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SOLDERING INSTRUMENT

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NICAD CHARGER

PRACTICAL
ELECTRONICS

VOLUME 20 No. 12 DECEMBER 1984

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GENERAL FEATURES

NEWS AND COMMENT

BUYER'S GUIDE

OUR JANUARY 1985 ISSUE WILL BE ON SALE FRIDAY, DECEMBER 7th, 1984
(for details of contents see page 50)

WATFORD ELECTRONICS

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POLYESTER RADIAL LEAD CAPACITORS: 250V; 10n, 20n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **8p**; 150n, 220n **10p**; 330n, 470n **15p**; 680n **19p**; 1µ **23p**; 1µ5 **40p**; 2µ2 **46p**.

ELECTROLYTIC CAPACITORS (Values in µF). **500V**: 10µF **52p**; 47 **78p**; **63V**: 0·47, 1·0, 1·5, 2·2, 3·3, **8p**; 4·7 **9p**; 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **16p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V**: 68 **20p**; 100 **17p**; 220 **24p**; **40V**: 68 **15p**; 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **45p**; 2200 **90p**; **25V**: 4·7, 10, 22, 47 **8p**; 100 **11p**; 150 **12p**; 220 **15p**; 330 **22p**; 470 **25p**; 680, 1000 **34p**; 1500 **42p**; 2200 **50p**; 3300 **76p**; 4700 **92p**; **16V**: 2·5, 40 **8p**; 47, 68, 100 **9p**; 125 **12p**; 220 **13p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

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

TANTALUM BEAD CAPACITORS: **35V**: 0·1µ, 0·22, 0·33 **15p**; 0·47, 0·68, 1·0, 1·5 **16p**; 2·2, 3·3 **18p**; 4·7, 6·8 **22p**; 10 **28p**; **16V**: 2·2, 3·3, **16p**; 4·7, 6·8, 10 **18p**; 15 **36p**; 22 **36p**; 33, 47 **50p**; 100 **95p**; 220 **100p**; **10V**: 15, 22 **26p**; 33, 47 **50p**; 100 **75p**.

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**. 220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF **21p**. 1000, 1200, 1800 **30p each**; 3300, 4700 **60p each**.

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

CERAMIC Capacitors: 50V Range 1pF to 6800pF **4p**; 10nF, 15n, 33n, 47nF **5p**; 100nF/30V **7p**.

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

POTENTIOMETERS: Carbon Track, 0·25W Log & Linear Values.
500Ω, 1K & 2K (LIN ONLY) Single **35p**
5KΩ-2MΩ single gang **35p**
5KΩ-2MΩ single gang D/P switch **95p**
5KΩ-2MΩ dual gang stereo **99p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track
5KΩ-500KΩ Single gang **80p**

PRESET POTENTIOMETERS
0·1W 50Ω-2·2M Mini Vert. & Horiz. **8p**
0·25W 220Ω-4M7 Vert. & Horiz. **12p**

RESISTORS Hi-stab, Miniature, 5% Carbon.

	RANGE	Val.	1-99	100+
0·25W	2Ω2 - 4M7	E24	3p	1p
0·5W	2Ω2 - 4·M7	E12	3p	1p
1W	2Ω2 - 10M	E12	6p	4p
1% Metal Film 51Ω-1M		E24	8p	6p

RESISTORS S.I.L. Package: 7 Commoned, 100Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K **24p**.
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K, 100K **26p**.

TRANSISTORS

AC127/8	35	BC308B	16	BFR98	105	TIP30C	37	2N914/5	32	2N5458/9	30
AC141/2	35	BC327/8	15	BFX29/84	35	TIP31A	38	2N918	40	2N5485	36
AC176	35	BC337/8	15	BFX84	35	TIP31C	45	2N930	20	2N5777	45
AC187/8	35	BC441	34	BFX85/86	35	TIP32A	43	2N1131/2	40	2N6027	32
AC188	35	BC461	34	BFX87/88	28	TIP32C	45	2N1303/4/5		2N6109	60
AD142	120	BC477/8	40	BFY50/51	30	TIP33A	70	2N1307	70	2N6290	70
AD149	79	BC516/7	40	BFY52	30	TIP33C	75	2N1613	30	2SA636	250
AD161/2	42	BC547/8	12	BFY53	35	TIP34A	85	2N1671B	160	2SA671	250
AF118	95	BC549C	15	BFY55	35	TIP34C	105	2N2160	325	2SA715	75
AF139	40	BC556/7	15	BFY56	35	TIP35A	120	2N2219A/20A/		2SC495/6	85
AF239	55	BC558/9	15	BFY64	40	TIP35C	130	21A/22A	25	2SC1061	250
BC107/8	12	BCY41/42	30	BFY90	80	TIP36A	130	2N2369A	18	2SC1096	85
BC107B	14	BCY70	18	BRY39	50	TIP36C	140	2N2646	45	2SC1162	45
BC108B	14	BCY71/2	20	BSX20	30	TIP41A	50	2N2846	80	2SC1172/3	125
BC108C	12	BCY72	25	BSX29	45	TIP41B	52	2N2904A/05A/		2SC1306	100
BC109	12	BCY78	30	BSY26	35	TIP42A	55	06A/07A	26	2SC1307	150
BC109B	14	BD131/2	65	BSY95	35	TIP42B	58	2N2926G	10	2SC1449	95
BC109C	14	BD133	60	BU105	180	TIP120	70	2N3053	25	2SC1679	190
BC114/5	30	BD135	45	BU205	190	TIP121	73	2N3054	55	2SC1678	140
BC117/8	25	BD136/7	40	BU206	200	TIP141	120	2N3055	50	2SC1923	65
BC140	38	BD138/9	40	BU208	200	TIP142	120	2N3442	140	2SC1945	225
BC142/3	38	BD140	40	MJ2955	90	TIP147	120	2N3615	199	2SC1953	90
BC147/8	12	BD158	68	MJE340	54	TIP2955	70	2N3663	20	2SC1957	90
BC147B	15	BD245	65	MJE371	100	TIP3055	70	2N3702/3	10	2SC1969	165
BC148C	10	BD434	70	MJE2955	99	TIS43	50	2N3704/5	10	2SC2028	85
BC149	12	BD695A	150	MJE3055	70	TIS44	45	2N3706/7	10	2SC2029	200
BC149C	15	BD696A	150	MPF102	40	TIS88A	50	2N3708/9	10	2SC2078	170
BC153/4	30	BF115	45	MPF103/4	30	TIS90	30	2N3710	10	2SC2091	85
BC157/8	14	BF154/8	30	MPF105	30	TIS91/93	32	2N3771	179	2SC2166	165
BC159	11	BF167	35	MPSA05	30	VK1010	99	2N3772	195	2SC2314	85
BC167A	14	BF173	35	MPSA06	25	VN10KM	70	2N3773	210	2SC2335	200
BC168C	12	BF177	35	MPSA08	30	VN46AF	95	2N3819	35	2SC2465	125
BC169C	12	BF178	35	MPSA12	32	VN66AF	110	2N3820	60	2SC2547	40
BC171/2	12	BF179	40	MPSA55	30	VN88AF	120	2N3822/3	60	2SC2612	200
BC173	15	BF194/5	12	MPSA56	30	VN89AF	120	2N3866	90	2SD234	75
BC177/8	16	BF198/9	18	MPSA70	40	ZTX107/8	12	2N3903/4	15	2SK45	90
BC179/81	20	BF200	30	MPSU02	58	ZTX109	12	2N3906/5	15	2SK288	225
BC181	30	BF224	40	MPSU05	60	ZTX212	28	2N4037	60	2SJ83	225
BC182/3	10	BF244A	28	MPSU06	60	ZTX300	13	2N4058	15	2SJ85	225
BC184	10	BF244B	29	MPSU52	65	ZTX301/2	16	2N4061/2	15	3N128	115
BC182L	10	BF245	50	MPSU55	60	ZTX303	25	2N4264	30	3N140	115
BC183L	10	BF256B	50	MPSU56	60	ZTX304	17	2N4286	25	40251	150
BC184L	12	BF257/8	32	OC23	170	ZTX320/26	30	2N4289	25	40311	60
BC186/7	28	BF259	40	OC28/36	220	ZTX500/1	14	2N4400	25	40313	130
BC212/3	12	BF394	40	OC41/42	75	ZTX502/3	18	2N4427	80	40361/62	70
BC212L	10	BF451	40	OC70	40	ZTX504	25	2N4859	78	40408	76
BC213L	12	BF494/5	40	OC72	50	ZTX531	25	2N5135	30	40412	90
BC214	10	BF594/5	30	OC75/76	55	ZTX550	25	2N5138	25	40467	130
BC214L	12	BFR39/40	25	OC76	50	2N696	30	2N5172	25	40468	85
BC237/8	15	BFR41/79	25	OC81/82	50	2N697	23	2N5180	45	40594	105
BC307B	15	BFR80/81	25	OC83/84	70	2N698	40	2N5191	75	40595	110
				TIP29A	32	2N699	48	2N5194	80	40603	110
				TIP29C	38	2N706A	25	2N5305	24	40673	70
				TIP30A	35	2N708	25	2N5457	30	40871/2	90

LINEAR IC's

555 CMOS	105	LM324	55	SAB3271	485	ZN426E-8	200
702	75	LM334Z	115	SAB4209	595	ZN427E-8	620
709C 8 pin	35	LM335	135	SG3402	295	ZN428E	450
710	48	LM337	275	SL490	350	ZN429E-8	245
741	16	LM339	50	SL924	00	ZN459	615
747C 14 pin	70	LM348	60	SL6270	150	ZN1034E	200
748C 8 pin	30	LM349	125	SN76013N	350	ZN1040E	695
753 8 pin	185	LM358	60	SN76033	350	ZNA234E	925
810	159	LM377	240	SN76488	525		
9400CJ	375	LM379	495	SP0256AL	625		
ADC0808	885	LM380	120	TA7120	140		
AY-1-1320	225	LM381N	175	TA7130	125		
AY-1-5050	99	LM382	200	TA7204	150		
AY-1-5051	160	LM384	225	TA7205	90		
AY-1-6720	210	LM386	90	TA7222	150		
AY-3-1270	730	LM387	160	TA7310	00		
AY-3-8910	390	LM389	145	TAA900	395		
AY-3-8912	500	LM393	85	TAA621	295		
AY-5-1317A	630	LM394CH	385	TAA661	190		
CA3011	130	LM558	170	TAA700	275		
CA3012	175	LM725CN	300	TAD100	159		
CA3014	275	LM733	70	TBA120S	70		
CA3018	86	LM1871	300	TBA540	275		
CA3019	90	LM1889	350	TBA550Q	330		
CA3020	210	LM2907	395	TBA641	290		
CA3023	210	LM3900	70	TBA651	190		
CA3028A	130	LM3909	85	TBA800	80		
CA3035	255	LM3911	185	TBA810S	95		
CA3036	270	LM3914	445	TBA820	80		
CA3043	275	LM3915	350	TBA920Q	200		
CA3045	365	LM3916	350	TBA990	350		
CA3046	70	LM13600	150	TCA270	350		
CA3048	220	LS7220	280	TCA280A	220		
CA3059	325	M51513L	230	TCA940	175		
CA3075	213	M51515L	320	TCA950	00		
CA3080E	75	M51516L	475	TCA965	180		
CA3081	190	MB3712	200	TDA1008	310		
CA3085	160	MB3756	440	TDA1010	235		
CA3086	60	MC1204	250	TDA1022	499		
CA3089E	200	MC1301	90	TDA1024	115		
CA3090AQ	375	MC1303	98	TDA1034	350		
CA3123	165	MC1304P	260	TDA1054	00		
CA3130	90	MC1310P	150	TDA1490	350		
CA3140	50	MC1445	250	TDA2002	325		
CA3160	95	MC1455	50	TDA2003	250		
CA3161E	199	MC1458	35	TDA2004	300		
CA3162	525	MC1469	300	TDA2006	330		
CA3189	275	MC1494	694	TDA2020	320		
CA3240	110	MC1495	350	TDA2030	190		
HA1366	175	MC1496L	70	TDB0791	420		
HA1388	235	MC1596	225	TL061CP	40		
ICL7106	690	MC1648	290	TL062CP	65		
ICL7107	975	MC3302	75	TL064CN	98		
ICL7611	99	MC3401	50	TL071CP	40		
ICL7660	248	MC3403	95	TL072CP	78		
ICL8038CC	360	MC3404	85	TL074CN	150		
ICL8211	350	MC3405	150	TL081CP	35		
ICM7205	1150	MC3442	00	TL082CP	60		
ICM7207	475	MC3423P	80	TL083CP	75		
ICM7215	1050	MC3487	00	TL084CP	120		
ICM7216A	£22	MC4016	00	TL091CP	60		
ICM7217A	750	MF10	350	TL170	50		
ICM7224	785	MFC6040	75	TL430C	90		
ICM7240	300	ML924	275	TL507	110		
ICM7555	105	NE515	275	TL509	110		
ICM7556	150	NE529	225	UA2240	120		
LA3350	250	NE531	140	UA78540	230		
LA4031P	340	NE543	225	UAA170	180		
LA4032	295	NE544	200	UAA180	180		
LA4400	350	NE555	25	ULN2003	90		
LA4422	320	NE556DB	65	ULN2004	90		
LC7120	300	NE558	170	ULN2283	100		
LC7130	320	NE560	350	ULN2803	190		
LC7137	350	NE562B	410	UPC556	00		
LF347	150	NE564	420	UPC575	275		
LF351	70	NE565A	120	UPC1025H	375		
LF353	90	NE566	155	UPC1156H	295		
LF355	95	NE567	140	UPC1181	00		
LF356	99	NE570	410	UPC1182	425		
LF357	110	NE571	400	UPC1366	195		
LF398	495	NE5532	175	XR2206	375		
LM10	325	NE5534	160	XR2207	400		
LM301A	35	OM335	750	XR2211	575		
LM307	45	RC4136D	60	XR2216	675		
LM308	95	RC4558	60	XR2266	360		
LM311	65	S566B	225	ZN414	80		
LM318	150	SAB3209	425	ZN419CE	180		
LM319	195	SAB3210	325	ZN423E	130		
				ZN424E	130		
				ZN425E-8	345		

COMPUTER IC's

2102L	160	8214	495	TMS9927	£14
2114	325	8216	200	TMS9928	£20
2147-3	425	8224	350	TMS9929	£16
2516	350	8226	360	TMS9980	£20
2532-4	400	8228	270	TMS9995	£12
25L32	450	8243	550	ULN2003	75
2564	700	8250	£11	UPD7002	725
27L08	450	8253	750	UPD7007	725
2716-5V	350	8255	950	WD1691	£14
2732	450	8256A	£15	WD1770	£19.95
2764-250	475	8257A	700	WD2143	850
27C64	1095	8259	£7	Z80CPU 2·5	300
26501	75	8271	POA	Z80ACPU4M	375
27128/250n	£16	8272	£25	Z80ACTC	335
256K DRAM	£49	8279	750	Z80B	£11
3242	675	8282	450	Z80DART	495
4027	95	8283	450	Z80ADART	820
4164-150	425	8284	550	Z80ADMA	925
4416-2	475	8288	£11	Z80DMA	795
4532-3	250	8748	£55	Z80P10	325
4816-100ns	250	8T26A	99	Z80AP10	350
4864-15	425	8T27	150	Z80S10-1	850
5514	250	8T31	350	Z80AS10	900
6116-150	400	8T95N	90	Z80AS10-2	£9
6116L-120ns	425	8T97N	90	Z8002CPU	00
6117-100n	575	9364AP	550		
6167-6	795	9602	220		
6264L-15	£26	AM26LS31C	125		
6402	350	AM26LS32A	125		
6502 CPU	355	AM26LS33	150		
6502A	545	AM7910	£30		
6503	650	AY-3-1015	300		
6504	600	AY-5-1013	300		
6505	650	AY-5-1350	388		
6520	175	AY-5-3600	750		
6522 VIA	340	CD4724	150		
6530 RRIOT	£11	COM8017	275		
6532 RIOT	650	COM8116	700		
6545 CRTC	899	DM8131	275		
6551 ACIA	650	DP8303	450		
6592	00	DP8304BN	350		
6800	220	DS3647	00		
6802	275	DS3691N	595		
6803	850	DS8820	110		
6805	670	DS8830	198		
6808	520	DS8831	125		
6809	650	DS8832	250		
6810	175	DS88LS120	495		
68B21	220	E9364	800		
6821	175	E9365	£36		
6840	375	FD1691	£15		
6843	800	FD1771	£15		
6845	650	FD1791	£22		
6845SP	750	FD1793	£23		
6846	625	FD1795	£28		
6847	650	FD1797	£28		
6850	175	HD26501	75		
6852	250	HM6845	755		
6854	750	IM6402	350		
68B54	600	INS8060N	1250		
6875	500	MC1488	100		
68000	£50	MC1489	100		
8035	525	MC14411	675		
8080A	425	MC14412	725		
8085A	950	MC3242	590		
8088	£15	MC3446	250		
81LS95/96	140	MC3447P	315		
81LS97/98	140	MC3486	175		
8123	160	MC3487	175		
8131	475	MK3886-2M	£7		
8154	750	MM5280D	695		
8155	750	MM5303	635		
8156	650	MM5307	1275		
8202	£25	MM5387A	475		
8212	495	MM58174	875		
		RO-3-2513L	700		
		RO-3-2513U	650		
		SAA5050	875		
		SFF96364E	800		
		SP0256AL2	495		
		TCM3101J	£13		
		TMS2716-3	725		
		TMS4047	100		
		TMS4164-15	395		
		TMS4416-2	595		
		TMS4500	£12		
		TMS4532-3	350		
		TMS5100	600		
		TMS6011	500		
		TMS9914	895		

74S

74S00	70	74S260	70
74S02	60	74S262	£12
74S03	60	74S274	00
74S04	60	74S275	00
74S05	60	74S280	00
74S08	60	74S281	00
74S09	60	74S283	00
74S10	40	74S287	200
74S11	50	74S288	180
74S15	60	74S289	200
74S20	40	74S299	540
74S30	60	74S301	350
74S22	50	74S365	250
74S30	40	74S373	400
74S32	70	74S374	490
74S37	70	74S412	380
74S38	90	74S470	325
74S40	45	74S471	620
74S51	45	74S472	1150
74S64	45	74S473	00
74S65	45	74S474	400
74S74	85	74S475	800
74S85	295	74S571	620
74S86	115	74S573	950
74S112	90		
74S113	90		
74S114	80		
74S124	300		
74S132	110		
74S133	60		
74S134	80		
74S135	110		
74S138	195		
74S139	195		
74S140	60		
74S151	180		
74S153	182		
74S157	250		
74S158	195		
74S162	00		
74S163	300		
74S168	00		
74S169	00		
74S174	250		
74S175	320		
74S181	00		
74S182	00		
74S188	200		
74S189	320		
74S194	320		
74S195	275		
74S196	00		
74S197	400		
74S201	350		
74S225	525		
74S226	00		
74S240	430		
74S241	430		
74S244	520		
74S251	270		
745257	250		
745258	250		

75

75107/8/9	95
75110	90
75121	00
75150	125
75154	195
75158	150
75159	140
75160	420
75162	650
75182/3	99
75188/9	100
75322	140
75353	00
75361	00
75365	00
75376	00
75450	86
75451/2	52
75454	70
75491/2	65

TTL 74

7400	30	7453	40	74196	140
7401	30	7454	40	74197	120
7402	30	7460	60	74198	245
7403	30	7470	60	74199	250
7404	65	7472	50	74221	120
7405	40	7473	50	74246	130
7406	70	7474	55	74247	135
7407	70	7475	70	74248	175
7408	30	7476	48	74249	175
7409	30	7480	70	74251	100
7410	40	7481	200	74259	100
7411	30	7482	100	74265	80
7412	30	7483	120	74273	210
7413	50	7484	140	74276	150
7414	70	7485	120	74278	180
7416	50	7486	50	74279	100
7417	50	7489	225	74283	120
7420	30	7490	75	74284	350
7421	30	7491	70	74285	350
7422	40	7492	75	74290	120
7423	40	7493	75	74293	100
7425	40	7494	120	74297	175
7426	60	7495	70	74298	200
7427	40	7496	90	74351	210
7428	55	7497	230	74365	90
7430	45	74100	200	74366	90
7432	50	74104	70	74367	90
7433	40	74105	70	74368	90
7437	40	74107	50	74376	175
7438	95	74109	75	74390	120
7440	45	74110	80	74393	145
7441	150	74111	80	74490	150
7442	80	74112	170		
7443	110	74116	175		
7444	110	74118	110		
7445	110	74119	180		
7446	110	74120	100		
7447	115	74121	65		
7448	110	74122	70		
7450	40	74123	90		
7451	40	74125	65		
		74126	60		
		74128	60		
		74132	80		
		74136	75		
		74141	100		
		74142	260		
		74143	280		
		74144	280		
		74145	125		
		74147	180		
		74148	145		
		74150	190		
		74151	90		
		74153	90		
		74154	190		
		74155	90		
		74156	95		
		74157	90		
		74159	195		
		74160	120		
		74161	120		
		74162	120		
		74163	120		
		74164	125		
		74165	120		
		74166	150		
		74167	250		
		74170	200		
		74172	430		
		74173	150		
		74174	120		
		74175	110		
		74176	110		
		74177	110		
		74178	150		
		74179	150		
		74180	110		
		74181	350		
		74182	150		
		74184	190		
		74185	190		
		74186	70		
		74188	75		
		74190	145		
		74191	140		
		74192	140		
		74193	140		
		74194	110		
		74195	90		

74C

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

74LS

LS00	30	LS83	75	LS322	360
LS01	30	LS85	100	LS323	360
LS02	30	LS86	40	LS324	150
LS03	30	LS90	55	LS325	150
LS04	35	LS91	100	LS326	290
LS05	35	LS92	65	LS327	290
LS08	30	LS93	60	LS347	130
LS09	30	LS95	80	LS348	200
LS10	30	LS96	100	LS352	125
LS11	30	LS107	50	LS353	125
LS12	30	LS109	55	LS355	220
LS13	35	LS112	55	LS356	220
LS14	60	LS113	45	LS363	180
LS15	30	LS114	45	LS365	60
LS19	45	LS122	75	LS366	50
LS20	30	LS123	120	LS367	75
LS21	30	LS124	100	LS368	60
LS22	30	LS125	55	LS373	110
LS24	80	LS126	55	LS374	140
LS26	30	LS132	75	LS375	80
LS27	30	LS133	50	LS377	145
LS28	30	LS135	28	LS378	120
LS30	35	LS136	45	LS379	150
LS32	95	LS138	70	LS380	310
LS33	25	LS139	70	LS382	310
LS37	25	LS145	120	LS384	457
LS38	45	LS147	195	LS385	330
LS40	30	LS148	150	LS386	50
LS42	65	LS151	75	LS390	90
LS47	100	LS153	75	LS393	120
LS48	100	LS154	200	LS395	135
LS49	60	LS155	75	LS396	300
LS51	25	LS156	75	LS398	195
LS52	25	LS157	70	LS399	150
LS54	25	LS158	60	LS445	125
LS55	25	LS160	75	LS447	80
LS63	00	LS161	75	LS465	150
LS73	35	LS162	75	LS467	120
LS74	40	LS163	85	LS490	160
LS75	50	LS164	95	LS540	145
LS76	40	LS165	130	LS541	145
LS78	40	LS166	195	LS624	150
		LS168	140	LS629	150
		LS169	90	LS640	200
		LS170	175	LS641	200
		LS173	110	LS645	200
		LS174	100	LS668	90
		LS175	80	LS669	90
		LS181	210	LS670	190
		LS183	200	LS673	890
		LS190	100	LS674	00
		LS191	75	LS682	250
		LS192	100		
		LS193	100		
		LS194	80		
		LS195	80		
		LS196	100		
		LS197	100		
		LS221	100		
		LS240	100		
		LS241	100		
		LS242	100		
		LS243	100		
		LS244	100		
		LS245	200		
		LS247	115		
		LS248	115		
		LS249	115		
		LS251	80		
		LS253	80		
		LS256	175		
		LS257	75		
		LS258	80		
		LS259	130		
		LS260	80		
		LS261	190		
		LS266	60		
		LS273	140		
		LS275	380		
		LS279	75		
		LS280	195		
		LS283	95		
		LS290	85		
		LS292	850		
		LS293	90		
		LS294	999		
		LS295	140		
		LS298	110		
		LS299	240		
		LS320	230		

CMOS

4000	20	4036	275	4520	53
4001	25	4037	115	4521	115
4002	25	4038	75	4522	125
4006	75	4039	280	4526	60
4007	25	4040	60	4527	65
4008	60	4041	57	4528	70
4009	45	4042	50	4529	150
4010	60	4043	42	4530	90
4011	25	4044	50	4531	130
4012	25	4045	110	4532	65
4013	60	4046	60	4534	400
4014	60	4047	60	4536	275
4015	60	4048	55	4538	80
4016	40	4049	38	4539	90
4017	60	4050	35	4541	95
4018	60	4051	70	4543	70
4019	58	4052	60	4544	150
4020	90	4053	60	4549	400
4021	58	4054	85	4553	245
4022	67	4055	85	4554	180
4023	30	4056	85	4555	35
4024	50	4057	£10	4556	55
4025	22	4059	435	4557	250
4026	90	4060	68	4558	120
4027	48	4061	£5	4559	395
4028	45	4062	995	4560	160
4029	75	4063	85	4561	104
4030	35	4066	45	4562	350
4031	130	4067	245	4566	165
4032	70	4068	25	4568	250
4033	130	4069	25	4569	175
4034	140	4070	25	4572	45
4035	70	4071	25	4580	255
		4072	25	4581	125
		4073	26	4582	99
		4075	25	4583	100
		4076	68	4584	60
		4077	25	4585	70
		4078	25	4599	155
		4081	25	40097	45
		4082	25	40098	42
		4085	60	40100	215
		4086	60	40101	130
		4089	125	40102	140
		4093	37	40103	412
		4094	70	40104	120
		4095	95	40105	220
		4096	100	40106	60
		4097	275	40107	55
		4098	80	40108	325
		4099	75	40109	100
		4160	95	40110	235
		4161	99	40114	240
		4162	99	40161	194
		4163	99	40163	75
		4174	99	40174	75
		4175	105	40175	75
		4194	105	40181	220
		4408	850	40192	75
		4409	850	40193	95
		4410	725	40194	90
		4411	750	40195	80
		4412	805	40244	195
		4415	590	40245	195
		4419	280	40257	198
		4422	770	40373	220
		4433	770	40374	220
		4435	850		
		4440	999		
		4450	350		
		4490	450		
		4500	395		
		4501	38		
		4502	60		
		4503	40		
		4504	99		
		4505	385		
		4506	100		
		4507	45		
		4508	130		
		4510	55		
		4511	55		
		4512	55		
		4513	150		
		4514	115		
		4515	125		
		4516	65		
		4517	275		
		4518	48		
		4519	32		

JUST PHONE YOUR ORDER. WE DO THE REST. 0923 50234

SPEAKERS

8Ω, 0.3W, 2", 2.25", 2.5", 3"	80p
0.3W, 2.5" 40Ω; 64Ω or 80Ω	80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	14
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

BRIDGE RECTIFIERS

(plastic case)

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

ZENERS

Range: 2V7 to 39V 400mW **8p each**

Range: 3V3 to 33V 1.3W **15p each**

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

SCR's Thyristors

0.8A-100V	32
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5064	38
2N4444	130

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	125

DIAC

ST2	25

SOLDERCON PINS

100	75p
500	370p

OPTO

LEDS price includes Clips

TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 .2" Red	12
0.2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip, R, G & Y	45
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0.2" Flashing LED Red	56
0.2" Bi colour LEDs Red/Green	100
Green/Yellow	80
0.2" Tri colour LEDs Red/Green/Yellow	85
0.2" Red High Bright	59
High Bright Green or Yellow	100
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	55
TIL38	50
TIL81 82; TIL100	90

7 Segment Displays

TIL321 .5" C.An	140
TIL322 .5" C.th	140
DL704 .3" C.Cth	125
DL707 .3" C.Anod	125
FND357 or 500	130
.3" Green C.A.	140
±1 .3" Red or Green	150
Bargraph 10 seg. Red	275
Bargraph NSM3914	500

FERRIC CHLORIDE

Crystals 1lb

195p + 50p p&p

DALO ETCH RESIST

Pen plus spare 11p — 100p

COPPER CLAD BOARDS

	Single-sided	Double-sided	SRBP 9.5"×8.5"
Fibre Glass 6"×6"	100p	125p	110p
6"×12"	175p	225p	

VEROBOARDS 0.1"

	Clad	Plain		
2½×3¾"	95	—	'VQ' Board	180
2½×5"	110	—	'DIP' Board	395
3¾×3¾"	110	—	Vero Strip	144
3¾×5"	125	95p	**PROTO-DECs**	
3¾×17"	420	275p	Veroblock	480
4¾×18"	590	—	S-Dec	395
Pkt. of 100 pins	55p		Eurobreadboard	590
Spot Face Cutter	150p		Blmboard 1	695
Pin Insertion Tool	185p		Superstrip SS2	£13

VERO WIRING PEN and Spool — 380p

Spare Wire (Spool) 75p; Combs 6p ea.

Wire Wrapping Stakes 100 — 250p

0.5" LCD DISPLAYS

3½ digit	495
4 digit	530
6 digit	625

OPTO

BPX25	250
BPW21	320
BPX65	320
ILD74	145
ILQ74	275
ILCT6 Darlington Isolator	135
TIL111	70
OCP71	120
ORP12	78
2N5777	50
4N33	135
Pin diode	720
Schmitt Receiver	715

OPTO SWITCH

Reflective TIL139	225
Slotted similar to RS	186

ALUM.BOXES

4×2½×2"	100
4×2½×2½"	103
4×4×2½"	120
5×4×2"	105
5×2½×1½"	90
5×2½×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

VOLTAGE REGULATORS

1A T0220 Plastic Casing

	+ve		−ve	
5V	7805	45p	7905	55p
12V	7812	45p	7908	55p
15V	7815	45p	7912	55p
18V	7818	45p	7915	55p
24V	7824	45p	7918	55p

100mA T092 Plastic Casing

5V	78L05	30p	79L05	50p
6V	78L62	30p	—	
8V	78L82	30p	—	
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	50p

ICL7660	248	LM317K	250
78H05 5V/5A	550	LM317P	99
78H12 12V/5A	640	LM323K	500
78HG+5 to +24V 5A	599	LM337T	175
		LM723	30
79HG −2.25V to −24V 5A	685	TBA625B	75
		RC4194	375
LM309K	120	RC4195	160

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40

PUSH BUTTON Spring loaded

Latching or Momentary 6A	
SPDT c/over	150
DPDT c/over	200

MINIATURE Non Locking

Push to make	15p
Push break	25p

TOGGLE 2A 250V

SPST	35
DPDT	48
4 pole on off	54

SUB-MIN TOGGLE 2 amp

SP changeover	64
SPST on off	58
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	80
DPDT C/OFF	88
DPDT on/on/on	185
DPDT Biased	145
4-pole 2 way	220

ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way — 48p

ROTARY: Mains 250V AC, 4 Amp — 64p

DIP SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 87p; 10 way 100p; (SPDT) 4 way 190p.

AMPHENOL CONNECTORS

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

ASTEC UHF MODULATORS

6MHz Standard	375p
8MHz Wideband	550p

ANTEX Soldering Irons

C15W	535p	**Spare bits**	90p
G517W	545p	**Elements**	280p
G18W	550p	**Iron stand**	180p
XS25W	560p	**Heat Shunt**	35p

DIL SOCKETS

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

ZIF DIL SOCKET

24 way	575p
28 way	695p
40 way	845p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
28	185p	290p
40	195p	218p

RIBBON CABLE

(price per foot)

Ways	Grey	Colour
10	15p	28p
16	25p	40p
20	30p	50p
26	40p	65p
34	60p	85p
40	70p	90p
64	100p	135p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	80p	75p	75p	90p

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

SIL Sockets

0.1"

20 way **65p**

32 way **95p**

EDGE CONNECTORS

1"

2×18 way	210p
2×22 way	215p
2×23 way	175p
2×25 way	285p
2×28 way	190p
2×30 way	310p
2×36 way	360p
2×40 way	380p
2×43 way	450p
2×75 way	650p

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied. **ONLY £22**

IDC CONNECTORS (Speed block type)

2 rows	PCB Male with latch Strt. Pins	Angle Pins	Female Header Socket	Female Card-Edge Connector
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	195p
20 way	145p	166p	125p	240p
26 way	175p	200p	150p	320p
34 way	205p	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS

Gold flashed contacts

	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41612 2x32 way	275p	—	220p	285p
DIN 41612 2-3x32 way	295p	—	240p	300p
DIN 41612 3x32 way	360p	385p	260p	395p

TRANSFORMERS (mains Prim. 220-240V)

3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA — **98p**

6VA: 2x6V-5A; 2x9V-4A; 2x12V-0.3A; 2x15V-25A — **250p**

12VA: 2x4V5-1.3A; 2x6V-1.2A; 2x12V-.5A; 2x15V-.4A — **345p** (35p p&p)

24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-.8A 15-.8A; 20V-.6A — **385p** (60p p&p)

50VA: 2×6V-4A; 2×9V-2.5A; 2×12V-2A; 2×15V-1.5A; 2×20V-1.2A; 2×25V-2A; 2×30V-0.8A — **520p** (60p p&p)

100VA: 2×12V-4A; 2×15V-3A; 2×20V-2.5A; 2×30V-1.5A; 2×40V-1.25A; 2×50V-1A — **965p** (60p p&p)

JUMPER LEADS Ribbon Cable Assembly

DIL Plug (Headers)

Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	325p

Double Ended Leads

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

IDC FEMALE RECEPTACLE Jumper Leads 36"

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

COMPUTER CORNER

- **EPSON RX80** Printer — **£229**
- **EPSON RX80** F/T Printer — **£245**
- **EPSON FX80** Printer — **£316**
- **EPSON FX100** Printer — **£435**
- **SEIKOSHA GP100A** — **£125**
- **KAGA/TAXAN KP810** Printer — **£235**
- **KAGA/TAXAN KP910** Printer — **£435**
- **QUEN-DATA DPW1120** Daisywheel — **£175**
- **BROTHER HR15** Daisywheel Printer — **£339**
- **Centronics PRINTER CABLE** for all the above printers to interface with the BBC Micro — **£7**
- **KAGA – RGB** 12 inch medium resolution colour monitors — **£195**
- **ZENITH 12" Hi-RES**, Green Monitor 40/80 column select switch, value for money. — **£75**
- **MICROVITEC 14"** colour monitor. RGB input. Lead incl. — **£173**
- **MICROVITEC 1451** Hi-res 14" Monitor incl. Lead — **£295**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. — **£30**
- **Spare** 'UV lamp bulbs — **£8**
- **C12 COMPUTER Grade BASF Cassettes** in Library Cases — **36p**
- **8½" or 9½" Fan fold paper** (1000 sheets) **(150p)** — **£7**
- **Teleprinter Roll** (no VAT) — **£4**

MANY MORE PRINTERS, MONITORS, INTERFACES, AVAILABLE. CALL IN AT OUR SHOP FOR DEMONSTRATION OR WRITE IN FOR OUR DESCRIPTIVE LEAFLET.

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2.4576M	200
2.5MHz	225
2.56250M	220
3.2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.194304M	200
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	200
7.0MHz	150
7.168MHz	250
7.68MHz	200
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8.08333M	395
8.867237M	175
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9.375MHz	350
10.0MHz	175
10.5MHz	250
10.7MHz	150
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12.528MHz	300
14.31818M	170
14.7456M	175
14.765MHz	250
15.0MHz	240
16.0MHz	220
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	265
24.0MHz	170
24.930MHz	325
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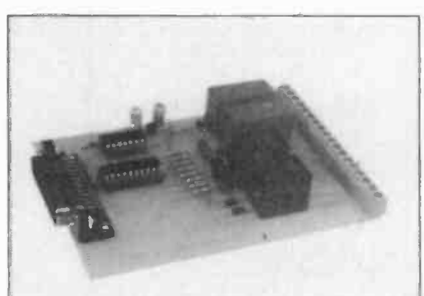

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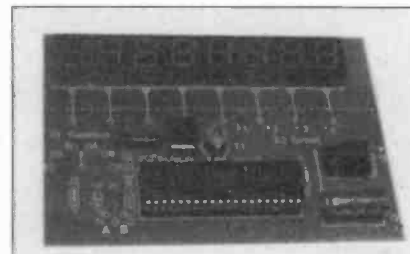

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Size; 112 x 71 x 37mm 01-00409 4.95

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To charge PP3 type NiCads.
Size; 70 x 50 x 32mm 01-00159 4.30

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

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Meter movement fully protected against overloads. 3-colour mirrored scale in robust case. Supplied complete with comprehensive instructions, test leads, transistor test leads and batteries (2 x HP-7, 1 x PP3).

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

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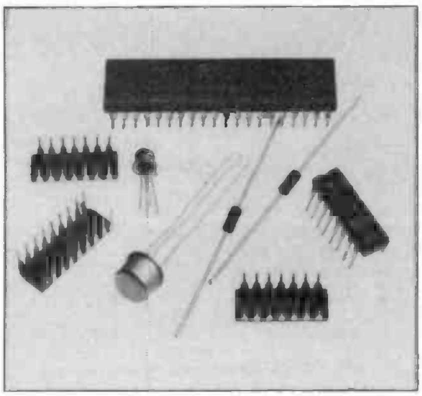

Linear ICs

		Stock No.	Price
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LF353	Dual version of LF351	61-03530	0.81
LM380N	IW AF power amp	61-00380	1.45
LM381	Stereo pre-amp IC	61-00381	3.27
NE544	14 pin DIL servo driver IC	61-00544	1.80
NE555N	Multi-purpose low cost timer	61-05550	0.21
uA741CN	DIL low cost op-amp	61-07411	0.42
TDA1062	RF oscillator and mixer system for 1-200MHz	61-01062	1.95
TDA1083	Portable radio AM/FM audio in one IC	61-01083	1.95
HA1388	18W PA from 14V	61-01388	2.75
MC1496P	Double balanced mixer/ modulator	61-01496	1.25
TDA2002	8W into 2 ohms power amp	61-02002	1.25
ULN2283	1W max 3-12V power amp	61-02283	1.00
CA3089	FM IF amp, detector, mute, AFC, AGC system	61-03089	2.84
CA3130E	BIMOS op amp	61-31300	0.80
CA3140E	BIMOS version of 741	61-31400	0.46
MC3359	Low current dual conversion NBFM IF and det	61-03859	2.95
LM3900	Quad norton amp	61-39000	1.20
LM3909N	8-pin DIL LED flasher	61-39090	0.68
KB4412	Two balanced mixers IF amp with AGC for AM/SSB	61-04412	1.95
ICM7555	Low power CMOS version of 55 timer	61-75550	0.98
HA11225	Low noise FM IF	61-11225	1.45
HA12017	83dB S/N phono preamp 0.001% THD	61-12017	0.80
MC14412	300 baud MODEM controller (Euro/US specs)	61-14412	6.85

Selected Lines

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10M08AA	10.695 Filter	20-11152	3.49
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14 x 0.3"	IC socket	28-14000	0.13
16 x 0.3"	IC socket	28-16000	0.13
6V	KUIT-A Relay	46-80000	0.48
9V	KUIT-A Relay	46-80001	0.48
12V	KUIT-A Relay	46-80002	0.48
CX120P	COAX Relay	46-90120	11.96
CX520D	COAX Relay	46-90520	26.98
CX540D	COAX Relay (BNC)	46-90540	26.98

Books

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Beginners Guide to Electronics	02-04134	4.50
Active Filter Cookbook	02-21168	12.70
CMOS Cookbook	02-21398	11.85
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PE

VOLUME 20 No. 12 DECEMBER 1984

IN CAR ELECTRONICS

ELECTRONICS in motor cars has provided PE with many interesting features and projects over the years. Back in 1965 we were publishing car alarms, instruments and parking lights as projects. Interestingly one news item at that time reported the first car to car 'phone call across the Atlantic. The call was made on July 5 1965 from a car in London using a Radiophone made by Pye to a taxi cab in Montreal also using Pye equipment. This event followed the official opening of the London Radiophone service which covered an area of about 30 miles around London.

Electronics has moved on in the last twenty years and of course so have our projects. In December '81 we published our first car computer which broke new ground in this area and is still an unsurpassed design. Now we are pleased to publish another, totally different car computer design, a design based on a computer model of the car's performance, consumption etc. This new design is not as complex as the PE Car Computer of 1981 but provides all the basic information without the need to fix a fuel sensor and is consequently an inexpensive item to build. We believe this design again breaks new ground in its mode of operation.

BUYER'S GUIDES

Buyer's guides, as regular readers may have noticed, are becoming quite a part of PE. It seems that the information we provide is of great value to hobbyists and those involved in the electronics industry and education. We have now covered quite a wide field with our guides and are planning further subjects for next year.

Soldering equipment is well covered in this issue and, while we make no claim that the guide is complete, it will give readers a good basis on which to build a list of required equipment. No doubt many readers will find new companies and products which they were not aware of before. If you make an enquiry about any product we describe (especially those detailed in our buyer's guides) would you please mention PE as the source of the original information. This applies equally to educational establishments and industry or training departments etc., as such feedback to the suppliers assists us to give good coverage in future guides.

INDEX

As usual this issue of PE carries the index for the year. If you find an article you would like to read our back numbers department may be able to assist—see below. Alternatively a local library, particularly a technical one or one attached to a school or college etc., might carry copies.

In extreme cases we can supply a photostat of the article from the editorial office but we do have to charge 75p for each article or part of a series.

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

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

Back Numbers and Binders

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

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

...NEWS &

Mains' utilities Monitoring System

A new remote-monitoring system, designed for load-management of electricity, gas and water supplies, is presently undergoing trials in London and Milton Keynes. The Thorn/EMI system *Mainsborne Telecontrol* uses the electricity mains to carry bi-directional coded data between the central control and the consumer combining far more cost effective tariff structures with remote meter reading.

The purpose of the trials is to establish the long term levels of reliability of the unique spread spectrum bi-directional signalling system over the low voltage mains, a system adopted to overcome excessive noise problems. A spread spectrum signal essentially provides a continuous frequency over the band and is highly resistant to narrow band interference. It is also capable of signalling through a high noise level environment such as the mains and additionally provides high security.

The consumer is provided with a microprocessor controlled home unit and communications module. These carry out a number of tasks including accumulating signal pulses from electricity, gas and water meters; tariff switching; calculating actual and estimated costs incurred by the consumer; operating 80 amp and 25 amp contactors for space and water heating control and also for detecting any tampering with the meters. The communications module contains a clock/calendar synchronised to that of the central controller which is housed in the local C.E.G.B. transformer chamber. Non-volatile RAM storage of 1K byte permits a one day store of incremental meter readings for each utility.

The central controller can communicate via the mains with up to 1,024 addresses. There is 500K bytes of non-volatile bubble memory capable of storing three days of 48 half-hourly meter readings from all three utilities as well as storing data retransmission upstream to Load Management Control or downstream to home units.

The customer display (pictured) has a 10 digit, alpha numeric, vacuum fluorescent display with 19 touch sensitive keys. A series of control and data display functions are available to the customer such as display of meter reading including multi-tariff metering; display of units consumed and cost so far since last bill; display of estimated cost of next bill; display of water and space heating on/off times; when not in use for any other reason the display shows the time.

Two other communication systems are presently being tested in the UK for remote-monitoring and load management; one uses an idle line facility on the standard telephone network, the other uses radio signals transmitted in the 200kHz band by the BBC.

NOV. SHOW CANCELLED

Leisuretronics, the broad based electronics show which was to be held at the Royal Horticultural Hall in London from November 8th to the 11th, has had to be cancelled by the show's organisers Trident International.

Despite the fact that the show was being sponsored by ten leading magazines, PE included, it did not receive the necessary backing from the electronics industry and the organisers felt it would not be possible to go ahead with the show under these conditions.

Mr. Gordon Johns, Managing Director of Trident International, said "We are very disappointed. It was obvious from the reaction of the public that there is a very real demand for a show that reflects all aspects of the leisure industry but because of general market conditions many companies were unwilling to give the show their support."

Trident do hope however to stage the show as soon as market conditions improve.

TOP WOMEN?

Women in London will have the opportunity to train for top engineering jobs in new technology thanks to £350,000 in grants from the Greater London Enterprise Board, the Greater London Training Board and the European Commission.

The grants are in recognition of the work being done by the GLEB-sponsored London New Technology Network (LNTN) based in Camden and will finance training courses for women to be supervisors and trainers in micro-electronic engineering.

Enter MSX

The long awaited MSX computer range is finally finding its way into the UK shops. MSX is a standard system adopted by 15 multinational electronics companies, mainly based in Japan. The standard is based on the Z80 processor, a TI video display chip and a General Instruments sound generator chip; all MSX machines and their peripherals are totally compatible. It is undoubtedly the hope of the conglomerate that their standard will eventually dominate the home-computer market.

Mitsubishi, Toshiba, Sony, Sanyo, JVC, Hitachi and Canon recently held a joint launch for their machines which all cost around the same—between £279 and £300. The software has been written by the American company Microsoft, it is a version of Basic. Around 75 general interest software packages are currently available. All the machines have a similar appearance and each possesses 64K bytes of user RAM with a separate 16K bytes of video RAM; the Basic is stored in a 32K byte ROM.

Peripherals available will include 3½ in floppy discs, printers, data cassette recorders, joysticks, touchpads, tracker balls and communications adaptors. Mitsubishi are the only company to launch two machines, the cheaper version (pictured) is a 32K byte model ML F48 costing £249.

MARKET PLACE

WATFORD'S MODEM 84

The Watford Modem 84 is a direct connect unit for use with BBC micros; it is a fully British Telecom approved device and is probably the cheapest way to connect to Prestel. The unit is supplied with or without a software ROM.

Having a full duplex capability the system can send and receive data at the same time. Only 1K byte of memory is used by the system for preparing mailboxes and system operation. User passwords can be optionally programmed into the ROM giving automatic log-on whilst still allowing you to change the personal passwords from the keyboard. The system has many special features. Modem 84 costs £97 including the software ROM. The two can be bought separately, Modem 84 alone £74, software alone £23. All prices include VAT and p&p. For further details and full specification contact: Watford Electronics, 33/35 Cardiff Road, Watford, Herts, WD1 8ED. (0923 40588).

Computer look alikes

Systema has introduced a mini desk calculator together with an LCD clock both styled like modern computer terminals.

The DC2 computer-calculator has a full working keyboard with memory, percentage and square root functions. Its eight digit display is fitted into the VDU cabinet. Overall measurements are 80 × 75 × 47mm.

The time and date are displayed alternately on the VDU of the CC1 computer-clock and its time keeping is accurate to within two seconds a day. Overall measurements are 52 × 45 × 41mm.

Both items are fitted with long life batteries. Prices are £6.95 for the DC2 computer-calculator and £3.68 for the CC1 computer-clock, inc VAT and P & P. From, Systema (UK) Ltd., 72/74 South Street, Reading, Berks. RG1 4LG. (0734 586429).

Briefly...

Constructors please note: as part of a 'moving sale' the Midwich Computer Co. Ltd. is featuring many BBC products and compatible peripherals at low prices. Examples include a 100K, 40 track disc drive for £99.95, and the Uchida daisy wheel printer for £227.65. Prices exc VAT. All offers are while stocks last. New address: *Gilray Road, Diss, Norfolk IP22 3EU. (0379 4131).*

● ● ● ●

The Mitsubishi Electric Corporation has developed a method of access control that recognises personnel by their palm prints. Employees' palms are photographed and entered into a Charge Coupled Device (CCD) camera recognition system. Access to restricted areas is gained as the prospective entrant keys in a personal code and simultaneously presses his palm on a recognition plate; a positive palm print check coupled with the correct code number permits entry.

POINTS ARISING . . .

PARALLEL/SERIAL CONVERTER
September '84

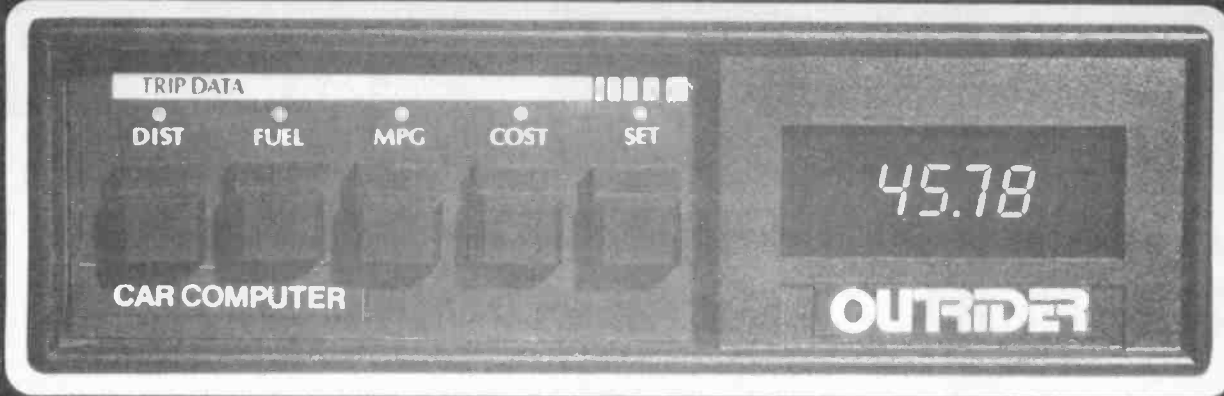
The +ve connection of C2 should be connected to +5V and not to TR2 as printed. See page 18, Fig. 3 (circuit diagram).

Countdown . . .

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

Leisuretronics *Cancelled* (see report, far left.)
Compec Nov. 13–16. Earl's Court. **K2**
P.c.b. Manufacture & UV Box Construction (meeting) Nov. 17. Electronic Organ Constructors Society. **Y4**
Systems Security Nov. 19–20. Barbican Cntr., London. **E**
Computers In The City Nov. 20–22. Barbican, London. **O**
Data Security Nov. 20–22. Barbican, London. **O**
Business & Data Processing Nov. 20–24. Kelvin Hall, Glasgow. **M**
Northern Computer Fair Nov. 22–24. Belle Vue, Manchester. **K2**
Northern Energy Manager Nov. 27–28. Lancashire County Cricket Club, Old Trafford, Manchester. **W3**
Transducer Tempcon Nov. 27–29. Harrogate Exhibition Centre, Yorkshire. **T**
Electronic Displays Nov. 28–30. Kensington Ex. Cntr., London. **D4**
Electron & BBC Micro User Dec. 6–9. New Horticultural Hall, London. **L**
Amusement Trades International Dec. 18–Jan. 14 '85. Olympia. **E5**
Your Computer Xmas Fair Dec. 30–Jan. 2 '85. Olympia. **K2**
International Light Show Jan. 14–28 '85. Olympia. **E6**
British Toy & Hobby Fair Jan. 18–Feb. 2 '85. Olympia. **D6**

D4	Network ✆ 0280 815226
D6	✆ 01-701 7127
E	Evan Steadman ✆ 0799 26699
E5	✆ 01-228 4107
E6	✆ 058 84 658
K2	Reed Exhibitions, Surrey Ho., 1 Throwley Way, Sutton, Surrey
L	Database ✆ 061-456 8383
M	Montbuild ✆ 01-486 1951
O	Online ✆ 01-868 4466
T	Trident Exhibitions ✆ 0822 4671
T1	Cahners ✆ 0483 38085
W3	MCM ✆ 01-231 1481
Y4	Percy Vickery ✆ 0202 423863



CAR COMPUTER

S.H.COUSINS BSc PhD P.D.WILSON BEng

PART ONE

HOW MUCH DOES IT *REALLY* COST TO USE YOUR CAR?

LONDON, Geneva, Frankfurt, Paris . . . hardly a motor show goes by without a major car manufacturer introducing a new top-of-the-range car fitted with either a trip computer or a digital m.p.g. readout integrated into the instrument panel. Now here is an opportunity to bring your car right up to date with one of the new generation of car computers. These devices are designed primarily to add interest to your motoring, but they can save you money as well.

There is plenty of money to be saved. The average motorist drives 9000 miles each year, which given a typical 30m.p.g. means consuming 300 gallons per annum, costing £540 at £1.80 a gallon. Next year petrol is likely to go above £2 a gallon if only to keep pace with inflation and the weak pound. But this is only half the story because, as a rule of thumb, for every pound spent on petrol another pound is spent in total on oil, tyres, maintenance costs and car depreciation due to additional miles on the clock.

The Outrider car computer has been developed after the first wave of car computer novelties, and we are able to build on their experience. We have concentrated on achieving a high standard of design so that the Outrider will be simple and safe to use whilst driving, easy to fit to the car and easy to refit if you change cars. But most important of all we have developed a high quality digital m.p.g. readout which is stable under continuous driving conditions, such as on a motorway, yet is also responsive to acceleration, and responsive too, when easing off the accelerator pedal. It is not necessary to fit sensors to the accelerator incidentally!

When the car is stationary other features of the computer can be accessed. For example, the computer will *predict* the gallons of fuel required for a trip and the trip cost before you travel. To do this simply enter onto the computer the distance you expect to travel and view the appropriate functions. Precisely how data is entered is dealt with later, but it is worth noting at this stage that, as a safety measure, data can only be entered into the computer when the car is stationary.

Another important computer feature is the calculation of long term average m.p.g. which provides the information you require to decide whether the car needs servicing.

CAR SHARING

Displaying the trip cost can be an incentive for car sharing. Not only do *you* become fully aware of the cost of car travel, which may encourage you to share, but so do *your passengers!*

The Outrider automatically displays the cost of the trip (petrol cost plus a mileage charge) when you switch off the ignition. This is shown for ten seconds before the computer switches off the display.

BUSINESS TRAVEL

Many of us have to record our mileage in order to reclaim expenses from our employers. The trip distance key is invaluable for this as we can easily underestimate the true length of trips when claiming expenses. Self-employed people and company managers may also benefit from knowing the cost of car operation for particular business trips.

CAR OPERATING COSTS

So how should we evaluate the cost of travelling by car, and at what value should the mileage charge within the computer be set? To work out the cost of operating your car fill-in Balance Sheet 1.

The most obvious cost of motoring is fuel cost and if the mileage charge is set to zero then just the fuel cost of a trip will be displayed by the COST key.

However, each time you drive you incur additional costs. When you have estimated these and set the mileage charge to cover these costs then the trip cost displayed by the COST key will be the sum of the fuel cost and the extra costs that you incur having driven the distance of your trip. If you had stayed at home this is the total amount that you would have saved. If you use the trip cost prediction facility you would have an estimate of the trip cost that you could directly compare to the rail fare or a telephone call. Setting the mileage charge to cover these additional costs is the most useful setting for household owned cars.

Business users, the self employed and car sharers may however want to add the fixed car costs into the figure, not just those additional costs which are incurred at the time of driving.

BALANCE SHEET 1

Annual cost £

Oil	£ ....
Tyres	£ ....
Servicing	£ ....
Maintenance (brakes, exhaust, etc)	£ ....
Half the annual depreciation	£ ....
	Total, A = £ ....

Mileage charge in pence is given by:

$$\frac{100 \times A}{\text{annual mileage}} = \text{.......................} \text{ pence}$$

BALANCE SHEET 2

Fixed costs £

Annual Vehicle Tax	£ ....
Insurance	£ ....
Finance charges	£ ....
Half annual depreciation	£ ....
Other, e.g. AA/RAC membership	£ ....
	Total, B = £ ....

Mileage charge in pence covering all non-petrol costs is given by:

$$\frac{100 \times (A+B)}{\text{annual mileage}} = \text{.............} \text{pence}$$

Just for interest sake we can now calculate the cost of a year's fuel, this is given by:

$$\frac{\text{annual mileage}}{\text{average MPG}} \times \text{price per gallon} = £ \text{.....} = C$$

Your car costs you in total for a whole year

$A + B + C =$ £.............

MAIN BOARD

The heart of the circuit is a Motorola 6803 single chip microcomputer. This chip contains the processor, 128 bytes of RAM, a programmable timer and 13 input/output lines. The program for the microcomputer resides in a 2K byte EPROM. A 74LS373 is used to latch the low order address lines from the 8 bit multiplexed address/data bus. Timing information is derived from the 3·579545 MHz crystal. This part is commonly available as it is used in colour t.v. sets.

KEYBOARD AND DISPLAY

Each of the four l.e.d. digits and the function indicator l.e.d.s are controlled by a transistor driven from one of five output lines of the 6803. Rapid scanning of the digits synchronising with the data to switch segments on or off, which is held in the 74LS374 latch, gives the impression of all digits being on simultaneously but with great economy in wiring and components.

The 7-segment l.e.d.s were selected for both their appearance and their high brightness. The latter is particularly important for car instruments which must be readable in all light conditions

The five digit lines are also used to scan the five input keys, which have a common line of input to the processor. The processor detects a key press when this line goes high.

The Outrider contains calibration and trip information which must not be lost when the ignition is switched off. 64 bytes of the 6803 memory can be retained even when the processor is turned off, through the Vcc standby pin. This pin is connected directly to the 5V regulator which is in turn connected directly to the 12V car battery. The power to the rest of the circuit is switched by a transistor which is turned on either by the ignition line or an output line from the 6803. This enables the 6803 to hold the power on to enter a defined power down sequence and to display trip cost information for a 10 second period after ignition is turned off.

TRANSDUCER

This is a high inductance coil mounted as close as possible to the rotating magnet found in all conventional speedometers. Normally it is sufficient to place the coil tight up against the back of the speedometer case and mounted at right angles to the axis of the drive cable. Exceptionally it is necessary to drill through the speedometer side or back and locate the transducer internally.

Each time a pole of the speedometer magnet passes the sensor coil a voltage is induced which is then converted to a digital signal by a Schmitt trigger on the main circuit board. A twisted pair connects the sensor coil to the main board to remove any electrical noise problems coming from the car's ignition circuit.

A computer model eliminates the need for a fuel flow meter

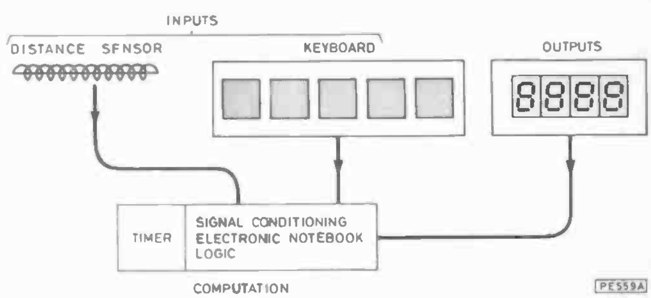
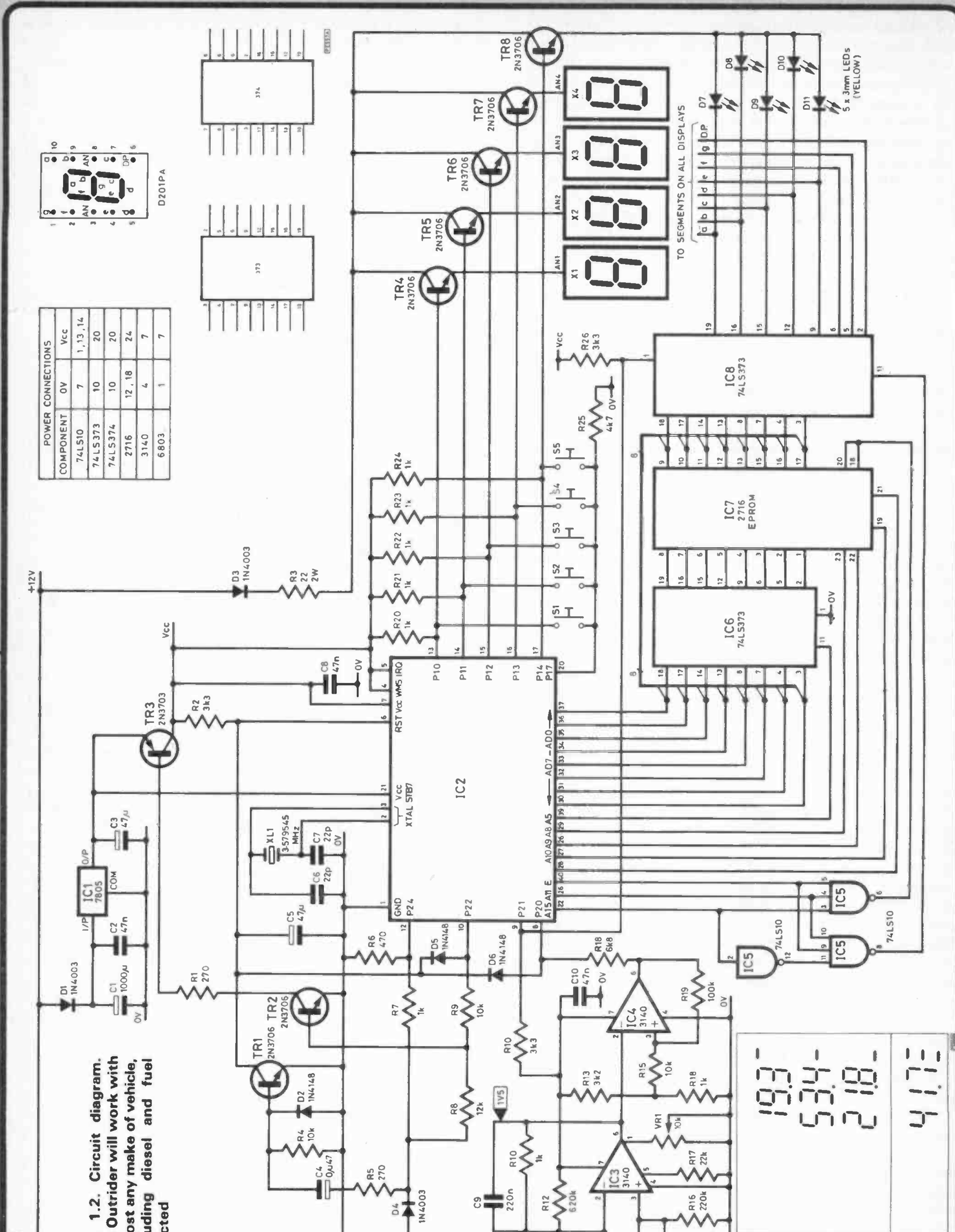


Fig. 1.1. Block diagram

THE COMPUTER OUTPUTS

The keys display these functions

Keys	Functions
DIST	Distance travelled on trip
FUEL	Fuel used on trip
MPG	Instantaneous m.p.g. (above 20m.p.h.) Trip average m.p.g. (below 20m.p.h.)
COST	Trip cost in £.p
SET	Display brightness



POWER CONNECTIONS

COMPONENT	0V	Vcc
74LS10	7	1, 13, 14
74LS373	10	20
74LS374	10	20
2716	12, 18	24
3140	4	7
6803	1	7

Fig. 1.2. Circuit diagram. The Outrider will work with almost any make of vehicle, including diesel and fuel injected

HOW THE COMPUTER WORKS

The overall configuration of the computer is shown in Fig. 1.2. Distance travelled is detected by a sensor coil located behind the speedometer. Fuel consumption information is fed into the computer via the computer keyboard. This is done by entering into the computer's electronic notebook the amount, in pounds and pence, spent when fuel is purchased. The computer then displays the price of a gallon of petrol the previous time it was bought to check that this is still the current price. The amount spent on fuel purchase is then divided by the price of a gallon of petrol to give the volume of petrol purchased. The volume of fuel purchased is not displayed but is retained in the computer and ultimately divided by the total distance travelled when the user requests a calculation of long term average m.p.g. This calculation is best made when the tank is completely filled and gives a highly accurate result. Long term average m.p.g. may be displayed at any time by pressing the MPG key when the computer is in calibration mode.

The distance sensor controls the dynamic behaviour of the computer outputs in conjunction with the crystal oscillator which provides a time source. Together the distance and time inputs are used to determine distance travelled, cold starts, vehicle speed, vehicle acceleration and vehicle braking. These factors are used in the computer model to determine instantaneous m.p.g. using the long term average m.p.g. to calibrate the model itself. Readers will recognise this *kinetic* method of calculating instantaneous m.p.g. as being very similar to the approach taken in the standard EEC driving cycle for new cars. Here m.p.g.s are given according to the speed at which they are driven (56m.p.h. and 75m.p.h.) and for an urban driving cycle involving acceleration and braking.

There are advantages to this kinetic method of determining instantaneous m.p.g. Flow meters in the fuel line can be inaccurate or expensive and there is always a slight additional risk of a petrol leak if a meter is introduced into the fuel line. Fuel flows reflect the characteristics of the carburettor float chamber as well as driver behaviour and the combination can be confusing to the driver particularly during continuous, e.g. motorway driving. By contrast the kinetic method can give a high quality signal to the driver.

Trip m.p.g. is the average of the instantaneous values over the period since the trip data were reset to zero. Fuel consumed on trip and trip cost are also calculated from the trip average m.p.g. figure. In the latter case the cost of fuel used and distance times the mileage charge are also used to determine the total trip cost. Users determine an appropriate charge per mile to reflect an average of all non-petrol costs or those costs less the truly fixed costs (tax, insurance, etc.).

Provided that the power supply to the computer is maintained, all trip and calibration data are retained when the computer display is off and the car is not in use.

THE M.P.G. READOUT

There has been considerable debate about whether a digital or analogue readout is best for car instrumentation in general and for the m.p.g. display in particular. Our display (Fig. 1.2) is something of a hybrid using three of the 7-segment l.e.d.s to display digital m.p.g. while the fourth l.e.d. is effectively an analogue display summarising how the car is being driven. This horizontal bar can be usefully positioned at the edge of the driver's vision when the driver is at the wheel and looking straight ahead.

DATA ENTRY

Always begin data entry by pressing the SET key (for two seconds until SET is displayed and the light above the SET key flashes slowly). Next choose the function key that you wish to tell the computer about, e.g. COST. Now any number between 00·00 and 99·99 can be entered as follows. Each of the four left-hand keys rolls a separate digit on the display. "Roll-up" your desired number (the price of a gallon of petrol, say 1·75 in this case) then press the SET key to finish.

This is the sequence keys you will press to enter data

SET (2 secs) FUNCTION NUMBER SET

Remember the car must be stationary and the SET key pressed for two seconds.

Data entries are as follows for each function key:

SET DIST 0000 SET– Resets all trip data to zero, e.g. fuel used on trip, distance travelled on trip and cost of trip

SET DIST NUMBER SET– Predicts the fuel required and cost of a trip a NUMBER miles long

SET FUEL NUMBER SET Enter the amount spent on fuel each time you buy petrol. The NUMBER is the total cost of fuel which you have just purchased. The computer also needs to know the cost per gallon of the fuel and to help here the computer *automatically* goes over to the cost function and displays the cost per gallon last used. Change if necessary. Press SET to return to normal computer operation.

SET MPG tF.00 SET– Calculates your average m.p.g. over the last 6 to 10 gallons*. tF stands for "tank Fraction". Enter here the position of the needle on your petrol gauge. If it is reading half full enter tF·50; if it is a quarter full enter tF·25 etc. *To make a completely accurate result* fill the tank and enter fuel purchases in the usual way (above) then the tF·99 should be entered. After pressing SET, average m.p.g. will be displayed. Press SET to return to normal computer operation.

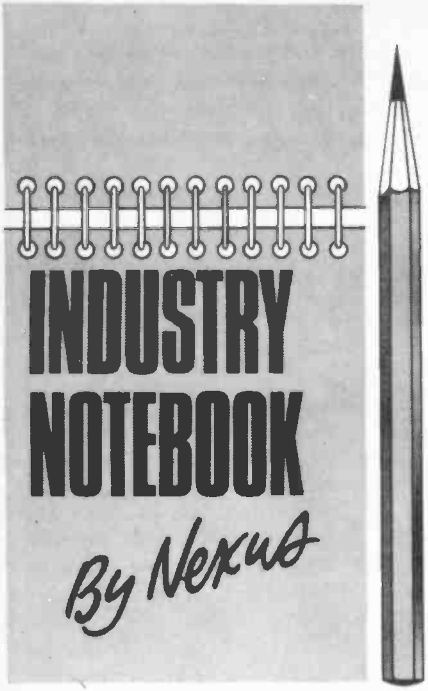
SET COST NUMBER SET Enter here the cost of a gallon

*Equal to the volume of your petrol tank, see calibration section.

The Outrider car computer is available from: Mark Space Enterprises, 11 Church Green Rd., Bletchley, Milton Keynes MK3 6BJ. The complete kit costs £59.95 inclusive of carriage and VAT. A kit comprising those parts not generally available, i.e. case, label, 5 × front panel switches, p.c.b.s, 4 × 7-seg. displays, coil, programmed ROM is available for £29.95—most useful for the constructor with a well endowed spares box!

When ordering, please specify the make and model of the vehicle if known.

NEXT MONTH: Construction, installation and setting up.



Breezy Business

Economic predictions are notoriously unreliable. The experts are often proved wrong, not by failure to correctly analyse and marshal data from which to fashion a conclusion, but by unforeseen events. Pity the poor economist whose job is to predict in an unpredictable world.

Energy demand and resource forecasting should have a much better record if only because it is a narrower field. But it has been no more reliable. In the 1950s we were all worrying that the world would soon run out of oil. In the 1960s there was an enormous surplus. In the 1970s the price explosion forced us to think about alternative sources as well as renewing fears that oil would soon run out. Today, nearing the mid-80s, we have another glut of oil not to mention more coal in the ground than has ever been mined, natural gas in abundance and an increasing capacity in atomic energy.

Of course nobody in the 1950s imagined that in the 1980s the family car would travel 50 miles to the gallon instead of 30, or that all-solid-state TVs would consume only 30 percent of the energy of their valved predecessors, or that double glazing and loft insulation would cut domestic heating demand by 10 percent.

Abundance of supply plus more efficient usage has eased our fears and almost, but not quite, extinguished popular enthusiasm for the alternative energy sources so keenly debated in the late 70s. Whatever happened to tidal power, wind power and solar energy?

Wind power, I am happy to report, is alive and well. The Wind Energy Group, a consortium of GEC Energy Systems, British Aerospace and Taylor Woodrow Construction, has identifed a world market for wind turbine generators estimated to be in tens of thousands of installations.

The demonstration model is now under construction on a hill at Ilfracombe, Devon, and should be operational by the end of the year. It has a three-bladed rotor 25m in diameter and will generate up to 250kW. The project is financially aided by the EEC and by the Department of Trade and Industry. Naturally, the control system is electronic and one of the more interesting features is that microprocessor technology is employed for remote control over a telephone link from WEG's offices in Greenford, Middlesex, together with feedback of operating data for analysis.

The windmills of the 80s and 90s will help conserve oil resources but that is not the main sales message. The real truth behind WEG's optimistic sales forecast is that by clever engineering wind energy is now price-competitive with conventional diesel generated electricity in small communities.

Turnabout

Conventional wisdom has it that the requirements of national defence and, in particular, a fighting war, is the forcing ground for truly innovative developments. The most notable example is radar which made enormous progress during World War 2 and didn't come into civil use on any scale until after the conflict.

An offshoot of radar was microwave technology which, again, only surfaced for civil communications use after the war. Today we still hear stories that defence R & D operates on the very frontiers of knowledge and with large budgets, especially in the United States, there is still an element of truth in such assertions.

But curiously, the most revolutionary innovations of all time, the integrated circuit and later the microprocessor, had their origins in the civil market and were adopted only with some reluctance by the military.

The first simple i.c.s were the brainchildren of Jack Kilby of Texas Instruments and Bob Noyes of Fairchild Semiconductor in 1958 and 1959. Acceptance by the industry was painfully slow until ten years later Intel was formed (in 1968) as a specialist i.c. company with its first product a 64-bit solid state memory.

In 1969 a Japanese company, Busicom, asked Intel to help produce a set of i.c.s for a projected range of high performance calculators. Busicom's ideas were very good but in the opinion of Intel's project engineer, Dr Marcian E. Hoff Jr, they could be made more cost-effective by adopting a systems approach using a general purpose central processor and using peripheral memory chips to achieve the calculator functions.

Hoff had previously worked on the PDP-8 computer at Digital Equipment and was systems-trained. He also foresaw many applications other than calculators where a CPU could be of value. This was the beginning of the MPU as we know it today and what brought Intel to its present impressive status in the industry.

Hoff's ideas came to the open market in November 1971 with the 4004 CPU chip followed by the 8008, the first of the 8-bit chips and a succession of more powerful devices. By 1975 the new innovation was gaining ground with Intel and its competitors shipping 1 million chips.

Five years later the annual shipments had topped 50 million. Ironically, Busicom who had started the bandwagon rolling went out of business. Note, too, that cross-fertilisation of TI and Fairchild's original work plus Digital Equipment system experience plus market demand (Busicom) combined with Intel's own expertise to generate something entirely new.

The military are not entirely to blame for tardiness in adopting the new technology. They were apprehensive over reliability in view of earlier experience with transistors which were sensitive to breakdown through power line surges and spikes. Additionally there were storage and other military specifications to be met. Many of today's operational devices for the military demand Mil Spec qualification in both production and testing but in non-operational or sheltered environments good commercial quality is good enough.

We see this also in certain items of equipment. Naval minesweepers and patrol vessels, for example, frequently use good commercial quality radio equipment originally designed for the trawler market. Financial constraints even led to the idea of VTOL Harriers and helicopters operating from converted merchant ships instead of conventional aircraft carriers which are very much more expensive.

There are many areas of course where military R & D is essential and money well spent. But it is good to see that many products pioneered in the civil field for civil application are no longer sneered at by the military establishment.

Self-Help

One of the Government objectives has been to encourage self-reliance as being far more virtuous than outright dependence on the nanny-state. Cut-backs in central funding have forced many organisations to seek internal economies and, in some cases, to search for alternative sources of revenue.

University R & D is a case in point. It has been traditional for research departments to take out patents and enjoy the benefits of royalties but there are now signs that our academics are becoming far more business-minded. They are actually forming separate companies to sell their services. Thus we see Salford's Industrial Centre, Unisheff Ventures owned by Sheffield University and Unived Technology set up by Edinburgh University.

There are others and the trend is likely to continue. As private companies they can raise their own funds in the commercial market and even conceivably go beyond R & D and consultancy work through to manufacture and marketing, either independently or in joint ventures with existing companies.

How refreshing to see people rising to a challenge instead of indulging in perpetual self-pity.

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Sequential Logic Techniques Part 3

M.TOOLEY BA and D.WHITFIELD MA MSc C Eng MIEE

WE have already made some use of a simple data latch configured around the four D-type bistable stages of a 7475. Data latches are ideal for the temporary storage of data and several enhanced devices have appeared. One such device, the 74175, is a quad edge-triggered bistable which can be used both as a conventional parallel type latch having separate data input and output lines from each bistable, and as a serial type shift register where data is fed from one bistable stage to the next.

The 74175 is housed in a 16-pin d.i.l. package, the pin connections of which are shown in Fig. 3.1. The internal logic of the device is shown in Fig. 3.2. A common clock input is applied to each of the bistable stages and data present on the D inputs is transferred to the Q outputs on the positive-going edge of the clock pulse. It should be noted that clock triggering occurs at a particular voltage level present at the clock input and is not directly related to the transition time of the positive-going pulse. A common master reset input is also provided which, when taken low, asynchronously clears all of the Q outputs.

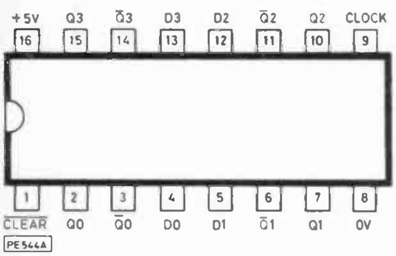


Fig. 3.1. Pin connections for the 74175

74175 4-BIT PARALLEL DATA LATCH

We shall start our investigation of the 74175 by showing how it can be used as a 4-bit parallel data latch in the arrangement shown in Fig. 3.3. The four incoming data lines are connected to the four D inputs whilst the four output lines are derived from the four Q outputs. The latch enable signal is applied to the clock input whereas the clear signal is applied to the master reset pin.

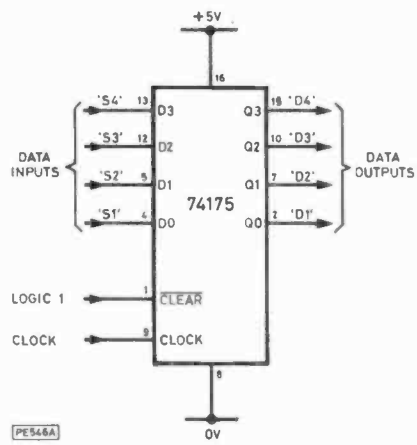


Fig. 3.3. A 4-bit parallel data latch using the 74175

The 74175 should be inserted into socket C of the Logic Tutor ensuring, as usual, that pin 1 aligns with C1. The following connections should be made:

C1	to logic 1	(active low clear)
C2	to D1	(D1 shows state of Q0)
C4	to S1	(data input, D0)
C5	to S2	(data input, D1)
C7	to D2	(D2 shows state of Q1)
C8	to 0V	(common)
C9	to clock	(latch enable)
C10	to D3	(D3 shows state of Q2)
C12	to S3	(data input, D2)
C13	to S4	(data input, D3)
C15	to D4	(D4 shows state of Q3)
C16	to +5V	(supply)

Adjust S1 to S4 to produce logic 0 on all input lines. Check the state of the output lines (Q0 to Q3) by examining the state of D1 to D4 and verify that these all go to logic 0 (and stay at logic 0) after the first rising clock edge. Now wait until the clock goes low and depress S4 so that logic 1 appears on this input. The corresponding output (indicated by D4) should remain at logic 0 until the clock next goes high, at which point the output should change to logic 1.

Readers should experiment with various combinations of data input obtained by appropriate adjustment of S1 to S4. It should be noted that, in all cases, data is only latched on a positve going clock edge (i.e. as the clock l.e.d. becomes illuminated). Furthermore, after the clock transition has occurred, the 74175 ignores any further changes on its data inputs until the next rising clock edge arrives. In practice, this means that input data MUST remain stable for the duration of the rising latch enable input signal since this is the only time at which the input data is valid.

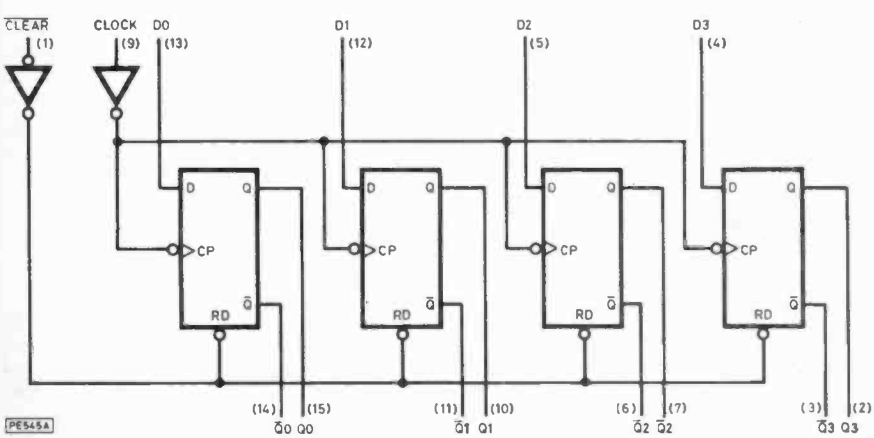


Fig. 3.2. Internal logic of the 74175

The clear input may now be tested by first loading data into the latch, disconnecting the link from C1 to +5V (the input pin of the 74175 remains at logic 1 during this process) and then connecting the link from C1 to logic 0. All four outputs should then immediately go to logic 0 and no further data will be latched until the clear input is returned to logic 1 (or left to float high again).

A SIMPLE LOGIC ANALYSER

Here is an example of the use of the data latch. One of the primary functions of a logic analyser is that of "capturing" transient data present in a microprocessor based system and "freezing" it so that it can be displayed and examined at leisure.

The point at which data is captured is defined by a "trigger event". This usually takes the form of a particular set of logic states present on the control bus. When this pre-set bit pattern occurs, data is latched into the memory of the logic analyser, decoded and displayed in binary or hexadecimal form.

A very simple form of logic analyser is shown in Fig. 3.4. Two 4-bit data latches are used to capture the lower nibble (present on data lines D0 to D3) and the upper nibble (present on data lines D4 to D7). The clock and clear lines of all eight bistable stages are common; the clock being driven from the trigger event decoding logic (which is arranged to produce a 0 to 1 transition when the trigger event occurs) whilst the clear line is connected to a push-button 'reset' switch.

Whilst this simple arrangement is only capable of capturing a single byte (i.e. the eight data bits present on the bus) at a time, most logic analysers provide a memory of 1K bytes (or more) and, in addition, will offer the facility to capture data both before and after the pre-determined trigger event.

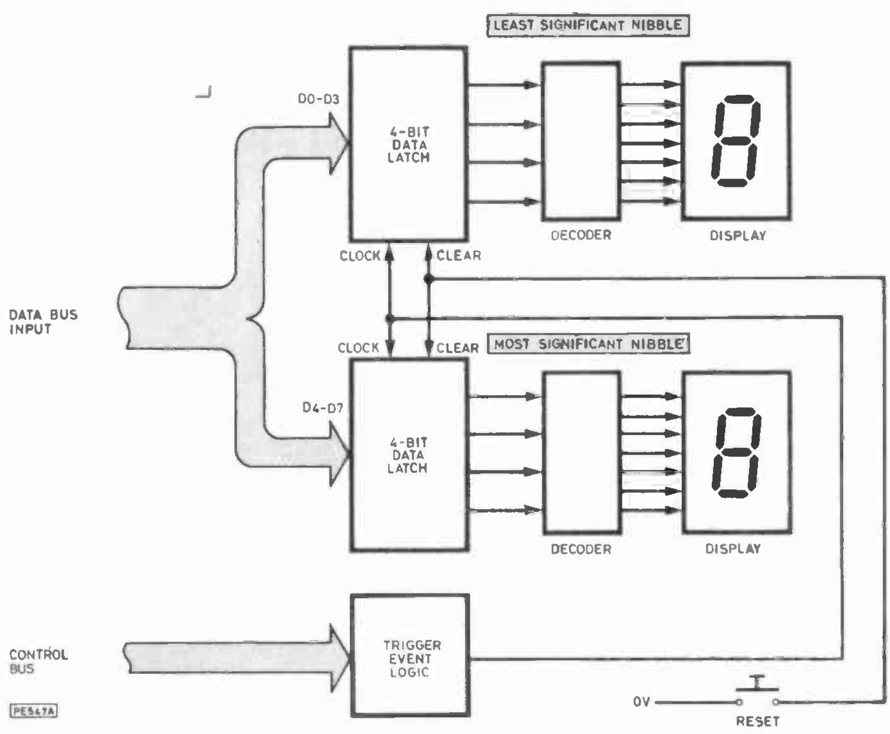


Fig. 3.4. A simple logic analyser

SHIFT REGISTERS

Shift registers essentially provide a form of serial memory (as opposed to the parallel form of data latch which we looked at last month) in which data can be synchronously clocked from one stage to the next. In a simple shift register made from D-type bistables this means that the Q output of the first stage must be taken to the D input of the next stage, and so on. A register of this type is shown in Fig. 3.5 and is known as a serial-input/serial-output (SISO) shift register.

Instead of using D-type bistable elements in the SISO shift register we could, of course, use J-K bistables. The equivalent of Fig. 3.5 using J-K bistables is shown in Fig. 3.6. Both of these arrangements use four cascaded bistable elements, thus four clock pulses will be needed in order to shift data right through the shift register.

At this point it is probably worthwhile making a clear distinction between the SISO shift register and the simple binary counter. In the former case, the clock line is common to every bistable element whereas, in the latter, the Q output from the first stage feeds the clock input of the next stage, and so on.

On its own, the SISO type of shift register is only capable of providing a delay equivalent to the length of the shift register in clock pulses. Hence an 8-stage SISO shift register will, for example, impose a delay of eight clock pulses between serial data entering the register and that leaving it.

Other types of shift register do, however, have a seemingly endless variety of applications arguably the most important of which involves the conversion of serial data to parallel data and vice versa. In such cases the basic SISO register arrangement must be modified so that parallel data access (input and/or output) is possible. One

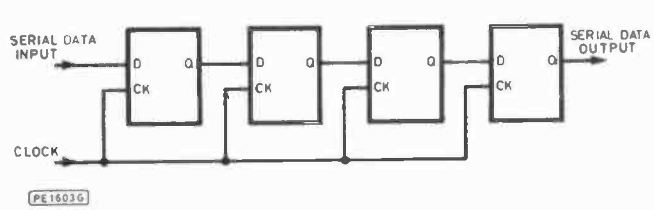


Fig. 3.5. A 4-bit SISO shift register using D-type bistables

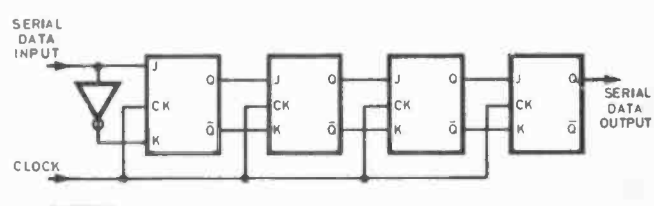


Fig. 3.6. A 4-bit SISO shift register using J-K bistables

obvious possibility is that of making each Q output of the SISO shift register available. Such an arrangement is shown in the serial-input/parallel-output (SIPO) register of Fig. 3.7. Here serial data is synchronously clocked into the register and, after the requisite number of clock pulses (four in this particular case), the register is completely loaded and the data is then available in parallel form from the four Q outputs.

Another possibility is that of parallel loading the data into a shift register using the PRESET and PRECLEAR inputs of the bistable elements. Data may then be shifted out in serial form. Such an arrangement is known as a parallel-input/serial-output (PISO) shift register, a simplified form of which is shown in Fig. 3.8. The data on the parallel inputs should not, of course, be allowed to affect the state of the bistable elements during the shifting process and hence the PISO shift register must have additional logic to control the parallel loading of data. Most, if not all, PISO shift registers also provide a serial data input and thus can be also used for serial-to-parallel data conversion.

A further refinement is that of providing both parallel data input and parallel data output from the shift register. Such an arrangement is shown in Fig. 3.9 and is known as a parallel-input/parallel-output (PIPO) shift register. This arrangement, which is sometimes also referred to as a "universal shift register", is very similar to that of the PISO, the only difference being the addition of data output lines derived from the Q outputs of each bistable stage.

We shall begin our practical investigation of shift registers showing how a simple SIPO arrangement can be built using the four D-type bistables of a 74175 quad data latch. The 74175 was introduced last month and hence we will not repeat the pin-out or internal logic schematic of the device.

SIPO SHIFT REGISTER USING THE 74175

The circuit diagram of a simple SIPO shift register based on the 74175 is shown in Fig. 3.10. It should be noted that the clock input (pin-9) is common to each D-type bistable. The active-low clear input is taken to logic 1 and the serial data input (derived from push button S1) is taken to the D input of the first bistable stage. The four l.e.d. indicators of the Logic Tutor are used to monitor the state of the Q outputs. With the 74175 in socket C (and with pin-1 aligned with C1), make the following connections on the Logic Tutor:—

C1 to logic 1 (active low clear)
C2 to D1

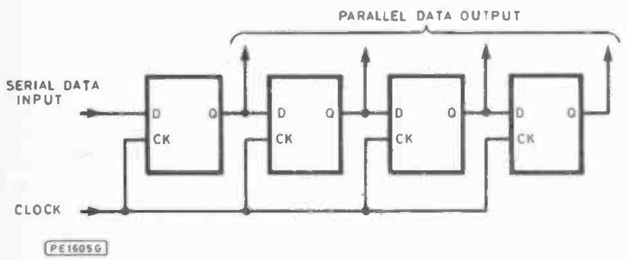


Fig. 3.7. A 4-bit SIPO shift register using D-type bistables

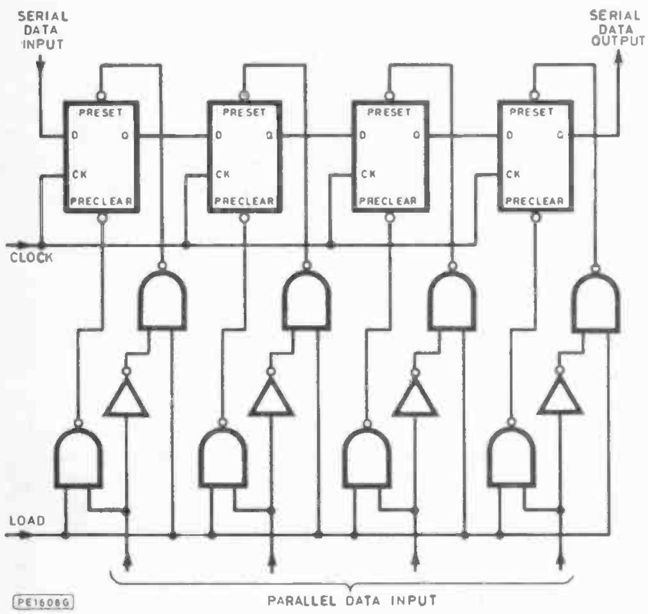


Fig. 3.8. A 4-bit PISO shift register using D-type bistables

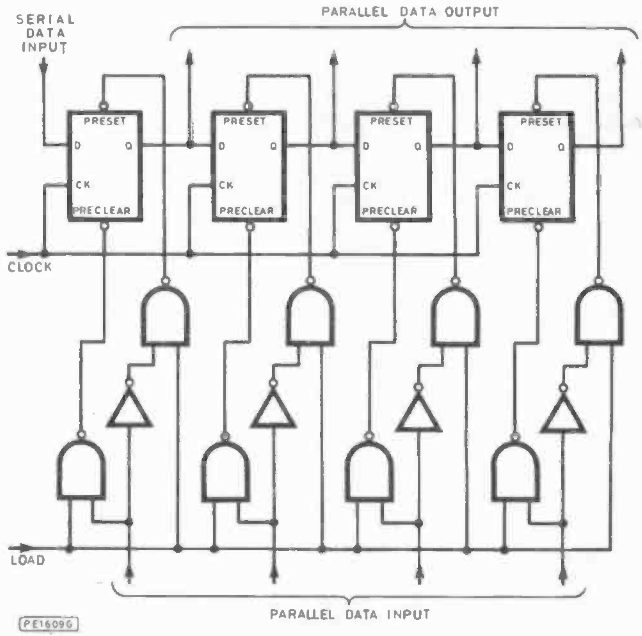


Fig. 3.9. A 4-bit PIPO shift register using D-type bistables

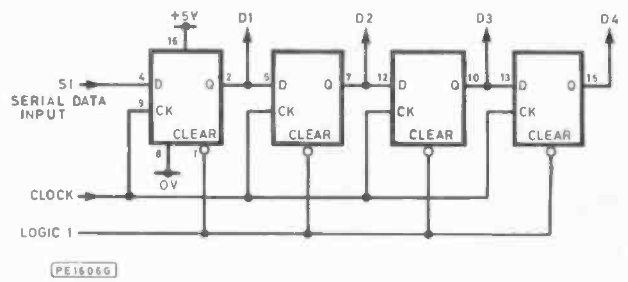


Fig. 3.10. A SIPO shift register based on a 74175 quad data latch

C4 to S1 (data input)
C5 to C2
C7 to D2
C8 to 0V (common)
C9 to clock
C10 to D3
C12 to C7
C13 to D10
C15 to D4
C16 to +5V (supply)

Outputs (indicated by D1 to D4) of the shift register should initially all be zero. With S1 providing a logic 0 data input, the outputs should remain at zero as the logic 0 is effectively shifted into the register during subsequent clock cycles. Now wait for the clock to go low and then depress S1. Nothing should happen until the clock next goes high, at which point D1 will become illuminated indicating that the logic 1 has been loaded into the first stage of the shift register. Now release S1 to produce a logic 0 input. On the next rising clock edge D2 should become illuminated and D1 should become extinguished. This shows that the logic 1 has now shifted into the next stage of the shift register whilst the subsequent logic 0 input has moved to replace the initial logic 1 output of the first stage. The subsequent movement of the logic 1 should be observed as it shifts right through the register. Operation should conform to the timing diagram shown in Fig. 3.11.

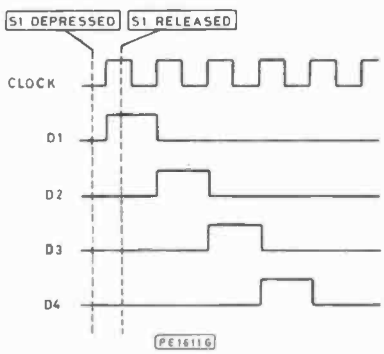


Fig. 3.11. Timing diagram for the shift register of Fig. 3.10

It should be noted that, had we stopped the clock after four complete clock cycles, we would have produced parallel output data on the four Q output lines that was equivalent to the serial data input (i.e. 1000).

It is now suggested that readers repeat the foregoing exercise holding S1 down for the first four clock cycles. A logic 1 will then be seen to load into the register, apparently filling the register from left to right. After the fourth clock cycle, S1 should then be released and the register will empty as the logic 1's are successively replaced with logic 0's. After observing this process for one or two further periods of four clock cycles, readers should be reasonably familiar with the operation of this simple form of 4-bit SIPO shift register.

It should be noted that the outputs of the 74175 shift register can be simultaneously set to logic 0 by taking the active-low clear input to logic 0. Readers may wish to confirm that this is so.

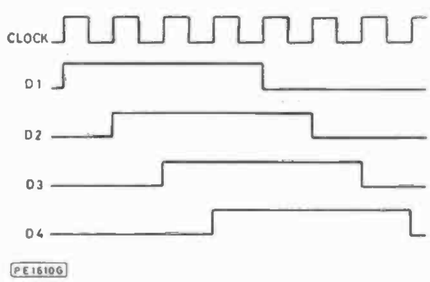


Fig. 3.13. Timing diagram for the walking ring counter of Fig. 3.12

THE WALKING RING COUNTER

We shall now digress slightly from our main theme of shift registers to take a look at an interesting application of the SIPO shift register. If the complementary output from the last stage of a shift register is fed back to the input of the first stage, we can produce a counter which has twice as many states in its counting sequence as there are stages in the shift register. Such an arrangement is known as a "walking ring counter" or "Johnson counter". In this type of counter, as compared with a conventional binary counter, only one stage changes state at a time.

A practical four stage walking ring counter using a 74175 is shown in Fig. 3.12, the $\overline{Q}$ output of the last stage is fed back to the D input of the first stage. Since all four Q outputs start at zero, a logic 1 is fed to the D input and the first stage changes state as soon as the clock input goes high. The register thus first fills with logic 1's but, when the fifth clock pulse arrives the logic 0 present on the $\overline{Q}$ output of the fourth stage is transferred into the first stage and hence the register then begins to fill with logic 0's. The timing diagram for the four stage walking ring counter is shown in Fig. 3.13.

To convert the arrangement used in

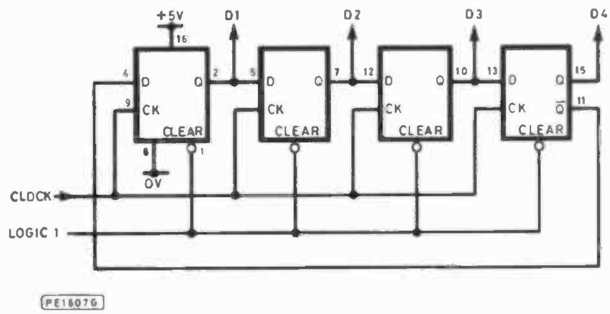


Fig. 3.12. A 4-bit walking ring counter based on a 74175 quad data latch

Fig. 3.10 to that in Fig. 3.12 it is only necessary to disconnect the link from C4 to S1 and reconnect C4 to C14. When power is applied the register will successively fill with 1's and then 0's, taking eight clock cycles for the complete sequence.

THE 74195

The 74195 is a versatile 4-bit parallel access PIPO shift register. The device is useful in a wide variety of shifting, counting and storage applications. The 74195 is particularly suited to high speed serial-to-parallel and parallel-to-serial data conversion. The device is housed in a 16-pin d.i.l. package, the pin connections of which are shown in Fig. 3.14. The internal logic of the device is shown in Fig. 3.15.

The 74195 has two distinct modes of operation: shift right and parallel load. These modes are selected by means of a SHIFT/$\overline{\text{LOAD}}$ input. In the shift mode the SHIFT/$\overline{\text{LOAD}}$ control input is taken to logic 1 and serial data enters the first bistable via the J and K inputs when the SHIFT/$\overline{\text{LOAD}}$ input is at logic 1. Data is then shifted through the register one bit (in the direction Q0

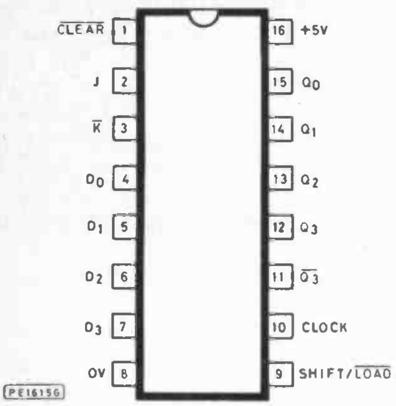


Fig. 3.14. Pin connections for the 74195

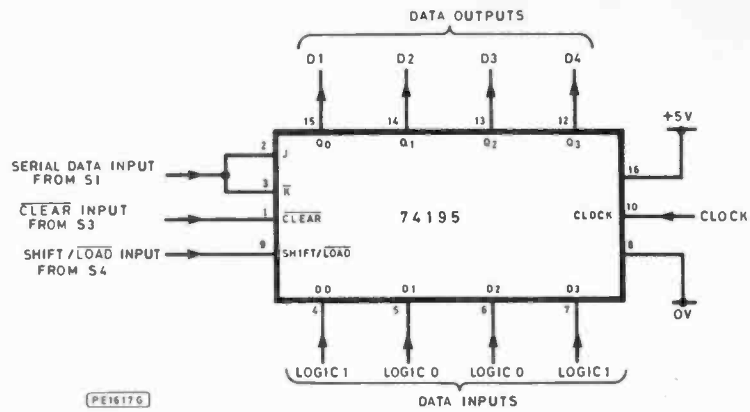


Fig. 3.16. Parallel 4-bit PIPO shift register using the 74195

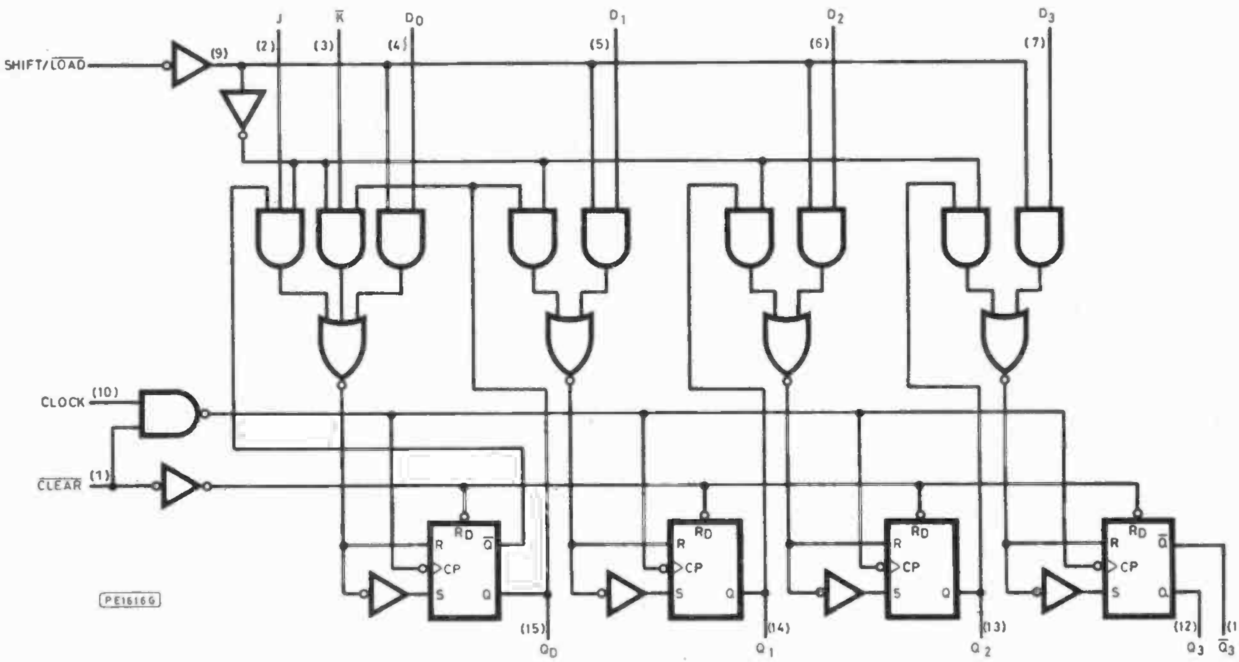


Fig. 3.15. Internal logic of the 74195

→ Q1 → Q2 → Q3) following each low-to-high clock transition.

In the parallel load mode the SHIFT/$\overline{\text{LOAD}}$ control input is taken to logic 0 and data on the four parallel data inputs (D0 to D3) is transferred to the respective bistable outputs (Q0 to Q3) at the next low-to-high clock transition.

Shift left operation (Q3 → Q2 → Q1 → Q0) can also be achieved by tying the Q_n outputs to the D_{n-1} inputs (i.e. Q3 to D2, Q2 to D1, Q1 to D0) and holding the SHIFT/$\overline{\text{LOAD}}$ control input at logic 0.

It should be noted that all parallel and serial data transfers are synchronous and occur after each positive clock edge is received. Furthermore, by virtue of the edge triggered characteristic, there is no restriction on the activity on the J, K, D and SHIFT/$\overline{\text{LOAD}}$ inputs other than that associated with set-up and release.

The 74195 also has an active low clear input which sets all Q outputs low independent of any other input condition. It should be noted that, since the clear and clock inputs are internally gated, to avoid false clocking a low-to-high transition on the clear input should only be permitted during the period for which the clock is low.

The 74195 should be inserted into socket B of the Logic Tutor ensuring, as usual, that pin-1 aligns with B1. The following connections should then be made:—

B1 to S3	(active low clear)
B2 to B3	
B3 to S1	(serial data input)
B4 to logic 1	(parallel data input D0)
B5 to logic 0	(parallel data input D1)
B6 to logic 1	(parallel data input D2)
B7 to logic 0	(parallel data input D3)
B8 to 0V	(common)
B9 to S4	(shift/load control)
B10 to clock	(clock input)
B12 to D4	(D4 shows state of Q3)
B13 to D3	(D3 shows state of Q2)
B14 to D2	(D2 shows state of Q1)
B15 to D1	(D1 shows state of Q0)
B16 to +5V	(supply)

(A total of 15 links)

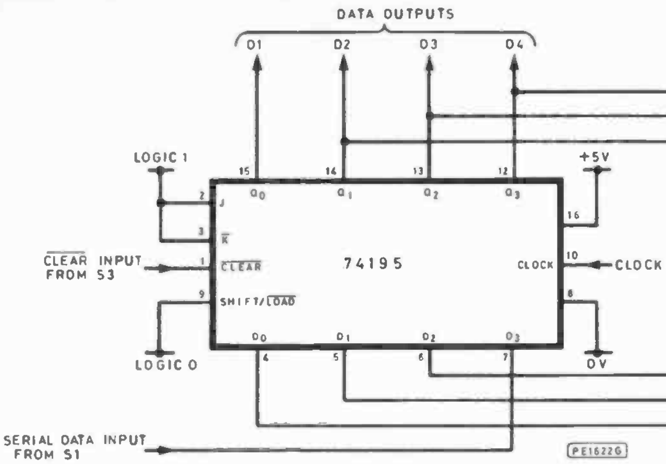


Fig. 3.17. Arrangement used to permit left shifting of the 74195 (SIPO model)

The Logic Tutor arrangement conforms to the circuit shown in Fig. 3.16. The shift register should be tested by first adjusting S3 to produce a logic 0 input on the clear line. All l.e.d. indicators should immediately become extinguished as all the Q outputs go low. Note also that S1 and S4 have no effect whilst the clear line is held low. Now adjust S4 to produce a logic 1 on the SHIFT/$\overline{LOAD}$ input and then operate S3 to generate a logic 1 on the clear line. The register will now commence loading from the serial input but, since S1 is producing logic 0, there will be no change in any of the Q outputs and the l.e.d. indicators will remain extinguished.

Now wait for the clock to go low (D9 extinguished) and depress S1. This places a logic 1 on the serial input. Notice how, as the clock next goes high, this logic 1 is transferred into the first stage of the shift register and D1 becomes illuminated as the first bistable changes state and Q0 goes high. Now release S1 and notice how a logic 0 loads into the first stage on the next rising clock edge whilst the previous logic 0 is transferred into the next stage. Readers may now like to experiment with serial loading of the shift register, inputting data manually by means of S1.

Readers should also confirm that S3 can be used to clear the register on the next rising clock transition after S3 has been set to produce a logic 0.

The parallel load mode can be selected by adjusting S4 to produce a logic 0 input, checking first that the clear input is at logic 1. On the next rising clock transition the data (1010) that has been hard-wired on the data inputs will be transferred to the Q outputs. The data remains static as long as the SHIFT/$\overline{LOAD}$ control input is held low but as soon as S4 is set to produce a logic 1 normal shift right operation is restored.

SHIFT LEFT OPERATION

In order to obtain shift left operation, the 74195 should be left in socket B and the links re-arranged as follows:—

B1	to S3	(active low clear)
B2	to B3	
B3	to logic 1	
B4	to B14	
B5	to B13	
B6	to B12	
B7	to S1	(serial data input)
B8	to 0V	(common)
B9	to logic 0	
B10	to clock	(clock input)
B12	to D4	(D4 shows state of Q3)
B13	to D3	(D3 shows state of Q2)
B14	to D2	(D2 shows state of Q1)
B15	to D1	(D1 shows state of Q0)
B16	to +5V	(supply)

(A total of 15 links)

This arrangement conforms to the circuit diagram shown in Fig. 3.17. Serial data can be fed into the register by means of S1 and cleared by means of S3 (a logic 0 being required to clear the register). Now wait for the clock to go low and then press S1 to generate a logic 1. D4 will become illuminated when the next rising clock edge occurs and data will then be subsequently transferred from Q3 to Q2 (D4 to D3) on the next rising clock edge, and so on. To clear the register S3 should be adjusted for logic 0 and all Q outputs will then go low regardless of the state of the clock.

NEXT MONTH: Pseudo random numbers and universal shift registers

RING MODULATOR

JOHN M.H. BECKER PART 2

AT this point it is worthwhile looking at some oscillograms of simple waveform combinations, produced with the unit described in Part 1. Table 1 shows a schematic representation of the control settings used.

Fig.	S7	S4	S6	S5	S3	S2	VR1	VR5	VR4	VR6	S1
3a	↓	↓	↓	↓	X	←	X	↘	↙	X	←
3b	↓	↓	↓	↓	X	←	X	↘	↙	X	↘
3c	↓	↓	↑	↓	X	←	X	↘	↘	X	↗
4	↓	↓	↓	↓	X	←	X	↘	↘	X	←
5a	↓	↓	↓	X	X	↘	X	↘	X	X	X
5b	↓	↓	↓	X	X	↘	X	↘	X	X	X
5c	↓	↓	↓	X	X	↘	X	↘	X	X	X
5d	↓	↓	↓	X	X	↘	X	↘	X	X	X
6a	↓	↑	↓	↓	X	←	X	↘	↙	X	←
6b	↓	↑	↓	↓	X	←	X	↘	↙	X	↘
6c	↓	↑	↑	↓	X	←	X	↘	↘	X	↗
6d	↓	↑	↓	↓	X	←	X	↘	↙	X	→
6e	↓	↑	↓	↓	X	←	X	↙	↙	X	←
6f	↓	↑	↓	↓	X	←	X	↙	↙	X	↘
6g	↓	↑	↑	↓	X	←	X	↙	↙	X	↗
6h	↓	↑	↓	↓	X	←	X	↙	↙	X	→
6i	↓	↑	↓	↓	X	←	X	↘	↙	X	←
6j	↓	↑	↓	↓	X	←	X	↘	↙	X	↘
6k	↓	↑	↑	↓	X	←	X	↘	↙	X	↗
6l	↓	↑	↓	↓	X	←	X	↘	↙	X	→
7a	↓	↑	↓	X	X	↘	X	X	X	X	X
7b	↓	↑	↓	X	X	↘	X	X	X	X	X
7c	↓	↑	↓	X	X	↘	X	X	X	X	X
7d	↓	↑	↓	X	X	↘	X	X	X	X	X

PE1510P

Table 1. Switch settings

WAVEFORM OSCILLOGRAMS

In Fig. 3, a triangle wave of 3kHz is being used as the carrier signal going to one input, though its actual waveshape is irrelevant at this moment. This is being modulated by a second waveform, on the other input, at a much lower frequency of about 150Hz. The two frequencies shown are widely diverse for illustrative convenience but a similar principle applies to other spacings. The modulating waveform is shown in the upper trace, and the composite output in the lower, with the higher frequency inside the 'bubble' envelope. It will be immediately apparent that the unit in the mode selected has doubled the frequency of the sine and triangle modulators to 300Hz. Although the ramp modulator appears not to be doubled, close examination of the scope reveals that each diamond 'bubble' is in fact two, with a very fast change at the centre, coinciding with the ramp trailing edge. The effect of modulating by square wave is not shown as the edges are too fast to produce a readily visible effect, though it can just be discerned audibly. What is not apparent in the oscillogram is that the carrier within the 'bubble' now consists of 3kHz—300Hz = 2700Hz, and 3kHz + 300Hz = 3300Hz and on the oscilloscope the carrier in the alternate 'bubbles' is seen to be phase shifted by 180°, with a slight vibrato on its edges. Although the full harmonic content of the product signal is not seen in the oscillograms, the differentials can be heard clearly through an amplifier. Using two signal generators with one supplying a fixed frequency, the other is slowly swept across the audio spectrum. When the sweep frequency is rising but below the fixed one, two notes are heard at the output, one rising, the other falling. Close to frequency equality the lower note becomes progressively deeper until at the balance point the low frequency is totally cancelled and only a doubling of the fundamental is heard. As the sweep progresses upwards so two frequencies are again heard, but each rising, one more slowly than the other. The very low frequency heard near the balance point is clearly shown in Fig. 4. The high frequency within the shape is at twice the original. This then is the sum of the two, and the difference. The frequency doubling can also be verified without a scope by taking both the final signal and one of the originals into a mixer and alternating the pan control between both, whereupon the octave differential will be heard. The same can be repeated when a low frequency note modulates a high frequency one. If the high frequency is out of audio range, the low frequency modulator will be heard to be one octave lower than the bass content of the output.

FREQUENCY DOUBLING

Fig. 5 shows the effect of deliberately feeding the same signal in to both the modulating and carrier inputs. From these photos it will be clear that frequency doubling occurs with each of the four different, original waveforms, but also that the output does not have the shape of the original. In the photographs of the ramp and squarewaves, both original waveforms have been intentionally slightly distorted so that the very fast intermediate peaks are more clearly seen. In all cases the frequency doubled waveform takes on a much

spikier shape, even for the sine wave. Indeed in other frequency doubling methods known to the author, a similar degree of sharpening is experienced. Any frequency doubled signal is thus bound to be a harsher note one octave higher, especially so with the ramp, and from an audio position, frequency doubling of a square wave will only produce objectionable clicks as the mark-space ratio is so wide. Doubling still takes on a harsher sound when introducing a time delay, which produces a phase shift, to one of two identical signals. (Interesting sounds are produced though, if the complete ring modulator is preceded or followed by echo, or reverb units). The doubling effectiveness is also subject to the complexity of the original signal. For simple monotonic frequencies, the effect is quite usable. However, if used when the signal is complex, like trying to double the pitch of a chord or of multiple instruments, the effect is cacophony. Speech too takes on extremely odd noises if octave raising in a ring modulator is attempted. For true frequency doubling with waveform retention, much more complex equipment is needed.

and interesting effects. When using a low frequency simple waveform with a higher frequency source such as speech or music, tremolo can be given to the music, and speech can be made to sound robot-like. In creating Dalek voices, one of the essentials is to modulate the voice at a low frequency, though other factors are involved in the production of the authentic Dalek sound. Tremolo and vibrato modulation are both effects that when used with discretion can greatly enhance the interest of many sounds.

For music the speed of modulation is at its most satisfying if the rate is in the region of 6·5Hz. In an analysis some years ago of the modulation given by violin players and opera singers, there was remarkable consistency between all of them, modulating their pitch within about 1 cycle of 6·5Hz. The author is involved in many types of effects units and finds that when testing rhythmic sources the most satisfying, and eventually the most hypnotic rates, are those within this same range. It is an interesting speculation that there might be a correlation between this frequency and the brain wave frequencies associated with Alpha and Theta rhythms. Theta rhythms are those with a frequency of about 4Hz to 7Hz, and which appear to be connected with mood. Alpha rhythms occur between 8Hz and 12Hz and occur most often in relaxed meditation. It is possibly no coincidence that the most satisfying tremolo and vibrato rates lie between the two.

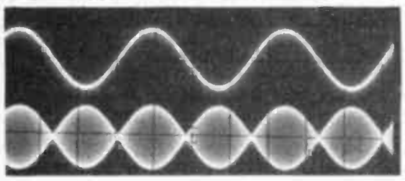


Fig. 3a. Sine-wave modulator

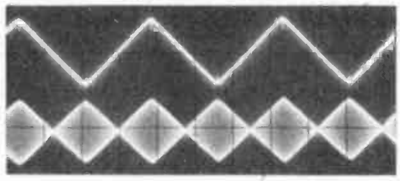


Fig. 3b. Triangle modulator

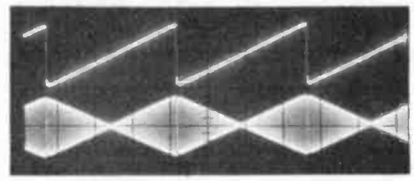


Fig. 3c. Rising-ramp modulator

Fig. 3 (above). Triangle wave 3kHz, used as the carrier. The upper trace is the modulating waveform and the lower, the composite output

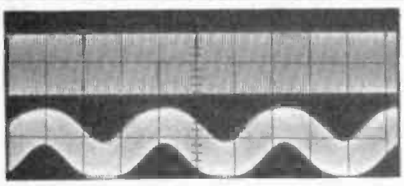


Fig. 4 (above). High frequency modulator, with modulating carrier at almost same frequency showing effective slow-beat frequency

Fig. 5 (right). Effects of using the same signal in both modulating and carrier inputs

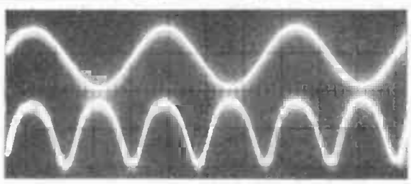


Fig. 5a. Sine-wave

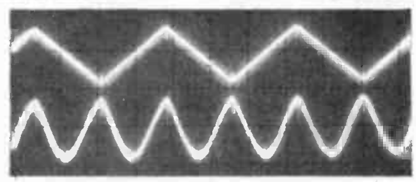


Fig. 5b. Triangle-wave

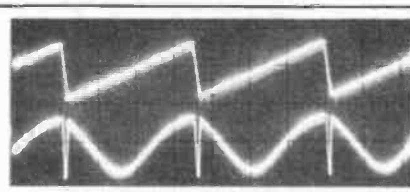


Fig. 5c. Rising ramp-wave

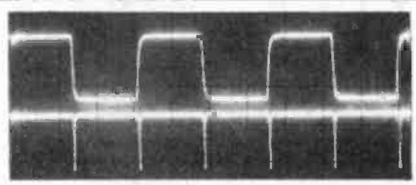


Fig. 5d. Square-wave

TRACKED RING MODULATING

Another option available is to use the inputs with two accurately controlled waveforms of different frequencies. The most usual source of these is two oscillators of a synthesiser, with the frequencies tracking identically, and exactly spaced so that the correct harmonic relationship is the same throughout the range. The complex chording structure is then simpler to achieve. Referring back to the frequency example earlier, 'G' at 396Hz is 1·5 times the frequency of 'C' at 264Hz. Similar relationships between two original signals will produce other equivalent composites, though not necessarily of a concordant nature.

FIXED CARRIER

It is not necessary for the carrier frequency to be shifting in sympathy with the modulator and in many cases it is better to keep the carrier static for the production of some weird

Proper vibrato cannot be readily produced by a ring modulator as it involves true frequency shifting without additional tone generation, but tremolo with a trace of vibrato is easily obtained through low frequency amplitude modulation around 6·5Hz. Voice modulation for Dalek-type production lies in the range of about 15Hz to 30Hz. At frequencies lower than this the modulation tends to be lost amongst the consonant peaks of speech as the vowels are usually much shorter than in singing. As the modulation rate increases between 400Hz and 1kHz so a metallic quality is acquired by the voice, becoming more pronounced but less intelligible as the carrier goes beyond 1kHz. If music is modulated with a fixed carrier in the higher frequency ranges extremely uncanny effects are produced. This is particularly true of carriers between 3kHz and 6kHz, when music can take on an almost nightmarish quality. When working on the prototype, the author found that 10 or 15 minutes of this upper frequency modulation was all that was tolerable at one time. Using low frequency ramps and squarewaves to modulate complex higher frequency sounds usually results in objectionable clicks. However, these clicks can be made use of if the carrier is a single high frequency or white noise source. With the former 'pinging' sounds can be produced and with the white noise, a variety of steam engine effects can be created. Using a white noise generator in conjunction with an external pulse source can also produce sounds akin to gun shots.

Fig. 6 shows the effect of VR5 in the d.c. control mode at three settings when a high frequency intermodulates with a low frequency. As will be seen some quite distinctive waveform shapes appear, all of which have their own unique effect upon the final output quality. When bypassing the ALC control a 180° phase change occurs and the ramp waveform changes to the opposite slope introducing a fifth set of variations. Full modulation in the d.c. mode is intentionally inhibited as the increased level required would inherently raise the carrier breakthrough level. Full carrier modulation is of course provided when S4 is in the a.c. mode. When switching between both modes, the nature of the circuitry produces a cross-fade effect between them. This is due to the relative d.c. levels applied to C21 changing, at a rate determined by the biasing resistors and provides a smooth changeover. A similar effect is produced when S7 is switched in and out. Fig. 7 shows the effect of using the same signal as both modulator and carrier in the d.c. mode. Frequency doubling still occurs but with a changed amplitude relationship.

Fig. 6. Various effects in the d.c. control mode with a high frequency intermodulating with a low frequency

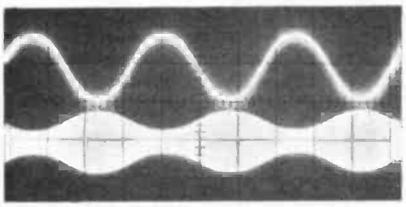


Fig. 6a. Sine-wave

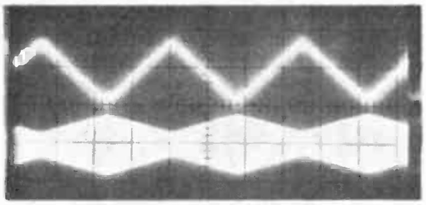


Fig. 6b. Triangle-wave

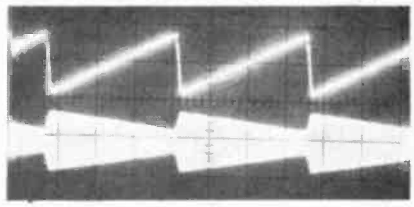


Fig. 6c. Rising ramp-wave

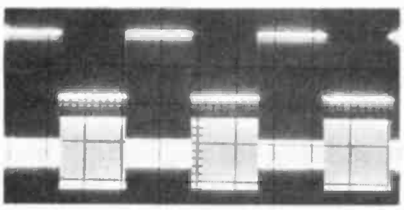


Fig. 6d. Square-wave

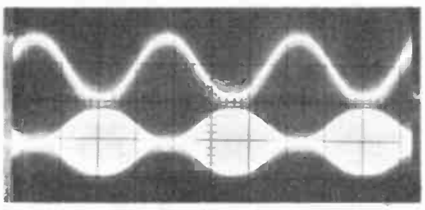


Fig. 6e. Sine-wave

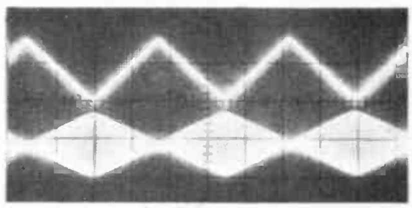


Fig. 6f. Triangle-wave

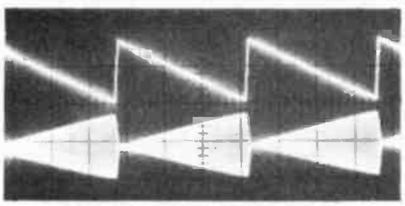


Fig. 6g. Falling ramp-wave

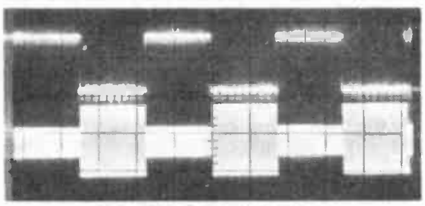


Fig. 6h. Square-wave

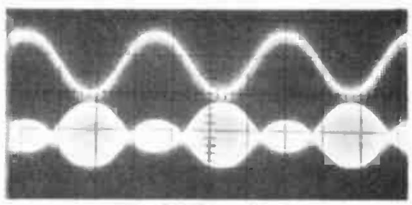


Fig. 6i. Sine-wave

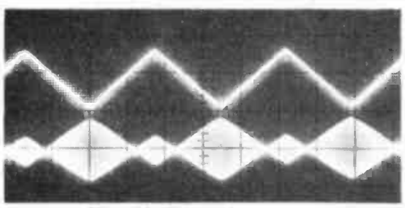


Fig. 6j. Triangle-wave

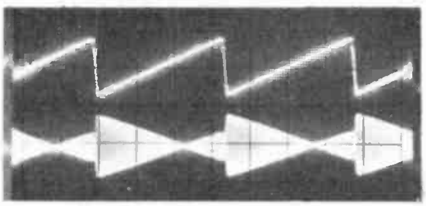


Fig. 6k. Rising ramp-wave

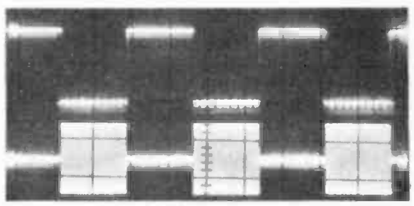


Fig. 6l. Square-wave

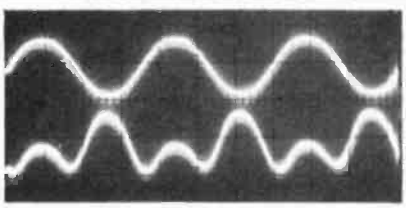


Fig. 7a. Sine-wave

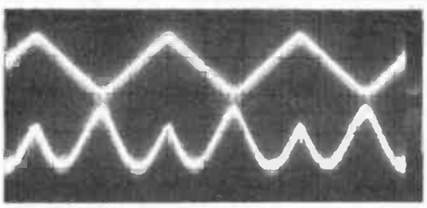


Fig. 7b. Triangle-wave

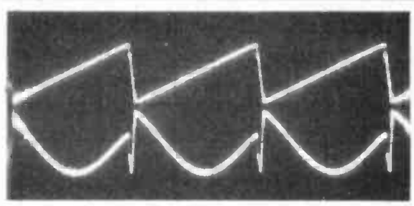


Fig. 7c. Rising ramp-wave

Fig. 7. Effects of using the same signal for modulator and carrier in the d.c. mode

ASSEMBLY

The p.c.b. layout is shown in Fig. 8 and the wiring diagram in Fig. 10. It is easiest to assemble the printed circuit board in order of component size, leaving the insertion of i.c.s into their sockets until last. The short wire links on the p.c.b. can be shaped from resistor offcut leads. It also helps with subsequent checking if the components are mounted with their identities readily visible. Diodes, electrolytic capacitors and i.c.s must only be inserted the correct way round as shown. At the very least the circuit will not work properly if this is ignored, at worst components could suffer extinction. Wiring to the controls must be tackled neatly and methodically to avoid the unit looking like a pig's nest! Make the connections between the panel components first, then wire up to the p.c.b., keeping all wires coming round the edges of the p.c.b.—coming over it makes it messy. They should be reasonably short, but long enough to enable the p.c.b. to be turned over for track side examination. Try to get it right first time as the box space is tight and it is tricky to manoeuvre the p.c.b. between the various panel parts. Ticking off components and wires as they are connected minimises errors, as does closely studying solder joints with a magnifying glass. These should look round and shiny, covering all round the solder pad on the p.c.b. If they look dull, crazed or daylight can be seen through them, then they are not good joints. Neither is one that has the solder spread across adjacent tracks. The author sometimes sees home assembled projects returned for servicing, and in practically all cases the only reason for malfunction is that improper attention has been given to soldering. It is very rare for modern components to be the cause of any misbehaviour.

SETTING UP

Alignment of the three presets is quite straightforward and no specialised equipment is needed. First, VR1 min, VR2 and 3 fully right, VR4 midway, VR5 min, VR6 max, VR7 midway, S1 position 1 (sinewave), S2 position 1 (internal VCO), S3 up (gate off), S4 off (d.c. coupled), S5 up (slow VCO), S6 up (ALC bypass), S7 up (R-mod override). If a signal generator is not available it is preferable to use a pre-recorded speech or music track from a cassette recorder or similar during testing. Plug this in to the high input jack socket, and the output jack socket into the main amplifier. Check that the cassette signal reaches the amplifier, if necessary increasing VR1

Fig. 8. The p.c.b. layout of the Ring Modulator

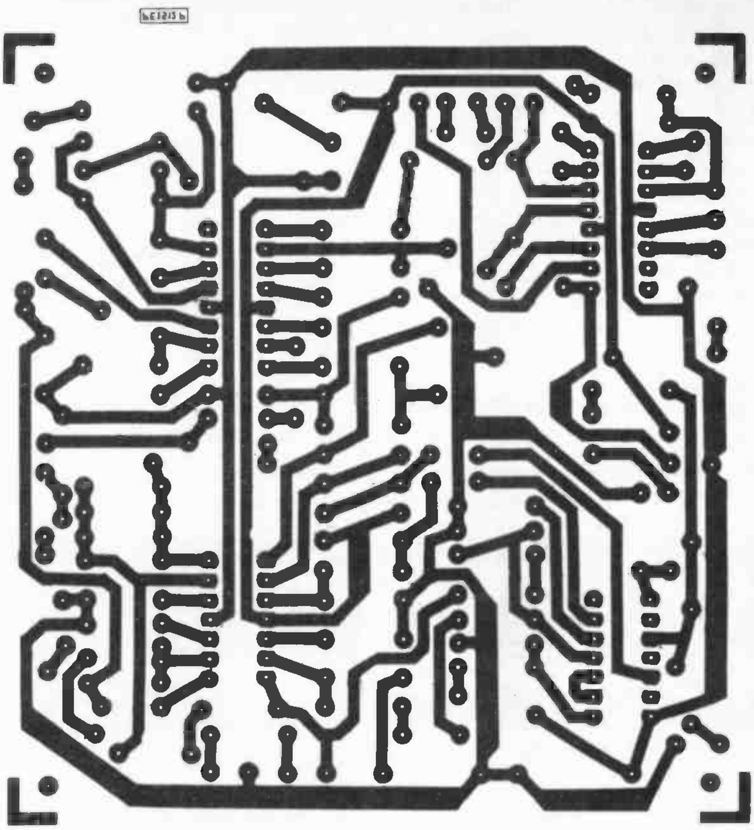
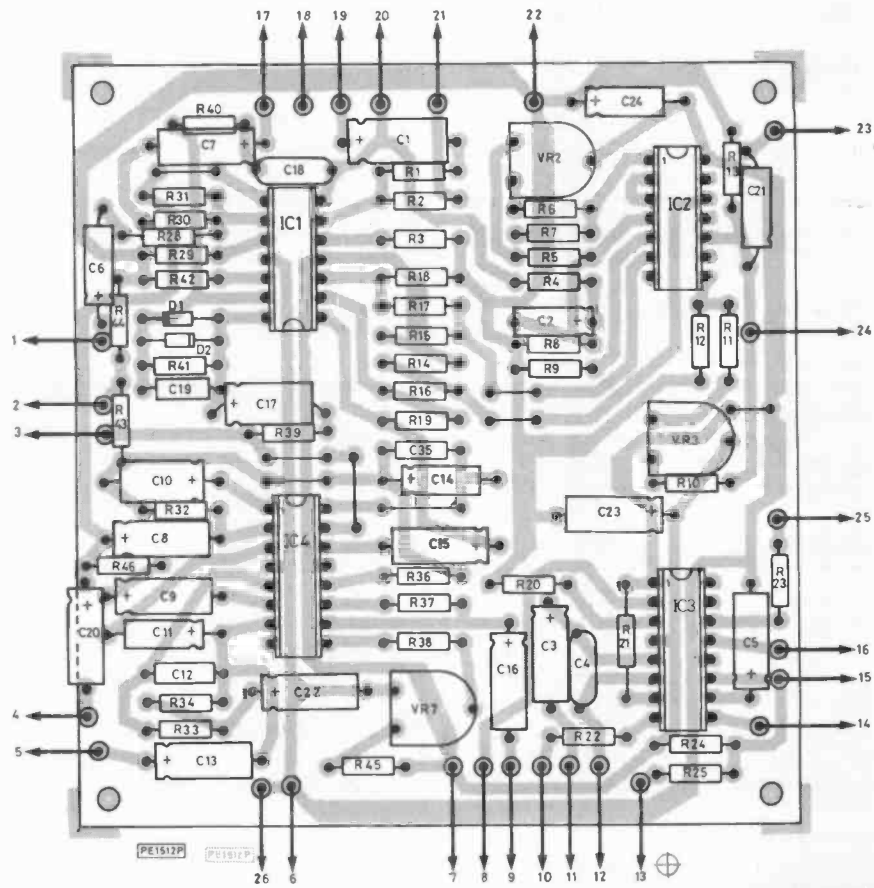


Fig. 9. The component layout of the Ring Modulator



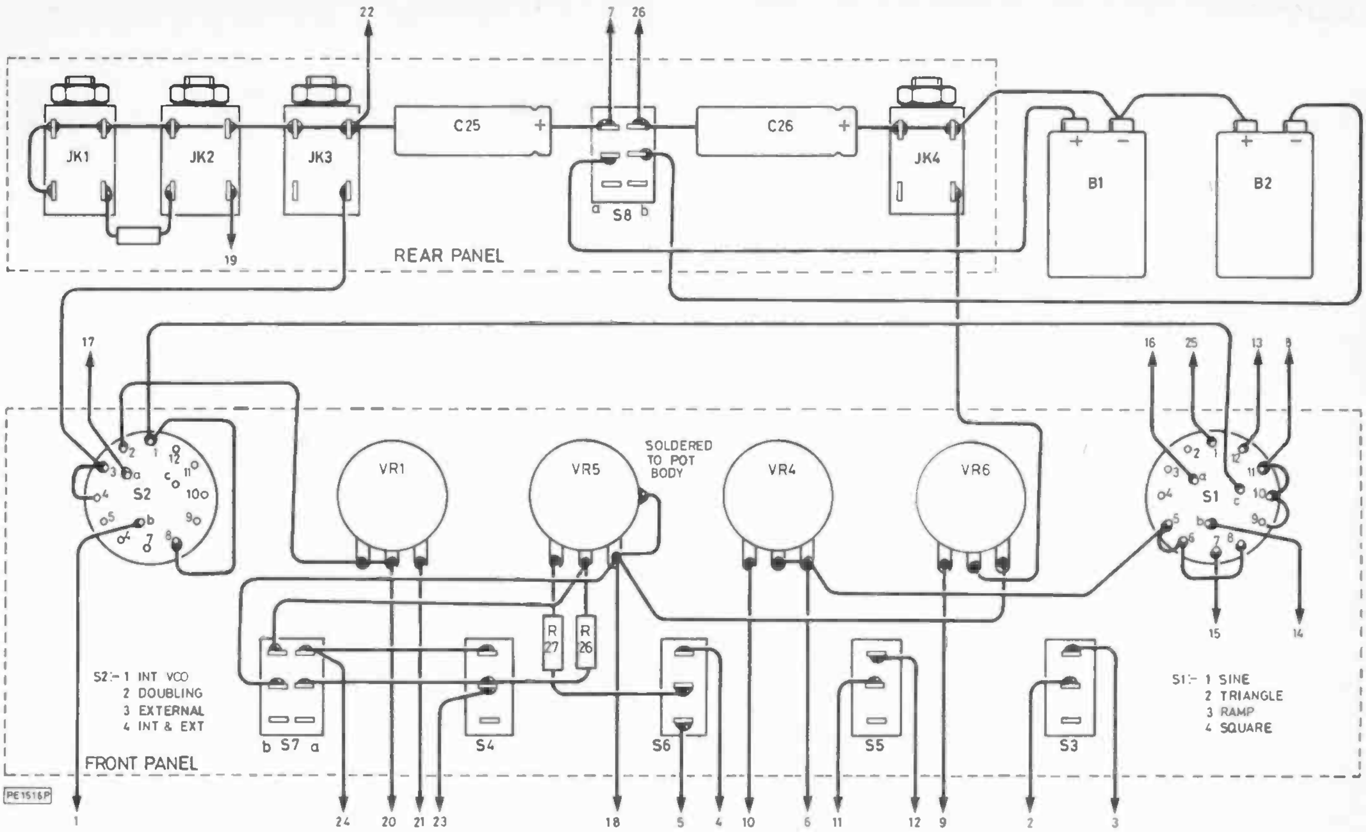
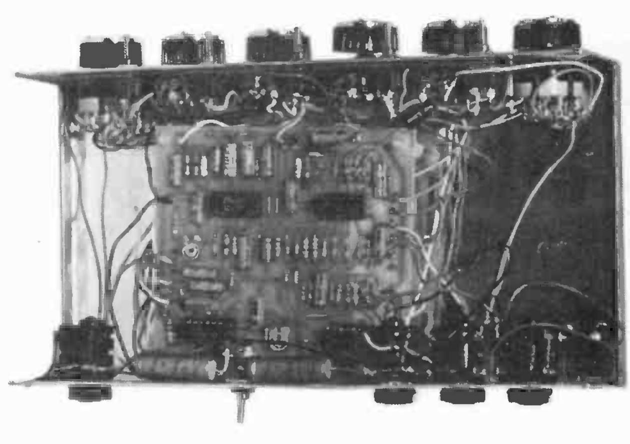


Fig. 10. Wiring diagram of the Ring Modulator

to a suitable level without distortion. Switch on S7 and a similar output level should remain. Switch on S4 to a.c. mode whereupon the sound should diminish. Slowly adjust VR3 around its midway point until the minimum level is heard. Bringing up VR5 to maximum, a slow modulation of the sound should be heard. Varying VR4 the modulation rate will change. Switching on S5 the rate will increase dramatically, and the quality of the audio output change with it. Remove audio source from the input leaving only the carrier signal. Switch S1 through its four settings and note that changes in carrier quality are evident. The carrier level will also change with the settings of S1. With S6 switched on to ALC mode the variations will be less pronounced and on an amplifier VU meter, the levels will appear practically the same. Maximise VR5 and carefully adjust VR2 around its midway point until carrier breakthrough is as low as possible. Again apply audio source from cassette. Switching on S7, carrier modulation will cease leaving only the original sound. Now align VR7 adjusting it around its midway point until minimum waveform distortion is heard at higher amplitudes. If no difference is noticeable, leave midway and ignore, though the correct setting will be obvious on an oscilloscope if a triangle waveform from a signal generator is used. Finally again remove the cassette, switch off S7, set VR5 max, VR4 and S5 set for maximum frequency. Increase amplifier volume until carrier breakthrough is audible. Switching on S3 the noise gate should come into operation and close down the output, eliminating all but the very smallest trace of crosstalk within IC4. Experiment with all the controls and switches with various types of speech and music inputs until familiar with the operation of the unit. If making minute adjustments to VR2 and VR3 allow the unit to be switched on first for a few minutes in case of a slight temperature sensitivity, although this was not apparent in the author's model.

The basic functions of a ring modulator have been covered in the introduction. The use of the unit is otherwise subject only to the imagination of the user. It will soon become familiar knowledge which settings are best for which type of input, whether for trains or tremolo, musical effects, or for modifying speech for robot and Dalek type vocalisations. ★

Photographs illustrating the internal and external assembly of the complete unit



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ZN432E-10	13.00
ZN433CJ-10	25.00
ZN434	0.98
ZN435	4.38
ZN436E	1.26
ZN440	55.00
ZN441	46.80
ZN447	7.80
ZN448E	6.66
ZN448J	12.48
ZN449	2.72
ZNA134J	22.50
ZNA234E	9.40

VOLTAGE REF.

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

BUFFERS

81LS96	1.10
81LS97	1.10
81LS98	1.10
8T26A	1.10
8T28	1.10
8T28A	1.10
8T95	1.10
8T97A	1.10
8T98	1.10

OPTOISOLATORS

4N25	0.75
4N26	0.75
4N33	0.90

UHF MODULATORS

UM1111	2.95
UM-1233	3.45

VOLTAGE REG.

7805	0.75
7812	0.75
7815	0.75
78H05SC	7.50
78H12ASC	8.95
78HGASC	9.95
78L05	0.30
78L12	0.30
78L15	0.30
78S40DM	7.50
78S40PC	3.00
7905	0.95
7912	0.95
7915	0.95
LM309K	0.95
LM317K	2.45
LN323K	4.95
LM338K	4.50

FAIRCHILD FAST

74F00PC	0.60
74F04PC	0.60
74F08PC	0.65
74F109PC	0.65
74F11PC	0.52
74F138PC	0.52
74F138PC	1.26
74F139PC	1.26
74F151	1.26
74F153	1.26
74F157	1.30
74F158	1.17
74F161	2.34
74F164	1.68
74F175	1.82
74F181	3.90
74F189	5.10
74F190	3.20
74F191	3.20
74F194	1.68
74F20PC	0.52
74F240	3.16
74F241	2.42
74F243	2.80
74F244	2.96
74F245	6.08
74F251	1.26
74F253	1.26
74F257	1.26
74F258	1.34
74F280	1.74
74F283	1.74
74F32PC	0.52
74F352	1.26
74F353	1.26
74F373	3.16
74F374	3.16
74F379	1.83
74F381	6.62
74F382	4.22
74F398	3.16
74F399	2.70
74F521	2.76
74F533	3.16
74F534	3.16
74F537	6.02
74F538	4.38
74F539	4.38
74F64PC	0.52
74F74PC	0.58
74F86PC	0.77

HIGH SPEED CMOS

74HC00N	0.42
74HC02N	0.42
74HC03N	0.64
74HC04N	0.44
74HC08N	0.42
74HC107N	0.78
74HC109N	0.50
74HC10N	0.64
74HC112N	0.86
74HC113N	0.86
74HC132N	1.28
74HC137N	1.81
74HC138N	1.20
74HC139N	0.78
74HC151N	1.16
74HC153N	0.90
74HC157N	1.02
74HC158N	1.02
74HC160N	0.90
74HC161N	0.90
74HC162N	1.51
74HC163N	1.51
74HC164N	0.95
74HC165N	2.24
74HC173N	1.35
74HC174N	0.80
74HC175N	0.78
74HC194N	1.28
74HC195N	1.28
74HC20N	0.40
74HC237N	1.80
74HC240N	1.38
74HC241N	1.34
74HC242N	2.24
74HC243N	2.24
74HC244N	1.32
74HC251N	1.03
74HC253N	1.03
74HC257N	1.03
74HC266N	0.92
74HC273N	2.24
74HC27N	0.80
74HC280N	3.26
74HC32	0.40
74HC373N	2.40
74HC374N	2.40
74HC393N	1.78
74HC4002	0.64
74HC4017	1.16
74HC4020	1.46
74HC4024	1.20
74HC4040	1.46
74HC4060	1.46
74HC4075	0.64
74HC42N	0.90
74HC4511	2.51
74HC4514	3.76
74HC4538	2.36
74HC4543	3.04
74HC51N	0.64
74HC533N	2.40
74HC534N	2.40
74HC589N	1.72
74HC58N	0.64
74HC595N	1.84
74HC597N	1.72
74HC73N	0.84
74HC74N	0.84
74HC75N	0.92
74HC76N	0.64
74HC85N	2.02
74HC86N	0.80
74HCU04N	0.80

TTL

74LS00	0.25
74LS01	0.25
74LS02	0.25
74LS03	0.25
74LS04	0.25
74LS05	0.25
74LS08	0.25
74LS09	0.25
74LS10	0.25
74LS109	0.54
74LS11	0.25
74LS112	0.54
74LS113	0.42
74LS114	0.44
74LS12	0.25
74LS122	0.75
74LS123	0.95
74LS124	2.30
74LS125	0.49
74LS126	0.49
74LS13	0.46
74LS132	0.73
74LS136	0.46
74LS138	0.77
74LS139	0.77
74LS14	0.80
74LS145	1.23
74LS148	1.50
74LS15	0.25
74LS151	1.10
74LS153	1.10
74LS155	0.77
74LS156	0.77
74LS157	0.62
74LS158	0.62
74LS160	0.80
74LS161	0.80
74LS162	0.80
74LS163	0.80
74LS164	1.10
74LS165	1.30
74LS166	1.95
74LS173	1.13
74LS174	1.30
74LS175	0.96
74LS181	2.09
74LS190	0.98
74LS191	0.75
74LS192	1.10
74LS193	1.10
74LS194	0.78
74LS195	0.78
74LS196	1.10
74LS197	1.10
74LS20	0.25
74LS21	0.25
74LS22	0.25
74LS221	1.08
74LS240	1.40
74LS241	1.40
74LS242	1.36
74LS243	1.36
74LS244	1.40
74LS245	1.95
74LS248	1.16
74LS249	1.16
74LS251	0.78
74LS253	0.78
74LS257	0.78
74LS258	0.78
74LS259	1.77
74LS26	0.30
74LS261	2.60
74LS266	0.35
74LS27	0.25
74LS273	1.35
74LS279	0.77
74LS28	0.25
74LS283	1.00
74LS290	0.86
74LS293	0.86
74LS30	0.25
74LS32	0.25
74LS33	0.30
74LS365	0.55
74LS366	0.55
74LS367	0.55
74LS368	0.55
74LS37	0.25
74LS373	1.50
74LS374	1.50
74LS375	0.75
74LS377	1.50
74LS378	1.22
74LS379	1.50
74LS38	0.25
74LS386	0.50
74LS390	1.10
74LS393	1.10
74LS40	0.25
74LS42	0.85
74LS47	1.00
74LS48	1.00
74LS49	1.00
74LS51	0.25
74LS54	0.25
74LS55	0.25
74LS670	2.30
74LS73	0.30
74LS74	0.35
74LS75	0.50
74LS76	0.35
74LS78	0.35
74LS83	0.90
74LS85	1.16
74LS86	0.42
74LS90	0.66
74LS91	1.30
74LS92	0.66
74LS93	0.66
74LS95	0.77

CMOS 4000 Series

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

CRYSTALS

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

DIL SKTS TIN

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

DIL SKTS GOLD

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

DIL SKTS W/WRAP TURNED PIN

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

ZIF SOCKETS

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

components

GILRAY ROAD, DISS, NORFOLK. TEL: 0379 4131

INSULATION DISPLACEMENT CONNECTOR SYSTEM

HEADERS	SHROUDED 90°	OPEN 90°	OPEN — STRAIGHT PINS
10 way	0.86	0.65	0.47
14 way	1.22	0.83	0.59
16 way	1.34	0.92	0.65
20 way	1.36	1.13	0.77
26 way	1.70	1.40	0.95
34 way	2.04	1.78	1.19
40 way	2.28	2.07	1.37
50 way	2.70	2.54	1.67
60 way	3.20	3.02	1.96

CABLE ASSEMBLIES

IDC JUMPERS SINGLE ENDED

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

DIP JUMPERS

Single Ended

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

Double Ended

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

SOCKETS

10 way	0.88
14 way	1.06
16 way	1.16
20 way	1.38
26 way	1.66
34 way	1.94
40 way	2.08
50 way	2.78
60 way	3.34

DIP PLUGS

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

D-TYPE PLUGS

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

TRANS. CONNS.

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

CARD EDGE

10 way	1.84
20 way	3.14
26 way	3.80
34 way	4.90
40 way	5.52
50 way	6.68
60 way	8.06

D-TYPE SOCKETS

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

DISC DRIVE CONNECTING CABLES

34 way card edge to 34 way card edge 1M	11.30
34 way card edge to 2 × 34 way card edge 1.5M	18.00
34 way card edge to 34 way IDC SKT (BBC) 1M	8.50
34 way card edge to 2 × 34 way IDC KT (BBC) 1.5M	14.50
BBC Power Cable — Single Drive	3.50
BBC Power Cable — Dual Drive	4.75

RIBBON CABLE (PRICED PER FOOT)

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

BBC MICRO CONNECTORS

DIN PLUG 7 PIN	0.40
DIN PLUG 6 PIN	0.40
DIN PLUG 5 PIN 180°	0.40
DIN PLUG 5 PIN DOMINOE	0.40
POWER PLUG (36" CABLE)	3.00
ANALOGUE INPUT PLUG	2.25
5 WAY DIN SKT 180°	0.90
5 WAY DIN SKT DOMINOE	0.90
6 WAY DIN SKT	0.90
7 WAY DIN SKT	0.90
15 WAY DIN SKT	2.15

Connecting cables for personal computers

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

Part number	Description	Computer	
Video cables			
CON100	Phono plug to phono plug (2M)		1.20
CON101	Phono plug to BNC plug (2M)		2.95
CON102	BNC plug to BNC plug (2M)		3.95
CON107	6 pin DIN to open end (1M)	BBC	1.05
CON108	6 pin DIN to 6 pin DIN (1M)	BBC	1.50
CON119	Phono plug to coax plug		1.35
CON160	DIN plug to 2 phono plugs	Dragon	1.20
Cassette recorder cables			
CON109	7 pin DIN to open end	BBC	1.25
CON110	7 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	BBC	2.50
CON111	7 pin DIN to 5 pin DIN + 2.5mm J/plug	BBC	2.50
CON118	5 pin DIN to 2 × 3.5mm J/plugs	Spectrum/ZX	2.50
CON117	5 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	Dragon	2.50
Parallel printer cables			
CON130	36 way plug to 36 way plug (2M)	Sirius/Apricot	18.00
CON131	36 way plug to 36 way plug (5M)	Sirius/Apricot	26.50
CON132	36 way plug to 36 way socket (2M)		18.00
CON133	36 way plug to 36 way socket (5M)		26.50
CON144	36 way plug to 25 way male D type (2M)	IBM/TI PC	19.00
CON145	36 way plug to 25 way male D type (5M)	IBM/TI PC	27.50
CON134	36 way plug to 25 way male D type (2M)	RML/Apple	19.00
CON135	36 way plug to 25 way Male D type (5M)	RML/Apple	27.50
CON142	36 way plug to 20 way IDC socket (2M)	Dragon	13.95
CON139	36 way plug to 26 way IDC socket (2M)	BBC	9.95
CON140	36 way plug to 26 way IDC socket (5M)	BBC	22.95
CON141	36 way plug to 34 way card edge (2M)	TRS80 Lev. 1	18.50
CON143	36 way plug to 34 way IDC socket (2M)	TRS80 Lev. 2/ Memotech	10.95
RS232 Cables			
CON106	25 way male D type to 5 pin DIN	BBC	5.85
CON128	'Universal' RS232 cable (pins 1-8, 20 connected and 20 jumpered as required) 2M		15.95
CON164	'Universal' RS232 cable as above but 5M		20.95
CON120	25 way male to male 1-25 connected (2M)		16.95
CON121	25 way male to male 1-25 connected (5M)		22.50
CON122	25 way male to male 1-25 connected (10M)		32.50
CON123	25 way male to male 1-25 connected (30M)		68.00
CON124	25 way male to female 1-25 connected (2M)		15.45
CON125	25 way male to female 1-25 connected (5M)		21.00
CON126	25 way male to female 1-25 connected (10M)		31.00
CON127	25 way male to female 1-25 connected (30M)		66.50
CON129	25 way male to 9 way male	Spectrum	15.95
CON162	25 way male to 9 way male	Mackintosh	15.95
CON163	25 way male to 5 pin DIN	RML 480Z	14.95

PART NO.	DESCRIPTION	MAIL ORDER PRICE
BBC MICROS AND ACCESSORIES		
ANB01	BBC Model B Micro	£325.00
ANB02	BBC Model B Micro with Econet I/F	£385.00
ANB03	BBC Model B Micro with Disc I/F	£406.00
ANB04	BBC Model B Micro with Disc & Econet	£445.00
ALA01	Acorn Electron	£139.00
ANB21	DNFS ROM	£17.91
ANB23	Disc Interface Kit	£71.65
ANB14	Speech Interface	£40.00
ANK01	IEEE488 Interface Adaptor	£277.75
ANB22	Econet I/F Kits	£35.00
BBC 45	Joysticks	£8.00
STAND	Monitor Stand	£7.50
SRE1	Sideways ROM Expansion Board	£25.95
DISC DRIVES WITHOUT POWER SUPPLY		
BBC30	Single 100k TEC 40 track single sided	£99.95
BBC31S	Single 100k TEC (expandable to dual) 40 track	£115.00
BBC31D	Dual (2 × 100k) TEC 40 track single sided	£225.00
BBC34	Single 400k TEC 80 track double sided	£174.00
BBC34S	Single 400k TEC (expandable to dual) 40/80 track switchable double sided	£194.00
BBC34SW	Single 400k TEC 40/80 track switchable double sided	£184.00
BBC 34D	Dual (2 × 400k) TEC 40/80 track switchable double sided	£310.00
BBC 34S/80	Single 400k TEC (expandable to dual) 80 track double sided	£184.00
BBC34D/80	Dual (2 × 400k) TEC 80 track double sided	£300.00
DISC DRIVES WITH POWER SUPPLY		
BBC30P	Single 100k TEC 40 track single sided with P.S.U.	£130.00
BBC31SP	Single 100k TEC (expandable to dual) 40 track with P.S.U.	£150.00
BBC31DP	Dual (2 × 100k) TEC 40 track singleside with P.S.U.	£250.00
BBC34P	Single 400k TEC 80 track double sided with P.S.U.	£209.00
BBC34SP	Single 400k TEC (expandable to dual) 80 track with P.S.U.	£229.00
BBC34DP	Dual (2 × 400k) TEC 40/80 track switchable with P.S.U.	£345.00
MECHANISMS		
FB501	TEC 100k single sided	£91.00
FB504	TEC 400k double sided	£150.00
FLOPPY DISCS		
MD-1C/B	Nashua single sided, single density 40 track (10 discs)	£12.00
MD-1DC/B	Nashua single sided, double density 40 track (10 discs)	£13.00
MD-2DC/B	Nashua double sided, double density 40 track (10 discs)	£15.50
MD-2FC/B	Nashua double sided, quad density 80 track (10 discs)	£17.85
SPECIAL OFFER		
BBC40TD	BASF double sided, double density 40 track (10 discs)	£14.00
DISC STORAGE BOXES		
MDT25/3	3½" Flip 'N' file Micro disc box (cap. 25)	£7.75
DT25/5	5¼" Flip 'N' file lockable disc box (cap. 25)	£18.77
DT60/5	5¼" Standard lockable disc box (cap. 60)	£10.65
MONITORS		
9MON	9 inch green screen high resolution NEC high quality monitor	£125.00
12MON	12 inch green screen high resolution NEC high quality monitor	£135.00
1431	Microvitec 14" RGB colour monitor	£175.00
1441	Microvitec 14" RGB colour monitor high resolution	£410.00
1451	Microvitec 14" RGB colour monitor medium resolution	£295.00
1431/AP/MS	Microvitec 1431 PAL & RGB inputs and sound facility	£225.00
BBC COMPATIBLE SOFTWARE		
SBB03	View Rom	£45.00
SBB04	View Printer Driver	£7.50
AES20	Fileserver Level 1-40 track	£80.50
AES21	Fileserver Level 2-80 track	£202.00
SNB08	Acornsoft Invoicing program	£16.00
SNB09	Acornsoft Mailing System program	£16.00
SNB10	Acornsoft Accounts Receivable program	£16.00
SNB11	Acornsoft Stock Control program	£16.00
SNB12	Acornsoft Order Processing program	£16.00
SNB13	Acornsoft Acounts Payable program	£16.00
SNB14	Acornsoft Purchasing program	£16.00
SNL01	Forth — 40 track	£15.00
SNL02	Lisp — 40 track	£15.00
SNL04	Microtext — 40 track	£47.50
MATRIX PRINTERS		
RX80	Epson RX80 100cps matrix printer	£204.00
RX80F/T	Epson RX80F/T 100 cps matrix printer friction or tractor feed	£231.00
FX80	Epson FX80 150cps matrix printer	£328.50
MT80SP	Mannesmann Tally MT80 matrix printer friction or tractor feed with film ribbon and tear off facility	£209.00
LETTER QUALITY PRINTERS		
HR5	Brother HR5 Thermal printer A/C mains or battery	£115.00
HR15	Brother HR15 Daisy wheel printer (13cps)	£326.00
HR25	Brother HR25 Daisy wheel printer (23cps)	£550.00
UCHIDA	Uchida DWX305 Daisy wheel printer (20cps)	£227.00
PRINTER SUPPLIES		
11241P160	11×9½ 1 part plain listing paper (2,000)	£11.25
11241P2CI	11×9½ 2 part (otc) plain listing paper (1,000)	£14.00
11241P3CI	11×9½ 3 part (otc) plain listing paper (700)	£16.25
11370R160	11×14½ 1 part ruled listing paper (2,000)	£13.50
11370R2NC	11×14½ 2 part (ncr) ruled listing paper (1,000)	£22.50
11370R2CI	11×14½ 2 part (otc) ruled listing paper (1,000)	£15.00
12235P160S	12×9½ 1 part plain listing paper with side perfs. (2,000)	£12.00
HR1R	Brother HR1 ribbon	£2.20
RIB119	Diablo Hytype II Multistrike film ribbon	£1.75
GP205	Diablo Hytype II fabric ribbon	£2.50
MX80	Epson MX80, RX80, FX80, fabric ribbon	£3.00
MT80	Mannesmann Tally MT80 film ribbon	£6.50
RIB117	Uchida DWX305 multistrike film ribbon	£2.75
HR5R	Brother HR5 ribbon	£2.20
HR15R	Brother HR15 multistrike ribbon	£4.00
HR25R	Brother HR25 multistrike ribbon	£4.00
	Brother daisy wheels	£14.00
	Uchida/Qume daisywheels	£4.00
LAB089361C	3½×1.7/16 Labels — 1 wide (12,000)	£20.00
LAB089361S	3½ 1.7/16 Labels — 1 wide (2,000)	£13.00
LAB070363F	2¾ 1.7/16 Labels — 3 wide (1/10") (2,000)	£8.00

SOLDERING is one area of electronics where many constructors seem to give little thought to either the equipment they use or the methods they adopt. This often causes damage to components and p.c.b. tracks and can result in many unnecessary hours of fault finding once the project has been assembled. These problems can be easily overcome by using a suitable soldering iron and following the few simple rules set out below.

The basic requirement of a soldered joint is to provide an electrically conductive path with a secondary consideration being the mechanical strength of the joint.

Before soldering it is essential that the surfaces to be soldered are clean and free from any dirt or grease. If solder is to be applied to any heat-sensitive components then a suitably sized heat-shunt should be used. These are normally in the form of specially designed tweezers, although many people prefer to use a small pair of pliers.

The most important part of the soldering iron is the 'tip' or 'bit'. This is the part of the iron which stores the heat ready for passing onto the joint. The size of the bit and the power rating of the iron will determine the amount of heat that is supplied by the iron to the work and also the rate at which the work can be carried out.

the entire joint. The solder should be removed first and then the iron. After the joint has cooled it should then be checked. Remember, to ensure a good joint, never blow or move a soldered joint before it has set!

A good joint should have a smooth, shiny appearance with no pitting, spikey or dull parts; and should of course be mechanically sound.

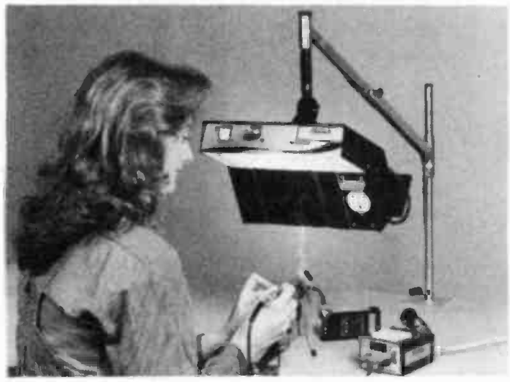
It doesn't take long to realise that when you are soldering you always seem to need an extra pair of hands to hold either the work or the component. If you are working on a p.c.b. then it is best to use a p.c.b. holder which will allow you easy access to both sides of the board and hold it steady whilst you are soldering.

Before you start soldering ensure that all the components you require are laid out in the order in which they are to be soldered. An ideal method of storing components prior to soldering is to use a polystyrene block; note though that MOS components should be kept in their packages until you are ready to solder them into place.

You should also ensure you have plenty of light over your workplace and that you have a comfortable sitting position.

Always replace your iron in its holder when you have finished with it. Never leave an iron on your workbench.

SOLDERING INSTRUMENT BUYER'S GUIDE



If the temperature of the bit is incorrect it can lead to a number of problems. Too low a temperature can result in the insufficient activation of the flux, poor solder flow and therefore dry joints. If a joint is dry it will exhibit a high resistance which can be very difficult to trace. It should be noted that the majority of dry joints will only become dry after a period of time.

When the temperature setting is too high the flux will be vaporised, causing the solder to oxidise, resulting in poor quality joints and perhaps damage to any heat-sensitive components.

Soldering iron bits are usually made from copper to provide the maximum heat transfer at low cost. Because the copper soon becomes eroded many bits are coated with either nickel or chromium on their non-soldering surfaces to prevent oxidising whilst the tip can be coated with iron to increase its operating life.

The surface of the bit should be clean and free from any pits, burrs or indentations. To enable the smooth flow of heat from the surface of the bit to the joint a small amount of solder is placed on the bit prior to soldering each joint, this is called 'tinning'. After each soldering operation the bit should be cleaned with either a damp cloth or sponge and re-tinned if another joint is to be made.

When making a soldered joint the pre-tinned bit of the iron should be held against the joint and the flux-cored solder applied; the solder should flow immediately covering

When choosing a soldering iron for your particular needs you must take into account all the applications for which it will be used. Soldering irons come in a variety of wattages, bit sizes and operating voltages. Some irons come as part of a soldering station and include a holder, sponge tray and a temperature adjustment to set the operating temperature of the bit.

In this buyer's guide we have tried to show the wide range of soldering irons currently available and have also included some of the soldering aids that can be used.

The prices shown include VAT but not post and packing except where stated.

PLEASE NOTE

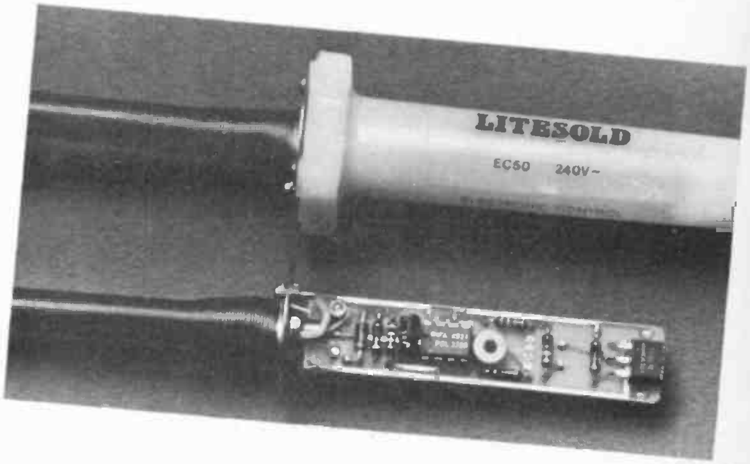
We would like to point out that readers buying from the guide are not protected by the Mail Order Protection Scheme unless the company concerned have advertised the product in a display advertisement in this issue.

The guide is designed as an aid to the purchaser and makes no recommendations.

SOLDERING INSTRUMENT BUYER'S GUIDE

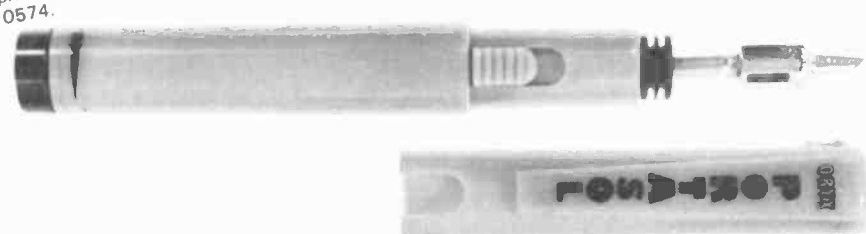
The **Oryx M3** iron is rated at 17 watts and has a normal operating temperature of 380 degrees centigrade. It is supplied complete with a replaceable push-on tip and storage hook. The M3 is available in 12V, 110V and 210/240V versions with the 12V model fitted with a cigar-lighter plug for car repair work. Priced at £6.85 it is available from **Greenwood Electronics**, Portman Road, Reading, Berks ✆0734 595844.

The Litesold **EC50** has an electronic temperature control which can be easily adjusted via an aperture in the handle. The temperature can be adjusted between 280 and 400 degrees centigrade. The bits are iron coated copper for long life and are retained by circlips to prevent sticking. The 50 watt iron is priced at £28.00 and is available from **Light Soldering Developments Limited**, Spencer Place, 97/99 Gloucester Road, Croydon ✆01-689 0574.

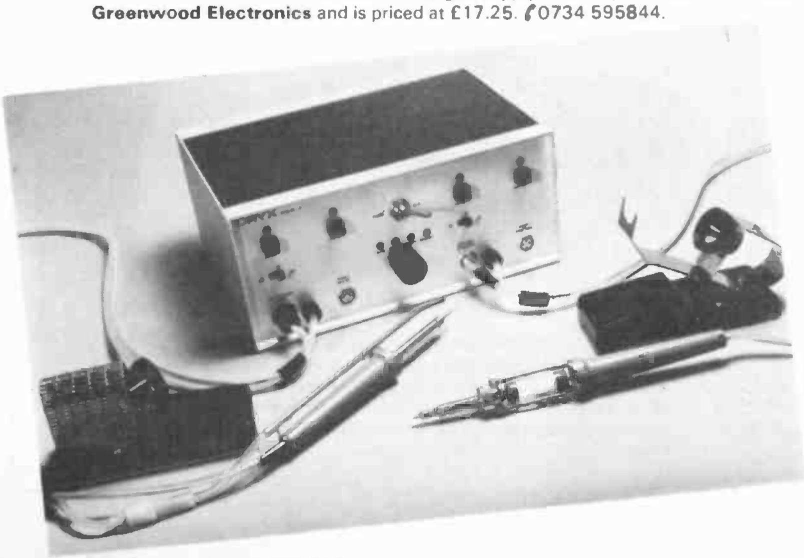


The **LC18** from Litesold is a high efficiency iron suitable for general electronic assembly and servicing work. It can be either mains or low voltage powered and takes a wide range of bits. The **LA12** is similar to the LC18 but is rated at 12 watts and is mainly intended for smaller work. The LA12 is priced at £7.25 and the LC18 is priced at £7.31. **Light Soldering Developments Ltd.** ✆01-689 0574.

The Weller **WM12D** weighs just 7 ounces and is the smallest iron in their range. It is rated at 12 watts and develops a tip temperature of 425 degrees centigrade. There is a choice of three tips which can be easily interchanged. The WM12D which is priced at £6.58 is also available in kit form together with two spare tips, a pair of tweezers and a supply of resin cored solder. **Cooper Tools Limited,** Sedling Road Wear, Washington, Tyne & Wear ✆091 416 6062.



The new portable butane powered soldering iron from Oryx is only slightly bigger than a felt-tip pen. There is no flame during use, the chemical energy of the gas is converted into heat by means of a catalytic converter in the bit. The iron delivers the equivalent of 60 watts with the tip temperature being variable between 250 and 450 degrees centigrade. The iron will run for 60 minutes on its gas supply. The Oryx Portasol is available from **Greenwood Electronics** and is priced at £17.25. ✆0734 595844.



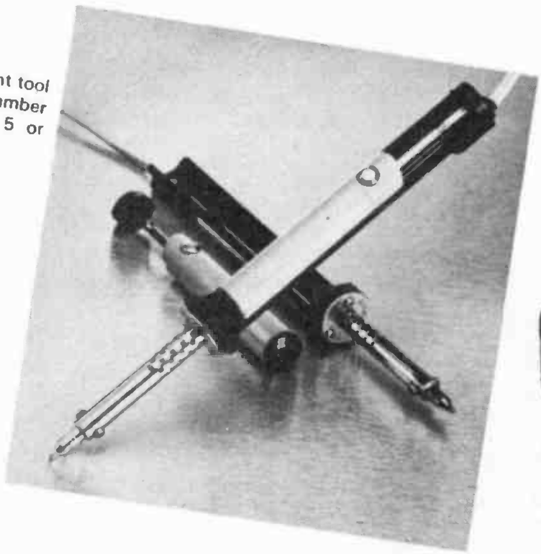
The totally self-contained **Oryx HSR1** requires no external air or vacuum supply lines. It consists of five units: the TC84 temperature controlled iron, the SR84 vacuum solder removing iron, p.s.u. and two magnetic base safety stands for the irons. The TC84 is fitted with a fume extractor which can be switched from the TC84 to the SR84 as required. The workstation is priced at £570.00. **Greenwood Electronics** ✆0734 595844.

SOLDERING INSTRUMENT BUYER'S GUIDE

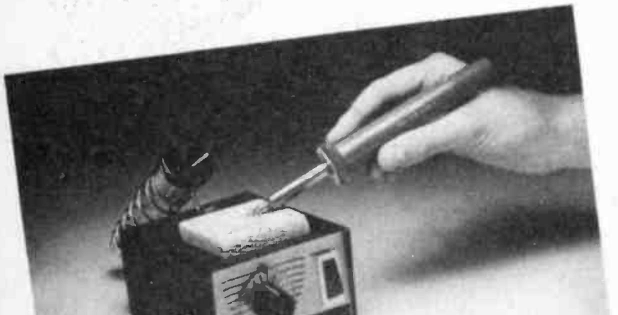
The **Litesold ETC-4/FXc** soldering station has a built in fume extractor (see Inset), and fully variable electronic temperature control with digital readout. The 40 watt iron uses a thermocouple sensor, is "spike" and "r.f.i." free, and also free of static and leakage. Price £299 + p&p from **Light Soldering Developments Ltd.**, Spencer Place, 97/99 Gloucester Rd., Croydon, Surrey CRO 2DN. ✆ 01-689 0574.

The **TCSU-D** is a 60-watt soldering station with an electronic temperature control range of ambient to 495 deg. C. The iron itself works on 24V stepped down from mains to safety and isolation. Price £80·81 from **Antex (Electronics) Ltd.**, Mayflower House, Plymouth, Devon. ✆ 0752 667377.

P.c.b. Track Repair Kit includes master frames with tracks, fingers, pads, elbows and flatpack pads, eyelets and funnelets plus the setting tools. Includes epoxy, flux, cleaner, spatulas, abrasive sticks, tweezers, clamps and knives. An economy version is also available. Price, standard £145·90. Economy £72. **OK Industries UK Ltd.**, Dutton Lane, Eastleigh, Hants SO5 4AA. ✆ 0703 619841.



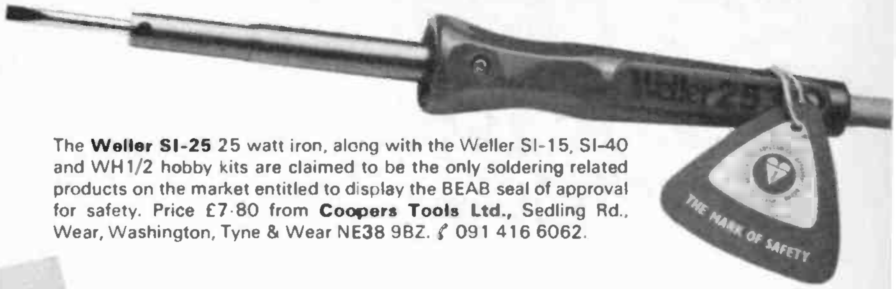
SA-6 desoldering iron is a powerful lightweight tool combining heating and suction. The suction chamber is easily removed for cleaning. Available 115 or 230V. Price £19·19 from **OK Industries.**



Adcola 101 electronic controlled soldering iron is production orientated. Features r.f.i. free temperature control, zero leakage, open circuit failsafe protection, l.e.d. temp. indicator, and lockable temp. dial (120–420 deg. C) Bifilar wound to prevent magnetic effects. Price £78·40 (+ £6 carriage) from **Adcola Products Ltd.**, Adcola House, Gauden Rd., London SW4 6LH. ✆ 01-622 0291.

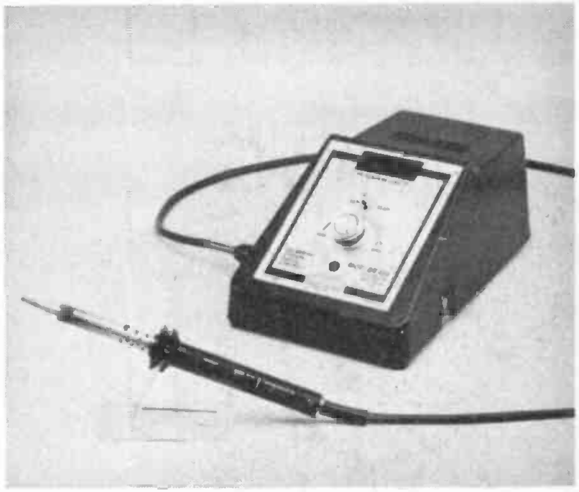
SA-8 series industrial grade soldering irons, available in 371 deg. C (SA-8-15) and 427 deg. C (SA-8-20), heat-up in two minutes using ceramic elements. They may be used with static-sensitive components without earthing. Tips are corrosion resistant. Available in 115 and 230V versions. Price £21·50, from **OK Industries.**

SOLDERING INSTRUMENT BUYER'S GUIDE

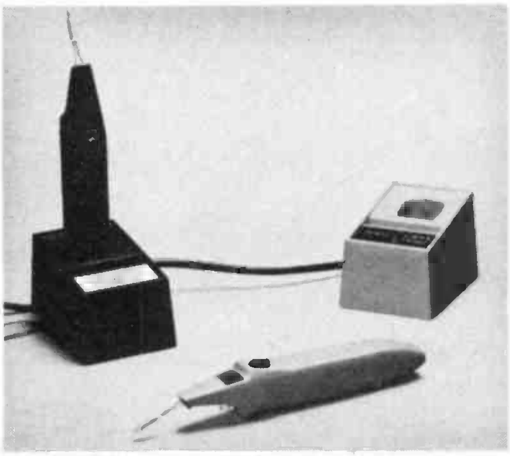


The **Weller SI-25** 25 watt iron, along with the Weller SI-15, SI-40 and WH1/2 hobby kits are claimed to be the only soldering related products on the market entitled to display the BEAB seal of approval for safety. Price £7·80 from **Coopers Tools Ltd.,** Sedling Rd., Wear, Washington, Tyne & Wear NE38 9BZ. ✆ 091 416 6062.

Litesold SK18 Soldering Kit includes the LC18 18 watt iron along with a selection of bits, 18 s.w.g. fluxed solder, tweezers, three other aids and desolder braid. All in p.v.c. wallet. Price £15·24 from **Light Soldering Developments.**



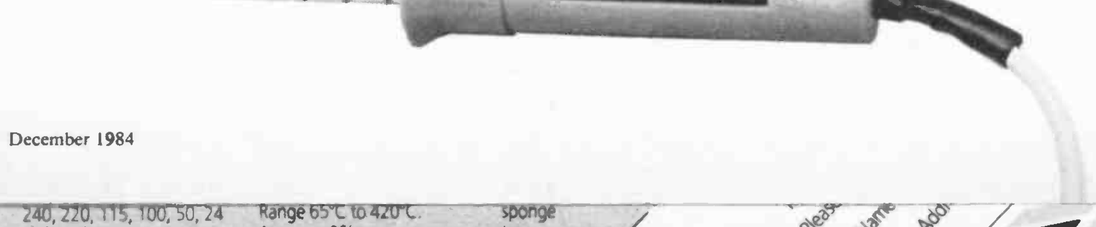
Solon-Electrex DS400 Station supplied with TC24 Iron (50 watt) is thermostatically controlled from 150–400 deg. C (1% precision) with digital readout. The iron takes the 'Duratyp' range of bits. Price £138·69 from **GEC-Henley,** Gravesend, Kent DA11 9DA. ✆ 0474 64466.



Oryx ISO-TIP series irons are cordless (rechargeable) for complete mains isolation. The iron automatically recharges itself when placed in its base, and has a built in spotlight. The 50 watt iron can solder 100 joints between charges. Tip temperature is 370°C. Also takes a drill attachment. Price £41 from **Greenwood Electronics,** Portman Road, Reading, Berks RG3 1NE. ✆ 0734 595844.

Adamin Model 15 miniature iron is available in 240V or 12V (12 watts). One of the smallest irons in the world and takes a range of bits from 1·2mm to 4·7mm. Price (iron) £5·97, (spring stand) £5·11 from **Light Soldering Developments Ltd.,** Spencer Place, 97/99 Gloucester Road, Croydon, Surrey CRO 2DN. ✆ 01-689 0574.

Solon-Electrex 325 is a 25 watt mains 'instant' heat soldering iron of maximum temperature 380 deg. C. It uses C25 tip or TP30. Price £10·79 from **GEC-Henley.**



GLORIOUS PAST—BRIGHT FUTURE

A rather sad note has been struck. The Carnegie Institute of Washington, which operates the observatory on Mount Wilson in California, has announced that during 1985 the great 100-inch Hooker reflector there will be "mothballed", and support for the two famous solar tower telescopes, the 150-foot and the 60-foot, will be gradually withdrawn. The other large instrument, the 60-inch reflector, will remain in service, but, as one commentator has said, the decision "sounds the death-knell" for Mount Wilson as a leading astronomical institution.

The trouble is due to the continued spread of the city of Los Angeles, which has become not only larger, but also brighter and more polluted. From the city, the summit of Mount Wilson can be clearly seen, and from the top of the mountain the sky is not nearly so dark as it was in 1917, when the 100-inch reflector came into operation. This means that many branches of research can no longer be carried out there.

The 100-inch has a glorious history. When it was completed, it was not only the world's largest telescope, but it was in a class of its own, and it remained so until 1948, when it was surpassed by the Palomar 200-inch.

Using the Mount Wilson reflector in the 1920s, Edwin Hubble proved that the objects then called "spiral nebulae" were in fact independent galaxies, far beyond the limits of our own Milky Way system. Hubble achieved this by studying the behaviour of certain variable stars inside the spirals. These variables, known as Cepheids, "give away" their real luminosities—and hence their distances—by the way in which they brighten and fade. In Hubble's day, only the 100-inch was powerful enough to be used in studying them.

The telescope itself is as good today as it ever was, but by modern standards it is old-fashioned, and there is no thought of moving it to a better site. So its story may be coming to a close, even though it is still capable of carrying out really valuable research. At any rate, its place in history is assured, and mercifully there has been no suggestion as yet that it will be dismantled, so that hope remains.

Two major telescopes are being planned elsewhere: one in Hiroshima in Japan, and the other to be set up at the observatory on La Palma, in the Canary Islands, where the I.N.T. or Isaac Newton Telescope is now in full operation. (While I was there, a few months ago, we used the I.N.T. to obtain a colour video picture of the Ring Nebula in Lyra—the first time that this had been achieved for an object beyond the Solar System.) The projected new telescope is a 100-inch reflector, and will be a joint venture by Norway, Sweden, Denmark and Finland. The optics will be made at Turku in Finland.

Halley's Comet is now under regular observation, and continues to brighten slowly as it draws in toward the Sun, but it will not come within the range of average-sized telescopes until the middle of next year. Unfortunately, this is a poor return, and the comet will be not nearly so conspicuous as it was in 1910 or in 1835, though with luck it will be easily visible with the naked eye towards the end of 1985.

THE SUN

On 22–23 November there will be a total eclipse of the Sun. The path of totality begins in the Molucca Islands and then crosses New Guinea, passing north of New Zealand and ending in the South Pacific. The maximum length of totality is exactly two minutes.

The partial phase will be seen from the Philippines, parts of Australia and New Zealand, and also from part of Antarctica, but of course the eclipse will be invisible from Europe, as it occurs during European night. The next total eclipse to be seen from anywhere in Britain will be that of 11 August 1999, when the track of totality will cross Cornwall.

Despite *Skylab* and other space-stations, total solar eclipses are still of tremendous importance, because it is only when the Sun is completely covered by the Moon that ground-based observers can see the corona in its full glory. At this month's eclipse the corona will be of the "minimum" type, because the Sun is now approaching the lowest point of its 11-year cycle of activity. There have already been several spotless periods this year, when the solar disc has been entirely blank.

The solar cycle is not perfectly regular, and the usually quoted figure of 11 years between successive maxima is only an average. Moreover, it may well be that we know less about the Sun than we used to believe. Even the cycle may not be permanent; there is excellent evidence that between 1645 and 1715 there were almost no sunspots at all—a period now generally known as the Maunder Minimum, since attention was first drawn to it by the British astronomer E. W. Maunder (and, independently, by Spörer in Germany).

SPACE MINE

Very important studies are being carried out from what is undoubtedly one of the strangest observatories in the world. It is situated a mile below ground, at Homestake Mine in South Dakota. This is the country of the gunslingers; little more than a century ago it was the home of colourful characters such as Calamity Jane, Wild Bill Hickok and "Doc" Holliday.

It is also a gold-mining area. Today the gunslingers have gone, but the gold is still there, and Homestake Mine is the largest in the whole of the United States. The solar observatory has been set up in a special chamber, or rather pair of chambers, hollowed-out specially for the purpose.

The Sun is radiating by nuclear transformations taking place near its core. Basically, hydrogen nuclei are combining to form nuclei of helium, with release of energy and loss of mass. (The mass-loss amounts to 4,000,000 tons per second, though by solar standards this is not very much, and there is no reason to suppose that the Sun will change dramatically

THE SKY THIS MONTH

This is not a particularly good month from the viewpoint of planetary enthusiasts. Mercury, Venus, Mars and Jupiter are all technically evening objects, but Mercury is well south of the celestial equator and is badly placed from Britain, even when at its greatest eastern elongation on 25 November.

Mars and Jupiter are also in the southern hemisphere of the sky, and set not long after the Sun; moreover Mars is now so far away that its magnitude has faded to 0.8, about the same as that of Aldebaran, and even large telescopes will show little upon its disc. Saturn is in conjunction with the Sun on November 11, and is therefore out of view altogether.

It may be worth noting that Ceres, the largest and first-discovered of the minor planets or asteroids, comes to opposition on November 10. It is in Taurus, near the stars Xi and Omicron Tauri, but its magnitude is only 6.9, so that it is too faint to be seen with the naked eye. Binoculars will show it, though of course it looks exactly like a star. Its diameter is rather over 620 miles, and it is much the most massive member of the asteroid swarm.

Plans for asteroid probes are now being made, and should be put into practice by the mid-1990s, but it seems likely that the first target will be not Ceres, but Vesta—the brightest member of the group—which is smaller than Ceres, but considerably closer-in to the Sun.

for at least 5,000 million years in the future.) Theorists also calculate that there should be the emission of neutrinos, which are particles with no electrical charge and virtually no mass—so that they are extremely hard to detect, since they can pass through the Sun and also through the Earth without being checked.

The only way to catch them is by making them interact with atoms of chlorine. If a neutrino hits a chlorine atom, the result will be an atom of Argon-37, which is radioactive and is therefore comparatively easy to track down.

THINK TANK

In Homestake Mine, Dr. Ray Davies and his colleagues have set up a large tank containing 100,000 gallons of perchloroethylene, which contains a great deal of chlorine and is nothing more nor less than cleaning fluid! The procedure is to leave the tank for a period of around eight weeks, and then carry out tests to see how many atoms of Argon-37 have been produced.

Since there will not be more than about a dozen of them, and the whole tank contains about a thousand million million million atoms of various kinds, the tests are far from straightforward. But for the radioactive qualities of Argon-37, there would be no hope at all.

Why "go underground"? The answer is simple. Cosmic rays from space will affect the chlorine in exactly the same way as neutrinos. But cosmic rays cannot penetrate a mile of solid rock—at least, not easily; a few can get through, but these can be allowed for. This is why Homestake is so suitable for this particular experiment.

The solar observatory has now been in action ever since the 1960s, and the results have been startling. Apparently the Sun is sending out only about a quarter as many neutrinos as in theory it ought to do. Unless there is something wrong with the experiment, which seems unlikely, or else there is a defect in our theories—or even the possibility that at the present epoch the Sun is behaving abnormally.

Neutrino emission is very sensitive to temperature. It has been calculated that the temperature at the core of the Sun is about 15,500,000 degrees Centigrade. If we reduce this by a million degrees, the neutrino results fall neatly into place, but such a fall in calculated temperature would raise other theoretical problems. Is it possible that neutrinos are more complicated than we think, so that they could break up or become modified during their 93,000,000-mile journey from the Sun to the Earth?

As yet we do not know. The Homestake results seem reliable enough, and are confirmed by a similar experiment being carried out in the Soviet Union. So we must do some re-thinking, and it is not surprising that solar physicists are placing great importance on the behaviour of a tank of cleaning fluid deep in a South Dakota gold-mine.

PRACTICAL ELECTRONICS PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain PE constructional projects are now available from the PE PCB Service, see list. They are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: ***PE PCB Service, Practical Electronics Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG.*** Cheques should be crossed and made payable to IPC Magazines Ltd.

Please note that when ordering it is important to give project order code and the quantity. Please print name and address in Block Caps. Do not send any other correspondence with your order.

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed here or in the November issue.

PROJECT TITLE	Order Code	Cost
SEPT '81		
Horologicum	109–01	£3.16
"	109–02	£3.11
"	109–03	£2.97
Analogue Frequency Meter	109–04	£2.87
Ignition System	109–05	£2.47
"	109–06	£2.28
APRIL '82		
Med. Resolution Equaliser (UK 101)	204–01	£1.73
Enlarger Timer	204–02	£4.02
AUG '82		
Automatic Photographer	208–01	£1.94
Home Alarm	208–02	£3.21
SEPT '82		
Waveform Digitiser	209–01	£8.24
FEB '83		
Radio Booster	302–02	£1.80
MAR '83		
Into the Real World	303–01	£3.99
Accessory PSU	303–02	£1.35
4½ Digit Frequency Meter	303–03	£3.69
APRIL '83		
Phaser	304–01	£3.41
JUNE '83		
Program Conditioner	306–01	£2.30

PROJECT TITLE	Order Code	Cost
SEPT '83		
Guitar Active Tone Control	309–01	£2.27
Ground Communication System	309–02	£2.13
"	309–03	£2.31
DEC '83		
Expanding the Vic 20	312–01	£5.18
MAR '84		
Spectrum Autosave	403–01	£1.83
APRIL '84		
Microstepper	404–01	£10.74
MAY '84		
Sustain Unit	405–02	£2.82
Audio Signal Generator	405–03	£4.28
"	405–04	£2.51
JUNE '84		
Cross Hatch Generator	406–01	£3.52
JULY '84		
Simple Logic Generator	407–01	£7.73
EPROM Duplicator	407–02	£3.74
Alarm System	407–03	£3.19
Oscilloscope Calibrator	407–04	£4.23
AUG '84		
Comm. 64 RS232C Interface	408–01	£3.02
Field Measurement	408–02	£3.19
"	408–03	£2.76
Digital Dice	408–04	£4.23
Simple Logic Analyser	408–05	£2.93
Alarm System	408–06	£4.24
"	408–07	£3.14
"	408–08	£3.23
SEPT '84		
Parallel to Serial Converter	409–01	£2.92
Through the Mains Controller	409–02	£2.88
"	409–03	£2.71
OCT '84		
Logic Probe	410–01	£1.90
NOV '84		
Computer DFM Adaptor	411–01	£2.76
DEC '84		
Ni-Cad Charger	412–01	£2.40

NICKEL CADMIUM BATTERIES PART TWO

MICHAEL TOOLEY BA
DAVID WHITFIELD MA MSc CEng MIEE

UNLIKE their lead acid counterparts, nickel cadmium cells require a constant current rather than a constant voltage charging source. Furthermore, comparable sintered and mass plate cells have different charge rate requirements and this must also be taken into account.

The maximum indefinite charge rate for a sintered cell is usually taken as C/8, i.e. for a 1Ah battery the maximum indefinite charging current is 125mA. Cells may, however, be charged at higher rates provided care is taken to avoid overcharging which can permanently damage the cells. The maximum charge rate for a sintered cell is usually assumed to be 10C but, before attempting to 'fast-charge' a nickel cadmium cell of any variety, it is essential to ensure that the cell is initially fully discharged. Using the same 1Ah battery, for example, a 2C charge would be achieved by charging at 2A for 30 minutes.

The relationship between charge period and charge rate for nickel cadmium cells is illustrated in Fig. 1. To ensure a long cell life and a maximum number of charge/discharge cycles, charge rates in excess of C should be avoided if at all possible. Mass plate cells cannot, by virture of their construction, be charged at the high rates associated with sintered cells. The maximum charge rate for such cells is usually C/10 for 14 hours whilst the maximum indefinite charging current is often no more than C/100. Hence, for a 110mAh PP3 battery, the recommended charging current is 11mA for a period of 14 hours. Furthermore, if this type of battery is to be left on-charge indefinitely, the charging current should not be allowed to exceed 1·1mA. Table 1 shows the recommended charge rate for a number of popular nickel cadmium batteries.

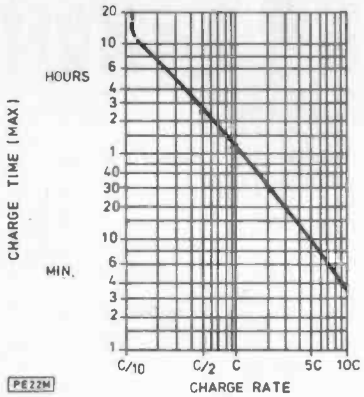


Fig. 1. Charge time versus charge rate for nickel cadmium cells

Battery type	Max. indefinite charging current (mA)
AAA	20
AA	66
C	250
D	500
PP3	1·1
PP9	100

Table 1. Maximum indefinite charge rates for various nickel cadmium batteries

We shall now describe a simple automatic charger which provides a total of 24 different charge rate options.

NiCad CHARGER

The easiest method of obtaining a reliable constant current source involves nothing more than a d.c. supply, one transistor and just three other components. Fig. 2 shows a typical family of output (collector) characteristics for a transistor operated in common emitter mode. It should be noted that, for a fixed value of base current, the collector current remains substantially constant and is reasonably independent of the value of collector-emitter voltage. Hence, if the battery to be charged is connected as the load in the collector circuit, and the base voltage held constant, the battery will receive a reasonably constant current charge. A typical circuit is shown in Fig. 3. The base voltage is stabilised by means of the Zener diode, D, and the base current is determined by the value of emitter resistor, R_E. Since the collector current is equal to the base current multiplied by the value of common emitter current gain for the transistor concerned, the charging current can be set by appropriate choice of R_E.

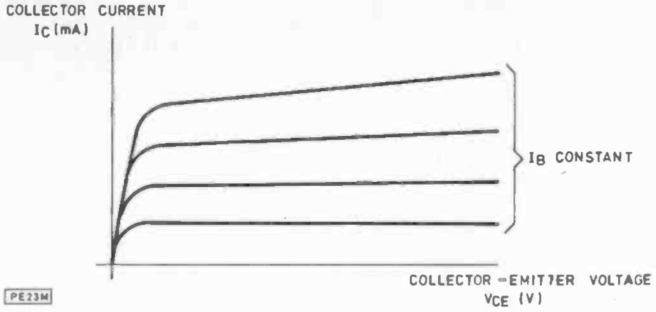


Fig. 2. Typical output characteristics for a transistor connected in common emitter mode

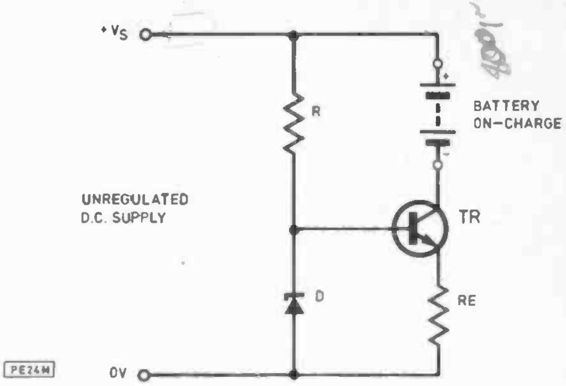


Fig. 3. A simple charger using a transistor connected as a constant current source

Another simple constant current charging source is shown in Fig. 4. Here a conventional monolithic three-terminal regulator is connected in what, at first sight, may appear to be a strange arrangement. The normal regulator output is, in fact, developed across Rs and since this voltage remains substantially constant, the current flowing through it will also be constant. The output current is given by:—

$$I_O = \frac{5}{R_S} + I \text{ where } I \approx 5mA$$

The value of R_S can be varied so that different charge rates can be catered for, as shown in Table 2.

With the two previous circuits, the charge rates may be easily selected by changing just one component. In practice, different charge rates can be obtained either by switching resistors or by incorporating a variable resistor into the circuit. There is, however, one problem; it is all too easy to connect the charger to a battery, switch 'on', and then forget it! Whilst this may be of little consequence when charge rates of C/10 are concerned, serious damage may be done if a fast charge rate is selected and thus, ideally, a charger should incorporate a facility which will discontinue the charge after a pre-determined time interval has elapsed. Hence, if separate controls for charging current and charging time are provided, a wide variety of charge rates can be accommodated to suit almost any type of cell which may be encountered. Furthermore, the user can rest assured that no harm will be done if the unit is left connected for an indefinite period!

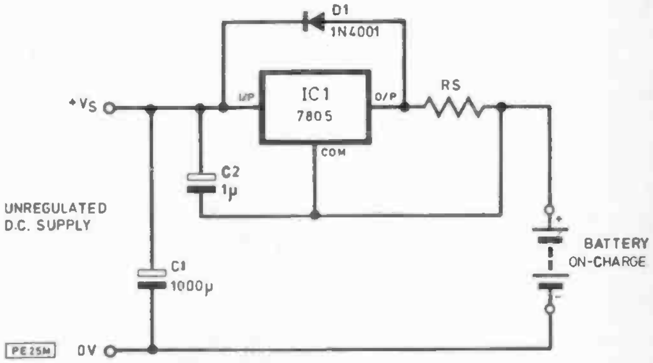


Fig. 4. Simple charger using a monolithic three-terminal voltage regulator

R_S (ohm)	(W)	Charge current (mA)
820	0·5	11
470	0·5	15
330	0·5	20
220	0·5	28
82	0·5	66
56	1	100
22	2·5	250
10	4	500

Table 2. Relationship between R_s and charge current for the circuit of Fig. 4

AN AUTOMATIC CHARGER

The complete circuit of the automatic charger is shown in Fig. 5. A conventional mains transformer, T1, and bridge rectifier, REC1, provides an unregulated supply rail of approximately 17V. A programmable timer, IC1, is used to provide accurate monostable timing periods which are derived from a timebase and eight-stage binary counter. The two fundamental timing components are C2 and R2 and only the last four divider outputs are employed. A miniature normally-open push-button switch, S4, is used to initialise the timing sequence whilst a similar switch, S3, is used to re-set the timer, aborting the current timing period and discontinuing the charge.

The time period is selected by a rotary switch, S1, and the voltage at this point goes low for the duration of the timing period removing the bias from TR1 and switching the transistor 'off'. In this condition, R5, D1 and D2 supply bias for the constant current source, TR2. At the end of the monostable period the base voltage of TR1 rises and TR1 conducts. In this condition, D1 no longer achieves its Zener voltage and no base current is supplied to TR2. The output current, which is selected by means of rotary switch S2, thus falls to zero and remains in this state until another charging period is initialised by the user.

CONSTRUCTION

The majority of the components for the automatic charger are mounted on a single sided p.c.b. measuring approximately 53 x 104mm, the design of which is shown in Fig. 6. The corresponding component layout is shown in Fig. 7. The recommended sequence for mounting components is: terminal pins, d.i.l. socket, resistors, diodes, transistor, bridge rectifier, and capacitors.

The underside of the completed p.c.b. should be carefully checked for solder bridges and dry joints whilst the component side should be examined paying particular attention to the placement and orientation of the polarised components. The remainder of the components, excluding the mains transformer, fuseholder, and mains connector, are all mounted on the aluminium front panel. The wiring of the front panel should follow the layout given in Fig. 8 and connec-

COMPONENTS . . .

Resistors

R1	47k	R8,R9	5Ω6 (2 off)
R2	2M2	R10	10
R3	100	R11	15
R4	10k	R12	1
R5	1k	R13	22k
R6	56	R14	1k
R7	2Ω2		

R1 to R5, R13 and R14 are $\frac{1}{4}$W 5% carbon
R6 to R12 are $\frac{1}{2}$W 10% carbon

Capacitors

C1	1000µ 16V p.c. electrolytic
C2	220µ 16V p.c. electrolytic
C3	100n polyester

Semiconductors

D1	BZY88 C4V7 Zener
D2	Green 0·2in l.e.d.
D3,D4	IN4148 (2 off)
D5	Red 0·2in l.e.d.
TR1	BC108
TR2	TIP32A
IC1	2240
REC1	50V 1A p.c. mounting bridge rectifier

Miscellaneous

T1 6VA mains transformer with 2 x 6V or 1 x 12V secondary winding rated at 500mA
16-pin d.i.l. socket TO220 heatsink (see text)
S1 3P 4W rotary switch (1 pole only used)
S2 2P 6W rotary switch (1 pole only used)
S3 normally-open miniature push-button switch
S4 normally-open miniature push-button switch
S5 DPST mains switch
PCB Plastic case (West Hyde)
Push-on knobs (2 off) Terminal pins (20 off)

tions to the p.c.b. may be most conveniently made using short lengths of ribbon cable.

Where less than six series connected cells (or a battery of equivalent voltage) is to be charged at currents of 100mA, or more, the series transistor, TR2, MUST be mounted on a heatsink. This should be a TO220 variety of 10·5°C/W, or better. The front panel should be labelled as shown in the photograph.

INITIAL TESTS

When all wiring is complete, a final check should be made before inserting IC1 into the d.i.l. socket (taking care to observe the correct orientation). The mains supply should then be connected and the charger switched 'on'. The red l.e.d., D5, should immediately become illuminated whilst the green l.e.d., D2, should remain extinguished. At this point it is worth checking the positive supply rail voltage which appears at pin 16 of IC1. This should be 17V ±1·5V. If this is not the case, connections to the mains switch, fuse, and transformer should be carefully checked.

The charge period switch, S1, should then be switched to give the shortest time (3·5 hours) whilst the charge current switch, S2, should be switched to the lowest current setting (12·5mA). S4 should now be momentarily pressed at which point the green l.e.d., D2, should become illuminated. Now momentarily depress S3 to reset the charger. As S3 is released, D2 should become extinguished. This set/reset procedure should be repeated a few times until the user is familiar with its operation. If no charge is apparent, readers

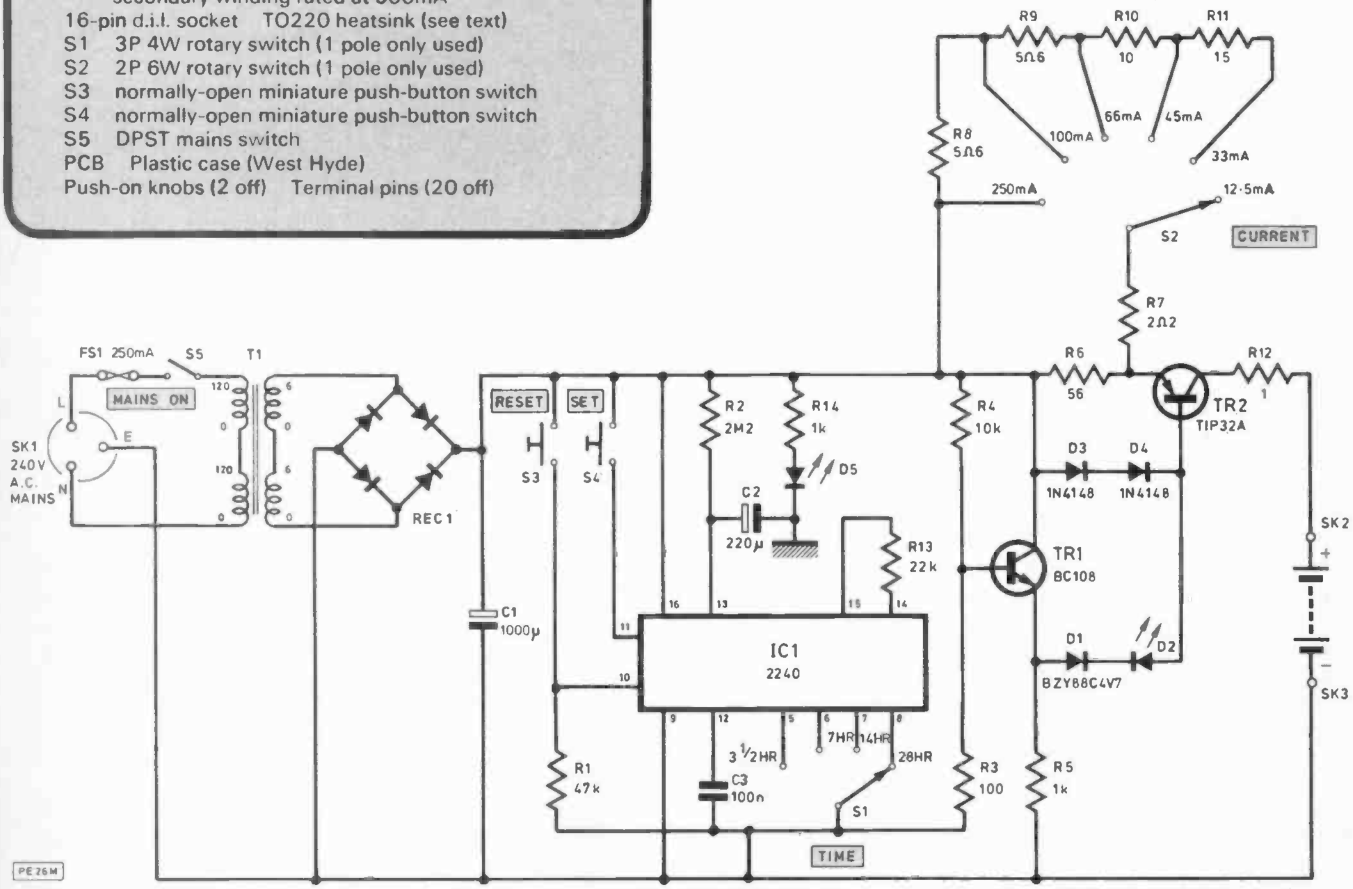


Fig. 5. Complete circuit diagram of the automatic charger

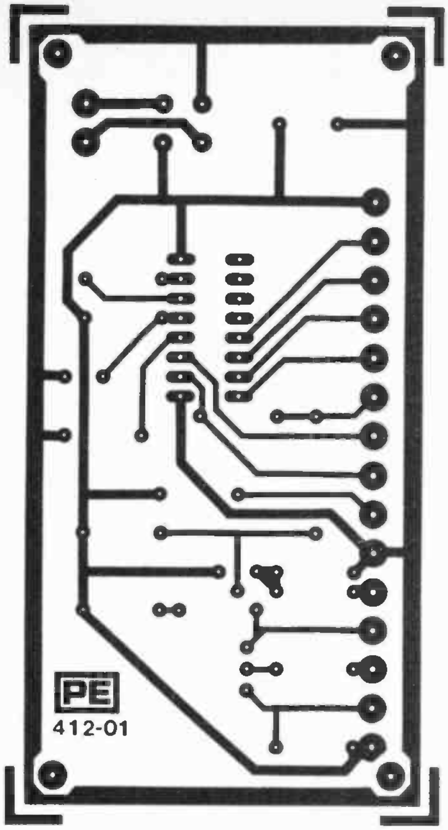


Fig. 6. P.c.b. design

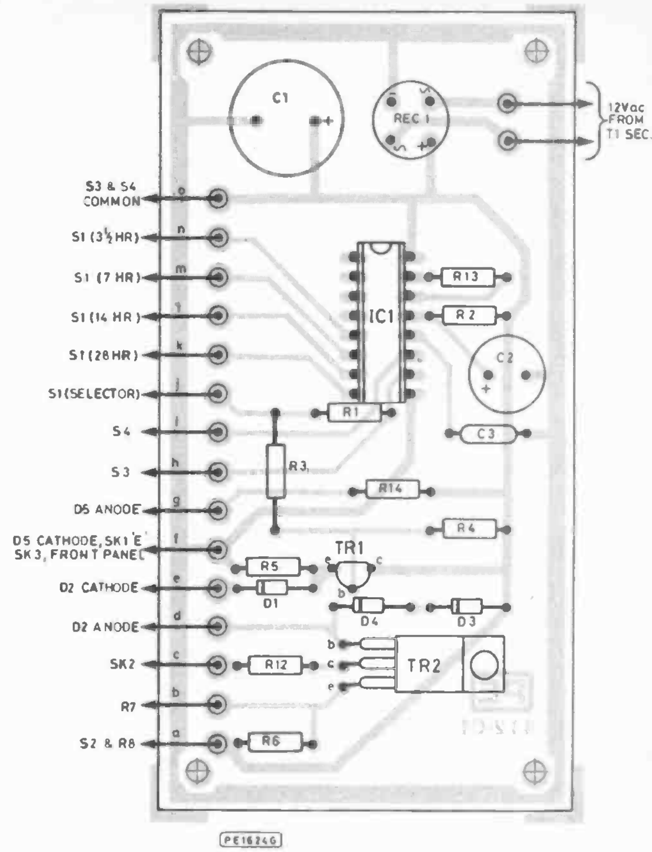


Fig. 7. P.c.b. component layout

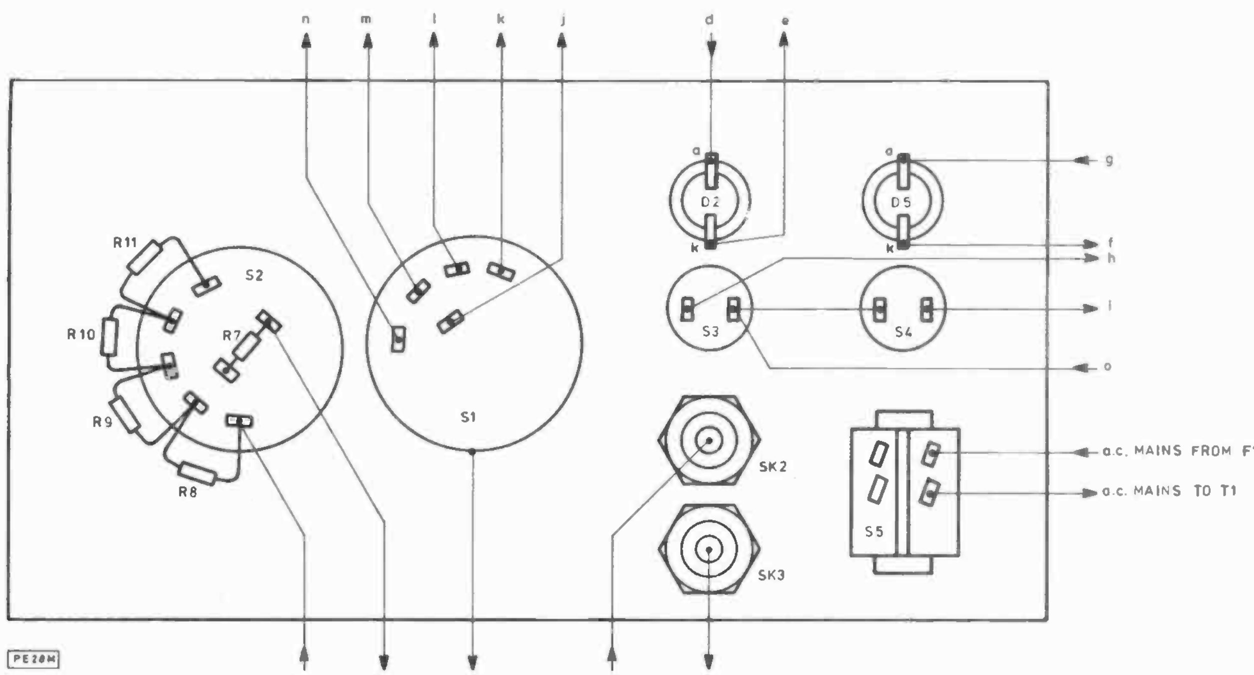


Fig. 8. Front panel wiring

Test point		Voltage	
		Reset	Set
IC1	pin-16	17·0	17·0
TR1	c	17·0	17·0
	b	14·0	1·0
	e	13·4	8·8
TR2	c	0	16·6
	b	16·8	16·0
	e	17·0	16·7
Output (Sk2)		0	16·6

All voltages measured with a 20kohm/V multimeter

Table 3. Test voltages

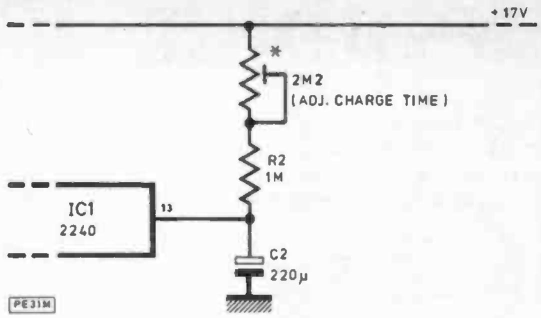


Fig. 10. Circuit modification for precise time period adjustment

should refer to the test voltages provided in Table 3. If the supply voltage is correct but neither l.e.d. is illuminated, it is worth checking the polarity of D2 and D5.

Having confirmed that the set/reset switching is functional, the next stage is to check the charge time. Since it would be somewhat tedious to wait for even the shortest charge period (approx. 3·5 hours) it is more expedient to employ one of the unused shorter time periods available from the programmable timer, IC1. The shortest of these is available at pin 1 and readers should refer to the test circuit of Fig. 9a. The time period for a 'high' output should be measured using the following procedure:—

1. Connect the test circuit using either a voltmeter or digital timer. The voltmeter should be switched to the 20V, 25V or 30V range whilst the timer should be adjusted to 'start' on a positive edge and 'stop' on a negative edge.
2. Depress S4. The voltage at pin-1 should be 'low' for several minutes and then it will go 'high'. At this point timing should commence (using a stopwatch or the digital timer).
3. After approximately 13 minutes the voltage should go 'low' again. At this point timing should stop.

The time period at pin-1 is 1/16 of the nominal 3·5 hour period. However, due to component tolerances (particularly that associated with C2), the time period will seldom be exact. Where a precise time interval is desired, R2 may be replaced with a 2M2 pre-set resistor in series with a 1M fixed resistor, as shown in Fig. 10. The pre-set resistor is then adjusted for a pin-1 high output time of approximately 790 seconds.

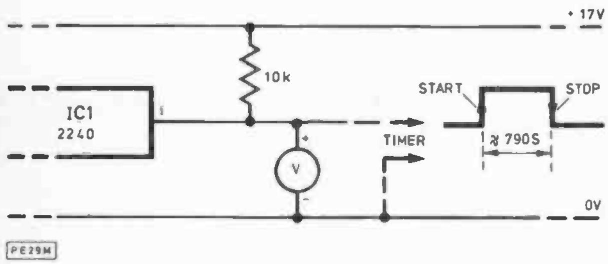


Fig. 9a. Arrangement for testing the charge time

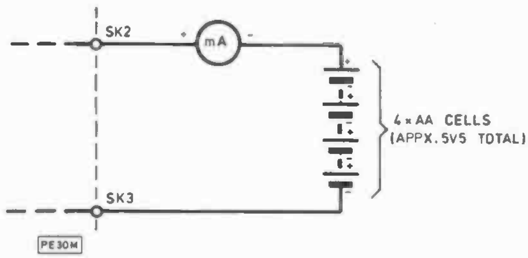


Fig. 9b. Arrangement for testing the charge current

Finally, the charge current should be checked. This is accomplished using a typical battery pack consisting of four series connected AA cells and measuring the current delivered with the charger 'set'. The required circuit arrangement is shown in Fig. 9b. The charge current on each range of S2 should be measured and this should be within approximately 10% of that marked. If this is not the case, minor adjustment to the appropriate resistor (R7 to R11) may be made simply by connecting larger resistance values in parallel and trimming for the exact current desired.

		Charge Time (hours)			
		3·5	7	14	28
Charge Current (mA)	12·5	30	60	90 (PP3)	180 (AAA)
	33	80	160 (AAA)	320	640
	45	110 (PP3)	220	440 (AA)	880
	66	160 (AAA)	320	640	1280 (PP9)
	100	250	500 (AA)	1000 (PP9)	2000 (C)
	250	612	1200 (PP9)	2400 (C)	4800 (D)

(Note: Battery capacity is shown in mAh)

Table 4. Recommended charge rates for the automatic charger

This completes the initial tests and the automatic charger is now ready for use. Table 4 provides a guide as to the charge rate obtained with various combinations of S1 and S2. Recommended rates for charging various common types of nickel cadmium battery are also shown. Note that only cells of similar type should be charged at any time and they should ALWAYS be connected in series. Users should equip themselves with a range of battery holders to suit the cells currently in use. Such holders are readily available from most electronic component suppliers.

Finally, care should be taken to ensure correct polarity of cells connected to the charger. Failure to observe this precaution may result in damage to both the cells themselves and to the charger! ★

VERNON TRENT *at Large!*

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

HERE'S A QUESTION: just how many companies in the components business, do you think, started out as a display of valves in the side window of a butcher's shop? I know of only one. That's the firm of A. F. Bulgin—a household name in the industry for more than half a century.

The founder was one Arthur Bulgin whose father was a respected purveyor of high-quality meats to the gentry (this was the grand title, or something similar, that graced his letterheads). And although he was probably disappointed that his son showed no inclination to follow the tradition of victualling the well-to-do, he gave the lad every encouragement in a venture which was, on the face of it, somewhat dicey. So the side window was donated willingly, if, I suspect, with not a little trepidation. What the squire and other distinguished beef-champers thought about it is not recorded.

Arthur justified his father's confidence when he set up a business proper in April 1923. This was at a time when the British Broadcasting Company had just launched the first public radio service in the UK and the future was rich in golden opportunity.

"The first product . . . was a light-emitting escutcheon"

Long before he went in for manufacturing, Arthur traded as a distributor—he was totally dedicated to this method of marketing. His family claims—and who shall blame them—that he was one of the first to operate in this now firmly established branch of the component sector.

The first product to come out of Bulgin's modest stable was described as a light-emitting escutcheon. Or, to put it more simply, a signal window. It was set in the cabinet of a radio receiver and a quick gander through it told you if your valves were alive and well. A comforting glow meant you were in business. An inky blackness spelt trouble.

By 1948—and we're having to skip a bit of history here—Bulgin had become a limited company employing 250 people and turning out what the Americans call panel hardware: passives, switches, connectors, fuses, fuse-holders, signal lamps, clips and so on. And in spite of a considerable broadening of the range over the years, such "nuts and bolts" remain the firm's bread and butter.

Arthur's four brothers emulated their father's farsighted support of his meat-shy son and one-by-one they came into the business, leading it on to bigger and better things and consolidating the high reputation it continues to enjoy.

Today the family tide runs even more strongly. Ronnie Bulgin, son of the founder, is chairman and MD of what has become a group rather than a single company. His cousin Robert is his deputy. Ronnie's son Richard (25) bowler-hatted his way through the Stock Exchange for three years before joining the fold in 1980 and is now involved in selling and marketing with a new Bulgin venture—of which more anon. Robert's son Clifford (23) is equally active on the production side. And I'm told there is a reserve stock of other little Bulgins—too young yet to get in on the family act—watching out for their cues.

I met Ronnie and Robert the other day. Ronnie is shrewd and softly-spoken. Robert is a burly, jovial extrovert. That's understandable. Before joining the firm he was in advertising for a spell. It's the group's good fortune that he eventually decided to mend his ways. Between them, the cousins house a lot of ability and a treasury of enthusiasm.

"Let's tell you about our exciting new operation," said Ronnie. "Some months ago we consolidated Ambit International, Solent Component Supplies, Broxlea and Projex Distribution—which represent Bulgin's distribution and custom manufacturing activities—into a single company called Cirkit. It's the first stage of a major development programme.

"Cirkit, far from taking a 'me too' stance in the distributor ranks by stocking all and sundry, is going for the specialist route. It is building an inventory of essential popular components from the top manufacturers with an emphasis on exclusivity. Among the lines for which it is sole stockist are Alp's (the world's largest manufacturer of electromechanical devices) and Toko (tops in wound components). Additionally, we're appointed distributors in the South of England for Cooper Tools/Weller, brand leaders in soldering and desoldering equipment. And we're not stopping there. We plan to secure other important franchises, with the accent on high-volume components and high technology, in such key areas as telecoms, defence, control and computers."

Cirkit is also stepping up its operations in the home-user and hobbyist market, through both mail order and across-the-counter outlets. New kits coming on to the market include, in the 'expert' category, a 20W, 144MHz linear power amplifier for boosting the output of hand-held and transportable transceivers, but also, in the 'enthusiast' bracket, a universal audio function generator with on-board mains PSU.

The aspiring 'student' class is not forgotten either. Kits in this area range from a universal temperature sensor which can be used as a frost warning, deep freeze alarm, greenhouse temperature alarm, etc., to a locomotive sound generator with whistle—a boon and a blessing for the rabid thwarted railwayman who has turned his attic into a miniature Clapham Junction.

While Ronnie and Robert Bulgin keep a watchful eye on Cirkit as non-executive members of the board, they have mustered a whole new team to steer the company on its adventurous path. Spearheading the team is Chief Executive Christopher Sawyer, a born leader who has achieved a particularly successful track record with such giants as BMW, Smedleys and the Ross Group. Alongside him is Financial Director, Ronald McKellar CA, who like Sawyer is in his late 30's and has an equally impressive business background.

Chairman of Cirkit is Alistair McDonald, who brings not only a wealth of experience in top-level financial-type appointments, but also, I suggest, an odour of sanctity. He spent many years with the Church Commissioners, juggling, as investment secretary, with assets in excess of £1,000 million. Another stalwart is ex-sailor Ken Hollingsworth. He came into electronic component distribution in 1963 and has become rich in the knowledge of the game. Then there's Jonathan Burchell, who is master-minding the introduction of Cirkit's new range of kits. Richard Bulgin (Consumer Services) and Clifford Bulgin (Manufacturing Services) represent the third generation of the founding family.

"We have tried," said Ronnie Bulgin, "to bring a real breath of fresh air into the business of electronic component distribution. This is typified by the appointment of Alistair McDonald, who, in spite of coming into this sector for the first time, is generating enormous enthusiasm.

"When you think about it, this kind of consolidation of several distribution companies into one is plain commercial common sense. Promoting each of them individually, with their own advertising and catalogues, as well as premises, is not only hideously expensive, but inefficient."

There's one point the Bulgins underline in bold capitals: In spite of its expansion in the distribution area, it remains firmly in the business of manufacturing, with a main factory at Barking (Essex) and a satellite at Broxbourne (Herts). In fact, in the current year the ratio will be 40 per cent distribution to 60 per cent production, turning out components for internationally-known customers with products ranging, as Robert Bulgin said, from toasters to telecoms, robots to oil rigs.

With an eye, no doubt, on future manpower needs, Cirkit has put £100,000 into an electronics award scheme for young people at schools and colleges. They must make and design an electronic device with a viable application in everyday life—for business or leisure. Any design taken up will attract royalities and, what's more, the company will help with patenting.

Arthur Bulgin would, I'm sure, be delighted to see what that valve display, cheek-by-jowl with the lamb chops, has led to in the space of one man's lifetime. But would he, like me, have some doubts about that name Cirkit? It's certainly ingenious. But, because I've that sort of mind, I can't for the life of me resist adding 'and see'.

And I'm sure we shall.

SPECIAL OFFER!

QUASAR CASSETTE DECK £29·95

INCLUDING VAT & CASE PLUS £2·75 P and P

In April 1982 PE, in conjunction with RT-VC, published the *PE Quasar Stereo Cassette Deck* design. The design provides some outstanding features, including variable recording bias and a gate noise reduction system. As a result of this successful design we are now pleased to be able to offer kits to PE readers at this exclusive price. The kits, including a wrap round simulated wood finish case, will be accompanied with a reprint of the PE articles which fully describe the unit and its construction.

The offer is for a limited period only and a coupon should be sent to the address shown. The specification of the made-up unit is given below:

SPECIFICATION

Case size 285 x 260 x 90mm approx.
Mechanism with automatic stop and tape counter with reset button.
Tape Speed: 4·76cm/sec. (1⅞in/sec.).
Wow & Flutter: Typically 0·1%.
Drive Motor: 12V d.c. with electrical governor.
Play Torque: 40–75g/cm (DYNAMIC).
Rewind & Fast Forward Torque: 60–140g/cm (STATIC).
Rewind & Forward Time: Less than 100 sec. for C60 tapes.
Bias/Erase Oscillator: Externally variable, frequency 90–100kHz.
Output: (Adjustable) Up to 1 volt r.m.s.
Mic. Sensitivity: 1mV @ 47k.
DIN Sensitivity: 30mV @ 47k.
Frequency Response; 30Hz–12·5kHz (–3dB).
Signal to Noise Ratio.
Noise reduction OFF –50dB
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SEMICONDUCTOR CIRCUITS

TOM GASKELL BA(Hons) CEng MIEE

DIGITAL NOISE SOURCE (MM5837N)

AT first sight it might seem a little odd that someone should produce a special i.c. to generate noise. After all, noise is something that we usually strive to get rid of in electronics! Indeed, there are very few areas of the business where noise doesn't regularly cause problems. Video noise results in the familiar 'snow' on pictures, digital noise (especially when carried along power supply tracks) can cause spurious changes in logic states, corrupting data or even causing serious malfunction of equipment. Audio engineers face a continuous battle against noise in microphone amplifiers, record deck pickup cartridge pre-amps, and most of all in cassette and reel-to-reel tape recorders, where noise reduction systems such as Dolby or dbx are often used specifically to try to overcome limitations of the medium.

So why should anybody actually want to produce noise? One reason is connected with the sort of problems that have just been described. In order to test out designs of noise reduction equipment, and to test the ability of circuits to reject noise or remain unaffected by it, we need to have a reliable source of noise, probably at a relatively high level initially so that it can be reduced and controlled to produce exactly the effect that we require. Noise is, by definition, a random or semi-random type of signal, and the very unpredictability of it can prove useful in generating random numbers in digital systems, or random voltages in analogue systems. Many digital communication links are tested with digital noise sources to simulate a wide range of signal types. Analogue noise has applications in sound synthesis, forming the basis for many types of sound or sound effect. It's used in speech synthesis to model the hissing sounds made by the human mouth and vocal tract, and it's also used extensively in audio systems to allow the precise adjustment of tone controls or graphic equalisers when optimising the response of a sound system in any given room or building.

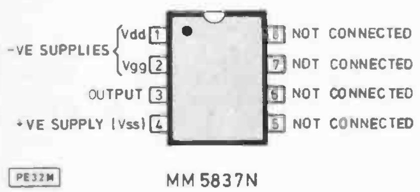
GENERATING NOISE

We've already considered the fact that noise is a random type of signal. It contains no steady frequency components at all which are discernible; in fact, a perfect broadband noise signal can be considered to simultaneously contain all possible frequencies from d.c. up to infinity, the net result of which is a wavepattern in which no repetitive waveforms or tones can be distinguished. This is the type of signal produced by natural phenomena within all normal semiconductor materials, albeit at an extremely low level. In very high gain amplifiers this noise is amplified along with the signal, resulting in unwanted background 'hiss'.

One technique for generating noise uses exactly this effect, and is shown in Fig. 2. TR1 is connected as a reverse biased diode with its collector open circuit. The tiny noise current generated by this is amplified, first by TR2 then by the op-amp IC1. This technique is simple, and usually works fairly well, although different types of transistor used for TR1 can give different types of noise, i.e. noise signals with different amplitudes at different parts of the spectrum; a lack of low frequency components in the noise, an excess of mid-band components, or similar. A more consistent performance can be obtained by using a special noise generating Zener diode, such as the Z5J, with a suitable high gain amplifier configuration, although these tend to be quite expensive. There can also be problems with mains hum and interference, or instability, caused by the very high gains of the circuitry involved, so care must be taken with the design and construction of this type of system.

A DIGITAL NOISE SOURCE

An alternative way of generating noise uses an 'artificial', rather than an amplified natural effect, and this is the basis for the i.c. featured this month, the MM5837N from National Semiconductor. It's a digital technique using a clocked shift register with multiple feedback paths. Fig. 3 shows the block diagram of the i.c. An internal high frequency clock oscillator is used to continuously clock a 17 bit shift register. The shift register acts as a 17 bit 'first



Characteristic	Notes	Minimum Value	Typically	Maximum Value	Units
V_{dd} supply voltage	With respect to +ve supply pin, V_{ss} (pin 4). (absolute maxima)	V_{ss} −25	V_{ss} −14	V_{ss} +0·3	V
V_{gg} supply voltage		V_{ss} −33	V_{ss} −27	V_{ss} +0·3	V
+ve supply V_{ss} for normal operation	V_{dd} and V_{gg} connected to 0V	+8·9*	+14	+25	V
Temperature range		0		+70	°C
For all following spec's, V_{ss} = 0V, V_{dd} = −14V, V_{gg} = −27V					
Quiescent current, V_{dd} (pin 1)	No output load	3		8	mA
Quiescent current, V_{gg} (pin 2)				7	mA
Half power point		24		56	kHz
Cycle time		1·1		2·4	s
Output voltages:	(pin 3 loaded with 20k to V_{ss} and 20k to V_{dd})				
LOGIC 1		V_{ss} −1·5		V_{ss}	V
LOGIC 0		V_{dd}		V_{dd} +1·5	V
LOGIC 0	V_{gg} = V_{dd}, i.e. −14V	V_{dd}		V_{dd} +3·5	V

* = data not available from manufacturer— this was measured on prototype circuit.

Fig. 1. Pinout and specification

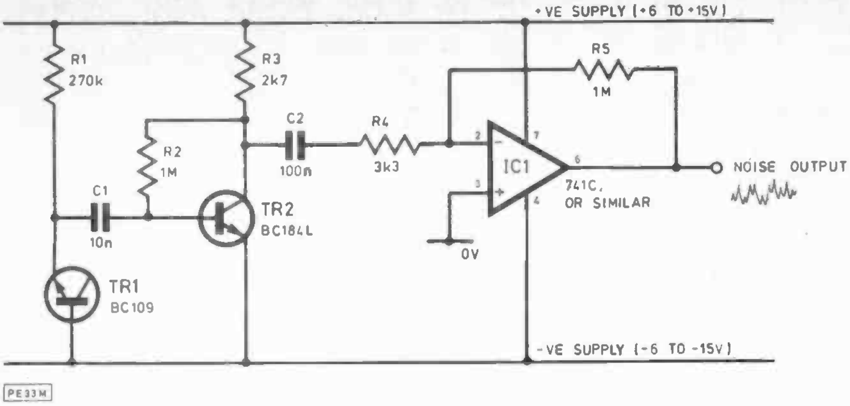


Fig. 2. Analogue noise generator

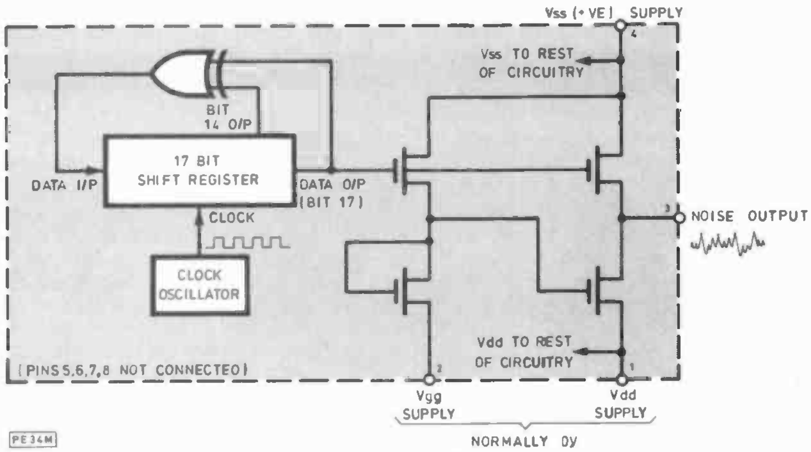


Fig. 3. Block diagram

in first out' storage device. Any data bit present at its input when the clock is pulsed will emerge at the data output pin exactly 17 clock cycles later. In this respect, the action of the shift register can be likened to pushing coloured balls into a length of tubing one by one; they emerge at the other end, one by one, a fixed time later, in exactly the same order that they were pushed in. If the output of the register is connected back to its data input, whatever pattern of logic 1's and 0's is present within the register at that time will be 'rotated' continuously round the register without changing.

If we look at other points within the shift register, such as the 14th bit rather than the output (the 17th bit), we see the state that the input was at 14 clock cycles earlier, rather than 17 cycles earlier as would be the case when looking at the output. If the 14th and 17th bits are combined together with some logic gating, such as an exclusive-OR gate, we can feed a rather oddly derived signal back to the data input of the shift register. The mathematics of the resultant effect are very complex, but the practical end result is an almost purely random digital signal, known as a 'pseudo-random' signal. In fact, it's not *perfectly* random; it does have a pattern which repeats, but only every 1·1 to 2·4 seconds, which only affects very low frequency applications of the noise source. Various different lengths of shift register, and various combinations of output bits in multiple feedback paths could be used, but the arrangement employed by the MM5837N is quite satisfactory for most applications.

OUTPUTS FROM THE I.C.

The i.c. is fabricated using PMOS technology, hence the unusual approach of calling the positive supply V_{ss}, and the negative supply V_{dd}. A third, optional supply V_{gg} can be biased somewhat more negatively than V_{dd} if required, which will slightly improve the output drive voltage available from the MOSFET output buffer stage connected to pin 3. The manufacturer's specifications are based on using the i.c. in a positive earth arrangement, with 0V connected to pin 4, −14V connected to pin 1, and −27V connected to pin 2. This would cause considerable headaches in most potential applications, so it is quite acceptable to simply connect pin 4 to the positive supply rail (+8·9 to +25V) and connect both pins 1 and 2 to 0V. This will give an acceptable output voltage swing for most purposes. Note that the lower voltage limit given in the specification, Fig. 1, is derived from experimentation on the prototype applications circuit, not by the i.c. manufacturers, who don't give a lower limit figure. As the voltage drops to around this figure, the noise spectrum becomes somewhat irregular, and below this voltage fixed frequency tones start to become discernible within the noise.

The clock oscillator is completely self-contained, so no external timing components are needed. This is a high frequency oscillator, and it totally defines the maximum high frequency limit of the output noise spectrum. The 'half power' (i.e. the −3dB) point is specified as between 24 and 56kHz, inferring that the clock frequency must be around 100kHz or more.

NOISE COLOUR

The spectral content of a noise signal is referred to as its colour. There are actually many colours of noise: red, blue, etc., but the two types most commonly used are white and pink.

White noise is characterised by having equal energy per constant bandwidth in the spectrum. For example, the energy content in the region between 1kHz and 2kHz will be the same as that between 2kHz and 3kHz, because in each case the bandwidth is 1kHz. The energy content will rise by 3dB per octave, however, with an octave being defined as a doubling of frequency, so the energy contained in the region 2kHz to 4kHz will be 3dB higher than that in the region 1kHz to 2kHz. The converse is true for pink noise, which has an equal energy level per octave, i.e. a 3dB loss in amplitude per constant bandwidth. For example, the energy content in the region 2kHz to 4kHz will be 3dB LOWER than that in the region 1kHz to 2kHz. Put very simply, white noise is a very hissy sound with high frequency content, whereas pink noise is a duller 'wooshing' low frequency content sound.

For audio use, especially in the setting up of graphic equalisers and sound systems, the use of pink noise is widespread. Graphic equalisers are usually calibrated in octaves, with each control cutting or boosting the audio signal in a narrow octave wide, or even one third of an octave wide band. Using pink noise ensures that the mean signal amplitude will be the same in each band of the equaliser, allowing the spectral response of the system to be tailored precisely.

CONVERTING WHITE NOISE TO PINK

The MM5837N produces only white noise, so to obtain a pink noise signal we must include filtering to roll off the amplitude at the rate of 3dB per octave. Unfortunately, even a simple resistor/capacitor network has a 6dB

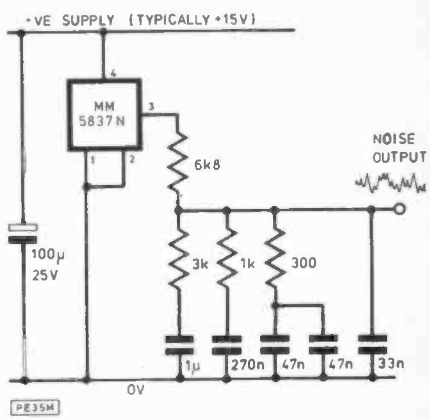


Fig. 4. Simple pink noise generator

per octave slope, and most active filters are designed for 12, 18, or more dB's per octave. The easy solution is to cascade several resistor/capacitor networks together, each set to different turnover frequencies in such a way that they combine to produce an overall slope of only 3dB per octave. National Semiconductor's recommended network to do this for the MM5837N is shown in Fig. 4. Note that the output of this circuit has a fairly small amplitude for the actual noise signal (only about 1V peak-to-peak) but this rides on a d.c. level of just over half the supply rail voltage, and as a result will normally need a series decoupling capacitor prior to feeding into any other circuitry.

APPLICATIONS

The i.c. can be used either as a purely digital noise source, or with suitable filtering or amplification as an analogue noise source. Consider using the i.c. output to feed into a CMOS serial in/parallel out register's data input, then clock that register with a regular slow clock pulse. The output from the register will be a pseudo-random digital number. If fed into a digital to analogue converter, this would produce a regularly changing random analogue voltage, ideal for use in experimental sound or music synthesis. Other potential uses for a noise generator have already been discussed, but perhaps the most obvious is the basis for this month's applications project.

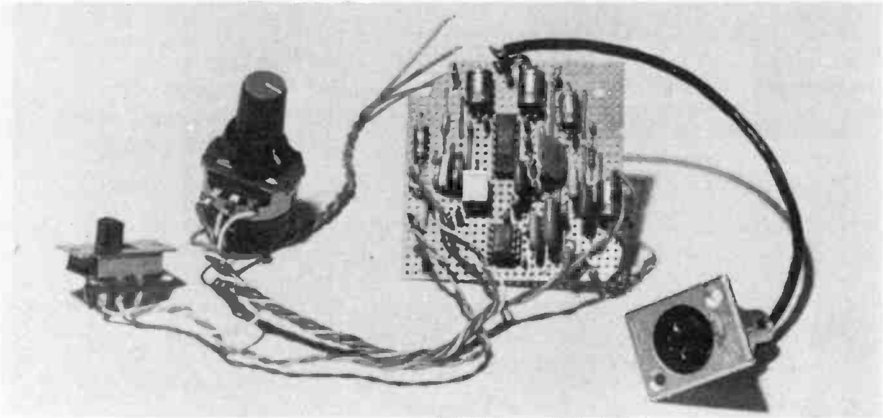
The MM5837N can be obtained from **Alpha Electronics**, 66 Wilbury Way, Hitchin, Herts, SG4 0TT.

AUDIO NOISE GENERATOR

THE circuit diagram for a useful audio noise generator is shown in Fig. 5. It can produce either white or pink noise, and has a variable level control to adjust output amplitude. The output is electronically balanced, making it ideal for feeding into balanced inputs to audio equipment, although it can equally well be used with unbalanced systems.

One of the attractions of the MM5837N is that it is very compact, replacing several larger i.c.s with an 8-pin d.i.l. package. The circuit, and its Veroboard layout, have been designed to take advantage of the small size of the device, and the result is a very small assembly, ideal for building into a hand-held case. R1, R4, R5, R6, R7, R8, C2, C3, C4, and C5 form the passive network which derives pink noise from the i.c. output. The more difficult to obtain values in Fig. 4 have been replaced by different quantities of other values of component to make it easier to build with full accuracy. The pink noise is amplified up to a reasonably high level by IC2a, then fed to the selector switch S1. The white noise feed to S1 comes from the output of IC1, decoupled by C1, attenuated and biased to 0V by R3, and with a high frequency roll-off provided by R2 and C7 to help reduce high frequency components in the waveform caused by the sharp edges of the digital output of IC1.

IC2d buffers the output of the level control VR1, and feeds into the two halves of the balanced output, IC2b and IC2c. These are connected to give EXACTLY the same gain, one with signal inversion, and the other without. The two outputs are thus symmetrical, i.e. mirror images, about 0 volts. This



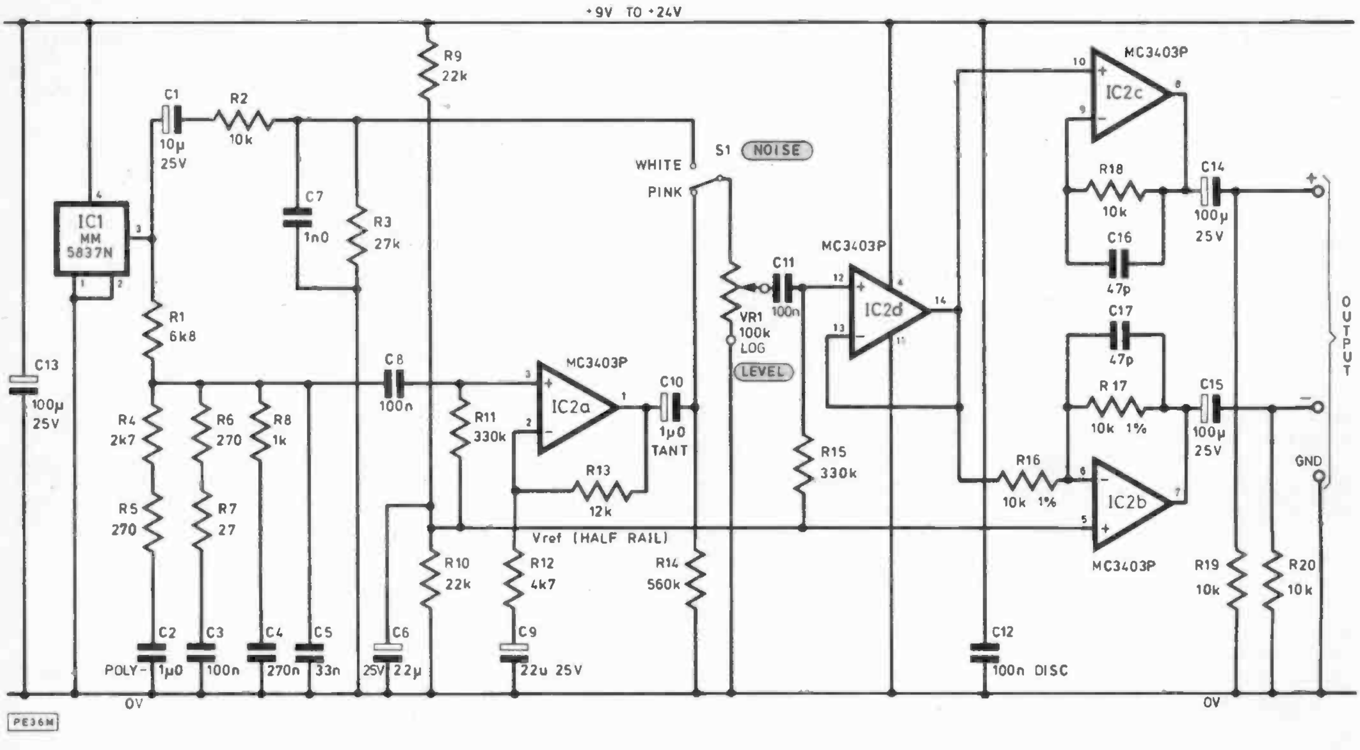


Fig. 5. The Audio Noise Generator

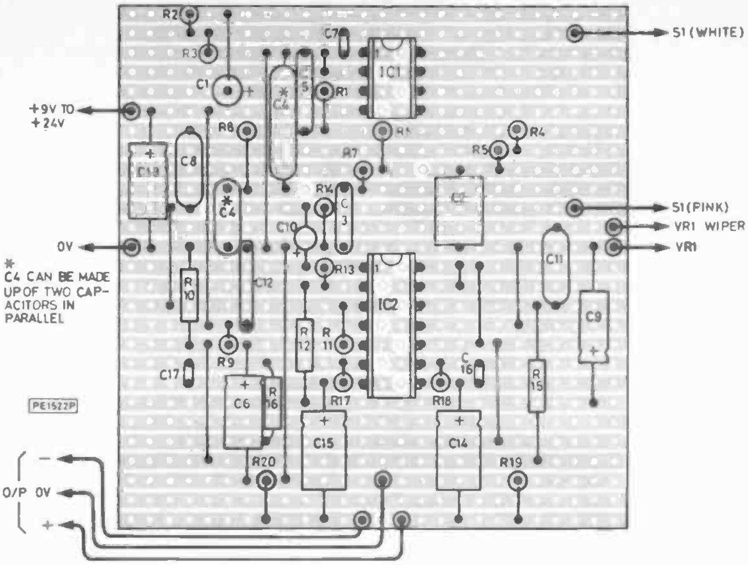


Fig. 6. Veroboard layout

can directly drive into balanced inputs of audio equipment, while for conventional unbalanced systems, either output, positive or negative, can be used, with the common 0V or ground connected as the return. C16 and C17 roll off the response of the amplifiers at high frequencies to keep them stable, and R18 helps to match the response of IC2c as closely as possible to that of IC2b. Ideally, the values of R16 and R17 should be within 0·1% of *each other,* although the actual value itself is not as critical. Practically, 1% is adequate for most systems, and even 5% resistors can be used if non-critical uses are anticipated.

BIAS POINT

Components R9, R10, and C6 provide a half-rail bias point for the op-amps, C12 and C13 decouple the supply, C14 and C15 decouple the outputs to block d.c. from the op-amps, and R19 and R20 bias the outputs to 0V. The output impedance is very low indeed, so if a 600 ohm output impedance is required, then a pair of 300 ohm resistors, again matched to within 0·1% or 1% of each other, should be added in series with the +ve and −ve outputs. The relative amplitudes of pink and white noise can be adjusted by varying the gain of IC2a (change R12 or R13) or the attenuation of the white noise source (change R3), although care must be taken to avoid clipping of the waveform, which could be checked for on an oscilloscope. Many quad op-amp packages could be used for IC2, but some do not work well on low supply voltages in the voltage follower mode. The MC3403P does work well under these conditions, although if supplies of 18V or more (or +/− 9V) are used the TL074 offers better high frequency performance, and is to be preferred.

The noise generator can be used for testing noise rejection or reduction systems, for setting up graphic equalisers or room equalisers, or even for generating special effects. Its compactness is largely due to the diminutive MM5837N, and shows a typical use for this digital noise source i.c.

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1985

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RICHARD B. H. BECKER — SYSTEM DESIGN AND MECHANICAL ENGINEERING.
TIM ORR — COMPUTER INTERFACE AND CONTROL ELECTRONICS.

ROBOTS

neptune and mentor

PART FOUR

THIS SERIES is concerned in part four with the control electronics and mechanical construction of the MENTOR robot. Like the NEPTUNEs, MENTOR interfaces directly to any one of three popular home computers and provides the facility for control either from the keyboard, or by making use of the "learning arm".

PRINCIPLES OF OPERATION

MENTOR is a 6-axis servo controlled electric robot (Fig. 4.1). Whilst the NEPTUNEs are designed for industrial use, MENTOR is primarily intended for educational purposes but as can be seen from the specification (Table 1) it too has the repeatability for many commercial applications, where the load is light. Each of the axes is powered by a small d.c. servo motor with integral gearbox with a large reduction ratio.

Axis Ø is the centre column which rotates in a nylon bearing in the top plate of the base of the robot and is powered by the motor through an additional pair of gears (Fig. 4.2). The radial position of the column is sensed by a conductive polymer potentiometer fitted to the underside of it. The column is hollow to enable the cables to pass down it to the computer interface board.

Axis 1 is the lower section of the arm which rotates about an axle fitted to the centre column (Fig. 4.3). Again a pair of gears is used to transfer torque from the motor to the axle and a potentiometer provides the feedback information. The axle is hollow for the cables to pass through it.

Axis 2, the fore arm is driven in the same manner as axis 1. A large piece of steel at the back end of the lower arm section counterbalances the weight of this section of the arm making the robot's position stable when there is no power applied to it;

Table 1. MENTOR SPECIFICATION

AXIS Ø (centre column)	Angular movement 210°. Axle centre 170mm above top of base.
AXIS 1 (shoulder)	Angular movement 180°. Arm length between axle centres 165mm.
AXIS 2 (elbow)	Angular movement 230°. Arm length between axle centres 150mm.
AXIS 3* (left wrist axle)	Angular movement 320°.
AXIS 4* (right wrist axle)	Angular movement 320°.
WRIST PITCH	Angular movement 140°.
WRIST ROTATION	Angular movement 320°.
AXIS 5 (gripper)	Jaw opening 30mm. Jaw pressure 10 newton. Distance from end of jaws and axis 3 and 4 axles 105mm.
REPEATABILITY	2mm.
LIFTING CAPACITY	300gm.
REACH (from axis 1 axle centre)	420mm.
BASE DIMENSIONS	Overall width 320mm. Overall depth 270mm. Overall height 189mm.

CONTROL SYSTEM	All axes servo controlled with servoing performed by the control electronics. Position defined by 8 data bits giving angular resolution of 0·4%.
COMPUTER INTERFACE	Parallel. Robot addressed as if part of computer memory. Connects to expansion port (1MHz bus on BBC).
SOFTWARE	Accepts commands in BASIC or machine code.
SOFTWARE PROVIDED	Extensive package of BASIC programs including direct control from computer keyboard, control by simulator, sequence storing, replay, sequence editing, sequence storage on disc or tape, multi-speed control and graphical illustration of robot dynamics.

*AXIS 3, 4 movements are combined to provide wrist pitch and wrist rotation.

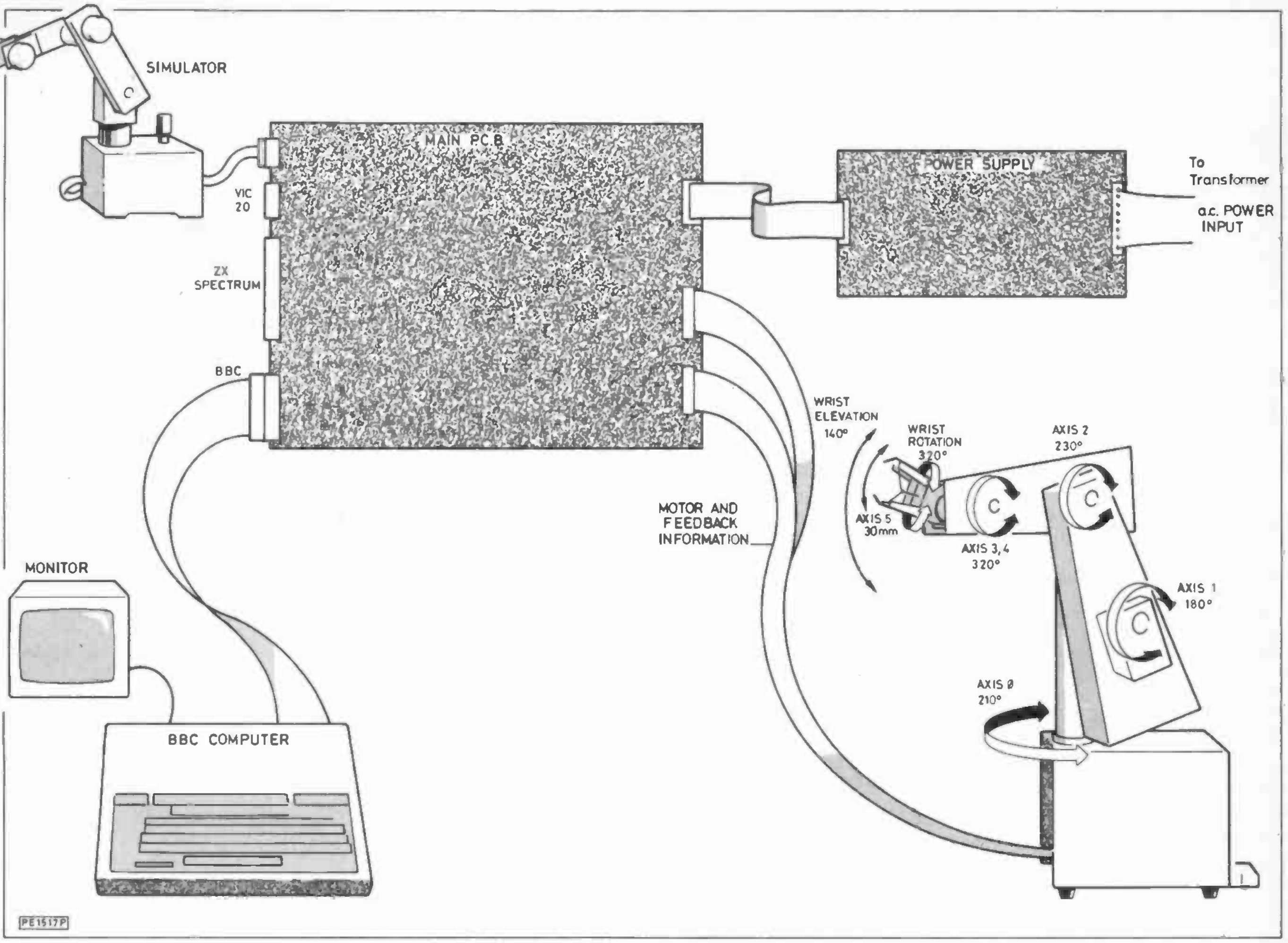
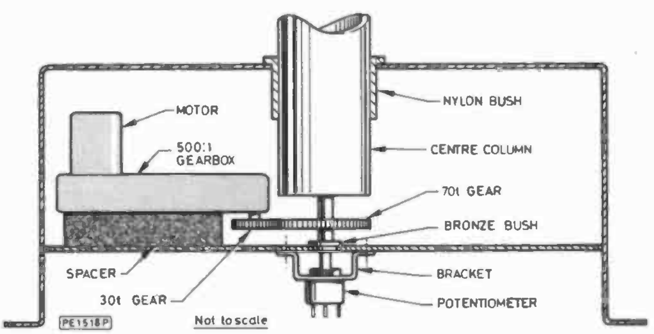


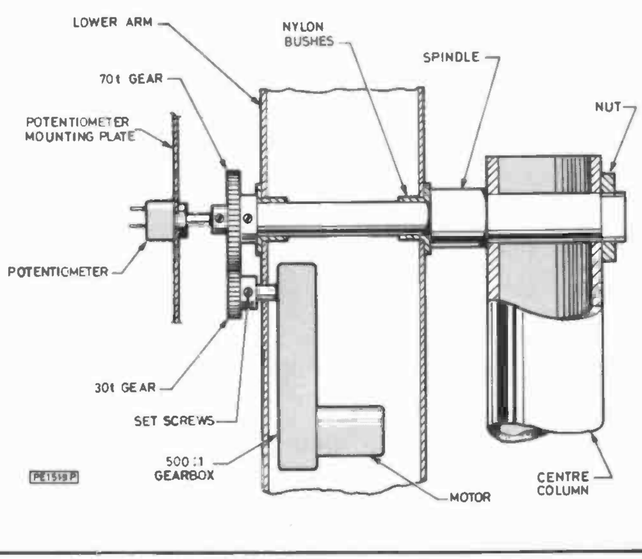
Fig. 4.1. Exploded view of the complete MENTOR system

therefore the drive motor does not have to be continuously on to keep the arm in position. There are also counterbalance weights on the fore arm to balance out the wrist motors.

Axes 3 and 4 are the wrist drive motors. The movements are combined to provide wrist elevation and wrist rotation by means of a set of bevel gears. When axes 3 and 4 advance together the



Axis drive systems: Fig. 4.2, above, shows the system used to drive axis Ø. Fig. 4.3, opposite, shows the drive system for axis 1. See also Fig. 4.1, and the text



wrist rises. When the axes move in equal and opposite directions the elevation remains constant but the wrist rotates, as shown in Figs. 4.4 and 4.5.

Axis 5 is the gripper which is also servo controlled. To keep down the weight at the front end of the fore arm the drive motor for this is fitted to the lower arm with the power applied to the jaws via a flexible cable consisting of a nylon-coated multi-strand steel wire inside a spiral wound PVC-coated conduit. This is similar to the brake cable of a bicycle. Torsion springs open the jaws when tension is released on the cable. Being servo controlled it is possible to program different degrees of jaw closure. If the programmed position is for a gap between the jaws of less than the size of the object to be handled then the grip will depend on how much further the servo system is trying to move the jaws.

THE MENTOR CONTROL SYSTEM

The MENTOR, like the NEPTUNE, can be connected to one of three popular computers, the Commodore VIC20, the Sinclair ZX Spectrum and the BBC. When the computer sends the robot new data it responds by moving to a position where the feedback information from the potentiometers exactly matches the information from a DAC (digital-to-analog converter) controlled by the computer. This process is called servoing. Each of the 6 axes of movement can be defined with 8-bit (1 part in 256 or 0·4%) resolution.

ROBOT CONTROL

To move each of the axes the computer sends (WRITEs) 6 bytes of data to the robot, one to each axis. The servoing is performed by dedicated hardware on the computer interface board of the robot. In a typical movement of the robot, the computer sends 6 new bytes of data to the robot. The computer is then writing to what it "thinks" is just another area of its memory. The interface board then stores these 6 bytes of information and converts them to 6 position control voltages. The analog electronics on the interface board then compares these voltages with the feedback voltages. The difference between these two voltages is delivered to high power operational amplifiers which drive the motors in the direction which reduces the difference to zero. This is the servoing process.

FEEDBACK

The computer is not involved in the servoing, it is merely generating data and relying on the robot to follow the instructions correctly. However the computer can perform a READ of any or all of the 6 feedback voltages and can thus be aware of all the movements of the arm. This process can be used to delay sending the next set of co-ordinates until the previous set of co-ordinates have been reached or for varying the speed of the robot during playback of a sequence. It is also easy to produce a graphical display of the movements and observe the effect of varying loads and of alterations to the components determining the characteristics of the servo system.

The computer can also READ the position of the simulator, which is a small hand operated model of the robot which can be plugged into the learn axis input CN400. The computer READS the position of the simulator and then WRITES this data into the robot. The arm follows the real-time motion of the simulator. The movements are stored in the memory of the computer and can be transferred to tape or disc for later use.

COMPUTER INTERFACES

All three computers make available various signals for external use. See Fig. 4.6. These include the data bus DØ to D7, some of the lower address lines, READ and WRITE signals, the system clock and on the VIC20 and BBC a memory block decode. The BBC and VIC20 both use the 6502 microprocessor, so have relatively similar decoding electronics. The Spectrum uses a Z80. This together with some unusual practices in the Spectrum design makes interfacing somewhat different.

All the data and address lines are hard wired together so if two computers were simultaneously connected a bus clash would occur. However there is no reason why two or more robots should not be daisy-chained together either to perform the same task or completely different tasks if a different address is used. For example, using a BBC Computer one robot could be addressed with the link-selected "FRED" decode (FCØØ-FCFF) whilst the other is addressed with the link-selected "JIM" decode (FEØØ-FEFF). All three interfaces generate a VALID WRITE signal. The Spectrum WRITES to the block ØØØØ-1FFF which is where the ROM resides and as ROMs are not normally written to no conflict occurs. The other computers WRITE to non-existent areas of RAM. IC302 is a multiplexer which selects which interface will generate the READ and WRITE signals. The Spectrum interface generates two READ signals (ZXRD63 and ZXRD95). These are not passed through the multiplexer but are used later on in the electronics to perform direct READs.

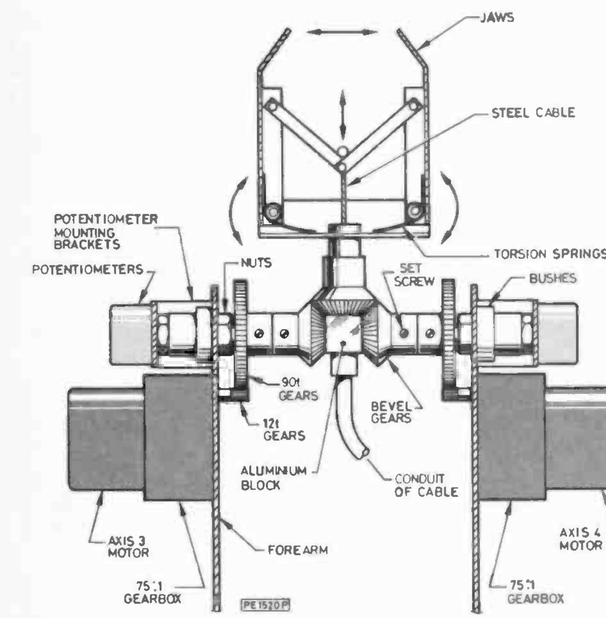
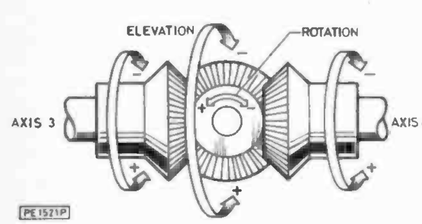
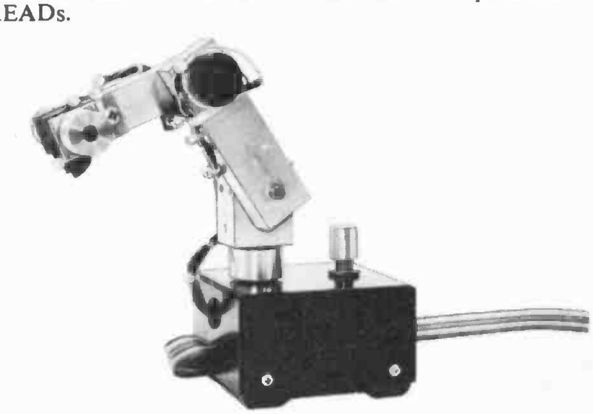


Fig. 4.4. Wrist and gripper drive system

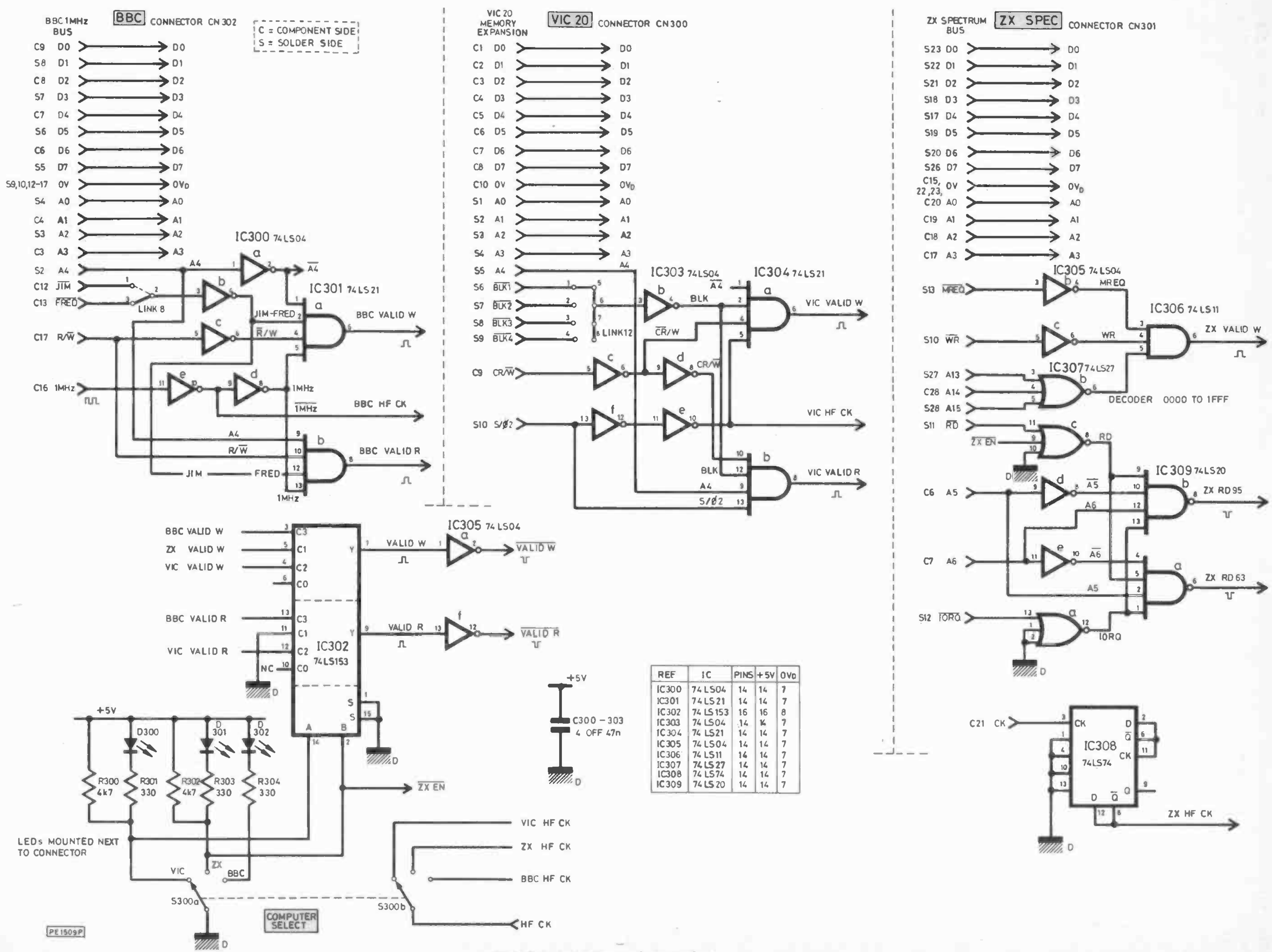


AXIS 3	AXIS 4	E	R
0	−1	−½	+½
0	+1	+½	−½
−1	0	−½	−½
−1	−1	−1	0
−1	+1	0	−1
+1	0	+½	+½
+1	−1	0	+1
+1	+1	+1	0

Fig. 4.5. Wrist operation showing effect of one-bit change on axes 3 and 4



The MENTOR simulator (learning arm)



REF	IC	PINS	+5V	0VD
IC300	74LS04	14	14	7
IC301	74LS21	14	14	7
IC302	74LS153	16	16	8
IC303	74LS04	14	14	7
IC304	74LS21	14	14	7
IC305	74LS04	14	14	7
IC306	74LS11	14	14	7
IC307	74LS27	14	14	7
IC308	74LS74	14	14	7
IC309	74LS20	14	14	7

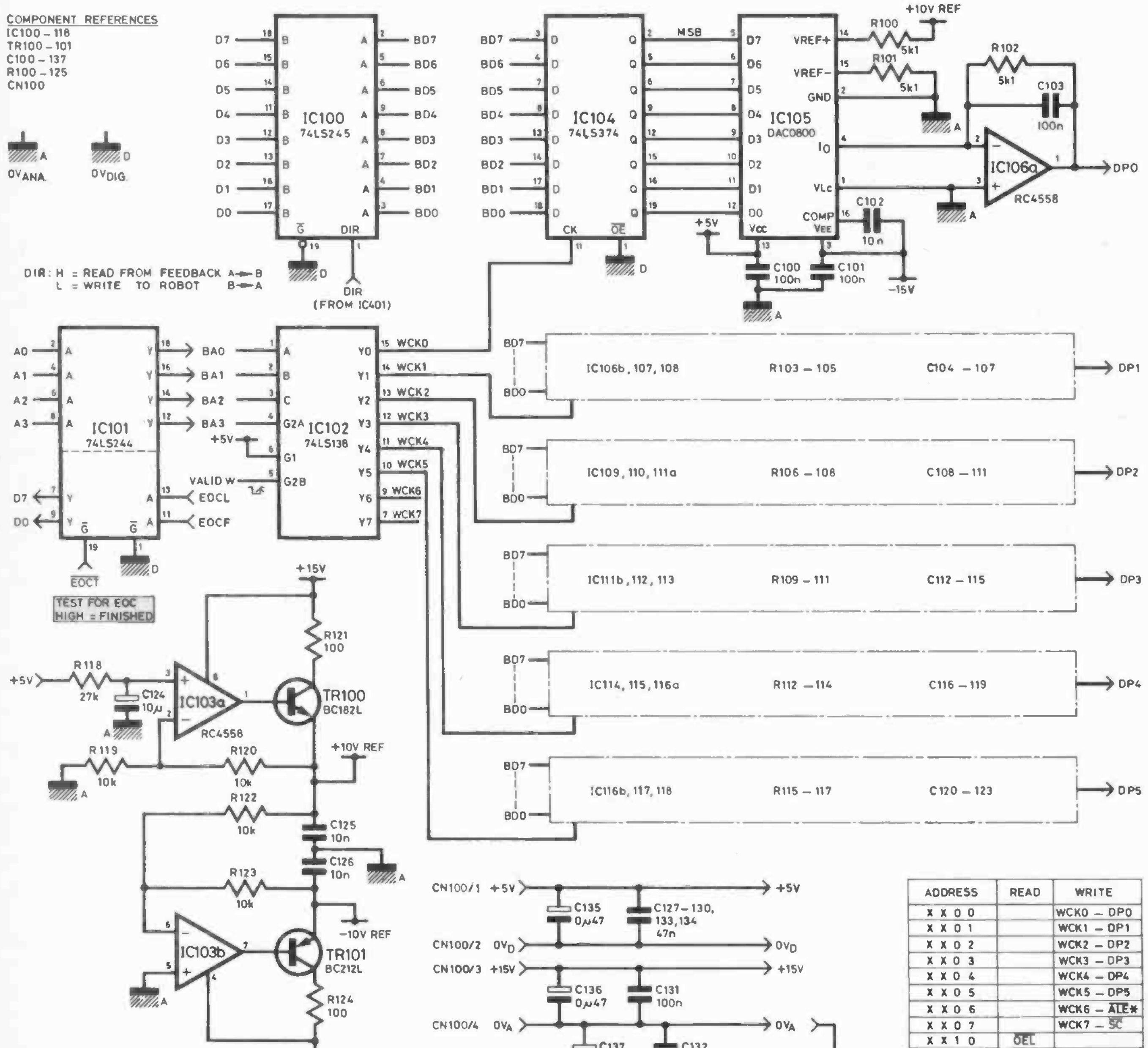
Fig. 4.6. Interface electronics

WRITING

Data is sent to the robot as 6 bytes, each with a different address. See Fig. 4.7. Six latches are used to store this data (IC104, 107, 109, 112, 114, 117). These are individually clocked with the address decodes from IC102, which is driven by the lowest three address lines. A typical WRITE is as follows. In one computer instruction cycle, the data is set up on the data bus, a VALID WRITE signal is generated and the LSBs of the address bus are set to the correct axis address. When the VALID WRITE signal goes high the data is written into the latch corresponding to that axis. The other axes are then written to similarly. The data held in the latches is converted into position control voltages by the DACs (IC105, 108, 110, 113, 115, 118). All the data passes through IC100 which is a 74LS245 bus transceiver. When the DIRection signal is low, data passes from B to A (WRITE mode). When the DIR signal is high, data passes in the other direction from A to B (READ mode).

READING

There are two ADCs in the system, IC400 and 402 as shown in Fig. 4.8. These are 8-bit devices with integral 8-way analog multiplexers and integral 3-bit address latches. IC400 is used to look at the feedback voltages VFBØ to VFB5 and the other looks at the learn axis (simulator) signals VLØ to VL5. The input voltages to the analog multiplexer must not exceed the ADC



POWER PINOUT

DEVICE	PINS	+5V	$0V_D$	+15V	–15V
74LS244	20	20	10	–	–
74LS245	20	20	10	–	–
74LS374	20	20	10	–	–
74LS138	16	16	8	–	–
RC4558	8	–	–	8	4

ADDRESS	READ	WRITE
X X 0 0		WCK0 – DP0
X X 0 1		WCK1 – DP1
X X 0 2		WCK2 – DP2
X X 0 3		WCK3 – DP3
X X 0 4		WCK4 – DP4
X X 0 5		WCK5 – DP5
X X 0 6		WCK6 – $\overline{\text{ALE}}$*
X X 0 7		WCK7 – $\overline{\text{SC}}$
X X 1 0	$\overline{\text{OEL}}$	
X X 1 1	$\overline{\text{OEF}}$	
X X 1 2	$\overline{\text{EOCT}}$	
X X 1 3		

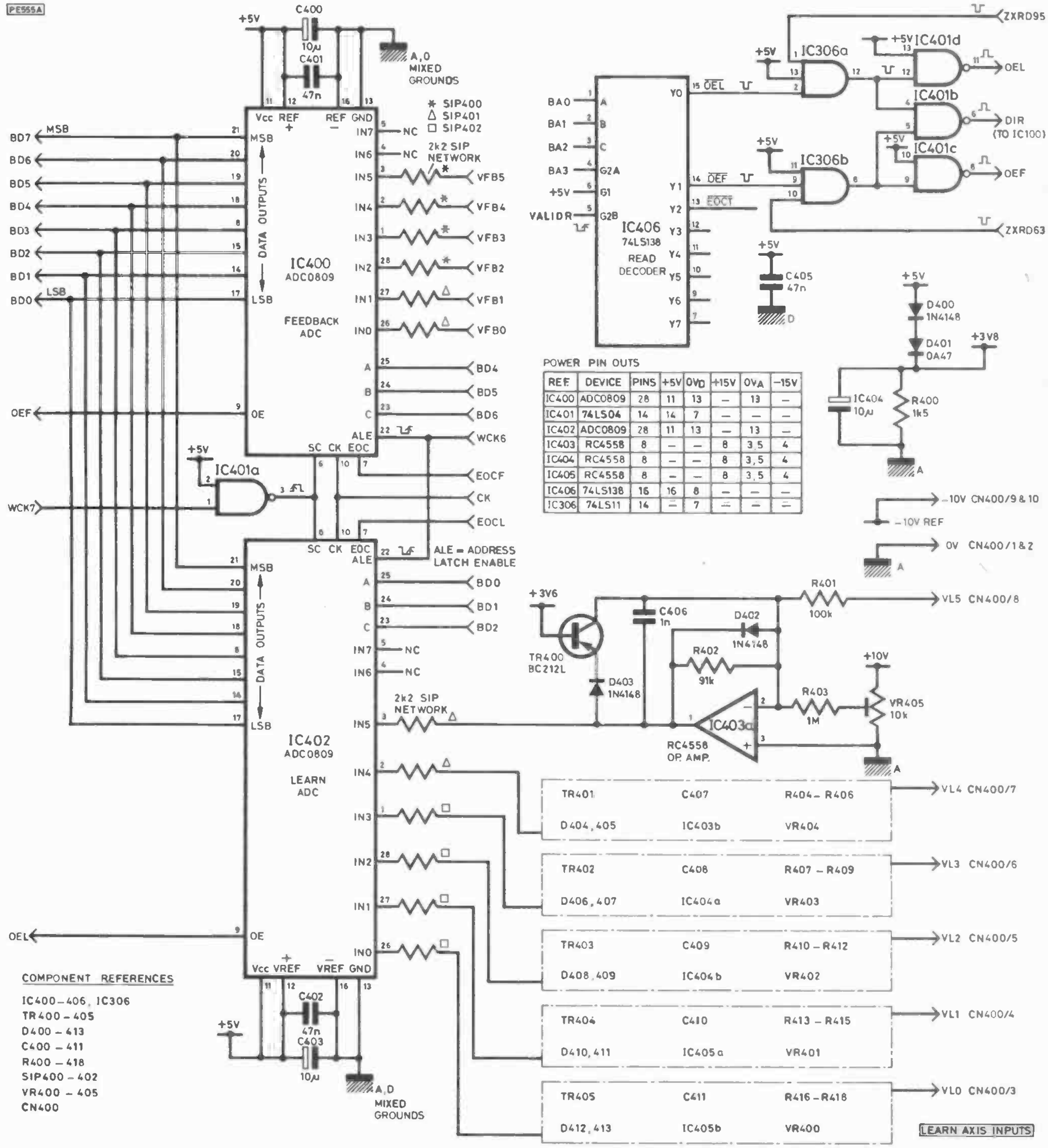
*D7 D6 D5 D4 D3 D2 D1 D0 — CONTROL BYTE $\overline{\text{ALE}}$
X C B A X C B A
$\underbrace{\text{C B A}}_{\text{FB}}$ $\underbrace{\text{C B A}}_{\text{LEARN}}$

Fig. 4.7. The electronics concerned with a "Write" operation

supply rails. To prevent this from occurring diode and transistor clamps are used wherever higher voltages could possibly arise.

A READ is performed as follows. The axis channel is selected by writing a 3-bit code (BDØ,1,2, and BD4,5,6) into the ADCs. The ALE (Address Latch Enable) signal latches these codes into the ADC internal registers. These codes select the multiplexer position. A start conversion signal is then generated. The ADC takes about 100 microseconds to perform the conversion. A test can be made for the end of conversion (EOC). By generating the $\overline{\text{EOCT}}$ signal both EOCs can be tested as both ADCs convert at the same time. A high indicates end of conversion (see IC101). When the conversion is complete then one or both of the ADCs can be READ. The ADCs have tri-state outputs which are enabled by the OEF and OEL signals (active high). The READ is then performed by generating a VALID READ signal and an address code to select one of the two ADCs. This enables the tri-state output of the selected ADC and also generates a DIR signal which sends data out from the interface board onto the computer's data bus. The computer can then READ the axis data.

NEXT MONTH: MENTOR construction



POWER PIN OUTS

REF	DEVICE	PINS	+5V	$0V_D$	+15V	$0V_A$	−15V
IC400	ADC0809	28	11	13	–	13	–
IC401	74LS04	14	14	7	–	–	–
IC402	ADC0809	28	11	13	–	13	–
IC403	RC4558	8	–	–	8	3,5	4
IC404	RC4558	8	–	–	8	3,5	4
IC405	RC4558	8	–	–	8	3,5	4
IC406	74LS138	16	16	8	–	–	–
IC306	74LS11	14	–	7	–	–	–

Fig. 4.8. Analog-to-digital conversion for a "Read" operation

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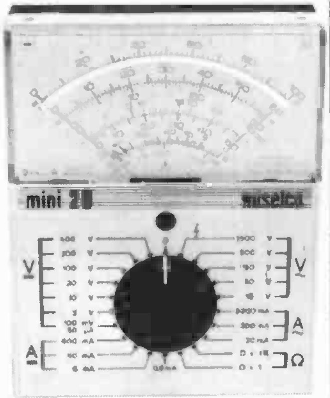

Accuracy: 2% d.c. and resistance, 3% a.c.
28 ranges: d.c. V 100mV, 3V, 10V, 30V, 100V, 300V, 600V. d.c. I 150μA, 600μA, 6mA, 600mA. a.c. V 15V, 50V, 150V, 500V, 1500V. a.c. I 130mA, 300mA, 3.0A. Ohms 0–2kΩ, 0–2MΩ dB from −10 to +62 in 6 ranges.
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★ **20KΩ/V** AC AND DC
★ **39 RANGES**
★ **INDESTRUCTIBLE** (automatically protected on all ranges but 10A)

Accuracy: d.c. ranges and Ω 2% a.c. 3% (of f.s.d.)
39 ranges: d.c. V 100mV, 1·0V, 3·0V, 10V, 30V, 100V, 300V, 1000V.
d.c. I 50μA, 100μA, 300μA, 1.0μmA, 3mA, 10mA, 30mA, 100mA, 1A, 10A
a.c. V 10, 30V, 100V, 300V, 1000V;
a.c. I 3mA, 10mA, 30mA, 100mA, 1.0A, 10A.
Ω 0–5.0kΩ, 0–50kΩ, 0–500kΩ, 5MΩ, 50MΩ.
dB from −10 to +61 in 5 ranges.
Dimensions: 105 × 130 × 40mm.

These special offers is a wonderful opportunity to acquire an essential piece of test gear with a saving of nearly £20.00.

(complete with carrying case, leads and instructions) **ONLY £33·50**

PRICES Our prices include VAT and postage and goods are normally despatched by return.

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ALCON Instruments Ltd.

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neptune

for low-cost training in

real-life robotics

The advanced design of the Neptune 2 makes it the lowest cost real-life industrial robot.
It is electro-hydraulically powered, using a revolutionary water based system (no messy hydraulic oil!)
It performs 7 servo-controlled axis movements (6 on Neptune 1) – more than any other robot under £10,000.
Its program length is limited only by the memory of your computer.
Think what that can do for your BASIC programming skills!

And it's British designed, British made.

Other features include:
- Leakproof, frictionless rolling diaphragm seals.
- Buffered and latched versatile interface for BBC VIC 20 and Spectrum computers.
- 12 bit control system (8 on Neptune 1).
- Special circuitry for initial compensation.
- Rack and pinion cylinder couplings for wide angular movements.
- Automatic triple speed control on Neptune 2 for accurate 'homing in'.
- Easy access for servicing and viewing of working parts.
- Powerful – lifts 2.5 kg with ease.
- Hand held simulator for processing (requires ADC option).

Neptune robots are sold in kit form as follows:

Neptune 1 robot kit (inc. power supply)	£1250.00	ADC option (components fit to main control board)	£95.00
Neptune 1 control electronics (ready built)	£295.00	Hydraulic power pack (ready assembled)	£435.00
Neptune 1 simulator	£45.00	Gripper sensor	£37.50
		Optional extra three fingered gripper	£75.00
Neptune 2 robot kit (inc. power supply)	£1725.00	BBC connector lead	£12.50
Neptune 2 control electronics (ready built)	£475.00	Commodore VIC 20 connector lead and plug in board	£14.50
Neptune 2 simulator	£52.00	Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of March 1985

mentor

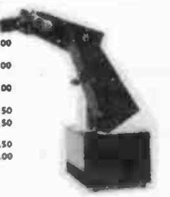
desk-top robot

This compact, electrically powered training robot has 6 axes of movement, simultaneously servo-controlled. It gives smooth operation, and its rugged construction makes it ideal for use in educational establishments. Other features include long-life bronze and nylon bearings, integral control electronics and power supply, special circuitry for inertial compensation, optional on-board ADC, and hand-held simulator as the teaching pendant. Like Neptune, Mentor's program length is limited only by your computer's memory. Programming is in BASIC.

Mentor is all-British in design and manufacture and comes in kit form at an astonishingly low price.

Mentor robot kit (inc. power supply)	£345.00
Mentor Control electronics (ready built)	£135.00
Mentor Simulator (requires ADC option)	£42.00
ADC option (Components fit to control electronics board)	£19.50
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of March 1985



Cybernetic Applications

CYBERNETIC APPLICATIONS LIMITED
PORTWAY TRADING ESTATE, ANDOVER, HANTS SP10 3PE
TEL: (0264) 50093 Telex: 477019

AA117	0.090
AA119	[illegible]
AAY32	[illegible]
AC107	0.280
AC126	0.170
AC127	0.150
AC128	0.150
AC128K	0.230
AC141K	0.230
AC142K	0.220
AC153K	0.232
AC176	0.180
AC176K	0.200
AC187	0.150
AC187K	0.200
AC188	0.170
AC188K	0.230
ACY18	0.480
ACY19	0.480
AD142	0.600
AD149	0.450
AD161	0.220
AD162	0.220
AF124	0.250
AF125	0.250
AF126	0.250
AF127	0.250
AF139	0.220
AF239	0.220
AL112	0.700
AL113	0.800
ASZ15	1.000
ASZ17	1.000
AU110	1.100
AY102	1.800
AY106	1.800
BA145	0.100
BA148	0.100
BA154	0.080
BA157	0.120
BB101	0.130
BB103	0.160
BB105B	0.180
BB205B	0.240
BC107	0.070
BC108	0.070
BC109	0.070
BC115	0.100
BC118	0.110
BC140	0.190
BC141	0.190
BC142	0.190
BC143	0.190
BC147	0.055
BC148	0.055
BC149	0.055
BC157	0.055
BC159	0.055
BC182	0.060
BC182L	0.060
BC183	0.060
BC183L	0.060
BC184	0.060
BC184L	0.060
BC212	0.060
BC212L	0.060
BC213	0.060
BC213L	0.060
BC214	0.060
BC214L	0.060
BC237	0.070
BC238	0.070
BC300	0.180
BC301	0.180
BC302	0.180
BC303	0.180
BC327	0.080
BC382	0.060
BC337	0.060
BC328	0.060
BC557	0.060
BCY32	1.500
BCY33	1.500
BCY34	1.500
BCY42	0.200
BCY56	0.360

BCY70	0.160
BCY71	0.160
BCY72	0.160
BD115	0.260
BD124P	0.500
BD124	1.100
BD128	0.350
BD131	0.250
BD132	0.250
BD135	0.200
BD136	0.200
BD137	0.200
BD138	0.200
BD139	0.200
BD140	0.200
BD144	0.900
BD150	0.300
BD157	0.380
BD158	0.380
BD166	0.300
BD175	0.300
BD177	0.300
BD179	0.320
BD181	0.450
BD201	0.330
BD202	0.380
BD203	0.420
BD204	0.420
BD222	0.310
BD225	0.310
BD232	0.310
BD237	0.210
BD238	0.240
BD433	0.280
BD437	0.280
BD535	0.380
BD536	0.380
BD537	0.400
BD538	0.400
BDX32	1.000
BDX65	0.800
BF180	0.160
BF181	0.180
BF183	0.200
BF184	0.200
BF185	0.200
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BF196	0.060
BF199	0.060
BF200	0.180
BF257	0.180
BF258	0.180
BF259	0.180
BF336	0.200
BF337	0.200
BF338	0.200
BF362	0.300
BF422	0.210
BF458	0.180
BF459	0.190
BFX29	0.200
BFX84	0.200
BFX85	0.200
BFX87	0.150
BFX88	0.150
BFY50	0.140
BFY51	0.140
BFY52	0.140
BFY56	0.250
BFY57	0.250
BFY64	0.250
BR100	0.140
BSX19	0.150
BSX20	0.150
BSX21	0.150
BSX26	0.160
BSX29	0.100
BZX76	0.180
BT106	0.900
BT109	0.900
BT116	0.800
BT119	1.000
BT120	1.000
BU104	1.000
BU106	0.800
BU108	1.000
BU110	1.100

BU111	1.400
BU126	0.700
BU204	0.750
BU205	0.700
BU208	0.750
BU208A	0.800
BU208D	1.200
BU326	0.850
BU406	0.850
BU407	0.750
BU408	1.000
BU500	1.100
BU526	0.800
BY126	0.080
BY127	0.080
BY133	0.080
BY164	0.220
BY176	0.850
BY179	0.350
BY182	0.320
BY184	0.320
BY187	0.320
BY196	0.200
BY206	0.110
BY207	0.110
BY223	0.720
BYX10	0.150
CA270	0.400
CA3086	0.250
CA3089	1.500
CA3240	0.900
C106D	0.230
MC1327	0.700
MJ2500	1.000
MJ2501	1.100
MJ2955	0.850
MJ3000	1.150
MJ3001	1.150
MJE29A	0.300
MJE30A	0.300
MJE340	0.250
MJE350	0.800
MJE520	0.300
MJE2955	0.800
OA47	0.060
OA90	0.048
OA91	0.048
OA200	0.070
OA202	0.070
OC28	1.000
OC29	0.800
OC35	1.000
OC45	0.800
OC71	0.300
OC72	0.500
OC200	1.000
OCP71	1.000
ORP12	1.000
ORP60	1.000
ORP61	1.000
R2008B	0.800
R2010B	0.800
SAS560	1.100
SAS570	1.100
SN76003N	1.800
SN76013N	1.000
SN76023N	1.400
SN76033N	1.500
SN76110N	0.700
SN76115N	0.700
SN76226	0.800
SN76227	0.800
T2800D	0.520
TAG06-60	0.420
TAG521-200	0.720
TAG444	0.780
TAA550	0.100
TBA120S	0.450
TBA395	0.600
TBA396	0.600
TBA520	0.750

TBA530	0.750
TBA540	0.750
TBA560	0.700
TBA800	0.350
TBA810S	0.600
TBA820	0.750
TBA920	0.800
TBA950	0.800
TBA990	0.800
TCA800	0.800
TCA940	0.850
TDA1170	0.900
TDA1412	0.600
TDA2002	0.800
TDA2003	1.500
TDA2020	1.400
TDA2030	1.400
TDA2522	0.800
TDA2530	0.800
TDA2532	0.750
TDA2540	0.700
TDA2560	0.700
TDA2593	0.800
TDA2690	0.700
TIP29	0.150
TIP29A	0.220
TIP29C	0.250
TIP30	0.160
TIP31A	0.240
TIP32	0.240
TIP32A	0.240
TIP33	0.500
TIP34	0.500
TIP41A	0.220
TIP41C	0.250
TIP42A	0.220
TIP42C	0.250
TIP47	0.400
TIP48	0.400
TIP49	0.400
TIP110	0.470
TIP112	0.540
TIP115	0.450
TIP117	0.500
TIP120	0.430
TIP121	0.460
TIP122	0.470
TIP125	0.470
TIP126	0.560
TIP127	0.560
TIP2955	0.340
TIP3054	0.380
TIP3055	0.340
TIS61	0.150
TIS90	0.150
TIS91	0.100
2N.2904	0.200
2N.2905	0.200
2N 2906	0.100
2N 2907	0.180
2N 2926	0.080
2N 3019	0.260
2N 3063	0.100
2N 3054	0.350
2N 3055	0.320
2N 3055H	0.300
2N 3440	0.580
2N 3442	0.850

2N 3771	0.850
2N 3772	0.800
2N 3773	1.000
2N.4031	0.250
2N.4036	0.250
2N.4037	0.250
2N.4443	0.700
2N 4444	0.760
2N 5061	0.200
2N 5294	0.300
2N.5296	0.300
2N.6106	0.400
2N 6107	0.400
2N 6109	0.400
3N.128	0.550
3N.143	0.650
IN 914	0.020
IN.4001	0.040
IN.4002	0.040
IN.4003	0.040
IN 4004	0.040
IN 4005	0.040
IN 4006	0.040
IN.4007	0.060
IN.4148	0.020
IN 5400	0.090
IN 5401	0.100
IN.5402	0.100
IN 5403	0.110
IN 5404	0.110
IN 5405	0.120
IN 5406	0.130
IN.5407	0.130
IN 5408	0.130
VOLTAGE REGULATORS	
7803	0.350
7812	0.350
7815	0.350
7818	0.350
7824	0.350
7905	0.350
7912	0.400
7915	0.400
7918	0.400
7924	0.400
78L05	0.280
78L12	0.280
78L15	0.280
74L18	0.280
74L24	0.350
LM309K	1.000
LM317K	2.200
LM317T	1.000
LM323K	4.200
LM723	0.320
78HGKC	0.700
78H05KC	5.200
78GU1C	1.900
79GU1C	2.150
79HGKC	0.700

JAPANESE TRANSISTORS	
2SA73	0.300
2SA104	0.320
2SA198	0.220
2SA203	0.300
2SA473	0.370
2SB54	0.250
2SB77	0.320
2SB337	1.200
2SB405	0.220
2SC460	0.210
2SC495	0.600
2SC733	0.400
2SC1161	1.100
2SC1172Y	1.500
2SC1279	0.240
2SC1306	1.000
2SC1307	1.000
2SC1520	0.250
2SC1969	1.300
2SC2029	1.200
2SC2078	1.200
2SC2122A	2.000
2SC2952	0.270
2SD234	0.370
2SK135	4.000
MB3712	1.500
TA7205	1.500
UPC575	1.000
ICS SOCKETS	
8 pin	0.060
14 pin	0.080
16 pin	0.090
18 pin	0.120
20 pin	0.140
22 pin	0.160
24 pin	0.180
28 pin	0.200
40 pin	0.250
VALVES	
DY87	0.530
DY802	0.450
ECC82	0.400
ECC83	0.430
ECC83	0.400
ECC85	0.400
ECH81	0.490
ECH84	0.520
ECL80	0.570
ECL82	0.250
ECL84	0.570
ECL85	0.570
ECL86	0.490
EF80	0.310
EF85	0.340
EF89	0.430
EF183	0.450
EF184	0.530
EL34	1.900
EY86	0.310
EY87	0.310
PC97	1.000

PCC85	0.420
PCF80	0.500
PCF200	1.350
PCF801	1.100
PCF802	0.670
PCF806	1.150
PCH200	1.000
PCL81	0.540
PL519	4.500
PCL82	0.630
PCL84	0.500
PCL85	0.550
PCL86	0.550
PCL805	0.560
PFL200	0.850
PL36	0.800
PL504	0.960
PL508	1.900
PY81	0.700
PY88	0.480
PY500A	1.600
ZENERS	
400MV BZY88 Range 2V7 to 39V0	060
13W Zeners BZX61 Range 2V7 to 39V0	120
MEMORIES	
2114	2.000
2716	3.000
2532	4.000
2732	4.000
2764	7.000
4116	0.750
6116	6.000
LM324	0.300
LM380	0.500
LM381	1.000
LM709 Dil	0.200
LM723	0.320
LM741 Dil	0.150
LM741 Met	0.450
LM3900	0.250
NE555	0.150
NE556	0.400
BYX55/350	0.300
BYX55/600	0.300
BYX55/600	0.300
BYX55/800	0.320
BYX70/500	0.290
BYX70/500	0.310
BYX70/800	0.360
BYX71/600	0.800

LED	
LED 3mm RED	0.050
LED 3mm YELLOW	0.100
LED 3mm GREEN	0.100
LED 5mm RED	0.050
LED 5mm YELLOW	0.100
LED 5mm GREEN	0.100
BRIDGE RECTIFIERS	
1A/50V	0.160
1A/100V	0.180
1A/200V	0.190
1A/400V	0.210
1A/600V	0.230
1A/800V	0.280
2A/100V	0.350
2A/200V	0.360
2A/400V	0.420
2A/600V	0.540
2A/800V	0.580
3A/200V	0.600
3A/400V	0.600
3A/600V	0.780
6A/200V	1.000
6A/400V	0.800
25A/100V	1.800
ELECTROLYTIC	
4700UF-16V CAN	0.200
TRIPLERS	
LP1195 (4000Ser)	2.250

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All brand-new Components. All valves are new and boxed
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JANUARY 1984 TO DECEMBER 1984

VOLUME 20

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENTS

ORIC AND SINCLAIR COMPUTERS

Oric 1 computer 48K £95 (£92) £102. Oric Atmos computer 48K £171 (£158) £168. Oric Colour Printer £134 (£123) £140. Oric disc drive £304 (£278) £298. New Sinclair QL Computer £406 (£385) £410. Sinclair Spectrum 48K (with 6 free programs while Sinclair's offer lasts) £131 (£131) £143. Microdrive £51 (£50) £60. RS232 interface 1 £51 (£50) £60. Limited period special offer:- Microdrive + Interfce 1 + 4 Blank cartridges £102 (£100) £120. Blank microdrive cartridges £8 (£8) £9. Interface 2 £20.45 (£20) £24. 32K memory upgrade kit for 16K Spectrum (Issue 2 and 3 only) £31 (£28) £30. Fuller Master Unit for the spectrum including speech synthesizer, sound synthesizer, amplifier and joystick port £56 (£56) £62. Fuller FDS full sized keyboard for the spectrum with proper space bar £52 (£52) £62. Spectrum printer interfaces with cables:- Centronics £51 (£47) £52, RS232 £35 (£33) £38. ZX printer has been replaced by the Alphacom 32 £71 (£67) £77. 5 printer rolls (State whether Sinclair or Alphacom) £13 (£16) £21. ZX81 computer £45 (£44) £54. 16K ram packs for ZX81 £28 (£25) £30.

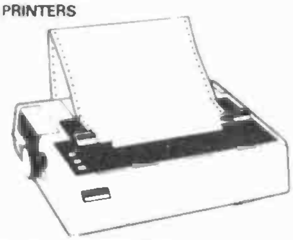
COMMODORE COMPUTERS

Commodore 64 £204 (£184) £204. Vic 20 £104 (£97) £117. Vic 20 starter pack £150 (£143) £173. Convertor to allow most ordinary mono cassette recorders to be used with the Vic 20 and the Commodore 64: £9.78 (£9) £11. Bargain package:- cassette convertor + compatible cassette recorder £37 (£38) £44. Commodore cassette recorder £43 (£44) £50. Printer Interfaces for Vic 20 and the Commodore 64:- £45 (£41) £46. RS232 £45 (£41) £46. Disc drive £233 (£209) £234. 1520 Printer/Plotter £165 (£149) £159. 1525 Printer £235 (£220) £245. 1526 Printer £350 (£330) £360. Light pen £29 (£29) £33. Vic 20 Accessories:- Super expander high res cartridge £33 (£29) £34, Programmers aid cartridge £33 (£29) £34, Extra memory ram packs 8K £19 (£17) £20, 3K £6 (£7) £9.

ACORN COMPUTERS

Electron £203 (£209) £229. Electron joystick and printer interface £61 (£62) £69. BBC Model B £404 (£357) £387. BBC Light Pen £29 (£29) £33. 14" Colour monitor £228 (£299) £319. Kenda double density disk interface system £139 (£125) £135. Disc drives 5.25" 40 track:- single £200 (£184) £204, dual £356 (£325) £355.

PRINTERS



Brother HR5 £185 (£171) £190. Shinwa CTI CP80 £225 (£218) £248. Cannon PW1080A £332 (£299) £329. Epson RX80 £277 (£251) £282. Epson RX80F/T £314 (£286) £316. Epson FX80 £399 (£358) £388. Combined matrix printers and electric typewriters:- Brother EP22 £173 (£166) £186. Brother EP44 £258 (£235) £260. Smith Corona TP1 Daisy wheel printer £252 (£225) £255. MCP40 Oric colour printer/plotter £134 (£123) £140. Interfaces to run the above printers from Vic and the Commodore 64 £45 (£41) £46. We can supply interfaces to run the above printers from Sharp computers £58 (£52) £55.

SWANLEY ELECTRONICS
The Computer Export Specialists
Dept PE, 32 Goldsel Rd., Swanley, Kent BR8 8EZ, England.
Please allow 7 days for delivery.

Tel: Swanley (0322) 64851. *Official orders welcome. UK prices are shown first and include post and VAT. The second price in brackets is for export customers in Europe and includes insured airmail postage. The third price is for export customers outside Europe (including Australia etc) and includes insured airmail postage.*

"TORUS"

Computer-controlled Robot built around the gearbox described below. Complete kit of parts inc PCB, program listings for BBC (other micros soon). **£44.85**. 20W ribbon cable (min 3m recommended – 5m better) **£1.30/m.** SAE for illustrated leaflet.

The unit has 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle, and a gearbox contained within the black ABS housing, reducing the final drive speed to approx 50rpm. Data is supplied with the unit showing various options on driving the motors etc. **£5.95**. Suitable wheels also available: 79mm dia plastic with blue tyre, drilled to push-fit on spindle. 2 for **£1.30** (limited qty). 3" dia aluminium disc 3mm thick drilled to push-fit on spindle. 2 for **68p.**

FIBRE OPTICS

Scoop purchase of single and twin cable. For use with visible light or Infra-red. Core 1mm dia, overall 2.25mm dia. Single **50p/m**; 20m coil **£6.30**. Twin **90p/m; 20m coil £11.00.**

MINIATURE RELAYS

PCB mounting, DPCO size 20 × 15 × 15mm. Available in 3, 9 or 12V. **£1 each.**

1W AMPLIFIER

Z914 Audio amp panel 95 × 65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol control. Just connect batt. and speaker. Full details supplied. **Only £1.50; 10 for £12; 25 for £25; 100 for £75.**

Z915 Stereo version of above 115 × 65mm featuring 2 × TBA820M and dual vol control. **£3.50; 10 for £30; 25 for £65; 100 for £200.**

AM TUNER PANEL

Z916 For use with mono amp above. Neat panel 60 × 45mm. **Only £1.50; 10 for £12.00.**

NI-CAD CHARGER SCOOP!!

Ever-Ready model CH4, this charger will take up to 4 AA, c or D cells plus 2 PP3 if required. Smart two tone grey case 212 × 97 × 60mm. **Only £7.95.**

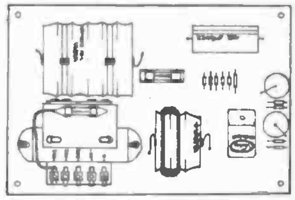
1984/5 CATALOGUE

84 page A4 size – Bigger, Brighter, Better – more components than ever before! With each copy there's discount vouchers, Bargain List, Wholesale Discount List, Bulk Buyers List, Order Form and Reply Paid Envelope. **All for just £1.00!!** Winter Supplement due out November – Send large SAE for your free copy.

These digital multimeter cases are moulded in high impact black plastic and are offered at an extremely attractive price to clear stocks.

OP2010 110 × 80 × 20mm, this too has cut-outs for range switches and terminals, with a smart aluminium fascia marked with ranges etc. Battery accessible by removable cover on back. **75p.**

OP100 Same size as above, but this was for use as a digital thermometer, so there's only a single 9mm Ø hole in the front panel. **75p.**



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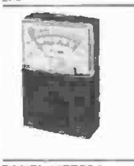

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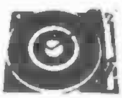

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