wheel column. The electrical output diode 24 is amplified at 25, shaped at 26, decoded at 27 and fed to drive circuit 28 for control of the appropriate car function. This could for instance be the waveband change and volume control of a radio.

Light fibre links can be used to improve optical coupling. The ring 23 is shaped to allow light from the diode to propagate inside the ring and escape only at the face adjacent the photo sensor.

The transmission code relies on pulses of 2·78 milli/sec width at a frequency of 180Hz and a duty factor of 50%. This enables a full message to be transmitted in 15 millisec. Because the switch is likely to be depressed for at least 100 millisec, each coded message is transmitted at least twice for safety.

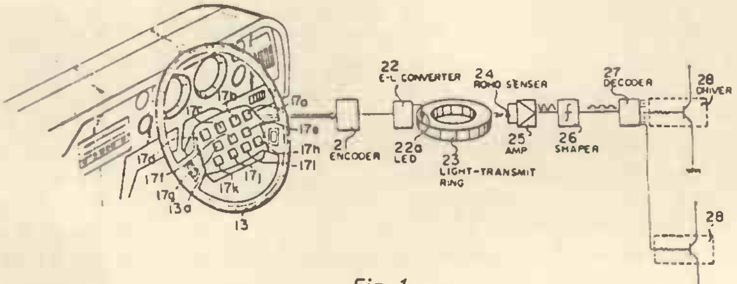


Fig. 1

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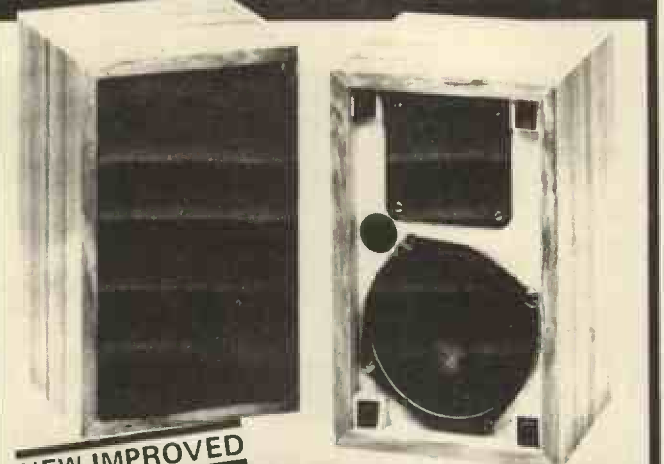

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	1X012	12 + 12	1 25		
	1X013	15 + 15	1 00		
	1X014	18 + 18	0 83		
	1X015	22 + 22	0 68		
	1X016	25 + 25	0 60		
	1X017	30 + 30	0 50		
50 VA 80 x 35mm 0 9 Kg Regulation 13%	2X010	6 + 6	4 16	£5 83 + £1 10 P/P	£4 93 + £1 10 P/P
	2X011	9 + 9	2 77		
	2X012	12 + 12	2 08		
	2X013	15 + 15	1 66		
	2X014	18 + 18	1 38		
	2X015	22 + 22	1 13		
	2X016	25 + 25	1 00		
	2X017	30 + 30	0 83		
	2X028	110	0 45		
	2X029	220	0 22		
	2X030	240	0 20		
80 VA 90 x 30mm 1 Kg Regulation 12%	3X010	6 + 6	6 64	£6 51 + £1 43 P/P	£5 47 + £1 43 P/P
	3X011	9 + 9	4 44		
	3X012	12 + 12	3 33		
	3X013	15 + 15	2 66		
	3X014	18 + 18	2 22		
	3X015	22 + 22	1 81		
	3X016	25 + 25	1 60		
	3X017	30 + 30	1 33		
	3X028	110	0 72		
	3X029	220	0 36		
	3X030	240	0 33		
120 VA 90 x 40mm 1 2 Kg Regulation 11%	4X010	6 + 6	10 00	£7 55 + £1 43 P/P	£6 38 + £1 43 P/P
	4X011	9 + 9	6 66		
	4X012	12 + 12	5 00		
	4X013	15 + 15	4 00		
	4X014	18 + 18	3 33		
	4X015	22 + 22	2 72		
	4X016	25 + 25	2 40		
	4X017	30 + 30	2 00		
	4X018	35 + 35	1 71		
	4X028	110	1 09		
	4X029	220	0 54		
	4X030	240	0 50		
160 VA 110 x 40mm 1 8 Kg Regulation 8%	5X011	9 + 9	8 89	£9 97 + £1 43 P/P	£8 44 + £1 43 P/P
	5X012	12 + 12	6 66		
	5X013	15 + 15	5 33		
	5X014	18 x 18	4 44		
	5X015	22 + 22	3 63		
	5X016	25 + 25	3 20		
	5X017	30 + 30	2 66		
	5X018	35 + 35	2 28		
	5X026	40 + 40	2 00		
	5X028	110	1 45		
	5X029	220	0 72		
	5X030	240	0 66		

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE inc VAT	PRICE ex VAT
225 VA 110 x 45mm 2 2 Kg Regulation 7%	6X012	12 + 12	9 38	£11 83 + £1 73 P/P	£10 06 + £1 73 P/P
	6X013	15 + 15	7 50		
	6X014	18 + 18	6 25		
	6X015	22 + 22	5 11		
	6X016	25 + 25	4 50		
	6X017	30 + 30	3 75		
	6X018	35 + 35	3 21		
	6X026	40 + 40	2 81		
	6X025	45 + 45	2 50		
	6X033	50 + 50	2 25		
	6X028	110	2 04		
	6X029	220	1 02		
	6X030	240	0 93		
300 VA 110 x 50mm 2 6 Kg Regulation 6%	7X013	15 + 15	10 00	£13 67 + £1 73 P/P	£11 66 + £1 73 P/P
	7X014	18 + 18	8 33		
	7X015	22 + 22	6 82		
	7X016	25 + 25	6 00		
	7X017	30 + 30	5 00		
	7X018	35 + 35	4 28		
	7X026	40 + 40	3 75		
	7X025	45 + 45	3 33		
	7X033	50 + 50	3 00		
	7X028	110	2 72		
	7X029	220	1 36		
	7X030	240	1 25		
500 VA 140 x 60mm 4 Kg Regulation 4%	8X016	25 + 25	10 00	£18 17 + £2 05 P/P	£15 53 + £2 05 P/P
	8X017	30 + 30	8 33		
	8X018	35 + 35	7 14		
	8X026	40 + 40	6 25		
	8X025	45 + 45	5 55		
	8X033	50 + 50	5 00		
	8X042	55 + 55	4 54		
	8X028	110	4 54		
	8X029	220	2 27		
	8X030	240	2 08		
625 VA 140 x 75mm 5 Kg Regulation 4%	9X017	30 + 30	10 41	£25 10 + £2 20 P/P	£21 54 + £2 20 P/P
	9X018	35 + 35	8 92		
	9X026	40 + 40	7 81		
	9X025	45 + 45	6 94		
	9X033	50 + 50	6 25		
	9X042	55 + 55	5 68		
	9X028	110	5 68		
	9X029	220	2 84		
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Semiconductor UPDATE...

FEATURING LM1035 99000 SERIES 8X60 R. W. Coles

REMOTE CONTROL

In days of yore, when I ran a sort of audio amplifier assembly facility in my back shed, I became well versed in the tricky business of connecting sensitive volume, bass, and treble pots into the rest of the circuitry using carefully screened and earthed leads. Of course, these amplifiers used transistors or even valves (Ah! Pentodes!) which always needed an element of black-magic to ensure success anyway, but in today's chip orientated circuitry, electronic sorcery at the soldering iron stage seems out of place somehow. My own special witches' brew for amplifier control connections has been rendered obsolete overnight by a new chip from National, the LM1035.

The trouble with the old method of connecting amplifier controls was the fact that the pots had to be on the front panel while the amplifier itself was several inches away, and the interconnections made marvellous transmitting or receiving aerials for cross-talk, noise, mains hum, and even Radio Luxembourg. What National have done is to provide electronic control circuits which are controlled directly by d.c. voltage levels, so that the sensitive audio signal path never has to leave the chip. Pots are still used of course, but now they are used to get, not a signal level, but a d.c. level which can be slugged with a big electrolytic capacitor to remove any stray signals which could interfere. Inside the chip are two signal channels (for stereo) which have individual electronic attenuators for gain and balance, and individual voltage controlled filters for treble and bass control with each feature being controlled by a single voltage level so that there is no longer a need for expensive ganged pots!

The LM1035 has a distortion level of 0·02% at 1kHz and gives a volume control range of 80dB with 22dB of balance range. Maximum bass and treble boost or cut is 15dB, channel tracking is good to within 1dB and channel separation is −60dB at 1kHz. An on-chip voltage regulator is provided to allow the device to operate on unstabilised supply rails of from 8 to 20 volts, and the whole thing lives in a tiny 20 pin package.

SUPERCHARGED 9900

When Texas Instruments introduced the first true 16 bit microprocessor, the 9900, they claimed that it spelled "The end of the two-bit eight-bit" and sat back to watch their tall-in-the-saddle processor steal sockets from Intel and Motorola who were then still clinging to their puny 8 bit devices. Unfortunately the market was not really ready for a 16 bit chip, and although the 9900 was reasonably successful, it certainly did not sweep the other 8 bit chips off the board, and even found itself a poor second when Intel, Zilog, and then Motorola introduced their own 1000 series 16 bitters several years later.

Well Texans don't take a licking easily, and so after a long cool analysis of the opposition, Texas have supercharged their 9900 design and brought out a new bit slinger family which appears to have the drop on those upstarts from the competition. Their new chip is still a sixteen bitter and is downwards compatible with the instruction set of the 9900, but there the similarity ends because the 99000 series offers some real innovations which increase its speed and power far beyond that of its ancestor and even beyond the fast guns of the Motorola 68000. First to hit the streets will be the 99105 which has 82 basic instructions including multiprecision arithmetic, stack operations, memory bit manipulations, and parallel I/O instructions to overcome the limitations of the weird serial-only scheme of the 9900. Next will be the 99110 which has the great additional feature of an on-chip floating point arithmetic library which allows it to add, subtract, multiply, divide, move and convert real variables in the IBM format, a feat which has hitherto required substantial external software.

Fundamental to all members of the new processor family will be a clock speed of 24 MHz (almost v.h.f.!) which is twice as fast as the competition and means that with a memory cycle time of just 167 nS it will be necessary to choose the faster memory chips to take advantage of the power available. Inherent in the architecture of the family is a main memory address range of 256K bytes, and a separate "Macro-Store" address range of 120K bytes which can be used to augment the instruction set of the basic processor without the need to use main memory. The 99110 has its floating point arithmetic instructions implemented in Macro store space and actually uses a special on-chip 1K ROM and 32 byte RAM for this purpose. In the future other family members will use this same on-chip store to provide other high level features such as a real-time operating system or special I/O control routines. Unlike the 9900 which used a monster 64 pin package, the first members of the 99000 family both use 40 pin packages and have multiplexed data and address buses to suit.

FIFO

If you have a pet micro with a printer you probably get frustrated waiting for it to output listings at a rather pedestrian rate, during which it studiously ignores its keyboard and refuses to do anything else. One way round this problem is to create a spooler program which runs under interrupt control to give apparently simultaneous service to both the printer and the keyboard so that you can go on typing in more code while the listing is printed. This scheme relies on the fact that it takes a short time to send a character to the printer but it takes a much longer time for the printer to actually print it. Since the micro is only involved in the sending operation the spare time can be used to service other tasks.

Unfortunately, all the spooler programs I have seen implemented on micros have suffered from shortcomings such as missed keyboard characters while printing, and of course there is the complication of running under interrupt control which needs careful attention while writing programs. A much simpler solution is possible which is used already on many printers such as the Nascom Imp and involves the use of a character buffer store implemented in hardware and not under the control of the microcomputer itself. In this case the micro "sees" an apparently very fast printer and dumps whole pages of text in next to no time. If the listing will fit entirely within this print buffer then no waiting is involved, and with memory prices dropping all the time a big print buffer looks economically feasible.

The buffer can be fitted between a micro and a printer, and needs to be organised as a FIFO (First In First Out), which raises the problem of how to control the two memory address pointers required to control writing at one rate and reading at a different rate. The Nascom printer uses a microprocessor to control this feature, but this starts to look a bit complicated for a stand alone buffer unit which is why, to my knowledge, no designs have been published. Fortunately the concept has now become much more practical thanks to a new chip from Signetics called the 8X60 FIFO controller.

This 28 pin device contains all the arbitration and control logic and two 12 bit address pointer registers to handle a buffer RAM array of up to 4K characters, quite adequate for the majority of day to day printouts. If you used a couple of 2K by 8 static RAMs you could make the heart of a print buffer with just three chips, with additional devices probably required to handle interfacing to the micro and the printer. The exact form of any interface would depend upon whether serial or parallel drive is required. In the case of a serial in–serial out link two UARTs would be needed, but a Centronics parallel interface would be much simpler.

In addition to Read and Write strobe inputs and address outputs, the 8X60 also has outputs to say whether the buffer is full, half full, or empty.

FRANK W. HYDE

TIME FOR DATA PROCESSING

A major problem has been forcing its attention upon the groups who examine and analyse the data from satellites and probes. As usual the basic delay is funding. The amount of data has been so great that a very systematic priority clamp has had to be imposed upon some important sections of this work. It is of course readily understood that certain political requirements are involved and what might be considered by many of us as of humanitarian areas of priority are only of secondary consideration. With the present recession brought about indeed by the wrong priorities in many cases it could be deemed prudent to take an honest look at the terms of priorities. This requires a state of mental honesty extremely difficult to achieve when judged by action. A great many researchers all over the globe are seeking ways to improve the lot of mankind but work under conditions that demand for the continuance of their activities a constant campaign of begging donations from private resources for the funds to continue. So the inverse spiral of illogical thought publicly eulogises the endeavours of those engaged in these humanitarian works but denies them at the same time the means to forward them.

Now is the time to remember that the whole Earth and its environs is a system which is self generating or perhaps more correctly, regenerating and that every individual part is also the whole. Only now are some of the answers beginning to emerge. Much of the data could come from the environment of the atmosphere. Many false notions are still being bandied about such as that increasing carbon dioxide in the atmosphere will sooner or later make life impossible on Earth. Strange ideas about man's destruction of his environment AND EVEN HIMSELF is a tribute to vertical thinking and dealing in doom-mongering is an idiot course of action. Lateral thinking and a proper assessment with complete mental honesty in every phase of human activity is required to bring some impetus to those with vision and a certainty that the resources of the Earth are for the people of the Earth and should be brought into active use for their wellbeing. The mass of data requires funding and its ultimate benefit can be decided by the stroke of a pen in a political hand, which could deny the benefit of health to millions.

HIGH ALTITUDE EXPLORER SATELLITE

Explorer DE-1 has brought details of the aurora and the flow of solar energy and other matter from space. The interesting thing about the results provided by DE-1 and its companion DE-2 in a lower orbit which were equipped with instruments to provide data about the electric currents, fields and plasma between the magnetosphere, the ionosphere and the atmosphere is that it repeats history in the sense of 'it's been done before'. It is perhaps pertinent to point out that it is some fifty years since the basis of these phenomena were laid down and the archives contain records of papers on the subject of aurora.

In the latter part of the 1920's before the popularisation of the superheterodyne receiver multistage high frequency 'front ends' were used. Sometimes there were up to four stages. The coupling between stages was by HF transformers which looked like balls of string. Some of us searched in vain for the solution to what appeared to be instability. It appeared spasmodically and took the form of whistles sometimes rising in cadence and in other cases falling. Eventually there appeared headlines in the press to the effect that electrons shuttled backwards and forwards between the auroral points because they were trapped in the Earth's magnetic field. It was announced with some gusto that by timing some of these they followed lines of magnetic force more than 800m from the earth. These whistlers became the happy hunting ground for many postgraduates. Some of these 'whistlers' were given names like 'nose, lips, profile etc.' based on the shape which the graphs took as a result of the changing frequency. It would be interesting to know how many readers remember those days.

Now all this has been brought up to date as a result of DE-1 and DE-2 activity. The orbits of the satellites are:

DE-1 an eccentric orbit apogee 15,000 mi. perigee 354mi.

DE-2 apogee 628mi. perigee 192mi.

The arrangement of these two spacecraft allows the bracketing of the region of the leaking of low energy plasma into the magnetic field cusp from space where it is transformed into the high energy stream which initiates the aurora. It is well known now that the aurora is formed at a level which varies from 3,000 to 12,000 miles several times in 24 hours. At these levels the electrons trapped in the magnetic field are reflected back along the field lines and may continue this oscillating activity until their energy falls below a certain level.

The imaging system of DE-1 consists of three spin-scan photometers which permit daytime viewing of the aurora. The images are built up from line scans of the earth at the rate of one line per rotation of the spin stabilised satellite. This system uses 'super-reflecting' mirrors to avoid the light scatter which prevents the use of lenses for this work. Two cameras operate in the visual part of the spectrum and a third operates in the ultra-violet. This imaging system is being used for other tasks also which include ozone observations, a special search for marine bioluminescence from space and the observation from high polar altitudes of the Earth-glow which is now called the geo-corona.

As the DE-1 apogee moves towards the Earth's equatorial region it is hoped that the cameras will be able to observe the red-glow bands that circle the Earth to the north and south of the equator. The drifting of the apogee will later enable the south polar regions to be observed. DE-2 carries instrumentation for the observation of particle and wave field environments. The instruments are capable of providing details of electron velocity every 2km.

A report by S. D. Shawhan on the radio waves generated in the auroral regions revealed that the more powerful emissions are associated with auroral storms. The frequencies are of the order 100–200kHz though sometimes as high as 800kHz (this was the range of whistlers). They are directed away from Earth and have powers of the order of billions of watts and can be picked up more than 15,000 miles from the auroral zones. This is of the same order as the radiations from Jupiter. They are characterised by rising and falling tones, each burst lasting about a second and changing in frequency by 1kHz. Detailed measurements of these waves have been made by DE-1. Its plasma instrument which monitors frequencies from a few Hertz to 400MHz detects the most intense waves when the spacecraft crosses magnetic field lines that pass through the aurora. Waves were detected by both satellites in the audio range, that is below 20kHz. This suggests that these waves must be guided away from the power source by the Earth's magnetic field.

High winds and high temperatures have also been recorded by DE-2. Data reveals that there are winds in the auroral zone which are of the order of hundreds of miles per hour and at times over 1,000 miles an hour. Temperatures have reached the order of 1,500 to 2,000K.

It is not possible to resist commenting that the Earth is far from approachable by alien spacecraft.

UNMANNED LAUNCH VEHICLE

The Boeing Aerospace Company has been selected to conduct a one year study for the National Aeronautics and Space Administration of an unmanned launch vehicle.

The vehicle which is designated SRB-X is being considered as a means of augmenting the space shuttle when payload and space is not immediately available in the shuttle orbiter. It will be capable of boosting a 65,000lb payload into low earth orbit or 12,000lb into a geosynchronous orbit. The SRB-X would be built from tried components with minimum modifications to boosters and launch facilities.

There are also three other studies—a liquid rocket booster and a side mounted shuttle derived cargo vehicle, studied by Martin Marietta; and another shuttle derived cargo vehicle—in line version, under study by Boeing.

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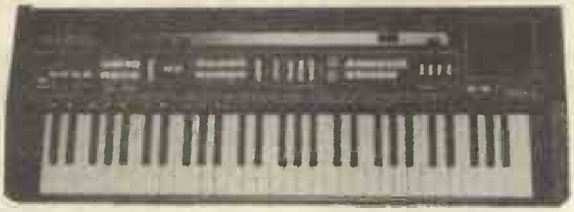

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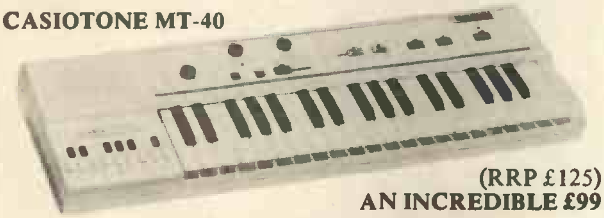

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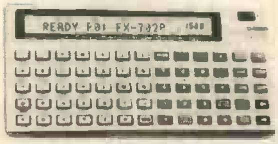

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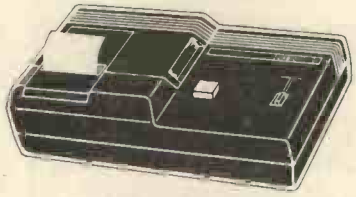

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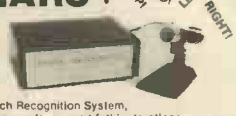

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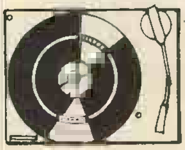

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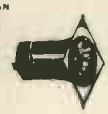

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1 end	145p	165p	240p	380p
2 ends	210p	230p	345p	540p

Cable with Sockets

	20 pin	26 pin	34 pin	40 pin
1 end	160p	210p	270p	300p
2 ends	290p	385p	490p	540p

EDGE CONNECTOR

	0.1"	0.156"
2×18 Way	—	150p
2×22 Way	310p	170p
2×23 Way	335p	—
2×25 Way	350p	200p
1×43 Way	260p	—
2×43 Way	450p	—
2×50 Way	—	400p
1×77 Way	700p	—

EURO CONNECTORS

DIN STD	PLUG	SKT
41617 31 Way	200p	200p
41612 2×32 Way	300p	350p
2×32 Way (angled)	350p	400p
41612 3×32 Way	370p	420p
3×32 Way (angled)		450p

(for 2×32 way please specify a+b or a+c)

BOOKS (NO VAT) (P&P £1.00 per book)

The Pascal Handbook	£10.05
CRT Controller Handbook	£5.95
Understanding Microprocessors	£3.50
Micros – Interfacing Techniques	£12.10
Introduction to Micro Computers	£10.95
6502 Assy. Lang. Prog.	£12.10
8080A/8085 Assy. Lang. Prog.	£11.60
TTL Cookbook	£7.15
CMOS Cookbook	£7.95
TI TTL Data Book	£7.50
Video Cookbook	£5.95
Z-80 Interfacing (1)	£7.95
Z-80 Interfacing (2)	£9.75
Prog. the Z80	£11.50
Prog. the 6502	£10.25
6502 Applications	£10.25

Please add £1.00 P&P per book

ADD SOUND – ★ ZX80/81 USER PORT ★

(As described in Oct/Nov PCW)

Port module plugs directly into ZX80/81 to provide 8 input and 8 output lines. These allow input of data from switches, photocells, sensors, joysticks etc and control of 8 relays. Also 7 segment displays and LED may be used – "VARIABLE TONE AUDIO OUTPUT CAN PRODUCE YOUR OWN SOUND EFFECTS." Port access is by simple PEEK & POKE COMMANDS. Kit £11.50.

READY BUILT AND TESTED UNIT £14.95 + 70p P&P

Reprint of PCW Oct/Nov. articles £1 + large SAE
For ZX81 users: Extender cord provided f.o.c. to enable to be plugged directly.

EXPERIMENT WITH COMPUTER VISION

★ ATOM ULTRASONIC VISION ★

Module connects to the ATOM printer port to give an ultrasonic radar picture of the surroundings, eg. room, furnishings, people. Experiment with computer measurement, image recognition, movement tracking, robot vision. Project to be described in PRACTICAL ELECTRONICS April/May 81.

★ UK101: INTERFACING SYSTEM ★

Two board interface system plugs directly into computer expansion socket to provide wide facilities accessible from BASIC or MACHINE CODE.

1) DECODING MODULE: Providing a dual 5v supply, 16 bit programmable i/o port, plus extensive address decoding for a wide variety of interfaces, including full decoding for a programmable sound generator, and also a 40 pin skt for further expansion.

2) ANALOGUE BOARD: Plugs into the decoding module to provide D/A converter, 8 channel multiplexed A/D converter with 20nS conversion time. AY3-8910 SOUND GENERATOR plus 6522 VIA provide complex timing & counting functions and additional 16 bit port.

DECODING MODULE KIT £27.50 ANALOGUE BOARD £39.95
P&P 0.75p/Kit

ACORN ATOM

A personal computer with full size QWERTY board and a built in UHF modulator to allow direct connection to domestic TV. A simple to build, simple to operate computer with all the features found in machines twice the price but with the advantage of expandability. Basic ATOM has 2K RAM and 8K ROM and on board expansion capability up to 12K + 12K.

Basic built £135, Built & Fully Expanded £185. P&P £3. 4K Floating Point ROM £20, 1K RAM (2 × 2114L) £2. NEW 3A 5v Regulated Power Supply £22 + £1.50 P&P.

ATOM CONNECTORS

	PLUG	SOCKET
2x32 Way	£3.00	£4.00
26 Way	£2.00	£2.00
10 Way	£1.20	£1.20

ATOM SOFTWARE

Games Pack 1-10	£10 each
Fr. Machine, Breakout, UFO Bomber, Disassembler	£3.50 each
Prog Tool Box ROM	£25.00

Suitable high quality printers available soon, watch for details. Send SAE for ATOM memory expansion system 13K RAM or 64K DRAM.

BOOKS: Getting Acquainted with ATOM £7.95; ATOM Business £7.00; ATOM Magic Book £5.95.

UV EPROM ERASERS

UV1B (upto 6 EPROMS)	£42.00
UV140 (upto 14 EPROMS)	£61.50
UV141 (as UV140 but with timer)	£78.00

ALL ERASERS with built in safety devices.

SOFTY

PROM PROGRAMMER & ROMULATOR
Software development tool
MKII (for 2516/2716/2532/2732). Built complete with psu £169.00 + £2 p&p

TECHNOMATIC TECHNOMATIC TECHNO

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TTLs

Type	Price
7400	11p
7401	11p
7402	12p
7403	12p
7404	12p
7405	18p
7406	25p
7407	25p
7408	14p
7409	15p
7410	14p
7411	20p
7412	20p
7413	22p
7414	32p
7416	25p
7417	25p
7420	16p
7421	20p
7422	22p
7423	22p
7425	27p
7426	30p
7427	25p
7428	28p
7430	15p
7432	25p
7433	27p
7437	27p
7438	27p
7440	17p
7441	70p
7442A	36p
7445	60p
7446A	93p
7447A	45p
7450	17p
7451	17p
7453	17p
7454	17p
7472	30p
7473	30p
7474	20p
7476	30p
7483A	45p
7485	60p
7486	22p
7489	210p
7490A	25p
7491	45p
7492A	30p
7493A	30p
7494	40p
7495A	50p
7496	45p
7497	120p
74100	85p
74107	22p
74109	30p
74116	60p
74118	75p
74119	90p
74120	70p
74121	27p
74122	45p
74123	40p
74125	40p
74126	40p
74128	40p
74132	30p
74136	32p
74141	65p
74142	200p
74145	50p
74147	100p
74148	75p
74150	60p
74151A	45p
74153	45p
74154	60p
74155	50p
74156	50p
74157	50p
74159	100p
74160	60p
74161	60p
74162	60p
74163	60p
74164	50p
74165	55p
74166	55p
74170	140p
74172	300p
74173	65p
74174	60p
74175	60p
74176	50p
74177	70p
74178	100p
74180	50p
74181	130p
74182A	90p
74184A	90p
74185	120p
74186	500p
74188	325p
74190	50p
74191	50p
74192	50p
74193	50p
74194	70p
74195	60p
74196	60p
74197	60p
74198	100p
74199	100p
74221	60p
74259	150p
74278	150p
74279	80p
74283	75p
74284	200p
74285	200p
74290	200p
74293	100p
74298	100p
74365	40p
74366	40p
74367	40p
74368	55p
74390	100p
74393	100p
74490	120p

74LS SERIES

Type	Price
74LS00	11p
74LS01	12p
74LS02	12p
74LS03	12p
74LS04	12p
74LS05	15p
74LS08	14p
74LS09	15p
74LS10	15p
74LS11	15p
74LS12	15p
74LS13	25p
74LS14	40p
74LS15	30p
74LS20	15p
74LS21	15p
74LS22	15p
74LS26	15p
74LS27	16p
74LS28	16p
74LS30	14p
74LS32	14p
74LS33	16p
74LS37	16p
74LS38	16p
74LS42	36p
74LS47	60p
74LS48	80p
74LS51	15p
74LS55	30p
74LS73	25p
74LS74	16p
74LS75	24p
74LS76	20p
74LS83	45p
74LS85	55p
74LS86	16p
74LS90	28p
74LS92	40p
74LS93	30p
74LS95	45p
74LS96	100p
74LS107	45p
74LS109	30p
74LS112	34p
74LS113	30p
74LS114	30p
74LS122	42p
74LS123	50p
74LS124	120p
74LS125	30p
74LS126	30p
74LS132	45p
74LS133	30p
74LS136	30p
74LS138	35p
74LS139	36p
74LS145	75p
74LS147	160p
74LS148	90p
74LS151	30p
74LS153	40p
74LS154	90p
74LS155	40p
74LS156	40p
74LS157	35p
74LS158	36p
74LS160	40p
74LS161	40p
74LS162	40p
74LS163	40p
74LS164	45p
74LS165	100p
74LS166	90p
74LS170	90p
74LS173	70p
74LS174	45p
74LS175	50p
74LS181	140p
74LS190	50p
74LS191	50p
74LS192	50p
74LS193	48p
74LS194	40p
74LS195	50p
74LS196	60p
74LS197	65p
74LS221	60p
74LS240	80p
74LS241	80p
74LS242	80p
74LS243	80p
74LS244	65p
74LS245	90p
74LS251	40p
74LS253	40p
74LS257	45p
74LS258	40p
74LS259	90p
74LS260	24p
74LS266	25p
74LS273	70p
74LS279	45p
74LS280	250p
74LS283	45p
74LS293	50p
74LS298	160p
74LS299	400p
74LS323	250p
74LS324	180p
74LS348	150p
74LS352	100p
74LS353	100p
74LS363	160p
74LS364	160p
74LS365	32p
74LS367	32p
74LS368	50p
74LS373	70p
74LS374	70p
74LS375	50p
74LS377	70p
74LS378	60p
74LS390	55p
74LS393	60p
74LS399	200p
74LS445	110p
74LS540	135p
74LS541	135p
74LS640	200p
74LS641	200p
74LS642	200p
74LS643	200p
74LS644	250p
74LS645	250p
74LS668	200p
74LS669	200p
74LS670	170p

74S SERIES

Type	Price
74S00	60p
74S02	60p
74S04	60p
74S05	75p
74S08	75p
74S10	60p
74S11	60p
74S20	60p
74S30	60p
74S32	90p
74S37	60p
74S74	90p
74S85	300p
74S86	180p
74S112	90p
74S113	90p
74S114	90p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S163	300p
74S174	250p
74S175	320p
74S188	350p
74S189	350p
74S194	350p
74S200	450p
74S201	400p
74S225	550p
74S241	400p
74S260	70p
74S261	300p
74S262	£10
74S287	350p
74S288	350p
74S373	400p
74S374	400p
74S471	650p
74S474	400p
74S571	900p
74S573	900p

74C SERIES

Type	Price
74C00	28p
74C04	20p
74C08	28p
74C10	28p
74C14	90p
74C20	28p
74C42	95p
74C48	143p
74C73	57p
74C74	59p
74C76	57p
74C85	134p
74C90	99p
74C95	106p
74C107	127p
74C151	255p
74C157	229p
74C160	140p
74C161	115p
74C162	115p
74C163	115p
74C164	108p
74C173	93p
74C174	93p
74C175	99p
74C192	115p
74C193	115p
74C194	120p
74C195	106p
74C221	120p
74C902	70p
74C912	800p
74C922	450p
74C923	500p
74C925	600p
74C928	600p

74ALS SERIES

Type	Price
74ALS00	60p
74ALS02	60p
74ALS04	75p
74ALS08	60p
74ALS10	75p
74ALS20	75p
74ALS32	75p
74ALS74	90p
74ALS138	150p
74ALS139	150p
74ALS157	150p
74ALS175	250p
74ALS244	375p
74ALS373	450p
74ALS374	450p

93 SERIES

Type	Price
9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	360p
9368	250p
9370	300p
9374	200p

4000 CMOS

Type	Price
4000	12p
4001	14p
4002	15p
4006	65p
4007	16p
4008	60p
4009	30p
4010	30p
4011	14p
4012	16p
4013	35p
4014	60p
4015	60p
4016	30p
4017	45p
4018	60p
4019	32p
4020	60p
4021	65p
4022	60p
4023	18p
4024	36p
4025	20p
4026	130p
4027	30p
4028	60p
4029	75p
4030	40p
4031	170p
4032	125p
4033	180p
4034	160p
4035	80p
4036	295p
4038	120p
4040	55p
4041	70p
4042	55p
4043	60p
4044	70p
4045	120p
4046	70p
4047	75p
4048	55p
4049	27p
4050	27p
4051	60p
4052	80p
4053	60p
4054	130p
4055	125p
4056	120p
4059	500p
4060	90p
4063	100p
4066	35p
4067	400p
4068	18p
4069	16p
4070	16p
4071	16p
4072	16p
4073	16p
4075	16p
4076	60p
4077	26p
4078	20p
4081	16p
4082	16p
4086	72p
4089	150p
4093	40p
4094	150p
4095	95p
4096	95p
4097	340p
4098	90p
4099	115p
40102	150p
40103	180p
40105	120p
40106	45p
40109	100p
4501	28p
4502	70p
4503	50p
4504	75p
4506	35p
4507	40p
4508	200p
4510	65p
4511	50p
4512	65p
4514	150p
4515	150p
4516	75p
4518	45p
4520	70p
4521	150p
4526	75p
4527	90p
4528	75p
4532	90p
4534	500p
4536	300p
4538	120p
4539	110p
4543	100p
4553	290p
4555	45p
4556	45p
4560	180p
4566	180p
4568	300p
4569	180p
4572	30p
4583	90p
4584	45p
4585	100p
40014	90p
40085	90p
40097	90p
40163	100p
40174	90p
40175	100p
40193	115p
14495	400p
14599	290p

LINEAR I.Cs

Type	Price
AN103	200p
AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-8910	700p
AY3-8912	650p
AY5-1224A	240p
AY5-1315	600p
AY5-4007D	520p
CA3028A	120p
CA3019	80p
CA3046	70p
CA3048	225p
CA3059	300p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	190p
CA3162E	450p
CA3189E	300p
CA3240E	120p
CA3280G	200p
DAC1408-8	200p
HA1366	300p
HA1388	270p
ICL7106	850p
ICL8038	300p
LC7120	350p
LC7130	350p
LF347	160p
LF351	48p
LF353	100p
LF356P	95p
LF357	120p
LM10C	425p
LM301A	27p
LM310	300p
LM311	75p
LM318	150p
LM319	225p
LM324	45p
LM335Z	140p
LM339	65p
LM348	75p
LM358P	75p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM386	95p
LM387	120p
LM389	95p
LM393	100p
LM394	350p
LM709	36p
LM710	50p
LM711	100p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM1871	375p
LM1872	375p
LM1886	700p
LM1889	350p
LM2917	200p
LM3302	140p
LM3900	55p
LM3909	95p
LM3911	130p
LM3914	210p
LM3915	225p
LM3916	225p
LM13600	125p
M51513L	300p
M51516L	500p
MB3712	250p
MC1310P	150p
MC1458	40p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3401	90p
MC3403	120p
OK50398	750p
ML920	800p
MM57160	620p
NE531	150p
NE555	20p
NE556	50p
NE564	420p
NE565	130p
NE566	155p
NE567	140p
NE570	425p
NE571	425p
NE5534A	250p
PLL02A	500p
RC4136	70p
RC4151	200p
RC4558	60p
S566B	260p
SAD1024A	1250p
SFF96364	800p
SL490	350p
SN76477	175p
SP8515	750p
TA7120	200p
TA7204	250p
TA7205	200p
TB7120	200p
TA7204	250p
TA7222	200p
TA7310	200p
TBA621AX1	275p
TBA641BX1	300p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA920	200p
TBA950	300p
TC9109	£10
TCA210	350p
TCA220	350p
TCA940	200p
TDA1004A	300p
TDA1008	320p
TDA1010	225p
TDA1022	550p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2020	320p
TL071/81	45p
TL072/82	75p
TL074	130p
TL084	110p
TL094	200p
TL170	50p
TL430C	70p
UAA170	170p
UA2240	300p
ULN2003	100p
ULN2004	100p
UPC575	400p
UPC592H	200p
UPC1156H	300p
XR2206	300p
ZNA234	£14
ZN414	90p
ZN419C	225p
ZN423E	150p
ZN424E	135p
ZN425E	350p
ZN427E	625p
ZN1034E	200p
ZN1040E	700p

VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		-ve	
5V 1A	7805	*50p	7905	55p
12V 1A	7812	*50p	7912	55p
15V 1A	7815	*55p	7915	60p
18V 1A	7818	*55p	7918	60p
24V 1A	7824	*55p	7924	60p
5V 100mA	78L05	30p	79L05	65p
12V 100mA	78L12	30p	79L12	70p
15V 100mA	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K 1A 5V	135p	78HGKC	600p
LM317K	325p	78HOSKC	550p
LM317T 1A Adj	200p	78MGT2C	140p
LM337T	225p	78GUIC	200p
LM323K 3A 5V	500p	79GUIC	225p
LM723 150mA Adj	37p	79HGKC	700p
TL494	400p	TL497	300p
78S40	300p	LM305H	250p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL113	90p
ILQ74	240p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	13p
TIL209 Red	11p	TIL222 Gr	15p
TIL211 Gr	13p	TIL228 Yel	22p
TIL212 Ye	18p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p	NSB5881	670p
		TIL311	600p
		TIL312/3	110p
		TIL321/2	130p
		TIL330	140p
		7750/60	200p

DISPLAYS

Type	Price
3015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	90p
FND507	90p
MAN3640	175p
MAN4640	200p

DRIVERS

Type	Price
9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

COMPUTER COMPONENTS

CPUs

Type	Price
1802CE	750p
2650A	£12
6502	450p
6502A	650p
6800	370p
6802	425p
6809	£10
6809E	£15
8035	750p
8039	850p
8080A	350p
8085A	550p
INS8060	£11
TMS9980	£20
Z80	370p
Z80A	450p
Z80B	£16
8088	£19

SUPPORT DEVICES

Type	Price
3242	800p
3245	450p
6522	500p
6532	775p
6551	650p
6821	160p
6845	£10
6847	£10
6850	180p
6852	370p
6875	600p
8154	950p
8155	800p
8205	320p
8212	180p
8216	180p
8224	220p
8226	250p
8228	250p
8243	450p
8250	850p
8251	350p
8253	800p
8255	350p
8257	800p
8259	800p
8279	950
TMS9927	£18
Z80PIO	300p
Z80APIO	350p
Z80CTC	300p
Z80ACTC	350p
Z80ADART	800p
Z80ADMA	£12
Z80S10-1	£14

CRT CONTROLLER

Type	Price
CRT5037	£18
SFF96364	£8
MC6845	£10
MC6847	£10

MEMORIES

Type	Price
2101A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	160p
2114-4L	130p
2147	450p
4027-3	300p
4116-20	200p
4118-3	500p
4118-4	450p
4164-2	650p
5101	300p
6116P-3	900p
6514-45	300p
6810	200p
7489	210p
74S189	325p
74S201	350p
74S289	325p
93415	600p
93425	600p

ROMs/PROMs

Type	Price
74S188	325p
74S287	300p
74S288	225p
74S387	325p
74S471	650p
74S473	850p
74S474	650p
74S570	650p
74S571	650p
74S573	950p

EPROMs

Type	Price
1702A	500p
2708	300p
2716 (+5V)	300p
2564	£25
2516 (+5V)	300p
2532	550p
2732	550p
2716-300n	500p
2732-300n	750p

UARTs

Type	Price
AY-3-1015P	300p
AY-5-1013P	350p
IM6402	450p
TR1602	300p
COM8017	300p

CHARACTER GENERATORS

Type	Price
RO-3-2513UC	750p
RO-3-2513LC	700p
SN74S262AN	£10

MODULATORS

Type	Price
6MHz UHF	375p
8MHz UHF	450p

INTERFACE ICs

Type	Price
AD558CJ	775p
AD561J	£14
AM25S10	350p
AM26LS31	160p
AM26LS32	190p
COM8116	800p
DAC80-V	£20
DM8131	375p
DP8304	450p
DS8832	250p
DS8833	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC4024	325p
MC4044	325p
MC14411	£7
MC14412	£9
MM58174	£12
ULN2003A	100p
ULN2004A	100p
75107	160p
75110	160p
75112	160p
75114	160p
75115	160p
75150P	140p
75154	140p
75182	230p
75324	250p
75361	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	70p
8T26	120p
8T28	120p
8T95	120p
8T97	120p
81LS95	90p
81LS96	90p
81LS97	90p
81LS98	90p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p

DISC CONTROL

Type	Price
FD1771	£20
FD1791	£30
FD1793	£32
FD1795	£35
FD1797	£37
WD1691	£15
WD2143	550p

CRYSTALS

Frequency	Price
32.768KHz	100p
100KHz	300p
200KHz	370p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	250p
2.00MHz	250p
2.45760MHz	250p
2.5MHz	250p
3.276MHz	150p
3.5795MHz	100p
3.686MHz	300p
4.00MHz	150p
4.194MHz	250p
4.43MHz	125p
5.0MHz	175p
6.0MHz	150p
6.144MHz	150p
7.0MHz	150p
7.168MHz	200p
8.00MHz	175p
8.86MHz	175p
10.00MHz	175p
10.7MHz	250p
12.0MHz	250p
13.0MHz	350p
14.3168M	150p
16.00MHz	250p
18.00MHz	250p
18.432	200p
19.968MHz	390p
20.00MHz	175p
24.0MHz	350p
26.690MHz	300p
27.145MHz	250p
38.6667MHz	350p
48.0MHz	300p
55.5MHz	400p
115MHz	350p

KEYBOARD ENCODER

Type	Price
AY-6-2376	600p
74C922	500p

DIL SWITCHES

Type	Price
4 Way	90p
6 Way	105p
8 Way	120p
10 Way	150p

ZIF SOCKETS

Type	Price
24 Pin	600p
40 Pin	£11

TELETEXT

Type	Price
SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£6

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

LOW PROFILE DIL SOCKETS BY TEXAS

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

TRANSISTORS

Type	Price
AD161/2	45p
BC107/8	13p
BC109C	14p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	25p
BC477/8	30p
BC516/7	40p
BC547B	14p
BC548C	12p
BC557B	16p
BC559C	16p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD241	60p
BD242	60p
BF244B	35p
BF256B	50p
BF257/8	32p
BF259	36p
BF337	30p
BFR39	25p
BFR40/1	25p
BFR79	25p
BFR80/1	25p
BFX29	40p
BFX30	27p
BFX84/5	40p
BFX86/7	27p
BFX88	27p
BFX89	150p
BFY50	24p
BFY51/2	24p
BFY56	33p
BFY90	80p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
J310	50p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	50p
MJE2955	100p
MJE3055	70p
MPF102	40p
MPF103/4	30p
MPF105	30p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	40p
TIP32C	45p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	180p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP120	75p
TIP122	90p
TIP142	130p
TIP147	130p
TIP2955	78p
TIP4055	70p
VN10KM	100p
VN66	80p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	18p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	25p
2N2222A	25p
2N2369A	25p
2N2484	25p
2N2646	45p
2N2904/5	25p
2N2906A	25p
2N2907A	25p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	40p
2N3823	50p
2N3866	90p
2N3902	700p
2N3903/4	16p
2N3905/6	16p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5194	90p
2N5245	40p
2N5296	65p
2N5401	50p
2N5457/8	32p
2N5459	32p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1172	150p
2SC1306	150p
2SC1307	150p
2SC1957	90p
2SC1969	200p
2SC2028	120p
2SC2029	250p
2SC2078	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES

Type	Price
BY127	12p
OA47	8p
OA90/91	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

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

ZENERS

Type	Price
2.7V-33V 400mW	9p
1W	15p

TRIACS PLASTIC

Type	Price
3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

Type	Price
1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
C106D	45p
MCR101	36p
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2N3525	130p
2N4444	180p
2N5060	30p
2N5064	35p

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